Waste management, animals and society

A social zooarchaeological study of Bronze Age Asine

Macheridis, Stella

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

ACTA ARCHAEOLOGICA LUNDENSIA
Series altera in 8°, no 69

Waste management, animals and society

A social zooarchaeological study of Bronze Age Asine

STELLA MACHERIDIS
DEPARTMENT OF ARCHAEOLOGY AND ANCIENT HISTORY | LUND UNIVERSITY

STUDIES IN OSTEOLOGY 3

Waste management, animals and society

Acta Archaeologica Lundensia Series altera in 8°, no 69

Waste management, animals and society

A social zooarchaeological study of Bronze Age Asine

Stella Macheridis

LUND UNIVERSITY

Historical Osteology
Department of Archaeology and Ancient History
Lund University

Studies in Osteology 3

Printed in Sweden by Media-Tryck, Lund University
Lund 2018

Cover image by Stella Macheridis
English revised by Anthony Prince

ISBN 978-91-88473-61-5 (print)
ISBN 978-91-88473-62-2 (electronic)

ISSN 0065-0994 (Acta Archaeologica Lundensia Series altera in 8°)
ISSN 1654-2363 (Studies in Osteology)

To Selma

Contents

Preface and acknowledgements

Animal bones found in archaeological contexts are common, and while they make up a valuable source for the understanding of prehistoric animal production, management and consumption, they provide an equally important key hole in to the various practices and norms related to animal waste. Although animal bones often provide primary data on the latter, zooarchaeological research traditionally focuses on former; the initial pondering which led to this study stems from this observation. The process in which these thoughts were formulated, and finally printed in this book, has been a social experience, and not only an intellectual challenge. I have had some enjoyable, albeit challenging, years as a PhD student, and there are many persons who have helped me along the way.

This thesis consists of a collection of five papers with a synthesizing text. The choices on the focus of the papers were formulated early on, and were part of the initial project idea. Although these case studies and the synthesis have been written independently, their completion would not have been the same nor possible without certain persons. I would first like to thank my main supervisor Torbjörn Ahlström for his great help and support, and for encouraging me to find my own way as an academic. Without the supporting shoulder and the equally constructive feedback from my assistant supervisor Dimitra Mylona, I fear what would have become of this study. Dimitra, thank you.

Before formulating these thoughts as a thesis project, they were latently present when I wrote my Master's thesis and became interested in the terminology of waste. For the encouragement of this, I thank Elisabeth Rudebeck, who also provided me with relevant literature for initial studies. The interest of what archaeological animal bones really represent should be traced to a genuine feeling for animal osteology as an integrated archaeological sub-discipline, here called zooarchaeology. I received this interest from my professor in Historical Osteology at Lund University, Elisabeth Iregren. I started to study the subject in 2008; but Elisabeth has not stopped encouraging me to develop my interests and engage intellectually. Thank you.

By the time I had finished my M.A., I had already stumbled upon a suitable study material to waste my thoughts on, namely the animal bones from Asine. This was much thanks to the help of many persons active at the Swedish Institute at Athens at the time. I thank Ann-Louise Schallin, who welcomed me to the Institute and to Nauplion in 2009. I am grateful to Arto Pentinnen, who was particularly helpful with making my stay at the Institute at Athens spring 2014 most enjoyable and effective. Thank you. I am very grateful to Monica Nilsson who introduced me to the Aegean prehistory through excursions and field work in Argolis, and who always has been of great support.

Anne Ingvarsson has continuously been there for me during the course of this project, with everything from talking about important non-archaeology stuff to commenting on text, giving constructive feedback and giving me valuable pep-talks. I am grateful to Anne and her family who always welcomed me in their home when I have been on visits to Uppsala, where the animal bones from Asine are stored. In relation to this, I thank the staff of Museum Gustavianum, especially Ludmila Werkström who has been very helpful with storage issues. I was kindly permitted to loan the Asine bone collection from the museum in 2013. This material was returned early 2017.

The animal bones from the more "recent" excavations during the 1970s are kept in Nauplion, Greece. I studied them during spring 2014. I am grateful to the Institute for this opportunity to study the animal bones stored in Greece. Much thanks to the helpful staff at the 4th ephorate and at the Leonardo storage facilities at Nauplion, my stay was successful. I would also like to thank the staff at the Institute at Athens for their kindness during my stay there. Further, it must be acknowledged that the documentation of the Asine excavations not always is straight-forward. Thanks to the help from Gullög Nordquist I have been able to understand the stratigraphy at the site adequately in order to use it for my waste management perspective. I am grateful to Michael Lindblom for helping with pottery issues and for giving valuable feedback on the papers. I thank Erika Weiberg for generously sharing data, feedback and advicing on literature.

Among the people who have enriched my perspectives, are my fellow doctoral student colleagues these years, and I thank you all! Special thanks for our feedback seminars and valuable discussions go to my doctoral student colleagues in historical osteology: Anna Tornberg, Helene Wilhelmson, Ylva Bäckström and Adam Boethius. Thank you, Anna and Helene, for being there on my first day (and onwards), introducing me to life as a PhD student. I am grateful to Lovisa Brännstedt for therapeutic conversations, help and support. Thank you, Fanny Kärfve, for being a delightful room-mate. Susan Hydén, thank you for our time in a deserted part of Turkey. I am grateful to Sian Anthony and Lena Strid for commenting on the text.

I extend my gratitude to the senior colleagues and the staff at the department. Special thanks go to Fredrik Ekengren for interesting discussions, academic feedback and long coffee breaks. I also thank Melissa Isla Venegas for encouragement and support. I am grateful to Nicolo Dell'Unto for being helpful and advicing on literature for this and other projects. I am much indebted to Kristina Jennbert who has read the whole manuscript and provided invaluable feedback to my work. Thank you. Special thanks go also to my Asine friends at the department, Carole Gillis and Renée Forsell.

I am grateful to Åsa Berggren for inviting me to be a part of the Swedish team at Çatal Höyük. Our times there were exciting, but also a much needed breathing pause from the work with this thesis. I am grateful to Mats Rundgren at the Radiocarbon Dating Laboratory (Dept. of Geology, Lund University) for his collaboration. Ola

Magnell gave me critical feedback on the whole manuscript, as well as the papers, during the final phase of this thesis project. I am very grateful for your help.

Financial support for this project has gratefully been given by Bokelunds resestipendiefond, Knut och Alice Wallenbergs stiftelse, Swedish Institute at Athens, Stiftelsen Fil. Dr. Uno Otterstedts fond, Stiftelsen Helge Ax:son Johnson, Stiftelsen Karin och Hjalmar Tornblads fond, and Stiftelsen Längmanska Kulturfonden. Thank you all.

I thank my dear friend Christoffer Hagberg for his support and company through the years. We are both part of a board game community called the "Bitter Gang", to which I am grateful for all the good times. To Maja, Fredrika, Björn, Agnes, Leif, and Paul: Thank you! My old study partners have consistently given me support, nice dining and company during these years, especially Elisabeth Ingo, Julia Mason, Ola Svensson, and Sofia Winge. I thank Frida, Tilde and Ulrika for always reminding me that there are other things than archaeology. I am grateful for my parents and my younger brothers, Kostas and Kristoffer. They have always been core ingredients in my life, and I thank them for being the strong and unique individuals they all are, inspiring me in different ways. I am thankful for my grandmothers, giagia Stella on my Greek side and mormor Birgitta on my Swedish side, both of them kicking it in their own ways.

The final writing phase of this study was concentrated to the autumn 2016 and spring of 2017. The publication, however, had to be postponed another ten months. The 2nd of May 2017 my daughter Selma was born, and thus the finalization of the study had to wait until I came back from parental leave in January 2018. Becoming pregnant during the latest phase of a PhD project was weirdly the most calming thing that could have happened. Instead of the commonly stressed, thinned, sickly and slightly crazy appearances of fellow PhD students in the final stage, I just became bigger, hungrier, slightly confused, and a bit less flexible. To consider the addition of another human life in the household put my work in perspective; I believe this has improved the study overall. Therefore, thank you Selma for deciding to be made during this period. This work is dedicated to you. To my co-parent, life partner and best friend I wish to say: Paul, thank you for everything - I look forward for the years to come.

Stella Macheridis

Lund, January 2018

1. Introduction

> *ANY one who would take the trouble on going, to a strange city, to examine the rubbish in its suburbs and streets, and carefully collect and compare the fragments of pottery, pieces of cloth, of paper, cordage, the bones of different animals used as food, worked pieces of stone, wood, bone, or metal, might gain some insight into the modes of life of the inhabitants, and form a fair conception of the progress they had made in the arts of civilization.*
>
> Jeffries Wyman (1868:561)

Since the beginning of archaeological research, it has been acknowledged that waste production and accumulation, as visible in the depositional context, is the cornerstone of archaeological fieldwork and most archaeological data. A deposition can be created in several ways, but the most common is created by the direct or indirect disposal of waste. The deposition of waste shapes the formation of archaeological sites through accumulation and sedimentation processes. The waste-related depositional context is important to understand, in order to approach any given archaeological site. One vital characteristic of the waste-related context, as highlighted in the above quote, is that it is the product of human consumption, production, selection and action. It not only has a strong link to behavioural aspects of a society, but also to social, nutritional, economic, technological, normative/ritual and functional aspects.

Bulks of animal bones are not uncommon in generic cultural layers, especially not in those formed by long-term accumulation of waste. This kind of material is in most cases the disarticulated remains of consumption, which has accumulated through the reoccurring management of animal waste within a specific society. The acknowledgement that animal bones from waste-related contexts primarily give information on the waste management activities of the studied prehistoric society is important in this thesis. The complexity of the formation of any such animal bone assemblage has occupied zooarchaeologists for decades: it has after all survived through a myriad of processes and factors, including, among other things, prehistoric human selections and strategies, local environmental conditions during deposition, geological post-depositional circumstances, and excavation and storage methodologies chosen. In relation to this, the management of waste has been investigated foremost as a formation process, a taphonomic process, within zooarchaeology. In this thesis I make use of the previous research, but intend to further delve into waste management as an important process for any prehistoric society, one that has serious cultural implications for, among other, social organization, structure and material classification.

1.1 Aims of the study

I aim to investigate, analyse and discuss 'waste management' as a methodological and theoretical concept in zooarchaeological research. In order to discuss waste management, several specific research questions need to be addressed. First, what is waste? How has waste been defined in previous anthropological and archaeological research? Second, what is waste management, and how has this process been discussed in previous archaeological and zooarchaeological research? Thirdly, in what ways does the waste management provide information on social aspects of the studied community? These questions direct the theoretical discussion on waste management to centre on its use as a concept for social studies in zooarchaeology. As mentioned, the study of waste management as presented in this thesis is seen as socially connoted, meaning that it encompasses the study of the social aspects of any given society. The discussion of waste management as a theoretical and methodological concept in zooarchaeology therefore includes sections on the nature of social studies in zooarchaeology, encompassed in the term 'social zooarchaeology', as well as ones on the use of analogical thinking in this endeavour.

Another general aim is to apply the discussion of waste management as a theoretical concept for social zooarchaeological studies at a specific study site. The case is made on the animal bones from Bronze Age Asine in Peloponnese, Greece, with the aim of shedding new light on the prehistoric society of this site. I provide five case studies of Bronze Age Asine, which are appended to this thesis. The papers constitute the methodological application of the waste management perspective. The specific aims and objectives of each paper are described in more detail in the next section. Along with the papers, I also provide an extensive background to the animal bones from Bronze Age Asine, in Chapters 4 and 5, which includes a quantitative overview, methodological choices and a general zooarchaeological discussion on identified taxa and animal consumption patterns of the Bronze Age at the site.

The last aim of this thesis is to evaluate the application of the waste management perspective in the case of Bronze Age Asine. First, this involves a critical discussion of the papers: Which methodological issues are common for all the case studies of waste management presented in this thesis? This analysis is found in Chapters 6 and 7. Secondly, the waste management perspective as a general approach is discussed and concluded (Chapter 7). For this purpose the following questions are important: Which future applications does this study have? What is the benefit of applying a waste management perspective in zooarchaeology as opposed to standard zooarchaeological research strategies? How has the waste management perspective improved the understanding of Bronze Age Asine?

1.2 The papers: aims and objectives

The five papers, I-V, are case-studies of specific aspects of Bronze Age Asine and they hold relevance to the discussion of a waste management perspective. All papers are independently authored by the researcher. In this short introduction, the aims of the papers are briefly outlined. Chapter 6 presents a summary of the main results of the papers, as well as a critical discussion of them.

Paper I presents zooarchaeological data from the Bronze Age at the site, which has not been made previously. Because the site is relatively unpublished from a zooarchaeological perspective, the aim of Paper I has been to provide perspectives on the animal management and consumption at Asine from a diachronic perspective, with special emphasis on regional socio-economic change and changes in site function and centralization processes. The value of Paper I in a waste management perspective is to provide the zooarchaeological context of the site (Section 6.1.1).

Paper II is a methodological paper on the identification of taphonomic processes in an animal bone assemblage. The aim of Paper II has been to apply a taphonomic perspective on the identification of waste management practices at Asine. Specifically, it is of interest to study how we might identify waste management practices from the zooarchaeological assemblage, and how taphonomic markers on bone surfaces are linked to processes related to waste management. The taphonomic approach in Paper II aims to identify the various taphonomic processes affecting an assemblage limited to a specific time period, namely the Middle Helladic phase at Asine (ca. 2100-1700 BCE). Paper II is discussed in 6.1.2.

Paper III is a study of the social organisation of the EH III-MH I (ca. 2200-1900 BCE) society at Asine through the zooarchaeological study of animal bones found in the so called *bothroi,* pits, and through a waste management perspective (see 6.2). Paper IV discusses the two main dwelling areas of Asine during the MH III-LH I period (ca. 1800-1600 BCE), namely the Barbouna Hill and the Lower Town areas. The comparison of the animal bones from these areas is based on waste content and taphonomic markers of waste management. This study investigates the social topography, i.e. the spatial distribution of any socio-economic differentiation, at the site during a specific period (Section 6.3). The aims of both Paper III and Paper IV are to investigate the relationships between the presence of waste and the management of waste, and to study the social aspects of Asine society, such as its socio-spatial organization and socioeconomic differentiation within the settlement. In other words, it addresses the following question: can studying the spatial patterns of waste material within the settlement be useful for the discussion of social organization, or of status differentiation, i.e. inequalities in socio-economic terms, at the site, and, if so, how?

Paper V is devoted to the symbolic aspects of waste, and possible connections to animal symbolism of the studied society. It aims to explore such aspects by comparing waste found in the settlement context with animal bones found as grave goods at the site (Section 6.4). The focus was the early MH period of the site, ca. 2100-1800 BCE. Specifically, it focuses on discussing whether or not we can compare the settlement's waste material to the animal bones found as grave goods in a meaningful way, and, if so, what such a comparison indicates.

2. Waste management as a theoretical concept in zooarchaeology

The theoretical basis of this thesis is divided in three parts. First, the theoretical starting points underlying this work are discussed. Focus lies on the ways in which I make use of analogies in my work, as well on the definition of social zooarchaeology, which includes what is really meant by the term "social". Second, the concepts of waste and waste management are clarified and discussed. This includes not only the definition of this concept but also a review of earlier research on waste and waste management in zooarchaeology, general archaeology and anthropology. Third, based on the discussion of waste management, I formulate four key areas of waste management in theory that are in need of further exploration. These key themes are investigated in the papers appended in this thesis.

2.1 Theoretical starting points

2.1.1 The use of analogies in zooarchaeology

Most archaeologists and zooarchaeologists implicitly agree that we can study prehistoric cultures, based on the traces of architectural remains and other material remains revealed by excavations, survey or other exploratory techniques. This presumes an analogical reasoning in which we infer what the traces represent based on comparisons with similar modern examples. For example, the shape of tools and buildings familiar to our society and its more recent history are often used as analogies to prehistoric finds, e.g. knives, houses and fire installations such as hearths. We assume that the geological processes burying the finds acted in similar ways as we see today, such as involving sedimentation or soil erosion. This kind of thinking includes uniformitarian assumptions which acknowledge that archaeological features and finds, e.g. bone, stone or pottery, respond to various processes in similar ways and in uniform rates over time (Gifford-Gonzalez 1991:219). Uniformitarianism is a 19th century principle formed as part of the discussion about the origin and shaping of the world, in which catastrophists, such as French zoologist Cuvier, believed that the change from one geological state to another was caused by quick, catastrophic events, while uniformitarianists asserted that such changes were gradual and happened over a long period of time (e.g. Scott 1963; Baker 2014:77; Romano 2015:66).[1]

Classical uniformitarianism must be regarded as oversimplifying because it contains *a priori* assumptions of how nature is supposed to act, i.e. it decides in advance that changes and processes are the same regardless of the temporal or spatial context (Baker 2014:77). There are two major hypotheses of uniformitarianism as discussed by Gould (1965). First, substantive uniformitarianism (similar to gradualism), proposes that natural processes are uniform and always produce slow, cumulative and gradual changes (see Romano 2015:67). Second, methodological uniformitarianism is a strategy for studying the past. It assumes that natural laws are constant, and since this is the case, we can study past results through modern processes (e.g. Lyman 1994:47; Romano 2015:67).

Actualism is a form of methodological uniformitarianism that asserts that natural laws are constant through time and space, and that past conditions can be studied through analogies with present ones (see Lyman 1994:46-69). Actualistic studies are common in zooarchaeology. The research focus here has been on answering descriptive questions, such as 'how would a certain taphonomic process affect animal cadavers or the remains of meals, and how can we detect this impact?' through experimental studies (e.g. Behrensmeyer 1978; Binford 1978; 1981; Haynes 1983; Shipman *et al.* 1984). Still, researchers acknowledge that there are certain dangers with bringing uniformitarian assumptions to the study of animal bones from prehistoric contexts (Binford 1981:27-28; Gifford-Gonzalez 1991:219; Lyman 1994:50-52). Uniformitarian methodologies are especially problematic in studies of prehistoric behavior because classical uniformitarianism assumes that the ecological requirements of any species are constant through time and space (e.g. Scott 1963:511; Lawrence 1971:599). Still, uniformitarian assumptions have been important starting points in the development of the archaeological and geological disciplines, and have helped shape subjects to be as they are viewed today.

Simple analogical thinking does not, however, imply a uniformitarian assumption. For example, Baker (2014) writes about the study of future geological processes, warning about the dangers of bringing uniformitarian assumptions and methods. Because of the sudden shift to large-scale anthropogenic impacts on nature during the process of industrialization and beyond, we cannot use uniformitarian principles to predict the future, because no past condition is similar to the current one (Baker

[1] Uniformitarianism was popularized by Charles Lyell in his 1830's Principles of Geology; however, another scholar of the time, James Hutton, formulated the concept (Lyman 1995; Romano 2015).

2014).[2] Instead, he advocates the use of analogical reasoning through an abductive approach.

My use of analogies in the interpretational process, i.e. when discussing practices of waste management in prehistory, acknowledges that analogical thinking can be made without a basis in uniformitarianism. As advocated by Baker (2014), I prefer an abductive approach or 'inference to best explanation' (IBE, Lipton 2000) to the study of prehistoric human culture. This means that the formulation of a research question or hypothetical scenario precedes data collection and material analysis. The data which is generated on the basis of observation will often provide the best explanation to the initial research question.[3]

Analogical thinking is especially useful in the interpretation of data. When examining the generated archaeological data, the researcher has to interpret it. Analogical reasoning can be a good methodological strategy. The use of analogies should be a reflective way of thinking which corresponds to the materials on site, and not a direct application of a specific culture's action sequences. Analogies are best used as inspirations and as a framework to think about, rather than reflect on true action sequences (e.g. Kaliff & Østigård 2013:26; cf. Currie 2016).[4] When discussing waste management from a cultural perspective ethnographic analogies are important because they can aid us in the avoidance of our own cultural pre-perceptions. However, they also have a heuristic value in that they can function as comparative material when discussing traces of social processes which present academic cultural frames cannot comprehend (see Currie 2016).

2.1.2 Social zooarchaeology

The study of waste management practices is ultimately the study of social practices, traditions and/or behavior. Waste management is made within a social context; it is transformed, practiced and communicated by people to other people. A

[2] Baker writes: "The use of analogies from Earth's past to understand Earth's future is not a form of uniformitarianism. […] uniformitarianism is and always has been a logically problematic concept; it can neither be validly used to predict the future nor can its *a priori* assertions about nature be considered to be a part of valid scientific reasoning." (Baker 2014:78). See also Paul (2015), who acknowledges that geological and uniformitarian principles in geological history are necessary in multi-disciplinary studies of future natural processes, but that uniformitarian principles in such a study nevertheless would be anachronistic.

[3] The best explanation is the best because it is the most preferred by the analyst, given the generated data and context, see *loveliness* (Lipton 2000:188).

[4] I disagree with Currie's cynical view on this perception of analogical thinking as a type of "special pleading". Ethnographic analogies cannot function as direct parallels; they must be considered as belonging to a specific social context. Thus, it is not scientific to directly infer prehistoric cultures on the basis of other, non-related cultures. The most suitable approach to ethnographic analogy is as a comparative and reflexive tool.

zooarchaeological study of waste management should include a social perspective. Therefore, it should be regarded as a social zooarchaeological study. Social zooarchaeology is the zooarchaeology of the social interactions, practices and relations interconnecting humans and animals. It includes studies on animal bones from ritual contexts, such as graves, to more ambiguous contexts, masses of bone often found as redeposited material. Further, it acknowledges that zooarchaeological and anthropological research is tainted by anthropocentrism: the idea that animals are relative entities because they are not human (Weil 2010:13; Hoquet 2013; Wilkie 2015:324).[5]

In recent decades, social zooarchaeology has rapidly grown within zooarchaeological discourse (e.g. Marciniak 2005; Orton 2010; 2012; Russell 2012; Hill 2013; O'Connor 2013; Overton & Hamilakis 2013). One of the first explicit social zooarchaeological studies is Marciniak's (2005) on Neolithic LBK culture in Poland. He postulated that animal bone assemblages are ultimately the "outcome of the complex life history of an animal", meaning that the study of animal bones can yield insights into different levels of interaction, such as human-animal interaction, food consumption, and refuse disposal or waste management (Marciniak 2005:2). Russell's (2012) comprehensive overview can be regarded as a milestone in social zooarchaeology. Her contribution is valuable because she develops the theoretical and methodological aspects of social zooarchaeology by providing literary reviews as well as theoretical discussion of the assumptions underlying our discipline.

In order to avoid a human (subject)-animal (object) oriented research, Hill (2013) proposes investigating human-animal relationships through what she calls 'relational ontologies', systems in which animals are independent actors, sentient and capable of social interaction. Animals "are persons, possessing traits or capacities that […] tend to be restricted to humans" (Hill 2013:120). In this scheme, animal persons are not defined by their products but through their actions and interactions.[6] Similarly, Overton and Hamilakis (2013) strongly call for a social zooarchaeology which avoids anthropocentrism and actively engages in studies of animals as agents, with their own rights and means to affect human life and decisions.

I disagree with Hill (2013:117), who apparently equates social zooarchaeology with the interpretative zooarchaeological approaches that emerged during the 1990s. Social zooarchaeology is a relatively new sub-field, in need of further theoretical and methodological development. Although the ideas of the post-processual era have

[5] For example, Russell (2012:2) writes that "the opposition of humans and animals is artificial and anthropocentric". In this thesis the term 'animal' is devoted to nonhuman animals. Thus, this artificial boundary is maintained in this thesis as well.

[6] To investigate animals in terms of personhood can be problematic, since it may border on another sort of anthropocentrism, *anthropomorphism* - another way to view the world through a human filter, namely by the assignment of human characteristics, capabilities, feelings and mental states on animals or other beings (Libell 2014:141-142; see Russell 2012, and references therein).

been, and still are, important, for the continued development of social zooarchaeology as a sub-field in its own right, social zooarchaeology should not be restricted to post-processual theories and methods only. This sub-discipline is interdisciplinary in the sense that it is connected to other disciplines beyond archaeology. Instead, I argue that social zooarchaeology should be viewed as the formalization of the so called "Animal Turn" seen in general academic discourse during the last two decades. The focus on animals as sentient beings with agency, multispecies research, and interspecies interaction, i.e. the interplay between predominantly humans and other animals in social zooarchaeology, is related to the "Animal Turn" in the social sciences in particular (e.g. Ritvo 2007; Weil 2010; Andersson Cederholm *et al.* 2014), but also in other fields of study. For example, we can note the paper by Hoquet (2013), in which he calls for a nominalist turn in historical animal studies, meaning that we should see animals as individuals, because the animal as a concept is not real and only individuals exist.

The Animal Turn can be seen as an ideological movement connecting various academic subjects, formed as a separate interdisciplinary field (Wheeler & Williams 2012; Wilkie 2015:326).[7] The general characteristic of this kind of study is to implement scientific methodologies and theories in which animals are not studied as objects separate from and defined by humans, but are viewed as subjects which have their own agenda and are capable of social interaction with humans or other animals (e.g. Weil 2010:19; Pedersen 2014:15; Wilkie 2015:333).[8] Further, the Animal Turn contains a political meaning, in which the oppression of animals is apparent, that the struggle for justice and empathy should encompass non-human animals, and that humans and non-humans have the same moral value (e.g. Francione 2014). This rising acknowledgement of animal suffering encompassed in the Animal Turn is placed by Weil in the "wake of post-structuralist and postmodern decenterings that have displaced the human as a standard for knowledge" (Weil 2010:20). Anthropocentrism, which consequentially puts the human before any non-human animal, is therefore avoided.

The 'social zooarchaeology' proposed by Overton and Hamilakis (2013), as well as the focus on animal personhood in prehistoric studies proposed by Hill (2013), are clearly related to the Animal Turn. Other zooarchaeological studies can also be connected to this. When Marciniak wrote that animal bone assemblages are "a

[7] Often comprised in the term 'Human-Animal Studies' or HAS.

[8] An important perspective on interspecies social interaction is given by Nadasdy (2007) from his studies of the Kluane people of the Southwest Yukon. Animals, or "other-than-human persons", are perceived by several hunting peoples of the North American region to "give themselves" to the hunter. Nadasdy means that employing the traditional anthropological approach to this as purely metaphorical is to neglect the reality of the hunters in which the reciprocal exchange is real. He opposes Ingold's (e.g. 1994:7-8) *a priori* assumptions that animals, although conscious sentient beings, do not have the capacity to think or use language, and therefore cannot actively engage in complex social interactions in the way humans can, such as interspecies reciprocal exchange (Nadasdy 2007:33-34).

medium of social life through which humans live in a world which they change and modify but which also transforms them" (*ibid.* 2005:2), the underlying meaning seems to be that humans and animals co-exist and affect each other in daily life. Russell (2012:7) emphasizes the social roles of animals in human life and interaction as equal to or transcending the roles animals have as food and commodities.

The common denominators of recent social studies in zooarchaeology seems to acknowledge that i) animals are not only objects but also subjects (see Orton 2010), especially considering that in certain cultures there are no animals but other kinds of persons (e.g. Nadasdy 2007; Hill 2013), ii) that the Western anthropocentrism and the dichotomy human/animal must be abandoned or at least re-considered in studies of prehistoric human-animal relations (e.g. Russell 2012:2-5; Overton & Hamilakis 2013; Vandergugten 2015), and iii) animals are independent actors or agents which can have a large impact on human social life (e.g. Nyyssönen & Salmi 2013; O'Connor 2013).[9] These denominators can be related to the ideological thoughts of the Animal Turn as described above. Therefore, I mean that the formulation of a 'social zooarchaeology' should be seen as a formalization of the Animal Turn within zooarchaeology.

Waste management is the handling of waste from animal remains, and as such it does not directly involve the social interventions of nonhuman animals. However, the social interaction between humans and other animals has indirect influence of the waste content, i.e. which animals are eaten and consumed, how and why. Further, it can also influence the practice of waste management, i.e. animal and animal part symbolism or perceptions can direct which disposal locations are assigned to certain waste categories. To place the study of waste management within a social zooarchaeological frame is to accept that animals play active roles in human social life, and that the interactions and relationships between humans and animals are not only metaphorical but also real and tangible. This affects human consumption of animals as well as human categorization of animal remains (see Sections 2.2 and 2.3.3).

Let us now turn to the 'social' of social zooarchaeology. What is the social? Which connotations does social have? Although a full review of the 'social' is beyond the scope of the thesis, a brief discussion of the social is needed because most advocates of social zooarchaeology rarely express what they mean by it (e.g. Marciniak 2005; Hill 2013; Overton & Hamilakis 2013). Russell is an exception, and in her book about social zooarchaeology, she writes that:

---

[9] Ingold's (e.g. 1994) research provides valuable starting points for delving into animal personhood or animal sociality. Lately he argues for an "anthropology beyond humanity" that transcends and rejects the species concept altogether (Ingold 2013), or, in his words: "humans, baboons and reindeer do not *exist*, but humaning, babooning and reindeering *occur* – they are ways of carrying on" (*ibid.* 2013:21).

> My goal is to place the social in the center. I operate from a basis in practice theory […], focusing on the power relations enacted in social life. […] In these societies, many of these relations are enacted through animals and their products, and we ignore them at our peril. (Russell 2012:9).

Russell makes use of the works on practice by Bourdieu.[10] Bourdieu wrote that everyday life and the accumulation of everyday situations are lived through everyday practices; these actions are structured by the cultural systems and the values of a given society. He meant that social practices mediate the social world, or the 'habitus' of any given community, habitus being the background to which practice is made (Bourdieu 1977:76). It is also structured and maintained by practice. Our habitus is reflected in everything we do, from the way we organize our drawers to how we talk to members of another social stratum. The rules and regularities of culture are thus mirrored in its practices (Bourdieu 1977:22). Using his concepts, the animal bone remains from culturally regulated practices, such as waste management, can give valuable information beyond economic strategies, on social organization, norms and traditions within the studied society. Bourdieu's thoughts on structure, cultural and social life have been relevant to the work of this thesis. For example, a modified version of his concept of 'social topography', the spatial differentiation of socio-economic differences (Richer 2015) forms the theoretical basis of Paper IV where the animal bones from two different dwelling areas were compared in order to discuss differences in social stratification at the site.

In Bourdieu's work, social life is transformed and negotiated through social practices and reflects societal structures. A different perception of the social is that of Latour, who formulated the Actor-Network-Theory (ANT).[11] There are, Latour said, no social structures, no context and no social forces that can be the cause of what we see as society. Social is the outcome and the movement between non-social entities (*sensu* Latour 2005). In Latour's world, the social will always leave a traceable association manifested in non-social things, and if it does not do this then it is not social. In this sense, animal bones from archaeological contexts are traces of interaction, of a social movement, and as such they must be interpreted as social. This argumentation is close to that of Hodder (2011), when he discusses the entanglement of humans and things. As humans depend on things, he called for archaeologists to start to "engage seriously" with the things themselves and the associations belonging to them (Hodder 2011:173).

---

[10] Bourdieu's theories of practice have been employed in many archaeological studies (e.g. Marciniak 2005; Knapp & van Dommelen 2008; Jusseret 2010; Gifford-Gonzales 2014). In the mentioned book by Marciniak, Bourdieu's concept of *habitus* and theory of practice are also applied (Marciniak 2005:76).

[11] ANT and other concepts by Latour have been of importance for archaeological theoretical discussions, such as materiality and symmetrical archaeology (e.g. Fahlander 2008:223; Shanks 2007:593; Olsen 2012).

I do not wish to extend the anti-structuralist approach provided by Latour to an interpretational level. It is my opinion that structures, hierarchies and social traditions within a society do exist. Still, it is important to define what is meant by 'social', because it forces us to focus on the nature of the research problem. For example, when analyzing bones in order to establish or discuss animal husbandry, the social movement (in Latour's terminology) one wants to trace is between animals and humans, between two living actors. In this case, the animal bones in themselves are not that important as material culture, but rather as mirroring the living conditions of ancient animals. When studying waste management, the dead remains of the animals are in focus and the social lies instead between remains of animals: there are different parameters to include, with new material properties affecting the interaction (see Latour 2005:65).[12] This is an important consideration in order to use waste management as a social zooarchaeological concept. To have considered what the social of the material really is, or rather what kind of social one is studying and where this is traced, is the basis of such studies.

The focus here is on prehistoric human life through the study of animal bone waste. Waste management is regarded as a practice situated within a habitus (see Bourdieu 1977). In the above I have postulated that waste management is a social process, and therefore it must be acknowledged that social interaction and relations between humans and animals could have affected the waste management processes of any given society. Nevertheless, human-living animal relations, whether social, economic, symbolic or functional, do not necessarily mirror the relation between humans and dead animals or animal remains. It is important to recognize the various processes affecting the dead body and affecting the waste of consumption practices, i.e. the new properties of matter which can affect the social interactions, and to integrate this with how prehistoric peoples might have categorized, valued and handled their waste. The above outlined understanding of zooarchaeology and the social defines the underlying approach to the subject taken here, but also explains the approach to waste management in this thesis.

[12] This relates to the research around 'materiality' within the broader archaeological discourse (e.g. Knappett 2012). In materiality studies, things are considered to have their own agency, and can thus be social (Fahlander 2008:131).

2.2 Waste and waste management

The Oxford Dictionary (2017) defines management as "the process of dealing with or controlling things or people". Not all societies organize and coordinate the disposal of all waste matter in an orderly or perhaps even intentional fashion. Still, the term waste management puts emphasis on the aspect of waste disposal which is cultural and in which it is acknowledged that waste somehow must be dealt with. Although this sub-chapter includes a section on waste management as a taphonomic process, the focus overall is on waste management as a cultural process and/or action.

2.2.1 What is waste?

Garbage, refuse, trash, dirt, junk – there are many terms for discarded material. In this thesis, I use the term 'waste'.[13] Included in this term are several aspects, of which three have been chosen to be discussed in greater detail. The choice of these three characteristics is subjective, and there are surely traits that others might deem more important. Each of the three chosen aspects of waste mirrors the contribution of the research of waste from different theoretical directions within archaeology and anthropology. Together, these three characteristics compose the definition of waste used in this thesis. The following section provides a description and discussion of each of them.

A) Waste is stuff that has lost its socio-economic and techno-functional value to the degree that it is discarded

In processual archaeological research, the concept of waste, or more often refuse, implicates that the object has lost its practical value in socio-economic, technological and functional terms. Because it has been replaced by something considered better or because it is broken or worn, it is not needed for its purposes anymore, and therefore it should be discarded. This view on waste is mirrored in the works of Schiffer, especially his model of the 'life history of durable elements' in which refuse is the last phase of an object (Schiffer 1972:158). According to Schiffer (1972:159), an object is discarded when it has lost any of its functions, and no longer belongs in a behavioral system. The famous categories of waste formulated by him include primary refuse (discarded at its use location), secondary refuse (transported and discarded elsewhere), *de facto* refuse (abandoned but still functional objects) and provisional refuse (stored refuse, with remaining possibility of reuse) (Schiffer 1972; 1983; 1987:18, 89).

[13] Not everyone prefers the term 'waste' in zooarchaeology. For example 'refuse' is used by many (e.g. Gifford-Gonzalez 2014). When I use the term 'waste' it will, unless specified, refer to the waste from dead animals, i.e. bone waste. This is the biggest limitation of the study. To make a comprehensive study of waste management would include all archaeological finds. They are, unless stated, not included in most of the text, because it lies beyond the scope of this thesis.

Schiffer's categories are commonly used and referred to in studies of formation processes and refuse disposal patterns (e.g. Bartram *et al.* 1991; Needham & Spence 1997; Yeshurun *et al.* 2014). Tertiary refuse is another term related to this vocabulary, and includes the waste found as redeposited material from other waste deposits, such as middens (Kuna 2015:182; Haak 2016:84). It is likely to reflect on average and recurrent activities of everyday life (Fuller *et al.* 2014:181).

The categories proposed by Schiffer, and later additions, are verbalized as hierarchical, i.e. primary as first-hand information, secondary as second-hand, etc. However, the heuristic value of primary deposits versus secondary deposits cannot be properly compared, as they separately give insight on different aspects of the studied society. For example, while primary deposits reflect on a direct disposal action at one given point or on the activity at one given spatial area, secondary layers include material which give information on general patterns of consumption, production and on waste management, e.g. through the study of taxonomic and anatomical representation and presence of taphonomic markers on the bones.

The social consequences of waste management have been given less attention than the outcomes of material patterning and formation of the archaeological record within processual archaeological research. Ethnoarchaeological studies are common, and often aim to formulate universal patterns of refuse disposal, e.g. concerning choice of discard location (Murray 1980) and the relation between household organization and refuse disposal strategies and/or zones (e.g. Hayden & Cannon 1983; Staski & Sutro 1991). Within this category of studies, we also find Rathje and Murphy (2001), who presented an exhaustive examination of trash from selected households, landfills and other repositories in comparison to social variables, such as class (Rathje & Murphy 2001:133-150). Among other things, their results showed that what people throw away is not what they claim to have consumed, and that waste content often can often be tied to certain social strata. The 'garbology' approach provided by Rathje & Murphy has been applied in later studies as well. For example, Brunclíková (2016) used a garbological approach for investigating modern landfills in the Czech Republic (see also Sosna 2016).

The Schifferian waste categories have certain heuristic value, because they provide a descriptive terminology. For example, in Paper I, the categories 'primary deposits' and 'secondary layers' are used to describe the animal bones from contexts that are closed and can be regarded as separate events, such as oven infills, contra the redeposited material from open air cultural layers, often accumulated over time.[14] Clearly, these

[14] Tertiary refuse, if defined as the product of re-occurring disposal actions where waste is re-located, is closely related to secondary refuse. The boundary between the two is thus a bit blurred. It has been hard to exclude the possibility of tertiary refuse in secondary contexts. Nevertheless, I have chosen to use the terms 'primary' and 'secondary' layers in Paper II. They denote that the primary deposits include primary waste, i.e. deposited at its original location, while secondary layers can include waste re-located from its original waste location, either in second hand, i.e. once from the original waste

categories are influenced by Schiffer's more functional terminology of waste. His definitions are also nomothetic, i.e. aim to provide universal traits of waste.[15] Are they then enough for understanding contextual practices, which cannot be described by universal laws? Surely, there are other cultural aspects of waste which can help us to understand different ways of viewing waste.

B) Waste contains symbolic meaning
Although the functional view on waste is valuable, it puts emphasis on mainly one aspect of waste. However, we must focus on the social aspects of waste as well. Because waste can be directly connected to the society producing it, we must assume that the categorization and perception of waste is embedded within a cultural system. Thus, the second characteristic of waste which is highlighted is that the transition from use to waste implies a symbolic, metaphorical change. Here, symbols are viewed as 'operators in the social process' (Ortner 1984:131), a perspective on symbols formulated by Turner (1966; 1967), who studied how symbols worked in predominantly ritual processes among the Ndembu in Zambia. According to him, it is not meaningful to study symbols outside their social context because they are actively used and combine in social actions and processes to produce certain communications or effects.[16]

The ethnoarchaeological study of Hodder (1987) on the meaning of ash discard among the Ilchamus in Baringo, Kenya, is suitable to epitomize the symbolic importance of waste. Ash was discarded inside the compound in contrast to other refuse which was taken outside. Because ash is symbolically linked to women, cooking and providing food, it is prohibited for men to empty the domestic hearth from ash (Hodder 1987:441). The meaning of ash discard in this society is associated with gendered social strategies, and strongly with avoidance among men and women.

In his study, Hodder concluded that there can be no universal rules, methods or theory in the study of prehistoric discard because "the meaning of settlement organization and discard can only be derived from the context" (Hodder 1987:424). This opposes the processual functionalistic view on waste, especially the one by Schiffer as described above. To investigate the meaning of discard it is important to trace all contextual "clues" that can be inferred to the waste material. For example, Hodder had to discuss the role of women in the studied society, among other things, because it was women who produced and discarded the ash in this society (*ibid.* 1987:424). Similarly, other scholars argue that waste categorization is not universal, but constructed within a specific context (e.g. Moore 1982; Hill 1995; Martin &

---

location, or in third hand, i.e. twice or more from the waste location. Distinguishing between the two latter has not always been possible in the case of Asine.

[15] Examples of such laws are in Section 2.2.2.

[16] In Turner's own words, "I found that I could not analyze ritual symbols without studying them in relation to other 'events', for symbols are essentially involved in social process" (Turner 1967:20).

Russell 2000:58; Marciniak 2005:78-80; Högberg 2016). That waste is not a universal category was at the time long since accepted within anthropological research, thanks to the research of Douglas discussed below, which has inspired many post-processual scholars (see Gifford-Gonzalez 2014).

C) Waste categorization, value and disposability are defined by the cultural classification of the material world

Let us turn to anthropological research where the study of discard, dirt and waste is common. In this context, it is generally agreed that waste is a relative notion. In the now classical study on pollution and danger, Douglas (1966) argued that waste creates disorder as well as recreating it, and taking it away is always a positive process, since it restores order.[17] Strasser extended this discussion by adding that trash is created by sorting materials. Since sorting and classification are relative, waste also has a temporal dimension (everyday life changes over time), as well as a spatial dimension (different trash materials are disposed of in different places) (Strasser S 1999). Indeed, in this sense the notion of dirt as a matter *out of place* does not seem to be applicable, since it actually has one or many places (Lucas 2002:7). But as Lucas (2002:7) points out, such places, e.g. landfills or garbage bins, are used to separate trash from our material world, in an abstraction, to keep it from disorder.[18] In relation to the relativity of waste, the view on the same kind of waste material is negotiable and can change over time. For example, Högberg (2016) considers the difference in Western perception of nuclear waste through the 20th century. From viewing nuclear waste as more of a resource for high technology, the perception changed to the understanding that it needs to be permanently handled and stored as radioactive waste.

Classification of waste is made based on the social practices and conventions regarding hygiene (see Douglas 1966:8; Lucas 2002:8). Because of this, it can be perceived as a potential risk which becomes aesthetically unpleasing, again reinforcing the need to remove it (Drackner 2005:178; see Reno 2015:566).[19] As Reno (2014; 2016) points out, waste is, however, not exclusively produced by humans. According to him, waste should be discussed in a semi-biotic sense, in which waste is constituted by the “deposits rejected and released by animals” (Reno 2014:15). He distinguishes it from mass waste, which is the consequence of industrialization and historical European urbanization; the link to the original body producing the waste is lost. The development of modern waste management, such as sanitary landfills, was not only caused by a will to protect humans from unwanted smells, but also from keeping the waste from different vermin (*ibid*. 2014:17-18).

[17] Dirt is “matter out of place” (Douglas 1966:44).

[18] Landfills in particular are argued by Sosna (2016) to be an excellent example of a heterotopia (Foucault 1998:178-185), in the sense that it is a place where heterogeneous and incompatible material classes can co-exist.

[19] For a comprehensive review of modern waste management regimes, I refer to Reno (2015).

Douny's (2007) study of the Dogon of Mali is a valuable contribution to the increasing research of waste in anthropology. In the Dogon society, domestic waste can have both negative and positive connotations, and as such implicates waste as matter 'all over the place', as opposed to Douglas's 'out of place' (Douny 2007:329). This is a useful view of disorder in relation to Douglas initial definitions. Depending on its material properties, such as its ability to be productive, waste can have potential use and can be recreated, including the reuse and recycling of seemingly worthless material.[20] Therefore, certain kinds of disorder created by waste can be positive in the way it is perceived in society, as observed amongst the Dogon (Douny 2007:329).

To conclude, waste as a theoretical concept contains at least the three aspects discussed above. First, we cannot ignore that there is a certain universality attached to waste; all societies produce waste. The terminology formulated by Schiffer can be used to describe archaeological waste-related contexts. Second, we cannot ignore that the categorization and perception of waste is culturally specific; it is not universal and not necessarily based on loss of functional value. It means that waste can have metaphorical meaning, which directs the management of waste. It also means that waste materials can affect the management of it. Examples of this would be the effect of changes in the smell of the waste, such as decomposition or the burning of waste (see Pawłowska 2014). Because waste categorization is culturally specific, I have chosen not to predetermine and defining any waste categories, such as craft waste, primary and secondary butchery waste. The content of such categories can clearly differ between societies. Instead, I employ abductive reasoning, in which the processing of data, such as spatial distribution of bones from specific species and contexts, reveals patterns which can be discussed in terms of categorization. Third, the social dimension of waste cannot be neglected; after all the management of waste is made on a practical level, and often involves some kind of social interaction, whether throwing food remains to dogs or letting someone else take it out.

2.2.2 Waste management is a taphonomic formation process

This section deals with waste management as a taphonomic process; nevertheless, it starts with a discussion on waste management as a formation process, a term known from general archaeological research in which taphonomy is not always the used term.[21] Archaeologists, mainly processual, discuss waste management as a cultural formation process. In this context, the study of formation processes must precede any

[20] This connects us again to the materiality and potential materiality of waste (see Section 2.1.2.2)

[21] An exception is Sommer's (1990) paper on archaeological sites and "dirt theory". By applying terminology from paleontology, she built up a taphonomic-archaeological approach which included the phases of biocoenosis, thanatocoenosis, taphocoenosis and oryctocoenosis. This model has not been widely used globally (but see Dietrich 2016:24), although the paleontological terminology is very familiar to zooarchaeologists.

archaeological inference, and any explanation is sound only if it can prove a valid causality (see Schiffer 1975; 1987:74; Murray 1980; Binford 1981:26; Sommer 1990; Lamotta 2012). A symbolic explanation, according to Schiffer, will only be causal when the behavior departs from predictions of it, and thus does not make a sound explanatory law (Schiffer 1987:74). Schiffer acknowledged waste management, or refuse disposal, which is his preferred term, as a cultural formation process, critical in forming the archaeological record, but one that can only be described by nomothetic laws (Schiffer 1972; 1987:74).[22] Therefore, the study of refuse disposal patterns as formation processes has been focused on functional and practical aspects. The following are examples of nomothetic laws on refuse disposal, as described by Schiffer (1987:59-71):

- If an area is well used, it will be maintained, i.e. cleaned often.
- Where people throw stuff, other people will also throw stuff.
- In areas that are infrequently maintained, larger items tend to accumulate, especially outdoors. This is called in transit refuse.
- The famous McKellar principle: “Small items will be left behind as primary refuse in regularly maintained areas”.
- Where dogs are held, they will disperse material.

Universal laws on waste and waste management were also provided by Sommer (1990). For example, she wrote that the “place for sweepings” will be found in front of doors, where small trampled finds will gather (*ibid.* 1990:53). This is similar to the above McKellar principle.[23] These universal laws are general, some quite obvious, and they do not say much about the prehistoric society of interest. Some of them are strongly influenced by Western notions about waste. For instance, ethnographic cases exist in which certain categories of waste are allowed, and are even displayed, in frequently maintained areas. One example is the kitchen of the Dogon of Mali, where certain waste is permitted, and functions as signs of vitality (Douny 2007).

Taphonomy is the study of the processes, factors and agents affecting a bone specimen after the death of the animal up to the present day. Clearly, the taphonomic study is also a study of formation processes. However, a taphonomic approach includes other aspects and assumptions than the one described above. It includes a higher level of complexity; for example: a taphonomic process cannot be made without the influence of various factors and agents. It builds on an uniformitarian

[22] Schiffer established the subdiscipline ‘behavioral archaeology’, which aimed to describe human behavior. It builds upon the establishment of laws, and the need of laws to be able to get information of past behaviors (Schiffer 1972; 1975; 1987; *sensu* LaMotta 2012:65).

[23] Although there are other examples of rules similar to Schiffer’s (1987) in her study, Sommer did not refer to his 1987 opus at all in her 1990 paper.

base and strongly relies on actualistic studies. Taphonomic research is grounded on modern analogies. Taphonomy is in its essence a critical approach and is common in zooarchaeological analyses. It reconstructs what is representative in a bone assemblage in terms of bias but it also shows the importance of describing processes, factors and agents in themselves (Lyman 1994; Orton 2012:321).

Waste management of animal bones "is at the heart of zooarchaeological research" (Reitz & Wing 1999:113). Taphonomic variables can help us to distinguish patterns specific for the management of waste. The biggest problem in this identification is recognizing 'cultural' impact from 'natural', and, in the words of Lyman (1994:216), to sort out food waste from non-food remains.[24] There are several taphonomic markers that can help the zooarchaeologist in this issue, such as burning, fragmentation, erosive markers (e.g. weathering), butchery marks, and skeletal parts' representation. Any taphonomic variable is causally linked to a taphonomic process which is determined by certain factors and/or agents. For example, weathering is the process in which a bone is exposed on the ground surface, and therefore subjected to the impact of local weather, e.g. exposure to sun and wind.

One of the most common problematic issues with distinguishing certain patterns and relating them to a specific process is gathered in the concept of 'equifinality' (Gifford-Gonzalez 1991:232-233; Lyman 1994:38, 63; Lyman 2004). A result is equifinal if it can be reached by different processes, i.e. different processes can cause similar results (Lyman 2004). In zooarchaeological research, the most common example of this is when skeletal part frequencies can be explained by different taphonomic processes. The classical example is a skeletal parts' representation dominated by compact long bones, which can be explained as density-mediated attrition, i.e. relative survivorship by the degree of density, or human selection of meaty body parts (Lyman 1994:235; Bar-Oz & Munro 2004:202; Orton 2012:323).

Of course, a crucial taphonomic variable is the context in which the bones were found. It is important to have at least a basic understanding of geological processes and conditions of the site in order to fully grasp all taphonomic possibilities (Lyman 1994:405). To make a holistic interpretation, a basic understanding of environmental processes is needed by the zooarchaeologist in question, and not only from expertise in other scientific fields. Waste management can, according to Lyman (1994), be found in processes of dispersal and accumulation, since most waste will not be buried instantly, although this can sometimes be the case.

To conclude, waste management is a taphonomic formation process. Thus, this thesis needs to contain a taphonomic reconstruction that aims to identify and explain a taphonomic process *per se*, namely waste management. In order to conduct any

[24] However, it must be noted that non-food remains do not necessarily imply that they are non-cultural. Consumption processes other than eating, such as crafting or butchering, can produce waste.

zooarchaeological study of any social processes or activities in a prehistoric context, it is important to have a proper taphonomic tool box to identify which patterns can be tied to the prehistoric human activities on site and which cannot be accounted to them (Orton 2012). A taphonomic approach in the study of waste management aids to identify such patterns in a zooarchaeological assemblage as well as to which extent post-depositional erosion has disturbed the survival of the material.

2.2.3 Waste management as a culturally specific practice

One objection against the processual approaches towards waste management is that it should not only be regarded as a nomothetic cultural transformation process, but also as a complex social practice beyond functional value (Marciniak 2005:75-87).[25] Waste management is a repetitive practice that reinforces any categorization of animal remains. In the following text examples are provided which support the notion that studying waste management traditions can be indicative and contribute to the discussion of i) the social organization of the settlement, ii) social topography, meaning the spatial differentiation of socio-economic strata, and iii) symbolic aspects of waste, which can have several consequences for waste management traditions.

2.2.3.1 Social organization

Douglas inferred that presence of waste causes disorder by being 'matter out of place', i.e. being in the wrong location.[26] For order to be restored, the waste needs to be handled and removed (Douglas 1966:50). As a simple example, she gave food, which is not dirty as a material, and if in the wrong place, such as food splatters on clothes, it is considered as dirt in Western societies (Douglas 1966:46-47). More importantly, this implies that waste must be handled and removed to a place where it belongs, whether a pit or garbage can. Following this logic, the spatial organization of waste management is culture-specific, meaning that it follows cultural norms of social organization in relation to perceptions of waste and cleanliness.

There are many ethnoarchaeological examples of the role of waste management in the social organization of settlements. For example, Hayden and Cannon (1983) investigated the dwelling area organization of the Highland Mayas of Chiapas and Guatemala. They argued that the refuse disposal practices were structured spatially by principles involving the economy of effort, the value of potentially recyclable objects and minimizing hindrances to mobility. Other cases are provided in the anthology "The Ethnoarchaeology of Refuse Disposal" (Staski & Sutro 1991). For example, Sutro provides a case study on the agricultural village of Diaz Ordaz in Mexico in

[25] For more discussions on the characteristics of waste, see Section 2.2.1.

[26] Douglas used the word 'dirt', not waste.

which ‘useless’ garbage was thrown in water streams, while ‘useful garbage’ was moved to the fields or burnt in domestic hearths (Sutro 1991).[27]

This relates also to waste production, which directs the need for organized waste management. At one end, we have the ‘nothing is wasted’ ideal of modern Greenlandic hunters, in which bones were smashed and boiled, leaving only a few splinters of bones for the zooarchaeologists (Pasda & Odgaard 2011). Since a few scraps of animal waste are left as waste, there is little need for organized waste management areas, such as larger refuse pits. At the other end, we have the excessive food waste produced by domestic households in the 21st century, of which ca. 35% of the food waste in domestic households are unnecessary, i.e. edible if prepared properly, according to the Swedish National Environment Agency (Naturvårdsverket 2014). In this society, all waste is categorized and sorted according to material category, e.g. plastic, paper and organic waste, by the household which produced the waste.[28] Excessive waste accumulation is a real problem in modern urban societies. Landfill sites are classical urban phenomena of waste management areas.

2.2.3.2 Social topography

It is generally acknowledged that perceptions of food and food culture are culturally specific, and can be a means of expressing power or social identity (e.g. Douglas 1972; Goody 1982; Dietler 1996; Curet & Pestle 2010). This explains why status differentiation, as reflected in diet, has been named one of the most popular topics within the zooarchaeology and archaeology (Twiss 2012:367-369).[29] This topic is often investigated through biochemical analysis of the bones from human individuals, or through the study of connections between status and food stuffs and/or food-related utilities (*ibid.* 2012:368), of which the focus here is on the latter, specifically animal food waste.

Studying the spatial patterns of animal bones in terms of food waste is essentially to study traces of the management of food waste, the content of food waste, and indirectly the consumption of food. Depending on the cultural context, some food is accessible only to upper social strata or are indicative of specific social groups. Ervynck *et al.* (2003) draws on sociological and economic research in developing a schematic framework to identify luxury food, which is defined as foods acquired at unnecessarily high costs, causing consumption “beyond the level of affluence” (*ibid.* 2003:429). As zooarchaeological characters of luxury foods, they point out imported, locally rare and/or expensive animals or animal products, as well as the selection of

[27] These ethnographic examples are perhaps best suited as analogies for the study of traditional and neolithized societies, and might not be suitable when studying prehistoric hunter-gatherers.

[28] Åkesson’s (2012) analysis of the perception of waste and waste management among Swedes constitute a good insight into the cultural aspects of waste in this particular society.

[29] For a detailed review of available literature, I refer to Twiss’s 2012 review article on the archaeology of social diversity. I highlight only the most relevant studies for this text.

specific body parts or ages of animal individuals (*ibid.* 2003:431-433). Similarly, Isaakidou (2007) presented an approach to studying elite cuisine which is based on Goody's (1982) comparative sociological study of cuisine and class. To identify elites at her study site, the Bronze Age palatial site Knossos on Crete, she used the criteria of rare ingredients (exotic/imported or rare), complex or exotic recipes, and ingredients requiring higher degrees of labour investment or specialised personnel (Isaakidou 2007:7; Goody 1982).[30]

Further, there is a link between waste content, i.e. what people throw away, and food consumption, i.e. what people eat. Rathje and Murphy (2001) effectively demonstrated that waste content is indicative of social group identity and/or socio-economic status in modern American cities. They found that the characteristics of waste differed significantly from one neighbourhood to another. For example, the waste of a middle-income household was more likely to contain food stuff from ""status" brand name foods and drinks", while affluent families would have more "diet soft drinks, store-brand and generic foods" in their garbage bin (*ibid.* 2001:135).[31] The food waste found in elite contexts can often be described in similar terms. For example, bones of hunted animals are often more abundant in elite contexts such as castles in North European Medieval contexts. This is connected to the restriction of such animals to the nobility in this period and region, and as such becomes a zooarchaeological indicator of higher social status (e.g. Sten 1992; Thomas 2007; Magnell 2009; Macheridis & Tornberg 2011).

Until now, examples have been given of how food consumption and waste can be tied to status differences. On the basis of this, we can finally approach the concept of social topography, as formulated by Richer (2015) to mean the spatial distribution of status differentiation. Status is named as one of the three mechanisms that generate social inequality by Weber ([1918] 1978), the others being resources and power. Ridgeway (2014) meant that status has been given too little attention and has not been regarded as an independent factor, like resources and power, in bringing social inequality. People, she wrote, "care about status quite as intensely as they do money and power" (*ibid.* 2014:2). Status is based on cultural world views about social groups of people, ranked as being relatively more or less esteemed by others in the society (*ibid.* 2014:3). Social topography, i.e. the spatial distribution of status differences, has been studied for example in rural Morocco (Ilahian & Park 2001), and in urban

[30] In similar terms, Hruby (2008) approached Mycenaean cuisine and class. For this purpose she studied the archaeological evidence, mainly pottery, in conjunction with Linear B tablets, from Pylos. Her conclusion was that the Mycenaean elite indeed had access to haute cuisine, as indicated by the presence of a wide range of ingredients, specialized cooking techniques and specialized cuisine personnel.

[31] A similar approach was applied on modern landfills from different localities in the Czech Republic (Brunclíková 2016), in which, among other things, the refuse of two socioeconomically different urban areas were compared. For example, brand clothes in good conditions were discarded in the relatively wealthier area.

contexts such as Istanbul, in which certain areas' names has become distinctive of status (Richer 2015:361). As a concept founded in relevant sociological research, 'social topography' has great potential in archaeological and zooarchaeological studies of status differentiation and social complexity. Given that there existed an uneven social topography within the settlement, spatial patterns in waste management and content, i.e. where people threw stuff and what people consumed, might be indicative of status differences within the settled area.

2.2.3.2 Symbolic aspects of waste management

Turner's (1966; 1967) research on rituals of the Ndembu people, Zambia, showed that symbols are used and combined to produce certain effects or communicate certain meanings. The symbolism of animals, body parts and/or bones might thus have practical applications on the management of these entities. Hodder's ethnoarchaeological studies of the Moro and the Mesakin cultures of the Nuba region in Sudan are interesting for this discussion (Hodder 1982:125-184). The only bones Hodder noted inside the settled area of these societies were jaws and skulls of domesticated animals. The head bones were hung from the roofs of granaries in Moro compounds, and in front of the granaries in Mesakin compounds. Hodder connects this with the fertility symbolism of the grain, for which head bones were hung as 'ritual protection'. Both pig and cattle jaws/skulls were hung (*ibid.* 1982:156-157). This contains a gendered dimension, since pigs were considered unclean and were taken care of by women, while cattle symbolized male power and were kept by men. This also explains the other practice concerning bone refuse, namely the differentiated disposal of the postcranial bones from pig and cattle. Postcranial bones were in general thrown outside the compound to dogs (*ibid.* 1982:155). However, if there was a risk of the pollution of cattle by pig bones, these bones were deposited at least 40 m away from the compound (*ibid.* 1982:158). This would produce a certain zooarchaeological patterning, with heads inside the settlement and all other bones outside, or perhaps outside the excavation perimeter.

Another case of symbolic connotations of waste can be found among Soviet Mongol tribes described by Szynkiewicz (1990). Here, the tibia of sheep was a powerful symbol of the patrilineal descent and was used as a tool for communication with ancestors.[32] The bone waste containing this bone was to be burnt and then deposited on a proper sacred location (Szynkiewicz 1990:74). If chanced upon in nature, it could not be left outside but had to be taken home; otherwise the household would be cursed with impotence and infertility. On the other hand, the pelvic bone was considered symbolic of the devil, and if chanced upon it was to be kicked it away and left (Szynkiewicz 1990). This is a clear example of how waste management can be symbolically meaningful.

[32] It was also an important meat dish reserved to men only (Szynkiewicz 1990).

Regarding the symbolic meanings of depositional patterns, the concept 'structured deposition' is common in archaeology and zooarchaeology (e.g. Richards & Thomas 1984; Hill 1995; Needham & Spence 1997; Marciniak 2005:209; Garrow 2012; Isaakidou & Halstead 2013; Gifford-Gonzalez 2014; Rudebeck & Macheridis 2015). This concept includes the notion that, because rituals are "highly formalized, repetitive behaviour", the deposition of materials associated with the rituals would be made in a structured fashion (Richards & Thomas 1984:191). This was recently questioned by Garrow (2012).[33] He meant that the concept has become its own interpretation since it was formulated, meaning that "people have often felt compelled to interpret *all* variability as being representative of some kind of symbolic scheme" (*ibid*. 2012:108).[34]

Garrow's solution is to divide 'structured deposition' to two categories of deposits, namely 'odd deposits' and 'average practice' (*ibid*. 2012:109).Although he wrote that they should be considered on a 'sliding scale' or a 'spectrum', he frequently made a clear distinction between these two categories (*ibid*. 2012: e.g. 105, 106; see Thomas 2012:124). I agree that the concept 'structured deposition' should not be used as an explanatory term; however, the categories provided by Garrow might reinforce sacral/profane dichotomization of the past, something that might only reflect our modern understanding of reality.[35] In relation to this debate, it is acknowledged by others that 'structured deposition' should be used as heuristic for describing the deposits of also non-ritual remains, and which might reflect on cultural norms and traditions, situated in a cultural context (e.g. Hill 1995:95-96; Rudebeck & Macheridis 2015:185). Nevertheless, the use of the concept cannot be considered to be particularly neutral; especially given that it has often been equated with 'deliberate', 'conscious', or 'intentional'.

In this study, when discussing the distribution or patterning of zooarchaeological material I avoid the term 'structured deposition' but frequently use the term 'waste management' instead, for three main reasons. First, structured deposition remains a description of material culture patterning as we see it; it echoes only what we as analysts see as patterns in the archaeological record. Because it is a descriptive term, it

[33] It should be mentioned that the concept has not only been questioned in a British context. According to Wolfram (2016), 'structured deposition' has been largely ignored in Germany because it presupposes that the archaeological deposit and its content directly reflect on human behaviour or "that complicated ritual behavior is mirrored by a similarly complicated assemblage" (*ibid*. 2016:125).

[34] An example of this is provided by Isaakidou and Halstead (2013) in their study of structured deposition in the Aegean from the Neolithic to the Iron Age. Although structured deposition is part of the title and the aim, it remains unclear how they define the concept, although it seems to be equated with 'deliberate' deposition (*ibid*. 2013:90). Nevertheless, it is an important study because it constitutes a call for ritual, symbolic and social approaches in Greek zooarchaeology, as well as providing a long-term perspective of 'structured' deposits, including odd deposits and material culture patterning, following Garrow's terminology.

[35] Or 'ritual' versus 'mundane' which is used by Garrow (2012: cf. Fontijn 2012:123-124).

is not suitable as an interpretative tool. If the material is found in waste-related contexts it will primarily mirror waste management, whether this was made conscious or not. Waste management is therefore a more suitable term for discussing zooarchaeological mass material from waste-related contexts.

Secondly, waste management as a concept implies that the handling of waste was managed, meaning that it was handled and directed according to cultural norms and decisions at a structural level. In other words, although the disposal of any remains might be random or unintentional, it is made within a cultural system (e.g. Martin & Russell 2000:58; Marciniak 2005:75; Gifford-Gonzalez 2014:345). Waste management can be connected to the practices of everyday life, since waste is constantly produced. Potential waste material is continuously defined, categorized and valued according to the cultural views of e.g. recycle or reuse, but also danger and uncleanliness (e.g. Douglas 1966; Strasser S 1999; Martin & Russell 2000:58; Marciniak 2005:75; Gifford-Gonzalez 2014:345). Thirdly, the concept of waste management does not reject any ritual or symbolic connotations of waste disposal or connection to waste materials. Conversely, there are no ritual interpretations or symbolical assumptions included in waste management.

It is important to remain open to the possibility that in some societies, waste management, or aspects of it, is highly ritualized. The term 'waste management' does not contain meanings that can be interpreted as in favour of or against this. The term 'ritualization' encompasses a view on ritual as a process; ritualized practices are characterized by repetitive formal action sequences directed by conventions and traditions, and are dynamic and transformative (Bell 1992:220; Bradley 2005:34). Waste management can be considered as a repetitive action sequence directed by conventions in most societies. However, a ritualized practice should not necessarily be equated with normative practice. In other words, cultural norms are not the same as rituals, although ritualized practice is always situated in cultural norms and conventions. Ritualized action is, however, not necessarily intentional because the definition of the ritualized act is independent of the actor (Humphrey & Laidlaw 1994:89). Ritual practices are social entities which have specific goals set in social conventions and order (Ekengren 2009:41). Consequently, since waste management is a practice directed by cultural norms and conventions, the idea that waste management might become a ritualized practice in some societies cannot be rejected.

2.3 Four key themes in the zooarchaeological study of waste management

Which characteristics of waste management can we zooarchaeologically examine? Based on the theoretical review above, four key themes have been defined as potential starting points and explored separately in the articles of this thesis. This is made in order to further test the potential of waste management as a concept in social zooarchaeological studies.

Theme 1: Definition of context
The initial step should be to identify and define which patterns within the data that can be attributed to waste management. As acknowledged in Section 2.2.2, waste management can be detected through the use of a taphonomic perspective. This is because waste management is a taphonomic formation process, meaning that any selections made or any actions made during the peri-depositional phase of waste management will be a shaping factor in the formation of the zooarchaeological record. Each case study will be different because each site has different archaeological, geological and ecological pre-conditions. As this case study is restricted to one site, namely Asine, we can partially avoid this issue.[36] At Asine, the definition of context concerns also a presentation of the zooarchaeological data. This means also a discussion on topics related to animal management and consumption, which is provided in Paper I and Chapter 5. The taphonomic approach is provided in Paper II.

Theme 2: Waste management and social organization
As discussed in Section 2.2.3, waste management is often directed by the spatial and social organization of the settlement. As such, this is an approach which can give more information about the social organization at Asine. Waste management practices reflected as distributional patterns in archaeological features related to the settlement organization can give information about whether or not the features and their contents were categorized by proximity to activity areas, i.e. if the waste was thrown close to specific consumption or butchery areas, or animal/body part categorizations, i.e. if specific types of animal or body part remains had designated waste areas. This would also be valuable for understanding the organization of the settlement. This is explored in Paper III in which the bone waste from specific features from the Early Helladic III period, pits called *bothroi*, is studied in order to examine the pits as part of the social organization on a household level.

[36] This is not entirely true, since different geological conditions affect the site in different areas of it, such as Barbouna Hill versus the Lower Town, see Section 3.2.

Theme 3: Waste management and social topography
Thirdly, we have the discussion of waste management as indicative of social topography at the study site. During the MH III-LH I period at least two dwelling areas were present at Asine. The differences between these in terms of material culture and architectural evidence have been discussed as signs of increasing social complexity. Applying a waste management perspective to this discussion tests this hypothesis, but also investigates whether or not this reasoning about the connections between waste and social topography is useful in an archaeological context. This discussion is made in Paper IV. As mentioned, food consumption has been directly tied to socio-economic background in many studies. Further, how to value and handle waste is also connected to culturally specific perceptions. Studying spatial patterns of status differentiation as reflected in waste content and waste management can potentially be a powerful tool in detecting differences between dwelling areas, and might shed light on the social complexity of the study site. The characteristics of food waste cannot alone account for symptomatic status identity; the zooarchaeological study should be based also on other archaeological evidence such as architectural features and other material culture (e.g. Kamp 1991:30).

Theme 4: Symbolic aspects of waste
Finally, the fourth key theme concerns the study of the symbolic connotations of waste from settlement contexts. In the above Section 2.2.3.1, I provided several examples on how certain waste categories can have symbolic connotations in everyday life. Asine makes a good case study of this issue, since there are contemporary houses and burials on the site. This closeness in time and space makes it possible to compare the consumption waste from the settlement with the animal bones deposited as grave goods (see Iregren 1997). This can give further information on the site and on symbolic aspects of common animals. This theme is explored in Paper V.

2.3.1 Methodological framework

The four key themes defined above are investigated through a heuristic workflow, illustrated in Figure 1. The workflow was developed on the basis of a theoretical discussion of waste management and the four key themes. As shown in Fig. 1, after an initial contextual assessment and general discussion of the site (Paper I), the emphasis is on the identification of waste management, which requires a taphonomic approach (Paper II). Issues of representativity in the material should be detected during this stage. Thereafter, more qualitative approaches might be needed in order to analyse and interpret specific patterns in terms of social aspects of waste management, of which I have focussed on social organisation (Paper III), social topography (Paper IV) and symbolic aspects (Paper V).

The heuristic structure of the workflow simplifies the complexity of waste management studies by providing loopholes in which certain aspects of the phenomenon can be discussed, thus giving crucial insights into the structure, organization and practices of the studied society. The workflow is divided into a three-stage structure, starting with a phase called identification, followed by analysis and interpretation. Within these phases, one or more analyses or crucial topics are defined, of which each has one or more analytical components. The inferential value of each component is described in more detail in Appendix 1 according to the level of contextual resolution. The contextual resolution is dependent on documentation quality. This is an important aspect of the Asine material, which might in some aspects suffer from lower documentation quality, having been excavated long ago and in more than one campaign. This is discussed in more detail in 3.1. How this has affected the study of waste management at the study site is discussed in 6.1 and 7.1.1. I underline that the workflow in Fig. 1 is not an absolute set of rules. In this thesis it has functioned as a methodological structure, providing the necessary frames for the exploration of waste management in the appended papers.

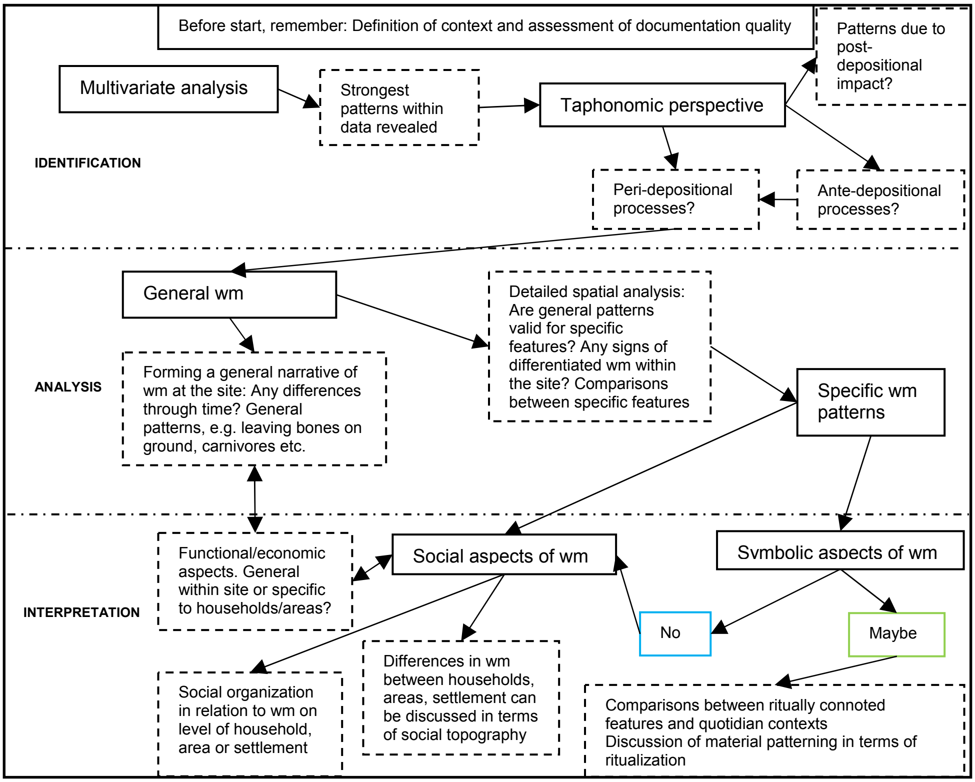

Figure 1.
Heuristic workflow for the zooarchaeological study of waste management. Analytical steps are described in more detail in Table 7 (Appendix 1). wm = waste management

3. Asine: a short site biography

Ancient Asine (Figures 2-3) is situated on a protruding cliff in the Argolid bay in the north-eastern part of the Peloponnese in Greece. Asine is important to the development of Classical Archaeology in Sweden. The early excavations of Asine preceded, and motivated, the emergence of the Swedish Institute at Athens. It has been the training ground for Swedish scholars active in both the Mediterranean as well as the Scandinavian area.[37] Asine has been the focus of several doctoral theses (Santillo Frizell 1980:679; Wells 1983; Nordquist 1987; Frisell 1989; Dietz 1991; Sjöberg 2001; Ingvarsson-Sundström 2008) and material studies (see contributions in e.g. Hägg *et al.* 1996; Wells 2002a). In Table 1 the chronological periods used in this thesis are presented.

Table 1.
Chronological periods of the Bronze Age, with corresponding absolute dates. The chronology for the Early Helladic periods is based on Voutsaki *et al*. (2009) and Manning (2010, 23), the Middle Helladic periods is based on Voutsaki *et al*. (2009) and Bintliff (2012), and the Early and Late Helladic is based on Shelmerdine (1997), Manning (2010:23) and Bintliff (2012).

Chronological periods and subperiods			Calendar Years BC
Early Helladic (EH)	EH I		3100-2650
	EH II		2650-2200
	EH III		2200-2100
Middle Helladic (MH)	MH I		2100-1900
	MH II		1900-1800
	MH III		1800-1700
Late Helladic (LH)	LH I		1700-1635/00
	LH II		1635/00-1420/10
	LH III	LH IIIA	1420/10-1330/15
		LH IIIB	1330/15-1200
		LH IIIC	1200-1050

[37] Among these we can note Holger Arbman (the excavator of e.g. Swedish Iron Age town of Birka), Einar Gjerstad (famous for his works on e.g. Cypriote Archaeology), Natan Valmin (famous for e.g. the excavations of Malthi in the Peloponnese) and Berit Wells (former Director of the Swedish Institute, and Director of the excavations of the Sanctuary of Poseidon at Kalaureia on Poros).

Figure 2.
Asine in Argolis. Top: Location of Asine in Greece, created using ArcGIS 10.0 by Esri. Bottom: View of the excavations in the Lower Town from the north, 1926 (courtesy of Alvin, platform for digital collections and digitized cultural heritage, alvin-record:102633).

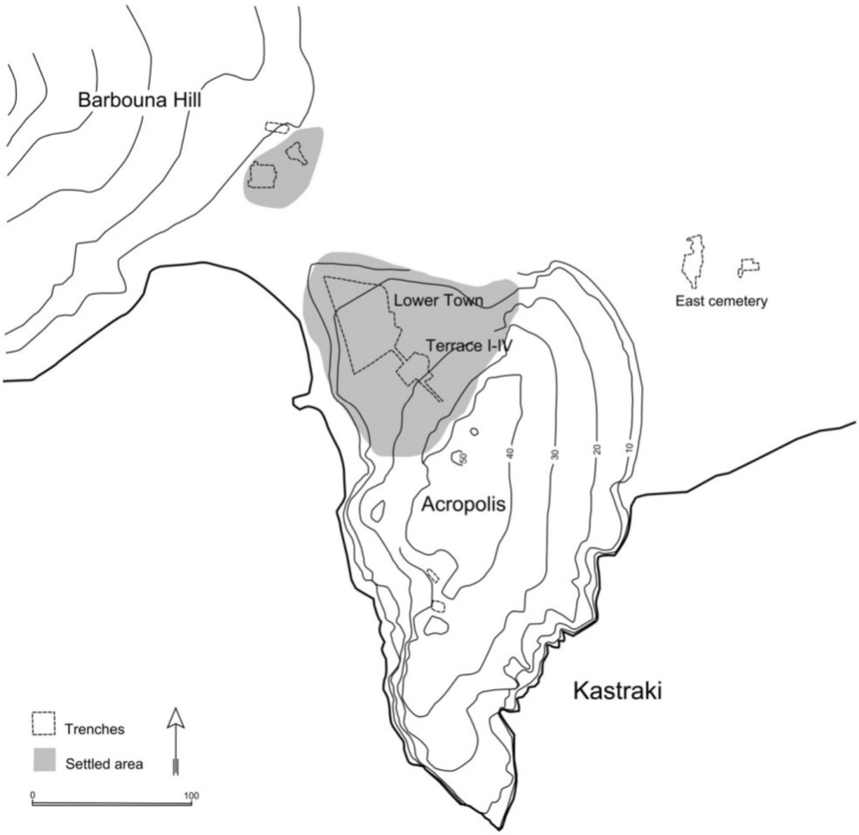

Figure 3.
Settled and excavated areas of ancient Asine, as mentioned in the text. Excavation trenches and approximate extension of settled areas primarily during the Middle Helladic. The settlement on Barbouna Hill were apparently only in use in the end of the Middle Helladic period, while Terrace I-III and the Lower Town contained architectural remains from dwelling structures from all Bronze Age periods. Map modified from Nordquist (1987:153, Fig. 8).

3.1 The Swedish excavations at Asine

Ancient Asine is located in a special topographic setting (Figs. 2-3). The protruding cliff, or the Kastraki, encloses a smaller bay. Opposite to this cliff is a hill, the Barbouna Hill, which is also part of the prehistoric Asine site. These two areas, as well as a third area east of the acropolis on the Kastraki cliff, have been the focus of intensive excavations during several campaigns of the 20th century.[38] The early Asine excavations were extensively planned and organized. An indication of the importance of a large-scale Swedish archaeological project on Greek soil is that Oscar Montelius, one of the most famous Swedish archaeologists of all time, was involved with the organization of the project.[39] After his death in 1921, the Swedish Asine committee was founded (Frödin & Persson 1938:2). The Asine committee was filled with famous scholars from Classical and Scandinavian Archaeology, and the Crown Prince of Sweden at the time, later the King of Sweden Gustav IV Adolf, was the Chairman of the committee. The committee included members such as Profs. Oscar Almgren, Lennart Kjellberg, Martin P:son Nilsson and Bernhard Salin (Frödin & Persson 1938:10).[40] The Asine project was going to show the rest of the world the importance and quality of Swedish archaeological techniques, and point to the need of a Swedish Institute in Greece. Indeed, the practical issues that occurred during the course of the project showed that the lack of a Swedish Institute was problematic. This is expressed in the introduction of the publication of the excavations (Frödin & Persson 1938:12), and the publication's preface written by members of the Committee.

As field directors, the Asine committee chose Axel W. Persson and Otto Frödin. While Frödin specialized in Scandinavian prehistory, Persson had been involved in the project prior to the formalization of the Asine committee in 1921. For example, he had investigated the site, in order to formulate the application for an excavation permit to the Greek authorities (Wells 2002b:13; Schallin 2014:61). From 1922 to 1930 the site was excavated in five expeditions. These excavations focused on the Lower Town and its terraces on the Kastraki, and the two necropoles on Barbouna Hill. The excavations uncovered the ancient settlement of Asine, chambers tombs, terraces, and city walls, as wells as rich findings of pottery, metals, bones, and other finds. The publication of these excavations came in 1938. It was systematic, detailed and comprehensive, at least for its time. The publication was allegedly delayed because of disagreements between the directors.[41] Without Alfred Westholm as editor

[38] The area east of the Kastraki cliff was named the Karmaniola sector after the owners (Styrenius 1975). The East Cemetery on Fig. 3 belongs to this sector.

[39] Montelius is most famous for the typology of and construction of the chronology of the Scandinavian Bronze Age, still used today, is sometimes called the "Father of Typology"; this is somewhat misleading, since it was anticipated in many ways by Hans Hildebrand, another 19th century archaeologist (Gräslund 1987).

[40] Almgren is famous for his works on Swedish Roman Iron Age, especially his typology of fibulae. Kjellberg was a Classical archaeologist, and known for his excavations of the Sanctuary of Poseidon at Kalaureia on Poros, together with Samuel Wide (see Berg 2016). Martin P:son Nilsson was a Classical scholar, most famous for his works on ancient Greek mythology and religion. Salin was the King's Custodian of Antiquities in Sweden.

[41] The communications and process of the Asine project also touch on issues of colonialism, class, gender, power relations, diplomatic relations and the cultural history of the region. A detailed discussion of the political consequences of and strategies behind the Asine project is, however, beyond the scope of this thesis. I refer to Berg's 2016 thesis, which contains a discussion of a similar approach regarding the Swedish excavations of the Sanctuary of Poseidon at Kalaureia on Poros in 1894.

of the publication, it is doubtful whether the results would have been published to the same extent.[42]

The excavation history at Asine did not finish with the publication in 1938. The site was re-visited by Swedish scholars during the 1970s and 1989-1990 (Hägg & Hägg 1973; 1976; Styrenius 1975; Hägg & Fossey 1980; Dietz 1980; Dietz 1982; Wells 1983; see Nordquist & Hägg 1996). These later campaigns were initiated by the Greek authorities, who invited the director of the Swedish Institute at Athens, Carl-Gustaf Styrenius, to manage the excavations.[43] The excavation areas relevant to this thesis are illustrated in Fig. 3. For the location of all excavated areas of Asine, I refer to Styrenius (1998). The new excavation campaigns increased the knowledge of the long-term continuity of the Asine area. These projects were focused on the east of the acropolis on the Kastraki in 1970-1974 (Dietz 1980; 1982), and on the Barbouna Hill in 1970-1974 (e.g. Hägg & Hägg 1973; Styrenius 1975), 1977, 1985 (Wells 1988), and 1989 (Hägg & Nordquist 1992), as well as on the acropolis in 1990 (Pentinnen 1997). The material of this thesis from the later excavations derives from the archaeological features on the Barbouna Hill, which were excavated during the 1970s and in 1989.[44]

3.1.1 Reconstructing old excavations: the spring of the 1926 season and the field diaries

Conducted over 90 years ago, the 1926 excavation was the most extensive campaign on the Asine site. Excavations took place on the Barbouna Hill, the Acropolis, the Lower Town, and the Large Section which went through the Lower Town up to Terrace I and II, and in which Terrace III was further extended and excavated (Frödin & Persson 1938; see Nordquist & Hägg 1996:12). The animal bones from the 1926 spring season are stored as part of the Asine collection at Museum Gustavianum, Uppsala. They constitute the major part of the study material forming the basis of this thesis.[45] These bones were hand-collected during the excavation,

---

[42] Westholm was clearly important in the excavation project. His contribution to the main excavation publication describes and presents all architectural elements of the Lower Town and Terraces. His chapter, Chapter 3, is the most extensive in page numbers, most informative and very detailed and useful. He was also the photographer during the 1926 campaign.

[43] The Swedish involvement was initiated by the Greek General Direction of Antiquities. The investigations were aided by the staff of Nauplion Museum, especially Mrs. E. Deilaki, according to Styrenius (1975).

[44] These bones are stored in the Archaeological Museum in Nauplion, Greece (see Appendix 2), as opposed to the finds from the 1926 campaign, which are stored in Museum Gustavianum, Uppsala University (Sweden).

[45] The finds from the 1926 excavation, with emphasis on the pottery, are published digitally in the database PRAGMATA (Swedish Institute at Athens *et al.* 2017). The animal bone catalogue produced within the frames of thesis is included in this interface, and is further discussed in 4.1 and Appendix 2.

although some excavation units were sieved. There is no detailed document specifying this, but notes can be found on the find boxes. That the animal bones collected were kept makes the old Asine excavations special in regards to other contemporary excavations, in which the animal bones often were discarded or not collected at all (MacKinnon 2007).

An important source of information on the archaeological features excavated during the 1926 season is the field diaries. They contain the responsible excavator's interpretations and thoughts, as well as the proceedings of the excavation itself. In these diaries, stratigraphic information can be found which relates to the information on the find boxes. Thus, links between the stratigraphy of the site and the find material is easily made using the diaries. In some cases, reading the diaries is the only way to understand certain stratigraphic relations or archaeological features at the site.

One important task in the work for this study has been to use the documentation of the old excavations. The disentanglement of the old Asine archive has previously been attempted successfully by Nordquist (1987) in her work on Middle Helladic Asine. With a basis in her thesis and the use of the field diaries and plans, it is possible to make use of the old Asine collection, and sometimes even to reconstruct single contexts. One example of how to handle this old archive can be found in Paper III, where the stratigraphy of the *bothroi* of Asine was reconstructed through the examination of the diaries together with radiocarbon dating on animal bones from upper and lower strata in the features, as well as the taphonomic information provided by the animal bones, such as whether the surface of the bones indicate prolonged exposure on the ground.[46] Still, the field diaries seldom mention any discussion of microstratigraphy of houses and features, such as the distinction between make-up layers and activity layers from floors.

The field diaries function as intermediaries between the researchers and the excavators, even though the excavators are deceased. I have used the five diaries describing the excavations of the areas from which most of the Bronze Age animal bones derive. The documentation of the excavations of Terrace II and III was made by Erik Jo Knudzon (Diaries 3:1 and 3:2). The diary of the excavation of the Oval House (House B) area was written by Neander Nilsson (Diary 5), the West extension of the Lower Town by Krister Hanell (Diary 7), and the North and South extensions of the Lower Town by Holger Arbman (Diary 9).

The Asine find material is stored in boxes, labelled with so called Asine-numbers (AS).[47] Separate find boxes often derive from the same context. Using the diaries together with the information on the find boxes' labels, it is possible to trace the

[46] A *bothros* is a large find-rich pit often found in Early Helladic settlements in the Aegean. They are often seen as storage pits. Eventually, however, they were used as refuse pits (see Paper III).

[47] These numbers are modern, i.e. not part of the original documentation. The context information belonging to the numbers is, however, original.

animal bones to one specific context, a stratigraphic unit. By using the information on the find label and the information from the diaries, it is possible to trace the units back to their stratigraphic origin. One example of how this reconstruction can take shape is provided in Figure 4. This cistern was found in a room of House M, which was connected to the production of oil (Frödin & Persson 1938:82).[48] In the publication, the only reference to the stratigraphy of the cistern is a few sentences which include information on depth and width (Frödin & Persson 1938:67). The detailed reading of the diaries has, in this example, provided different stratigraphic units as well as the shape and finds of the feature, and thus might enable more contextual assessment. Since the cistern is of Hellenistic and not Bronze Age origin, it is not further discussed in this study; however, it is a good example of how I have worked with the diaries in order to understand the excavated contexts and layers at Asine.

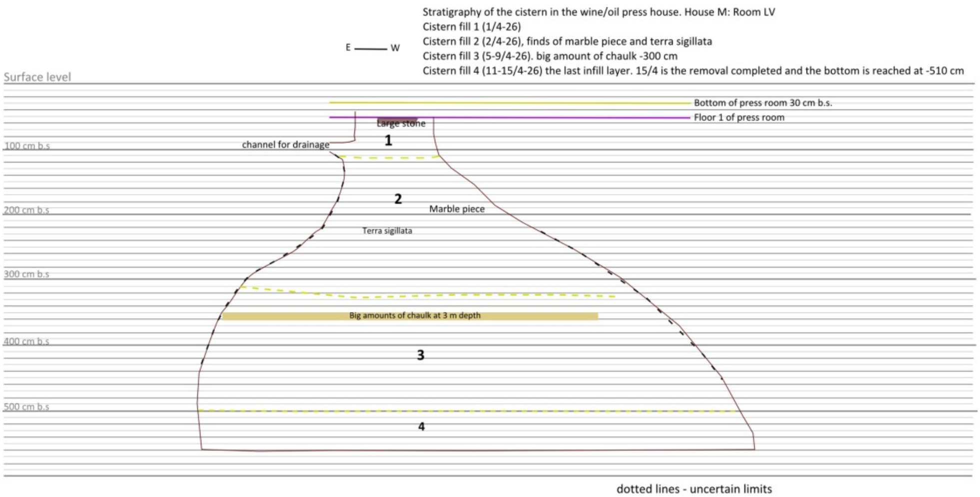

Figure 4.
Reconstructed stratigraphy of the Cistern in the Hellenistic House M, interpreted as an oil press by the excavators. B.s. = below surface level.

3.1.2 Chronological issues and possibilities

Because the documentation of some stratigraphic sequences, such as the houses, can be limited, some of the animal bones from Asine suffer from the loss of contextual and temporal integrity. Although most finds from one stratigraphic unit can be safely assigned a certain time period, the possibility that the unit might have been mixed with other strata exists. This is sometimes indicated by instances of pottery sherds

[48] See Klingborg 2017 (cat. no 129) for specific information on this particular cistern.

typologically dated to other time periods than the assigned date for the stratigraphic unit. However, due to the recent typological assessments of the Asine pottery, this issue has been easier to evaluate for each unit.[49] One example is AS 4799 from Layer 7, below the middle wall in Terrace III (Fig. 6).[50] The pottery consists of about 10-50 sherds, of which 97 % is dated to the Early Helladic II period (EH II, ca. 2650-2200 BCE), while one sherd is from the later Late Helladic period (ca. 1700-1050 BCE). This stratigraphic unit is almost a "clean" Early Helladic II context. As a rule, units in which one time period dominates have been typologically considered as deriving from that period. In the example provided above, I assume that the animal bones derive from EH.

One solution to the temporal integrity of some stratigraphic has been to evaluate typological assessments through ^{14}C-analyses. Because of financial reasons, selected Asine-contexts were sampled for radiocarbon dating. More than 50 radiocarbon dates have been acquired from animal bones from the Asine collection. All dates are presented in Appendix 3. The most notable example from this integrated approach can be found in Paper III. In most cases, radiocarbon dates correspond to the typological assessments of the pottery, which speaks against the stratigraphic units being mixed with over- or underlying strata to a larger degree.

3.2 Bronze Age Asine

Asine was continuously inhabited from at least the Early Helladic (ca. 3100-2100 BCE) to the 8th century BCE. This was succeeded by a period of decline, in which the site was only moderately settled or visited. It was later resettled during the Hellenistic period, or rather around 300 BCE, which is the probable date for the Hellenistic fortification of the site (see Pentinnen 1996: 167). Asine was abandoned in Late Antiquity (ca. 200-650 AD). The rocky peninsula has later been revisited; it was lastly occupied by Italian soldiers during World War II. Unfortunately, this resulted in destruction of ancient architecture at the site, especially in the Lower Town area (Yioutsos 2017).[51]

The ancient activities at the site and its long term continuity is evidenced by the results of the many archaeological investigations (Frödin & Persson 1938; Hägg & Hägg 1973; 1976; Hägg & Fossey, 1980; Dietz 1980; 1982; Wells 1983; Nordquist

[49] Typological assessments of pottery from AS-numbers can be accessed from the PRAGMATA database (Swedish Institute at Athens *et al.* 2017).

[50] In contextual descriptions of the field diaries, 'below' often meant 'north of'.

[51] Asine was modified into a coastal fortress, largely because of its topographically strategic position. Yioutsos (2017) writes about this latest historical phase and reports on the current state of the ancient remains as well as the modifications made by the Italians.

unpubl.; see Nordquist & Hägg 1996), specialized typological analyses of pottery (e.g. Pullen 1987; Frisell 1989), and of architecture (e.g. Höghammar 1984). The early excavations revealed different phases of habitation at Asine, some of its burial grounds, as well as the fortification wall and an acropolis. Excavation trenches, burial areas and settled areas are illustrated above in Figure 3. The Lower Town consists of several chronological phases, illustrated in Figure 5. Associated with the Lower Town are the houses on Terrace III, illustrated in Figure 6.

During the Bronze Age the Argolis region, where Asine is situated, became increasingly drier and more affected by human activity and land use. The climate of the region would have been similar in the Bronze Age to recent times, with hot dry summers and mild winters (Nordquist 1987:17; French 2002:13). At the beginning of the Bronze Age a change from dense deciduous forest dominated by oak to pine and hazel is seen. Generally, with the occurrence of other signs, such as the increase of *Plantago*, this has been interpreted as a more intense anthropogenic influence on vegetation in the Argive plain during the Bronze Age (Jahns 1993). Atherden *et al.* (1993:255) suggested that the palynological evidence points to an anthropogenic land use with mixed farming, which would have had emphasis on animal husbandry, because of e.g. the increase of grassland types.

3.2.1 The earliest settlement (Early Helladic, EH, ca. 3100-2100 BCE)

General outline of the EH period

The Early Helladic (EH, ca. 3100-2100 BCE) on the Peloponnese was initially a period of expansion; during this period the number of settlements increased to above that of both the preceding Final Neolithic and the succeeding Middle Helladic (Bintliff 2012:84). At the beginning of EH II (ca. 2650-BCE), we see the forming of larger sites, such as Lerna and Tiryns in the Argolid. Additionally, the appearance of organized site plans, central administration implied by seals, fortification and larger buildings, such as the distinctive 'corridor houses', have been seen as signs of a region, which was to some extent centralized (Weiberg *et al.* 2016:55).[52] According to Nilsson (2014), the sense of community and communal organization characterize the earlier EH, based on the occurrence of communal storage structures.[53]

[52] Corridor houses are best exemplified by the famous 'Corridor House' at Lerna. Another contemporary monumental building type is the 'Rundbau' at Tiryns.

[53] According to Nilsson, the Rundbau structures, larger circular buildings, best exemplified by the one at Tiryns, are to be seen as connected to storage. This is a view not shared by everyone. For example, Maran argues that the Rundbau at Tiryns should be interpreted as a strong tower which was built to intimidate competing settlements (Maran 2016).

Figure 5.
Chronological phases of architectural units in the Lower Town of Asine based on Frödin & Persson (1938:59-90), Nordquist (1987) and Sjöberg (2001). Plan redrawn after the original publication in Frödin & Persson (1938: Figs. 42-42).

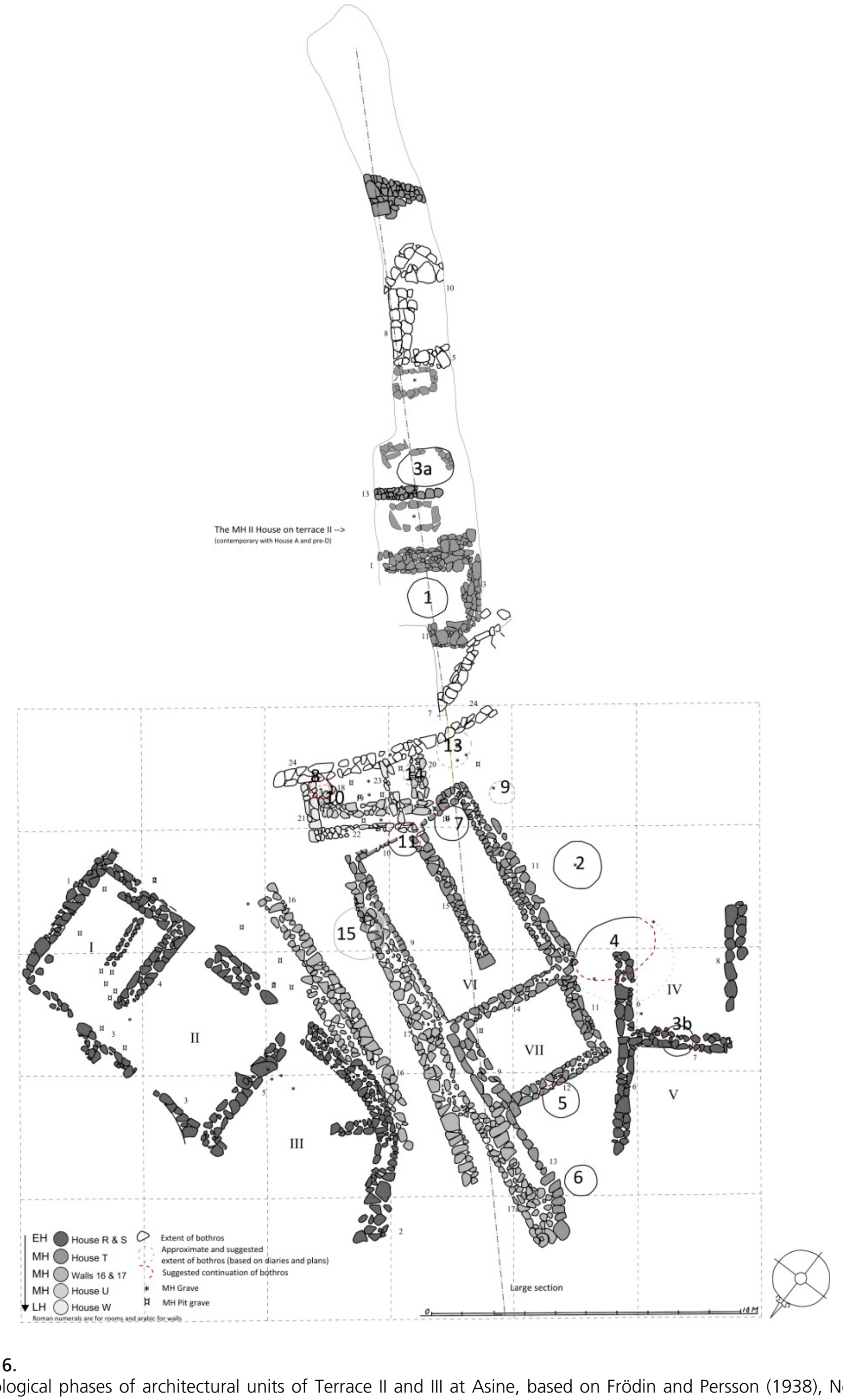

Figure 6.
Chronological phases of architectural units of Terrace II and III at Asine, based on Frödin and Persson (1938), Nordquist (1987) and Sjöberg (2001). Plan of Terrace III (squared part) re-drawn after the original publication in Frödin and Persson (1938: Fig. 92), Terrace I-II (on top) after Nordquist (1987:68).

Eventually, the regional system went through a major change during the late EH, at around 2200 BCE, the so-called EH II/III collapse, or gap (e.g. Forsén 1992; Maran 1998; Bintliff 2012:91-92; Davis 2013; Weiberg & Finné 2013; Wiener 2014). A shift to a drier and colder period of ca. 200 years is observed at around 2200 BCE (e.g. Davis 2013; Weiberg & Finné 2013; Wiener 2014). Also Gejvall (1969) observed early a change in the avian fauna during this transition, which indicates a shift to a more arid climate. The dominance of grallatorial and swimming birds which thrive in humid conditions in EH II changed, to include birds more confined to agrarian or drier fields, such as rock partridge and scavengers, during EH III (Gejvall 1969: 55). Recent radio-carbon analyses of EBA sites in the Aegean show that the late EBA phases should perhaps be placed further back in time (Wild *et al.* 2010; Renfrew *et al.* 2012); thus, the cultural transformations might have occurred earlier than the onset of this well-attested dry period.

Asine during the EH period

The earliest settlement phase at Asine is not well studied. Based on architectural remains, it should be dated to the Early Helladic; however, we have pottery evidence indicating a Neolithic presence at the site (e.g. Hägg & Nordquist 1992:63). In his paleogeographical reconstruction of Asine, Zangger (1994) proposes that the Kastraki was a free-standing island at ca. 3000 BCE, in the onset of the Early Helladic. This suggested island must have disappeared sometime during the EH period, or at the latest the MH, but the date remains unknown.[54]

The settlement on Terrace III can be traced at least to the EH II period (Nordquist 1987: 71). While the remains of House S only consist of one room and a wall, the plan of House R is more intact (Fig. 6). Pullen (1987:539) has reconstructed the history of this house. According to him, the first room to be constructed was Room I, followed by Room II. Finally, Room III was added. It had the typical apsidal shape which was introduced in the late EH (see Warner 1979). The construction of House R has also been suggested to have an EH II date (Caskey 1960:60). House S was built later, probably during the EH III-MH I period (ca. 2200-1900 BCE). It was built over *bothros* 3b, which is dated to the EH III-MH I period, or between 2275-2024 BCE according to radiocarbon dates (Paper III; Appendix 3). It is possible that House S did not have a long use period, and it seems to have been abandoned in order to make room for the construction of House T in the MH I period (Frödin & Persson 1938:94; Nordquist 1987:72).

[54] Additional data is needed to affirm this geological reconstruction; it should be considered preliminary. For example, in his chronology of the auger cores, Zangger could only provide a good stratigraphic sequence for three of them, of which only one (AS121) included EH II in the stratigraphy (Zangger 1994). One sherd each in three other cores provided a date for only one depth unit, while two cores that had two depth units were dated typologically. However, the existence of few but datable sherds in one or two depth units does not provide a good stratigraphic sequence for the whole auger cores. Also, only one depth unit provided wood suitable for radiocarbon dating. The sample yielded the calibrated date 4307±137 BCE.

During the Early Helladic, Asine does not seem to have functioned as a key site for the region, as e.g. Lerna or Tiryns. Although not many architectural features testify to the EH Asine, there is ample evidence in the form of pottery, artefacts and animal bones. In her detailed regional study of the late EH 'collapse' or break in the area, Forsén (1992) examined the contemporary stratigraphic evidence from Asine. Important in her discussion was the dating of the 'destruction layer' described in the early excavation publication (Frödin & Persson 1938). Frödin initially dated this to the late EH III period. The initial description of this layer is difficult to comprehend, since Persson and Westholm contradicted each other, as exemplified in the publication (Frödin & Persson 1938:97 cf. 202; see Forsén 1992:59).

The EH III date was questioned foremost by Caskey (1960:301-302), on the basis of mainly the pottery from House R and a deep trench in the Lower Town (in square G14, see Frödin & Persson 1938: fig. 42). He suggested an EH II date for the destruction layer, which was in line with his observations of a EH II/III crisis of several sites in the Peloponnese region. Pullen (1987:541) notes that this house might be too damaged by later burials to provide good typological information about the destruction layer. Forsén (1992:61) conclusively agreed on a EH II/III date, i.e. around 2200 BCE, of the destruction layer, on the basis of notes in Persson's field diary and Caskey's 1960 re-examination of the pottery in the deep trench in the Lower Town.

To sum up, Asine was already visited or even inhabited by the beginning of the Early Helladic period. The area of Terrace III was certainly settled in EH II when House R was constructed. House S was built close to House R in the later EH period. A turbulent period testified to a widely spanning destruction layer at the site dated to the EH II/III transition, at ca. 2200 BCE. Similar layers have been detected in other sites in the region and have been called the EH II/III 'crisis' or 'collapse' or 'gap'. This event has been widely debated in respect of this region (e.g. Forsén 1992; Maran 1998; Bintliff 2012:91-92; Davis 2013; Wiener 2014; Weiberg & Finné 2013). The many *bothroi* between Houses R and S were perhaps in use during this transition. However, almost all were filled in and closed in the period between 2135-2078 BCE. They were perhaps constructed for food storage, but were certainly used as refuse pits in their last usage phase. These pits are important as they testify to household organization as well as activities on site.

3.2.2 Expansions during the Middle Helladic (MH, ca. 2100-1700 BCE) and early Late Helladic (LH I, ca. 1700-1600)

General outline of MH to early LH periods

During the Middle Helladic period (ca. 2100-1700 BCE), the settlement pattern on the Peloponnese was different from the preceding EH, with a decreasing number of settlements. After the dry period ended the EH, the climate became gradually wetter during the MH. Interestingly, in the transition to the early LH there was another dry period (Weiberg *et al.* 2016:47-48). This coincides with dynamic transformations encompassed in this transitional phase, also called the Shaft Grave Period, which later lead to the Mycenaean cultural complex.

According to Bintliff, the type site of the MH period is, "a hill-top village […] which had a possible chief's house in its center and peasant houses dispersed elsewhere inside its primitive fortification wall" (Bintliff 2012:165). He based this on Malthi in Messenia, which is problematic, because the site has no clear chronology.[55] Bintliff also pointed to the smaller scale of buildings and the simple pottery as signs of a cultural decline during this period. The poverty of artefacts in the often simple pit graves is another characteristic of the MH (Nordquist 1990:36; Hielte-Stavropoulou 2004:17).[56]

In her study of the political organization of the MH-LH periods, Voutsaki suggested that the organization of the MH period was based on kinship relations. She based this on mortuary evidence, which consists of a few grave goods and simple grave types, and the apparent circulation of goods between households, i.e. there was seemingly no concentration of luxury items, such as imported pottery ware connected to specific households (Voutsaki 2010a). In this study, and in other, Voutsaki used Asine as type-site for the MH, therefore I return to her research several times in this text and in the papers (e.g. Voutsaki 2010a; 2010b; Voutsaki *et al.* 2011).

The organization of the MH communities changes at the end of this period, in MH III (ca. 1800-1700 BCE). On the Peloponnese a general increase of settlements and colonization of new areas is observed (Weiberg *et al.* 2016:55). We begin to see the appearance of monumental graves such as the tumuli and chamber tombs, and an increased richness in grave goods that did not exist in the earlier MH.[57] From being not very different from other sites in the region, Mycenae clearly stands out in the later MH with the unequivocal wealth exhibited in its shaft graves. Voutsaki argues that this is symptomatic of the increased importance of this settlement in the region

[55] On-going investigations of Malthi are currently aimed at acquiring, among other things, a better resolved chronology of the site (Lindblom 2016).

[56] This poverty of grave goods is also discussed in Paper V.

[57] Nevertheless, there are earlier examples of tumuli, such as the Asine IQ tumulus, which is dated to the MH II period (Dietz 1980; Voutsaki *et al.* 2011).

(Voutsaki 2010a:97). It seems to indicate a shift in power balance, to the advantage for Mycenae in the subsequent Late Helladic period, in which the Mycenaean cultures flourished.

Asine during the MH to early LH periods

Despite the general tendencies of settlement decline, Asine grew in size during the Middle Helladic period. The houses and the walls dated to the Middle Helladic have been re-examined by Nordquist (1987:75-90). The following is largely based on Nordquist's analysis of the architectural remains of MH Asine. The houses mentioned are illustrated on Figs. 5 and 6. Many animal bones were found in association with these houses. Further, the architectural history is important, in order to understand the growth of Asine during this period, and thus to understand the context of this thesis.

During the end of EH, House T on Terrace III was built. It was in use already in MH I. This house was later partly overbuilt by the MH House U (Nordquist 1987:74; Wiersma 2013:121). However, we see most architectural changes in the Lower Town area (Fig. 5). The earliest MH addition to the Lower Town was House A, which was much disturbed by later constructions. This house was built slightly later than House T on Terrace III, probably during the MH II period (ca. 1900-1800 BCE) judging by the pottery (Nordquist 1987:76). Approximately contemporary with House A was House Pre-D, which was defined by Nordquist (1987), and not in the old publication (see Frödin & Persson 1938). Nordquist defined and detected this house, because of three walls that did not fit with the house plan of House D. She also defined a floor level (Floor 1) belonging to this house, based on the diaries (Nordquist 1987:81). Although this is a plausible reconstruction, finds assigned to this floor level should probably be considered as deriving from a mixed context.

The burials of the previous EH period are very few (see Pullen 1987), but they increase in number in the Middle Helladic period.[58] Burials were frequently found in the Lower Town and Terrace III trenches during the early excavations. At least 111 graves from the MH period were excavated on the Kastraki hill (Nordquist 1987:90). During the early MH we see the creation of a more formal burial ground, namely the East Cemetery (see Fig. 3). Except for the comparison between the Kastraki and the East Cemetery by Nordquist (1987:101), differences between these two burial areas have been explored by Voutsaki *et al.* (2011) and Ingvarsson-Sundström *et al.* (2013). Their research, which covers the late MH and early LH, has been based in mortuary evidence, i.e. grave architecture, grave goods and bioarchaeological remains. During

[58] For a more recent perspective on the Early Helladic graves on the Greek mainland, I refer to Weiberg (2013). She compiled mortuary evidence from many sites. Asine is mentioned, but not discussed in detail. Through the contextual evaluation of mortuary evidence, especially from the sites of Aghios Kosmas, Cheliotomylos, Manika, Tsepi and Zygouries, she showed that the archaeological evidence, although sketchy, is highly usable for the discussion of EH burial traditions.

the MH period at Asine, the graves of the Kastraki and the East Cemetery differ in mainly two aspects: the Kastraki graves contained more neonates and children than the East Cemetery graves, and the East Cemetery graves were more elaborate in general. For example, they were almost never simple pits, as was more common on the Kastraki (Ingvarsson-Sundström *et al*. 2013:156).

A second, and more extensive, expansion of Asine is evidenced from the late MH period, MH II-III (ca. 1900-1700 BCE). This expansion took place on the Lower Town area that extended to the slope of the opposite Barbouna Hill (Fig. 3). In the late MH II to the early MH III period, Houses B and D were built. They were constructed partly over Houses A and pre-D. House B is also called the Oval House on find labels and in the field diaries.[59] Although House B was partially disturbed during the Roman period, a large part of it remained intact and was documented during the excavations. Both Houses B and D had a complex planning: House D had an irregular shape, multi-roomed site plan, while House D had a rectangular shape, stairs, and many square rooms in different sizes. Both probably had an upper story. House D also had a courtyard to the west (Nordquist 1987:82). It is generally thought that Houses B and D were inhabited by people belonging to the wealthier social strata of the settlement because of their complex plans and shapes (*ibid*. 1987:90).

Contemporary to Houses B and D, we see the construction of dwellings on the opposite slope of the Barbouna Hill (Fig. 3; Hägg & Hägg 1973; Nordquist 1987:85). Buildings 1 and 2 belong to the Barbouna Hill area. They were smaller and less complex in their planning than the houses in the Lower Town. However, they have been severely disturbed by later activities. Even so, the Barbouna Hill houses have been compared to the Lower Town area (Voutsaki 1997; Voutsaki 2010b, Paper IV). Apart from the mentioned architectural differences between the areas, other differences between the areas indicate the beginning of a social stratification at Asine. For example, this is visible in the higher abundance of imported ceramic ware and wild animals/food stuff in the Lower Town vs. Barbouna Hill (Paper IV). The mortuary evidence also seems to support this, as discussed below.

The existence of differences in social status within the Asine population is supported by the mortuary evidence of the late MH and early LH periods. The Barbouna Hill settlement was abandoned after a short time of use, and was re-used as a place for burials (Hägg & Hägg 1973; Nordquist 1987; Milka 2010). The three cemeteries, East Cemetery, Barbouna Hill and Kastraki, and differences between them have been explored from several angles in order to discuss the social complexity at Asine (e.g. Voutsaki *et al*. 2011; Ingvarsson-Sundström *et al*. 2013). Subtle differences found between the East Cemetery and the Kastraki during the early MH became more pronounced during the late MH. The East Cemetery is different, because its burials

[59] The Oval House is called 'Ovalhuset' in Swedish.

contained more grave goods, were most often cist graves and not pits, and contained the only burials with golden objects (Voutsaki *et al.* 2011:453; Ingvarsson-Sundström 2008; Ingvarsson-Sundström *et al.* 2013:153). Fewer graves with gifts were found in the Kastraki. More children and newborns were buried in Kastraki and Barbouna.

Further, the people buried in East Cemetery might have had a different diet. This is indicated by the stable isotope analysis made on individuals buried at Asine (Ingvarsson-Sundström *et al.* 2009). Ingvarsson-Sundström *et al.* (2009) suggest that some individuals found in East Cemetery graves relied on terrestrial animal protein in their diet. This heavy focus on meat from land sources could not be found from the analyses of other individuals at Asine buried in Barbouna or Kastraki graves (Ingvarsson-Sundström *et al.* 2009; Ingvarsson-Sundström *et al.* 2013). According to Ingvarsson-Sundström *et al.* (2009) the dietary patterns in general indicate that marine resources were not an important part of the diet (see Section 3.2.1).

To summarize, it seems that the Middle Helladic period was a dynamic period for the inhabitants of Asine. House T on Terrace III can be traced to at least the MH I period (ca. 2100-1900 BCE). Houses were constructed in the Lower Town area during the earlier MH, such as Houses A and Pre-D. In the MH III period, Houses D and B were built in the same area, and the slope on the opposite Barbouna Hill was settled as well. These different parts, the Lower Town and the Barbouna Hill, were most likely inhabited by the different social strata of the village, with the wealthier stratum situated in the Lower Town. This increased complexity is reflected in where certain people were buried. At the time, a formal cemetery, the East Cemetery, existed. It contained relatively wealthier graves than the other areas. Eventually, the settlement on Barbouna Hill was abandoned at the end of the period and remade into a third burial ground. It has been suggested that the social system of the time was based in kinship relations, manifested in trade networks, a non-specialized economy and domestic craft production (Voutsaki 2010a). Nordquist (1987) suggested that, during this period, Asine was important for its immediate valley. Although Asine was part of the regional organization, perhaps as a node to other regions, it did not however achieve the same central status regionally as, for example, Argos probably did (Bintliff 2010:760).

3.2.3 Late Helladic Asine and after the LBA “crisis”, ca. 1700-1050 BCE

General outline of the Late Helladic, focusing on the Mycenaean period

During the early Late Helladic period (LH I-II, ca. 1700-1420/10 BCE), we can see the emergence of the Mycenaean cultural complex on the Peloponnese. The culmination of this system is traditionally placed in the LH IIIA-B periods (ca. 1420/10-1200 BCE). The Mycenaean culture is often visualized by the grandiose and richly furnished elite graves, such as the tholos tomb called ‘Treasury of Atreus’ or

‘Tomb of Agamemnon’ in Mycenae. However, this period is characterized by the construction of palaces and palatial centers, such as Mycenae in Argolis and Pylos in Messenia. These centers formed the nodes in a large interregional economic system, which had communicative links well beyond the sphere of the Peloponnese or indeed the Aegean (e.g. Shelmerdine 1997; Tartaron 2013). Besides the wealth attested in the elite burials, as well as the palatial centers, the Mycenaean period is also characterized by an increase in settlements (Dickinson 1994:77; Shelmerdine 1997:551).

The organization of the system has been the focus of research on the Mycenaean period (e.g. Galaty & Parkinson 1999; Nakassis *et al*. 2011; Halstead 2011a), and is not elaborated on here. However, textual sources indicate that the palatial centers managed to maintain the power to mobilize several resources through negotiations, such as taxation and exchange, with the hinterland (e.g. Shelmerdine 1997:567; Burns 2010:111; Bintliff 2012:197-199). While certain types of production, especially crops and animals, was mainly located outside the palatial centers, production of prestige items such as jewelry was made within the palatial sector. Thus, the palaces could redistribute such items both to ranked individuals as payments, or rewards, and to long-distance contacts (Halstead 1999:42). Eventually, the palatial system collapsed around 1200 BCE, coinciding roughly with the downfall of New Kingdom of Egypt and the Hittite empire. This collapse of civilizations was initially explained as the consequence of the invasion of ‘Sea Peoples’, unknown destructive migrants, but this hypothesis is now outdated (see Dickinson 2010:483). Most explanations relate either to warfare (invasions and/or internal struggle), natural catastrophes, or system failure (Shelmerdine 1997:483; Dickinson 2010:487; Kaniewski *et al.* 2013).[60] The collapse coincided with a period of a more arid climate as well. It has been suggested that the Mycenaean system became stressed because of various internal and external reasons, and that it was this increasing strain that was the more causal factor in the collapse of the Mycenaean cultures (e.g. Maran 2009; Dickinson 2010:489; Weiberg *et al*. 2016:55).

Although the Mycenaean system with palace centers and extensive trade networks collapsed, the Peloponnese was not depopulated in the succeeding period, the LH IIIC (ca. 1200-1050 BCE). In fact, several settlements, such as Midea and Asine, flourished (e.g. Weiberg *et al.* 2010:168). Also, the palatial Tiryns was continuously settled in LH IIIC. At Tiryns the citadels were restored and the Lower Town given new layouts. Maran (2006) argued that this is indicative of the ideology of the post-palatial period, where the legitimation of power was partly based on remembrance of the past and providing proof of descent to the Mycenaean rulers.

[60] I refer to Weiberg *et al.* (2010) for a brief but insightful review of various scholarly attempts to explain the demise of the Mycenaean culture.

Asine during the Late Helladic, with emphasis on the Mycenaean and after
The continued inhabitation of Asine throughout the Late Helladic period is well attested. Styrenius (1975:183) suggested that the settlement of Asine was moved several times during the Late Helladic period. According to him, the area east of the Kastraki (the location of East Cemetery, Fig. 3) was settled in the early LH; then the settlement moved to the Barbouna Hill during the 13^{th} century BCE, and then back to east of the Kastraki again in the 12^{th} century BCE. Additionally, the excavations on the acropolis also revealed that Hellenistic fortifications were dug in to the remains of a LH IIIC settlement (Pentinnen 1997). This might mean that the settlement nucleus might have moved several times during the LH. However, this is not fully clear because several parts of the settlement might have been spread along the cliff and across the surrounding plain.

During the LH III (ca. 1420/10-1050 BCE), it seems as if the habitation on Terrace III diminished, while more houses were added to the Lower Town. The construction of houses took place both before and after the LBA collapse. I return to houses constructed in the LH IIIC period further down. Sjöberg (2001) has provided an architectural overview of the Lower Town houses from the later Late Helladic, LH III. This period should perhaps be viewed as a third expansion of the settlement, or perhaps relocation further down the cliff. Although Cavanaugh and Mee (1998:89) argued for the abandonment of this area at Asine in LH IIIB (ca. 1330/15-1200 BCE), this was later disproven by the presence of pottery from that period (Sjöberg 2002:65). Also, Hägg and Nordquist (1992:59-60) reported on the Late Helladic remains on the Barbouna Hill as mainly belonging to the LH II-LH IIIB period, with continuity to the LH IIIC, Proto-Geometric and Geometric periods.

Beside the habitation remains, we also have mortuary evidence from the Late Helladic period. From the Lower Town, at least 12 LH I-II (ca. 1700-1420/10 BCE) pit or cist graves were excavated (Frödin & Persson 1938; Cavanaugh & Mee 1998:57; Nordquist 1996). While Frödin and Persson (1938) only published eight chamber tombs, additionally 24 tombs were documented. Three of these were constructed in the LH II period; however, they remained in use until LH IIIC (Sjöberg 2002:67; see Frödin & Persson 1938:357). Most tombs were built during the LH III period. According to Sjöberg (2002), several tombs were used in both LH IIIA and C periods, which indicates that these tombs were not reused by new inhabitants but by people who had emotional connections to the site. Together with inclusion of LH IIIB pottery, she concluded that the site was not abandoned during the LH IIIB (Sjöberg 2002:67).

Several studies have been made on the finds from the chamber tombs.[61] For example, Gillis's 1996 study of the tin-foiled vessels in the Asine chamber tombs revealed that

[61] For example, there are several studies on the finds from chamber tombs I:1 and I:2 in Hägg *et al.* (1996). See also Gillis (2013).

this material category was more common at Asine than in most other sites in the Argolid. This has been taken as evidence of the prosperity of the upper class at the site. Gillis (1996:98) discussed the occurrence of exotic material in tombs in terms of site function, meaning that Asine was probably an important harbor town in the Mycenaean network of Argolis.

After the Mycenaean 'collapse' ca 1200 BCE, it appears that several houses were added to the Lower Town; for example, House F, interpreted as a domestic building, was constructed during the LH IIIC (Sjöberg 2001). In this period we also see the appearance of Houses G, I, K, and L (Fig. 5).[62] House G is a larger house, which seems to have been inhabited well into the Geometric Period. It contained two large rooms with preserved floors, Rooms XXX and XXXII (Frödin & Persson 1938:75-76). Room XXXII, of which the latter was a megaron-like room. On the floor of this room a deposit of vessels was found, with quite special finds; for example, the famous 'Lord of Asine' terracotta figurine (Frödin & Persson 1938:308).[63] This deposit is contemporary with the settlement remains on the acropolis (Pentinnen 1997:165). The Lord of Asine has since become a classical symbol of ancient Asine.[64] House I was interpreted as a multifunctional house, perhaps a place of production based on the presence of a kiln in Room XLII (Frödin & Persson 1938:67). It is dated to the LH IIIC and the Geometric Period, while House K and L are dated to the LH IIIC respectively LH IIIB (Sjöberg 2001). Additionally House H replaced House G in LH IIIC. Terrace III seem to have been re-activated with the addition of House W, which destroyed House U. This is, however, uncertain since the remains of this house are so poorly preserved (Frödin & Persson 1938:93; Sjöberg 2001).

To summarize, Asine was continuously inhabited during the Late Helladic period. The activities were mostly concentrated in the Lower Town and the Barbouna Hill. In the beginning of this period the settlement either including several areas on the Kastraki and the opposite Barbouna hill, or had a moving or rotating nucleus. Several chamber tombs testify of the social complexity at the site. Besides these, ordinary pit or cist graves have also been found. After the collapse of the Mycenaean system and through the LH IIIC period, the settlement at Asine thrived and even expanded, with at least four new houses added.

---

[62] House G was called the 'Mycenaean Palace' by the excavators.

[63] The finds on the floor of Room XXXII were described by Frödin and Persson (1938). Additionally, sixteen animal bones from this context (AS 3998, 4106) were recorded. None were identified to species although two ribs and one metapodial fragment were identified among these bones.

[64] This figurine has been the focus of some re-interpretations, starting with the initial interpretation, as it belonging to a male figurine, based on its beard-like protruding chin. One of the last interpretations was made by D'Agata (1996), who suggested that it belonged to a figurine of a fantastic animal and should be dated to the mid-LH IIIC, based on technological, morphological and chronological characteristics.

4. The animal bones from Bronze Age Asine

In order to provide a contextual background to the study of waste management at Bronze Age Asine, it is necessary to present the study material and the methods applied to it. Therefore this chapter includes, first, a quantitative and qualitative description of the animal bones from Asine, with a discussion on the preservation, fragmentation and identification rates among the bones. A longer elaboration on which methodologies were used in the zooarchaeological analysis is also included. Second, the taphonomic history of the Asine assemblage is discussed, which consists of a description of the taphonomic impact on the Asine bones, starting with the latest processes after the excavation and finishing with the earliest, the slaughter and butchery of animals.

4.1 Material overview and methods of zooarchaeological analysis

Although the bulk of the Asine animal bone collection has not been studied, zooarchaeological analyses have been conducted on parts of the material. Gejvall studied samples recovered from the 1970s excavations, but he never published his work. Moberg Nilsson published segments of the material in two papers (Moberg 1992; Moberg Nilsson 1996) and one appendix (in Hägg & Nordquist 1992:67-68). In her Bachelor thesis she discussed some of the animal bones from Terrace III and *bothroi* 2, 4 and 11 (Moberg 1986).[65] Mylona studied the animal bones from the excavations east of the Acropolis, the Karmaniola sector.[66] The catalogue of the animal bones from Asine recorded as part of this thesis has been published as part of the PRAGMATA database (Swedish Institute at Athens *et al.* 2017). PRAGMATA enables interested researchers to continue the study of these remains from Asine and

[65] Her results were not used in Paper III, which is based on a re-examination of the animal bones and the stratigraphic units associated with *bothroi.*

[66] Mylona has kindly provided preliminary results, which were used in Paper V.

its material culture, especially the pottery and the bones, via an interactive web-interface. The web-based bone catalogue is described in Appendix 2.

The zooarchaeological remains from the Bronze Age settlement of Asine, i.e. Early Helladic to the Late Helladic IIIC, amount to 17 498 bones in total (ca. 141 971g).[67] Of these, 6 129 bones (35%) were identified by taxon, while 11 369 (65%) remain unidentifiable (Figure 7).[68] This is roughly consistent in all sub-assemblages from all Bronze Age periods. On average, an animal bone from the Asine collection weighs 8.47 g and is 28.9 mm long (Table 2). We can observe that, during some periods, the identification rate is higher, as, for example, in the EH III-MH I period. This correlates with heavier fragment weight and bigger fragment size on average. This sub-assemblage is better preserved compared to the others. Many animal bones from this period derive from *bothroi* (Paper III). These pits were closed relatively quickly, which probably partly protected these bones from mechanical erosion on the ground surface, as opposed to much of rest of the Asine assemblage, which was found in open-air cultural layers, accumulated during time and covering large parts of the site. This might explain the seemingly better preservation of these bones.

We can observe that in some periods the identification rate is lower than average (Table 2; Fig. 7). This correlates to the lighter average weight and smaller average sizes of the animal bones. For example, a lowest identification rate can be found in the sub-assemblage from the Late Helladic, where 70% remain unidentifiable. The bones from this period are also, on average, the smallest (24 mm) and lightest (6.5 g). This information suggests that the animal bones from the LH are the most fragmented, in relation to the other sub-assemblages.

In Table 3, recording methods are presented. Not all variables stated in this table are of direct relevance to the aims of this thesis, but were included because they are considered standard in any zooarchaeological analysis. For example, measurements were taken following the standards provided by von den Driesch (1976), even though osteometric analyses have not been important for the articles incorporated in this thesis. The same reasoning applies to pathological features on animal bones, which were recorded when observed. The following text is devoted to the methods of recording and assessing quantification, identification, age/sex and taphonomic markers.

[67] For the purpose of providing a quantitative overview and a rough generalization of the material from the Bronze Age, Section 4.1 includes the bones from all contexts dated to the more broad EH, EH III-MH I, MH, MH III-LH I, LH and LH IIIC. In the next part of this chapter, I provide the NISP-counts from more narrowly dated periods (EH, EH III-MH I, MH I-II, MH III-LH I, LH I-II, LH IIIA-B and LH IIIC).

[68] The count presented here excludes grave-related contexts. Animal bones found in the graves of the Middle Helladic Asine are included in Paper V.

Table 2.
Quantitative overview of the animal bones from Bronze Age Asine. Number of Specimens (NSP), Number of Identified Specimens (NISP) and Number of Unidentified Specimens (NUSP) are used as quantification. I refer to Section 4.1.1 for clarification on quantification

	EH	EH III-MH I	MH	MH III-LH I	LH	LH IIIC	Total
NISP	354	817	2 418	488	1 530	522	6 129
NUSP	670	1 247	4 007	810	3 838	797	11 369
NSP	1 024	2 064	6 425	1 298	5 368	1 319	17 498
NISPWeight (g)	5 946.5	15 851.3	39 931.2	7 318.4	23 770.7	9 701	102 519.1
NUSPWeight (g)	2 665.2	4 704.2	15 322.8	2 683.7	11 101.4	2 974.7	39 452
TotalWeight (g)	8 611.7	20 555.5	55 254	10 002.1	34 872.1	12 675.7	141 971.1
Average weight (g)	8.41	9.96	8.60	7.71	6.5	9.61	8.47
Average size (mm)*	31.86	31.98	31.41	27.23	24	26.89	28.89

*in total, 13 646 bones were measured, covering at least 55 % of NSP (MH III-LH I) up to 96% of NSP (EH III-MH I)

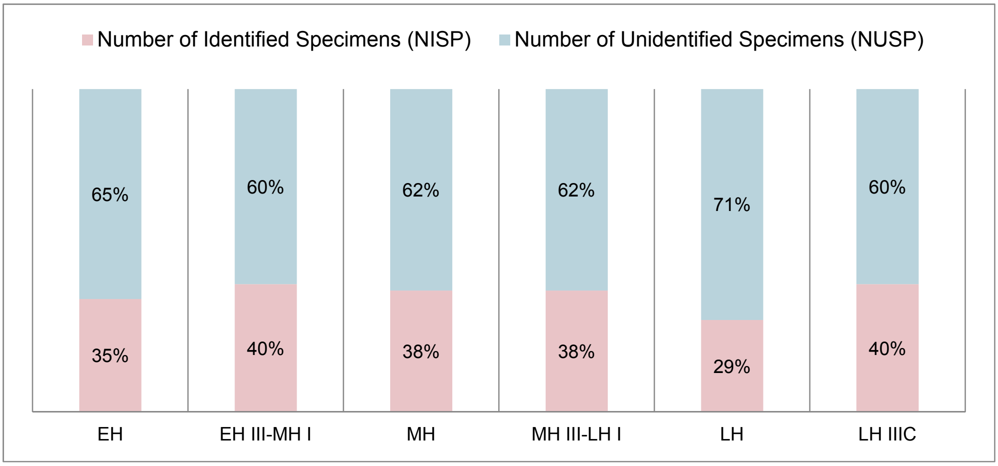

Figure 7.
Identification rates (%NSP) in each chronological phase of Bronze Age Asine. Number of Specimens (NSP), Number of Identified Specimens (NISP) and Number of Unidentified (NUSP) are used as quantification. Section 4.1.1 includes a clarification on quantification terminology.

Table 3.
Recorded osteological variables in the zooarchaeological analysis.

	Methodological unit or issue	Recording procedure	Reference
Quantification	NSP	All recorded bones	Lyman 2008:266
	NISP	All recorded bones	e.g. Reitz & Wing 1999:156; Lyman 2008:27
	NUSP	All recorded bones	Lyman 2008:266
	Weight (g)	All recorded bones	Reitz & Wing 1999
	Approximate size (mm)	All recorded bones after October 2013	
	MNE	Derivative measure based on the most numerous skeletal elements	Reitz & Wing 1999: 215-216; Lyman 2008:218-222
	MNI	Derivative measure based on the most numerous skeletal elements	Reitz & Wing 1999: 215-216; Lyman 2008:38-43
Taxonomic identification	Distinguishing between sheep and goat	Species identification was based on horn core morphology (Schmid 1972), cranial features (Boessneck 1969; Prummel & Frisch 1984) and the bone elements assessed as highly reliable by Zeder & Lapham (2010:Figs. 1-9)	Boessneck 1969; Schmid 1972; Prummel & Frisch 1984; Zeder & Lapham 2010
	Distinguishing between red deer and cattle	Species identification was based the characteristics of specific bone elements provided by Prummel (1988)	Prummel 1988
	Distinguishing between fallow deer and red deer	Species identification was based the characteristics of specific bone elements provided by Lister (1996)	Lister 1986
	Distinguishing between equids	Species identification was based on the occlusal patterns of the teeth (Davis 1980)	Davis 1980
	Distinguishing between domestic pig and wild boar	Non-metrical methods (morphology on certain cranial bones, such as the lacrimal bone, and canine size) are only used in evident cases. Measurements on the lower third molar were used to evaluate the pigs at Asine. Further measurements listed by Rowley-Conwy *et al*. (2012) have been taken. It is the lower third molar that is used for osteometrical analysis of the inclusion of wild boar in the sample.	Payne & Bull 1988; Mayer *et al*. 1998; Rowley-Conwy *et al*. 2012
Age assessments	Cattle, sheep/goat and pig	Postcranial epiphyseal union data	Silver 1969:285-286; O'Connor 1982; Vretemark 1997:41
	Equids	Postcranial epiphyseal union data	Silver 1969:285-286; O'Connor 1982; Vretemark 1997:41
	Dog	Tooth eruption and epiphyseal fusion followed the ages provided by Silver (1969) and Schmid (1972).	Silver 1969:285; Schmid 1972:75
	Cattle	Grant's score system (1982) was used for loose teeth and mandibles. CEJ score system by Jones & Sadler (2012) was implemented to test the method. The ages provided by Brown *et al*. (1960) and Silver (1969) were used for tooth eruption	Brown *et al*. 1960; Silver 1969; Grant 1982; Jones & Sadler 2012
	Sheep and goat	Both Payne's and Grant's score systems were recorded on loose teeth and mandibles. The ages provided by Silver (1969) were used for tooth eruption	Silver 1969; Payne 1975; 1987; Grant 1982; see Greenfield & Arnold 2008
	Pig	Grant's score system (1982) was used for loose teeth and mandibles. The ages provided by Silver (1969) and Magnell and Carter (2005) were used for tooth eruption	Silver 1969; Grant 1982; Magnell & Carter 2005

	Horse	The ages provided by Habermehl (1961) and Silver (1969) were used for tooth eruption. Measurements of heights and mesio-distal diameter provided by Levine (1982) were used for age assessment	Habermehl 1961; Silver 1969; Levine 1982
	Red deer	The score system by Brown *et al.* (1991) were used, although very few mandibles were found	Brown *et al.* 1991
Sex assessments	Cattle	The characteristics of the pelvis provided by Vretemark (1997:41) were used	Vretemark 1997
	Sheep and goat	The characteristics of the pelvis provided by Boessneck (1969) were used	Boessneck 1969:344-347
	Pig	Sex assessment was made on basis of canine morphology after Lehr-Brisbin and Meyer (1988)	Mayer & Lehr Brisbin 1988:411
Measure-ments	millimeter (mm)	Measurements were taken according to the von den Driesch (1976) standard. Crown heights were measured according to Klein and Cruz-Uribe (1984)	von den Driesch 1976; Klein & Cruz-Uribe 1984
Pathological marker		Pathological change on bone was noted whenever observed. The recording of age of enamel hypoplasia on pig teeth followed Magnell and Carter (2005)	Magnell & Carter 2005
Taphonomic marker	Butchery	Following Binford (1981)	Binford 1981
	Gnawing	Following Haynes (1985) and Thilderquist (2013) (see Appendix 4)	Haynes 1985
	Trampling	Following Andrews and Cook (1985) (see Appendix 4)	Andrews & Cook 1985; see Thilderquist 2013:13
	Thermal modification	Color changes and bone surface changes were recorded	Lyman 1994:385-392; Asmussen 2009
	Weathering	The score system formulated by Behrensmeyer (1978) was used (see Appendix 4)	Behrensmeyer 1978
	Root erosion	Root etchings visible on bone surface	
	Post-depositional erosion	Surface change (abraded surfaces), mineral encrustation and calcification (see Appendix 4)	
	Excavational erosion	E.g. hatchet marks (see Appendix 4)	
	Post-excavation breakage	Fresh fractures, acid cleaning, fresh fragmentation (see Appendix 4)	
Other	Remarks on articulation status, sample taken for chemical analysis, photographs taken		

4.1.1 Quantification methods

The choice of quantification methods is central to presenting data on the number of animal bone fragments within an assemblage. How one chooses to quantify the material is also important when processing and analysing skeletal part representations of the different species represented in the assemblage. In Table 3 the different quantification methods mentioned in this thesis are presented. The Number of Identified Specimens (NISP) is provided in all papers. The inclusion of the Number of Specimens (NSP) and the Number of Unidentified Specimens (NUSP) is important because the unidentifiable specimens might also exhibit important information about waste management and other taphonomic processes (see Lyman 2008: 266). This is illustrated in Paper I, in which a multiple correspondence analysis (MCA) was applied to the MH animal bone assemblage from Asine. For example, the unidentifiable long bones were more weathered. If only including identifiable specimens, this would then lead to a picture of the impact of weathering on the assemblage which is incorrect.

Minimum Number of Individuals (MNI) is included in Paper IV, and Minimum Number of Elements (MNE) in Paper V.[69] These two methods are secondary in their nature, meaning that, while NISP is simply the total count of the specimens, MNI and MNE are derived measures. I have included information on other quantification measures, alongside NISP, such as weight, MNI and MNE, in all papers, except Paper I. The advantages and disadvantages of MNI-related methods contra NISP is a widely debated subject within zooarchaeology. It will not be elaborated on here; for a full review of this discussion I refer to Grayson (1984), Ringrose (1993), Pilgram and Marshall (1995) and Lyman (2008).

In general, I agree with Magnell (2005:19), who argued for the use of several methods instead of one, especially where there are known problems with both MNI and NISP. For example, NISP suffers from a possible interdependence of bone remains, i.e. that two fragments could theoretically derive from the same bone. Thus the same bone would be counted twice using NISP (e.g. Lyman 2008:30). However, when it comes to the Asine animal bone assemblage, there are insurmountable problems with the use of MNI, in terms of the so-called “Adams’ dilemma” (Grayson 1984:29; Lyman 2008:59-60). Depending on which level of contextual resolution one chooses to use, e.g. all the bones from one time period or divided into specific contexts, such as grave infills, the MNI-count will be different. I consider this an issue greater than the high fragmentation induced by post-depositional erosion, especially on the Barbouna Hill bones, mentioned above (see Paper IV).

This issue is related to the problems of reconstructing the stratigraphy in some areas of the site (see Chapter 3). Each defined context must be evaluated through the field diaries in which the excavation method also is mentioned. This might have differed between excavators. Some excavated the soil in spits and some stratigraphically. Single contexts, such as dump layers within a larger infill in a room, might not always have been seen or might have been neglected, which makes the derivation of MNI on basis of strata or architectural features uncertain. There is insufficient documentation to

[69] In relation to MNI, the Most Likely Number of Individuals (MLNI), a variant of the Lincoln Index, which is based on pair-matching of elements, has proven useful as a quantification of well-preserved commingled human remains (Adams & Konigsberg 2004). However, Adam and Konigsberg (2004:150) acknowledged that, in very fragmentary or poorly preserved materials, this method is limited. Its usefulness in heavily fragmented and large zooarchaeological assemblages is uncertain.

make such derivations plausible. Instead, we would have to make the MNI-calculation over broader time periods. Given the nature of MNI, this count will be smaller than if it was based on more detailed documentation: thus, it is not trustworthy. Using the NISP-counts is therefore better, because they are cumulative and do not change, regardless of contextual level. The number of identified bones added together is the same, whether or not they are separated between different strata.

Data on MNE and MNI is presented in some of the papers. If used, the basis of the calculation of MNI has been stated accordingly: the maximum distinction method (maxMNI), i.e. high contextual resolution, such as graves or specific infill layers, or minimum distinction method (minMNI), i.e. all bones from one area or time period, disregarding stratigraphic units (Lyman 2008:29). These counts differed while the NISP-count remained the same, disregarding the choice of context resolution. In the continuation of this thesis, only NISP-counts are provided unless stated otherwise.

During analysis, every specimen, i.e. bone, teeth or fragment thereof, was counted and weighed. Additionally, the approximate size (mm), rounded to the closest even number, of each specimen was measured. The weighing and measuring was made in order to provide basis for calculating average fragment sizes and weights; as such they are not used for quantification *per se* but for assessing the material's fragmentation degree. The average sizes and weights for the Asine animal bones are summarized in Table 2. In Paper IV I provide average fragment sizes and weights in order to discuss differential fragmentation in the two dwelling areas, Lower Town and Barbouna Hill, at Asine during MH III-LH I.

4.1.2 Taxonomic identification

This section focuses on the separation of sheep from goat, and of wild boar from domestic pig. Because of their similar size and morphology, the differentiation between sheep and goats is known to be difficult. This is problematic, because there are certain differences in their behaviour and their products. When separating the two animals, I have used the morphological characteristics of the post-cranial skeleton, following the recommendations of Zeder and Lapham (2010).[70] Additionally, horn core morphology and cranial features have been used, as described by Boessneck (1969) and Prummel and Frisch (1986). The Zeder and Pilaar (2010) study on using the mandibles and mandibular teeth for identifying sheep and goat showed that certain teeth, such as M1, are particularly unreliable in the separation of sheep and goat (cf. Payne 1985a; Halstead *et al.* 2002). More importantly, the dental criteria are positively biased towards sheep, i.e. they perform well in the identification of sheep

[70] Recently, morphometrical approaches to this issue have been presented (e.g. Davis 2017; Salvagno & Albarella 2017), showing that such methods are promising for the osteological separation of sheep from goat. However, the bone recording for this study finished before these papers were published.

but not so well for goats. Also the study of Zeder and Lapham (2010) on postcranial elements as the basis for separating species showed that the postcranial criteria are more reliable than the dental criteria. For these reasons, I have chosen to exclude dental criteria in the separation of sheep from goat.

When it comes to wild boar and domestic pig, size differences and metric data have traditionally been used to separate them (e.g. Payne & Bull 1988; Mayer *et al.* 1998). Except for a few obvious specimens, I have not used morphological characteristics for this separation.[71] Instead, I have assessed the input of wild boar by using metric data from the width and length of the lower M3, although also other measurements, as suggested by Rowley-Conwy *et al.* (2012:14), can be used. Figure 8 is a scatterplot of the breadth and the length in the lower M3 of suids at Asine from different time periods, compared to the average width and length from other known pig populations. Data from temporally and spatially closer sites are included. Table 4 contains measurements used in Fig. 8.

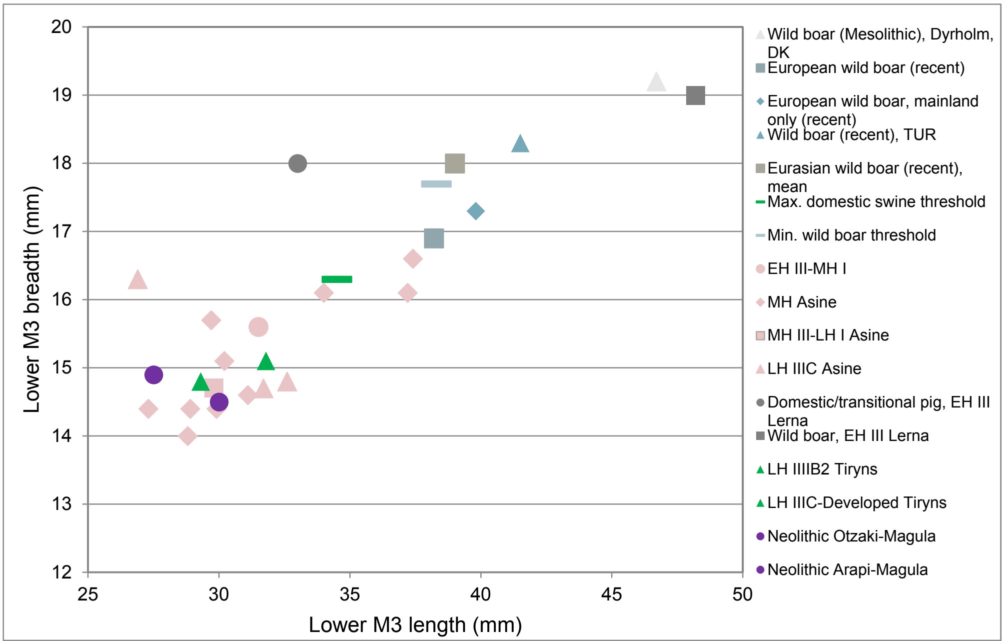

Figure 8.
Scatter plot of the length against the breadth of the lower third molar of pigs. Specimens from Bronze Age Asine are plotted against a selection of specimens from other Greek sites from the Neolithic and the Bronze Age, from the North European Mesolithic and from modern references in Europe (Data presented in Table 4).

[71] On some level, this follows the logics of Gejvall (1969), where the "distinction between wild and domestic pig in a collection such as this one, with the kind of fragments which make it up, is inevitably somewhat arbitrary". The exceptions have been exceptionally large canines. But this could still be an uncertain identification, since there are ethnographic cases of pig rearing to produce large canines, such as on the Vanuatu in Melanesia (Funabiki 1981).

Table 4.
Measurements of the breadth and the length of the lower third molar at Asine, as well as from modern and prehistoric specimens. Data used for Figure 8.

Site	Length, lower M3	Breadth, lower M3	References
EH III-MH I Asine	31.5	15.6	
MH Asine	37.4	16.6	
MH Asine	27.3	14.4	
MH Asine	28.9	14.4	
MH Asine	34	16.1	
MH Asine	30.2	15.1	
MH Asine	29.7	15.7	
MH Asine	29.9	14.4	
MH Asine	28.8	14	
MH Asine	31.1	14.6	
MH Asine	37.2	16.1	
MH III-LH I Asine	29.8	14.7	
LH IIIC Asine	32.6	14.8	
LH IIIC Asine	31.7	14.7	
LH IIIC Asine	26.9	16.3	
Neolithic Otzaki-Magula, Greece, mean	27.5	14.9	Boessneck 1956:35
Neolithic Arapi-Magula, Greece	30	14.5	Boessneck 1956:35
Domestic/transitional pig, EH III Lerna, Greece	33	18	Gejvall 1969:72
Wild boar, EH III Lerna, Greece	48.2	19	Gejvall 1969:72
LH IIIB2 Tiryns, Greece, mean	31.8	15.1	von den Driesch & Boessneck 1990:139
LH IIIC-Developed Tiryns, Greece, mean	29.3	14.8	von den Driesch & Boessneck 1990:139
Wild boar (Mesolithic), Dyrholm II, Denmark, mean	46.7	19.2	Rowley-Conwy *et al*. 2012: table 2
Domestic pig, Neolithic Durrington Walls, UK, mean	34.5	15.7	Rowley-Conwy *et al*. 2012: table 1
Wild boar (recent), Turkey, mean	41.5	18.3	Payne & Bull 1988
Eurasian wild boar (recent), mean	39	18	Mayer et al. 1998: table 1
European wild boar (recent), mean	38.2	16.9	Albarella *et al*. 2009:108
European wild boar (recent), mainland, mean	39.8	17.3	Albarella *et al*. 2009:108
Maximum domestic swine threshold	34.5	16,3	Mayer *et al*. 1998: table 1
Minimum wild boar threshold	38.3	17.7	Mayer *et al*. 1998: table 1

The osteometric evaluation in Fig. 8 indicates that the input of wild boar in the Asine assemblage is small. From the MH, there seems to be occasional instances of feral or wild boar. The two measured specimens from nearby EH III Lerna were determined as belonging to a wild boar and a domestic or transitional pig (Gejvall 1969:72). While the former clearly is of the size of wild boar, the latter might be a feral swine. The Lerna teeth are clearly bigger than the probably domestic specimen from EH III Asine. The pigs at MH, MH III-LH I and LH IIIC Asine seem to have been similar in size to individuals from LH III Tiryns.[72] According to von den Driesch & Boessneck (1990:102), the tooth sizes from Tiryns are characteristic of Late Bronze Age pigs. The measured teeth from Neolithic Otzaki-Magula and Arapi-Magula (Boessneck 1956:35) are similar to the smaller measurements obtained through teeth from MH Asine.

4.1.3 Age and sex assessment methods

I have mainly used information on the age and sex of the animals in the discussion of selection of specific animals in consumption or refuse disposal patterns. Data on the distribution of body parts as well as age and sex data are included in Papers I, III, IV and V. The chosen methods of age and sex assessments for each species are specified in Table 3. Since the aims of this thesis did not include a mortality study, I have not delved into the refinement and evaluations of existing age and sex assessment methods. Traditional morphological characteristics of the pelvis were used for sexing the bovines and caprines. Canine morphology was used for assessing suid sex. Osteometric evaluations have not been made, although there is a large sexual dimorphism at least in wild boar (Magnell 2005:31).

In general, zooarchaeologists distinguish between age data deriving from i) dental features, i.e. tooth eruption and wear, and ii) post-cranial epiphyseal fusion status. These two kinds of data have advantages and disadvantages, discussed in relevant literature (e.g. Reitz & Wing 1999:161-162 and references therein). In the analysis, both dental and post-cranial features were recorded whenever possible. However, in the processing of the data and the papers post-cranial data on epiphyseal fusion states were mainly used. This depends on preservation factors. Although teeth, with their enamel, are fairly resistant towards post-depositional destruction, few complete mandibles were preserved in relation to the dia- and epiphyses which could provide fusion data. Loose teeth were not used in reconstructing mortality curves, although they were more numerous than complete mandibles. Dental ages are reconstructed on basis of tooth eruption and attrition. Often attrition patterns within the dentition, i.e. relative wear patterns, rather than on individual teeth are considered more relevant. This is because tooth wear depends on many factors, which might be relative, such as diet, the non-feeding habits of the animal (e.g. biting the crib), tooth development and microstructure. It is therefore hard to assume constant wear rates for any given species (Hillson 2005:215).

In short, any reconstruction of mortality curves were made on the basis of post-cranial data because there is a larger data set based on this material. Using only post-cranial data makes the mortality curves less exact for the most juvenile ages and the senior

[72] For the locations of Tiryns and Lerna, see Figure 2.

adult specimens. This is especially unfortunate if the focus is to provide a discussion on the animal management at the site, or any specialization thereof, because the culling of very young individuals remained invisible. This is problematic for Paper I. In this paper, I could not give a precise overview of the animal management in regards to culling patterns; they remained relative and with broader age categories. Using broader age categories can, however, be sufficient for detecting any indication of sorting animal waste based on age or sex of the animals. For example, in Paper IV the occurrences of older pigs in the Lower Town were detected using postcranial data. Although based on low bone counts, this tendency was discussed in terms of a possible preferred consumption of older pigs in Lower Town of Asine, as opposed to the Barbouna area, during the MH III-LH I.

4.1.4 Taphonomic markers

A taphonomic perspective is important because waste management is a taphonomic formation process, meaning that the prehistoric refuse disposal strategies helped shape the zooarchaeological assemblage.[73] For example, burning bone as a waste management strategy would heavily increase fragmentation in the assemblage (e.g. Lyman 1994:389-391; Ballantyne *et al.* 2018). Because of this issue, the recording of taphonomic variables is of great importance in this study. Nine taphonomic markers on bones have been recorded on the Asine animal bones, namely butchery marks, gnawing, trampling, burning, weathering, root etchings, post-depositional erosion, damage from the excavation (e.g. hatchet marks), and recent breakage or other types of attrition (e.g. mold) after excavation.

Burning was recorded because it might have been a conscious waste management practice in prehistory. Marks of gnawing and trampling were also noted, since they indicate any throwing of the bones to carnivores or on a commonly trampled surface. Weathered bone signals exposure on the ground for a prolonged period of time, and could also be the consequence of decisions relating to waste management, such as leaving waste on the ground, and not depositing it instantly. In Table 3, the methods of recording these variables are presented. In Appendix 4, I provide typical examples of most the different taphonomic markers from the Asine assemblage, giving examples of how I have recorded these markers.[74]

The recording of butchery marks
Markers left on bone from the butchery are not directly relatable to the waste management process, in the sense that a cut mark is not a primary indication of the handling of waste. Rather, such indications are found in peri-depositional processes,

[73] Waste management as a cultural process and as a formation process is discussed in detail in Chapter 2.

[74] Examples of butchery marks, root etchings and burning are not provided in Appendix 4.

i.e. the period around the deposition of the bones, which involve e.g. weathering, carnivore gnawing and trampling. One might argue that butchery strategies might influence the size of the animal remains which were discarded as waste, for example. Still, the presence of butchery marks is less indicative of such patterns than bone fragment size, especially in a heavily fragmented sample. I have recorded both butchery marks and fragment size, and have not been able to find any definite indications of size sorting in the assemblage from Asine.

Fragment size may also be affected by butchery, if pounding bones for marrow was common. This particular process might be hard to quantify, although fractures from marrow extraction sometimes are visible on bone (Binford 1981:148-163). There are few indications of this process in the Asine assemblage. I have included data on butchery marks in Papers I and III. Butchery marks were recorded if present, following the terminology and recommendations by Binford (1981) based on the hunting society of the Nunamiut Eskimo from Alaska. Their butchery techniques may not necessarily be applicable in an Aegean Bronze Age context. Still, the terminology is widely used and its application can thus be justified in this study.

The recording of burning

It is well known that the chemical processes induced by fire cause colour changes of the bone. Additionally, the external and mechanical forces brought on by heat also affect the bone (e.g. Lyman 1994:387; Asmussen 2009:529). Asmussen (2009) provides an overview of the different variables available for the recording of burnt bone. Since this study focuses on waste management, it was important that the recording of burnt bone could generate insights on whether or not burning bones was a common refuse disposal method.[75] It is standard to record the colour of the bone surface in order to investigate the use of fire on bones. The compilation made by Lyman (1994:386), with the addition of a score chart, was used in the recording of burnt bones at Asine. The score chart is presented in Paper I. Colour was recorded using Munsell Soil Color Charts (1975), in controlled light conditions. Additionally, the degree of uniformity of burning on a bone, i.e. whether or not the whole bone was burnt, or only parts of it, was noted.

Except for the above two variables, it was initially planned to record changes of the bone surface, as described by Asmussen (2009).[76] Such changes include, among other things, shallow longitudinal fissures on calcined bones, which are indicative of the fact that the bone was dry before burning (Lyman 1994:387; Asmussen 2009:529). Asmussen (2009) asserts that the surface changes should only be regarded as complementary information (see also Macheridis 2013).[77] At least one cm^2 is needed

[75] This is discussed briefly in Paper I and Paper IV, see also Section 4.1.4.

[76] I refer to her study and to Lyman (1994) for references on surface changes of burnt bone

[77] In an experimental study on bone surface changes through burning, Goncalvez *et al.* (2011) showed that the presence of bone warping is not restricted to fleshed bone. Although the study was made on

in order to actually evaluate whether or not the cracks of the bone are longitudinal, shallow or deep in general, or if it is just the occasional crack. Surface changes have previously been observed on mainly calcined bone (Buikstra & Swegle 1989:255; Asmussen 2009:529), which means that they should be recorded only on calcined bone. Since calcined bones are very rare in the Asine animal bone assemblage, the recording of surface changes unfortunately did not yield sufficient amount of data on cracks to give a complementary picture of the fleshed or dry state of the bones prior to burning.[78]

The recording of gnawing and trampling

Gnawing and trampling should be attributed to the peri-depositional phase, i.e. around the time of deposition. Animal gnawing and the impact of scavengers are known taphonomic processes affecting most animal bone assemblages. Additionally to leaving distinctive gnawing marks, they also cause bone destruction and bone movement. Therefore animal gnawing and scavengers have been popular taphonomic research topics during the last decades (e.g. Binford 1981; Hayne, 1983; Marean *et al.* 1991; Klippel & Synstelien 2007; Fillios 2015).[79] The impact of this kind of bone destruction is important to evaluate because it has been shown that carnivores can have a large impact on the formation of the animal bone assemblage (Binford 1981; Marean *et al.* 1991). Their presence has been documented at Asine: thus we might hypothesize that they had some impact on bone taphonomy there.

In this study the recording of gnawing is important in order to assess bone destruction undertaken by carnivores, and to assess the throwing of bones to carnivores as a kind of waste management strategy in prehistory. I have used the identification guide of gnaw marks provided by Haynes (1983). Binford (1981) and Lyman (1994:207-216) to provide similar depictions of gnaw marks as well. Following these studies, I have recorded gnaw marks in the form of the presence or absence of tooth scratches, pitting or puncture marks. Some typical examples are provided in Appendix 4.

Trampling is often connected to the scattering of bones in areas such as streets or of intensive animal activity, causing bone movement.[80] Trampling can cause bone movement (vertical and horizontal), higher degrees of bone fragmentation (Gifford-Gonzalez *et al.* 1985; Lyman 1994:379-380), and scratch marks (e.g. Andrews & Cook 1985; Thilderqvist 2013). Trampling, in the form of scratch marks, has been

human skeletons, the recording of bone surface changes should perhaps be regarded as dubious. This supports the view on bone surface changes as complementary and not primary evidence of burning.

[78] Only 157 bones were partially (grey-white) or completely (white) calcined. This is 4.6 ‰ of the total recorded amount of bone, 33 687 specimens (including undated and mixed contexts).

[79] A good review of the research up to 1994 can be found in Lyman (1994:205-216)

[80] In relation to the term trampling, ‘treadage’ is used by Gifford-Gonzalez *et al.* (1985) for the vertical movement of objects.

recorded for this thesis. A typical example is found in Appendix 4. In his dissertation on early Medieval bone deposits of Northern Europe, Thilderqvist (2013) uses a relative score system from 0 (absent) to 3 (covering the whole specimen) to record trampling. This score system was applied initially to this study, but was found problematic in two aspects. First, trampling is often masked by other processes (Andrews & Cook 1985; Madgwick 2014). This is especially the case in the Asine assemblage, which is affected by root etching and other post-depositional processes (see 4.2). Thus, a score system based on the increasing intensity of marks is hard to use, since a specimen scored as 1 (few but clear marks), should perhaps be scored as 2, but root etches and gnawing often covered large parts of the bone. Second, trampling marks are often hard to identify from cutting or other scratch-producing processes, such as tooth scratches caused by gnawing. Therefore I believe that the evaluation of each specimen in terms of trampling involves an interpretative process resulting in either presence or absence.

Further, because of the large assemblage and limited amount of time the recording was made macroscopically. A microscopic investigation would probably have resulted in identifying more trampled bones. The identification of the presence of macroscopically detectable trampling are regarded as certain signs of trampling activities. However, the recorded absence of trampling marks does not necessarily reflect absence, but rather that, if the bone was affected by trampling it was not very destructive to the bone surface, or it was later masked by other kinds of erosive processes.

The recording of weathering
Weathering is a taphonomic process which involves the destruction of bone through chemical and mechanical erosion on the ground or in the uppermost soil. Thus, marks of weathering indicate prolonged exposure of the bones on the ground to the active elements, such as weather and sun. Weathering was recorded following the stages formulated and described by Behrensmeyer (1978), which ranges from 0 to 5, and are adjusted to mammals weighing over 5 kg.[81] The stages are cumulative and historical, meaning that weathering on bone increases with time. Bone can undergo post-depositional chemical weathering below the ground surface (Lyman 1994:360). This is not a common feature of the Asine animal bone assemblage, since the process of weathering left uneven marks on different side of affected specimens.

In his discussion of the interpretative potential of taphonomic observations, Orton (2012) chose not to use Behrensmeyer's method, because he claimed that "direct comparability between analysts is probably illusory". This is true if one regards the

---

[81] Behrensmeyer's definition of weathering is as follows: "the process by which the original microscopic organic and inorganic components of a bone are separated from each other and destroyed by physical and chemical agents operating on the bone in situ, either on the surface or within the soil zone" (*ibid.* 1978:153).

Behrenmeyer weathering stages as truly reflecting the time passed since exposure of the bones on the ground surface. Although attempts have been made to translate the weathering stages to absolute years (see Lyman 1994:354-360), it has been acknowledged that this is difficult, as the effect of the process depends, among other factors, on vegetation and climate zone. This is perhaps best exemplified by the study of a decaying cow cadaver in Somerset, conducted by Andrews and Cook (1985). No weathering could be detected on the bones during the seven years the cadaver was studied, while in Behrensmeyer's study, the first stage of weathering of the bone surface appeared between 0-3 years after the animal's death (Behrensmeyer 1978:157). Still, comparing frequencies using Behrensmeyer's stages can reveal information about differences within a sample, in terms of e.g. different contexts or time periods. In such cases, the problem of different definitions and the recording of weathering might be avoided if it is the same analyst recording the bones.

In most of the papers included in this thesis, the presence of weathering on bone has been seen as enough to indicate prolonged exposure, whether for one or ten years. Since it is apparent that the time span of weathering depends on local climate, active animals in the area, the presence of vegetation and other external factors, the Behrensmeyer stages are regarded as relative phases. In this way, it is possible to compare between analysts; however, this comparison remains relative in essence. This relates to the acknowledged notion that taphonomic studies are case-specific, since geological and archaeological conditions are different from site to site. This was also important in the formulation of taphonomy by Efremov (1940).[82]

The recording of post-depositional markers

Plant root etching can potentially destroy the outer layers of bone, and thus mask the markers from earlier processes, such as trampling, as discussed above. In the zooarchaeological analysis, the presence or absence of root etching was recorded. Root etching is not necessarily a post-depositional process, although one can perhaps assume that root etches are the consequence of the natural deposition background, i.e. that plants grew in the deposition area. This taphonomic marker was included to enable the possibility of evaluating the impact of root etching on the animal bones of Asine.

Post-depositional erosion can be assigned the phase of taphonomic histories sometimes called diagenesis. We can expect that all bone assemblages have more or less been affected by diagenetic factors or modified by such. Post-depositional markers might indicate the extent to which post-depositional processes might have formed the

[82] The notion that taphonomy is site-specific and contextual is perhaps most apparent in the following quote: "Each complex of land-forms found in one locality, and called by us a "fauna", is in truth but an accidental accumulation of animal remains. The formation of each locality depends on many causes, and, firstly, on the coincidence in a given place of a concentration of animal remains with geological conditions favorable to the conservation of these remains" (Efremov 1940).

assemblage, and the degree to which they have possibly masked earlier processes' marks on bones. Chemical erosion sub terra, such as bacterial action or decomposition of molecular structure, re-exposure to the ground due to soil erosion or other processes, and the degree of water permeability in the soil, are all important factors in post-depositional processes affecting a bone sample (Lyman 1994: 417). The recording of post-depositional markers included noting the presence of mineral encrustation, or calcification, on bone (Appendix 4). Also, any abraded bone surface from water erosion was recorded. Such processes involve for example a higher permeability of water in the soil, which could have affected the bone surface.

Mineral encrustations are present on the bones from Asine, caused by the transport of soluble salts from sediments through the ground water (Lyman 1994:420).[83] It thus relates to the degree of water permeability, which determines the degree of enrichment or leaching of sediments through the soil matrix. This type of concretion is frequent where water gathers and evaporates (Dupras & Schultz 2013:233). In the Asine case, most such encrustation is made from calcium-carbonate salts (calcification). This is as expected, since the Kastraki cliff on which most bones were found consists of lime stone (Bannert 1973). The presence of calcification in the Asine assemblage indicates that the moisture in the soil has been insufficient to wash the salts from bones (Lyman 1994:420), but that the degree of permeability through geological sediments has been enough to transport these calcium-carbonate salts into the archaeological soil layers.

The recording of taphonomic markers from the excavation and the storage

It has been important to evaluate the impact deriving from excavation techniques, such as using hatchets, and decisions regarding storage, such as moving the bones between facilities. The finds from the 1926 excavation season were moved several times before they ended up in Uppsala (Wells 2002b:16-17). The recording of these later taphonomic markers involved noting the presence of recent fractures on bone, hatchet or other tool marks, the presence of fungi or other kinds of organic alteration of the bones.

Two examples of damage from the excavation or after are given in Appendix 4. The first represents a case of recent fragmentation, probably induced by the excavation techniques, perhaps by a hatchet, and then by compression or bone movement. The second example is the growth of fungi in the cavity of a bovid incisor. This has been noted on several specimens. It can perhaps be explained by the bones not being sufficiently dry enough before storage, or that the storage facilities at some point did not provide a controlled environment in terms of e.g. humidity for the finds.

[83] Hard mineral crusts on the Asine bones were also observed by Moberg Nilsson (1996).

4.2 The taphonomic history of the animal bones from Asine

The most visible or invisible taphonomic processes forming the animal bone assemblage from Asine are discussed in four major chronological groups, starting with the latest: the excavation and storage, post-deposition (after deposition and in the ground), around the time of deposition, and before the deposition of the material in the ground. Figure 9 illustrates the relative distribution of taphonomic markers in the animal bones from Bronze Age Asine. In total, 71% of the animal bones exhibited taphonomic markers. This does not mean that 29% of the bones were not affected by the taphonomic process. For example, the results of Paper IV reveal that the more fragmented bones from the Barbouna Hill exhibited fewer taphonomic markers than the bones from the Lower Town. This probably depends on the fact that the smaller surface of fragmented bone makes the detection of taphonomic markers more difficult.

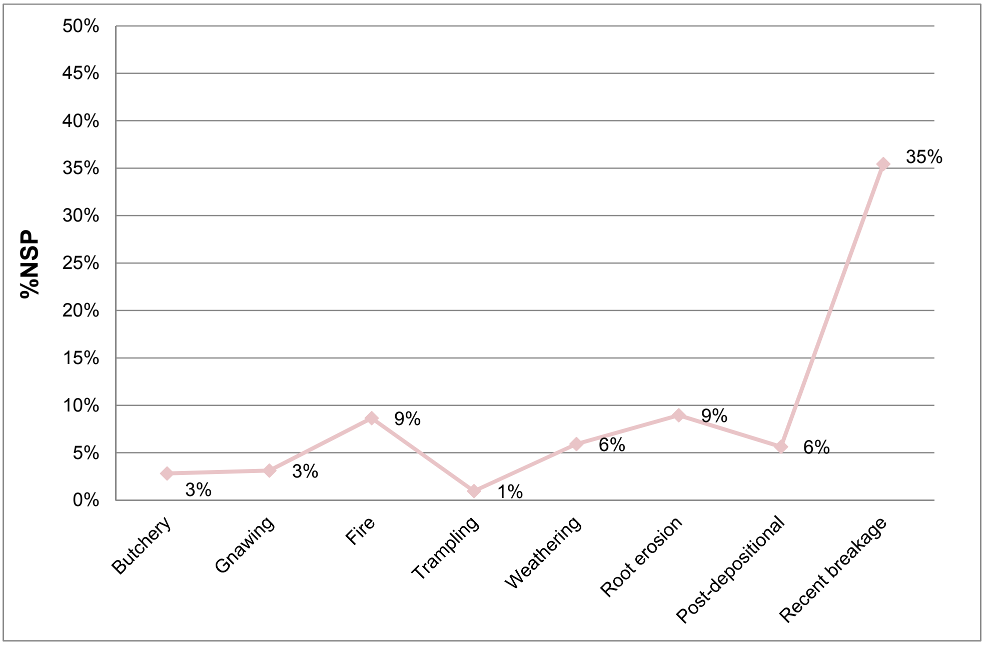

Figure 9.
Relative distribution (n=12 508) of taphonomic markers in the animal bone assemblage from Bronze Age Asine. The tally does not amountt to a total of 100% of NSP but to 71%, since 71 % of the animal bones exhibited taphonomic markers. Thus, 29% of the bones did not exhibit any marker. This proportion is excluded from this graph.

4.2.1 From excavation to analysis

Of all the recorded taphonomic variables, markers from the excavation and after are the most common (Fig. 9). Most damage derives from fragmentation after the excavation, but from exactly when is uncertain. The movement of the material between storage facilities have probably increased fragmentation. It is known that the material was moved from Greece to Sweden, back to Greece, and then finally ended up in Sweden again (Wells 2002b:16). The material has been handled in storage for more than 80 years. As a consequence, the material has been re-packed and moved within the facilities. Within the frame of this thesis, the material was moved from Uppsala to Lund, where the zooarchaeological analysis was made, and back again. The case of Asine illustrates that bone movement after excavation can have a serious impact in the formation of an animal bone assemblage, in the sense of leaving clear markers, increasing fragmentation, and perhaps masking the marks from previous formation process. This became especially clear in the multivariate analysis performed in Paper II, in which recent breakage strongly corresponds with unidentifiable bone.

Although the above gives a somewhat distressing picture of the preservation of the Asine animal bones, there are positive aspects. As part of this thesis project, fifty-three bones from the Asine collection were sampled for radiocarbon dating (Appendix 3). Nearly all samples were rich in collagen, and gave an excellent basis for radiocarbon dating. Interestingly, the five samples that were not as successful derive from the excavations on the slope of the Barbouna Hill. The rest came from the Lower Town area. This issue is re-visited in the next section, as this difference in preservation of collagen within the site must be discussed with regards to the geological circumstances at the site.

Sixteen bones from cattle and sixteen from pig were sampled for aDNA-analyses within the frames of another research project. These bones came from various stratigraphic units in the Lower Town and Terrace III areas. Ancient DNA was successfully extracted from eight samples from cattle, and eight from pig (Meiri *et al.* 2017). The successful extraction of aDNA together with the presence of collagen in the bones, visible in the radiocarbon analyses, indicate that while the post-excavation period might have damaged the bones physically, it has not affected the chemical composition of the bones in general. In other words, the case of Asine illustrates that old collections have potential in chemical bone studies and can be used for such research.

Bones of fish, birds and smaller mammals, such as rodents or insectivores, are rare in the Asine assemblage. The excavated soil was not systemically sieved at Asine, which has probably caused this lack of the more fragile and small animals (see Mylona

2003).[84] The lack of systematic sieving might also have biased the anatomical representation in the Asine assemblage, such as under-representing smaller bones, e.g. phalanges, carpals and tarsals, from medium-sized mammals (Davis 1987:29). The lack of systematic sieving has probably shaped the material as it is presented in this thesis.

In relation to this, chemical analyses made on human skeletons from the Middle Helladic cemetery of Barbouna as well as the East Cemetery at Asine indicate a diet which relied mostly on terrestrial food stuff, in terms of C_3 plants and animal protein intake (Ingvarsson-Sundström *et al.* 2009). In a study of isotopic signals using combined $\delta^{15}N$ and $\delta^{13}C$-values of fish of different species and from different parts of the Aegean, Vika and Theodoropoulou (2012) showed that the range of values overlaps with those who mark terrestrial input in protein intake. Isotope data alone cannot be used to completely exclude the possibility of fish consumption as a larger part of the diet in Antiquity. This possibility cannot be fully excluded at Asine either. Therefore, the extent of fish consumption at prehistoric Asine remains unknown.

4.2.2 From burial to excavation

Root etching and markers from post-depositional processes, mainly mineral encrustation on bone, are present among the Asine animal bones (Fig. 9). The bones from the MH to the LH IIIC are in general more affected by root etching than the Early Helladic bones. This might be a consequence of stratigraphy as the closer to the surface the closer the bone is to various roots; by laws of stratigraphy, the highest layers are usually the most recent. Periods of abandonment might have encouraged the growth of roots as well.

As mentioned above, the chemical composition of animal bones seems to be well preserved in general. However, the Barbouna Hill assemblage was in Paper IV shown to suffer from high degrees of fragmentation. Together with the unsuccessful results from radiocarbon analyses, it seems as the Barbouna Hill assemblage is poorer preserved than the Lower Town bones. The fragmentation of the Barbouna bones has produced smaller bone splinters on which taphonomic markers more seldom are recognizable. Thus the research potential of recording taphonomic markers is possibly higher in less fragmented materials, such as the bones from the Lower Town, as opposed to the fragmented assemblage from the Barbouna Hill area.

There are geological differences between these areas which could explain the difference in preservation. The location of the later excavations of Barbouna Hill was

[84] Information on which soil layers were sieved can often be found on the find labels for the 1926 material. For example, AS 3774 was sieved (see Swedish Institute at Athens *et al.* 2017: search word "AS3774").

extended to mainly the slope, which has probably been more exposed to external erosive processes, such as wind and landslides (Bannert 1973:20). Such processes could affect the assemblage in a post-depositional phase. Landslides could for example re-expose underground soil layers, as well as any bones within, to external mechanical forces such as wind. Bannert (1973) found that, while the Kastraki is mainly composed by limestone, the larger parts of Barbouna Hill consist of flysch. Flysch is a sedimentary rock in which sandstone and conglomerates are layered with denser rocks. According to Bannert, the rocks layered with the sandstone are weathered and eroded (*ibid.* 1973:20). The geological circumstances explains the more fragmented state of the Barbouna Hill assemblage, which is probably much more affected by the erosive post-depositional forces than the Kastraki bones (Paper IV).

The Kastraki, on the other hand, consists of limestone, which promoted the preservation of bones. Mineral encrustations on bone are more common from the Lower Town area. Encrustation processes could have promoted preservation by the enrichment of calcium-carbonate salts on the bone surface. The greater number of houses and walls could also have helped shelter animal bones from underlying geological processes. This kind of dense architecture is not observed at Barbouna Hill. Another factor in the differential preservation of bones between the areas might be the period of excavation project itself. More acid precipitation after the mid-20th century might have affected the bones remaining in the soil matrix, which were excavated during the late excavations in the 1970s and 1980s. The escalated anthropogenic impact on the environment during the course of the 20th century might extend to the preservation of archaeological features. However, this remains an observation in need of further testing.

4.2.3 From consumption waste to burial

Markers from weathering and gnawing are present in the material (Fig. 9). The presence of weathering indicates whether or not bones were exposed on the ground surface to sub-aerial erosion in general, while gnaw marks indicate that bones were thrown to dogs or scavenged, and trample marks indicate that bones were deposited on frequently trampled surfaces areas. In Paper II, the distribution of these markers in different type of contexts, as well as in different species and body parts, was the basis of discussing any spatial difference in handling bone waste. One example is that weathering was present on bones in some floors. This was further discussed as a probable consequence of stratigraphic uncertainties during the excavation in Paper IV, i.e. that this particular floor context should be regarded as a mixed context, contaminated by the surrounding stratigraphic units during the excavation.

Weathering on bone is not especially common in the Asine assemblage. However, it seems to have increased through the Bronze Age at Asine. The exception is the LH period when the relative abundance of weathering on bones decreased. Perhaps this tendency indicates an increased practice of leaving bones exposed on the ground surface. Alternatively, it can be explained by contextual differences through time. An example of this would be the EH III-MH I period, in which most of the bones derive from the *bothroi*. As discussed in Paper III, based on stratigraphic sequences and zooarchaeological indicators of exposure, some of these pits were filled faster than others, and they were closed contexts in the sense that the bones would not have been exposed to external forces such as weather and wind during a longer period of time. The distribution of weathering between redeposited layers and floors in the Lower Town and Barbouna Hill areas shows that it is most common in redeposited contexts (Paper IV). Considering that redeposited layers include bones which were exposed in open-air contexts, this is not surprising.

The presence of gnawing is not high. Together with the weathering frequencies, this indicates relatively fast deposition rates in general. However, the presence of gnawing shows that the practice of throwing bones to dogs existed during the whole Bronze Age. There is no indication of an intensification of this practice through this period. Gnaw marks were more common on bones from redeposited layers that from floors, and more common in the Lower Town than in the Barbouna Hill area. This can be explained by the fact that redeposited material might derive from many different sources, such as open-air layers or deposits, while bones in floors are assumed to derive from indoor activities. Also, the Lower Town was more densely occupied and might have offered more opportunities for dogs to scavenge on food waste.

The difficulties of identifying trampling make it hard to generalize on this type of process. Trampling was not identified on bones from the EH and the LH. In the rest of the periods of the BA it was present to a minor degree. In the comparison between the MH III-LH I Lower Town and the Barbouna Hill areas (Paper IV), trampling was present in bones from redeposited layers in the Lower Town and not in floors. Trampling was identified only in bones from floors in the Barbouna Hill. This might indicate that bones were more commonly dispersed and trampled during a prolonged period of time inside the Barbouna Hill houses.

Almost a tenth of the taphonomic markers on the Asine animal bones were caused by burning (Fig. 9). Many of the burnt bones were burnt to different degrees on different parts of the bone surface. The input of non-uniformly burnt bone at Bronze Age Asine is relatively high (Table 5). The exception is the Middle Helladic Period, which constitutes 13% of the burnt bone total at Asine. Altogether, 74% of the burnt bones belong to the LH material. Most of these bones were non-uniformly burnt. This could perhaps support the hypothesis that bones were burnt also as a consequence of food preparation techniques, or left on dying fires. These practices would not fragment and affect the bones, as would be expected if burning was the general way to dispose of animal bones. For example, the use of bone as fuel can be an efficient way of handling bone waste, which produces distinct patterns, such as increased fragmentation, the domination of burnt bone in general and calcined bone in particular (e.g. Costamagno *et al*. 2005; Costa 2016). The practice of throwing bones in the hearth as an indoor refuse disposal practice in both the Lower Town and the Barbouna Hill dwelling areas during the MH III-LH I period is discussed in detail in Paper IV. This practice, as a mean of removing waste, remains a possible scenario in general for the burnt bones of Asine.

Table 5.
Degree of burning and uniformity of degree at Bronze Age Asine (n=1 519)

Score	Description	EH (n=77)		EH III-MH I (n=17)		MH (n=194)		MH III-LH I (n=57)		LH (n=1 126)		LH IIIC (n=48)	
		NSPBurnt bone	Non-uniformly burnt bone of total NSP	NSPBurnt bone	Non-uniformly burnt bone of total NSP	NSPBurnt bone	Non-uniformly burnt bone of total NSP	NSPBurnt bone	Non-uniformly burnt bone of total NSP	NSPBurnt bone	Non-uniformly burnt bone of total NSP	NSPBurnt bone	Non-uniformly burnt bone of total NSP
1	Red-brown	23	6	4	1	85	15	9	1	20	3	12	1
2	Dark brown	14	2	5	2	38	5	9	0	56	12	27	18
3	Black-grey-blue	26	10	7	4	42	10	5	2	492	131	4	3
4	Grey-white	5	1	1	0	8	0	7	0	542	499	1	0
5	White	9	9	0	0	21	20	27	20	16	1	4	3
Total		77	36%	17	41%	194	26%	57	40%	1 126	57%	48	52%

4.2.4 From slaughter to consumption

The presence of non-uniform burn marks on bone, in most cases of which the epiphyses were more affected than the meat-bearing diaphysis, might perhaps be used to discuss food preparation techniques, such as roasting. In relation to this, I have not detected any indication of portion-sizes in the butchering of meat quarters. Further, only low frequencies of the taphonomic markers on the Asine animal bones were attributed to butchery (Fig. 9). It is possible that processes related to butchery, such as crushing bones for marrow, have caused higher degrees of fragmentation. However, merely 17 bones from Bronze Age layers bear impact marks from marrow retrieval. In general it has been hard to detect such processes on the bones from Asine. The impact of this process on the material might be higher than is visible. Future studies focusing on the pre-depositional processes, such as butchery, food preparation and consumption, would be valuable for an understanding of the Asinean society during the Bronze Age. Such studies may shed light on butchery strategies and perhaps even workshop locations within the settlement.

The distinction between consumption waste and waste from artefact production might be important in the discussion of waste management, since the prehistoric people might have distinguished between waste from artefact production versus waste from consumption, and might have disposed of them differently. However, bones with tool marks are quite scarce.[85] No significant temporal or spatial differences indicating any such prehistoric notions have been detected. Still, it cannot be excluded and might be tested in future studies. There are several bone artefacts from Asine. Most of the Middle Helladic bone items are included in a catalogue in Nordquist (1987). Waste from craft activities is visible in the remains of raw material, most often fragments of deer antler. Few antler fragments exhibit signs of working; in fact, most do not. Since deer was hunted and eaten, it is assumed that antlers could have been removed as part of the butchery of the carcass, but they could also have been occasionally found as shed antlers. Although the consumption of deer indicates that the former might have been common, both these possibilities are indicated by the presence by both shed antlers and antlers attached to the frontal bone.

4.2.5 Summary

The animal bones from Asine were affected by many processes before, during and after the burial of them in the ground. This study has shown that the bones had been damaged to a relative high extent from the excavation and archive of the bones. The bones suffered during the excavation due to practices such as the choice of tools and perhaps due to not being dry enough before storage. Further, the bones were hand-collected, meaning that smaller bones and bones from smaller mammals, fish and birds most probably are heavily underrepresented. The bones suffered from being moved between storage facilities, the latest movement being made for this thesis. Still, the chemical analyses of the bones, radio-carbon dating and aDNA-analyses provided

[85] From Bronze Age layers, only two bones and 27 antler fragments exhibited clear tool marks related to artefact production, e.g. polishing marks on bone and antler. Fragmented antlers without tool marks are found in greater frequencies (see Appendix 5); these might be waste from artefact production at the site. Finished bone, teeth and antler artefacts are also found at BA Asine. Some instances can be found in Nordquist (1987: Figs. 19-21). Finished products are not considered in this thesis, because they have transformed from being animal bones and remains of consumption into hand-made items.

good results which indicate that neither the excavation nor the storage had much negative impact on the chemical preservation of the bones.

The taphonomic history of the Asine animal bones has affected the zooarchaeological study of them in several aspects. For example, the lack of systematic sieving has biased taxonomic, and perhaps also anatomical, representativity of the sample. This has directed this study to focus on the medium- and large-sized mammals. The movement of bones between storage locations has increased fragmentation, which lowers the degree of identification of the bones. On a more positive note, since gnawing is not very frequent, it has probably not biased the distribution of different age classes targeting more fragile juvenile specimens (e.g. Lyman 1994:129), or different skeletal parts, to any significant extent (e.g. Marean *et al.* 1991). Further, the chemical analyses of the bones in terms of radiocarbon dating and aDNA-analysis showed that the general preservation of the bones is good.

5. The zooarchaeology of Bronze Age Asine

A zooarchaeological overview of Bronze Age Asine has not previously been attempted. It is necessary to have an understanding of the site in general terms, before attempting any contextual analysis, such as for waste management. First, a synthesis of previous zooarchaeological research in the area is provided in order to situate this thesis in a regional context. Second, the animals identified in the Asine bone collection are presented. The discussion of fauna is related to other finds and sites in the region. Third, the animal consumption and management at the site during the Bronze Age is discussed. The use of comparative materials is restricted to the Peloponnese and to the Bronze Age.

5.1 Trends in zooarchaeological research

The following text is a brief description of the zooarchaeological research in the Peloponnesian area. For more detailed reviews I refer to Payne (1985b), Trantalidou (2001), Reese (1994), and Fillios (2006:90-116).[86] One of the pioneering zooarchaeological studies of the Peloponnese was made by Gejvall on faunal remains from Lerna in 1969.[87] The osteologist Gejvall (1969) provided a thorough review of the fauna in a historical perspective; it was not a contribution to the study of the behavior and traditions of the prehistoric Lerna people. This is symptomatic of the traditional role of zooarchaeology in Greece, which has been to provide environmental background data to general archaeological and anthropological research (Trantalidou 1998:195; Fillios 2006:98). Before the Lerna publication, Gejvall also reported on the bones from Midea (in Åström 1968:56). He later

[86] This chapter focuses on providing a zooarchaeology of Asine. The use of comparative material is restricted to the Peloponnese and the Bronze Age.

[87] However, the first detailed and in-depth archaeozoological report on animal bones from Greek sites is considered to be the publication on the bones from Neolithic settlements, mainly Arapi-Magula and Otzaki-Magula, in Thessalia by Boessneck (1956), although a few previous examples of minor reports were given by Reese in his 1994 review.

returned to Midea, and provided a list of species from the excavations of the citadel (Gejvall 1983).[88]

During the mid-20th century, the general trend of zooarchaeological research was a focus on the interaction between nature, humans and other animals from a functional perspective (e.g. Reitz & Wing 1999:12-31). This in turn can be related to the wave of 'New Archaeology' or processual archaeology which occurred during the 1960-70s, in which archaeologists became more concerned with treating archaeology as science (e.g. Binford 1962; 1964). This included implementing scientific strategies in archaeological research, such as the nomothetic law-building of behavioral archaeology (Schiffer 1975). Cultural-ecological questions, i.e. the functional relationship between humans and nature, and cultural response to changes in the environment, which could be approached by the analysis of organic remains, became relevant. One example of this cultural-ecological approach from the Peloponnese is the publication of the animal bones from Bronze Age to Byzantine Nichoria by Sloan and Duncan (1974). Rather than discussing any cultural implications of the material, they focused on providing a long-term perspective on animal husbandry and subsistence strategies at the site. The faunal remains from LH I-II to Iron Age Nichoria have recently been restudied by Dibble (2017).

In the 1970s and 1980s the formation of an assemblage and its consequences became an important research focus in zooarchaeology. In relation to this approach, the synthesis of faunal research in the Greek area made by Payne (1985b) should be mentioned. His contribution contained not only a review of the existing bibliography; it was also a description of the zooarchaeological research process, which included, among other things, the difficulties in dealing with formation processes, methods of recording and processing data, and the importance of sieving to generate representative samples. He strongly encouraged further integration of zooarchaeology and general archaeology (see Payne 1985b:211). This paper was written just a few years before some of the most important studies on the formation, or taphonomy, of animal bone assemblages by Binford (1978; 1981) and Behrensmeyer (1978).[89] It thus reflects on general trends in zooarchaeology at the time. The concern about formation processes of archaeological record was, and still is, a hot topic in general zooarchaeological research. However, it has still not been extensively explored in an Aegean Bronze Age context (e.g. Trantalidou 1998:193). Trantalidou (1989) contributed with a cultural-historical synthesis of Aegean Bronze Age diet and animal

---

[88] As mentioned earlier, Gejvall also studied some of the animal bones from Asine. I have not found any publications or data generated from this analysis, but I have observed his re-packing of the material in the storage facilities (the Leonardo) at the Archaeological Museum of Nafplion.

[89] Binford's work on the impact of carnivore gnawing on bones as well as butchery strategies of humans has had huge impact on zooarchaeological and taphonomic research in general. Behrensmeyer's experimental work on the process of weathering is still viable, and her score system still used in standard zooarchaeological analyses.

husbandry. Closely after, the faunal report on the bones from Tiryns (von den Driesch & Boessneck 1990) was published, followed by Nobis (1993) on the animal bones from LH IIA-IIIB Pylos. Contemporary to these works, Reese (1994) updated the bibliography provided by Payne (1985).[90]

During the 1990s and 2000s, there was an increase in research aiming to discuss archaeological and historical research questions. In this context, we should mention the works of Halstead. For example, he focused on the discussion of the scale of animal husbandry in BA Greece, attempting a comprehensive, detailed integration of zooarchaeological research into the broader archaeological discourse (Halstead 1996). Halstead has also investigated other socially connoted themes, such as feasting and consumption (e.g. Halstead 2004), and the economic system of Mycenaean palatial societies (Halstead 1999; 2011a; Halstead & Isaakidou 2017). The anthology *Zooarchaeology of Greece* (Kotjabopoulou *et al.* 2003) should also be mentioned in this section. The meta-studies in this anthology are valuable. For example, Yannouli (2003) reviews the evidence for wild carnivores in Greece, and Mylona (2003) lists and includes data on the occurrence of fish remains on Greek sites.

During the late 1990s-2000s and onwards, there was also a steady increase of zooarchaeological studies focused on post-processual themes, such as the works by Hamilakis on the use of animals and/or food in mortuary settings (1996; 1998), and the symbolism of hunting (2003). In this wave of social and symbolic/ritual studies, we can note the discussion of burnt animal sacrifice during the Mycenaean period (Isaakidou *et al.* 2002; Hamilakis & Konsolaki 2004), the role of feasting and conspicuous consumption (e.g. Dabney *et al.* 2004), and the study of social complexity using zooarchaeological evidence (e.g. Fillios 2006; Isaakidou 2007, see also Dibble 2017). Another contribution to the study of rituals in archaeology using animal bones is the anthology *Bones, behavior and belief* (Ekroth & Wallensten 2013).

During the early 2000s, another review was made by Trantalidou (2001) who called for more ethnographical parallels and documentation of the knowledge still existing in parts of Greece on traditional animal husbandry. Encouragingly, we have lately seen contributions of ethnozooarchaeological case-studies (e.g. Vardaki 2004; Halstead & Isaakidou 2011). Further, we have also recently seen an increase in integrated scientific approaches. For example, the integration of isotopic analysis with zooarchaeological methods is becoming more common (e.g. Meier *et al.* 2014; Vika & Theodoropoulou 2012).

The last decade has seen in an increasing interest in integrating the study of animal bones with textual and archaeological sources, ethnographic parallels and chemical analyses, in order to investigate anthropological and zooarchaeological research

[90] Reese has done a lot of studies of Aegean mollusk and mammal bone assemblages (e.g. Reese 2008a; 2008b; 2013).

questions. Thus the focus on a cultural-ecological and traditional approach, seen in the history of zooarchaeology of Greece, and briefly outlined above, has been widened to also incorporate other approaches. In this research context, the study of waste management as a taphonomic process and as a cultural tradition is yet to be fully explored. It could be a valuable approach to the zooarchaeological study of Bronze Age sites in mainland Greece, both in terms of it being a window to prehistoric activities, decisions and strategies concerning waste management, but also in order to re-introduce a focus on formation processes in Aegean research (see Trantalidou 1998:193).

5.2 Identified taxa at Bronze Age Asine

From Bronze Age layers at Asine, a total of 4 191 bones were identified to taxon. Additionally 87 tortoise shell fragments and two fish bones were noted. Many of the taxa identified at Asine only occur in low numbers. Therefore, it is more suitable to discuss them in terms of their presence on the site. Table 6 presents the identified taxa from all phases of Bronze Age Asine.[91] Figure 10 is a visualization of the presence of identified taxa throughout the Bronze Age. Most animal bones derive from domesticated mammals, especially sheep/goat (1 387 bones, 33%), pig (1 231 bones, 29%) and cattle (979 bones, 23%). Human bones were identified, but are likely to derive from intramural graves. They are not included in the following subchapters.

Except for the common sheep/goat, cattle and pig, the dog is present in all phases of the Bronze Age, although in low numbers, in total 40 bones (Table 6). Both horse (13 bones) and donkey (9 bones) are identified from most periods of the Bronze Age at Asine, also in low numbers. Additionally, fourteen bones were identified as deriving from indeterminate equids at Asine. Horse is present from EH III-MH I (ca. 2200-1900 BCE), and donkey from MH I-II (ca. 2100-1800 BCE). At Tiryns only a few bones of equids are present in the EH III and MH phases of the site (von den Driesch & Boessneck 1990:93). At Nichoria, both horse and donkey are testified from the MH I onwards, although in very small numbers (Sloan & Duncan 1974:69-70).

Among the wild animals, deer predominate (433 bones, 10%). Red deer, fallow deer and roe deer are identified. Red deer is the most numerous wild animal, and was

[91] The previously mentioned 6 137 identifiable and 11 390 bones unidentifiable bones (Section 4.1.) derive from broader Bronze Age periods, namely EH, EHIII-MH I, MH, MH III-LH I and LH. The majority derive from sheep/goat, pig and cattle (4 793 bones, 87%). The remains of sheep/goat, pig and cattle from the broader Bronze Age periods make up the data used in Paper I, discussing Asine from a regional perspective. I have chosen to present the data from more narrowly defined periods in this section, in order to avoid an exaggerated generalization which can come from using very broad chronological periods.

identified in all periods of the Bronze Age. At Asine, the few bones of fallow deer were found in MH I-II and LH IIIA-B (ca. 1420/10-1200 BCE) strata, while roe deer was identified in MH I-II and MH III-LH I (ca. 1800-1600 BCE) layers. Fallow deer is not commonly found in Argolid sites. On the Peloponnese, it is only identified at EH and LH Tiryns (Yannouli & Trantalidou 1998). Red deer is more common. It is found in e.g. Bronze Age Lerna (Gejvall 1969:44) and Tiryns (von den Driesch & Boessneck 1990:104), MH (ca. 2100-1700 BCE) and LH IIIB (ca. 1700-1600 BCE) Midea (Reese 1998:278) in Argolis, and at LH (ca. 1700-1050) Pylos in Messenia (Nobis 1993:162). Similarly, roe deer are present in several sites on the Peloponnese, such as EH III and MH Lerna (Gejvall 1969:46) and LH III Tiryns (von den Driesch & Boessneck 1990:104), and LH Pylos (Nobis 1993:156). Wild boar is identified; however, it is possible that this animal is more numerous than visible (see Section 4.1.2). Wild boar is identified at e.g. Bronze Age Lerna and Tiryns, as well as LH Pylos.

Wild carnivores are rarely identified and seldom make up large parts of faunal assemblages in Bronze Age sites in Greece (Yannouli 2003:175). The carnivores at Bronze Age Asine consist of one bone each from red fox (EH) and brown bear (LH IIIA-B). Additionally two bones from brown bear were found in layers dated to the broader LH (ca. 1700-1050 BCE). Red fox is identified from EH II, ca. 2650-2200 BCE, at Asine (Fig. 10). The animal was recorded from assemblages from most of the Bronze Age phases at Lerna (Gejvall 1969:38), and from LH III Tiryns (von den Driesch & Boessneck 1990:108). At Lerna, the brown bear is identified from the MH (Gejvall 1969:39), while at Tiryns it was recorded from contexts dating to the LH IIIB-C. Further, from a LH IIIB2 layer at Tiryns, a radius bone from bear exhibited cut marks (von den Driesch & Boessneck 1990:109). Although not present at Asine, weasel, badger, otter, polecat and beech marten are identified from BA sites in Greece (Yannouli 2003:180-181). Evidence of lynx and lion exists from the EBA and the LBA in Greece; of all animals listed above, lion is the only one now extinct in the Greek area (Yannouli 2003:187).

The bones of fish, birds and small mammals are very rare in the Asine bone collection. This is partly explained by the chosen retrieval methods during excavation, since no systematic sieving was applied, although some stratigraphic units were dry-sieved (see Section 4.2.1). Larger and thus more visible bones were probably more often detected and hand-picked than the bones of fish, small birds and small mammals. A higher number of taxa would maybe have been identified with a more detailed excavation method (see Mylona 2003). Of smaller mammals, only hare have been identified, in layers belonging to the EH and LH at Asine (Fig. 10). Hare is identified in most prehistoric areas of Greece (Trantalidou 1989:402). Hedgehog has been identified in a stratigraphic unit associated with a floor level in House pre-D. However, this unit is not securely dated to the MH, although this is a probable date for this layer. It is not included in Table 6, but see Fig.10.

Table 6.
Identified taxa (NISP) from Bronze Age Asine. The bone from red fox was found in association with a grave and is not included in the text when discussing the data unless stated. Antler fragments of indeterminate deer and red deer are included, since no statistical difference appeared when removing them from the data set (see Appendix 5). Loose teeth are included since no statistical difference appeared when removing them from the data set (see Appendix 6).

	Taxon	EH	EH III-MH I	MH I-II	MH III-LH I	LH I-II	LH IIIA-B	LH IIIC	Total
Domesticates	Pig (*Sus domesticus*)	96	280	425	137	102	120	71	**1 231**
	Suid (*Sus* sp.)	4	5	2	1	1	1	2	**16**
	Sheep/goat (*Ovis aries/Capra hircus*)	87	177	307	182	151	178	135	**1 217**
	Sheep (*Ovis aries*)	5	12	21	9	1	3	13	**64**
	Goat (*Capra hircus)*	8	31	33	5	6	7	16	**106**
	Cattle *(Bos taurus*)	110	204	266	95	78	93	150	**979**
	Bovine (*Bos* sp.)	2	1	9	0	0	0	0	**12**
	Dog (*Canis familiaris*)	1	10	11	7	4	6	1	**40**
	Equid (*Equus* sp.)	1	1		2	5	5	0	**14**
	Horse (*Equus caballus*)	0	1	3	3	3	2	1	**13**
	Donkey (*Equus asinus*)	0	0	1	0	2	2	4	**9**
	Human (*Homo sapiens*)	4	29	2	2	0	0	0	**37**
Wild animals	Red deer (*Cervus elaphus*)	35	42	51	38	6	67	92	**331**
	Roe deer (*Capreolus capreolus*)	0	0	1	1	0	0	0	**2**
	Fallow deer (*Dama dama*)	0	0	1	0	0	2	0	**3**
	Deer (Cervidae)	12	6	15	4	0	27	33	**97**
	Wild boar (*Sus scrofa*)	1	0	0	0	0	0	0	**1**
	Brown bear (*Ursus arctos)*	0	0	0	0	0	1	0	**1**
	Red fox (*Vulpes vulpes*)	1	0	0	0	0	0	0	**1**
	Hare unid. (*Lepus* sp.)	0	0	0	0	1	0	0	**1**
	Hare (*Lepus europaeus*)	1	0	0	0	1	2	1	**5**
	Sea bream (*Sparus* cf. *auratus*)	0	2	0	0	0	0	0	**2**
	Hooded crow (*Corvus* cf. *frugilius)*	0	0	0	0	0	1	0	**1**
	Tortoise (Testudine)	3	16	14	2	47	3	2	**87**
	Fish (Pisces)	0	0	0	0	0	0	0	**0**
	Bird (Aves)	0	0	0	0	0	1	1	**2**
Total		**354**	**817**	**1 162**	**488**	**408**	**521**	**522**	**4 272**

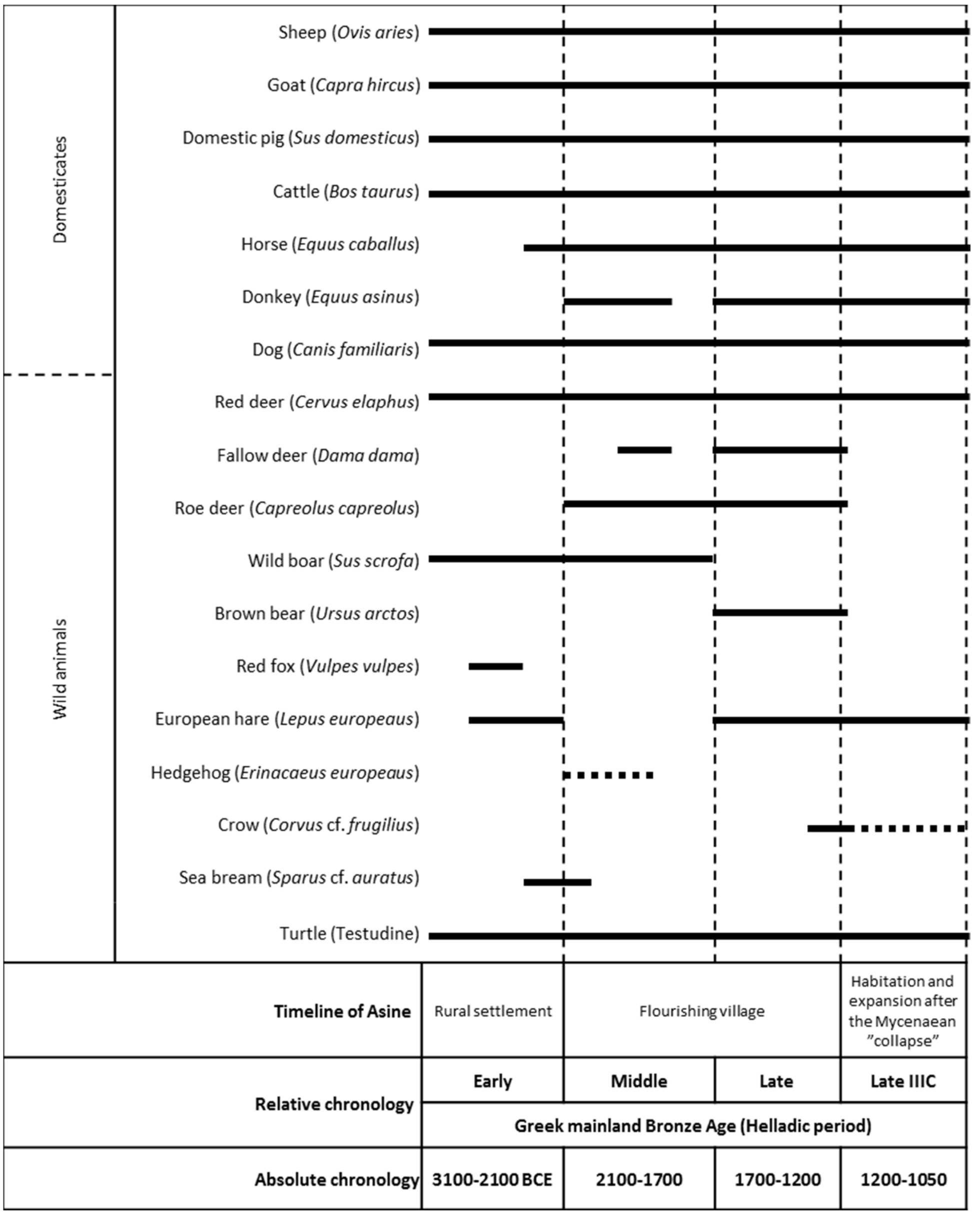

Figure 10.
Temporal presence of animals at Asine during the Bronze Age

Two bones from sea bream were identified (EH III-MH I). This fish was also identified at MH Lerna (Gejvall 1969).[92] One bone from a crow, probably a hooded crow, was identified from LH layers (Fig. 10). Gejvall (1969:48, 50) identified remains of hooded crow at EH III and LH Lerna. The presence of crow at Asine is more likely indicative of the animal as a commensal species living close to populated areas for food available in the form of waste, rather than it being purposefully hunted for its meat or feathers (see O'Connor 2013).

As mentioned, the lack of fish and avian bones at Asine, and in the Aegean in general, is partly due to retrieval strategies, which often did not include systematic dry or water sieving during the excavations (Mylona 2003). This is unfortunate, and is the reason why this thesis primarily considers the large and medium-sized mammals at the site. There is, however, a considerable assemblage of molluscs from Asine. Reese (1982) has published parts of this material, deriving from the excavations east of the Acropolis at Asine (Fig. 3). The abundance of this material indicates that the gathering of molluscs was of importance in Antiquity. It hints that marine resources played a larger role for the economy and subsistence than what it visible among the mammal bones at the site. Contrarily, the isotopic analyses of human remains from MH-LH Asine revealed a focus on protein intake from terrestrial resources (Ingvarsson-Sundström *et al.* 2009). Clearly, further studies are needed in order to fully understand the role of molluscs and marine resources in ancient Asinean society.

5.3 Animal consumption at Bronze Age Asine

Sheep/goat, pig, cattle, and to some extent deer, were the most common animals at Bronze Age Asine. In Figure 11 the relative abundances of these animals as they changed through time are presented.[93] I have previously examined the management of sheep/goat, pig and cattle at Asine in relation to regional change during the Bronze Age in Paper I, where data on relative abundances of sheep/goat, cattle and pig as well as body part distributions, mortality patterns and sex distributions is presented.[94] For those interested in using the Asine as comparative material, data on body parts in sheep/goat, cattle and pig is provided in Appendix 6.

[92] The fish bones from Lerna were determined by the osteologist Lepiksaar (Gejvall 1969).

[93] Since no statistical difference could be found between removing antler fragments of indeterminate deer and red deer and keeping them in the data, they are included in this figure. For raw data I refer to Appendix 5.

[94] A critical discussion of the conclusions of Paper I can be found in Section 6.1.1.

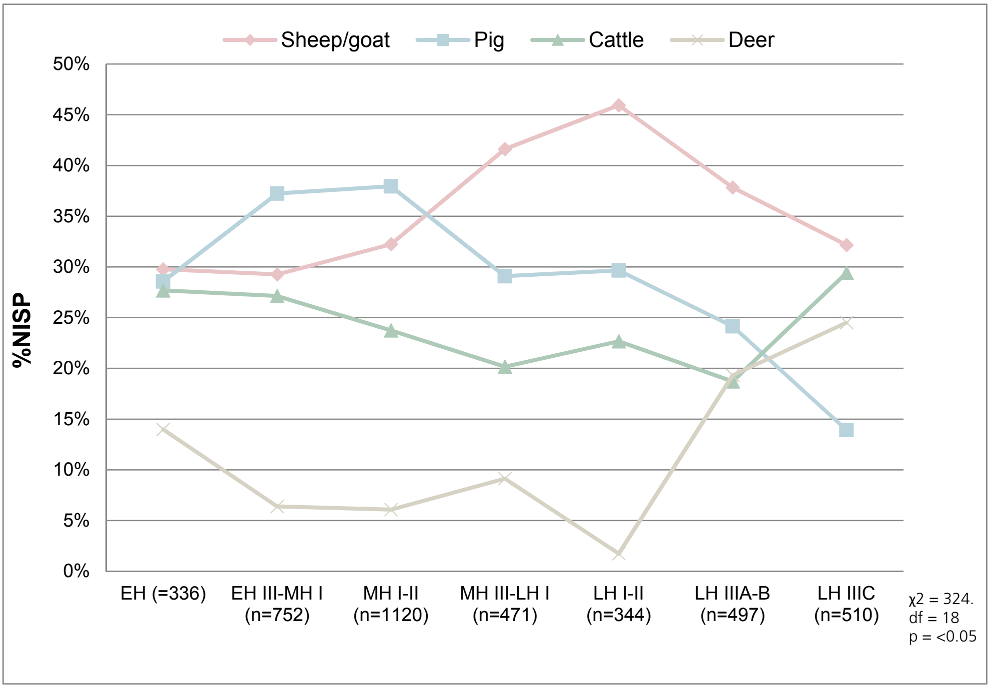

Figure 11.
Temporal changes of sheep/goat, pig, cattle and deer abundances (%NISP), Bronze Age Asine.

Early Helladic (ca. 3100-2100 BCE)

In total, 350 identifiable bones, excluding four human bones, derive from Early Helladic cultural layers at Asine. Altogether, 85% (297 bones) were found around and in the houses of Terrace III. The other bones were found scattered in different layers of the Lower Town trenches and Terrace II, and in the trench on the Acropolis. It is of no surprise that there is a smaller concentration of bones on Terrace III from this period, as it is on this area that most building and wall remains were found. Presumably, the bones reflect the waste management and consumption tendencies of the households on this terrace, namely House R and possibly House S. Only 26 bones could be tied to primary deposits. Of these, the majority (20 bones) derive from the older levels of *bothros* 4.[95] Reviewing the bones from contexts which are not tied to specific features but from cultural layers accumulated during longer periods of time, it is clear that almost equal proportions of sheep/goat, pig and cattle are represented in the zooarchaeological assemblage from the EH (Fig. 11; Paper I). Deer constitute about 14% of the identified animal bone assemblage.

[95] One specimen from AS 5201 associated to the older fills of *bothros* 4was radiocarbon-dated to 2569-2292 cal. BCE (95.4 % probability).

The even distribution of the cattle and pig at Asine is similar to EH II Tiryns where cattle (27% of NISP) and pig (26% of NISP) are abundant to approximately the same extent. Sheep/goat dominates the Tiryns assemblage, at 46% of the total amount (von den Driesch & Boessneck 1990). At Asine, the ratio between sheep and goat, 1:1.6, is relatively even (Table 6). Probably, this can be taken as an indication of a mixed herd strategy, in which neither animal were especially preferred. At EH II Lerna bones of cattle are not as common as pig, and, as at Tiryns, sheep/goat is most abundant (39 %) (Gejvall 1969). At EH I-II Tsoungiza (Halstead 2011c), the amount of sheep/goat bones is similar to the pig abundance, while pig bones are most common of all animals at EH II-IIIA Helike (Fillios 2006). Both sites contained unusually large amount of pig bones (around 35-40% of NISP). Fillios (2006) argues that the high occurrence of pigs indicates that this smaller settlement was independent in terms of production. Still, the bone assemblages from the above mentioned other sites of this period contained an even distribution of sheep/goat, pig and cattle, perhaps indicating a mixed small-scale husbandry (Halstead 1996:24). The even distribution of these animals during the EH at Asine is discussed in similar terms in Paper I. More clearly however, it shows that meat consumption was focussed on these animals.

Early Helladic III-Middle Helladic I (ca. 2200-2000 BCE)

In the transition to the early Middle Helladic, there is a clear increase of pigs at Asine in relation to sheep/goat and cattle (Fig. 11). Few wild animals other than deer have been detected from this period, except sea bream and tortoise. The consumption at the site continued to rely on sheep/goat, cattle and pig. Almost half of the identifiable bones dated to the EH III-MH I (331 of 788 bones, ca. 42%) derives from the *bothroi* discussed in Paper III.[96] Most pits were built in the middle of Houses R and S, and later overbuilt by House T, while some were older than House S (certainly *bothroi* 4 and 3b, probably *bothroi* 2, 5 and 6, see Fig. 6 and Paper III). The pits were probably connected to these houses, and their content might reflect consumption or activity areas around them. However, the material was deposited as waste.

In short, my conclusions in Paper III are that the bones from different pits reflect different waste management strategies. For example, the *bothroi* between Houses R and S (*bothroi* 7, 8, 9, 10, 11, 13, 14, 15, perhaps also 1 and 3a) were placed in two lines, with the eastern one containing mostly butchery waste, i.e. low nutrient parts such as feet, as well as head bones, while the western one contained clear consumption waste, i.e. bones from meaty body regions such as the long bones and the vertebral column.[97] This is perhaps an example of the division of work space, in which butchery took place east of House R and S, and the *bothroi* in between, while consumption took place close to the houses. Further, in some pits certain species were

[96] This count excludes the bones from older levels of *bothros* 4, included in Paper III.

[97] The discussion is reviewed in greater detail in Paper III.

deposited more often than in others, such as red deer in *bothroi* 8 and 6 or cattle and pig in *bothroi* 3a, 4 and 11. This is discussed as signs of waste categorization, in which the waste of certain animals might have been treated differently, i.e. deposited in separate pits.

The rest of the bones from the EH III-MH I context were found as redeposited material in room fill layers or open-air layers. All the bones derive from the Terrace III area, and should be connected to the houses there, i.e. Houses R and S, as well as House T, which was erected in MH I (Nordquist 1987:72). In the *bothroi*, the bones from pigs were most abundant, followed by sheep/goat and cattle (see Paper III: Table 4). This is also the case for the rest of the animal bones from this period. As demonstrated in Paper I, there was no significant difference in species composition of cattle, sheep/goat and pig between these two samples, i.e. from the *bothroi* and from the redeposited contexts. Thus, the consumption tendencies regarding these animals, as visible in the bothroi, might also reflect general behaviour during this period. Such tendencies would involve the reliance on meat consumption from pig, although cattle and sheep/goat were also common. The sheep to goat ratio, 1:2.6, indicates that goats increased in relation sheep compared to the EH.

At Asine there was a decrease of deer bones in relation to the earlier EH. This might indicate that the settlement became more densely occupied, as hunting became less important for the meat consumption while domestic animals such as pig increased. The increase of pigs in settlements has been seen as a marker of early urban environments in other temporal and spatial contexts, such as early medieval Scandinavia (e.g. Benecke 1994; Vretemark 1997). Perhaps also in this more rural context, the changes in animal abundances, especially the increase of pigs and decrease of deer, might indicate that the settlement became more occupied. Maybe the increase in pigs at Asine can be explained in similar terms as Fillios (2006), who suggested that high frequencies of pigs indicate smaller and independent settlements, more isolated from other sites in the region. If so, this supports the argument that the EH II/III 'collapse' reflects the collapse of a previous communication system on a regional level, which lead to decreased complexity in the regional organization in the EH III period (e.g. Bintliff 2012:91-92; Davis 2013; Wiener 2014; cf. Weiberg & Finné 2013). However, it might merely be an indication that the consumption of pig became more important than in the preceding period. In other approximately contemporary sites, such as EH III Lerna (Gejvall 1969), Tiryns (von den Driesch & Boessneck 1990) and Tsoungiza (Halstead 2011), the change towards a greater numbers of pigs has not been observed.

Middle Helladic I-II (ca. 2100-1800 BCE)

Asine flourished during the MH; the settlement grew in size as more houses were added to it (Section 3.2.2). There was no great change in the relative abundance of sheep/goat, pig, cattle and deer in the MH in comparison to the earlier EH III-MH I period (Fig. 11; Paper I). This is interesting, as it does not indicate animal consumption undergoing major transformations during the expansion of Asine to the Lower Town area during the MH period. The animal bones from the MH I-II are presented in detail in terms of taxonomic representation, anatomical distribution, mortality curves and sex distribution in Paper V.

From the MH I-II period, most of the animal bones derive from the excavation area on Terrace III (676 of 1 149 identifiable bones), where House T was active during the early MH, and from the Lower Town are (324 of 1 149 identifiable bones), where House A and some walls are dated to the early MH. The distribution of cattle, sheep/goat, pig and deer in each area is illustrated in Figure 12. Sheep/goat bones are more abundant in the Lower Town, while pig bones are more abundant in Terrace III. This difference is statistically significant ($\chi 2 = 10.8$, df = 3, $p = <0.05$). This might reflect a difference in consumption between the areas. The high abundances of pigs, seen in EH III-MH I, could have been maintained mainly by the inhabitants of the Terrace III area, specifically House T, during the MH I-II period. This would not have been the case with the dwellers in the Lower Town area, for whom meat intake came from mixed resources, i.e. sheep/goat, pig and cattle, to similar degrees. This difference between the areas might be explained in several ways. It is possible that the Lower Town area was settled by newcomers, while Terrace III was inhabited continuously from earlier periods. It could, however, also be a consequence of the Lower Town area being less densely occupied, and having larger gardens, which allowed for roaming and grazing animals.

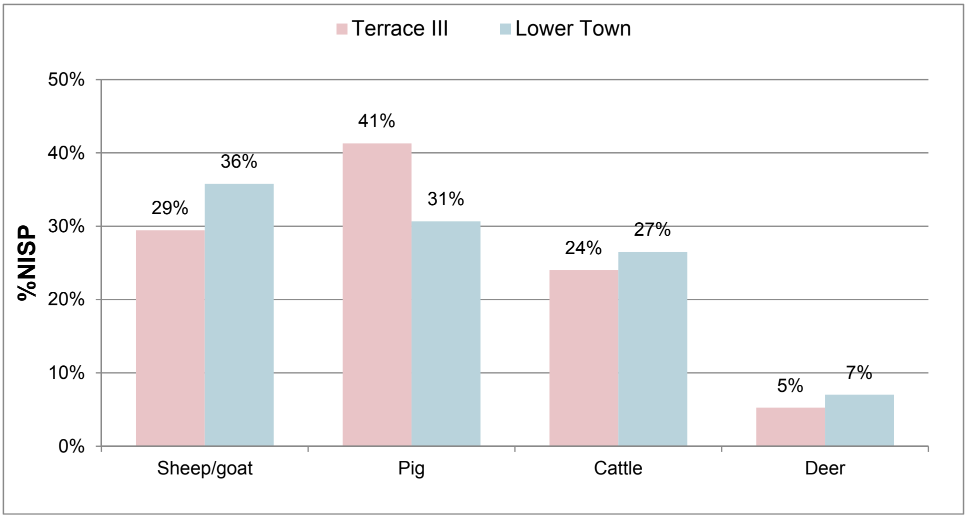

Figure 12.
Species distribution of sheep/goat (n=308), cattle (n=243), pig (n=371) and deer (n=57) on Terrace III versus the Lower Town, MH I-II Asine,.

In general for the assemblage as a whole, pigs were most abundant (37 % of 1 149 identifiable bones), followed by sheep/goat (31%), cattle (23%) and deer (6%) (Fig. 11, see Papers I and V). The ratio of sheep to goat, 1:1.6, at Asine is similar to the Early Helladic period. In other words, in relation to the previous EH III-MH I period, goats decreased or sheep increased. It seems that the latter might be more probable, since sheep continued to increase in the MH III-LH I period (see below). Pigs are also most abundant in other settlements, such as Lerna (Gejvall 1969), Nichoria (Sloan & Duncan 1978), Ayios Stefanos (Reese 2008a; Nicodemus 2008:507), and Aspis (Philippa-Touchais *et al.* 2014).

The predominance of pigs during the Middle Helladic is not visible at MH II Kolonna (Forstenpointner *et al.* 2010:737) or at Midea (Reese 1998:281). At both sites sheep/goat predominate the relative distribution of identifiable animal bones. This is especially the case at Kolonna, where the proportion of sheep/goat was over 60%. During the MH, Kolonna was the main settlement on Aegina, and functioned as a central node, tying together the mainland with the Cyclades and Crete, due to its strategic geographic position. The animal bones used as comparative material here derive from consumption waste deposit from the Large Building Complex, a residential mansion-type construction (Gauss *et al.* 2011). The animal bones most likely reflect the consumption behaviour of the mansion dwellers, according to the authors (Forstenpointner *et al.* 2010:740).

Middle Helladic III-Late Helladic I-II (MH III-LH I, ca. 1800-1400 BCE)
The animal bones from MH III-LH I contexts at Asine derive from two dwelling areas, namely the Lower Town (mainly from around and in Houses B and D) and the Barbouna Hill (from around and in Buildings 1 and 2). In both areas, the bones derive mainly from fill and open air cultural layers, though some were found on floors levels. The differences between them in terms of taxa, body parts and taphonomic markers, are discussed in Paper IV from the perspectives of consumption patterns and waste management. In brief terms, one result was that, although the general species composition was similar regarding the most common animals, a higher number of taxa were found in the Lower Town, indicating consumption of a wider range of animals. This was discussed in conjunction with distribution of other archaeological finds as a sign of social complexity at the site during this period.

During the MH III-LH I period there was a heavy increase of sheep/goat and a decrease of pigs, a trend which persisted in to the LH I–II periods (Fig. 11; Paper I). This coincides roughly with an expansion of Asine which incorporated the slope of the Barbouna Hill during this period (Section 3.2.2). It indicates a change to an increased consumption of animals which yield secondary products. During the MH III-LH I period we can note a continued increase in sheep in relation to goat, at a ratio of 1:0.5. Perhaps this can be related to higher demands for woolly animals in the region. However, sheep seem to have decreased in the LH I-II period, where the sheep to goat ratio was 1 to 6, based on a small number of fragments. Unlike earlier periods when pigs were in higher demand, we see a decrease for this animal. In Paper I, it is noted that, although there was a general decrease in pigs, there seems to have been an increase in juvenile swine during this phase. Does this mean that pigs were not consumed to the same extent? Rather, it may point to a scenario where juvenile pigs were preferred in meat consumption events, perhaps within the household.[98] The latter scenario is suggested in Paper I.

The similar changes observed at Asine, i.e. the decrease in pig and increase in sheep/goat, is reflected also at Lerna, where sheep/goat increased to about 40% in the LH I period (Gejvall 1969:6). A similar distribution of cattle, pig and sheep/goat is visible in MH-LH I Malthi in Messenia as well (Macheridis 2016). At Tiryns, there is an unusually high occurrence of cattle bones (ca. 39%) in comparison to e.g. Asine or Lerna (Gejvall 1969).[99] Interestingly, Tiryns became one of the Mycenaean palatial sites in the region. Perhaps wealth was tied to cattle. This is exemplified by several traditional societies, but is perhaps best attested in ethnographic studies of African pastoralists (Russell 2012:297-357).[100] If this was the case, the abundance of cattle might have contributed to the prospering of Tiryns.

LH IIB-IIIB, the Mycenaean period (ca. 1480/70-1200 BCE)

Of the 519 identifiable animal bones from the Mycenaean period at Asine, a mere 123 could be tied to primary deposits, mainly constructions of the Barbouna Hill area. Bones from two such deposits can be questioned as to whether they are waste related. The first one is the bones found in the fill of the so called cistern A73.91. Remains from the same juvenile pig below the age of twelve months were found.[101] The second deposit is similar: In the cut for the hearth A72.40, the remains of a juvenile sheep/goat, which died at an age between 1 to 1.5/2.5 years, were found.[102] Although these might be remains of food waste, they could also be remains of ritual activities tied to the construction, such as the closing of a cistern or well and the construction of a hearth.

[98] Dibble (2017:258) also notes a preference of younger male pigs at Nichoria during LH I-II.

[99] High occurence of cattle bones is visible at MH III Aspis as well, and is interpreted as dependent on environmental factors and agricultural intensification (Philippa-Touchais *et al.* 2014:534).

[100] Additionally, I refer to Marciniak (2005) who provides examples of cattle as wealth from European contexts.

[101] In total 25 of 29 bones belonged to the same pig. No teeth were preserved, but the pig was younger than that based on the small size of the bones. Based on preservation degree, and the fact that most body parts are represented, e.g. the head, long bones, vertebral column and ribs, my impression is that the skeleton was almost complete when deposited, but disturbed by later activities. Four sheep/goat bones were also recorded at this deposit.

[102] In total, 22 bones of this sheep/goat were found, of which two matching femora of each side, and metatarsals with articulating phalanges were recorded. Additionally, one goat calcaneus belonged to an older individual and one vertebral fragment to another sheep/goat individual.

In general, the relative proportions of sheep/goat, cattle and pig were similar in the Mycenaean period as they were in the preceding MH III-LH I-II periods, i.e. with a high abundance of sheep/goat (38%), pig (24%) and cattle (19%). The sheep to goat ratio, 1:2.3, indicates that sheep perhaps decreased in abundance, perhaps as a change in economic focus of the settlement, which shifted to hunting game more often. In comparison to the earlier period sheep/goat decreased in abundance, while deer increased significantly, to about 19% of total NISP. The relative abundance of deer is high at Mycenaean Asine, both from a diachronic and a regional perspective.[103] It is possible that hunting and consuming deer was important at Asine, perhaps especially in order to acquire and produce artefacts made in antler. Antler artefacts and fragments thereof are not uncommon finds at Asine.

It seems that the meat consumption patterns targeting these animals, with slightly higher focus on sheep/goat, persisted through to the end of MH until the end of the Mycenaean at Asine (Fig. 11). The high frequency of sheep/goat is replicated at Mycenaean sites on the Peloponnese, such as LH IIIB1-2 Tiryns (39-40%, von den Driesch & Boessneck 1990), LH IIA-IIIB Pylos (ca. 45%, Nobis 1993) and LH IIIB Mycenae (ca. 66%, Trantalidou 2009:134). At LH III Nichoria sheep and goats were the most common animals (Dibble 2017:146).[104] There seems to have been a regional focus on sheep/goat.

The increase in ovicaprines at Asine during the transition to the LH is discussed in Paper I in terms of the increased importance of Asine in relation to its immediate valley, as well as increased regional centralization, structured through the redistributive Mycenaean system. Sheep and goats are good to keep in organized economies because they yield secondary products that can create surplus, which can be stored. An increase in sheep/goat is common in regions with increased centralisation, and has been discussed for urbanized societies elsewhere (e.g. Zeder 1991; Vretemark 1997; Magnell 2009). That an increase in sheep/goat is observed in most of the Mycenaean sites should be seen in conjunction with the regional organization of the time. Pigs on the other hand often decrease in abundance at such sites and in such systems, since they do not yield the same amount of secondary products, and are mainly reared for their meat. This might be why pig in general decreased in the LH and Mycenaean at Asine and at other sites in the region.

The LH IIIC period

The animal bones from LH IIIC Asine mostly represent redeposited material from cultural layers around the site and are hard to tie to specific constructions or areas.

[103] Similar high relative abundances of deer bones are not visible in e.g. LH III Lerna (Gejvall 1969), LH IIA-IIIB Pylos (Nobis 1993), or LH IIIB1-2 Tiryns (von den Driesch & Boessneck 1990).

[104] Together with high mortality rates for sheep, Dibble (2017:298) interprets the increase of sheep and goats at LH III Nichoria as sign of an emphasis on wool production, perhaps a consequence of increased palatial demand of wool production from the hinterland.

Some deposits are worth highlighting, however. For example, there are some interesting deposits concerning red deer. Of the 51 identifiable remains found in floor 1 of Room XXXII (House G), 32 derive from red deer, of which all but one were antler fragments. It is probable, that they belonged together, though this is difficult to discern due to heavy fragmentation. Additionally, cattle, sheep/goat and pig were identified from this context. Another example is find unit AS 3214 from House B, which contained nine large red deer bones, of which four metapodial bones, a calcaneus and phalanx, as well as some mandible fragments and long bones were recorded.

The settlement at Asine expanded through the adding of more houses after the LBA 'crisis' (Section 3.2.3). For the LH IIIC period, we can observe changes in the relative abundances of the most common animals (Fig. 11). The decrease in pigs, which started during the transition to the Late Helladic, continued. Sheep/goat also decreased while cattle increased; these two animal groups showed similar abundance (32%, respectively 29% of NISP). During this period, we see that there was an almost equal sheep to goat ratio, 1:1.2, which might indicate a return to a mixed herd strategy similar to the EH period.

Deer increased further (25% of NISP) and became more common than pigs (14% of NISP). Perhaps this increased consumption of wild game was established already during the LH IIIA-B period, when deer abundances at Asine started to increase. At the closest palatial site, Tiryns, there was a steady decrease of sheep/goat compared to cattle throughout the period (von den Driesch & Boessneck 1990). Deer was virtually absent. This is similar to the faunal assemblage from LH IIIC Midea, which is dominated by cattle and sheep/goat (Gejvall 1983). At LH IIIC Kalaureia, a completely different strategy is apparent, where the animal bones most often derive from sheep/goat (ca. 71 % of NISP), while a comparatively low frequency of cattle was recorded (ca. 13% of NISP). Only a few percent of the bones belonged to deer (Lindblom *et al.* forthcoming). Similarly, at LH IIIC Mycenae sheep/goat were most common, at 62% of NISP, while cattle abundance was low, at 11% of NISP (Trantalidou 2009:134). The increase in deer at Asine might be connected to a decentralisation of the region, as some settlements disappeared and deer populations may well have grown as a result. It could also indicate that Asine held a more rural function, and became less occupied. This is, however, not in line with the architectural evidence, which shows that houses were added to Asine during this period. The increase in deer during this period speaks against major deforestation of the surrounding area.

6. Exploring waste management at Bronze Age Asine

The theoretical reasoning in Chapter 2 was applied in five papers using zooarchaeological data from Bronze Age Asine. The articles explore the four key themes formulated in Section 2.3. These themes are regarded as very important aspects in terms of understanding waste management at Bronze Age Asine, but also for investigating waste management as a theoretical and methodological concept in zooarchaeological research. This chapter is devoted to providing critical discussions on each paper.

6.1 Defining contexts at Asine: Papers I & II

6.1.1 The zooarchaeological context: Paper I

The aim of Paper I was to present the zooarchaeological material from Bronze Age Asine and to discuss it from a regional and diachronic perspective, focusing on changes related to centralization processes. Paper I is a diachronic discussion of animal management at Asine. Such a general perspective of the site had not been carried out previously and was needed in order to better understand the site. The paper focuses on the most abundant domestic animals, namely sheep/goat, cattle and pig. This choice was made because these animals made up the cornerstone of animal husbandry and animal consumption at this site. To complement Paper I, I have extended Chapter 5 to include a thorough presentation of identified taxa at the site, and to discuss consumption rather than management. This is important because waste production is more closely connected to consumption than to animal management.

Paper I provides a compilation of general zooarchaeological patterns indicative of centralization or urbanization processes by comparing zooarchaeological trends from different spatio-temporal urban environments. The patterns visible in the Asine animal bone assemblages were tested against the zooarchaeological trends of urbanization or centralization, resulting in the following brief summary of the changes of site function at Asine during the Bronze Age: During the EH, Asine was a smaller rural community, which expanded and gained importance as a central village for the immediate valley during the MH. To the LH, this function was kept. Additionally, Asine might have been an intermediary node in the regional communication network of the Mycenaean period, communicating whatever resources in the immediate valley to the larger palatial sites, such as Tiryns, and perhaps also the vaster region. Added to this is the possible harbour of Asine, which we do not know the extent of. Except for the zooarchaeological data, this narrative also builds on earlier studies of archaeological and architectural finds.[105]

What became apparent during the process of writing Paper I was that most animal bones could not be tied to single contexts at Asine. Instead, they derive from general cultural layers spanning over large parts of the site. In a few cases, single and closed contexts could be used for contextual discussions. The lack of high contextual resolution, i.e. that it is probable that not all single contexts or primary deposits were documented or recorded, means that the discussion remains on a general level. The variation in contextual resolution and documentation quality is an issue in relation to the other papers as well.

6.1.2 Zooarchaeological identification of waste management: Paper II

The taphonomic history of the animal bone assemblage from Asine is explored in Paper II. The aim is to identify traces of human behaviour, especially from waste management processes, by studying the distribution of identified taxa, body parts and taphonomic markers in different contextual categories at the site. Paper II is a methodological article, since the goal was to apply a statistical technique called Multiple Correspondence Analysis (MCA) in order to describe the taphonomic impact. MCA is an extension of Correspondence Analysis (CA) and aims to visualize the dependency, i.e. the relations, between objects (e.g. bones or contexts) and variables (e.g. species or body parts) within a data set. The advantage of MCA is that it is not confined to one set of variables, but explores the connections between variables and also to other variables and objects which are categorized on different ways.[106] This suits the nature of zooarchaeological and taphonomic data, in which one bone might be recorded through many variables. For this thesis, more than fifteen variables were recorded for each bone.[107] Because MCA can visualize the relations

[105] I refer to Chapter 3.2 for a description of the cultural history of Bronze Age Asine based on the archaeological evidence and previous research.

[106] I refer to Papers II and III for more detailed description of this method.

[107] The variables recorded were as follows: taxonomic identification, anatomical element, anatomical part/detail, side, number of fragments, weight (g), approximate size (mm), fragmentation status, epiphyseal fusion status distally and proximally, cut marks, gnawing marks, burning marks,

between these variables among the bones, I applied it with the aim of exploring the relations between identified taxa, body parts, taphonomic markers and contextual categories among the animal bones from Middle Helladic Asine.

The results show that the MCA is a good exploratory tool in terms of visualizing the various possible connections within a large set of zooarchaeological data. Importantly, it provides starting points for discussing the taphonomic history of the Asine animal bones. It shows that there is a certain degree of post-depositional bias in this material, which is apparent in how body parts are distributed in different categories of species and contextual types. Every category exhibits a low frequency of axial fragments, i.e. vertebrae, ribs and sternum which contain spongy bone known to be more prone to post-depositional erosive processes because of their less dense bone structure (e.g. Lyman 1994:234-258; Lam & Pearson 2005). This pattern could perhaps also be detected using a manual and time-consuming data compilation method, but the MCA visualizes this pattern instantly. MCA can simultaneously show the relations between axial fragments to other body parts, species and contextual categories within the assemblage. Apart from these results, the MCA points to several other associations which might be interesting for further studies.

It is observed that future studies should focus on identifiable specimens because it is among these that taphonomic markers were best preserved and might give insight to prehistoric processes. Identifiable bones were more likely to exhibit trampling, gnawing marks and cut marks. The bones from floors were specifically characterized by long bone splinters from medium-sized mammals. This could be seen as smaller refuse left behind in cleaning procedures, perhaps in terms of the McKellar principle (Schiffer 1983:679). These bones become incorporated into the floor matrix during the cleaning or maybe gather in corners or other areas of the indoor space not frequently used. The MCA also shows that floors were associated with weathered bone in a relatively high degree than the other contextual categories (which are described below). This is further explored in Paper IV. In terms of waste management at MH Asine, the pattern discussed above is amongst the strongest, as visualized by the MCA in Paper II. Additionally, the MCA reveals a relationship between the presence of the taphonomic markers of trampling, light to medium burning and gnawing on bone. This can be related to waste management at the site, but is not further discussed because of the issue of how the contextual categories were defined. For example, the used context types are not useful in determining distributions and differences between context types. This issue is discussed below.

Two main issues are revealed by Paper II: i) the low degree of contextual resolution, and ii) which anatomical categorizations of body parts were used. Including context type as a variable within the MCA is important because they reflect different kinds of

---

weathering, trampling, root etching, post-depositional erosion (including excavation and after), photo no, remarks. See Section 4.1.

activities and different levels of contextual resolution. The following categories were chosen: 'secondary layers', i.e. open-air layers with redeposited material such as levelling layers, 'room fills', i.e. fill layers in rooms of which most must be assumed to be redeposited, 'primary deposits', i.e. single contexts which could be associated to certain construction features and single events, such as the infill of an oven, and 'floors'.[108] Secondary layers and room fills both contain redeposited material, while primary deposits and floors contained bones were deposited directly after use. Most of the bones were found in secondary layers and room fills. This affects the MCA, because it meant that the 'average' bone from Asine derived from secondary layers. Thus, the variation within such layers is not visualized but merely labelled 'average'. Further, the variation in primary deposits is invisible because it did not contribute significantly to the analysis. The only category which shows variation and significantly contributed to the analysis is floors. The issue of contextual resolution affected most of the papers (see Section 7.1.1).

The second issue concerns the choice of anatomical categories. In Paper II the nine anatomical categories as formulated by Stiner (1991) were used, namely *horn* (horn core or antler), *head* (mandible and cranium), *neck* (atlas, axis and cervical vertebrae), *axial* (thoracic and lumbar vertebrae, sacrum, innominate bones and ribs), *upper front* (scapula and humerus), *lower front* (radius, ulna and metacarpals), *upper hind* (femur), *lower hind* (tibia, calcaneus, astragalus and metatarsals), and *feet* (phalanges 1 to 3) (Stiner 1991: 460, table 2).[109] Additionally, three categories were added to include unidentifiable fragments: metapodial fragments indeterminate to size; long bone fragments; and fragments indeterminate to anatomical element. This categorization was originally applied to MNE-data, i.e. Minimum Number of Elements, in a study aiming to investigate food procurement and transport by humans and nonhumans in Pleistocene material. Stiner's categories or versions of them have been frequently used by other scholars (e.g. Bar-Oz & Munro 2004; Marciniak 2005:117-118; Orton 2012). The choice to employ them in Paper II was thus to allow comparative analysis with other studies. The categorization made by Stiner suited the study in general; however, the choice of variables is of utmost importance when applying CA-related techniques, because it will affect the results. If another set of anatomical categories had been used, for example one which did not distinguish between the neck and the rest of the axial column, the results would probably have been negatively affected.

[108] See footnote 14 on the blurred boundary between tertiary and secondary refuse in secondary layers.

[109] Loose teeth were excluded.

6.2 Waste management and social organization: Paper III

Paper III is a contextual study of the animal bones in fourteen EH III-MH I *bothroi* found in the early excavations of Asine.[110] The aim is to provide a discussion of the social importance of these features in terms of household organization, waste management and reuse from a zooarchaeological perspective. To be able to work with the Asine *bothroi*, the paper includes a chronological and stratigraphic reconstruction of the pits themselves, since they were largely neglected in the publication of the excavation (Frödin & Persson 1938). Nineteen bones from twelve *bothroi* were sampled for radiocarbon dating. The samples came from different strata within the *bothroi*. The combined radiocarbon date indicates that the pits were filled during the period of ca. 2135-2078 BCE. The stratigraphic reconstruction was based upon careful examination of the excavation journals as well as the presence of peri-depositional markers on bones, such as weathering and trampling. This evaluation shows that some *bothroi* seem to have been closed quickly, with only one or two fill layers, while others might have been exposed for longer periods, based on e.g. the relatively higher abundance of weathering on bones, indicating longer exposure on the ground.

In order to examine the prehistoric social importance of the Asine *bothroi*, the distribution of animal bones in terms of species and body parts in the pits is investigated through the use of Correspondence Analysis (CA). CA aims to describe the variation within a data set, specifically by investigating the dependency between variables and objects. In Paper III two CA-analyses were performed: one of the species compositions in the pit, and one of the body parts' distribution within the pits. In both analyses, the objects were the *bothroi* themselves. The variables were in the first CA different animals, namely cattle, sheep/goat, pig and deer. In the second the variables were body regions, namely *Head* (cranial fragments, teeth, mandibles), *Axial* (vertebrae, ribs, sternum), *Upper* (scapula, humerus, radius, ulna, pelvis, femur, tibia and fibula) and *Lower* (carpal and tarsal bones, metacarpal and metatarsal bones, phalanges and sesamoids). Both sets of data are included in Paper III so that the analyses can be replicated.

The results show that the distribution of animal bones in the *bothroi* is not random. It seems as though certain pits were assigned specific waste categories. For example, red deer bones were rarely deposited unless in *bothroi* 6, 8 and 12, while *bothroi* 2, 7, 9, 13, and 14 seem to have been for the disposal of mainly sheep/goat and pig bones.[111] The results of the CA were merged with the spatial distribution of the *bothroi*. Most

[110] *Bothroi* are large, find-rich pits common during the EH period; often cut into the bedrock or cut into the earth and lined with clay.

[111] The sub-assemblages in *bothroi* 7, 9 and 13 were dominated by pig bones.

eastern *bothroi* contained body parts of low nutrient value (*Lower* and *Head*), while the meaty parts were found in the western pits. The results of the CA indicate that certain types of waste in terms of species and/or body parts were deposited in different pits. Based on this, I suggest that the waste management was to some degree formalized as a consequence of household organization. The organization of waste management was related to the perception of different taxonomic and/or anatomical categories, such as 'red deer', 'sheep/goat and pig'. Also, waste management was probably related to adjacent activity areas. For example, the eastern pits contained 'non-meaty' parts, while the western mostly contained 'meaty' parts. This is taken as an indication of proximity to activity areas of butchery vs consumption, where e.g. the western pitswere closer to the consumption area.

Few, if any, zooarchaeological studies in the Aegean focus solely on the animal bones from *bothroi*. The results of Paper III should be tested by zooarchaeological examinations of other sites with *bothroi* in the area. For example, Reese's (2013) analysis of the faunal remains from EH III Lerna revealed several instances of animal bones from *bothroi*. These contexts could provide a starting point of further zooarchaeological perspectives on the EH III-MH I *bothroi* of the Aegean area.

Three main issues that relate to the zooarchaeological study of waste management were detected while working on this paper, namely the use of CA to visualize data, the relation between body parts and waste categories, and the connection between waste content and waste management. Similar to Paper II, the chosen statistical processing tool was correspondence analysis (CA). This technique cannot be used as an interpretation in itself, because the choice of variables affects the outcome of the analysis. Therefore, the choice of variables follows the chosen research question. For example, if the focus is to study the relations between species and certain architectural features, the variables are the species of interest to the study. Although other variables within the data exist, they are excluded. In the Paper III example, only the most common animals were chosen (cattle, sheep/goat, pig and deer). This was based on two factors: i) other species were rarely identified in the *bothroi;* and ii) very rare instances would create 'outliers' which would disturb the patterns generated by the CA. In other words, the patterns would then only be a reflection of the fact that the rare species were rare and only found in one *bothros*. The CA would then be of no use for describing the general variability within the data. The above is an example of the chain of choices directing the results of the CA. This chain is often invisible; as is also the case in Paper III.

Secondly, there is a need to clarify the definition of body parts and how they really relate to prehistoric perceptions of waste categories. In Paper III it was proposed that the prevalence of upper extremities and the axial body region reflected consumption waste. This can be traced to the fact that these body parts contain in general the highest meat and nutrition values (e.g. Binford 1978; Metcalfe & Jones 1988). This is problematic because, although the distal extremities, such as feet, contain lesser amounts of meat, they can still be considered food or even delicacies in some societies because of their high content in marrow and gelatinous matter (e.g. Bartosiewicz 1997). This is also the case for heads, which are also often symbolically charged; further, the head contains high values of nutrition. The equation of certain body parts to certain waste categories occurs in many zooarchaeological studies, and to some extent also in Paper III. In Paper III the spatial separation of *bothroi* with meatier body parts and non-meaty body parts was an important part of the concluding discussion. This association, i.e. 'non-meaty' versus 'meaty' parts, was also apparent in the CA. This issue is further discussed in Section 7.1.2.

In Paper III, it is suggested that the distribution of body parts and species reflects spatial organization related to waste management. The waste management itself was probably affected by the proximity of waste locations to different activity areas of butchery and of consumption. I propose that the disposal of 'meaty' contra 'non-meaty' parts is related to proximity to either consumption or butchery areas. The disposal of waste from specific animals was more formalized and related to the sorting of waste in the moment of disposal, where certain taxonomic categories, such as deer, most often ended up in separate *bothroi*. The third issue is related to this reasoning, as it is concerned with the relation between waste content and waste management. How do we assert that the animal bones we find in certain archaeological features are linked to formalized waste management or to spatially formalized activity areas? This issue reappears in Papers IV and V, and is discussed as a general issue in Section 7.1.3.

6.3 Waste management and social topography: Paper IV

Paper IV is a zooarchaeological contribution to the discussion of the increasing social complexity during the Shaft Grave Period, or the Middle Helladic III to the Late Helladic I transitional period. This increase is perhaps best exemplified by the wealth exhibited in the Shaft Graves at Mycenae, which is in sharp contrast to the moderate wealth of grave goods in other sites in the surrounding region during this period. It is traditionally viewed as symptomatic of the emergence of the Mycenaean cultural complex (e.g. Dickinson 1989; Voutsaki 1997; Petrakis 2010). Paper IV is theoretically based in the concept of 'social topography', the spatial distribution of status differentiation, and the relation of this concept to the spatial distribution of consumption waste (see Section 2.2.3.2). Following a methodological framework loosely based on the discussion on luxury food by Ervynck *et al.* (2003), the animal bones from two different parts of MH III-LH I Asine settlement, the Lower Town and the Barbouna Hill, were analysed using the zooarchaeological indicators of i) weathering, gnawing, trampling, and contextual variation thereof (as indicators of waste management), and ii) waste content, with a focus on the presence and distribution of rare taxa and any specific election of body parts, age or sex of consumed animals.

A more diverse set of animals, including wild taxa, as well as higher abundances of adult male pigs and worked bone or antler characterised the animal bones from the Lower Town. Further, the animal bones of the Barbouna Hill were fragmented to a higher degree; therefore the patterns of the Barbouna Hill bones might be biased by post-depositional erosion. Several similarities between the areas were found, however, such as the similar species composition of the most common meat animals and similar traces of bones having been thrown in fire installations, as indicated by the non-uniform degree of burning of bones found in association with floor contexts.

In conjunction with the distribution of other material findings, such as the differentiated distribution of pottery, where most imported ware was found in the Lower Town, the existing hypothesis of an uneven social topography at MH III-LH I Asine in which the Lower Town area were assigned higher status position was supported. However, as mentioned above, other zooarchaeological patterns point to similarities between the areas, which might indicate that the manifestation of social topography was maybe not an important part of daily life, but rather demonstrated through the display of occasional imported objects or exotic/luxurious consumption event.

There are two main issues with Paper IV which are important in relation to the other articles of this thesis. These are the lack of contextual resolution and the relation between waste content and waste management. The first issue is one of the reasons sample sizes were small in this paper. Because there are low numbers of animal bones from this particular period and from each settlement area, inferential statistics have been used to evaluate and to show that the distribution between the samples from the Lower Town and the Barbouna Hill are statistically non-random.

The low contextual resolution means that the zooarchaeological data reflects more general patterns than specific. Therefore, the first issue is closely related to the second, namely the relationship between waste content and waste management. It is connected to the fundamental assumption that consumption waste was thrown away close to the consumption location. How can we assert that the consumers discarded their food waste in the location in which they consumed it, and if so, how can we assert that it represents the whole area? A large part of the animal bones presented in Paper IV are redeposited material deriving from open-air cultural layers or building infills. In the process of writing Paper IV it was considered necessary to assume that redeposited material was first deposited as primary refuse in the same settlement area in which it was excavated. This is because there is a lack of high contextual resolution which could provide primary deposits, i.e. contexts which can be related directly to the household, such as fills in ovens or old hearths. As mentioned, this assumption is potentially an issue, but without it old collections like Asine are difficult to study. In short, the issue of this assumption means that the picture provided in Paper IV is general and not specific (see Section 7.1.3).

6.4 Symbolic aspects of waste: Paper V

Paper V examines the symbolic connotations of bone waste at Asine by comparing the animal bones from the settlement with the animal bodies or body parts deposited as grave goods in the contemporary graves at the site. The study was restricted to the early MH (MH I-II, ca. 2100-1800 BCE) period, and included the settlement areas of Houses pre-D, B and D in the Lower Town and House T on Terrace III. Of the graves dated to this period, four were excavated in the Lower Town and Terrace III, and one at the East Cemetery, which was outside the settlement, contained animal bones. The comparison between the settlement and the graves was made through the variables of species composition and body parts.[112] The results of the intra-site comparison of the settlement and graves at Asine were compared to close-by Lerna, from which data from the settlement and the graves were available.[113] Additionally, other sites from the Peloponnesian region from the broader MH and LH periods were reviewed in order to provide a regional and diachronic perspective on the results.

At Asine, it became apparent that the pig was the most common grave good animal during the earlier MH period. The pig was also the most abundant animal in the settlement debris during this period, followed by sheep/goat and cattle. Besides pig, sheep/goat and cattle were identified in the graves as well. At Lerna cattle were most abundant in the graves, although the pig was most common in the settlement. The review of other sites in the region revealed that this tendency changed in the later MH and the LH, in which hunted animals, horses and dogs became more common as grave goods. During this later period, domesticated herd animals still had a ritual and symbolic significance, because they appear frequently in other ritually interpreted contexts, such as the remains of burnt animal sacrifices as discussed at Pylos (Isaakidou *et al.* 2002), Ayios Konstantinos (Hamilakis & Konsolaki 2004) and Eleusis (Cosmopoulos 2015:106).

It is necessary to highlight two main insights from the process of writing Paper V. First, the low contextual resolution at the site was evident because few bones could be tied to specific grave deposits. Animal bones in graves at Asine were in general not

[112] Additionally, age and sex assessments from the settlement debris were provided as well. However, this kind of data was not readily available from the graves.

[113] Information on animal bones from the settlement was taken from Gejvall (1969), while Reese generously provided data on the animal bones from the MH graves of Lerna.

described by the excavators, although they saved the bones during the excavations. In the region, animal bones were not always collected during the early to mid-20th century excavations (for this trend, see MacKinnon 2007). Therefore, the contextual information on animal bones in graves is questionable at other early excavated sites. A comparison between the animal bones from the graves of Asine and Lerna was, however, important for Paper V. Because of the issues with contextual information, it was hard to assert that animal bones were not part of grave goods, even if no animal bones were reported from the actual graves.[114] Therefore, a qualitative approach for evaluating contextual information on animal bones from graves was chosen for Paper V. For each grave the contextual integrity and resolution, i.e. whether or not the animal bones connected to the specific grave were mixed from overlying layers or belonged to the grave deposit, was assessed.

Secondly, we return to the issue of anatomical categories. Similar to Paper II, the anatomical categories by Stiner (1991) are used in Paper V. According to her study, this is based on MNE-derivations of the anatomical data, meaning that theoretically a body region can be represented by one splinter or ten. An example from Paper V is the one pig mandible in grave MH 102, which represents the head. In this example, the rest of the head was not found. This makes MNE problematic in terms of representativity issues. I return to the definition and choice of anatomical categories in Section 7.1.2.

[114] One good example of this is Malthi, a MH settlement in south-western Peloponnese excavated by Valmin in the early 1900s (Valmin 1938). He did not report any animal bones from the graves he excavated, the exception being from the Early Helladic period, namely Grave XXXVIII, a *bothros* pit with commingled human and animal remains. Valmin (1938:189) suggested that this feature should be regarded as an ossuary than a primary burial. However, in the recent excavations of Malthi, directed by Michael Lindblom, two child burials were excavated, and associated with the individuals in these graves were some animal bones, mainly of pig (Macheridis 2016).

7. Discussion and conclusions

The exploration of the waste management at Bronze Age Asine revealed several issues which are in need to be further discussed in order to understand waste management at the site and as a perspective in general. This discussion is contained within the first part of this chapter. The second part draws on the discussion and is devoted to summarizing the conclusions of this study.

7.1 Critical issues examined in the papers: a discussion

Although not explicitly mentioned in the previous chapter, an important part of any study is the choice of methods to describe, analyse and visualize multivariate data sets. As an initial part of the design of each study, this choice must be made according to the preconditions of each case study. Such pre-conditions could, for example, be the restriction of the study to specific archaeological features, a specific time, or specific zooarchaeological variables, such as concentrating on species composition.

Several usable frameworks to disentangle complex zooarchaeological data have been formulated previously. For example, the multivariate approach proposed by Bar-Oz and Munro (2004) aimed to solve the issue of equifinality. Bar-Oz and Munro's (2004) approach is suitable to assemblages with many subgroups, i.e. large sample sizes with a broader range of domestic and wild mammals, two or more different prey categories and two or more age groups. As it is detailed, it is also quite time-consuming and it cannot provide instant pictures of the connections between different variables within the data set. Another example of a previous approach to resolve complex zooarchaeological data is made by Orton (2012) who provides a six-staged framework for studying the taphonomic history of an animal bone assemblage. This approach is chronological, starting with post-excavation conditions and ending with human selection of animals and body parts (Orton 2012). Although it is reasonable to have a chronological approach if the aim is to reconstruct taphonomic histories, the framework requires that the intended project follows it and is not very flexible. Madgwick and Mulville (2011) also provided a multivariate statistical approach to the investigation of weathering prevalence in faunal assemblages from the UK. Although they could show that their approach is very informative, there is often a need to include more taphonomic variables than weathering when processing zooarchaeological data.

Because the identification of waste management is merely a first step towards the study of it within a prehistoric context, the description and analysis of multivariate data cannot be the only heuristic tools. For this reason, the choice of method to process data has been directed by the need for an exploratory tool which can simultaneously visualize the most significant patterns within the data set. Therefore, within the frames of this study, CA-related techniques have been applied (Nenadic & Greenacre 2006; 2007; Greenacre 2007). While ordinary correspondence analysis (CA) was used in Paper III to visualize the distribution of various taxa and body parts in the *bothroi* pits of EH III-MH I Asine, and to explore whether or not we could detect any patterns or clusters using CA (Section 6.2; Paper III), multiple correspondence analysis (MCA) was used in order to simultaneously explore and describe the relations within an assemblage. The various connections between taxa, body parts, contextual categories and taphonomic markers at the MH Asine were visualized simultaneously, making the taphonomic impact of certain processes on the Asine animal bone assemblage clearer. Splinters of bone corresponding with floor layers were explained by cleaning and/or trampling activities indoors during the MH. The correspondence between deer, cattle and feet was suggested to reflect the impact of post-depositional density-mediated attrition, which might have favoured this kind of bone (see Marean 1991). Fragmentation processes from the excavation and afterwards has affected mainly the unidentifiable bones, but have increased fragmentation overall in the assemblage.

The results also show that while CA-related techniques are useful for detangling multivariate data, the use of these techniques depends heavily on the research aim of the author. While I recommend the use of CA-related techniques to those with large, complex data sets, it might not suit all animal bone assemblages. For example, to apply CA-related techniques on assemblages with a small number of animal bones is redundant and unnecessary; in these cases it may be more advantageous for the analyst to make a qualitative assessment of the data and possible patterns within it. This was shown in Papers IV and V, in which I chose to not use advanced statistical tools because the data sets were smaller and in need of a detailed assessment of contextual resolution in order to be properly understood.

As mentioned in Section 6.2, the choice of variables directs the outcome of the analysis. This means that the variables must be presented and defined in order for the study to be transparent. Therefore, full data sets are provided in Papers II and III so that the results can be replicated and the data examined by other means. CA-related techniques are not interpretative *per se*; they are exploratory tools which describes data. This means that the use of these methods will provide a qualitative and interpretative approach in which all patterns must be carefully considered and discussed. This directs the study to be interpretative and qualitative rather than descriptive and quantitative. This is also one of the main reasons, besides being quick and exploratory, for choosing these techniques when studying the material from Asine. Most of the zooarchaeological data from Asine derives from the old excavations. Most evaluation of this data must involve a contextual assessment based on several sources of information, including the publication report, plan drawings and field journals. To handle this kind of material requires an interpretative approach. This has been important in the process of researching the papers. Foremost, this process has revealed three critical issues defined in Chapter 6, namely the importance of the degree of contextual resolution, the choice of anatomical categories, the relation between waste content and waste management. These issues are further discussed in the sub-sections below.

7.1.1 Contextual resolution and old collections

During the last few decades we have seen an increased interest in old collections from excavation projects. Asine fits the description of an older collection, as provided by Jones and Gabe (2015), in that it has been put through post-collection processes (such as moving the material) and is not gathered in one place, as the bones from the 1970s excavation are kept in Greece and the ones from 1926 in Sweden. On a positive note, the Asine bone collection includes contextual information in most cases and is relatively well preserved. The degree of preservation differs, however, between the bones from the older and later excavation periods.

An example of the renewed interest in old collections can be found at Lund University, in which the project *Magasinsarkeologi* (Eng. 'storage archaeology' or 'archival archaeology') aims to document older excavations and inventorise old collections which were previously partially or completely unpublished (Jennbert 2014).[115] Similarly, Smith (2008) has published the data from 1970s excavations in the Phlamoudhi area on Cyprus. She invited students to work with old material in order to gain experience and credits. This involved supervision and guidance to the same extent as if they were new excavations (Smith 2008:39). Further, her work showed that the analysis of the material functioned as a tool to understand the documentation. This is also the case at Asine, where the pottery has recently been re-examined and inventoried (see Swedish Institute at Athens *et al.* 2017). This has resulted in, among other things, preliminary dates of many stratigraphic units,

[115] Some collections have, however, been of interest to research for a long time, disregarding the state of publication. The old collection from Asine is one such example (e.g. Hägg *et al.* 1996; Wells 2002a). Another is the well-documented Guthe collection from the University of Michigan Philippine Expedition in Southeast Asia, led by C.E. Guthe during the 1920s. Research on this material has been on-going since at least the 1950s, although it was intensified at the end of the 20th and beginning of the 21th centuries (Sinopoli 2013:8).

allowing for the reconstruction of stratigraphy and chronology at the site. The study of pottery and bones can help us to understand and sometimes correct the documentation, such as is the case with the Asine *bothroi* (Paper III).

For some archaeological features from Asine, it has been possible to reconstruct stratigraphy and to analyse closed contexts. In Paper III this was attempted successfully by an integrative approach of examining the field journals and by means of radiocarbon dating and typological dating of pottery, creating a chronology of the studied features, the *bothroi*. This shows that it is possible to re-construct the stratigraphy, and that the integrity of specific closed contexts was considered during the 1926 excavation. Animal bones from the contexts documented in this detail at Asine are in the minority. Most bones derive from spits of thick cultural layers spanning over sometimes very large parts of the site. Specific dump layers or other kinds of single contexts were not documented consistently.

The low contextual resolution which is evidently a problem for the Asine assemblage is related to the Asine material being part of an 'old collection', even if more recent excavations can also suffer from a low degree of contextual resolution and poor documentation quality. Further, there is no first-hand knowledge of the assemblage from the early excavations, since all excavators are deceased. Additionally, the excavation methodology did not include systematic sieving. The low contextual resolution is also apparent, in that it is not always possible to distinguish the single context or primary deposits, such as separate fill layers in the documentation of the site. Because secondary deposits are representative of secondary or even tertiary waste, the material's link to the area and specific location is harder to assert. Another sign of a low contextual resolution is that not every excavated feature is documented by plan drawings, including coordinates. Since the context cannot be recreated in three dimensions, it diminishes the level of contextual resolution; a reconstruction of the formation of the infill material of the feature cannot be made. For example, it is harder to typologically date different layers of the infill, which means that we cannot reconstruct the chronological span of the infill events with confidence.

Jones and Gabe (2015) highlight three issues of old collections when compiling data for meta-analyses, namely screening (or sieving), context and documentation. All these three issues are also problematic in the case of Asine.[116] The issue of contextual resolution is evident in Paper II where it was revealed that most bones derived from redeposited material. This overshadowed any patterns in primary deposits and floors described by the MCA. The issue returned in Paper IV, where a minority of bones could be tied to the different settled areas of Asine. This representational issue was evaluated through inference statistics.

[116] Sieving is not further discussed here, as it is a bias of the material whether or not it is relevant to specific research questions.

Further, the animal bones connected to each settlement area were originally found as redeposited material. It can be argued that they derive from somewhere else originally. The issue of low contextual resolution likewise appeared in Paper V, in which the animal bones from the settlement were compared with those from the graves. Very few bones could be connected to the graves themselves, because animal bones were seldom documented in high detail, whether on plan drawings or in the field diaries. In other words, although it was possible in a few cases to trace the bones back to the grave, it was not possible to determine where and how in the graves they were deposited, as this information was not included in the documentation.

It must be acknowledged that the problem of low contextual resolution cannot be avoided in the case of Asine. In some instances, as with the Asine *bothroi*, it is possible to reconstruct the stratigraphic sequences, representative of narrow periods of time, e.g. the infill of a pit. The majority of finds at Asine, however, derive from the often mixed cultural open-air layers spanning over broad time periods connected to, around and within houses of the Lower Town, the Terraces and the Barbouna Hill. Such finds can at best be considered as secondary refuse, but could even be tertiary. Does the clearly lower contextual resolution mean that contextual studies, focussing on social aspects, of this material are impossible?[117]

Evidently, I do not believe that is the case.[118] Papers IV and V successfully explore research questions investigating social aspects. The papers show that studying specific contexts can be fruitful even when the contextual resolution of the site in general is low. We have to simply accept that the study of old collections will be more general than specific in character. The material might reflect redeposited material, which we will have to treat as redepositions of primary waste from the approximate same period and area. Each evaluation is contextual and site-specific. For example, the documentation practices of the different excavators, in the form of field diaries and plan drawings, have been important for highlighting and understanding Asine.[119]

---

[117] For example, Uerpmann (1973) did not believe so. According to him, bones "which have been redeposited or are found on the surface should not be included in the material to be analysed" (*ibid.* 1973: 307). While the latter (surface finds) often lack contextual information, this is not the case with either secondary or tertiary refuse. These kinds of material, when found in dated layers, are important sources of information on general patterns of consumption, production and waste management. Therefore, I disagree with his stance.

[118] The finds from secondary or tertiary deposits have been shown to be very informative in other studies as well (see Fuller *et al.* 2014). Lyne and Haarby Hansen (2016) demonstrate that the content information of the waste masses found in the moat fill from 17th century Copenhagen indeed can give highly valuable insight into the society of this period. For example, the finds testified to an intensive local pottery production in the city.

[119] This reasoning can be related to the concept of neo-documentation, which acknowledges the "multi-modality of documentation practices" (Börjesson *et al.* 2016). A neo-documentalist approach is useful in order to analyse and understand different modes of documentation, the objectives of the excavators as shaped by their professional identities and how knowledge about the site was and still is made (*ibid.* 2016:15-16).

This problem can partially be addressed by digital techniques, such as 3D GIS platforms (e.g. Katsianis *et al.* 2008; Dell'Unto *et al.* 2015; Dell'Unto 2016) or digital photogrammetry and image-based 3D modelling (e.g. Falkingham *et al.* 2014; Macheridis 2015). Although such solutions have not been applied to Asine (yet), it is possible to digitalize and create three-dimensional maps of the available documentation. This would greatly aid any study of closed contexts, chronological periods or areas. One example of a digital reconstruction through old documentation is provided by Falkingham *et al.* (2014). In their study, they applied digital photogrammetry to a series of 17 photographs from the older excavation of the Paluxy River dinosaur track site. Although the reconstructed 3D surface has varying degrees of resolution and detail, it still shows the potential for this method to be applied to old collections and photographic documentation. As they argue, this is especially important for cases in which the written documentation has been lost or degraded but photographic evidence remains (Falkingham *et al.* 2014). Similarly, Landeschi *et al.* (in press) reconstructed stratigraphic sequences of the excavations of the Stora Förvar cave on Gotland by integrating information from the original reports from the 1940s with a 3D model of the cave. The results clearly show how 3D-techniques have great potential as heuristic tools for understanding and analysing old excavations, as well as for integrating such information with new types of data (Landeschi *et al.* in press).

7.1.2 Translating anatomical categories into waste categories

An issue that was discussed in relation to several of the papers was the choice of anatomical categories in waste management studies. This problem can be summarized in the following questions: how do descriptive anatomical categories correlate to prehistoric waste categories connected to decisions, behaviour and cultural perceptions of slaughter, butchery and consumption? Which anatomical categories are most suited to the study of waste management? The links between what we see today (anatomical categories) and which prehistoric decisions formed the material as described today are therefore important to consider.[120]

7.1.2.1 Anatomical categories

In this subsection, focus lies on the different anatomical categorizations used in the papers, although a general review of anatomical categorizations used in zooarchaeology is beyond the scopes of this thesis. The decision to use different anatomical categorizations was pragmatic and based on the fact that, for some papers,

[120] This issue relates to middle range theory, and is perhaps best expressed by the classical Binford question “How do we know what experiences with living systems are relevant to the past” (Binford 1981).

the quantitative basis has been small, while in others it has been large. The heuristic value of anatomical categorizations has thus differed. For example, the animal bones of the *bothroi* in Paper III did not make up a very large assemblage. Therefore, to use a detailed anatomical categorization to analyse through correspondence analysis was considered futile and a simplified anatomical categorization was chosen. This made up a more general description of the data, but it suited the aims and the methods better.

As mentioned above, three anatomical categorizations were used in the paper. They each followed detailed, simplifying or established methods of categorizing animal anatomy, as presented in Papers I and IV, which include the categories *Head* (horn core/antler, skull, mandibles), *Trunk* (the axial skeleton), *Upper front* (humerus, scapula, radius and ulna), *Lower front* (carpal and metacarpal), *Pelvic region (pelvis and sacrum), Upper hind* (femur, patella, tibia, fibula), *Lower hind* (tarsal and metatarsal bone), and *Metapodials and phalanges* or *Feet and metapodials indet.* (metapodials, sesamoids, and phalanges indeterminate to anatomical orientation). The categorization used in Paper III is a simplified version of this, including four categories: *Head* (horn core/antler, skull, mandibles), *Axial* (vertebrae and ribs), *Upper* (humerus, scapula, radius, ulna, pelvic region, femur, patella, fibula and tibia) and *Lower* (carpals, tarsals, metapodials, phalanges and sesamoids). Further, Stiner's (1991) established anatomical categorization is used in Papers II and V. This system was described in Section 6.1.2.[121]

The choice of anatomical categorization can lead to different descriptions of the data. This is visualized in Figure 13 in which I use the anatomical data from pig bones from MH I-II Asine.[122] Conjoining the three systems of anatomical categorization, we can see that different narratives about the material can be made, especially between the detailed categories and the ones established by Stiner (1991). For example, Stiner's categories include the neck, which is not included in the detailed categories (Fig. 13). Using MNE magnifies the abundances of body regions which are present with low numbers using NISP. This is because NISP is more affected by the degree of fragmentation of spongy bone present in vertebral bodies. The higher abundance of axial in the Stiner categories is a clear example of this (Fig. 13). Using the detailed system by NISP produces a lower abundance of axial parts.

[121] Loose teeth were included in the *Cranial* or *Head* categories in all papers (except Papers II and V), because there is no statistical difference when removing them (see Appendix 6).

[122] The data can be found in Appendix 6.

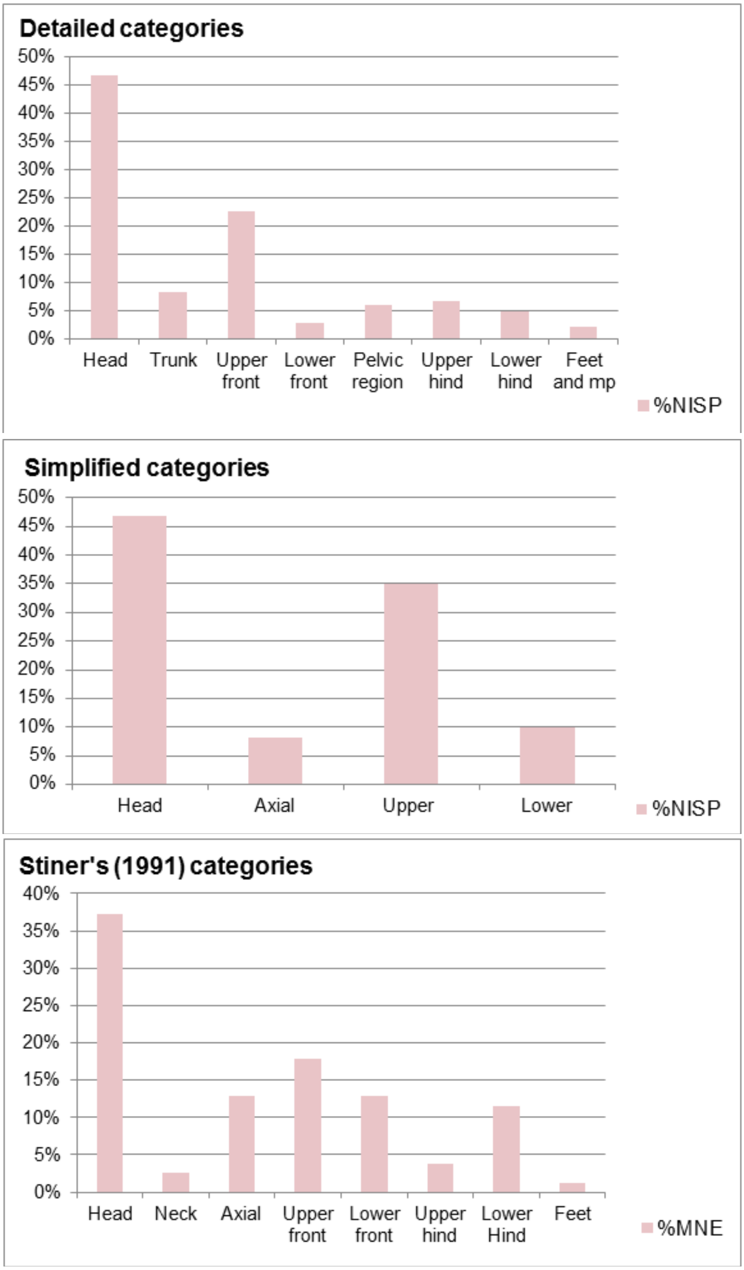

Figure 13.
Relative anatomical distribution of pig bones from MH I-II Asine (n=425), using three different anatomical categorizations. NISP (n=425) is used for the detailed and the simplified categorizations, while MNE (n=78) is used for the established (Stiner 1991). The Stiner category *Horn* is not applicable to the pig. Loose teeth are included, since no statistical significant difference could be detected when excluding them. Data is taken from Appendix 6 and Paper V.

Another interesting contrast is the relation between upper and lower hind limbs. In the detailed system the upper hind limb is more common than the lower, while the opposite pattern is visible using Stiner's system. This depends on two factors. First, the use of MNE represents the least fragmented bones. The calculation of MNE is often based on the minimum number of complete skeletal elements or parts of skeletal elements, such as the complete epiphyseal end (Reitz & Wing 1999:215-216; Lyman 2008:219). Second, the *Lower hind* category includes more bone elements than the detailed system used in Papers I and IV. In the Stiner version this includes the tibia, fibula, tarsals and metatarsals, while the two former are included in the category *Upper hind* in the detailed system. Knowing this difference, of which elements are contained within each category, is crucial when discussing the anatomical distributions.

Because of the issues previously stated regarding the use of MNE and MNI-derivations for the Asine animal bones, I preferred to use the categories based on NISP. Stiner's categories were made based on MNE, but can be used with NISP, as demonstrated in Paper II. However, it is common that axial bones are underrepresented in zooarchaeological assemblages, and this is certainly also the case for the Asine animal bones. Because of this, the separation of the axial column into two categories (*Neck* and *Axial*) is perhaps redundant, in the sense that axial bone will still be visualized as greatly underrepresented. The heuristic value of the chosen categorization might increase if it is more descriptive and follows general anatomical laws.

7.1.2.2 Non-meaty vs meaty body parts = butchery vs consumption waste

Animal bone waste is often categorized as butchery, consumption and production waste, depending on the anatomical distribution of the specific assemblage. However, these could be considered as the same or mixed in the prehistoric setting. The waste categories discussed in this section are not necessarily the only valid ones in the discussion of prehistoric waste categorization. Waste categorization depends on cultural categorizations of body parts and animals, such as folk taxonomy (Marciniak 2005:57; 2011). The terminology and distinction of butchery and consumption/production waste is useful because it describes traces of activity, in terms of butchering strategy and food culture. Butchery is culturally situated, and what is considered as butchery waste can differ, depending on cultural context. For example, the butchery of sheep in the Mahas region of Sudan included a primary waste of metapodials and phalanges, which were instantly removed to a dumping area some distance away from the butchery site (Arnold & Lyons 2011). Conversely, the observations of animal butchery in rural Iran revealed that horns, mandibles and teeth were primary butchery waste. This waste was tossed into rivers or left on site for scavengers (Kramer 1982).

In Western zooarchaeological research, the understanding of butchery and consumption waste has often been related to the concept of body part utility (see e.g. Uerpmann 1973:316; Binford 1978; 1981), meaning that non-meaty body parts which consist of other products, such as grease, are not consumed as often as meaty parts with high values of other products. This reasoning is permeated by assumptions of economic and nutritional rationality. For example, it is assumed that people would rather eat meaty parts than non-meaty parts, such as feet, which are discarded in the butchery stage. This is problematic, since there are a multitude of examples indicating otherwise. In his contemporary study of retail prices of pig and cattle cuts, Bartosiewicz (1997) show that the body parts preferred for consumption are different according to national customs, such as both the pig's head and brain being popular in Spain compared to other countries. As he also mentioned, his results do not correlate with the view that the valorization of meat corresponds to meat content, as expressed in, for example, Uerpmann's (1973) categories of meat value. Uerpmann divided the animal body into three "grades", of which grade A included the parts with the objectively highest meat value (vertebral column, upper legs, shoulder and pelvic region) and C the lowest (facial bones, tail, feet) (*ibid*. 1973:316).

An important assumption in this thesis is that animal bones from waste-related contexts represent waste, often in terms of consumption/production and butchery waste. What the above discussion illustrates is that this assumption is not always straightforward, and it must be contextually evaluated for each case study. This has been important in the work of the papers in this thesis. For example, in Paper III, the distribution of animal bones in the Asine *bothroi* is discussed in terms of butchery versus consumption waste. However, there were no *a priori* assumptions that non-meaty body parts necessarily represent slaughter waste. This suggestion was instead based on the results of the analysis, i.e. the clustering of non-meaty body parts and head bones, as opposed to groupings of meaty body regions, as visualized by correspondence analysis.

7.1.3 Waste content and waste management

In Paper IV animal bones found as redeposited waste in one area were assumed to represent that area. One question that was raised when contemplating the results of this paper was as follows: how can we assert that the consumers threw their food waste at the location where they consumed it, and if so, how can we assert that it represents the whole area? It requires a high contextual resolution in order to assert that the animal bones represent traces of single disposal events. This type of context information has not always been possible to acquire in the case of Asine (Section 7.1.1). Therefore, the assumption that patterns detected in the waste content represent disposal practices has in some cases remained *a priori*.

Another question which relates to this problem is: how do we discuss whether or not the animal bones we find in certain archaeological features represent formalized waste management? Do animal bones in any given waste context represent formalized waste management, such as the sorting of waste due to material category, or that they ended up as waste due to their proximity to activity areas, such as butchery workshops? This is a theoretical problem which must be acknowledged in the study of waste management. Ideologically, it is an important stance to make because it means that we cannot assert that, just because a certain material is represented from the waste content, it represents the whole community on a general level. For example, the over-representation of feet in a context does not necessarily mean that butchery occurred nearby. It could also mean that the waste thrown was made according to material categorization, i.e. the sorting of waste.

This theoretical standpoint represents a hypothetical taphonomic problem that is important to consider in relation to prehistoric contexts. Russell (2012) made a similar point about decisions or selections of species or body parts based on ritual or symbolical preferences. According to her, ritual practices might bias an animal bone assemblage in the same way as, for e.g., meat transport decisions might do. As an example, she mentioned that hunter-gatherer phenomena, such as hunting shrines, consciously target high-prestige taxa for ritual or symbolical reasons rather than "following the dictates of optimal foraging theory" (*ibid*. 2012:143).[123] For each context or locality, the theoretical possibility that an animal bone assemblage might be biased by human selection due to ritual or symbolical preferences is as likely as that it is due to economic or functional ones, and should be considered as such.

Whether animal bone waste is representative of the activity, the waste management, or both, is an important underlying question in the discussion part in Paper III. If we could assign waste as indicative of activity areas, this would be important for the interpretation of the site and its organization. The results supported both these scenarios: there was a certain degree of formalized waste management connected both to proximity to activity areas, i.e. that butchery waste was disposed of in the pits closest to the butchery workshop, *and* to material categories, i.e. that certain species and body parts were assigned to specific pits. To conclude, the question of what the waste content of e.g. a pit really represents, and how it is related to waste management, is vital to the understanding of the organization of the site and its waste management traditions. The issue discussed in this section is thus not mainly a methodological problem but a theoretical and hypothetical one, which has been considered through the process of the study.

[123] According to Russell's review, hunting is vital to the construction of male identity in many hunter-gatherer communities, as indicated by the occurrence of hunting shrines.

7.2 Conclusions

7.2.1 A waste management perspective in zooarchaeology

One of the main aims of this thesis was to "investigate, analyse and discuss 'waste management' as a methodological and theoretical concept in zooarchaeological research". In this thesis, waste is defined as the following:

> Waste is stuff that has lost its socio-economic and techno-functional value to the degree that it is discarded. Waste contains symbolic meaning. Waste categorization, value and disposability are defined by the cultural classification of the material world.[124]

The first sentence highlights the technological and functional aspects of waste which were mainly the focus of processual archaeological studies of waste management. The animal bones that were thrown away after a meal and are found in the general scatter of waste around the settlement of Asine illustrate this issue. In the research presented here functional or technological explanations also occur, such as when explaining the occurrence of splinters and smaller fragments in floors of the buildings of the MH period. This is discussed in Paper II as a consequence of the floors being swept regularly, thereby leaving splinters which eventually were embedded in the floors or perhaps trampled down (see Martin & Russell 2000: 62). While this kind of explanation is valuable for discussing the management of waste on site and any differences therein, the reasons why these differences occur cannot be explained solely by technological aspects. This is especially so if the differences are reflected in similar activity areas, such as floors. This is the main constraint of such explanatory models.

In order to highlight other aspects of waste, symbolic meanings of waste are included in the definition of waste. This aspect has been of most interest to post-processual researchers. It is difficult to investigate without a high contextual resolution or availability to defined ritual contexts at the site, such as graves. At Asine, graves contemporary with the settlement were excavated, which has made the comparison between obviously symbolically laden contexts (the graves) and more quotidian contexts in the settlement possible. This kind of comparison can give valuable information, especially since the possibility that the settlement contexts contain symbolic meaning in the general scatter of waste cannot be rejected. This is the idea behind Paper V, in which certain similarities between graves and settlement were detected, discussed in terms of symbolism and animal categorization. For example, the most common animals in the MH I-II settlement, namely cattle, sheep/goat and

[124] The definition is composed of three sentences, representing each aspect of waste discussed, labelled A to C in Section 2.2.

pig, reappeared as important in contemporary graves. It is probable that ritual events occurred and were important in everyday life during this period, as has been suggested by previous scholars (Nordquist 1987:111; Whittaker 2010:536). Based on these and the zooarchaeological pattern described above, I suggest that the consumption of meat from these animals might have been ritualized and/or symbolically connoted. However, whether this symbolism extended to the actual waste is hard to determine, and remains unknown.

The third sentence in my definition of waste contains the notion that cultural aspects of waste categorization, value and disposability, reflect, negotiate and structure cultural norms, traditions and material categorizations. These are common topics in social anthropological research, which has inspired several discussions, as illustrated in the appended papers. I have focused on the following aspects, namely social organization and social topography. The most notable example is perhaps the discussion of waste categorization in Paper III, which centres around the *bothroi* of EH III-MH I Asine. Based on the material patterning in these pits and the fact that they were filled up during the approximately same time period, I propose that they were part of a waste management system at the time (see Paper III:87). This suggestion is inspired by anthropological research on societies which have defined waste categories and strict ways of disposing of waste, such as the Dogon of Mali (Douny 2007).

One of the characteristics of waste management is that it is a taphonomic process. This is evident when reviewing the archaeological and zooarchaeological literature, and it has been an important key theme for this study. A taphonomic discussion has become relatively standard to zooarchaeological analysis and does not necessary imply a focus on waste management, although waste management is a taphonomic process. In order to investigate the patterns revealed by taphonomic analysis in more detail, and from a waste management perspective, the cultural aspects on waste management has been of more use. In my work, the taphonomic reconstruction and discussion has foremost functioned as an identification key to patterns within the material, which can be tied to human behaviour. The taphonomic approach presented here (Paper II) is based on a multivariate statistical technique (MCA), of which the results involve an interpretative approach, where knowledge about the site's geological and environmental conditions, excavation history and animal bone assemblage is important. For example, the association between recent breakage and unidentifiable bone in Paper II is best explained by the post-excavation periods of movement between storages.

The view on waste management as a practice situated in cultural traditions, categorization and perceptions on the material world have given valuable insight on Asine during different time periods of the Bronze Age. Papers III and IV are examples of this. In Paper IV, the hypothesis that Asine society was socially stratified during the

MH III-LH I was tested by the investigation of animal bones from different parts of Asine. In relation to this, the research by Rathje and Cullen (2001) has been used as inspiration. They showed that waste content is often tied to the consumption of the household, which in its turn is tied to that household's socio-economic status. An assumption has therefore been made that the waste content would be tied to consumption in the different areas. In order to sort waste and consumption out in Paper IV, a methodological framework which separated waste content and waste management was developed. In this framework, the waste management was tied to taphonomic peri-depositional markers on bone, i.e. gnawing, trampling and weathering, which indicated human and/or animal modification of bone after consumption. In this way the connection to waste and waste management could be achieved, and the waste management could be separated from consumption. When it comes to waste content, it is harder to separate consumption and waste, because essentially the waste reflects consumption behavior in general, especially when there is a low contextual resolution and we cannot tie the animal bones to specific waste deposits. The waste content could thus either reflect the deposition of one meal, or only one type of waste category, such as butchery waste.

One of the conclusions of this work is that the view on waste management as a cultural practice, beyond technological and functional value, enriches the understanding of a specific site. This has been exemplified with case studies using the Asine animal bones. Further it is concluded that a waste management perspective includes the notion that animal bones from waste-related contexts, such as fills, levelling and construction layers, should primarily be considered as waste material. This means that these bones can be used to study human waste management, a direct consequence of social order and traditions, as well as the cultural classification of the material world. Finally, a waste management perspective focuses on the traces of certain societal structures and values, as reflected through the society's perceptions of what waste is and how it should be handled.

7.2.2 Waste management at Bronze Age Asine

The second main aim of this thesis was to apply the waste management perspective "on the zooarchaeological material from Bronze Age Asine in order to shed new light on the site". In order to answer this aim, five papers were produced which each answered to separate objectives (see Section 1.2). In the following, focus is on changes in waste management processes at Asine during the Bronze Age. The discussion is exemplified through the results of the papers.

The need for a taphonomic perspective in order to identify and recognize patterns which could be associated with waste management has been acknowledged and explored in this thesis. It was concluded that the post-depositional attrition, targeting especially spongy bone, such as from the axial body region, affected the bones. A taphonomic perspective on the material provided patterns directly relatable to waste management, such as marks of gnawing and trampling on identifiable fragments and the high frequency of long bone splinters embedded in floors, as discussed in previous sections. However, one of the conclusions is also that a taphonomic perspective cannot be used to understand waste management processes as culturally situated practices (see Orton 2012:335).

The relations between the waste, waste management and social norms of Asine society during different time periods were investigated, especially in Papers III and IV. In Paper III, it became apparent that the disposal of trash in specific pits, the *bothroi*, was part of the household organization during the late EH III and the beginning of MH I, but not in later periods. The distribution of the animal bones showed that there was a certain structural element to the disposal patterns. It was concluded that waste categorization in the *bothroi* seems to have been tied to different body parts, in terms of butchery versus consumption waste. Perhaps also different taxa had certain connotations, which made it necessary to dispose of their remains in certain pits.

Zangger's (1994) suggestion that the Kastraki was a small island during the EH might be relevant when discussing the use of *bothroi* as refuse pits during the EH III period. Perhaps the use of pits for waste was a good solution, as opposed to polluting the small island's "coast" and water with animal waste or transporting it to designated fields or waste locations. It does not, however, explain the regional use of the *bothros*, which is documented across the vast Aegean area during this period (see Strasser TF 1999; Paper III). The tradition of disposing of waste in large pits within the household's boundaries, as mirrored in the *bothroi*, disappeared as early as the earlier part of the Middle Helladic, around ca 1900 BCE. It does not seem to have been practised again at Asine in the Bronze Age.

Few primary deposits, i.e. places with waste disposed at the original production place, are identified from the so-called Shaft Grave Period or MH III-LH I period, ca. 1800-1600 BCE. Instead the animal bones derive from cultural layers with redeposited material, mostly open air layers within the settlement. The different dwelling areas, the Lower Town and the Barbouna Hill, of the expanding settlement were explored in terms of animal taxonomic and anatomical dispersal in Paper IV. The hypothesis that some parts of the settlement connoted higher social status than others was previously formed in studies focusing on architectural elements and other archaeological finds at the site, as well as Asine's many contemporary burials. This hypothesis was tested on the basis of zooarchaeological remains, focusing on material from waste-related contexts. The results supported the idea that a differentiated social topography existed at the site, with the Lower Town as a dwelling area that had access to, among other things, a more diversified range of animals than Barbouna Hill. However, the study revealed that there were no differences in waste management in the two areas. The clearest examples appeared in floor contexts, in which small burnt bone splinters indicated that bone refuse were sometimes thrown into fire installations. Such small splinters were not always cleaned out but became embedded or trampled in the floors over time.

The processes of waste management at Asine, with possible differentiations over time and through space, could not be fully mapped, because the contextual resolution of the documentation is low. The EH III-MH I *bothroi* discussed above are an exception to this rule. In most other cases, the bulk of the animal bones derive from redeposited material found in large open air cultural layers. This in itself does illustrate a consistent, long-lived pattern of waste disposal. Apparently, food waste was not removed too far from the consumption areas; it was probably thrown within the premises of the settlement, in open spaces, ditches or in disused buildings; they were left exposed, to be scavenged, weathered and trampled over for indeterminate periods of time. In the event of settlement or building re-organisation and re-building, these materials were incorporated in the soil along with other similarly treated objects (e.g. broken pottery and stone tools) to be used as fills or building materials, thus creating a palimpsest of mixed assemblages of elements, which archeologically are identified as chronologically mixed contexts. The possibility of using the sea as a waste management area, as well as bringing organic waste to the fields, should be acknowledged (see Forbes 2013), especially during those periods when we have no clear waste management places. Still, considering that the site was inhabited for long periods of time, there might have existed certain waste locations in which organic waste was thrown, and which formed a resource for picking bone waste as part of e.g. construction material such as seen in levelling layers. Further mapping of the site might reveal whether or not such places existed.

To conclude, even though the contextual resolution of the Asine documentation in general is low, a waste management perspective has yielded new insight into the site during the Bronze Age. During the Early Helladic period, especially the later part, the *bothroi* were used as waste locations in their last usage phase. These pits and their contents were associated with the inhabitants of specific households, of which we can discern Houses R and S. The use of *bothroi* as waste pits disappears in the Middle Helladic period. For the rest of the Bronze Age, very few primary waste locations have been detected. The waste management processes at Asine could not be fully investigated because most material does not derive from the primary waste location. Still, material found in waste locations away from the production area or from open-air cultural layers accumulated over long periods of time has interpretative value when it comes to waste management. For example, the traces of burnt bone embedded in floors in the Lower Town and Barbouna Hill areas during the MH III-LH I are thought to reflect similar strategies of indoor cleaning practices.

7.2.3 Evaluation and future applications

The third aim of this thesis was to "evaluate the application of the waste management perspective in the case of Bronze Age Asine". Three research questions were formulated in order to answer this aim. The first centred on any methodological issues involved in studying waste management that might be revealed through the case studies (Chapter 6). The most important issues are i) the degree of contextual resolution and how this might affect the inferential potential of the material which is studied; ii) the relationships between modern anatomical and prehistoric body part categorization and waste categorization; and iii) the relationship between waste content and waste management.

The first, centred on contextual resolution, is critical for the study of Asine, but perhaps also other old collections of which documentation quality might have suffered through time. One conclusion is that the level of contextual resolution is implemented as a leading factor in how much research potential the material has. Because of the issue of contextual resolution, a qualitative approach was important in the papers. Despite the problem of the low contextual resolution of the Asine documentation, I have stated in several instances, and I conclude, that the Asine assemblage can and should be used for social studies in zooarchaeology. In the Asine case, the documentation has at times been sufficient and sometimes of high quality. The main problem is that it is inconsistent, probably because of the different excavations at the site at different times. Nevertheless, specific features, such as the *bothroi*, were sufficiently documented to permit a more detailed study of the social organization and waste management, while other cases were more general in character. Studies on the latter, e.g. Papers IV and V, are still valuable and have provided relevant results for this thesis.

The second issue considered how modern anatomical categorization might or might not correlate with prehistoric perceptions of the animal body and of waste material. This is an important problem which relates to other zooarchaeological field of studies. I have highlighted the different ways I have used anatomical categorizations and how they might affect interpretation and conclusions in Section 7.1.2. Because each case study has had different conditions of contextual resolution, I have chosen to adjust the choice of methods, according to the limitations of the material. Detailed anatomical categorizations have only been used in the case studies with large sets of data (e.g. Papers II and V). Modern anatomy does not necessarily correlate to prehistoric body perceptions, but it is needed as a methodological tool. I wish to emphasize that modern anatomical categories do not contain interpretations in terms of prehistoric choices or preferences, e.g. referring to body part symbolism or consumption. Further, I also emphasize that the assumption that finds of non-meaty vs meaty parts equal butchery vs consumption waste is problematic. Any such conclusion must be at the end of the study and not included as *a priori* assumption.

This has been important in the work of this thesis, especially in Paper III, where such an interpretation is made, but only after the data processing, in this case using Correspondence Analysis (CA).

The third issue is related to the relationship between waste content and waste management, and focuses on the question: How do we know that people threw food waste away in the location where they consumed it, and if so, how can we know that it represents the whole area? I consider this question to be central in the phase of the study when contextual information is assessed. In fact, I see this issue as important ideologically because we need to acknowledge that, in some cases, we cannot know that the waste content from a specific feature represents general waste management practices of the whole community. For example, in some cases with low contextual resolution, this question might not be completely resolved, but might remain an assumption. If so, it is important to clarify that any results are tentative than valid. Based on my results I conclude that such cases can provide new insight of the site. In addition, it is not always important to remain on a general level; it may well be just as interesting to study waste content as the remains of practices related to household or only occasional or specific features.

In order to evaluate the application of the waste management perspective, it is necessary to consider possible future applications. I have chosen not to formulate a set framework for the study of waste management because it has not been possible, since the documentation quality has differed in different areas of the site, and the study must thus be adjusted to such differences. Still, in future studies of the site, such issues might be addressed by applying a GIS platform. If the site could be visualized in this way, it would make it easier to make connections between strata and contexts, as well as different find categories. In relation to this, I acknowledge that a waste management perspective is not complete without the input of other find materials. When it comes to the *bothroi*, a more detailed investigation of the pottery would yield further insight into this type of feature. The study of social topography through waste remains at MH III-LH I Asine greatly benefited from existing research on the distribution of other archaeological categories, such as pottery and other finds (e.g. Nordquist 1987; Voutsaki 2010b). The understanding of the site would increase even more with the addition of studies in which several types of remains, zooarchaeological, archaeobotanical, ceramic, lithic, metallurgical and other, are compiled and discussed accordingly.

As one possibility for future applications, the heuristic workflow, presented in Chapter 2 (Figure 1) could be valuable. It does not contain an absolute set of rules to follow. Instead, it acknowledges the importance of context and documentation quality. Further, it stresses the need for a taphonomic reconstruction in the analysis of patterning within the assemblage. The workflow is based on the study of one specific site, namely Asine, but it might be adjusted to the analyst's interests, chosen methods or project aims. If so, it can be used to simplify complex matters and makes it possible to study them in graspable and clear ways, for the researcher interested in studying waste management from a zooarchaeological perspective at any given archaeological site.

The final question related to the last aim is the following: What is the benefit of using a waste management perspective in zooarchaeology? In a waste management perspective, the focus on animal bones primarily as waste is emphasised, and only secondarily on bones as reflecting the conditions of living animals. This means that the choice of a waste management perspective will have advantages, but also disadvantages, in relation to other approaches in zooarchaeology. A waste management perspective does not aim to investigate animal husbandry and management, and sometimes not even consumption, although consumption and waste are closely interlinked. There are several topics in zooarchaeology, such as the study of animal breeding, management and local changes on the fauna, in which a waste management perspective might not be the most critical. Nevertheless, a waste management perspective acknowledges that no material can be understood unless the formation of it is studied as well. Waste management practices forming an animal bone assemblage are vital to understand. In order to understand waste management at a site we must also acknowledge that it is a cultural process, affected by cultural categorizations of the social world, social norms and traditions. This is an advantage of a developed waste management perspective in our subject. Even in studies which do not have a waste management perspective as a main focus, it remains of importance to consider these issues.

In the case of Asine, my conclusion is that a waste management perspective has proven useful. By focusing on the waste disposal processes, I have been able to build narratives which relate to waste management and waste categorization situated in social practices during certain time periods. For the EH III-MH I *bothroi* a waste management focus enabled a detailed study of the distribution of bones and the use of ethnographic parallels in order to explain material patterning. Still, because Asine suffers, at times, from a lack of detailed documentation, the use of this perspective has not reached its potential. For example, in the comparison between the two dwelling areas of MH III-LH I Asine the lack of primary deposits was difficult. I could not study the direct traces of waste management traditions, but had to remain on a general level. This meant that any possible distinction between consumption and waste management perhaps became blurred and diffuse, because the primary deposits were not available to shed light on this issue. The reason primary deposits are important is that they contain material deposited right after the waste production event. If any structured element can be traced to such deposits, it can be traced to activities first-hand, and not accumulated over long time spans.

The symbolic aspect of waste as visible by the reading of anthropological literature provided the most challenging research topic attempted in this thesis. The lack of primary deposits from this period (MH I-II) meant that the comparison between events, i.e. discarding trash and depositing animal remains in graves, was difficult to formulate. Therefore, the study was adjusted to compare the bones from graves with bones found as redeposited material in cultural layers from the settlement. Another way to study symbolic aspects of waste would be to focus on primary deposits in the settlement, e.g. in order to detect material patterning in specific features. This approach could detect the presence of any formalized element related to waste management, and could enable a discussion of ritualization of waste management practices at the site. A good example of such an approach can be found in the study of the EH III-MH I *bothroi*. The material patterning in these pits was not interpreted as ritualized waste management practices within the settlement, but as related to household organization and material categorization in general.

The waste management perspective has been useful because it has provided an opportunity to study in depth the formation of the material; and through this new information about the site has been generated. Traces of waste management have been detected. For example, the similarities in waste management between the dwelling areas Lower Town and Barbouna Hill, such as burning refuse in fire installations, indicate similarities in cultural perceptions of indoor cleanliness. For the *bothroi* of EH III-MH I Asine, the various disposal processes, as indicated by differences in exposure and management of the waste, e.g. expressed in weathering and gnawing frequencies, showed that these types of pit, although ultimately used as refuse pits, were treated differently in this final usage phase. As has been discussed above, certain pits were devoted to certain material categories. A waste management perspective was applied to better understand these features in a cultural context. The material patterning in these pits could not be interpreted and discussed similarly, extensively aided by relevant anthropological literature and terminology, without the waste management perspective. If, for example, the term ‘structured deposition’ was applied instead, perhaps the discussion would mostly focus on the material in these pits as ritually connoted. This could have directed the discussion of the *bothroi*, and predetermined the interpretation of them. A waste management perspective is not loaded with such preconceptions, which is another advantage of this approach.

7.2.4 Final words

The zooarchaeological study of waste management is a social study, and should be regarded as part of the sub-discipline of social zooarchaeology. The acknowledgement of this has been the foundation of this study. Waste management is a social process, which can affect different social aspects of society. Having this perspective on waste management has enriched the understanding of Asine. I have shown that the waste management of animal remains in *bothroi* of EH III-MH I Asine was an important part of socio-spatial organization of this society. The pits themselves were important in the organization of the household and the Asinean people's homes. It is probable that they were important in putting boundaries between certain houses. The management of discarding the animal bones in these pits was formalized to some degree. Based on the distribution of body parts, a distinction between butchery and consumption waste was probably made, and based on the exclusion of bones of certain taxa in some pits, it can be concluded that waste was probably also categorized according to the animal to which it originally belonged.

I have demonstrated the value of a social perspective in waste management studies when discussing the possibly uneven social topography of the MH III-LH I Asine settlement. I have shown that the everyday routines of waste management and the general waste content did not differ very much. In fact, in only a few instances was the existence of an uneven social topography at the site apparent. Socio-economic differences were probably manifested through occasional prestige item, such as imported ware/exotic animals, or mortuary traditions, as seen in the more elaborate graves of the East Cemetery. A social perspective on the symbolic aspects of waste has also been important; I showed that the domestic animals, the animals most frequently socialized with, were the most important ritual animals in the early MH Asine society.

That waste management is social practice is understood also within general archaeology (e.g. Högberg 2016). However, within a social zooarchaeological regime, waste management is not only a social practice, it is also connected to relationships between human, animals and animal remains, to negotiations of material classifications, to aspects of folk taxonomy and the local environment, and to social aspects of behaviour, such as organization. This multivocality is important in the social zooarchaeological study of waste management and it has been important in the understanding of waste management at Bronze Age Asine in this particular study. The bone catalogue is published digitally on the PRAGMATA database (Swedish Institute at Athens *et al.* 2017), which hopefully means that zooarchaeologists interested in the site can take on new perspectives. Using well-formulated approaches to this particular collection is possible, as demonstrated by this study.

An important part of this study was the investigation of Asine as an old collection. Having a social zooarchaeological waste management perspective on this type of material has been challenging. Nevertheless, it has helped improve understanding of the site. Especially, a taphonomic and multivariate processing of the animal bone data has been valuable for understanding the formation of the animal bone assemblage, which has given insights into the Asine collection as a whole. For example, the previously unknown but relatively heavy impact of processes after excavation has been demonstrated, with high fragmentation due to recent breakage from bone movements between storage locations. Still, the many radiocarbon analyses performed within the frames of this study have demonstrated the good preservation degree of the assemblage. The presence of gnawing indicated that dogs chewed on bones at the site, but since it was not to a very high degree, it indicates a relatively dense settlement during the course of the site's history. The same can be said about the degree of weathering: although it exists on bones, it occurs in generally low frequencies. Both these instances tell us that the Asine collection was formed with relatively fast deposition rates in general, perhaps as a consequence of not depositing waste on open ground within the occupied area. To further investigate this, it would be important to compare the quality and preservation of other finds, such as pottery.

Since a waste management perspective by necessity is contextual, areas suitable for such research were identified. One such was the *bothroi* of the EH III-MH I. Another was the areas surrounding the houses in different dwelling areas of MH III-LH I. Graves containing animal bones as part of the originally deposited grave goods were detected through the careful examination of the field diaries and plan drawings. The above examples would not have been investigated without a contextual focus. This contextual investigation has improved understanding of the mentioned parts of Bronze Age Asine. That the animal bones in many cases derive from secondary or even tertiary deposits is also an important result of this study. This has not been viewed as a completely unfortunate circumstance, since such material can give insights into general waste management traditions and other aspects of the studied society.

Asine during the Bronze Age was a dynamic place. This study has demonstrated how a waste management perspective can contribute to the understanding of this site. It has provided keyholes to certain phases of this period at the site, and on different levels, thus: the household organization of the EH III-MH I; the general patterns of waste management and use of animals in graves during the MH I-II; and the socio-economic connotations of the different dwelling areas during MH III-LH I. At the same time, general patterns of waste management have provided information on behavioural patterns during the course of the Bronze Age, such as the prevalence of gnawing dogs, weathering frequencies and the use of burning at different periods. Approaching waste management as not only a general formation process but also a social practice has been a valuable zooarchaeological perspective, and has contributed to and will hopefully stimulate future research on the fascinating Bronze Age site of Asine.

Sammanfattning

Alla samhällen producerar avfall. Avfallet i sig måste hanteras, vilket innebär att det material som slängs måste kategoriseras. Detta sker idag ofta enligt materialets värde, vilket i sig är kulturellt betingat. Vad är avfall? Vilka konsekvenser medför hanteringen av det? Hur kan synen på vad som är avfall relateras till hur kulturella normer och ordningar struktureras och upprätthålls? Frågor likt dessa har intresserat antropologer sedan åtminstone mitten av förra seklet. Gemensamt för de flesta sådana studier är att de betraktar avfall som ett relativt begrepp; beroende på kulturspecifika uppfattningar är avfall något som inte passar in om en viss ordning ska kunna upprätthållas. Vidare har samtidsarkeologiska studier konstaterat att personers avfall säger mer om deras liv än vad de själva vill erkänna eller är medvetna om.

Arkeologiska djurbensmaterial hittas ofta i avfallsrelaterade kontexter, men själva avfallsbegreppet har inte alltid betraktats som särskilt meningsfullt inom zooarkeologin. Avfall används inte som vetenskapligt koncept i sig utan studeras snarare som en konsekvens av sociala aktiviteter såsom konsumtion, gemensamma måltider, ritualer och hantverk. Till skillnad från tidigare forskning är syftet med föreliggande avhandling att genom zooarkeologisk metod och analys belysa sociala strukturer och kulturella normer ur ett avfallshanteringsperspektiv. Med detta menas att benmaterial som deponerats/slängts inte nödvändigtvis har haft samma betydelse som de levande djuren av vilka det en gång varit del. Genom att studera djurben i avfallsrelaterade kontexter kan vi nå ny kunskap om hur människor hanterat sitt avfall, och därmed också om social ordning och kulturellt beteende.

Studiens syfte är att applicera ett zooarkeologiskt avfallshanteringsperspektiv på ett förhistoriskt material, nämligen djurbenen från bronsåldersboplatsen Asine i Grekland. Avhandlingen består av en sammanfattande kappa och fem artiklar. Djurbenen från Asine har tidigare inte publicerats. I kappan presenteras därför materialet ingående. Materialets representativitet, metoder för osteologisk analys och en tafonomisk rekonstruktion ingår i denna presentation. Därtill diskuteras konsumtion och djurhållning i bronsålderns Asine utifrån djurbensmaterialet.

Kappan innehåller inledningsvis en längre teoretisk diskussion kring begreppet avfallshantering inom zooarkeologin. I denna definieras fyra temata som är viktiga att utforska inom ett avfallshanteringsperspektiv. Dessa är a) definition av kontext och identifiering av avfallshantering ur ett tafonomiskt perspektiv, b) avfallshantering och social organization, c) avfallshantering och social topografi, samt d) symboliska aspekter på avfall. Avhandlingens fem artiklar behandlar dessa fyra temata, och syftar således att belysa olika aspekter av avfallshantering i bronsålderns Asine.

Artikel I definierar den zooarkeologiska kontexten i Asine, och diskuterar platsen utifrån ett långtidsperspektiv. Djurbenen från Asine diskuteras i relation till regionala förändringar under bronsåldern, med särskild tyngdpunkt på centraliseringsprocesser. Resultaten visar att Asine växte från att vara en rural boplats till att få en växande central betydelse, framför allt för den omkringliggande dalen och dess gårdar. Under den senare hälften av bronsåldern är det troligt att Asine var en intermediär plats som fungerade som kommunikationsnod mellan dalen och större regionala centra såsom Mykene och Tiryns.

Artikel II är en metodologisk studie av de olika tafonomiska processer som påverkar djurbenen från det mellanhelladiska Asine. Syftet är att identifiera kulturella processer, såsom avfallshantering, inom ett större djurbensmaterial genom att använda den statistiska metoden multipel korrespondensanalys (MCA). MCA undersöker associationerna mellan objekt och variabel i en sammanhängande mängd data, och illustrerar de mest betydelsefulla relationerna inom materialet. Resultaten visar tydligt att olika tafonomiska markörer på ben, olika kroppsdelar och olika identifiering relaterar till varandra på olika sätt. Exempelvis förekom recenta frakturer framför allt på oidentifierade ben. Högre vädringsgrader var mest förekommande på oidentifierade ben, medan lägre vädringsgrader, gnagspår, *trampling* och skärspår var vanliga på identifierade ben. Mindre fragment är ofta svårare att härleda till art och har ofta för liten benyta för att säkert kunna identifiera vissa tafonomiska markörer. Resultaten visar också att det fanns vissa kontextuella skillnader: i golvlager hittades exempelvis en relativt sett större andel vädrade benfragment från medelstora däggdjur.

Artikel III är en kontextuell studie som behandlar djurbenen som deponerats i så kallade *bothroi*, en typ av grop vanlig i tidighelladiska bosättningar i det egeiska området. Stratigrafin för de *bothroi* som ingick i studien rekonstruerades genom noggranna studier av fältdagböcker och planritningar, samt med hjälp av absoluta dateringar, vilka visade att de högst troligt fylldes igen under perioden 2135-2078 f.v.t. Korrespondensanalyser utfördes för att undersöka relationer mellan groparna och sammansättning av arter samt kroppsdelar. Resultaten visar att det fanns tydliga kopplingar mellan olika kroppsdelar, arter och *bothroi*. Medan exempelvis kronhjortsben enbart deponerades i vissa gropar, var andra starkt associerade med ben från svin och får/get. Köttrika kroppsdelar, såsom bak- och framben, deponerades i vissa gropar. Mindre köttrika delar, såsom falanger och metapoder, hamnade istället i andra *bothroi*. Givet att avfallet verkar ha deponerats utifrån anatomiskt element och art diskuteras avfallshanteringen som relaterat till hushållets organisation, i betydelsen närliggande till konsumtions- eller styckplats, och som relaterat till avfallskategorier beroende på art och anatomiskt element.

Artikel IV fokuserar på Asines sociala topografi under den sena mellanhelladiska perioden (ca. 1800-1600 f.v.t), då två väldefinierade områden i bosättningen var i bruk. Dessa områden, Lågstaden och Barbounakullen, jämfördes utifrån specifika zooarkeologiska indikatorer för att diskutera eventuella skillnader och likheter. Det fanns vissa skillnader, såsom den högre andelen vilt i Lågstaden. Detta ligger till viss del i linje med tidigare forskning som har påvisat skillnader i både gravgods och gravarkitektur i bosättningens olika gravområden, samt skillnader i andelen importerad keramik. Dessa skillnader tyder på att en social topografi fanns på platsen under denna period. Emellertid visar resultaten stora likheter i djurhållning och konsumtion av djur samt avfallshanteringspraktiker inomhus. Det i sin tur indikerar att tolkningen om en ojämn social topografi på platsen kan vara något missvisande; om en växande social topografi fanns, så tycks den framförallt ha manifesterats genom förekomst av importföremål, gåvor eller fester.

Artikel V behandlar de symboliska aspekterna av djurbensavfall under den tidiga mellanhelladiska perioden (ca. 2100-1800 f.v.t). I artikeln jämförs djurben från avfallslager i bosättningen med de djurkroppar eller delar av djur som deponerats i samtida gravar. De arter som dominerar bosättningens material, var också de vanligaste i gravarna. Svin var mest förekommande, följt av får/get och nötkreatur. Samma tendens går också att se i den närliggande boplatsen Lerna samt andra platser. På så vis skiljer sig den tidiga mellanhelladiska perioden från den senare mellanhelladiska perioden och efterföljande senhelladiska, då vilda djur introduceras som gravgods, särskilt i högstatusgravar. Domesticerade djur behöll dock en viktig symbolisk innebörd; de är de vanligaste djuren i kontexter som kan relateras till rituell konsumtion av kött. Att de vanligaste förekommande djuren också var viktiga rituellt och symboliskt hade förmodligen efterverkan i vardagens praktiker i Asine, såsom i djurhållning och avfallshantering.

I kappan utvärderas artiklarnas resultat utifrån deras användbarhet i ett zooarkeologiskt avfallshanteringsperspektiv. Jag definierar och diskuterar tre kritiska punkter vad gäller studiet av avfallshantering genom zooarkeologiska material, nämligen graden av dokumentationskvalité, valet av anatomiska enheter samt relationen mellan avfallsinnehåll och –hantering. Den första som rör den kontextuella upplösningen är särskilt viktig vad gäller Asine eftersom platsen grävdes ut i omgångar under 1900-talet. Majoriteten av djurbenen framkom under säsongen år 1926. De har varit arkiverade under en längre tid, har inte systematiskt sållats fram eller samplats och dokumentationskvalitén sett till planritningar och fältdagböcker är varierande. I vissa fall har kontexterna dokumenterats noggrant, såsom *bothroi*-groparna i artikel III. Ofta har dock inte den enskilda kontexten kunnat definieras. Djurbenen har i sådana fall enbart kunna konstateras härröra från mer generella kulturlager. Materialet har ändå kunnat användas för att ge information om avfallshanteringen på platsen, men resultaten har blivit mer generella.

Gällande den andra kritiska punkten - valet av anatomiska enheter - så belystes framför allt relationen mellan deskriptiva anatomiska kategorier som används av zooarkeologer idag och invånarnas beslut och uppfattningar kring styckning, konsumtion och djurkroppen generellt under bronsåldern. Olika anatomiska kategorier används av idag; vilket system som väljs kan ge olika resultat och kan tolkas på olika sätt. Särskilt problematiska är benämningarna ”köttrika” och ”köttfattiga” kroppsdelar som är relativt vanligt förekommande. Mängden användbart kött på benen är olämpligt som utgångspunkt för värderingen av kroppsdelar i en förhistorisk kontext. Så kallade köttfattiga delar, såsom fötter, kan anses vara delikatesser i vissa samhällen, medan de i andra slängs direkt som primärt styckavfall. Detta är viktigt att ta hänsyn till i studiet av avfallshantering eftersom avfall kan ha kategoriserats efter kroppsdel. Den här typen av frågor behandlas i artikel III, där just köttfattiga och köttrika delar diskuteras som viktig i avfallskategoriseringen i Asine. Dessa kategorier användes inte före analysen utan diskuterades som möjliga kategorier först efter resultatens genomgång.

Den tredje kritiska punkten – relationen mellan avfallsinnehåll- och hantering - är abstrakt på så sätt att den är svårt att diskutera utifrån ett arkeologiskt material. Relationen mellan avfallsinnehåll och –hantering kan ibland vara svår att definiera. Hur kan vi exempelvis säkerställa att avfallet slängdes på den plats där det producerades? När det gäller Asine har denna koppling stundom gjorts *a priori*. Det gäller framförallt artikel IV i vilken materialet som påträffades i specifika områden antogs ha producerats där. Studien visar att för att förstå vad innehållet i en avfallsrelaterad kontext representerar krävs en förståelse för platsen, dess dokumentation och för materialets karaktärer, särskilt vad gäller tafonomi. Det är en teoretisk utgångspunkt som är viktig utifrån ett kontextuellt avfallshanteringsperspektiv, och har legat till grund för arbetet med alla artiklar inom ramen för denna studie.

Att studera förhistorisk avfallshantering utifrån djurbenen ingår i en social zooarkeologisk diskurs; avfallshantering är en social process som påverkar och påverkas av olika kulturella förförståelser, praktiker och aspekter i samhället. Denna avhandling ger en fördjupad insikt gällande olika aspekter av bronsålderns Asine. Resultatet har uppnåtts genom ett studium av olika kontextuella nivåer: relationen mellan avfallshantering och hushållsorganisation under den tidiga bronsåldern, generella mönster för användning av djur i gravar och bosättningen under den mellersta bronsåldern, samt den sociala topografin under MH III-LH I. Den generella bilden av avfallshanteringen ur ett tafonomiskt perspektiv vittnar om olika praktiker relaterade till avfallshantering, såsom att slänga benavfall till hundar, att exponera benavfall vilket speglas i graden av vädring samt att använda sig av eld som avfallshanteringsmetod. Appliceringen av ett avfallshanteringsperspektiv med fokus på sociala aspekter har berikat förståelsen av Asine under bronsåldern.

References

Adams BJ and Konigsberg LW. (2004) Estimation of the Most Likely Number of Individuals from commingled human skeletal remains. *American Journal of Physical Anthropology* 125: 138-151.

Åkesson L. (2012) Waste in overflow. In Czarniawska B and Löfgren O (eds.) *Managing overflow in affluent societies.* Routledge: New York, 141-154.

Andersson Cederholm E, Björck A, Jennbert K and Lönngren, A-S. (2014) *Exploring the Animal Turn: Human-animal relations in science, society and culture,* Pufendorf Institute for Advanced Studies: Lund.

Andrews P and Cook J. (1985) Natural modifications to bones in a temperate setting. *Man, New Series* 20: 675-691.

Arnold ER and Lyons D. (2011) Ethnozooarchaeology of butchering practices in the Mahas region, Sudan. In Albarella U and Trentacoste A (eds.), *Ethnozooarchaeology: the present and past of human-animal relationships.* Oxbow Books: Oxford, 107-119.

Asmussen B. (2009) Intentional or incidental thermal modification? Analysing site occupation via burned bone. *Journal of Archaeological Science* 36: 528-536.

Åström P. (1968) The destruction of Midea. *Atti e memorie del 1. Congresso Intemazionale di Micenologia, Roma 27 settembre-3 ottobre 1967.* Atenea: Rome, 54-57.

Atherden M, Hall J and Wright JC. (1993) A pollen diagram from the northeast Peloponnese, Greece: implications for vegetation history and archaeology. *The Holocene* 2: 351-356.

Baker VR. (2014) Uniformitarianism, earth system science, and geology. *Anthropocene* 5: 76-79.

Ballantyne R, Macheridis S, Lightfoot E and Williams A. (2018) Biological remains. In Skre D (ed.), *Avaldsnes: A Sea King's Manor in First-Millennium Western Scandinavia*. Walter de Gruyter: Berlin/Boston, 455-510.

Bannert D. (1973) Geologische Bemerkungen zur Ausgrabung am Barbouna-Hügel. In Hägg I and Hägg R (eds.), *Excavations in the Barbouna Area at Asine. Fascicle 1: General Introduction, Bibliography, Geological Background and a Report on the Field-work in the Levendis sector, 1970-1972.* Boreas, Uppsala Studies in Ancient Mediterranean and Near Eastern Civilisations, 4:1. Uppsala University: Uppsala, 16-21.

Bar-Oz G and Munro N. (2004) Beyond cautionary tales: a multivariate taphonomic approach for resolving equifinality in zooarchaeological studies. *Journal of Taphonomy* 2: 201-222.

Bartosiewicz L. (1997) This little piggy went to market... An archaeozoological study of modern meat values. *Journal of European Archaeology* 5: 170-182.

Bartram LE, Kroll EM and Bunn HT. (1991) Variability in camp structure and bone food refuse patterning at Kua San hunter-gatherer camps. In Kroll EM and Price TD (eds.), *The interpretation of archaeological spatial patterning.* Springer Science+Business Media, LLC: New York, 77-148.

Behrensmeyer A. (1978) Taphonomic and ecological information from bone weathering. *Paleobiology* 4: 150-162.

Bell C. (1992) *Ritual theory, ritual practice.*Oxford University Press: Oxford.

Benecke N. (1994) *Archäozoologische Studien zur Entwicklung der Haustierhaltung in Mitteleuropa und Südskandinavien von den Anfängen bis zum ausgehenden Mittelalter.* Akademie Verlag: Berlin.

Berg I. (2016) *Kalaureia 1894: A cultural history of the first Swedish excavation in Greece.* Diss. Stockholm Studies in Archaeology, 69. Stockholm University: Stockholm.

Binford LR. (1962) Archaeology as anthropology. *American Antiquity* 28: 217-225.

Binford LR. (1964) A consideration of archaeological research design. *American Antiquity* 29: 425-441.

Binford LR. (1978) *Nunamiut ethnoarchaeology.* Percheron Press: New York.

Binford LR. (1981) *Bones: Ancient men and modern myths.* Academic Press: London.

Bintliff J. (2010) The Middle Bronze Age through the surface survey record of the Greek mainland. In Philippa-Touchais A, Touchais G, Voutsaki S and Wright JC (eds.), *Mesohelladika: The Greek mainland in the Middle Bronze Age.* Bulletin de Correspondance Hellénique Supplément, 52. École de française d'Athènes: Athens, 756-763.

Bintliff J. (2012) *The complete archaeology of Greece: from hunter-gatherers to the 20th century A.D.* Wiley-Blackwell: Malden.

Boessneck J. (1956) Zu den Tierknochen aus neolithischen Siedlungen Thessaliens. *Berichte der Römisch-Germanischen Kommission* 36: 1-51.

Boessneck J. (1969) Osteological differences between sheep (*Ovis aries* Linné) and goat (*Capra hircus* Linné). In Brothwell D and Higgs E (eds.), *Science in Archaeology.* Thames & Hudson: London, 336-359.

Boessneck J and von den Driesch A. (1979) Ein Löwenknochfund aus Tiryns. *Archäologischer Anzeiger* 447-449.

Bourdieu P. (1977) *Outlines of a theory of practice.* Cambridge University Press: Cambridge.

Bradley R. (2005) *Ritual and domestic life in prehistoric Europe.* Routledge: London.

Bronk Ramsey C. (2001) Development of the radiocarbon calibration program Oxcal. *Radiocarbon* 43: 355-363.

Bronk Ramsey C. (2009) Bayesian analysis of radiocarbon dates. *Radiocarbon* 51: 337-360.

Brown WAB, Christofferson DVM, Massler M and Weiss MB. (1960) Postnatal tooth development in cattle. *American Journal of Veterinary Research XXI* 80: 7-34.

Brown WAB and Chapman NG. (1991) The dentition of red deer (*Cervus elaphus*): A scoring scheme to assess age from wear of the permanent molariform teeth. *Journal of Zoology* 224: 519-536.

Brunclíková L. (2016) Recyclable waste as a marker of everyday life routines. In Sosna D and Brunclíková L (eds.), *Archaeologies of waste: Encounters with the unwanted.* Oxbow Books: Oxford, 100-120.

Buikstra JE and Swegle M. (1989) Bone modification due to burning: Experimental evidence. In Bonnichsen R and Sorg MH (eds.), *Bone modification*. Center for the Study of the First Americans: Maine, 247-258.

Burns BE. (2010) *Mycenaean Greece, Mediterranean commerce, and the formation of identity*. Cambridge University Press: New York.

Börjesson L, Dell'Unto N, Huvila I, Larsson C, Löwenborg D, Petersson B and Stenborg P. (2016) A neo-documentalist lens for exploring the premises of disciplinary knowledge making. *Proceedings of the Document Academy* 3: Article 5.

Caskey JL. (1960) The Early Helladic period in the Argolid. *Hesperia: The Journal of the American School of Classical Studies at Athens* 29: 285-303.

Cavanaugh W and Mee C. (1998) *A private place: Death in prehistoric Greece.* Studies in Mediterranean Archaeology, 125. Paul Åströms Förlag: Jonsered.

Munsell Color. (1975) *Munsell Soil Color Charts.* Munsell Color: Baltimore, Md.

Cosmopoulos MB. (2015) *Bronze Age Eleusis and the origins of the Eleusinian mysteries.* Cambridge University Press: New York.

Costa C. (2016) The use of animal bone as fuel in the third millennium BC walled enclosure of Castanheiro do Vento (northern Portugal). *International Journal of Osteoarchaeology* 26: 877-884.

Costamagno S, Théry-Parisot I, Brugal J-P and Guibert R. (2005) 6. Taphonomic consequences of the use of bone as fuel. Experimental data and archaeological applications. In O'Connor T (ed.), *Biosphere to Lithosphere: New studies in vertebrate taphonomy*. Oxbow Books: Oxford, 51-62.

Curet LA and Pestle WJ. (2010) Identifying high-status foods in the archaeological record. *Journal of Anthropological Archaeology* 29: 413-431.

Currie A. (2016) Ethnographic analogy, the comparative method, and archaeological special pleading. *Studies in History and Philosophy of Science* 55: 84-94.

D'Agata AL. (1996) The "Lord" of Asine reconsidered: Technique, type and chronology. In Hägg R, Nordquist GC and Wells B (eds.), *Asine III: supplementary studies on the Swedish excavations 1922-1930, Fascicle 1.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 45:1. Swedish Institute at Athens, Stockholm, 39-46.

Dabney MK, Halstead P and Thomas P. (2004) Mycenaean feasting on Tzoungiza at ancient Nemea. In Wright JC (ed.), *The Mycenaean feast.* American School of Classical Studies at Athens: Princeton, 77-95.

Davis SJ. (1980) Late Pleistocene and Holocene equid remains from Israel. *Zoological Journal of the Linnean Society* 70: 289-312.

Davis SJ. (1987) *The Archaeology of Animals*. B.T. Batsford Ltd: London.

Davis SJ. (2017) Towards a metrical distinction between sheep and goat astragali. In Rowley-Conwy P, Serjeantson D and Halstead P (eds.), *Economic zooarchaeology: Studies in hunting, herding and early agriculture*. Oxbow Books: Oxford & Philadelphia, 50-82

Davis JL. (2013) "Minding the gap": A problem in Eastern Mediterranean chronology, then and now. *American Journal of Archaeology* 117: 527-533.

Dell'Unto N. (2016) Using 3D GIS platforms to analyse and interpret the past. In Forte M and Campana S (eds.), *Quantitative methods in the Humanities and Social Sciences.* Springer.

Dell'Unto N, Landeschi G, Leander Touati A-M, Dellepiane M, Callieri M and Ferdani D. (2015) Experiencing ancient buildings from a 3D GIS Perspective: A case drawn from the Swedish Pompeii Project. *Journal of Archaeological Method & Theory* 23.

Demakopoulou K and Crouwel JH. (1993) More cats or lions from Thera? *Archaiologike ephemeris* 132: 1-11.

Dibble WF. (2017) *Politika zoa: Animals and social change in Ancient Greece (1600-300 B.C.)*. Unpublished diss. University of Cincinnati.

Dickinson OTPK. (1989) "The origins of Mycenaean civilisation" revisited. In Laffineur R (ed.), *Aegeum 3. Transition, Le Monde Egeen du Bronze Moyen au Bronze Recent*. Universite de Liege: Liege, 131-136.

Dickinson OTPK. (1994) *The Aegean Bronze Age*. Cambridge University Press: Cambridge.

Dickinson OTPK. (2010) The collapse at the end of the Bronze Age. In Cline EH (ed.), *The Oxford handbook of the Bronze Age Aegean (ca. 3000-1000 BC).* Oxford University Press: Oxford, 482-490.

Dietler M. (1996) Feasts and commensal politics in the political economy: Food, power and status in prehistoric Europe. In Wiessner P and Schievenhövel W (eds.), *Food and the status quest: An interdisciplinary perspective.* Berghahn Books: Providence and Oxford, 87-125.

Dietz S. (1980) *Asine II: Results of the excavations east of the acropolis 1970-1974. Fascicle 2: The Middle Helladic cemetery, the Middle Helladic and Early Mycenaean deposits.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 24:2. Almqvist & Wiksell: Stockholm.

Dietz S. (1982) *Asine II: Results of the excavations east of the acropolis 1970-1974. Fascicle 1: General stratigraphical analysis and architectural remains.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 24:1. Almqvist & Wiksell: Stockholm.

Dietz S. (1991) *The Argolid at the transition to the Mycenaean age: Studies in the chronology and cultural development in the Shaft Grave Period.* Diss. Dept. of Near Eastern and Classical Antiquities, National Museum of Denmark: Copenhagen.

Douglas M. (1966) *Purity and danger.* Routledge: London and New York.

Douglas M. (1972) Deciphering a meal. *Daedalus* 101: 61-82.

Douny L. (2007) The materiality of domestic waste: the recycled cosmology of the Dogon of Mali. *Journal of Material Culture* 12: 309-331.

Drackner M. (2005) What is waste? To whom? An anthropological perspective on garbage. *Waste Management & Research* 23: 175-181.

Dupras TL and Schultz JJ. (2013) Taphonomic bone staining and color changes in forensic contexts. In Pokines JT and Symes SA (eds.), Manual of forensic taphonomy. CRC Press: Boca Raton, 315-340.

Efremov JA. (1940) Taphonomy: New branch of paleontology. *Pan-American Geologist* LXXIV.

Ekengren F. (2009) *Ritualization - Hybridization - Fragmentation: The mutability of Roman vessels in Germania Magna AS 1-400.* Diss. Acta Archaeologica Lundensia Series prima in 4°, 28. Lund University: Lund.

Ekroth G and Wallensten J. (2013) *Bones, behaviour and belief: The zooarchaeological evidence as a source for ritual practice in ancient Greece and beyond.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 55. Swedish Institute at Athens: Stockholm.

Ervynck A, Van Neer W, Hüster-Plogmann H and Schibler J. (2003) Beyond affluence: The zooarchaeology of luxury. *World Archaeology* 34: 428-441.

Fahlander F. (2008) Differences that matter: Materialities, material culture and social practice. In Glørstad H and Hedeager L (eds.), *Six essays on the materiality of society and culture.* Bricoleur Press: Lindome, 127-154.

Falkingham PL, Bates KT and Farlow JO. (2014) Historical photogrammetry: Bird's Paluxy River dinosaur chase sequence digitally reconstructed as it was prior to excavation 70 years ago. *PLoS ONE* 9: e93247.

Fillios MA. (2006) *Measuring complexity in Early Bronze Age Greece: The pig as a proxy indicator of socio-economic structures*. Unpublished diss. Faculty of the graduate school, University of Minnesota.

Fillios MA. (2015) Food for thought: using game cameras to better understand the movement of bones by scavenging in archaeological faunal assemblages. *Archaeological and Anthropological Sciences* 8:1: 317-328.

Fontijn D. (2012) Meaningful but beyond words? Interpreting material culture patterning. *Archaeological Dialogues* 19: 124-127.

Forbes H. (2013) Off-site scatters and the manuring hypothesis in Greek survey archaeology: An ethnographic approach. *Hesperia* 82: 551-594.

Forsell R. (2001) *The Argolid under Roman rule (31 BC - AD 600)*. Diss. Lund University: Lund.

Forsén J. (1992) *The twilight of the Early Helladics: A study of the disturbances in east-central and Southern Greece Towards the end of the Early Bronze Age.* Diss. Studies in Mediterranean Archaeology, Pocket-Book, 116. Paul Åströms Förlag: Jonsered.

Forstenpointner G, Galik A, Weissengruber GE, Zohmann S, Thanheiser U and Gauss W. (2010) Subsistence and more in Middle Bronze Age Aegina Kolonna: Patterns of Husbandry, Hunting and Agriculture. In Philippa-Touchais A, Touchais G, Voutsaki S and Wright JC (eds.), *Mesohelladika: The Greek mainland in the Middle Bronze Age*. Bulletin de Correspondance Hellénique Supplément, 52. École de française d'Athènes: Athens, 733-742

Foucault M. (1998) *Aesthetics, method, and epistemology.* The New Press: New York

Francione GL. (2014) Animal welfare and the moral value of nonhuman animals.In Andersson Cederholm E, Björck A, Jennbert K and Lönngren, A-S (eds.), *Exploring the Animal Turn: Human-animal relations in science, society and culture.* Pufendorf Institute for Advanced Studies: Lund, 57-72.

French, E. 2002. *Mycenae: Agamemnon's capital*. Tempus Publishing: Gloucestershire

Frisell M. (1989) *The Hellenistic mould-made relief bowls at Asine.* Dept of Ancient History, Stockholm University: Stockholm.

Frödin O and Persson AW. (1938) *Asine. Results of the Swedish Excavations 1922-1930.* Generalstabens litografiska anstalts förlag: Stockholm.

Fuller DQ, Stevens C and McClatchie M. (2014) Routine activities, tertiary refuse, and labor organization: Social inferences from everyday archaeobotany. In Madella M, Lancelotti C and Savard M (eds.) *Ancient plants and people: Contemporary trends in archaeobotany.* The University of Arizona Press: Tucson, 174-217.

Funabiki T. (1981) On pigs of the Mbotgote in Malekula. In Allen M (ed.), *Vanuatu: Politics, economics and ritual in Island Melanesia.* Academic Press: Sydney.

Galaty ML and Parkinson WA. (1999) *Rethinking Mycenean palaces: New interpretations of an old idea.* The Cotsen Institute of Archaeology: Los Angeles.

Garrow D. (2012) Odd deposits and average practice: a critical history of the concept of structured deposition. *Archaeological Dialogues* 19: 85-115.

Gauss W, Lindblom M and Smetana R. (2011) The Middle Helladic large building complex at Kolonna: A preliminary view. In Gauss W, Lindblom M, Smith RAK and Wright JC (eds.), *Our cups are full: Pottery and society in the Aegean Bronze Age.* Archaeopress: Oxford, 76-87.

Gejvall NG. (1969) *Lerna: A preclassical site in the Argolid. Volume I: The fauna.* American School of Classical Studies at Athens: Princeton.

Gejvall NG. (1983) Appendix VI. Animal Bones from the Citadel. In Åström P (ed.), *The Cuirass Tomb and other finds at Midea. Part 2: Excavations in the cemeteries, the Lower Town and the Citadel.* Paul Åströms Förlag: Göteborg, 51-54.

Gifford-Gonzalez D. (1991) Bones are not enough: Analogues, knowledge, and interpretive strategies in zooarchaeology. *Journal of Anthropological Archaeology* 10: 215-254.

Gifford-Gonzalez D. (2014) Constructing community through refuse disposal. *African Archaeological Review* 31: 339-382.

Gifford-Gonzalez DP, Damrosch DB, Damrosch DR, Pryor J and Thunen RL. (1985) The third dimension in site structure: An experiment in trampling and vertical dispersal. *American Antiquity* 50: 803-818.

Gillis C. (1996) Tin at Asine. In Hägg R, Nordquist GC and Wells B (eds.), *Asine III. Supplementary studies on the Swedish excavations 1922-1930.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 45:1. Swedish Institute at Athens: Stockholm, 94-100.

Gillis C. (2013) Colorful Asine. In Schallin A-M (ed.), *Perspectives on ancient Greece: Papers in celebration of the 60th anniversary of the Swedish Institute at Athens*. Skrifter utgivna av Svenska Institutet i Athen, 8°, 22. Swedish Institute at Athens: Stockholm, 61-88.

Gonçalves D, Thompson TJU and Cunha E. (2011) Implications of heat-induced changes in bone on the interpretation of funerary behaviour and practice. *Journal of Archaeological Science* 38: 1308-1313.

Goody J. (1982) *Cooking, cuisine and class: A study in comparative sociology.* Cambridge University Press: Cambridge.

Gould SJ. (1965) Is uniformitarianism necessary? *American Journal of Science* 263: 223-228.

Grayson DK. (1984) *Quantitative zooarchaeology.* Academic Press: Orlando.

Greenacre M. (2007) *Correspondence Analysis in practice.* 2nd ed. Chapman & Hall/CRC: Boca Raton.

Greenfield HJ and Arnold ER. (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.

Gräslund B. (1987) *The birth of prehistoric chronology.* Cambridge University Press: Cambridge.

Haak A. (2016) Cesspits and finds: Archaeological study of waste management and its social significance in medieval Tartu, Estonia. In Sosna D and Brunclíková L (eds.) *Archaeologies of waste: Encounters with the unwanted.* Oxbow Books: Oxford, 83-99.

Halstead P. (1996) Pastoralism or household herding? Problems of scale and specialization in early Greek animal husbandry. *World Archaeology* 28: 20-42.

Halstead P. (1999) Towards a model of Mycenaean palatial mobilization. In Galaty ML and Parkinson WA (eds.), *Rethinking Mycenean Palaces: New interpretations of an old idea.* The Cotsen Institute of Archaeology: Los Angeles, 35-41.

Halstead P. (2004) Farming and feasting in the Neolithic of Greece: The ecological context of fighting with food. *Documenta Praehistorica* 31: 151-161.

Halstead P. (2011a) Redistribution in Aegean palatial societies: Terminology, scale, and significance. *American Journal of Archaeology* 115: 229-235.

Halstead P. (2011b) 13.The faunal remains. In Pullen DJ (ed.), *The Early Bronze Age village on Tsoungiza Hill.* The American School of Classical Studies at Athens: Havertown, 741-803.

Halstead P, Collins P and Isaakidou V. (2002) Sorting the sheep from the goats: Morphological distinctions between the mandibles and mandibular teeth of adult *Ovis* and *Capra*. *Journal of Archaeological Science* 29: 545-553.

Halstead P and Isaakidou V. (2011) A pig fed by hand is worth more than two in the bush: Ethnoarchaeology of pig husbandry in Greece. In Albarella U and Trentacoste A (eds.), *Ethnozooarchaeology: the past and present of human-animal relationships.* Oxbow Books: Oxford and Oakville, 160-174.

Halstead P and Isaakidou V. (2017) Sheep, sacrifices, and symbols: Animals in Later Bronze Age Greece. In Albarella U, Rizetto M, Russ H, Vickers K and Viner-Daniels S (ed.), *The Oxford Handbook of Zooarchaeology*. Oxford University Press: Oxford, 113-126.

Hamilakis Y. (1996) A footnote on the archaeology of power: Animal bones from a Mycenaean chamber tomb at Galatas, NE Peloponnese. *The Annual of the British School at Athens* 91: 153-166.

Hamilakis Y. (1998) Eating the dead: Mortuary feasting and the politics of memory in the Aegean Bronze Age societies. In Branigan K (ed.), *Cemetery and Society in the Aegean Bronze Age.* Sheffield Academic Press: Sheffield, 115-132.

Hamilakis Y. (2003) The sacred geography of hunting: Wild animals, social power and gender in early farming societies. In Kotjabopoulou E, Hamilakis Y, Halstead P, Halstead P, Gamble C and Elefanti P (eds.), *Zooarchaeology in Greece: Recent Advances.* The British School at Athens: London, 239-248.

Hamilakis Y and Konsolaki E. (2004) Pigs for the gods: Burnt animal sacrifices as embodied rituals at a Mycenaean sanctuary. *Oxford Journal of Archaeology* 23: 131-151.

Hayden B and Cannon A. (1983) Where the garbage goes: Refuse disposal in the Maya Highlands. *Journal of Anthropological Archaeology* 2: 117-163.

Haynes G. (1983) A guide for differentiating mammalian carnivore taxa responsible for gnaw damage to herbivore limb bones. *Paleobiology* 9: 164-172.

Hielte-Stavropoulou M. (2004) Traces of ritual in Middle Helladic funeral contexts including an assessment of geographical location. In Wedde M (ed.), *Celebrations: Sanctuaries and the Vestiges of Cult Activity.* Norwegian Institute at Athens: Bergen, 9-34.

Hill E. (2013) Archaeology and animal persons: Toward a prehistory of human-animal relations. *Environment and Society: Advances in Research* 4: 117-136.

Hill JD. (1995) *Ritual and rubbish in the Iron Age of Wessex: A study on the formation of a specific archaeological record.* British Archaeological Reports, British Series, 242. Tempus Reparatum: Oxford.

Hillson S. (2005) *Teeth.* Cambridge University Press: Cambridge.

Hodder I. (1982) *Symbols in action: Ethnoarchaeological studies of material culture.* Cambridge University Press: Cambridge.

Hodder I. (1987) The meaning of discard: Ash and domestic space in Baringo. In Kent S (ed.), *Method and theory for activity area research.* Columbia University Press: New York, 424-448.

Hodder I. (2011) Human-thing entanglement: Towards an integrated archaeological perspective. *Journal of the Royal Anthropological Institute* 17: 154-177.

Hodder I. (2012) *Entangled: An archaeology of the relationships between humans and things.* Wiley-Blackwell: Malden, MA.

Hope Simpson R and Hagel DK. (2006) *Mycenaean fortifications, highways, dams and canals.* Studies in Mediterranean Archaeology, 133. Paul Åströms Förlag: Sävedalen.

Hoquet T. (2013) Animal individuals: A plea for a nominalistic turn in animal studies? *History and Theory, Theme Issue* 52: 68-90.

Hruby J. (2008) You are what you eat: Mycenaean class and cuisine. In Hitchcock LA, Laffineur R and Crowley J (eds.), *DAIS: The Aegean feast, Proceedings of the 12th international Aegean Conference, University of Melbourne, Center for Classics and Archaeology, 25-29 March 2009.* Université de Liège/The University of Texas at Austin: Liege/Austin, 151-157.

Humphrey C and Laidlaw J. (1994) *The archetypal actions of ritual: A theory of ritual illustrated by the Jain rite of worship.* Clarendon Press: Oxford.

Hägg I and Fossey JM. (1980) *Excavations in the Barbouna area at Asine. Fascicle 4: The Hellenistic nekropolis and later structures on the middle slopes, 1973-77.* Boreas, Uppsala studies in ancient Mediterranean and Near Eastern civilizations, 4:4. Uppsala University: Uppsala.

Hägg I and Hägg R. (1973) *Excavations in the Barbouna area at Asine. Fascicle 1: General introduction, bibliography, geological background and a report on the field-work in the Levendis sector, 1970-1972.*Boreas, Uppsala Studies in Ancient Mediterranean and Near Eastern Civilisations, 4:1. Uppsala University: Uppsala.

Hägg I and Hägg R. (1976) Discoveries at Asine dating from the Shaft-Grave period. *Archaeologica Analektika ex Athinon* 8: 151-160.

Hägg R. (1974) *Die Gräber der Argolis in submykenischer, protogeometrischer und geometrischer Zeit, 1. Lage under Form der Gräber.* Diss. Boreas, Uppsala Studies in Ancient Mediterranean and Near Eastern Civilisations, 7:1. Uppsala University: Uppsala.

Hägg R and Nordquist GC. (1992) Excavations in the Levendis sector at Asine, 1989: A preliminary report. *Opuscula Atheniensia* 19: 59-68.

Hägg R, Nordquist GC and Wells B. (1996) *Asine III. Supplementary studies on the Swedish excavations 1922-1930.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 45:1. Swedish Institute at Athens: Stockholm.

Högberg A. (2016) Waste, very much a social practice. In Sosna D and Brunclíková L (eds.) *Archaeologies of waste: Encounters with the unwanted.* Oxbow Books: Oxford, 59-64.

Höghammar K. (1984) The dating of the Roman bath at Asine in Argolis. *Opuscula Atheniensia* 15: 79-106.

Ilahian H and Park TK. (2001) Sources for the socio-economic study of rural Morocco. *International Journal of Middle East Studies* 33: 271-290.

Ingold T. (1994) Introduction. In Ingold T (ed.), *What Is An Animal?* Routledge: London and New York, 1-17.

Ingold T. (2013) Anthropology beyond humanity. *Suomen Antropologi: Journal of the Finnish Anthropological Society* 38: 5-23.

Ingvarsson-Sundström A. (2008) *Asine III: supplementary studies on the Swedish excavations 1922-1930. Fascicle 3: Children lost and found.* Diss. Skrifter utgivna av Svenska Institutet i Athen, 4°, 45:2. Swedish Institute at Athens: Stockholm.

Ingvarsson-Sundström A, Richards MP and Voutsaki S. (2009) Stable isotope analysis of the Middle Helladic population from two cemeteries at Asine: Barbouna and East Cemetery. *Mediterranean Archaeology & Archaeometry* 9: 1-14.

Ingvarsson-Sundström A, Voutsaki S and Milka E. (2013) Diet, health and social differentiation in Middle Helladic Asine: A bioarchaeological view. In Voutsaki S and Valamoti SM (eds.), *Diet, economy and society in the Ancient Greek world: Towards a better integration of archaeology and science.* Peeters: Leuven, 149-162.

Iregren E. (1997) Why animal bones in human graves? An attempt to interpret animals present in Iron Age cremations in Sweden. In Smits E, Iregren E and Drusinin AG (eds.) *Cremation studies in archaeology: Proceedings of the Symposium, Amsterdam 26-27 October 1995*. Logos Edizioni: Saonara, 9-32.

Isaakidou V. (2007) Cooking in the labyrinth: Exploring cuisine at Bronze Age Knossos. In Mee C and Renard J (eds.), *Cooking up the past: Food and culinary practices in the Neolithic and Bronze Age Aegean.* Oxbow Books: Oxford, 5-24.

Isaakidou V and Halstead P. (2013) Bones and the body politic? A diachronic analysis of structured deposition in the Neolithic-Early Iron Age Aegean. In Ekroth G and Wallensten J (eds.) *Bones, behaviour and belief: The zooarchaeological evidence as a source for ritual practice in Ancient Greece and Beyond.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 55. Swedish Institute at Athens: Stockholm, 87-99.

Isaakidou V, Halstead P and Davis J. (2002) Burnt animal sacrifice at the Mycenaean 'Palace of Nestor', Pylos. *Antiquity* 76: 86-92.

Jahns S. (1993). On the Holocene vegetation history of the Argive plain (Peloponnesse, southern Greece). *Vegetation History and Archaeobotany* 2: 187-203.

Jennbert K. (2014) *Magasinsarkeologi*. Avslutade projekt. Available at: http://portal.research.lu.se/portal/sv/projects/storehouse-archaeology(e1edfa5b-9771-42bc-b0c9-f4cadf0a6618).html [Accessed: 2017-01-16].

Jones EL and Gabe C. (2015) The promise and peril of older collections: Meta-analyses and the zooarchaeology of Late Prehistoric/Early Historic New Mexico. *Open Quaternary* 1: 1-13.

Jones GG and Sadler P. (2012) Age at death in cattle: Methods, older cattle and known-age reference material. *Environmental Archaeology* 17: 11-28.

Jusseret S. (2010) Socializing geoarchaeology: Insights from Bourdieu's theory of practice applied to Neolithic and Bronze Age Crete. *Geoarchaeology: An international journal* 25: 675-708.

Kaliff A and Østigård T. 2013. Kremation och kosmologi: en komparativ arkeologisk introduktion. *Occasional Papers in Archaeology* 56. Uppsala University: Uppsala.

Kamp KA. (1991) Waste disposal in a Syrian village. In Staski E and Sutro LD (eds.), *The ethnoarchaeology of refuse disposal.* Arizona State University: Phoenix, Ariz., 23-32.

Kaniewski D, Van Campo E, Guiot J, Le Burel S, Otto T and Baeteman C. (2013) Environmental roots of the Late Bronze Age crisis. *PLoS ONE* 8: e71004.

Katsianis M, Tsipidis S, Kotsakis K and Kousoulakou A. (2008) A 3D digital workflow for archaeological intra-site research using GIS. *Journal of Archaeological Science* 35: 655-667.

Klingborg P. (2017) *Greek cisterns: Water and risk in ancient Greece 600–50 BC*. Diss. Department of Archaeology and Ancient History. Uppsala University: Uppsala.

Klippel WE and Synstelien JA. (2007) Rodents as taphonomic agents: Bone gnawing by brown rats and gray squirrels. *Journal of Forensic Sciences* 52: 765-773.

Knapp AB and van Dommelen O. (2008) Past practices: Rethinking individuals and agents in archaeology. *Cambridge Archaeological Journal* 18: 15-34.

Knappett C. (2012) Materiality. In Hodder I (ed.), *Archaeological theory today.* 2nd ed. Polity Press: Cambridge, 188-207.

Kotjabopoulou E, Hamilakis Y, Halstead P, Gamble C and Elefanti P. (2003) *Zooarchaeology in Greece: Recent advances.* The British School at Athens: London.

Kramer C. (1982) *Village ethnoarchaeology: Rural Iran in archaeological perspective.* Academic Press: London.

Kuna M. (2015) Categories of settlement discard. In Kristiansen K, Smejda L and Turek J (eds.) *Paradigm* found: *Archaeological theory present, past and future. Essays in honour of Evzen Neustupny.* Oxbow Books: Oxford, 278-292.

Lam YM and Pearson OM. (2005) Bone density studies and the interpretation of the faunal record. *Evolutionary Anthropology* 14: 99-108.

Lamotta V. (2012) Behavioral archaeology. In Hodder I (ed.), *Archaeological theory today.* 2nd ed. Polity Press: Cambridge, 62-92.

Landeschi G, Apel J, Lindgren S and Dell'Unto N. (in press) *An exploratory use of 3D for investigating a prehistoric stratigraphic sequence*. Proceedings of the Conference on Computer Applications and Quantitative Methods in Archaeology, Oslo 2016.

Latour B. (2005) *Reassembling the social: An introduction to Actor-Network-Theory.* Oxford University Press: Oxford.

Lawrence DH. (1971) The nature and structure of paleoecology. *Journal of Paleontology* 45: 593-607.

Levine M. (1982) The use of crown height measurements and eruption-wear sequences to age horse teeth. In Wilson B, Grigson C and Payne S (eds.), *Ageing and Sexing Animal Bones from Archaeological Sites.* British Archaeological Series, British Series 108. Oxford, 223-250.

Libell M. (2014) Seeing animals: Anthropomorphism between fact and function. In Andersson Cederholm E, Björck A, Jennbert K and Lönngren A-S (eds.), *Exploring the Animal Turn: Human-Animal Relations in Science, Society and Culture.* Pufendorf Institute for Advanced Studies: Lund, 141-154.

Lindblom, M. 2016. Personal communication [2016-08-16].

Lindblom, M., Bocher, S., Klintberg, L., Mylona, D., Sarpaki, A., Savini, E., Pakkanen, J. and Paulson, T. (forthcoming) 'A Late Helladic IIIC Settlement within the Later Sanctuary of Poseidon on Kalaureia', *Opuscula.*

Lipton P. (2000) Inference to the Best Explanation. In Newton-Smith WH (ed.), *A companion to the philosophy of science.* Blackwell: Oxford, 184-193.

Lucas G. (2002) Disposability and dispossession in the twentieth century. *Journal of Material Culture* 7: 5-22.

Lyman RL. (1987) Archaeofaunas and butchery studies: A taphonomic perspective. *Advances in Archaeological Method and Theory* 10: 249-337.

Lyman RL. (1994) *Vertebrate Taphonomy.* Cambridge University Press: Cambridge.

Lyman RL. (2004) The concept of equifinality in taphonomy. *Journal of Taphonomy* 2: 15-26.

Lyman RL. (2008) *Quantitative paleozoology.* Cambridge University Press: Cambridge

Lyne E and Haarby Hansen C. (2016) One man's trash: How the excavation of Copenhagen's moat is revealing valuable information about the city's 17th century population. In Sosna D and Brunclíková L (eds.), *Archaeologies of waste: Encounters with the unwanted.* Oxbow Books: Oxford, 65-82.

Macheridis S. (2013) *Eld, kultur och natur: Osteologisk analys av djurbensmaterial från Avaldsnes, Karmøy*. Reports in Osteology, 2013: 3. Lund University: Lund.

Macheridis S. (2015) Image-based 3D modeling as a documentation method for zooarchaeological remains in waste-related contexts. *Ethnobiology Letters* 6: 25-31.

Macheridis S. (2016). *A report on the preliminary osteological assessments of the bones from Malthi, 2016*. Unpublished technical report.

Macheridis S and Tornberg A. (2011) Matrester och slaktavfall på Hovdala borg: Osteologisk analys av djurbensmaterialet från Gårdstalien 2008. In Ödman A & C (ed.), *Händelser längs en väg: Finjasjöbygden med den medeltida Hovdalaborgen i centrum.* Norra Skånes medeltid, 5. Lund University: Lund, 286-303.

MacKinnon M. (2007) Osteological research in Classical Archaeology. *American Journal of Archaeology* 111: 473-504.

Madgwick R. (2014) What makes bones shiny? Investigating trampling as a cause of bone abrasion. *Archaeological and Anthropological Sciences* 6: 163-173.

Madgwick R and Mulville J. (2011) Investigating variation in the prevalence of weathering in faunal assemblages in the UK: A multivariate statistical approach. *International Journal of Osteoarchaeology* 22: 509-522.

Magnell O. (2005) *Tracking wild boar and hunters: Osteology of wild boar in Mesolithic South Scandinavia.* Diss. Lund University. Almqvist & Wiksell International: Stockholm.

Magnell O. (2009) Den urbana borgen och den lantliga staden. Djurhållning och kost i det medeltida Sölvesborg. *Ale, Historisk Tidsskrift för Skåne, Halland och Blekinge* (2009): 20-24.

Magnell O and Carter R. (2007) The chronology of tooth development in wild boar: A guide to age determination of linear enamel hypoplasia in prehistoric and Medieval pigs. *Veterinarija ir zootechnika* 40: 41-48.

Manning SW. (2010) Chronology and terminology. In Cline EH (ed.), *The Oxford Handbook of the Bronze Age Aegean (ca. 3000-1000 BC).* Oxford University Press: Oxford, 11-28.

Maran J. (1998) *Kulturwandel auf dem grieschischen Festland un den Kykladen im späten 3. Jahrtausend v. Chr.,* Verlag Dr. Rudolf Habelt: Bonn.

Maran J. (2006) Coming to terms with the past: Ideology and power in the Late Helladic IIIC. In Deger-Jalkotsky S and Lemos IS (eds.), *Ancient Greece: From the Mycenaean palaces to the Age of Homer.* Edinburgh University Press: Edinburgh, 123-150.

Maran J. (2009) The crisis years? Reflections on signs of instability in the last decades of the Mycenaean palaces. *Scienze Dell'Antichità Storia Archeologia Antropologia* 15: 241-262.

Maran J. (2016) The persistence of place and memory: The case of the Early Helladic *Rundbau* and the Mycenaean palatial *Megara* of Tiryns. In Bartelheim M, Horejs B and Krauss R (eds.), *Von Baden bis Troia: Ressourcennutzung, Metallurgie und Wissenstransfer.*Verlag Marie Leidorf: Rahden, Westf., 153-173.

Marciniak A. (2005) *Placing animals in the Neolithic: Social zooarchaeology of prehistoric farming communities.* UCL Press: London.

Marciniak A. (2011) Folk taxonomies and human-animal relations: The Early Neolithic in the Polish lowlands. In Albarella U and Trentacoste A (eds.), *Ethnozooarchaeology: The past and present of human-animal relationships.* Oxbow Books: Oxford and Oakville, 29-38.

Marean CW, Spencer LM, Blumenschine RJ and Capaldo SD. (1991) Captive hyaena bone choice and destruction, the Schlepp effect and Olduvai archaeofaunas. *Journal of Archaeological Science* 19: 101-121.

Martin L and Russell N. (2000) Trashing rubbish. In Hodder I (ed.), *Towards reflexive method in archaeology: The example at Çatalhöyük.* McDonald Institute for Archaeology Research: Cambridge, 57-69.

Mayer JJ and Lehr Brisbin Jr. I. (1988) Sex identification of *Sus scrofa* based on canine morphology. *Journal of Mammology* 69: 408-412.

Mayer JJ, Novak JM and Lehr Brisbin Jr I. (1998) Evaluation of molar size as a basis for distinguishing wild boar from domestic swine: Employing the present to decipher the past. In Nelson SM (ed.), *Ancestors for the pigs: Pigs in prehistory.* MASCA Research papers in science and archaeology, 15. Penn Press: Philadelphia, PA, 39-53.

Meier J, Price G and Shelton K. (2014) Animals beyond the Cyclopean walls: Integrating faunal and isotopic analysis at Late Helladic IIIA2 Petsas House. In Izeta AD (ed.), *Abstracts = Libro de Resúmenes. ICAZ 2014, 12th International Conference of ArchaeoZoology. September, 22nd-27th*. Universidad Nacional de Cordoba: San Rafael, Argentina, 107.

Meiri M, Stockhammer PW, Marom N, Bar-Oz G, Sapir-Hen L, Morgenstern P, Macheridis S, Rosen B, Huchon D, Maran J and Finkelstein I. (2017) Eastern Mediterrenean mobility in the Bronze and Early Iron Ages: Inferences from ancient DNA of pigs and cattle. *Scientific Reports* 7: 701. DOI: 10.1038/s41598-017-00701-y.

Metcalfe D and Jones KT. (1988) A reconsideration of animal body-part utility indices. *American Antiquity* 53: 486-504.

Milka E. (2010) Burials upon the ruins of abandoned houses in the Middle Helladic Argolid. In Philippa-Touchais A, Touchais G, Voutsaki S and Wright JC (eds.), *Mesohelladika: The Greek mainland in the Middle Bronze Age.* Bulletin de Correspondance Hellénique Supplément, 52. École de française d'Athènes: Athens, 433-443.

Moberg K. (1986) *En analys av animalt och humant skelettmaterial i Asine*. Unpublished Bachelor thesis. Uppsala University: Uppsala.

Moberg K. (1992) The animal bones. In Hägg R and Nordquist GC, Excavations in the Levendis sector at Asine, 1989: A preliminary report. *Opuscula Atheniensia* 19: 59-68.

Moberg Nilsson K. (1996) Animal bones from Terrace III in the Lower Town of Asine. In Hägg R, Nordquist GC and Wells B (eds.), *Asine III. Supplementary Studies on the Swedish Excavations 1922-1930. Fasc. 1.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 45:1. Swedish Institute at Athens: Stockholm, 111-115.

Moore HL. (1982) The interpretation of spatial patterning in settlement residues. In Hodder I (ed.), *Symbolic and structural archaeology.* Cambridge University Press: Cambridge, 74-79.

Murray P. (1980) Discard location: The ethnographic data. *American Antiquity* 45: 490-502.

Mylona D. (2003) Archaeological fish remains in Greece: General trends of the research and a gazetteer of sites. In Kotjabopoulou E, Hamilakis Y, Halstead P, Gamble C and Elefanti P (eds.), *Zooarchaeology in Greece: Recent advances.* The British School at Athens: London, 193-200.

Nadasdy P. (2007) The gift in the animal: The ontology of hunting and human-animal sociality. *American Ethnologist* 34: 25-43.

Nakassis D, Parkinson WA and Galaty ML. (2011) Redistributive economies from a theoretical and cross-cultural perspective. *American Journal of Archaeology* 115: 177-184.

Naturvårdsverket. (2014) *Matavfallsmängder i Sverige 2012*. Available at http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-8694-7.pdf?pid=11891 [Accessed: 2016-11-11].

Needham S and Spence T. (1997) Refuse and the formation of middens. *Antiquity* 71: 77-90.

Nenadic O and Greenacre M. (2007) Correspondence Analysis in R, with two- and three-dimensional graphics: The *ca* package. *Journal of Statistical Software* 20: 1-13.

Nenadic O and Greenacre MJ. (2006) Computation of Multiple Correspondence Analysis, with code in R. In Greenacre MJ and Blasius J (eds.), *Multiple Correspondence Analysis and related Methods.* Chapman and Hall/CRC: Boca Raton, 523-551.

Nicodemus A. (2008) The mammal and reptile remains, 1973-1977. In Taylour WD and Janko R (eds.), *Ayios Stefanos: Excavations at a Bronze Age and Medieval settlement in southern Laconia*. Supplementary volume 44. British School at Athens: London, 506-513.

Nilsson M. (2014) A note on domestic vs. communal grain storage in the Early Helladic Period. *Opuscula* 7: 223-239.

Nobis G. (1993) Archäozoologische Untersuchungen von Tierresten aus dem "Palast des Nestor" bei Pylos in Messenien/SW-Peloponnes. *ZFA (Zeitschrift für Archäeologie)* 27: 151-173.

Nordquist GC. (1987) *A Middle Helladic Village. Asine in the Argolid.* Diss. Boreas, Uppsala Studies in Ancient Mediterranean and Near Eastern Civilizations, 16. Uppsala University: Uppsala.

Nordquist GC. (1990) Middle Helladic burial rites: Some speculations. In Hägg R and Nordquist GC (eds.), *Celebrations of death and divinity in the Bronze Age Argolid.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 40. Swedish Institute at Athens: Stockholm, 35-41.

Nordquist GC. (1995) Who made the pots? Production in the Middle Helladic society. In Laffineur R and Niemeier W-D (eds.), *Politeia: Society and state in the Aegean Bronze Age, Part I.* Université de Liège: Liège, 201-211.

Nordquist GC. (1996) Grave concordance, Asine 1922-1930. In Hägg R, Nordquist GC and Wells B (eds.), *Asine III. Supplementary Studies on the Swedish Excavations 1922-1930. Fasc. 1.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 45:1. Swedish Institute at Athens: Stockholm, 117-119.

Nordquist GC and Hägg R. (1996) The history of the Asine excavations and collections, with a bibliography. In Hägg R, Nordquist GC and Wells B (eds.), *Asine III. Supplementary Studies on the Swedish Excavations 1922-1930. Fasc. 1.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 45:1. Swedish Institute at Athens: Stockholm, 11-18.

Nyyssönen J and Salmi A-K. (2013) Towards a multitangled study of reindeer agency, overlapping environments, and human-animal relationships. *Arctic Anthropology* 50: 40-51.

O'Connor TP. (1982) *Animal bones from Flaxengate, Lincoln.* Council for British Archaeology: London.

O'Connor TP. (2000) *The archaeology of animal bones.* Texas A&M University Press: College Station.

O'Connor TP. (2013) *Animals as neighbours: The past and present of commensal animals.* Michigan State University Press: East Lansing.

Olsen B. (2012) Symmetrical archaeology. In Hodder I (ed.), *Archaeological theory today.* 2nd ed. Polity Press: Cambridge, 208-228.

Ortner SB. (1984) Theory in anthropology since the sixties. *Comparative Studies In Society and History* 26: 126-166.

Orton DC. (2010) Both subject and object: Herding, inalienability and sentient property in prehistory. *World Archaeology* 42: 188-200.

Orton DC. (2012) Taphonomy and interpretation: An analytical framework for social zooarchaeology. *International Journal of Osteoarchaeology* 22: 320-337.

Overton NJ and Hamilakis Y. (2013) A manifesto for a social zooarchaeology: Swans and other beings in the Mesolithic. *Archaeological Dialogues* 20: 111-136.

Oxford Dictionary (2017). Query: management. Available at https://en.oxforddictionaries.com/definition/management [Accessed: 2017-01-09].

Pales L and Lambert C. (1971) *Atlas Osteologique pour servir á l'identification des Mammiféres du Quaternaire: 1. Les Membres, Herbivores.* Editions du Centre National de la Recherche Scientifique: Paris.

Pasda K and Odgaard U. (2011) Nothing is wasted: The ideal "nothing is waste" and divergence in past and present amongst caribou hunters in Greenland. *Quaternary International* 238: 35-43.

Paul JD. (2015) A question of uniformitarianism: Has the geological past become the key to humanity's future? *Anthropocene* 9: 70-74.

Pawłowska K. (2014) The smells of Neolithic Çatalhöyük, Turkey: Time and space of human activity. *Journal of Anthropological Archaeology* 36: 1-11.

Payne S. (1973) Kill-off patterns in sheep and goats: The mandibles from Asvan Kale. *Anatolian Studies* 23: 281-303.

Payne S. (1985a) Morphological distinction between the mandibular teeth of young sheep, *Ovis*, and goats, *Capra*. *Journal of Archaeological Science* 12: 139-147.

Payne S. (1985b) Zooarchaeology in Greece: A reader's guide. In Wilkie NC and Coulson WDE (eds.), *Contributions to Aegean Archaeology: Studies in honor of William A. McDonald.* Kendall/Hunt Pub. Co: Dubuque, Iowa, 211-244.

Payne S. (1987) Reference codes for wear states in the mandibular cheek teeth of sheep and goats. *Journal of Archaeological Science* 14: 609-614.

Payne S and 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* II/1.2: 27-66.

Pedersen H. (2014) Knowledge production in the "Animal Turn": Multiplying the image of thought, empathy, and justice.In Andersson Cederholm E, Björck A, Jennbert K and Lönngren A-S (eds.), *Exploring the Animal Turn: Human-animal relations in science, society and culture.* Pufendorf Institute for Advanced Studies: Lund, 13-18.

Pentinnen A. (1997) Excavations on the Acropolis of Asine in 1990.*Opuscula Atheniensia* 21: 149-167.

Petrakis VP. (2010) Diversity in form and practice in Middle Helladic and Early Mycenaean elaborate tombs: An approach to changing prestige expression in changing times. In Philippa-Touchais A, Touchais G, Voutsaki S and Wright JC (eds.), *Mesohelladika: The Greek mainland in the Middle Bronze Age.* Bulletin de Correspondance Hellénique Supplément, 52. École de française d'Athènes: Athens, 403-416.

Philippa-Touchais A, Touchais G, Decavallas O, Gardeisen A, Ghilardi M, Margaritis E, Metaxas O, Triantaphyllou S and Tsiolaki E. (2014) Environnement, alimentation, hygiene et mode de vie dans le Grece mesohelladique: Le cas de l'Aspis d'Argos. In Touchais G, Laffineur R and Rougemont F (eds.), *PHYSIS: L'Environnement naturel et la relation homme-milieu dans le monde égeen protohistorique.* Aegeaum, 37. Peteers: Leuven/Liege, 531-538

Pilgram T and Marshall F. (1995) Bone counts and staticians: A reply to Ringrose. *Journal of Archaeological Science* 22.

Prummel W. (1988) Distinguishing features on postcranial skeletal elements of cattle, *Bos primigenius* f. *taurus*, and red deer, *Cervus elaphus*. *Schriften aus der Archäologisch-Zoologischen Arbeitsgruppe Schleswig-Kiel* Heft 12: 5-52.

Prummel W and Frisch H-J. (1986) A guide for the distinction of species, sex and body side in bones of sheep and goat. *Journal of Archaeological Science* 13: 567-577.

Pullen DJ. (1987) Asine, Berbati, and the chronology of Early Bronze Age Greece. *American Journal of Archaeology* 91: 533-544.

Rathje W and Murphy C. (2001) *Rubbish! The archaeology of garbage.* The University of Arizona Press: Tucson.

Reese DS. (1982) Appendix 2: The molluscs from Bronze Age to Post-Geometric Asine in the Argolid, Greece. In Dietz S (ed.), *Asine II: Results of the excavations east of the acropolis 1970-1974. Fascicle 2: The Middle Helladic cemetery, the Middle Helladic and Early*

Mycenaean deposits. Skrifter utgivna av Svenska Institutet i Athen, 4º, 24:2. Almqvist & Wiksell: Stockholm, 139-142.

Reese DS. (1998) Appendix II: The faunal remains. In Walberg G (ed.), *Excavations on the Acropolis of Midea, vol. I: 1. The excavation on the Lower Terraces.* Paul Åströms Förlag: Stockholm, 277-291.

Reese DS. (2008a) Appendix 8: The mammalian and reptilian remains: Catalogue and comparanda. In Taylour WD and Janko R (eds.), *Ayios Stefanos: Excavations at a Bronze Age and Medieval settlement in Southern Laconia.* British School at Athens: London, CD156-185.

Reese DS. (2008b) Faunal remains from Late Helladic Lerna (Argolid, Greece). *Mediterranean Archaeology and Archaeometry* 8: 5-25.

Reese DS. (2013) Appendix V: The fauna. In Banks EC, *The settlement and architecture of Lerna IV.* The American School of Classical Studies at Athens: Princeton, 421-468.

Reese DS. (1994) Recent work in Greek zooarchaeology. In Kardulias PN (ed.), *Beyond the site: Regional studies in the Aegean area.* University Press of America: Lanham, 191-221.

Reimer PJ, Bard E, Bayliss A, Beck JW, Blackwell PG, Bronk Ramsey C, Buck CE, Cheng H, Edwards RL, Friedrich M, Grootes PM, Guilderson TP, Haflidason H, Hajdas I, Hatté C, Heaton TJ, Hoffmann DL, Hogg AG, Hughen KA, Kaiser KF, Kromer B, Manning SW, Niu M, Reimer RW, Richards DA, Scott EM, Southon JR, Staff RA, Turney CSM and van der Plicht J. (2013) IntCal13 and Marine13 radiocarbon age calibration curves 0-50,000 years cal BP. *Radiocarbon* 55: 1869-1887.

Reitz E and Wing E. (1999) *Zooarchaeology.* Cambridge University Press: Cambridge.

Renfrew C, Boyd M and Bronk Ramsey C. (2012) The oldest maritime sanctuary? Dating the sanctuary at Keros and the Cycladic Bronze Age. *Antiquity* 86: 144-160.

Reno J. (2014) Toward a new theory of waste: From "matter out of place" to signs of life. *Theory, Culture & Society* 31: 3-27.

Reno J. (2015) Waste and waste management. *Annual Review of Anthropology* 44: 557-572.

Reno J. (2016) Waste and values. In Sosna D and Brunclíková L (eds.) *Archaeologies of waste: Encounters with the unwanted.* Oxbow Books: Oxford, 17-22.

Richards C and Thomas J. (1984) Ritual activity and structured deposition in Later Neolithic Wessex. In Bradley R and Gardiner J (eds.), *Neolithic studies: A review of some current research.*BAR British Series, 133. British Archaeological Reports: Oxford, 189-218.

Richer Z. (2015) Toward a social topography: Status as a spatial practice. *Sociological Theory* 33: 347-368.

Ridgeway CL. (2014) Why status matters for inequality. *American Sociological Review* 79: 1-16.

Ringrose TJ. (1993) Bone counts and statistics: A critique. *Journal of Archaeological Science* 20: 121-157.

Ritvo H. (2007) On the Animal Turn. *Daedalus* 136: 118-122.

Romano M. (2015) Reviewing the term uniformitarianism in modern earth sciences. *Earth-Science Reviews* 148: 65-76.

Rowley-Conwy P, Albarella U and Dobney K. (2012) Distinguishing wild boar from domestic pigs in prehistory: A review of approaches and recent results. *Journal of World Prehistory* 25: 1-44.

Rudebeck E and Macheridis S. (2015) The proper way of dwelling at the Early Neolithic gathering site of Almhov in Scania, Sweden. In Brink K, Hydén S, Jennbert K, Larsson L and Olausson D (eds.), *Neolithic Diversities: Perspectives from a conference in Lund, Sweden.* Acta Archaeologica Lundensia Series altera in 8°, 65. Lund University: Lund, 173-187.

Russell N. (2012) *Social zooarchaeology: Humans and animals in prehistory.* Cambridge University Press: New York.

Salvagno L and Albarella U. (2017) A morphometrical system to distinguish sheep and goat postcranial bones. *PLoS ONE* 12(6): e0178543. DOI: 10.1371/journal.pone.0178543

Santillo Frizell B. (1980) *An Early Mycenaean settlement at Asine: The Late Helladic II B-III A: 1 pottery.* Diss. University of Göteborg: Göteborg.

Schallin A-L. (2014) Persson, kronprinsen och bronsålderns kungar i Argolis. In Whitling F (ed.), *Svensk antikforskning vid Medelhavet, Gustaf VI Adolf och fältarkeologi i historiskt perspektiv*, Konferenser, 87. KVHAA: Stockholm, 61-64.

Schiffer MB. (1972) Archaeological context and systemic context. *American Antiquity* 37: 156-165.

Schiffer MB. (1975) Archaeology as behavioral science. *American Anthropologist* 77: 836-848.

Schiffer MB. (1983) Toward the identification of formation processes. *American Antiquity* 48: 675-706.

Schiffer MB. (1987) *Formation processes of the archaeological record.* University of New Mexico: Albuquerque.

Schmid E. (1972) *Atlas of animal bones: For prehistorians, archaeologists and quaternary geologists.* Elsevier Publishing Company: Amsterdam.

Scott GH. (1963) Uniformitarianism, the uniformity of nature, and paleoecology. *New Zealand Journal of Geology and Geophysics* 6: 510-527.

Shanks M. (2007) Symmetrical archaeology. *World Archaeology* 39: 589-596.

Shelmerdine CW. (1997) Review of Aegean prehistory VI: The Palatial Bronze Age of the southern and central Greek mainland. *American Journal of Archaeology* 101: 537-585.

Shennan S. (2006) *Quantifying archaeology.* University of Iowa Press: Iowa City.

Shipman P, Foster G and Schoeninger M. (1984) Burnt bones and teeth: An experimental study of color, morphology, crystal structure and shrinkage. *Journal of Archaeological Science* 11: 307-325.

Sinopoli CM. (2013) New research on an old collection: Studies of the Philippine Expedition ("Guthe") collection of the Museum of Anthropology, University of Michigan. *Asian Perspectives* 52: 1-11.

Sjöberg B. (2001) *Asine and the Argolid in the Late Helladic III period: A socio-economic study.* Diss. Uppsala University: Uppsala.

Sjöberg B. (2002) Economic interaction on the Argive plain: A research note on Late Helladic Asine. In Wells B (ed.), *New research on old material from Asine and Berbati.* Skrifter utgivna av Svenska Institutet i Athen, 8°, 17. Swedish Institute at Athens: Stockholm, 57-69.

Sloan RE and Duncan MA. (1974) 6: Zooarchaeology of Nichoria. In Rapp E and Aschenbrenner SE (eds.), *Excavations at Nichoria in southwest Greece: Volume 1. Site, environs, and techniques.* University of Minnesota Press: Minneapolis, 60-77.

Smith JS. (2008) Bringing old excavations to life. *Near Eastern Archaeology* 71: 30-40.

Sommer U. (1990) Dirt theory, or archaeological sites seen as rubbish heaps. *Journal of theoretical archaeology* 1: 47-60.

Sosna D. (2016) Heterotopias behind the fence: Landfills as relational emplacements. In Sosna D and Brunclíková L (eds.) *Archaeologies of waste: Encounters with the unwanted.* Oxbow Books: Oxford, 162-178.

Staski E and Sutro LD. (1991) The ethnoarchaeology of refuse disposal. *Anthropological Research Papers* 42. Arizona State University: Phoenix, Ariz.

Sten S. (1992) Mat och djurhållning på medeltida borgar och kungsgårdar. In Andersson S, Hall B and Öborn G (eds.), *Borgar: Från forntid och medeltid i Västsverige.* Göteborgs arkeologiska museum: Göteborg, 200-213.

Stiner MC. (1991) Food procurement and transport by human and non-human predators. *Journal of Archaeological Science* 18: 455-482.

Strasser S. (1999) *Waste and want: A social history of trash.* Henry Holt and Company: New York.

Strasser TF.(1999) *Bothroi* in the Aegean Early Bronze Age'. In Betancourt PP, Karageorghis V, Laffineur R and Niemeier W-D (eds.) *Meletemata: Studies in Aegean archaeology presented to Malcolm H. Wiener as he enters his 65th year.* Aegaeum, 20. Liège, 813–817.

Styrenius C-G. (1975) Some notes on the new excavations at Asine. *Opuscula Atheniensia* 11: 177-183.

Styrenius C-G. (1998) *Asine: En svensk utgrävningsplats i Grekland.*Medelhavsmuséet: Stockholm.

Sutro LD. (1991) When the river comes: Refuse disposal in Diaz Ordaz, Oaxaca. In Staski E and Sutro LD (eds.), *The Ethnoarchaeology of Refuse Disposal.* Anthropological Research Papers, 42. Arizona State University: Phoenix, Ariz., 13-22.

Swedish Institute at Athens, Museum Gustavianum in Uppsala and Dept. of Archaeology and Ancient History, Uppsala University. (2017) The PRAGMATA database. Available at: pragmata.sia.uu.se/pragmata [Accessed: 2017-01-16].

Szynkiewicz S. (1990) Sheep bone as a sign of human descent: Tibial symbolism among the Mongols. In Willis R (ed.), *Signifying animals: Human meanings in the natural world.* Unwin Hyman: London.

Tartaron TF. (2013) *Maritime networks in the Mycenaean world*. Cambridge University Press: New York.

Thilderqvist J. (2013) *Ritual bones or common waste: A study of Early Medieval bone deposits in Northern Europe.* Diss. University of Groningen: Groningen.

Thomas J. (2012) Some deposits are more structured than others. *Archaeological Dialogues* 19: 127-129.

Thomas RM. (2007) Food and the maintenance of social boundaries in Medieval England. In Twiss K (ed.), *The Archaeology of food and identity.* Center for Archaeological Investigations, Southern Illinois University Carbondale: Carbondale, 130-151.

Trantalidou K. (1989) Animals and human diet in the prehistoric Aegean. In Hardy DA (ed.), *Thera and the Aegean world III, vol. 2: Earth sciences.* The Thera Foundation: Santorini, 392-405.

Trantalidou K. (2001) Archaeozoology in Greece: A brief historiography of the science. *Archaeofauna* 10: 183-199.

Trantalidou K. (2009) Διατροφικές επιλογές και στοιχεία οικονομίας στις Μυκήνες της Υστεροελλαδικής περιόδου. *Archaeologika Analekta ex Athinon* 40-41: 115-146.

Turner V. (1966) *The ritual process: Structure and anti-structure.* Cornell University Press: Ithaca, New York.

Turner V. (1967) *The forest of symbols: Aspects of Ndembu rituals.* Cornell University Press: Ithaca, New York.

Twiss K. (2012) The archaeology of food and social diversity. *Journal of Archaeological Research* 20: 357-395.

Uerpmann H-P. (1973) Animal bone finds and economic archaeology: A critical study of 'osteo-archaeological' method. *World Archaeology* 4: 307-322.

Valmin NM. (1938) *The Swedish Messenia Expedition.* Gleerup: Lund.

Vandergugten J. (2015) Bodies of information: Human-animal entanglement at Çatalhöyük and Cis-Baikal as seen through zooarchaeology. *Totem: The University of Western Ontario Journal of Anthropology and Education Quarterly* 23: 37-52.

Vardaki M. (2004) Animal husbandry revisited: The social significance of meat consumption in a highland village of Mt. Psiloritis, Central Crete. In Halstead P and Barrett JC (eds.), *Food, cuisine and society in prehistoric Greece.* Oxbow Books: Oxford, 196-205.

Warner J. (1979) The megaron and apsidal house in Early Bronze Age western Anatolia: New evidence from Karatas. *American Journal of Archaeology* 83: 133-147.

Weber M. ([1918] 1978) *Economy and society.* University of California Press: Berkeley and Los Angeles.

Weiberg E. (2013) An Early Helladic burial: Connecting the living and the dead. In Schallin A-L (ed.), *Perspectives on ancient Greece: Papers in celebration of the 60th anniversary of the Swedish Institute at Athens*. Skrifter utgivna av Svenska Institutet i Athen, 8°, 22. Swedish Institute at Athens: Stockholm, 29-47.

Weiberg E and Finné M. (2013) Mind or matter? People-environment interactions and the demise of Early Helladic II society in the northeastern Peloponnese. *American Journal of Archaeology* 117: 1-31.

Weiberg E, Lindblom M, Leppänen Sjöberg B and Nordquist GC. (2010) 5: Social and environmental dynamics in Bronze and Iron Age Greece. In Sinclair PJJ, Nordquist GC, Herschend F and Isendahl C (eds.), *The urban mind: Cultural and environmental dynamics.* Studies in Global Archaeology, 15. Uppsala University: Uppsala, 149-194.

Weiberg E, Unkel I, Kouli K, Holmgren K, Avramidis P, Bonnier A, Dibble F, Finné M, Izdebski A, Katrantsiotis C, Stocker SR, Andwinge M, Baika K, Boyd M and Heymann C. (2016) The socio-environmental history of the Peloponnese during the Holocene: Towards an integrated understanding of the past. *Quarternary Science Reviews* 136: 40-65.

Weil K. (2010) A report on the Animal Turn. *Differences, A Journal of Feminist Cultural Studies* 21: 1-23.

Wells B. (1983) *Asine II: results of the excavations east of the Acropolis, Fascicle 4: The Protogeometric period. Part 1: An analysis of the settlement.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 24:4:2. Swedish Institute at Athens: Stockholm.

Wells B. (1988) Early Greek building sacrifices. In Hägg R, Marinatos N & Nordquist GC (eds.), *Early Greek cult practice.* Skrifter utgivna av Svenska Insitutet i Athen, 4°, 38. Swedish Institute at Athens: Stockholm, 259-266.

Wells B. (1992) The walls of Asine. *Opuscula Atheniensia* 19: 135-142.

Wells B. (2002a) *New research on old material from Asine and Berbati.*Skrifter utgivna av Svenska Institutet i Athen, 8°, 17. Swedish Institute at Athens: Stockholm.

Wells B. (2002b) The prehistory of the Swedish Institute at Athens. In Wells B (ed.), *New research on old material from Asine and Berbati.* Skrifter utgivna av Svenska Institutet i Athen, 8°, 17. Swedish Institute at Athens: Stockholm, 9-22.

Whittaker H. (2010) Some thoughts on Middle Helladic religious beliefs and ritual and their significance in relation to social structure. In Philippa-Touchais A, Touchais G, Voutsaki S and Wright JC (eds.), Mesohelladika: The Greek mainland in the Middle Bronze Age. Bulletin de Correspondance Hellénique Supplément, 52. École de française d'Athènes: Athens, 535-543.

Wheeler W and Williams L. (2012) The Animals Turn. *New Formations* 76: 5-7.

Wiener MH. (2014) The interaction of climate change and agency in the collapse of civilizations ca. 2300-2000 BC. *Radiocarbon* 56: S1-S16.

Wiersma C. (2013) *Building the Bronze Age: Architectural and social change on the Greek mainland during Early Helladic III, Middle Helladic and Late Helladic I. Volume I.* Groningen Institute of Archaeology, University of Groningen: Groningen.

Wild EM, Gauss W, Forstenpointner G, Lindblom M, Smetana R, Steier P, Thanheiser U and Weninger F. (2010) ^{14}C dating of the Early to Late Bronze Age stratigraphic sequence of Aegina Kolonna, Greece. *Nuclear Instruments and Methods in Physics Research B* 268: 1013-1021.

Wilkie R. (2015) Multispecies scholarship and encounters: Changing assumptions at the human-animal nexus. *Sociology and Social Research* 49: 323-339.

Vika, E and Theodoropoulou, T. (2012) Re-investigation fish consumption in Greek Antiquity: Results from $\delta^{13}C$ and $\delta^{15}N$ analysis from fish bone collagen. *Journal of Archaeological Science* 39: 1618-1627.

Wolfram S. (2016) Waste wanted: No space without time and place. In Sosna D and Brunclíková L (eds.) *Archaeologies of waste: Encounters with the unwanted.* Oxbow Books: Oxford, 123-126.

von den Driesch A. (1976) *A guide to the measurement of animal bones from archaeological sites.* Peabody Museum of Archaeology and Ethnology, Harvard University: Harvard.

von den Driesch A and Boessneck J. (1990) Die Tierresten von der mykenischen Burg Tiryns bei Nauplion/Peloponnes. *Tiryns: Forschungen und Berichte, band XI.* Verlag Philipp von Zabern: Mainz, 87-164.

Voutsaki S. (1997) The creation of value and prestige in the Aegean Late Bronze Age. *Journal of European Archaeology* 5: 34-52.

Voutsaki S. (2010a) From the kinship economy to the palatial economy: The Argolid in the Second Millennium BC. In Pullen DJ (ed.), *Political economies of the Aegean Bronze Age.* Oxbow Books: Oxford, 86-111.

Voutsaki S. (2010b) The domestic economy in Middle Helladic Asine. In Philippa-Touchais A, Touchais G, Voutsaki S and Wright JC (eds.), *Mesohelladika: The Greek mainland in the Middle Bronze Age*. Bulletin de Correspondance Hellénique Supplément, 52. École de française d'Athènes: Athens, 765-779.

Voutsaki S, Ingvarsson-Sundström A and Dietz S. (2011) Tumuli and social status: A re-examination of the Asine tumulus. In Borgna E and Müller Celka S (eds.), *Ancestral landscapes: Burial mounds in the Copper and Bronze Ages.* Maison de l'Orient et de la Méditerranée: Lyon.

Voutsaki S, Nijboer AJ and Zerner C. (2009) Middle Helladic Lerna: Relative and absolute chronologies. In Manning SW and Bruce MJ (eds.), *Tree-rings, kings, and Old World archaeology and environment: Papers presented in honor of Peter Ian Kuniholm.* Oxbow Books: Oxford and Oakville, 151-161.

Vretemark M. (1997) *Från ben till boskap: kosthåll och djurhållning med utgångspunkt i medeltida benmaterial från Skara. Del 1.* Skaraborgs länsmuseum: Skara.

Wyman J. (1868). An account of some kjoekkenmoeddings, or shell-heaps, in Maine and Massachusetts. *The American Naturalist* 1: 561-584.

Yannouli E. (2003) Non-domestic carnivores in Greek prehistory: A review. In Kotjabopoulou E, Hamilakis Y, Halstead P, Gamble C and Elefanti P (eds.), *Zooarchaeology in Greece: Recent advances.* The British School at Athens: London, 175-192.

Yannouli E and Trantalidou C. (1998) The fallow deer (*Dama dama* Linnaeus, 1758): Archaeological presence and representation. In Benecke N (ed.), *The Holocene history of the European vertebrate fauna: Modern aspects of research.* Verlag Marie Leidorf GmbH: Berlin, 247-281.

Yeshurun R, Bar-Oz G, Kaufman D and Weinstein-Evron M. (2014) Purpose, permanence, and perception of 14,000-Year-old architecture: Contextual taphonomy of food refuse. *Current Anthropology* 55: 591-618.

Yioutsos N-P. (2017) The last occupation of Asine in Argolis. *Opuscula* 10: 164-189

Zangger E. (1994) The island of Asine: A paleogeographic reconstruction. *Opuscula Atheniensia* 20: 221-239.

Zeder MA. (1991) *Feeding cities: Specialized animal economy in the ancient Near East.* Smithsonian Institution Press: Washington.

Zeder MA and Lapham HA. (2010) Assessing the reliability of criteria used to identify postcranial bones in sheep, *Ovis*, and goats, *Capra*. *Journal of Archaeological Science* 37: 2887-2905.

Zeder MA and Pilaar SE. (2010) Assessing the reliability of criteria used to identify mandibles and mandibular teeth in sheep, *Ovis*, and goats, *Capra*. *Journal of Archaeological Science* 37: 225-242.

Appendix 1: Heuristic workflow for zooarchaeological studies of waste management

Table 7.
Description of the analytical steps included in the heuristic workflow in Figure 1, emphasizing the analytical potential of two interpretative groups based on contextual resolution, i.e. documentation quality.

	Main analytical steps		Interpretative groups	
	Analysis/topic	Components	High contextual resolution	Low contextual resolution
Identification	Multivariate analysis	Visualization of the strongest patterns, associations and dependencies within the data	Patterns connected to contextual categories are visible	The results provide patterns general for the assemblage
	Taphonomic perspective	Analytical discussion of each pattern in terms of taphonomic information loss and/or gain, e.g. impact of post-depositional processes	The taphonomic discussion includes contextual and stratigraphic variation to a higher degree, and can therefore provide a better taphonomic reconstruction	The discussion is based on general patterns, and is informative for the general assemblage
Analysis	General waste management patterns	Composition of zooarchaeological variables and taphonomic markers	The analysis is based on a better taphonomic reconstruction. It provides general patterns as well as tangible anomalies within the general patterns	The analysis gives a sufficient view of the most general and common patterns related to waste management
	Specific waste management patterns	Spatial analysis of the distribution of zooarchaeological variables in archaeological features	The analysis is made on a clearly mapped and well-documented area. The detected patterns are valid and tangible	The analysis is made on a poorly mapped and documented area. The analysis is restricted to specific features which were documented in detail, e.g. graves, pits etc.
		Zooarchaeological comparisons between specific archaeological features	Spatial analysis can also provide a comparative intra-site approach, since all distinguishable contexts were excavated separately and documented independently	Spatial analysis can only provide a comparative intra-site approach in rare cases, since not all contexts were separated during excavating and/or documented independently
Interpretation	Social aspects of waste management	Social organization	The discussion can be holistic, i.e. considering all excavated contexts in the area.	The discussion might be restricted to certain clusterings of archaeological features that were better documented than other parts of the excavated area
		Social topography	The discussion can be made on the intra-site comparison of primary waste, waste instantly disposed of, which allows for a more detailed and accurate results	The discussion provides general tendencies of intra-site comparison. It is based on the intra-site comparison of redeposited waste, i.e. the connection between area and waste cannot be completely asserted.
	Symbolic aspects of waste management	Comparison between quotidian contexts and grave goods Interpretative approach to material patterning in refuse contexts of the site	The discussion can be made on the intra-site comparisons of bones from ritual contexts and quotidian waste deposits, which allow for more detailed and accurate results. Material patterns in the distribution of bones in specific refuse contexts should be further investigated and considered from a symbolic and ritual perspective	The same applies as for high contextual resolution material, but the discussion remains on a tentative, and perhaps general, level.

Appendix 2: The web-based Asine animal bone catalogue

The animal bone collection from Asine is large, spanning many periods and taken from all excavated parts of the site. The bone catalogue which includes the study material of this thesis is part of the PRAGMATA database (Swedish Institute at Athens *et al.* 2017), and access to this digital catalogue is free. The PRAGMATA database contains information on the pottery finds, bibliographical notes and documentation, such as the field journals from the early excavations of Asine and photographs, apart from the bone catalogue. The animal bone catalogue is a small part of this large infrastructure. It is important to note that the animal bones were examined within the frame of this thesis. Since the raw data used in this thesis can be found in PRAGMATA, it is motivated by the desire to describe and discuss the nature of the Asine animal bone collection, as well as the structure of the catalogue.

The catalogue and the animal bones

In the bone catalogue, the animal bones are presented and summarized per Asine-number (AS) or find unit. The studied material counts to a total of 33 687 bone fragments (269 826.2 g). The examination of these bones, no matter chronological period, was made as part of this thesis. Focus has been on the Bronze Age, so the selection of which bones to record was made on that basis. Still much of the studied material remains undated, and some are from periods later than the Bronze Age.

The animal bone assemblages were recovered from two excavation periods at Asine. The first period comprises bones excavated during the season of 1926. These bones were recorded during 2013-2015 at the Osteological Laboratory, Lund University, with access to a large reference collection of animal bones from different species, as well as reference literature. Most bone fragments derive from this campaign (26 116 fragments; 239 065.9 g). The other part, the animal bones from the later excavations (1969-1977, 1989), constitute only a smaller fraction of the whole Asine assemblage, in total 7 571 bone fragments (30 760.3 g). They were recorded at the Leonardo museum storage in Nauplion, with a smaller reference collection; however, the same reference literature was used (e.g. Pales & Lambert 1971; Schmid 1972; Hillson 2005). The differential access to a suitable reference collection affects the rate at which identification was made. This is illustrated in Figure 14. In order to use the data gathered in this catalogue, it is important to bear this in mind.

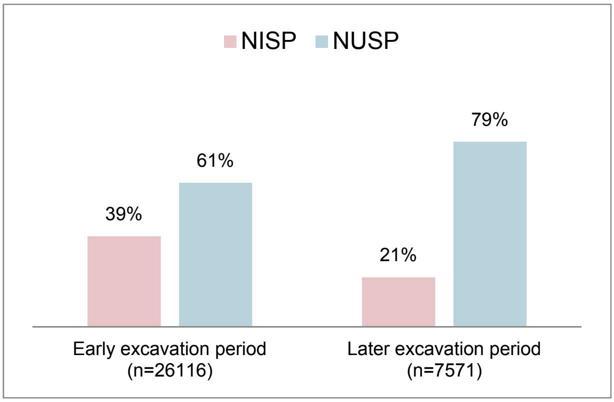

Figure 14.
Relative proportions of identified (NISP) versus unidentified (NUSP) bone in the sub-assemblages from the early excavations of 1926, and the later excavations during the 1980's and 1989 (n=33 687).

The animal bones from the 1926 excavation are part of the Asine collection located in the Museum Gustavianum, Uppsala University. During the 1990s, parts of the animal bone collection was studied by another PhD-student, who selected specific bones from some find boxes and stored in others for future studies. Thus some AS-numbers became separated into different boxes. This means that one AS-number, originally from one box, can be spread over several boxes. Some AS-numbers have thus been difficult and time-consuming to trace. Consequently, some Asine-numbers are not fully recorded. It would take a long time to put all the units back together; the previous separation of Asine-numbers severely prolonged the bone recording time. Permission to loan the animal bones to Lund University was granted in 2013. During the bone recording, they were stored in the facilities of the Osteological Laboratory at the Department of Archaeology and Ancient History, Lund University. The osteological reference collection in the Laboratory has been used for the bone recording.

The more recent campaigns did not focus on the Lower Town, but on other areas of Asine: the Barbouna Hill, including the Levendis, Samaras, and Karmaniola sectors. I have not studied the bones from the Karmaniola sector; they are therefore not included in the catalogue. The osteological examination of the animal bones from the later Swedish excavations at Asine did not suffer from separation of contexts, as described above. Other issues concern these bones. The lack of reference specimens has been problematic, and can partly explain the lower degree of identification in the Barbouna sub-assemblage (Fig. 14).

The structure of the catalogue

Nine variables were selected for the bone catalogue. These are unit, taxon, element, side, NSP, weight, measurements. These variables were chosen because they are the most basic categories, which would be vital for any query of the bone catalogue. The variables the following:

Unit no*:* This is my own code for each bone assemblage or find unit.

Taxon: The lowest taxonomic resolution is kingdom, and the highest is species. Otherwise, information on size-classes and indeterminate fragments is given here.

Elements and **Parts**: Anatomical information. In 'Elements' the skeletal element is described, while 'Parts' is used for anatomical orientation or specific skeletal markers.

Side: 'Dex' (Lat. *dexter*) equals right side, while 'sin' (Lat. *sinister*) equals the left side. For unknown side 'indet', short for indeterminate is used. 'Ant' (anterior) and 'post' (posterior) is used for phalanges which are nearly impossible to side, but can be oriented as hind or front. 'Uni' stands for unilateral, and was sometimes written during the recording of unilateral elements, such as vertebrae.

NSP: NSP stands for Number of Specimen. NSP was chosen instead of NISP as the heading since not all specimens are identified.

Weight (g): Each specimen has been weighted.

Measurements: Information on any taken measurements. Measurements follow the von den Driesch (1976) standard.

Remarks: This column includes remarks on e.g. sampling for radiocarbon dating

Information on age, sex, pathologies, and taphonomy is not included, but they are recorded. Any researcher interested in this can contact the author of the catalogue. If the Asine-number och the unit number is included in his/her query, it will simplify the process.

Appendix 3: Results of radiocarbon-analysis on animal bones from Asine

Ancient Asine is special because of its long continuity, from at least the Early Helladic to final abandonment in Late Antiquity. This is attested to by means of traditional relative chronological methods, mainly based on ceramic and architectural typology. In this thesis, it has been important to make contextual assessments, meaning to temporally and spatially define contexts. By retrieving absolute dates on specific layers and features, the contextual assessments of the old excavation have been tested. In this appendix, the results from the radiocarbon analyses are presented.

Table 8 presents data on the bones sampled for ^{14}C-analysis, including uncalibrated ^{14}C-dates. All ^{14}C-dates were, when needed, calibrated with Oxcal version 4.2 (Bronk Ramsey 2001: 2009), using IntCal 13 atmospheric curve (Reimer *et al.* 2013). The radiocarbon analyses of Asine samples were made in the Radiocarbon Dating Laboratory, Geological Department at Lund University. Within this project, a total of 53 samples were analyzed, of which one proved unsuccessful. Most dates belong to the Early to late Middle Helladic, as well as Sub-Mycenaean and Proto-Geometric. This is not surprising, since this thesis is focused on the Bronze Age, i.e. the selection of samples was focused on improving the chronological resolution of Bronze Age Asine. Many samples are from *bothroi*. Most other dates have been used to verify stratigraphic relationships at the site. Such relationships have been reconstructed from the documentation, especially the field journals, discussed in Section 3.1.1. In most cases the stratigraphic and typological assessments are confirmed by absolute dates.

Five samples were taken from animal bones from the Barbouna Hill, excavated during the 1970s. These samples provide a basis for the re-assessments of some of the excavated features. The infills of drains A72.36 and A73.82 should be dated to Proto-Geometric, according to the absolute dates (LuS-no 11048, 11051, Table 8). This is also the case with AS 1305 (from which two samples were taken), which has been thought to be mostly Middle Helladic in composition.

Table 8.
List of bone samples from Asine dated by means of radiocarbon-analysis.

LuS no	Asine-no /Find no	Box no	Context	Sampled bone	Acquired 14C-date (uncal. BP)
10927	2262	271	*Bothros* 1	*Bos taurus*, metatarsale III+IV	3725 ± 40
10928	5127	272	*Bothros* 11	*Bos taurus*, radius	3670 ± 40
10929	5115	273	*Bothros* 11	*Bos taurus*, astragalus	3655 ± 40
10930	5196	241	*Bothros* 7	Caprinae/Cervidae, radius	3625 ± 35
10931	2294	272	*Bothros* 13	*Cervus elaphus*, Phalanx I	3700 ± 40
10932	5171	272	*Bothros* 13	*Sus domesticus*, metatarsale IV	3595 ± 45
10933	5242	273	*Bothros* 14	*Bos taurus*, Radius	3660 ± 40
10934	5168	272	*Bothros* 1	*Bos taurus*, os zygomaticum	3655 ± 45
10935	4659	254	*Bothros* 2	*Sus domesticus*, radius	3715 ± 40
10936	4523	269	*Bothros* 2	*Capra hircus*, humerus	3655 ± 45
10937	2402	272	*Bothros* 3	*Cervus elaphus*, calcaneus	2835 ± 45
10938	5201	261	*Bothros* 4	*Bos taurus*, radius	3935 ± 45
10939	2307	261	*Bothros* 4	*Bos/Cervus*, costa	3690 ± 40
10940	4851	274	*Bothros* 8	*Sus domesticus*, humerus	3700 ± 45
10941	4655	264	*Bothros* 9	*Sus domesticus*, tibia	3680 ± 40
10942	2237	272	*Bothros* 21	*Sus domesticus*, scapula	4135 ± 45
11047	89/5438:2	AB.9	Cultural layer	*Bos/Cervus*, costa	2835 ± 35
11048	74/819:1	AB.2	Drain A73.82, Fill	*Bos taurus*, dens	2780 ± 40
11049	73/191:8	AB.1	Room C, Floor CII	*Bos taurus*, metacarpale III&IV	no results
11050	74/728:2	AB.4aII	Room F, Floor 2	*Sus domesticus*, scapula	3225 ± 50
11051	73/183:1	AB.1	Drain A 72.36, Fill	*Sus domesticus*, humerus	2730 ± 50
11521	?		Grave	*Homo sapiens*. Pars petrosa	2795±35
11522	2778		Grave	*Homo sapiens*. Pars petrosa	3400±35
11523	4484		Grave	*Homo sapiens*. Costa	3460±35
11524	3346	150	Grave	*Sus domesticus*, costa	3545±35
11525	4150	227	Grave	*Bos taurus*, humerus	2925±40
11526	4540	265	Cultural layer	*Sus domesticus*, costa	3960±40
11527	4540	265	Cultural layer	*Bos taurus*, humerus	3925±40
11528	4615	268	*Bothros* 15	*Sus domesticus*, humerus	3730±35
11529	4512	285	*Bothros* 15	*Ovis aries/Capra hircus*, ilium	3700±35
11530	2856	283	*Bothros* 15	*Bos taurus*, phalanx 1	3710±35
11531	1305	12	Cultural layer	*Ovis aries/Capra hircus*, radius	1615±35
11532	1305	12	Cultural layer	*Bos taurus*, femur	1630±40
11533	4298	179	Cultural layer	*Bos taurus*, ulna	3730±40
11534	4298	179	Cultural layer	*Bos taurus*, phalanx 2	3685±45
11535	3566	169	Cultural layer	*Sus domesticus*, scapula	3360±40
11536	3566	169	Cultural layer	*Bos taurus*, phalanx 1	3300±40
11537	3341	176	Cultural layer	*Ovis aries/Capra hircus*, scapula	3550±50
11538	3341	176	Cultural layer	*Sus domesticus*, humerus	3560±50
11539	4261	147	Cultural layer	Large mammal, long bone fragment	3410±45
11540	4261	147	Cultural layer	*Bos taurus*, phalanx 1	3340±45
11541	4220	163	Cultural layer	*Bos taurus*, metacarpale III & IV	3525±50
11542	4220	163	Cultural layer	*Bos/Cervus*, vertebra lumb.	3365±55

11543	4357	135	Cultural layer	*Ovis aries/Capra hircus*, metatarsale III&IV,	2950±45
11544	3863	226	Cultural layer	*Bos taurus*, metacarpale III & IV	2885±45
11545	3863	226	Cultural layer	*Bos taurus*, Dens	2920±35
11546	3651	214	Cultural layer	*Bos taurus*, mandibula	2845±35
11547	3992	178	Cultural layer	*Sus domesticus*, humerus	2210±35
11548	2402	272	*Bothros* 3	*Ovis aries/Capra hircus*, tibia	3725±35
11549	4061	231	Cultural layer	*Bos taurus*, ulna	2605±35
11550	2514	136	House Pre-D, floor	*Bos taurus*, humerus	3650±45
11551	2514	136	House Pre-D, floor	*Ovis aries/Capra hircus*, humerus	3645±35
11974	4187	159	Cultural layer	*Gallus gallus domesticus*, tarsometatarsus	1540±35

Appendix 4: Typical examples of taphonomic markers in the Asine assemblage

In this appendix, typical examples of certain taphonomic variables, gnawing, trampling, weathering, root etching, post-depositional erosion, and recent breakage are presented. If no typological date has been assigned the AS-number the specimen belongs to, no date is given. All photographs and illustrations were made by the author during 2016.

Figure 15.
Example of carnivore pitting. Right radius of sheep/goat from AS 2194 (MH I-II), Asine

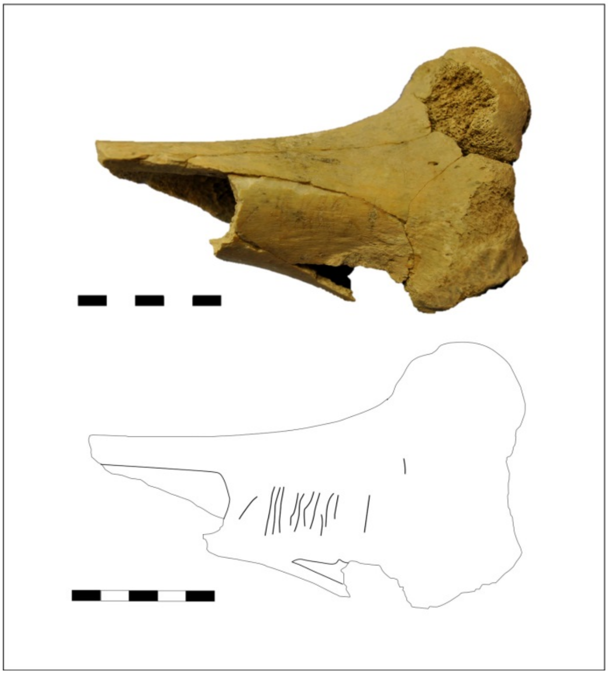

Figure 16
Example of carnivore tooth scratches. Left femur of cattle from AS 5299 (Mixed context), Asine

Figure 17.
Example of carnivore tooth scratches and bone destruction. Right mandible of pig from AS 2759 (MH I-II), Asine

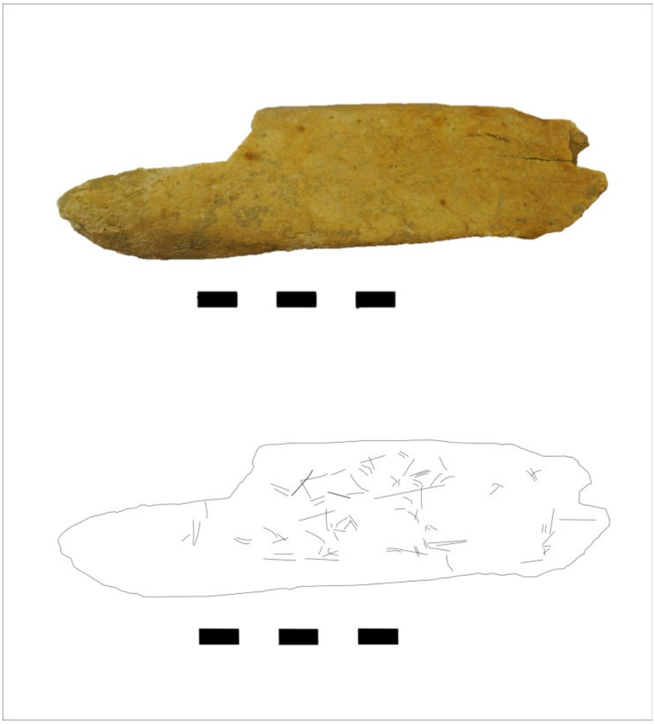

Figure 18.
Example of trampling. Long bone splinter of unspecified large-sized mammal from AS 4343, Asine.

Figure 19.
Example of weathering, Behrenmeyer's stage 1. Left mandible (angulus) of pig from AS 3020 (MH III-LH I), Asine (see Madgwick & Mulville 2013: Fig. 2).

Figure 20.
Example of mineral encrustation. Note that the bones are almost completely covered by crusts. Right mandible of sheep/goat (left) and right mandible of pig (right) from AS 5250, Asine

Figure 21.
Example of destruction from the excavation or after. Right metacarpus III+IV of cattle from AS 3447 (MH III-LH I), Asine

Figure 22.
Example of fungal growth, probably from the storage period. It could have been caused by insufficient drying. Bovid incisor from AS 3348, Asine

Appendix 5: Quantitative distribution of antler fragments

Table 9.
Quantitative distribution of antler fragments versus cranial and postcranial bones from deer at Bronze Age Asine.

	EH (n=47)		EH III-MH I (n=48)		MH I-II (n=68)		MH III-LH I (n= 43)		LH I-II (n=6)		LH IIB-IIIB (n= 94)		LH IIIC (n=125)	
	Antler	Bone	Antler	Bone	Antler	Bone	Antler	Bone	Antler	Bone	Antler	Bone	Antler	Bone
Red deer (*Cervus elaphus*)	19	16	8	34	14	37	16	22	1	5	6	61	6	86
Fallow deer (*Dama dama*)	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Roe deer (*Capreolus capreolus*)	0	0	0	0	0	1	0	1	0	0	0	2	0	0
Deer indet. (*Cervidae*)	10	2	4	2	2	13	3	1	0	0	26	1	27	6
Total	29	18	12	36	16	52	19	24	1	5	32	64	33	92

Table 10.
Differences between the total NISP-count including respectively excluding antler fragments in red deer (*Cervus elaphus*).

	EH	EH III-MH I	MH I-II	MH III-LH I	LH I-II	LH IIB-IIIB	LH IIIC
TotalNISP	35	42	51	38	6	67	92
TotalNISP excl.antler fragments	16	34	37	22	5	61	86
Difference between including and excluding antler fragments in totalNISP per period χ2 = 6.81 df = 6 p = 0.339							

Table 11.
Differences between the total NISP-count including respectively excluding antler fragments in indeterminate deer (Cervidae).

	EH	EH III-MH I	MH I-II	MH III-LH I	LH I-II	LH IIB-IIIB	LH IIIC
TotalNISP	12	6	15	4	0	27	33
TotalNISP excl. antler fragments	2	2	2	1	0	1	6
Difference between including and excluding antler fragments in totalNISP per period χ2 = 3.76 df = 5 p = 0.585							

Table 12.
Differences between the total NISP-count including respectively excluding antler fragments in red deer (*Cervus elaphus*) and indeterminate deer (Cervidae). No antlers belonging to roe deer and fallow deer were found.

	EH	EH III-MH I	MH I-II	MH III-LH I	LH I-II	LH IIB-IIIB	LH IIIC
TotalNISP	47	48	68	43	6	94	125
TotalNISP excl. antler fragments	18	36	52	24	5	62	92
Difference between including and excluding antler fragments in totalNISP per period χ2 = 6.08 df = 6 p = 0.414							

Appendix 6: Anatomical distributions of sheep/goat, pig and cattle

The following anatomical categories have been used: *Horn (*horn core), *Cranial* (skull fragments), *Mandible*, *Loose teeth, Vertebrae, Ribs*, *Upper front* (humerus, scapula, radius and ulna), *Lower front* (carpal and metacarpal), *Pelvic region (pelvis and sacrum), Upper hind* (femur, patella, tibia, fibula), *Lower hind* (tarsal and metatarsal bone), and *Mp + ph indet* (metapodials, sesamoids, and phalanges indeterminate to anatomical orientation).

Table 13.
Anatomical distributions of bones from sheep/goat (*Ovis aries/Capra hircus*) (n=1 401)during the Bronze Age, Asine.

	EH (n=100)	EH III-MH I (n=220)	MH I-II (n=361)	MH III-LH I (n=196)	LH I-IIB (n=158)	LH IIB-IIIB (n=188)	LH IIIC (n=164)	Total
Horn	4	18	18	1	3	1	6	51
Cranial	5	23	24	15	8	5	8	102
Mandible	14	23	28	38	19	17	14	153
Loose teeth	14	27	61	38	72	53	24	289
Vertebrae	0	5	21	6	3	5	3	43
Ribs	1	4	8	6	0	6	9	34
Upper front	27	59	91	42	21	39	48	327
Lower front	5	13	15	8	4	8	12	65
Pelvic region	3	8	15	7	2	5	10	50
Upper hind	21	14	33	19	9	27	16	139
Lower Hind	3	19	33	8	8	9	10	90
Mp+ph indet.	3	7	14	8	9	13	4	58
Total	100	220	361	196	158	188	164	1 401
Total excl. loose teeth	86	193	300	158	86	135	140	1 112

Difference between including and excluding loose teeth in totalNISP per period
$\chi 2 = 10.9$
df = 6
p = 0.091

Table 14.
Anatomical distributions of bones from pig (*Sus domesticus*) (n=1 231) during the Bronze Age, Asine.

	EH (n=96)	EH III-MH I (n=280)	MH I-II (n=425)	MH III-LH I (n=137)	LH I-IIB (n=102)	LH IIB-IIB (n=120)	LH IIIC (n=71)	Total
Cranial	27	58	74	20	16	16	17	228
Mandible	10	47	85	31	14	14	14	215
Loose teeth	11	33	40	14	11	7	2	118
Vertebrae	3	17	19	7	2	12	3	63
Ribs	2	8	17	8	1	12	1	49
Upper front	17	61	96	31	31	31	21	288
Lower front	1	5	12	1	3	4	3	29
Pelvic region	7	18	24	8	1	5	3	66
Upper hind	10	21	28	11	10	11	5	96
Lower Hind	3	11	21	4	7	6	2	54
Mp+ph indet.	5	1	9	2	6	2	0	25
Total	96	280	425	137	102	120	71	1 231
Total excl. loose teeth	85	247	385	126	91	113	69	1 117

Difference between including and excluding loose teeth in totalNISP per period
$\chi2 = 0.402$
df = 6
$p = 0.999$

Table 15.
Anatomical distributions of bones from cattle (*Bos taurus*) (n=996), during the Bronze Age, Asine.

	EH (n=93)	EH III-MH I (n=204)	MH I-II (n=266)	MH III-LH I (n=95)	LH I-IIB (n=78)	LH IIB-IIB (n=93)	LH IIIC (n=150)	Total
Horn	3	4	14	5	3	1	2	32
Cranial	8	19	21	7	6	6	20	102
Mandible	6	18	31	4	10	7	15	89
Loose teeth	9	15	23	20	15	19	16	117
Vertebrae	9	14	18	2	1	4	10	58
Ribs	4	1	4	2	0	3	4	18
Upper front	17	44	39	13	14	9	20	157
Lower front	6	9	12	8	4	10	1	50
Pelvic region	3	12	17	2	1	0	6	41
Upper hind	4	11	23	4	4	7	14	68
Lower Hind	6	29	31	14	11	13	27	133
Mp+ph indet.	18	28	33	14	9	14	15	131
Total	93	204	266	95	78	93	150	996
Total excl. loose teeth	84	189	243	75	63	74	134	865

Difference between including and excluding loose teeth in totalNISP per period
$\chi 2 = 1.65$
df = 6
p = 0.949

Paper I

Mediterranean Archaeology and Archaeometry, Vol. 17, No 2, (2017), pp. 159-174

DOI: 10.5281/zenodo.824731

CENTRALIZATION AT ASINE DURING THE BRONZE AGE FROM A ZOOARCHAEOLOGICAL PERSPECTIVE

Stella Macheridis

Department of Archaeology and Ancient History, Lund University, Sweden
(stella.macheridis@ark.lu.se)

Received: 02/03/2017
Accepted: 27/06/2017

ABSTRACT

From at least the Late Neolithic through the end of the Bronze Age and onwards, people continued to inhabit the settlement of Asine. For this reason, the site makes an interesting starting point for discussing long term change. This short paper presents new data on the animal bones from Bronze Age Asine. The data set is used for a zooarchaeological discussion of the site from a diachronic perspective in terms of centralization and regional change. This has not been attempted previously. Zooarchaeological patterns from urban or central sites in other parts of the world are compiled as a framework for this purpose. The focus is on patterns of relative taxonomic abundances, anatomical distribution, mortality curves and sex distributions of cattle, sheep/goat and pigs. These are examined specifically for the animal bone assemblage from Bronze Age Asine. Differences and/or similarities with the general trends indicative of centralization are discussed for the study site. The results show that the Early Helladic Asine should be seen as a smaller rural site. The even relative abundances of cattle, sheep, goat and pigs indicate that the animal management was not specialized but rather mixed, pointing the site was relatively independent in terms of animal management. The increase in sheep/goat during the Middle Helladic indicates an increasing dependency on animals yielding secondary products, symptomatic of regional and centralized organization. This supports the archaeological evidence of the site, indicating that it was an important village to its immediate valley during this period. This function persisted during the Late Bronze Age. From a zooarchaeological perspective, it is not likely that Asine was a regional center. Some degree of sustainable animal management was probably existent near or at the site. I propose that Asine should be seen as an intermediary key site in the communication system as well as for the exchange of animals.

KEYWORDS: Asine, Aegean Bronze Age, Zooarchaeology, Centralization, Regional change, Animal management

1. INTRODUCTION

On a peninsular cliff-and-bay-site in the region of Argolis, we find the prehistoric settlement of Asine. Here the habitation was more or less continuous from at least the Early Helladic (EH, ca. 3100-2100 BC), to the 8th century BC (Frödin & Persson, 1938; Hägg & Hägg, 1973; Wells, 1983; Nordquist, 1987; Figure 1). Because of its long continuity, Asine makes a good case for studying general patterns of change from a long-term perspective.

This paper aims to investigate Bronze Age Asine in terms of centralization, a concept including discussions regarding independence vs dependence on the surrounding area or local resources and regional organization. Because Asine was important for its immediate surrounding valley area in at least the Middle Helladic period (MH, 2100-1600 BC) (Nordquist, 1987), any changes in the local economy should be reflected in the archaeological record of the settlement. Are there any zooarchaeological indications of centralization at Asine during the Bronze Age? Asine has not been the focus of research from a zooarchaeological diachronic perspective, making this study even more relevant for the site and for the Argolis region.

Zooarchaeological perspectives on centralization during the Bronze Age in mainland Greece are needed. In order to expand this type of research a comparative approach is required. By pinpointing zooarchaeological patterns occurring at other central and/or urban sites a theoretical frame can be set up, which can be tested on a data set. In order to do so, a schematic review on zooarchaeological studies from early urban sites is presented. This schematic functions as a model for the process of centralization in this study.

2. ZOOARCHAEOLOGICAL PATTERNS OF CENTRALIZATION

Centralization is a process which concentrates interaction, decision-making and power within a specific group or location (e.g. Nakoinz 2012: 219; Joyce & Barber 2015: 820). Urbanization is a contextual concept where signs of growing dependency on surrounding farms indicate that the settlement is growing in importance regionally. This is due to the gathering of people who specialize in not only subsistence but also economic, administrative and/or religious aspects of the society. These settlements affect a larger hinterland (Smith 2007: 4; see Mogren 2013). While centralized environments often are characterized by the influence and dependence of the hinterland, such settlements are not necessarily characterized by urbanization in terms of the gathering of people. For example, political centres might not be characterized by the gathering of people, but rather as the location for the concentration of political authority.

In the present study, the focus is on relative taxonomic abundance, skeletal part frequencies, and mortality curves and sex distributions. These categories often form the basis of zooarchaeological studies of centralization or urbanization processes (e.g. Ekman 1973; Zeder 1991; Wapnish & Hesse, 1988; Vretemark 1997; Magnell 2009; Allentuck & Greenfield 2010; Redding 2010; cf. deFrance 2009). The data derive from sheep/goat, pig and cattle, because they are most abundant in number, and more prone to provide statistically significant counts.

In order to provide the frames for the study, I review examples from foremost urban environments, summarized in Table 1. Table 1 is not intended to be a formulation of a set of correlates. It is important to remember that complementary local data and trends are needed, since the effects of socio-economic processes regarding animal management and production differ geographically and temporally (deFrance, 2009).

2.1. *Relative taxonomic abundances*

Relative taxonomic abundances are basic ingredients of almost any zooarchaeological study, and can give important information about the animal consumption, management and production at a site.

Halstead (1996) connects the dominance by one species to a large scale specialization in animal management. An increase of sheep/goats in urban environments has been interpreted as the intensification of stock-keeping for centralized provision, import/export systems, and surplus (Zeder, 1991; Allentuck & Greenfield, 2010; deFrance, 2009; Table 1). The decrease of pig seems in some areas be symptomatic of the above as well. Since the pig is mainly a meat and fat animal, they are not as valuable for producing surplus (e.g. Ekman, 1973; Redding, 1991; Zeder, 1998). This was discussed by Zeder (1998) in her study of the decrease of pig in the Ancient Near East, which was linked to the eventual prohibition of the animal. The presence of pig that still occurred might be indicative of domestic production, i.e. at a household level (Redding, 1991). Similarly, a decrease in pig abundance at some Mediterranean sites, e.g. Cypriote LBA sites, has been demonstrated. In this area, the decrease in pigs is ascribed to deforestation, i.e. larger grazing areas, and improved agricultural technology, which made the keeping of bovids advantageous (Schwartz, 1974; Ekman, 1977; cf. Macheridis, 2011).

A decrease in pigs is often indicative of urban environments, explained by the increased import of sheep/goat and cattle from surrounding rural communities to support the population within the city walls (e.g. Vretemark, 1997; Magnell, 2009). This bovid/pig opposition is not universal and is not always 'positive' for the sheep/goats, as in the above examples. In the early stages of urbanism, the keeping of pigs could have been the easiest solution for generating meat for a larger amount of people. This has been noted for a number of Swedish as well as German Early Medieval towns (Vretemark, 1997; Benecke, 1994). Even if extensive large-scale pig husbandry seemingly decreased with time in Scandinavian towns, the keeping of pigs might have been an important part of urban household strategies. Since they are relatively easy to keep and feed, and can have a fast growth curve, it has been suggested that it was the most important type of urban animal husbandry until the 18th century (Szabó, 1970).

Table 1 Schematic overview of zooarchaeological patterns from central or urban sites

Variables	**Zooarchaeological trends in urban environments**		**Explanations**	**References**
	General	*Specific*		
Bovines and caprines	Increase		Intensification of stock-keeping for centralized provisioning, import/export systematization (in comparison to rural sites) and surplus of secondary products	Ekman, 1973; Vretemark, 1997; 2001; Magnell, 2009; Zeder, 1991; deFrance, 2009:115; Allentuck & Greenfield, 2010
	Specific age and sex patterns, beyond seasonal and pastoral need	Older culling ages; Older milk cows/draught oxen	Prime-age animals imported, local non-elite consumption of older animals	Wattenmaker, 1994
			Import of animals from surrounding farms/villages	Ekman, 1973; Vretemark, 1997; 2001; Magnell, 2009; Redding, 2013
Pigs	Decrease		Effect of demand of cattle due to agricultural intensification	Szabo, 1970; Ekman, 1973; Vretemark, 1997; 2001; Magnell, 2009; Redding, 1991; Zeder, 1998
		Increase within households	Not generating surplus of renewable kind needed for redistributive societies and large-scale husbandry, not as easily managed in closed space. Suitable for domestic rearing	
Anatomical distributions	end-products and consumption	Uneven distribution	Dependent on meat provision from imported animals	Zeder, 1991; Wapnish & Hesse, 1988
			Selective distribution of body parts and standardization of butchery	Zeder, 1991; Allentuck & Greenfield, 2010:21
		Differential spatial distribution	Selection of body parts made on basis of socioeconomic status	Wapnish & Hesse, 1988; Allentuck & Greenfield, 2010:21

2.2. *Skeletal part's representation*

In her study of the early urban economies in the Near East, Zeder found body part selection and standardized butchery to be the most indicative variable in the study of urban economies and redistributive systems (Zeder, 1991).

The interpretation of body part selection is made directly from animal bone assemblages, while animal husbandry is perhaps a more indirect measure (ibid., 1991). As a contrast, an even anatomical representation is often used as a sign of slaughter and butchery on-site, and not of the distribution of meat or provision from elsewhere. Before any interpretation, it is important to consider the matter from a taphonomic perspective. The most famous example of this discussion is the equifinality of patterns where compact long bones dominate (e.g. Binford, 1978; Lyman, 1994; 2004; Marciniak, 2005; Orton, 2012). It is thus important to discuss whether a cultural selection is the most probable explanation or whether such a pattern is due to post-depositional processes.

If an uneven anatomical distribution, such as a focus on the meaty long bones, is present within a sample, and is culturally derived, it can be interpreted in different terms than centralization. For example, it can be thought of as remains of consumption restricted to these body parts, while the slaughter waste has been disposed of elsewhere in the settlement. In order to discuss uneven anatomical representations as indicative of regional distribution of standardized meat portions, i.e. that the animal carcass was cut up and specific body parts selected prior to entering the settlement, other strands of evidence must also be considered, such as contextual information from the site.

Samples selected from a mixture of primary deposits could disturb general tendencies by instances of special depositions. For example, if the samples only derive from specific infills it cannot be guaranteed to accurately describe tendencies, such as the general patterns of body parts representation. For this purpose, samples from secondary or tertiary material could instead be more suitable, as they are more likely to represent average everyday-life activities (Fuller *et al.*, 2014: 181).

2.3. *Mortality curves and sex distributions*

The selection of specific ages seems to be a universal pattern indicating centralization or urbanization.

From non-elite dwellings at Kurban Höyük, Wattenmaker (1994) suggests the lack of 2-3 year-old caprines to be a sign of export of prime-age animals for meat purposes, while the older are eaten locally, perhaps part of a state-controlled system. At the Worker's Town at Giza, the large set of faunal remains is dominated by young male cattle and sheep/goat, taken as signs of import and not self-supported subsistence (Redding, 2010). The faunal remains from the EBA urban center Titris Höyük show an even skeletal element representation together with specific culling ages, which are interpreted by Allentuck and Greenfield (2010) as a sign that the animals were brought alive and then butchered, and also perhaps raised on site, i.e. that it was a consuming site. Later culling ages in slaughter frequencies of foremost cattle have been observed in urban environments (Vretemark, 1997; Magnell, 2009; deFrance, 2009). This particular pattern is seen, for example, in assemblages from Medieval Scandinavia, such as Skara (Vretemark, 1997), Kungahälla (Vretemark, 2001) and Lund (Ekman, 1973). In this region, it is often interpreted as the result of import or tax incantation.

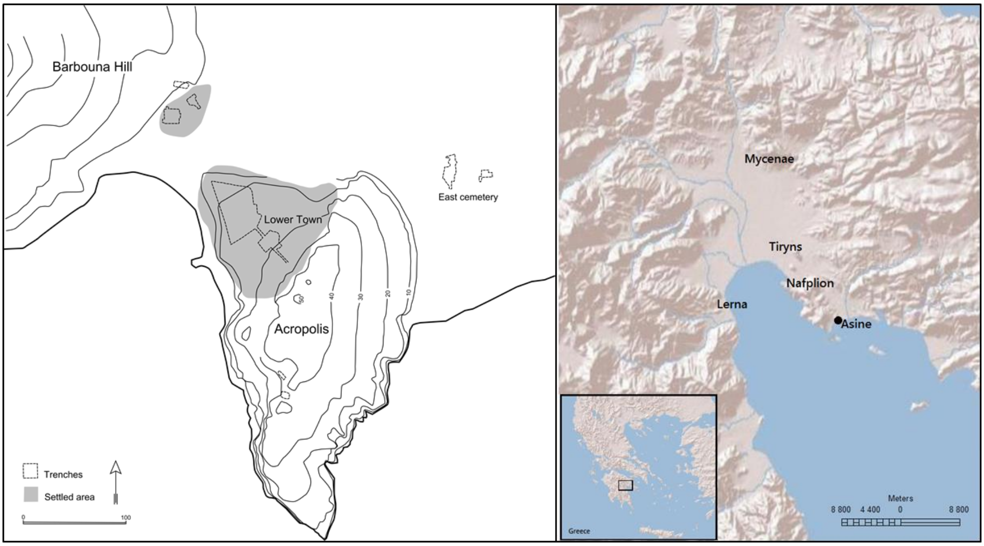

Figure 1 Map of Asine and Argolis. Right: the region Argolis with mentioned sites; Left: the excavation areas of Asine. Figure reproduced from Macheridis (2017) with permission.

3. ASINE DURING THE BRONZE AGE

Urbanization in Aegean Bronze Age societies has been the focus of debate and discussion (e.g. Branigan, 2001). According to Bintliff (1997), waves of urbanism are not evidenced in Greece until the Late Archaic, even if he later argued for towns and early state formation processes in the Middle and Late Bronze Ages of Greece (Bintliff, 2012). Asine was not a key site during these periods, but rather a village central to its immediate surrounding valley and the sites within (Nordquist, 1987). Further, as the settlement was coastally located, it is also possible that it had a harbour function, which would also have made Asine an important settlement in the region during this period. If the above is true, the faunal remains should nevertheless yield patterns indicative of centralization.

The Swedish excavations of Asine started with the initial project 1922-1930 (Frödin & Persson, 1938), and were followed by several campaigns in the 1970s (Hägg & Hägg, 1973; Hägg & Fossey, 1980;

Hägg & Nordquist, 1992). There is evidence of a smaller Early Helladic (EH, 3100-2100 BC) settlement. This continued in the EH III-MH I (ca. 2200-1900 BC), which is characterized, among other things, by its *bothroi*, a type of pit often found on EH sites (Strasser, 1999; Macheridis, 2016). The first real expansion of Asine was during the Middle Helladic (2100-1700 BC). As indicated by its architectural remains, diverse material as well as inclusion of differentiated grave goods and cemeteries (Nordquist, 1987), MH Asine could have had a central function for the immediate valley. The settlement expanded to the Barbouna Hill during the late part of the period (Figure 1). This area was reused as a cemetery during the Late Helladic (LH, 1700-1050 BC) (Nordquist, 1987; Ingvarsson-Sundström et al., 2013).

There are several signs of increasing social complexity in the MH III-LH I period (ca. 1800-1600 BC). The mortuary evidence, with graves from different burial areas, is different in, among other things, grave morphology and in number of grave goods (e.g. Nordquist, 1987: 101; Voutsaki et al., 2011; Ingvarsson-Sundström et al., 2013). This development continues to the LH. For example, the pottery of the LH settlement has been interpreted as modest; yet the chamber tomb collection of Asine is amongst the most numerous and "wealthy" in the region (Gillis, 1996). Judging by the graves and architectural remains as well as material culture, we have a rather complex social situation represented on a small area during these periods, compared to other sites such as Mycenae.

4. THE ANIMAL BONES FROM BRONZE AGE ASINE

Previous studies on the animal bones from Asine have only partly been published (Moberg Nilsson, 1996; Macheridis, 2016; 2017). The zooarchaeological data in this study derives from a re-examination of the animal bones from the excavations of the Lower Town 1926 and the Barbouna campaigns 1970-1974 and 1989.

4.1. *Sample selection*

Of the 6129 identifiable animal bone fragments from Bronze Age Asine, this paper focuses on the bones from sheep/goat (1833 bones), pig (1701 bones) and cattle (1264 bones). These animals constitute the majority, 4798 bones (ca. 78%), of the animal bones from the site. As visible in Table 1, these animals are often central in the discussion of zooarchaeological patterns of centralization. Further, the material from Asine was mostly hand-collected, which means that smaller bones from birds and fishes are most likely under-represented (Mylona, 2003). Because of this, a focus on smaller animals would probably be biased and is therefore excluded as a variable in this paper. Still, smaller bones, such as carpals and tarsals from medium-sized animals, could also be under-represented because of the lack of systematic sieving (Davis, 1987: 29).

The animal bones derive from mainly secondary, and even tertiary, deposits, meaning that they reflect redeposited waste materials from the site. Primary deposits, such as pit infills, are excluded. Thus, the animal bones from Asine reflect general tendencies rather than contextual variations as specific patterns of consumption (see section 2.2).

An exception from this is the bones from EH III-MH I, most of which derive from so called *bothroi*-pits. These are primary deposits, i.e. the animal bone waste that was thrown in the pits was produced nearby (Schiffer, 1987). It has been acknowledged that these features are probably closely connected to the houses and households at the site (Macheridis, 2016). Thus, the content of the *bothroi* might not be representative of the general EH III-MH I. However, a chi-square test of significance ($\chi 2$ = 0.480, df = 2, p=>0.05) showed that excluding animal bones from the *bothroi* did not produce any differences statistically, which is why they are included in this paper.

4.2. *Zooarchaeological methods*

In this study, the Number of Identified Specimens (NISP) is used as quantification, instead of secondary measures such as Minimum Number of Individuals (MNI). This depends mainly on the potential problem of 'interaggregate interdependence' when using MNI (Lyman 2008: 58). In short, MNI is a secondary measure and will be different, depending on the level of contextual resolution. The NISP-count remains the same whether based on single units or the whole assemblage. Further, research has shown that MNI-counts can be predicted using NISP, which is why the former is here considered redundant (Grayson & Frey 2004). Although NISP is problematic because, amongst other things, increased fragmentation increases NISP, it is nevertheless considered more suitable than MNI, given the above-mentioned issue.

Postcranial data have been used for age assessments (see section 4.5). Fusion status and recording follow Silver (1969), Habermehl (1961), and Vretemark (1997).

4.3. *Relative taxonomic abundances*

The relative abundances of cattle, sheep/goat and pig during the Bronze Age are illustrated in Figure 2. The results of a chi-square test indicate that the species compositions were different through time ($\chi 2$ = 98.5, df = 8, p=<0.05).

During the EH, it seems that a mixed herd strategy existed: all animals contributed 32-35% to Figure 2. The ratio between sheep and goats is relatively even, 1:1.6, supporting this scenario. An increase in pigs is visible during the EH III-MH I period. This could perhaps indicate that the settlement became more independent in terms of production and more isolated from other sites in the region. This was argued by Fillios (2006) regarding the over-representation of pig bones in the late EH Helike.

The EH III-MH I sheep:goat ratio, 1:2.6, shows that goats might have been more common, but this difference evens out in the MH period (1:1.3). A decrease of pig is visible during the Middle Helladic and into the early Late Helladic period (Figure 2). This coincided with an increase in sheep/goats. This general change has also been noted by Ingvarsson-Sundström et al. (2013). Perhaps the decrease in pigs can be connected to the growing social dynamics associated with the MH III-LH I. As discussed in section 2.1, the decrease in pigs and increase in sheep/goats is often associated with a regional change, in which the demand for a surplus of secondary products leads to an intensification of stock-keeping of ovicaprines (see Table 1). The regional changes during this period, as visible in e.g. the wealthy Shaft graves of Mycenae, are often seen as the prequel to the creation Mycenaean cultural complex later on. It is possible that already during this transitional period the process of centralization had begun in the region, leading to a focus on sheep/goat in animal production.

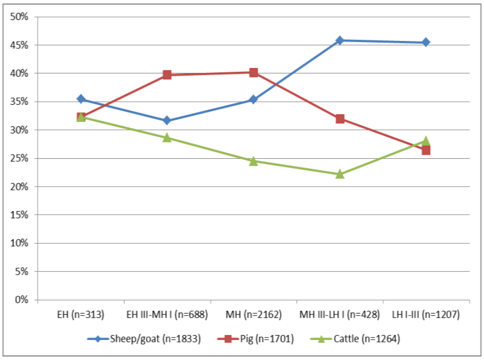

Figure 2 Relative abundances of sheep/goat, pig and cattle during the Bronze Age, Asine. Data from MH from Macheridis (2017).

Sheep increased in relation to goats (1:0.5), which changed to the LH when goats increased again (1:2.2). The LH animal management seems, however, to have been based on ovicaprines at Asine. This is consistent with the social dynamics in the region during the Mycenaean period, in which obvious central places, such as Mycenae and Tiryns, emerged. Cattle seem to diminish in importance after the EH, but then appear steady at around 25%. Still, the cattle body contains more meat in relation to the smaller animals, so the importance of cattle meat might be somewhat invisible in Figure 2 (see Gejvall, 1969).

4.4. *Skeletal parts' representation*

Anatomical distributions for sheep/goat, cattle and pig are illustrated on Figure 3. The following categories are used: *Head* (horn, skull, mandible, loose teeth), *Trunk* (vertebrae, sternum, ribs), *Upper front* (scapula, humerus, radius, ulna), *Lower front* (carpals, metacarpals), *Pelvis* (the innominate bones), *Upper hind* (femur, patella, tibia, fibula), *Lower hind* (astragalus, calcaneus, tarsal, metatarsals), and *Feet and metapodials indet.* (metapodials and phalanges).

Chi-square tests on the anatomical distributions with and without loose teeth of all three animals did not result in any statistical differences, which is why loose teeth are included. The anatomical part distributions of all three animals share some characteristics. Most of the body is represented, with an over-representation of head and upper body. The lower elements are missing, except for cattle. Since parts from the whole body are represented among all animals during the BA, this probably means that living animals or whole bodies were butchered on or close to the site (see Macheridis & Tornberg, 2011).

The under-representation of fragile bone fragments such as spongy bone as vertebrae and pelvises, as well as fragile juvenile remains, is evident. It is probable that post-depositional processes have disturbed the general character of the animal bone assemblages from Asine (Macheridis, 2017); post-depositional destruction often targets less dense bones, such as vertebrae and ribs (Lyman, 1994). The lime-rich soils of Asine have proved to preserve the fragile skeletal remains of many infants and children buried within the settlement (Ingvarsson-Sundström, 2008; see Bannert, 1973). This speaks against the assemblages as totally biased by taphonomic processes below ground.

The differences between skeletal parts' representations of sheep/goat, pig and cattle during the different periods of the Bronze Age were tested through chi square statistics. This allowed for the detection of any statistically significant patterns within each period. Non-significant results indicate that the anatomical distributions should not be used for archaeological discussion, as they are most likely random. Still, the extent of the post-depositional destruction bias warrants that the interpretation of statistically significant patterns of anatomical distributions must take this into account, as is the case below.

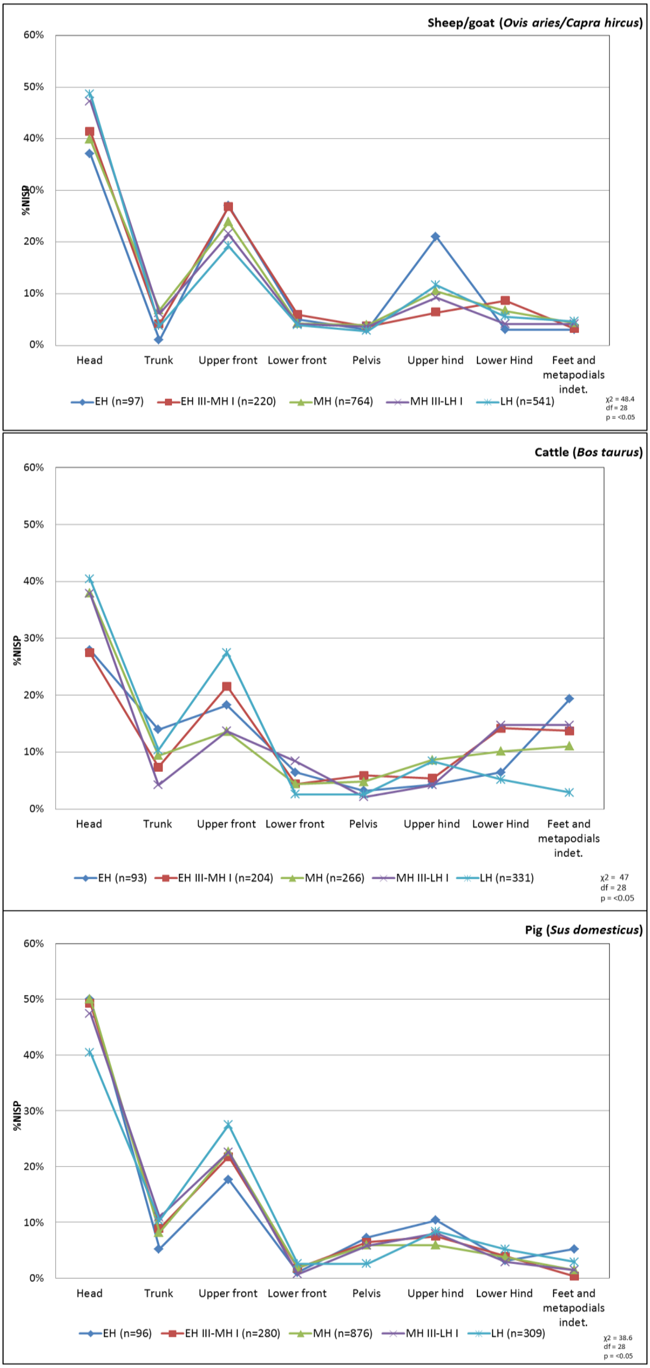

Figure 3 Skeletal part frequencies (%NISP) for sheep/goat, cattle, and pig, Bronze Age Asine

Even though the temporal differences of body parts' distributions of sheep/goat are statistically significant (Figure 3), there seems to be no major significant systemic change in carcass use. The peak of bones from the upper hind leg during the EH is unusual, but it cannot be verified, as it is based on a relatively small sample. The anatomical distributions of cattle are statistically different through time (Figure 3). The general characteristics, with relatively even frequencies of the head, upper limbs and the distal extremities, are different from the other animals (Figure 3). The head becomes gradually more abundant, while the proportion of the lower extremities and feet decreases towards the LH. This could be a consequence of chopping off the distal extremities or of skinning the carcasses before entering the settlement. If so, it would indicate that the bodies entered the village already slaughtered and perhaps butchered in larger pieces during the LH. As this can be contradicted by the presence of other parts of the body, it is hard to argue for.

The over-representation of head bones from pigs in the EH and MH is statistically significant (Figure 3). Although loose teeth are more uncommon in pigs than in the bovids, this over-representation could also be due to taphonomy, as the skull is more robust in suids. Still, the head is also meatier among pigs. The focus on heads seems to diminish after the MH period. Whether or not this reflects human selection is difficult to establish.

4.5. Mortality curves and sex distributions

The mortality curves for the three domesticates (Figure 4) are based on postcranial fusion data, since dental data was insufficient as complete mandibles were only found in a few cases. The use of such data means that juvenile and senior individuals are not well-represented. Figure 4 presents uniform curves for all animals in all Bronze Age periods.

For both sheep/goat and cattle, there is a focus on older individuals. This could be a taphonomic bias favouring adult specimens, since bone fragments from younger individuals are more fragile and smaller, and thus less prone to survive post-depositional density-mediated attrition. Individuals slaughtered at 2.5-3.5 years and above make up ca. 50-56% of the age assessed bones from sheep/goat (Figure 4). Ca. 13-17% derived from animals below the age of one year, indicating animal management in proximity of and/or connected to the site. No statistically significant difference between the mortality curves of sheep/goat could be detected (Figure 4).

Between 59-71% of the specimens from cattle were from individuals aged 3-4 years and above during all periods. Compared to other time periods, the mortality curves signal that less juvenile and young cattle were killed off during the MH and LH. This difference is statistically significant. Perhaps the herd management at Asine favoured the slaughter of predominantly old cattle. This does not explain the lack of juvenile individuals, needed to sustain the flock, in Figure 4. As mentioned above, taphonomic post-depositional erosion targeting fragile bone might explain the lack of juvenile bone fragments. Alternatively, this particular pattern could be discussed as the importation of such animals to the settlement from the surrounding farms. This was, as presented in Table 1, one of the most common zooarchaeological patterns of centralization.

The mortality patterns of pigs seem to differ (Figure 4). There is a gradual shift towards increasing culling of juvenile pigs (<12 and around 12 months). In the MH and during the transition to the LH, specimens from pigs aged one year or below make up 47%, respectively 43% of the age assessed assemblage, while this number increases to 57% in the Late Helladic. This corresponds to the general decrease in pigs through time (Figure 2). This is, however, not a statistically significant pattern, and is therefore difficult to discuss zooarchaeologically.

Table 2 includes sex assessments made on specimens from sheep/goat, cattle, and pig. The samples are small, and cannot be verified as representative. The results of Kolmogorov-Smirnov tests show that in none of the cases is the observed Dmax above the minimum Dmax, indicating that the H_0, i.e. that there is no differences between the samples, cannot be rejected (Shennan, 2007, 56-60). Sex assessed bones of sheep/goat are in general evenly distributed between males and females, although with slightly more males in the MH and LH. More males are identified in the EH sub-assemblages of cattle. Similar to sheep/goat, we can observe a peak of male specimens during the MH. Perhaps this is an indication of a focus on meat rather than milk production. There are more sex assessments of specimens of pigs.

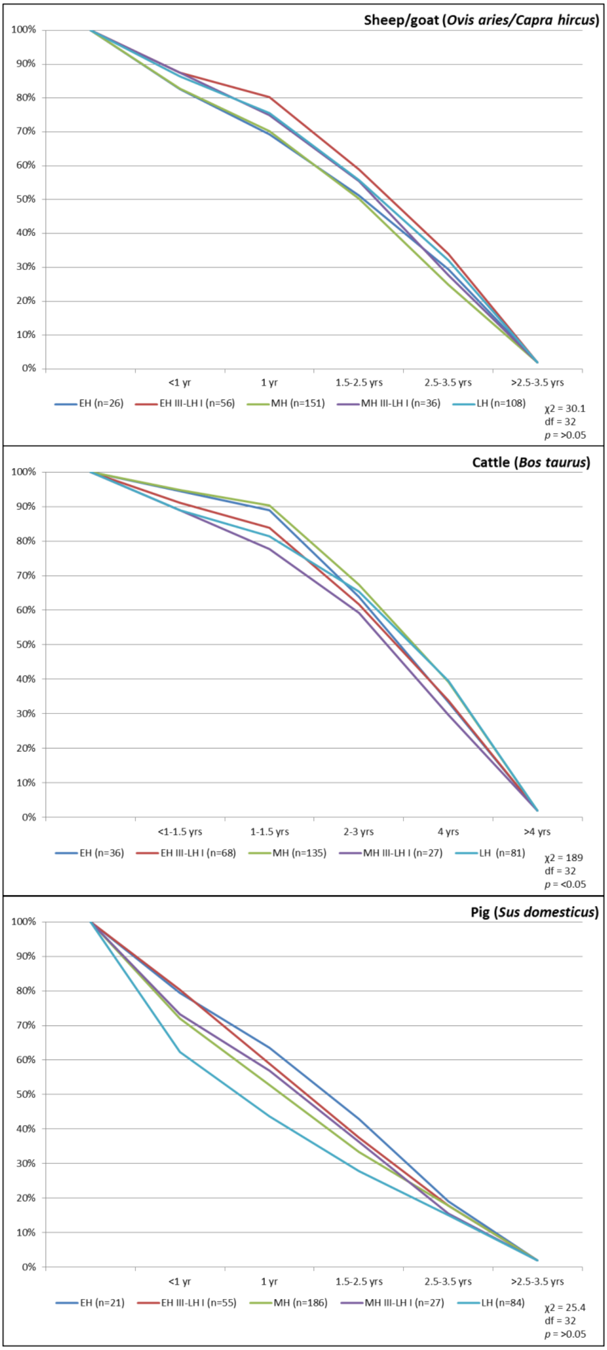

***Figure 4** Relative survivorship curves, based on epiphyseal union data (%NISP), of sheep/goat, cattle, and pig in Bronze Age Asine.*

This can be explained in taphonomic terms, since sex assessments are made on the basis of teeth, which are more resilient to post-depositional destruction than bone. There is a domination of tusks from suid males in all periods (Table 2).

Table 2 Sex assessments on bones from sheep/goat, cattle and pig from Bronze Age Asine.

	Sheep/goat		**Cattle**		**Pig**	
	Ram	*Ewe*	*Bull*	*Cow*	*Boar*	*Sow*
EH	1	1	2	0	5	0
EH III-MH I	4	3	2	1	6	2
MH	10	7	9	4	29	7
MH III-LH I	0	4	0	0	6	1
LH	4	3	2	0	10	5
Total	**19**	**20**	**14**	**6**	**57**	**15**
Dmax min.	0.435		0.581		0.395	
Dmax obs.	0.136		0.341		0.155	

5. ASINE, ITS FUNCTION AND ITS RELATION TO THE REGION

The aim of this paper is to provide some perspectives on Asine and its place in the region during the Bronze Age. Table *3* contains the general conclusions on whether or not the animal bones from the site indicate centralization in comparison, with general trends of such processes compiled in Table 1.

The relative taxonomic abundances of the three animals indicate that there was no large-scale specialization. Even if we can observe a trend with mixed relative abundances of sheep/goat, cattle and pig in the EH to more uneven in MH and LH, to call this a large-scale specialization is presumptuous, since no clear domination of any animal can be observed. This appears to be the case for other sites in Argolis, and the Aegean (Halstead, 1996; Trantalidou, 1989).

The animal bones do not indicate any centralization of Asine during the EH. The transition to a focus on pig during EH III-MH I could be a clue to changes of the regional communication and societal system in the end of EH, or the so called EH II/III collapse or gap (e.g. Bintliff, 2012; Davis, 2013; Wiener, 2014; cf. Weiberg & Finné, 2013). The high abundances of pigs at EH IIIA Helike have been suggested to be symptomatic of a more isolated rural environment (Fillios, 2006). Although uncertain because of revised chronologies (see Reese 2008), pig also increased between EH III and MH at nearby Lerna, according to Gejvall (1969).

At Asine, pigs decreased in abundance towards the LH, while sheep/goat increased. An increase of sheep/goat is visible also at LH I Lerna (Gejvall 1969:6). When compared to the general trends of centralization (Table 1) and the archaeological knowledge of the emergence of a complex societal structure, the so called Mycenaean economies, this ovicaprine increase perhaps reflect higher regional demands for such animals. This might have come from regional centers, or production centers, for wool making and/or meat consumption. In which part of the chain was Asine located: the importing or exporting node?

Although the input of prime-age and old sheep/goats at Asine could be used to indicate imported animals from the surrounding area, the existence of younger individuals suggests local husbandry, i.e. from the immediate surrounding or stockkeeping activities connected to the site. There are no clear signs of import of sheep/goats to the village. A focus on old cattle existed (60-70% of age assessed specimens), which could be explained in terms of them being imported to Asine. The older animals might have been brought to the village when no longer usable for work, as a form of taxation on the nearby farms, as in the Scandinavian parallel, mentioned earlier (Vretemark, 1997; Magnell, 2009). One possible interpretation of Asine's regional function is as a small but central village for the immediate valley, where animals were occasionally brought in by passing pastoralists and nearby farms.

Halstead (1996) has previously suggested that the supposed animal husbandry supporting Mycenaean palatial sites was neither large in scale nor highly specialized. Rather, the palace economies relied on mixed farming communities in the surrounding area. Palatial sites should then show similar characteristics to early urban environments, following the above reasoning, in terms of taxonomic abundance, body parts' selection, and age/sex distributions.

The closest palatial site with published animal bone data is Tiryns (von den Driesch & Boessneck, 1990). If we compare Asine to this site, we can note that the faunal remains from Asine actually duplicate some of the patterns that are also evident at Tiryns. Among these is the on-site slaughter of sheep/goats, primarily of adult ages, but with inclusion of older animals (von den Driesch & Boessneck, 1990). The faunal remains from Tiryns testify to a focus on wool production, according to von den Driesch and Boessneck (1990).

While local centres exported sheep to the bigger regional ones, for example, they still affected the hinterland and still maintained their central importance to the immediate surroundings. Tiryns was probably foremost supported by its own local area, but advantaged on trade input from other smaller local centres in the form of control of raw materials and craft production rather than subsistence and basic economic needs (Halstead, 1999; 2011; Earle, 2011). This reveals a regional economy built on local centres, communications and exchange, rather than pyramidal-controlled systems (cf. Small, 1999). It is possible that Asine was one such local centre. During the LH, sheep were lacking in relation to goats at the site (ratio 1:2.2). This indicates perhaps that they might have been imported rather than consumed within the site's boundaries. In addition to the zooarchaeological patterns, it is important to note the possible function of Asine as a harbour, as well as indications of social stratification at the site visible in the chamber tombs. This indicates a central and dynamic function of the site, at least to its immediate valley (see Gillis, 1996).

If there were no suitable areas to keep pigs, this might be a reason as to why pig decreases. This is maybe not the case, though, in Argolis, even if periods of aridity occurred throughout the Bronze Age (e.g. Wiener, 2014; Kaniewski et al., 2013; Weiberg et al., 2016). According to Redding (1991) and Zeder (1998), the pig is not as suitable as the main stock if the aim is to produce surplus and generate secondary products. At Asine, the slaughter of juvenile pigs and piglets becomes more accentuated towards the later Bronze Age. Together with the general decrease in pigs observed in this period, this indicates that perhaps the domestic production of pigs grew as a supplement to the increasing management of sheep/goat. More offspring than needed were produced inside the settlement. They were consequently killed off. An over-representation of juvenile pigs to slaughter and the possible local keeping of swine seem to have occurred at Tiryns (von den Driesch & Boessneck, 1990). As noted by Halstead and Isaakidou (2011), to fatten one or two pigs was a significant cost to the household. This would be consistent with the tendency at Asine over time to cut costs by not breeding too many pigs into adulthood or optimum meat weight.

Table 3 Zooarchaeological patterns of centralization at Bronze Age Asine

Variable	EH	EH III-MH I	MH	MH III-LH I	LH	General characteristics
Relative taxonomic abundances	Mixed stock	Increase in pigs	Slight increase of sheep/goat, slight decrease of pigs	Clear increase of sheep/goat, clear decrease of pigs		
Skeletal parts' representation					Decrease of cattle lower extremities and feet (result of long-term change or taphonomic bias?)	Presence of whole bodies on site
Age/sex distribution		Increase of juvenile pig			Increase of juvenile pig	Focus on adult and older cattle
Context information		Bone input of the *bothroi* does not disturb the general tendencies				Cultural layers with primary and secondary refuse
Post-depositional disturbance						Post-depositional impact is evident but to an uncertain degree
						Smaller elements of medium-sized mammals might be underrepresented due to lack of sieving
Overall indicative of centralization	No	No	Uncertain	Perhaps	Perhaps	Perhaps in the later Bronze Age periods

6. CONCLUSIONS

The comparison between more general patterns of centralization and the specific patterns at Bronze Age Asine has built up a narrative of animal management at the site from a diachronic perspective.

Starting off as a rural community during the Early Helladic, zooarchaeological evidence indicates that the settlement developed to include other site functions during the course of the Bronze Age. In the MH, it is credible that Asine took on an important function for its immediate surroundings and nearby farms. Older bovids were brought to the site, although Asine probably had an independent sustainable stock-keeping system for secondary products. Older and used cattle might have been occasionally brought into the settlement as large portions of meat. While pig keeping in general declined during the MH and onwards, it is possible that domestic production of pig became important into the Late Helladic, based on the increase in slaughter rates of juvenile pigs. In relation to the bigger regional sites, Asine passed on suitable animals for wool production or larger feasting activities. The site would in this scenario have functioned as a key site in the small region, connecting the Asine valley with the larger palatial sites and the vaster Argolid region.

In this discussion, the zooarchaeological patterns at Asine were briefly compared to the ones from the nearby sites, Lerna and Tiryns. However, as this study focuses on Asine solely, a holistic comparative approach was not attempted. For this purpose, other regional sites from Argolis and the vaster Peloponnesian region, which has been zooarchaeologically examined, such as Pylos (Nobis 1993), Midea (Gejvall 1983; Reese 1998) and Ayios Stefanos (Reese 2008), should be included. Future studies focusing on such a comparative approach are vital, in further testing the zooarchaeological patterns of centralization presented in this paper.

To further illuminate Asine's place in the region it is necessary to study the coastal as well as industrial aspect of the site, in terms of antler craft refuse. Together with the osteological analysis, isotopic studies of the bones could also further illuminate animal sourcing and management (e.g. Madgwick et al., 2013; Guiry et al., 2014; Meier et al., 2014; Reitsema et al., 2015). For example, analysis of strontium isotopes could give information on the migration and movement of animals, and thus provide a basis for the discussion of the export/import of animals, animal exchange and long distance trade of animals (e.g. Viner et al., 2010; Thornton, 2011; Arnold et al., 2013). The shifting functions of Asine during the Bronze Age can thus be further investigated, and the hypotheses proposed in this study more thoroughly tested.

ACKNOWLEDGEMENTS

This study has gratefully received funds from the Längmanska Kulturfonden. I am grateful to Torbjörn Ahlström, Dimitra Mylona and Ola Magnell for valuable comments on earlier drafts. I am thankful for the comments from two anonymous reviewers, which helped improved the paper greatly. Any faults or misconceptions are however my own. An earlier version of this paper was presented in the 12th ICAZ conference in San Rafael, Argentine, 2014. I wish to thank the session organizers for organizing the session and all participants at the conference.

REFERENCES

Allentuck, A., and Greenfield, H. (2010) The organization of animal production in an Early urban center: the zooarchaeological evidence from Early Bronze Age Titris Hoyük, Southeastern Turkey. In *Anthropological Approaches to Zooarchaeology: Complexity, Colonialism, and Animal Transformations*, S. Campana, P. Crabtree, S.D. deFrance, J. Lev-Tov, and A. Choyke (eds.), Oxbow Books, Oxford/Oakville, pp. 12-29.

Arnold, E. R., Greenfield, H. J., & Creaser, R. A. 2013. Domestic cattle mobility in early farming villages in southern Africa: Harvest profiles and strontium (87Sr/86Sr) isotope analyses from Early Iron Age sites in the lower Thukela River Valley of South Africa. *Archaeological and Anthropological Sciences,* vol. 5, pp. 129-144.

Bannert, D. (1973) Geologische Bemerkungen zur Ausgrabung am Barbouna-Hügel. In *Excavations in the Barbouna Area at Asine. Fascicle 1: General Introduction, Bibliography, Geological Background and a Report on the Field-work in the Levendis sector, 1970-1972*, I. Hägg, and R. Hägg (eds.), Uppsala University, Uppsala, pp. 16-21.

Benecke, N. (1994) *Archäozoologische Studien zur Entwicklung der Haustierhaltung in Mitteleuropa und Südskandinavien von den Anfängen bis zum ausgehenden Mittelalter*. Akademie Verlag, Berlin.

Binford, L. (1978) *Nunamiut Ethnoarchaeology*. Percheron Press, New York.

Bintliff, J. (1997) Regional survey, demography, and the rise of complex society in the Ancient Aegean: Core-Periphery, Neo-Malthusian, and other interpretive models. *Journal of Field Archaeology*, vol. 24, pp. 1-37.

Bintliff, J. (2012) *The complete archaeology of Greece: from hunter-gatherers to the 20th century A. D*. Wiley-Blackwell, Malden.

Branigan, K. (ed.) (2001) *Urbanism in the Bronze Age*. Sheffield Academic Press, London.

Davis, J. L. (2013) "Minding the Gap": A Problem in Eastern Mediterranean Chronology, Then and Now. *American Journal of Archaeology*, vol. 117, pp. 527-533.

Davis S. J. (1987) *The Archaeology of Animals*. B.T. Batsford Ltd, London.

deFrance, S. D. (2009) Zooarchaeology in complex societies: Economy, status, and ideology. *Journal of Archaeological Research,* vol. 17, pp. 105-168.

von den Driesch, A. and Boessneck, J. (1990) Die Tierresten von der mykenischen Burg Tiryns bei Nauplion/Peloponnes, In *Tiryns : Forschungen und Berichte, band XI*, Verlag Philipp von Zabern, Mainz, pp. 87-164.

Earle, T. (2011) Redistribution and the political economy: the evolution of an idea. *American Journal of Archaeology*, vol. 115, pp. 237-244.

Ekman, J. (1973) *Early Medieval Lund: the fauna and the landscape*. Museum of Cultural History, Lund.

Ekman, J. (1977) Animal bones from a Late Bronze Age settlement at Hala Sultan Tekke. *Studies in Mediterranean Archaeology*, vol. 45, pp. 237-244.

Fillios M. A. 2006. *Measuring complexity in Early Bronze Age Greece: The pig as a proxy indicator of socio-economic structures*. Unpublished PhD dissertation, Faculty of the graduate school, University of Minnesota.

Frödin, O. and Persson, A. W. (1938) *Asine. Results of the Swedish Excavations 1922-1930*. Generalstabens litografiska anstalts förlag, Stockholm.

Fuller, D. Q, Stevens, C. and McClatchie, M. (2014) Routine activities, tertiary refuse, and labor organization: Social inferences from everyday archaeobotany. In *Ancient plants and people: Contemporary trends in archaeobotany, M.* Madella, C. Lancelotti and M. Savard (eds.), The University of Arizona Press, Tucson, pp. 174-217.

Gejvall, N. G. (1969) *Lerna: A preclassical site in the Argolid. Volume I: The fauna.* American School of Classical Studies at Athens, Princeton.

Gejvall, N. G. (1983) Appendix VI. Animal Bones from the Citadel. In *The Cuirass Tomb and other finds at Midea. Part 2: Excavations in the cemeteries, the Lower Town and the Citadel,* P. Åström (ed.), Paul Åströms Förlag, Göteborg, pp. 51-54.

Grayson, D. K., & Frey, C. J. (2004) Measuring skeletal part representation in archaeological faunas. *Journal of Taphonomy*, vol. 2, pp. 27-42.

Gillis, C. (1996) Tin at Asine. In *Asine III. Supplementary studies on the Swedish excavations 1922-1930*, R. Hägg, G. C. Nordquist, B. Wells (eds.), Swedish Institute at Athens, Stockholm, pp. 94-100.

Guiry,. E.J., Harpley, B., Jones, Z., & Smith, C. (2014). Integrating stable isotope and zooarchaeological analyses in historical archaeology: A case-study from the urban nineteenth-century Commonwealth Block site, Melbourne, Australia. *International Journal of Historical Archaeology,* vol. 18, pp. 415-440.

Habermehl, K. H. (1961) *Die Altersbestimmung bei Haustieren, Pelztieren und beim jagdbaren Wild*. Verlag Paul Parey, Berlin.

Halstead, P. (1996) Pastoralism or household herding? Problems of scale and specialization in early Greek animal husbandry. *World Archaeology*, vol. 28, pp. 20-42.

Halstead, P. (1999) Towards a model of Mycenaean palatial mobilization. In *Rethinking Mycenean Palaces: New interpretations of an old idea*, M. L. Galaty, and W. A. Parkinson (eds.), The Cotsen Institute of Archaeology, Los Angeles.

Halstead, P. (2011) Redistribution in Aegean palatial societies: Terminology, scale, and significance. *American Journal of Archaeology*, vol. 115, pp. 229-235.

Halstead, P. and Isaakidou, V. (2011) A pig fed by hand is worth more than two in the bush: Ethnoarchaeology of pig husbandry in Greece. In *Ethnozooarchaeology: the past and present of human-animal relationships*, U. Albarella, and A. Trentacoste (eds.), Oxbow Books, Oxford and Oakville, pp. 160-174.

Hägg, I. and Hägg, R. (1973) *Excavations in the Barbouna Area at Asine. Fascicle 1: General Introduction, Bibliography, Geological Background and a Report on the Field-work in the Levendis sector, 1970-1972*. Uppsala University, Uppsala.

Hägg, I. and Fossey, J.M. (1980) *Excavations in the Barbouna area at Asine. Fascicle 4: The Hellenistic nekropolis and later structures on the middle slopes, 1973-77*. Uppsala University, Uppsala.

Hägg R. and Nordquist G. C. (1992) Excavations in the Levendis Sector at Asine, 1989: A Preliminary Report. *Opuscula Atheniensia*, vol. 19, pp. 59-68.

Ingvarsson-Sundström, A. (2008) *Asine III: supplementary studies on the Swedish excavations 1922-1930. Fascicle 3: Children lost and found*. Swedish Institute at Athens, Stockholm.

Ingvarsson-Sundström, A., Voutsaki, S. and Milka, E., (2013) Diet, health and social differentiation in Middle Helladic Asine: a bioarchaeological view. In *Diet, Economy and Society in the Ancient Greek World: Towards a better integration of archaeology and science*, S. Voutsaki, S. M. Valamoti (eds.), Peeters, Leuven, pp. 149-162.

Joyce, A.A., and Barber, S.B. (2015) Ensoulment, entrapment, and political centralization: A comparative study of religion and politics in Later Formative Oaxaca. *Current Antrhopology*, vol. 56(6), pp. 819-847.

Kaniewski, D., Van Campo, E., Guiot, J., Le Burel, S., Otto, T., and Baeteman, C. (2013) Environmental roots of the Late Bronze Age Crisis, *PLoS ONE*, vol. 8, e71004.

Lyman, R. L. (1994) *Vertebrate Taphonomy*. Cambridge University Press, Cambridge, United Kingdom.

Lyman, R. L. (2004) The concept of equifinality in taphonomy. *Journal of Taphonomy*, vol. 2, pp. 15-26.

Macheridis, S. (2011) Appendix 5: Preliminary report on the osteological material from Hala Sultan Tekke 2010. In New Swedish Cyprus Expedition 2010 Excavations at Dromolaxia Vizatzia/Hala Sultan Tekke: preliminary results, P. Fischer (ed.), *Opuscula*, vol. 4, pp. 93-94.

Macheridis, S. (2016) Home, refuse, and reuse during the EH III to the MH I transitional period: a social zooarchaeological study of the Asine *bothroi*. *Opuscula*, vol. 9, pp. 71-91.

Macheridis, S. (2017) The use of multiple correspondence analysis (MCA) in taphonomy: The case of Middle Helladic Asine, Greece. *International Journal of Osteoarchaeology*, vol. 27 (3), pp. 47-487.

Macheridis, S. and Tornberg, A. (2011) Matrester och slaktavfall på Hovdala borg: osteologisk analys av djurbensmaterialet från Gårdstalien 2008. In *Händelser längs en väg: Finjasjöbygden med den medeltida Hovdalaborgen i centrum*, A. & C. Ödman (eds.), Dept. of Archaeology and Ancient History, Lund University, Lund, pp. 286-303.

Madgwick, R., Sykes, N., Miller, H., Symmons, R., Morris, J., and Lamb, A. (2013) Fallow deer (*Dama dama dama*) management in Roman South-East Britain. *Archaeological and Anthropological Sciences*, vol. 5, pp. 111-122.

Magnell, O. (2009) Den urbana borgen och den lantliga staden. Djurhållning och kost i det medeltida Sölvesborg. *Ale, Historisk Tidsskrift för Skåne, Halland och Blekinge*, vol. 2009, pp. 20-24.

Marciniak, A. (2005) *Placing Animals in the Neolithic: Social Zooarchaeology of prehistoric farming communities*. UCL Press, London.

Meier, J., Price, G., and Shelton, K. (2014) Animals beyond the Cyclopean walls: Integrating faunal and isotopic analysis at Late Helladic IIIA2 Petsas House. In *Abstracts = Libro de Resúmenes. ICAZ 2014, 12th International Conference of ArchaeoZoology. September, 22nd-27th*. A.D. Izeta (ed.), Universidad Nacional de Cordoba: San Rafael, Argentina, p. 107.

Moberg Nilsson, K. (1996) Animal bones from Terrace III in the Lower Town of Asine. In *Asine III. Supplementary Studies on the Swedish Excavations 1922-1930. Fasc. 1*, R. Hägg, G. C. Nordquist, and B. Wells (eds.), Skrifter utgivna av Svenska Institutet i Athen, 4°, Stockholm, pp. 111-115.

Mogren, M. (2013) The first sparks and the far horizons: stirring up the thinking on the earliest Scandinavian urbanization processes – again. *Lund Archaeological Review*, vol. 18, pp. 75-88.

Mylona, D. (2003) Archaeological fish remains in Greece: General trends of the research and a gazetteer of sites. In *Zooarchaeology in Greece: Recent advances*, E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble, and P. Elefanti (eds.), The British School at Athens, London, pp. 193-200.

Nakoinz, O. (2012) Models of centrality. *Journal for Ancient Studies*, vol. 3, pp. 217-223.

Nobis, G. (1993) Archäozoologische Untersuchungen von Tierresten aus dem "Palast des Nestor" bei Pylos in Messenien/SW-Peloponnes. *ZFA (Zeitschrift für Archäeologie)*, vol. 27, pp. 151-173.

Nordquist, G. C. (1987) *A Middle Helladic Village. Asine in the Argolid*. PhD dissertation. Uppsala Universitet, Uppsala.

Orton, D. C. (2012) Taphonomy and interpretation: An analytical framework for social zooarchaeology. *International Journal of Osteoarchaeology*, vol. 22, pp. 320-337.

Reese, D. (2008) Faunal remains from Late Helladic Lerna (Argolid, Greece). M*editerranean Archaeology and Archaeometry*, vol. 8, pp. 5-25.

Reese, D. S. (1998) Appendix II: The faunal remains. In *Excavations on the Acropolis of Midea, Vol. I:1. The excavation on the Lower Terracess*, G. Walberg (ed.),Paul Åströms förlag, Stockholm, pp. 277-291.

Reese, D. S. (2008a) Appendix 8: The mammalian and reptilian remains: Catalogue and comparanda. In *Ayios Stefanos: Excavations at a Bronze Age and Medieval settlement in Southern Laconia*, W. D. Taylour and R. Janko (eds.), British School at Athens, London, pp. CD156-185.

Redding, R. W. (1991) The role of the pig in the subsistence system of ancient Egypt: a parable on the potential of faunal data. In *Animal use and culture change*, P. Crabtree, and K. Ryan (eds.), The University Museum, Univerisity of Pennsylvania Philadelphia, pp. 20-30.

Redding, R. W. (2010) Status and diet at the Worker's Town, Giza, Egypt. In *Anthropological approaches to zooarchaeology: Complexity, colonialism, and animal transformations*, S. Campana, P. Crabtree, S. D. deFrance, J. Lev-Tov, and A. Choyke (eds.), Oxbow Books, Oxford and Oakville, pp. 65-75.

Reitsema, L.J., Brown, T.E., Hadden, C.S., Cutts, R.B., Little, M.E., and Ritchison, B.T. (2015) Provisioning an urban economy: isotopic perspectives on landscape use and animal sourcing on the atlantic coastal plain. *Southeastern Archaeology*, vol. 35(3), pp. 237-254

Schwartz, J. (1974) The paleozoology of Cyprus: a preliminary report on recently analyzed sites. *World Archaeology,* vol. 5, pp. 215-220.

Silver, I. A. (1969) The ageing of domestic animals. In *Science in Archaeology*, D. R. Brothwell, and E. Higgs (eds.), Thames & Hudson, London, pp. 283-302.

Small, D. (1999) Mycenaean polities: states or estates? In *Rethinking Mycenaean Palaces: new interpretations of an old idea*, M. L. Galaty, and W. A. Parkinson (eds.), The Cotsen Institute of Archaeology, Los Angeles, pp. 43-48.

Smith, M.E. (2007) Form and meaning in the earliest cities: A new approach to ancient urban planning. *Journal of Planning History,* vol. 6(1), pp. 3-47.

Strasser, T. F. (1999) Bothroi in the Aegean Early Bronze Age. In *Meletemata: studies in Aegean Archaeology presented to Malcolm H. Wiener as he enters his 65th year*, P. P. Betancourt, V. Karageorghis, R. Laffineur, and W.-D. Niemeier (eds.), Université de Liège/University of Austin, Liège/Austin, pp. 814-817.

Szabó, M. (1970) *Herdar och husdjur: En etnologisk studie över Skandinaviens och Mellaneuropas beteskultur och vallningsorganisation*. Nordiska Muséet, Stockholm.

Thornton, E.K. (2011) Reconstructing ancient Maya animal trade through strontium isotope (87Sr/86Sr) analysis. J*ournal of Archaeological Science*, vol. 38 (12), pp. 3254-3263.

Trantalidou, C. (1989) Animals and Human Diet in the Prehistoric Aegean. In *Thera and the Aegean World III*, D. A. Hardy, J. Keller, V. P. Galanopoulos, N. C. Flemming, and T. H. Druitt (eds.), The Thera Foundation, Santorini, Greece, pp. 392-405.

Wapnish, P. and Hesse, B. (1988) Urbanization and the organization of animal production at Tell Jemmeh in the Middle Bronze Age Levant. *Journal of Near Eastern Studies*, vol. 47, pp. 81-94.

Wattenmaker, P. (1994) Household economy in early state society: Material value, productive context, and spheres of exchange. In *The Economic Anthropology of the State*, E. M. Brumfiel (ed.),University Press of America, Lanham, pp. 93-118.

Weiberg, E. and Finné, M. (2013) Mind or Matter? People-Environment Interactions and the Demise of Early Helladic II Society in the Northeastern Peloponnese. *American Journal of Archaeology*, vol. 117, pp. 1-31.

Weiberg, E., Unkel, I., Kouli, K., Holmgren, K., Avramidis, P., Bonnier, A., Dibble, F., Finné, M., Izdebski, A., Katrantsiotis, C., Stocker, S. R., Andwinge, M., Baika, K., Boyd, M. And Heymann, C. (2016) The socio-environmental history of the Pelopommese during the Holocene: Towards an integrated understanding of the past. *Quarternary Science Reviews*, vol. 136, pp. 40-65.

Wells, B. (1983) *Asine II: results of the excavations east of the Acropolis. Fascicle 4: the Protogeometric period. Part 1 an analysis of the settlement*. Svenska institutet i Athen, Stockholm.

Wiener, M. H. (2014) The interaction of climate change and agency in the collapse of civilizations ca. 2300-2000 BC. *Radiocarbon*, vol. 56, pp. S1-S16.

Viner, S., Evans, J., Albarella, U. and Parker Pearson, M. (2010) Cattle mobility in prehistoric Britain: Strontium isotope analysis of cattle teeth from Durringtown Walls (Woltshire, Britain). *Journal of Archaeological* Science, vol. 37, pp. 2812-2820.

Voutsaki, S., Ingvarsson-Sundström, A. and Dietz, S. (2011). Tumuli and social status: A re-examination of the Asine tumulus. In Ancestral landscapes: Burial mounds in the Copper and Bronze Ages, E. Borgna, and S. Müller Celka (Eds.), Maison de l'Orient et de la Méditerranée : Lyon, pp. 445-461.

Vretemark, M. (1997) *Från ben till boskap: kosthåll och djurhållning med utgångspunkt i medeltida benmaterial från Skara. Del 1*. Skaraborgs länsmuseum, Skara.

Vretemark, M. (2001) Kungahälla - om handel och varututbyte med animalieprodukter. In *Kungahälla - problem och forskning kring stadens äldsta historia*, H. Andersson, K. Carlsson, and M. Vretemark (Eds.), Bohusläns museums förlag, Uddevalla/Stockholm, pp. 111-133.

Zeder, M. A. (1991) *Feeding cities: specialized animal economy in the ancient Near East*. Smithsonian Institution Press, Washington.

Zeder, M. A. (1998) Pigs and emergent complexity in the Ancient Near East. In *Ancestors for the pigs: pigs in prehistory*, S. M. Nelson (ed.), The University Museum, Univerisity of Pennsylvania Philadelphia, pp. 109-122.

Paper II

International Journal of Osteoarchaeology
Int. J. Osteoarchaeol. (2016)
Published online in Wiley Online Library
(wileyonlinelibrary.com) **DOI**: 10.1002/oa.2571

The Use of Multiple Correspondence Analysis (MCA) in Taphonomy: The Case of Middle Helladic Asine, Greece

S. MACHERIDIS*
Department of Archaeology and Ancient History, Lund University, Lund, Sweden

ABSTRACT The goal of this paper is to investigate whether multiple correspondence analysis (MCA), a multivariate statistical technique, is a useful dimensionality-reduction tool in zooarchaeological and taphonomic studies. For this purpose, the focus is to detect and discuss traces of waste management. Animal bones from waste-related contexts at the Bronze Age site Asine, Greece, are investigated. The data consist of bone fragments dating to the Middle Helladic from this site. Unidentified fragments were categorised in size classes, where possible. Information on taxa, skeletal parts and the presence or absence of several taphonomic markers is included in the data set. The MCA reveals several correlations of zooarchaeological interest. For example, the association between indeterminate fragments and calcined bone points to issues concerning identification and preservation. Floors are characterised by weathered long-bone fragments from medium-sized mammals. Additionally, the results of MCA indicate that the material might have suffered from density-mediated attrition, based on the abundance of axial fragments, which did not differ between different contexts and taxa. The results show that MCA can be used to detect zooarchaeological and taphonomic patterns. This multivariate technique is useful when investigating large data sets, as is often the case with large zooarchaeological assemblages. Copyright © 2016 John Wiley & Sons, Ltd.

Key words: aegean bronze age; asine waste management; multiple correspondence analysis; taphonomy; zooarchaeology

Supporting information may be found in the online version of this article.

Introduction

Taphonomic studies in zooarchaeology are focused on the critical evaluation of the formation of the zooarchaeological record. Taphonomic studies are, by necessity, contextual because the shaping of any animal bone assemblage is sensitive to local geological, ecological and archaeological circumstances. Research has shown that a taphonomic perspective not only provides us with an understanding of what is lost but also supplies new information on an assemblage (e.g. Behrensmeyer & Kidwell, 1985; Wilson, 1988; Bar-Oz & Munro, 2004; Madgwick & Mulville, 2011). The development of taphonomic research in zooarchaeology, especially concerning data usage and analysis, has greatly benefitted from the contribution of several significant papers during the last decades (e.g. Bar-Oz & Dayan, 2003; Bar-Oz & Munro, 2004; Grayson & Frey, 2004; Marciniak, 2005; Madgwick & Mulville, 2011; Karr & Outram, 2015; Madgwick, 2015). Amongst these, we can find multivariate approaches to solving taphonomic issues (e.g. Bar-Oz & Munro, 2004; Madgwick & Mulville, 2011).

Butchery, thermal modification, gnawing, trampling, weathering, root etching and recent fractures are amongst the many taphonomic variables often included in zooarchaeological examinations of archaeological assemblages. Thus, zooarchaeological and taphonomic data are multivariate, voluminous and in need of appropriate tools in order to be properly understood. The goal of this paper is to demonstrate the use of multiple correspondence analysis (MCA) as a dimensionality-reduction tool for studying taphonomic processes in any given zooarchaeological material. The focus is on the identification of prehistoric waste management, both a taphonomic and a cultural process. As a case study, animal bones from the Bronze Age site of Asine

* Correspondence to: Stella Macheridis, Department of Archaeology and Ancient History, Lund University, Lund, Sweden.
e-mail: stella.macheridis@ark.lu.se

Received 23 February 2016
Revised 29 August 2016
Accepted 7 October 2016

in Argolis, Greece, are used. This study is thus not a controlled experiment but an application of MCA to zooarchaeological data (see Madgwick & Mulville, 2011:511).

Background to Asine

In the Argolid bay, on a cliff that protrudes into the sea, we find the ancient settlement of Asine (Figure 1). The site was excavated in several campaigns during the 20th century (e.g. Frödin & Persson, 1938; Hägg & Hägg, 1973; Dietz, 1982; Wells, 1983). Although earlier signs of occupation exist, it was during the Middle Helladic (MH) ca 2100–1700 BCE that Asine grew in size and became an important site for the valley (Nordquist, 1987; Macheridis, 2014). In the Late Helladic, ca 1700–1100 BCE, the site remained central for its immediate surroundings. Contemporary graves inside and outside of the village, labelled as rich or poor in terms of material culture, testify to growing social complexity during the later MH (Nordquist, 1987; Ingvarsson-Sundström, 2008; Ingvarsson-Sundström *et al.*, 2013). The zooarchaeological data used in this study derive from the MH period.

Asine was built on a limestone outcrop which also includes flysch sediments. The main geological problem in terms of bone preservation is that the site is located on a hill and exposed to external mechanical forces (Bannert, 1973: 19ff), resulting in differential preservation of materials. The good preservation of bone in relatively protected spots is exemplified by the survival of many infant burials on the settlement (Ingvarsson-Sundström, 2008).

Four types of waste-related context from different levels of contextual resolution at MH Asine are investigated: secondary deposits/layers, building and room fills and primary deposits and floors. These are broad categories, reconstructed on the basis of field diaries from the early campaigns, as well as published documentation (Frödin & Persson, 1938; Hägg & Hägg, 1973; Nordquist, 1987). The field diaries are stored in Museum Gustavianum, Uppsala University, Sweden.

Secondary layers, such as levelling fills, represent redepositional events, that is, the removal of waste from its primary deposition spot, for example, a garbage heap, to another place. Secondary deposits, as defined at Asine, are large cultural layers possibly spanning many parts of the site. They are likely to represent a general picture of waste management rather than specific events. Building and room fills are also secondary in their nature. They constitute their own category here because they were made in a restricted space and possibly preserve animal remains in a different way than is the case in open

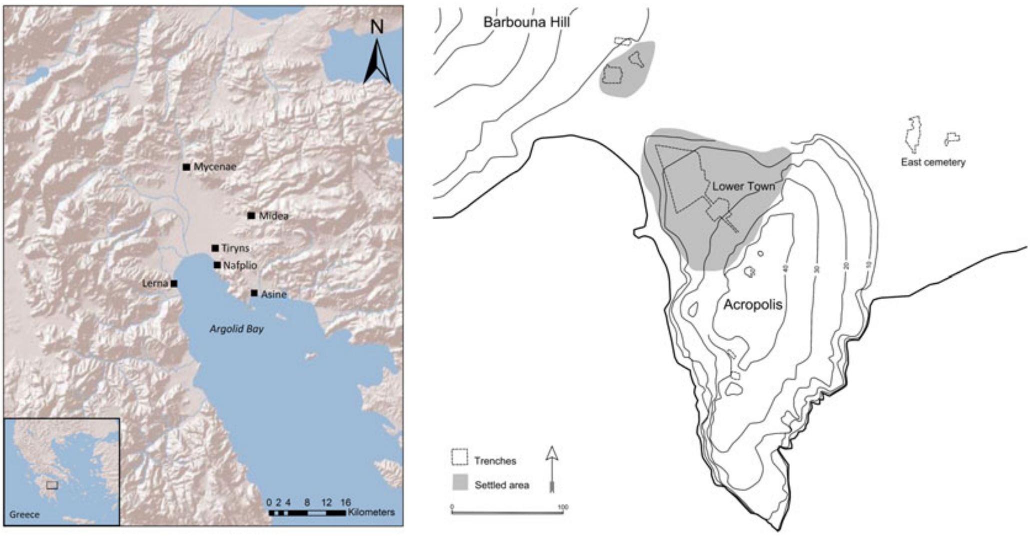

Figure 1. Asine in Argolis, Greece. Left: Argolis in the northeastern Peloponnese, Greece; produced by using ARCGIS v. 10. Right: excavation plan of Asine; modified from Nordquist (1987). This figure is available in colour online at wileyonlinelibrary.com/journal/oa

air contexts. Thus, they provide higher resolution in regard to the disposal event.

Another category consists of primary deposits, for example, single fill layers, which contain waste material from the original consumption. Pits filled with kitchen waste materials are such cases. The fourth category is floors, which are constructions and were actively used by the ancient Asine people. They are included in the category of 'waste-related' because bones found from these layers probably represent smaller fragments which became incorporated into the floors and were not swept away in regular cleanings (cf. Schiffer, 1983: 694; Hayden & Cannon, 1983: 126; Yeshurun *et al.*, 2014: 593).

Material and methods

The animal bones

Animal bones from Asine have been studied previously, but the findings were only partly published (Moberg Nilsson, 1996; Macheridis, 2016). Table 1 contains information on the frequencies of identified taxa and unidentified specimens at MH Asine. We can note a high abundance of pig bones, followed by those of sheep/goat and cattle. This follows earlier studies of Asine (Macheridis, 2014; see Ingvarsson-Sundström *et al.*, 2013, 154). Goats are slightly more abundant than sheep. Deer are represented by three species, but most fragments derive from red deer. Dog is also identified, as well as horse and donkey. All fragments of turtle are from the carapace, the shell. Although we can see that avian and reptilian bone fragments are represented, most (78%) are certainly from mammals. The indeterminate fragments are probably mammalian. However, because this has not been ascertained, they remain unidentified. No selection of anatomical elements was made in the zooarchaeological identification.

Table 1. List of identified mammalian taxa and unidentified specimens at MH Asine. Frequencies in Number of Identified Specimens (NISP) or Number of Specimens (NSP), and Minimum Number of Individuals, minimum distinction (minMNI). Loose teeth and redundant elements are excluded

Taxa/animal group		NSP or NISP	minMNI
Pig (*Sus* sp.)		761	17
of which	Domestic pig (*Sus domesticus*)	754	17
Sheep/goat (*Ovis aries*/*Capra hircus*)		625	16
of which	Sheep (*Ovis aries*)	42	9
	Goat (*Capra hircus*)	58	4
Bovine (*Bos* sp.)		473	11
of which	Cattle (*Bos taurus*)	471	11
Deer (*Cervus*/*Capreolus*)		154	6
of which	Red deer (*Cervus elaphus*)	134	4
	Fallow deer (*Dama dama*)	1	1
	Roe deer (*Capreolus capreolus*)	1	1
Dog (*Canis familiaris*)		31	3
Equids (*Equus* sp.)		12	2
of which	Horse (*Equus caballus*)	7	1
	Donkey (*Equus asinus*)	1	1
Small-sized mammals		15	—
Medium-sized mammals		1523	—
Large-sized mammals		1056	—
Indeterminate		1378	—
Total		6027	54

The number of identified specimens (NISP) and number of specimens (NSP) are used for quantification. The minimum distinction of minimum number of individuals denotes the determination of minimum number of individuals for the complete MH assemblage. It does not consider separate recovery units from this period (see Lyman, 2008, 58). The minimum distinction of minimum number of individuals data are presented in Table 1.

Size-classed specimens are recorded on the basis of bone thickness and size. Such specimens are often determined according to element rather than taxa, for example, tibial shaft fragments from either ovicaprines or small deer. The size classes used here are as follows: *small-sized mammals* (cats, martens, neonate humans, juvenile and small dogs and micromammalia), *medium-sized mammals* (dogs, pigs, sheep/goats, roe deer, donkeys, juvenile humans and other wild carnivores such as fox) and *large-sized mammals* (horses, cattle, red deer, fallow deer and bears). In Table 1, we can see that medium-sized and large-sized specimens are abundant, but small-sized mammals are not common at Asine. The bones were handpicked and rarely collected through sieving. This has certainly affected the abundance of small taxa and certain elements. The results of the following analysis are partly biased by this unfortunate circumstance.

Introduction to multiple correspondence analysis

Multiple correspondence analysis is an extension of ordinary correspondence analysis (CA), which is used to visualise the data set in terms of dependency between rows (objects, e.g. bones and contexts) and columns (variables, e.g. species and taphonomic markers; Greenacre, 1984, 2007). Both CA and MCA use categorical data, that is, data which are ordered in fixed groups or levels (Ringrose, 1992; Greenacre, 2007; Alberti, 2013). This suits zooarchaeological data, which in general are ordinal (Lyman, 2008: 78). However, MCA extends CA by including more than one set of data on the same objects (Greenacre, 2007; Nenadic & Greenacre, 2007:5).

Correspondence analysis and MCA are exploratory tools which provide us with visualisations of large data sets, but it is still up to us to make sense of the data. This involves an interpretational process, which often is based on the graphical result of the CA or MCA, which is a scatterplot with a horizontal and a vertical axis. These represent two different principal dimensions or axes, usually the first and the second. A dimension is the calculated best-fitting straight line of the average distribution of observations (Greenacre, 2007, 65). At the centre of the scatterplot, where the two dimensions 'meet', is the centroid, the statistically averaged distribution based on both dimensions. If the objects and variables cluster around this centroid, then the data are homogenous or randomly dispersed. If some objects or variables show more distance from the centroid, then this is an indication and a description of heterogeneous patterns within the data. Thus, CA and MCA are used to describe the homogeneity of the data.

The reduction of dimensions is an important characteristic of CA and MCA. Because the data cannot be observed in more than three dimensions, we need to reduce the number of dimensions needed to graphically display the data (Greenacre, 2007, 41–47). This is especially the case in very large data sets with large numbers of variables and objects. The success of the reduction is measured by the percentage of inertia. Inertia measures associations between objects and variables; it increases with higher association and decreases when more observations follow the average distribution (Greenacre, 2007, 29). Thus, inertia provides an approximation of the degree of homogeneity.

The advantage of MCA over ordinary CA

Ordinary CA has benefitted zooarchaeological studies (e.g. Moreno-Garcia *et al.*, 1996; Smith & Munro, 2009; Jones *et al.*, 2013; Weissbrod *et al.*, 2014; Macheridis, 2016). In ecological and archaeobotanical research, the use of the related canonical correspondence analysis (CCA) is common (ter Braak, 1986; ter Braak & Verdonschot, 1995). CCA, unlike ordinary CA, takes into account known variables, most often environmental factors, which are used to constrain the variation within the data set (ter Braak, 1986, 1168; Bogaard *et al.*, 1999, 1216; Smith & Munro, 2009, 928). CCA has been shown to be a useful exploratory technique which can describe how different species' compositions and localities are related within similar environmental circumstances, as described by the known variables.

The main advantage of MCA is that, unlike ordinary CA and extensions such as CCA, it is not confined to one set of variables. By using MCA, we can explore the relations between variables and other variables. Thus, the correspondences between variables are categorised in different ways, such as weathering, body parts, taxa, context and time, and can be described by the MCA. This makes MCA suitable for taphonomic studies because it provides a way to visualise the complexity of several interacting taphonomic factors and the multivariate nature of taphonomic data. MCA studies within zooarchaeology are, to my knowledge, non-existent.

Analysis and results

The data set and choice of variables

The data set is a 6027 × 11 matrix and can be viewed in Data S1. Each row in the data set represents one bone fragment. Most fragments derive from secondary deposits (NSP 4603), followed by room fills (NSP 936), floors (NSP 391) and primary deposits (NSP 97). Because there is an overrepresentation of bones from secondary deposits, we can expect bones from such contexts to cluster around the centroid in the MCA. The data set for the MCA excludes reptilian and avian specimens, loose teeth and anatomically redundant elements, as discussed in the succeeding texts.

The nine anatomical categories established by Stiner (1991) are used. Three categories have been added to include the unidentified fragments: metapodial fragments indeterminate to size, long-bone fragments and fragments indeterminate to anatomical element. In anatomical parts where the number of bone elements differs between species, only those in common are compared (Lyman, 2008, 30). The exception is two metacarpals and one metatarsal of dog, which are the only indications of these body parts being present on the site. Figure 2 shows the relative abundance of body parts within each animal group. Indeterminate fragments are generally overrepresented. This should be visible in the MCA. We can expect the MCA to provide us with nuances of this domination and how it relates to various taphonomic markers.

Besides context, taxon and body part, the presence of taphonomic markers is included in the data, which include recent breakage (during excavation, e.g. rough excavation techniques and during subsequent processing and storage, e.g. cleaning in acid solutions), post-depositional markers (chemical and mechanical impact, such as root etching and mineral encrustation) and peri-depositional and pre-depositional features. In the latter group, the following were recorded accordingly: butchery marks (Binford, 1981), carnivore gnawing (Haynes,

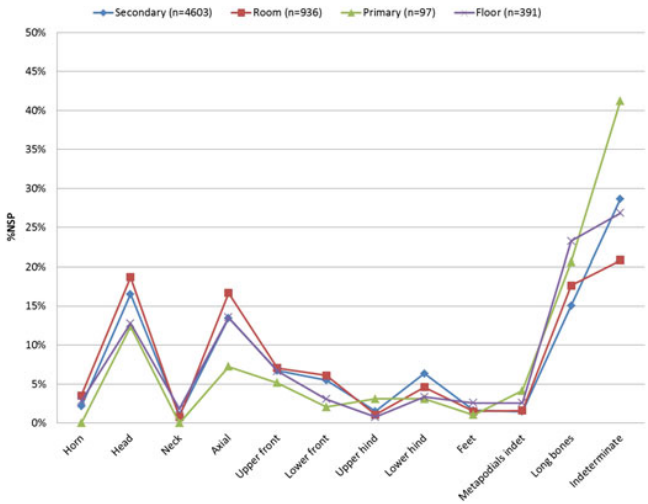

Figure 2. Relative frequencies of skeletal parts and regions at Asine. All specimens are included (n = 6027). This figure is available in colour online at wileyonlinelibrary.com/journal/oa

1983; Blumenschine *et al.*, 1996), trampling (Andrews & Cook, 1985; Thilderqvist, 2013), weathering (Behrensmeyer, 1978; see Madgwick & Mulville, 2011) and thermal modification, on the basis of changes in colour. Table 2 presents the stages of burning used in the recording of thermal modification, based on the schematic provided by Lyman (1994, 386; cf. Asmussen, 2009). Including the variables mentioned in the preceding texts, the MCA will test whether any correspondences amongst taxa, body region and the presence of taphonomic markers are discernible.

Results

The analysis was performed by using the software R, package *ca* (Nenadic & Greenacre, 2006, 2007). The results show that most inertia, or variation within the data set, was captured by the first two dimensions (50.6%), which we focus on here. The inertia is artificially made to underestimate the true variation in MCA due to coding issues (Greenacre, 2007, 144). Figure 3 is the resulting graph of the MCA. If the bones were randomly affected by various taphonomic processes, or randomly dispersed concerning taxa and body parts, then all variables would cluster around the centroid (the cross-section in Figure 3). In this case, we can see that the Asine data are not random (Figure 3).

Table 2. Score system employed in the recording of thermal modification of bones, based on color change (modified from Lyman, 1994, 386)

Score	Colour
—	Irrelevant–indeterminate
0	Not visibly burned
1	Red–brown
2	Dark brown
3	Blue–grey–black
4	Grey–white
5	White

As mentioned, the centroid represents the average distribution of all observations, that is, the 'average' bone fragment (cf. ter Braak, 1986, 269). The average bone fragment from MH Asine derives from secondary deposits and building/room infills. This is partly biased by the quantitative overrepresentation of such contexts (Table 2). The average bone fragment is not visibly weathered (Weat:A) and is not visibly diagenetically damaged (Postdep:A), cut (Cut:A), gnawed (Gnaw:A), burnt (Thermal:A) or trampled (Tram:A). Any variable close to the centroid on Figure 3 will be close to this general picture as well.

The discussion of the results in the succeeding texts is partly based on the contribution (ctr) columns in Table S1, which contain the summary of the results. In the *ca* package used here, the contribution is expressed in thousands or per mill (‰; Greenacre, 2007, 234). The ctr columns contain information regarding how much

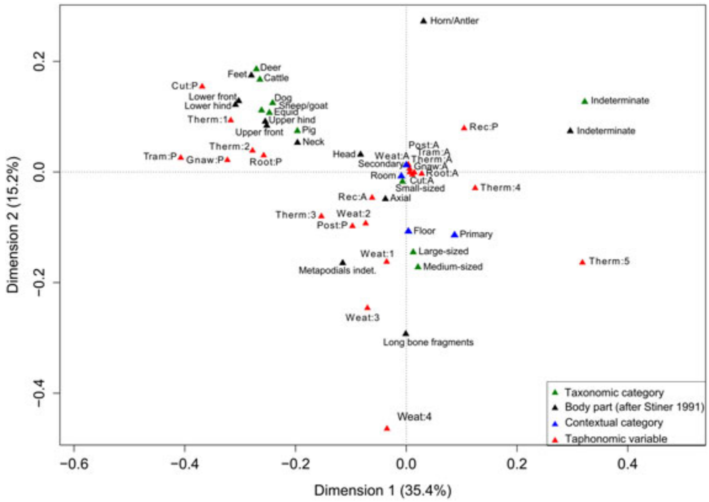

Figure 3. Graph of multiple correspondence analysis of distribution of identified specimens of cattle, sheep/goats and pigs in terms of body parts, contextual categories and presence (P) or absence (A) of taphonomic markers at Middle Helladic Asine. Weathering stages follow Behrensmeyer (1978). For stages in thermal modification, see Table 2. First and second dimensions. Produced with R, package ca (Nenadic & Greenacre, 2007). This figure is available in colour online at wileyonlinelibrary.com/journal/oa

each variable contributes to and can explain the contrasts seen in Figure 3. For example, indeterminate bone fragments contribute strongly (ctr 209) to the first dimension (left to right, divided by vertical line; Figure 3). This high contribution value indicates that the variable in question explains the contrasts seen in Figure 3. Variables with contributions below 20 are, unless stated, not considered.

In the following, the patterns along the first dimension (vertical line in Figure 3) are analysed first. This is continued by describing the patterns along the second dimension (horizontal line of Figure 3). Finally, a section is devoted specifically to the anatomical categories and how they relate to other variables and the dimensions in the MCA.

Dimension 1 — Identification and preservation

Most variation is explained in the first dimension (35.4%). I relate the strongest patterns along the first dimension to issues of identification and preservation. In Figure 3, we can clearly see a contrast between identified and unidentified bone fragments, visible as the clustering of indeterminate variables, which oppose specimens identified by taxa. Indeterminate species (ctr 206) and indeterminate element (ctr 209) shape this contrast. Although sheep/goat (ctr 61), pig (ctr 42) and cattle (ctr 48) together contribute to this pattern as well, the clustering of identified species is suppressed by the inclusion of unidentified bone fragments. Removing the unidentified variables would enforce any associations between species seen in Figure 3. Further, it should be noted that indeterminate bones include remains of species which are already present in the NISP counts. This is one of the disadvantages of using NISP, as the same bone from one individual could be split into many fragments and thus counted more than once (Lyman, 2008, 37).

We can further conclude that the bones identified by taxa and elements, statistically speaking, share a few similarities to those that remain indeterminate. Identified fragments are more likely to exhibit taphonomic markers, such as trampling (Tram:P, ctr 24), gnawing (Gnaw:P, ctr 39) and cut marks (Cut:P, ctr 34). This relates to the taphonomic paradox, as formulated by Madgwick & Mulville (2011, 511), in that identified fragment marks from attritional processes survive. Recent breakage (Rec:P, ctr 35) is more common amongst unidentified fragments. Perhaps the post-excavational erosive processes, visible as high fragmentation and recent fractures, have masked taxa-specific markers on the indeterminate bones, as well as earlier taphonomic markers, such as trampling (cf. Madgwick, 2013, 164).

Also related to this unidentified versus identified contrast is the association of calcined (Thermal:5) and heavily burnt bone (Thermal:4) to indeterminate variables (Figure 3). One can see this connection as meaning that indeterminate fragments are often calcined. However, returning to the data set (Data S1), this is not the case, as calcined bones are rare in the Asine assemblage. Also, heavily burnt bone does not contribute to the first dimension (ctr 3). This is a clear example of the importance of evaluating the associations or clusters visible in the graphical result of the MCA by returning to the actual data set.

Although the clustering of the identified specimens is decreased by including indeterminate bone, we can still separate groups amongst the identified fragments. These are related to taxa, body parts and taphonomic markers. Pigs and sheep/goats cluster with dogs and equids. In this group, the upper extremities are included, of which the upper front contributes the most (ctr 37). The cattle variable is distanced and forms its own group with deer and feet. The lower front (ctr 43) and hind (ctr 48) form a cluster with the presence of cut marks (ctr 34), as well as light thermal modification (Thermal:1). The latter does not contribute much to the forming of this cluster (ctr 12). The presence of trampling (ctr 24), gnawing (ctr 39) and root etching (ctr 56) is associated with identified taxa as well. In terms of identifying human action at MH Asine, these groups may hold potential.

Dimension 2 — Contextual differences, size classes and taphonomic impact

Approximately 15.1% of the variation is explained with the second dimension (vertical divided by horizontal line). I relate the patterns along this dimension mainly to relations among the contextual categories of the site, different animal size classes and taphonomic markers. Floors (ctr 15) stand out amongst the contextual variables. Together with primary deposits (ctr 4), the floor variable deviates from the centroid. The floors seem to be characterised by lightly to medium-weathered (ctr 29) long-bone fragments (ctr 278) from especially medium-sized (ctr 150) and large-sized mammals (ctr 74). On the other hand, bones from secondary deposits (ctr 3) and rooms (ctr 0) are close to the centroid in Figure 3, meaning that they are homogenous in their composition in terms of taxa, body parts and taphonomic markers. However, the contextual categories do not contribute strongly to the patterns along the second dimension. Only the floors seem to have had an influence on the variation visible in Figure 3.

Long-bone fragments are not as damaged by modern attrition as other elements are also visible in the second dimension, where long-bone fragments and recent breakage (Rec:P) are located on the opposite sides of the middle line. This is not surprising because compact bones with a higher density are more resilient to attrition. The MH floors at Asine were compact and clay-based (Nordquist, 2015). Perhaps soil enrichment or other related processes made such bones more resilient against damage during and after excavation. Long-bone fragments seem to have been relatively more weathered. This underscores the importance of including size-classed fragments when discussing taphonomic impact (e.g. Uerpmann, 1973; Marean & Kim, 1998).

Correspondences between anatomical categories

It has been shown that analysis of skeletal part frequencies is important in taphonomic studies, especially in studies aiming to resolve issues of equifinality (e.g. Marean, 1991; Lyman, 1994, 223–293; Bar-Oz & Munro, 2004). In the present study, skeletal parts are included, but their internal correspondences are overshadowed by the inclusion of indeterminate fragments. An exception is the horn/antler variable (ctr 36), which does not cluster with any other variable in Figure 3. This isolation might be explained by the fact that, in the Asine assemblage, horn or antler fragments are not common (Figure 2) and that they derive from either identified ungulate taxa or have remained unidentified (Data S1).

In the case of Asine, the MCA shows that the abundance of axial fragments is homogenous for all taxa/size classes and contexts. The Axial variable has a low contribution to both dimensions (ctr 2 and 7) and is close to the centroid (Figure 3). As axial fragments are known to be less prone to survival than more dense bone regions, this might be discussed in terms of density-mediated attrition (Lyman, 1994, 234–258; Lam & Pearson, 2005). A study focusing on whether or not this is the case for the Asine bones would shed light on how to best use this material to discuss MH Asine society. With this in mind, it is currently not appropriate to discuss general skeletal parts' frequencies and relative taxonomic abundance at Asine.

In future studies which aim to test the usability of MCA, it could prove valuable to make use of the *mass* column in the summary (Table S1). The *mass* column provides us with a relative abundance of bone fragments, meaning that it contains quantitative measures of each variable, as would traditional skeletal part frequencies (Figure 2). It would be of importance to evaluate whether this approach can be used as an alternative to %MAU values. If there is a positive correlation, then the *mass* column could be compared with element utility and bone density in order to evaluate the impact of density-mediated attrition (Lam &

Pearson, 2005; Potter, 2007; Collins, 2015). Such an investigation should focus on anatomical distributions in specific taxa. It would also need to incorporate age and sex data, which were excluded here. Further, it would benefit from including regionally available data, that is, those from close-by sites, in order to capture general taphonomic tendencies, such as density-mediated attrition in similar geological backgrounds.

Discussion

The patterns revealed by the MCA are related to contextual and/or taphonomic differences. Along the first dimension, we could see the contrast between unidentified and identified bones in the Asine assemblage. For example, identified bones are in general more likely to exhibit taphonomic markers. Along the second dimension, we detected the relations amongst contextual categories, different animal sizes and taphonomic markers. The association amongst floors, medium-sized animals and long-bone splinters is the most notable. The aim of this paper was to investigate whether or not MCA could be used to discern possible signs of human activities, especially waste management. The discussion includes therefore, firstly, a section on traces of human activities, and, secondly, a short evaluation of the method.

Identifying traces of human activities

The high abundances of long-bone splinters from medium-sized animals on floors could indicate indoor cleaning procedures at MH Asine. The floors were perhaps regularly swept, leaving splinters, which became embedded in them, or trampled down (e.g. Martin & Russell, 2000, 62; Yeshurun *et al.*, 2014). However, the fact that they are seemingly more weathered (Figure 3) indicates exposure outdoors. Could the bones originate from the makeup of floors; that is, that they were redeposited when the floors were constructed? Is it the consequence of the dispersal actions of dogs, or perhaps even children (Hayden & Cannon, 1983)? Here, the MCA has raised further questions about prehistoric behaviour at Asine.

Marks from gnawing and trampling are visible above all amongst the identified fragments in Figure 3. It has been hard to detect and record taphonomic markers from small, non-identifiable bone splinters, which might have explained this pattern in the MCA. We already knew that dogs had access to garbage at MH Asine, so the MCA did not provide new connections in this respect. Redoing the analysis focusing on identified taxa would elaborate the discussion of waste management at Asine.

Amongst the identified fragments in Figure 3, there are clusters which seem most to reflect either pre-depositional processes or identification issues. Unfortunately, there is insufficient space to discuss all of them. One example is the correspondence amongst cattle, deer and feet. This could be explained in terms of preservation, as the compact bones of these animals are more prone to survive post-depositional destruction (Marean, 1991). Further, the better preservation of compact bones makes them easier to identify.

Evaluation of MCA

The choice of variables in the MCA is important for the outcome because removing or adding variables alters the results. Because the actual observations are reduced to correlations, transparency in the choice of variables and objects is needed. This is important to remember in the interpretation of the results. At times, it seems that the MCA does not provide more than the use of relative bone counts would, such as the contrast between identified and unidentified specimens (Figure 3). However, because MCA is a way of describing data by calculating distances between variables (Greenacre, 1984, 2007), it can disentangle the complexity of taphonomic impact; that is, it can visualise the recorded variables and their internal relations in one bi-plot. Bivariate methods cannot do this, as only two dimensions, or columns, of the data are present.

The Asine case study makes a good example of how MCA is able to visualise the complexity of multivariate data. For example, the group with cut marks, light burning and lower extremities is close to two other clusters in Figure 3, namely the group with feet, cattle and deer, and the group containing upper extremities, sheep/goat, equids, dogs and pigs. Additionally, gnawing, root etching, trampling and medium burning make up another cluster in the vicinity. All these variables are somehow connected, but the small clusters show that certain variables are closer to each other than to others. None of the variables mentioned in the preceding texts are even remotely associated to indeterminate fragments or recent breakages in Figure 3, meaning that the bones characterised as by being indeterminate and/or recently fractured are in general not characterised by the many variables mentioned in the preceding texts. The variables of long bones, weathering, floors and size-classed specimens deviate from those in the preceding texts altogether. Additionally, some variables are isolated, such as horns/antlers and heavy weathering.

The patterns in the preceding texts, with various connections and contrasts, provide starting points for the continued study of Asine during the MH period. The MCA has pointed to some taphonomic issues which need to be investigated further, such as the impact of density-mediated attrition on the animal bone assemblage as well as the erosive factors after the excavation. The correspondences and contrasts within the Asine data are indeed many and complex. This is difficult to visualise by using only relative NISP frequencies. The MCA, however, is able to describe the complexity of the data, and for this reason, it must be admitted that MCA is a good exploratory tool for the investigation of large data sets.

Conclusions

In this paper, animal bones from MH Asine have been used to exemplify the application of MCA. This paper aimed to apply MCA to taphonomic and zooarchaeological data from the site and to evaluate the applicability of this method. It is concluded that MCA is a useful tool for visualising correspondences within any given set of data. However, without a focus on explaining and interpreting their zooarchaeological meaning, patterns provided by the MCA are not of much value. MCA, as other statistical techniques, does not analyse data in order to provide zooarchaeological explanations: This is the role of the analyst. An interpretative approach is necessary when applying MCA.

A second aim of this paper was to investigate whether or not traces of human waste management at Asine could be identified by using MCA. Certain patterns which could be discussed in terms of waste management did appear, such as the occurrence of weathering amongst splinters of long bone from medium-sized mammals on floors. Other patterns were revealed, such as the association amongst trampling, light-to-medium burning and gnawing. The application of the method has also revealed that the material might suffer from density-mediated attrition, based on the homogeneity of axial fragments, which do not differ in abundance amongst different contexts, taxa or taphonomic markers. Conclusively, the biggest advantage of the MCA technique is that it simultaneously describes the correlations between several variables within a data set. This suits the complex and multivariate nature of taphonomic and zooarchaeological data. The MCA can thus provide starting points for more detailed studies of formation processes, such as post-excavation destruction, post-depositional erosion and waste management.

Acknowledgements

I wish to thank Ola Magnell, Dimitra Mylona and Torbjörn Ahlström for their valuable feedback on earlier drafts of this paper. Additionally, I am grateful to the three anonymous reviewers whose feedback on an earlier draft has improved this version of the paper. Nevertheless, any misconceptions or faults are entirely my own. No conflict of interest existed in this research.

References

Alberti G. 2013. Making sense of contingency tables in archaeology: The aid of correspondence analysis to intra-site activity areas research. *Journal of Data Science* **11**: 479–499.

Andrews P, Cook J. 1985. Natural modifications to bones in a temperate settings. *Man, New Series* **20**(4): 675–691.

Asmussen B. 2009. Experiments in taphonomy. *Journal of Archaeological Science* **36**: 528–536. DOI:10.1016/j.jas.2008.10.005.

Bannert D. 1973. Geologische Bemerkungen zur Ausgrabung am Barbouna-Hügel. Excavations in the Barbouna Area at Asine. Fascicle 1: General Introduction, Bibliography, Geological Background and a Report on the Field-work in the Levendis Sector, 1970–1972, I Hägg, R Hägg (eds.). Uppsala University: Uppsala; 16–21.

Bar-Oz G, Dayan T. 2003. Testing the use of multivariate inter-site taphonomic comparisons: The faunal analysis of Hefzibah in its Epipalaeolithic cultural context. *Journal of Archaeological Science* **30**: 885–900.

Bar-Oz G, Munro N. 2004. Beyond cautionary tales: A multivariate taphonomic approach for resolving equifinality in zooarchaeological studies. *Journal of Taphonomy* **2**(4): 201–222.

Behrensmeyer A. 1978. Taphonomic and ecological information from bone weathering. *Paleobiology* **4**(2): 150–162.

Behrensmeyer A, Kidwell SM. 1985. Taphonomy's contributions to paleobiology. *Paleobiology no.* **11**(1): 105–119.

Binford L. 1981. Bones: Ancient Men and Modern Myth. Academic Press: London.

Blumenschine RJ, Marean CW, Capaldo SD. 1996. Blind tests of inter-analyst correspondence and accuracy in the identification of cut marks, percussion marks, and carnivore tooth marks on bone surfaces. *Journal of Archaeological Science* **23**: 493–507.

Bogaard A, Palmer C, Jones G, Charles M. 1999. A FIBS approach to the use of weed ecology for the archaeobotanical recognition of crop rotation regimes. *Journal of Archaeological Science* **26**: 1211–1224.

ter Braak CJF. 1986. Canonical correspondence analysis: A new eigenvector technique for multivariate gradient analysis. *Ecology* **67**(5): 1167–1179.

ter Braak CJF, Verdonschot PFM. 1995. Canonical correspondence analysis and related multivariate methods in aquatic ecology. *Aquatic Sciences* **57**(3): 255–289.

Collins BR. 2015. The taphonomy of the final Middle Stone Age Fauna from Sibudu Cave, South Africa. *International Journal of Osteoarchaeology* **25**: 805–815.

Dietz S. 1982. Asine II: Results of the Excavations East of the Acropolis 1970–1974. Fascicle 1: General Stratigraphical Analysis and Architectural Remains. Vol. 1, Acta Instituti Atheniensis Regni Sueciae, Series in 4°. Almqvist & Wiksell: Stockholm.

Frödin O, Persson AW. 1938. Asine. Results of the Swedish Excavations 1922–1930. : Stockholm.

Grayson DK, Frey CJ. 2004. Measuring skeletal part representation in archaeological faunas. *Journal of Taphonomy* **2**(1): 27–42.

Greenacre M. 1984. Theory and Applications of Correspondence Analysis. Academic Press: London.

Greenacre M. 2007. Correspondence Analysis in Practice. Chapman & Hall/CRC: Boca Raton.

Hägg I, Hägg R. 1973. Excavations in the Barbouna Area at Asine. Fascicle 1: General Introduction, Bibliography, Geological Background and a Report on the Field-work in the Levendis Sector, 1970–1972, Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilizations. Uppsala University: Uppsala.

Hayden B, Cannon A. 1983. Where the garbage goes: Refuse disposal in the Maya Highlands. *Journal of Anthropological Archaeology* **2**: 117–163.

Haynes G. 1983. A guide for differentiating mammalian carnivore taxa responsible for gnaw damage to herbivore limb bones. *Paleobiology* **9**(2): 164–172.

Ingvarsson-Sundström A. 2008. Asine III: Supplementary Studies on the Swedish Excavations 1922–1930. Fascicle 3: Children Lost and Found, Skrifter utgivna av Svenska Institutet i Athen, 4°. Svenska Institutet i Athen: Stockholm.

Ingvarsson-Sundström A, Voutsaki S, Milka E. 2013. Diet, health and social differentiation in Middle Helladic Asine: A bioarchaeological view. Diet, Economy and Society in the Ancient Greek World: Towards a Better Integration of Archaeology and Science, S Voutsaki, SM Valamoti (eds.). Peeters: Leuven; 149–162.

Jones JR, Mulville J, Evershed RP. 2013. Fruits of the sea: Investigating marine resource use in the North Atlantic Islands. Ancient Maritime Communities and the Relationship between People and Environment Along the European Atlantic Coasts/Anciens peuplements littoraux et relations Homme/Milieu sur les c¨tes de l'Europe Atlantique. Proceeding of the HOMER 2011 Conference, Vannes (France), 28/09–1/10/2011, MY Daire, C Dupont, A Baudry, C Billard, JM Large, L Lespez, R Normand, C Scarre (eds.). Archaeopress: Oxford; 501–511.

Karr LP, Outram AK. 2015. Bone degradation and environment: understanding, assessing and conducting archaeological experiments using modern animal bones. *International Journal of Osteoarchaeology* **25**: 201–212.

Lam YM, Pearson OM. 2005. Bone density studies and the interpretation of the faunal record. *Evolutionary Anthropology no.* **14**: 99–108.

Lyman RL. 1994. Vertebrate Taphonomy. Cambridge University Press: Cambridge.

Lyman RL. 2008. Quantitative Paleozoology. Cambridge University Press: Cambridge.

Macheridis S. 2014. The pastoralism of Bronze Age Argolis: A case-study of the interpedence between agropastoral transformation and waste management. In: Libro de resúmenes - Abstracts. 12da Conferencia Internacional ICAZ, Izeta AD. Córdoba: Universidad Nacional de Córdoba.

Macheridis S. 2016. Home, refuse, and reuse during the Early Helladic III to the Middle Helladic I transitional period: A social zooarchaeological study of the Asine *Bothroi*. In review process.

Madgwick R. 2013. What makes bones shiny? Investigating trampling as a cause of bone abrasion. *Archaeological and Anthropological Sciences* **6**: 163–173.

Madgwick R. 2015. New light on feasting and deposition: Exploring accumulation history through taphonomic analysis at later prehistoric middens in Britain. *Archaeological and Anthropological Sciences*. DOI:10.1007/s12520-015-0271-2.

Madgwick R, Mulville J. 2011. Investigating variation in the prevalence of weathering in faunal assemblages in the UK: A multivariate statistical approach. *International Journal of Osteoarchaeology* **22**: 509–522.

Marciniak A. 2005. Placing Animals in the Neolithic: Social Zooarchaeology of Prehistoric Farming Communities. UCL Press: London.

Marean CW. 1991. Measuring the post-depositional destruction of bone in archaeological assemblages. *Journal Of Archaeological Science* **18**: 677–694.

Marean CW, Kim SY. 1998. Mousterian large-mammal remains from Kobeh Cave: Behavioral implications for Neanderthals and early modern humans. *Current Anthropology* **37**(S1): S79–S114.

Martin L, Russell N. 2000. Trashing rubbish. Towards Reflexive Method in Archaeology: The Example at atalhöyük, I Hodder (ed.). McDonald Institute for Archaeology Research: Cambridge; 57–69.

Moberg Nilsson K. 1996. Animal bones from Terrace III in the Lower Town of Asine. Asine III. Supplementary Studies on the Swedish Excavations 1922–1930, R Hägg, GC Nordquist, B Wells (eds.). Swedish Institute at Athens: Stockholm; 111–115.

Moreno-Garcia M, Orton C, Rackham J. 1996. A new statistical tool for comparing animal bone assemblages. *Journal of Archaeological Science* **23**: 437–453.

Nenadic O, Greenacre MJ. 2006. Computation of multiple correspondence analysis, with code in R. Multiple Correspondence Analysis and Related Methods, MJ Greenacre, J Blasius (eds.). Chapman and Hall/CRC: Boca Raton; 523–551.

Nenadic O, Greenacre MJ. 2007. Correspondence analysis in R, with two- and three-dimensional graphics: The *ca* package. *Journal of Statistical Software* **20**(3): 1–13.

Nordquist GC. 1987. A Middle Helladic Village. Asine in the Argolid, Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilizations. Uppsala University: Uppsala.

Nordquist GC. Personal communication, 2015-10-29.

Potter BA. 2007. Models of faunal processing and economy in early Holocene interior Alaska. *Environmental Archaeology* **12**(1): 3–23.

Ringrose TJ. 1992. Bootstrapping and correspondence—Analysis in archaeology. *Journal of Archaeological Science* **19**(6): 615–629. DOI:10.1016/0305-4403(92)90032-X.

Schiffer MB. 1983. Toward the identification of formation processes. *American Antiquity* **48**(4): 675–706.

Smith A, Munro N. 2009. A holistic approach to examining ancient agriculture. *Current Anthropology* **50**(6): 925–936.

Stiner MC. 1991. Food procurement and transport by human and non-human predators. *Journal Of Archaeological Science* **18**: 455–482.

Thilderqvist J. 2013. Ritual Bones or Common Waste: A Study of Early Medieval Bone Deposits in Northern Europe. Diss. University of Groeningen: Groeningen.

Uerpmann H-P. 1973. Animal bone finds and economic archaeology: A critical study of 'osteo-archaeological' method. *World Archaeology* **4**(3): 307–322.

Weissbrod L, Malkinson D, Cucchi T, Gadot Y, Finkelstein I, Bar-Oz G. 2014. Ancient urban ecology reconstructed from archaeozoological remains of small mammals in the near east. *PLoS One* **9**(3): e91795. DOI:10.1371/journal.pone.0091795.

Wells B. 1983. Asine II: Results of the Excavations East of the Acropolis. Fascicle 4: The Protogeometric Period. Part 1, An Analysis of the Settlement. Swedish Institute at Athens: Stockholm.

Wilson MVH. 1988. Taphonomic processes: Information loss and information gain. *Geoscience Canada* **15**(2): 131–148.

Yeshurun R, Bar-Oz G, Kaufman D, Weinstein-Evron M. 2014. Purpose, permanence, and perception of 14,000-year-old architecture. *Current Anthropology* **55**(5): 591–618.

Supporting information

Supporting information may be found in the online version of this article.

Paper III

SVENSKA INSTITUTEN I ATHEN OCH ROM
INSTITUTUM ATHENIENSE ATQUE INSTITUTUM ROMANUM REGNI SUECIAE

Opuscula

Annual of the Swedish Institutes at Athens and Rome

9
2016

STOCKHOLM

STELLA MACHERIDIS

Home, refuse, and reuse during the Early Helladic III to the Middle Helladic I transitional period

A social zooarchaeological study of the Asine *bothroi*

Abstract*

The practice of digging, using, and filling large pits, cut into the ground and sometimes lined with clay, was extensive from the Early Helladic III to the Middle Helladic Period I (*c.* 2,200–1,900 BC) in large parts of the Aegean area. This particular type of feature is called *bothros* and has been reported since the early 20th century from many settlements, mainly from the Greek mainland. Although the *bothroi* are numerous in the archaeological record, few studies of them have been made. During the excavations at Asine, a prehistoric coastal settlement in the Argolid, a number of *bothroi* were identified. This paper is a contribution to the study of *bothroi*, and in particular of the faunal remains found within these features. I propose that the *bothros* was an important part of the domestic organization at Asine. Not only did it reflect spatial boundaries but it was also vital in the construction of "home". This is based on the zooarchaeological analysis and subsequent statistical processing of the faunal remains recovered from the features. New radiocarbon dates are presented which are used in establishing a chronology of the *bothroi* at Asine.

Keywords: Asine, *bothroi*, Early Bronze Age, social zooarchaeology, correspondence analysis, waste management, home

Introduction

Located a few kilometres to the west of Nauplion in the Argolid, Asine is a prehistoric settlement with long continuity. It was excavated by Swedish scholars in two large and several small campaigns during the 20th century.[1] It is foremost famous for its Middle Helladic (MH) and Late Helladic (LH) settlements and burials, but the excavation of the site during the 1920s also revealed remains of an Early Helladic (EH) settlement. During the earlier campaigns, several pits called *bothros* (pl. *bothroi*) were found, which since then have remained relatively neglected in the general literature. The *bothros* is defined as a large, often find-rich, pit. It is usually found cut in the bedrock or clay-lined.[2] The function of this type of pit has been much discussed since the findings of the first *bothroi* at the EH settlement of Orchomenos.[3] Disregarding the discussion of the function, for now, the fact that they were relatively common during a certain period of time would indicate that the maintaining of a *bothros* was an important part of social life at many places.[4] This of course presupposes a good established chronology of the *bothroi*.

In this article I attempt to illustrate the social importance of the *bothroi* at Asine by analysing the faunal remains found in them. The *bothroi* contain other categories of finds, especially ceramic artefacts, which need their own separate study and will not be considered here. A zooarchaeological perspective can give new knowledge and information on this feature type. By examining the animal bones I aim to study how the management and deposition of the animal remains can reflect social boundaries and behaviour or traditions regarding the closing of the features. To underline the importance of chronology in terms of restricted temporality of the *bothroi*, this

* The animal bones from the Asine *bothroi* are part of the Asine collection at Museum Gustavianum, Uppsala University, and I am grateful to the Museum for the loan of the material as well as the permit to sample it for radiocarbon dating. This study has gratefully received financial aid for the radiocarbon dating from the Karin & Hjalmar Tornblads Fond, Kungliga Fysiografiska Sällskapet. For valuable comments and feedback on early drafts, I wish to thank Dimitra Mylona and Anne Ingvarsson-Sundström, Michael Lindblom, and Gullög Nordquist. I am also very grateful for the information on typological dating and general assessments of the pottery from M. Lindblom and G. Nordquist. Additionally, I wish to thank Michael MacKinnon and one anonymous reviewer who provided valuable comments on an earlier version of this article. Any faults or misconceptions are my own.

1 E.g. Frödin & Persson 1938; Hägg & Hägg 1973; Nordquist 1987.
2 Cf. Strasser T.F. 1999.
3 Bulle 1907.
4 Cf. Weiberg 2007.

paper includes an overview of the results of radiocarbon dates recently acquired from animal bones from these features.

The animal bone assemblages are investigated by traditional zooarchaeological methods as well as through statistical processing. As the title suggests, in the final discussion I use three thematic approaches in the discussion of the *bothroi*. First, I discuss them with regard to their place in the EH III household organization and the possible connection to the concept of home. Secondly, I illustrate the importance of the *bothroi* as refuse pits and the social management of this. Thirdly, the remembrance of *bothroi* after they were actively used is briefly touched upon.

THEORETICAL PERSPECTIVES

Central to my attempt to connect the household with the *bothroi* from a zooarchaeological perspective is the concept of waste management. This notes the inevitability of waste production and consequences that may come from handling the waste. Any society must deal with this, and does so in its own specific ways.[5] When applied to zooarchaeological material, it gives importance to the animal remains as refuse and not only as mirroring the animal husbandry on the site. The concept of waste management implies active decisions and management tied to cultural norms and organization in regard to waste and waste production. It is used here as an alternate approach to the concept of structured deposition, which is a much-used and discussed term, describing the nature of material patterning often as symbolically meaningful.[6] Waste management is particularly useful regarding zooarchaeological material, which is produced by many means, such as consumption or production. The material properties of organic animal waste will change as it decomposes, and this influences the ways that people handle it. Change in smell is one such example. Since waste is connected to consumption activities as well as the living space, the waste management system can be connected to a level of practice, as for example in the physical acts of handling waste. As such it has been discussed as an important factor in everyday life on a domestic level.[7]

During the 1990s the concept of home and its applicability in archaeology was of interest.[8] It has not been widely used since then, probably because it is difficult to use as an absolute concept in archaeological settings. We cannot know what the idea of home comprised for members of prehistoric communities; one's concept of home is contained within a specific time and place.[9] Home is created by the people within it only to dissolve when the household members no longer feel the sense of or need for solidarity that keeps the home together. According to M. Douglas, the home is a kind of space organized over time by responding to memory of events, such as hot summers.[10] Storage, she says, is a common feature of the home, and involves an intentional planning for the future. The home is contained within strict rules of behaviour, and to break them implies a threat to the community sharing the home.[11] Even if it is problematic to use the idea of home in archaeological contexts, it is important to be able to think about the home since it is a universally known and vital idea. In other words, even if we can never fully know what "home" comprised on an individual level in prehistory, we should be able to discuss general features of the home, or specific aspects of home.[12] Such features could be, for instance, common architectural elements of dwellings and traces of depositional practices, which are also important when studying household organization.[13]

METHODS

The animal remains found within the *bothroi* have been zooarchaeologically examined to determine species and anatomical element. Too few fragments could be used for age or sex assessment, and so this aspect of study is not in focus here. Taphonomic markers such as weathering, gnawing, and thermal modification were noted.[14] The osteological examination was made with access to a large zoological reference collection at the Osteological Laboratory at Lund University. The assemblage is quantified by Number of Specimens (NSP) and Number of Identified Specimens (NISP).

In this study I have chosen to analyse the data by means of correspondence analysis (CA). CA is a statistical analysis that aims to visualize the dependency between rows (objects, e.g. bones) and columns (variables, e.g. species, body parts) in a contingency table, i.e. a cross-table.[15] The CA produces coordinates of each observation in the table, based on chi-square

[5] E.g. Douglas 1966; Strasser S. 1999.
[6] E.g. Richards & Thomas 1984; Hill 1995; Garrow 2012; Rudebeck & Macheridis 2015.
[7] Martin & Russell 2000; Marciniak 2005; cf. Bourdieu 1977.
[8] E.g. Tringham 1995; Kent 1995.
[9] In other words, home is a concept which has an emotional and ideological connotation; it is private and intimate. The archaeological consideration of home should not be confused with the household. One can live in a household, yet never call it one's home. In this article it is used as a term for briefly discussing emotional attachments to the household and its organization.
[10] Douglas 1991.
[11] Douglas 1991, 304.
[12] Cf. Rapoport 1995, 46.
[13] Discussions of households can be found in e.g. Glowacki 2007; Routledge 2013; Weiberg 2007.
[14] Weathering: Behrensmeyer 1978; fire and gnawing: Lyman 1994.
[15] For a practical introduction on correspondence analysis, see Greenacre 2007. For an illustrative archaeological application of the method, see Alberti 2013.

statistics. Each observation point (observation with coordinates) is then plotted on a map, or rather a developed scatterplot, similar to principal component analysis (PCA) and factor analysis (FA).[16] These co-ordinates form the basis of distances of the observations to the average profile, meaning the relative distribution of observations in each row on average. This average is placed where there is no variation from the average, i.e. where the assumption of homogeneity would be placed.[17]

This procedure is related to the concept of inertia, which measures the variation in the contingency table visualized by the CA. The inertia will be higher with higher association between rows (objects) and columns (variables), and it will be lower as more observations conform to the average.[18] This correspondence or association is visible on the map as proximity between the variables or the objects, and/or the average. A crucial aspect of CA is the so called reduction of dimensions. In large data sets, the number of columns can be high, but since it is hard for us to observe any points in more than three dimensions, we need to reduce the number of dimensions in which they are present.[19] CA tries to do this by "locking" the data where all points are represented. How successful this has been is measured by the percentage of inertia. If 90% of the inertia, which as mentioned above is a measure of variation, is visible in the display, i.e. on the map, it means that 10% of the variation is not displayed.[20]

The graphical display produced by CA facilitates interpretation of large data sets. The distances between different points can help the analyst interpret any correlation between them and specific variables. If we are interested in how certain artefact categories are combined in graves, and in which grave categories, as well as if this change with time and how, CA is an excellent tool for archaeological interpretation. CA has in this way been used in archaeology, in the study of activity areas,[21] in detecting traces of ritual behaviour and depositions,[22] and for seriation.[23] The software used to analyse the data is CAPCA—an add-in to Microsoft Excel.[24]

THE EH III *BOTHROS* IN AEGEAN ARCHAEOLOGICAL RESEARCH

Bothroi from EH III contexts are numerous, and they have been reported from many settlements in the Aegean, although predominantly from the Greek mainland. During the excavations at Lerna, on the western outskirts of the Argive Plain, *c.* 200 *bothroi* were uncovered.[25] At Orchomenos so many *bothroi* were identified that the excavator named the archaeological horizon in which they occurred after them.[26] Further away, instances of *bothroi* are found at, for example, Troy, and Thermi in Lesbos.[27] Other EH III *bothroi* have been recorded at prehistoric settlements at Korakou, Malthi, and Berbati.[28] Even if we focus just on the EH III period, it is worth mentioning that instances of earlier EH *bothroi* have been found at sites such as Tzoungiza and Aghios Kosmas, as well as Lerna and Orchomenos.[29] At the two latter settlements however, the EH III *bothroi* are much more numerous and frequent.

H. Bulle was the first to use the term *bothros* when describing this type of pit from a prehistoric setting.[30] The explanation he offered for the Orchomenos *bothroi* differs from most of the later reports of the 20th century. Bulle came to the conclusion that they seemed to have had ritual significance, in part because of the clay lining and the ash layers with burnt animal bones within them.[31] He suggested that the ash itself was of religious importance and through the conservation of this in the pits the power of the substance was kept.[32] Since Bulle's ritual explanation of the Orchomenos *bothroi*, the general view on this feature type has shifted to a more functional one. Based on ethnographic analogies, it has been suggested that they were built as some sort of oven,[33] or containers of ash.[34] Some scholars saw them as refuse pits.[35] However the most popular explanation is that they were constructed for storage, more specifically silos or granaries.[36] According to T.F. Strasser, the storage idea is supported by their construction, i.e. that they were clearly cut in rock, or clay-lined, which would protect from dampness, and also by the amount of ash

16 Ringrose 1992; Greenacre 2007; Alberti 2013.
17 Greenacre 2007; Alberti 2013.
18 Greenacre 2007, 29; Shennan 2006, 315.
19 Greenacre 2007, 41–47.
20 Cf. Greenacre 2007, 48. CA is thus suitable to visualize general characteristics of large data sets, rather than unique phenomena, which are often easily detected without statistical techniques.
21 E.g. Alberti 2013; Blasco *et al*. 2013.
22 E.g. Welinder *et al*. 2009.
23 E.g. Bolviken *et al*. 1982; Shennan 2006, 342.
24 This software was created by Madsen (2012).

25 Caskey 1960; Banks 2013.
26 Bulle 1907.
27 Troy (Blegen *et al*. 1950) and Thermi in Lesbos (Lamb 1936).
28 Korakou (Blegen 1921), Malthi (Valmin 1938), and Berbati (Säflund 1965).
29 Tzoungiza (Pullen 2011, 93) and Aghios Kosmas (Mylonas 1934), as well as Lerna (Caskey 1960) and Orchomenos (Bulle 1907).
30 Bulle 1907.
31 Bulle 1907, 30–34.
32 Bulle 1907, 34.
33 Wace & Thompson 1912, 95.
34 Valmin 1938; Marinatos 1968.
35 Säflund 1965; Caskey 1960; More recently, J. Rutter acknowledges that *bothroi* might have had many functions, but that they ultimately ended up as pits for refuse disposal (Rutter 2008, 463).
36 Blegen 1921; Mylonas 1934; Hutchinson 1935, 1936; Strasser T.F. 1999; Banks 2013; Nilsson 2014; cf. Marinatos 1968.

present, which Marinatos, using ethnographic analogies, suggested was used for the conservation of food.[37]

In a recent study of the numerous Lerna IV (EH III) *bothroi*, E. Banks identifies many different types of function. It seems that different types can be assigned to the three phases within Lerna IV.[38] The results of her work underline the diversity of this feature type in morphology and perhaps function. Banks suggest that many *bothroi* may have started out as cooking pits, but that storage is proposed for many of them throughout the Lerna IV phase.[39] M. Nilsson[40] argues that the management of storage was communal during the early part of the EH. Instances of *bothroi* are found in the EH I–II, but not in the same frequencies as in the EH III period. By then, the *bothros* truly becomes a common denominator for mainland settlements; the cultural management of storage has shifted to household-based,[41] or at least changed. Since this paper deals with the EH III *bothroi* from a zooarchaeological perspective, it will not delve much into their original function. However, I propose that *bothroi* were indeed household-based and reflect domesticity. In this aspect, Nilsson's interpretation lies close to my own perception of the *bothroi* during the EH III.

The prehistoric *bothroi* of Asine

During the initial excavations at Asine several *bothroi* were excavated. Some of them were reported in the publication, but most are described in the excavations journals only.[42] A total of 17 *bothroi* are presented, located on Terraces I–III. They represent the documented set of *bothroi* excavated during the 1926 season. *Table 1* illustrates the general morphology and other characteristics of the Asine *bothroi*. The zooarchaeological analysis and the CA is, however, restricted to the 14[43] *bothroi* containing bone dated to the EH III–MH I periods.[44] *Fig. 1* presents a plan of Terraces I–III at Asine with mentioned *bothroi* located. As illustrated, the largest number was found on Terrace III. No *bothroi* were found inside houses, as opposed to at Orchomenos.[45] The information about their location and general characteristics is gathered from the detailed descriptions made by the excavator of the area, E.J. Knudtzon.[46]

CHRONOLOGY

The stratification and the small-scale taphonomy of each *bothros* are very important for investigating patterns in cultural deposition. For the Asine *bothroi*, this is problematic. In the publication few notes on the stratigraphy of the *bothroi* were made.[47] The excavators kept very detailed diaries, now archived at the Museum Gustavianum, Uppsala University. From notebooks as well as the find labels, it has proven possible to reconstruct, in relative terms, the stratigraphy of some *bothroi*. *Table 2*, which presents a general chronology of each *bothros* (Bs), includes the number of separated fills, if possible. The stratigraphy of these pits should not be considered fully reconstructed. But the information we do have, is that some *bothroi* contained many different layers (such as Bs-11), while some fewer (such as Bs-2). Perhaps this reflects different depositional histories, where some *bothroi* were open during a longer time. I will return to this later.

The problem of recorded stratification is also related to chronology. In order to supplement typological dates and to establish an absolute chronology, 19 animal bones were sampled for radiocarbon dating from 12 *bothroi*. These *bothroi* were selected because of their clear stratigraphy and well-preserved bone content. The sampling of them aimed to represent as many stratigraphic levels as possible, including both stratigraphically older and younger fills. Bs-1, -13, and -15 provided suitable bone samples from the older levels. Bs-15 was excavated in spits meaning that we do not know whether this pit contained different fill layers or not. The sampling of other *bothroi* with more than one layer[48] (*Table 1*) remains restricted to the middle and upper stratigraphic levels, due to various degrees of bone quantity and quality.

---

37 Strasser T.F. 1999; Marinatos 1968.

38 Examples of interpretations from Banks (2013, 413–416) are foundation *bothroi*, clearing *bothroi*, *bothroi* with special features (Lerna IV:1–2), *bothroi* marked with slabs or stones, clay-lined *bothroi* (Lerna VI:3), storage *bothroi* and *bothroi* with metallurgical activities (Lerna VI:3). See also Rutter's work on EH III drinking behaviour in the Aegean (Rutter 2008). He bases his arguments partly on the ceramic contents of two Lerna *bothroi*, Bothros B-Uu and Bothros B-O.

39 Banks 2013, 416–417.

40 Nilsson 2014.

41 Nilsson 2014.

42 Frödin & Persson 1938, see Nordquist & Hägg 1996, 14; Hutchinson 1935, 3.

43 This count excludes Bs-21 since it is from an earlier period, see below discussion on stratigraphy and absolute dates. Bs-5 and -10 are also excluded, because they contained no animal bones. Bs-10 was not excavated, but why Bs-5 contained no bones could be interesting to investigate. This is not within the scope of the article, which focuses on *bothroi* with bone assemblages.

44 The chronology used here follows Voutsaki *et al*. 2009. According to the authors, the EH III period ends at approximately 2,100 BC, while MH I lasted to approximately 1,900 BC.

45 Bulle 1907.

46 Knudtzon 1926. This field diary concerns the excavation of Terrace III at Asine during the 1926 season. It is catalogued as Diary 3.

47 Frödin & Persson 1938.

48 Of specific interest are Bs-11 which contained seven layers, as well as Bs-4 and Bs-2, of which both contained four layers each.

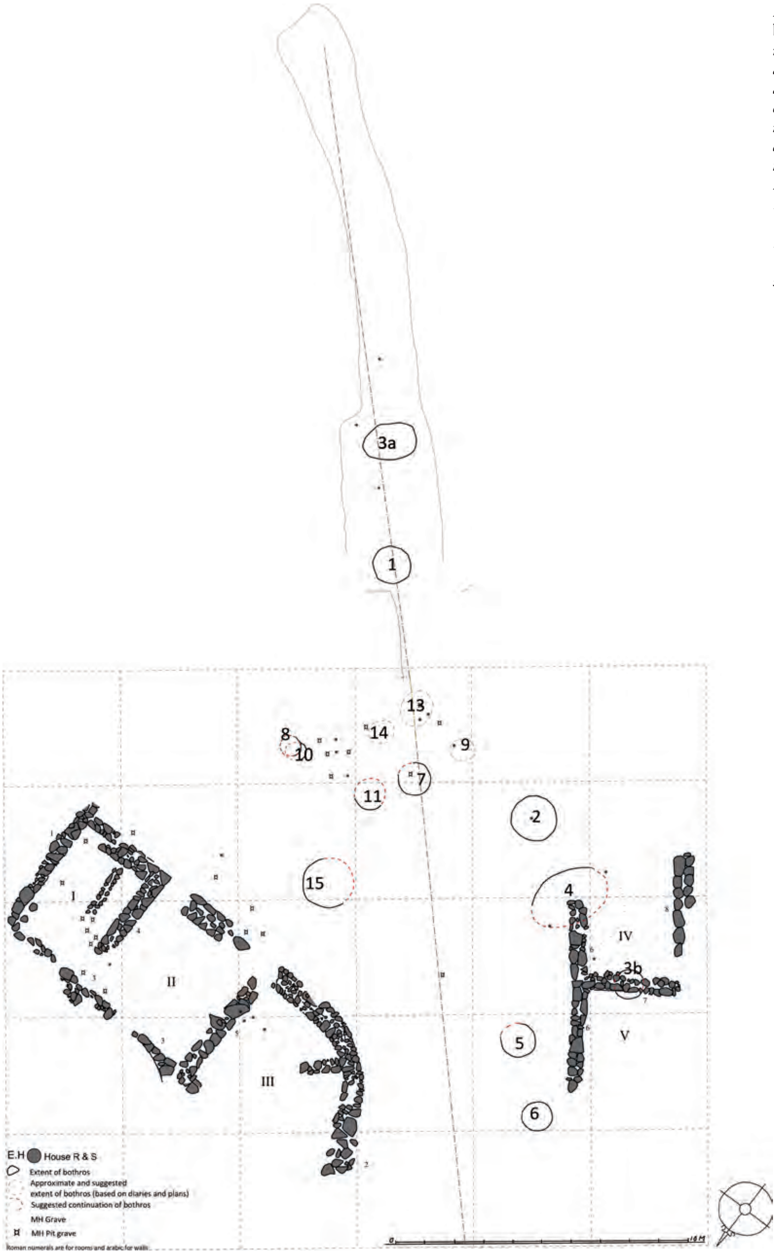

Fig. 1. Plan of mentioned bothroi *and EH houses on Terraces I–III. Locations of* bothroi *are marked with the large-sized arabic numerals. The locations of* bothroi *-12 and -21 were not found when examining the documentation from the excavations. The drawing of Terrace III is from Frödin & Persson 1938, 92, fig. 68. The drawing of Terraces I–II is from Nordquist 1987, fig. 68. Both drawings of Terraces I–II and Terrace III are slightly modified.*

Table 1. The morphology of the EH bothroi *at Asine. EJK is the initials for Erik Jo Knudzon.*

Bothros no.	*Shape*	*Width (m)*	*Depth (m)*	*Cut in bedrock*	*Ashy layers*	*Clay-lining*	*Min. no. of infill layers*	*Other*	*Diary reference*
Bs-1	Round	1.10	1–1.15	Yes	No[4]	No[4]	2		EJK 3:2, 21ff.
Bs-2	Round	1.40–1.50	1.15–1.50	–	No, but inclusions of charcoal	No[4]	4		EJK 3:1, 79, 81
Bs-3a	Slightly oval	*c.* 1–1.50	–	Yes	No[4]	No[4]	1	Cist grave (MH 98) abutting	EJK 3:2, 24
Bs-3b	Round	*c.* 1–1.50	–	Yes	No, but inclusions of charcoal	No[4]	–	Overbuilt by House S	EJK 3:1, 44f.
Bs-4	Round or lunate	*c.* 0.80–1.80[1]	>1	No[1]	No[4]	No[4]	4	Overbuilt by House S; lunate stonepaving laid on top	EJK 3:1, 53–54
Bs-5	Round	*c.* 0.80–1.80[1]	–	Yes	No[4]	No[4]	–	No bones	EJK 3:1, 45
Bs-6	Round	0.80–1 m	1.30–2	Yes	No[4]	No[4]	–	First 50 cm not recorded and mixed with surrounding soil	EJK 3:1, 52, 62
Bs-7	Round	*c.* 0.80–1.80[1]	–	Yes	No, but inclusions of charcoal	No[4]	3	Infant grave (MH 70) dug into it	EJK 3:1, 81, 89–90
Bs-8	Round	*c.* 0.8–1.20[2]	–	Partly	No[4]	No[4]	–	Partly dug into Bs-10	EJK 3:1, 95
Bs-9	Round	*c.* 0.80–1.20[2]	–	No[1]			2		EJK 3:1, 95–96
Bs-10	Round	*c.* 0.80–1.20[2]	–	Yes	No[4]	No[4]	–	No bones; not excavated	EJK 3:1, 96
Bs-11	Round	*c.* 0.80–1.80[1]	–	Yes			7		EJK 3:1, 103–105
Bs-12	Round	*c.* 0.80–1.20[3]	–	Yes	No[4]	No[4]	–		EJK 3:1, 105
Bs-13	Round	*c.* 0.80–1.80[1]	–	Yes	No[4]	No[4]	6		EJK 3:1, 110
Bs-14	Round	*c.* 0.80–1.20[3]	–	No[1]	No[4]	No[4]	–		EJK 3:1, 112–113
Bs-15	Round	1.40–1.45	0.90	Yes	No	No	–[5]	Until 3 April 1926 called "the well" by EJK	EJK 3:1, 37–38
Bs-21	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	–	Not found on map or in diary	

[1] No description was given in the field diary.
[2] Size reconstructed from stratigraphic descriptions in the field diary specifying its location in regards to other features.
[3] Described as a "small *bothros*" in the field diary.
[4] No mention of ashy layers and/or clay-lining exists in the description in the field diary.
[5] Bs-15 was excavated in five units (or spits). This means we cannot use them as separated contexts.

The radiocarbon dating was performed at the Laboratory of Radiocarbon Dating at the Geological Department of Lund University. Most of the samples are dated to the EH III/MH I transitional period (2,200–2,000 cal. BC), regardless of stratigraphic level. The typological dates based on the pottery from the *bothroi* also point to this general tendency; those *bothroi* which are relatively dated are normally assigned the periods EH III or EH III/MH I.[49] This is roughly consistent with the most intensive *bothros*-digging at Lerna IV,[50] but also at Orchomenos[51] and Berbati.[52] In *Table 2*, we can see the calibrated ^{14}C dates. Additionally, *Figure 2* shows the most probable date range for the features when combined, which

[49] Lindblom and Nordquist, pers. comm., 2015.

[50] Banks 2013.
[51] Bulle 1907; Sarri 2010, 43.
[52] Säflund 1965.

is *c.* 2,135–2,028 BC.[53] The true date is possibly in the early years of this time span, i.e. 2,135–2,078 BC, indicated by the distribution of the higher percentages. Two samples deriving from *bothroi* Bs-4 and -21, which are discussed in the next section, deviate from this date range.

Stratigraphic relations in relation to ^{14}C-dates

Houses R and S were the only buildings that were erected in the EH III period among the excavated remains. Previously, the construction of House R had been suggested to belong to the EH II period.[54] House S overlies Bs-3b and -4.[55] The stratigraphic relations with those *bothroi*, as well as the pottery indicate an EH III date.[56] Bs-4 is dated both by pottery and radiocarbon analysis to EH II–III, and seems to have been used for a longer period than the others. This stratigraphic circumstance could indicate that House S was the younger of the two EH houses. If so, House R would perhaps have been contemporary with the construction and usage of at least Bs-3b and -4. Perhaps we have the remains of a sequence of at least two *bothros* phases. First the *bothroi* beneath House S were used when this area was an open space. When the need to build another house (House S) arose, they were closed and new ones were constructed between House R and S. This would explain the earlier dates in Bs-4. Either way, House T was built over many of the *bothroi* in the early MH, destroying parts of House S and perhaps R during its construction.

The cluster of *bothroi* south-east of the middle ground between Houses S and R consists of Bs-7, -8, -9, -11, -13, and -14 (*Fig. 1*). Within this little gathering of pits we can observe the largest collection of MH graves on Terrace III, except for Room I of House R. In Bs-7 a burial of an infant of six ± two months of age (MH 76) was buried, during the construction of House T.[57] Graves have also been dug in Bs-9 and -13. Bs-8, -10, -11 and -14 are in close proximity to graves. The placement of so many graves in and around this *bothros* cluster might not be random. I suspect these *bothroi* would have been noticed when digging the graves. This visibility might have been important when choosing the spot for the burial. This in its turn could help us establish a relative sequence for them.

Among the *bothroi* (Bs-3b, -4, -5, and -6) in the vicinity of House S, only Bs-4 was in the close proximity to a burial and none of them was directly cut by burials (*Fig. 1*). Since graves often were made close to or in closed *bothroi*, as discussed above, this could be explained by the fact that these pits were already covered by House S and/or its surroundings. In that case, they should be considered to belong to the "first" *bothros* phase, and belonged to House R, while the rest would have been constructed later between House R and S. This observation and the relation between graves and *bothroi* at Asine will be further explored in the discussion.[58]

Bs-2 and -6 were not overbuilt by any constructions; however, their dates indicate the same time period as most of the other. Since they were not overlaid by any construction, then the fact that the radiocarbon dates are so consistent with those also overlaid by walls shows that the stratigraphy is not very mixed, and indeed that we can recognize closed units excavated during the 1920s. In that case, it is very probable that a distinct break, after which the *bothroi* were no longer used, filled up and closed, occurred. That time would have been the end of EH III, or early MH I.[59]

The two earliest dates come from Bs-4 and -21. As mentioned above, Bs-4 seems to have ceased to be in use approximately the same time as the majority of *bothroi*, but was made much earlier. The sample from Bs-21 came from its uppermost layer. This suggests it was used and sealed in an earlier period than the other and should perhaps be dated late EH I to EH II. Because of its much earlier date, Bs-21 is excluded from the following analysis, which concentrates on the *bothroi* closed in the transitional period (EH III/MH I). Further studies on the early *bothroi* are needed to fully understand the evolution of the feature.

Distribution of animal bones: analysis and results

The reconstructed stratigraphy has shown that there seem to be several fill layers in some *bothroi*, while some were filled up more quickly. Regardless, the filling of these pits is dated to somewhere between 2,135–2,028 BC, most likely 2,135–2,078 BC (*Table 2*, *Fig. 2*). This is based on dates from both older and younger layers in the *bothroi*. The animal bones found in these layers should represent waste materials from this period. In this section I present an overview of the animal bones from the *bothroi* of Asine.[60] This is followed by an

53 Calculated with the "combine date" function in Oxcal v. 4.2, web interface. All acquired dates have been calibrated with Oxcal v. 4.2 (Bronk Ramsey 2001; 2009), using IntCal13 atmospheric curve (Reimer *et al.* 2013).
54 Caskey 1960, 301; cf. Pullen 1987.
55 Frödin & Persson 1938; Nordquist 1987, 71.
56 Nordquist 1987, 72.
57 Nordquist 1987; Ingvarsson-Sundström 2008, 60.

58 The connection between graves and closed *bothroi* at Asine does not mean that all *bothroi* in Greece during this period became places for burials. This is a contextual observation, and is maybe relevant for Asine.
59 This break is also noticed at Lerna (Banks 2013), Berbati (Säflund 1965), and other sites (see Hutchinson 1935; Strasser T.F. 1999).
60 It should be mentioned that the animal bones were at least not discarded, as was often the case during the early years of archaeological excavation projects (e.g. MacKinnon 2007, 475). They are now stored at the facilities of Museum Gustavianum, Uppsala University.

Table 2. Chronology of the EH bothroi *at Asine. Calibration of ^{14}C dates derived from Oxcal v 4.2 (Bronk Ramsey 2001; 2009). The LuS nos are the numbers assigned by the Radiocarbon Dating Laboratory, Lund University.*

Bothros no.	*Asine no.*	*LuS no.*	*Uncal. ^{14}C-date BP*	*68.2% probability (cal. BCE)*	*95.4 % probability (cal. BCE)*	*Typological date*	*Proposed date*
Bs-1	2262	10927	3725 ± 40	2198–2040	2279–1982	EH III	EH III–MH I
Bs-1	5168	10934	3655 ± 45	2129–1956	2192–1911		EH III–MH I
Bs-2	4659	10935	3715 ± 40	2195–2036	2275–1978	EH III–MH I	EH III–MH I
Bs-2	4523	10936	3655 ± 45	2129–1956	2192–1911		EH III–MH I
Bs-3b	2402	11548	3725±35	2197–2042	2275–2024	EH/MH I	EH III–MH I
Bs-4	5201	10938	3935 ± 45	2488–2346	2569–2292	EH II–III	EH II–III
Bs-4	2307	10939	3690 ± 40	2136–2025	2199–1960		EH III–MH I
Bs-7	5196	10930	3625 ± 35	2031–1940	2129–1892	EH/MH	EH III–MH I
Bs-8	4851	10940	3700 ± 45	2191–2030	2266–1951	EH III–MH I	EH III–MH I
Bs-9	4655	10941	3680 ± 40	2136–1984	2196–1950	EH III–MH I	EH III–MH I
Bs-11	5127	10928	3670 ± 40	2134–1979	2195–1939	EH III–MH I	EH III–MH I
Bs-11	5115	10929	3655 ± 40	2127–1961	2141–1918		EH III–MH I
Bs-13	2294	10931	3700 ± 40	2141–2031	2203–1972	EH III–MH I	EH III–MH I
Bs-13	5171	10932	3595 ± 45	2019–1894	2129–1777		EH III–MH I
Bs-14	5242	10933	3660 ± 40	2131–1965	2190–1926	EH III–MH I	EH III–MH I
Bs-15	4615	11528	3730 ± 35	2198–2044	2276–2028		EH III–MH I
Bs-15	4512	11529	3700 ± 35	2137–2036	2201–1978		EH III–MH I
Bs-15	2856	11530	3710 ± 35	2190–2036	2204–1981		EH III–MH I
Bs-21	2237	10942	4135 ± 45	2864–2628	2875–2581	EH I (II)	

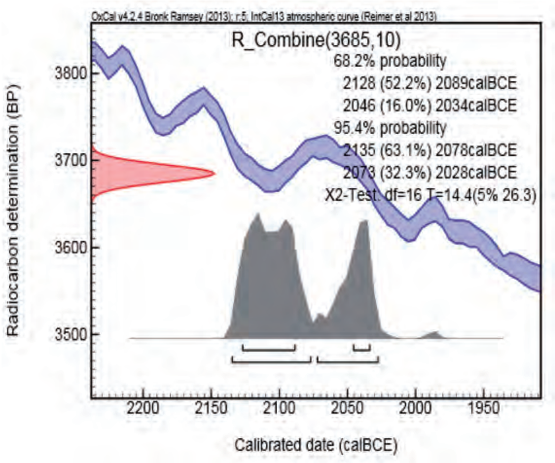

Fig. 2. Combined date range for radiocarbon dates from the bothroi *of Asine. This figure includes all derived dates except the early date from Bs-4, As 5201 (*Table 2*). It was made using Oxcal v 4.2 (Bronk Ramsey 2001; 2009).*

investigation of possible material patterning by means of correspondence analysis. The CA is done twice, for the species distribution and for the distribution of body parts.

The 14 *bothroi* zooarchaeologically investigated contained 861 animal bone fragments (8,703 g), of which 339 were identified to genus. As mentioned above only data on species and body parts and the distribution of these are presented, since too few fragments were suitable for age or sex assessment. A quantitative distribution can be seen in *Fig. 3*. As is visible, most fragments derive from Bs-4, -11, -13, -14, and -15, while the *bothroi* with the fewest bone fragments were Bs-3a, -6, -8, and -12. Cattle, sheep/goat, pig, red deer, horse, dog, and tortoise are identified.

Many *bothroi* are dominated by cranial fragments, but this is not always the case. For example, Bs-3b, -7, -8, -9, and -12 contained more post-cranial than cranial fragments.[61] This can be important information because cranial fragments, especially loose teeth, are known to be more prone to survive harsher conditions. That bone fragments deriving from all body regions are identified indicates, rather, that there is relatively good preservation of the bones. The occurrence of spongy bones in the different *bothroi* is also a sign of good preservation, as well as the well-preserved juvenile human remains from graves elsewhere on the site.[62] The lack of fragile bones in some features could be a consequence of taphonomic loss. Because there are little to no different geological circumstances between the features, this speaks against it being a pure post-depositional bias. Although the bones are in good condition, the assemblage probably suffers from size bias caused by the excavation methodology.[63] The animal bones were recovered during 1926, as part of the Swedish Asine project. The finds were hand-picked and not sieved, meaning that smaller fragments such as from fish, might have been a part of the depositional assemblage but were not recovered during excavation.[64]

In *Table 3*, different taphonomic frequencies are presented. As one can see, the most common taphonomic marker amongst the bones is weathering. It seems that this process did affect some bones (51 fragments), but this is still a minor part (*c*. 8 %) of the total NSP. In addition to this, root etching appeared on 19 fragments. This could indicate that the assemblages in the *bothroi* were exposed for some time before deposition. However, this cannot be ascertained since root

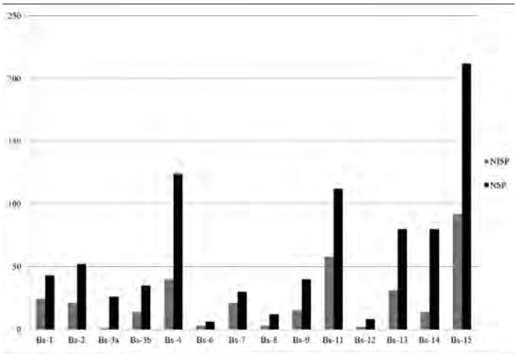

Fig. 3. Quantitative distribution of animal bone fragments in bothroi *of Asine, including total NISP and NSP counts.*

marks have been found also on human remains from graves, and roots might have reached deep under the ground. Furthermore, it has been said that the *bothroi* of Asine contained calcined bones.[65] I have found no such indications: of all the bones recorded, only eight fragments were burned, and they were not calcined. Probably, these few fragments represent food preparation or something similar.

A closer look at *Table 3* reveals that weathering is not recorded from all features. Only in about half of the *bothroi* are there bones which evidence this process. Together with the fact that gnawing appeared on fragments from almost all *bothroi*, perhaps it indicates that there were different strategies in the filling of the *bothroi*. The *bothroi* with the most fragments with weathering are Bs-14, from which no stratigraphy could be reconstructed, and Bs-4. If Bs-4 was in use the longest, which is supported by the ^{14}C dates, it would be logical that it had been exposed for a longer time. Even if the lack of gnawing, weathering and other taphonomic markers does not automatically correspond to a quick depositional history, it does not contradict it. That the animal bone fragments are relatively well-preserved do point to a more likely scenario of closed refuse accumulation or quick filling events. Judging from the reconstructed stratification of the *bothroi* (see *Table 2*), and the taphonomy of the bone fragments, it does seem that some of the assemblages bear signs of longer accumulation periods, that is, time exposed, while others were relatively quickly deposited, perhaps during a year, some months or even less. It can thus also be argued that different modes of

---

[61] Animal bone fragments assigned to body regions, and their distribution within the *bothroi*, are included in *Table 5* below, which is the data set for the correspondence analysis of body regions.

[62] See Ingvarsson-Sundström 2008.

[63] See Bannert 1973.

[64] See Mylona 2003 on archaeological fish remains in the Greek region.

[65] Hutchinson 1935, 3.

Table 3. Distribution of taphonomic markers in the animal bone assemblages from the bothroi *of Asine.*

Bothros *no.*	*Cut marks*	*Gnawing*	*Fire*	*Weathering*	*Root etching*	*Post-depositional markers*	*Excavational/post-excavational markers*
Bs-1	1	1	0	0	0	0	8
Bs-2	2	2	0	6	2	2	12
Bs-3a	0	0	0	0	0	0	22
Bs-3b	2	0	3	5	1	0	10
Bs-4	5	3	3	14	6	1	37
Bs-6	0	2	0	0	0	1	1
Bs-7	0	0	0	0	0	0	19
Bs-8	0	2	0	0	0	0	3
Bs-9	0	2	2	1	1	1	16
Bs-11	6	3	0	6	1	1	37
Bs-12	0	2	0	0	1	0	5
Bs-13	1	1	0	7	3	3	33
Bs-14	2	0	0	12	3	0	30
Bs-15	8	9	1	0	1	1	200
Total	**27**	**27**	**9**	**51**	**19**	**10**	**433**

handling the faunal remains, eventually deposited in *bothroi*, existed. The pottery sherds from the *bothroi* seem to be fragmentary in general, but not extremely worn. They appear to derive mainly from pots related to storage and cooking. For now, it appears that the handling of the material deposited in *bothroi* was different from case to case: some material was accumulated and exposed over a longer period while some was deposited relatively quickly. To confirm or contradict this general picture, more detailed studies of the pottery are needed.[66]

CORRESPONDENCE ANALYSES

I have chosen to use correspondence analysis to visualize the distribution of animal bone fragments in the *bothroi*. The reason to use CA is that it is a way to get a more detailed overview of larger data set, such as this one, than general species lists and distributions of body parts. It is also a more effective way than producing graphs of frequencies of species and body parts for each *bothros*, and then to try to manually compare them. The assumption that underlies this exercise is that patterns of the discarded body parts within the *bothroi* reflect patterns in refuse disposal or management of these in the features. The CA is done once on species distribution and once on body part distribution. All data used in the analyses are presented in *Tables 4–5*. The statistical analyses are restricted to cattle, sheep/goat, pig, and red deer. These are chosen because they are the dominant taxa of the assemblages from the *bothroi*. It is true that the NISP for red deer is low (n=28), but the numerous antler fragments/raw material refuse found elsewhere in the settlement make it interesting to include this animal.[67]

First, we test the species distribution in the *bothroi* to see if it is random or not. The variables are cattle, sheep/goat, pig, and red deer. Also, in the data set in *Table 4* we can already now see that red deer did not occur in each *bothros*, and might have been differently deposited. We want to know if there are specific associations between these four taxa, and if there is any clustering of *bothroi* in relation to the species distribution.

Second, we want to test the body part distribution among the *bothroi*. There seem to be an overrepresentation of cranial fragments, such as teeth, in some *bothroi*. But also more fragile bone fragments occur, which might indicate a diverse picture of the *bothroi* contents in terms of body parts. The aim of the second CA is to examine the body parts, in order to investigate if there are any useful patterns which can be used for the discussion of waste management of different body parts, butchery strategies, or activity areas in connection to the

[66] Preliminary information on the general characteristics of the pottery from the *bothroi* is provided by Lindblom and Nordquist, pers. comm.

[67] Frödin & Persson 1938, 253–254; Nordquist 1987, 31, 40; cf. Moberg Nilsson 1996, 115. Most of these instances are later, dated to the MH. Still, it is interesting to test whether a different use of remains of red deer can be traced further back or not.

Table 4. Data set for the correspondence analysis of species composition within the bothroi*, Asine.*

Bothros *no.*	*Bos*	*Ovis/Capra*	*Sus*	*Cervus*
Bs-1	7	11	5	0
Bs-2	1	11	7	0
Bs-3a	1	0	0	0
Bs-3b	2	5	2	4
Bs-4	15	9	11	4
Bs-6	0	1	1	1
Bs-7	2	1	7	1
Bs-8	0	1	1	1
Bs-9	3	3	9	0
Bs-11	21	12	22	2
Bs-12	0	1	0	1
Bs-13	2	8	20	2
Bs-14	4	4	6	0
Bs-15	23	23	32	12

Table 5. Data set for the correspondence analysis of body parts' distribution within the bothroi*, Asine.*

Bothros *no.*	*Head*	*Axial*	*Upper extremities*	*Lower extremities*
Bs-1	13	0	6	4
Bs-2	6	1	10	2
Bs-3a	1	0	0	0
Bs-3b	5	0	5	3
Bs-4	11	5	17	6
Bs-6	0	1	1	1
Bs-7	3	1	6	1
Bs-8	1	0	2	0
Bs-9	5	1	8	1
Bs-11	24	7	19	7
Bs-12	0	0	1	1
Bs-13	16	2	8	6
Bs-14	7	1	4	2
Bs-15	44	5	28	13

houses. The assumption here is that different parts of the body from the most abundantly represented animals provide the best alternative to study patterning concerning refuse disposal or management of these in the *bothroi*.

I have chosen not to separate the taxa in the second CA since this would lead to very low NISP counts resulting in insignificant statistics. The variables used are *Head* (*calvarium*, *cornu*, *mandibula*), *Axial* (*vertebrae*, *costae*), *Upper* (*scapula*, *humerus*, *radius*, *ulna*, *ossa coxae*, *femur*, *tibia*, *fibula*), and *Lower* (*ossa carpi/tarsi*, *metapodia*, *phalanges*). This division of the body is a simplified categorization of the bulk of the animal body. It could be translated to meat-bearing regions (axial and upper extremities) and non-meat-bearing parts (head and lower extremities). This division is not entirely correct as the head is full of nutrients, although it takes longer to butcher.[68] In many societies, the head, or parts of it, is considered to be a delicacy. I will not further relate these simple categories to cultural preferences as it is not my intent to equate them with a prehistoric concept of the animal body.

Species composition

The results of the analysis can be seen in *Fig. 4a–c*, which illustrates the graphs produced by the CA. All inertia, basically meaning variability,[69] is contained within the first three dimensions. The percentage of inertia in the first axis, or dimension, is 42%, the second 33.4%, and the third 24.8%.[70] This means that 75% of the variation is captured in *Fig. 4a* (first–second axes), 66.8% in *Fig. 4b*, etc.

As suspected, the most dominant pattern involves red deer and is visible in *Fig. 4a*. Here, the variable red deer is distanced from the other domesticates. Red deer explains the first axis with *c.* 83%, meaning it is the most important variable in shaping the distances and/or proximities of the *bothroi* (rows) and variables (columns). Bs-3b, -6, -8, and -12 are forming a group around the red deer variable. This pattern is also clear in *Fig. 4b*, where the first and the third axes are combined. The second pattern lies with the three domesticates where cattle remains seem to have been deposited differently from the sheep/goat and pig. Cattle contribute with *c.* 71% to the second axis; sheep/goat with 55% and pig 23%. Cattle is thus the biggest factor in shaping the plotting of the observation points. This is visible in *Fig. 4a* along the second dimensions and in *Fig. 4c*. The sheep/goat variable is slightly closer to the middle, or the centroid, in *Fig. 4a*, indicating that it is of less significance in explaining any variability.[71] The same can be said for cattle in *Fig. 4b* (third axis). Returning to the data set, we can see that cattle seem not to be as abundantly represented as sheep/goat and pig in general. Also, when pig remains appeared in larger counts, the number of cattle fragments became proportionally smaller, while sheep/goat remains approximately the same. This relationship is visible along the second axis in *Fig. 4a*.

In *Fig. 4b*, we can observe that pig and cattle seem to be associated. This is probably because of the even number of cattle and pig in Bs-4 and -11 . Two *bothroi* cluster around the sheep/

[68] E.g. Stiner 1991, 471.
[69] Shennan 2006, 315.
[70] Cf. Greenacre 2007; Shennan 2006.
[71] Greenacre 2007, 22.

goat variable (Bs-1 and -2). This is because ovicaprine remains are more abundant in those pits than both cattle and pig, and red deer is not represented at all. Three *bothroi*, Bs-7, -9, and -13, remain close to the pig-variable in all dimensions. This could indicate that pig was specifically deposited in these pits. This is partially confirmed by returning to the data set in *Table 4*, where we can see that pig is indeed most numerous of all taxa in these *bothroi*.

Bs-15 is always close to the average. This can probably be explained by it actually being unique and ordinary at the same time. It is unique because of its rich bone content of all animal species. However, its relative proportions seem to be quite common in relation to the rest of the data set, that is, the contents of this particular *bothros* do not deviate from the calculated average profile of all objects (rows). This average has a low proportion of red deer and more even cattle and sheep/goat abundances, and a slightly higher content of pig.

All in all, according to the CA of species distribution, the typical pattern in a *bothros* at Asine is that all domestic animals are represented relatively evenly, with a low proportion of red deer. Depending on their abundance, the *bothros* will deviate from this pattern. This is visualized by closeness and distances of these variables in *Fig. 4a–c*. Red deer, which we already knew was much less abundant, did not cluster with the domesticated taxa. This probably indicates that red deer was not as commonly consumed, and it was not deposited in all *bothroi*. When it was deposited, it mainly ended up in Bs-3b, -6, -8, and -12. In general, cattle do not associate with sheep/goat and pig. This does not mean that they are not found together, but that there is a tendency of frequencies of cattle being lower when pig and sheep/goat occur in higher numbers. This could mean that some *bothroi* were more frequently used for the deposition of medium-sized domesticates.

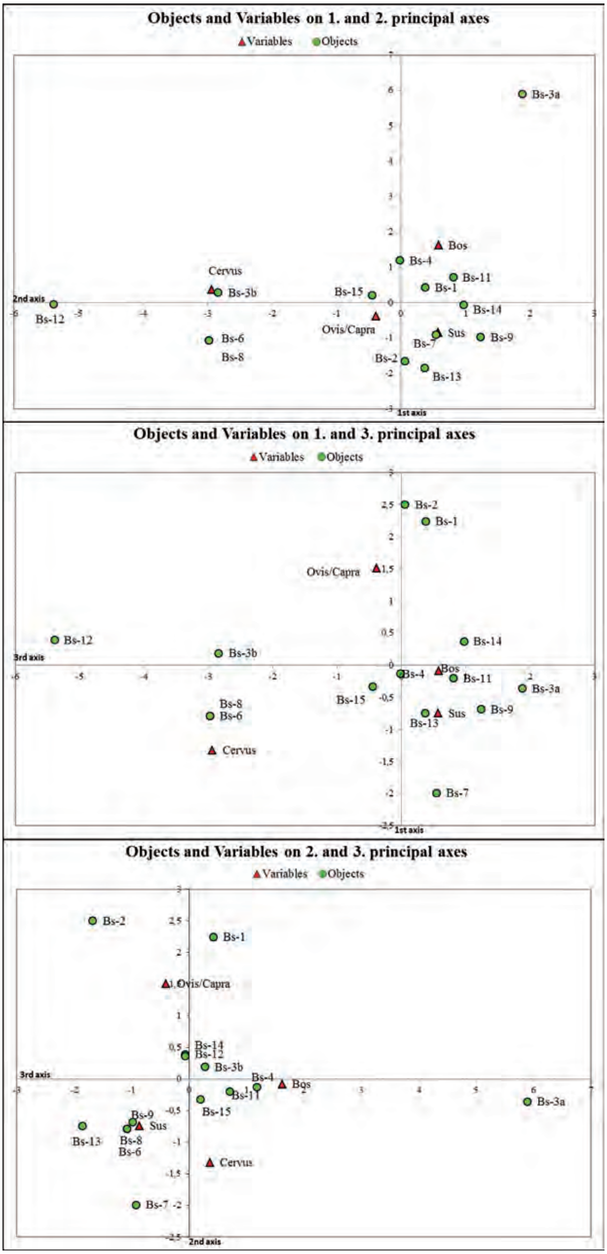

Fig. 4a–c (from top to bottom). Results of correspondence analysis of species composition (cattle, sheep/goat, pig, and red deer) within the bothroi*, Asine. 4a) observations along the first and second principal axes; 4b) observations along the first and third principal axes; 4c) observations along the second and third principal axes.*

Body part distribution

In *Fig. 5a–c* we see the graphical results of the second CA, which investigated the body parts distribution between the *bothroi*. The first dimension contains *c.* 56% of the total percentage of inertia, the second 26% and the third 18%. The highest variation is thus explained in *Fig. 5a* (82%) and *Fig. 5b* (74%).

The first and third axes (*Fig. 5a–b*) both show a similar pattern where fragments from the head together with those from *Lower* are opposing those from *Axial* and *Upper*. In *Fig. 5a–b* we can observe two groups of *bothroi* returning. One group is associated with *Axial* and *Upper* (Bs-2, -4, -7, -8, -9, and -12) and one with *Lower* and *Head* (Bs-1, -3b, -13, -14, and -15). This pattern indicates dissociation between body parts with easy access to meat (*Axial* and *Upper*) and body parts with less meat or special in other ways (*Lower* and *Head*). It can be a sign of differentiated handling of the remains from butchering versus consumption. Perhaps this can be discussed in terms of proximity of butchery workshops or consumption areas. Bs-11 is close to the average in *Fig. 5a–b*, probably reflecting that its distribution of body parts is homogenous.

A second pattern lies along the second axis, visible in *Fig. 5c*. Here we see *Head*, but also *Upper*, close to the average, the centroid. Many *bothroi* are placed around the centroid. This is because they contained *Head* and *Upper*. Bs-3a is much distanced, because it only contained one cranial fragment. Similarly we have Bs-8, which contained both *Head* and *Upper* but not the other, and Bs-6 (*Axial*) and Bs-12 (*Lower*) where the opposite situation is occurring. Returning to the data set in *Table 5*, we can see that the "normal" distribution consists of well-represented *Head* and *Upper* parts,

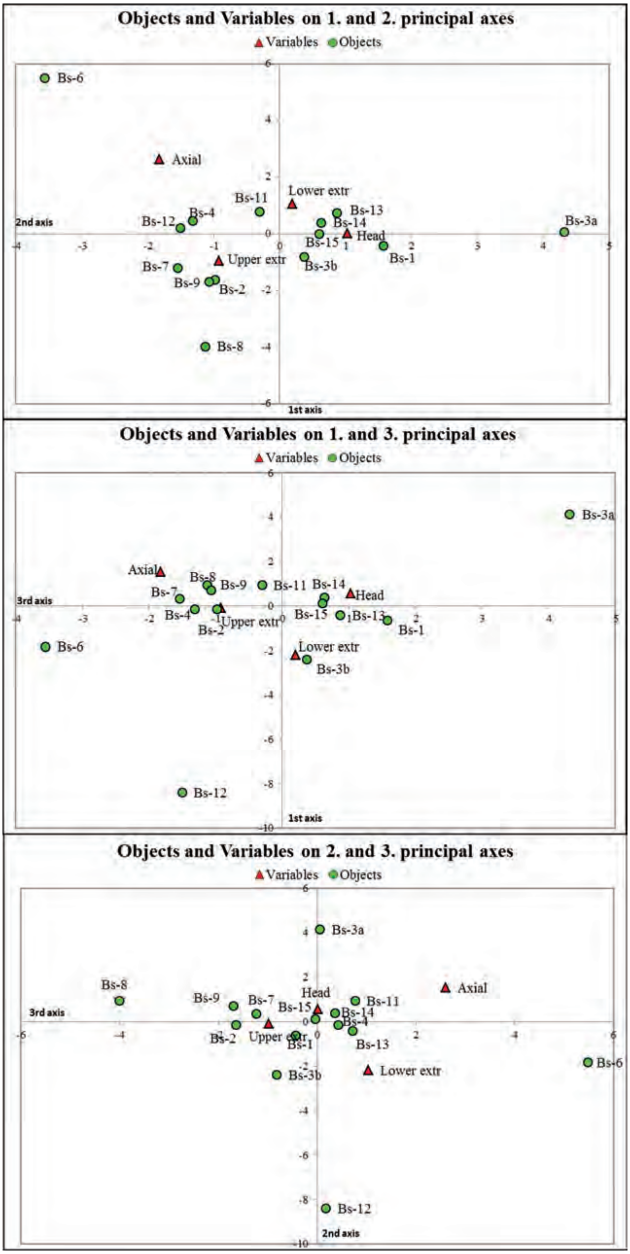

Fig. 5a–c (from top to bottom). Results of correspondence analysis of body parts' distributions of cattle, sheep/goat, pig, and red deer within the bothroi*, Asine. 5a) observations along the first and second principal axes; 5b) observations along the first and third principal axes; 5c) observations along the second and third principal axes.*

Table 6. Categorization of the bothroi *of Asine according to the interpretation of the correspondence analysis.*

Group	Bothros *no.*	*General characteristics*	*Explanation*	*Interpretation*
A	3b, 6, 8, 12	Association with red deer	Red deer and medium-sized are present, but not cattle.	*Bothroi* for the deposition of butchery and consumption waste from red deer, not cattle (sheep/goat and pig still present).
B	4, 11, 3a	Association with cattle and pig	Cattle and pig predominant. Presence of cattle in this proportion quite ordinary, therefore Bs-11 close to *origo*. Bs-3a is almost an outlier because it only contained one cattle fragment.	*Bothroi* for the deposition of cattle and pig.
C	7, 9, 13, 14, 2	Association with sheep/goat and pig	Sheep/ goat and/or pig predominant. Proportionally low inclusions of large herbivores. Bs-7, -9, -13 dominated by pig.	*Bothroi* for the deposition of mainly medium-sized animals.
D	1, 13, 14, 15, 3a, 3b,	Association with head and lower extremities	Relatively unusual large proportions of head and lower extremities.	*Bothroi* for the deposition of mainly butchery waste.
E	2, 4,7, 9, 8, 6, 12	Association with axial and upper extremities	Relatively unusual large proportion of axial and/or upper extremities.	*Bothroi* for the deposition of mainly consumption waste.

while the other two variables are more unusual. This reflects a taphonomic issue because cranial fragments such as teeth and compact fragments from long bones are more resistant to decomposition and density-mediated attrition, i.e. more prone to be overrepresented in zooarchaeological assemblages.[72] This pattern is thus probably taphonomically biased, showing the features as deviating simply because they contained either only better-preserved body parts or unusually high degree of normally not as abundant body parts which are more prone to destruction after deposition.

Short summary

The two correspondence analyses revealed some interesting patterns. First, we have detected that red deer disassociates with the domesticated animals, and is specifically associated with Bs-3b, -6, -8, and -12. This does not mean that the domesticated animals did not occur in these *bothroi*. Further, red deer is also found, although sporadically, in other features. Cattle is not represented in Bs-6 and -8. Secondly, we can see that cattle contrasts with sheep/goat and pig. Bs-1, -2, -7, -9, -13, and -14 should be associated with the deposition of mainly medium-sized animals. In a similar way, cattle should be associated with mainly Bs-3a, -4, and -11. In Bs-4 and -11 pig remains were also abundant. Again, this does not presuppose a lack of other animals in these *bothroi*, as e.g. cattle is abundant in Bs-1 and -14. But, it might mean that certain animal remains were deposited in certain *bothroi* rather than others, even if this rule was not followed strictly.

The third and the fourth patterns I choose to discuss are based on the CA of body parts' distributions. The third consists of an association between *Head* and *Lower* while *Upper* and *Axial* group together. This might reflect a division in the deposition of meat-rich vs. non-meaty limbs and the head. At Asine this might translate to consumption and butchery waste. Finally, the fourth pattern is that of taphonomic bias in terms of post-depositional disturbance, in the sense that normal proportions of body parts are strongly overrepresented by *Head* and *Upper*. A majority of pits conform to this pattern. Thus, the CA has shown that while taphonomic processes have affected the material we have a stronger pattern which probably can be connected with the archaeological handling of bones or bodies at the settlement.

In *Table 6* I have made a categorization of the *bothroi* according to the results of the above analyses. When considering *Table 6*, it is important to retain the notion that there is a taphonomic bias which strongly shaped the distribution of observations, and that these categorizations are based on deviations from it. I will not discuss the taphonomy more in this article, but it is clear that the analysis illustrates the potential of this method within the field of vertebrate taphonomy, and should be explored in future studies.

I have distinguished five groups in *Table 6*. Groups A, B, and C are based on species distribution. They do not correlate with groups D and E which are based on body part distribution. This means that each *bothros* is assigned two groups: one on basis of species composition and one relating to distribution of body parts. Bs-11 and -15 are exceptions because Bs-15 could not be tied to any groups in the CA of species distribution; the same concerns Bs-11 in the CA of body part's distri-

72 Lyman 1994; Orton 2012.

bution. In these instances, these *bothroi* were placed close to the centroid of the CA, thus not conforming to any pattern.

While one *bothros* might have been the destination of primarily consumption waste from cattle and pig, another could have contained mainly butchery waste of medium-sized mammals. I do not wish to categorize them any further, e.g. "butchery waste from red deer", since the results do not really support more detailed interpretation. Many of the Asine *bothroi* are represented by small sample sizes. For example, the "red deer" *bothroi* Bs-6, -8, and -12, contained very few bone fragments, as did Bs-3a. Their assignments to any of the anatomical groups D or E are perhaps dubious. Because of this quantitative issue, the categories in *Table 6* remain interpretative in their nature. Nevertheless, the use of CA can, even in small samples, provide general patterns of archaeological interest.

SPATIAL CONNECTIONS

In *Fig. 6*, I have merged my interpretations of the *bothroi* and their location on the map. Additionally, my perception of the chronology of the *bothroi* has been added. The reconstructed stratigraphy combined with absolute and relative dates indicates that although different strategies existed while filling the *bothroi*, they were probably filled up during the same approximate period. This could be during the same year, but it could also be two generations, if following the narrowest span of the calculated combined date, *c.* 2,135–2,078 BC (*Table 2*). It is thus possible that House S was not in use for a very long time. Shortly after filling up the *bothroi*, graves were dug into some of them and House T was erected. Phase 1 refers to the *bothroi* presumably older than House S. Phase 2 refers to *bothroi* in the middle of Houses R and S, and seems to constitute the last phase of usage. "Unknown phase" refers to the *bothroi* of Terraces I–II which might actually belong to phase 1, or more probably another household not yet excavated.

The most interesting spatial connections based on the CA and the categorization in *Table 6* is contained within the cluster of *bothroi* south-east of the middle between Houses S and R. They formed two rows aligned north–south with three *bothroi* each: to the west Bs-7, -9 and -11, and to the east Bs-8, -13, and -14. Two of the western *bothroi*, Bs-7 and -9,[73] are categorized as destinations of mainly consumption waste from medium-sized mammals (sheep/goat and pig), while the third one, Bs-11, is labelled a "cattle/pig" pit. Two of the eastern *bothroi*, Bs-13 and -14, contained butchery waste from medium-sized mammals (sheep/goat and pig). The third *bothros* in the eastern row, Bs-8, is labelled a "red deer" pit. Thus, it seems that the western *bothroi* in the cluster between Houses R and S were destinations for mainly consumption waste, while the eastern pits might have been intended for butchery waste.

Southeast of this small cluster, we find Bs-1 and -3a which are not assigned to any phase on *Fig. 6*. They are also categorized as *bothroi* for butchery waste. If they were to be included in Phase 1, the interpretation that the eastern *bothroi* were destinations for mainly butchery waste would be reinforced. In the sense of spatial patterning, Phase 1 *bothroi* do not show any specific tendencies. Phase 1 organization might thus have been less formalized than phase 2, for reasons unknown.

Discussion

THE *BOTHROS* AS PART OF THE HOUSEHOLD ORGANIZATION

The results show that the distribution of animal bones in the Asine *bothroi* is not random. At least in the stage of closing the features, they should not be considered as uniform. This confirms my initial impression that the material is not coherent, but complex and variable. It is also probable that more than one phase in the life of a *bothros* existed.[74] The patterns apparent in this study would support the hypothesis that *bothroi* were built at a domestic level. It is relatively clear they were constructed in similar manners, according to similar traditions. This is visible in the architecture and also in the chronology at Asine. Phase 1 *bothroi* might have been less formalized than phase 2, because they were connected to only one household (*Fig. 6*). In this case, it is possible that when either the household became crowded or the settled area became denser, it necessitated a more formal place of storage, the *bothros*. These pits then conveniently became places for stricter waste management. This formalization combined with the diversity of the filling strategy would indicate that the digging of these features for one's household was part of the normative behaviour connected to the idea of the "home".[75]

The concept of home at Asine was probably different from one household to another. We have no idea of the structure of family. Even if we did, we do not know if the family was the "embryonic community" that structured one's home. What we can discuss however are house plans and storage features, refuse materials and consumption remains, which we connect to the household or the domestic sphere. It is obvious that *bothroi* were part of human life on a domestic as well as on a community level. The hypothesis that a *bothros* was constructed for storage on a domestic level includes an assumption that it was part of the household organization. It is thus possible

[73] Bs-11 could not be categorized according to body parts, see previous section.

[74] This is also how I read Bank's detailed study where the functional diversity of *bothroi* at Lerna IV is emphasized: Banks 2013.

[75] Douglas 1991.

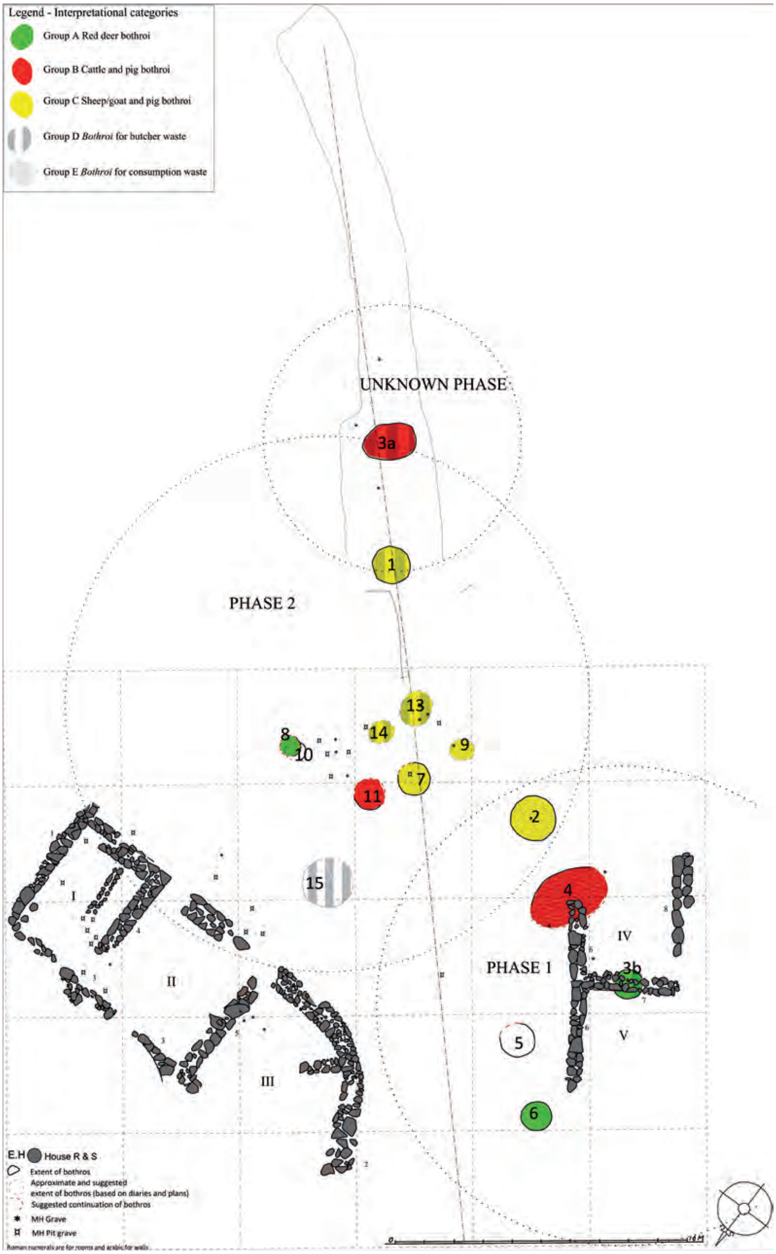

Fig. 6. Plan of the Asine bothroi *used in the correspondence analyses, including interpretative categories, see* Table 6.

that the *bothros* was a part of many persons' home at Asine. It was important for the structuring of space and the function was tied to the memory of perhaps hot summers (storage). They were even important when used as refuse pits, in the sense that they continued to structure space and to direct movement and labour.[76]

WASTE MANAGEMENT AND DIVERSITY: THE CLOSING OF A *BOTHROS*

I have proposed that *bothroi* were built as part of the household organization. I suggest they were filled up at approximately the same time period, i.e. between 2,135–2,078 BC, although a more narrow date range might be possible. The features were filled up in different ways as suggested by the reconstructed stratigraphy. The most formalized deposition of faunal remains seems to regard the similar-sized *bothroi* clustering between Houses R and S. It is possible to argue that these pits were used in connection with different activities, reflected in the refuse disposal. Whereas Bs-13 and -14 were used for butchery waste of primarily sheep/goat and pig, Bs-7 and -9 were used for consumption waste of the same. In Bs-11 we found an association with cattle and pig. The above mentioned features differ finally from Bs-8 in which remains of red deer is associated.

Since the faunal remains should derive from the filling period, which could have been over several years, another scenario might be suggested. The *bothroi* could be seen as waste management systems, where certain remains of certain animals and/or body parts where thrown in certain pits. This would explain the presence of red deer specifically tied to certain *bothroi*, sheep/goat to others, and pig to yet others. It would also explain the seemingly linear disposal of the axial body and upper extremities versus heads and lower extremities, which in the Asine case can perhaps be translated into meaty versus non-meaty body parts. In this sense it is reasonable to think that in the closing of the *bothroi*, the type of refuse deposited in them would also have been sorted or at least considered. It does not necessarily imply strictly ritual behaviour. This waste management could have been directed from the perspective of activity areas (as butchery versus consumption areas), or simply waste categories (such as red deer versus cattle). It could be argued to have involved both, especially when regarding the "sheep/goat-and-pig-*bothroi*" where "non-meaty" parts were associated with Bs-13, -14, perhaps also Bs-1 and -3a, to the east, and meat-rich parts in Bs-7 and -9 to the west.

Spatial and social organization in relation to waste management can be observed in most societies. In modern Sweden, there is a rigorous practice concerning the everyday sorting and categorizing of waste. This is directed and normalized through governance and education.[77] In this setting, bones and other food waste are integrated in the same category. For the Dogon people of Mali, domestic waste is a positive disorder and is used to manifest the vitality of the household, while bodily waste and menstrual blood is considered dangerous and polluting.[78] On Greenland, the Inuits had for a long time an ideal practice of "nothing is wasted" regarding the consumption of caribou, meaning that virtually nothing was considered waste and only bone splinters would remain as waste from the animal body.[79] More ancient examples of waste management strategies have been evidenced from Neolithic Çatalhöyük, Central Anatolia, where refuse would have been handled as an intricate part of everyday life by removing it from the house context.[80] Other examples can be found at Early Neolithic Almhov, Scania, where refuse was disposed in certain pits,[81] or the accumulation of refuse in the Late Bronze Age "midden sites" in the United Kingdom.[82] As the above ethnographic and archaeological examples demonstrate, the part of life involving the handling waste was and still is important. The *bothroi* seem to have been important in the spatial arrangement of things, in the social organization of the living area. The disposal of faunal remains, or rather, the remains of food consumption and animal processing, were probably a part of this arrangement. In this article the faunal remains are central to the discussion of household organization, and indubitably waste management is a part of this.

This study would definitely benefit from the comparison and inclusion of other zooarchaeological assemblages from waste-related contexts at the site. It would make it possible to test if the patterns from the *bothroi* are specific to the feature type or similar to general trends on site. This would in its turn also provide knowledge about the feature type as well as site function in terms of animal husbandry and economy. It would also add another spatial dimension of the management of waste. While this is clearly a desirable aspect, it is at the moment not possible, because the animal bones from the *bothroi* constitute the largest Asine assemblage from the EH III to the MH I transitional period at the moment. Hopefully more animal bones will be dated to this narrow time period in the near future. This study has focused on the zooarchaeological remains; however, other find categories found in the *bothroi* are important to include in future research. Such studies can

[76] I.e. reinforcing the idea of how it should be done at home. Cf. Douglas 1991.

[77] Åkesson 2012.
[78] Douny 2007.
[79] Pasda & Odgaard 2011.
[80] Martin & Russell 2000.
[81] Rudebeck & Macheridis 2015, 181–185.
[82] Needham & Spence 1997.

test the hypothesis proposed in this article, as well as contribute to the increased understanding of this pit phenomenon.

Few other zooarchaeological studies in the Aegean area focus solely on *bothroi*. P. Halstead has studied the animal bones from the Neolithic to Bronze Age settlement Tsoungiza in the Nemea Valley. Some of these bones derive from *bothroi*, but most are dated to EH I–II.[83] At Tsoungiza contextual differences in bone content in pits,[84] floors, and fills exist. Even so, Halstead acknowledges that individual variation within the context types is apparent (i.e. bone content can vary between pits) which suggests that the remains may reflect differential discard.[85] This is consistent with the above interpretation of the Asine *bothroi*.

THE AFTERLIFE OF A *BOTHROS* AT ASINE

A few words can perhaps be devoted to the importance of the *bothroi* after their usage and closing. While erecting House T or perhaps directly after, Bs-7, an infant burial was still visible.[86] On the plan in *Fig. 6*, all MH graves on Terraces I–III are plotted and we can observe a possible connection between them and the *bothroi*. Perhaps this meant that people were reminded of the past by the *bothroi*, at least for a few generations. This visibility does not necessarily mean that the original perception of the feature, i.e. as a pit, was transferred. The remains—a circled coloration and clustering of pottery, could be enough for it to transform in function and importance. In this sense, the *bothroi* were perhaps long-lived in prehistoric memory, although this is more of a speculative suggestion. In either case, the construction and use of *bothroi* was abandoned, and this happened quite abruptly. Could it be in association with new-coming ideals or migrants? Perhaps the settlement grew and *bothroi* fell out of fashion, because the spatial social organization changed? Since we see similar trends elsewhere on the mainland, perhaps these questions should be more regional relevant as well. Regardless of what processes triggered its existence and disappearance, the *bothros* can provide a good example of the social dynamics of this transitional period, in the sense of activity, function, and management of the household.

[83] Halstead 2011, 780, 783.

[84] *Bothroi* are called pits, a category which seems to include other types of pits such as suggested cisterns (e.g. EH I Cistern 2) (Halstead 2011, 783). This makes it hard to in detail use this study as comparative material.

[85] Halstead 2011, 782–784. For example, the animal bones from Pit 55 contained remains of many neonates, but low degrees of gnawing, postneonatal fragmentation, and no cattle, while Pit 32 contained higher fragmentation and gnawing, but few neonates.

[86] Nordquist 1987.

Concluding remarks

In this paper the EH III/MH I *bothroi* of Asine have been examined from a zooarchaeological perspective. The faunal remains from the features have also been studied by means of correspondence analysis (CA), in terms of species composition and body parts' distribution. The CA of body parts distribution revealed a strong pattern related to taphonomy, most probably to post-depositional processes affecting the assemblages. This pattern consisted of higher proportions of cranial and compact fragments from the upper extremities. The fact that such a pattern can be visualized and strongly indicated by means of CA opens up to future studies of the identification of cultural versus natural processes in a specific material.

One important result is that the diversity of the faunal remains' distribution in the *bothroi* further problematizes the view of them as functionally one type of unit. It is possible that they were tied to different activity areas within the settlement. Some were storage for grain or other food, some perhaps drying pits for food. Most, maybe all of them, ended up as refuse pits. Some were reused for burial, and some were not. The common denominator is the morphology of the pits and the synchronicity in the closing of them.

In this contextual and zooarchaeological study, I propose that the *bothroi* were part of the household organization. In that sense, they could have been connected to the cultural formal idea of home for many of the inhabitants at Asine. Even if this theory might suit the *bothroi* at Asine, it is however hard to use for explaining the multitude of *bothroi* at Lerna IV. As Weiberg proposes,[87] the digging of this multitude of *bothroi* can indeed be seen as meaningful. However, the filling of them might also have been significant actions for the prehistoric people, but perhaps in another sense. Refuse disposal was necessary at Asine, just as in any other society. I have proposed there was an intentional waste management strategy tied to the filling and closing of the *bothroi*. This waste management should be connected to activity areas of butchering or consumption, as well as to formalized ideas of where to throw certain remains of certain animals.

STELLA MACHERIDIS
Department of Archaeology and Ancient History
Lund University
Helgonavägen 3
SE-221 00 Lund
stella.macheridis@ark.lu.se

[87] Weiberg 2007, 116.

Bibliography

Åkesson, L. 2012. 'Waste in overflow', in *Managing overflow in affluent societies*, eds. B. Czarniawska & O. Löfgren, New York, 141–154.

Alberti, G. 2013. 'Making sense of contingency tables in archaeology: The aid of correspondence analysis to intra-site activity areas research', *Journal of Data Science* 11, 479–499.

Banks, E.C. 2013. *Lerna: A preclassical site in the Argolid* 6. *The settlement and architecture of Lerna IV*, Princeton, New Jersey.

Bannert, D. 1973. 'Geologische Bemerkungen zur Ausgrabung am Barbouna-Hügel', in *Excavations in the Barbouna area at Asine*, Fasc. 1. *General introduction, bibliography, geological background and a report on the field-work in the Levendis sector, 1970–1972* (Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilisations, 4:1), eds. I. Hägg & R. Hägg, Uppsala, 16–21.

Behrensmeyer, A. 1978. 'Taphonomic and ecological information from bone weathering', *Paleobiology* 4, 150–162.

Blasco, R., J. Rosell, M. Dominguez-Rodrigo, S. Lozano, I. Pastó, D. Riba, M. Vaquero, J.F. Peris, J.L. Arsuaga, J.M.B. de Castro & E. Carbonell 2013. 'Learning by heart: Cultural patterns in the faunal processing sequence during the Middle Pleistocene', *PLoS ONE* 8, e55863, http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0055863

Blegen, C.W. 1921. *Korakou. A prehistoric settlement near Corinth*, Boston.

Blegen, C.W., J.L. Caskey, M. Rawson & J. Sperling 1950. *Troy* I. *General introduction. The first and second settlements*, Princeton, New Jersey.

Bolviken, E., E. Helskog, K. Helskog, I.M. Holm-Olsen, L. Solheim & R. Bertelsen 1982. 'Correspondence analysis: An alternative to principal omponents', *WorldArch* 14, 41–60.

Bourdieu, P. 1977. *Outlines of a theory of practice*, Cambridge.

Bronk Ramsey, C. 2001. 'Development of the radiocarbon calibration program OxCal', *Radiocarbon* 43(2A), 355–363.

Bronk Ramsey, C. 2009. 'Bayesian analysis of radiocarbon dates', *Radiocarbon* 51:1, 337–360.

Bulle, H. 1907. *Orchomenos* I. *Die älteren Ansiedelungsschichten*, München.

Caskey, J.L. 1960. 'The Early Helladic period in the Argolid', *Hesperia* 29, 285–303.

Douglas, M. 1966. *Purity and danger*, London & New York.

Douglas, M. 1991. 'The Idea of home: A kind of space', *Social Research* 58, 287–307.

Douny, L. 2007. 'The materiality of domestic waste: The recycled cosmology of the Dogon of Mali', *Journal of Material Culture* 12, 309–331.

Frödin, O. & A.W. Persson 1938. *Asine* 1. *Results of the Swedish excavations 1922–1930*, Stockholm.

Garrow, D. 2012. 'Odd deposits and average practice: A critical history of the concept of structured deposition', *Archaeological Dialogue* 19, 85–115.

Glowacki, K. 2007. 'House, household and community at LM IIIC Vronda, Kavousi', in *Building communities: Houses, settlement and society in the Aegean and beyond: Proceedings of a conference held at Cardiff University* (BSA, 15), eds. R. Westgate, N. Fisher & J. Whitley, London, 129–139.

Greenacre, M. 2007. *Correspondence analysis in practice*, Boca Raton.

Hägg, I. & R. Hägg 1973. *Excavations in the Barbouna area at Asine*, Fasc. 1. *General introduction, bibliography, geological background and a report on the field-work in the Levendis sector, 1970–1972* (Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilisations, 4:1), Uppsala 1973.

Halstead, P. 2011. 'Chapter 13. The faunal remains', in *The Early Bronze Age village on Tzoungiza Hill* (NVAP, 1), Princeton, New Jersey & Athens, 741–803.

Hill, J.D. 1995. *Ritual and rubbish in the Iron Age of Wessex: A study on the formation of a specific archaeological record* (BAR-BS, 242), Oxford.

Hutchinson, R.W. 1935. '*Bothroi*', *JHS* 55, 1–19.

Hutchinson, R.W. 1936. 'Early Bronze Age. Hearths and house-pits', in *Excavations at Thermi in Lesbos*, ed. W. Lamb, New York, 55–64.

Ingvarsson-Sundström, A. 2008. *Asine* III. *Supplementary studies on the Swedish excavations 1922–1930*, Fasc. 3. *Children lost and found* (ActaAth-4º, 45:2), Stockholm.

Kent, S. 1995. 'Ethnoarchaeology and the concept of home: A cross-cultural analysis', in *The home: Words, interpretations, meanings, and environments*, ed. D.N. Benjamin, Aldershot, 163–180.

Knudtzon, E.J. 1926. 'Stora profilen, Tredje terrassen uppifrån, Våren 1926', Unpubl. field diary, archived at Museum Gustavianum, Uppsala.

Lamb, W. 1936. *Excavations at Thermi in Lesbos*, New York.

Lyman, R.L. 1994. *Vertebrate taphonomy*, Cambridge.

MacKinnon, M. 2007. 'Osteological research in classical archaeology', *AJA* 111:3, 473–504.

Madsen, T., ed. 2012. *CAPCA, Version 2.2*, http://www.archaeoinfo.dk/

Marciniak, A. 2005. *Placing animals in the Neolithic: Social zooarchaeology of prehistoric farming communities*, London.

Marinatos, S. 1968. 'Some new evidence on ash pits or *bothroi*', *AAA* 1, 89–90.

Martin, L. & N. Russell. 2000. 'Trashing rubbish', in *Towards reflexive method in archaeology: The example at Çatalhöyük* (British Institute of Archaeology at Ankara Monograph, 28), ed. I. Hodder, Cambridge, 57–69.

Moberg Nilsson, K. 1996. 'Animal bones from Terrace III in the Lower Town of Asine', in *Asine* III. *Supplementary Studies on the Swedish Excavations 1922–1930* (ActaAth, 45:1), eds. R. Hägg, G.C. Nordquist & B. Wells, Stockholm, 111–116.

Mylona, D. 2003. 'Archaeological fish remains in Greece: General trends of the research and a gazetter of sites', in *Zooarchaeology in Greece: Recent advances* (BSA Studies, 9), eds. E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble & P. Elefanti, London, 193–200.

Mylonas, G.E. 1934. 'Excavations at Haghios Kosmas', *AJA* 38, 258–279.

Needham, S. & T. Spence 1997. 'Refuse and the formation of middens', *Antiquity* 71, 77–90.

Nilsson, M. 2014. 'A note on domestic vs. communal grain storage in the Early Helladic Period', *OpAthRom* 7, 223–239.

Nordquist, G.C. 1987. *A Middle Helladic village. Asine in the Argolid* (Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilisations, 16), Uppsala.

Nordquist, G.C., & R. Hägg 1996. 'The history of the Asine excavations and collections, with a bibliography', in *Asine* III. *Supplementary studies on the Swedish excavations 1922–1930* (ActaAth, 45:1), eds. R. Hägg, G.C. Nordquist & B. Wells, Stockholm, 11–18.

Orton, D.C. 2012. 'Taphonomy and interpretation: An analytical framework for social zooarchaeology', *International Journal of Osteoarchaeology* 22, 320–337.

Pasda, K. & U. Odgaard 2011. 'Nothing is wasted: The ideal "Nothing is waste" and divergence in past and present amongst Caribou hunters in Greenland', *Quaternary International* 238, 35–43.

Pullen, D.J. 1987. 'Asine, Berbati, and the chronology of Early Bronze Age Greece', *AJA* 91, 533–544.

Pullen, D.J. 2011. *The Early Bronze Age village on Tzoungiza Hill* (NVAP, 1), Princeton, New Jersey & Athens.

Rapoport, A. 1995. 'A critical look at the concept "Home"', in *The home: Words, interpretations, meanings, and environments*, ed. D.N. Benjamin, Aldershot, 25–52.

Reimer, P.J., E. Bard, A. Bayliss, J.W. Beck, P.G. Blackwell, C. Bronk Ramsey, C.E. Buck, H. Cheng, R.L. Edwards, M. Friedrich, P.M. Grootes, T.P. Guilderson, H. Haflidason, I. Hajdas, C. Hatté, T.J. Heaton, D.K. Hoffmann, A.G. Hogg, K.A. Hughen, K.F. Kaiser, S.E. Marian, J.R. Southon, R.A. Staff, C.S.M. Turney & J. van der Plicht 2013. 'IntCal13 and Marine13 radiocarbon age calibration curves 0–50.000 years cal BP', *Radiocarbon* 55, 1869–1887.

Richards, C. & J. Thomas 1984. 'Ritual activity and structured deposition in Later Neolithic Wessex', in *Neolithic studies. A review of some current research*, eds. R. Bradley & J. Gardiner, Oxford, 189–218.

Ringrose, T.J. 1992. 'Bootstrapping and correspondence-analysis in archaeology', *JAS* 19, 615–629.

Routledge, B. 2013. 'Household archaeology in the Levant', *BASOR* 370, 207–219.

Rudebeck, E. & S. Macheridis 2015. 'The proper way of dwelling at the Early Neolithic gathering site of Almhov in Scania, Sweden', in *Neolithic diversities: Perspectives from a conference in Lund, Sweden* (Acta-Lund-8°, 65), eds. K. Brink, S. Hydén, K. Jennbert, L. Larsson & D. Olausson, Lund, 173–187.

Rutter, J.B. 2008. 'The Anatolian roots of Early Helladic III drinking behavior', in *The Aegean in the Neolithic,* *Chalcolithic and the Early Bronze Age: Proceedings of the international symposium, Urla-Izmir, October 13–19, 1997* (Ankara University Research Center for Maritime Archaeology Publication, 1), eds. H. Erkanal, H. Hauptmann, V. Şahoğlu & R. Tuncel, Ankara, 461–481.

Säflund, G. 1965. *Excavations at Berbati 1936–1937* (Stockholm Studies in Classical Archaeology, 4), Stockholm.

Sarri, K. 2010. *Orchomenos* 4. *Orchomenos in der mittleren Bronzezeit*, München.

Shennan, S. 2006. *Quantifying archaeology*, Iowa City.

Stiner, M.C. 1991. 'Food procurement and transport by human and non-human predators', *JAS* 18, 455–482.

Strasser, S. 1999. *Waste and want: A social history of trash*, New York.

Strasser, T.F. 1999. '*Bothroi* in the Aegean Early Bronze Age', in *Meletemata: Studies in Aegean archaeology presented to Malcolm H. Wiener as he enters his 65th year* (Aegaeum, 20), eds. P.P. Betancourt, V. Karageorghis, R. Laffineur & W.-D. Niemeier, Liège, 813–817.

Tringham, R. 1995. 'Archaeological houses, households, housework, and the home', in *The home: Words, interpretations, meanings, and environments*, ed. D.N. Benjamin, Aldershot, 79–108.

Valmin, N.M. 1938. *The Swedish Messenia Expedition* (SkrLund, 26), Lund.

Voutsaki, S., A.J. Nijboer & C. Zerner 2009. 'Middle Helladic Lerna: Relative and absolute chronologies', in *Tree-rings, kings, and Old World archaeology and environment: Papers presented in honor of Peter Ian Kuniholm*, eds. S.W. Manning & M.J. Bruce, Oxford & Oakville, 153–161.

Wace, A.J.B. & M.S. Thompson 1912. *Prehistoric Thessaly*, Cambridge.

Weiberg, E. 2007. *Thinking the Bronze Age: Life and death in Early Helladic Greece* (Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilisations, 29), Uppsala.

Welinder, S., C. Hadevik, K. Gidlöf & E. Rudebeck 2009. 'Grismönster i gropkaos: en korrespondensanalys av djurben i tidigneolitiska gropar', in *Tematisk rapportering av Citytunnelprojektet*, eds. C. Hadevik & M. Steineke, Rapport 48, Arkeologienheten, Malmö, 137–156.

Paper IV

This manuscript is accepted for publication (with revisions) in Gaastra J and Greenfield HJ (eds.), *Zooarchaeology of the Metal Ages: Production, Specialisation and Technology during the Copper Age, Bronze and Iron Ages*. Lockwood Press.

A zooarchaeological study of the social topography of Asine (Greece) during the late Bronze Age

Abstract

This paper investigates the growth in social complexity of the late Middle Helladic to early Late Helladic settlement Asine, Greece, in terms of social topography. Two different parts of the settlement, namely the Lower Town and Barbouna Hill, are compared. Zooarchaeological indicators of waste management, e.g. weathering and gnawing, and waste content, e.g. taxonomic representation and body parts' selection, are analyzed. The results indicate that the higher frequencies of wild animals and the greater use of bone-/antler artefacts are specific to the Lower Town, and not Barbouna Hill. In conjunction with the differential distribution of other finds, such as pottery, the animal bones support the existence of a growing social topography. Still, there are several similarities between the areas in the composition of the most common animals, skeletal part frequencies, bovid mortality curves, and in domestic cleaning procedures, indicating a more complex picture. This indicates that the proposed social complexity, expressed through social topography, was perhaps not implemented in everyday life practices.

Key words: Aegean Bronze Age, Asine, old collections, zooarchaeology, social topography, waste management

1. Introduction

Waste production and management is associated not only with social status or identity, but also with cultural perceptions of danger, spatial borders and norms (e.g. Douglas 1966; Strasser 1999; Martin & Russell 2000; Rathje and Murphy 2001; Douny 2007; Gifford-Gonzales 2014; Yeshurun *et al.* 2014). The connection between waste and social topography, i.e. the spatial manifestation of socioeconomic differences, is rarely investigated in zooarchaeology. In this paper this is attempted. Social topography is defined as the spatial distribution of socio-economic differences following the research of Richer (2015).

The basis of social topography can be traced back to research by Bourdieu (e.g. 1979; 1989). For him, 'social space' is a spatial metaphor for social distances. In this paper, physical space is regarded as important in the expression of status hierarchy (Richer 2015:362). By using modern Istanbul as case study, Richer exemplifies how location not only reflects status, but also how it is imbued with social meanings constructed and negotiated by the population of the city (*ibid.* 2015). The idea of social topography is strengthened by the conceptual metaphor, 'social distance is physical distance', discussed by Wiseman (2016) based on cognitive and ethnoarchaeological studies. In small settlements, people often choose to locate their homes in proximity of their closest kin or other people with similar social identities. According to Wiseman (2016), this phenomenon is present in most societies but especially those characterized by kinship relationships.

As basis for the discussion, the ancient settlement Asine during the Middle Helladic III (MH III, ca. 1800-1700 BCE) to Late Helladic I (LH I, ca. 17000-1600 BCE) in Argolis, Greece, is investigated. The existence of a social topography at Asine is discussed by studying differences in the distribution of animal bone waste in the two main areas, Barbouna Hill (BH) and the Lower Town (LT). The MH III-LH I is characterized by diversity in the quantity and quality of graves and grave finds, by increased settlements, and by the resettlement of previously abandoned areas (Voutsaki 2010a: 104). This period is connected to the emergence of the Mycenaean cultural complex, which flourished during the Late Bronze Age in Argolis in particular (e.g. Dickinson 1989; Voutsaki 1997; 2010a; Petrakis 2010). The question of the social complexity at Asine itself and in the broader region has been a focus for research in several papers, explored from many angles (e.g. Nordquist 2002; Voutsaki 2010b; 2010c; Voutsaki *et al.* 2011; Ingvarsson-Sundström *et al.*, 2013). It has been established that the Asine society experienced growing social complexity during the transition to the Late Helladic. Based on diversity in mortuary evidence (Nordquist 1990; Gillis 1996; Voutsaki *et al.* 2011), in diet and health indicators (Ingvarsson-Sundström *et al.* 2009; Ingvarsson-Sundström *et al.* 2013), in different architectural features, and in the presence of imported goods (Nordquist 1987; Voutsaki 2010b), the settlement seems to have had an uneven social topography. The transition to Late Helladic in Asine provides an interesting scenario to test the hypothesis that this growth would also be reflected in other aspects of the material culture, such as the zooarchaeological evidence.

The finds from the Asine site can be regarded as part of an 'old collection'. 'Old' collections are here characterized by long periods of storage, of analogue documentation including the fact that important aspects of the site might only be found in unpublished field journals and plan drawings, and of differing excavation methodologies often without systematic dry or water sieving (see Jones & Gabe 2015). If saved at all, animal bones were often hand-collected, meaning that smaller finds such as bones from fish and birds, were not always collected (e.g. Mylona 2005; MacKinnon 2007). Since the above can be relevant for 'newer' collections, the term 'old' collection is relative and depends on the conditions of the site, its excavation methodologies, documentation quality and storage history (Jones & Gabe 2015).

Most of the finds from Asine fit in to the above definition of 'old collections'. They derive from older excavations of 1926 (the Lower Town area, Frödin & Persson 1938) and the 1970s (the Barbouna Hill area, e.g. Hägg & Hägg 1973). During the 1926 excavation, the finds were hand-collected and not sieved. Importantly, the collection has been in storage for a very long time, and the documentation quality depends on access to unpublished plans and diaries, of which not all are of a high quality. These issues also concern the finds from the 1970s collection. The methodology applied in this paper is contextually adjusted to the limitations of the study material.

2. Asine during the MH III-LH I period

Several excavation campaigns investigated ancient Asine during the 20th century (Frödin & Persson 1938; Hägg & Hägg 1973; Dietz 1982; see Nordquist 1987; Nordquist & Hägg 1996). The results showed that Asine was inhabited during at least the Early Helladic period (EH, ca. 3100-2100 BCE), and was continuously settled until about 700 BCE when settlement declined. It was revisited occasionally until resettlement during the Hellenistic and abandonment in Late Antiquity. The site was excavated by mainly Swedish scholars, starting with the 1920s project, which unearthed a large Lower Town complex as well as a Mycenean necropolis at the site (Frödin & Persson 1938). The early excavations focused on the peninsular cliff, the Kastraki (Fig. 1), where the Lower Town (LT) was found, as well as an acropolis. On Barbouna Hill (BH), across from Kastraki, two Mycenaean necropoles with chamber tombs, as well as later burials, were found (Frödin & Persson 1938). The 1970's campaigns also revealed remains of dwellings on the slope of Barbouna, showing that the settlement had been extended to the hill during the late MH and early Mycenaean times (Hägg & Hägg 1973; 1976; Nordquist 1987).

A large part of the Lower Town at Asine was already built in MH III. The settlement extended to cover the slope of the Barbouna Hill (see Fig. 1). This growth is reflected in the diversity of graves, for example in types such as pits, vessels and cists, in content such as find-rich opposed to find-poor, and in location, such as both intramural and extramural graves (Frödin & Persson 1938; Dietz 1982; Nordquist 1987:101-106; Ingvarsson-Sundström 2008). More pronounced differences between the three extramural burial grounds, East Cemetery, Barbouna Hill and the Kastraki (the cliff where LT is situated; Fig. 1), have been discussed in terms of growing social complexity and/or changed social strategies at Asine during the late MH (Voutsaki *et al.* 2011:459; Ingvarsson-Sundström *et al.* 2013:158). A material example of such difference is that gold objects are only found in the graves at the East Cemetery (Ingvarsson-Sundström *et al.* 2013:155).

This social complexity is presumably supported by the existence of differentiated social organization in two dwelling areas, the LT and the BH (Fig. 1). There are architectural differences between the areas. The houses were more complex in LT, including larger and more detailed buildings, showing careful planning of the area, with many rooms. The animal bones in this paper derive from close to or inside Houses B and D, both built in the late MH II-early MH III (Fig. 1). Few animal bones were found in proximity to contemporary House C (Appendix 1), which had an unclear site plan, and an unknown extent. The majority of the finds derive from Houses B and D. House B had an irregular shape and was large, covering at least 110 m^2. It was divided into four long and narrow rooms, which might have been partitioned. Based on the width of some walls and presences of strong stone bases, it is possible that the house had an upper floor (Nordquist 1987:76). House D had a complex site plan, with two parallel parts oriented NW-SE and one NE-SW (Fig. 1). It is not certain whether there was internal communication between the parts. It replaced an earlier house, called House pre-D, and seems to have been remodeled several times, for example the floors were refurnished. The house, including all parts, covered ca 192 m^2, according to Nordquist (1987:79). Dissimilar to House B, House D had a regular site plan, and consisted of at least six rectangular or square rooms.

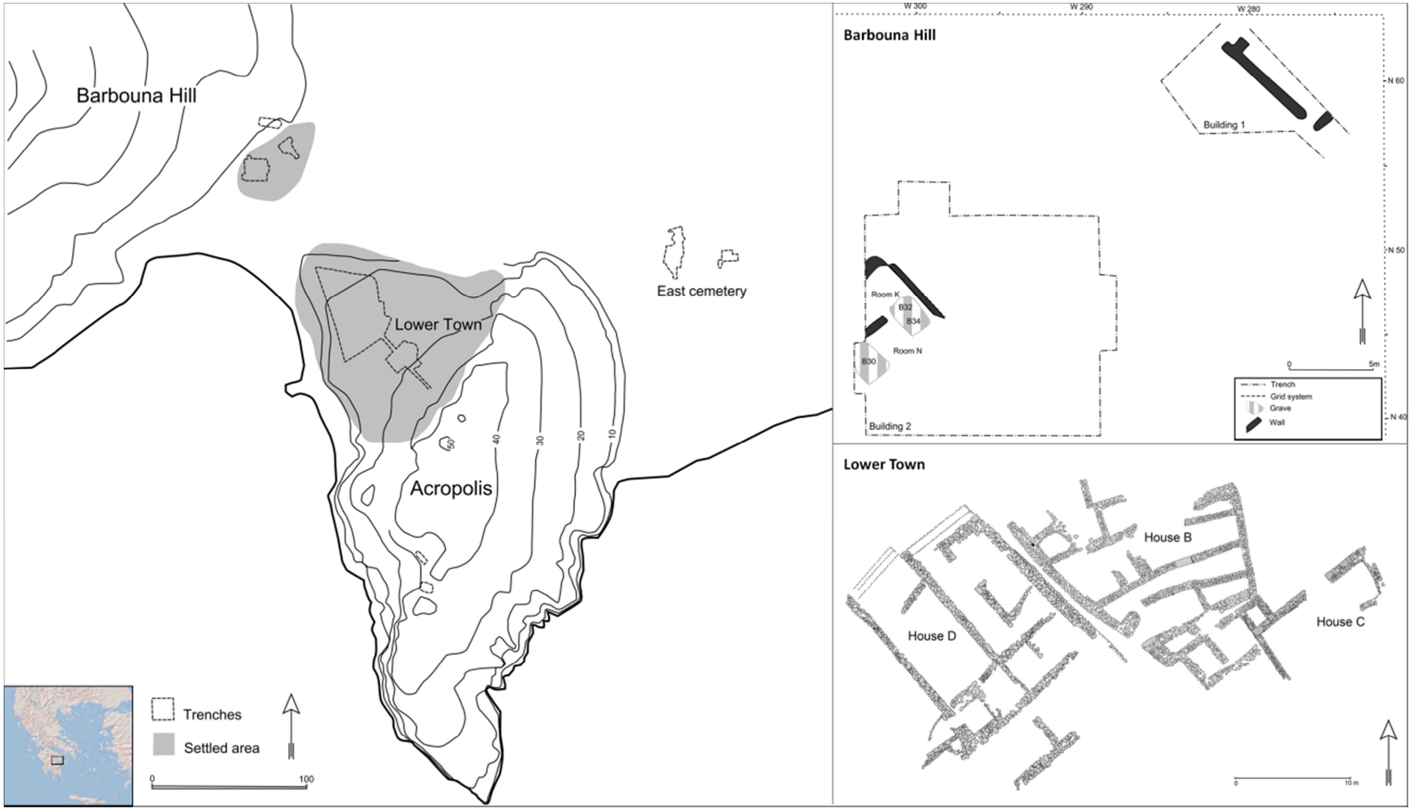

Figure 1.
Topographical plan of Asine, with excavation areas (right). After Nordquist (1987: Fig. 8); Remains of houses on the slope of Barbouna Hill (top left). After Nordquist (1987: Fig. 16; Remains of houses in the Lower Town (bottom left). Modified after Frödin and Persson (1938: Fig. 42).

While the houses in the Lower Town were built close together, the houses of BH, Buildings 1 and 2, were more detached and smaller (Nordquist 1987:87-89; Ingvarsson-Sundström *et al.* 2013:156). Building 1 consisted of at least one room. The same regards Building 2, which had at least two rooms, of which one measured ca 16 m^2. These houses seem not to have been of the same complexity as Houses B and D; they seem to have been at the most medium-sized houses. Because they had been placed away from the Lower Town and because of their smaller structures, the houses on BH can easily be regarded as a more peripheral part of the settlement, and often are. The settlement area of Barbouna Hill (BH) was remade into a burial ground at the end of the MH III. The generalizations made of these two dwelling areas, especially BH, are tentative, since the exact extent of Asine remains to be defined archaeologically (Nordquist 1987:28). Houses B and D at LT and the houses on the slope of BH were in use during MH III (Frödin & Persson 1938; Nordquist 1987; Voutsaki 2010c:5).

3. Methodological framework

The framework of this study is divided in two analytical parts (Table 1). The first, *waste management,* includes a practical aspect, with a focus on everyday life (Marciniak 2005:80; Gifford-Gonzalez 2014). The management of waste is important in the spatio-social organization of any society. The identification of the manner of waste management is based on the relative frequencies of peri-depositional taphonomic markers, indicating the handling and exposure of bones. Following Orton (2012), this includes evaluation of weathering and carnivore gnawing; recording of weathering follows Behrensmeyer (1978); and gnawing identification, following Binford (1981) and Haynes (1983). Additionally, the relative impact of trampling (scratch marks), recorded after Andrews and Cook (1985) and Thilderqvist (2013), is included in the analysis, as is burning. The recording of burnt bone was based on changes in color (Lyman 1994a:386). Taphonomic variables were recorded on both identifiable and unidentifiable bones.

The second aspect is *waste content,* and it puts emphasis mainly on animal consumption. Consumption is symbolically loaded and is often used to discuss social, ritual and economic meanings and differentiation in archaeological settings (Twiss 2012). Following the recommendations of Ervynck et al. (2003), two variables are chosen in this study: i) presence of “rare”, e.g. rare and/or imported, taxa, including wild animals (Ervynck *et al.* 2003; see Goody 1982; Isaakidou 2007); and ii) the selection of body parts, age and/or sex. The discussion of any taxa as rare is based on its relative lack of abundance in the regional context of Asine, i.e. Argolis and Peloponnese. Selection of body parts, age and sex can be indicative of socioeconomic differentiation (e.g. Ervynck *et al.* 2003:433; Redding 2010). Although selection of species, body parts and age/sex might reflect tendencies in consumption, it is important to remember that disposal patterns can also be directed by the sorting of specific bone elements (e.g. Hill 1995; Gifford-Gonzalez 2014; Rudebeck & Macheridis 2015).

Table 1.
Theoretical framework for the zooarchaeological study of social topography. The framework focuses on differences in waste management and/or waste content in different areas within a specific site.

	Waste management		Waste content	
Analytical variables	Presence of weathering, gnawing, trampling, and burning	Casual waste on floors versus waste in redeposited sediments	Presence of rare taxa (i.e. uncommon wild or imported)	Selection of body parts, age and/or sex
Zoo-archaeological potential	Information on movement, exposure, handling and attrition on animal bone waste	Information on management of waste indoors	Information on differences in meat consumption within the settlement.	Information on any preferential consumption of certain body parts, age, sex

3.1 Adjusting the framework to an 'old' collection

Several aspects of Table 1 should be adjusted to the restrictions of the documentation quality of the Asine collection. The lack of systematic sieving in the Asine excavations has meant that rare avian or fish taxa underrepresented, and perhaps not detectable. The hand-collection strategy might also have caused an underrepresentation of smaller bones of medium-sized animals, e.g. phalanges, carpals and tarsals, which might not have been visible during excavation (see Davis 1987:29). The presence of rare taxa mainly focuses on mammals of medium to large sizes. This affects the discussion on rare taxa as a marker of socially connoted meat consumption and taxonomic abundance, and should therefore be regarded as tentative and partial. This issue is relevant also for the discussion on body part selection and mortality and sex data. For example, juvenile bone can be small and was therefore perhaps not collected. Also juvenile bone is more fragile and often suffers from post-depositional erosion.

An in depth study of the bone's spatial distribution in these houses can partially be achieved. Few bones could be associated with particular rooms in the houses, or specific fills or features within them (Appendix 1). This relates to the issue of Asine as an old collection. The animal bones from LT unearthed in 1926 were saved during the old excavations. Still, the context information pertaining to the bones was not always detailed, or indeed in some cases even existent. The Barbouna Hill data is not extensively published, so to make contextual assessments or reconstruction closer than house or room level would be premature. Nevertheless, through the study of field journals, plans and other documentation, it has been confirmed that all bones in this study derive from the settled areas of Barbouna Hill and the Lower Town (Fig. 1, see Appendix 1).

Two general contextual categories are included in Table 1. Firstly, redeposited material includes open-air layers and building infills. Bones from such layers represent the last link in the chain of the waste management procedure, i.e. waste which has been redeposited in secondary, or even tertiary, deposits from its original waste location (see Schiffer 1987:18, 89; Kuna 2015). They reflect an accumulated series of events, i.e. general characteristics of waste management at the site during a particular chronological range. Different lenses or smaller contexts were not documented during the early excavations. The majority of the animal bones consist of redeposited material found in outdoor areas in the vicinity of Houses B, C and D in the LT, and the buildings and rooms of BH (Fig. 1; Supplementary Table).

The other contextual category is floors, which are waste-related activity areas and might contain remains of actual behaviour towards clean and/or unclean spaces (Martin & Russell 2000). A regularly swept floor will contain smaller fragments as well as more trampled bones (e.g. Schiffer 1987; Yeshurun *et al.* 2014:593). Floors are among the few primary deposits which were recognized, although sometimes with difficulty, during the old excavations (see Frödin & Persson 1938:66). This study includes animal bones found in the floors of Room XX in House D (floor level 1, Frödin & Persson 1938:73; Nordquist 1987:81); Room K in Building 2 (Hägg & Hägg 1976; Nordquist 1987:85); and Room M1 in the Deep Trench (see Hägg & Nordquist 1992). The latter is located in squares N 40.5–43.4 and W 289.4–292.7, but is not included in Fig. 1 (Hägg & Nordquist 1992:60). Nordquist (1987:81) has evaluated the field documentation of the excavation of the floors in House D. According to her, two floor levels were excavated, of which the first and earlier one, Floor 1, is considered.

3.2 Notes on the zooarchaeological analysis

The bones are quantified on the basis of Number of Identified Specimen (NISP), as defined by Lyman (1994b; 2008). Number of Specimens (NSP) and Number of Unidentified Specimens (NUSP) are used to include unidentifiable bone fragments (e.g. Grayson 1991; Lyman 2008:266). Secondary derivations such as Minimum Number of Individuals (MNI) or Minimum Number of Elements (MNE) are excluded because of the so-called aggregation problem (Lyman 2008:57-59). Such counts differ between levels of contextual resolutions, i.e. if calculated on a broad basis, such as all the bones being dated to one time period, the count will be different than if calculated on the basis of all the available context types of that period, such as all the pit fills of one specific period. This problem can be especially pertinent for old collections. In the case of Asine, it cannot be assumed that this kind of documentation was made consistently in all excavation areas. Therefore MNI-counts cannot be based on the contextual categories that are important to this study.

Identification by association is not employed (Driver 2011). Limb bone fragments identified by size class are therefore not included among identifiable fragments but as part of the unidentified sub-assemblages instead. The following anatomical categories are used: *Head* (horn/antler, skull, mandibles), *Trunk* (vertebrae, sternum, ribs), *Upper front* (humerus, scapula, radius, ulna), *Lower front* (carpal and metacarpal bone), *Pelvis* (pelvis and sacrum), *Upper hind* (femur, patella, tibia, fibula), *Lower hind* (tarsal and metatarsal bone), and *Metapodials and phalanges* (metapodials, sesamoids and phalanges, indeterminate to anatomical orientation). A chi-square test was used to investigate whether loose teeth exaggerate the proportion of cranial fragments from the most common animals, cattle, sheep/goat and pig, showing no statistically significant difference ($\chi 2 = 9.98$, df = 7, $p = >0.05$). Loose teeth are thus not excluded. Pigs have more bones in their body than ruminants, which is problematic when using NISP. One way to deal with this is to exclude all anatomical parts where pigs have more bone elements, such as the feet (Lyman 2008:32). Of such redundant elements, only two phalanges and one metapodial fragment (*metatarsale III*, also present in ruminants) were identified as pig; these are included in this study.

Age assessments were based on epiphyseal fusion data from post-cranial bone elements. Estimation of age at death based on epiphyseal fusion data on cattle, sheep/goat and pig follows Silver (1969) and O'Connor (1982). Sex assessments on cattle and sheep/goat were based on morphological features of the pelvic bones (Boessneck 1969). Sex assessment of pig was made on the basis of canine morphology (Mayer & Lehr Brisbin Jr 1988).

4. Material overview

This paper presents hitherto unpublished data on animal bones dated to MH III to LH I, ca. 1800-1600 BCE, recovered from the BH and the LT areas at Asine. The documentation of the excavations differs between the two areas because of the temporal discrepancy in the campaigns of ca. 40 years (Nordquist & Hägg 1996). The preliminary total number of bones from the whole MH and the LH periods (ca. 2100-1050 BC) is ca. 14 410, of which approximately one third has been identified by taxon (ca. 5 000). The only zooarchaeological evidence from a period in which both the BH and LT areas were inhabited, and which could be used for this paper, is only a fraction of this material, as it consists of 1 298 fragments (ca. 10 kg).

Table 2 presents the quantitative distribution of animal bones among the two areas. Both provided similar amounts of bone. The lower average weight (4.77 g) and the small average size (22.08 mm) observable at BH coincide with a lower degree of identification (22% NSP; 49% Weight). The bones from LT are seemingly in better condition; about half could be identified by taxon (53% NSP; 84% Weight). The average bone fragment is both bigger and heavier (9.47 g, respectively ca. 50.24 mm). It seems that a large difference between the areas may be one of preservation.

Table 2. Characteristics of animal bone sub-assemblages from Barbouna and Lower Town, MH III-LH I Asine. NISP includes specimens identified by genus; weight in grams

	Lower Town		Barbouna Hill	
	No (%)	Weight (g)	No (%)	Weight (%)
NISP	351 (53)	5 850.4 (84)	137 (22)	1 468 (49)
NUSP	310 (47)	1 140.9 (16)	500 (78)	1 542.8 (51)
Total (NSP)	661 (100)	6 991.3 (100)	637 (100)	3 010.8 (100)
Average fragment weight (g)	9.47		4.77	
Average fragment size (mm)	50.24[1]		22.08	

[1]only 84 fragments were measured

No soil volume data is present, which makes it hard to compare bone density volumes between the areas. The excavated area of LT (the Large Trench, ca. 2288 m^2) is much larger than the roughly 230 m^2 at BH (Hägg & Hägg 1973:23; Nordquist 2016). To investigate whether this difference affects the spatial distribution of animal bones in general terms, a chi-square test was performed. The results indicate that the actual distribution of animal bones cannot be explained by the differences of excavated areas ($\chi 2 = 778$, df = 1, p=<0.05). In fact, the amount of bone from the Barbouna is larger than expected from its smaller excavation area.

Taphonomic markers are generally more common in the LT sub-assemblage (680 taphonomic markers on 661 bones), suggesting that they were more affected by taphonomic processes than the BH bones. However, fewer taphonomic marks are visible on the BH bones (420 taphonomic marks on 637 bones), probably reflecting the fact that BH bones are generally more fragmented. The smaller surfaces on very fragmented bones are less likely to preserve macroscopically detectable traces of taphonomic processes. The fragmented BH sub-assemblage is more damaged by post-depositional erosion, which is why fewer signs of taphonomic markers are identified. This is supported by the fact that the Barbouna Hill area is also topographically more exposed to external erosion, such as wind and landslides, due to its location on a hill slope.

5. Waste management at MH III-LH I Asine

5.1 Redeposited material

Figure 2 illustrates the relative abundances of taphonomic markers in relation to total bone count (NSP). In the redeposited material, weathering, although in low frequencies (19 bones; 16 %), is the most common taphonomic marker in the LT sub-assemblage. Some bones in the Lower Town were also gnawed (29 bones; 5 %), some were trampled (21; 4 %), and some burnt (20; 3 %). In the BH material, the most common taphonomic marker is of burning (28 bones; 7 %). Smaller numbers of gnawed (19; 4%) and of weathered (14; 5%) bones were identified. Together with weathering, the occurrence of both gnawing and trampling among the LT bones is consistent with them being interpreted as exposed bone waste. Based on the fact that at least weathering is more frequent at LT than at BH, the main difference between the two areas seems to be that bones from LT show more indications of outdoor exposure. As gnawing and weathering are present in the BH sub-sample, at least some of the bones were exposed over a longer period. The most common taphonomic marker at BH, however, derives from burning. Only eight bone fragments were burnt white, i.e. calcined, the rest being either black or dark brown. Although some bones might have been destroyed completely by burning, the majority remained unburnt, which suggests that the burning of refuse was not the dominant waste management strategy at Asine during this period.

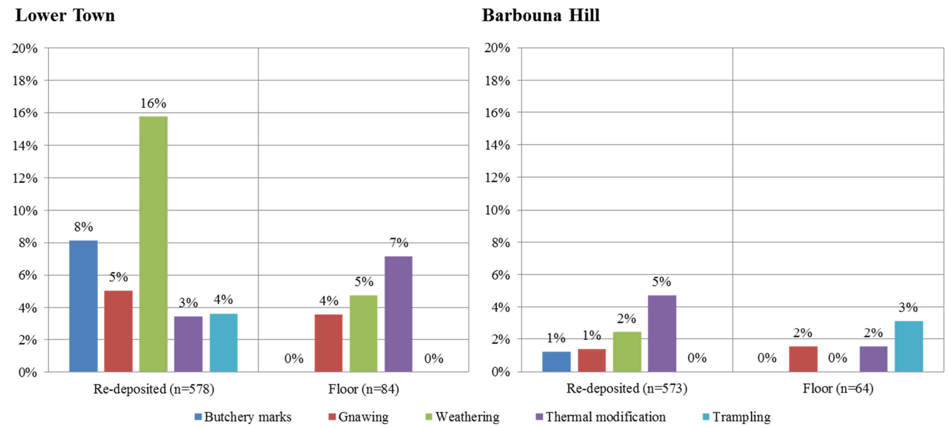

Figure 2.
Taphonomic markers distribution in redeposited versus floor layers in the Lower Town (left) and the Barbouna Hill (right), MH III-LH I Asine. Post-depositional markers, such as mineral encrustation, are excluded. Numbers include markers on identifiable and unidentifiable bones.

5.2 Floor layers

About one tenth of the bones in each area derive from floor layers. A few bones found on LT floors (Fig. 3) had traces of weathering, gnawing or trampling. Seven bones were burnt, four weathered and three gnawed. The presence of weathering could indicate that previously exposed bones from outside areas could have been moved back indoors. In some cultures children are active dispersal agents (e.g. Hayden & Cannon 1983:132; Marciniak 2005:82). Perhaps more likely, the weathered bones derive from the floor make-up, or collapsed wall/roof rubble, and not the actual floor.

In general, the bones from the earthen BH floors (Fig. 2) exhibit only a few traces of gnawing, burning and trampling: two bones were trampled, one bone was burnt and one gnawed. As these few splinters indicate the presence of these processes, i.e. trampling, burning and carnivore gnawing, it might support the general idea that bones from floors should show signs of being trampled down and fragmented, occasionally called *casual refuse* (Schiffer 1987; Yeshurun *et al*. 2014). The presence of burning is similar to both LT and BH. It is possible that these burnt bones are remains of waste thrown into fire installations as a kind of waste management. The fire installations were probably scooped out, and the content redeposited elsewhere (see Martin & Russell 2000:62). The few burnt bones from the Asine floors could be remains of casual refuse, left over from sweeping of the domestic area.

6. Waste content from MH III-LH I Asine

6.1 Taxonomic compositions

The abundance of identified taxa from LT and BH (Table 3) shows that, in general, sheep/goats are most common, followed by pigs and cattle. Sheep/goat, pig, cattle, horse, red deer and tortoise are identified in both areas; additionally roe deer, goat and human are identified at LT. The human bones are not further discussed as they might be inclusions from intramural graves (Ingvarsson-Sundström 2006). A chi square-test was applied to the distribution of NISP. The results ($\chi 2 = 14.5$, df = 7, $p = <0.05$) indicate that there is a significant difference between the distribution of taxa in each area. For example, the abundance of deer is less than expected in the Barbouna sample (Table 3). Ten percent of the identifiable bones at LT derive from deer, while only two percent at BH consists of deer bones. About half derive from deer antlers which probably derive from tool production processes rather than meat consumption only. Sheep/goat is relatively more common in BH compared to LT (47% of NISP and 37 % of NISP, respectively).

Table 3.
Identified taxa at MH III-LH I Asine.

Taxon		Lower Town		Barbouna Hill	
		NISP	%NISP	NISP	%NISP
Domestic animals	Sheep/goat (*Ovis aries/Capra hircus*)	120	34	62	45
	Sheep (*Ovis aries*)	6	2	3	2
	Goat (*Capra hircus*)	5	1	0	0
	Pig (*Sus sp.*)	0	0	1	1
	Domestic pig (*Sus domesticus*)	100	28	37	27
	Cattle (*Bos taurus*)	70	20	25	18
	Dog (*Canis familiaris*)	6	2	1	1
	Equids (*Equus sp.*)	2	1	0	0
	Horse (*Equus caballus*)	1	0	2	1
	Human (*Homo sapiens*)	2	1	0	0
Wild animals	Deer (Cervidae)	1	0	3	2
	Red deer (*Cervus elaphus*)	35	10	3	2
	Roe deer (*Capreolus capreolus*)	1	0	0	0
	Turtle (Testudine)	2	1	0	0
Total		351	100%	137	100%

6.2 Selection of body parts

Figure 3 illustrates the skeletal parts' frequencies of sheep/goat, pig and cattle in both areas. The Kolmogorov-Smirnov test (Shennan 2006:57) was applied in order to test whether the anatomical distributions from the two dwelling areas are statistically different from each other. Only distributions of pig bones proved statistically significant. Thus, it is hard to argue for specific differences in the anatomical distributions, and about the differential use of the various body parts of sheep/goat or cattle between the areas. All body parts of sheep/goat are represented, although vertebrae, ribs, the pelvic region and distal extremities are not as abundant as cranial and long bone fragments (Fig. 3).

Compared to an expected distribution of the animal body (e.g. Stiner 1991), the vertebrae and ribs are under-represented. Instead of a human preference for the head and the limbs, this might be explained by density-mediated attrition, since compact bone is more resilient to post-depositional destruction (e.g. Lyman 1994b). This was discussed in an earlier study of the broader MH animal bone assemblage of Asine, which showed that axial bone was under-represented (Macheridis 2016a). For cattle, we see higher proportions of distal extremities and the skull at BH, while the upper extremities are more abundant at LT. Although it might be of zooarchaeological relevance, this pattern is not statistically significant and therefore not discussed further.

The proportion of pig skull fragments is higher in LT. Axial fragments are more abundant at BH. This difference is statistically significant. Considering the poorer preservation status of the BH bones, it is probable that axial bones initially constituted an even larger proportion of the assemblage of the actual leftovers than what we can observe today. Elements of the axial skeleton, such as vertebral bodies, are less densely built, thus being more prone to post depositional attrition (Lyman 1994b:234-258). Among the specimens that have been identified at the level of sized-classed but unidentified specimens, vertebra and ribs are abundant, while limb bone fragments are heavily over-represented; if identifiable, both elements would have contributed higher percentages to the distributional charts, perhaps for all animals.

6.3 Selection of age and sex

Age at death determination was not possible for many bones, thus the following results are tentative. Few juvenile fragments are identified. Juvenile bone is more fragile, and is often more prone to post-depositional destruction (e.g. Symmons 2005). Mostly prime-age and older animals are represented in Table 4. For example, only two sheep/goat bones derived from juveniles (<12 months) in LT. For cattle, there is a similar pattern with a focus on adult individuals (Table 4). Slightly more juvenile cattle bones derive from BH, though this is based on few fragments. All sex assessments derive from LT, so they cannot be used for intra-site comparison. Four ovicaprine pelvis fragments could be assessed as deriving from females. No clear differences in selection of age and sex of cattle or sheep/goats are visible between LT and BH.

About half of the age-assessed pig bone fragments in BH derive from individuals aged ca. 30 months or younger (7 of 13 bones). In LT, four of sixteen bones are from individuals aged 30 months or younger. The pigs represented at LT in Table 4 reached somewhat older ages than those of the BH. Eight pig bones from LT could be sex assessed, of which six were certainly from males, one probably male, while only one fragment derived from a female. No sexing data are available from BH. Whether BH and LT shared the same resources in terms of pig herds is hard to discern; however, the age and sex assessments might indicate that the inhabitants of the LT perhaps had a preference for male pigs of a relatively older age (Table 4) than in BH. This observation is, however, based on a small data set.

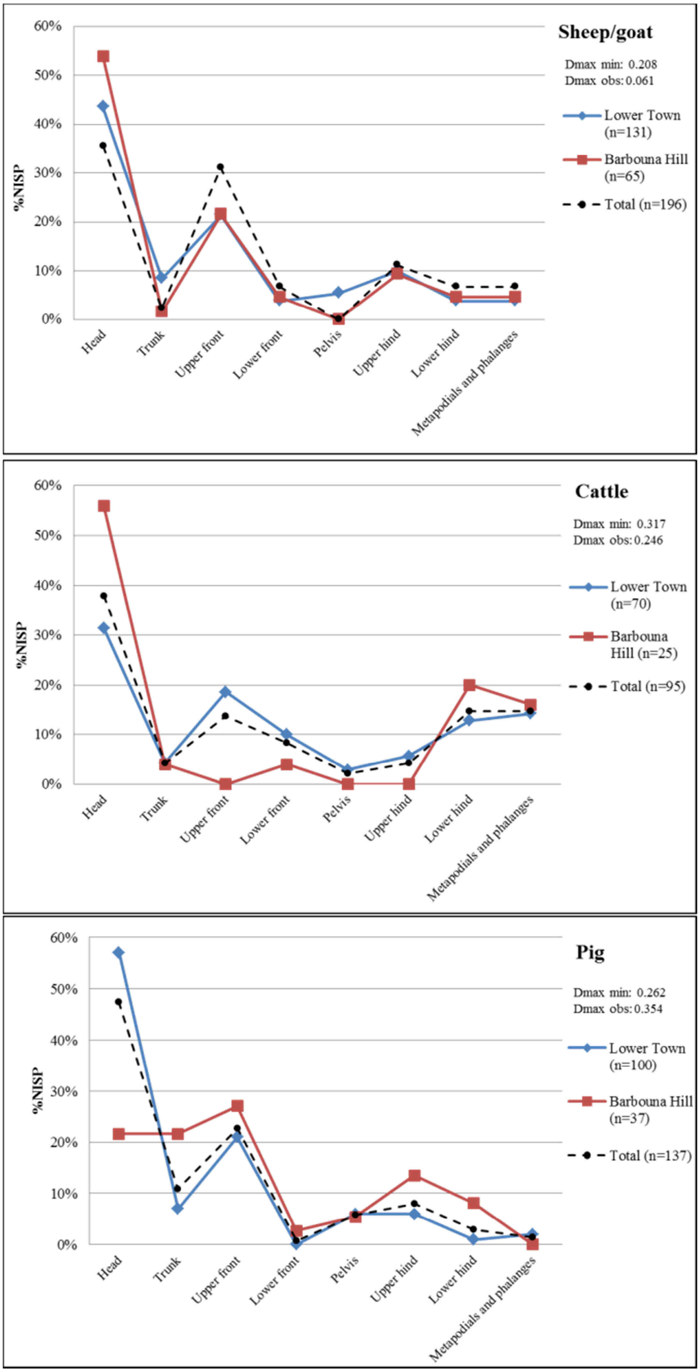

Figure 3.
Skeletal part frequencies (%NISP) of sheep/goat, cattle, and pig, MH III-LH I Asine

Table 4.

Postcranial epiphyseal union data of sheep/goat, pig, and cattle, MH III-LH I Asine. Translation to absolute ages (months) taken from Silver (1969); O'Connor (1982), as compiled by Vretemark (1997)

Cattle (n=27)	Lower Town				Barbouna Hill			
Fusion age (months)	Unfused	Fusing	Fused	Total	Unfused	Fusing	Fused	Total
12-18	0	0	10	10	0	0	3	3
24-36	2	0	5	7	1	0	1	2
>48	1	1	1	3	2	0	0	2
Sheep/goat (n=36)								
Fusion age (months)	Unfused	Fusing	Fused	Total	Unfused	Fusing	Fused	Total
12	1	1	8	10	0	0	9	9
18-30	3	0	4	7	2	0	1	3
30-42	0	1	0	1	3	1	2	6
Pig (n=29)								
Fusion age (months)	Unfused	Fusing	Fused	Total	Unfused	Fusing	Fused	Total
12	1	1	7	9	3	0	4	7
30	1	1	1	3	4	0	1	5
42	4	0	0	4	0	1	0	1

7. Discussion

The goal of this paper is to investigate whether or not the growing social complexity testified by mortuary evidence and architecture of MH III-LH I Asine is also reflected in the distribution of the waste produced by this community with a focus on the zooarchaeological remains. The analysis revealed zooarchaeological tendencies of interest. Table 5 includes a summary of the similarities and differences within the animal bone assemblage from the LT and BH areas during this period.

Table 5.
Differences and similarities between the Lower Town and the Barbouna Hill areas. Summary of results based on the methodological framework (Table 1).

	Analytical variables	Lower Town	Barbouna Hill	Similarities
Waste management	General taphonomy	More indicators of exposure (weathering, gnawing and trampling)	Biased by post-depositional taphonomy visible through higher degree of fragmentation	
	Floor layers	Inmixed material from construction or destruction layers on floor 1 of House D		Remains of casual refuse, in form of burnt bones, produced by occasional domestic sweeping into fire installations
Waste content	Taxonomic composition	More remains of deer than at BH	No rare taxa identified	Sheep/goat most abundant, followed by pig and cattle. Horse and red deer identified.
	Skeletal part frequencies	More cranial bones of pigs than at BH	More vertebrae and ribs of pig than in LT	All body parts present of all animals
	Age structure	Juvenile and older pigs	Juvenile pigs	No clear differences between the areas regarding cattle and sheep/goat (few juveniles)
	Sex structure	Predominantly male pigs		No clear differences between the areas

7.1 Differences and similarities in waste management

The biggest difference between the two areas is the higher degree of exposure visible in the redeposited material from LT. This can be explained as a consequence of people living in denser communities, thus producing more waste. The houses were bigger, more elaborate and closer to each other in LT (Nordquist 1987:87-89). The leftovers from these households might have been accumulated in specific locations, but ultimately they were redeposited in this area, e.g. in levelling layers or construction fills. Some bones were thrown to carnivores, as indicated by signs of gnawing and weathering (e.g. Hayden & Cannon 1983:130). If these bones were left on the ground surface they would also bear signs of outdoor exposure to a higher degree. This is observed among the LT bones, which were seemingly more exposed outdoors before final deposition. Although this supports the idea that the LT was more densely occupied, this is not an indication of social topography within the settlement.

In general, the remains of burnt bone on floors in bones from both areas can indicate that there was a practice of sweeping bones into fire installations in both areas. The presence of weathering among the floor bones from the LT raises doubts regarding whether the bones derive from a closed floor context or not. This could be an 'old collections'-bias rather than an indication of differences in waste management. The floors of the LT were hard to define during excavation (Frödin & Persson 1938:66). Perhaps then, the finds, including the animal bones ascribed to this particular floor have been mixed with under- or overlying stratigraphic units, such as collapsed wall rubble. This can explain the inclusion of weathered bone. On the other hand, bones from BH floors were typically trampled bone splinters, and are characterized by trampling, burning and gnawing. They correspond to the picture of casual refuse embedded in floors, i.e. bone splinters that get trampled into floors during sweeping (e.g. Yeshurun *et al.* 2014:594).

7.2 Differences and similarities in waste content

The higher abundance of deer bones in the LT area indicates that inhabitants of this area more often hunted and/or consumed deer. This could be a consequence of social topography. Hunting, evidenced in the presence of wild game as food or source of raw materials, is seen as a symbolically laden activity during the LBA (Hamilakis 2003). Isaakidou (2007) proposed that fallow deer are an indicator of the elite at BA Knossos. The presence of both red and roe deer at LT might be an indicator of better access to game animals compared to BH. Still only a few bones were found. Other than signifying activities symbolically related to power, the presence of game animals represented by small bone counts could be an indication of opportunistic hunting. Also, they could have been rare in the wild and therefore caught in small numbers. It is difficult to discuss whether there was a differentiation in availability, access, or preference of wild animals between LT and BH based on bones alone. We should include other types of archaeological evidence in this discussion.

The distribution of pottery ware within the settlement indicates that relatively more imported ware is found in the individual houses of the Lower Town at Asine than those of Barbouna Hill (Nordquist 1987:90). The more intense consumption of both imported pottery and relatively rare game animals at LT might indicate that the dwellers of this part of the town had better access to unusual resources than those living on BH. Together with the suggestion of a more intense consumption of hunted animals at LT, this might indicate that the inhabitants of this dwelling area had better access to imported ware and rare animals or foodstuffs. Together, these instances indicate a social topography where the Lower Town inhabitants formed a socially distinct group in relation to the others.

The anatomical distribution and the mortality curve of pigs might be related to the manufacture of pig tusk plates at the site. There is a tendency for juvenile pigs to be slaughtered in higher frequencies slaughtered at BH (Table 4). Pig skulls are more common from the LT. The majority of sex assessed pig bones in LT are from males. This distinct preference for male heads might possibly be linked to pig tusk plate production, which is evidenced in the area by at least 13 unfinished plates. These elements, which were used for the manufacture of the elaborate so called "boar-tusk helmets", are found in the settlement debris of MH Asine, at various locations (Nordquist 1987:115; see Frödin & Persson 1938:311). Such an association has to remain tentative due to the small sample size for both pig head bones and tusk plates. Still, some bone craft is witnessed on site, hinting at some degree of specialization. The deer antler fragments were found predominantly in LT (16/19 fragments). They are likely not the traces of consumption but of craft activities. Only four worked bone or antler fragments were found in BH; two from graves. This is in parity with the 77 bone artefact finds mentioned by Nordquist (1987:112-114), of which some, however, might have been imported. In terms of social topography, this could perhaps be discussed as spatial differentiation within Asine, where the Lower Town inhabitants might have specialized in bone craft or acquired such items to a higher degree. As this does not seem to have been the case at Barbouna Hill, it might reflect an uneven social topography.

7.3 Conclusions: social topography at MH III-LH I Asine

The zooarchaeological tendencies reflecting subtle differences between the two areas could be discussed in terms of social topography, i.e. the social mapping of status hierarchies as expressed by location (Richer 2015). These are the pronounced consumption of wild animals and the possibility of more intense consumption of bone/antler artefacts in the Lower Town. Together with the differential distribution of crafted bone items and imported pottery wares, this subtlety can support the hypothesis of an uneven social topography in the Asine society during the MH III-LH I. However, the bones reveal that similarities existed between the areas, especially in the keeping and consumption of domestic animals and in waste management. This indicates that the signs of social topography detected in the material culture are overestimated. If a growing social topography was manifested, it was not in the every-day life routines but perhaps mainly during occasional events, such as receiving gifts or the import of objects.

8. Epilogue: On the use of the 'old' collections in social zooarchaeology

Certain aspects of the methodological framework suggested in Table 1 could be investigated, while others were harder to discuss. For example, through the study of taphonomic markers more signs of weathering, trampling and gnawing were visible among the LT bones. However, the BH bones were more fragmented, and taphonomic markers might have been masked through the high fragmentation degree producing smaller bone surface areas to inspect for taphonomic markers. Waste management practices indoors were hard to detect. The occurrence of smaller burnt bones fragments embedded in floors was suggested to be the remains of casual refuse, such as from occasional domestic sweepings in to fire installations. Still, the weathering prevalence in a LT floor (House D), suggested that some of the material probably was inmixed from collapsed walls or the make-up of the floor itself. The excavators did not separate between make-up layers and activity layers in floors, and they also acknowledged the difficulties of recognizing some of the floors in the LT area (Frödin & Persson 1938:66).

There are, however, some questions which remain open in the discussion on social topography at Asine. The results show that both areas are similar in terms of mammal species composition, with the exception of more deer taxa in the LT area. Still, the diversity of fish and birds remains unknown due to the chosen sampling strategies (see Mylona 2005; Jones & Gabe 2015:2-3). Although inferential statistics could in some cases aid in investigating whether the distributions were random or not, using such data as the anatomic elements of pig (see Shennan 2006:56-57), the low bone counts are unsuitable for detailed analysis of body part distributions. Patterns of mortality could only partially be discussed, because of this problem. Juvenile bones are small and were not always collected in old excavations, where sieving was applied inconsistently. They are also more fragile and prone to post-depositional destruction (e.g. Symmons 2005). In addition to the problems of the contextual resolution, the animal bones from the BH area were seemingly more disturbed by post-depositional erosion. This makes it hard to ascertain whether any difference or similarity correctly reflects prehistoric conditions.

I suggested that it is in conjunction with the previous research that we can use the contrasts between the sub-assemblages from both areas to discuss social topography, such as the higher prevalence of imported pottery ware in the LT area (see Nordquist 1987:90). The architectural differences between the areas, with more elaborate house planning in the LT, also supports this. The bones have contributed greatly to the picture, by showing that there were many similarities in both waste management and waste content between these areas (Table 5). It is important to acknowledge that similar issues of being part of an old collection are present for other kinds of material culture, such as pottery, metal objects and bone artefacts, which have traditionally been the main basis of research on the site. Since sieving was not always systematically applied at Asine, an unknown number of smaller fragments, or perhaps uninteresting ones according to the excavators, of material culture have been lost.

Dealing with old collections, such as the one from Asine, requires a more comprehensive preparation and must be preceded by the qualitative and reflexive study of unpublished and published documentation. It is, for example, necessary to determine the level of contextual resolution, based on factors such as whether or not all visible archaeological features were recorded systematically, and whether sieving was applied consistently (Jones & Gabe 2015; see also Orton 2012:322). Acknowledging these pitfalls makes it possible to adjust any methodological framework to the material. Although the zooarchaeological results remain general and at times difficult to verify, this paper further testifies that the animal bones from the Asine excavations in the 20th century can and should be used for social studies of prehistoric Asine.

Acknowledgements

The animal bones from the excavations on the Barbouna Hill used in this study are stored in Nauplion, Greece, under the supervision of the 4th Ephorate of Prehistoric and Classical Antiquities. I thank the 4th Ephorate of Prehistoric and Classical Antiquities in Greece for the permit to study the bones in their storage facilities (The Leonardo) in Nauplion. I am grateful for the kindness and encouragement received from the staff working at the Leonardo. The animal bones from the excavations of the Lower Town are stored at the Museum Gustavianum, Uppsala, Sweden. I am thankful to the museum for the permit to loan the material in order to study the bones in the Osteological Laboratory at Lund University. I am thankful for the invaluable advice and feedback from Dimitra Mylona, Torbjörn Ahlström, Anne Ingvarsson, Kristina Jennbert, Helene Wilhelmson and Gullög Nordquist.

References

Andrews P and Cook J. (1985) Natural modifications to bones in a temperate settings. *Man, New Series* 20(4): 675-691.

Behrensmeyer A. (1978) Taphonomic and ecological information from bone weathering. *Paleobiology* 4(2): 150-162.

Binford, LR. (1981) *Bones: Ancient Men and Modern Myths*. Academic Press: London.

Boessneck J. (1969) Osteological differences between sheep (*Ovis aries* Linné) and goat (*Capra hircus* Linné). In: Brothwell D and Higgs E (eds.), *Science in Archaeology*. Thames & Hudson: London, 336-359.

Bourdieu P. (1979) *Distinction: a social critique on the judgement of taste*. Harvard University Press: Cambridge, Massachusetts.

Bourdieu P. (1989) Social space and symbolic power. *Sociological Theory* 7(1): 14-25.

Dickinson OTPK. (1989) "The origins of Mycenaean civilisation" revisited. In Laffineur R (ed.), *Aegeum 3. Transition. Le Monde Egeen du Bronze Moyen au Bronze Recent.* Universite de Liege: Liege, 131-136.

Dietz S. (1982) *Asine II: Results of the Excavations East of the Acropolis 1970-1974. Fascicle 1: General Stratigraphical Analysis and Architectural Remains*. Skrifter utgivna av Svenska Institutet i Athen, 4º, 24:1. Svenska Institutet i Athen: Stockholm.

Douglas M. (1966) *Purity and Danger*. Routledge: London and New York.

Douny L. (2007) The materiality of domestic waste: the recycled cosmology of the Dogon of Mali. *Journal of Material Culture* 12(1): 309-331.

Driver JC. (2011) Identification, classification and zooarchaeology. *Ethnobiology Letters* 2: 19-39.

Ervynck A, Van Neer W, Hüster-Plogmann H and Schibler J. (2003) Beyond affluence: the zooarchaeology of luxury. *World Archaeology* 34(3): 428-441.

Frödin O and Persson AW. (1938) *Asine. Results of the Swedish Excavations 1922-1930*. Generalstabens litografiska anstalts förlag: Stockholm.

Gifford-Gonzalez D. (2014) Constructing community through refuse disposal. *African Archaeological Review* 31: 339-382.

Gillis C. (1996) Tin at Asine. In Hägg R, Nordquist GC and Wells B (eds.), *Asine III. Supplementary studies on the Swedish excavations 1922-1930*. Svenska Institutet i Athen: Stockholm, 94-100.

Goody J. (1982) *Cooking, Cuisine and Class: a Study in Comparative Sociology*. Cambridge University Press: Cambridge.

Grayson DK. (1991) Alpine faunas from the White Mountains, California: adaptive change in the late prehistoric great basin? *Journal Of Archaeological Science* 18(4): 483-506.

Hamilakis Y. (2003) The sacred geography of hunting: wild animals, social power and gender in early farming societies. In Kotjabopoulou E, Hamilakis Y, Halstead P, Gamble C and Elefanti P (eds.), *Zooarchaeology in Greece: Recent Advances*. The British School at Athens: London, 239-248.

Hayden B and Cannon A. (1983) Where the garbage goes: refuse disposal in the Maya Highlands. *Journal of Anthropological Archaeology* 2: 117-163.

Haynes G. (1983) A guide for differentiating mammalian carnivore taxa responsible for gnaw damage to herbivore limb bones. *Paleobiology* 9(2): 164-172.

Hill JD. (1995) *Ritual and Rubbish in the Iron Age of Wessex: a Study on the Formation of a Specific Archaeological Record*. British Series, 242. British Archaeological Reports: Oxford.

Hägg I and Hägg R. (1973) *Excavations in the Barbouna Area at Asine. Fascicle 1: General Introduction, Bibliography, Geological Background and a Report on the Field-work in the Levendis sector, 1970-1972.* Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilizations, 4:1. Uppsala University: Uppsala.

Hägg I and Hägg R. (1976) Discoveries at Asine dating from the Shaft-Grave Period. *Archaeologica Analektika ex Athinon* VIII(2): 151-160.

Hägg R and Nordquist GC. (1992) Excavations in the Levendis Sector at Asine, 1989: a preliminary report. *Opuscula Atheniensia* 19: 59-68.

Ingvarsson-Sundström A. (2008) *Asine III: supplementary studies on the Swedish excavations 1922-1930. Fascicle 3: Children lost and found.* Skrifter utgivna av Svenska Institutet i Athen, 4°, 45:2. Svenska Institutet i Athen: Stockholm.

Ingvarsson-Sundström A, Voutsaki S and Milka E. (2013) Diet, health and social differentiation in Middle Helladic Asine: a bioarchaeological view. In: Voutsaki S and Valamoti SM (eds) *Diet, Economy and Society in the Ancient Greek World: Towards a better integration of archaeology and science*. Peeters: Leuven, 149-162.

Isaakidou V. (2007) Cooking in the Labyrinth: exploring cuisine at Bronze Age Knossos. In: Mee C and Renard J (eds.), *Cooking up the past: Food and culinary practices in the Neolithic and Bronze Age Aegean*. Oxbow Books: Oxford, 5-24.

Lucas G. (2002) Disposability and dispossession in the twentieth century. *Journal of Material Culture* 7(1): 5-22.

Lyman RL. (1994a) *Vertebrate Taphonomy*. Cambridge University Press: Cambridge.

Lyman RL. (1994b) Quantitative Units and Terminology in Zooarchaeology. *American Antiquity* 59(1): 36-71.

Lyman RL. (2008) *Quantitative paleozoology*. Cambridge University Press: Cambridge.

Marciniak A. (2005) *Placing Animals in the Neolithic: Social Zooarchaeology of prehistoric farming communities*. UCL Press: London.

Martin L and Russell N. (2000) Trashing rubbish. In Hodder I (ed.), *Towards reflexive method in archaeology: the example at Çatalhöyük.* McDonald Institute for Archaeology Research: Cambride, 57-69.

Mayer JJ and Lehr Brisbin Jr I. (1988) Sex identification of *Sus scrofa* based on canine morphology. *Journal of Mammology* 69(2): 408-412.

Nordquist GC. (1987) *A Middle Helladic Village. Asine in the Argolid*. Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilizations, 16. Uppsala University: Uppsala.

Nordquist GC. (1990) Middle Helladic burial rites: some speculations. In Hägg R and Nordquist GC (eds.), *Celebrations of Death and Divinity in the Bronze Age Argolid*. Svenska Institutet i Athen: Stockholm, 35-41.

Nordquist GC. (2002) Pots, prestige and people: symbolic action in Middle Helladic burials. *Opuscula Atheniensia* 27: 119-135.

Nordquist GC. (2016) Personal communication.

Nordquist GC and Hägg R. (1996) The history of the Asine excavations and collections, with a bibliography. In Hägg R, Nordquist GC and Wells B (eds.), *Asine III: supplementary studies on the Swedish excavations 1922-1930. Fascicle 1*. Skrifter utgivna av Svenska Institutet i Athen, 4°, 45:1. Svenska Institutet i Athen: Stockholm 11-18.

O'Connor TP. (1982) *Animal Bones from Flaxengate, Lincoln*. Council for British Archaeology: London.

Orton DC. (2012) Taphonomy and interpretation: an analytical framework for social zooarchaeology. *International Journal of Osteoarchaeology* 22(3): 320-337.

Petrakis VP. (2010) Diversity in form and practice in Middle Helladic and Early Mycenaean elaborate tombs: an approach to changing prestige expression in changing times. In Philippa-Touchais A, Touchais G, Voutsaki S and Wright J (eds.), *Mesohelladika: The Greek Mainland in the Middle Bronze Age. Proceedings of the International Conference held in Athens, March 8-12 2006*. Athens, 403-416.

Rathje W and Murphy C. (2001) *Rubbish! The Archaeology of Garbage*. The University of Arizona Press: Tucson.

Redding RW. (2010) Status and diet at the Worker's Town, Giza, Egypt. In Campana S, Crabtree P, deFrance SD, Lev-Tov J and Choyke A (eds.), *Anthropological approaches to zooarchaeology: Complexity, colonialism, and animal transformations*. Oxbow Books: Oxford and Oakville, 65-75.

Richer Z. (2015) Toward a social topography: status as a spatial practice. *Sociological Theory* 33(4): 347-368.

Rudebeck E and Macheridis S. (2015) The proper way of dwelling at the Early Neolithic gathering site of Almhov in Scania, Sweden. In Brink K, Hydén S, Jennbert K, Larsson L and Olausson D (eds.), *Neolithic Diversities: Perspectives from a conference in Lund, Sweden*. Acta Archaeologica Lundensia Series altera in 8°, 65. Dept. of Archaeology and Ancient History, Lund University: Lund, 173-187.

Schiffer MB. (1987) *Formation Processes of the Archaeological Record*. University of New Mexico: Albuquerque.

Shennan S. (2006) *Quantifying Archaeology*. 2nd ed. University of Iowa Press.: Iowa City.

Silver IA. (1969) The ageing of domestic animals. In Brothwell D and Higgs E (eds.), *Science in Archaeology*. Thames & Hudson: London 283-302.

Strasser S. (1999) *Waste and want: A social history of trash*. Henry Holt and Company: New York

Symmons R. (2005) New density data for unfused and fused sheep bones, and a preliminary discussion on the modelling of taphonomic bias in archaeofaunal age profiles. *Journal Of Archaeological Science* 32: 1691-1698.

Thilderqvist J. (2013) *Ritual Bones or Common Waste: a Study of Early Medieval Bone Deposits in Northern Europe*. Diss. Rijksuniversiteit Groningen: Groningen.

Twiss K. (2012) The archaeology of food and social diversity. *Journal of Archaeological Research* 20(4): 357-395.

Voutsaki S. (1997) The creation of value and prestige in the Aegean Late Bronze Age. *Journal of European Archaeology* 5(2): 34-52.

Voutsaki S. (2010a) Mainland Greece. In Cline EH (ed.) *The Oxford Handbook of the Bronze Age Aegean (ca. 3000-1000 BC)*. Oxford University Press: Oxford, 99-112.

Voutsaki S. (2010b) The domestic economy in Middle Helladic Asine. In Philippa-Touchais A, Touchais G, Voutsaki S and Wright J (eds.), *Mesohelladika: The Greek Mainland in the Middle Bronze Age. Proceedings of the International Conference held in Athens, March 8-12 2006*. Athens, 1-17.

Voutsaki S. (2010c) From the kinship economy to the palatial economy: the Argolid in the Second Millenium BC. In Pullen DJ (ed.), *Political Economies of the Aegean Bronze Age*. Oxbow Books: Oxford 86-111.

Voutsaki S. Ingvarsson-Sundström A and Dietz S. (2011) Tumuli and social status: a re-examination of the Asine tumulus. In: Borgna E and Müller Celka S (eds.), *Ancestral Landscapes: Burial Mounds in the Copper and Bronze Ages*. Maison de l'Orient et de la Méditerranée: Lyon, 445-461.

Vretemark M. (1997) *Från ben till boskap: kosthåll och djurhållning med utgångspunkt i medeltida benmaterial från Skara. Del 1*. Skrifter från Länsmuséet Skara. Skaraborgs länsmuseum: Skara.

Yeshurun R, Bar-Oz G, Kaufman D and Weinstein-Evron M. (2014) Purpose, permanence, and perception of 14,000-year-old architecture: contextual taphonomy of food refuse. *Current Anthropology* 55(5): 591-618.

Supplementary data

Distribution of animal bones in MH III-LH I Asine, by area and context

Lower Town dwelling area, MH III-LH I Asine		House B			House D		House D Floor			
	Taxon	Hearth room	Not specified	Around, in or close to House B	Room XIX (A)	Close to "megaron wall", Room XX or XIX	Floor 1, Room XX	Floor, probably in House D	Around Houses B, C, and D	Total
Domesticates	Sheep/goat (*Ovis aries*/*Capra hircus*)	5	9	2	2	7	12	0	83	**120**
	Sheep (*Ovis aries*)	1	1	0	0	0	1	0	3	**6**
	Goat (*Capra hircus*)	0	1	0	0	0	0	0	4	**5**
	Cattle (*Bos taurus*)	0	9	2	1	4	3	1	50	**70**
	Pig (*Sus domesticus*)	0	19	2	5	3	5	0	66	**100**
	Dog (*Canis familiaris*)	0	1	0	0	1	0	0	4	**6**
	Horse or donkey (*Equus spp.*)	0	0	0	1	0	0	0	1	**2**
	Horse (*Equus caballus*)	0	0	0	0	0	0	0	1	**1**
	Human (*Homo sapiens*)	0	1	0	0	0	0	0	1	**2**
Wild animals	Deer (Cervidae)	0	0	0	0	0	0	0	1	**1**
	Red deer (*Cervus elaphus*)	0	5	1	0	0	1	0	28	**35**
	Roe deer (*Capreolus capreolus*)	0	0	0	0	0	0	0	1	**1**
	Turtle (Testudine)	0	0	0	0	0	0	0	2	**2**
Mammal	Small-sized mammals	0	0	0	0	0	1	0	2	**3**
	Medium-sized mammals	0	11	2	10	5	26	15	89	**158**
	Large-sized mammals	1	15	1	1	6	11	1	55	**91**
	Indeterminate size	0	6	2	0	4	6	0	38	**56**
Indeterminate							1		1	**2**
Total		**7**	**78**	**12**	**20**	**30**	**67**	**17**	**430**	**661**

Barbouna Hill dwelling area, MH III-LH I Asine		Building 2	Building 1			Close to deep trench[1]	East extension[1]	Deep trench[1]	Around houses and walls in Main Trench	Total
	Taxon	Room N	Floor, Room K	Fill in Room W	Collapsed rubble, Room W	Fill in Room M(s)	Room E	Floor, Room M1		
Domesticates	Sheep/goat (*Ovis aries*/*Capra hircus*)	0	0	1	1	2	1	10	47	**62**
	Sheep (*Ovis aries*)	0	0	0	0	0	0	2	1	**3**
	Cattle (*Bos taurus*)	0	0	0	0	0	1	1	23	**25**
	Pig (*Sus domesticus*)	1	1	1	0	0	1	5	29	**38**
	Dog (*Canis familiaris*)	0	0	0	0	0	0	0	1	**1**
	Horse or donkey (*Equus spp.*)	0	0	0	0	0	0	0	1	**1**
	Horse (*Equus caballus*)	0	0	0	0	0	0	0	2	**2**
Wild animals	Deer (Cervidae)	0	0	0	0	0	0	0	3	**3**
	Red deer (*Cervus elaphus*)	0	0	0	0	0	0	1	2	**3**
Mammal	Medium-sized mammals	1	3	5	2	4	2	20	183	**220**
	Large-sized mammals	0	2	1	0	5	0	16	99	**123**
	Indeterminate size	0	0	1	2	8	1	3	141	**156**
Total		**2**	**6**	**9**	**5**	**19**	**6**	**58**	**532**	**637**

[1]no detailed plans are available, but see Hägg and Nordquist 1989: Fig. 1

Paper V

SVENSKA INSTITUTEN I ATHEN OCH ROM
INSTITUTUM ATHENIENSE ATQUE INSTITUTUM ROMANUM REGNI SUECIAE

Opuscula

Annual of the Swedish Institutes at Athens and Rome

10
2017

STOCKHOLM

OPUSCULA • 10 • 2017

Contents

STELLA MACHERIDIS

Symbolic connotations of animals at early Middle Helladic Asine

A comparative study of the animal bones from the settmement and its graves

Abstract*

This paper is a contribution to the zooarchaeological research on animals or animal parts found in human graves during the Middle Bronze Age in Greece. The animal bones from the early Middle Helladic settlement (MH I-II, *c.* 2100-1800 BC) and contemporary burials at Asine are presented. The goal is to compare the animal bones from the settlement with those from the burials, in terms of species composition and body part distribution. Through this comparison, this paper aims to discuss any symbolic connotations of bone waste from everyday-life practices. The results show that the most common domesticates from settlement contexts, pig, sheep/goat and cattle, also appear to be the most abundant animals deposited in the early MH graves at Asine. This is consistent with mortuary data from other sites on the Peloponnese, especially Lerna. The pig was most abundant in both settlement and graves at Asine. The similarities between wild and domestic pigs might be important, and are discussed as a possible inspiration for the pig symbolism in MH I-II Asine. I also propose a regional change in the later Bronze Age of how animals were deposited in graves, in which period the presence of wild mammals, dogs, and horses in high status graves increases. Throughout, pig, sheep/goats and cattle remained the most important animals for ritually connoted events such as funerary meals or feasts.

Keywords: Asine, zooarchaeology, Middle Bronze Age, settlement debris, grave goods

* The animal bones from the 1926 excavations of Asine are part of the Asine collection at Museum Gustavianum, Uppsala University. I am grateful to the Museum for the loan of the material. I am particularly thankful to David Reese, who has kindly assisted me in providing faunal data from the Middle Helladic graves from Lerna, to Gullög Nordquist, who has provided valuable feedback on earlier drafts as well as aiding with stratigraphic issues concerning the graves of Asine, and to Dimitra Mylona, who has provided valuable feedback on the text and has kindly shared zooarchaeological data from the graves of the East Cemetery at Asine. I thank Fredrik Ekengren, Anne Ingvarsson-Sundström, Kristina Jennbert, and Michael Lindblom for valuable comments and feedback on earlier drafts of this paper. Additionally, I am very grateful to the comments and recommendations from Gerhard Forstenpointner and Sofia Voutsaki, which greatly improved the quality of the paper. Any misconceptions or mistakes are my own.

Introduction

During the last decades we have witnessed an increase of studies of animal bones from ritual contexts in the Aegean Bronze Age. We can find examples of animals occasionally found in human grave contexts, such as the dogs in the Mycenaean chamber tomb at Galatas, Peloponnese, or the horse burials at the Mycenaean cemetery at Dendra.[1] Traces of ritual activities from Mycenaean sites in the form of burnt animal bones have been discussed as the remains of burnt animal sacrifices, e.g. at Pylos.[2] However, animal bones as part of grave goods in human graves rarely constitute the focus of archaeological research of the Middle Helladic societies of Greece.

The excavations of Asine in the north-eastern Peloponnese, Greece, revealed, among other things, the remains of a Middle Helladic (MH, *c.* 2100–1700 BC) settlement and its contemporary burials. These excavations produced a large animal bone assemblage.[3] This material provides an exceptional opportunity to compare the settlement and the graves zooarchaeologically. The goal of this paper is to do such a comparison, i.e. between the animal bones from the settlement of Asine and those from the contemporary graves at the site as well as in the vaster southern Mainland region in Greece. This enables the discussion of symbolic or ritual aspects of various contexts from a zooarchaeological perspective. Can we infer any meanings in terms of symbolic connotations in any proposed connections between food waste and grave goods?

[1] For the Mycenaean tomb at Galatas see Hamilakis 1996, 41; for the horse burials at Dendra see e.g. Protonotariou-Deilaki 1990a and Pappi & Isaakidou 2015.

[2] Isaakidou *et al.* 2002.

[3] The animal bones from Bronze Age Asine make up the basis for the author's doctoral research at Lund University. This paper is part of this research.

The study is restricted to the early Middle Helladic (MH I–II or early MH, *c.* 2100–1800 BC) Asine. This paper presents hitherto unpublished data on the faunal remains from this period at the site. The animal bones from the graves at the nearby coastal settlement of Lerna are used as comparative material, enabling a discussion of possible patterns at Asine from a regional perspective. Examples from nearby sites (see *Fig. 1*) from the broader MH and Late Helladic (LH, *c.* 1700–1050 BC) are included to nuance the regional perspective and provide a long-term perspective to the discussion of animal bones in grave-related contexts.

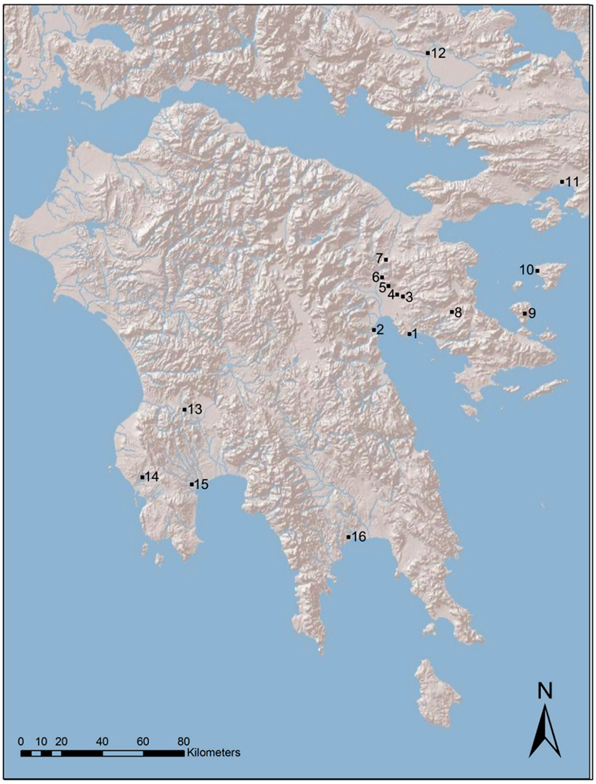

Fig. 1. Map of the Peloponnese, with the locations of mentioned sites. 1) Asine, 2) Lerna, 3) Midea, 4) Dendra, 5) Prosymna, 6) Mycenae, 7) Zygouries, 8) Epidauros, 9) Ayios Konstantinos, 10) Aegina Kolonna, 11) Eleusis, 12) Orchomenos, 13) Malthi, 14) Pylos, 15) Nichoria, and 16) Ayios Stephanos.

Theoretical perspectives

SYMBOLIC CONNOTATIONS OF BONE WASTE

The assumptions underlying this paper are based on what is called "the symbolic connotations of bone waste". This asserts the importance of and associations between two theoretical terms, 'symbol' and 'waste'. Since the animal bones studied here should be considered as the remains of prehistoric social actions or processes, a view on symbols as vital in social processes is important.[4] This follows the works of the anthropologist V. Turner, who investigated how symbols function in mainly ritual processes of the Ndembu people of north-western Zambia. According to him, symbols are combined and are used for metaphorical communication between people in any social process in order to direct the outcome or consequences of that process.[5] It is thus not meaningful to study symbols in isolation from their social context. In most societies, animals have symbolic meaning beyond merely providing protein intake.[6] Therefore, it is assumed that the choice of consuming a specific animal, or disposing of its remains in any or specific locations, can have symbolic connotations. By this I mean that such a choice communicates certain meanings to other people. The classic example is perhaps a choice of animal which signals religious beliefs, such as the avoidance of certain animals prescribed in for example Moslem or Jewish traditions.[7]

The notion of dirt as "matter out of place", formulated by M. Douglas, became the starting point for research on waste. Since material categorization and valorization is culturally specific, the material category of waste is seen as a relative and dynamic notion.[8] Waste has a temporal (everyday-life practices change over time) as well as a spatial dimension (different waste materials are disposed of in different places). Not only is the categorization of waste due to the use of physical space, i.e. refuse goes there but not

[4] Ortner (1984) provided a review of the main theoretical perspectives in anthropological research from the 1960s to the 1980s. According to her, the view of symbols as operators in the social process was essential for Victor Turner's work (1966 and 1967; see Ortner 1984, 131).
[5] Turner 1966; 1967.
[6] E.g. Russell 2012.
[7] See Douglas 1966 (2002), 51–71.
[8] E.g. Douglas 1966 (2002); Strasser 1999; Drackner 2005.

there, but it can also be connected to symbolic aspects of the material itself.[9]

That bone waste is often symbolically laden has zooarchaeological implications. As N. Russell argues, ritual or symbolic preferences can be a biasing factor in human deposition of animal bones, and thus in the formation of the zooarchaeological record.[10] Also, animal bones bear traces of cultural perceptions of bone waste and symbolic associations of different materials, animals, and body parts.[11] One example of bone symbolism can be found in the Mongol tribe described by S. Szynkiewicz.[12] In this case, the sheep tibia was a symbol of patrilineal descent and a spiritual communication tool. Strict rules applied to the disposal of this bone, involving burning and deposition in a ritually clean space.[13]

Consumption waste from the settlement can thus reflect the symbolic preferences of the studied prehistoric society. This concords with the idea that ritual activities were embedded in everyday life during the Middle Helladic.[14] This idea should be connected to a definition of ritual as a process, which is encompassed in the term 'ritualization'.[15] Ritualization acknowledges that rituals are repetitive formalized action sequences, directed by social conventions and thus dynamic in their essence. Rituals are not restricted to the sacral sphere, and to infer the existence of a sacral/profane dichotomization in any prehistoric world view is not always relevant. In this paper, I use the term 'ritual' mainly for graves.[16]

GRAVE GOODS AND FUNERARY MEALS

The material studied in this paper also includes animal bones found as grave goods in MH graves. It is necessary to clearly define what is included in the term 'grave good', and why I do not use more traditional concepts, such as grave offerings or gifts, for animal bones or other finds connected to the grave deposit. Further, in providing a regional perspective on the animal bones found in graves at Asine, I look beyond solely grave contexts and consider examples with remains of the ritual consumption of animals, e.g. funerary meals and feasts. Therefore, there is a need to define 'feasting' and 'funerary meals' or 'feasts', commonly reoccurring terms in archaeological research.[17]

Grave goods

As a term, 'grave goods' can be a good alternative to describe grave finds in order not to imply social meanings beyond the ritual context of burial.[18] For example, the terms 'offering' or 'gift' imply the act of offering/giving, which in its turn indicates a specific social meaning within the burial ritual which cannot always be ascertained by the material culture or the contextual circumstances. Grave goods can have many different meanings.[19] The neutral expression 'grave goods' is suitable for this paper for other reasons as well. It includes animal bones, besides other artefacts, which were found in connection with the dead individual in the ritual context of formal burial, but not always documented with high contextual resolution. Most of the graves at Asine were excavated in the early 20th century, which has made it difficult, sometimes impossible, to reconstruct the necessary contextual information needed to differentiate between such categories as the ones mentioned above. The exact location of bones is most often missing since they generally were not documented on plan drawings. This hinders the evaluation of intentionality in the placement of grave goods, which would be expected if animal parts were part of, for example, the gifts to the dead individual.

The term 'grave good' is not used here as an alternative aiming to escape the issue of lack of documentation. I acknowledge this problem as it concerns the Asine assemblage. Therefore, each grave, to which animal bones are associated, is evaluated individually in order to assess whether or not the animal bones were connected with the grave as grave goods, or belonged to the infill of the grave. This contextual discussion of the animal bones from the MH Asine graves can be found in Appendix 1 of this paper.

Funerary feasts or meals

Feasts are large-scale ritual events which involve communal consumption of foods and drinks.[20] The funerary feast can have large impact on the society, alliances, and power dynamics;[21] such specific events require specific food.[22] In this study, the term 'funerary meal' is preferred in order also to include small-

[9] E.g. Douglas 1966 (2002); Hodder 1982; 1987; Moore 1982; Strasser 1999; Marciniak 2005; Gifford-Gonzalez 2014.
[10] Russell 2012, 143.
[11] E.g. Russell 2012; Rudebeck & Macheridis 2015.
[12] See Szynkiewicz 1990.
[13] Szynkiewicz 1990, 74.
[14] Nordquist 1987, 111; Whittaker 2010, 536.
[15] Bell 1992, 220; Bradley 2005, 34.
[16] Considering that rituals probably were embedded in everyday life for the MH Asineans, it might be inconsistent to use the term ritual only for graves. However, this approach has been chosen mainly because no clear ritually connoted contexts have been documented from the settlement, other than graves. In other words, the existence of traces from ritual activities in the settlement debris is hard to detect, even if some meals were ritually connoted.

[17] E.g. Hamilakis 1998; Wright 2004; see also Twiss 2012, 363.
[18] Ekengren 2013.
[19] See Härke 2014, 45–52. Among others, grave goods might represent gifts or equipment for the dead (e.g. Méry & Tengberg 2009), remains of funerary meals/feasts (e.g. Hamilakis 1996, 165), and indicators of social status/identity (e.g. Jennbert 2011, 158–159).
[20] Dietler 1996, 88; 2001, 65; see Pollock 2003, 21.
[21] Hayden 2009.
[22] Marciniak 2005, 72.

scale consumption events. Animal bone waste from funerary meals reflects the actual consumption, in terms of which animals and animal parts were chosen, and disposal strategies, i.e. if all waste ended up in the grave infill or in specific disposal locations for remains from funerary meals.[23] Food and drink are symbolically important because of everybody's basic biological need to eat.[24] Consumption waste, both in terms of leftovers and biological refuse, is a consequence of consumption. This, a direct link between consumption and consumption waste, is an important presumption of this paper.

Early Middle Helladic Asine: the material

Ancient Asine is located on a peninsular cliff on the north-eastern Peloponnese (*Figs. 1–2*). The site was excavated in several campaigns during the last century, of which the majority was directed by Swedish archaeologists. The initial 1922–1930s project was followed by several excavation seasons during mainly the 1970s.[25] These campaigns revealed the long continuity of Asine, dating from at least the Early Helladic period (*c*. 3100–2100 BC) to the 8th century BC. During the Archaic and Classical periods the settlement declined, but it was densely occupied in the Hellenistic period. It was finally abandoned during Late Antiquity, although it was revisited in later historical periods.

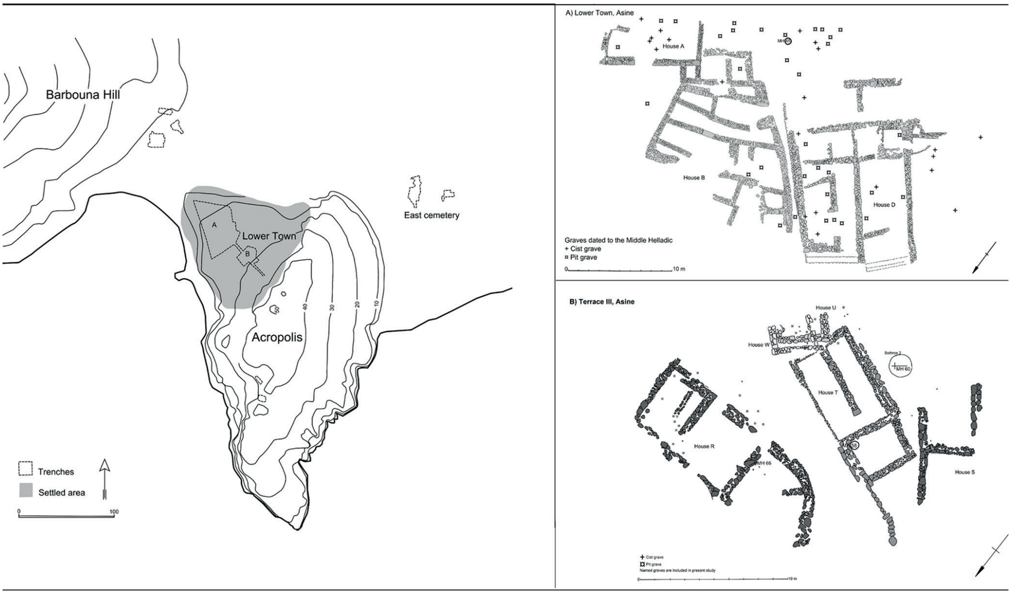

Fig. 2. Map of Asine during the MH I-II. Only the locations of burials in the Lower Town trenches are illustrated. Right plan drawings are made after Frödin & Persson (1938). Left plan drawing is made after Nordquist (1987). With permission.

[23] In this case study I do not delve in to the latter, i.e. if there are any specific locations for the disposal of funerary meals, because clear examples of such contexts are not evident in the documentation or the publication of the excavations of the site.

[24] E.g. Dietler 1996, 89; Pollock 2003, 18.

[25] Frödin & Persson 1938; e.g. Hägg & Hägg 1973; Dietz 1980; 1982; Wells 1983.

THE SETTLEMENT

During the MH and the Late Helladic (LH, *c*. 1700–1050 BC), Asine flourished as a settlement. This is testified by expansions of the settled areas, increase in archaeological finds, more diverse material culture, and the establishment of burial areas. Some of the biggest changes to the settlement were the additions of House T on Terrace III during MH I (2100–1900 BC), and Houses pre-D, B, and D in the Lower Town in MH II–early MH III (about 1900–1750 BC).[26] This growth of the settlement is visible in the rich material culture from this period.[27]

The animal bones, excavated in 1926, were found in cultural layers in or around the houses; strata covering large parts of the open trenches.[28] Because the excavation was not always made in respect of single contexts, i.e. separate events such as the filling of a specific construction with soil, it is possible that separate fill layers within these strata existed. Therefore, I do not to focus on single events, but on cultural layers tied to the different dwelling areas. This provides a lower level of contextual resolution. The areas are the Lower Town (around Houses pre-D, B, and D) and Terrace III (around House T). The houses are similar in degrees of complexity, i.e. with more than one room, although the house plans differ (*Figure 2*).

Although the MH houses excavated in the Lower Town were constructed later than House T, the animal bones from the settlement used in this study are all from layers dated to the same period (early MH, or MH I-II). While animal bones from the settlement, dated to the broader Middle Helladic, have been published elsewhere, the early MH assemblage from Asine has not been studied previously.[29] In total, 3,014 animal bones from the settlement, of which 1,149 bones (38% of total NSP) were identified to species, are presented in this paper.[30]

THE GRAVES

Two burial areas were in use during the earlier MH (*Fig. 2*): in and around the houses in the Lower Town and Terrace III (the Kastraki), and the East Cemetery (EC). The EC is different from the Kastraki because of the formality in its design. The Kastraki graves are intramural, often in floors, abandoned house plots, or between walls, while the EC is a burial area located outside the settlement, and contained a tumulus construction with a *peribolos* marking its boundaries.[31] The human remains and the artefacts found in the Asine burials have been analysed from several angles.[32] The EC burials were more often made in cists rather than in pits, which is the case at Kastraki.[33] Adults are overrepresented in EC, while children were most often buried within the settlement's boundaries.[34] The differences between the burials in the EC and the Kastraki continued and became more pronounced in the latter MH III–LH I period.[35]

At least 147 Middle Helladic graves have been excavated at Asine.[36] About 72% (106 graves) did not contain any grave goods. Just over half of the graves with goods (22 graves) contained the occasional object, for example one vessel.[37] The low occurrence of grave goods is characteristic of this period.[38] Thus, it is not surprising that the number of MH graves at Asine containing animal bones as part of the grave goods is also small. Five such graves could be identified (*Table 1*).[39] Fifty animal bones, of which 28 have been identified to taxa, were found in these graves.[40] Although this number provides a small data set, these bones were part of the grave goods, and are unique in this aspect.

In Appendix 1 the contextual assessments on whether or not the animal bones should be connected to the grave goods or to the grave fill are included. The location, or even the presence, of animal bones in graves is seldom mentioned in the publications. Available contextual information present on

[26] Nordquist 1987, 72, 79; see *Fig. 1*.
[27] See Nordquist 1987.
[28] Frödin & Persson 1938.
[29] Moberg Nilsson (1996) discussed smaller parts of the MH animal bone assemblage from Asine, while Macheridis (2016a) studied the complete collection of animal bones dated to the broader MH from Asine.
[30] The zooarchaeological analysis of the animal bones from Asine was made with access to reference literature and collections at the Osteological Laboratory, Lund University. Few small mammals, fish or bird remains have been identified, which could be explained by the lack of systematic sieving (e.g. Mylona 2003). This remains a problematic issue for this particular collection. Number of Identified Specimen (NISP) and Minimum Number of Elements (MNE) are used for quantification. Information on Minimum Number of Individuals (MNI) is provided. Additionally, Number of Specimens (NSP) is included to note the unidentified bones (e.g. Grayson 1991; Lyman 2008, 266).

[31] Dietz 1980; Nordquist 1987, 101; Voutsaki *et al.* 2011, 455.
[32] E.g. Nordquist 1987; Gillis 1996; Nordquist 2002; Ingvarsson-Sundström 2008; Voutsaki *et al.* 2007, 71–80; Voutsaki *et al.* 2011; Ingvarsson-Sundström *et al.* 2013.
[33] Voutsaki *et al.* 2011, 452.
[34] Ingvarsson-Sundström 2008, 102; Ingvarsson-Sundström *et al.* 2013, 153.
[35] E.g. Voutsaki *et al.* 2011, 453.
[36] Frödin & Persson 1938; Hägg & Hägg 1973; 1975; Dietz 1980; Nordquist 1987, 91.
[37] Nordquist 1987, 101.
[38] Nordquist 1990, 36; Hielte-Stavropoulou 2004, 17.
[39] Additionally, one grave (MH 45) contained one long bone splinter from a large animal. Since the animal bone could not be identified it is not discussed further in this study.
[40] Additionally, according to the excavators, grave MH18 contained fish vertebrae, and grave MH62 contained bones of small animals (Frödin & Persson 1938, 117, 123). These bones could neither be found nor re-examined for the purpose of this paper.

find unit labels indicates if the animal bones were retrieved from graves. In order to assess whether or not this means the grave deposit or the grave fill requires a thorough reading of available documentation, i.e. of field journals and plan drawings.

It is hard to assert with certainty that the samples from the grave fills contain material from activities connected to the burial, because they might also derive from nearby soil used for the infill. The graves in the Lower Town were made in abandoned settled areas (*Fig. 2*), so the animal bones might derive from settlement debris. Because of this issue, the animal bones from the grave fills are not discussed in this text. They are included in Appendix 1 in order to i) to present data from the site, and ii) to illustrate the process which led to the assignment of animal bones to either grave fill or deposit. It is important to be transparent with the latter, because the assignment of animal bones to grave fills or deposits involves an interpretation of the documentation by the analyst, and could be uncertain.

The assignment of animal bones to grave deposits or fills has been based on two variables. First, the contextual information, such as any notes on the location of the bones in the field journals and/or plan drawings, is of importance. Secondly, zooarchaeological indicators of peri-depositional processes affecting bone condition have been used. This includes the degree of fragmentation, articulation status of bones, and surface wear, i.e. the presence of marks from weathering, trampling,

Burial area	Grave no	Grave type	Age/sex	Artifacts	NSP	Identified animal bones	Date
Kastraki	MH 58	Pit	Adult (ca. 50 or 44 yrs)	Bronze spear head	18	1 pig mandible 1 cattle rib 9 large-sized rib fragments (probably from cattle rib)	Probably MH II
	MH 60	Cist	Adult female	Terracotta whorl	14	5 pig bones: 1 tooth, 1 frontal bone, 1 phalanx I, 1 pelvic fragment, 1 maxillary bone 2 cattle bones: 1 humerus, 1 phalanx I 1 sheep/goat radius	Early MH I
	MH 66	Pit/ Wooden box	Child (5 yrs±6 months)	None	3	2 pig bones: 1 rib, 1 mandible	MH II
	MH 102	Pit	Child (ca, 1 year)	None	8	2 pig bones: 1 mandible, 1 pelvis bone	MH II-III
East Cemetery	1971-13	Cist	Adult (30 yrs) female	None	7	1 astragalus, 1 tibia and 1 metatarsal of sheep/goat (sheep?) from the hind leg of one individual 1 radius and 1 ulna of pig from the lower front leg of one individual	MH II

Table 1. Middle Helladic Asine graves with animal bones. Contextual information is taken from Field diaries 3:1 (E.J. Knudzon) and 9 (H. Arbmann), from Nordquist (1987; 1996a, 1996b), and from Dietz (1980). Bioarchaeological information from Ingvarsson-Sundström (2008). Number of Specimens (NSP) counts the total amount of bone. Data on animal bones from the East Cemetery graves were provided by D. Mylona.

and gnawing on the bone.[41] When information on the location of animal bones within the grave is absent from field journals or plan drawings, conclusions are based on zooarchaeological indicators.

Four of five graves are from the Kastraki. Three graves contained juvenile individuals, while two burials were of adults, of which one was female. No male grave was identified. None of the graves of children or newborns contained grave goods. This is not true for all such burials; a few did receive burial gifts.[42] Further, jewellery artefacts are often as common or more abundant in child graves when compared to adult burials in the greater Peloponnesian region.[43] All adult burials used in this study contained grave goods other than animal remains (*Table 1*). The one EC grave, 1971-13, contained an adult female. Interestingly, it is among the poorest EC graves in regards to other find categories. In general, the distribution of grave goods other than animal bones, e.g. jewellery and sets of pottery, in the MH graves at Asine and other sites do not indicate any specific gendered differences.[44]

Taxon		**NISP**	**MNE**	**MNI**
Domestic pig (*Sus domesticus*)		425	78	15
Sheep/goat (*Ovis aries/Capra hircus*)		361	52	8
of which:	Sheep (*Ovis aries*)	21	20	5
	Goat (*Capra hircus*)	33	17	4
Cattle (*Bos taurus*)		266	49	5
Dog (*Canis familiaris*)		11	8	2
Horse (*Equus caballus*)		3	3	1
Donkey (*Equus asinus*)		1	1	1
Deer (Cervidae)		15	-	-
Red deer (*Cervus elaphus*)		51	22	3
Roe deer (*Capreolus capreolus*)		1	1	1
Fallow deer (*Dama dama*)		1	1	1
Tortoise/turtle (*Testudine*)		14	-	-
Total		**1149**	**215**	**37**

Table 2. List of identified species from the MH I-II settlement at Asine

Intra-site comparison of settlement and graves in early MH Asine

The comparison between settlement debris and grave goods at Asine is based on species composition and body part distribution. Age and sex data is included only from the settlement, since very few bones from grave-related contexts provided such information. Mortality patterns and sex distributions are provided for the settlement in order to give a fuller overview of the animal consumption and management at the site.

SPECIES COMPOSITION

In the settlement debris of the early MH, we can note the presence of both horse and donkey among the domesticated animals, although pigs, sheep, goats, and cattle dominate (*Table 2*). The slight focus on pigs and predominance of medium-sized mammals is also seen in other Middle Helladic settlements on the Mainland.[45] Red deer dominate the wild animals at Asine. Additionally, roe deer and fallow deer are represented. While roe deer are often present on Aegean sites, fallow deer are not as common. The latter species is rarely identified in the Peloponnese during this period.[46]

The taxonomic compositions in MH I-II settlement and graves at Asine are illustrated in *Fig. 3*. In the settlement, pigs were most common (38%) followed by sheep/goat (32%) and cattle (24%). Goat bones are slightly more abundant than those of sheep.[47] However, considering MNI counts these animals are almost equally represented in the material (*Table 2*). About 6% derive from deer, predominantly red deer. Animal bones from grave deposits correspond partly to this picture. The results of a chi-square test of the distribution of pig, sheep/goat, cattle, and deer between the settlement and the graves indicated a statistical significant difference (χ^2=8.86, df= 3, p=<0.05). This is best explained by the frequencies of pig and sheep/goat bones in the graves; pigs are more abundant than

[41] Table B in Appendix 1 presents data on the presence of zooarchaeological indicators on the bones from each grave.
[42] Ingvarsson-Sundström 2008, 110.
[43] Nordquist 2002, 126.
[44] E.g. Nordquist 2002, 126–127. See also Voutsaki *et al.* 2007, 78.

[45] Examples of zooarchaeologically investigated Mainland settlements where pigs are most abundant is Lerna (Gejvall 1969), Nichoria (Sloan & Duncan 1974), and Ayios Stephanos (Nicodemus 2008, 507; Reese 2008a). In contrast, an emphasis on sheep/goat rearing is observed at Aegina Kolonna (Forstenpointner *et al.* 2010) and Midea (Reese 1998, 281).
[46] Yannouli & Trantalidou (1998) provided a review of the archaeological representation of fallow deer in ancient Greece. The animal is present at nearby Tiryns, according to von den Driesch & Boessneck 1990.
[47] Sheep and goat were distinguished using postcranial bone elements recommended by Zeder & Lapham (2010). Additionally, horn core morphology and cranial features described by Boessneck (1969) and Prummel & Frisch (1986) were used for this purpose.

expected if the bones from settlement and graves were homogenously distributed, while sheep/goats are less abundant than expected. Deer bones are not present in the graves. This absence might be due to the low sample size, or that deer were not common as grave goods during this period.

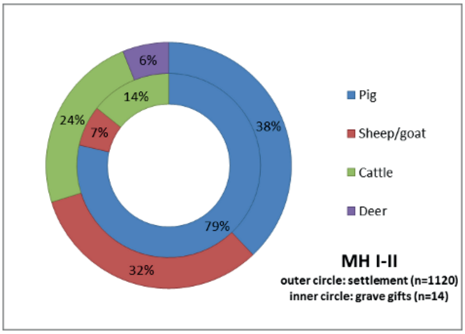

Fig. 3. Relative taxonomic abundance (%NISP) in the general settlement debris compared to grave-related contexts, early MH Asine. Three articulating sheep/goat bones and two articulating pig bones in grave 1971-13 are counted as one NISP each in this graph.

BODY PART DISTRIBUTION

In the settlement debris, all body parts are represented.[48] The vertebrae and the ribs are overrepresented (*Fig. 4*). Vertebral bone elements and ribs have a less dense structure, and are thus more prone to post-depositional destruction.[49] It is possible that a certain degree of density-mediated attrition has affected the assemblage. This was indicated in an earlier study of animal bones from MH Asine in which the axial fragments proved to be underrepresented in relation to the other body regions no matter the contextual category or taxonomic representation.[50] It is therefore expected that these parts are underrepresented. Processes of post-depositional destruction are known to cause representation issues in animal bone assemblages, with biases towards higher abundances of loose teeth.[51] In this study, the overrepresentation caused by including loose teeth is avoided since the quantification of MNE was based on mandibles. Still, the head region is overrepresented in the case of Asine.

The meaty areas of the pig's body, i.e. the axial region and the limbs, are represented with between 11–20%. However, considering the probable post-depositional bias, the abundance of the trunk was probably larger. The head is overrepresented (37%), while feet are rare (1%). It seems that the remains of pig in settlement remains are from consumption rather than butchering. Most body parts common in settlement debris were occasionally deposited in graves. Similarly to the settlement debris, the graves most often also contained pig bones from the head and the axial skeleton. One each of the lower front limb and lower hind limb is present.

In the settlement debris, the categories of horn, neck, axial, and feet each contribute less than ten percent each to the relative distribution of sheep/goat MNE. The limbs and the head are well represented. Since the neck, vertebrae and ribs trunk might be underrepresented, it is not unlikely that the distribution of the body parts resembled the one discussed above for pigs. That the material derives from mainly consumption waste is also supported by the underrepresentation of the non-meaty feet, which is sometimes discarded early in the carcass processing.[52] Four sheep/goat bones representing one lower front and one lower hind limb could be assigned to graves MH60 and 1971-13. This does not correspond to the settlement debris, in which the head and the upper front limb were among the most common body parts.

In the settlement debris, feet are the most common body part among cattle bones (22%), followed by head (20%). Other body parts contribute with less than 11%, except lower hind limb (14 %) and upper front limb (12%). Higher abundance of foot bones is traditionally connected to the so called *schlepp* effect, i.e. transporting the body using the feet. However, it is as likely explained by damage caused by canids, where the meat-rich elements are often targeted first.[53] The phalanges are small but compact, relatively resistant to post-depositional destruction.[54] Thus, the *schlepp* effect is not the only possible explanation. The abundance of low-nutrient body parts as the feet should perhaps rather be discussed as the remains of mainly butchery waste.[55] It can also partly be seen as the consequence of post-depositional destruction of less dense bone structures, such as vertebral bodies. Still, at least the neck and axial parts should in that case be represented to the same degree as the compact meaty limbs. The trunk, i.e. vertebrae and ribs, and feet are represented in the graves. This corresponds partly to the cattle bone waste from the settlement.

[48] The anatomical categories provided by Stiner (1991) are used, i.e. *horn*, *head* (skull and mandible), *neck* (atlas, axis, and cervical vertebrae), *axial* (vertebrae, ribs, sternum, pelvis), *upper front* (humerus, scapula), *lower front* (radius, ulna, carpals, metacarpals), *upper hind* (femur, patella), *lower hind* (tibia, fibula, metatarsals, tarsals), and *feet* (phalanges, sesamoids). Raw data of the distribution of the body parts at the Asine settlement is presented in Appendix 2.
[49] Lyman 1994, 234–258.
[50] Macheridis 2016a.
[51] E.g. Peres 2010, 20.
[52] E.g. Arnold & Lyons 2011.
[53] Marean *et al.* 1991.
[54] Lyman 1994, 246–247, Table 7.6.
[55] E.g. Thomas & Lacock 2000.

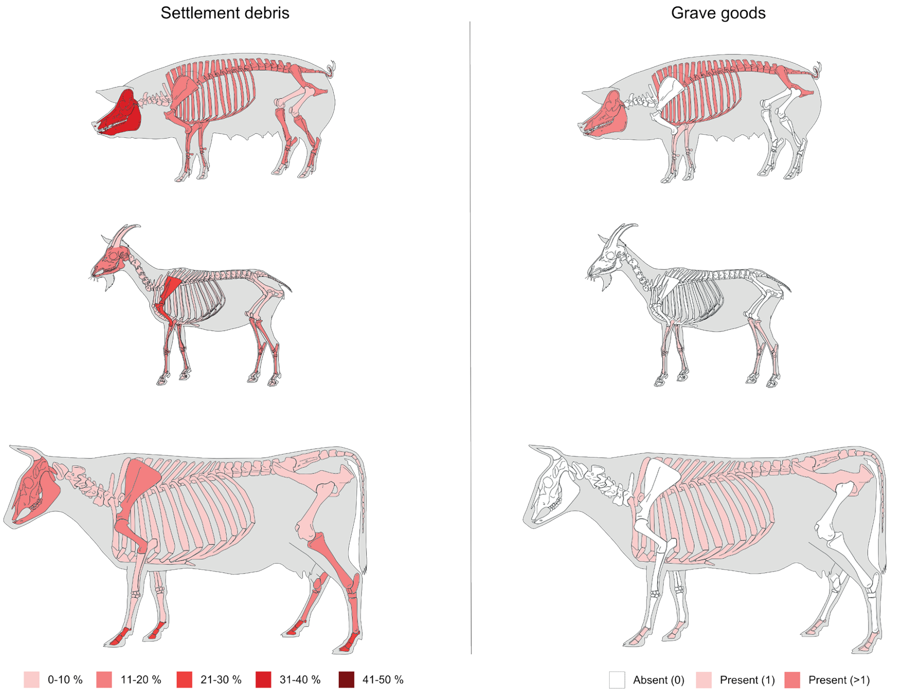

Fig. 4. Relative (%MNE) body part distribution of pig, sheep/goat (represented by goat), and cattle in the settlement debris (left) versus grave goods (right). The bones from graves are presented in terms of presence and absence of each body part.

MORTALITY PROFILES AND SEX DISTRIBUTIONS[56]

In *Fig. 5*, the distribution of slaughter ages in the three common domesticates from the settlement debris, we can see that the husbandry and/or consumption of pigs focused on juvenile (46% below 12 months) and young adult individuals (12–42 months). Some reached older ages (19% above 3.5 years). There seems to be a slight focus on male individuals (13 of 19 bones). An excess of adult males is not necessary for the continuation of the herd. As fragile juvenile bone is more prone to post-depositional destruction, this could explain the slight overrepresentation of adult males. It could also be explained in terms of manifestation of wealth, as it is more expensive to feed older individuals than to kill off juvenile pigs.[57]

About 18% of the age-assessed sheep/goat bones derive from juvenile individuals (<12 months). Two of these were from newborn animals. About 26% survived to ages above 30–42 months (2.5–3.5 years, *Fig. 5*). There seems to be an even sex distribution (4 females, 3 males). The survival of older individuals together with an even sex distribution is similar to the optimal kill-off pattern from wool production described by S. Payne.[58] This is a possible scenario for early MH Asine, considering that some young individuals are missing due to post-depositional biases. Because there is an even species composition, and varied ages, it remains equally plausible that the

[56] Age assessments were based on epiphyseal union data from post-cranial bone elements. Age translation of fusion status of cattle, sheep/goat, and pig was based on data from Silver (1969) and O'Connor (1982), cf. Vretemark (1997, 41). Sex assessments of cattle and sheep/goat were based on morphological features of the pelvic bones (Boessneck 1969). Sex assessment of pig was made on basis of canine tooth morphology (Mayer & Lehr Brisbin 1988).

[57] Halstead & Isaakidou 2011, 169.

[58] Payne 1973, 284.

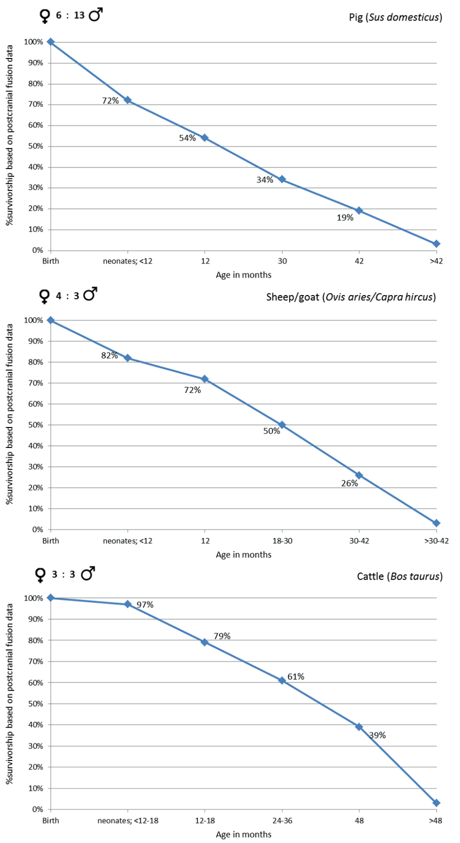

Fig. 5. Relative survivorship curves of pig, cattle, and sheep/goat at early MH Asine. Information on sex distribution is provided in the top left corner of each animal category.

focus of animal management and consumption was mixed, and not specialized.[59]

The survivorship curve of cattle is similar to that of sheep/goat, but with fewer neonate and juvenile individuals. Approximately 40% were slaughtered between the ages of 12–18 months to 48 months (1–4 years). The same proportion (*c.* 40%) were slaughtered at ages above 48 months. The focus on older animals has been explained as a consequence of older draught and milk animals being brought from the hinterland in to the village.[60] This is common in early urban and/or central sites.[61] This could be a scenario for some of the older cattle consumed at the site, and as such it could be a function of the growing central importance of Asine within the surrounding region.

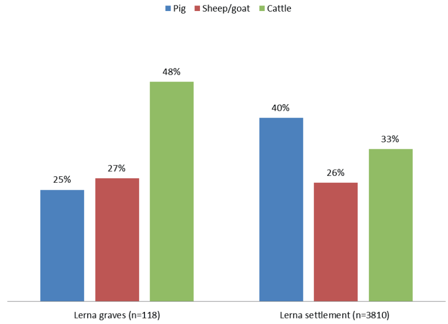

Fig. 6. Relative distributions of pig, sheep/goat, and cattle in MH Lerna. Data on the settlement is taken from Gejvall (1969, 6–8) and the graves is provided by D. Reese.

Inter-site comparison between MH graves at Asine and Lerna

In this section, the animal bones from early MH Asine are compared to the animal remains from graves at the nearby Middle Helladic settlement at Lerna (*Fig. 1*). This is made in order to evaluate the most obvious pattern from the Asine collection, namely that the same animals dominating the settlement are most common in the graves. I briefly evaluate the body parts' representation in the Lerna material. Although it is important to include other findings beside animal bones in this discussion, this is only partially done as it is beyond the scope of this paper.

At least 228 Middle Helladic graves were excavated at Lerna. E. Blackburn (1970) has provided an inventory of the Lerna graves.[62] There are several similarities between the MH burials at Lerna and Asine. Mentions of animal bones among the grave offerings or the material associated to graves are scarce. Most graves were located within the settlement's boundary, and most burial types were small in their form, often as pits, jars or cists.[63] In her study on age/gender distinctions in the mortuary evidence, e.g. grave goods and grave types, at

[59] See Halstead 1996.

[60] Macheridis 2014.

[61] E.g. Magnell 2009.

[62] Blackburn 1970.

[63] Voutsaki 2004, 344–345.

MH I-II Lerna, S. Voutsaki could not find good evidence of specific gender or age categories.[64] The exception is a long term trend in which adult burials became located outside the settlement in the MH III–LH I period, while children were buried inside it. This is also consistent with the situation at Asine, where the extramural East Cemetery contained mostly adult burials. Additionally, at Lerna children also received a more diverse set of grave goods than adults.[65]

N-G. Gejvall studied the animal bones from MH Lerna; however, he did not focus on the graves.[66] The animal bones have since been re-examined by D. Reese, who has kindly provided the unpublished data on animal bones from the Middle Helladic graves. Reese reports on animal bones from at least 58 graves.[67] This number excludes mollusc remains. It is uncertain whether or not these bones should be regarded as grave goods, as many were probably included with the overlying grave fill.[68] They are used here for illustrative purposes, and seen as probably deriving from activities connected to the burial. Still, we cannot avoid a degree of uncertainty regarding the contextual integrity of these samples.

Fig. 6 presents an overview of the composition of pig, sheep/goat, and cattle from Lerna graves and settlement. The settlement data is taken from Gejvall's 1969 publication on the animal bones from Lerna. Since publication, some chronological assessments have been revised, and so this distribution is only approximate. Nevertheless, we can observe that the distribution of pigs, sheep/goat, and cattle in the Lerna settlement is similar to Asine (*Table 2, Fig. 3*). Contrary to the animal bones in the Asine graves, the animal bones in the Lerna graves do not correspond to the general picture provided by its settlement. Instead, cattle are most common, followed by sheep/goats and pigs. This is interesting as it is different from the consumption waste found in settlement layers at Lerna.

Pigs were the most common animal in the consumption on an everyday basis at both Lerna and Asine. However, it seems each site regarded different animals as most important for ritual use (cattle at Lerna and pig at Asine). Perhaps, this indicates that values other than purely economic or functional were important in choosing animals for funerary purposes, and that this preference varied between sites within the same region. This also highlights the difficulties in using animal

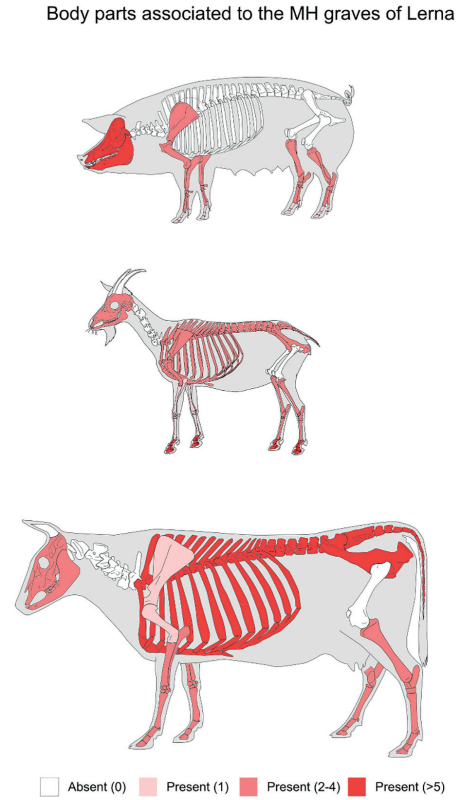

Fig. 7. Relative (%MNE) body part distributions of pig, sheep/goat, and cattle in the MH Lerna graves. Data provided by D. Reese.

bones from ritual contexts to reflect on general animal consumption in everyday life. This discrepancy is similar to the one discussed by S. Isaksson in an Early Medieval Scandinavian context, in which written sources indicate meat-focused diet, while lipid analyses from pottery revealed a probable lack of animal protein in everyday-life food consumption.[69]

In *Fig. 7* we can see the distribution of the body parts of the three most common animals in the graves from Lerna.[70] Almost the whole body, except horn core, neck, and the upper hind leg, is represented for sheep/goat and cattle. The trunk is

[64] Voutsaki 2004.
[65] Voutsaki 2004, 356.
[66] Gejvall 1969.
[67] Graves dated to the latter phases of the MH period, as published by Blackburn (1970) and based on data from Voutsaki *et al.* (2013) are excluded. Among the included graves for this paper, 19 graves remain more broadly dated to the MH phase. These graves could be of later MH origin. This underlines the above-discussed uncertainty of contextual integrity of these samples.
[68] Reese, personal communication, 26 May 2016.

[69] saksson 2000, 55.
[70] Raw data of body part distribution from the Lerna graves is presented in Appendix 2.

best represented among the body parts of cattle at MH Lerna, while for sheep/goat the feet are most common. The pig is represented by the head, the upper front and lower front leg, the lower hind leg, and the feet. This is different from Asine, where the only the trunk and the head are represented (see *Fig. 4*). Similarly to Asine, the pig's head is most common in the Lerna graves. This can perhaps partly be explained by low sample sizes.

Animal bones from ten of the later MH III–LH I graves were studied by Reese. Pig bones were found associated with five graves, while cattle and sheep/goat were found in two graves.[71] Only in one of the graves were these three animals deposited together.[72] The common occurrence of pig bones in the later Lerna graves is similar to the early MH graves at Asine. It indicates that the preference of pigs in the graves of early MH Asine was local for that specific period, but that the ritual use of pigs in graves was not singularly unique for MH I Asine, as it is evidenced in other sites of other periods in the region, such as early LH Lerna.

Regional and long-term perspectives

In the Middle Helladic graves of other sites, I have found few mentions of animal bones as grave goods.[73] Animal bones were sometimes neglected and not collected in older excavations.[74] Different local geological circumstances might result in differential preservation of bones. Nevertheless, the lack of animal bones also corresponds to the general lack of other kinds of grave goods during this period.[75] Thus it is probable that this lack not only is the consequence of the bones not being collected but also reflects the burial practices, where it was not common to deposit animals/animal parts in graves.

Below, I use other regional examples of animal bones from mortuary contexts dated to the broader MH and LH periods to illustrate two points.[76] First, I argue that the trend in which the most common domesticates, pig, sheep/goat and cattle, dominate as grave good animals, as exemplified by Asine and Lerna, is temporally restricted to the earlier MH. This becomes evident through a brief review of regional examples of animal bones in graves from the later MH, in which animals not commonly consumed and/or herded become more common. Second, I argue that in the early MH mainly the domesticated animals were deposited as grave goods. During the later MH and Mycenean periods, these animals became reserved instead for ritually connoted consumption activities, such as funerary meals. As is exemplified below, this argument is based on the fact that domestic animals are abundant in other types of ritually interpreted contexts, besides graves.

Bones of horse, dog, and wild boar, seemingly as part of food offerings, gifts, or equipment for the dead, became common among the grave goods in the rich graves of the later Bronze Age. The earliest horse burials can be found in the LH II period.[77] For example, nearby Dendra is famous for its horse burials, which should be placed in the LH IIIA-B periods.[78] Examples of the deposition of dogs in rich graves during the MH III-LH I can be found at Midea, specifically in Pit II of the tholos tomb.[79] Another example of animal-related grave goods consists of the worked boar tusks often for or as part of helmets which are found in graves of the Shaft Grave Period.[80]

Bones of horse, dog, and wild boar are not present in the early MH graves at Asine, although most animals are identified at the settlement (*Table 2*). The end of the MH was a socially dynamic period, resulting in the formation of the Mycenaean societies. In this cultural complex, hunting seems to have been a manifestation of power, important for the élite. This is presumably reflected by the use of dogs in burial contexts and boar tusk helmets as artefacts and in iconography.[81] This appears to not have been the case during the early Middle Helladic, at least not at Asine. Further, most of the instances of dogs, horses, and wild mammals can be tied to high status graves. Meanwhile, in the early MH Asine monumental structures indicating higher social complexity arrive first in MH II, as exemplified by the tumulus construction in the East Cemetery.[82]

---

71 Reese 2008b, 18-20; Reese unpubl.

72 Pit grave DB-1. In this grave a pig skull and mandible, two cattle teeth and one sheep/goat scapula were found along with some shells (Reese 2008b, 20). Other mammal species identified from the bones of these later Lerna graves includes dog (DC-1-2, Reese 2008b, 18) and red deer (BE-2, Reese unpubl.)

73 No animal bones are mentioned in the graves at Mycenae (Alden 2000), Orchomenos (Bulle 1907), Zygouries (Blegen 1928, 55–56), or Prosymna (Blegen 1937, 30-50). For the locations of these sites, see *Fig. 1*.

74 MacKinnon 2007. One example is the site of Malthi. During the 2016 excavations of the site two child burials were excavated, in which animal bones were found (Lindblom personal communication 16 August 2016; Macheridis 2016b). Pig was identified in both burials, while sheep/goat was found in one. This is in contrast to the older excavations of MH graves, in which no animal bones are mentioned (Valmin 1938). The presence of pig bones at Malthi is similar to the Asine graves in which pig bones are most common.

75 See Cavanaugh & Mee 1998, 31.

76 The inclusion of later temporal examples is motivated because animal bone data from early MH graves is, as mentioned, scarce. The scarceness of the evidence has made it necessary to contrast the data of this time to other regionally and temporally close contexts. This is made in order to define tendencies of the MH I-II which are not apparent due to the limited amount of data.

77 Pappi & Isaakidou 2015, 477; but see Reese 1995, 36.

78 Pappi & Isaakidou 2015; cf. Protonotariou-Deilaki 1990b, 101.

79 Persson 1931, 39.

80 Such examples can be found among other in the Cuirass Tomb at Dendra (Åström 1977) and the "Warrior Grave" at Eleusis (Cosmopoulos 2015, 76).

81 Hamilakis 2003, 243; see also Day 1984.

82 Dietz 1980; Voutsaki *et al.* 2011, 448.

Among other ritual contexts, besides graves, we have the large Middle Helladic ritual pit underneath the sanctuary for Apollo Maleatas at Epidauros. Among its many finds were the bones of sheep, cattle, pigs, and antler fragments from deer; as they have not been zooarchaeologically analysed the identifications remain uncertain.[83] The presence of domesticated animals in this type of context, i.e. ritual non-grave contexts, continues into the LH. We can note the MH-LH examples of the bones belonging to "a goat and two other small animals" which were found in a pit near grave Δπ18 at Eleusis.[84] Associated to Tomb IV at Zygouries, C.W. Blegen reported on the presence of two nearly complete goat skeletons, which he suggested were sacrificial remains in connection to the burial.[85] The material found in the infill of Shaft Grave 1 and Shaft Grave 2 at LH I Lerna has been interpreted as the remains of one or two funerary feasts.[86] A re-examination of the animal bones revealed that sheep/goat and pig were the most common animals chosen for meat consumption within these events, although wild species also have been identified.[87]

Another example of the use of the common domesticated animals in ritual consumption contexts is the discussion of burnt animal sacrifices, a seemingly wide-spread practice in the Mycenaean cultures. For example, at Pylos the burnt animal sacrifices focused on cattle, specifically the jaw, upper front limbs, and upper hind limbs.[88] Y. Hamilakis and E. Konsolaki discuss the burnt remains of juvenile pigs in Room A of the main sanctuary at Ayios Konstantinos as remains of burnt animal sacrifice.[89] Similarly, M. Cosmopoulos regards the burnt bones from the non-meaty parts of at least three pigs in Megaron B as evidence of burnt animal sacrifice at Eleusis.[90] Although the domesticated animals are occasionally found in MH III–LH I or II graves, such as at above-mentioned LH I Lerna, the above examples show the increasing reliance on pigs, sheep/goat, and cattle in ritually connoted consumption events, such as meals, feasts, or sacrifices, during the later Bronze Age periods.

[83] Theodorou-Mavrommatidi 2010.

[84] See Cavanaugh & Mee 1998, 32; Cosmopoulos 2015, 54–55.

[85] Blegen 1928, 41.

[86] This is based on the magnitude of the pottery assemblage, its relative completeness, the high inclusion of imported ware, and the large animal bone assemblage, representing a substantial amount of meat (Lindblom 2007; 2008, 191).

[87] Sheep/goat was more abundant of the two. Bones of cattle, red deer, dog, hare, fox, donkey, and tortoise were also identified, with the addition of goosehawk and heron in Shaft Grave 2 (Lindblom, personal communication, 16 August 2016). The remains from the infill of these graves are interpreted as the remains of one or two funerary feasts (Lindblom 2007; 2008, 191).

[88] Isaakidou *et al*. 2002.

[89] Hamilakis & Konsolaki 2004.

[90] Cosmopoulos 2015, 106.

Discussion and conclusions

Let us return to the focus of this paper, namely to discuss the symbolic connotations of animals in early MH Asine on the basis of the various connections between animal bone waste from the settlement and the animals or animal parts deposited in its graves. In the above, I have focused on species compositions and body part distribution of pig, sheep/goat and cattle. The latter, the comparisons of body parts, did not provide good basis for the discussion of symbolic aspects of the settlement debris. For example, the low-nutrient parts of cattle were abundant in the settlement, which could indicate butchery waste and some input of preservation bias to the advantage of compact and small bones such as phalanges and tarsals. On the other hand we do see meaty body parts in the graves, which indicate that butchery waste was not the most common in grave-related contexts. This conforms with the idea that the grave goods were either meat portions as gifts for the dead or the remains of some funerary meal.[91] It does not provide us with direct symbolic connotations of the bones found in the settlement debris.

SYMBOLIC VALUE OF THE PIG

The clearest similarity between settlement and graves at Asine, which can be discussed in terms of symbolic connotations, is that the pig is most abundant in the settlement and graves at Asine.[92] In the graves, pig bones were present in higher abundances than expected. The animal was not only of economic and nutritional use; it was also used for symbolic and ritual purposes at Asine, as testified by its abundance as grave goods. In contrast, at MH Lerna, cattle bones were most abundant in graves, while pig remains were most common in the settlement debris there (*Fig. 6*). The pig appears also to have been the most abundant animal at other settlements in the southern Mainland during the MH.[93]

The research on suid symbolism during the Bronze Age centres on the wild boar, predominantly in terms of power

[91] See Härke 2014.

[92] By this I presume that the deposition of pig in graves had symbolic connotations, which did not stop at the grave, but were present also in daily life. This is based on the proposal that there was no strict sacral versus profane sphere during the MH (Nordquist 1987, 111; Whittaker 2010, 536), and that animal symbolism is an important cosmological component in many traditional societies. For an overview of the latter, I refer to Russell 2012, 7–51. There might have been symbolic connotations to other animals, such as tabooed ones, which were at least as important for the MH people; these are harder to discuss on basis of present data. I highlight the pig because it clearly was both an important meat animal and an important ritual animal at early MH Asine.

[93] Sloan & Duncan 1974; Reese 2008a; see Trantalidou 1990, 398; Halstead 1996, 29.

and increased importance of hunting for the élite during the late MH and the Mycenean periods.[94] Few discuss the domestic pig in terms of animal symbolism during the MH I–II periods. This probably results from the lack of systematic assessments of available data. It is thus hard to discuss further in this text. Still, the characteristics of the pig itself might be interesting for this discussion. For example, the similarities between wild boar and pig are generally acknowledged, and were probably recognized by the prehistoric people as well.[95] Such general similarities perhaps affected the prehistoric perception of these animals, in which they were considered related.[96] Because of their closeness physically and morphologically, the pig could have been viewed as related to the wild boar.

The pig as a symbol during the MH I-II could thus have been multireferential, i.e. both as meat provider and as a liminal being with ties to the wild boar, hunting and the "wild".[97] This would further indicate that the early MH animal symbolism maybe had long-lasting influences for the rest of the Bronze Age, when the wild boar symbolism gradually became more important as reflected in the archaeological and the iconographical evidence. This remains an idea for future research and not a conclusion of this paper. What the results of this paper show is that the use of pigs in the early MH society at Asine was not only of economic importance as reflected in its high frequency in the settlement debris, but also of ritual and symbolic importance, as evidenced by its presence as grave goods during this period.

[94] The wild boar symbolism is evidenced foremost by the presence of tusk helmets as grave goods in high status graves, and of the animal in iconography (Morris 1990; Crowley 1995, 487, 489; Hamilakis 2003, 241 and 243).

[95] Ethnozooarchaeological observations have testified of the occasional interbreeding between wild and domestic pigs, resulting not only in increased similarity in morphology but also increased physical closeness between wild and domestic pigs, as described by e.g. Halstead & Isaakidou (2011, 161 and 170), Albarella *et al.* (2011, 151), and Hadjikoumis (2012, 357).

[96] Animals sharing morphology and behaviour are sometimes considered related in traditional societies. A contemporary example is 20th century Malekula in Melanesia, where pigs are categorized on the basis of age and gender, rather than domestication status (Funabiki 1981, 179). See also examples in n. 97.

[97] Examples of liminal attitudes towards certain animals can be found elsewhere. For example, the red deer in Ireland during the Early Middle Ages were labelled "wild cattle" because of the species' liminal status. It was seen as belonging to the domestic and social sphere, as it was similar to cattle, but also as belonging to the wild as it was hunted (Soderbergh 2004, 168). Among the Ethiopian Konso, the consumption of deer meat, or meat from horned animals, was allowed because they were similar to cattle, sheep, and goats (Hallpike 2008, 329).

RITUAL USE OF HERDED ANIMALS CONTRA HUNTED ANIMALS, HORSES AND DOGS

The dominance of bones from sheep/goats, cattle, and pigs in the graves of Asine and Lerna suggests that these animals were ritually and symbolically important as grave goods during the Middle Helladic. It is reasonable that the symbolism tied to these animals also permeated everyday life outside the burial sphere, and that for example the consumption of these animals was symbolically or ritually laden. Perhaps meat consumption was ritualized in occasional but recurrent events such as feasts for the community or smaller but more frequent meals within the household.[98] This would be in line with the proposed idea that everyday life was permeated by ritual meaning.[99]

The domesticated animals in the MH graves of Asine and Lerna were exchanged for hunted animals or those animals used during hunts during the Late Bronze Age in the region. It is however reasonable that domesticated animals retained ritually important functions in large-scale events, such as meals, feasts, or sacrifices, probably because they symbolized economic power.[100] The appearance of the burnt animal sacrifices in the Mycenaean period is cited as an example of this.[101] The public sharing and distribution of meat, for gods and/or humans, would have been more important in a social context; the funerary feast (or meal) is an important event in terms of building alliances and manifesting power.[102] The increase of wild animals in grave goods during the LBA was perhaps rather an indicator of a dead individual's identity than symptomatic of the social dynamics at the time, for which feasts probably had a more important function. The presence of wild animals in high status graves can perhaps be tied to the rising social inequalities during this period, visible foremost in the mortuary evidence, in which some graves exhibit extreme wealth compared to others, such as the Shaft Graves of Mycenae.

In conclusion, this paper shows the potential in comparing zooarchaeological intra-site patterns to discuss symbolic connotations of the leftovers from everyday life. Future studies will test the conclusions of this paper. This is needed in order to more fully understand which parts animals played in early Middle Helladic life. Although sites documented with modern-day techniques might provide higher contextual resolution, this does not mean that we should neglect the evidence from old excavations. This is illustrated in this study by using the almost century-old documentation of the 1926s excavation of Asine.

[98] I refer to the discussion earlier in this text where I distinguish between feasts and meals. The former are large-scale ritual events impacting on the power relations on a communal level (Dietler 1996, 88 and 2001, 65), while the latter include smaller consumption events.

[99] Nordquist 1987, 111; Whittaker 2010, 536.

[100] E.g. Russell 2012, 331.

[101] Hamilakis & Konsolaki 2004; Isaakidou *et al.* 2002.

[102] E.g. Hayden 2009.

Appendix 1

Three systems of labelling the graves of the Lower Town (Kastraki) have earlier been employed. In the text, I use the grave numbers stated in the column "Grave no.". When trying to reconstruct the animal bones associated to the Kastraki graves, the following field diaries from the old excavations have been consulted: Diaries 3:1 and 3:2 by Erik Jo Knudzon, Diary 5 by S. Neander Nilsson, and Diary 9 by Holger Arbman. The diaries are stored in Museum Gustavianum at Uppsala University.

Age assessments of juvenile individuals are taken from Ingvarsson-Sundström 2008. Adult ages by both Fürst (F) and Angel (A) are provided for the Kastraki graves. Information on the animal bones found in the East Cemetery graves has been kindly provided by Dimitra Mylona (DM). The author (SM) has analysed animal bones from the Kastraki graves. References to plans and/or photographs are present in the "References" column. Data on zooarchaeological indicators needed for Table B were only present from the Kastraki graves.

Table A. Contextual assessments of the animal bones found in the MH graves of Asine. For data on zooarchaeological indicators of bone condition, such as articulation status, exposure and surface wear, see Table B in this Appendix.

Burial area	Grave no.	Date	Stratigraphic discussion	Conclusion	References
East Cemetery	1971-11	MH II	The remains of a 30–40 years old female (61AS) were found in this cist grave. It is hard to tell whether or not the two unidentified animal bones recorded by DM are from the grave deposit, but as no goods were found, it is assumed that they derive from the fill of the grave. No grave goods. This grave was made in the upper layer of the IQ tumulus at Asine.	The animal bones belong to the grave fill. This burial of this individual should perhaps be associated to 1971-12.	Dietz 1980, 23. Plans/photographs: Dietz 1980, 16, fig. 3; 24, fig. 10.
	1971-12	MH II	This was the cist grave of a 6–12 years old child (62AS). Three animal bones were found in the grave: one sheep/goat rib, one tooth of red deer, and one unidentified but large-sized bone splinter, according to DM. This is the only instance of wild mammals among the graves in this study. No goods were found in the grave. Dietz (1980, 26) mentioned the bones of sheep/goat in the fill. The three bones examined by DM are most likely from the fill of this grave. 1971-12 was also made in the upper layer of the tumulus. It is perhaps near-contemporary, but a bit later, than 1971-11.	The animal bones belong to the grave fill. This burial of this individual should perhaps be associated to the earlier 1971-11.	Dietz 1980, 25–26; Voutsaki *et al.* 2011, 451. Plans/photographs: Dietz 1980, 16, fig. 3; 25, fig. 11; 26, fig. 12.

Burial area	Grave no.	Date	Stratigraphic discussion	Conclusion	References
East Cemetery	1971-13	MH II	This grave was made outside the tumulus. It was a cist grave containing the remains of an adult (around 30 years old) female (63AS). Seven animal bones were examined by DM: three sheep/goat (probably sheep) fragments from the hind leg (one astragal, one tibial, one metatarsal bone) of the same individual, two pig bones from the front leg (one radius, one ulna), and two unidentified medium-sized rib bones. DM interpreted these as remains of body parts forming food goods, since they articulate and form specific body parts. This seems plausible. The animal bones were not specified by Dietz (1980, 60). No other goods are specified.	The animal bones belong to the grave deposit.	Dietz 1980, 60–61. Plans/photographs: Dietz 1980, 16, fig. 3; 61, fig. 71.
Kastraki	MH 22	MH II–III	This pit grave contained the fragmentary remains of a new-born infant. It was made in the foot-end of MH 21, the burial of an adult male. It was located above wall 2 of House A (earlier MH), but was seemingly below House C (later MH). However, these graves might not be connected according to the excavators. The animal bones (AS 3400) were labelled as "animal bones grave no 158 (grave V)" or "around grave V". Grave V equals MH 22. Since the exact placement of the bones does not seem to be with the buried individual but around it, I assume they were found in the fill of the grave. It is possible that they also were found around the grave construction as well. Three animal bones are recorded of which one pig humerus was identified, as well as an unidentified small-sized fragment and one unidentified bone splinter. The small fragment might derive from the buried infant of this grave. No indicators of exposure were found on the animal bones.	The animal bones probably belong to the grave fill.	Diary 5: 24/06/1926; Frödin & Persson 1938, 117; Nordquist 1987, 129; 1996a, 23; 1996b, 118. Plans/photographs: Nordquist 1987, 194, fig. 99; 1996a, 24, fig. 5.
	MH 45	MH II–III	MH42 and MH 45 belong to the same cluster of graves south of House D, below House E. They were most probably contemporary with House D, and date to the MH II or MH III periods. This pot-grave contained an infant aged to around birth to 2 months. The animal bone (AS 3377) were labelled "in vessel of *bothros* grave". Therefore it is assumed that the contents of this single vessel should be associated to the burial event. Considering this relatively good contextual information it is unfortunate that only one cattle or deer tibia was recorded from this grave. No other burial gifts are recorded from this grave. No indicators of exposure were found on the animal bone.	The animal bones belong to the grave deposit.	Diary 9: 24/04/1926; Frödin & Persson 1938, 121; Nordquist 1987, 132; 1996b, 118. Plans/photographs: Nordquist 1987, 194, fig. 98; 1996a, 28, fig. 10.

Burial area	Grave no.	Date	Stratigraphic discussion	Conclusion	References
Kastraki	MH 58	Post MH I, probably MH II	This pit grave contained the remains of an adult aged to *c.* 50 (F) or 44 (A) years. A spearhead was found in the burial. It is located on Terrace III and was made on top of the stone floor of room VII in House T. Although it might have been made in a house which was in use at the time, due to its elaborate and space-demanding construction (cist grave) it is more probable that it is younger than House T. However, it seems clear judging from the diary that these bones do not belong to the usage phase of House T. The AS no. of the animal bones associated to this grave is probably AS 4800. According to the field diary, on the day that these bones were found, 13 March, the human skull was found. The soil around and under the skull was kept in a box. It is plausible that the animal bones belong to this unit and are from the grave deposit. A total of 18 animal bones were recorded: one pig mandible and one cattle rib, as well as seven unidentified mammal splinters. Nine large-sized rib fragments probably belong to the cattle rib. No indicators of exposure were found on the animal bones.	The animal bones probably belong to the grave deposit.	Diary 3a: 13/03/1926; Frödin & Persson 1938, 123; Nordquist 1987, 132; 1996a, 27; 1996b, 118. Plans/photographs: Nordquist 1996a, 28, fig. 10.
	MH 59	MH I	This cist grave contained the remains of an adult female, 40-50 (F) or around 30 years old (A). It is located on Terrace III. An obsidian chip was found in connection to the grave. It was found on 19 March, and most animal bones (AS 2138) derive from the day of the initial excavation of the grave on 20 March. They seem to belong to the grave fill. From this fill, five pig fragments were identified: one left maxillary, one right temporal, and three tibiae (two right and one left). One cattle tooth was identified. In addition, one medium-sized limb bone fragment and one mammal cranial fragment, and two unidentified fragments were recorded. Three animal bones, belonging to AS 5228, which was excavated ten days after this, when they lifted the skeleton. They probably derive from a deeper level of the fill: one pig pelvic bone and one cattle tooth. No indicators of exposure were found on the animal bones.	The animal bones belong to the grave fill.	Diary 3a: 19, 20, 29/03/1926; Frödin & Persson 1938, 123; Nordquist 1987, 132; 1996a, 28; 1996b, 118. Plans/photographs: Nordquist 1996a, 28, fig. 10.

Burial area	Grave no.	Date	Stratigraphic discussion	Conclusion	References
Kastraki	MH 60	Early MH I	This cist grave contained the remains of an adult female. It was located on Terrace III, and it was made in bothros 2 south-west of House T. One terracotta whorl was found. The grave was fully excavated and documented on 7 April, and most of the saved finds were found associated with the burial itself (AS 2360), which was located below a layer of hard soil. The stratigraphy is unusually well documented. Fourteen animal bones were recorded, five of which derived from pig: one frontal bone, one maxillary fragment, one tooth, one pelvic bone and one phalanx. Additionally one sheep/goat radius, one cattle phalanx and one cattle humerus were recorded. One unidentified large-sized fragment and five cranial fragments from medium-sized mammals were also among these bones. Although the one phalanx of pig was mildly weathered (Table B), the generally good condition of the bones as well as the possible articulated pig's skull suggest that the bones derive from the grave deposit. Possibly, the phalanx might be intrusive.	The animal bones belong to the grave deposit.	Diary 3a: 07/04/1926; Frödin & Persson 1938, 123; Nordquist 1987, 131; 1996a, 28; 1996b, 118. Plans/photographs: Nordquist 1996a, 30, fig. 13.
	MH 66	Possibly MH II	This burial was a pit grave on Terrace III, located above wall 5 of room II in House R, which was used during EH and early MH. Therefore the feature should be dated to early MH, most probably MH II. The burial contained the remains of a child aged 5 years ±6 months. The animal bones (AS 4737) were excavated the day after the skeleton was identified. The grave was documented and fully excavated on this day. It is assumed that the animal bones should be regarded as part of the actual grave. One pig rib and one pig mandible were found together with an unidentified mammal fragment. No indicators of exposure were found on the animal bones.	The animal bones probably belong to the grave deposit.	Diary 3a: 20/05/1926; Frödin & Persson 1938, 124; Nordquist 1987, 132; 1996a, 29; 1996b, 118. Plans/photographs: Nordquist 1996a, 31, fig. 15.
	MH 102	MH II–III	The grave was excavated on Terrace II above Terrace III. The stratigraphy and dating of it remains preliminary. Based on its location stratigraphically and physically over bothros 1 (EH III-MH I), a possible date is MH II-III. This pit grave contained the remains of a one-year-old child. The animal bones (AS 2171) were excavated on 17 May. The burial was removed the same day. The AS no. is also the label for the child skeleton, which is why it is assumed that the animal bones were located very close to the body and should be considered part of the grave deposit. Eight animal bones were recorded: one mandible and one pelvic bone of pig, four fragmented mammal specimens, and two medium-sized bones (one rib and one limb bone). No indicators of exposure were found on the animal bones.	The animal bones probably belong to the grave deposit.	Diary 3b: 17/05/1926; Frödin & Persson 1938, 17; Nordquist 1987, 134; 1996a, 29; 1996b, 118. Plans/photographs: Nordquist 1996a, 36, fig. 24.

Table B. Zooarchaeological indicators of average size, articulation status and surface wear (weathering, trampling, and gnawing) on bones from the Kastraki graves in Table A.

Grave	Grave fill/ deposit	No. of bones	Average size (mm)	Articulation (yes/no /possibly /not applicable*)	Weathering	Trampling	Gnawing
MH 22	Grave fill	3	40	Not appl.	None	None	None
MH 45	Grave deposit	1	not appl.	Not appl.	None	None	None
MH 58	Grave deposit	20	20.5**	Possibly (cattle rib)	None	None	None
MH 59	Grave fill	14	40.7	No	None	None	None
MH 60	Grave deposit	14	36	Possibly (pig skull)	One weathered bone (pig phalanx)	None	None
MH 66	Grave deposit	3	43.3	Not appl.	None	None	None
MH 102	Grave fill	11	23.2	No	None	None	None

* Not applicable signifies that the count of bones is too small for this assesment.
**The average size is small due to post-depositionally fragmented splinters and therefore not representative for bone status prior to deposition.

Appendix 2

The anatomical distributions of pig, sheep/goat and cattle, MH I–II Asine, the settlement.

	Pig (*Sus domesticus*)	**Sheep/goat** (*Ovis aries/ Capra hircus*)	**Cattle** (*Bos taurus*)
Horn core	Not applicable	18	14
Cranial	74	24	21
Mandible	85	28	31
Loose teeth	40	61	23
Vertebrae	19	21	18
Ribs	17	8	4
Scapula, humerus	66	47	21
Radius, ulna	30	44	18
Carpals, metacarpals	12	15	12
Pelvic region	24	15	17
Femur, patella	9	8	11
Tibia, fibula	19	25	12
Tarsals, metatarsals	21	33	31
Metapodials, phalanges, sesamoids	9	14	33
Total	**425**	**361**	**266**

The anatomical distributions of pig, sheep/goat and cattle, MH Lerna, the graves. Graves dated to the MH III and/or LH I are excluded. Data kindly provided by Reese (unpubl.).

	Pig (*Sus domesticus*)	**Sheep/goat** (*Ovis aries/ Capra hircus*)	**Cattle** (*Bos taurus*)
Horn core	Not applicable	0	0
Cranial	2	1	2
Mandible	8	2	0
Loose teeth	4	9	5
Vertebrae	0	0	9
Ribs	0	0	0
Scapula, humerus	4	2	1
Radius, ulna	5	0	2
Carpals, metacarpals	0	1	1
Pelvic region	0	3	3
Femur, patella	0	0	0
Tibia, fibula	2	2	2
Tarsals, metatarsals	3	1	2
Metapodials, phalanges, sesamoids	1	6	2
Shaft or fragment*	0	5	28
Total	**29**	**32**	**57**

* 7 of Reese's *Bos* identifications are labelled as fragments

STELLA MACHERIDIS
Department of Archaeology and Ancient History
Lund University
Helgonavägen 3, 221 00 Lund
Sweden
stella.macheridis@ark.lu.se

Bibliography

Albarella, U., F. Manconi & A. Trentacoste 2011. 'A week on the plateau: Pig husbandry, mobility and resource exploitation in Central Sardinia', in *Ethnozooarchaeology: The past and present of human-animal relationships*, eds. U. Albarella & A. Trentacoste, Oxford & Oakville, 143–159.

Alden, M. 2000. *Well built Mycenae,* Fasc. 7; *The prehistoric cemetery: Pre-Mycenaean and Early Mycenaean graves*, Oxford.

Arnold, E.R. & D. Lyons 2011. 'Ethnozooarchaeology of butchering practices in the Mahas region, Sudan', in *Ethnozooarchaeology: The present and past of human-animal relationships*, eds. U. Albarella & A. Trentacoste, Oxford & Oakville, 107–119.

Åström, P. 1977. *The Cuirass Tomb and other finds at Dendra*, Part 1: *The chamber tombs*, Göteborg.

Bell, C. 1992. *Ritual theory, ritual practice*, Oxford.

Blackburn, E.T. 1970. *Middle Helladic graves and burial customs with special reference to Lerna in the Argolid*, Ph.D. thesis, Cincinnati, Ann Arbor.

Blegen, C.W. 1928. *Zygouries: A prehistoric settlement in the valley of Cleonae*. Cambridge, Massachusetts.

Blegen, C.W. 1937. *Prosymna: The Helladic settlement preceding the Argive Heraeum*, Cambridge.

Boessneck, J. 1969. 'Osteological differences between sheep (*Ovis aries* Linné) and goat (*Capra hircus* Linné)', in *Science in archaeology*, eds. D. Brothwell & E. Higgs, London, 336–359.

Bradley, R. 2005. *Ritual and domestic life in prehistoric Europe*, London.

Bulle, H. 1907. *Orchomenos* I: *Die älteren Ansiedelungsschichten*, München.

Cavanaugh, W. & C. Mee 1998. *A private place: Death in prehistoric Greece* (SIMA 125), Jonsered.

Cosmopoulos, M.B. 2015. *Bronze Age Eleusis and the origins of the Eleusinian mysteries*, New York.

Crowley, J.L. 1995. 'Images of power in the Bronze Age Aegean', in *POLITEIA: Society and state in the Aegean Bronze Age*, eds. R. Laffineur & W-D. Niemeier (*Aegaeum* 12), Liège/Austin, 475–491.

Day, L.P. 1984. 'Dog burials in the Greek world', *AJA* 88, 21–32.

Dietler, M. 1996. 'Feasts and commensal politics in the political economy: Food, power and status in prehistoric Europe', in *Food and the status quest: An interdisciplinary perspective*, eds. P. Wiessner & W. Schievenhövel, Providence & Oxford, 87–125.

Dietler, M. 2001. 'Theorizing the feast: Rituals of consumption, commensal politics, and power in African contexts', in *Feasts: Archaeological and ethnographic perspectives on food, politics, and power*, eds. M. Dietler & B. Hayden, Washington & London, 65–114.

Dietz, S. 1980. *Asine* II: *Results of the excavations east of the Acropolis 1970–1974.* Fasc. 2: *The Middle Helladic cemetery, the Middle Helladic and Early Mycenaean deposits* (ActaAth-4°, 24:2), Stockholm.

Dietz, S. 1982. *Asine* II: *Results of the excavations east of the Acropolis 1970–1974,* Fasc. 2. *General stratigraphical analysis and architectural remains* (ActaAth-4°, 24:2), Stockholm.

Douglas, M. 1966 (2002). *Purity and danger*, London/New York.

Drackner, M. 2005. 'What is waste? To whom? An anthropological perspective on garbage', *Waste management & research* 23, 175–181.

Ekengren, F. 2013. 'Contextualizing grave goods: Theoretical perspectives and methodological implications', in *The Oxford handbook of the archaeology of death and burial*, eds. S. Tarlow & L. Nilsson Stutz, Oxford, 173–192.

Forstenpointner, G., A. Galik, G.E. Weissengruber, S. Zohmann, U. Thanheiser & W. Gauss 2010. 'Subsistence and more in Middle Bronze Age Aegina Kolonna: Patterns of husbandry, hunting and agriculture', in *Mesohelladika: The Greek Mainland in the Middle Bronze Age* (*BCH* Supplément 52), eds. A. Philippa-Touchais, G. Touchais, S. Voutsaki & J. Wright, Athens, 733–742.

Frödin, O. & A.W. Persson 1938. *Asine* I; *Results of the Swedish excavations 1922–1930*, ed. A. Westholm, Stockholm.

Funabiki, T. 1981. 'On pigs of the Mbotgote in Malekula', in *Vanuatu: Politics, economics and ritual in Island Melanesia*, ed. M. Allen, Sydney, 173–188.

Gejvall, N.-G. 1969. *Lerna: A preclassical site in the Argolid*, vol. 1: *The fauna*, Princeton.

Gifford-Gonzalez, D. 2014. 'Constructing community through refuse disposal', *African Archaeological Review* 31, 339–382.

Gillis, C. 1996. 'Tin at Asine.' in *Asine* III: *Supplementary studies on the Swedish excavations 1922–1930* (Acta-Ath, 45:1), eds. R. Hägg, G.C. Nordquist & B. Wells, Stockholm, 94–100.

Grayson, D.K. 1991. 'Alpine faunas from the White Mountains, California: Adaptive change in the late prehistoric great basin?', *JAS* 18, 483–506.

Hadjikoumis, A. 2012. 'Traditional pig herding practices in southwest Iberia: Questions of scale and zooarchaeological implications', *Journal of Anthropological Archaeology* 3, 353–364.

Hägg, I. & R. Hägg 1973. *Excavations in the Barbouna area at Asine,* Fasc. 1: *General introduction, bibliography, geological background and a report on the field-work in the Levendis sector, 1970–1972* (Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilizations 4:1), Uppsala.

Hägg, I. & R. Hägg 1975. 'Discoveries at Asine dating from the Shaft-Grave Period', *AAA* 8, 151–160.

Hallpike, C.R. 2008. *The Konso of Ethiopia: A study of the values of a Cushitic people*, rev. ed., Central Milton Keynes.

Halstead, P. 1996. 'Pastoralism or household herding? Problems of scale and specialization in early Greek animal husbandry', *World Archaeology* 28:1, 20–42.

Halstead, P. & V. Isaakidou 2011. 'A pig fed by hand is worth more than two in the bush: Ethnoarchaeology of pig husbandry in Greece', in *Ethnozooarchaeology: The past and present of human-animal relationships*, eds. U. Albarella & A. Trentacoste, Oxford & Oakville, 160–174.

Hamilakis, Y. 1996. 'A footnote on the archaeology of power: Animal bones from a Mycenaean chamber tomb at Galatas, NE Peloponnese', *The Annual of the British School at Athens* 91, 153–166.

Hamilakis, Y. 1998. 'Eating the dead: Mortuary feasting and the politics of memory in the Aegean Bronze Age societies', in *Cemetery and society in the Aegean Bronze Age*, eds. K. Branigan, Sheffield, 115–132.

Hamilakis, Y. 2003. 'The sacred geography of hunting: Wild animals, social power and gender in early farming societies', in *Zooarchaeology in Greece: Recent advances*, eds. E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble & P. Elefanti, London, 239–248.

Hamilakis, Y. & E. Konsolaki 2004. 'Pigs for the gods: Burnt animal sacrifices as embodied rituals at a Mycenaean sanctuary', *Oxford Journal of Archaeology* 23:2, 131–151.

Härke, H. 2014. 'Grave goods in early medieval burials: Messages and meanings', *Mortality* 19:1, 41–60.

Hayden, B. 2009. 'Funeral as feasts: Why are they so important?', *Cambridge Archaeological Journal* 19, 29–52.

Hielte-Stavropoulou, M. 2004. 'Traces of ritual in Middle Helladic funeral contexts including an assessment of geographical location', in *Celebrations: Sanctuaries and the vestiges of cult activity*, ed. M. Wedde, Bergen, 9–34.

Hodder, I. 1982. *Symbols in action: Ethnoarchaeological studies of material culture*, Cambridge.

Hodder, I. 1987. 'The meaning of discard: Ash and domestic space in Baringo', in *Method and theory for activity area research*, ed. S. Kent, New York, 424–448.

Ingvarsson-Sundström, A. 2008. *Asine* III: *Supplementary studies on the Swedish excavations 1922–1930*, Fasc. 3: *Children lost and found* (ActaAth-4°, 45: 2), Stockholm.

Ingvarsson-Sundström, A., S. Voutsaki & E. Milka 2013. 'Diet, health and social differentiation in Middle Helladic Asine: A bioarchaeological view', in *Diet, economy and society in the Ancient Greek world: Towards a better integration of archaeology and science*, eds. S. Voutsaki & S.M. Valamoti, Leuven, 149–162.

Isaakidou, V., P. Halstead, J. Davis & S. Stocker 2002. 'Burnt animal sacrifice at the Mycenaean "Palace of Nestor", Pylos', *Antiquity* 76, 86–92.

Isaksson, S. 2000. *Food and rank in Early Medieval time*, Stockholm.

Jennbert, K. 2011. *Animals and humans: Recurrent symbiosis in archaeology and Old Norse religion*, Lund.

Lindblom, M. 2007. 'Early Mycenaean mortuary meals at Lerna VI with special emphasis on their Aeginetan components', in *Middle Helladic pottery and synchronisms*, eds. F. Felten, W. Gauss & R. Smetana, Wien, 115–136.

Lindblom, M. 2008. 'Funerary meals at the LH I Shaft Graves at Lerna', *Bulletin of the Institute of Classical Studies* 51, 191–192.

Lyman, R.L. 1994. *Vertebrate taphonomy*, Cambridge.

Lyman, R.L. 2008. *Quantitative paleozoology*, Cambridge.

Macheridis, S. 2014. 'The pastoralism of Bronze Age Argolis: A case-study of the interdepedence between agropastoral transformation and waste management', in *Abstracts. ICAZ 2014, 12th International Conference of Archaeozoology*, ed. A.D. Izeta, Córdoba, 99.

Macheridis, S. 2016a. 'The use of multiple correspondence analysis (MCA) in taphonomy: The case of Middle Helladic Asine, Greece', *International Journal of Osteoarchaeology*, doi:10.1002/oa.2571.

Macheridis, S. 2016b. 'A report on the preliminary osteological assessments of the bones from Malthi, 2016', unpublished technical report.

MacKinnon, M. 2007. 'Osteological research in Classical Archaeology', *AJA* 111, 473–504.

Magnell, O. 2009. 'Den urbana borgen och den lantliga staden. Djurhållning och kost i det medeltida Sölvesborg', *Ale, Historisk Tidsskrift för Skåne, Halland och Blekinge* 2009:4, 20–24.

Marciniak, A. 2005. *Placing animals in the Neolithic: Social zooarchaeology of prehistoric farming communities*, London.

Marean, C.W., L.M. Spencer, R.J. Blumenschine & S.D. Capaldo 1991. 'Captive hyaena bone choice and destruction, the *schlepp* effect and Olduvai archaeofaunas', *JAS* 19, 101–121.

Mayer, J.J. & I. Lehr Brisbin 1988. 'Sex identification of *Sus scrofa* based on canine morphology', *Journal of Mammology* 69:2, 408–412.

Méry, S. & M. Tengberg 2009. 'Food for eternity? The analysis of a date offering from a 3rd millennium BC grave at Hili N, Abu Dhabi (United Arab Emirates)', *JAS* 36, 2012–2017.

Milka, E. 2010. 'Burials upon the ruins of abandoned houses in the Middle Helladic Argolid', in *Mesohelladika: The Greek mainland in the Middle Bronze Age* (*BCH* Supplément 52), eds. A. Philippa-Touchais, G. Touchais, S. Voutsaki & J. Wright, Athens, 433–443.

Moberg Nilsson, K. 1996. 'Animal bones from Terrace III in the Lower Town of Asine', in *Asine* III: *Supplementary Studies on the Swedish excavations 1922–1930* (ActaAth, 45:1), eds. R. Hägg, G.C. Nordquist & B. Wells, Stockholm, 111–115.

Moore, H.L. 1982. 'The interpretation of spatial patterning in settlement residues', in *Symbolic and structural archaeology*, ed. I. Hodder, Cambridge, 74–79.

Morris, C.E. 1990. 'In pursuit of the white tusked boar: Aspects of hunting in Mycenaean society', in *Celebrations of death and divinity in the Bronze Age Argolid. Proceedings of the Sixth International Symposium at the Swedish Institute at Athens, 11–13 June, 1988* (ActaAth-4°, 40), eds. R. Hägg & G.C. Nordquist, Stockholm, 149–156.

Mylona, D. 2003. 'Archaeological fish remains in Greece: General trends of the research and a gazetteer of sites', in *Zooarchaeology in Greece: Recent advances*, eds. E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble & P. Elefanti, London, 193–200.

Nicodemus, A. 2008. 'The mammal and reptile remains, 1973–1977', in *Ayios Stefanos: Excavations at a Bronze Age and Medieval settlement in southern Laconia*, eds. W.D. Taylour & R. Janko, London, 506–513.

Nordquist, G.C. 1987. *A Middle Helladic village. Asine in the Argolid* (Boreas. Uppsala Studies in Ancient Mediterranean and Near Eastern Civilizations 16), Uppsala.

Nordquist, G.C. 1990. 'Middle Helladic burial rites: Some speculations', in *Celebrations of death and divinity in the Bronze Age Argolid. Proceedings of the Sixth International Symposium at the Swedish Institute at Athens, 11–13 June, 1988* (ActaAth-4°, 40), eds. R. Hägg & G.C. Nordquist, Stockholm, 35–41.

Nordquist, G.C. 1996a. 'New information on old graves', in *Asine* III: *Supplementary Studies on the Swedish excavations 1922–1930* (ActaAth, 45:1), eds. R. Hägg, G.C. Nordquist & B. Wells, Stockholm, 19–38.

Nordquist, G.C. 1996b. 'Grave concordance, Asine 1922–1930', in *Asine* III: *Supplementary studies on the Swedish excavations 1922–1930* (ActaAth, 45:1), eds. R. Hägg, G.C. Nordquist & B. Wells, Stockholm, 117–119.

Nordquist, G.C. 2002. 'Pots, prestige and people: Symbolic action in Middle Helladic burials', *OpAth* 27, 119–135.

O'Connor, T.P. 1982. *Animal bones from Flaxengate, Lincoln*, London.

Ortner, S.B. 1984. 'Theory in anthropology since the sixties', *Comparative Studies in Society and History* 26:1, 126–166.

Pappi, E. & V. Isaakidou 2015. 'On the significance of equids in the Late Bronze Age Aegean', in *Mycenaeans up to date: The archaeology of the North-eastern Peloponnese – Current concepts and new directions* (ActaAth-4°, 56), eds. A-L. Schallin & I. Tournavitou, Stockholm, 469–481.

Payne, S. 1973. 'Kill-off patterns in sheep and goats: The mandibles from Asvan Kale', *Anatolian Studies* 23, 281–303.

Peres, T.M. 2010. 'Methodological issues in zooarchaeology', in *Integrating zooarchaeology and paleoethnobotany: A consideration of issues, methods, and cases*, eds. A.M. VanDerwarker & T.M. Peres, New York,15–36.

Persson, A.W. 1931. *The royal tombs at Dendra near Midea* (Acta Regiae Societatis humaniorum litterarum Lundensis 15), Lund.

Pollock, S. 2003. 'Feasts, funerals, and fast food in Early Mesopotamian state', in *The archaeology and politics of food and feasting in early states and empires*, ed. T.L. Bray, New York, 17–38.

Protonotariou-Deilaki, E. 1990a. 'The tumuli of Mycenae and Dendra', in *Celebrations of death and divinity in the Bronze Age Argolid. Proceedings of the Sixth Inter-*

national Symposium at the Swedish Institute at Athens, 11–13 June, 1988 (ActaAth-4°, 40), eds. R. Hägg & G.C. Nordquist, Stockholm, 85–106.

Protonotariou-Deilaki, E. 1990b. 'Burial customs and funerary rites in the prehistoric Argolid', in *Celebrations of death and divinity in the Bronze Age Argolid. Proceedings of the Sixth International Symposium at the Swedish Institute at Athens, 11–13 June, 1988* (ActaAth-4°, 40), eds. R. Hägg & G.C. Nordquist, Stockholm, 69–83.

Prummel, W. & H.-J. Frisch 1986. 'A guide for the distinction of species, sex and body side in bones of sheep and goat', *JAS* 13, 567–577.

Reese, D. 1995. 'Equid sacrifices/burials in Greece and Cyprus: An addendum', *Journal of Prehistoric Religion* 9, 35–42.

Reese, D. 1998. 'Appendix II: The faunal remains', in *Excavations on the acropolis of Midea,* vol. I:1. *The excavation on the Lower Terraces*, ed. G. Walberg, Stockholm, 277–291.

Reese, D. 2008a. 'Appendix 8: The mammalian and reptilian remains. Catalogue and comparanda', in *Ayios Stefanos: Excavations at a Bronze Age and Medieval settlement in southern Laconia*, eds. W.D. Taylour & R. Janko, London, 156–185.

Reese, D. 2008b. 'Faunal remains from Late Helladic Lerna (Argolid, Greece)', *Mediterranean Archaeology & Archaeometry* 8:1, 5–25.

Reese, D. 'Lerna animal bones and shells from graves', unpublished manuscript.

Rudebeck, E. & S. Macheridis 2015. 'The proper way of dwelling at the Early Neolithic gathering site of Almhov in Scania, Sweden', in *Neolithic diversities: Perspectives from a conference in Lund, Sweden*, eds. K. Brink, S. Hydén, K. Jennbert, L. Larsson & D. Olausson, Lund, 173–187.

Russell, N. 2012. *Social zooarchaeology: Humans and animals in prehistory*, New York.

Silver, I.A. 1969. 'The ageing of domestic animals', in *Science in archaeology*, eds. D. Brothwell & E. Higgs, London, 283–302.

Sloan, R.E. & M.A. Duncan 1974. '6: Zooarchaeology of Nichoria', in *Excavations at Nichoria in southwest Greece*, vol. 1: *Site, environs, and techniques*, eds. E. Rapp & S.E. Aschenbrenner, Minneapolis, 60–77.

Soderbergh, J. 2004. 'Wild cattle: Red deer in the religious texts, iconography, and archaeology of Early Medieval Ireland', *International Journal of Historical Archaeology* 8, 167–183.

Stiner, M.C. 1991. 'Food procurement and transport by human and non-human predators', *JAS* 18, 455–482.

Strasser, S. 1999. *Waste and want: A social history of trash*, New York.

Szynkiewicz, S. 1990. 'Sheep bone as a sign of human descent: Tibial symbolism among the Mongols', in *Signifying animals: Human meanings in the natural world* (One World Archaeology 16), ed. R. Willis, London.

Theodorou-Mavrommatidi, A. 2010. 'Defining ritual action: A Middle Helladic pit at the site of Apollo Maleatas in Epidauros', in *Mesohelladika: The Greek Mainland in the Middle Bronze Age* (*BCH* Supplément 52), eds. A. Philippa-Touchais, G. Touchais, S. Voutsaki & J. Wright, Athens, 521–533.

Thomas, R. & M. Lacock 2000. 'Food for the dogs? The consumption of horseflesh at Dudley Castle in the eighteenth century', *Environmental Archaeology* 5:1, 83–91.

Trantalidou, C. 1990. 'Animals and human diet in the prehistoric Aegean', in *Thera and the Aegean world* III, vol. 2: *Earth sciences (Proceedings of the third international congress, Santorini, Greece 3–9 September 1989)*, Greece, 392–405.

Turner, V. 1966. *The ritual process: Structure and anti-structure*, Ithaca & New York.

Turner, V. 1967. *The forest of symbols: Aspects of Ndembu rituals*, Ithaca & New York.

Twiss, K. 2012. 'The archaeology of food and social diversity', *Journal of Archaeological Research* 20:4, 357–395.

Valmin, N.M. 1938. *The Swedish Messenia Expedition* (SkrLund 26), Lund.

von den Driesch, A. & J. Boessneck 1990. 'Die Tierresten von der mykenischen Burg Tiryns bei Nauplion/Peloponnes', in *Tiryns: Forschungen und Berichte* XI, Mainz, 87–164.

Voutsaki, S. 2004. 'Age and gender in the southern Greek Mainland, 2000–1500 BC', *Ethnographisch-Archäologische Zeitschrift* 45, 339–363.

Voutsaki, S. 2010. 'Agency and personhood at the onset of the Mycenaean period', *Archaeological Dialogues* 17:1, 65–92.

Voutsaki, S., S. Triantaphyllou, I. Ingvarsson-Sundström, K. Sarri, M. Richards, A. Nijboer, S. Kouidou-Andreou, L. Kovatsi, D. Nikou & E. Milka 2007. 'Project on the Middle Helladic Argolid: A report on the 2006 season', *Pharos* 14, 59–99.

Voutsaki, S., A. Ingvarsson-Sundström & S. Dietz 2011. 'Tumuli and social status: A re-examination of the Asine tumulus', in *Ancestral landscapes: Burial mounds in the Copper and Bronze Ages*, eds. E. Borgna & S. Müller Celka, Lyon, 445-461.

Voutsaki, S., E. Milka, S. Triantaphyllou & C. Zerner 2013. 'Middle Helladic Lerna: Diet, economy, society', in *Diet, economy and society in the ancient Greek world,* eds. S. Voutsaki & S.-M. Leuven, 133-147.

Vretemark, M. 1997. *Från ben till boskap: Kosthåll och djurhållning med utgångspunkt i medeltida benmaterial från Skara*, del 1: *Skrifter från Länsmuséet Skara*, Skara.

Wells, B. 1983. *Asine* II: *Results of the excavations east of the Acropolis*, Fasc. 4: *The Protogeometric period*, Part 1: *An analysis of the settlement*, Stockholm.

Whittaker, H. 2010. 'Some thoughts on Middle Helladic religious beliefs and ritual and their significance in relation to social structure', in *Mesohelladika: The Greek Mainland in the Middle Bronze Age* (*BCH* Supplément 52), eds. A. Philippa-Touchais, G. Touchais, S. Voutsaki & J. Wright, Athens, 535–543.

Wright, J.C. ed. 2004. *The Mycenaean feast*, Princeton.

Yannouli, E. & C. Trantalidou 1998. 'The fallow deer (*Dama dama* Linnaeus 1758): Archaeological presence and representation', in *The Holocene history of the European vertebrate fauna: Modern aspects of research*, ed. N. Benecke, Berlin, 247–281.

Zeder, M.A. & H.A. Lapham 2010. 'Assessing the reliability of criteria used to identify postcranial bones in sheep, *Ovis*, and goats, *Capra*', *JAS* 37, 2887–2905.

Acta Archaeologica Lundensia

Series altera in 8°

1. ERIK CINTHIO, Lunds domkyrka under romansk tid. 1957.
2. MATS P. MALMER, Jungneolitisiche Studien. 1962.
3. MATS P. MALMER, Metodproblem inom järnålderns konsthistoria. 1963.
4. BRITAS MALMER, Nordiska mynt före år 1000. 1966.
5. EGON THUN, Medieval Tommarp. Archaeological investigations 1959–1960. 1967.
6. GAD RAUSING, The Bow. Some notes on its origin and development. 1967.
7. MÄRTA STRÖMBERG, Der Dolmen Trollasten in St. Köpinge, Schonen. 1968.
8. BERTA STJERNQUIST, Beiträge zum Studium von bronzezeitlichen Siedlungen. 1969.
9. MÄRTA STRÖMBERG, Die Megalithgräber von Hagestad. Zur Problematik von Grabbauten und Grabriten. 1971.
10. MÄRTA STRÖMBERG, Studien zu einem Gräberfeld in Löderup. Jungneolithikum bis römische Kaiserzeit. Grabsitte, Kontinuität, Socialstruktur. 1975.
11. RIKARD HOLMBERG, Den skånska öresundskustens medeltid. 1977.
12. LARS LARSSON, Ageröd V. An Atlantic bog site in central Scania. 1983.
13. ANDERS ANDRÉN, Den urbana scenen. Städer och samhälle i det medeltida Danmark. 1985.
14. INGER HÅKANSSON, Skånes gravfynd från äldre bronsålder som källa till studiet av Social struktur. 1985.
15. ELISABETH HERNER, Profession med tradition. Teknisk-kvalitativ analys av den äldre bronsålderns spiralornamentik, dess central- och lokalproduktion. 1987.
16. Trade and exchange in prehistory. Studies in honour of Berta Stjernquist. (Eds.) B. Hårdh, L. Larsson, D. Olausson & R. Petré. 1988.
17. BOZENA WYSZOMIRSKA, Ekonomisk stabilitet vid kusten. Nymölla III. En tidigneolitisk bosättning med fångstekonomi i nordöstra Skåne. 1988.
18. MATS G. LARSSON, Runstenar och utlandsfärder. Aspekter på det senvikingatida samhället med utgångspunkt i de fasta fornlämningarna. 1990.
19. TOVE HJØRUNGDAL, Det skjulte kjønn. Patriarkal tradisjon og feministisk visjon i arkeologien belyst med fokus på en jernalderkonekst. 1991.
20. Regions and reflections. In honour of Märta Strömberg. (Eds.) K. Jennbert, L. Larsson, R. Petré & B. Wyszomirska-Werbart. 1991.
21. JOHN TROENG, Worldwide chronology of fifty-three prehistoric innovations. 1993.
22. ANNE CARLIE, På arkeologins bakgård. En bebyggelsearkeologisk undersökning i norra Skånes inland baserad på synliga gravar. 1994.

23. PER KARSTEN, Att kasta yxan i sjön. En studie över rituell tradition och förändring utifrån skånska neolitiska offerfynd. 1994.
24. The earliest settlement of Scandinavia and its relationship with neighbouring areas. (Ed.) L. Larsson. 1996.
25. BIRGITTA HÅRDH, Silver in the Viking Age. A regional-economic study. 1996.
26. MATS G. LARSSON, Från stormannagård till bondby. En studie av mellansvensk bebyggelseutveckling från äldre järnålder till medeltid. 1997.
27. MÄRIT GAIMSTER, Vendel period bracteates on Gotland. On the significance of Germanic art. 1998.
28. Centrala platser – Centrala frågor. Samhällsstrukturen under järnåldern. En vänbok till Berta Stjernquist. (Eds.) L. Larsson & B. Hårdh. 1998.
29. LENNART CARLIE, Bebyggelsens mångfald. En studie av södra Hallands järnåldersgårdar baserad på arkeologiska och historiska källor. 1999.
30. Fynden i centrum. Keramik, glas och metall från Uppåkra. (Ed.) B. Hårdh.1999.
31. Form, function & context. Material culture studies in Scandinavian archaeology. (Eds.) D. Olausson & H. Vandkilde. 2000.
32. ELISABETH RUDEBECK, Tilling nature – harvesting culture. Exploring images of the human being in the transition to agriculture. 2000.
33. BO KNARRSTRÖM, Flinta i sydvästra Skåne. En diakron studie av råmaterial, produktion och funktion med fokus på boplatsteknologi och metalltida flintutnyttande. 2000.
34. Uppåkra. Centrum och sammanhang. (Ed.) B. Hårdh. 2001.
35. PÅVEL NICKLASSON, Strävsamma bönder och sturska stormän. Stafsinge och Halland från bronsålder till medeltid. 2001.
36. Uppåkra. Centrum i analys och rapport. (Ed.) L. Larsson. 2001.
37. Bilder av bronsåldern. Ett seminarium om förhistorisk kommunikation. Rapport från ett seminarium på Vitlycke museum 19e–22a oktober 2000. (Ed.) J. Goldhahn. 2002.
38. BERTIL HELGESSON, Järnålderns Skåne. Samhälle, centra och regioner. 2002.
39. Central places in the Migration and Merovingian periods. Papers from the 52nd Sachsensymposium, Lund, August 2001. (Eds.) B. Hårdh & L. Larsson. 2002.
40. Centrality – Regionality. The social structure of southern Sweden during the Iron Age. (Eds.) B. Hårdh & L. Larsson. 2003.
41. Landskapsarkeologi och tidig medeltid. Några exempel från södra Sverige. (Eds.) M. Anglert & J. Thomasson. 2003.
42. MAGNUS ANDERSSON, Skapa plats i landskapet. Tidig- och mellanneolitiska samhällen utmed två västskånska dalgångar. 2003.
43. FREDRIK SVANBERG, Decolonizing the Viking Age 1. 2003.

44. BJÖRN NILSSON, Tingens och tankarnas landskap. Försök i naturumgängets arkeologi med exempel ur Blekinges och Smålands förflutna. 2003.
45. Fler fynd i centrum. Materialstudier i och kring Uppåkra. (Ed.) B. Hårdh. 2003.
46. LIV NILSSON STUTZ, Embodied rituals & ritualized bodies. Tracing ritual practices in Late Mesolithic burials. 2003.
47. ANNA GRÖHN, Positioning the Bronze Age in social theory and research context. 2004.
48. Continuity for centuries. A ceremonial building and its context at Uppåkra, southern Sweden. (Ed.) Lars Larsson. 2004.
49. PETER SKOGLUND, Vardagens landskap. Lokala perspektiv på bronsålderns materiella kultur. 2005.
50. PÅVEL NICKLASSON, En vit fläck på kartan. Norra Småland under bronsålder och järnålder. 2005.
51. OLA MAGNELL, Tracking wild boar and hunters. Osteology of wild boar in Mesolithic South Scandinavia. 2005.
52. Back to the origin. New research in the Mesolithic-Neolithic Zvejneki cemetery and environment, northern Latvia. (Eds.) L. Larsson &I. Zagorska. 2006.
53. Arkeologi och identitet. (Eds.) B. Petersson & P. Skoglund. 2008.
54. TOM CARLSSON, Mesolitiska möten. Strandvägen, en senmesolitisk boplats vid Motala ström. 2007.
55. TOM CARLSSON, Where the river bends. Under the boughs of trees. Strandvägen – a late Mesolithic settlement in eastern middle Sweden. 2008.
56. MIKAEL DAHLGREN, Stilla flyter Maas. Senromersk strategi och logistik i den arkeologiska rekonstruktionen. 2008.
57. PÅVEL NICKLASSON, Det lilla landet Vista. 2008.
58. Arkeologi och samhälle. (Eds.) B. Pettersson, K. Jennbert & C. Holtorf. 2009.
59. KRISTINA JENNBERT, Kullabergs grottor. Mellan istid och nutid, mellan humaniora och naturvetenskap. 2009.
60. I tillvarons gränsland. Perspektiv på kroppen mellan liv och död. (Eds.) F. Ekengren & L. Nilsson Stutz. 2009.
61. Från romartida skalpeller till senvikingatida urnesspännen. Nya materialstudier från Uppåkra. (Ed.) Birgitta Hårdh. 2009.
62. Experimental archaeology. Between enlightenment and experience. (Eds.) B. Petersson & L. E. Narmo. 2011.
63. ULLA ISABEL ZAGAL-MACH WOLFE, Grasping technology, assessing craft. Developing a research method for the study of craft-tradition. 2013.
64. Folk, fä och fynd. (Eds.) B. Hårdh & L. Larsson. 2013.
65. Neolithic diversities. Perspectives from a conference in Lund, Sweden. (Eds.) K. Brink, S. Hydén, K. Jennbert, L. Larsson & D. Olausson. 2015.

66. KATARINA BOTWID, The artisanal perspective in action. An archaeology in practice. 2016.
67. BIRGITTA HÅRDH, The Perm'/Glazov rings. Contacts and economy in the Viking Age between Russia and the Baltic Region. 2016.
68. HELENE WILHELMSON, Perspectives from a human-centered archaeology. Iron Age people and society on Öland. 2017.
69. STELLA MACHERIDIS, Waste management, animals and society. A social zooarchaeological study of Bronze Age Asine. 2018.

Studies in Osteology

1. OLA MAGNELL, Tracking wild boar and hunters. Osteology of wild boar in Mesolithic South Scandinavia. 2005.
2. HELENE WILHELMSON, Perspectives from a human-centred archaeology. Iron Age people on Öland. 2017.
3. STELLA MACHERIDIS, Waste management, animals and society. A social zooarchaeological study of Bronze Age Asine. 2018.

Waste management, animals and society

Animal bones are often found as waste-related material in archaeological excavations. This book explores the ways in which archaeological animal bones can be used to discuss cultural implications of waste management. How waste is handled reflects several aspects of society, from socio-spatial organization and normative practices to material classification and perceptions of value and risk. In this book, animal bones found at the Bronze Age settlement Asine, Greece, make up the case study for the application and evaluation of a zooarchaeological waste management perspective, and are thus used to shed new light on the prehistoric society at the site.

Stella Macheridis is a zooarchaeologist interested in the social aspects of human-animal relations. This book is her doctoral thesis in Historical Osteology.

Printed by Media-Tryck, Lund 2018 NORDIC SWAN ECOLABEL 3041 0903

LUND UNIVERSITY

Historical Osteology
Department of Archaeology and Ancient History
ISBN 978-91-88473-61-5
ISSN 0065-0994 (Acta Archaeologica Lundensia Series altera in 8°)
ISSN 1654-2363 (Studies in Osteology)