An Insight into Life at Geometric Zagora

Provided by the Animal Bones

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October, 2012

Abstract

This thesis is a study of the animal bone distribution at the Geometric period settlement of Zagora (ca. 850-700 BC), on the island of Andros. The animal bones were excavated during the 1967-74 University of Sydney excavations and analysed in 1977 by a specialist who compiled a report of her findings. The report is currently in preparation for publication and is the primary source for this thesis. The data it provided was limited but enough could be extracted to identify patterns that permitted a tentative reconstruction of social life and the economy at Zagora.

There is a paucity of excavated settlements from the Greek EIA and few of these have published faunal material, an essential element in reconstructing past lifeways. Those preserved settlements from which animal bones have been published are not extensive with good domestic contexts but usually sites of minimal extent. Hence, it has not been possible to conduct an analysis of the spatial distribution of animal bones from such a settlement. Zagora, being an extensive settlement containing mainly domestic structures, is therefore unique and the animal bone report provided the opportunity for such a study to be undertaken.

A number of analyses were performed using both statistical and non-statistical methods. Through these it was discovered that there is a relationship between the animal size and the size of the architectural unit within which it was found. Similarly, there appeared to be a relationship between larger architecture and the presence of fish, postulated as being a pelagic species. The patterns observed were interpreted as evidence of ‘special’ meals with a larger than usual number of diners in attendance and hence the need for a larger space to host them. Using the animal bones’ distribution and architectural evidence it is proposed that feasting was an important event at Zagora, conducted at the household level to possibly reinforce bonds of kinship and friendship. The evidence also suggests that the H area could have been inhabited by people of better means than elsewhere in the settlement, particularly by the hypaethral sanctuary.

Ideally the animal bones would have been studied in conjunction with associated artefacts, but this was not possible and so this would be something desirable to be performed in the near future. With 21st century excavation techniques, the future Zagora excavations should provide greater granularity in the faunal information obtained from the settlement to allow better precision in subsequent analyses.

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Acknowledgements

I would like to thank my supervisor, Professor Margaret Miller for her guidance, advice and thoughtful supervision, without which my thesis would have certainly veered off course. Thanks also to Dr Lesley Beaumont for starting me off in the right direction whilst Professor Miller was on leave.

I wish to thank the Australian Archaeological Institute at Athens for allowing me to use the unpublished animal bone report and for access to the excavation notebooks from the original Zagora excavations. My thanks for this are especially extended to Beatrice McLoughlin for enduring my endless questions regarding Zagora and for her patience during my data entry of the bone material into Heurist.

A thank you must also go to Dr Katerina Trantalidou who generously provided me with copies of her recent articles.

Finally, I would like to acknowledge my grandparents, Rudolf (Zenzo) and Millie Alagich and Mijo and Elizabeta Kraljičković, for all those memorable conversations I had with them learning about simple life in the old days. It was this accidental ethnography that gave me a real insight into what pre-modern village life was like in southern Europe, and perhaps how it might have been for those generations before them.

Abbreviations

AAIA Australian Archaeological Institute at Athens.

EIA Early Iron Age.

ES Enclosed space. Used to refer to any space enclosed by walls; can be either roofed (such as rooms or shelters) or unroofed (such as courtyards or animal pens).

LBA Late Bronze Age.

MNI Minimum number of individuals.

NISP Number of identified specimens.

Zagora 1 Cambitoglou et al. 1971.

Zagora 2 Cambitoglou et al. 1988.

Zagora 3 Forthcoming and final publication of the original Zagora excavations covering the 1971-1974 seasons.

ZBR Zagora animal bone report; Barnetson (forthcoming).

1. Introduction

> Thus, to obtain a clear picture of Geometric [period] farming, we need an analysis of organic remains from an excavated settlement, inhabited only during our period. Zagora, when fully studied, may produce some evidence of this kind; meanwhile we must be content with the meagre remains of funeral feasts, chiefly from Athenian graves.[1]

Today, three and a half decades after this observation by Nicolas Coldstream was first published, analyses of animal bones from extensive settlements of the Greek EIA are still in short supply. Animal remains are extremely useful for our understanding of ancient societies since they can provide insight into trade, status, ethnicity, economy, social and political conditions, as well as the local environment. This thesis is a study of the animal bone distribution at one of the best-preserved Geometric period settlements, Zagora, on the northern Cycladic island of Andros (figs. 1 and 2; maps 1 and 2). Both the Greek Geometric period and the broader EIA to which it belongs (fig. 3) came to a close around the time that Zagora was abandoned, ca. 700 BC, although the site saw continued activity down until the late 5th century, centred on the Archaic period temple.[2]

Since the beginning of Greek EIA archaeology, the publication of faunal material has been sporadic, with most of the literature appearing in the last three decades. This is a reflection not only of a general disinterest in environmental data, but also a genuine lack of excavated remains from the period.[3] The most notable absence of EIA zooarchaeological material is that from extensive settlements with good domestic contexts, as at Zagora.[4] Composed in 1977, and set for publication in the planned *Zagora 3* volume, the Zagora animal bone report (ZBR)[5] was well ahead of anything else published by that time on Greek EIA settlements. However, due to the haste of its composition, the report contains a number of inconsistencies and a lack of good quantification information, both of which are important when trying to compare data between contexts or conduct statistical analyses. Still, this does not mean that it cannot prove useful.

[1] Coldstream 1979, 312.
[2] Cambitoglou 1981, 20.
[3] Payne 1985a, 211; Reese 1994, 192; Trantalidou 2001, 184; Mylona 2003, 193-5.
[4] That is, ordinary houses.
[5] Barnetson (forthcoming).

1. Introduction

Figure 1 – Map of Greece showing EIA sites referred to in text (source: USGS).

Figure 2 - Island of Andros indicating location of Zagora and Neolithic settlement of Strofilas (source: USGS).

It is important to 'mine' such sources for as much information as possible since the animal bones originally studied may no longer be intact enough and separated by context to allow for a re-analysis. Amorosi et al. offer a suggestion here:

> There is no reason to accept every bone collection as equally valuable, but there is even less reason to assert that sites are inherently incomparable, or that nothing can be done with low-to-medium quality zooarchaeological evidence. Rather than prolonging debates about numbers, we believe that it is time to focus on patterns.[6]

Legacy data may not be comparable between sites in its raw form, but if patterns can be identified then these patterns can be used in a wider context. Patterns identified in the Zagora material can be compared with those from other sites and ethnographic studies in order to better interpret them. Extracting the maximum amount of information is particularly important for a period like the Greek EIA, where there is a dearth of well-excavated or preserved settlements that can provide insight into contemporary society. Therefore, this thesis embarks with the principal aim of identifying patterns in the animal bone distribution at Zagora, in order to help us further understand social and economic aspects of life here.

Period	**Date Range**
Late Bronze Age	1700-1050 BC
Early Iron Age	1050-700 BC
Geometric period	900-700 BC
Archaic period	700-480 BC
Classical period	479-323 BC

Figure 3 - Chronological periods referred to in text (source: Whitley 2001, 60; Dickinson 2006a, 7; Manning 2010, table 2.2).

The primary source material for this study comes from the University of Sydney excavations at Zagora, conducted between 1967 and 1974. This includes data from the unpublished ZBR as well as the *Zagora 1* and *Zagora 2* publications (covering the 1967-69 excavation seasons), the University of Sydney's Heurist application,[7] the Zagora ArcGIS database,[8] and the excavation notebooks and registers kept at the Australian Archaeological Institute at Athens (AAIA). The spatial information provided by the ZBR only indicates whether a species was present in a location and does not include stratigraphic information for all deposits. Some measurements, quantities and reports of butchery marks are provided on an ad-hoc basis and traces of burning are occasionally noted. However, the report does not allow us to assume that where these observations are not mentioned they did not exist. Still, it was hoped that by utilising all of these sources, enough information could be extracted to allow for a satisfactory study.

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[6] Amorosi et al. 1996, 151.
[7] The Heurist application was developed at the Archaeological Computing Laboratory at the University of Sydney and provides a web-based interface into the Zagora database (http://heuristscholar.org).
[8] Created by the *Zagora 3* architect, Matthew McCallum.

1. Introduction

The scope of this thesis is limited to the settlement of Zagora during the Geometric period with the majority of analyses encompassing the domestic complexes only. Evidence from the Geometric period levels below the later temple (H30-31) and the fortification wall (FW6) were used to supplement this (for locations see maps 1 and 2). Although the settlement went through numerous building phases, the architecture at final occupation was used and only those enclosed spaces (ESs) within buildings excavated by the University of Sydney were included.[9] Artefacts were not incorporated into the analyses because the Heurist database was not yet populated with artefacts from the 1970s excavation seasons and only a partial picture was available. This study is thus limited to animal bones and architecture.

To begin with, this thesis will present an overview of animal bone studies from Greece, with particular focus on the EIA, showing how the animal remains from Zagora fit into the bigger picture. The analysis of the Zagora data will first proceed as objectively and with as little bias as possible in order to extract patterns from the evidence. Based upon these identified patterns, tentative propositions regarding the social and economic makeup of Zagora will be made. Such a study is necessary, even with the limited evidence available, because this is the only spatially significant settlement of the period and therefore cannot be neglected.

[9] The data from the excavations in 1960 conducted by Nicolas Zapheiropoulos were not included in this study.

2. Literature review

2.1 Introduction

The first major synthesis of the Greek EIA was published by Snodgrass in 1971, followed closely by those of Desborough (1972) and Coldstream (1977) who specifically dealt with the Geometric period.[10] The main focus of these studies was the pottery, which is a good tool for organising chronology and examining exchange, and particularly useful at a time when few EIA settlements had been excavated. Even the latest work on the period by Dickinson (2006) finds gaps in settlement evidence and the agricultural economy.[11] Certainly, were any zooarchaeological publications from EIA settlements available to the scholars in the 1970s, they would have been incorporated into their studies. Although the recovery and study of animal remains from Greece and the Aegean dates back to the late 19th century (AD), the discipline is still in its infancy.

Until only recently, the recovery of animal remains from Greek archaeological sites tended to focus on the prehistoric periods for which it is an essential illuminator.[12] The study of such remains not only informs us of past diets (obviously), but it can also reveal other aspects such as the type of animal husbandry employed, local environmental conditions, social issues, trade and ethnicity.[13] By analysing the bones and teeth from animals, zooarchaeologists can not only identify butchery or gnaw marks but also the sex, age and weight bearing damage the animal withstood, to assist in determining past herding practices.[14] The kind of primary information recorded and analysis performed tends to vary depending on the zooarchaeologist undertaking the work, and so we cannot expect to approach a problem in the same way when using reports produced by different people.[15]

Animal bones from ancient Greece have traditionally been studied in isolation of their archaeological context, even though they are crucial to building its picture. The paucity of

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[10] Snodgrass 1971; Desborough 1972; Coldstream 1979 [paperback edition published two years later].
[11] Dickinson 2006a, 6.
[12] Only recently have archaeologists started realising that this is also the case for historical periods as well; Payne 1985a, 211; Jones O'Day et al. 2004; Landon 2005, 20, 24.
[13] Amongst other things; Crabtree 1990, 156; Hamilakis 2000, 60; Vaughan 2000, 2; deFrance 2009, 106, 120; Russell 2012.
[14] Whether animals were kept for primary products such as meat, bone or leather, or for their secondary products such as milk, wool or plough traction (Payne 1973).
[15] Payne 1985a, 214. An interesting study has shown how three analysts produced three quite different results when independently interpreting legacy zooarchaeological data (Atici et al. 2012).

excavations from well-preserved Greek EIA settlements has limited the faunal data that we have from the period. It is largely due to this that there has not yet been a study of the spatial distribution of animal remains from an extensive contemporary settlement with good domestic contexts. The evidence thus far from EIA Greece is limited to cult sites such as Eretria, mixed industrial/domestic/ritual areas as at Oropos, or a settlement of limited extent as at Kavousi Kastro. The unpublished ZBR from the Zagora excavations is restrictive in the kind of information that it provides, but it can still be mined for useful data with which we can conduct a satisfactory study to establish the role that animals played in this Geometric period settlement.

2.2 Reconstruction of EIA life

Zooarchaeology plays an important role in our reconstruction of the ancient world, not least because "the arrangements by which different human cultures provided themselves with food are one of the most fundamental factors that determined what those cultures were like".[16] It is unsurprising then that animal remains have been used to try and better understand early Greek life. Even during the period when little information on animal remains was revealed by excavation, attempts were made at synthesising what was available. Kenton Vickery's 1936 book *Food in Early Greece*, attempts to reconstruct the prehistoric Greek diet using the handful of zooarchaeological publications available at the time and was the first integrated approach to the study of palaeodiet in Greece.[17] Apart from the works he was able to draw upon, Vickery also incorporated iconographic evidence of various animals from Bronze Age Crete as well as evidence from early historic texts, mainly Homer.[18] Forty years later, Coldstream still needed to resort to similar means, revealing the subsistence of Geometric period Greeks using iconography, literature and the minimal publications of environmental remains he could draw upon.[19]

The archaeological 'invisibility' of the Greek EIA was explained by some as being a side effect of a pastoral existence and for which the publication in 1978 of the animal bone study from Nichoria introduced new evidence.[20] In his 1987 work, *An Archaeology of*

[16] Rowly-Conwy 2008, 291.
[17] Vickery 1936; Sarpaki 2000.
[18] For example, to use as evidence for the domestication of certain species (Vickery 1936, 62-3). This was prior to the decipherment of the Bronze Age Linear B script.
[19] Coldstream 1979, 312-4.
[20] Sloan and Duncan 1978; Dickinson 2006a, 98-9.

Greece, Snodgrass draws upon the faunal evidence from Nichoria, along with botanical and archaeological remains from other parts of Greece, to conclude that during this period the Greeks moved away from an agricultural life typical of the LBA, to become predominantly pastoralist.[21] Ian Morris suggests that the propensity of beef consumption at Nichoria and at Tiryns during the earliest part of the EIA could indicate lower population stress on the surrounding hinterland. He believes a later increase in population necessitated a move towards less resource intensive stock such as ovicaprids (sheep and goats).[22] However, using the evidence from Nichoria has its drawbacks.[23]

In addition to the Nichoria data, Snodgrass cited a change in the abundance of botanical remains at Iolkos in Thessaly to back his argument. He suggested that the quantity of pulse seeds on a floor here from the Protogeometric period could have been animal fodder from a mainly pastoralist society, while the predominantly grain covered floor of the ensuing Geometric period was evidence of a move towards crop agriculture.[24] However, pulses are also human food as well as being a source of protein and we need to be careful drawing conclusions based on relative abundances because of the differential and usually poor preservation of botanical remains.[25] More recently, the concept of a primarily pastoralist society in the Greek EIA has been largely rejected.[26] Rather, it is believed that cereal crops still formed the basis of agriculture during the EIA. Only those farming practices that required large-scale labour input or palatial organisation declined or disappeared from the preceding LBA, and some form of mixed farming was probably the norm.[27]

All of these economic reconstructions of EIA society are based mainly on the limited zooarchaeological evidence available from settlements.[28] The data from individual sites across Greece is compared to try to find patterns in animal husbandry practices that will answer broader regional questions. Given that the various regions in Greece during the EIA developed individualistically,[29] this will probably be a difficult measure to achieve. Instead, it

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[21] Snodgrass 1987.
[22] Morris 2004, 719.
[23] That is, the small sample size used. Dickinson (2006a, 6) also raises the good point of the tendency for scholars to base "very important and wide-ranging conclusions" on the limited evidence we have, in reference to Nichoria.
[24] Snodgrass 1987, 204-5.
[25] VanDerwarker and Peres 2010, 3-6.
[26] Lemos 2002, 196-7; Dickinson 2006a, 102-3.
[27] Foxhall 1995, 243-4, 248; Dickinson 2006a, 102; 2006b, 118.
[28] Dickinson 2006a, 102.
[29] Such as with respect to pottery styles (Coldstream 1968, 336-41), burials (Snodgrass 1971, 177-97), and architecture - compare the fieldstone houses at Karphi on Crete with those of mud brick and wattle and daub at

makes more sense that the model of animal husbandry and agriculture practiced in the various regions was that which best suited their local environmental and climatic conditions.[30] Furthermore, any search for patterns would have a sounder basis if they were conducted internal to each settlement and that such *patterns* were then compared more broadly. Unfortunately, the lack of well-excavated EIA settlements with published faunal remains has limited such studies to allow a comparison. The kind of zooarchaeological data that was produced varied considerably and depended to an extent on when it was published. The publications can be said to belong to one or more of four phases: descriptive, analytical, enhanced retrieval and full integration.

2.3 Zooarchaeology's descriptive phase

The earliest phase of zooarchaeology generally produced simple descriptions of the recovered animal bones that were of interest to zoologists only so far as they could track the evolution and distribution of different species.[31] This is evident in most of the early publications on material from Greece and the Aegean, starting with the first conducted by a specialist on the animal remains recovered by Schliemann at Troy.[32] Not long after this, William Boyd-Dawkins published the earliest material from the Greek EIA in 1902 on bones from the Dictaean Cave on Crete.[33] In his study, he identified cattle, goat, sheep, fallow deer and pig from amongst the fragments belonging to the EIA levels.[34] His identification included both those remains in "perfect condition", that were believed to be sacred offerings, as well as the "food refuse" that was in a poorer state of preservation.[35] More importantly, he

Nichoria (Pendlebury et al. 1938, 66-7; Coulson 1983, 31, 38-40). This individualism does not mean that they were isolated since there is good evidence for contact with regions both within and outside of Greece (Whitley 1991, 365).

[30] As is argued by Howe (2008, 126-7).

[31] Payne 1972b, 65.

[32] Schliemann 1880; Reese 1994, 191. In a later publication Rudolf Virchow (1884, 348-50), when looking at the bones from the oldest levels, determined that they were broken intentionally so that they could fit into the cooking pot. More recently, a similar conclusion was drawn at EIA Kavousi on Crete (Snyder and Klippel 2000, 65). At Troy cattle bones were found to be the most numerous followed by ovicaprid and pig - not an unexpected result from an assemblage that was hand collected and not sieved (see Payne 1972a).

[33] Boyd-Dawkins 1902. This also happens to be the first publication by a zoologist on Greek material from any period (Reese 1994, 191).

[34] Boyd-Dawkins (1902, 165) identified the bones as belonging to the upper stratum of the cave which were identified by Hogarth (1900, 97-8) as belonging to the Geometric period.

[35] Boyd-Dawkins 1902, 162, 165.

recorded the measurements of some of the bones, a practice that would prove standard later in some schools of zooarchaeology.[36]

Many of the early zooarchaeological analyses, however, were conducted by non-specialists.[37] One of these was the late 1930s excavation of EIA Karphi on Crete where bones are barely mentioned, and where they are it is largely limited to artefacts.[38] The only references to non-artefactual animal remains are boars' tusks, shells from invertebrates, and cattle, goat and deer horns. No attempt at analysis was done short of providing lengths for a couple of the specimens and noting any human modifications such as drilled holes.[39] Similarly, at the Temple of Apollo at Dreros, little attention was paid to the animal remains, with goats, cattle, sheep and pigs being identified, and horns and teeth being the only anatomical parts mentioned.[40]

2.4 Zooarchaeology's analytical phase

In measuring the bones from the Dictaean Cave, Boyd-Dawkins revealed early glimpses of an analytical approach to animal bone studies in Greece where scholars moved beyond simple species identification. Prior to the 1970s, animal and plant remains were treated merely as a food source in the static sense, when new questions started to be asked by processual archaeology in order to establish the relationship between animal bones and humans.[41] In 1973 the first detailed analysis of faunal remains from EIA Greece, from the Sanctuary of Demeter at Knossos, was published.[42] The work, by Michael Jarman, undertook a diachronic study of the bones and discovered that the Geometric period levels had fewer pigs and more ovicaprids than the later Archaic levels. This indicated to Jarman that the earlier sanctuary was dedicated to a different deity, that it was not a sanctuary during the Geometric period, or that the offerings to Demeter were different then.[43] This work signalled

[36] Particularly the central Europeans (Albarella 2002, 51).
[37] Reitz and Wing 2008, 17.
[38] Pendlebury et al. 1938.
[39] Pendlebury et al. 1938, 71, 78, 133-4.
[40] Marinatos 1936. With regards to the goat horns, specific reference is made to those belonging to kids (Marinatos 1936, 242-4).
[41] Payne 1972b, 65; Amorosi et al. 1996, 135-6; Hamilakis 2000, 60; Russell 2012, 6.
[42] Jarman 1973.
[43] Although the EIA samples are restricted to the sanctuary, evidence from the periods before and after strongly suggests this (Jarman 1973, 177). However, we need to treat such findings with caution since the sample size of 20 specimens is small (Jarman 1973, 177-9). Nevertheless, we should be open to the possibility of cult continuity here since an early Archaic inscription from Gortyn on Crete records the sacrifice of sheep to Demeter, not just the 'standard' pigs (Coldstream and Higgins 1973, 182, n. 2).

the beginning of a detailed analytical approach to zooarchaeological remains in EIA Greece, although the depth and focus of the work differed depending on the analyst.

By studying the pattern of bone breakages, butchery marks, and gnaw marks from carnivores, insights can be made into the life cycle of the animal carcass and the products derived from it. Walter Klippel and Lynn Snyder noticed the pattern in the breakages of the bones with higher fat content at Kavousi Kastro on Crete was typical of bones broken when they are 'green' or fresh. They determined that the residents likely broke the bones intentionally so that the marrow would be extracted during cooking in a process referred to as "pot-sizing".[44] At Minoa on the island of Amorgos, the Late Geometric cultic building Edifice K contained bones with "pit-like" fractures that indicated they were left unburied for some time after disposal.[45] Similar conditions were reported for the faunal remains at Geometric period Asine, where the bones had evidence of gnawing and bad weathering due to being left exposed on the surface for some time before burial.[46] The Asine bones also showed evidence of processing by humans because of the splintering, cut marks and traces of burning.[47]

The 'age at slaughter' pattern of an assemblage allows zooarchaeologists to determine the type of economy practiced by a past society.[48] The ages at death of the animals from Kavousi Kastro suggested that the animal husbandry practiced here in the EIA was mixed but dominated by ovicaprids, which were kept mainly for meat. This was a move away from the earlier palace-centred wool economy documented in the Linear B palace archives.[49] The opposite was found at Assiros Toumba in northern Greece where cattle dominated the assemblage during the Bronze Age and sheep dominated the subsequent period, probably heralding a move toward a greater emphasis on wool production.[50]

The study of the animal bones from Nichoria combined minimum number of individual (MNI) counts and animal ages to examine diachronic change through the 1,300 years of continuous occupation of the site from the Bronze Age through to the end of the

[44] Klippel and Snyder 1991, 183. Those bones with lower fat content, such as of young animals, were not broken in this manner.
[45] Trantalidou 2012, 1062.
[46] Moberg 1992.
[47] Moberg 1992, 66.
[48] With the idea being that animals were killed at different ages in different exploitation strategies. For details on this method, see section on animal slaughter patterns and the economy, page 39.
[49] Klippel and Snyder 1991, 185-6.
[50] Halstead and Jones 1980, 266.

Dark Age III period (ca. 775 BC). The results showed that the economy went from a mainly milk producing one in the Bronze Age, exploiting both ovicaprids and cattle, through to a primarily beef raising economy where cattle numbers increased over ovicaprids.[51] However, the results from here have been seen as a point of contention,[52] and notable is the small sample of teeth whose ages were used to determine the type of economy practiced.[53]

One of the focuses of zooarchaeology in the EIA has been the analysis of the distribution of different animal body parts, particularly in relation to cult. Paul Halstead and Glynis Jones, working on the animal bones from the remains of funerary offerings on Thassos, found that cattle bones were mostly restricted to the right femur. This suggested to them that this part of the animal was a standard grave offering here, showing glimpses of both Greek and Near Eastern cult practice.[54]

The femur and the tailbone are attested in ancient Greek textual sources and iconography as being the portions of the sacrificial victim offered to the gods.[55] It was these two body parts that comprised the vast majority of charred animal remains excavated from the Geometric period altar at the Temple of Apollo Daphnephoros at Eretria, with the femurs exhibiting cut marks synonymous with them being carefully extracted.[56] This study not only confirmed the ancient sources with respect to the gods' portions, but also those allocated to humans by the conspicuous absence of femurs and tailbones in areas of human dining refuse.[57] Similarly at Minoa, burnt femurs were found amongst sacrificial offerings to the local hero or chthonic deity believed worshipped here.[58] Oddly, however, a similar study undertaken by Emmanuelle Vila on the animal remains from the contemporary Temple of Athena Alea at Tegea found the femurs and tailbones to be completely absent. Vila believed that as there was limited evidence here of scavenging animals, the bones from the missing body parts could have suffered destruction beyond recognition in the intense burning.[59] Some sites, such as Xobourgo on Tenos, show evidence for secular activities as well as cult. By

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[51] Sloan and Duncan 1978.
[52] Dickinson 2006a, 99-101.
[53] Foxhall 1995, 245. Only eight specimens were used to determine the economy practiced for the Dark Ages III period (850-775 BC) out of a total of 72 for the entire 1,300 years of continuous occupation dating back to the Middle Helladic period (Sloan and Duncan 1978, 66-7, fig. 6.2).
[54] Halstead and Jones 1992, 753.
[55] For example, Hom. *Il* I.460–4; *Od.* IX.551–5; Ar. *Peace* 1053-5. Examples of iconographic evidence from Greek figured pottery can be seen in Forstenpointner (2003, figs. 21.6c, 21.7b).
[56] Chenal-Velarde 2001, 32; Chenal-Velarde and Studer 2003, 216, 219.
[57] Chenal-Velarde and Studer 2003, 217-9.
[58] Trantalidou 2012, 1060-2.
[59] Vila 2000, 198-201.

focusing on the type of bones absent from skeletons in the assemblage and the condition and spatial distribution of those present, Katerina Trantalidou was able to establish the presence of a bone working area here.[60]

As useful as all of these studies are to our reconstruction and understanding of EIA society, they tend to focus on extraordinary loci such as temples and cemeteries that certainly do not reflect daily life. Thus, reconstructing diet and animal husbandry practices using animal remains from such sites would give us a skewed version of daily reality, since they reflect temple, not domestic, consumption practices.

2.5 Zooarchaeology's enhanced retrieval phase

Up until the Franchthi Cave excavations in the late 1960s, specialists such as zooarchaeologists and palaeoethnobotanists were usually only called upon after the excavations had finished, when they were provided with bags of material to analyse out of context.[61] Even into the 1990s, much research was still not being integrated with specialists throughout the entire lifecycle of the project.[62] Today this is happening less frequently with zooarchaeologists studying animal remains within their archaeological contexts and focusing scholarship on the reconstruction of the palaeoenvironment and of everyday life, including the political, social and economic spheres.[63]

Zooarchaeological remains have been widely neglected by classical archaeology not only in its early years, but also in more recent times.[64] It was due to the archaeology of the pre- and proto-historic periods and their introduction of systematic sieving to Greece that we have seen an interest in the recovery of palaeoenvironmental remains from later periods

[60] Trantalidou 2012, 1064-6.
[61] Sarpaki 2000, 116.
[62] Sarpaki 2000, 116.
[63] Trantalidou 2001, 195; Kotjabopoulou and Gamble 2003, 111; deFrance 2009, 120; Russell 2012. It is now compulsory for applications for funding from INSTAP (one of the largest funding bodies for research on the prehistoric Aegean) to have plans for the sampling and retrieval of zooarchaeological remains (Halstead 2003, 249).
[64] Trantalidou 2001, 187; Theodoropoulou 2007, 427; Payne 1985a, 211. This is largely due to the history of the discipline of 'classical archaeology', dating back to the 18th century, where contextual information was not as important as the recovery of ancient Greek art and architecture in the pursuit of the source of "European excellence" (Fowler and Wheeler 1909, 11; Trigger 2006, 53-5; 60-1; Morris 2008, 258). The reason this continued for so long was partly because of the abundance of textual sources and inscriptions available to scholars providing economic and dietary information (Payne 1985a, 211; Halstead 2003, 249), and partly no doubt because of the priorities of those funding the excavations. James Whitley (2001, 42) places the appearance of a 'modern' archaeology of Greece in 1977 when Anthony Snodgrass published a work influenced by David Clarke and processual archaeology (Snodgrass 1977).

develop.[65] It is apparent that recovering such material by hand in the trench is not the most efficient and only by sieving soil are we able to get a representative sample of what was buried.[66] The fact that the earlier excavations (and even many recent ones[67]) neglected to sieve, means that it is important to note the recovery methods used when comparing material between different sites or when trying to integrate legacy data.[68]

2.6 Zooarchaeology's full integration phase

From the 1970s until the present day, the focus of the study of EIA animal remains has been varied but includes at least taxonomic identification and some form of quantification (usually either number of identified specimens (NISP) or MNI). Most studies also provide a breakdown of the body parts present and occasionally bone measurements, their condition (including burning, cut and gnaw marks), their weight and animal age at death.[69] However, the study of animal remains in general tended to still be relegated to either an appendix of the excavation report or a separate stand-alone publication, although the trend is changing.[70]

One of the model sites for this change in Greek EIA zooarchaeology, where the approach taken included integrating palaeoenvironmental data into the archaeological

[65] Animal remains are the second most commonly recovered class of archaeological material (behind pottery) from prehistoric farming settlements (Marciniak 2005, 1). Prior to the 1960s, excavations in Greece rarely sieved and it was not until the Franchthi Cave excavations in the late 1960s that systematic sieving was introduced to Greece (Payne 1985a, 220; Diamant 1979, 206). Not only dry sieving, but also water sieving and flotation were introduced at this time (Sarpaki 2000, 115).

[66] Larger animals such as cattle are overrepresented in hand sorted assemblages. Experiments have shown that sieving results in a doubling of the fragments of smaller species such as sheep, goat and pig and only a smaller increase in cattle (Payne 1972a, 59-61; Snyder and Klippel 2000, 69-70). With even smaller animals and fragile remains such as crabs and sea urchins, they are only ever recovered with sieving (Snyder and Klippel 2000, 78). Other important factors include environmental conditions and personnel, whether dry sieving or water sieving was conducted, and the size of screen used in the sieve (Payne 1972a, 49, Payne 1975, 16, fig. 8). Dry sieving is not very effective in retrieving small specimens that can be encased in clumps of soil, and which are broken up when water sieving (Hesse and Wapnish 1985, 57).

[67] Sarpaki 2000, 115-6. Some excavations only partially sieved soil, such as at EIA Assiros Toumba in northern Greece where most finds were hand retrieved (Halstead and Jones 1980, 265).

[68] Amorosi et al. 1996, 130. One thing to keep in mind when working with legacy data is that the recovery methods are rarely mentioned in publications prior to the introduction of systematic sieving (Payne 1972a, 63).

[69] For example: Jarman (1973) in a preliminary report lists NISP counts only; Halstead and Jones (1992) provide animal age at death and list parts of the skeleton present; Moberg (1992) provides a breakdown of species per period, indications of cut marks, gnawing and burning, some age estimates (young/old) and measurements of bones that were intact enough; Vila (2000) gives animal ages at death, distribution of different body parts, and indications of gnaw marks and burning; Snyder and Klippel (2000) provide NISP counts, perform a diachronic comparison of subsistence, provide evidence of cut and gnaw marks as well as breakage patterns and burning; Chenal-Velarde (2001; 2007) provides NISP counts, age at death, evidence of cut marks and burning, and body part distribution; Trantalidou (2007; 2012) gives NISP, bone weight, age at death, distribution of the different body parts, plus evidence of cut and gnaw marks, and burning.

[70] Nevertheless, such practice is still visible even in recent times (Payne 1985a, 211; Trantalidou 2001, 192; Halstead 2003, 249).

research plan, is Azoria on Crete under the direction of Donald Haggis.[71] Although the site's occupation spanned the entire EIA and the period is well represented, a major rebuilding phase during the Archaic period destroyed many of the earlier buildings and caused much disturbance to the stratigraphy.[72] Due to the need to preserve Archaic period structures, it has not been possible to reconstruct complete plans where EIA buildings have survived, thereby rendering a detailed spatial analysis near impossible.[73] An eagerly awaited forthcoming excavation report including information on EIA levels excavated during the 2005-6 season, is sure to produce some good data on the faunal remains given the project's integrated approach.[74]

2.7 Zooarchaeology at Zagora

The Geometric period settlement of Zagora was occupied between ca. 850-700 BC. After the town was abandoned, a temple was constructed on the site during the Archaic period that continued in use until the late 5th century BC.[75] The site of Zagora was first excavated by Nicolas Zapheiropoulos in 1960 and then by the University of Sydney under Alexander Cambitoglou in four seasons between 1967 and 1974. Additionally, four study seasons were carried out by the Sydney team between 1968 and 1977. The results were published in two volumes, *Zagora 1* and *Zagora 2,* in 1971 and 1988 respectively. A further volume covering the work from the 1970's, *Zagora 3*, is in the latter stages of preparation for publication. What makes the Sydney excavations impressive from a zooarchaeological perspective is that they sieved all excavated soil at a time when systematic sieving had only just been introduced to Greece.[76] Since all soil was sieved, we would not expect the bones from larger animals to have been overrepresented.[77]

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[71] Haggis et al. 2004; 2007; 2011a; 2011b.
[72] Haggis et al. 2004, 390; Haggis et al. 2007, 697.
[73] Haggis et al. 2007, 696-701.
[74] Haggis et al. (forthcoming).
[75] Cambitoglou 1981, 20; *Zagora 2*, 267.
[76] *Zagora 1*, 37; Diamant 1979, 206; Payne 1985a, 220. I have had difficulty in finding out the mesh size used in the excavations. The size can have a significant bearing on the kind of material recovered, and therefore an insight into the type and quantity of animal remains that were potentially missed. For example, an experiment showed that sieving the same deposit using a $^{1}/_{8}$ inch (3 mm) mesh resulted in over 53 times more animal remains than when it passed through a ¼ inch (6.35 mm) one (Peres 2010, 23). Another experiment demonstrated that 74-100% of bone fragments from mammals with a body weight of less than 100g were lost through a ¼ inch sieve, while the loss from a $^{1}/_{8}$ inch one ranged from 0-91%, depending on the deposit (Lyman 2005, 849).
[77] Although this is highly dependent on a number of factors including the size of the sieve mesh and consistency of the soil (Payne 1972a; Payne 1985a, 223; Snyder and Klippel 2000, 69-70).

2.7 Zooarchaeology at Zagora

A report on the recovered animal bones was prepared by Lin Barnetson of the University of Edinburgh during a short two-week period in the final study season in 1977, and will be published in *Zagora 3*. Although the report was quite thorough by contemporary Greek EIA standards, it lacked consistent recording of quantification and stratigraphic information.[78] The recovered species documented by Barnetson include sheep, goat, cattle, pig, fish, hare, canid, equid and rat. Two bird bones were found in the topsoil but were treated as more recent intrusions.[79] It should be noted that the bone remains from the Archaic period temple were unusual when compared to the Geometric period settlement in both the absence of cattle and the large volume of identified specimens found here.[80]

Barnetson's report on the vertebrate remains found at Zagora comprises six sections. The first introduces the study, outlining the methods used and limitations encountered with the material. The second is a table listing the deposits with the species present. Since not all deposits in which bones were recovered are listed in the report, it must contain only those with fragments that were assigned to species. Some deposits provide the precise excavation unit in which the bones were found, while others only provide the ES or excavation grid square. Since there are a number of specimens without a stratigraphic location, it makes it difficult to study changes through time or even compare contemporaneous samples across the site.[81] The report did not distinguish between sheep and goat due to the "weathered" state of the bones and limited time allocated to the study and so they were grouped together as ovicaprids; that sheep and goat were both present is indicated by the identification of their horn cores.[82] The third section lists the animal ages at death based on tooth eruption data from ovicaprid and pig mandibles using Ian Silver's ageing tables.[83] In the fourth section are listed various bones and their measurements along with the deposit from which they were excavated. The fifth section provides a summary of the animal bone distribution including limited fragment counts and the condition in which some of the bones were found. The sixth and final section has concluding remarks.

[78] For example, NISP counts per species were only given for Room D8, the temple H30-31, and a fortification wall deposit (FW).
[79] ZBR, 24.
[80] ZBR, 19-20. Out of the 274 identifiable fragments recovered from the temple's cella, only one was confirmed to be from cattle, in a pre-temple Geometric period level.
[81] For example, all bone found within ESs in B, D and F blocks do not have stratigraphic location specified.
[82] ZBR, 3.
[83] Silver 1969; ZBR, 2-3.

Overall, whilst the ZBR was advanced in what it provided for Greek EIA settlements published prior to its composition in 1977, it lacks consistent recording and details that can be found in works published earlier, particularly on material from the Greek Neolithic period.[84] However, this is a reflection of the short amount of time allocated to the study and therefore its hasty preparation rather than anything else.

2.8 Spatial analyses in zooarchaeology

The spatial analysis of animal bones in conjunction with other finds and architecture has the potential to uncover numerous patterns including various household activities. Cornelia Becker has demonstrated this working with three houses and both quantitative and qualitative animal bone data at LBA Kastanas in Macedonia.[85] In his spatial analysis of Building Complex I-O-N at EIA Kavousi Vronda, Kevin Glowacki used precise find spots of objects within rooms to identify household activities.[86] Even without quantitative data or precise find spots it is possible to undertake a successful spatial study of animal remains, particularly on a larger scale such as at the settlement or regional level.[87]

An analysis of the spatial distribution of animal bones has not yet been conducted on an extensive settlement site of the Greek EIA containing good domestic contexts. This is most likely due to there being limited preservation and excavation of such sites, precluding the recovery of faunal material to analyse.[88] Notable settlements from the EIA from which animal bones have been published include: Oropos and Nichoria on the mainland; Kavousi Kastro, Kavousi Vronda and Azoria on Crete; and Assiros Toumba and Kastanas in Macedonia. Yet, hardly any of these excavations included an analysis of the spatial distribution of the recovered bones. The animal bones from Kavousi Vronda were all badly eroded making identification of species difficult.[89] The nearby Kavousi Kastro, on the other hand, produced bones of better preservation although no spatial analysis was conducted and instead a diachronic comparison over the village's 500-year life was made.[90] Azoria and Assiros Toumba have not yet produced a full publication of the animal bones found, while

[84] For example, Jarman and Jarman (1968).
[85] Becker 1998.
[86] Glowacki 2004.
[87] Grayson 1982; Wilson 1996.
[88] This is particularly so on the mainland and the Anatolian coast where houses tended to be constructed from perishable materials (Akurgal 1962, 369; Coldstream 1979, 19-21, 50; Foxhall 1995, 245; Dickinson 2006a, 94-6).
[89] Klippel and Snyder 1991, 179-82.
[90] Snyder and Klippel 2000.

the latter along with Nichoria are best described as hamlets too small to establish wider spatial patterning across house clusters.[91] The excavated area of Kastanas is also of small extent with only 12-60% of the ca. 9,600 m^2 settlement revealed and like Kastro, a large diachronic study of the 13m of occupation levels, covering 2,200 years, was conducted.[92]

The examination of the spatial distribution of animal bones at Oropos by Trantalidou is the closest such work, although the site included areas of a liminal nature combining residential, industrial and sacred roles and can therefore not be considered in the same light.[93] The Oropos study provides a spatial breakdown of the relative frequency of the different species found at the site along with suggested final uses for the fragments based on building functions.[94] A similar study, also by Trantalidou, was conducted more recently at the cultic site of Minoa where the spatial distribution of animal remains was examined.[95] The focus was on identifying the condition of the different bones of the various species and a comparative study was undertaken of other sites, to determine the kind of cult practice that took place here.

The examination of animal bone distributions can take place both vertically and horizontally, and the former is what we tend to get with intrasite archaeological analyses.[96] This is particularly so for the EIA where there is a lack of excavations of extensive settlements that are well preserved. Those that are, such as Karphi on Crete, were early excavations whose faunal remains suffered from neglect. Zagora is in a unique position here because it is itself a well-preserved settlement and its soil was systematically sieved producing the animal bones that are the subject of this thesis.

2.9 Overview

The scholarship on Greek EIA animal bones usually includes a wide variety of information such as species and body part identification, measurements, specimen counts, identification of butchery and gnaw marks, the level of burning, and estimating the age of the

[91] Sloan and Duncan 1978; Halstead and Jones 1980, 265-6; Haggis et al. (forthcoming). For Assiros Toumba, Halstead and Jones (1980, 266) make brief mention of the greater spatial distribution of cattle bones compared to ovicaprids and pigs that they put down to being the greater amount of bone discard from the larger animal.
[92] Becker 1986, 13, 293-5.
[93] However, it is believed that the bulk of the animal bones were food scraps from the houses (Trantalidou 2007, 386-7).
[94] Such as daily food refuse being used as fuel (Trantalidou 2007, 386-7, fig. 2).
[95] Trantalidou 2012 1059-63.
[96] Ault and Nevett 1999, 51-2.

individual at death. These all provide useful information for a particular locus in time and space, but used alone rarely contribute to our understanding of society at large. To compensate for this, scholars conduct both diachronic and spatial analyses to locate patterns in the animal bone distributions that may glean information of greater value. Changes through time can indicate a variety of underlying environmental, social, political and economic factors while synchronic spatial analyses can provide information on things such as difference in status, ethnicity and space function.[97] Both diachronic and synchronic analyses have been conducted at Greek EIA cultic sites, whilst only the former has been performed within contemporary domestic contexts; a spatial analysis has yet to be conducted on animal bones in ordinary domestic dwellings of significant scale.

Unfortunately, at Zagora we lack the stratigraphic location for enough bones to be able to make diachronic comparisons. Moreover, we do not have good quantification data typically produced in other publications that would allow us to study the relative abundances across the settlement.[98] What the ZBR does provide are present/absent indicators for the different species and their spatial location down to the ES or excavation grid square. This permits a study of the patterning produced to allow one to gauge whether there are any unique roles for the different locations or bone types, along with any social distinction amongst its inhabitants. Such a study is yet to be performed on a well-preserved settlement from the Greek EIA. Even with the limited data, it is hoped that by using animal bones alone a successful reconstruction of the economy and diet of a Geometric period settlement can be made, without being obliged to rely upon literature and iconography like Coldstream.

[97] These can also be combined to study changes in space throughout time as Marín Arroyo (2009) has done with the animal remains from the El Mirón Cave in Spain.
[98] The quantification data we do have is scattered and a specific breakdown per species is only provided for three deposits. This is certainly not adequate to incorporate into an analysis of spatial distribution.

3. Methodology

3.1 Introduction

A number of methods were incorporated in order to analyse the animal bone distribution at Zagora. The various analytical approaches that were used included both spatial and aspatial statistical analyses, visual observations of patterning, and modelling of the economy based on animal ages at death. In order to limit errors, the statistical analyses required the careful collection of information from the legacy ZBR and the excavation notebooks and registers from the 1967-74 seasons. All of the data and calculations are reproduced in detail in appendices 2-5.

Where relevant, the results of statistical tests were followed up with non-statistical methods such as analysing trends in the architecture associated with the bone finds. Wheatley and Gillings rightly suggest that spatial statistical analyses alone should not be seen as a way to solve archaeological problems, but rather to complement and assist the human interpretations of them by providing objective evidence and guidance.[99] A number of assumptions needed to be made to account for the data being limited in places. These are specified here as well as the logic behind them.

3.2 Data collection

This study's primary data comes from several sources. The most important is the ZBR written by Lin Barnetson in 1977 and which is to be published in *Zagora 3*. The excavation reports from the 1967 and 1969 seasons, *Zagora 1* and *Zagora 2* respectively, provided some of the information on architecture and dating. For those deposits excavated after 1969, which will be published as part of *Zagora 3*, the University of Sydney's Heurist application and the excavation notebooks and registers kept at the AAIA were used. Spatial information pertaining to architecture was obtained from the ArcGIS layer package created by Matthew McCallum, the *Zagora 3* architect, and dated January 2012. In all cases where further details were required or where existing information needed verification, the excavation notebooks and registers were referenced.

[99] Wheatley and Gillings 2002, 125.

3.2 Data Collection

The only locations referred to in the ZBR were those containing fragments of bone identified to species. The excavation notebooks and registers were used to determine which deposits contained only unidentified fragments of bone (map 12). It was discovered that some registers listed excavation grid squares and not ESs and it could not be determined in all instances whether a bone fragment came from within an ES or not. In such cases, an excavation square was considered an ES if more than 50% of that square sat within the bounds of the ES. This is not ideal but it was felt that this would be more appropriate than to exclude these ESs in the analyses.

A similar situation was discovered in the ZBR. Within the ZBR four excavation grid squares, spanning rooms F1 and F2, were reported to contain animal bones identified to species. These squares (F1055, F1060, F1555 and F1560) covered areas not only within the rooms but also outside and two of them (F1055 and F1555) crossed both rooms. Since the rooms were neighbours, were almost identically sized and the squares contained animal bones identified to species, it was thought imperative to include them in the analyses. As such, it was decided that the room whose surface area took up a greater portion of an excavation grid square would be assigned that square. Therefore, F1055 and F1555 were assigned to F2 and F1060 and F1560 were assigned to F1.

Since many ESs were only partially excavated, a guideline was needed to determine which of these to include in the study in order to reduce as much bias as possible. It was decided that the only ESs to include were those where it is obvious that at least 75% of their walls had been exposed and at least 50% of their floor area cleared down past the latest occupation level. We cannot establish this by simply looking at a plan of the site since many ESs were cleared so that their extents could be traced and therefore only their upper walls were revealed. To obtain this information the excavation publications and excavators' notebooks were used in addition to the site plans. The reason why 75% was chosen is that we cannot be certain whether an excavated segment of wall actually belonged to an ES or not unless a good deal of that ES was excavated. For floor area clearance, over 50% was deemed sufficient; 100% would not have been possible in many ESs since the excavators left baulks running across them. The 47 ESs incorporated into this study are shown in map 3. Those ESs or excavation grid squares excluded from the statistical analyses were still considered separately since their context could provide supplementary information even though the evidence from them may be incomplete.

3.2 Data Collection

In a number of places Barnetson refers to a fortification wall or “FW” deposit without being specific which one she means. The table in the ZBR showing where species were present across the site (appx. 2, table A2.1) only gives three possible candidates: FW1, FW5 and FW6. In Barnetson’s description of the fortification wall she points out canid and hare bones and horn cores being found here, and FW6 was the only trench to produce any of these. Furthermore, she describes the bones from the fortification wall as having good contextual pottery from multiple stratigraphic levels and FW6 was the only trench to provide this; there was no dateable pottery recovered from FW1-4[100] and Heurist mentions only one fragment recovered from FW5. Hence, it has been assumed that when mentioning the fortification wall, she is referring to FW6. According to the excavators’ notebooks for the final excavation season in 1974, the fortification wall at FW6 had at least two external faces representing different phases. The deposits at FW6 to produce animal bones were all outside of the innermost of these wall faces. It has therefore been assumed that this was a ‘dump’ area over the wall, just outside of the settlement.

The data collected from the various sources was entered into a Microsoft Excel spreadsheet from where it was sorted and manipulated to prepare it for presentation and for export to the applications used for statistical calculations. The list of species present by deposit in the ZBR was used as the source for the categorical present/absent data with a 1 used to indicate presence and a 0 absence (appx. 2, table A2.1). Separate worksheets were used to record other details such as architecture size and animal bone ages (appx. 2, tables A2.2 and A2.3).

Individual complexes of ESs, or houses, were based on those defined in *Zagora 1*, *Zagora 2* and Heurist (map 4).[101] For the purposes of this thesis, the complexes were named with a ‘C’ followed by a letter, or letters, of the area(s) they spanned and a numerical identifier. Those that appear to have comprised a single ES (such as in B area) were not listed since they may have been part of a larger, as yet unexcavated, complex. Furthermore, other complexes that had a minimal number of excavated ESs were also excluded. The complexes distinguished, and the ESs they contained, were: CD1 (D6-7-8-27), CDH1 (D26-H17-18-20), CH1 (H19-21-22-23-28-29), CH2 (H34-35), CH3 (H26-27-42-43-47), CH4 (H24-25-32-33-40-41), CJ1 (J3-4-5), CJ2 (J1-2-15-17-18), CJ3 (J7-24-26-27), CJ4 (J8-9-10-11-12) and CJ5

[100] *Zagora 2*, 53-4.
[101] Although it was not always clear what defined a house here (*Zagora 2*, 154).

(J6-21-22).[102] Only one of these spaces, D26, was not specified as being open or roofed in the excavation reports and Heurist. Based on its size and position within the house it has been designated here as roofed.

3.3 Identifying spatial patterns

By examining the spatial distribution of archaeological artefacts it may be possible to detect patterns in their distribution, such that upon further investigation could reveal a number of different things. With respect to animal bones, spatial clustering of particular types of bone could indicate a variety of characteristics of the population that created them including socio-economic status or ethnicity.[103] It was hoped that spatial patterning might be identified in the distribution of animal bones at Zagora that would allow the targeting of further interpretative analyses. As with any archaeological assemblage, if a random distribution were identified it does not mean that there was not a pattern there since we are not dealing with the evidence of one event in time but rather a palimpsest of events.[104] For instance, after the slaughter of a large animal such as an adult cow, the meat may have been distributed only amongst people from a particular familial or social group leaving a pattern that might be detectable soon after the event. The overlaying of subsequent events along with taphonomic processes may have disturbed this pattern to the point that it would appear random.

The state of Zagora's architecture at the time of abandonment (ca. 700 BC) was used to define the individual architectural units. The reason for this is that it is difficult to associate the animal bones with a particular period since a considerable number of deposits in the ZBR do not provide stratigraphic information. The ESs and their functions were all thus treated as non-changing when in fact they changed through time possibly in both layout and function. In other words, it has been assumed that "the processes producing the configuration had a 'memory' such that when elements were added to the configuration the spatial location of previously entered elements was known".[105]

[102] In my opinion it makes sense that CJ1, CJ4 and CJ5 are closely related and belong to the same family or group due to their common entryway.
[103] Crabtree 1990, 156; Landon 2005, 20.
[104] Hodder and Orton 1976, 9-10.
[105] A fundamental assumption of spatial statistical analyses is that the data being compared is contemporaneous, which is rarely the case with archaeological assemblages retrieved from earthen floors (Voorrips and O'Shea 1987, 502).

3.3 Identifying spatial patterns

The ESs and excavation grid squares that contained animal bones were plotted onto McCallum's ArcGIS map of Zagora. These plots were used to visually identify patterns in the distribution of animal bones. Both the architecture in which they were found and their location within the site were considered. Treated as equally significant in the analyses were those ESs in which animal bones were *not* found.

Once patterns had been identified visually, statistical tests were performed to see whether the patterns had any basis mathematically and to discover any patterning not obvious to the eye. The statistical testing was necessary to ensure that as much subjectivity was eliminated from the pattern identification as possible. In order to rule out bias due to differing excavation and retrieval methods used by the excavators of the different excavation grid squares, the bones retrieved (or not) from each ES or excavation square were compared to the list of supervisors responsible for those ESs or squares. It was found that out of 15 supervisors, six excavated one of the four ESs in which no bone was found, and none excavated more than one of these.[106] Furthermore, it was discovered that only four supervisors did not excavate one of the five ESs in which fish bone was found.[107] Therefore, it was concluded that excavator bias did not appear to have an obvious impact on the results.

Running a traditional aspatial statistical test for correlation (such as Pearson's *r*) does not take into account the effects of space and this is why here a test measuring spatial autocorrelation needed to be performed. The phenomenon of spatial autocorrelation can be defined as where the presence of an observation in one area impacts neighbouring areas such that its presence there is more or less likely (positive and negative spatial autocorrelation, respectively).[108] Tobler's first law of geography, which states that objects spatially closer are more alike than those further away, implies that there is no spatial randomness and that samples taken across space are autocorrelated.[109] This applies more so to geographical phenomena than it does to anthropogenic ones but it is still useful to check for spatial patterns

[106] The rooms in which no bone was found (H25, J12, J24 and J26) were supervised by J.W., D.F., I.McP., J.C.S., M.B. and M.L..

[107] Fish bones are a good indicator for recovery bias since of all the species at Zagora they are the most affected by it (Payne 1985a, 223; Mylona 2003, 193-5). Unfortunately, from the excavation notebooks we cannot tell what type of bone was recovered and so we cannot determine the date when fish were retrieved and then match it to the supervisor for that date. Thus we need to compare excavations over all seasons. Those who did not excavate one of the five rooms that produced fish bones were D.F., A.C., M.B. and P.R.. The remaining 11 supervisors all excavated in one of these five rooms.

[108] Hodder and Orton 1976, 174.

[109] Schwarz and Mount 2006, 157.

in archaeological contexts since a non-random pattern may imply some underlying human activity as its cause.

To test for the existence of autocorrelation in the animal bone distribution at Zagora, the join-count statistic test was conducted. The join-count statistic is the spatial autocorrelation test of choice for nominal data, which is what we have with the animal bones at Zagora (that is, presence or absence).[110] The join-count statistic is not often found used in archaeological applications, although it has been used in the past with some success.[111] If NISP counts of individual species were available for all ESs, then the preferred geospatial statistical test to use would be Moran's *I* statistic since it reflects spatial change in quantity.[112] Moran's *I* has seen a wider use in archaeology than the join-count statistic since it takes into account this quantification information.[113]

The join-count test assigns the locations containing a particular observation (in our case the presence of bone) the value B (black). Those locations where the observation is not present are assigned W (white). The connections between the various locations then become either BB, WW or BW joins. The observed number of joins of each type are counted and compared with the number of joins that would be expected if the distribution of B and W was random. A result indicating positive autocorrelation suggests clustering; negative autocorrelation, dispersion; and no autocorrelation, random distribution.[114] An example of each of these is shown in figure 4 with the areas shaded grey representing B (black) regions. A limitation of this test is that the topography is not taken into consideration when examining the joins.[115]

To conduct the test, the "Joint-Counts" function within the PASSaGE 2 program was used. PASSaGE 2 was developed by Michael Rosenberg and Corey Anderson from Arizona State University and can be used to conduct a variety of different spatial statistical

[110] Hodder and Orton 1976, 176-7; Cliff and Ord 1981, 15-5; Griffith and Amrhein 1991, 136; Rogerson 2001, 165-6.
[111] Voorrips and O'Shea 1987. It is not commonly used because by neglecting volumes of artefacts across space some precision is lost. In the case of the Zagora animal bones, we do not have quantities.
[112] Cliff and Ord 1981, 15. There were some NISP counts provided in the ZBR, however, they were usually quite vague, such as "Rooms with less than 20 fragments were…" and "22 identifiable pieces of bone from rooms B2, B3 and B4…". Moreover, all but three are totals, and do not provide a breakdown of species; ZBR, 15, 18.
[113] Premo 2004; Schwarz and Mount 2006; Fletcher 2008, 2049.
[114] Silk 1979, 115-7; Conolly and Lake 2006, 158.
[115] Not such a big problem here as in areas with highly variable geography (Cliff and Ord 1981, 15-6).

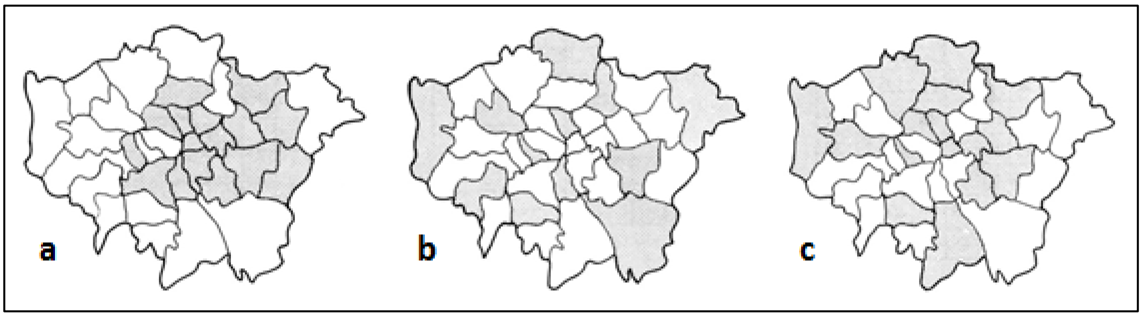

Figure 4 – Map of 33 Greater London boroughs showing examples of a. positive, b. negative, and c. no spatial autocorrelation (after Silk 1979, fig. 9.2b-d).

analyses.[116] Prior to use, the program was tested against a published set of data and the results of the join-count statistic compared to the results in the publication to ensure its integrity.[117] In order to calculate the join-count statistic, the program requires two input files: a connectivity matrix that indicates the connectivity between the ESs and another file indicating the presence or absence of animal bone for each ES. In the connectivity matrix (essentially a table with one column and one row for each ES) a value of 1 indicated that there was a join between the two ESs, and a 0 indicated no join. Connections, or joins, between individual ESs were assigned wherever spaces were adjoining, regardless of whether or not there was a passage (such as a doorway) between the two since a party wall may indicate a relationship between them. The second file is a simple list of each ES and an associated value: 1 indicating the presence of animal bone, 0 indicating the absence of animal bone. These matrices are reproduced in appendix 4 (tables A4.1-2; figs. A4.3-4).

The test was run for each type of bone found at Zagora (apart from hare, equid and canid, which each occur only once or twice within the analysed sections). The regions across which the join-count statistic is conducted must be contiguous.[118] The ESs included in the analysis were from H and J areas (not including the temple H30-H31). Sections B, D and F were excluded because they contain a small number of contiguous ESs and lacked contiguity with the larger sections (H and J). Even though 'artificial' joins can be created between non-

[116] Rosenberg and Anderson 2011; http://www.passagesoftware.net/.
[117] The data tested was the "Buffalo crime data example" from Griffith (1987, 35-6, figs. 3.1 and 5.2). The test was conducted not only to confirm that the software would produce the desired results but also to ensure that the present author could successfully navigate the program's interface.
[118] Contiguous regions are the basis for almost all autocorrelation studies (Silk 1979, 114-5).

contiguous ESs to merge all areas in the test, it would ignore the as yet unexcavated ESs that we know exist in between them.[119]

The join-count statistic can run under two assumptions: the free sampling and non-free sampling models,[120] where the sampling case is used to generate the expected values in the test (that is, if the distribution of B and W was random). The 'free sampling' case is used when the sample being considered is part of a larger population and the probability of whether a certain point or polygon has a particular value is known. The 'non-free sampling' case is where the sample is being treated as the entire population and that the probability that one point or polygon has a particular value cannot be determined *a priori* and must be extracted from the sample.[121] The non-free sampling case was used since only the settlement of Zagora was considered for the tests and not an already known larger population.[122]

3.4 Aspatial statistical methods

A further test was conducted in order to determine whether the co-occurrence of the various species was patterned or whether their distribution is what would be expected by chance. For this a chi square test of independence was performed.[123] This test is useful for measuring the relationship between nominal variables, which in our case are the present and absent categories for the bones. Here, the chi square test compared the presences and absences of each pair of animal species to produce four totals: 1. and 2. the number of ESs in which one exists and not the other; 3. the number of ESs in which they both exist; and 4. the number of ESs in which they both do not exist. It then compares each of these four totals with the four totals we would expect if the distribution of the two species were left to chance.

One of the requirements of the chi square statistic is that all of the totals need to have an expected count of at least five.[124] Not all of the Zagora bones meet this requirement. However, this limitation can be overcome by performing Fisher's exact test, which produces

[119] In such as case, the coordinates of the centroids of each space could be used to make distance-weighted calculations.
[120] Cliff and Ord 1973, 9.
[121] Cliff and Ord 1973, 9.
[122] Silk 1979, 117-20; Cliff and Ord 1973, 22-3. The non-free sampling or randomisation assumption is the most useful for archaeological data (Hodder and Orton 1976, 178).
[123] The chi-square test has been used extensively in archaeological applications (Shennan 1988, 65; VanPool and Leonard 2011, 238-53).
[124] VanPool and Leonard 2011, 249.

the exact probability by calculating all possible permutations of the bone distributions.[125] Using the exact probability, we can determine whether our results are statistically significant.

A further area explored for patterns was the size of the ES in which the animals were found. It was felt that a pattern in the ES size for certain animal types might reflect the kind of activities that took place in those ESs. Alternatively, no observable patterning could indicate that there was no relationship between the size of the space and the kind of animal consumed or disposed of there. This was explored for both individual ESs, roofed and unroofed, and also between the various complexes since certain activities may have taken place in similar locations within each complex.

A final test was conducted to establish whether there was a correlation between the size of the ovicaprid and the size of the ES within which it was found. Since the number of bone measurements for this test were few (9) and there was no way to determine whether the population was (statistically) normal, the type of statistical test was limited. A non-parametric test needed to be performed and one that would include tied results when comparing ordered ranks (since three bones had the same measurement) in its calculations.[126] Therefore, the Gamma statistic was chosen and since the sample size was small, Fisher's exact test was used to determine the probability of the statistical significance.[127] All aspatial statistical tests were run using the SPSS software package.

3.5 A note on statistical significance

A statistical test is usually setup with a null hypothesis (H_0) and an alternate hypothesis (H_1). For example, in the spatial statistical tests being conducted in this study, H_0 states that the animal bones are distributed randomly and H_1 states that they are not random, but that they are spatially autocorrelated. In null hypothesis statistical testing we either reject or do not reject the null hypothesis, depending on the results of the analysis. Statistical significance should not be confused with colloquial 'significance', which signifies the importance or consequence of something. The statistical level of significance, or α value, is the probability that the null hypothesis is true if we reject it (also known as a Type I error).[128]

[125] Hinton et al. 2004, 285-6; Mehta and Patel 2011, 148-9.
[126] Hill and Lewicki 2006, 37-8.
[127] Mehta and Patel 2011, 187-8.
[128] Shennan 1988, 51-2.

Therefore, the lower the probability, the more confident we are in rejecting the null hypothesis.

In statistics, the level of significance chosen varies but is usually either .05 or .01, commonly referred to as statistically significant (.05) or highly statistically significant (.01) in the literature.[129] When the results of a statistical test have a significance value greater than .05 then the null hypothesis tends not to be rejected or if it is not too much greater then larger samples can be collected to increase the significance of the result (and decrease the probability).[130] When we have small samples in archaeology we normally cannot simply go out and collect more data, and need to look at the results differently. In archaeology, it seems flawed to outright reject a likely correlation or non-random occurrence simply because of a small percentage chance that we are wrong. Robert Drennan suggests that archaeologists should not strictly adhere to rejecting or not rejecting the null hypothesis, but rather focus on the probability that the null hypothesis might be right or wrong (fig. 5).[131] Thus where appropriate, instead of simply rejecting or not rejecting a null hypothesis, this thesis will follow Drennan's lead and report how "likely" or "unlikely" is a particular statement of hypothesis.[132]

Q: How likely is it that the observation is random?	
Probability	**Likelihood**
0.8	extremely likely
0.5	very likely
0.2	fairly likely
0.1	not very likely
0.06	fairly unlikely
0.05	fairly unlikely
0.01	very unlikely
0.001	extremely unlikely

Figure 5 – Statistical probabilities and their equivalent likelihoods (data from Drennan 1996, table 11.3).

3.6 Establishing characteristics of the economy

Many aspects of past lifeways can be determined through the study of animal bones. Not only can they inform us of diet, but the sex, age and pathologies of the animals' bones can tell us whether they were kept for primary products such as meat, bone and leather or for secondary products such as milk, wool or plough traction.[133] Models based on the patterns of age and sex of ovicaprid bones were developed by Sebastian Payne to determine the primary

[129] The value .05 is the most commonly used in null hypothesis statistical testing and is an arbitrary value chosen for no apparent reason but which has become an accepted norm in statistics (Masicampo and Lalande 2012, 1).
[130] When a sample size is large, then the results usually have greater statistical significance than a smaller sample of the same data (Drennan 1996, 162). A recent survey of articles published in peer-reviewed psychology journals has found an unusually high prevalence of significance values just below .05, indicating in some instances that researchers may have increased their samples until the desired 'significance' was achieved (Masicampo and Lalande 2012).
[131] Drennan 1996, vii, 160-3.
[132] Drennan 1996, table 11.3.
[133] Payne 1985a, 226-34.

type of husbandry practiced.[134] When conducting such analyses, caution must be exercised for a number of reasons but particularly because of the taphonomic processes that can significantly affect the results since both young and adult female bones are smaller and weaker than adult male bones.[135]

The ZBR provides the estimated ages of ovicaprid and pig mandibles with teeth in situ, based on Silver's ageing tables.[136] These tables suggest ages for animals based on the ages at which their various teeth erupt and their eruption sequences.[137] Ages can also be determined by examining the fusion state of the epiphyses of bones.[138] The non-mandible specimens were not attributed ages, apart from the odd mention of the epiphyseal fusion state of long bones, presumably due to the time constraints imposed on the study.[139] Although the age data is limited and chronologically covers the entire period of occupation at Zagora, tentative suggestions can be made as to the primary economy practiced.[140] The slaughter ages for the ovicaprids from Zagora were plotted against Payne's models to see which economic strategy they fit best and hence which one may have been employed here. Animal sex data was not provided in the report and so could not contribute to these analyses.

The ages provided by Silver include both those of modern improved breeds as well as rough goats and late 18th century sheep and pigs.[141] Scholars have found a number of issues with the 18th century ages he cited,[142] and so the ages for modern breeds have been used here.[143] Apart from the 18th century ages being clearly incorrect, it was felt that the modern values were better because the optimal slaughter ages for various economic functions were attained via ethnography using modern breeds.

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[134] Payne 1973. Payne developed models for wool, dairy and meat exploitation based on ovicaprid kill patterns. However, his models do not account for mixed farming, only specialised, so many of the small time agriculturalists' farming practices would not be identified (Klippel and Snyder 1991, 185). Furthermore, his model for a milk-based economy had been seen by some as problematic based on ethnographic as well as early Christian documentary evidence which shows that cows needed their calves present in order for them to give milk (McCormick 1992). Such views have been rejected by others on the basis of the studies being of more recent populations and under different circumstances (Halstead 1996, 25; Isaakidou 2006, 95).
[135] Payne 1985a, 230.
[136] Silver 1969; ZBR, 2, 9-11.
[137] Silver 1969, table A.
[138] Payne 1973, 283.
[139] ZBR, 1-2.
[140] Such proposals have been made by scholars with similarly small numbers of identified specimens. See, for example, Sloan and Duncan (1978, 66, fig. 6-2), Curci and Tagliacozzo (2003, 130, table 13.4) and Allentuck and Greenfield (2010, 13, 17, 21).
[141] Silver 1969, tables E, F, G.
[142] Payne 1973, 299; Klippel and Snyder 1991, 183-5.
[143] The late 18th century sources were found to be unreliable in both their tooth eruption sequences and ages. The eruption ages were considerably different to 17th–18th century archaeological data, and 19th and 20th century measurements, which were comparable (Bull and Payne 1982, 55 n. 2, 65-7, 71).

3.7 Limitations of the study

A number of limitations were encountered in the data that influenced the methods chosen in this thesis and therefore some assumptions needed to be made. These assumptions, along with the limitations encountered, are provided here to make it clear how the results were produced.

Whether or not an excavation sieves is an important factor in determining the kind of material that is retrieved. Experiments have shown that large animals such as cattle are overrepresented in assemblages that have been hand-sorted meaning the importance of the smaller animals such as ovicaprids is understated.[144] In these experiments, ovicaprid fragments more than doubled after sieving while cattle increased by less than half. Sometimes smaller, more fragile, remains like crab or sea urchin are only recovered by sieve and not by hand.[145] The difference between sieving and not sieving highlights that we should be careful when comparing data between different excavations.[146]

Given that we do not know the retrieval methods used in Zapheiropoulos' excavations in 1960, and since systematic sieving was not introduced into Greek archaeology until the latter part of that decade, it has been assumed that the material excavated in 1960 was hand-retrieved and not sieved.[147] The University of Sydney excavations from 1967 onwards sieved all soil apart from surface "dust" meaning we cannot compare data between the two excavations without introducing significant bias.[148] The exceptions are those partially excavated ESs from 1960 that were later revisited by the Sydney team who cleared the occupation layers. Therefore D2-D5, D9-D14 and E1-E2 were excluded from the analyses.[149] D1, D6, D7 and D8, partially excavated in 1960, were included in the analyses since at least 50% of their latest occupation floor areas were excavated by the University of Sydney team.[150] The temple, H30-H31, was excluded since only data from domestic contexts was

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[144] Payne 1972a, 59-61; Payne 1975; Snyder and Klippel 2000, 68-70.
[145] Snyder and Klippel 2000, 78.
[146] Other conditions can impact upon the efficacy of sieving such as the moisture in the soil (for dry sieving), the person doing the recovery, the weather, light, mesh size, number of finds recovered, the backlog of soil to be processed and whether wet- or dry-sieving was conducted (Payne 1972a, 49, Payne 1975, 16, fig. 8; Peres 2010, 23).
[147] Diamant 1979, 206; Payne 1985a, 220.
[148] *Zagora 1*, 37.
[149] That is, the rooms excavated in 1960 (*Zagora 1*, 13). The rooms and dumps from the 1960 excavation were explored by the University of Sydney team in 1969 (*Zagora 2*, 71-4).
[150] Room D1 was only excavated by Zapheiropoulos down to roof level, while the Sydney team in 1969 cleared the floor and below (*Zagora 2*, 71-3). The 1971 excavation notebooks provided information on excavated rooms D6, D7 and D8, which will be published in *Zagora 3*. Zapheiropoulos only excavated D6 to threshold level with

statistically investigated; a comparison between cultic and domestic contexts was performed separately. Such a comparison was possible since the 1960 excavations only excavated to the temple's Archaic floor-level and the Sydney team excavated the remainder.[151]

The ZBR prepared by Lin Barnetson lists the presence of bone specimens identified to species by ES or excavation grid square.[152] If bone fragments were recovered but not identified to species then it was assumed that they were not included in the report. Therefore a definitive listing of the ESs and deposits that contained bone fragments, including those which could not be identified to species, was obtained using the original excavation notebooks and registers kept at the AAIA.

Not all bone present/absent data listed in the ZBR provides stratigraphic information.[153] As a result, this study has assumed that all animal bones found within an ES or excavation grid square were contemporaneous and where the raw data in the ZBR does indicate precise deposits, these were ignored. This should not be too much of an issue for our results because by comparing between chronologies using pottery styles we are creating artificial phases of time that do not necessarily indicate a cultural change or a change in dietary preference.[154] Similarly, we cannot be more certain that two bone fragments in a cultural layer were deposited simultaneously rather than decades apart.[155] Furthermore, not only is the trampling of bone fragments into the earthen floors a problem for dating, but some rooms suffered from post-abandonment wall and roof collapses as well. In some cases where the heavy schist slabs collapsed, they pushed surface artefacts into the floor making it difficult to distinguish between a floor and sub-floor deposit.[156] Such factors have meant that an examination of diachronic change was not possible in this study.

Another limitation is the minimal amount of quantitative data provided in the ZBR.[157] The report only provides total NISP values for several ESs and approximations for several

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the exception of a trench running along the northern wall and a small one in the southern part of the room. For D7 it says that Zapheiropoulos' excavation reached the floor-level and had "possibly" "mostly destroyed" its surface; the floor fill was intact. Likewise with D8, Zapheiropoulos only reached floor-level in most parts although along the walls he excavated deeper.

[151] *Zagora 1*, 13.

[152] ZBR, 4-9.

[153] ZBR, 4-9.

[154] Payne 1972b, 66. The only intrasite chronological comparison that makes sense would be one based on architectural sequences that could indicate a space's change in function.

[155] The only way we can be more certain is by conducting sedimentary analysis and 'geo-archaeology' in a laboratory (Jones 2007, 16-7).

[156] B. McLoughlin (pers. comm.).

[157] ZBR, 15-20.

more. Only two deposits from the Geometric period (Room D8 and FW6 by the fortification wall) are given a breakdown of NISP per species, which is far too small to make a generalised assessment of the relative abundance of different species across the site. Additionally, Barnetson did not attempt to calculate MNI counts given the fragmented state of the bones and the small size of most deposits.[158]

3.8 Overview

This thesis uses both visual and statistical methods to identify spatial patterning amongst the animal bones found at Zagora. Other aspatial statistical and non-statistical analyses were performed to further assist in pattern identification and in determining the kind of animal husbandry practiced. A number of limitations were discovered in the available data, restricting the type of analyses that could be performed. Even though the evidence is limited in places, it was deemed sufficient to permit a tentative reconstruction of aspects of life at Geometric Zagora.

[158] ZBR, 2. These days both NISP and MNI are the most popular methods of quantification in zooarchaeology, although both have their shortcomings. Generally with high fragmentation, as we have here, NISP can exaggerate the abundance of certain species. For example, pigs' molars are identifiable even in a highly fragmented state whereas those of ovicaprids in the same state may not be (Peres 2010, 26). For a good short overview of the two methods based on the results of experiment, see Payne (1985a, 219-24).

4. Analysis of the economy and diet

4.1 Introduction

At Zagora, there is evidence of several different animal species. Represented in the bone assemblage are sheep, goat, cattle, pig, fish, hare, equid, canid and rat. Molluscs were also quite common at the site. The most frequently occurring of the vertebrate species are the domesticates: ovicaprids, cattle and pig. Fish and hare are the next most frequent, with hare being quite common at the fortification wall (trench FW6).[159] Canid and equid occur in only one ES each with the former also appearing at FW6, while the latter is represented by only one hoof fragment.[160] The remaining species, rat, only appears in deposits outside of houses.

The Homeric texts and Linear B tablets attest that animal husbandry was a specialisation practiced by swineherds, goatherds, shepherds and cheese makers, all of which may have been present at Zagora.[161] Large herds of ovicaprids and cattle would have been kept penned somewhere outside the town but small herds of animals could have been kept near houses within the town; stalling cattle within a field house alongside humans was not unheard of in Greece in more recent times.[162] Pigs, on the other hand, may have been better suited closer to the household, although they too may have been let out to forage at certain times of the year.[163] We will not know for certain how suitable the settlement was for keeping livestock until a full survey is complete.[164] To attempt a reconstruction of the animal-based economy and diet of the Geometric settlement, it is worth first examining each of the species present.

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[159] ZBR, 16, 24.

[160] The ZBR mentions a single equid phalanx (hoof) fragment found in room H41 (ZBR, 23). However, the cover letter to the ZBR Barnetson submitted to the AAIA mentions that an equid tooth was found. This is inventory number 2692 which is listed as a molar within the Heurist database. Barnetson had treated loose teeth and bones separately.

[161] Trantalidou 1990, 395, 399.

[162] Chaniotis 1999, 190; Forbes 2007, 236-7.

[163] Marciniak 2005, 45.

[164] Likely being conducted in late 2012.

4.2 The animal species found at Zagora

Ovicaprids

Ovicaprids at Zagora are represented by both sheep and goat. At the best of times, it is difficult for a zooarchaeologist to distinguish between the bones of the two species and this is also the case here.[165] That both sheep and goat were present is evidenced by the identification of horn-core fragments.[166] Sheep and goat are used for their meat, hide, milk, wool (usually hair in the case of goat) and manure. In fact, the secondary products provided by these species could have been more valuable to ancient Greeks than their primary products since they could have been continually exploited.[167] To cite a recent example, in 1977 only 14% of the total calorie output of Greek goats came from meat, with 86% coming from milk. Similarly, 27% of goats' protein output came from meat with milk comprising 73%.[168]

A higher number of older ovicaprids would indicate secondary products such as milk or wool were produced.[169] Maturity for ovicaprids is about 3½ years and their fertility normally ends at around six years of age after which point those raised for milk production would be slaughtered.[170] Sheep reach their optimal weight gain for meat production between 1½ and 2½ years of age.[171] The slaughter of young could be a byproduct of a dairy economy or a reflection of status; in the modern highlands of Crete, lamb is considered a luxury food

[165] Boessneck 1969, 331; Payne 1985a, 215; Payne 1985b, 139; Buitenhuis 1995, 140-1; Reitz and Wing 2008, 166. Barnetson (ZBR, 3) tells us this is the case at Zagora due to the high fragmentation of the bones and the short time available to undertake the identification; coincidentally, the reasons given for grouping sheep and goats at Nichoria were the same (Sloan and Duncan 1978, 61).

[166] ZBR, 3; coincidentally again, as was done at Nichoria (Sloan and Duncan 1978, 61). The actual breakdown between sheep and goat is not certain but it makes sense for a farmer to have both for herd security since in the event of a disease or parasite outbreak only a part of the herd would be lost. Redding (1984, 234) calculated the 'ideal' sheep/goat ratio for the Middle East as being between 1:1 and 1.7:1, taking into consideration the reproduction rate needed to rebound from trouble and ideal ages at slaughter for the different economic strategies.

[167] Primary products are those that can be extracted from the animal only once in their lifetime (such as meat, bone and hide) whereas secondary products can be repeatedly obtained (such as milk, wool and manure) (Greenfield 2010, 30). The term 'secondary product' is deceiving since they are often much more important than primary products (Payne 1972b, 71).

[168] Payne 1985a, table 5.

[169] Curci and Tagliacozzo 2003, 127.

[170] Sloan and Duncan 1978, 65; Reese et al. 2000, 451.

[171] Crabtree 1990, 162; Allentuck and Greenfield 2010, 19. Marciniak (2005, 50) puts this figure at between 12-18 months for both sheep and goat.

and its availability is regulated.[172] Also, the manure from ovicaprids could have been used to fertilise crops.[173]

Pigs

Pigs are the ideal urban 'farm animal' and are usually kept close to the home since a small number of pigs can be sustained on domestic kitchen waste alone.[174] They are omnivores that can eat just about anything, and in modern times have been known to keep the streets clean of domestic and other refuse.[175] After their first year, pigs grow beyond the size that a single household could immediately consume. Their meat therefore would have been shared, exchanged, or preserved by salting or smoking.[176] They could also have been kept alive longer by farmers as 'insurance' against a bad crop year. Not only can pigs be kept penned in at home but they can also be let out to roam in the woods to feed off acorns, roots and other vegetation. Stable isotope values of nitrogen and carbon from the bones and teeth of pigs, along with the examination of tooth microwear, can help distinguish between a pig that was fed off domestic refuse and one that foraged for food.[177]

Zooarchaeological remains of pig bones are the most difficult of all the major species to differentiate between the wild and domestic variety.[178] The best method for differentiating between the two is by measuring the bones of a large enough sample and then observing a dual population pattern; the domestic typically has the smaller measurements.[179] With such a small sample of measurable bones from Zagora, whether we have any wild pigs present in the assemblage remains an open question. Even if there were none native to the island, piglets could have been introduced by humans and left to run wild, creating a significant local population of wild pigs reasonably quickly.[180]

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[172] Vardaki 2004, 200-1. This does not mean that old animals were reserved for the poor since they may have been intentionally aged for the extra fat they produce (Ervynck et al. 2003, 433).
[173] Moreno-Garcia and Pimenta 2011, 20-3.
[174] Isager and Skydsgaard 1992, 85; Clinton 2005, 167; Marciniak 2005, 45.
[175] Pigs will also eat decaying vegetation, carrion and human waste (Clinton 2005, 167; Masseti 2007).
[176] Halstead and Isaakidou 2011, 172. The historical period Greeks had the technology to preserve meat in the form of sausages and hams (Frost 1999).
[177] Rowley-Conwy et al. 2012, 31-34.
[178] Rowley-Conwy et al. 2012, 2.
[179] Rowley-Conwy et al. 2012.
[180] As has been demonstrated in many examples worldwide (Rowley-Conwy et al. 2012, 29-30).

4.2 The animal species found at Zagora

Cattle

Of all the domestic species found at Zagora, cattle are the most 'expensive' and difficult to raise.[181] It is likely for this reason that at most sites, as at Zagora, their numbers are lower than the other domestic species (see fig. 16).[182]

As was the case with ovicaprids, the secondary products provided by cattle (milk, manure and traction for agriculture) could have also had greater importance to a farmer than their primary products (meat, leather, bone). In its lifetime, a cow produces 10-20 times the food value in milk than it does through meat.[183] Furthermore, traction from cattle alone can provide far greater rewards to farmers than their meat or milk can. Payne estimates that the traction from two bullocks ploughing a field would produce each year 25 times the food value of their meat in grain.[184] Both male and female cattle could have provided traction and it was common to castrate the males to make them more manageable for such purposes.[185]

It is easy to forget that animals produce more dung than any other products and cattle would have produced more than the other species found at Zagora. Not only would it have been useful for fertilising crops but also it makes a readily available and highly useful fuel source.[186] At Akrotiri, remains of charred dung from a large herbivore were found in a kitchen hearth, indicating that it were used here, along with butchery scraps (such as horns), as a source of fuel.[187] Cow dung is used in modern times not only as a fertiliser or fuel source, but also as a temper for construction, to insulate walls and coat floors, or as a raw material for making pottery vessels.[188]

Canids and Equids

The canid bones identified at Zagora were believed to have most likely come from a dog.[189] In ancient Greece, dogs were used in their capacity as a guard or to assist in

[181] Howe 2008, 31-2.
[182] The most notable exception from the EIA is Nichoria (Sloan and Duncan 1978, table 6-1).
[183] Payne 1972b, 71.
[184] Payne 1972b, 71.
[185] Johannsen 2011, 13-6.
[186] Moreno-Garcia and Pimenta 2011, 20-3.
[187] Sarpaki and Asouti 2008; Trantalidou 2008a, 368. It is peculiar that at Azoria on Crete, the incidence of burnt animal bones inside houses was considered unusual and therefore believed to be indicative of hearth sacrifice (Haggis et al. 2011a, 477).
[188] Moreno-Garcia and Pimenta 2011, 23-4. In their ethnographic study in modern Morocco, Moreno-Garcia and Pimenta (2011, 20-3) found that when cowpats were used as fuel, they were either used fresh or collected and dried on roofs to be used later.
[189] ZBR, 17, 19.

hunting.[190] There is also evidence that they were occasionally consumed by humans, as evidenced at EIA Kavousi on Crete by butchery marks on skeletal remains.[191] The bones of dogs are very difficult to distinguish from that of the jackal when they are of similar size.[192]

Equids too may have been eaten, but they also served the valuable role as a draught or pack animal carrying all manner of loads as they do in modern Greece.[193] The excavators at Zagora interpreted the rounded external edges of buildings at the site as being intentionally constructed to allow passage for the pack animals navigating the narrow streets as in some modern Greek villages.[194] Not much attention will be given to these two species since the information we have on them from the ZBR is little and they only occur in one ES each.

Wild Animals

The presence of wild animals can help to establish the local environmental conditions.[195] Unfortunately, the evidence thus far for hunted land fauna from Zagora is limited to hare,[196] something also true at other EIA Cycladic sites.[197] This may be a factor of the local environmental conditions at the time or a genuine preference for domesticates and crop food. Rock art at the Neolithic settlement of Strofilas on Andros, a little north of Zagora, has been interpreted as showing fishing and hunting scenes with deer, wolves and jackals.[198] Deer were very common on the European mainland but as yet there is no evidence for their existence in the Cyclades, where the conditions are not favourable for them.[199]

The other wild species to occur at Zagora was fish. Fish remains have rarely received the attention land animals have in archaeology but fishing must have played an important role for the Greeks given how important the sea was to their trade and communication.[200] The number of themes related to fishing and other maritime activities on the rock art at Strofilas

[190] Trantalidou 1990, 400-1.
[191] Klippel and Snyder 1991, 181; Snyder and Klippel 2003.
[192] Payne 1985a, 214. Coincidentally, rock art at the nearby Neolithic settlement of Strofilas was believed to include depictions of jackals (Televantou 2008, 47).
[193] Payne 1985a, 226.
[194] The exterior walls of rooms J4 and D3 (*Zagora 1*, 14; *Zagora 2*, 131).
[195] For example, red deer could indicate developed wooded areas nearby (Curci and Tagliacozzo 2003, 130).
[196] The canid bones are likely from domestic dogs, although they could have also been from wild species such as jackals or wolves. With the pigs too, we cannot be certain whether they were wild or domestic. Also, the rat bones may have been from intrusive animals that were not eaten and none have been identified in houses.
[197] Such as Minoa on Amorgos and Xobourgo on Tenos; the remains of deer found here were probably imports (Trantalidou 2012, 1065, fig. 4, table 12).
[198] Televantou 2008, 47.
[199] Trantalidou 2008b, 23; 2012, 1065-6.
[200] Powell 2003, 75. However, cf. Berg (2011) for the limited evidence of seafood in the Minoan diet.

Figure 6 – One of the dry sieves used at the Zagora excavations 1967-74 (photograph courtesy of the AAIA).

indicates the importance that fishing and the sea had to the community here.[201] Fishing is evident in ancient Greece through not only remains of fish bones and scales, but also through literary and iconographic evidence, and remains of fishing equipment.[202]

The species of fish recovered from Zagora was not identified in the ZBR, nor were any photos available, so we are left to speculate as to what they were.[203] Fish can be exploited in three ways: by hand collection, line, or net.[204] Those fish caught close to shore, the littoral species, would have generally been of the smaller variety, while the larger deep-sea fish such as tunny would usually need to be caught by line from a boat.[205] The species recovered by excavation depends on the size of the fish bones. Larger bones preserve better and have a better chance of being identified in the trench or captured by sieves with a large sized mesh.[206] If maximum recovery of fish is the aim, especially for the smaller species caught by nets near the shore, then water flotation is necessary.[207] The mesh size used in the sieving at Zagora was not specified, but based on contemporary mesh sizes and available photographs (fig. 6) we may make a fair guess that it was somewhere between 3.5mm and 7mm.[208] Dry-sieving with a 7mm mesh would not be sufficient to capture bones

[201] Televantou 2008, 46-50.
[202] Powell 1992.
[203] All we are told is that they were vertebrae (ZBR, 19, 24).
[204] Fishing nets are elusive archaeologically and the fishermen then, as now, no doubt used anything to weigh them down with, even possibly loom weights - although it is difficult to prove (Powell 1992, 309-10 n. 15).
[205] Powell 1992; Berg 2010, 66. From the *Odyssey* there is evidence that fishermen knew of the routes of migratory fish (Trantalidou 1990, 402).
[206] Payne 1975, 13; Mylona 2003, table 19.1; Lyman 2005, 849.
[207] Reitz and Wing 2008, 148.
[208] Since it has not proved possible to find out the precise size of mesh, we may guess that it would not be smaller than the smallest one used in the shaker sieve at Franchthi, which was 3.5mm (Jacobsen 1969, 350). Franchthi was the most advanced excavation for its time (and arguably even now) in terms of recovery of environmental remains. At Nichoria, a site also commended for its recovery of environmental data, they hand-collected and dry sieved with a mesh size of 7mm (Sloan and Duncan 1978, 60).

of the smaller species and if such a mesh size were used we may be left with the remains of a larger pelagic variety, the product of a more specialised kind of fishing.[209]

4.3 Animal slaughter patterns and the economy

In order to reconstruct the exploitation strategy of the domestic species from Zagora, particularly ovicaprids and cattle, the ages at which the animals were killed need to be examined. The idea is that people would slaughter different percentages of their animals at different ages depending on their primary economic strategy (such as meat, milk or wool production).[210] Ages can be determined by the epiphyseal fusion state of bones or by tooth eruption and wear.[211] The teeth of an animal erupt at different ages and then wear down at reasonably consistent rates,[212] with ages varying between species.[213] Similarly, different bones of animals fuse at different ages and this also varies between species.[214] There are issues in using the epiphyseal fusion state to age bones, such as underestimating the number of younger animals due to their bones' poorer preservation. Mandibular teeth generally preserve better even in infants and are the preferred bone to age.[215]

In his oft-cited production models,[216] Sebastian Payne suggests slaughter ages for sheep and goats that reflect three different economic strategies.[217] Although they reflect specialised production well, they do not account for mixed farming and so are unlikely to represent the slaughter ages from small mixed operations.[218] For example, young male sheep are expected to be killed in a dairy economy, but in a smaller mixed farming system they might be castrated and raised for wool, thus producing both products. Similarly, where cattle are raised for milk, male calves may be castrated and used as draught animals rather than be

[209] Furthermore, the general observation by Barnetson (ZBR, 2) that all the bones across the site were very fragmented and unidentifiable does not vouch well for the survival of smaller fish bones.
[210] Payne 1973, 281-2.
[211] Payne 1973, 283.
[212] Although this largely depends on the diet. For example, sheep fed leafy hay would wear their teeth faster than those that eat from lush pasture (Mainland 2003). Also, with pigs such a measure is prone to error since pigs digging for food is a major source of their tooth wear and therefore makes foraging pigs seem older than penned ones (Halstead and Isaakidou 2011, 171).
[213] Silver 1969, 289-301.
[214] Silver 1969, 283-9.
[215] Payne 1973, 283-4; Greenfield 1988, 576; Reese et al. 2000, 487. They are less affected, but not without their own preservation problems.
[216] Greenfield 1988, 574.
[217] Payne 1973.
[218] Klippel and Snyder 1991, 185. Another potential for skewed data is the lack of infant bones due to their poorer preservation and also bones from older animals that may have been intentionally broken up (Halstead 1987, 77-8).

slaughtered.[219] Even if slaughter ages of an assemblage are a perfect fit to the profiles provided by Payne, it does not mean that his models are the only way that the evidence can be explained.[220]

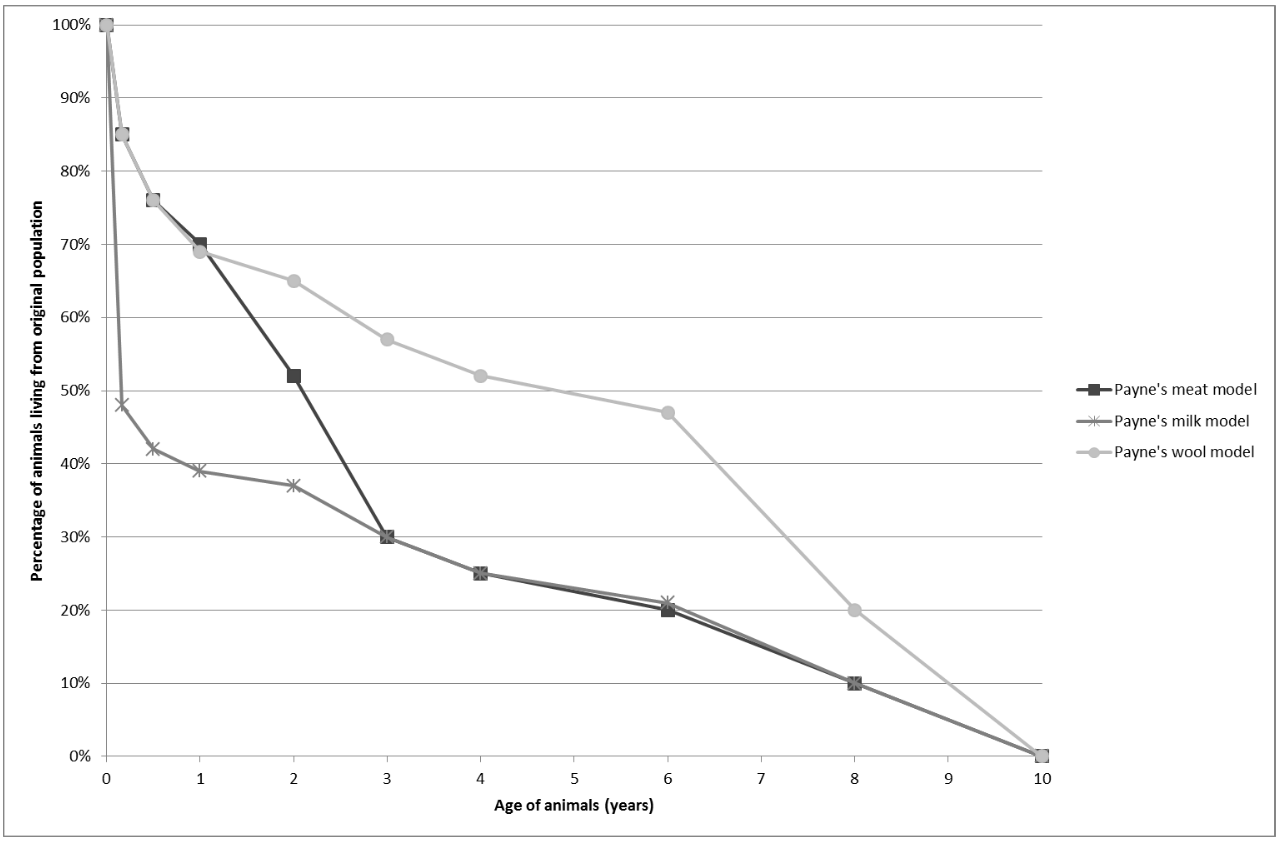

Figure 7 - Sebastian Payne's economic models showing survival percentages by age of ovicaprids for specialised meat, milk and wool production (data from Payne 1973, figs. 1-3).

Payne's models provide slaughter ages for three production strategies: meat, milk and wool (fig. 7). In a primarily meat producing economy, animals are usually slaughtered when they reach optimum size and some (mostly females) would remain beyond that age for breeding, being slaughtered when they were no longer productive.[221] In an economy that focuses on dairy production, young animals are slaughtered as long as the milk output is not affected, with young males not needed for breeding tending to be killed.[222] If the exploitation of ovicaprids was for wool or hair then we would expect to find a higher proportion of remains from older animals with juveniles only being slaughtered when stock did not need

[219] Sloan and Duncan 1978, 65.
[220] Greenfield 1988, 576.
[221] Payne 1973, 281; MacKinnon 2004, 25.
[222] Payne 1973, 281. This would primarily leave a larger proportion of young male bones and older female bones in the assemblage. The issue with identifying the sex of the animal makes this a difficult task at times, especially with juvenile bones for which it is almost impossible (Ruscillo 2003, 37).

replacing.[223] Males not needed for breeding are usually castrated since male sheep produce more wool than females and wethers are easier to control than rams.[224] The fleece from ovicaprids is normally taken from 2-6 years of age before the quality degrades and so few would be expected to grow beyond that.[225] It should also be noted here that a zooarchaeological indicator of wealth maximisation follows most closely a wool production strategy, with animals of both sexes primarily being slaughtered when they are adults.[226]

Cattle are not represented in Payne's models but nonetheless show similar patterns in their slaughter ages. When slaughtered between two and four years of age it indicates they were raised for meat, whereas with dairy production there is higher infant mortality.[227] Cows normally become infertile at 12 years of age and we would rarely expect any living beyond this age in a dairy producing economy.[228] Cattle killed beyond six years of age would indicate they were not bred specifically for meat since they are past the optimal age for meat productivity and must have been used for other purposes instead, such as traction.[229] Cattle used as draught animals can exhibit a wide variety of ages at death, since they could be worked for a few years and eaten while still fairly young or worked until an old age when they could no longer pull the plough.[230] Use of animals for traction is also identifiable by stress pathologies on the bones expected to bear the most weight.[231]

Not every settlement was a producer of the animals it consumed for food. Two further patterns in animal ages at death represent producer and consumer sites.[232] Such patterns are seen in areas where rural sites supply animals at an optimal age for meat to an urban centre, where we would find evidence of these prime-aged animals.[233] At the rural supplier sites, we would tend to find evidence of older females and breeding males at the age where they are no

[223] Payne 1973, 281.
[224] Jameson 1988, 88.
[225] Payne 1973, 281; MacKinnon 2004, 25.
[226] Russell 2012, 331-2.
[227] Jones 2007, 258-9. Marciniak (2005, 40) says the best age to slaughter cattle for meat is between 4-5 years of age.
[228] Sloan and Duncan 1978, 65.
[229] Jones 2007, 258-9.
[230] Johannsen 2011, 17.
[231] Isaakidou 2006, 108-9; Greenfield 2010, 40-2.
[232] Stein 1987, 106-7.
[233] For sheep and goat this is 1.5-2.5 years (Crabtree 1990, 162; Allentuck and Greenfield 2010, 19).

longer productive.[234] The same patterns could also be indicative of indirect and direct supply rather than consumer and producer sites.[235]

The only bones at Zagora to have been aged were the mandibles of ovicaprids and pigs with teeth in situ. Loose teeth and epiphyseal fusion states of long bones were not aged, the latter because of the excessive fragmentation of the bones, although the ZBR provides fusion states for a few bones in the section describing the bone distribution.[236] There are a total of 12 ovicaprid and 12 pig mandibles from the Geometric settlement that have been described and assigned ages.[237] The mandibles and their approximate ages are listed in appendix 2, table A2.3. The sample we have is far too small to be able to reconstruct the ancient economy of Zagora with any confidence since the addition of only one or two mandibles to some age groups may change the conclusions. However, even with such small samples it is not uncommon to find in the scholarship tentative proposals as to what the primary economy may have been.[238] Therefore, following Allentuck and Greenfield it will be stressed that "the possibility remains that these results are misleading due to the small sample size".[239]

Slaughter pattern of pigs at Zagora

Pig slaughter ages should correspond closely to those that are optimal for meat production: since pigs would have only been exploited for their primary products, they are usually kept alive until they get to the size required for their meat and possibly hide.[240] The use of animals for their bone or hide generally comes as a by-product from their slaughter for meat and is usually not driven by the need for raw materials.[241] For both meat and hide,

[234] Stein 1987, 106-7.
[235] An example of indirect supply is purchase from a butcher and direct supply purchase from a farmer (Allentuck and Greenfield 2010, 21).
[236] ZBR, 2, 15-20.
[237] Tooth eruption sequences are different for sheep and goat. Some scholars question putting them both together in the same category since their exploitation strategies may be quite different hence skewing the data, but is nonetheless something still practiced (Allentuck and Greenfield 2010, 17). This was something recognised by Payne (1973, 284) when he developed his models. In our case here, the mandibles were not differentiated and so we must treat them together.
[238] Even though the sample size is very small, it is not unheard of that such small samples are used, although 'usually' caution is stressed upon. For example, at the 38ha Early Bronze Age site of Titriş Höyük in Turkey only 11 cattle and 18 goat mandibles were aged to propose an admittedly highly tentative herding strategy (Allentuck and Greenfield 2010, 13, 17, 21). An even fewer eight teeth were used to age ovicaprids at the EIA site of Nichoria for the DA III period which covered 75 years (Sloan and Duncan 1978, 66, fig. 6-2).
[239] The size of the sample they were referring to was 11, see note 238 (Allentuck and Greenfield 2010, 22).
[240] Payne 1985a, 226; Reese et al. 2000, 481; Greenfield and Fowler 2003, 140. Pigs offer no secondary products except manure (Halstead and Isaakidou 2011, 172).
[241] Bement 2010, 227.

younger pigs are preferred over mature pigs.[242] In modern Greece, pigs are usually killed between 1-2 years of age when they are fully-grown and rarely do they live longer than 3½ years.[243] Those kept longer are usually used for breeding. Pigs sexually mature between 1 and 1½ years of age; reproductive males are kept for 2-3 years and females for 4-5 years before they are slaughtered.[244] Under certain conditions, they can produce up to ten offspring twice per year and as they only take between one to two years to reach full maturity, the turnover is usually quite quick.[245] The treatment of the litter will vary depending on whether they were produced for local consumption or for sale elsewhere.

Figure 8 shows the ages at slaughter for the pigs at Zagora based on the mandibular tooth eruptions. Barnetson also reports that pigs were being killed "before full maturity in many cases, that is, in the 1-3 year age range".[246] These ages she is citing must be the epiphyseal fusion state of the bones since the mandibular ages do not in all instances give an age range, but rather a minimum or maximum age.[247] Therefore, from the mandible ages we can merely suggest that the majority of pigs (83%) were being kept alive for at least 12 months, which is the lower value in the age-range within which they are normally slaughtered in modern Greece. The 33% that are slaughtered after 17 months of age may have been kept for one day or several years past that age. If we had more precise ages based on dental attrition, then we would be in a better place to comment.

Age Group	no.	Cumulative Percentage
<12 months	1	8%
>7 months	1	92%
>12 months	6	83%
>17 months	4	33%

Figure 8 – Survival percentages of Zagora pigs based on tooth eruption data.

Slaughter pattern of ovicaprids at Zagora

The ages at which teeth erupt in sheep and goats are different,[248] so even though their mandibles were not distinguished from one another, different age groupings need to be assigned for each species. Figures 9 and 10 show the three age categories from Zagora that have been defined for the ovicaprid mandibles: younger than three months for both sheep and goat; younger than 21 months for sheep (17 for goat); older than 21 months for sheep (17 for goat). The charts show the percentage of animals that died in each category as well as the

[242] Older pig skin is rough and dry, being difficult to work (Reese et al. 2000, 481).
[243] Trantalidou 1990, 396-7; Hadjikoumis 2012, 361.
[244] Hadjikoumis 2012, 361.
[245] Marciniak 2005, 45. Since they grow rapidly and produce large litters, it may not be economical or even possible to rear them all and may make more sense to kill them at a young age even though the meat would hardly be worth it (Halstead and Isaakidou 2011, 169).
[246] ZBR, 22.
[247] For this thesis, some age ranges were adjusted so they could be grouped together. See appendix 2, table 3.
[248] Silver 1969, tables E and F.

4.3 Animal slaughter patterns and the economy

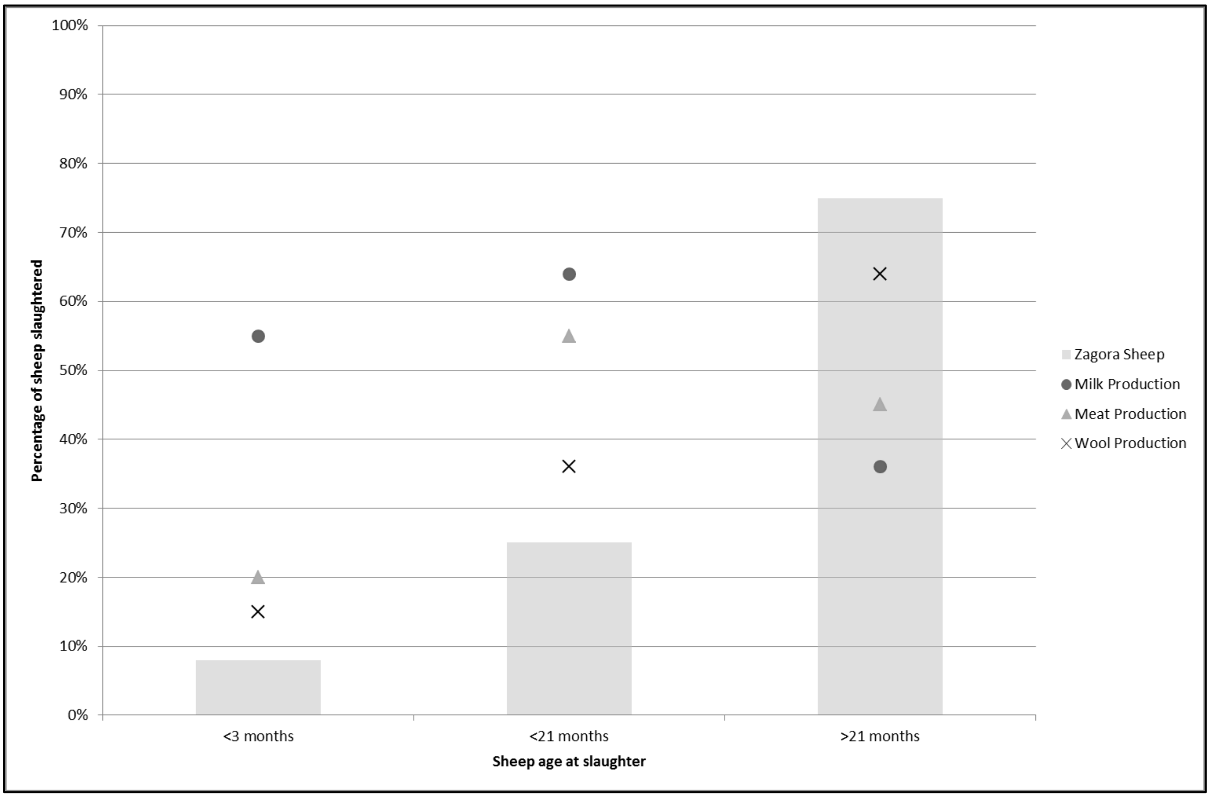

Figure 9 - Percentages of ovicaprids slaughtered at Zagora for each age range, plotted against Sebastian Payne's three economic models. Ages based on sheep tooth eruption stages (data from Payne 1973, figs. 1-3; ZBR; Silver 1969, tables E-F).

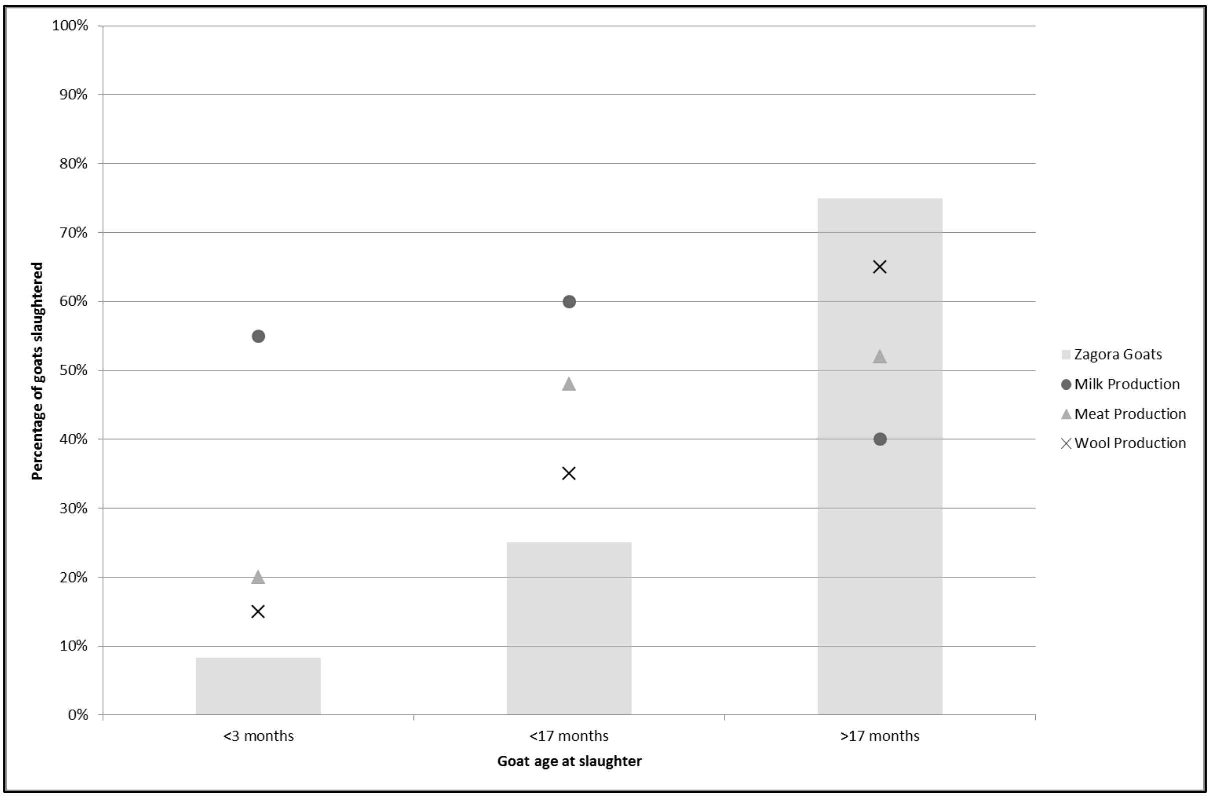

Figure 10 - Percentages of ovicaprids slaughtered at Zagora for each age range, plotted against Sebastian Payne's three economic models. Ages based on goat tooth eruption stages (data from Payne 1973, figs. 1-3; ZBR; Silver 1969, tables E-F).

corresponding values from Payne's three exploitation models. By comparing the Zagora data with Payne's models, it is clear that they fit the wool model best. This would imply an emphasis on the exploitation of ovicaprids for their wool or hair. Barnetson believed that based on their ages, ovicaprids were being raised for their meat, hides, milk, and wool.[249] Only with a larger sample size with more specific estimates of age based on tooth attrition will we be able to draw any firmer conclusions.

Slaughter pattern of cattle at Zagora

We do not have any ages for cattle although estimates were made by Barnetson based on whether or not the epiphyses of the long bones were fused.[250] An actual number of specimens was not provided, however she tells us that all identified cattle were from mature animals with the exception of two.[251] Maturity for cattle is about 3½ years, while all bones' epiphyses are fused by five years.[252] The bones from the two immature cattle were both distal epiphyses from metapodial bones that fuse between two and three years.[253] Thus, we may suppose then that the only immature cattle recovered were younger than three. Barnetson believed that they were not used for meat but rather for milk, manure, possibly horn and as draught animals instead of mules.[254] If, then, we accept the age observations made, it seems most likely that cattle were primarily used for draught (and manure) and if cow milk were produced, it was incidental.

4.4 Diet and economy at Zagora

The butchery marks identified on a few ovicaprid and cattle fragments found at Geometric period Zagora show that the diet of the people here would have included animal-based foods.[255] Even though the smaller ovicaprids made up the majority of bone fragments recovered, it does not mean that they were the most important species in the diet since cows can provide up to five times the amount of meat that a sheep or goat can.[256]

249 ZBR, 23.
250 ZBR, 18-9, 22.
251 ZBR, 18-9.
252 Silver 1969, table A; Reese et al. 2000, 487.
253 Silver 1969, 285-6; ZBR, 18-9.
254 Due to there being only two fragments of equid found (ZBR, 22-3).
255 ZBR, 18-9.
256 Reese et al 2000, 450-1. As to the exact quantity, we need to be careful using such values since the meat output of animals varies from region to region (Sasson 2006, 34).

4.4 Diet and economy at Zagora

The extensive evidence for the processing (and potential storage) of crops,[257] means that we cannot say that the people of Zagora subsisted purely on animals for their diet. Moreover, for a purely pastoralist existence, it has been estimated that the average family of four would need more than 300 ovicaprids to sustain it under normal conditions, not counting major losses.[258] For Zagora, this would imply a significant herd. By appealing to 'pre-modern'[259] ethnographic material from a nearby island, we can gain an insight into the kind of subsistence practiced by communities in a similar environment. On the Cycladic island of Amorgos in the late 19th century AD, the main diet of the inhabitants was legumes with not much meat (consisting mainly of salted lamb and goat), supplemented with cheese, sardines, wine, olive oil and other crops.[260] The same island's human population in the mid-19th century was 2,800 and they maintained 7,000 ovicaprids, 3,000 cattle, and 2,000 equids.[261] Although the human population living at Zagora may not have been this high, the average of 2½ ovicaprids and one cattle per person would not seem an unreasonable number to have been kept here.[262]

Animals are a way to indirectly store surplus grain and keep it available for times of need, such as when crops fail.[263] In lean times, pigs could have provided the best solution to get meat stocks back up again quickly. Of all the domesticates they have the fastest reproductive turnaround, the widest dietary range, and the most efficient conversion rate of feed into meat. Of the energy they consume, 35% is converted to meat whereas sheep and cattle convert 13% and 6.5%, respectively.[264] Sheep and goats are preferable to cattle if quick production is required since they grow around four times faster.[265] Alternatively, in times of stress the bone marrow from the ungulates (cattle, sheep and goat) may have been targeted since the marrow fat is the last fat of the animal to be depleted in the late winter and early spring. The fatty marrow only occurs in adult animals and the fat content can be as high as 90%.[266] This could have been a dietary option for the residents of Zagora since at least 75% of ovicaprids had reached the optimal meat producing age and as has been noted, there were

257 Such as pithoi and storage vessel emplacements in benches, and stone pounders (*Zagora 2*, 84, 154, 181-4).
258 Halstead 1996, 34.
259 Pre-modern in this instance refers to the time before domestic refrigeration.
260 Trantalidou 2006, 230.
261 Trantalidou 2006, 230.
262 Chaniotis (1999, 206) estimates that the wool from 4-5 sheep would meet the clothing needs of one person and so if wool was the main component of clothing at Zagora, an average of 2½ may not be enough.
263 Halstead 1996, 35.
264 Marciniak 2005, 45.
265 Marciniak 2005, 50.
266 Snyder and Klippel 2000, 72-3.

only two fragments of immature cattle identified. However, we lack evidence of specific breakages in the bones such as the intentional green breaks synonymous with marrow extraction as were identified at Kavousi Kastro.[267]

If we deduce that cattle, based on their generally mature age and low infant mortality (of which we would expect to be higher in a dairy economy), were raised primarily for their draught and manure, then we could assume that the products of agriculture were an important part of peoples' livelihoods. The agricultural terraces surrounding Zagora, along with the accompanying threshing floors (fig. 11), are evidence that agriculture was practiced in the vicinity at some point in time.[268] This leaves open the possibility that crops could have been grown in the area during the Geometric period, although it would not be unusual if the people spent a few hours walking to work the fertile valley not far away.[269] As far as the meat diet at Zagora goes, the ubiquity of ovicaprids across the site and their high relative abundance in deposits where NISP counts were given imply that they were the most common source of meat.[270]

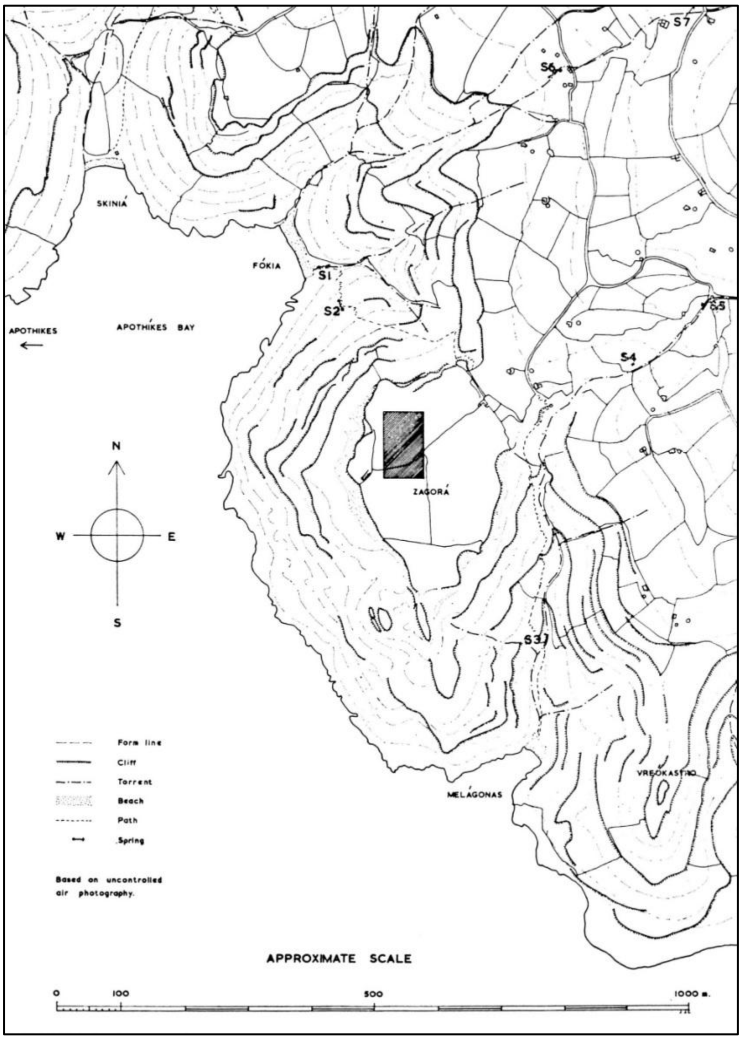

Figure 11 - Map of Zagora and surrounds showing terraces and threshing floors denoted by small hollow circles (*Zagora 1*, Map III).

[267] Snyder and Klippel 2000, 65.
[268] The terraces and threshing floors have not been dated (B. McLoughlin pers. comm.).
[269] *Zagora 1*, 6. In more recent times it is still not unheard of for people to walk six hours to their fields as was the case in early 20th century Methana (Foxhall 1995, 247 n. 43); in northern Nigeria agricultural workers are known to spend up to seven hours daily walking to and from their fields (McCall 1985, 340).
[270] We are only speculating since without any of the samples being water sieved using a fine mesh we cannot be sure as to how important smaller species, such as littoral fish, were.

We may speculate that the people of Zagora, who might have raised sheep and goats primarily for their wool and hair, ate a predominantly crop-based diet that was supplemented with sheep and goat meat on a regular basis from those animals that were no longer useful for providing fibre. Pig and cattle were also eaten and pigs were perhaps used as an insurance measure and as a means of reducing town waste, turning it into a useful product.

Animal bones, especially the larger and more robust ones, may have also been used for the manufacture of tools or decorative items. Such items may have included knife handles, needles, jewellery or furniture attachments.[271] Bone artefacts were found at Geometric period Zagora but we lack any debitage or other evidence for their manufacture at the site.[272]

4.5 Overview

The animal remains at Zagora reflect a varied diet and economy. Based on the limited ageing data available, we can tentatively propose that ovicaprids were raised primarily for their wool or hair and that they were likely consumed when the quality of their fibre declined. They were the most commonly consumed of the species recovered from Zagora. Although the ages available for cattle lack any quantification, the anecdotal evidence suggests that they would have been mainly used for secondary products such as traction and manure. It appears they were consumed more rarely than ovicaprids and only after they were too old to be used for draught, or before they reached old age and their meat was rendered less palatable. The last of the domesticates, pigs, would have been used primarily for their meat with at least 83% reaching the minimum age for optimal consumption. Their hide may have also been utilised as a by-product. There is no evidence that the canid or equid remains were from animals that had been consumed for food, although such a use was possible.

The wild animals, fish and hare, did not occur as frequently as the domestic species and would have at least supplemented the diet. Since the sieving at Zagora was dry sieving and we do not know the mesh size used, we have to be cautious in drawing too many

[271] Cattle metapodial bones were commonly used in tool manufacture (MacKinnon 2004, 26).
[272] Such as a bone point (possibly needle) and a cylindrical segment with four drilled holes (inv. 1789). Bone artefacts tend to be studied in isolation of the remaining bone assemblage unlike lithics where debitage and raw materials are studied together with the tools (Isaakidou 2003, 233).

conclusions concerning these smaller animals. Furthermore, we do not know the kind of fish recovered and they may turn out to be a larger pelagic species if the dry-sieve mesh was not fine enough to capture smaller fish bones, or if the soil contained clumps that encased the small fragments.[273] We may find with further excavation using better retrieval methods that many more smaller animals are identified, providing a greater insight into the diet, lives and economy of the people of Zagora.

[273] Payne 1975, 16.

5. Analysis of the animal bone distribution

5.1 Introduction

In this chapter, the distribution of the animal bones will be analysed. First, the possible effects of taphonomy on the assemblage will be explored in relation to both natural deterioration and the actions of humans and other animals. This is important to understand since the fragments of bones recovered from archaeological sites can reveal significant information on the kinds of activities that generated them.[274] The process of uncovering patterns in the animal bone distribution involved both statistical and non-statistical methods. These methods included examining changes in relative frequencies across the settlement, the architectural peculiarities of the ESs in which the various animal bones were found and the spatial patterning of the bones across the site. Such steps were necessary in order to reveal the patterns upon which the later interpretations are based.

5.2 Examination of taphonomy

With respect to human action, there are numerous ways in which bone can be deposited in archaeological contexts.[275] An example of an animal processing lifecycle is shown in figure 12. As can be seen, many different activities can reduce a carcass and influence the kind of portions that remain. The refuse that remains is then deposited 'as is' and buried, or it is burnt, or it is left on the surface to decompose naturally if it is not further reduced by animals. From deposition to excavation, what remains is largely the result of taphonomic processes.

Barnetson reported that all the bones were generally "very fragmented" and that "much" of the bones were small unidentifiable fragments.[276] She particularly noted those in the B area by the fortification wall as being "all rather friable and 'weathered' in appearance".[277] Weathering of bones can be caused by a number of factors, both when they

[274] This is particularly so when the analyst has included details on the condition of the individual fragments (such as cut marks, burning, rodent gnawing, or intentional break patterns). The ZBR rarely provides this detail.
[275] Bone is not only deposited through human action but also via other animals such as dogs and rats.
[276] ZBR, 2.
[277] ZBR, 15.

are on the surface or buried in soil.[278] Bones that are buried soon after deposition can still look reasonably fresh after thousands of years, whereas bone left exposed on the surface can become weathered quite quickly.[279] For example, on the shores of Lake Turkana in Kenya, Diane Gifford observed the rate of decomposition of bovid bones on the ground and estimated they would completely disappear within 20 years of continuous exposure.[280] Not all

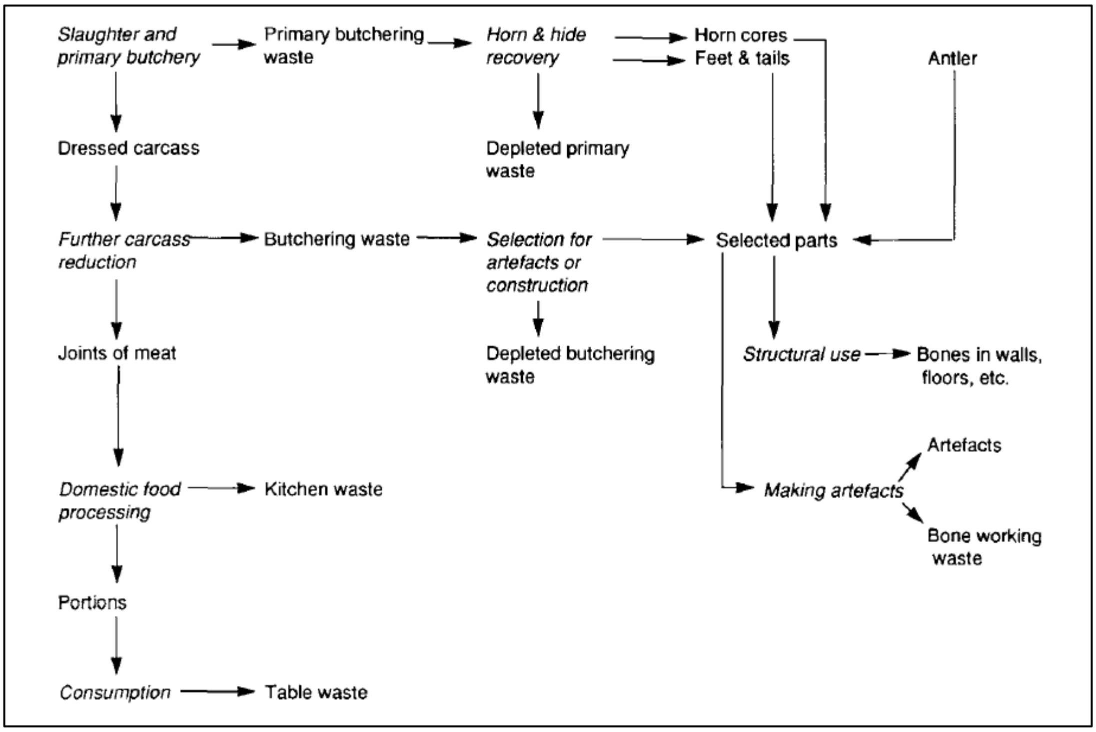

Figure 12 - Hypothetical carcass processing lifecycle showing animal utilisation and resultant assemblages (O'connor 1993, fig. 1).

bones preserve similarly, since the weaker bones such as ribs and vertebrae decompose faster, and those from young and female animals do not preserve as well as adult male bones.[281] Likewise, not all buried bone survives, and it largely depends on the conditions of the soil, with bone being less likely to survive in acidic surroundings.[282] Although the soil from the

[278] Behrensmeyer (1978).
[279] Hesse and Wapnish 1985, 24-5.
[280] Gifford 1980, 103.
[281] Payne 1972b, 68; 1985a, 230. Sometimes higher bone density does not correlate with survival in the archaeological record. Adult bones tend to be those used for making tools and could therefore influence their survival (Payne 1972b, 76; Enloe 2004).
[282] Lyman 1994a, 421-2. Even bone buried in some soils will not survive at all no matter how deep it is buried (Payne 1972b, 68), as is shown by the burials at Lefkandi (Catling 1985).

Cyclades tends to be acidic,[283] the results from the analysis of 11 soil samples from Zagora showed that they were all slightly basic.[284]

There was generally a bias in the Zagora bone assemblage towards those bone types that are sturdier and survive better.[285] Some of the deposits at Zagora contained bones that were well preserved, indicating that they were likely buried in the alkaline soil not long after disposal. Most notable are the bones found just outside the fortification wall (trench FW6), with Barnetson noting they were "reasonably intact … large identifiable pieces, and only a small number of splinters could not be positively identified to species".[286] FW6 contained the largest number of specimens in the settlement that were preserved well enough to allow their measurement (map 14). The body parts found here include most of the ovicaprid, including limb bones, so we cannot say that these were solely butchery waste but included parts of the animal that may have been consumed. That there was butchery waste here as well is evidenced by the presence of horn core fragments.[287]

If bone is left on the floor within a closed abandoned house it is not expected to decompose as fast, although it depends on how the house eventually collapses. Within one of the buildings at Azoria, a collapsed wall was believed possibly responsible for exposing bones to the elements and causing their subsequent weathering.[288] We cannot be certain as to whether this was the case at Zagora since we lack both quantified analyses of the bones and their stratigraphic location. It is likely that any bone remaining on the floors of rooms may have been pushed into the floor when the roof and walls eventually collapsed.

Floors made of permeable material are known to retain small fragments of refuse such as bone and pottery.[289] Ethnoarchaeological studies of houses with earthen floors have shown that when small fragments of bone are trampled they suffer uneven vertical displacement (sometimes over 20cm), even on floors that are regularly swept.[290] However, the earthen floors at Zagora contained little bone. Barnetson noted that the settlement was quite a "clean"

[283] Trantalidou 2006, 224.
[284] According to the Zagora soil report by Dan Leevers (unpubl. AAIA archives), the pH results of the samples were all between 7.5 and 8.0 except one that had a pH of 8.5. This indicated to Leevers that the samples would have all originated from a similar source, possibly from the local limestone schist formations.
[285] ZBR, 21.
[286] ZBR, 16.
[287] Lower legs, feet and horn cores could indicate the primary butchery of animals or they may reflect ritual or social choices (Snyder and Klippel 2000, 70; Haggis et al. 2004, 384; Trantalidou 2012, 1062).
[288] Haggis et al. 2011a, 442.
[289] Marciniak 2005, 81.
[290] Stahl and Zeidler 1990, 150-5; Lyman 1994a, 377-81.

site, in that there was not much bone refuse found in the houses compared to similar sites; the only exception to this was the courtyard J6.[291] General household trash can leave little trace since waste such as bone can be fed to dogs or pigs.[292] Dogs or pigs may have also contributed to the unidentifiable state of many of the bones found at Zagora.[293]

That there are a number of bones with traces of burning is expected.[294] It makes sense that bones were burnt both for hygienic reasons and because they would have been a source of fuel.[295] Although precise findspots within the ESs at Zagora are near impossible to determine based on the evidence available, we would expect most burnt fragments to have come from a hearth. An exception to this would be those found in the sanctuary.

5.3 Relative frequency of species

The ubiquity value is an indicator used by palaeoethnobotanists, and to a lesser extent zooarchaeologists, to give an idea of how common the remains of a particular species are at a site rather than how abundant they are.[296] It is the abundances that are usually used by zooarchaeologists to quantify animal remains.[297] Measures of abundance cannot and should not be used in an attempt to reconstruct original numbers of animals at a site but rather to get an idea of the relative importance of the various species.[298] Such measures depend on the identification of bone fragments to species and can be affected by a number of things other than taphonomic processes, such as the experience of the zooarchaeologist sorting the sample.[299] The ubiquity value is less sensitive to these effects and so can be preferred over measures of abundance when dealing with bones that may have been incompletely excavated

[291] ZBR, 21. Within J6 was originally thought to have been a pit but this is now believed to more likely be floor fill in which bone scraps were found.
[292] Clarke 2001, 161-2; Marciniak 2005, 82-3.
[293] Payne 1972b, 68.
[294] At least in B3, J23 and H30 (ZBR, 15, 18-9).
[295] Trantalidou 2008a, 368.
[296] Purdue et al. 1989, 149; VanDerwarker 2010, 65-7. The value has greater importance in palaeoethnobotany than it does in zooarchaeology due to the poorer preservation of plant remains and where absolute specimen counts can be affected by a larger number of factors (Popper 1988, 60-4). However, zooarchaeologists have found the measure effective when dealing with more fragile remains such as fish (Wheeler and Jones 1989, 152-3).
[297] The number of identified specimens (NISP) and the minimum number of individuals (MNI) are the most popular methods of quantification in zooarchaeology (Payne 1985a, 220; Lyman 1994b, 38; VanDerwarker and Peres 2010, 5-6).
[298] There are far too many different taphonomic processes at work to treat the remains as an accurate measure of the original living population (Lyman 1994a, 3-5; Amorosi et al. 1996, 138).
[299] Grayson 1984, 25-6; Payne 1985a, 214; Lyman 1994b; Atici et al. 2012, 3.

5.3 Relative frequency of species

Type	No. ESs Present	Ubiquity
Ovicaprid	35	74.5%
Cattle	28	59.6%
Pig	21	44.7%
Fish	5	10.6%
Hare	4	8.5%
Canid	1	2.1%
Equid	1	2.1%
Unidentified fragments only	7	14.9%
No bone	4	8.5%

Figure 13 – Ubiquity values for species found at Zagora. Unidentified fragments and those ESs from which no animal remains were recovered are included for reference (based on the 47 ESs analysed in this study).

or sieved.[300] Furthermore, studies have shown that ubiquity percentages duplicate the results produced by other quantitative measures such as MNI and biomass.[301] The ubiquity values for Zagora are shown in figure 13.[302] As can be seen, ovicaprids are the most commonly occurring species (75% ubiquity) followed closely by cattle (60% ubiquity). This is rather surprising given the prestige and expense associated with cattle.[303]

If we look at the breakdown of species ubiquity by area (fig. 14), then we notice the maximum occurs in the H area for all species except ovicaprids and hare. The lower values in

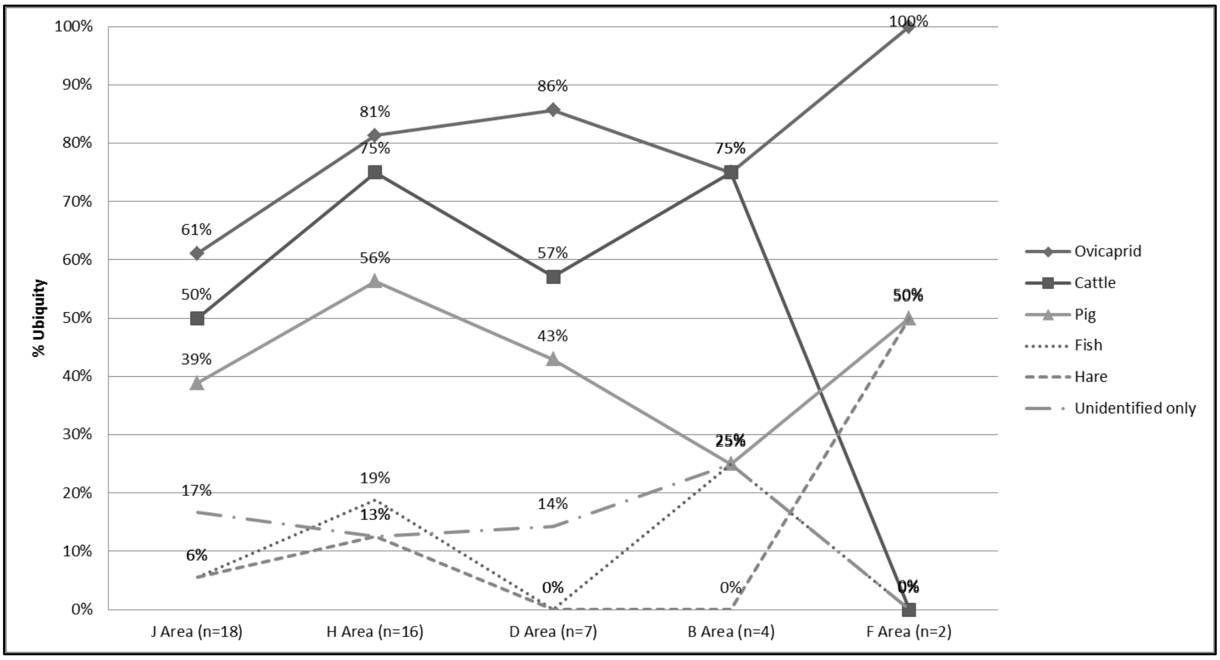

Figure 14 – Zagora ubiquity values for each species by area; including ESs with unidentified specimens only.

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300 Wheeler and Jones 1989, 152-3.
301 Crane and Carr 1994, 68.
302 It should be noted that there are four rooms thus far excavated at Zagora that contained no bone at all (H25, J12, J24, and J26), which span three house complexes (CH4, CJ4 and CJ3). This lack of bone does not appear to be due to excavator bias since all those who supervised these rooms had recovered bones from other rooms (J.W., I. McP., D.F. - H25; M.L. - J12 & J24; and P.J.C. - J26). It could be that the fragments were so small that they either fell through the sieve mesh or they were embedded in soil clumps that did not break up in the dry sieve.
303 Generally we should avoid projecting modern-day ‘perceptions’ of wealth associated with animals so far into the past, although in the case of cattle there is good documentary evidence from ancient Greece (Howe 2008, 31-2; deFrance 2009, 123).

the J area can be partly explained due to the presence of three ESs here in which bone was not recovered. The H area has one only ES devoid of bone but other factors must be causing the spike in ubiquity values here. When we look at the same measures without including the spaces where no animal bones were found or identified to species, we get a similar result (fig. 15). It is almost as if the area nearest the hypaethral sanctuary (H area) was 'attracting' the deposition of animal bones. The figures for ubiquity are interesting for the fact that the animals follow a similar pattern across the various sections of the site (we may pay less attention to B and F areas due to their small sample size).

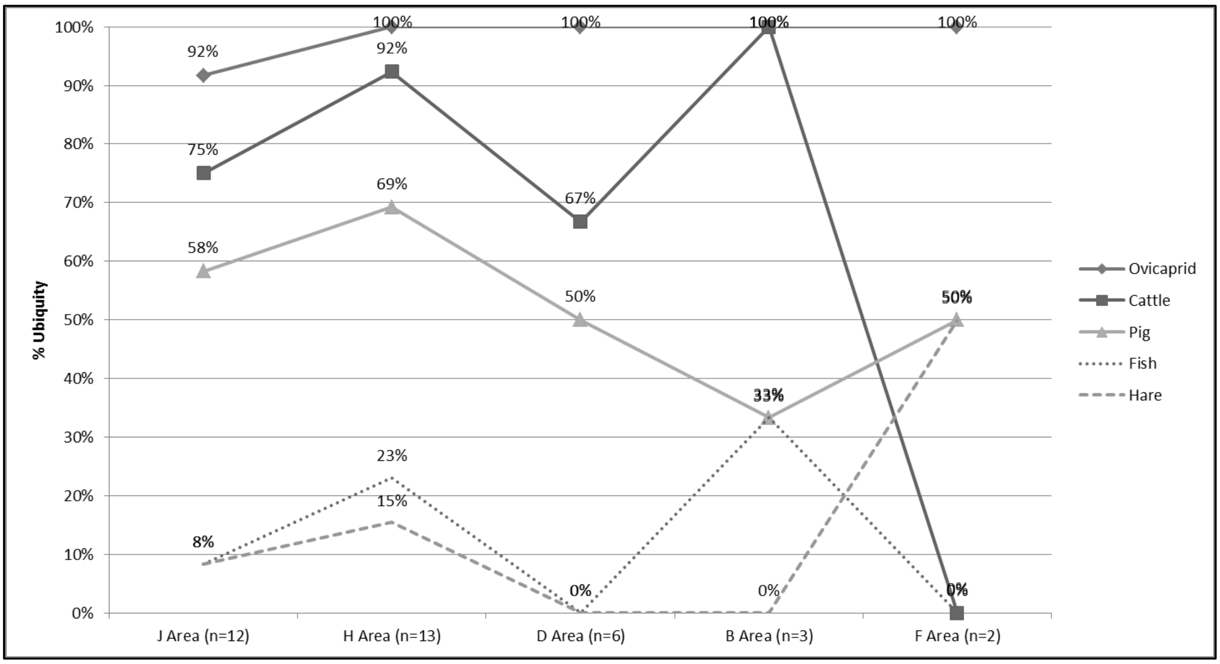

Figure 15 - Zagora ubiquity values for each species by area; not including ESs with unidentified specimens only.

Unfortunately, the ZBR does not provide NISP counts by species for all ESs. Such a measure would complement the ubiquity value and allow for a more precise spatial analysis. The ZBR does, however, provide the *total* NISP count for several individual ESs[304] and for one of these, D8, a breakdown by species. In D8 were recovered 57 identifiable specimens, comprising 33 ovicaprid, 19 pig and 5 cattle. In addition to D8, a breakdown of the NISP by species is provided for one of the fortification wall deposits (FW6) dating to the 9th century. Here were found 82 identifiable specimens of the main domesticates (57 ovicaprid, 18 pig and 7 cattle) along with four hare bone fragments. We cannot compare the two deposits, neither synchronically nor diachronically, since the stratigraphy is not specified for the D8

[304] Rooms D3, D4 and D5 had 0; D6 – 14; D7 – 2; D8 – 57; H19 – 51; H21 – 36; H22 – 71; H23 – 87; J4 – 1; J5 – 2; J6 > 90; J8 – 13; J9 – 4; J10 and J11 – 0; J21 – 25; J22 – 13. Unidentified fragments were obviously excluded from NISP counts.

deposit and the trench registers list bone being recovered from three different phases of the room.[305]

Figure 16 shows the ratio of abundance between the three main domestic species, cattle, ovicaprids and pig, from the two Zagora deposits with NISP data as well as from other Greek EIA sites. A number of different ratios are evident with ovicaprids making up at least half of most assemblages; the exceptions are Eleutherna, Kastanas and Nichoria. Of all the settlements, the proportions from Asine (albeit with a small sample size) most closely match those at Zagora. The variety in the relative frequencies can probably be explained by the differing local environmental conditions at each site.[306] For example, Nichoria has surroundings favourable for rearing cattle, perhaps accounting for their dominance in the assemblage.[307] Other reasons are needed to explain sites such as Kastanas, which was located on a small river-estuary island, 70m from the shore. Here, where there was little room for the

Settlement	**NISP**	**Cattle**	**Ovicaprid**	**Pig**
Zagora, Room D8 (Geometric)	57	8.8%	57.9%	33.3%
Zagora, Fortification Wall (9th C. BC)	82	8.5%	69.5%	22.0%
Oropos, Euboea (8th-6th C. BC; >44% is 8th C.)	4,097	8.5%	86.8%	4.6%
Kavousi Kastro, Crete (mainly Late Geometric)	2,640	8.7%	82.0%	9.3%
Profitis Ilias (Gortyn), Crete (8th C. BC)	110	10.0%	71.8%	18.2%
Asine, Peloponnese (Geometric)	18	11.1%	66.7%	22.2%
Eleutherna, Crete (1400-700 BC)	86	15.1%	33.7%	51.2%
Kastanas, Macedonia (1000-800 BC)	4,826	19.2%	43.3%	37.5%
Nichoria, Peloponnese (DA III, 850-775 BC)	130	48.5%	34.6%	16.9%
Cultic & Cemetery				
Minoa, Amorgos - Stratum IV (mainly Geometric)	1,669	3.1%	94.7%	2.2%
Daphnephoron, Eretria (Geometric)	94	3.8%	86.2%	10.6%
Sanctuary of Athena Alea, Tegea (Geometric)*	-	9.0%	67.7%	23.2%
Xobourgo, Tenos - pyres (Geometric)	167	10.2%	74.3%	15.6%
Kastri, Thassos (EIA)	86	17.4%	77.9%	4.7%
Sanctuary of Demeter, Knossos (Geometric)	21	19.1%	61.9%	19.1%

* Estimates from chart published by Vila (2000, fig. 1)

Figure 16 - Abundance ratios of the three main domesticates from Greek EIA sites (data from Trantalidou (2007, fig. 20; 2012, tables 2 and 11); Vila (2000, fig. 1); Wilkens (2003, table 8.4)).

management of livestock, it was assumed that they were probably brought in from the mainland.[308] Pigs may well have been the only exception since they can live at close quarters

[305] According to the records in Heurist, the pottery from this room dates from the 9th century to the turn of the 7th century BC.
[306] Trantalidou 1990, 394.
[307] Dickinson 2006a, 99.
[308] Becker 1998, 79.

with humans, recycling their food waste and refuse, and their higher percentage here could testify to that. Eleutherna has the highest proportion of pigs (over 50%) which is surprising given its mountainous surrounds that one would think to be more suitable for ovicaprids.

5.4 Patterns in size of space

Across the site of Zagora, the average ES size where each species is present is larger than where they are absent (fig. 17). The species that are on average found in the largest ESs in the settlement are fish, cattle and hare. Given the commonness of ovicaprid fragments, we would not expect the average ES size for where they are present to be far from the site average. On the other hand, species that have been found in few ESs (fish and hare) are expected on average to be absent in ESs sized close to the settlement average. Pigs occur in 43% of the analysed ESs. The difference between the average size of the ESs in which they are present and those where they are absent is relatively small; almost equidistant either side of the settlement average. It is interesting to note that ESs in which only unidentified fragments were found are on average smaller than ESs in which they were not found, reversing the trend. ESs in which only such fragments were found could be areas with poorer preservation than the others on the site or else they may have been kept cleaner by the residents, with only these smaller fragments escaping their eye.

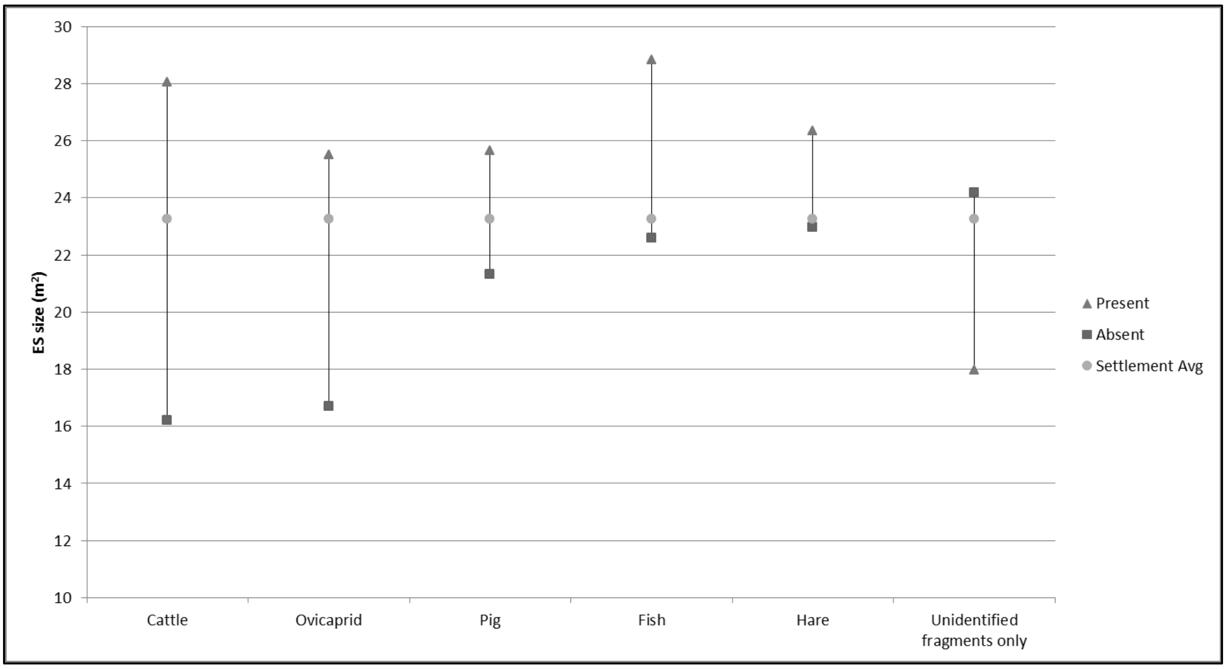

Figure 17 – Average ES size where each species were present or absent, plotted with the average ES size of all ESs included in the study. 'Unidentified fragments only' values provided for reference.

5.4 Patterns in size of space

In order to discount the effects of outliers skewing the results, the 5% trimmed means were calculated for each of the species (fig. 18). The 5% trimmed mean is calculated by removing the largest and smallest 5% of ES sizes for each species and then computing the average.[309] If the result was radically different then we would know that it was due to the outliers.[310] As can be seen, the results produced are similar and outliers do not seem to be affecting the results. Other answers must be sought to explain the patterns observed.

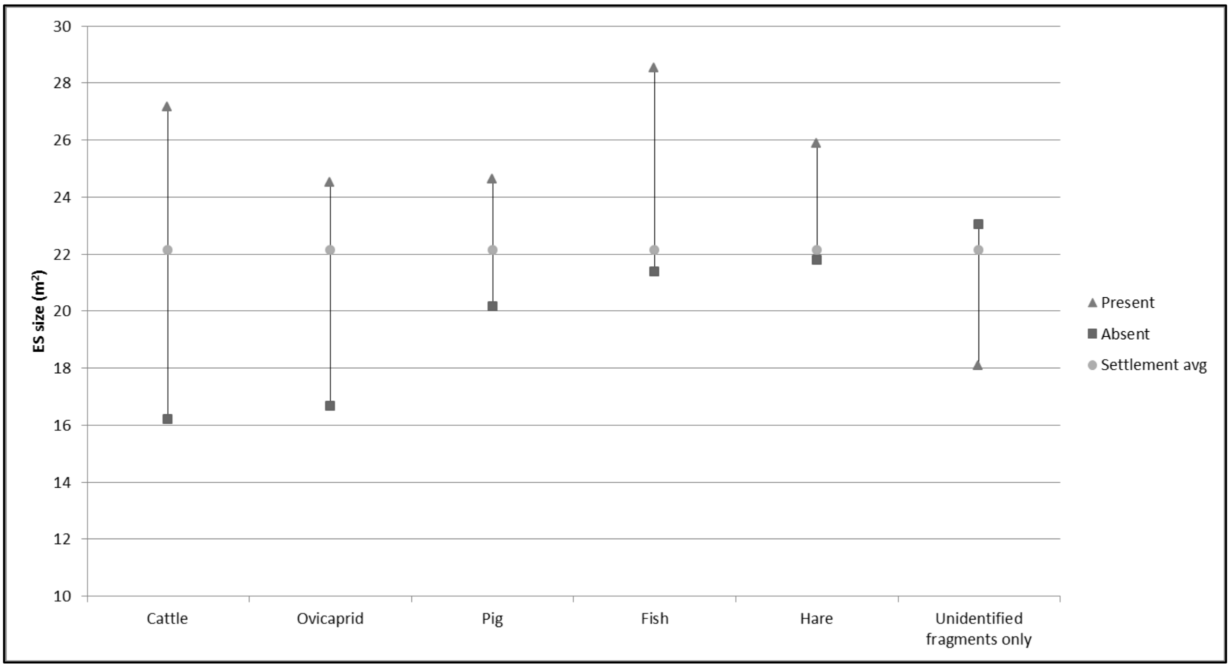

Figure 18 - Average ES size where each species were present or absent, plotted with the average ES size of all ESs included in the study. 'Unidentified fragments only' values provided for reference. All values shown here are the 5% trimmed mean values.

The average ES size in which cattle and fish occur is greater than 28 m^2, and hare a little over 26 m^2. The average ES size where cattle do not occur is smaller than the average ES size where any other species does not occur. The greatest variance between the size of the average ES where a species was present and where they were absent is exhibited by cattle. The average size of the ESs devoid of fish and hare bones are not far from the site average as is expected given the small number of occurrences of each of these species.[311] It appears then that, generally speaking, these three species may have been intentionally treated differently to ovicaprids and pigs by the people of Zagora. If the fish remains are in fact from a larger deep-sea species, then we may be dealing here with a rarer, seasonal food.

[309] This is calculated using a formula so that even though there may not be enough of a sample to remove a whole outlier, the upper and lower 5% of the sample is still trimmed.
[310] However, we could not assume that all outliers have been removed.
[311] Fish was found in five rooms and hare in four.

5.4 Patterns in size of space

When we break down the average space size for the three main species by J, H and D areas, we get a similar result (figs. 19 and 20). It appears that cattle bones have an aversion for small spaces since the average size of the ESs in which they are absent is the smallest of the species. Where they are present, they appear in the largest space size on average with the exception of D in which they are a close second to pig. This demonstrates that the pattern we are seeing here with respect to cattle is not a mere reflection of one area skewing the results but rather a broader trend. Fish and hare were not included in this breakdown since they both only occur once in J and do not appear at all in D.

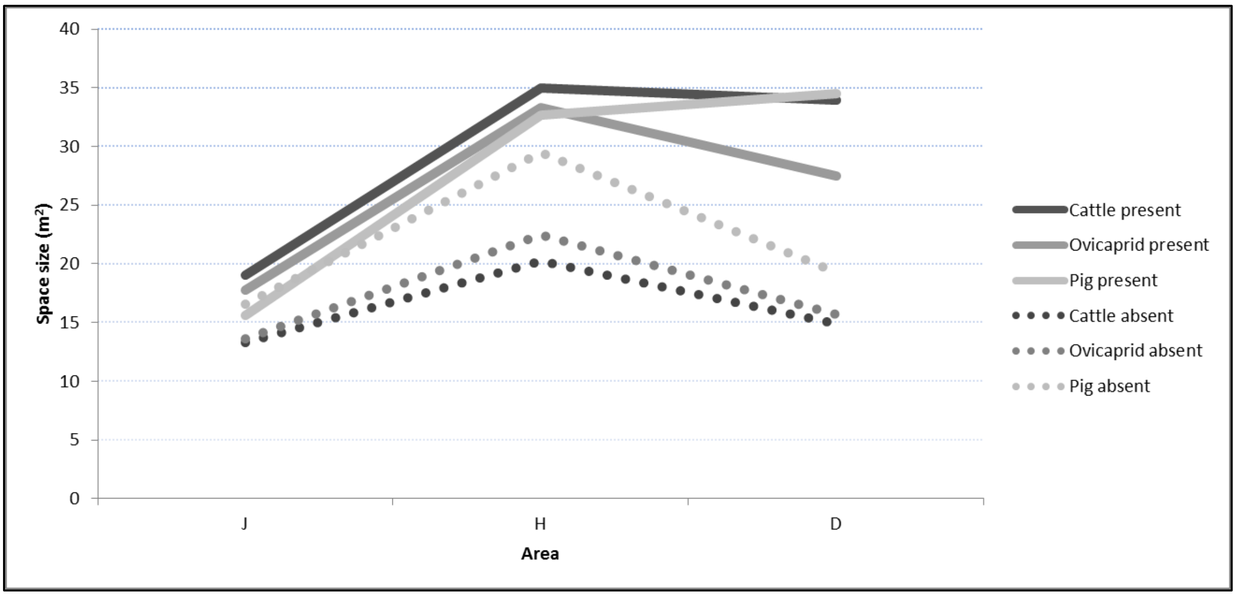

Figure 19 – Average ES size where each of the three main domestic species were present or absent across J, H and D areas.[312]

	J area	H area	D area	All (J, H, D, F, B)
No.	18	16	7	47
Avg size	16.16 m^2	31.30 m^2	25.79 m^2	23.26 m^2

Figure 20 – Average ES size by J, H and D areas, with average ES size of all ESs included in the study.

312 Fish and hare are excluded.

5.5 Ovicaprid sizes

Although a significant number of bones were measured, it was mostly limited to just one example of each type. If we were to use bone measurements in estimating original animal sizes, such as with allometry, we would need larger samples that were measured following strict parameters.[313] Unfortunately, the samples from Zagora do not meet these requirements. The largest sample of measurements provided in the ZBR is for ovicaprid astragali, of which we have nine. There is a relationship between the size of the weight-bearing elements of an animal and the animal's weight and size.[314] The astragalus, being a weight-bearing bone in the lower leg, is therefore an indicator of how large the animal was from which the bone came. We may then use the size of the ovicaprid astragali to get an indication of the relative sizes of each; at a minimum we can establish their size ranking order.

If we compare the size of the astragali recorded in the ZBR with the size of the ESs in which they were found, we see that when one increases, so does the other (figs. 21 and 22). The results from the Gamma statistic test show a strong relationship between the size of the ovicaprids and the ESs within which they were found (appx. 3). Also, the statistical significance is such that it is fairly unlikely that this relationship is due to chance. The two largest ovicaprid astragali were found in H21 and H23, both opposite the hypaethral sanctuary.

ES	ES Size (m^2)	Astragalus max lateral length (mm)
B3	23.45	28.5
D8	53.76	28
J6	12.78	26
J6	12.78	29
J21	9.32	26.5
H21	60.76	33
H23	31.55	32
H35	23.04	28
H41	23.12	28

Figure 21 – Measurements of ovicaprid astragali from Geometric period Zagora and the corresponding ES size within which they were found.

313 Reitz and Wing 2008, 66-8.

314 Although it is not a linear relationship (Johnstone and Albarella 2002, 23; Reitz and Wing 2008, 64-5).

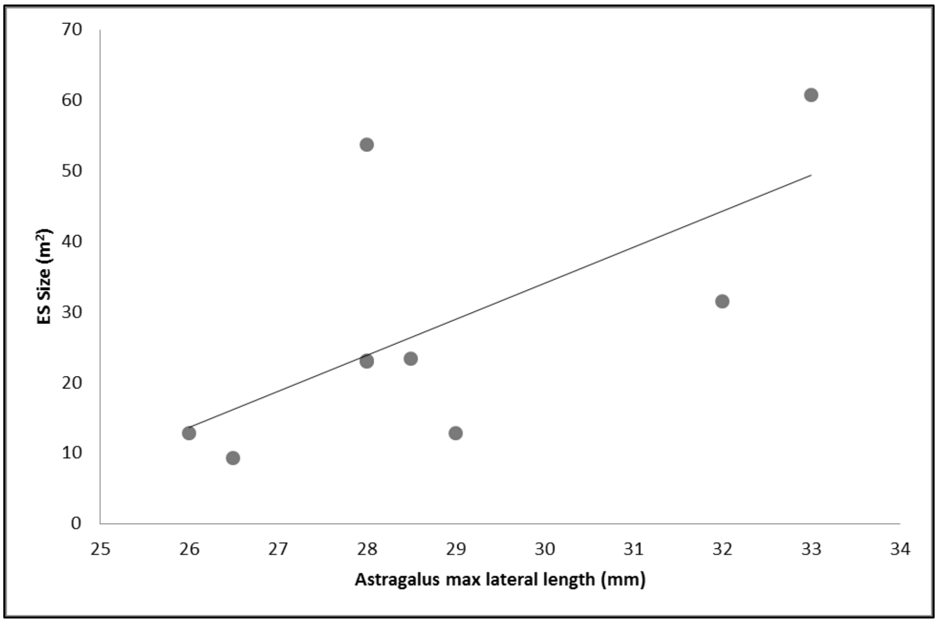

Figure 22 – Scatter plot showing relationship between ES size and ovicaprid astragalus size.[315]

5.6 Spatial patterns

The distribution of the various species of animal bone was first examined visually to see if any patterns stood out. Ovicaprid, the most common of the species at Zagora, appear to show some clustering, particularly in the J section (map 5). Given its prevalence, it is difficult to observe too much more except in the odd patches where the species was not found.[316] The next most common species, cattle, also do not have anything obvious in their distribution (map 6).[317] Pigs were identified in 43% of analysed ESs which means that there is roughly an even split between ESs containing them and not. There are what appear to be clusters in their distribution in both H and, more obviously, J areas (map 7).[318]

Fish and hare are not common enough and too well spread for any patterns to be discerned in their distribution, while equid and canid only occur in one ES each (maps 8-11). All we can say is that all four species occur in the H area, with equid and canid only occurring here. Although fish and hare are found spread across the site, they are more common in the H area where they appear to be focused in ESs near the hypaethral sanctuary.

[315] The Gamma statistic that was used to measure the relationship between ES size and ovicaprid size is produced using the rank of scores whilst this scatterplot displays the raw data and therefore is not indicative of how the correlation was calculated.
[316] There are occasional clusters of two neighbouring rooms without ovicaprid bones such as J24 and J26; J10 and J11; J1 and J2; H25 and H32.
[317] Similarly, with cattle there are pairs of rooms in which they are absent: J24 and J26; J10 and J11; J4 and J5; J1 and J17; J12 and J17; H25 and H32.
[318] In the J area there appears to be two clusters of rooms containing pig bones: J5, J6, J21, J22, J8 and J15, J17.

However, such visual observations need to be tested statistically to see whether any of them hold true or if others can be revealed.

As an additional measure in determining whether there is any spatial patterning, the join-count statistic was used to test for the presence of spatial autocorrelation. Because it requires contiguous joins between ESs, the test was performed separately for both J and H areas; D, B and F areas with few contiguous ESs were not included. Hare, canid and equid were excluded from the test since they each occur in too few ESs. The results and the calculations are presented in appendix 4. The J area did not show any statistically significant spatial autocorrelation for any of the species tested. In the H area, the only species to exhibit patterning is fish, which shows slight negative autocorrelation. The result tells us that it is not very likely that the distribution of fish here is random but rather that it is showing some dispersion. It is interesting to note that the three ESs in the H area where fish bones were found belong to three different houses (see map 4), meaning that the dispersion shown statistically is also validated by human classification. However, due to the small sample size involved we should treat this result cautiously.[319]

Thus with the exception of fish in the H area, we should accept that the animal bones of each species were randomly distributed within at least the J and H areas. This does not necessarily mean that they were randomly distributed whilst the site was occupied, but rather that the variety of different activities and taphonomic processes that took place on the site resulted in the random distribution with which we are left.

A further test was conducted to see if there were any patterns in the co-occurrence of different species. A chi square test of independence was performed to determine whether the species co-occurrence was the same as one would expect due to chance or whether there might be something significant in their distribution. The calculations and results are reproduced in appendix 5. There is only one result worth noting and that is the co-occurrence of pig and fish. The results of the chi square test means that it is fairly unlikely that it is simply the result of chance that pig and fish occur together, or conversely that they do not occur together. The strength of this association was found to be medium. Thus, the presence of pig and fish together in the same ES might be related in some way other than by chance.

[319] See Griffith (1987, 34) for details regarding sample sizes that produce the most reliable results.

It is interesting to note that such a connection has been observed at Mesolithic and Neolithic fishing sites across the Mediterranean and in Scandinavia. It is as yet unexplained why these geographically and temporally separated fishing communities chose pigs almost exclusively when other ungulates were also available in their surrounding environment.[320] It was suggested that the pigs may have scavenged the shore for molluscs or were fed seafood leftovers by the people in these communities.[321] In the EIA, the low quantity of fish bones recovered from the seaside settlement of Oropos could be due to their remains having been given to pigs rather than being disposed of elsewhere as suggested.[322]

5.7 Complexes of space

Several houses have been identified by the excavators and the *Zagora 3* team based on the settlement's architecture during its final occupation phase (map 4).[323] These houses or 'complexes' are domestic units comprising of linked spaces both roofed and unroofed. Most of the complexes contain an unroofed area, or courtyard, and in many it is centrally located. A breakdown of spaces within houses and the species found there is given in appendix 2, tables A2.4-6.

The courtyards tended to be the largest sized ES within each complex and may have served as spaces for cooking and dining in good weather when larger groups gathered. Fragments of cattle and ovicaprid bone were found in all five courtyards where species were identified and pig was found in three of these. Fish and hare bones were not found in courtyards. This could be due to a number of factors; most likely, because they do not preserve as well as the larger animals and exposure to the elements would have had a greater impact on their survival. CJ3 is unique in being the only complex not to have pig bone found within it. This could be because just one room here contained bone (50% of its rooms did not have any bone at all) and its large courtyard, J7, had only a fraction excavated to bedrock, in its northeast corner. Nothing else stands out rather obviously concerning the distribution of the animal bones or patterns both within and between complexes.

[320] Masseti 2007.
[321] In of one of these cases (Gotland, Scandinavia) the stable isotope values of the pig bones were tested and came up negative for a marine diet. One possible reason suggested for this was that the pigs may have been seasonally hunted by the local inhabitants (Masseti 2007, 168-70).
[322] Theodoropoulou 2007, 430.
[323] The only houses to have been reproduced for analysis were those whose walls were 'completely' revealed and had a majority of their ESs included in this study. Possible single-room houses in B and F areas were not included since further excavation may reveal they were part of larger complexes.

5.8 Overview

Many of the animal bones recovered from Zagora were badly fragmented or weathered, thus rendering them unidentifiable. This could be due to extended exposure on the surface or because they were processed by humans, domestic animals or scavengers. Those fragments that have been identified were randomly distributed across the site apart from fish, which shows a dispersive distribution in the H area. No obvious patterns in the bone distribution have been identified between the different house complexes. The ubiquity values have given an indication of how common the species were and allowed an examination of their varying frequencies across the different areas of the settlement. If we exclude the smaller samples from B and F areas, the ubiquity for all species peaks in the H area.

To a certain extent, the size of the animal appears to be related to the size of the ES within which it was found. Since there are two independent sources of evidence for this, the cattle and the ovicaprid sizes, it suggests that the pattern evident is genuine and the correlation in these instances between space size and animal size is surely not a coincidence. This should not be seen as implying that large animals were only found in large ESs, or that all large ESs served the same purpose, but rather that this is a trend across the settlement.

6. Interpretation of the animal bone distribution

6.1 Introduction

This study was conducted using only the animal bone and architectural evidence from Zagora. The associated artefacts, which were not all available, were not considered in the interpretations here; something far from ideal but nonetheless useful observations can still be made. Therefore, the following discussion contains a number of assumptions incorporating a fair amount of subjectivity. As with all interpretations of evidence, the further they are removed from the scientific the less verifiable they will be. Wherever such bias does occur, as much reasoning as possible is provided for the choices made, even though at times they may not seem acceptable.

6.2 Cult at Geometric Zagora

During the Archaic period, some time after the settlement had been abandoned, a temple was built in the large open section between the H and J areas, at one of the highest points of the site.[324] The altar in the temple sits on a Geometric period level, which implies that this was also a cultic area during the life of the settlement, likely an open-air one.[325] Part of a Geometric period wall discovered here a few metres to the west of the temple has been identified as either a retaining wall for this built-up area or an enclosure wall possibly demarcating the pre-temple hypaethral sanctuary.[326]

Animal bones were found not only in the Archaic period temple, but also in the Geometric levels below. Barnetson reports that there was little bone here in general during the settlement's occupation but there were "the remains of two very immature pigs, an immature O/C, a burnt piece of O/C femur (age not determinable) and a fragment of O/C innominate (pelvis) with ancient cut mark". [327] Precise proportions of species are not provided, however we can make some estimates based on the few numbers we have. Of the

[324] Cambitoglou 1981, 82-4.
[325] Cambitoglou 1981, 83-4; *Zagora 2*, 168-71.
[326] *Zagora 2*, 173-5.
[327] ZBR, 19.

274 fragments reportedly found here, we are told 74 were from pigs although not all levels were provided specific quantities. The Geometric period contained *at least* two fragments ("remains of two very immature pigs"), the temple floor *at least* three fragments ("a number of bones from at least three piglets"), and above the temple floor 60 fragments ("very immature pigs (some 47 bones and 13 teeth)").[328] Only one cattle bone fragment has been positively identified and that was from the Geometric period.[329]

Although at first glance the near absence of cattle may appear unusual for the settlement, it could actually correspond to the proportions found in the other deposits. If we accept that based on the above there were between two and eleven pig fragments found in a Geometric period context below the temple, it would mean a cattle-to-pig ratio of between 1:2 and 1:11. The approximate ratio of cattle-to-pig from D8 is 1:4 and from FW6 it is 1:3. The cattle-to-pig ratio at both the Sanctuary of Apollo Daphnephoros at Eretria and the Sanctuary of Athena Alea at Tegea is 1:3 (fig. 16), within the possible range of the Zagora sanctuary. Thus based on the proportions of these two animals, there is probably nothing out of the ordinary in the Geometric period sanctuary. The lack of cattle from the sanctuary's Archaic levels and therefore their difference to the settlement should not occupy discussion here since not only are we dealing with a chronological gap, but also the husbandry practiced may have been different. We would be better to compare the Archaic assemblage with that of the settlement from where the visitors likely came.[330]

It is feasible to compare the animal bones from the Geometric period levels described above with those from contemporary sanctuaries. From a zooarchaeological perspective, the biggest hint that there existed a sanctuary here during the Geometric period is the presence of a fragment of burnt ovicaprid femur, the standard anatomical offering to the gods. The evidence from Zagora agrees with the findings of Chenal-Velarde and Studer, that femurs should be absent from areas of human consumption.[331] Of all the body parts mentioned in the ZBR, the femur is only mentioned once, here in the sanctuary. All the other bones that are measured, aged or noted in the text are from other parts of animals.

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[328] ZBR, 19-20.
[329] ZBR, 19.
[330] Given that the offerings tended to be lambs and piglets, an interesting hypothesis could be that a number of visitors to the Archaic period sanctuary arrived by ship and could therefore only transport livestock of a smaller nature. This would be feasible since Zagora sits along an important navigational route between the important Euboean settlements and the east (*Zagora 1*, 1 n. 3).
[331] Although they were unable to compare with contemporaneous secular buildings (Chenal-Velarde and Studer 2003, 217-9).

6.3 'Special' food at Zagora

Timothy Howe has shown that based on literary evidence including Homer, Hesiod and Aristotle, large animals such as cattle were considered the most prestigious in ancient Greece.[332] At least by the later Archaic period, such prestigious animal wealth had an important link to family reputation and identity.[333] Given that cattle were the most expensive of all the domesticates at Zagora, their slaughter for food must have taken place during a special occasion. Even if they were used primarily for secondary products and slaughtered when they were no longer useful, their consumption would have been an important event since they would have provided a rarely consumed meat for many people. During the later Classical period, the sacrifice of working cattle was generally forbidden and was only conducted under exceptional circumstances.[334] One might imagine that this was because their draught capabilities were valued higher than their meat. Whilst sheep and goats are easy to maintain and can live off the smallest shrubs in a dry environment, cattle need to be well-watered and have access to large amounts of open pasture and feed – especially expensive in rough, rocky areas with a dry climate and where valuable water, land and feed would have needed to be diverted.[335]

The sharing of cattle meat beyond the insular household would have been essential unless large-scale preservation, such as by smoking or salting the meat, took place.[336] Barnetson in her analysis of the cattle bones reports:

> Some of the cattle bones in the houses showed signs of butchering but not all parts of the skeleton are represented. There may have been joint selection from the beef carcass or greater dispersal of the elements of the carcass.[337]

This observation agrees with the situation where cattle meat was shared amongst the town's inhabitants.[338] That the slaughter and consumption of cattle were 'special' occasions is evidenced by the large average size of ES in which their bones were found. One might ordinarily assume that expensive animal equals rich person and therefore a large rich person's house to host feasts. However, given the frequent occurrence of cattle bones and their random

[332] Howe 2008, 31-44.
[333] Howe 2008, 44-5.
[334] Jameson 1988, 87.
[335] Howe 2008, 31-2.
[336] In modern Greece before the advent of domestic refrigeration, cattle were usually sold in towns and rarely consumed in villages due to their size (Dabney et al. 2004, 201).
[337] ZBR, 23.
[338] Dabney et al. 2004, 213; Haggis et al. 2011b, 26; Russell 2012, 118-9, 389-90.

distribution, different reasons must be sought to explain the appearance of such 'special' meals or feasts within the larger spaces.

Although Zagora's location so close to the sea makes it quite possible that the inhabitants' diets included small shore fish, we lack their evidence. If in fact the remains recovered from Zagora are from larger fish, then what we may have is a pelagic species that would have required more expertise in catching than the littoral variety.[339] This might then make its consumption yet another 'special' meal. Since fish remains were found in the largest average space size of all species in the settlement, we may have evidence that such loci were used to prepare or consume these 'special' meals.

By the Archaic period, the meat consumed from domestic animals is believed to have been generally obtained by sacrifice and there is nothing to suggest that this was not also the case during the Geometric period.[340] At Zagora, the sacrifice and subsequent feast could have taken place in the open near the hypaethral altar, or in the larger ESs nearby, with people taking home leftovers or certain cuts of meat to explain the dispersal of cattle body parts. We are yet to be provided with good evidence for butchery waste at Zagora; the goat horn core in H23 could have been or it may have had ritual significance, as was the case at Geometric period Dreros.[341]

6.4 Interpreting the spatial distribution of the animal bones

During the EIA, cattle were a symbol of wealth and they were used to trade and barter for goods and services.[342] Nerissa Russell suggests that in early societies animal remains, along with architecture, should be used to establish prosperity at the individual household level as is already done with metals, since animals would have been an important signifier of wealth.[343]

[339] When retrieval methods are poor or not specific (here Zagora mesh size), caution must be observed in assuming that larger fish dominated the smaller, more easily accessible, species in the diet (Mylona 2003, 198). The level of sieving can have a significant impact on the conclusions drawn from the material. For example, at medieval Flanders in Belgium up until the 1990s, scholars believed that cod was a fairly common fish in households. In the 1990s, when large samples were starting to be systematically sieved with fine meshes, it was revealed that smaller fish previously missed in excavation were in fact more common, thereby elevating cod to a higher status amongst food consumed here given its now relative 'rarity' (Ervynck et al. 2003, 434).
[340] Jameson 1988, 88; Durand 1989; Russell 2012, 118-9. Tuna is the only fish sacrificed before being eaten but only under exceptional circumstances when offered to Poseidon (Detienne 1989, 3 n. 8).
[341] Deonna 1940, 111; ZBR, 13.
[342] Dickinson 2006a, 103-4.
[343] Russell 2012, 357.

6.4 Interpreting the spatial distribution of the animal bones

Of all the domesticates found at Zagora, pigs are the easiest to rear and are the most efficient converters of energy consumed to meat. It is chiefly because of these reasons that pigs have been seen as the meat of the ordinary people, whereas ovicaprids and cattle are linked to greater wealth.[344] May we (cautiously) consider that under ordinary circumstances pigs at Zagora were a utilitarian animal of lesser value and status than ovicaprids or cattle?[345] If this was so, it may explain some of the differences in their distribution across the settlement.

One way to check for socio-economic differences is to examine the changes in animal ubiquity between areas. It is not worth comparing ovicaprids since they are found in nearly all of the spaces where animal bones have been identified to species. Similarly, fish, hare, equid and canid are not worth comparing since they are so few and do not occur in the D area. Pig and cattle then are the best to compare, since not only are their ubiquity values comparable, but they also represent the opposite ends of the scale in terms of wealth and so can assist in locating any social differentiation. Moreover, cattle make a good control for the results observed. This is because the two main impacts on the content of a zooarchaeological assemblage, taphonomy and excavator or analyst bias, would not appear to be influencing factors.[346] If the ubiquity values were affected by taphonomy then we would not have such a high ubiquity percentage for ovicaprids, which are more fragile than cattle and therefore not as well preserved.[347] The results are not likely to have been skewed due to excavator or analyst bias either because cattle are the most overrepresented domestic species when recovery methods are poor and they are the most readily identified due to their better state of preservation.[348] We can therefore expect that the results of any analyses of cattle bones will be the closest to being true.

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344 Grigson 2007, 102-8; deFrance 2009, 117.

345 The status with which someone holds certain foods depends on the viewpoint of their particular culture. We should be cautious with how we make such assumptions and place modern values on ancient food. At least in medieval Britain, pigs were considered high status because of their lack of secondary products and the fact they compete with humans for food (deFrance 2009, 126). Certainly they would not have been a luxury if a small number were kept by the home and fed entirely off human waste and kitchen refuse (Isager and Skydsgaard 1992, 85).

346 Payne 1985a, 212-5.

347 Reese et al 2000, 416, 450-1.

348 Sebastian Payne has shown that cattle bone has the best recovery percentage when an assemblage is dry-sieved only (as at Zagora) compared to smaller species such as ovicaprids and pigs. In the experiment, 83% of cattle, 60% of pig and 58% of ovicaprid bones were recovered by dry-sieving alone (Payne 1975, fig. 8; 1985a, table 2). Even if a particular deposit was only hand-sorted and not sieved, larger species such as cattle would have been overrepresented (Payne 1972a, 59-61; Payne 1975; Snyder and Klippel 2000, 68-70).

The difference in the ubiquity values of pig and cattle is largest in the H area. This could be an indicator of a preferred taste for beef here, the differential survival between the areas, or a difference in wealth where those better off needed to resort to pig less often. Furthermore, the ubiquity value of cattle increases by the largest amount of all the species from D to H and J to H (fig. 23). Given that cattle were such prominent animals, these observations suggest that H could be an area with households of higher wealth.

	J -> H	H -> D	D -> J
Ovicaprid	8.3%	0.0%	-8.3%
Cattle	17.3%	-25.6%	8.3%
Pig	10.9%	-19.2%	8.3%
Fish*	14.7%	-23.1%	8.3%
Hare*	7.1%	-15.4%	8.3%

***Fish and hare were not found in the D area**

Figure 23 – Difference in ubiquity values between the J, H and D areas at Zagora by species (percentages calculated using only those ESs containing fragments identified to species).

The two biggest astragali were found in H21 and H23, both in prime positions opposite the hypaethral sanctuary.[349] Both of these ESs belong to CH1, which was the complex with the largest concentration of identified specimens (map 13). Another room from the same building, H22, was one of only two ESs to contain a fragment from immature cattle, that all-important signifier of wealth. Killing a valuable draught animal for food before its time could have been a display of status.[350] Also belonging to this complex is H19, the large room with a pithos storage bench and hearth that was the only ES at Zagora in which all the identified species (with exception of canid and equid) occurred together. This is also the only ES in which the species that occur on average in the three largest ESs were found together.[351] The courtyard here, H21, is an ideal open location for feasting on an animal sacrificed at the adjacent sanctuary and capable of accommodating a large number of people.

Some might remark that the recovery could be bias on the part of the excavators, who paid more attention here than elsewhere given that this complex (CH1) was closest to the later temple. There could also be another reason to account for it. This building contains the oldest structures in H block, dating to the Middle Geometric period, so one would expect a higher number of bones to have accumulated here and this is what we see with the NISP

[349] Coincidentally, astragali have a very long history of use in ritual and divination (Dandoy 2006).
[350] In consuming a 'luxury' food (Ervynck et al. 2003, 433).
[351] That is, cattle, fish and hare.

counts (map 13). Furthermore, if we look at the distribution across the settlement of those bones that were preserved well enough to measure, we find the largest concentration (nine) here (map 14). By comparing maps 13 and 14, it can be seen that the ESs with the greatest NISP counts were also those with the greater quantity of measurable bones. Although not true in all instances, it makes sense that a room with a greater number of identifiable fragments will produce a larger quantity of both well and poorly preserved specimens. In the case of CH1, this is just as likely due to its antiquity as it is excavator bias.

6.5 Feasting as an explanation of the spatial distribution

Feasting in the EIA is best known from the Homeric epics where it is one of the most common activities represented.[352] There are a number of different definitions of feasting in the literature; however, they almost all agree that a feast involves a meal that is out of the ordinary.[353] A simple but adequate definition for our purposes here is Brian Hayden's: that a feast is "any sharing between two or more people of special foods (i.e. foods not generally served at daily meals) in a meal for a special purpose or occasion".[354] Feasts can occur anywhere, depending on the nature of the event. They can take place from the household level through to large-scale banquets involving hundreds of people. They can be used to create and maintain relationships on a number of levels from establishing kinship at the household level to reaffirming bonds between leaders of different groups.[355] All feasts usually have some typical archaeological correlates that characterise them such as rare, high status or large volumes of food, distinguished architecture, or special eating, drinking or serving vessels.[356]

Based on ethnographic observations, there is generally a relationship between the size of the largest animal being consumed and the size of the feast.[357] If large animals such as cattle were being consumed, then a large feast would be expected and a larger space needed to hold the participants. Large domestic animals are conspicuous at feasts in a variety of

[352] Sherratt 2004, 301-11.
[353] Russell 2012, 377-8.
[354] Hayden 2001, 28.
[355] Dietler 2011, 182.
[356] Dietler 2011, 184-5.
[357] Hayden 2001, 49.

cultures and they are usually synonymous with feasting due to the difficult logistics of a single family consuming them.[358]

The zooarchaeological evidence suggestive of feasting at Zagora includes at a bare minimum cattle, which would have provided both a high status and large quantity of food. Possibly also a high status and rare food was a pelagic species of fish, if we accept the earlier assertion that this is indeed what they were. The larger ovicaprids would have also constituted a bulk food item suitable for feasting. The distinguished architecture here would have included the larger ESs[359] where cattle, fish and larger ovicaprids were found, and a maximum number of participants could be present. Since we are dealing with average ES size, it is not an automatic implication that all of the ESs where these species were present had the same function. Similarly, the fact that the distribution of nearly all species' bones is random means we cannot say that any particular area of the site was the focal point for feasting. This could thus be interpreted as evidence for feasting at the individual household level, for the likely purpose of cementing bonds with friends and kin. The slight negative spatial autocorrelation, or dispersion, observed in the distribution of the three ESs to produce fish in the H area contributes to such a proposal. Here one ES in three different complexes (CH1, CH2 and CH3) contained fish. This means that in being dispersed, the consumption or processing of (larger?) fish could have been isolated to one particular ES in each house. Without evidence of associated primary use artefacts, we cannot be certain whether these larger than average ESs were where the feasts took place, where they were prepared and cooked or where their remains were disposed.

Everyday household food waste is normally either burnt or dumped near the house with dogs and pigs consuming the scraps.[360] After a feast there tends to be much more bone waste collected - too much to burn and too much for domestic animals to clean up - so for hygienic reasons, the refuse needs quick burial to avoid spoilage.[361] As we have seen earlier, the animal bones just outside the fortification wall were likely buried soon after disposal and not left on the surface for much time. These may well be the remains of feasts.

[358] Hayden 2001, 41; Russell 2012, 387. However, feasting does not demand larger animals since status foods can be rare or expensive to procure rather than large (deFrance 2009, 123; Russell 2012, 387).
[359] Especially courtyards H17 and H21, and rooms D8 and H19.
[360] Russell 2012, 390.
[361] Haggis et al. 2011b, 62; Russell 2012, 390. Alternatively, at Zagora they could have been thrown off the cliff.

The earlier premise, that pigs were lower status food, would imply that they would not have been a 'prime' candidate for feasting, although they would not have been excluded. Bone fragments from pigs make up 33.3% of the domestic animal bone assemblage in Room D8, while at the fortification wall (FW6) they comprise 22%. If the 'dump' outside the fortification wall included waste from feasts, then the 11.3% fewer pig fragments here would be expected if pigs were not a significant component of feasting. Also found in FW6 were a number of hare bones.[362] Although on average they are not found in the same size ESs as cattle and fish, they are third behind these two species. Quite often hunting is positively correlated to status,[363] and so these remains of hare could be the discard from feasting as the other animal bones here.

6.6 Overview

Useful observations have been made using the limited evidence available. In summary, it appears that cattle, fish and larger ovicaprids were specifically feast food, and perhaps hare were too. While pigs could also have been, they were not that important and instead served a more standard meal function. The evidence we have for this is: 1. the large average ES size in which cattle and fish were found; 2. the relationship between larger ovicaprids and larger ESs; and 3. the possible refuse area for remains of feasts outside the fortification wall contained a smaller proportion of pig bones than D8. Based on the cattle remains being found in larger than average ESs and spatially distributed across the site, we can suggest that these 'inclusive' feasts were conducted at the household level for purposes of bonding with friends and kin. However, since the size of the animal suggests sharing or large-scale preservation, it is not certain whether these feasts had a single sponsor or whether the different families supplied their own animals.

[362] ZBR, 5, 16-7.
[363] They could also be the remains of opportunistic hunting by those with nothing else to eat (deFrance 2009, 127). Although it is more likely that such correlations refer to the larger animals such as deer or wild boar, whose hunting held a high status for the earlier Mycenaean Greeks (Chapin 2010, 231).

7. Conclusions

One of the main objectives with which this thesis set out has been accomplished. That is, that the legacy data be searched for patterns that can better illuminate the society and economy at Geometric Zagora, which in turn can help us better understand life more broadly in this early period. This thesis has shown that the difficulty in dealing with legacy animal bone data with inconsistent reporting can be overcome by looking for and finding patterns in their distribution.

In addition to the patterning, some other observations into the life of the inhabitants of Zagora have been possible. It appears that the people here kept and consumed sheep, goats, cattle and pigs. Based upon the limited age data we have, sheep and goats were likely kept primarily for their wool and hair, and cattle probably used for their draught; the latter would have been highly useful for Zagora's agricultural subsistence. Evidence of other animals includes fish, hare, canid, equid and rat although exactly how many of these were consumed is uncertain.

With the state of the data as it is, we can propose two levels of conclusion, one with more certainty than the other. The first is as objective in its method as possible and therefore is at this stage incomplete, needing the further evidence of the bones' stratigraphic context and their associated artefacts for elaboration. The second is moving further away from the certain towards developing a model of socio-economic life at Geometric Zagora, by making a tentative interpretation of the evidence as it stands.

7.1 Conclusion A

Through a variety of means, incorporating spatial and aspatial statistical analyses, patterns have been identified in the legacy data. It has been discovered that there is likely a relationship between the size of the animal and the ES within which it was found. Of all the species, the average size of the ES in which cattle were found is second largest. The average size of the ES where they were absent is the smallest. We have also observed that fish bones were found in the largest sized ESs on average but due to the lack of species identification, we do not know whether this was related to size or prestige, or was simply a chance occurrence. Also demonstrated is that the size of the ovicaprid has a strong relationship to the size of the ES where it was found. These are all important observations for the Greek EIA, where such comparisons have not yet been made. If this has any value in the wider discussion of social structure and settlement layout will be known in the future. Once information on associated artefacts becomes available, along with contextual data for the existing animal bones (where possible), it will allow the framework developed in this thesis to be re-tested, producing results that are more reliable.

It should be accepted that the above patterns exist and are not the result of chance. Even if the stratigraphy were available so that architectural units could be compared through time, it seems likely that the patterns observed across both cattle and ovicaprids would be verified. It will be interesting to see whether the artefacts produce any patterns comparable to those seen in the animal bones.

7.2 Conclusion B

The second, more tentative conclusion is constructed using the limited evidence drawn from this study. Although the evidence is far from complete, some suggestions for conceptualising a model of socio-economic life at Zagora are given.

This thesis has proposed that because special and larger animals synonymous with feasting have been found in larger ESs, some of these larger ESs could have been used for hosting feasts. Moreover, the spatial distribution of the animal bones indicates the existence of localised feasting at the household level, possibly for cementing ties of kinship and friendship. An early version of the courtyard house with small entranceway recognised at Zagora, is suggested to be indicative of a move towards privacy and the segregation of space.[364] This could also indicate the emergence of stronger familial ties in the face of increasing settlement size, with the delimiter between public and private space providing emphasis to this. A similar purpose has been proposed for the peribolos enclosures at EIA Oropos by Mazarakis Ainian who suggested they could imply the "existence of strong family bonds".[365] Feasting at the family or kin level would reinforce family bonds, not unlike an occasion such as Christmas in the modern era.

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[364] Morris 1999, 308-9; cf. Nevett (2007, 9) who sees their development as organic growth of the original one- or two-room houses rather than intentional segregation.
[365] Mazarakis Ainian 2007, 166.

7.2 Conclusion B

Ian Morris views the evidence from EIA Greece as revealing rule by an elite group over an excluded "lower group".[366] From the distribution of the animal remains that have been thus far excavated, it cannot be said that such a social division appears to be the case at Zagora. However, it does not preclude that such groups existed here since so much more of the settlement is yet to be revealed.

On EIA Crete, where the difference in the size of houses in settlements is not great,[367] Donald Haggis sees both a wide dispersion of wealth and the existence of a "dominant family" within each settlement.[368] Across Crete, feasts were hosted not only at ordinary dwellings but also in custom-built structures that were not controlled by any particular group or person, such as the Karphi "Megarons", indicating that feasting was not centralised under a single ruler.[369] This is reminiscent of what James Whitley would refer to as a "big man" society, where local "big men" vie for influence and power through acts such as hosting feasts for the populace.[370] Whitley suggests that at Zagora the conditions were not appropriate for such a model, something with which the animal bone evidence agrees.[371] The feasts here took place in a variety of locations, and it seems more likely they were hosted in ordinary domestic dwellings. Nonetheless, this feasting took place inside the largest spaces of these dwellings; similarly, at Karphi there is strong evidence for feasting in the largest buildings: the Great House, the "Megarons" block, and the Priest's House, with the latter containing the largest room on the site at 31.96m^2.[372]

However, not all feasting would have been at the household level. Larger feasts would have taken place in open areas or in the larger ESs and may have been acts of community solidarity. These commensal meals would have been perfectly located in the area by the hypaethral sanctuary in front of the houses in the H area, where the sacrifice and subsequent sacred offerings would have been situated for all to see. The animal bone evidence gives the impression that the H section, and particularly CH1 in front of this cult area, was a location of higher social significance. CH1 contained the largest number of identifiable bones, the two largest ovicaprids (as can be discerned) at the settlement and was one of only two complexes

[366] Morris 1998, 24-5.
[367] Wallace 2011, 326.
[368] Dickinson (2006a, 110), citing Haggis (2000).
[369] Here evidence for "special" feasting is found in more than one building in the quantity of dining and drinking equipment, and large and elaborate architecture (Wallace 2005, 263; 2011, 329-32).
[370] Whitley 1991.
[371] Whitley 1991, 352.
[372] Day and Snyder 2004, 75, table 5.1; Wallace 2005, 263-4.

to contain immature cattle. It was also the only complex to contain all the animal species found at Zagora (apart from equid) including the top three with respect to average ES size (fish, cattle and hare).

These animal remains were unbeknownst to Mazarakis Ainian who in his "rulers' dwellings to temples" model saw complex CH1 as a chieftain-priest's house where people of higher standing came to dine.[373] Mazarakis Ainian suggested that on special political or religious occasions, the wider community would have come to feast in the open here "or perhaps even in their own homes".[374] The latter implies families taking home joints of meat to feast on and for which the distribution of faunal remains at Zagora suggests. The argument that CH1 was a chieftain's house relies in part on the questionable claim that the storage bench in H22 was a kind of 'proto-kline' used in early symposia.[375] Nonetheless, it is certainly more than feasible that such a complex close to the sanctuary, and containing prominent animal remains, could have belonged to a significant person or persons, possibly possessing a priestly role.

From the animal bone evidence then, two hypotheses can be proposed. The first is that within the settlement feasting was an important event conducted at the household level and used to reinforce (or establish) bonds of kinship and friendship. The second is that there is evidence for a 'more exclusive' segment of society that would have resided in the H area, particularly near the hypaethral sanctuary. The evidence for animal wealth in complex CH1 agrees with Mazarakis Ainian's proposal that this house was that of an important member of the community, possibly a priest of high standing.

7.3 To the future

If the patterns uncovered in the faunal material from the 1967-74 excavations are to be further enhanced, more information, such as the associated artefactual record, is needed. Moreover, some of the gaps in the legacy data have revealed areas that would be valuable to include in future research at Zagora. These desiderata follow.

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[373] Mazarakis Ainian 1988, 109.
[374] Mazarakis Ainian 1988, 109; 1997, 171-6.
[375] Mazarakis Ainian 1997, 293. There are many more benches with evidence of pot emplacements, such as in rooms D27, H25, H26, H34, H28, J12, J15, J17 and more. Moreover, the house CH1 is not unusually large for the settlement and is comparable in size to others (*Zagora 2*, 79).

A re-study of the existing zooarchaeological material

If the bones recovered are still in bags labelled with the deposit from which they came, and are preserved well enough, it would worthwhile that a specialist revisits them to record greater details, specifically with respect to quantification, age (including tooth attrition), sex (if possible), bone type, butchery or gnaw marks, level of burning, and intentional break patterns. This would be valuable since the areas thus far excavated are unique spatially and by having the extra precision in the data better comparisons will be possible with any material excavated in the future. It will also allow for the re-testing of the results of this thesis with stratigraphic and quantitative information. Stratigraphic location will allow for diachronic comparisons allowing for the observation of changes through time in things such as diet and economy. Quantification information will provide greater accuracy in the calculation of spatial autocorrelation and give us a better indication of relative animal importance across the settlement.

Even if the previously excavated material is no longer separated by context, it would still be useful for the fish vertebrae to be located and documented for identification by a specialist. This will allow us an insight into whether the fish were in fact a pelagic species requiring expert fishing knowledge (a special food) or a littoral species that were easier to catch.

Once all of the artefactual information has been entered into the Heurist database then it would be desirable to incorporate it into the work presented in this thesis. Two areas that would be most useful are the functional determination of space with respect to the use of animals and the wider artefact patterning. The best way to determine space function is through evidence of primary use artefacts such as small sherd fragments.[376] For patterning, we should at least be in a position to measure the relative quantities of different sherd types across the settlement to see if any patterns emerge that may be comparable to the distribution of the bones.

Future excavations at Zagora

For future excavations at Zagora, it would be important for a sampling strategy to be developed that includes selective water sieving or flotation (with finer mesh sizes) of samples from hearths or floors, particularly edges where accumulation might be greater. It is only by

[376] Even in the situation where artefacts are trapped by a building collapse, it is difficult to determine which were used within the building and which were merely stored there (Driessen and Fiasse 2011, 296).

having a sampling strategy for retrieving the finer material that we will know the extent and breadth of diet, economy and environment at Zagora. The sample should include a good range of houses, well distributed spatially. It would be also ideal if more excavation of areas just outside houses or in courtyards were conducted since that might give us better understanding of discard patterns. Whatever sampling strategy is adopted, it must be noted along with the mesh sizes used and to what extent wet and dry sieving were performed.

So that the more thorough modern recovery can be related back to the legacy data, it would be good that a number of samples are monitored through both wet and dry sieving with the fragments retrieved being recorded during each phase. If possible, the same mesh size should be used in the dry sieve as was used in the original excavations. This will give an indication of the quantity and kind of material that was missed the first time around and allow better integration of the original material with future work.

It should be expected that a zooarchaeologist working under modern conditions would record all manner of detail in the animal remains, including those already listed above. In the worst case, where due to time or budgetary constraints these analyses cannot be completed, the analyst should note precisely what has and has not been completed. This will help future researchers understand the scope of their comparisons. For example, if we are told that three ovicaprid scapulae were found with cut marks, it does not mean much apart from telling us that it was likely that ovicaprids were consumed here. If the information is to be of maximum value then we need to know where these scapulae were found and more importantly, whether all bones were examined for cut marks and if not, how many and which ones.

With respect to excavation, more accurate findspot recording of bone fragments including the bone types and their quantities, especially within houses, would be desirable. With the precise location of the fragments, we could determine their spatial density and be able to identify areas such as provisional refuse spots within ESs or houses.[377] By analysing the accurate spatial distribution of different body parts of the different species, many conclusions can be drawn such as butchery and discard locations, joint selection, differences in consumption between different areas of the site, and differences between sacred and secular deposits.[378] Furthermore, since micro-debitage embedded in floors (such as bone, shell, or the by-products of manufacturing) are the best indicators of activity, having their

[377] Costello 2011, 82.
[378] For example, Chenal-Velarde and Studer (2003, 219), Prummel (2003, 156), Haggis et al. (2004, 384).

accurate contextual information will allow us to be more confident in assigning function to space.[379]

Scientific studies

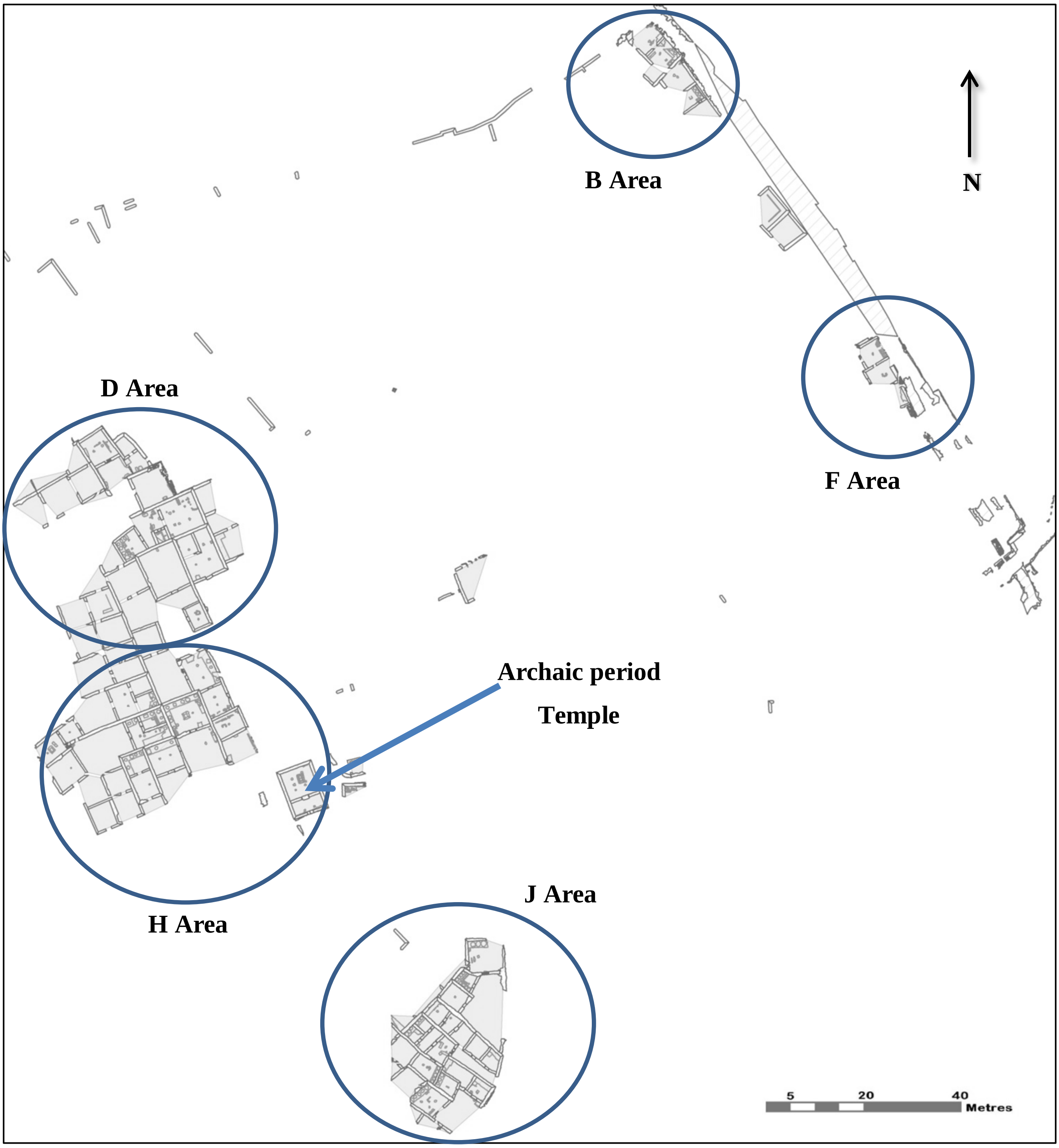
One of the questions worth answering is what kind of pig husbandry was practiced at Zagora. As we have seen, pigs are omnivores that can live off just about anything and therefore a variety of management strategies would have been available to the residents here. Stable isotope values of carbon and nitrogen taken from collagen in the bones and dentine of pigs, can provide an insight into their diets.[380] This may tell us whether pigs lived off a primarily seafood, terrestrial animal, or vegetarian diet. If comparative samples from contemporary carnivores (dogs) and herbivores (cattle, ovicaprids) can also be acquired and tested then they will provide good local baselines for interpreting the results.[381] Additionally, dental microwear analysis can help differentiate between stall-fed and foraging or grazing pigs.[382]

It is believed that the ‘wish list’ in the preceding three sections would prove valuable not only for an insight into social life and the economy at Zagora, but also in the wider Aegean based on the evidence for the settlement’s external contacts.[383] In reality, fulfilling such an agenda is probably not feasible; however, undertaking even a selection would enhance our understanding.

[379] Hayden and Cannon 1983, 135.
[380] Where degradation has occurred in the collagen, dental enamel can be used (Pollard et al. 2007, 187-8).
[381] Ervynck et al. 2007, 178, 182-5.
[382] Wilkie et al. 2007.
[383] Cambitoglou 1981, 20.

Appendix 1 - Maps

Map 1



Map 1 – Settlement of Zagora showing areas B, D, F, H, and J.

Map 2

Map 2 – Detail showing ES numbering with those shaded grey included in this study (<u>not to scale</u>).

Map 3

Map 3 - The 47 ESs analysed in the study are shaded in grey. Those ESs identified by excavators but not included in the study are left plain.

Map 4

Map 4 - Map showing houses defined and labels referred to in the text. Roofed ESs are designated by hatching and open ESs by grey shading.

Map 5

Map 5 - Distribution of ovicaprid bones. ESs in which ovicaprid bones were found are shaded in dark grey; those in light grey are part of the study area where they were not found; and those unshaded were ESs identified by excavators but not included in this study.

Map 6

Map 6 - Distribution of cattle bones. ESs in which cattle bones were found are shaded in dark grey; those in light grey are part of the study area where they were not found; and those unshaded were ESs identified by excavators but not included in this study.

Map 7

Map 7 - Distribution of pig bones. ESs in which pig bones were found are shaded in dark grey; those in light grey are part of the study area where they were not found; and those unshaded were ESs identified by excavators but not included in this study.

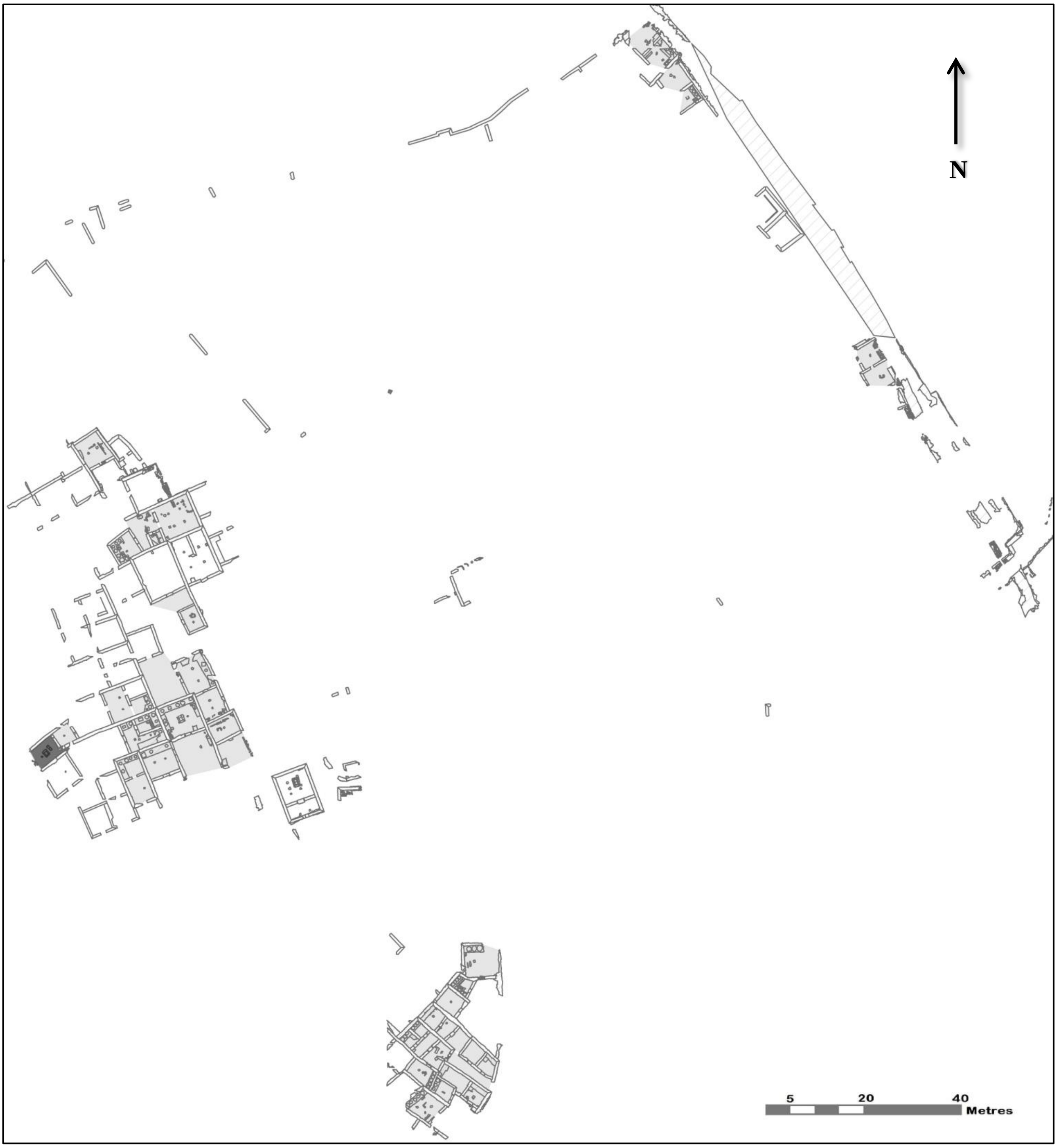
Map 8

Map 8 - Distribution of fish bones. ESs in which fish bones were found are shaded in dark grey; those in light grey are part of the study area where they were not found; and those unshaded were ESs identified by excavators but not included in this study.

Map 9

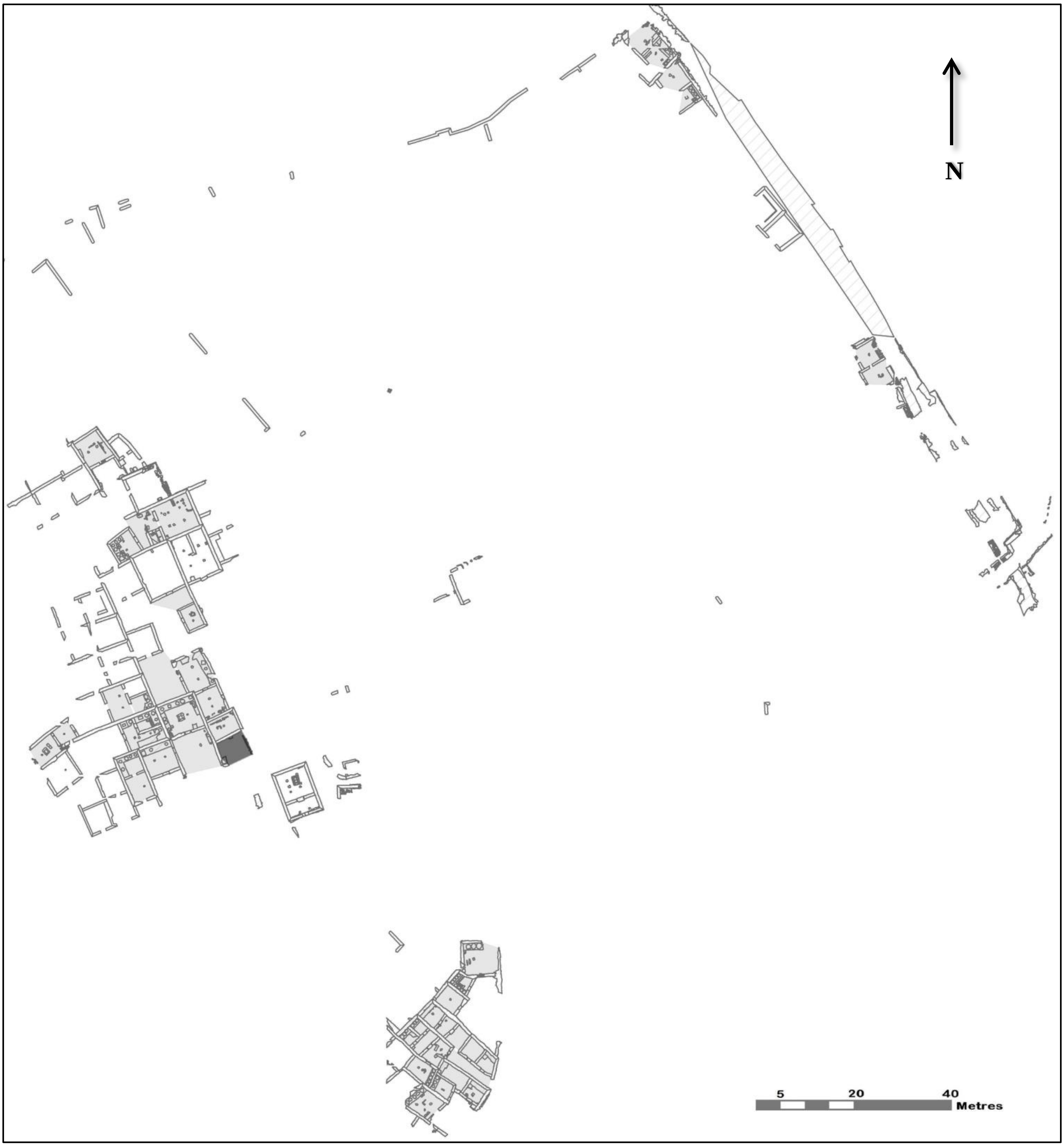
Map 9 - Distribution of hare bones. ESs in which hare bones were found are shaded in dark grey; those in light grey are part of the study area where they were not found; and those unshaded were ESs identified by excavators but not included in this study.

Map 10



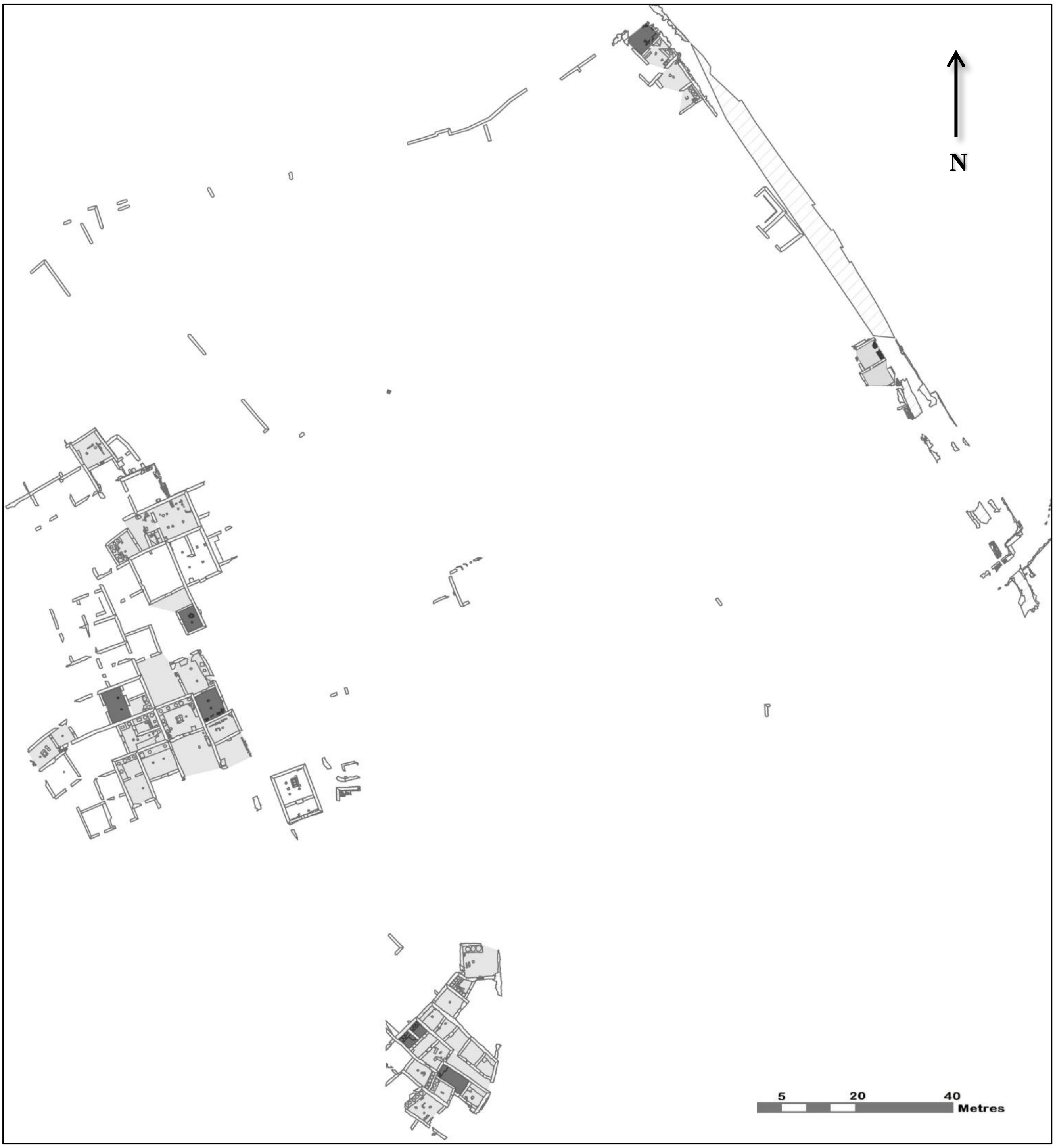
Map 10 - Distribution of equid bones. ESs in which equid bones were found are shaded in dark grey; those in light grey are part of the study area where they were not found; and those unshaded were ESs identified by excavators but not included in this study.

Map 11



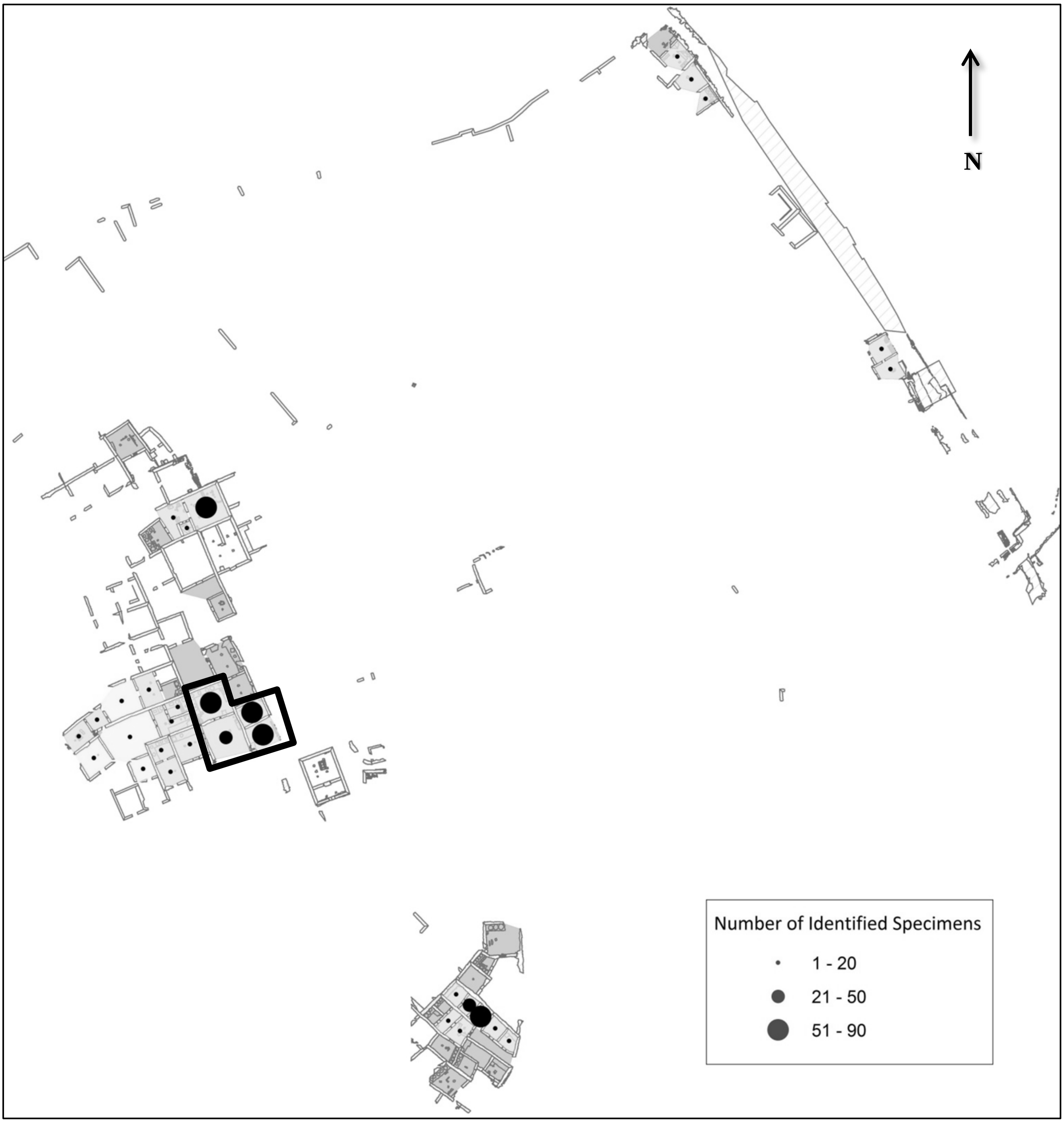
Map 11 - Distribution of canid bones. ESs in which canid bones were found are shaded in dark grey; those in light grey are part of the study area where they were not found; and those unshaded were ESs identified by excavators but not included in this study.

Map 12



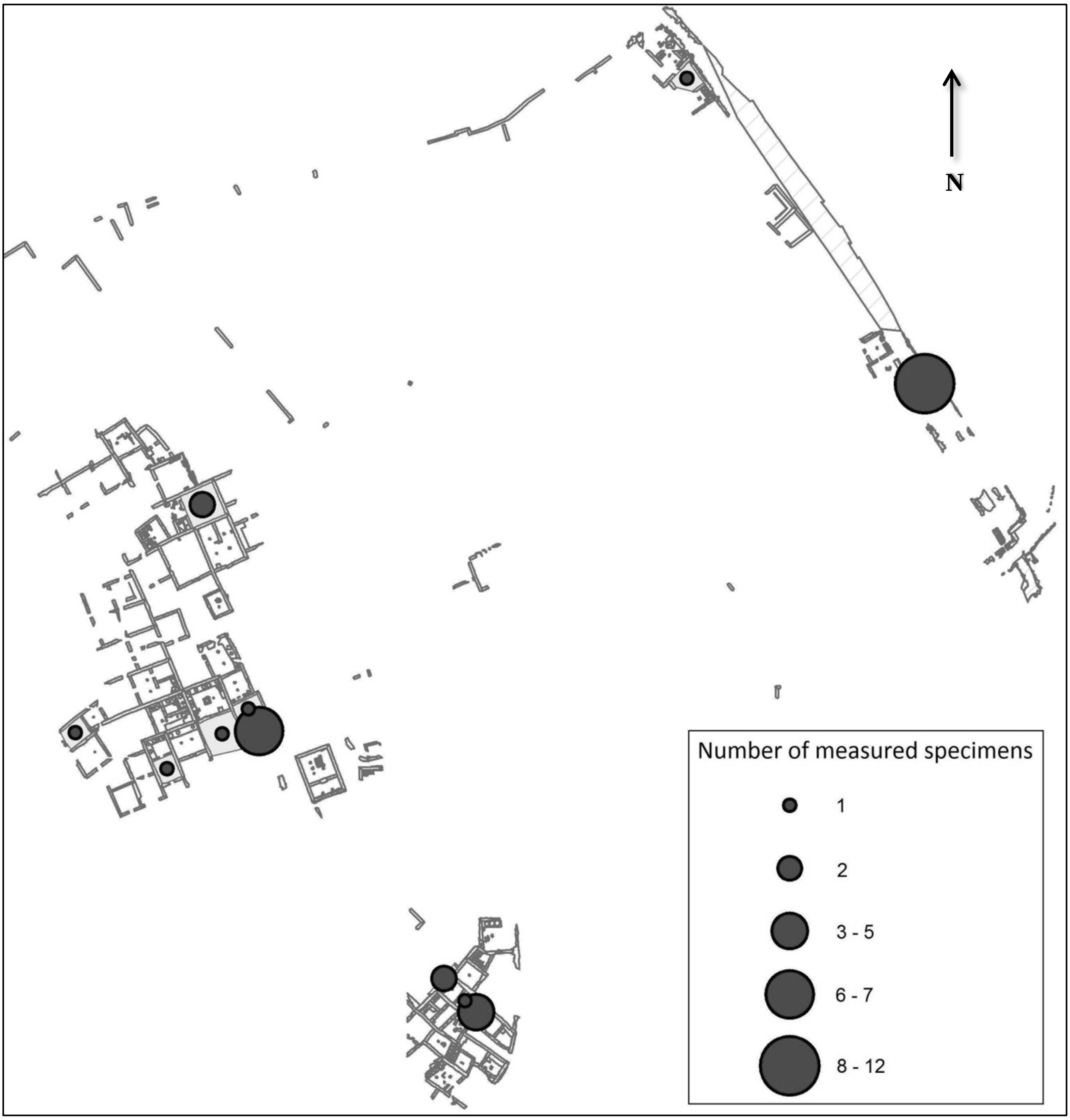
Map 12 – ESs containing only bone fragments unidentified to species. ESs in which only unidentified bones were found are shaded in dark grey; those in light grey are remaining parts of the study area; those unshaded were ESs identified by excavators but not included in this study.

Map 13



Map 13 – Showing volumes of NISP counts and estimates where provided by the ZBR. Note: also includes ESs that were not included in this study. In complex CH1, ESs H19-21-22-23, dating to the Middle Geometric period, are enclosed in polygon.

Map 14



Map 14 – Showing volumes of specimens that were measured and included in the ZBR. Note: includes the fortification wall deposit FW6.

Appendix 2 – Data

Location	Ovicaprid	Cattle	Pig	Hare	Fish	Canid	Equid	Rat
B2	1	1	0	0	0	0	0	0
B3	1	1	0	0	0	0	0	0
B4	1	1	1	0	1	0	0	0
D1	1	1	0	0	0	0	0	0
D6	1	1	1	0	0	0	0	0
D7	1	0	0	0	0	0	0	0
D8	1	1	1	0	0	0	0	0
D15	1	1	1	0	0	0	0	0
D27	1	0	0	0	0	0	0	0
E2510	1	1	1	0	0	0	0	0
E2515	1	1	0	0	0	0	0	0
WE15	1	0	0	0	0	0	0	0
WE18	1	1	0	0	0	0	0	0
WE20	1	1	0	0	0	0	0	0
WE21	1	0	0	0	0	0	0	0
F1055	1	0	0	0	0	0	0	0
F1060	1	0	0	0	0	0	0	0
F1555	1	0	0	0	0	0	0	0
F1560	0	0	1	1	0	0	0	0
FW1	1	1	0	0	0	0	0	0
FW5	1	1	0	0	0	0	0	0
FW6	1	1	1	1	0	1	0	0
J2	0	1	0	0	0	0	0	0
J3	1	1	0	0	0	0	0	0
J4	1	0	0	0	0	0	0	0
J5	1	0	1	0	0	0	0	0
J6	1	1	1	0	0	0	0	0
J8	1	1	1	0	0	0	0	0
J9	1	1	0	0	0	0	0	0
J15	1	1	1	0	1	0	0	0
J17	1	0	1	0	0	0	0	0
J21	1	1	1	1	0	0	0	0
J22	1	1	1	0	0	0	0	0
J23	1	1	1	0	0	0	0	0
J27	1	1	0	0	0	0	0	0
H17	1	1	0	0	0	0	0	0
H18	1	1	1	0	0	0	0	0
H19	1	1	1	1	1	0	0	0
H21	1	1	1	0	0	0	0	0
H22	1	1	1	1	0	0	0	0
H23	1	1	1	0	0	1	0	0
H26	1	1	0	0	0	0	0	0
H27	1	1	1	0	1	0	0	0
H28	1	1	0	0	0	0	0	0
H34	1	1	1	0	0	0	0	0
H35	1	1	1	0	1	0	0	0
H40	1	0	1	0	0	0	0	0
H41	1	1	0	0	0	0	1	0
H30	1	1	1	0	0	0	0	0
H31	1	0	1	0	0	0	0	0
H9560	1	1	1	0	0	0	0	1
H9070	1	1	1	1	0	0	0	1
H9075	1	0	1	0	0	0	0	0
J0570	1	1	1	0	0	0	0	0
J0575	1	1	1	0	0	0	0	0
TOTAL	53	41	31	6	5	2	1	2

Table A2.1 - Raw data from the ZBR with stratigraphic levels of locations (where provided) combined together. A single letter followed by one or two digits indicates an ES. A single letter followed by four digits indicates an excavation grid square. Two letters followed by one or two digits refer to a wall deposit. A 1 indicates presence and a 0, absence.

Appendix 2 - Data

Location	Size (m^2)	75% excavated to floor level and 50% cleared	Roofed	No. of Measured Bones	Bone Fragments Present
B1	22.392924	yes	No	0	Yes
B2	22.865609	yes	Yes	0	Yes
B3	23.452801	yes	Yes	1	Yes
B4	11.381339	yes	Yes	0	Yes
D1	32.385704	yes	Yes	0	Yes
D2	27.564075	unknown	n/a	0	No
D3	9.857005	unknown	n/a	0	No
D4	13.308393	unknown	n/a	0	No
D5	44.819389	unknown	n/a	0	No
D6	28.37046	yes	No	0	Yes
D7	5.340532	yes	Yes	0	Yes
D8	53.757469	yes	Yes	2	Yes
D9	72.935192	unknown	n/a	0	No
D10	13.746153	unknown	n/a	0	No
D11	47.714305	unknown	n/a	0	No
D12	17.282479	No	n/a	0	No
D13	14.258385	No	n/a	0	No
D14	27.006158	No	n/a	0	No
D15	21.415114	yes	No	0	Yes
D16	15.650244	yes	Yes	0	Yes
D17	43.216979	No	n/a	0	No
D18	31.306826	No	n/a	0	No
D19	29.580322	No	n/a	0	Yes
D20	40.842898	No	n/a	0	No
D21	13.493446	No	n/a	0	No
D22	10.32048	No	n/a	0	No
D23	28.337206	No	n/a	0	No
D24	38.004138	No	n/a	0	No
D25	13.809222	No	n/a	0	No
D26	27.375592	No	n/a	0	No
D27	23.642589	yes	Yes	0	Yes
D28	14.302501	No	n/a	0	No
D29	28.558146	No	n/a	0	No
D30	28.050478	No	n/a	0	No
D31	3.913345	No	n/a	0	No
D32	21.546695	No	n/a	0	No
E1	25.786879	No	n/a	0	No
E2	24.753774	No	n/a	0	No
E3	28.206747	No	n/a	0	Yes
F1	20.423208	yes	Yes	0	Yes
F2	20.405594	yes	Yes	0	Yes
F3	6.207229	No	n/a	0	No
H17	62.466261	yes	No	0	Yes
H18	42.461092	yes	Yes	0	Yes
H19	51.516505	yes	Yes	0	Yes
H20	27.539147	yes	Yes	0	Yes
H21	60.76243	yes	No	1	Yes
H22	24.136596	yes	Yes	1	Yes
H23	31.548132	yes	Yes	7	Yes
H24	12.145775	No	n/a	0	No
H25	12.312693	yes	Yes	0	No
H26	14.989706	yes	Yes	0	Yes
H27	29.062137	yes	Yes	0	Yes
H28	38.576084	yes	Yes	0	Yes
H29	23.258048	No	n/a	0	No
H30	37.697414	yes	Yes	0	Yes
H31	17.339174	yes	Yes	0	Yes
H32	27.502504	yes	Yes	0	Yes
H33	48.053637	No	No	0	No

Space	Size (m^2)	75% excavated to floor level and 50% cleared	Roofed	No. of Measured Bones	Bone Fragments Present
H34	18.361147	yes	Yes	0	Yes
H35	23.042404	yes	Yes	1	Yes
H36	20.912544	No	n/a	0	No
H37	22.398477	No	n/a	0	No
H38	18.297114	No	n/a	0	No
H40	13.475002	yes	Yes	0	Yes
H41	23.116838	yes	Yes	1	Yes
H42	34.815315	No	n/a	0	Yes
H43	83.635428	No	No	0	Yes
H44	46.927711	No	n/a	0	No
H45	22.968936	No	n/a	0	Yes
H46	22.982207	No	n/a	0	No
H47	26.1359	No	No	0	No
J1	18.66696	yes	Yes	0	Yes
J2	13.204065	yes	Yes	0	Yes
J3	21.168855	yes	No	0	Yes
J4	10.932674	yes	Yes	0	Yes
J5	13.224137	yes	Yes	0	Yes
J6	12.776727	yes	No	5	Yes
J7	86.540093	No	No	0	No
J8	17.293368	yes	Yes	0	Yes
J9	11.648661	yes	Yes	0	Yes
J10	6.592473	yes	Yes	0	Yes
J11	7.507038	yes	Yes	0	Yes
J12	19.183256	yes	Yes	0	No
J13	21.680161	unknown	n/a	0	No
J14	21.431104	unknown	n/a	0	No
J15	29.129616	yes	Yes	0	Yes
J16	3.456637	No	n/a	0	No
J17	13.256914	yes	Yes	0	Yes
J18	40.565739	No	No	0	No
J19	5.978575	No	n/a	0	No
J20	3.02816	No	n/a	0	No
J21	9.316094	yes	Yes	1	Yes
J22	14.05403	yes	Yes	0	Yes
J23	7.180069	No	n/a	2	Yes
J24	19.076243	yes	Yes	0	No
J25	2.065149	No	n/a	0	No
J26	10.935345	yes	Yes	0	No
J27	42.945264	yes	Yes	0	Yes
J28	9.625752	No	n/a	0	No
J29	5.553567	No	n/a	0	No
J50	4.765295	No	n/a	0	No
FW6	n/a	No	No	12	Yes
J51	6.394923	No	n/a	0	No

Table A2.2 - Data used in analyses (data from the Zagora ArcGIS database; excavation notebooks and registers; *Zagora 1*; *Zagora 2*; ZBR; Heurist).

Location	Teeth	Age old/rough	Age modern	Adjusted age	Comment
Pig					
D6	P3	>24m	>12-16m	>12m	
D8	C-M2M3	>36m	>17-22m	>17m	
F1560	C(erupting)-p3p4M1	12m	8-12m	<12m	added to a wider range for grouping purposes
FW6	M1M2	>18-24m	>7-13m	>7m	
FW6	P2(erupting)	24m	12-16m	>12m	added to a wider range for grouping purposes
H35	P3P4	>24m	>12-16m	>12m	
J6	P3P4M1	>24m	>12-16m	>12m	
J6	M2M3(erupting)	36m	17-22m	>17m	added to a wider range for grouping purposes
J6	C-P2P3	>24m	>12-16m	>12m	
J17	P3P4M1	>24m	>12-16m	>12m	
J21	M2M3	>36m	>17-22m	>17m	
J22	M1M2M3	>36m	>17-22m	>17m	
Sheep					
D8	P3P4	>40m	>21-24m	>21m	
D8	P4M1M2	>40m	>21-24m	>21m	
D8	P4M1	>40m	>21-24m	>21m	
FW6	P3P4	>40m	>21-24m	>21m	
FW6	P3(erupting)	30m	21-24m	>21m	added to a wider range for grouping in chart
FW6	M2M3	>36-48m	>18-24m	>21m	adjusted to match chart groupings (still within range)
FW6	P3P4M1	>40m	>21-24m	>21m	
FW6	p2p3p4	<30m	<21-24m	<21m	adjusted to match chart groupings (still within range)
H22	p2p3(both erupting)	n/a	6w	<3m	added to a wider range for grouping in chart
H22	P2P3P4	>40m	>21-24m	>21m	
H23	P2P3P4(all erupting)	30m	>21-24m	>21m	
J6	p2p3p4M1(erupting)	6m	3m	<21m	Less than 3 months not chosen since it has reached this age. Added to a wider range for grouping in chart
Goat					
D8	P3P4	>30m	>17-20m	>17m	
D8	P4M1M2	>30m	>17-20m	>17m	
D8	P4M1	>30m	>17-20m	>17m	
FW6	P3P4	>30m	>17-20m	>17m	
FW6	P3(erupting)	30m	17-20m	>17m	added to a wider range for grouping in chart
FW6	M2M3	>30m	>18-24m	>17m	adjusted to match chart groupings (begins 1 month outside of range)
FW6	P3P4M1	>30m	>17-20m	>17m	
FW6	p2p3p4	<30m	<17-20m	<17m	adjusted to match chart groupings (still within range)
H22	p2p3(both erupting)	n/a	12w	<3m	added to a wider range for grouping in chart
H22	P2P3P4	>30m	>17-20m	>17m	
H23	P2P3P4(all erupting)	30m	17-20m	>17m	added to a wider range for grouping in chart
J6	p2p3p4M1(erupting)	n/a	5-6m	<17m	added to a wider range for grouping in chart

Table A2.3 - Ages and dental formula for ovicaprid and pig mandibles with teeth in situ. Ages listed are for modern species as well as rough goats and late 18th century sheep and pigs. Adjusted age is the age grouping used for the purposes of the analyses and based on Silver's modern ages and Payne's younger ages (data from Silver (1969); Payne (1973, 299); ZBR). P=adult premolar, p=deciduous premolar, M=adult molar, C=canine.

	CD1	CDH1	CH1	CH2	CH3	CH4	CJ1	CJ2	CJ3	CJ4	CJ5	Total Count
Open												
O/C		1					1					2
O/C/P	1		1								1	3
Unknown					2	1		1	1			5
Open Count	1	1	1		2	1	1	1	1		1	10
Roofed												
C								1				1
None						1			2	1		4
O	2						1					3
O/C			1		1				1	1		4
O/C/E						1						1
O/C/P	1	1		1						1	1	5
O/C/P/Can			1									1
O/C/P/F				1	1			1				3
O/C/P/F/H			1									1
O/C/P/H			1								1	2
O/P						1	1	1				3
Unidentified		1				1		1		2		5
Unknown		1	1		1	1						4
Roofed Count	3	3	5	2	3	5	2	4	3	5	2	37
Total Count	**4**	**4**	**6**	**2**	**5**	**6**	**3**	**5**	**4**	**5**	**3**	**47**

Table A2.4 - Breakdown of identified houses with counts of species present. O=ovicaprid, C=cattle, P=pig, F=fish, H=hare, E=equid, Can=canid.

	CD1	CDH1	CH1	CH2	CH3	CH4	CJ1	CJ2	CJ3	CJ4	CJ5	Total Size
Open												
O/C		62.47					21.17					83.64
O/C/P	28.37		60.76								12.78	101.91
Unknown					109.77	48.05		40.57	86.54			284.93
Open Total	28.37	62.47	60.76		109.77	48.05	21.17	40.57	86.54		12.78	470.48
Roofed												
C								13.20				13.20
None						12.31			30.01	19.18		61.51
O	28.98						10.93					39.92
O/C			38.58		14.99				42.95	11.65		108.16
O/C/E						23.12						23.12
O/C/P	53.76	42.46		18.36						17.29	14.05	145.93
O/C/P/Can			31.55									31.55
O/C/P/F				23.04	29.06			29.13				81.23
O/C/P/F/H			51.52									51.52
O/C/P/H			24.14								9.32	33.45
O/P						13.48	13.22	13.26				39.96
Unidentified		27.54				27.50		18.67		14.10		87.81
Unknown		27.38	23.26		34.82	12.15						97.59
Roofed Total	82.74	97.38	169.04	41.40	78.87	88.55	24.16	74.26	72.96	62.22	23.37	814.94
Total Size	**111.11**	**159.84**	**229.80**	**41.40**	**188.64**	**136.61**	**45.33**	**114.82**	**159.50**	**62.22**	**36.15**	**1,285.42**

Table A2.5 - Breakdown of identified houses showing total size (m^2) of ESs and species present. O=ovicaprid, C=cattle, P=pig, F=fish, H=hare, E=equid, Can=canid.

	CD1	CDH1	CH1	CH2	CH3	CH4	CJ1	CJ2	CJ3	CJ4	CJ5	Total Average
Open												
O/C		62.47					21.17					41.82
O/C/P	28.37		60.76								12.78	33.97
Unknown					54.89	48.05		40.57	86.54			56.99
Open Average	28.37	62.47	60.76		54.89	48.05	21.17	40.57	86.54		12.78	47.05
Roofed												
C								13.20				13.20
None						12.31			15.01	19.18		15.38
O	14.49						10.93					13.31
O/C			38.58		14.99				42.95	11.65		27.04
O/C/E						23.12						23.12
O/C/P	53.76	42.46		18.36						17.29	14.05	29.19
O/C/P/Can			31.55									31.55
O/C/P/F				23.04	29.06			29.13				27.08
O/C/P/F/H			51.52									51.52
O/C/P/H			24.14								9.32	16.73
O/P						13.48	13.22	13.26				13.32
Unidentified		27.54				27.50		18.67		7.05		17.56
Unknown		27.38	23.26		34.82	12.15						24.40
Roofed Average	27.58	32.46	33.81	20.70	26.29	17.71	12.08	18.56	24.32	12.44	11.69	22.03
Total Average	**27.78**	**39.96**	**38.30**	**20.70**	**37.73**	**22.77**	**15.11**	**22.96**	**39.87**	**12.44**	**12.05**	**27.35**

Table A2.6 - Breakdown of identified houses showing average size (m^2) of ESs and species present. O=ovicaprid, C=cattle, P=pig, F=fish, H=hare, E=equid, Can=canid.

Appendix 3 – Gamma statistic calculations

The software package used to calculate the Gamma statistic was SPSS, version 20.0.0.1. The crosstabs procedure within SPSS was used to produce the Gamma statistic. The crosstabs (or cross-tabulation) is defined as a matrix that "shows the distribution of one variable for each category of a second variable".[384] The crosstab for the ovicaprid astragalus sizes and ES sizes is reproduced with the results at the end of this appendix.

Since the sample size we have is small, Fisher's exact test was used to determine the probability of the test. If we follow Drennan's likelihoods in figure 5, the Fisher's exact probability of .066 means that it is fairly unlikely that the association observed between the size of the ovicaprid astragalus and the size of the ES within which it was found is a chance occurrence. The value of the Gamma statistic, .563, means that we have evidence of a strong association between astragalus size and ES size (table A3.1).

Strength of Association	*Value of Measures of Association (Lambda, Gamma, Pearson's r)*
None	0.00
Weak/Uninteresting association	±.01 to .09
Moderate/Worth noting	±.10 to .29
Evidence of strong association/ Extremely interesting	±.30 to .99
Perfect/Strongest possible association	±1.00

Table A3.1 – Guidelines for interpreting the strength of association between two variables (after Babbie et al. 2007, table 13.1)

Gamma statistic output from SPSS

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.	Exact Sig.
Ordinal by Ordinal	Gamma	.563	.231	2.216	.027	.066
N of Valid Cases		9				

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

384 Babbie et al. 2007, 423.

Appendix 3 – Gamma statistic calculations

Room Size (m2) * Astragalus max lateral length (mm) Crosstabulation

			Astragalus max lateral length (mm)				
			26.0	26.5	28.0	28.5	29.0
Room Size (m2)	9.316094	Count	0	1	0	0	0
		Expected Count	.1	.1	.3	.1	.1
	12.776727	Count	1	0	0	0	1
		Expected Count	.2	.2	.7	.2	.2
	23.042404	Count	0	0	1	0	0
		Expected Count	.1	.1	.3	.1	.1
	23.116838	Count	0	0	1	0	0
		Expected Count	.1	.1	.3	.1	.1
	23.452801	Count	0	0	0	1	0
		Expected Count	.1	.1	.3	.1	.1
	31.548132	Count	0	0	0	0	0
		Expected Count	.1	.1	.3	.1	.1
	53.757469	Count	0	0	1	0	0
		Expected Count	.1	.1	.3	.1	.1
	60.762430	Count	0	0	0	0	0
		Expected Count	.1	.1	.3	.1	.1
Total		Count	1	1	3	1	1
		Expected Count	1.0	1.0	3.0	1.0	1.0

Room Size (m2) * Astragalus max lateral length (mm) Crosstabulation

			Astragalus max lateral length (mm)		Total
			32.0	33.0	
Room Size (m2)	9.316094	Count	0	0	1
		Expected Count	.1	.1	1.0
	12.776727	Count	0	0	2
		Expected Count	.2	.2	2.0
	23.042404	Count	0	0	1
		Expected Count	.1	.1	1.0
	23.116838	Count	0	0	1
		Expected Count	.1	.1	1.0
	23.452801	Count	0	0	1
		Expected Count	.1	.1	1.0
	31.548132	Count	1	0	1
		Expected Count	.1	.1	1.0
	53.757469	Count	0	0	1
		Expected Count	.1	.1	1.0
	60.762430	Count	0	1	1
		Expected Count	.1	.1	1.0
Total		Count	1	1	9
		Expected Count	1.0	1.0	9.0

Appendix 4 – Join-count statistic calculations

The software package used to calculate the join-count statistic was PASSaGE version 2. The “Joint-Counts” function within PASSaGE was used to calculate the statistic. The joins created between the various ESs are reproduced graphically for the H area in figure A4.1 and for the J area in figure A4.2. From these joins, a connection matrix was created for each area so that these joins could be represented within the program. The matrix for the H area is reproduced in table A4.1 and for the J area in table A4.2.

The present/absent data used in the calculations was entered into separate matrices for each of the species and a matrix was also created for all bone. A ‘1’ was used to indicate presence and a ‘0’ absence. These matrices are reproduced in figures A4.3 and A4.4. Equid, canid and hare were not included since they were represented in too few ESs to warrant testing for spatial autocorrelation. The test was run under the ‘non-free sampling’ assumption, which is referred to as “sampling without replacement” in PASSaGE 2. A permutation test within PASSaGE was run with 10,000 permutations in order to calculate the significance of the join-count statistic. The results for the join-count statistic are reproduced at the end of this appendix.

The only result that is near a statistically significant result (that is, probability of .05) is fish in the H area. Both the “0 x 0” joins (two adjoining spaces without fish) and the “0 x 1” joins (a space with no fish adjoining one with fish) have a probability of .069. Based on Drennan’s likelihoods in figure 5, these probabilities mean that it is fairly unlikely that the spatial distribution of fish bones is random. The expected count of the “0 x 0” joins is 17.5 and the observed count is 13, while the expected count of the “0 x 1” joins is 10.5 and the observed count is 15. This means that the joins between ESs where there is no fish is less than expected under random conditions and the joins between ESs with fish and those without is greater than expected under random conditions. Therefore, we have some dispersion, or negative spatial autocorrelation, in the distribution of fish in the H area.

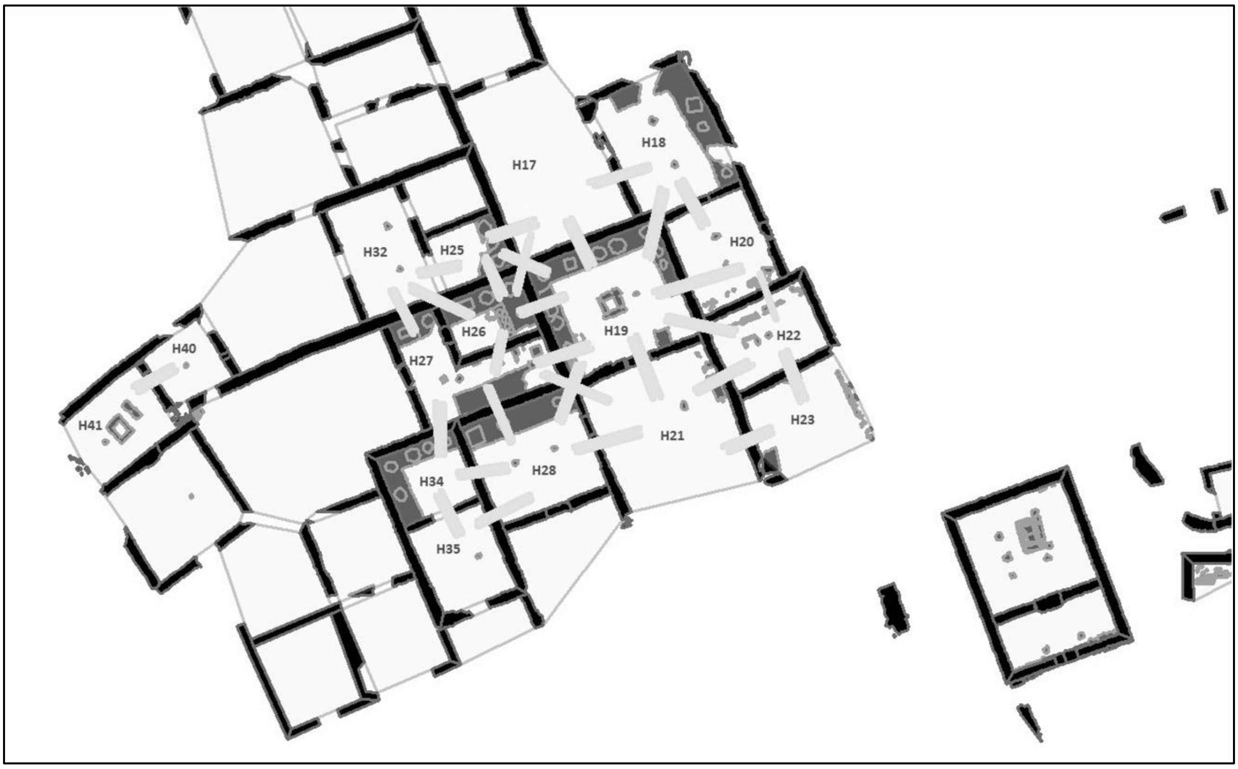


Figure A4.1 – Map of H area showing 'joins' between ESs (H40-41 were not included in the test due to their lack of contiguity with the other ESs).

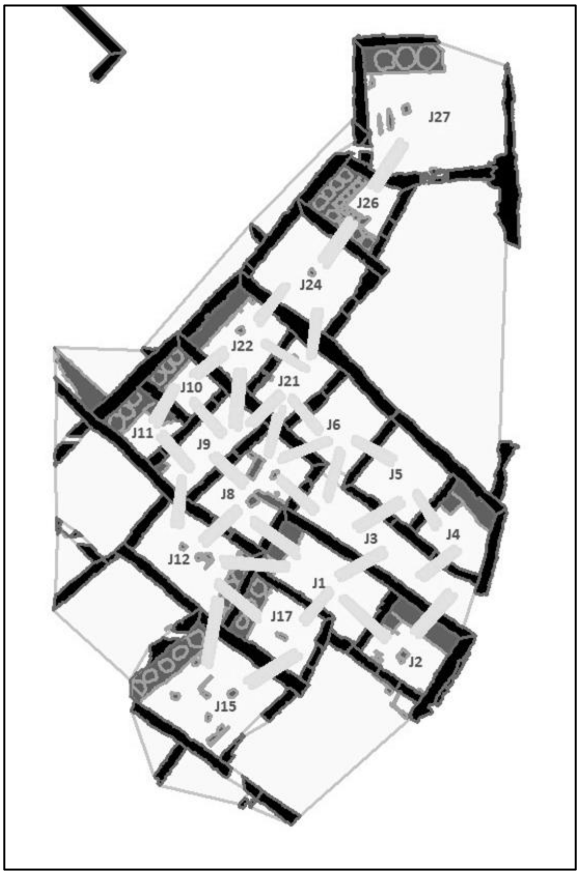


Figure A4.2 - Map of J area showing 'joins' between ESs.

Appendix 4 – Join-count statistic calculations

	H17	H18	H19	H20	H21	H22	H23	H25	H26	H27	H28	H32	H34	H35
H17	0	1	1	0	0	0	0	1	1	0	0	0	0	0
H18	1	0	1	1	0	0	0	0	0	0	0	0	0	0
H19	1	1	0	1	1	1	0	1	1	1	1	0	0	0
H20	0	1	1	0	0	1	0	0	0	0	0	0	0	0
H21	0	0	1	0	0	1	1	0	0	1	1	0	0	0
H22	0	0	1	1	1	0	1	0	0	0	0	0	0	0
H23	0	0	0	0	1	1	0	0	0	0	0	0	0	0
H25	1	0	1	0	0	0	0	0	1	0	0	1	0	0
H26	1	0	1	0	0	0	0	1	0	1	0	1	0	0
H27	0	0	1	0	1	0	0	0	1	0	1	1	1	0
H28	0	0	1	0	1	0	0	0	0	1	0	0	1	1
H32	0	0	0	0	0	0	0	1	1	1	0	0	0	0
H34	0	0	0	0	0	0	0	0	0	1	1	0	0	1
H35	0	0	0	0	0	0	0	0	0	0	1	0	1	0

Table A4.1 – Connection matrix for H area reflecting the joins created between ESs. A 1 indicates a join between two ESs.

	J1	J2	J3	J4	J5	J6	J8	J9	J10	J11	J12	J15	J17	J21	J22	J24	J26	J27
J1	0	1	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0
J2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
J3	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
J4	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
J5	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
J6	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0
J8	1	0	1	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0
J9	0	0	0	0	0	0	1	0	1	1	1	0	0	1	1	0	0	0
J10	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0
J11	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
J12	1	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0
J15	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
J17	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
J21	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	0	0
J22	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0
J24	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
J26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
J27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Table A4.2 – Connection matrix for J area reflecting the joins created between ESs. A 1 indicates a join between two ESs.

All Bone		Cattle		Fish		Ovicaprid		Pig	
Room	Bone	Room	Bone	Room	Bone	Room	Bone	Room	Bone
H17	1	H17	1	H17	0	H17	1	H17	0
H18	1	H18	1	H18	0	H18	1	H18	1
H19	1	H19	1	H19	1	H19	1	H19	1
H20	1	H20	0	H20	0	H20	0	H20	0
H21	1	H21	1	H21	0	H21	1	H21	1
H22	1	H22	1	H22	0	H22	1	H22	1
H23	1	H23	1	H23	0	H23	1	H23	1
H25	0	H25	0	H25	0	H25	0	H25	0
H26	1	H26	1	H26	0	H26	1	H26	0
H27	1	H27	1	H27	1	H27	1	H27	1
H28	1	H28	1	H28	0	H28	1	H28	0
H32	1	H32	0	H32	0	H32	0	H32	0
H34	1	H34	1	H34	0	H34	1	H34	1
H35	1	H35	1	H35	1	H35	1	H35	1

Figure A4.3 – Data matrices used in calculations for the H area. A 1 indicates presence and a 0 absence.

All Bone		Cattle		Fish		Ovicaprid		Pig	
Room	Bone	Room	Bone	Room	Bone	Room	Bone	Room	Bone
J1	1	J1	0	J1	0	J1	0	J1	0
J2	1	J2	1	J2	0	J2	0	J2	0
J3	1	J3	1	J3	0	J3	1	J3	0
J4	1	J4	0	J4	0	J4	1	J4	0
J5	1	J5	0	J5	0	J5	1	J5	1
J6	1	J6	1	J6	0	J6	1	J6	1
J8	1	J8	1	J8	0	J8	1	J8	1
J9	1	J9	1	J9	0	J9	1	J9	0
J10	1	J10	0	J10	0	J10	0	J10	0
J11	1	J11	0	J11	0	J11	0	J11	0
J12	0	J12	0	J12	0	J12	0	J12	0
J15	1	J15	1	J15	1	J15	1	J15	1
J17	1	J17	0	J17	0	J17	1	J17	1
J21	1	J21	1	J21	0	J21	1	J21	1
J22	1	J22	1	J22	0	J22	1	J22	1
J24	0	J24	0	J24	0	J24	0	J24	0
J26	0	J26	0	J26	0	J26	0	J26	0
J27	1	J27	1	J27	0	J27	1	J27	0

Figure A4.4 – Data matrices used in calculations for the J area. Fish occur in only one ES here and so their result from J area was ignored. A 1 indicates presence and a 0 absence.

Join-count statistic output from PASSaGE 2

Output for H area:

Join Count Output

```
Data Matrix: H Rooms Data - All Bone
  Column: Bone
Connections: H Rooms Connection Matrix
# of points = 14

Assuming sampling without replacement
Binary weighting
```

Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	0.00000	0.00000	0.00000	NAN	1.00000	1.00000

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	24.85714	25.00000	1.76705	0.08085	0.93690	1.00000

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	4.14286	4.00000	1.76705	0.08085	0.93690	1.00000

Join Count Output

Data Matrix: H Rooms Data - **Cattle Bone**
Column: Bone
Connections: H Rooms Connection Matrix
# of points = 14

Assuming sampling without replacement
Binary weighting
Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	0.95604	1.00000	0.81419	0.05399	0.95783	1.00000

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	17.52747	20.00000	2.43866	1.01389	0.33064	0.45315

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	10.51648	8.00000	2.30080	1.09374	0.29554	0.32120

Join Count Output

Data Matrix: H Rooms Data - **Fish Bone**
Column: Bone
Connections: H Rooms Connection Matrix
# of points = 14

Assuming sampling without replacement
Binary weighting
Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	17.52747	13.00000	2.43866	1.85654	0.08808	0.06869

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	0.95604	1.00000	0.81419	0.05399	0.95783	1.00000

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	10.51648	15.00000	2.30080	1.94868	0.07510	0.06930

Join Count Output

Data Matrix: H Rooms Data - **Ovicaprid Bone**
Column: Bone
Connections: H Rooms Connection Matrix
# of points = 14

Assuming sampling without replacement
Binary weighting
Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	0.95604	1.00000	0.81419	0.05399	0.95783	1.00000

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	17.52747	20.00000	2.43866	1.01389	0.33064	0.45935

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	10.51648	8.00000	2.30080	1.09374	0.29554	0.33000

Join Count Output

Data Matrix: H Rooms Data - **Pig Bone**
Column: Bone
Connections: H Rooms Connection Matrix
# of points = 14

Assuming sampling without replacement
Binary weighting
Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	4.78022	5.00000	1.76876	0.12426	0.90317	1.00000

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	8.92308	10.00000	2.24723	0.47922	0.64039	0.68913

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
29	15.29670	14.00000	2.19728	0.59014	0.56604	0.66120

Output for J area:

Join Count Output

Data Matrix: J Rooms Data - **All Bone**
Column: Bone
Connections: J Rooms Connection Matrix
# of points = 18

Assuming sampling without replacement
Binary weighting
Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	0.62745	1.00000	0.69904	0.53294	0.60140	1.00000

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	21.96078	23.00000	2.32177	0.44760	0.66045	0.68833

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	9.41176	8.00000	2.28530	0.61776	0.54543	0.67890

Join Count Output

Data Matrix: J Rooms Data - **Cattle Bone**
  Column: Bone
Connections: J Rooms Connection Matrix
# of points = 18

Assuming sampling without replacement
Binary weighting
Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	7.52941	6.00000	2.12873	0.71846	0.48283	0.51175

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	7.52941	10.00000	2.12873	1.16059	0.26283	0.33897

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	16.94118	16.00000	2.52215	0.37316	0.71392	0.84760

Join Count Output

Data Matrix: J Rooms Data - **Fish Bone**
  Column: Bone
Connections: J Rooms Connection Matrix
# of points = 18

Assuming sampling without replacement
Binary weighting
Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	28.44444	30.00000	1.57135	0.98995	0.33693	0.50105

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	0.00000	0.00000	0.00000	NAN	1.00000	1.00000

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb

32	3.55556	2.00000	1.57135	0.98995	0.33693	0.50100

Join Count Output

Data Matrix: J Rooms Data - **Ovicaprid Bone**
Column: Bone
Connections: J Rooms Connection Matrix
# of points = 18

Assuming sampling without replacement
Binary weighting
Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	4.39216	4.00000	1.72916	0.22679	0.82346	1.00000

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	11.50327	14.00000	2.40540	1.03797	0.31472	0.40146

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	16.10458	14.00000	2.52352	0.83398	0.41657	0.40890

Join Count Output

Data Matrix: J Rooms Data - **Pig Bone**
Column: Bone
Connections: J Rooms Connection Matrix
# of points = 18

Assuming sampling without replacement
Binary weighting
Permutation test based on 10000permutations

Join Counts: "0" x "0"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	11.50327	11.00000	2.40540	0.20922	0.83691	0.84792

Join Counts: "1" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	4.39216	6.00000	1.72916	0.92984	0.36627	0.36666

Join Counts: "0" x "1"

# Pairs	E(JC)	JC	SD	T-score	Prob	RandProb
32	16.10458	15.00000	2.52352	0.43771	0.66745	0.68900

Appendix 5 – Chi square statistic calculations

The software package used to calculate the chi square statistic was SPSS, version 20.0.0.1. As with the Gamma statistic, the crosstabs procedure within SPSS was used to run the chi square test of independence. When all ESs were included in the chi square test, the ovicaprids (with high ubiquity) were producing unusually highly significant results. This was because ovicaprids occur in all but one ES in which bones were identified to species, meaning their co-occurrence with other species will happen in all but one instance. The chi square test will treat this as highly significant since it does not realise that there are ESs in which no bones can be identified to species. Therefore, since we are testing for the co-occurrence of species, only those ESs in which specimens identified to species occur were included in this test. That is, out of the 47 ESs, 11 were excluded (four with no bone, and seven containing only unidentified specimens).

Due to some of the comparisons having expected counts less than five, Fisher's exact test was also included to determine the statistical significance. Two-tailed significances were used since we are not sure in which direction the relationships went. In order to calculate the strength of any relationships observed, the phi coefficient (ϕ) was also calculated. Calculations were not performed for canid and equid, both of which occur in one ES each. The results of the chi square test of independence are reproduced at the end of this appendix.

The only result close to being statistically significant was the co-occurrence of fish and pig. The exact significance of their co-occurrence is .062. Based on Drennan's likelihoods in figure 5, these probabilities mean that it is fairly unlikely that the co-occurrence of fish and pig was the result of chance. The strength of their association, or phi value, is .339 which means that it is a medium strength relationship (fig. A5.1).

General Interpretation of the Strength of a Relationship	The *d* Family[a]	The *r* Family[b]		
	d	*r* and ϕ	*R*	η (eta)[c]
Very Large	≥ 1.00[d]	≥ .70	.70+	.45+
Large	.80	.50	.51	.37
Medium	.50	.30	.36	.24
Small	.20	.10	.14	.10

Figure A5.1 – Strengths of relationship between two variables (Leech et al. 2005, table 3.5).

Appendix 5 – Chi square statistic calculations

Chi square statistic output from SPSS

Cattle * Pig

Crosstab

			Pig		Total
			Absent	Present	
Cattle	Absent	Count	4	4	8
		Expected Count	3.3	4.7	8.0
	Present	Count	11	17	28
		Expected Count	11.7	16.3	28.0
Total		Count	15	21	36
		Expected Count	15.0	21.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.294[a]	1	.588	.694	.441
Continuity Correction[b]	.018	1	.892		
Likelihood Ratio	.291	1	.590	.694	.441
Fisher's Exact Test				.694	.441
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	.090	.588	.694
	Cramer's V	.090	.588	.694
N of Valid Cases		36		

Cattle * Hare

Crosstab

			Hare		Total
			Absent	Present	
Cattle	Absent	Count	7	1	8
		Expected Count	7.1	.9	8.0
	Present	Count	25	3	28
		Expected Count	24.9	3.1	28.0
Total		Count	32	4	36
		Expected Count	32.0	4.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.020[a]	1	.887	1.000	.652
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.020	1	.889	1.000	.652
Fisher's Exact Test				1.000	.652
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	-.024	.887	1.000
	Cramer's V	.024	.887	1.000
N of Valid Cases		36		

Appendix 5 – Chi square statistic calculations

Cattle * Fish

Crosstab

			Fish		Total
			Absent	Present	
Cattle	Absent	Count	8	0	8
		Expected Count	6.9	1.1	8.0
	Present	Count	23	5	28
		Expected Count	24.1	3.9	28.0
Total		Count	31	5	36
		Expected Count	31.0	5.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.659[a]	1	.198	.322	.261
Continuity Correction[b]	.502	1	.479		
Likelihood Ratio	2.735	1	.098	.322	.261
Fisher's Exact Test				.566	.261
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	.215	.198	.322
	Cramer's V	.215	.198	.322
N of Valid Cases		36		

Cattle * Ovicaprid

Crosstab

			Ovicaprid		Total
			Absent	Present	
Cattle	Absent	Count	0	8	8
		Expected Count	.2	7.8	8.0
	Present	Count	1	27	28
		Expected Count	.8	27.2	28.0
Total		Count	1	35	36
		Expected Count	1.0	35.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.294[a]	1	.588	1.000	.778
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.511	1	.475	1.000	.778
Fisher's Exact Test				1.000	.778
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	-.090	.588	1.000
	Cramer's V	.090	.588	1.000
N of Valid Cases		36		

Appendix 5 – Chi square statistic calculations

Fish * Ovicaprid

Crosstab

			Ovicaprid		Total
			Absent	Present	
Fish	Absent	Count	1	30	31
		Expected Count	.9	30.1	31.0
	Present	Count	0	5	5
		Expected Count	.1	4.9	5.0
Total		Count	1	35	36
		Expected Count	1.0	35.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.166[a]	1	.684	1.000	.861
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.304	1	.582	1.000	.861
Fisher's Exact Test				1.000	.861
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	.068	.684	1.000
	Cramer's V	.068	.684	1.000
N of Valid Cases		36		

Fish * Pig

Crosstab

			Pig		Total
			Absent	Present	
Fish	Absent	Count	15	16	31
		Expected Count	12.9	18.1	31.0
	Present	Count	0	5	5
		Expected Count	2.1	2.9	5.0
Total		Count	15	21	36
		Expected Count	15.0	21.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.147[a]	1	.042	.062	.054
Continuity Correction[b]	2.396	1	.122		
Likelihood Ratio	5.959	1	.015	.062	.054
Fisher's Exact Test				.062	.054
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	.339	.042	.062
	Cramer's V	.339	.042	.062
N of Valid Cases		36		

Appendix 5 – Chi square statistic calculations

Fish * Hare

Crosstab

			Hare		Total
			Absent	Present	
Fish	Absent	Count	28	3	31
		Expected Count	27.6	3.4	31.0
	Present	Count	4	1	5
		Expected Count	4.4	.6	5.0
Total		Count	32	4	36
		Expected Count	32.0	4.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.465[a]	1	.496	1.000	.466
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.400	1	.527	1.000	.466
Fisher's Exact Test				.466	.466
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	.114	.496	1.000
	Cramer's V	.114	.496	1.000
N of Valid Cases		36		

Hare * Ovicaprid

Crosstab

			Ovicaprid		Total
			Absent	Present	
Hare	Absent	Count	1	31	32
		Expected Count	.9	31.1	32.0
	Present	Count	0	4	4
		Expected Count	.1	3.9	4.0
Total		Count	1	35	36
		Expected Count	1.0	35.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.129[a]	1	.720	1.000	.889
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.239	1	.625	1.000	.889
Fisher's Exact Test				1.000	.889
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	.060	.720	1.000
	Cramer's V	.060	.720	1.000
N of Valid Cases		36		

Appendix 5 – Chi square statistic calculations

Hare * Pig

Crosstab

			Pig		Total
			Absent	Present	
Hare	Absent	Count	15	17	32
		Expected Count	13.3	18.7	32.0
	Present	Count	0	4	4
		Expected Count	1.7	2.3	4.0
Total		Count	15	21	36
		Expected Count	15.0	21.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.214[a]	1	.073	.125	.102
Continuity Correction[b]	1.575	1	.209		
Likelihood Ratio	4.666	1	.031	.125	.102
Fisher's Exact Test				.125	.102
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	.299	.073	.125
	Cramer's V	.299	.073	.125
N of Valid Cases		36		

Ovicaprid * Pig

Crosstab

			Pig		Total
			Absent	Present	
Ovicaprid	Absent	Count	1	0	1
		Expected Count	.4	.6	1.0
	Present	Count	14	21	35
		Expected Count	14.6	20.4	35.0
Total		Count	15	21	36
		Expected Count	15.0	21.0	36.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.440[a]	1	.230	.417	.417
Continuity Correction[b]	.029	1	.864		
Likelihood Ratio	1.791	1	.181	.417	.417
Fisher's Exact Test				.417	.417
N of Valid Cases	36				

Symmetric Measures

		Value	Approx. Sig.	Exact Sig.
Nominal by Nominal	Phi	.200	.230	.417
	Cramer's V	.200	.230	.417
N of Valid Cases		36		

Works cited

Akurgal, E. 1962. "The Early Period and the Golden Age of Ionia." *AJA* 66 (4):369-79.

Albarella, U. 2002. "'Size Matters': How and Why Biometry is still Important in Zooarchaeology." In *Bones and the Man: Studies in Honour of Don Brothwell*, edited by K. Dobney and T. O'Connor, 51-62. Oxford: Oxbow Books.

Allentuck, A., and H. J. Greenfield. 2010. "The Organization of Animal Production in an Early Urban Center: the Zooarchaeological Evidence from Early Bronze Age Titriş Höyük, Southeastern Turkey." In *Anthropological Approaches to Zooarchaeology: Complexity, Colonialism, and Animal Transformations*, edited by D. Campana, P. Crabtree, S. D. deFrance, J. Lev-Tov and A. Choyke, 12-29. Oxford: Oxbow Books.

Amorosi, T., J. Woollett, S. Perdikaris, and T. McGovern. 1996. "Regional Zooarchaeology and Global Change: Problems and Potentials." *WorldArch* 28 (1):126-57.

Atici, L., S. W. Kansa, J. Lev-Tov, and E. C Kansa. 2012. "Other People's Data: a Demonstration of the Imperative of Publishing Primary Data." *Journal of Archaeological Method and Theory*. doi: 10.1007/s10816-012-9132-9.

Ault, B. A., and L. C. Nevett. 1999. "Digging Houses: Archaeologies of Classical and Hellenistic Greek Domestic Assemblages." In *The Archaeology of Household Activities*, edited by P. M. Allison, 43-56. London: Routledge.

Babbie, E., F. Halley, and J. Zaino. 2007. *Adventures in Social Research: Data Analysis using SPSS 14.0 and 15.0 for Windows*. 6th ed. Thousand Oaks: Pine Forge Press.

Barnetson, L. Forthcoming. "Report on the Animal Bones from Zagora [tentative title]." In *Zagora 3,* edited by S. Paspalas.

Becker, C. 1986. *Kastanas: Ausgrabungen in einem Siedlungshügel der Bronze-und Eisenzeit Makedoniens 1975-1979. Die Tierknochenfunde*. Berlin: Wissenschaftsverlag Volker Spiess.

———. 1998. "Can Animal Bones Reflect Household Activities? A Case Study from a Prehistoric Site in Greece." In *Man and the Animal World: Studies in Archaeozoology, Archaeology, Anthropology and Palaeolinguistics in Memoriam Sándor Bökönyi*, edited by P. Anreiter, L. Bartosiewicz, E.Jerem and W. Meid, 79-86. Budapest: Archaeolingua.

Behrensmeyer, A. K. 1978. "Taphonomic and Ecologic Information from Bone Weathering." *Paleobiology* 4 (2):150-62.

Bement, L. C. 2010. "Replicating Bone Tools and Other Fauno Technologies." In *Designing Experimental Research in Archaeology*, edited by J. R. Ferguson, 225-40. Boulder: University Press of Colorado.

Berg, I. 2010. "Re-Capturing the Sea: The Past and Future of 'Island Archaeology' in Greece." *Shima* 4 (1):16-26.

———. 2011. "Towards a Conceptualisation of the Sea: Artefacts, Iconography and Meaning." In *The Seascape in Aegean Prehistory*, edited by G. Vavouranakis, 119-38. Athens: Danish Institute at Athens.

Boessneck, J. 1969. "Osteological Differences Between Sheep (*Ovis Aries Linné*) and Goats (*Capra Hircus Linné*)." In *Science in Archaeology: a Survey of Progress and Research*, edited by D. Brothwell and E. Higgs, 331-58. 2nd ed. London: Thames and Hudson.

Boyd-Dawkins, W. 1902. "Remains of Animals Found in the Dictaean Cave in 1901." *Man* 2:162-5.

Buitenhuis, H. 1995. "A Quantitative Approach to Species Determination of Ovicapridae." In *Archaeozoology of the Near East II: Proceedings of the Second International Symposium on the Archaeozoology of Southwestern Asia and Adjacent Areas*, edited by H. Buitenhuis and H.-P. Uerpmann, 140-55. Leiden: Backhuys Publishers.

Bull, G., and S. Payne. 1982. "Tooth Eruption and Epiphysial Fusion in Pigs and Wild Boar." In *Ageing and Sexing Animal Bones from Archaeological Sites* BAR-BS109, edited by B. Wilson, C. Grigson and S. Payne. Oxford: BAR.

Cambitoglou, A. 1981. *Guide to the Finds from the Excavations of the Geometric Town at Zagora*. Athens: Archaeological Museum of Andros.

Cambitoglou, A., A. Birchall, J. J. Coulton, and J. R. Green. 1988. *Zagora 2: Excavation of a Geometric Town on the Island of Andros. Excavation Season 1969; Study Season 1969-1970*. Athens: Athens Archaeological Society.

Cambitoglou, A., J. J. Coulton, J. Birmingham, and J. R. Green. 1971. *Zagora 1: Excavation Season 1967; Study Season 1968-9*. Sydney: Sydney University Press.

Catling, H. W. 1985. "The Arrangement of Some Grave Goods in the Dark Age Cemeteries of Lefkandi." *BSA* 80:19-23.

Chaniotis, A. 1999. "Milking the Mountains: Economic Activities on the Cretan Uplands in the Classical and Hellenistic Period." In *From Minoan Farmers to Roman Traders: Sidelights on the Economy of Ancient Crete*, edited by A. Chaniotis, 181-220. Stuttgart: Franz Steiner Verlag.

Chapin, A. P. 2010. "Frescoes." In *The Oxford Handbook of the Bronze Age Aegean (ca. 3000-1000 BC)*, edited by E. H. Cline, 223-36. New York: Oxford University Press.

Chenal-Velarde, I. 2001. "Des Festins à l'Entrée du temple? Sacrifices et Consommation des Animaux à l'Époque Géométrique dans la Sanctuaire d'Apollon à l'Erétrie, Grèce." *Archaeofauna* 10:25-35.

———. 2007. “Analyses Archéozoologiques.” In *Eretria XVII: les Pratiques Funéraires d'Époque Géométrique à Érétrie. Espace des Vivants, Demeures des Morts.* Vol. II, edited by B. Blandin, 132-3. Gollion: Ecole Suisse d'Archéologie en Grèce.

Chenal-Velarde, I., and J. Studer. 2003. “Archaeozoology in a Ritual Context: the Case of a Sacrificial Altar in Geometric Eretria.” In *Zooarchaeology in Greece: Recent Advances,* BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 215-20. London: The British School at Athens.

Clarke, M. J. 2001. “Akha Feasting: An Ethnoarchaeological Perspective.” In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*, edited by M. Dietler and B. Hayden, 144-67. Washington and London: Smithsonian Institution Press.

Cliff, A. D., and J. K. Ord. 1973. *Spatial Autocorrelation*. London: Pion.

———. 1981. *Spatial Processes: Models and Applications*. London: Pion.

Clinton, K. 2005. “Pigs in Greek Ritual.” In *Greek Sacrificial Ritual, Olympian and Chthonian*, edited by R. Hägg and B. Alroth, 167-79. Stockholm: Paul Åströms Förlag.

Coldstream, J. N. 1968. *Greek Geometric Pottery: a Survey of Ten Local Styles and their Chronology*. London: Methuen.

———. 1979. *Geometric Greece*. London: Methuen.

Coldstream, J. N., and R. A. Higgins. 1973. “Conclusions: the Cult of Demeter at Knossos.” In *Knossos: the Sanctuary of Demeter.* BSA Supplementary Volumes 8, edited by J. N. Coldstream, 180-7. London: The British School of Archaeology at Athens.

Conolly, J., and M. Lake. 2006. *Geographical Information Systems in Archaeology*. Cambridge: Cambridge University Press.

Costello, B. 2011. “The Waste Stream of a Late Roman House: Case Study of the Commissary Block in the Earthquake House at Kourion.” In *Pottery in the Archaeological Record: Greece and Beyond*, edited by M. L. Lawall and J. Lund, 75-84. Aarhus: Aarhus University Press.

Coulson, W. D. E. 1983. “The Dark Age: the Architecture.” In *Volume III: Dark Age and Byzantine Occupation*, edited by W. A. McDonald, W. D. E. Coulson and J. Rosser, 9-60. Minneapolis: The University of Minnesota Press.

Crabtree, P. J. 1990. “Zooarchaeology and Complex Societies: Some Uses of Faunal Analysis for the Study of Trade, Social Status, and Ethnicity.” *Archaeological Method and Theory* 2:155-205.

Crane, C. J., and H. S. Carr. 1994. "Integration and Quantification of Economic Data from a Late Preclassic Maya Community in Belize." In *Paleonutrition: The Diet and Health of Prehistoric Americans,* edited by K. D. Sobolik, 66-79. Carbondale: Center for Archaeological Investigations, Southern Illinois University.

Curci, A., and A. Tagliacozzo. 2003. "Economic and Ecological Evidence from the Vertebrate Remains of the Neolithic Site of Makri (Thrace-Greece)." In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 123-31. London: The British School at Athens.

Dabney, M. K., P. Halstead, and P. Thomas. 2004. "Mycenaean Feasting on Tsoungiza at Ancient Nemea." *Hesperia* 73 (2):197-215.

Dandoy, J. R. 2006. "Astragali Through Time." In *Integrating Zooarchaeology*, edited by M. Maltby, 131-7. Oxford: Oxbow Books.

Day, L. P., and L. M. Snyder. 2004. "The 'Big House' at Vronda and the 'Great House' at Karphi: Evidence for Social Structure in LM IIIC Crete." In *Crete Beyond the Palaces: Proceedings of the Crete 2000 Conference*, edited by L. P. Day, M. S. Mook and J. D. Muhly, 63-79. Philadelphia: INSTAP Academic Press.

deFrance, S. D. 2009. "Zooarchaeology in Complex Societies: Political, Economy, Status, and Ideology." *Journal of Archaeological Research* 17:105-68.

Deonna, W. 1940. "Les Cornes Gauches des Autels de Dréros et de Délos." *Revue des Études Anciennes* 42:111-26.

Desborough, V. R. d'A. 1972. *The Greek Dark Ages*. London: Ernest Benn.

Detienne, M. 1989. "Culinary Practices and the Spirit of Sacrifice." In *The Cuisine of Sacrifice Among the Greeks*, edited by M. Detienne and J.-P. Vernant, 1-20. Translated by P. Wissing. Chicago: The University of Chicago Press.

Diamant, S. 1979. "A Short History of Archaeological Sieving at Franchthi Cave, Greece." *JFA* 6 (2):203-17.

Dickinson, O. T. P. K. 2006a. *The Aegean from Bronze Age to Iron Age: Continuity and Change Between the Twelfth and Eighth Centuries BC.* Abingdon: Routledge.

———. 2006b. "The Mycenaean Heritage of Early Iron Age Greece." In *Ancient Greece: From the Mycenaean Palaces to the Age of Homer*, edited by S. Deger-Jalkotzy and I. S. Lemos, 115-22. Edinburgh: Edinburgh University Press.

Dietler, M. 2011. "Feasting and Fasting." In *The Archaeology of Ritual and Religion*, edited by T. Insoll, 179-94. Oxford: Oxford University Press.

Drennan, R. D. 1996. *Statistics for Archaeologists: A Commonsense Approach*. New York: Plenum Press.

Driessen, J., and H. Fiasse. 2011. "'Burning Down the House': Defining the Household of Quartier Nu at Malia Using GIS." In *Στεγα: The Archaeology of Houses and Households in Ancient Crete*, edited by K. T. Glowacki and N. Vogeikoff-Brogan, 285-96. Princeton: The American School of Classical Studies at Athens.

Durand, J-L. 1989. "Greek Animals: Toward a Typology of Edible Bodies." In *The Cuisine of Sacrifice Among the Greeks*, edited by M. Detienne and J.-P. Vernant, 87-118. Translated by P. Wissing. Chicago: The University of Chicago Press.

Enloe, J. G. 2004. "Equifinality, Assemblage Integrity and Behavioral Inferences at Verberie." *Journal of Taphonomy* 2 (3):147-65.

Ervynck, A., A. Lentacker, G. Müldner, M. Richards, and K. Dobney. 2007. "An Investigation into the Transition from Forest Dwelling Pigs to Farm Animals in Medieval Flanders, Belgium." In *Pigs and Humans: 10,000 Years of Interaction*, edited by U. Albarella, K. Dobney, A. Ervynck and P. Rowley-Conwy, 171-93. Oxford: Oxford University Press.

Ervynck, A., W. Van Neer, H. Hüster-Plogmann, and J. Schibler. 2003. "Beyond Affluence: the Zooarchaeology of Luxury." *WorldArch* 34 (3):428-41.

Fletcher, R. 2008. "Some Spatial Analyses of Chalcolithic Settlement in Southern Israel." *JAS* 35:2048-58.

Forbes, H. 2007. *Meaning and Identity in a Greek Landscape: An Archaeological Ethnography*. New York: Cambridge University Press.

Forstenpointner, G. 2003. "Promethean Legacy: Investigations into the Ritual Procedure of 'Olympian' Sacrifice." In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 203-13. London: The British School at Athens.

Fowler, H. N., and J. R. Wheeler. 1909. *A Handbook of Greek Archaeology*. New York: American Book Company.

Foxhall, L. 1995. "Bronze to Iron: Agricultural Systems and Political Structures in Late Bronze Age and Early Iron Age Greece." *BSA* 90:239-50.

Frost, F. 1999. "Sausage and Meat Preservation in Antiquity." *Greek, Roman and Byzantine Studies* 40 (3):241-52.

Gifford, D. P. 1980. "Ethnoarcheological Contributions to the Taphonomy of Human Sites." In *Fossils in the Making: Vertebrate Taphonomy and Paleoecology*, edited by A. K. Behrensmeyer and A. P. Hill, 93-106. Chicago: University of Chicago Press.

Glowacki, K. T. 2004. "Household Analysis in Dark Age Crete." In *Crete Beyond the Palaces: Proceedings of the Crete 2000 Conference*, edited by L. P. Day, M. S. Mook and J. D. Muhly, 125-36. Philadelphia: INSTAP Academic Press.

Grayson, D. K. 1982. “Toward a History of Great Basin Mammals During the Past 15,000 Years.” In *Man and Environment in the Great Basin*, edited by D. B. Madsen and J. F. O'Connell, 82-101. Washington DC: Society for American Archaeology.

———. 1984. *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. Orlando: Academic Press.

Greenfield, H. J. 1988. “The Origins of Milk and Wool Production in the Old World: a Zooarchaeological Perspective from the Central Balkans.” *CurrAnthr* 29 (4):573-93.

———. 2010. “The Secondary Products Revolution: the Past, the Present and the Future.” *WorldArch* 42 (1):29-54.

Greenfield, H. J., and K. Fowler. 2003. “Megalo Nisi Galanis and the Secondary Products Revolution in Macedonia.” In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 133-43. London: The British School at Athens.

Griffith, D. A. 1987. *Spatial Autocorrelation: A Primer*. Washington D.C.: Association of American Geographers.

Griffith, D. A., and C. G. Amrhein. 1991. *Statistical Analysis for Geographers*. Englewood Cliffs: Prentice Hall.

Grigson, C. 2007. “Culture, Ecology, and Pigs from the 5th to the 3rd Millennium BC around the Fertile Crescent.” In *Pigs and Humans: 10,000 Years of Interaction*, edited by U. Albarella, K. Dobney, A. Ervynck and P. Rowley-Conwy, 83-108. Oxford: Oxford University Press.

Hadjikoumis, A. 2012. “Traditional Pig Herding Practices in Southwest Iberia: Questions of Scale and Zooarchaeological Implications.” *JAnthArch* 31:353-64.

Haggis, D. C. 2000. “Settlement Patterns and Social Structure in the Dark Age Aegean.” (conference paper). In*: Lighten our Darkness: Cultural Transformations at the Beginning of the First Millennium BC – from the Alps to Anatolia* conference proceedings, convened by K. A. Wardle, at the University of Birmingham, January 6-9, 2000.

Haggis, D. C., M. S. Mook, T. Carter, and L. M. Snyder. 2007. “Excavations at Azoria, 2003-2004, Part 2: The Final Neolithic, Late Prepalatial, and Early Iron Age Occupation.” *Hesperia* 76 (4):665-716.

Haggis, D. C., M. S. Mook, R. D. Fitzsimons, M. Eaby, M. Liston, C. M. Scarry, L. M. Snyder, and R. Doonan. Forthcoming. “The Excavation of Late Minoan IIIC, Early Iron Age, and Orientalizing Levels at Azoria in 2005-2006.” *Hesperia.*

Haggis, D. C., M. S. Mook, R. D. Fitzsimons, C. M. Scarry, and L. M. Snyder. 2011a. “The Excavations of Archaic Houses at Azoria in 2005-2006.” *Hesperia* 80 (3):431-89.

Haggis, D. C., M. S. Mook, R. D. Fitzsimons, C. M. Scarry, L. M. Snyder, and W. C. West. 2011b. "Excavations in the Archaic Civic Buildings at Azoria in 2005-2006." *Hesperia* 80 (1):1-70.

Haggis, D. C., M. S. Mook, C. M. Scarry, L. M. Snyder, and W. C. West. 2004. "Excavations at Azoria, 2002." *Hesperia* 73 (3):339-400.

Halstead, P. 1987. "Man and Other Animals in Later Greek Prehistory." *BSA* 82:71-83.

———. 1996. "Pastoralism or Household Herding? Problems of Scale and Specialization in Early Greek Animal Husbandry." *WorldArch* 28 (1):20-42.

———. 2003. "Beyond Bones: Introduction." In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 249-50. London: The British School at Athens.

Halstead, P., and V. Isaakidou. 2011. "A Pig Fed by Hand is Worth Two in the Bush: Ethnoarchaeology of Pig Husbandry in Greece and its Archaeological Implications." In *Ethnozooarchaeology: the Present and Past of Human-Animal Relationships*, edited by U. Albarella and A. Trentacoste, 160-74. Oxford: Oxbow Books.

Halstead, P., and G. Jones. 1980. "Bio-Archaeological Remains from Assiros Toumba." In K. A. Wardle "Excavations at Assiros, 1975-9: a Settlement Site in Central Macedonia and its Significance for the Prehistory of South-East Europe." *BSA* 75:265-7.

Halstead, P., and G. Jones. 1992. "Animal Bones and Burial Customs in Early Iron Age Thasos: the Faunal Remains from the Cemeteries of Kastri Settlement." In *Προϊστορική Θάσος. Τα νεκροταφεία του οικισμού Καστρί*, edited by C. Koukouli-Chrysanthaki, 753-5. Athens: Ministry of Culture.

Hamilakis, Y. 2000. "The Anthropology of Food and Drink Consumption and the Aegean Archaeology." In *Palaeodiet in the Aegean: Papers from a Colloquium Held at the 1993 Meeting of the Archaeological Institute of America in Washington D.C.*, edited by S. J. Vaughan and W. D. E. Coulson, 55-63. Oxford: Oxbow Books.

Hayden, B. 2001. "Fabulous Feasts: A Prolegomenon to the Importance of Feasting." In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*, edited by M. Dietler and B. Hayden, 23-64. Washington and London: Smithsonian Institution Press.

Hayden, B., and A. Cannon. 1983. "Where the Garbage Goes: Refuse Disposal in the Maya Highlands." *JAnthArch* 2:117-63.

Hesse, B., and P. Wapnish. 1985. *Animal Bone Archaeology: from Objectives to Analysis*. Washington: Taraxacum.

Hill, T., and P. Lewicki. 2006. *Statistics: Methods and Applications. A Comprehensive Reference for Science, Industry, and Data Mining*. Tulsa: StatSoft.

Hinton, P. R., C. Brownlow, I. McMurray, and B. Cozens. 2004. *SPSS Explained*. London and New York: Routledge.

Hodder, I., and C. Orton. 1976. *Spatial Analysis in Archaeology*. Cambridge: Cambridge University Press.

Hogarth, D. G. 1900. "The Dictaean Cave." *BSA* 6:94-116.

Howe, T. 2008. *Pastoral Politics: Animals, Agriculture and Society in Ancient Greece*. Claremont: Regina Books.

Isaakidou, V. 2003. "Worked and Utilised Bone and Antler: Practical and Cultural Rationales for the Selection of Raw Materials." In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 233-8. London: The British School at Athens.

———. 2006. "Ploughing with Cows: Knossos and the Secondary Products Revolution." In *Animals in the Neolithic of Britain and Europe*, edited by D. Serjeantson and D. Field, 95-112. Oxford: Oxbow Books.

Isager, S., and J. E. Skydsgaard. 1992. *Ancient Greek Agriculture: an Introduction*. London: Routledge.

Jacobsen, T. W. 1969. "Excavations at Porto Cheli and Vicinity, Preliminary Report, II: The Franchthi Cave, 1967-1968." *Hesperia* 38 (3):343-81.

Jameson, M. H. 1988. "Sacrifice and Animal Husbandry in Classical Greece." In *Pastoral Economies in Classical Antiquity*, edited by C. R. Whittaker, 87-119. Cambridge: The Cambridge Philological Society.

Jarman, M. R. 1973. "Preliminary Report on the Animal Bones." In *Knossos: the Sanctuary of Demeter*. BSA Supplementary Volumes 8, edited by J. N. Coldstream, 177-9. London: The British School of Archaeology at Athens.

Jarman, M. R., and H. N. Jarman. 1968. "The Fauna and Economy of Early Neolithic Knossos." In P. Warren, M. R. Jarman, H. N. Jarman, N. J. Shackleton and J. D. Evans "Knossos Neolithic, Part II." *BSA* 63:241-64.

Johannsen, N. 2011. "Past and Present Strategies for Draught Exploitation of Cattle." In *Ethnozooarchaeology: the Present and Past of Human-Animal Relationships*, edited by U. Albarella and A. Trentacoste, 13-9. Oxford: Oxbow Books.

Johnstone, C., and U. Albarella. 2002. *The Late Iron Age and Romano-British Mammal and Bird Bone Assemblage from Elms Farm, Heybridge, Essex.* Centre for Archaeology Report 45. London: English Heritage.

Jones, M. 2007. *Feast: Why Humans Share Food*. Oxford: Oxford University Press.

Jones O'Day, S., W. van Neer, and A. Ervynck. 2004. Introduction to *Behaviour Behind Bones: the Zooarchaeology of Ritual, Religion, Status and Identity*, edited by S. Jones O'Day, W. van Neer and A. Ervynck. Oxford: Oxbow Books.

Klippel, W. E., and L. M. Snyder. 1991. “Dark-Age Fauna from Kavousi, Crete: the Vertebrates from the 1987 and 1988 Excavations.” *Hesperia* 60 (2):179-86.

Kotjabopoulou, E., and C. Gamble. 2003. “Subsistence Through the Ages: Introduction.” In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 111-3. London: The British School at Athens.

Landon, D. B. 2005. “Zooarchaeology and Historical Archaeology: Progress and Prospects.” *Journal of Archaeological Method and Theory* 12 (1):1-36.

Leech, N. L., K. C. Barrett, and G. A. Morgan. 2005. *SPSS for Intermediate Statistics: Use and Interpretation.* 2nd ed. Mahwah, N.J.: Lawrence Erlbaum Associates.

Lemos, I. S. 2002. *The Protogeometric Aegean: the Archaeology of the Late Eleventh and Tenth Centuries BC*. Oxford: Oxford University Press.

Lyman, R. L. 1994a. *Vertebrate Taphonomy*. Cambridge: Cambridge University Press.

———. 1994b. “Quantitative Units and Terminology in Zooarchaeology.” *AmerAnt* 59 (1):36-71.

———. 2005. “Zooarchaeology.” In *Handbook of Archaeological Methods.* Vol. 2, edited by H. D. G. Maschner and C. Chippindale, 835-70. Lanham: Altamira Press.

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

Mainland, I. 2003. “Dental Microwear in Modern Greek Ovicaprids: Identifying Microwear Signatures Associated with a Diet of Leafy-Hay.” In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 45-50. London: The British School at Athens.

Marciniak, A. 2005. *Placing Animals in the Neolithic: Social Zooarchaeology of Prehistoric Farming Communities*. London: UCL Press.

Marín Arroyo, A. B. 2009. “Assessing what Lies Beneath the Spatial Distribution of a Zooarchaeological Record: the use of GIS and Spatial Correlations at El Mirón Cave (Spain).” *Archaeometry* 51 (3):506-24.

Marinatos, S. 1936. “Le Temple Géométrique de Dréros.” *BCH* 60:214-85.

Masicampo, E. J., and D. R. Lalande. 2012. A Peculiar Prevalence of p Values Just Below .05. *The Quarterly Journal of Experimental Psychology*:1-9. Doi 10.1080/17470218.2012. 711335.

Masseti, M. 2007. "The Economic Role of Sus in Early Human Fishing Communites." In *Pigs and Humans: 10,000 Years of Interaction*, edited by U. Albarella, K. Dobney, A. Ervynck and P. Rowley-Conwy, 156-70. Oxford: Oxford University Press.

Mazarakis Ainian, A. 1988. "Early Greek Temples: their Origin and Function." In *Early Greek Cult Practice: Proceedings of the Fifth International Symposium at the Swedish Institute at Athens, 26-29, June, 1986,* edited by R. Hägg, N. Marinatos and G. Nordquist, 103-19. Stockholm: Svenska Institutet i Athen.

———. 1997. *From Rulers' Dwellings to Temples: Architecture, Religion and Society in Early Iron Age Greece (1100-700 B.C.),* Studies in Mediterranean Archaeology Vol. CXXI. Jonsered: Paul Åströms Förlag.

———. 2007. "Architecture and Social Structure in Early Iron Age Greece." In *Building Communities: House, Settlement and Society in the Aegean and Beyond,* BSA Studies 15, edited by R. Westgate, N. Fisher and J. Whitley, 157-68. Athens: British School at Athens.

McCall, M. K. 1985. "The Significance of Distance Constraints in Peasant Farming Systems with Special Reference to Sub-Saharan Africa." *Applied Geography* 5:325-45.

McCormick, F. 1992. "Early Faunal Evidence for Dairying." *OJA* 11 (2):201-9.

Mehta, C. R., and N. R. Patel. 2011. "IBM SPSS Exact Tests." Retrieved from ftp://public.dhe.ibm.com/software/analytics/spss/documentation/statistics/20.0/en/client/Manuals/IBM_SPSS_Exact_Tests.pdf

Moberg, K. 1992. "The Animal Bones." In R. Hägg and G. C. Nordquist "Excavations in the Levendis Sector at Asine, 1989: a Preliminary Report." *OpAth* 19:66-8.

Moreno-Garcia, M., and C. M. Pimenta. 2011. "Animal Dung: Rich Ethnographic Records, Poor Archaeozoological Evidence." In *Ethnozooarchaeology: the Present and Past of Human-Animal Relationships*, edited by U. Albarella and A. Trentacoste, 20-8. Oxford: Oxbow Books.

Morris, I. 1998. "Archaeology and Archaic Greek History." In *Archaic Greece: New Approaches and New Evidence*, edited by N. Fisher and H. van Wees, 1-91. London: Duckworth.

———. 1999. "Archaeology and Gender Ideologies in Early Archaic Greece." *TAPA* 129:305-17.

———. 2004. "Economic Growth in Ancient Greece." *Journal of Institutional and Theoretical Economics* 160 (4):709-42.

———. 2008. “Classical Archaeology.” In *A Companion to Archaeology,* edited by J. L. Bintliff, 253-71. Oxford: Blackwell Publishing.

Mylona, D. 2003. “Archaeological Fish Remains in Greece: General Trends of the Research and a Gazetteer of Sites.” In *Zooarchaeology in Greece: Recent Advances,* BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 193-200. London: The British School at Athens.

Nevett, L. 2007. Greek Houses as a Source of Evidence for Social Relations. In *Building Communities: House, Settlement and Society in the Aegean and Beyond,* BSA Studies 15, edited by R. Westgate, N. Fisher and J. Whitley, 5-10. Athens: British School at Athens.

Payne, S. 1972a. “Partial Recovery and Sample Bias: the Results of Some Sieving Experiments.” In *Papers in Economic Prehistory: Studies by Members and Associates of the British Academy Major Research Project in the Early History of Agriculture,* edited by E. S. Higgs, 49-64. Cambridge: Cambridge University Press.

———. 1972b. “On the Interpretation of Bone Samples from Archaeological Sites.” In *Papers in Economic Prehistory: Studies by Members and Associates of the British Academy Major Research Project in the Early History of Agriculture*, edited by E. S. Higgs, 65-81. Cambridge: Cambridge University Press.

———. 1973. “Kill-off Patterns in Sheep and Goats: the Mandibles from Aşvan Kale.” *AnatSt* 23:281-303.

———. 1975. “Partial Recovery and Sample Bias.” In *Archaeozoological Studies: Papers of the Archaeozoological Conference 1974, Held at the Biologisch-Archaeologisch Instituut of the State University of Groningen,* edited by A. T. Clason, 7-17. Amsterdam: North-Holland Publishing Company.

———. 1985a. “Zooarchaeology in Greece: a Readers Guide.” In *Contributions to Aegean Archaeology: Studies in Honor of W. A. McDonald,* edited by N. C. Wilkie and W. D. E. Coulson, 211-44. Dubuque: Kendall/Hunt.

———. 1985b. “Morphological Distinctions Between the Mandibular Teeth of Young Sheep, *Ovis,* and Goats, *Capra*.” *JAS* 12:139-47.

Pendlebury, H. W., Pendlebury J. D. S., and M. B. Money-Coutts. 1938. “Excavations in the Plain of Lasithi III. Karphi. A City of Refuge of the Early Iron Age in Crete.” *BSA* 38:57-145.

Peres, T. M. 2010. “Methodological Issues in Zooarchaeology.” In *Integrating Zooarchaeology and Paleoethnobotany: a Consideration of Issues, Methods, and Cases,* edited by A. M. VanDerwarker and T. M. Peres, 15-36. New York: Springer.

Pollard, A. M., C. M. Batt, B. Stern, and Young S. M. M. 2007. *Analytical Chemistry in Archaeology*. New York: Cambridge University Press.

Popper, V. S. 1988. “Selecting Quantitative Measurements in Paleoethnobotany.” In *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*, edited by C. A. Hastorf and V. S. Popper, 53-71. Chicago and London: The University of Chicago Press.

Powell, J. 1992. “Archaeological and Pictorial Evidence for Fishing in the Bronze Age: Issues of Identification and Interpretation.” In *Eikωn. Aegean Bronze Age Iconography: Shaping a Methodology*, edited by R. Laffineur and J. L. Crowley, 307-16. Liège: Université de Liège.

———. 2003. “Fishing in the Mesolithic and Neolithic - the Cave of Cyclops, Youra.” In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 75-84. London: The British School at Athens.

Premo, L. S. 2004. “Local Spatial Autocorrelation Statistics Quantify Multi-Scale Patterns in Distributional Data: an Example from the Maya Lowlands.” *JAS* 31:855-66.

Prummel, W. 2003. “Animal Remains from the Hellenistic Town of New Halos in the Almirós Plain, Thessaly.” In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 153-9. London: The British School at Athens.

Purdue, J. R., B. W. Styles, and M. C. Masulis. 1989. “Faunal Remains and White-Tailed Deer Exploitation from a Late Woodland Upland Encampment: The Boschert Site (23SC609), St. Charles County, Missouri.” *Midcontinental Journal of Archaeology* 14 (2):143-63.

Redding, R. W. 1984. “Theoretical Determinants of a Herder's Decisions: Modeling Variation in the Sheep/Goat Ratio.” In *Animals and Archaeology: 3. Early Herders and their Flocks* BAR-IS202, edited by J. Clutton-Brock and C. Grigson, 223-41. Oxford: BAR.

Reese, D. S. 1994. “Recent Work in Greek Zooarchaeology.” In *Beyond the Site: Regional Studies in the Aegean Area*, edited by P. N. Kardulias, 191-221. Lanham: University Press of America.

Reese, D. S., M. J. Rose, and D. Ruscillo. 2000. “The Iron Age Fauna.” In *Kommos: an Excavation on the South Coast of Crete by the University of Toronto and the Royal Ontario Museum Under the Auspices of the American School of Classical Studies in Athens.* Volume IV, edited by J. W. Shaw and M. C. Shaw, 415-645. Princeton: Princeton University Press.

Reitz, E. J., and E. S. Wing. 2008. *Zooarchaeology*. 2nd ed. New York: Cambridge University Press.

Rogerson, P. A. 2001. *Statistical Methods for Geography*. London: Sage Publications.

Rosenberg, M. S., and C. D. Anderson. 2011. “PASSaGE: Pattern Analysis, Spatial Statistics and Geographic Exegesis. Version 2.” *Methods in Ecology and Evolution* 2 (3):229-32.

Rowley-Conwy, P. 2008. “Animal Bones and Plant Remains.” In *A Companion to Archaeology*, edited by J. L. Bintliff, 291-310. Oxford: Blackwell Publishing.

Rowley-Conwy, P., U. Albarella, and K. Dobney. 2012. “Distinguishing Wild Boar from Domestic Pigs in Prehistory: a Review of Approaches and Recent Results.” *Journal of World Prehistory* 25:1-44.

Ruscillo, D. 2003. “Alternative Methods for Identifying Sex from Archaeological Animal Bone.” In *Zooarchaeology in Greece: Recent Advances*, BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 37-44. London: The British School at Athens.

Russell, N. 2012. *Social Zooarchaeology: Humans and Animals in Prehistory*. Cambridge: Cambridge University Press.

Sarpaki, A. 2000. “The Study of Palaeodiet in the Aegean: Food for Thought.” In *Palaeodiet in the Aegean: Papers from a Colloquium Held at the 1993 Meeting of the Archaeological Institute of America in Washington D.C.*, edited by S. J. Vaughan and W. D. E. Coulson, 115-21. Oxford: Oxbow Books.

Sarpaki, A., and E. Asouti. 2008. “A Glimpse through a Kitchen Key-Hole of Late Bronze Age Akrotiri: the Organic Remains.” In K. Birtacha “‘Cooking’ Installations in LC IA Akrotiri on Thera: a Preliminary Study of the ‘Kitchen’ in Pillar Shaft 65.” In *Horizon: A Colloquium on the Prehistory of the Cyclades* edited by N. Brodie, J. Doole, G. Gavalas and C. Renfrew, 370-6. Cambridge: McDonald Institute for Archaeological Research.

Sasson, A. 2006. “Animal Husbandry and Diet in Pre-Modern Villages in Mandatory Palestine, According to Ethnographic Data.” In *Integrating Zooarchaeology*, edited by M. Maltby, 33-40. Oxford: Oxbow Books.

Schliemann, H. 1880. *Ilios: the City and Country of the Trojans. The Results of Researches and Discoveries on the Site of Troy and Throughout the Troad in the Years 1871-72-73-78-79*. London: John Murray.

Schwarz, K. R., and J. Mount. 2006. “Integrating Spatial Statistics into Archaeological Data Modeling.” In *GIS and Archaeological Site Location Modeling*, edited by M. W. Mehrer and K. L. Wescott, 154-75. Boca Raton: Taylor and Francis.

Shennan, S. 1988. *Quantifying Archaeology*. Edinburgh: Edinburgh University Press.

Sherratt, S. 2004. “Feasting in Homeric Epic.” *Hesperia* 73 (2):301-37.

Silk, J. 1979. *Statistical Concepts in Geography*. London: George Allen & Unwin.

Silver, I. A. 1969. “The Ageing of Domestic Animals.” In *Science in Archaeology: a Survey of Progress and Research*, edited by D. Brothwell and E. Higgs, 283-302. 2nd ed. London: Thames and Hudson.

Sloan, R. E., and M. A. Duncan. 1978. “Zooarchaeology of Nichoria.” In *Excavations at Nichoria in Southwest Greece I: Site, Environs, and Techniques*, edited by G. Rapp and S. E. Aschenbrenner, 60-77. Minneapolis: University of Minnesota Press.

Snodgrass, A. M. 1971. *The Dark Age of Greece: an Archaeological Survey of the Eleventh to the Eighth Centuries BC*. Edinburgh: Edinburgh University Press.

———. 1977. *Archaeology and the Rise of the Greek State: an Inaugural Lecture*. Cambridge: Cambridge University Press.

———. 1987. *An Archaeology of Greece: the Present State and Future Scope of a Discipline*. Berkeley: University of California Press.

Snyder, L. M., and W. E. Klippel. 2000. “Dark Age Subsistence at the Kastro Site, East Crete: Exploring Subsistence Change and Continuity During the Late Bronze Age - Early Iron Age Transition.” In *Palaeodiet in the Aegean: Papers from a Colloquium Held at the 1993 Meeting of the Archaeological Institute of America in Washington D.C.*, edited by S. J. Vaughan and W. D. E. Coulson, 65-83. Oxford: Oxbow Books.

———. 2003. “From Lerna to Kastro: Further Thoughts on Dogs as Food in Ancient Greece; Perceptions, Prejudices and Reinvestigations.” In *Zooarchaeology in Greece: Recent Advances,* BSA Studies 9, edited by E. Kotjabopoulou, Y. Hamilakis, P. Halstead, C. Gamble and P. Elefanti, 221-31. London: The British School at Athens.

Stahl, P. W., and J. A. Zeidler. 1990. “Differential Bone-Refuse Accumulation in Food-Preparation and Traffic Areas on an Early Ecuadorian House Floor.” *Latin American Antiquity* 1 (2):150-69.

Stein, G. J. 1987. “Regional Economic Integration in Early State Societies: Third Millennium B.C. Pastoral Production at Gritille, Southeast Turkey.” *Paléorient* 13 (2):101-11.

Televantou, C. A. 2008. “Strofilas: a Neolithic Settlement on Andros.” In *Horizon: A Colloquium on the Prehistory of the Cyclades* edited by N. Brodie, J. Doole, G. Gavalas and C. Renfrew, 43-53. Cambridge: McDonald Institute for Archaeological Research.

Theodoropoulou, T. 2007. “’Gifts’ from the Gulf: the Exploitation of Molluscs in the Geometric Artisan Site of Oropos.” In *Oropos and Euboea in the Early Iron Age: Acts of an International Round Table, University of Thessaly, June 18-20, 2004,* edited by A. Mazarakis Ainian, 427-45. Volos: University of Thessaly Publications.

Trantalidou, K. 1990. “Animals and Human Diet in the Prehistoric Aegean.” In *Thera and the Aegean World III.* Vol. 2, *Earth Sciences,* edited by D. A. Hardy, J. Keller, V. P. Galanopoulos, N. C. Flemming and T. H. Druitt, 392-405. London: The Thera Foundation.

———. 2001. “Archaeozoology in Greece: A Brief Historiography of the Science.” *Archaeofauna* 10:183-99.

———. 2006. "The Bones and Bone Tools." In *Markiani, Amorgos: an Early Bronze Age Fortified Settlement. Overview of the 1985-1991 Investigations*, edited by L. Marangou, C. Renfrew, C. Doumas and G. Gavalas, 223-42. Athens: British School at Athens.

———. 2007. "The Contribution of the Study of Animal Bones in the Social Understanding of Early Iron Age Oropos." In *Oropos and Euboea in the Early Iron Age: Acts of an International Round Table, University of Thessaly, June 18-20, 2004*, edited by A. Mazarakis Ainian, 379-425. Volos: University of Thessaly Publications.

———. 2008a. "The Microcosm of a Kitchen: Evidence from the Mammal Remains." In K. Birtacha "'Cooking' Installations in LC IA Akrotiri on Thera: a Preliminary Study of the 'Kitchen' in Pillar Shaft 65." In *Horizon: A Colloquium on the Prehistory of the Cyclades* edited by N. Brodie, J. Doole, G. Gavalas and C. Renfrew, 363-9. Cambridge: McDonald Institute for Archaeological Research.

———. 2008b. "Glimpses of Aegean Island Communities During the Mesolithic and Neolithic Periods: the Zooarchaeological Point of View." In *Horizon: A Colloquium on the Prehistory of the Cyclades*, edited by N. Brodie, J. Doole, G. Gavalas and C. Renfrew, 19-27. Cambridge: McDonald Institute for Archaeological Research.

———. 2012. "Animal Remains Related to Sacred Areas on the Cycladic Islands Amorgos and Tenos, During the Geometric Period: Two Distinct Examples Bearing Evidence of Sacrificial Rites and Bone Working Activities." In *The 'Dark Ages' Revisited: Acts of an International Symposium in Memory of William D. E. Coulson: University of Thessaly, Volos, 14-17 June 2007*, edited by A. Mazarakis Ainian, 1059-105. Volos: University of Thessaly Press.

Trigger, B. G. 2006. *A History of Archaeological Thought*. 2nd ed. New York: Cambridge University Press.

VanDerwarker, A. M. 2010. "Simple Measures for Integrating Plant and Animal Remains." In *Integrating Zooarchaeology and Paleoethnobotany: a Consideration of Issues, Methods, and Cases*, edited by A. M. VanDerwarker and T. M. Peres, 65-74. New York: Springer.

VanDerwarker, A. M., and T. M. Peres. 2010. Introduction to *Integrating Zooarchaeology and Paleoethnobotany: a Consideration of Issues, Methods, and Cases*, edited by A. M. VanDerwarker and T. M. Peres. New York: Springer.

VanPool, T. L., and R. D. Leonard. 2011. *Quantitative Analysis in Archaeology*. Chichester: Wiley-Blackwell.

Vardaki, E. A. 2004. "Animal Husbandry Revisited: the Social Significance of Meat Consumption in a Highland Village of Mt Psiloritis, Central Crete." In *Food, Cuisine and Society in Prehistoric Greece*, edited by P. Halstead and J. C. Barrett, 196-205. Oxford: Oxbow Books.

Vaughan, S. J. 2000. "A Review of Palaeodietary Research in the Aegean and Introduction to the Monograph." In *Palaeodiet in the Aegean: Papers from a Colloquium Held at the 1993 Meeting of the Archaeological Institute of America in Washington D.C.*, edited by S. J. Vaughan and W. D. E. Coulson, 1-9. Oxford: Oxbow Books.

Vickery, K. F. 1936. *Food in Early Greece*. Urbana: The University of Illinois.

Vila, E. 2000. "Bone Remains from Sacrificial Places: the Temples of Athena Alea at Tegea and of Asea on Agios Elias (the Peloponnese, Greece)." In *Archaeozoology of the Near East IV*, edited by M. Mashkour, H. Buitenhuis, A. M. Choyke and F. Poplin, 197-205. Groningen: Archaeological Research and Consultancy.

Virchow, R. 1884. "On the Bones Collected During the Excavations of 1882, in the First and Most Ancient Prehistoric City at Hissarlik." In *Troja: Results of the Latest Researches and Discoveries on the Site of Homer's Troy and in the Heroic Tumuli and Other Sites, Made in the Year 1882; and a Narrative of a Journey in the Troad in 1881*, edited by H. Schliemann, 348-50. London: John Murray.

Voorrips, A., and J. M. O'Shea. 1987. "Conditional Spatial Patterning: Beyond the Nearest Neighbour." *AmerAnt* 52 (3):500-21.

Wallace, S. A. 2005. "Last Chance to See? Karfi (Crete) in the Twenty-First Century: Presentation of New Architectural Data and their Analysis in the Current Context of Research." *BSA* 100:215-74.

———. 2011. "Tradition, Status Competition, and the Templates of Domestic and Special Buildings in Post-Collapse Crete." In *Στεγα: The Archaeology of Houses and Households in Ancient Crete*, edited by K. T. Glowacki and N. Vogeikoff-Brogan, 323-32. Princeton: The American School of Classical Studies at Athens.

Wheatley, D., and M. Gillings. 2002. *Spatial Technology and Archaeology: the Archaeological Applications of GIS*. London: Taylor and Francis.

Wheeler, A., and A. K. G. Jones. 1989. *Fishes*. Cambridge: Cambridge University Press.

Whitley, J. 1991. "Social Diversity in Dark Age Greece." *BSA* 86:341-65.

———. 2001. *The Archaeology of Ancient Greece*. Cambridge: Cambridge University Press.

Wilkie, T., I. Mainland, U. Albarella, K. Dobney, and P. Rowley-Conwy. 2007. "A Dental Microwear Study of Pig Diet and Management in Iron Age, Romano-British, Anglo-Scandinavian, and Medieval Contexts in England." In *Pigs and Humans: 10,000 Years of Interaction*, edited by U. Albarella, K. Dobney, A. Ervynck and P. Rowley-Conwy, 241-54. Oxford: Oxford University Press.

Wilson, B. 1996. *Spatial Patterning Among Animal Bones in Settlement Archaeology: an English Regional Exploration*, BAR-BS251. Oxford: Tempus Reparatum.