An Isotopic Analysis of Dietary Habits in Early Bronze Age Anatolia

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by

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Abstract

This dissertation aims to examine the dietary habits of several Early Bronze Age (3000-2000 BC) populations in Anatolia. The investigated sites are İkiztepe (north Anatolia, Samsun region, on the Black Sea coast), Titriş Höyük (south east Anatolia, Urfa region), Bademağacı (south Anatolia, Antalya region), and Bakla Tepe (south west Anatolia, in the İzmir region). Dietary habits of the Early Bronze Age (EBA) in Anatolia have, so far, been poorly dealt with; instead research in this area has focused predominantly on the Neolithic period. When dietary habits of the EBA have been examined it has been on an individual site basis and reliant on examination of the archaeobotanical and archaeozoological material. This research utilises the results of stable isotope analyses of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) from human bone collagen in conjunction with published archaeological, archaeobotanical, and archaeozoological data (where present) to address this issue. This allows for a more complete approach to dietary habits analysis, including the quantitative scientific data of stable isotope analyses. This will permit, for the first time, a wider observation of EBA dietary habits across the region as well as examining the nature of dietary habits on an intra- and inter-site level, and temporally across the 3rd millennium BC. Intra-population issues of dietary habits such as possible social divisions (e.g. between sexes, ages, and socio-economic status) were addressed as well as examining potential differences between populations.

Analysis of carbon and nitrogen stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) was employed on bone collagen from ca. 200 human and faunal osteological samples taken from the laboratory of the Anthropology Department of Hacettepe University, Ankara, Turkey. Collagen extraction and the stable isotope analyses were conducted at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany.

The results show that during the EBA in Anatolia there was a general degree of homogeneity in dietary habits at an intra- and inter-site and regional level and across the millennium of the EBA with diets being predominantly terrestrial C3 based. The means of $\delta^{13}C$ and $\delta^{15}N$, respectively, are -20‰ and 8.9‰ for İkiztepe, -19.8‰ and 7.1‰ for Titriş Höyük, -20‰ and 8.6‰ for Bademağacı, and -19.6‰ and 8.3‰ for Bakla Tepe. The range of $\delta^{13}C$ values in the data from all sample sites is 2‰ (-21‰ to -19‰), and for $\delta^{15}N$ it is 4.3‰ (5.8‰ to 10.1‰). Furthermore, the results suggest that we can now begin to discuss about an ‘EBA package’ with regards to food resources.

Dedication

To мotiвation and nutriment

Acknowledgements

"No one can whistle a symphony. It takes an orchestra to play it" – H. E. Luccock

This work, like so many of its kind, is not merely the efforts of a single person but a collection of cumulative determination and collaboration over hours, days, weeks, months, and even years. There are so many people that I am incredibly lucky to have been able to work with and be in contact with and I am forever grateful and appreciative of for their time, help, advice, and assistance. Without them this project would simply have remained as an idea. There are also so many people I have met along the way and new and old friends who have offered help, advice, and support. Unfortunately I cannot mention and thank you all individually by name but I would like to let you know that I am forever thankful and grateful for everything and anything you have done that has helped me in any way.

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Sub Sole Sub Umbra Virens

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List of Abbreviations

AIR	Ambient Inhalable Reservoir
AMTL	Ante-Mortem Tooth Loss
BFT	Blunt Force Trauma
BP	Before Present
C	Carbon
CF-IRMS	Continuous Flow Isotope Ratio Mass Spectrometry
EBA	Early Bronze Age
F	Female
LBA	Late Bronze Age
LCh	Late Chalcolithic
M	Male
MA	Middle Adult
MBA	Middle Bronze Age
MH	Middle Helladic
MPI	Max Planck Institute
N	Nitrogen

O	Oxygen
OA	Old Adult
PB	Plaster Basin
PDB	Pee Dee Belemnite
PPN	Pre-Pottery Neolithic
S	Sulphur
Sr	Strontium
SFT	Sharp Force Trauma
TMJD	Temporomandibular Joint Disorder
YA	Young Adult

Chapter One: Introduction

The primary goal of this research is to examine the dietary habits of several (four) EBA (Early Bronze Age) Anatolian populations using primary data from stable isotope analyses, as well as secondary data from archaeobotanical, archaeozoological, and archaeological analyses. By combining these various sources of information a good indication of the types of food resources consumed, and in what relative amounts, should be able to be interpreted. At its most simplified, this research aims to establish what people were eating in the 3rd millennium BC of Anatolia and furthermore, if there are any patterns in dietary habits across the millennium, if there are differences within settlement populations (e.g. between sexes, ages etc.) and/or between other contemporary populations in the region. It will also aim to examine if reasons for interpreted and observed patterns can be inferred. These deductions will be performed at an intra-site level by interpreting the stable isotope data in the context of published overviews of the sampled sites and the results of specialist analyses into aspects such as material culture (e.g. ceramics and metallurgy). On a wider regional and temporal scale, interpretations will be made by examining the data of my stable isotope analyses and intra-site conclusions in association with the archaeological and specialist analyses of many other EBA Near Eastern/Eastern Mediterranean sites, as well as Anatolian sites of different periods.

The EBA archaeology of Anatolia is largely an “archaeology of the object” (Massa 2015, 274) where artefacts are studied individually, largely detached from their surrounding environment and social, cultural, technological, and economic contexts. Furthermore, unlike the Neolithic period in Anatolia, the EBA has had very little focus prioritised on dietary habits, subsistence practices, farming and related interactions with the landscape, instead focusing on material culture (Bachhuber 2015, 33). One of the benefits of stable isotope analysis is that it allows a greater interaction and exchange of information, for example between archaeology and ecology in dietary reconstruction (Katzenberg 2008, 431; Makarewicz & Sealy 2015, 154). Also, stable isotope research in Turkey has so far only dealt with other time periods (see Chapter Six), and predominantly the Neolithic. This research and thesis aims to address these issues providing an all-inclusive approach to the analysis of dietary habits and subsistence patterns of EBA Anatolia based upon a foundation of the results of stable isotope analysis.

This chapter provides an introduction to some of the key background features of the research. Firstly will be a historical summary of stable isotope analyses and how they came to be applied in archaeology and palaeodietary studies. This is followed by an introductory overview of the EBA period of Anatolia to provide the appropriate information for placing the sample sites and their populations in context. This will also be of benefit to the analysis and discussion chapters (Chapters Five and Six), allowing the results of the stable isotope analyses to be engaged within a wider regional perspective of the period. The usefulness and implications of studying dietary habits will then be discussed demonstrating the importance of this type of research. Finally, this chapter will conclude with the research objectives of this doctoral project.

1.1 Background to the Research

Stable isotopes were first discovered in 1913, and by the mid-1930s most had been identified (Katzenberg 2008, 414). Variation in the relative proportions of stable carbon isotopes was first measured by Nier and Gulbransen in 1939 and the general distribution of carbon isotopes in nature was explored in 1953 by Craig (Tykot 2010, 132). The first commercial mass spectrometer was used to analyse petroleum in 1942, and mass spectrometers and the application of stable isotope studies advanced in the 1950s and '60s in the fields of chemistry, biology, and geochemistry. In the 1950s and '60s major advances in understanding variation in the biosphere and geosphere were made as botanists and geochemists explored stable carbon isotope variation in plants (Katzenberg 2008, 414). The similarities in isotopic values of plants and animals from the same environment were noted as early as 1953 (Hoefs 1997, 137). This was followed with an interest by researchers working in radiocarbon dating labs, and thus carbon was the first to be used in archaeology as some archaeological researchers were already familiar with radiocarbon (Katzenberg 2008, 414-415). Stable isotopes were first proposed to be used to examine diet when it was noticed that maize (a C4 plant) had anomalously young (by about ca. 200 years) radiocarbon dates and that the $\delta^{13}C$ values were elevated compared to other (C3) plants from the same archaeological context (Ambrose & Krigbaum 2003, 196; Katzenberg 2008, 415; Makarewicz & Sealy 2015, 147; Tykot 2004, 433; Tykot 2010, 132). It was subsequently realised that maize had a different photosynthetic pathway with different relative quantities of ^{14}C and ^{13}C (Katzenberg 2008, 415; Tykot 2004, 433; Tykot 2010, 131). Following this Robert Hall (1967) proposed using stable carbon isotope analysis of bone to estimate maize consumption after it was realised that carbon isotope ratios in consumer tissues (e.g. bone) would also be affected, and therefore the measurement of carbon isotope ratios could be used to indicate the importance of maize in human diets (Ambrose & Krigbaum 2003, 196; Tykot 2004, 433). The pathways and fractionation undergone by ^{13}C and ^{12}C now compromise the best understood isotopic system (Lee-Thorp *et al* 2003, 105). In the early 1980s $\delta^{13}C$ values were used to estimate the dependence on marine foods of natives of the Canadian Pacific coast (Schwarcz & Schoeninger 2011, 725). It was later observed that nitrogen isotope values varied between different food sources, especially between marine and terrestrial and that there were differences in nitrogen ratios caused by trophic level effects (Tykot 2004, 433; Tykot 2010, 132; Walker & DeNiro 1986, 51). This was supported by early controlled animal feeding experiments which determined that “you are what you eat plus a few per mille” (Schwarcz & Schoeninger 2011, 725). These controlled feeding studies of the late 1970s and early 1980s on several species examined and established the relationship between stable carbon and stable nitrogen isotope ratios in diet and animal tissues, which was followed up by an examination of trophic level effects (see Chapter Three) and regional variations in stable nitrogen isotopes (Katzenberg 2008, 415; Makarewicz & Sealy 2015, 147).

Then from the 1970s a new era of dietary research based on the isotopic composition of human bone was ushered in, a procedure that is now increasingly used (Triantaphyllou *et al* 2006, 629; Tykot 2004, 433*).* Apart from the use of carbon (for dating), archaeologists have been relative latecomers to stable isotope study, and it is only over the last 20 years or so that advances in resolution, detection, and design of mass spectrometers as well as advances in stable isotope methodologies have had a massive impact enabling the ability to run more samples and at a lower cost, making it possible to sample and analyse more than only a few samples (Katzenberg 2008, 414-415). It is now understood that the isotopic composition of the tissues of animals and humans is determined by the proportion of various consumed nutrients, which allows us to determine how much of each of the available foods were consumed over their lifetime (Schwarcz & Schoeninger 2011, 725). Stable isotope analysis is now an established and important tool for reconstructing general diet on individual and population levels, subsistence patterns at population level, local (palaeo)environmental and climate conditions, agricultural practices (mainly regarding irrigation, fertilisation techniques, and the state of soils), migration, trade, status and health differences, animal management practices, and the health of prehistoric animal and human populations (Ambrose & Krigbaum 2003, 193; Fiorentino *et al* 2012, 327; Soltysiak & Schutkowski 2015, 176; Szpak *et al* 2013, 1; Stonge 2012, 2; Thompson *et al* 2005, 452; Trella 2010, 292). In particular, stable isotopic reconstruction of palaeodiet in archaeological populations is now an important area of bioarchaeological research which measures the relative importance of food types to individual diets and can be used to explore differential access of foods according to gender or social status on both an individual and demographic scale (Bourbou & Richards 2007, 63; Choy *et al* 2015, 314; Turner *et al* 2007, 1). For palaeodietary reconstructions the implications of the light elements of carbon and nitrogen are the main focus, but hydrogen, oxygen, and sulphur are also utilised (Katzenberg 2008, 415; Schwarcz & Schoeninger 2011, 726). Despite iron (Fe), zinc (Zn), and selenium (Se) also all being essential in animal metabolism, there has been no attempt yet to use these elements to trace the diets of animals or humans (Schwarcz & Schoeninger 2011, 726).

A more in-depth introduction to stable isotopes of carbon and nitrogen and how they work, as well as their application in palaeodiet reconstruction and bioarchaeology will be discussed in Chapter Three.

This section has briefly surveyed the history of stable isotope analyses, with particular regard to the natural sciences, and its development into being applied to archaeology and palaeodietary studies. The next section provides an introductory overview of the EBA of Anatolia dealing with chronological issues as well as examining key features of the period such as settlement and social organisation, the rise of elites, metallurgy, subsistence practices, trade networks, burial habits, and inter-group violence.

1.2 The Early Bronze Age (EBA) in Anatolia

To understand the EBA of Anatolia one must go back a little further to the poorly known period in Anatolian archaeology of the Late Chalcolithic (Schoop 2011, 29). This is because the general tendencies of the 4th millennium BC (Late Chalcolithic) continued into the 3rd millennium (EBA) in terms of technology and development of material culture (Bachhuber 2015, 29; Massa 2015, 38; Schoop 2011, 30). Problems regarding chronology and the terminology of chronology will be discussed below. For example the presence of metal weapons is often considered an EBA phenomenon, but it is the 4th millennium BC which actually sees the first appearance of metal instruments of war (albeit mainly made of copper) as artefacts in the material record (Efe & Fidan 2006, 17 & 20; Schoop 2011, 30). Continuation is also seen in architectural plans (radial enclosures), pottery traditions (hand-made and often dark-burnished), textile industries (using weighted looms), and burial practices such as the use of extramural cemeteries (Bachhuber 2015, 29). Bachhuber (2015, 29) even goes as far as to suggest that the approximate 3000 BC date for the beginning of the Anatolian EBA may perhaps be arbitrary due to the continuation in a range of material cultures (e.g. hand-made dark burnished ceramics, radial planned settlements, use of extramural cemeteries, and metallurgy) between the 4th millennium BC and the early 3rd millennium BC. I would agree with this assessment, that the beginning of the Anatolian EBA is one that is not clearly defined and there is no substantial break in material culture. However, despite this, ca. 3000 BC is the date selected for the beginning of the Anatolian EBA as a development is observed in demographic trends. Settlements become more visible in the archaeological record, being more substantial in both their number and building materials - i.e. the use of mud-brick upon stone foundations as opposed to wattle and daub techniques utilised pre-3000 BC; see Demircihöyük as an example of this (Bachhuber 2015, 30).

The chronology of the Anatolian EBA is problematic and is still not fixed, beginning sometime between 3500 and 2900 BC and ending between 2200 and 1950 BC (Massa 2015, 35; Üncü 2010, 4-6). Traditionally the EBA of Anatolia has been split into three distinct periods (I, II, and III), although this is largely artificial and there is not a clear distinction between the EBA I and II that can be applied regionally/pan-regionally. Instead, it is more related to site specific sub-phasing and regionalised ceramic traditions (Bachhuber 2014, 140; Bachhuber 2015, 29; Massa 2015, 35). Therefore the Early Bronze Age (EBA) in Anatolia, in terms of development should instead more accurately be separated into two distinct periods, ca. 3200-2500 BC (i.e. EBA I-II), and 2500-1950 BC (EBA II-III; 2200-1950 BC is also sometimes referred to as a transitional period) – see Figure 4 for a chronological chart of the EBA in Anatolia and adjacent regions (Bachhuber 2014, 140; Bachhuber 2015, 29). Further to this Bachhuber (2015, 26) refers to the EBA of Anatolia as a narrative with a beginning (ca. 3000 BC), a seminal moment in development (ca. 2600 BC), and an end (ca. 2200-2000 BC). Whilst this narrative form is inevitably limiting in its linear nature, it should be considered as a good way to initially approach the Anatolian EBA and give a general overview allowing order to be found in a period that may be considered on first glance to be chaotic. Despite the flaws with the tripartite system I will use it in this thesis as in most cases site specific divisions are dealt with (e.g. between early and later phases of a cemetery's use).

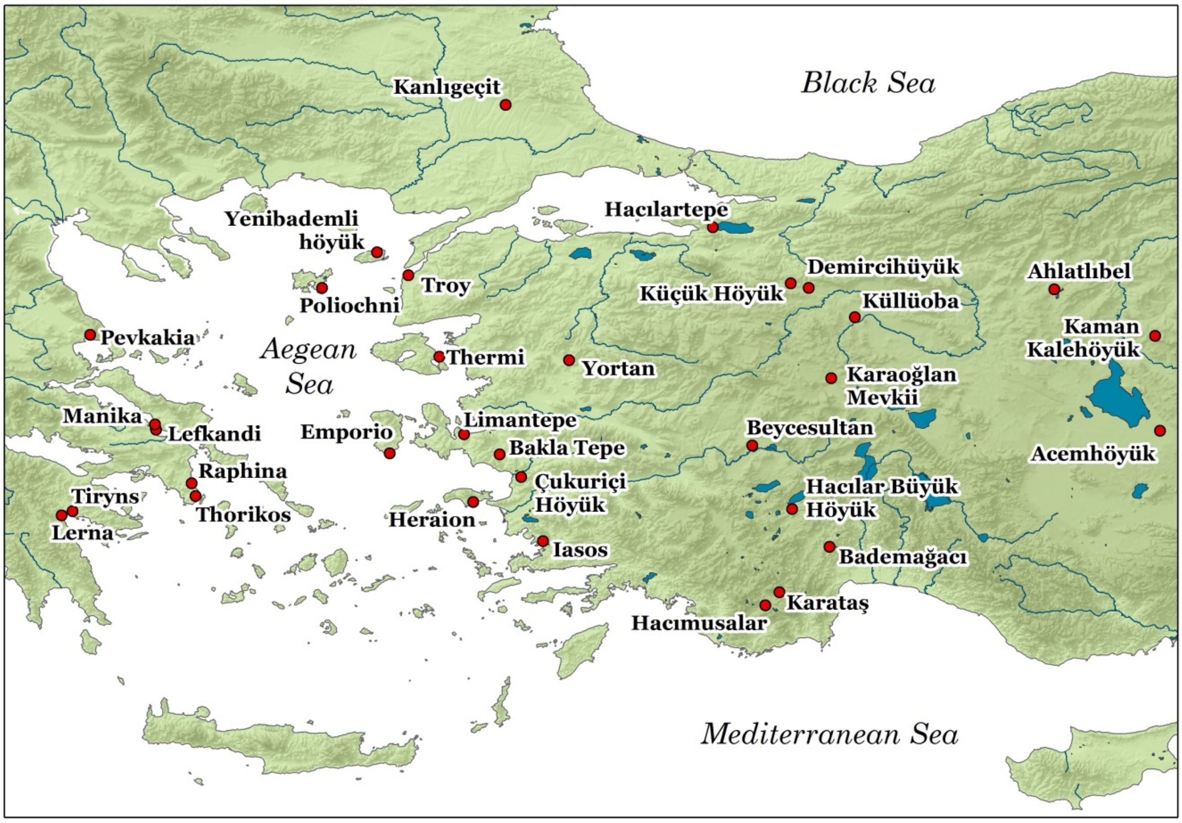


Figure 1: Map showing the sites of western Anatolia, the Aegean, and mainland Greece mentioned in the text. Map produced by M. Massa

This means that I will use the denominations of EBA I, II, and III in many cases, especially with reference to the sample sites as that is often how the original excavators and researchers determined phases within the sites. Where possible and appropriate, though, how these intra-site temporal divisions fit into the wider regional chronology (of Anatolia and the Near East) will be addressed as well as giving absolute dates (i.e. from radiocarbon dating) where they are available. To further complicate matters, the EBA of Anatolia in absolute dating and the terminology of the tripartite system is different between the west coast, inland western Anatolia, and within the Kızılırmak bend (Massa 2015, 35). This can be seen in Figure 4 below where the chronologies of places like Troy, Demircihöyük, Karataş, and Tarsus, which are all within Anatolia but of different regions, are different to each other and to the overall chronological system of the Anatolian peninsula. This is due to relative chronological sequences that are site and/or region specific, predominantly based on pottery. One of the issues is that there are no, or more accurately not enough, “stratigraphic pillars”, as Massa defines them (2015, 36), for piecing together regional chronologies. There are very few sites which have been excavated extensively enough with good enough excavation and documentation techniques covering a sufficient time span (Massa 2015, 36). The ones which meet these criteria are so far restricted to western Anatolia, namely Küllüoba, Troy, Tarsus, Thermi, Emporio, Heraion, Demircihöyük, Karataş, and Beycesultan (Bachhuber 2015, 15 & 18; Massa 2015, 36).

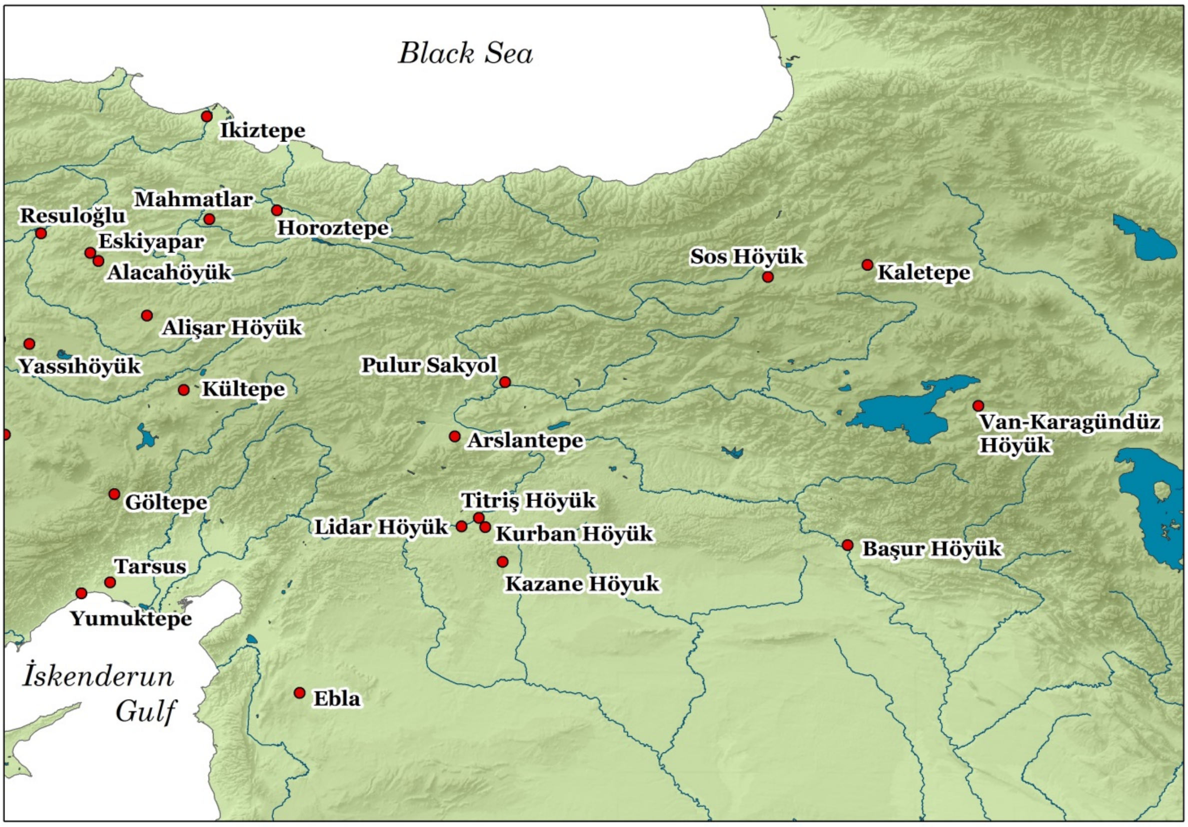


Figure 2: Map showing the sites of central, east, and south east Anatolia, and northern Mesopotamia mentioned in the text. Map produced by M. Massa

For example in the Pontic/Black Sea regions of northern Anatolia, which are considered to be separate from the rest of Anatolia, there are very few large scale, well documented and published excavations and surveys to establish a regional chronology (Welton 2010, 91). Thus, it still remains a challenge to relate this region to the chronologies of the better known and excavated regions of Anatolia such as the central, southern, and western regions (Welton, 2010, 91). This has implications, even with the existence of radiocarbon dates, for the chronology and temporal placement of İkiztepe which will be further discussed in Chapter 2.2.

The second half of the 3rd millennium BC sees a break in the previous patterns and profound changes. There is a shift in settlement patterns as witnessed at Troy II, Küllüoba, Kanlıgeçit (Thrace), and Kültepe amongst others with the emergence of sites much larger than others (for example; Liman Tepe, Hacımusalar, and Beycesultan in the west and Alişar, Kültepe, Yassıhöyük, and Acemhöyük on the plateau. All of which grow to 20-30 ha or more – see Figure 3), the detachment of a centre from the rest of the settlement by a wall and gate system and containing special (arguably monumental) architecture such as the megaron, and the surrounding of the settlement with a large fortification wall, as well as gradual but steady increase in social complexity (Bachhuber 2014, 150; Massa 2015, 39; Schoop 2011, 31; Şahoğlu 2005, 340). There is also a significant reduction in the number of settlements in Anatolia from the first half of the millennium to the latter (Bachhuber 2014, 140 & 150; Massa 2015, 40). The fate of the populations of these abandoned smaller sites is discussed in greater depth in Chapter 6.2

Very generally the EBA of Anatolia can be summed up as a turning point; a period of flux and intensification, with impressive cultural and demographic shifts (Massa 2015, 29; Riehl 2009, 94). The 3rd millennium BC is a pivotal point in the relationship between humans and their environment with intensification of agriculture and deforestation, of resource exploitation, and of metallurgy. There is an increase in settlement size and urbanisation, as well as social complexity and organisation and the emergence of social/political/economic elites, an increase in regional and interregional interaction and the development of long-range exchange networks, and an increase in inter-group tensions. To some extent there is a 'standardisation' of many features of material culture across Anatolia with the contemporaneous presence of large administration buildings, separated upper and lower cities, strong fortification walls, the presence of different social groups, a new economic system, red, black, and grey burnished fine-wares and the use of the potter's wheel (Massa 215, 29; Kouka 2016, 203; Şahoğlu 2005, 340). All these aspects will be dealt with in greater depth below. Mesopotamia tends to be dealt with as a separate entity by scholars, and those who approach the Anatolian EBA with a large, holistic, expansive overview (see Bachhuber 2015, and Massa 2015) tend to focus on the 'Anatolian peninsula', i.e. the Kızılırmak bend and westwards, providing only cursory reference to south eastern Anatolia/northern Mesopotamia and even then mainly focusing only on trade and exchange contacts between the regions. South eastern Anatolia tends to be absorbed into the research of northern Mesopotamia, with the Taurus Mountains providing a geographical barrier for research areas (see Sagona & Zimansky 2009, 174-175).

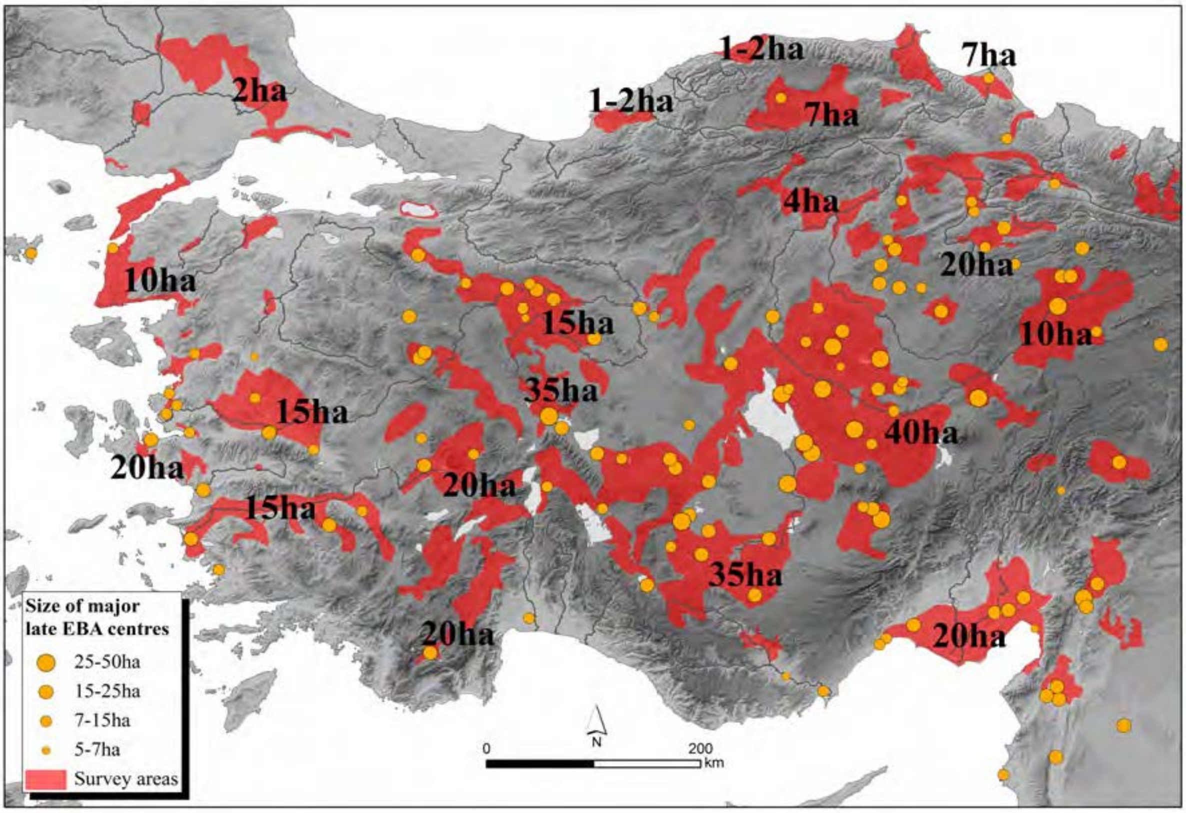


Figure 3: Map showing estimated size of EBA Anatolian settlements documented from various survey and excavation projects. Adapted from Massa 2015, 373, fig. 1.16

Whilst southern Mesopotamia endured a culturally, and socio-politically and socio-economically different experience to northern Mesopotamia (and Anatolia in particular) in the 3rd millennium BC, characterised by numerous city-states with regional power and literacy, in northern Mesopotamia (including south eastern Turkey, northern Syria, and northern Iraq) settlement patterns were based on small, dispersed villages with the development of some large (30-100 ha) settlements which likely played a role as regional centres (Laneri 2007, 242). This pattern in northern Mesopotamia, as will be discussed further below, is a pattern in some ways similar to that of the Anatolian peninsula, but the scale is certainly not the same with it being much larger in northern Mesopotamia. And whilst there are established differences, there are many similarities (as we shall see in the rest of this chapter's section) between northern Mesopotamia and the Anatolian peninsula such as regional settlement hierarchy, the fundamental role of agriculture and animal husbandry in their economies, long distance commercial exchange, the presence of numerous craft specialists involved in the economy, and planned settlements (for an overview of northern Mesopotamia in the 3rd millennium BC see Laneri 2007, 242-244).

Year (BCE)	Cyprus	Anatolian peninsula	Troia	Demicihöyük	Karataş	Tarsus	Syro-Meso
2000		Transitional	IV			EB IIIb	Ur III
2100							
2200	EC I–II		III				Guti
2300		EB III				EB IIIa	Akkad
2400	Philia		II	abandoned	abandoned		Markikh IIb1 Brak L
2500				P–Q	VI		
2600	Late Chalc.			M–N K–L	V		Mardikh IIa Brak K
2700				I–J H	IV	EB II	
2800		EB I–II	I	G F	III		Ninevite V
2900				E D		EB I	
3000				No stratigraphy	II		
					I		

Figure 4: Chronological chart for the Early Bronze Age in Anatolia and neighbouring regions. Adapted from Bachhuber 2014, 140

The 3rd millennium BC is a pivotal point in the relationship between humans and the environment with the modification of their surroundings and resource exploitation on a previously unseen scale (Massa 2015, 38).

- <u>Intensification of agriculture and deforestation</u>

The EBA of Anatolia sees an intensification of agricultural practices (such as the use of the plough) in terms of scale and organisation as well as an increased emphasis on agricultural production, for example at EBA III Demircihöyük and Troy (Bachhuber 2014, 150; Massa 2015, 38, 41 & 271). An examination of the types, frequencies and ratios of plants and crops for EBA sites with published archaeobotany analyses is provided in Chapter 6.2. At Karataş, 65% of the chipped stone assemblage are sickle blades, and indeed the majority of chipped stone assemblages at EBA sites are sickle blades, indicating the importance of agriculture (Massa 2015, 103 & 162; Sagona & Zimansky 2009, 179). It should be noted, however, that sickle blades were probably not used exclusively in an agricultural context but may have also been used for cutting other plant materials such as reed and wood. This intensification and re-organisation and restructuring of agricultural labour (more organised projects and field maintenance) is intertwined with the reworking of social relationships within urban communities such as the production of agricultural surplus and exploitation of secondary products and the emergence of elites and specialists (White *et al* 2014, 364). The 3rd millennium BC sees the first cultivation of grape vines in Anatolia, the earliest seed evidence of which comes from Level XV of Beycesultan and the EBA I-II of Kaman Kalehöyük, Kurban Höyük, Yenibademli Höyük, and Poliochni Blue (Bachhuber 2014, 143; Bachhuber 2015, 36; Cultraro 2013b, 110; Miller 2008, 942; Nesbitt 1995, 75). The presence of crushed olive pits in EBA layers at some sites suggests the production of oil, and both this and the production of wine suggest an intensification of horticulture (Hüriyılmaz 2014, 22; Massa 2015, 38-39). The cultivation of grape vines in collaboration with the emergence of fine drinking and table ware (discussed below), and ceramic pouring forms has been argued as an indication of the importance of feasting and alcohol consumption in EBA Anatolia (Bachhuber 2014, 143; Bachhuber 2015, 131; Schoop 2011, 34; Şahoğlu 2005, 354; Ünlü 2016, 346). The EBA in Anatolia also sees the intensification of the exploitation of animals for secondary products with evidence of cattle being used for traction at Demircihöyük as well as evidence of woollen textile industry there and at Karataş, and Troy, amongst others for example (Bachhuber 2014, 149; Massa 2015, 38 & 93 & 104; Sagona & Zimansky 2009, 210-211). The development and intensification of the woollen textile industry and its implications for this research will be discussed in Chapter 6.2. The exploitation of animals to carry goods and produce and/or pull wagons also helped to dramatically develop the range, volume, and mobility of trade and exchange networks (Sagona & Zimansky 2009, 211-212).

For example, the domesticated donkey was used as an animal of burden and its remains have been found at exchange network hubs such as Acemhöyük (Arbuckle 2013, 58). As well as the greater land requirements necessary for keeping herds for wool, herd management on this increased scale would have required greater complexity (Bachhuber 2014, 149). The 3rd millennium BC in Anatolia also sees the production and storage of agricultural surplus (a factor connected to the emergence of both elites and craft specialists – see further below). Evidence of grinding stones for the processing of grains and granary storage has been discovered at Demircihöyük, (EBA II) Küllüoba, Karataş, EBA Yenibademli Höyük, and (EBA I-II) Tarsus (Bachhuber 2014, 149; Massa 2015, 103; Oybak-Dönmez 2005, 46). Additionally the rising importance of dairy products and textiles (from sheep wool) promoted a wider diversification of, yet specialised, economic strategies which provided an economic background for the sustainable growth of larger settlements (Massa 2015, 271).

To provide timber for building materials, fuel for pottery production and metallurgy, and to clear land for agricultural and pastoral use deforestation on a previously unseen scale is witnessed in the 3rd millennium BC of Anatolia (Bachhuber 2014, 150; Massa 2015, 38 & 271). The pollen records show evidence for significant deforestation in 4500-4000 cal. BP (i.e. EBA III) (Bachhuber 2015, 50; Roberts *et al* 2001, 731-733). At Sos Höyük (northeast Turkey) deforestation as a probable result of human impact, and a reduction of plant resources as a result of livestock grazing has been attested in the first half of the 3rd millennium BC (Longford *et al* 2009, 123 & 131). At Kurban Höyük (south east Turkey) there is evidence for a major deforestation episode that occurred between the early and mid-3rd millennium BC (Miller 1997, 126). This episode of deforestation was probably related to high population densities and clearing space and land for the pasture of *ovis/capra* herds, as it is during this time that the bones of these species dominate the faunal assemblage (Miller 1997, 129). A decline in wood cover is also suggested for EBA Gritille (south east Turkey) over time (Miller & Marston 2012, 98). In Troy I-II (EBA I-II – ca. 2950-2250 BC) there is an increase in maquis-type vegetation and light demanding shrubs such as *Cistus* sp., Fabaceae (cf. *Genista*), and Monocotyledonae which become even more pronounced in Troy III (EBA III – ca. 2250-2200 BC) and indicate a reduction of woodland and the opening of the landscape (Riehl & Marinova 2016, 324). Anthropogenic related deforestation is also suggested by the charcoal remains from Troy which indicate a decrease in deciduous oak and pine trees from Troy I-IV (Riehl & Marinova 2016, 329). It has even been suggested that the practice of deforestation in Anatolia would have been so rigorous and widespread that the abandonment of EBA I/II settlements may have been related to deforestation and the subsequent instability of the landscape, e.g. erosion (Bachhuber 2014, 141). Palumbi (2010, 163) has suggested that the presence of axes in grave assemblages (in the case of his argument from the assemblage of the 'Royal Tomb' of EBA I Arslantepe) may be related to the importance of deforestation as an activity and the working of wood. Furthermore, that deforestation to create open spaces for agricultural and/or pastoral lands may have been a deliberate and strategic tactic related to the control and management of territory (Palumbi 2010, 163).

- Intensification of metallurgy

Whilst the EBA undoubtedly sees an intensification in metallurgical activity and technology, the first smelting of ores and open mould casting was practised from 5000 BC onward (Schoop 2011, 30). In the Middle Chalcolithic settlement of Mersin (Levels XVII-XVI), metal tools (mostly chisels and axes) were produced by pouring molten copper into open moulds (Sagona & Zimansky 2009, 205). It is around the same time that the first alloy (arsenical copper) appears (Sagona & Zimansky 2009, 205; Schoop 2011, 30). Arsenical copper alloys continued to be popular throughout the 4th millennium BC and into the Anatolian EBA, being the most common type of metal in assemblages of the period (see Begemann *et al* 1994; Bachhuber 2014, 146; Bachhuber 2015, 49; Massa 2015, 39). Also, from the 4th millennium BC gold, silver, and lead make an appearance into the metal repertoire of the region (Massa 2015, 39; Schoop 2011, 30; Yener 2000, 47, 54 & 68). The earliest evidence of secondary metal production (i.e. metal/metal objects refined/produced from metal already smelted from an ore source) in the Aegean basin comes from the Late Chalcolithic (3300-3000 cal. BC) layers of Bakla Tepe and Liman Tepe noted by the presence of intra-site workshops containing crucibles, metal furnaces, tuyères, stone crushing devices, stone/clay moulds, and sometimes slag (Erkanal-Öktü & Erkanal 2015, 186; Massa 2015, 174-175). And metallurgy at these two sites continues to be an important activity into the 3rd millennium BC (Erkanal-Öktü & Erkanal 2015, 188). Metallurgy is witnessed across the region during the 3rd millennium and there is an increased circulation of metal, for example large scale metallurgy is witnessed at Göltepe (phase II) amongst others (Bachhuber 2014, 145-146; Bachhuber 2015, 45-46; Yener 1994, 33). Over a ton of ceramic furnaces and crucibles were recovered from Göltepe, as well as storage jars containing ground ore, un-processed nodules, hearths, and lots of stone crushers (Sagona & Zimansky 2009, 201). Tin first became widely used as an alloy (for producing tin bronze) in the EBA I-II (ca. 3000-2700 BC) of Anatolia comprising 21-22% of all artefacts from this period (Bachhuber 2014, 146; Bachhuber 2015, 49; Massa 2015, 39 & 186-187; Şahoğlu 2005, 341). Tin bronzes become more common after 2700 BC with a presence of 45-70% of intra-site metal assemblages of tin bronzes with a ≥8-12wt% of tin and comprising 29-37% of all EBA III artefacts (Massa 2015, 186-187). Tin bronzes were not contemporaneously widespread however, not appearing until the late 3rd millennium BC in eastern Anatolia and being absent or in small quantities and with a low tin content of <6wt% in inland western Anatolia (Massa 2015, 186). The tin for producing bronze may have come from as far as western Iran or Afghanistan (Massa 2015, 100; Schoop 2011, 32), although there are sources in Turkey, for example at the prehistoric mine of Kestel-Sarıtuzla in the Taurus foothills within Anatolia which has been radiocarbon dated to the 3rd millennium BC – 2874-2133 cal. BC (Bachhuber 2014, 146; Massa 2015, 100; Şahoğlu 2005, 341; Yener *et al*, 1989, 201-202; Zimmermann 2007b, 72). Indeed Anatolia is a rich source of metals and ores, including copper, iron, lead, silver, and gold, of which copper, silver, and gold can appear in their native state (Sagona & Zimansky 2009, 200). Some have argued that the intensification of metallurgy was likely linked to the demand for metal in intensifying inter-regional exchange networks; for example at Göltepe (II) ingot moulds and ingots were found indicating that the produced metal was intended for exchange/movement as well as the presence of Syrian-inspired bottles indicative of contact with the Upper Euphrates (Bachhuber 2014, 145; Bachhuber 2015, 46; Yener 1995, 180). The appearance of rod-shaped ingots and moulds in the EBA indicates a wider range and circulation of metal as it is easier to transport it in this semi-finished form (Massa 2015, 177). The development of these standardised ingot forms as found at Liman Tepe, Bakla Tepe, and Cukiriçi Höyük would have facilitated the flow of metal (Bachhuber 2014, 146). Also, the presence of stone weights and balance beams in connection with metallurgical activity suggests a standardisation of the metal trade (Massa 2015, 189).

In the past it has been suggested that metal use and metal production were at the root of social changes witnessed during the period, with control over metal resources arguably a prime mover for increasing social complexity (Schoop 2011, 31). Şahoğlu (2005, 340) argued that the development of metallurgy had an important role in disseminating innovations from northern Syria, across Anatolia and the Aegean, and to mainland Greece in the 3rd millennium BC. However, it should now be considered that metallurgy and metal alone were not the prime movers for social change in the (4th and) 3rd millennium BC (Schoop 2011, 37). The majority of metal items from the period are unimpressive, common use items such as needles, perforators, and wire (Schoop 2011, 35-36). Whilst any metal objects may theoretically been seen as impressive in this period, these were everyday use, practical items which would suggest they were not regarded as esteemed or prestigious pieces. Larger metal pieces, conversely though, were likely to have been restricted to ceremonial use rather than practical use (see discussion further below in the section on increasing social complexity).

- Intensification of resource exploitation

The development and intensification of metallurgy from the Chalcolithic period and into the EBA of the 3rd millennium BC required a more general intensification of resource exploitation. Timber is one such resource, as discussed above, and the other main resources connected with metallurgy are metal ores. The earliest evidence of mining of copper deposits comes from Kozlu (near Tokat in the central Black Sea region) in 4700-4500 cal. BC and Murgul (near Artvin in the eastern Black Sea region) in 3600-3400 cal. BC (Massa 2015, 170; Wagner & Öztunalı 2000, 46-50).

The exploitation and exchange of obsidian continues in the Anatolian EBA with the main sources being Melos (one of the Cyclades Islands in the Aegean), East Göllü Dağ and Nenezi Dağ (central Anatolia), Bingöl, Nemrut Dağ and Meydan Dağ (eastern Anatolia) (see Carter 2009; Massa 2015, 154). The wide range of obsidian sources and the discovery of obsidian from several sources at a particular site is evidence for the presence of wide ranging trade and exchange networks (further discussed below).

Increase in settlement size and urbanisation

There is an increase in the number of settlements in Anatolia in the early 3rd millennium (Sagona & Zimansky 2009, 178) followed by a reduction in the number of settlements (Bachhuber 2015, 50), with some abandoned, and the growth of larger 'hub' settlements. This rapid growth in the number of settlements in the first half of the 3rd millennium BC includes expansion into previously sparsely populated areas (Massa 2015, 38). At EBA Hacılartepe (2900-2600 cal. BC, contemporary with the early-middle phases of Demircihöyük and Troy I a-f) the settlement was continuously occupied and probably grew gradually in density through time (Eimermann 2008, 362-363, 367, & 375-376). The second half of the 3rd millennium BC sees the emergence of a settlement hierarchy and settlements which are much larger than others; i.e. regional centres (Bachhuber 2014, 146; Massa 2015, 40 & 264; Schoop 2011, 31; Şahoğlu 2005, 344). The decrease in the number of settlements between EBA I/II and EBA III (for example from 30 settlements to one in the Troad), is most likely related to the emergence of these regional centres which absorbed or dispersed populations (Bachhuber 2014, 150). These regional centres could have caused the movement of people out of an area, perhaps by force, to allow greater control over lands for agricultural use and pastoralism, or over routes for trade and exchange (e.g. control over natural route-ways such as through valleys or river crossings etc.). Alternatively, or perhaps even concurrently, these large regional centres may have absorbed the populations of the smaller centres resulting in their abandonment; their growing populations had to arguably come from somewhere – these issues will be discussed further in Chapter 6.2. Many of these larger settlements of the later EBA grow to 20-30 ha or more, for example Liman Tepe, Hacımusalar, Beycesultan, Alişar, Kültepe, Yassıhöyük, and Acemhöyük (Massa 2015, 39). Despite the emergence of large regional centres the majority (90%) of EBA mounds are between 0.3 and 3 ha, 7% are between 3 and 15 ha, and only 3% are between 15 and 30 ha (Massa 2015, 41). This demonstrates that these large urban centres were a minority in Anatolia, and instead the majority of EBA settlements would have been small villages; very much like modern settlement patterns where a large regional centre (often designated as provincial/county capital) is surrounded by smaller dispersed settlements. Sagona & Zimansky (2009, 176) argue that in Anatolia there were three types of demographic transformation in the third millennium BC; urbanisation in the south east with large cities controlling the hinterland, centralisation in central and western Anatolia where the largest settlements only loosely controlled the surrounding region, and a rural landscape in the eastern highlands with no indication of hierarchy. It is certainly true that settlements in the south east could be much larger than the largest of those of the Anatolian peninsula (ca. 30 ha), for example Titriş Höyük at 43 ha, and Kazane Höyük (in the Urfa region) at ca. 100 ha (Sagona & Zimansky 2009, 175). For estimating population sizes Massa (2015, 41) uses a figure of 300 people/ha, meaning that he calculated that a typical Anatolian EBA settlement had between 100 and 1000 people, with a few having 5000-10000 inhabitants. The population density and size of the sample sites will be dealt with on a site-by-site basis in Chapter Two. The trend towards urbanisation is witnessed in new building types and plans which demonstrate pre-planned, organised layouts and construction (Zimmermann 2007b, 66). At Göltepe larger, more permanent buildings based upon stone foundations with a longhouse form are built in phase II

(Bachhuber 2014, 145, Bachhuber 2015, 46; Yener 1994, 34-36). There is arguably a standardised 'Anatolian model' of settlement plan and architectural layout, common although not ubiquitous across Anatolia – the '*Anatolisches Siedlungsschema*' first put forward by M. Korfmann in the late 1970s (Fidan 2013, 113). This basic Anatolian settlement pattern is pre-planned and organised and involves adjacent touching structures in a radial pattern around a courtyard or open space surrounded by a boundary fortification wall with gates (Erarslan 2008, 177; Erkanal 2011, 131; Fidan 2013, 113). The earliest example of this settlement plan is actually from Early Chalcolithic Hacılartepe I, and then late Middle Chalcolithic Mersin XVI, and Late Chalcolithic Yumuktepe (Erarslan 2008, 177-178; Fidan 2013, 113). The earliest EBA example of this type of settlement plan is level 5 (LCh-EBA I transition; 3200-3000 BC) of Küllüoba in the province of Eskişehir (Bachhuber 2015, 59; Erarslan 2008, 178). Hacılartepe was probably also a radial planned settlement in the EBA with light structured mainly courtyard buildings, and the settlement was surrounded by a stone wall (Eimermann 2008, 361 & 387-388). Other EBA sites with this kind of settlement plan include EBA I Bakla Tepe (western Anatolia), Liman Tepe (western Anatolia), Pulur Sakyol (eastern Anatolia), Van-Karagündüz Höyük (eastern Anatolia), EBA I-II Demircihöyük (on the Eskişehir plain), EBA II Bademağacı (southern Anatolia), Troy I (western Anatolia), Thermi (on the island of Lesbos), Karaoğlan Mevkii (Afyon), and EBA II-III Ahlatlıbel (near Ankara) (Bachhuber 2015, 59; Erarslan 2008, 178-180; Erkanal & Şahoğlu 2016, 158; Fidan 2013, 113-114; Massa 2015, 93; Sagona & Zimansky 2009, 194; Şahoğlu 2005, 350). Many of the houses within these settlements also followed a standardised pattern of construction with stone foundations topped with a timber strengthened mud-brick superstructure (Erkanal 2011, 134). Centralised planning and urban standardisation of settlements appears to have been a key factor, for example at Poliochni Yellow there is evidence of an organized water system, a regular layout to path networks, and the well planned arrangement of the residential buildings (Bachhuber 2015, 114; Cultraro 2007, 57). Whilst there is arguably a single process or urbanisation with a standardised, common Anatolian 'style' of settlement plan and building type tradition from the Chalcolithic to the Bronze Age there are some regional and site specific differences and flavours (Erarslan 2008, 182). For example, whilst Kanlıgeçit has some distinctly Thracian cultural aspects, the architectural layout and many of the artefacts are Anatolian in nature (Şahoğlu 2005, 346). And at Pulur Sakyol, the settlement layout is of the 'Anatolian' radial style yet many of the household furnishings and ceramics are distinctly Kura-Araxes in tradition (Sagona & Zimansky 2009, 184). In the EBA I (3000-2800 BC) and EBA II (2800-2500 BC) periods at Sos Höyük the houses were built of mud brick walls on stone foundations, free-standing, and single roomed, constructed like houses of the ‘Anatolian model’ but laid out unlike the ‘Anatolian model’ of shared walls and instead very much like Kura-Araxes houses (Sagona & Sagona 2000, 63). At Karataş a divergent spatial and architectural layout is seen, with the settlement organised around a Central Complex, and then later a central mound (see Warner 1994; Bachhuber 2015, 70-71). Also, in Phases I-IV the houses were built of wattle and daub unlike the stone based houses of other EBA western Anatolian houses and were also anomalously free-standing (Bachhuber 2015, 70-71; Massa 2015, 102). However, in the later periods (Phases V-VI) the house construction style falls more into line with the typical style of Anatolia (at least in terms of construction style), being built of a timber and mud brick superstructure upon a stone foundation, but still free-standing (Bachhuber 2015, 70-71). This is also witnessed at EBA Yenibademli (on the island of Gökçeada off the western coast of the Troad) where the structures were relatively uniform free-standing rectangular buildings with stone foundations (Oybak-Dönmez 2005, 41). The architectural construction techniques of the houses at Poliochni Yellow are divergent from most of the rest of Anatolia, instead of being constructed of mud-bricks upon a stone foundation the walls are built of large stones set into clay (Cultraro 2007, 61). Karataş was also not surrounded by a wall (Bachhuber 2015, 70) as many other EBA settlements in Anatolia were (see further below). In the southeast of Anatolia at places such as Titriş Höyük, Kurban Höyük, and Lidar Höyük the settlement model is much more Mesopotamian in character, with a regular and organised linear layout with intersecting streets and large houses with the rooms arranged around a central courtyard (Fidan 2013, 115). Fidan (2013, 116) suggests that the ‘Anatolian settlement pattern’ is actually restricted to western and western-central Anatolia as the south east is more Mesopotamian in personality, and eastern Anatolia (apart from a few exceptions such as Pulur Sakyol and Karagündüz) is more Caucasian in nature. For example in eastern and north eastern Anatolia at places such as Arslantepe, Norsuntepe, and Taskun Mevkii the houses are free-standing wattle-and-daub structures (Frangipane 2014, 172; Crisarà 2013, 185; Marro 2011, 302).

As previously mentioned the second half of the 3rd millennium sees a profound shift in many aspects, and settlement patterns are no different. In the latter part of the millennium the settlement pattern changes from a radial one to a linear one at some places (Erarslan 2008, 180). For example at late EBA II Küllüoba the settlement has a linear layout (Sagona & Zimansky 2009, 198). The acropolis of the later 3rd millennium BC settlements maintains the oval shape, with fortifications and gates, but the (lower) city layout becomes linear built in accordance to road networks of streets, avenues, and courts running perpendicular to each other (Erarslan 2008, 180). Troy IIc is a classic example of this later 3rd millennium settlement plan, and is also apparent at Kanlıgeçit (Erarslan 2008, 181).

Increase in social complexity and the emergence of social/political/economic elite(s)

Social complexity can be both vertical and horizontal. Hierarchy would be an example of vertical differentiation, whilst specialisation would be counted as horizontal differentiation. Both can be inter-linked, an increase in specialisation correlates with the activities becoming more hierarchical (Zeder 1991, 19). For an economy with a high degree of internal and external specialisation to operate on a regional scale there must be a co-ordinating mechanism to ensure operational efficiency between each set of economic activity (Zeder 1991, 13). For example, full-time metalsmiths need to receive the correct ores, or raw metals to craft metal wares, the specialist potters need to receive food, the farmers need to be supplied with pots, and all of these activities (and others) need to act together as a coherent whole (Zeder 1991, 13). This 'co-ordinating mechanism' can be state-level regulation as controlled/run by a state-level hierarchy, sometimes referred to as an 'elite' (either an individual or group). By co-ordinating a specialised economy and ensuring its coherence, productive potential can be maximised resulting in the economic and physical growth of a settlement/state. This also permits a ruler/ruling group to enable control over an interdependent population. Being in control of the production and movement of goods allows an imbalanced channelling of these goods for elite aggrandisement, thereby strengthening social and economic disparity as well as enhancing political control (Zeder 1991, 13).

It seems clear that for the first time in the 3rd millennium BC the presence of early elites is explicitly visible in the archaeological record of Anatolia (Şahoğlu 2005, 344; Zimmermann 2007b, 66). The emergence of a detached area in many settlements separated from the rest of the settlement by a wall and gate system in the second half of the 3rd millennium with special architecture such as the 'megaron' has been suggested as an indication of the emergence of polity rulers and elites separate and distinct from the rest of the population (Massa 2015, 39; Schoop 2011, 31; Zimmermann 2016, 277). Bachhuber (2015, 106) refers to these enclosed, separated areas with interiors accessed by gates as 'citadels'. For example at Sos Höyük near Erzurum in east Anatolia, a large fortification wall separating internal areas was built at the end of the 4th millennium BC, consisting of a mud brick superstructure on stone foundations preserved to 1.75 m in height and measuring 2.5 m across in places (Sagona & Sagona 2000, 57-59). A detached and separated internal area of the settlement is also observed at Troy, Kanlıgeçit, Kültepe, (EBA I-II) Liman Tepe, and Küllüoba (Bachhuber 2014, 150; Erkanal & Şahoğlu 2016, 157). Many of these citadels are accompanied by lower/outer towns, for example at Liman Tepe from the middle of the 3rd millennium BC (Erkanal & Şahoğlu 2016, 157). Despite the use of the word 'megaron' in much of the literature they are more accurately variations of rectilinear flat-roofed longhouses (Bachhuber 2015, 14).

Also, the existence of hoards and large quantities of gold/items made from gold is arguably an indication of the upward channelling of material wealth within a society (Schoop 2011, 32). It has been suggested that at Troy IIg the settlement plan and the luxury items found in this phase (including gold, silver, and lapis lazuli) are one indication of an increasingly hierarchical social system with power in the hands of a wealthy elite (Sagona & Zimansky 2009, 196). The presence of elites is likely also seen through the items of specialised craft production which were most likely only for elite consumption (Schoop 2011, 32). For example wheel made pottery was likely to have been a 'prestige technology' with its wares, with few exceptions, associated with the 'citadel' and restricted to elite contexts and not used in day-to-day contexts (Bachhuber 2015, 14, 121 & 132). Wheel made pottery is restricted to a small range of vessels associated with aristocratic feasting activities such as plates, platters, and drinking vessels; famously the *depas amphikypellon* of western Anatolia and the smaller cups of the east which were both linked to the ritual consumption of alcohol (Bachhuber 2014, 143-144; Massa 2015, 144; Schoop 2011, 34; Şahoğlu 2005, 354). These fine table wares have been associated with feasting activities as they seem to have been produced with an emphasis on sharing; large plates and platters, and two handled drinking tankards (Bachhuber 2014, 144; Bachhuber 2015, 131-132; Ünlü 2016, 350). For example, at Troy II there tankard types including *depas amphikypellon* are popular suggesting the importance of feasting and more specifically drinking (Sagona & Zimansky 2009, 197; Ünlü 2016, 352). And at EBA I (3000-2750 BC) Arslantepe there is a great quantity of drinking vessels which indicates the importance of drinking (Crisarà 2013, 188). Furthermore, the majority of the larger metal objects from the 3rd millennium BC are prestige objects often not intended for practical use (Schoop 2011, 35-36). For example, the bronze 'ceremonial' standards from graves contexts at Alaca Höyük, Kalınkaya, and Horoztepe (Zimmermann 2006, 285-286; Zimmermann 2016, 278). Metal objects could be used to perform grand and conspicuous gestures of display, as seen by the large volume of metal deposited in mortuary contexts of the EBA I-II cemeteries of Göndürk Höyük, Bakla Tepe, Sarıket at Demircihöyük, and Karataş (Bachhuber 2014, 146-147). The sophistication of some of the metalworking as well as the amount of precious metals used and, in some cases (e.g. the 'Royal' graves of Alacahöyük and Horoztepe, and the hoards of Troy, Poliochni, Eskiyapar, and Mahmatlar) the find context point to the manufacture of metal (in some cases, mainly) for elite consumption (Massa 2015, 176; Zimmermann 2016, 277). In Anatolia the EBA sees the presence of archaeologically visible status symbols such as large and fine metal objects produced for show rather than practical use (such as 'ceremonial' standards mentioned previously) along with items like 'knobbed mace-heads' from rich graves which were probably status symbols of emerging elites (Massa 2015, 96-97; Zimmermann 2007b, 68; Zimmermann 2016, 281).

One of the benefits of a high social position is the ability to direct the production, movement, and distribution of commodities (Zeder 1991, 12). Therefore, the control of trade and (raw) materials most likely became an important source of power for the emerging elites of 3rd millennium BC Anatolia, with the exchange networks of metal and textiles likely being dominated by elites (Bachhuber 2014, 149; Schoop 2011, 32; Zimmermann 2016, 277). This is because metallurgy and wool-based textile industries required control of metal (ore) sources and large amounts of land respectively, as well as a control of trade and trade networks (Bachhuber 2014, 151). It is also possible that some specialised metallurgical workshops themselves were under direct institutional control (Massa 2015, 176). Furthermore, for a lot of these long journeys along the trade and exchange networks a high degree of organisation would have been necessary, suggesting a degree of social control or organisation (Massa 2015, 90).

An increase in social complexity is witnessed partly through the intensification of agriculture, the production of agricultural surplus, and the exploitation of secondary products from animals. This is because the harvesting, processing and storing of food and the mobilisation of secondary products involves significant labour organisation and collaboration (Bachhuber 2014, 149; Massa 2015, 201; White *et al* 2014, 374). The introduction of the practice of keeping one species of sheep for wool and another for meat (or at least separating/differentiating herds) would have required a greater scale and complexity of herd management (Bachhuber 2015, 43). Centralised storage is attested at numerous EBA Anatolian settlements including Demircihöyük, Karataş, Thermi Town I, the EBA I-II citadel of Poliochni Blue, Poliochni Yellow, Alaca Höyük, EBA I-II Küllüoba, Bademağacı, and

Troy IIf-III (Bachhuber 2015, 64, 74, 76, 94 & 126; Cultraro 2013b, 105). At Demircihöyük it has been argued that the large subterranean rectilinear storage bins with a capacity of 3800-4000 kg in the central court area would have held more than required by the inhabitants of the village and it has been theorised that this agricultural surplus may have been saved for times of scarcity such as periods of drought etc., exchanged for goods, or sent to large settlement centres (Bachhuber 2015, 64; Halstead & O'Shea 1989, 3; Massa 2015, 99). Whichever of these ideas is correct, and it may be several of them, all would require social complexity involving the organisation and collaboration of labour. In addition, the presence of clay and lead stamp-seals and *bullae* at places like Karataş in association with storage vessels provide evidence of the existence of control mechanisms as part of a social hierarchy (Bachhuber 2015, 77-78; Şahoğlu 2005, 346).

Increase in regional and interregional interaction and the development of long-range exchange networks

Whilst there is evidence of regional and inter-regional networks in Anatolia in earlier times, they expanded considerably during the late 4th – early 3rd millennium BC (Massa 2015, 268). These long distance trade and contact networks further developed and intensified (in terms of traffic and material volumes as well as distance) in the 3rd millennium BC from about 2700 BC (Erkanal-Öktü & Erkanal 2015, 191; Massa 2015, 40; Şahoğlu 2005, 345). Evidence for long distance cultural interactions between regions is suggested by the progressive standardisation of burial customs, the spread of the megaron and megaroid architectural plan, the spread of the potter's wheel technology and the widespread occurrence of red coated thin-walled wares and distinctive drinking vessels across Anatolia (Massa 2015, 40; Türkteki 2010, 2012). In terms of material culture the 3rd millennium BC witnesses an increase in the circulation of finished objects, raw materials and technologies, jewellery, raw semi-precious stones, tin, and weaponry (Massa 2015, 40; Yılmaz 2009, 441). This becomes much more pronounced in the EBA III period (Bachhuber 2014, 140). Evidence for this can be witnessed by the presence in Anatolia of lapis lazuli and tin from Afghanistan (Bachhuber 2014, 148; Massa 2015, 231; Schoop 2011, 32). The trade in tin from Afghanistan to Anatolia and Ebla is known from textual evidence of the Ebla archives of the 2nd millennium BC (Weisberger & Cierny 2002, 179–180; Yılmaz 2009, 442). Tin may not have come from quite as far as Afghanistan as there are sources in the Taurus foothills, however, its presence in other parts of Anatolia are testament to its distribution via trade and exchange networks (Zimmermann 2007b, 72). The treasures of Troy IIg included lapis lazuli indicating far reaching networks of contact, trade, and exchange (Sagona & Zimansky 2009, 197). Lapis lazuli may have come through direct contact with distant regions, however, it may have arrived in Troy indirectly via 'down the line' trade meaning a shorter range of contact to obtain this material. As well as lapis lazuli (potentially) indicating long distance exchange at Troy, there is also the presence of Baltic amber beads, Carnelian beads from the Caucasus, and Bulgarian inspired stone hammer axes (Bachhuber 2015, 158; Treister 1996, 211 & 219-222). The creation of an 'Anatolian Trade Network' (see Figures 5 to 7) running across Anatolia during the second half of the 3rd millennium was most probably related to the trade in metals and rare metals such as tin, which would have necessitated a tighter control of their circulation and acquisition (Kouka 2016, 204; Şahoğlu & Tuncel 2014, 79). At EBA Ebla silver and gold, which are not local, are present and it has been suggested that these precious metals could have come from Anatolia, even if indirectly (Bachhuber 2015, 159).

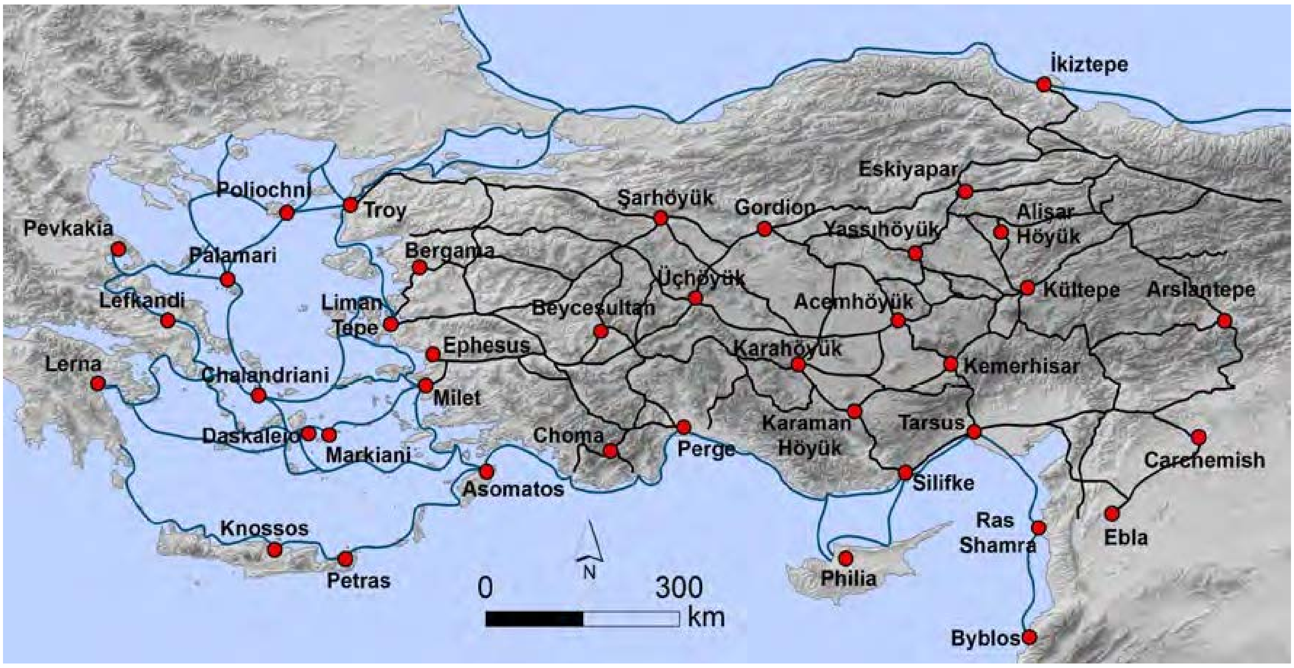
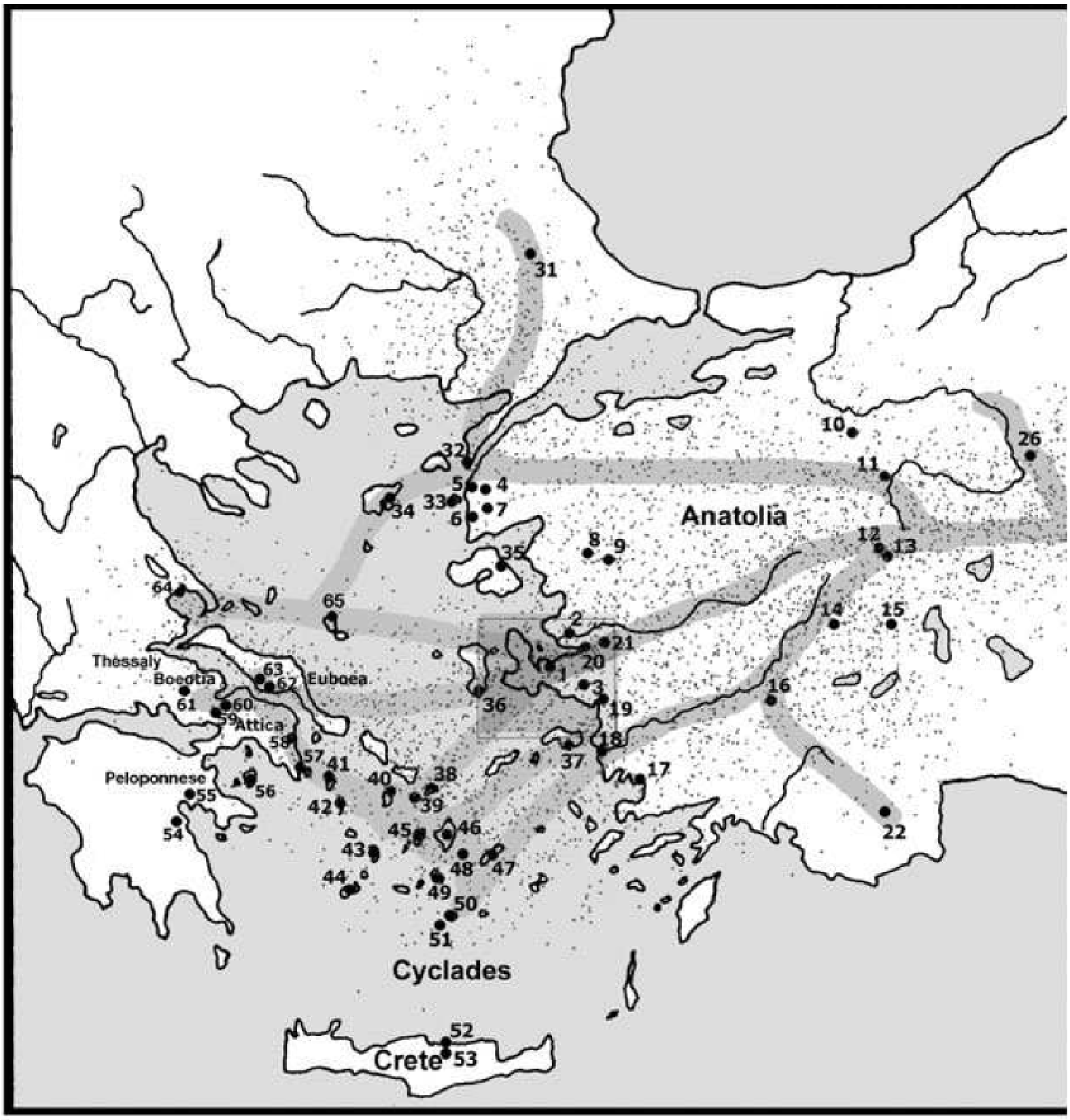


Figure 5: Map of land and sea routes of trade and exchange, and main centres as proposed by Massa (2015, 400 – fig. 3.29)

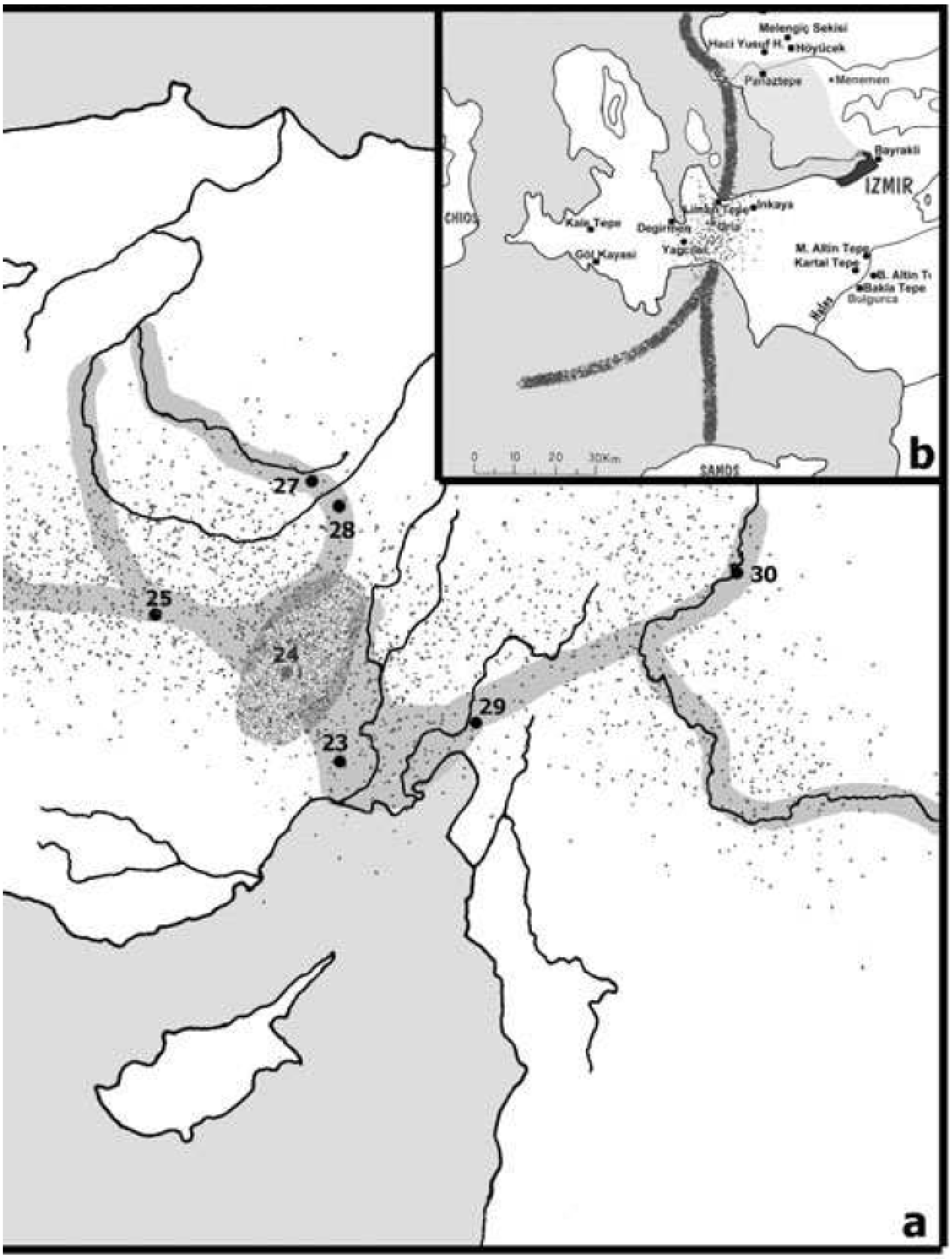
Connections with the southern reaches of the Near East are suggested by the presence across Anatolia and to the Aegean of incised bone tubes (which likely contained/were used for pigments), as they are known to have origins in Egypt, the Levant, and the Middle Euphrates region (Bachhuber 2015, 156). Textiles were likely circulated together as part of elite dominated exchange networks not just of Anatolia, but of all western Asia in the EBA, and into the MBA (Bachhuber 2014, 149).

The textually attested exchange networks across Anatolia in the 2nd millennium BC (see Barjamovic 2011) are believed to have already been present in the 3rd millennium BC (Bachhuber 2015, 147; Efe 2007, 60-62; Özgüç 1986, 43-45). Metal and wool (likely in the form of woollen textiles) were easily mobilised as low bulk, high value commodities in exchange networks, specifically elite networks of exchange connecting large regional centres (Bachhuber 2014, 151). The demand for metals and textiles would have joined these emerging elites together, as well as connecting them to more exotic and distant polities (such as those of Mesopotamia) (Bachhuber 2015, 176). As well as metals and related metallurgical objects, e.g. ores – although these are unlikely to have been transported over large distances, and textiles, pottery was also involved in the trade and exchange networks of 3rd millennium BC Anatolia. At Liman Tepe the wares came from across Anatolia, the Cyclades, as well as mainland Greece, and Anatolian pottery connections (either direct imports or copies) have been found in the Cyclades (Erkanal & Şahoğlu 2016, 161; Şahoğlu 2005, 350 & 352). The evidence for links with Anatolia comes via the circulation in the Aegean of Anatolian finished pottery vessels, vessels containing products, and pottery production technology and the presence of Anatolian pottery on mainland Greece at sites such as Manika, Lefkandi, Raphina, Thorikos, Pevkakia, Lerna, and Tiryns; in general it can be said that there was high amount of contact with Anatolia in Attica, Euboea, the Cyclades, and the Sporades (Massa 2015, 219-220; Şahoğlu 2005, 353). At Lerna evidence of contact with Anatolia includes the presence of *depas amphikypellon*, sealed containers, and seal-stamped pots (Massa 2015, 219). The exchange of pottery in this region was multi-directional and locally made copies of Aegean 'frying-pans' have been found at Liman Tepe and Bakla Tepe as well as seals, probably from Crete, at the same sites (Erkanal-Öktü & Erkanal 2015, 189; Massa 2015, 216-217). The presence of the 'frying pans' and Cycladic figurines in Anatolia, both with possible ritual connotations, as well as specific funerary practices (e.g. rock-cut graves) suggests the circulation not just of material goods but also of cultural behaviour (Massa 2015, 220).



1-Liman Tepe
2-Panaztepe
3-Bakla Tepe
4-Troya
5-Kum Tepe
6-Beşik Tepe
7-Hanay Tepe
8-Babaköy
9-Yortan
10-Demircihöyük
11-Küllüoba
12-Karaoğlan Mevkii
13-Kaklık Mevkii
14-Beycesultan
15-Kusura
16-Aphrodisias
17-Iasos
18-Milet
19-Efes
20-Bayraklı
21-Ulucak
22-Karataş - Semayük
23-Tarsus - Gözlükule
24-Kestel
25-Acemhöyük
26-Polatlı
27-Alişar
28-Kültepe
29-Gedikli - Karahöyük
30-Titriş Höyük
31-Kanlıgeçit
32-Protesilas
33-Imbroz - Yenibademli Höyük

Figure 6: Map of the western part of the 'Anatolia Trade Network' as proposed by Şahoğlu (2005, 342)



34-Lemnos - Poliochni
35-Lesbos - Thermi
36-Chios - Emborio
37-Samos - Heraion
38-Mykonos
39-Delos
40-Syros
41-Keos
42-Kythnos
43-Siphnos
44-Melos
45-Paros
46-Naxos
47-Amorgos
48-Keros
49-Ios
50-Thera
51-Christiana
52-Poros
53-Knossos
54-Lerna
55-Tiryns
56-Aegina
57-Thorikos
58-Raphina
59-Eutresis
60-Thebes
61-Orchomenos
62-Lefkandi
63-Manika
64-Pevkakia
65-Skyros

Figure 7: Map of the eastern part of the 'Anatolia Trade Network' as proposed by Şahoğlu (2005, 343). Insert (b) shows flow of route across the İzmir peninsula.

The presence of imported *depas amphikypellon* and of a locally made version of a western Anatolian style ceramic teapots at Titriş Höyük in the south east of Anatolia are evidence that the extent of cultural interactions and trade in the EBA was far more complex than has previously been thought (Yaylalı 2002, 118). Indeed *depas amphikypellon* (see Figure 8), as the 'poster boys' of EBA exchange, have a distribution range from mainland Greece to the upper Euphrates, and 'Syrian bottles' (see Figure 9), as well as locally made copies and adaptations of them, are found from the Euphrates to the Aegean (Bachhuber 2014, 144 & 148; Massa 2015, 227; Özgüç 1986, 34-41; Yılmaz 2009, 442). The presence of locally imitated 'Syrian bottles' in Anatolia further demonstrates evidence of the communication of an idea, a transfer of fashion, as well as the transport of an object and/or its contents (Bachhuber 2015, 153; Zimmermann 2005, 165; see also Zimmermann 2006b). Furthermore, the distribution of artefacts like 'Syrian bottles' and *depas amphikypellon* show that in the latter quarter of the 3rd millennium BC contact between the north west fringes of the Near East and northern Mesopotamia increased in flux and exchange of both indigenous Anatolian and Near Eastern fashions, technologies, and innovations (Şahoğlu 2005, 345; Zimmermann 2007b, 65-66).

The probable existence of dirt roads and established routes connecting different settlements and regions of Anatolia (and beyond) in the EBA has been convincingly argued and demonstrated by Massa (2015) in his doctoral thesis. The range of the networks and the mobility of goods and products were increased with the exploitation of traction and draught power of animals such as cattle and equids, notably the donkey; either as animals of burden themselves or in conjunction with wheeled wagons along these routes (Yılmaz 2009, 441). Donkey is believed to have been present in Anatolia from at least the end of the EBA and probably from the latter half of the 3rd millennium (Massa 2015, 89), and the presence of donkey remains at late 3rd millennium BC Acemhöyük is indicative of the settlement's role in regional trade networks (Arbuckle 2013, 58). The wheel was invented ca. 3500 BC and was common in Europe, Anatolia, and Mesopotamia by 3000 BC (Massa 2015, 71; Sagona 2013, 283). The introduction of wheeled carts, larger boats, and donkey allowed people to move substantial and increasing quantities of materials across large distances of increasing range (Massa 2015, 153).

As an idea of journey times along these network routes, a return trip across central Anatolia (Üçhöyük – Kültepe via Acemhöyük) is estimated by Massa's calculations (2015, 88) to have taken 30-45 days whilst a return trip between Troy and Kültepe is estimated to have taken less than 3 months.

Figure 8: Example of a *depas amphikypellon* from the EBA II/III cemetery of Bakla Tepe (BT-19086) Adapted from Şahoğlu 2005, 348

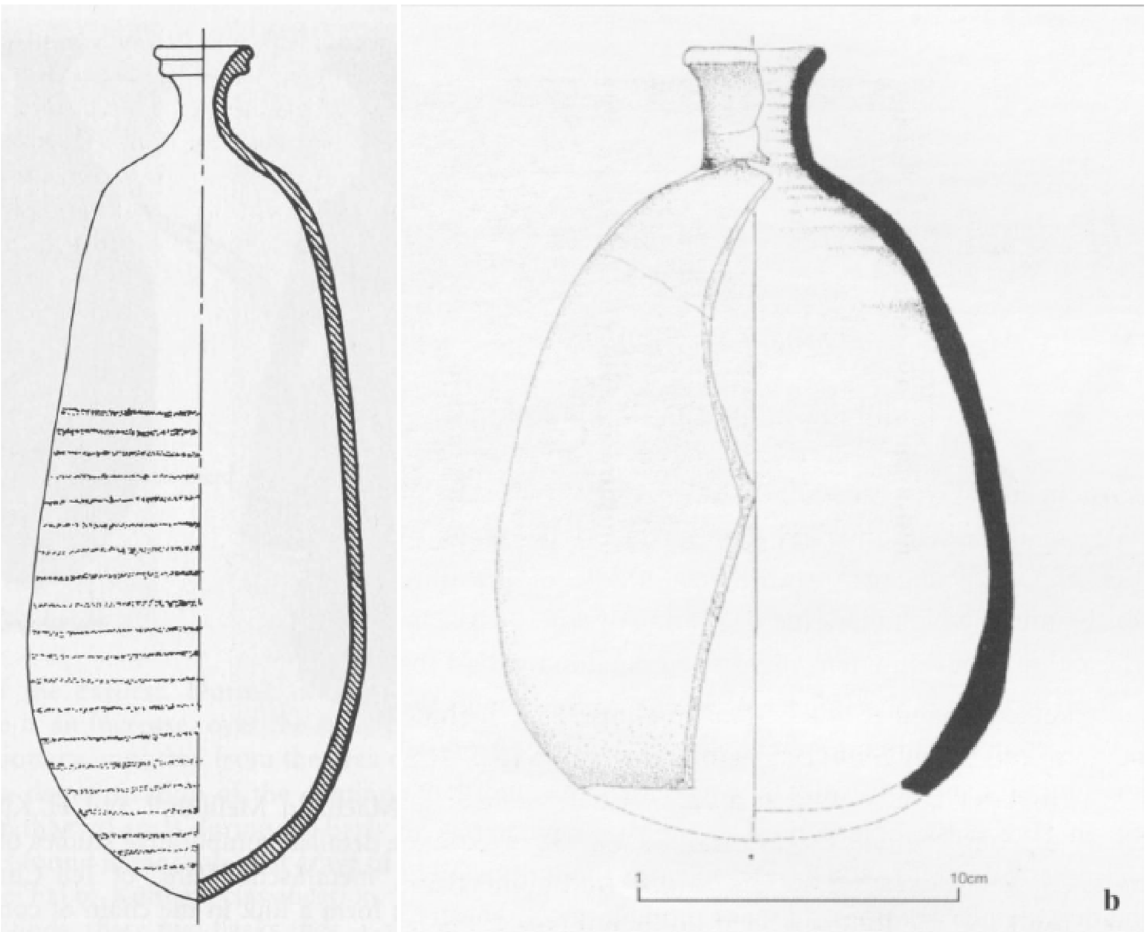


Figure 9: Examples of 'Syrian bottles' from EBA Kültepe on the left, and EBA Küllüoba on the right. Adapted from Özgüç1986, 35 and Efe 2007, 59 respectively

The trade and exchange networks were also developed and increased by the likely establishment of maritime routes in the EBA (Kouka 2016, 205; Massa 2015, 84). A large number of EBA harbour settlements have been discovered in western Anatolia, and pictures and models of ships from the Cyclades demonstrate the importance of the sea for trade, exchange, and contact (Erkanal 2011, 135; Yılmaz 2009, 441-442).

The movement and adaption of technologies and styles were multi-directional exchanges as witnessed by the distribution of 'knobbed maceheads' in Bronze Age Anatolia, Europe, and Eurasia (Zimmermann 2007b, 68). These long distance contacts were promoted by caravan routes stretching in a roughly south east – north west direction across the central Anatolian plateau (Efe 2007, 60-61; Zimmermann 2007b, 66). However, trade and exchange in EBA Anatolia was multi-directional, passing from east to west and vice-versa as well as north to south and vice-versa (Yılmaz 2009, 441; Zimmermann 2007b, 72). The presence of metal pan balance weights and ingots across Anatolia are suggestive of established and organised trade and exchange networks (Bachhuber 2014, 148; Bachhuber 2015, 148; following the work of Rahmstorf 2006 & 2006b).

Technological development, intensification of and the emergence of specialists

The EBA in Anatolia is definitely a period of intensification in many aspects, and this is also true regarding technology. For example, the 3rd millennium BC sees the first appearance of the fast rotating potter's wheel in Anatolia (Schoop 2011, 32). This develops in the latter part of the 3rd millennium with the rapid uptake (although not universal adoption) of wheel-made red slipped ceramics dominated by plates, platters, and drinking tankards (Bachhuber 2014, 143-144). The technical expertise of objects, such as the use of complex casting processes and metal working techniques (e.g. metal inlay), demonstrates the presence of specialists (Massa 2015, 39; Schoop 2011, 32). Innovative and technically sophisticated and exquisitely crafted metallurgy is present in Anatolia from EBA I-II, but is especially evident in metal objects from the EBA III (Bachhuber 2014, 147; Bachhuber 2015, 48). The EBA III sees greater experimentation with alloys and polychromatic effects; at Troy II-III and Mahmatlar (north central Anatolia) there are alloys of zinc and silver, of silver, copper, and gold, and of silver and copper from Resuloğlu (north central Anatolia) (Bachhuber 2014, 147; Zimmermann 2016, 282).

The emergence of these specialists was only possible as a result of the organisation and restructuring of agricultural labour (White *et al* 2014, 364). Metallurgy and the wool-based textile industry are labour intensive and would have required agricultural surplus to support the specialists involved in these industries (Bachhuber 2014, 151). Evidence for the production of agricultural surplus has been provided by the presence of granary storage at sites such as Demircihöyük, Küllüoba, and Tarsus (Bachhuber 2014, 149).

Increase in inter-group tensions:

An increase in inter-social tensions and inter-group and inter-personal violence is witnessed in the 3rd millennium of Anatolia, and especially in the transition from EBA I/II to EBA III, with an increase in the frequency and size of fortifications, the increased occurrence of weapons, an increase in inter-personal violence related skeletal trauma, and an increase in intentional settlement destruction (Bachhuber 2014, 150; Massa 2015, 40). Indeed Bachhuber (2015, 57) asserts that in the EBA of Anatolia "evidence for violence is a recurring feature". Erdal & Erdal (2012, 88-89) have suggested that the combination of fortification systems, the amount of weapons recovered from EBA contexts, burnt layers at settlements, the presence of mass burials, and peri-mortem traumatic injuries, especially when all these factors are present at a single settlement, could suggest the presence of organised violence in the EBA of Anatolia. The reason for the increase in conflict witnessed in the 3rd millennium is not known, but the wider use and distribution of metals may have been one cause as the access to metals and control over metal resources must have had an important impact on the social stratification process (Massa 2015, 38; Schoop 2011, 31; Şahoğlu & Tuncel 2014, 78). Bachhuber (2014, 150) has also suggested that conflict may have arisen from the extension of pastoral land for wool producing herds. The increasing role of metallurgy may also have played a part in increasing conflict during the EBA. Metallurgy and textiles are expansive industries, requiring access to sources of metal and greater areas of land for pasturage respectively, and both of these factors would have increased the potential for conflict with aggression related to land consolidation (Bachhuber 2015, 175).

- Increase in frequency and size of fortifications

Many of the sites of the third millennium BC in Anatolia are surrounded by massive fortification walls and systems (Bachhuber 2014, 150; Massa 2015, 39; Schoop 2011, 31). For example, settlement boundary fortification walls are witnessed at Troy, Kanlıgeçit, Liman Tepe, Alişar Höyük, Küllüoba, Yumuktepe, Kaletepe, Arslantepe, Thermi, Bademağacı, Poliochni, Bakla Tepe, Demircihöyük, Hacılar Büyük Höyük, Yenibademli, and Kültepe (Bachhuber 2014, 150; Bachhuber 2015, 114; Erdal & Erdal 2012, 89; Erkanal 2011, 131; Massa 2015, 39 & 93; Oybak-Dönmez 2005, 41). The enclosure wall built in association with Göltepe II was also probably for defensive purposes (Bachhuber 2015, 46). These walls were, in general, very large and impressive constructions with gates and often with accompanying ditches; for example the wall at Demircihöyük is 2 m thick and 7 m high in places with two gates and an associated ditch (Massa 2015, 93). At Liman Tepe the EBA I stone wall is 0.9 m thick with crenellations at 1.5 m intervals, as well as an impressive gateway flanked two rectangular towers, and the exterior southern face of the wall was covered with uncut stones creating a sloping surface (Erkanal 2011, 131; Erkanal & Şahoğlu 2016, 157-158). In the mid-3rd millennium BC the nature of Liman Tepe's layout changed with a citadel and lower town being established, both of which had monumentally impressive defensive walls surrounding them, possibly being up to 12 m in height (Erkanal 2011, 131-132; Erkanal & Şahoğlu 2016, 162; Sagona & Zimansky 2009, 198).

Whilst most of the enclosure walls of EBA Anatolian settlements would have been for military defence, not all should be considered to have been built solely, or even at all, for that purpose (Bachhuber 2015, 56-57). Enclosure walls may have been constructed to keep domestic animals in and wild animals out, to shelter the inhabitants from wind and/or extreme weather, and in the case of *höyüks* to serve as a retainer wall for the loose fill the settlements were built upon (Bachhuber 2015, 56). Additionally, enclosure walls may have served a symbolic as well as/instead of a practical purpose. Cultraro (2007, 57) has suggested that the fortification walls of Poliochni Yellow, reconstructed from the previous Red period, would likely have been ineffective as a defensive structure. Instead, he has proposed that the re-built fortification walls were mainly to establish new forms and levels of social control over the population, and possibly to create boundaries between internal and external space, between the settlement and the rural hinterland (Cultraro 2007, 57). In other words, the fortification walls "defined a new socio-economic and political landscape and they stood as visible symbols of the new social order" (Cultraro 2007, 57).

In my opinion, all 'fortification' walls present at EBA settlements would have served several purposes and been multi-effectual. Whether primarily constructed for defence, animal and human shelter, to demarcate areas/space, or to create a symbolic effect, these boundary walls were likely to have had more than one functional use at EBA Anatolian settlements. For example, at Bademağacı (see Chapter 2.4), the settlement is surrounded by a paved slope. It has been argued that this would have been ineffective as a defensive measure, but was instead built to prevent erosion and protect against rising water levels (De Cupere et al 2008, 369; Duru & Umurtak 2006, 14; Duru & Umurtak 2011, 33; Umurtak 2010, 22). However, it hypothetically also would have been an effective means of identifying the settlement in the landscape and create a symbolic division between internal and external spaces for both humans and animals.

- Increased occurrence of weapons

Whilst there is arguably an increase in conflict/violence, there is definitely an observed increase in (what has been argued as) a positivity of organised male violence as a source of prestige, witnessed in the inclusion of a large range of weapons in male grave assemblages

(Bachhuber 2014, 150; Bachhuber 2015, 57; Massa 2015, 40; Schoop 2011, 30). The inclusion of weapons in male grave assemblages suggests their association with the male costume, and may indicate the defining of 'warriors' within populations. This in turn may suggest that organised violence was viewed positively (in so much as a source of status) by the EBA populations of Anatolia. For example at Demircihöyük 10-15% of adult males were buried with weapons (Bachhuber 2015, 68; Massa 2015, 97). However, the increased use of weapons in the 3rd millennium BC should potentially be viewed as a consequence of social changes rather than the cause (Schoop 2011, 35). This is because, so far, there is little evidence for elite control over the access to metal weaponry. Furthermore, as mentioned above, even at small rural settlements like Demircihöyük the presence of weapons (of both metal and stone) are a regular component of adult male grave assemblages (Schoop 2011, 35). This implies that weaponry was not limited to elite groups, or settlements of a certain size or hierarchical standing. It seems probable that violence was related to self-defence or aggression during activities such as herding, procuring mineral (metal and/or stone) resources, travel for trade/exchange, and perhaps raids on other settlements (Bachhuber 2015, 69). As mentioned earlier, inter-group conflict was also likely to have been related to competition arising from the intensification of expansive industries such as metallurgy and woollen textiles. These factors further suggest that the presence and use of weapons in the 3rd millennium BC was a consequence of changes in economic and social practices, rather than the driving force. In other words, an increase in competition over resources, land, and trade networks was the cause of an increase in inter-personal conflict and thereby an increase in the presence of weapons and the way weapons and those wielding them were viewed by EBA societies.

- Increase in inter-personal violence related skeletal trauma

We witness an increase in the frequency of traumatic injuries related to weapon use and inter-personal violence is witnessed in the 3rd millennium BC, especially when comparing the first half with the second half of the millennium (Bachhuber 2014, 150; Bachhuber 2015, 57; Massa 2015, 40). At Karataş ca. 20% of the adult males have cranial traumatic injuries, and ca. 10% of the injuries on the adult males were weapon related traumatic injuries (Erdal & Erdal 2012, 81; Massa 2015, 110). The frequency of cranial traumatic injuries amongst the adults of İkiztepe is 28.9%, with males being more affected than females; 43.4%:12.4% respectively (Erdal & Erdal 2012, 82). Of the injuries on the individuals from İkiztepe, 19.7% were peri-mortem penetrating injuries caused by sharp-edged weapons (Erdal & Erdal 2012, 83). Furthermore, there appears to be a temporal shift in the incidence of trauma, for example at Titriş Höyük a doubling in the rate of traumatic injuries is witnessed between the EBA I-II and EBA III from 6.7% to 14.3% (Erdal 2012, 9; Erdal & Erdal 2012, 82). Mass burials have also been witnessed at EBA Anatolian settlements including Arslantepe, where Sepulture 216, dated to the beginning of the 3rd millennium BC, contained 12 adults and four sub-adults (Erdal 2012b, 303-306; Erdal & Erdal 2012, 81). Single or multiple peri-mortem injuries account for 66.7% of the injuries, and there are 15 peri-mortem fractures across eight crania (Erdal 2012b, 305; Erdal & Erdal 2012, 81). Another example is seen at EBA III Titriş Höyük with the deposition of 16 adults and three sub-adults in a plaster basin (see Erdal 2012; Erdal & Erdal 2012, 82). It was determined that 81.3% of the 16 adult crania present in this deposition had at least one traumatic injury, and many of them had several with there being a total of 26 peri-mortem injuries across the remains of the Plaster Basin deposition (Erdal 2012, 7; Erdal & Erdal 2012, 82). This unique burial deposition will be discussed further in Chapter 2.3. More recently an EBA I (early 3rd millennium BC) mass burial was identified at Başur Höyük in southeast Turkey, although research into its aetiology is still ongoing (Hasset 2016, Sağlamtimur 2016).

- Increase in intentional settlement destruction

Many of the settlements of the 3rd millennium BC in Anatolia show episodes of violent and seemingly intentional destruction and conflagration (Bachhuber 2014, 150; Bachhuber 2015, 57; Massa 2015, 40). For example EBA II Tarsus was violently destroyed and rebuilt in the EBA III (Bachhuber 2014, 145), and Demircihöyük was probably destroyed as a result of hostilities in Phase L (ca. 2650 BC) (Massa 2015, 94). Karataş also has evidence of settlement destruction by fire which was possibly the result of intentional human action (Massa 2015, 110 & 116). At Troy there is evidence for several episodes of destruction, the Troy I fortress was burnt followed by the building of a larger citadel (phase IIa) with two gateways on top of the debris, and then in Troy IIc there is another episode of fire destruction (Sagona & Zimansky 2009, 194 & 196). In the EBA II layers of Liman Tepe there is evidence of destruction by a violent fire (Erkanal-Öktü & Erkanal 2015, 189). Violent destruction is also witnessed at Alaca Höyük, with one event destroying building ABC (Bachhuber 2015, 93). There is also evidence of catastrophic destruction at Poliochni Yellow (Bachhuber 2015, 113). Moreover, towards the end of the EBA 75% of all excavated settlements experience a fire event that engulfed the entire site (Massa 2015, 116). These occurrences of catastrophic conflagrations were often followed by reconstructive periods which also included the strengthening of the settlement's enclosure wall (Bachhuber 2015, 57). For example in the EBA I layers of Arslantepe there are continuing and successive episodes of destruction (Frangipane 2014, 181). These episodes were not limited to the Anatolian peninsula: in northern Mesopotamia, at places such as Ebla, the latter part of the 3rd millennium BC is one of great turmoil with two phases of violent destruction, in 2300 BC and 2000 BC (Fiorentino *et al* 2008, 52-53). Whilst intentional settlement destruction is the most probably cause in the examples listed here, one must bear in mind that some burning episodes at settlement may also be correlated with a denser arrangement and build-up of buildings at urban sites and the use of vast quantities of wood as part of the structures.

When we examine the evidence for inter-group tensions in the EBA of Anatolia it is clear that inter-group violence not only increases relative to previous periods in frequency and degree, but is also more visible in the archaeological record. Many of the settlements have a boundary wall of some sorts, with many being impressive and substantial, and there is a notable increase in the size and frequency of these walls in the 2nd half of the 3rd millennium BC. It seems clear that whilst these boundary walls may have numerous functions, defining internal and external space and separating outside(rs) and inside(rs) was clearly a main factor in many of them and, indeed, we can safely assume that in those cases that their primary role would have been a defensive one. There is also an increase in the frequency and prominence of weapons, especially those made of copper and bronze. These weapons are not restricted to certain settlements (i.e. only found in larger settlements), elites or find contexts suggesting that the objects themselves and their associated symbolism were not limited to certain peoples or groups and instead were permeated throughout EBA Anatolian culture. It is also no surprise that with an increase in the ubiquitous nature of weapons in the EBA that there is also an increase in skeletal trauma in the osteoarchaeological record. Furthermore, these traumatic injuries are often related in size and shape to the weapons of the period, and the injuries are often reflective of inter-personal combat in the way that they were attained. These factors would perhaps suggest that the EBA may indicate the commencement of large(r) scale inter-personal and inter-group violence. Finally, the episodes of settlement destruction are ubiquitous in the EBA settlements of Anatolia. Even if we consider some of them to be the result of accidents and/or intensified by urban density etc. it is notable and noticeable that the majority of settlements in the 3rd millennium experienced at least one episode of intentional violent destruction, even if only partial. Therefore, it appears to be unquestionable that the EBA of Anatolia was a dynamic period with violence and violent interactions on a scale and frequency previously unseen in the region.

Burial patterns:

As with other features of EBA Anatolian settlements where there are some general standardisations and common features, the burial habits of the 3rd millennium in Anatolia are no different. Some of the common features include the interment of the individual in a foetal ('Hocker') position on one side (99% of intact burials are in this flexed 'Hocker' position), a generally standardised funerary goods assemblage (pottery, personal ornaments, and weapons), differential treatment of sub-adults with <1 year buried under house floors, and particular attention to small children – in some cases they have very rich grave assemblages with jewellery and figurines (Bachhuber 2015, 85; Massa 2015, 211). There are also some regional differences regarding mortuary practices (Sagona & Zimansky 2009, 212). For example, formal extramural cemeteries are present across western and northern Anatolia, whilst in the Konya plain, Cappadocia, and the southern Kızılırmak bend burials are intramural (Massa 2015, 212). These extramural cemeteries are often located on features in the landscape, such as on a hill in the case of Sarıket-Demircihöyük and on a rock outcrop above the plain at Yortan, or on settlement mounds with little or no evidence for contemporary occupation such as the EBA II-III cemetery of Bakla Tepe (Bachhuber 2015, 84). Whilst generally located away from the settlement, some extramural cemeteries were on the immediate peripheries, for example Alaca Höyük and Karataş (Bachhuber 2015, 84). In the western Anatolian highlands large multi-burial 'family' *pithoi* are almost exclusively used for burial whilst in central Anatolia there is a co-existence of jars, stone cists, simple pits, and stone lined burial types; see Figure 10 (Massa 2015, 212). Examples of cemeteries with exclusively *pithos* burials are Ulucak (in the İzmir region), Ahlatlı Tepecik (Manisa region), Harmanören-Gündürle (İsparta region), and Karataş (Şahoğlu 2016, 169). Mixed burial habits can be seen for example at EBA I-II Ilıpınar where the graves consist of *pithoi* and pit burials (Şahoğlu 2016, 168), and in the extramural cemetery of Hacılartepe (2850-2600 cal. BC - contemporary with Sarıket and Küçükhüyük) where there were three categories of burial type; in *pithoi* (with the mouths blocked by stones), on *pithoi* sherds, and in simple pits, with all types containing grave goods (Roodenberg 2008b, 335-340).

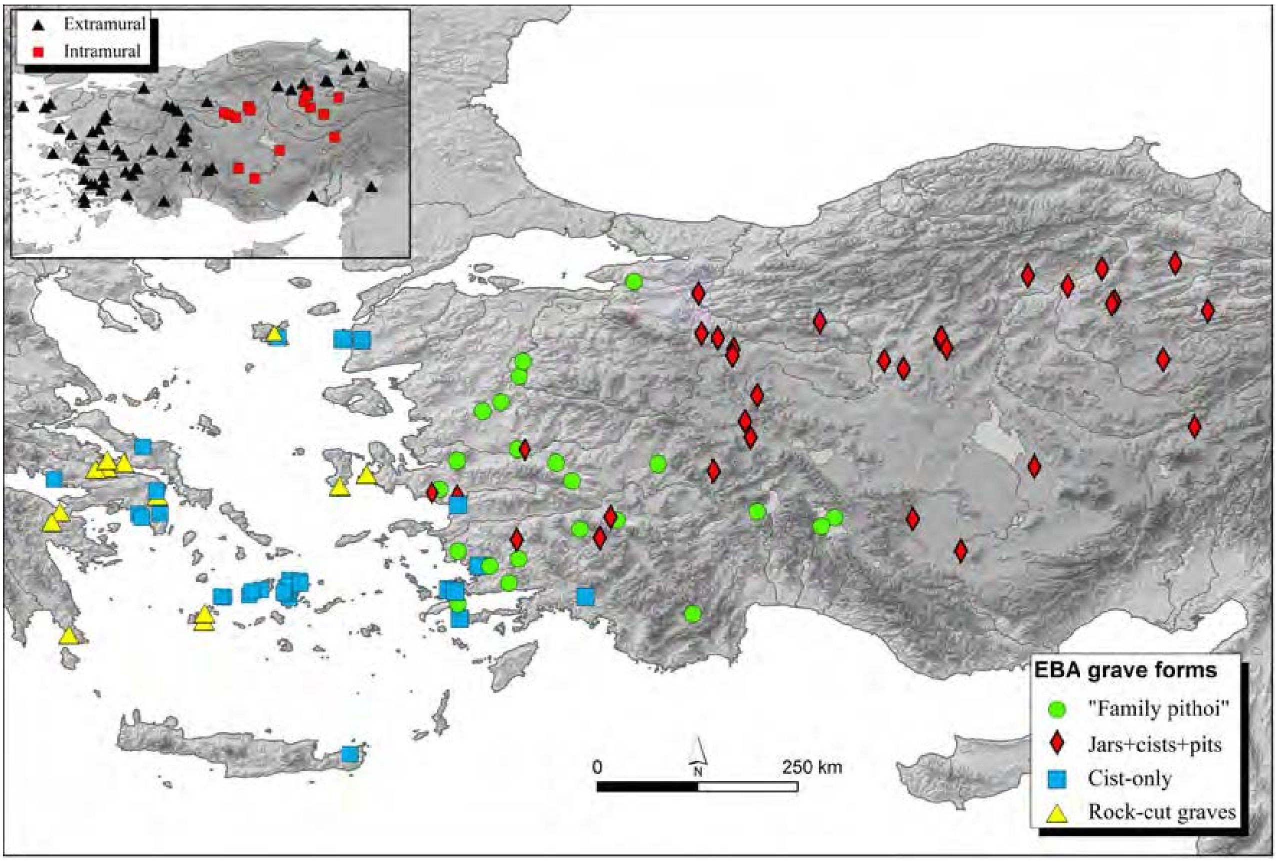


Figure 10: Map showing distribution of main grave types across the EBA Anatolian peninsula and the Aegean. Adapted from Massa 2015, 481

There are some exceptions though, with some cemeteries in the Büyük-Menderes-Gediz triangle having multiple burial types which demonstrates the role of the valleys as major natural routes of exchange (not just of goods or materials, but of information and practices) between western Anatolia and the central plateau (Massa 2015, 212). Related to this some cemeteries on the Aegean coast of Anatolia have rock-cut graves or cist only cemeteries (e.g. İasos) which indicates a strong interaction with western Aegean communities where these types of burials are typical; see Figure10 (Masa 2015, 212; Sagona & Zimansky 2009, 213; Şahoğlu 2016, 168). As well as regional differences, there are also temporal changes within regions. In the western half Anatolia, from the EBA II period the use of *pithoi* angled into the ground with the opening facing east and sealed with a flat stone or large sherd is the most common form of inhumation, as witnessed at places like Yortan, Karataş, and Babaköy amongst others (Sagona & Zimansky 2009, 213). In the southeast (specifically the Adıyaman-Urfa district), the burial habits change through time in a broadly linear fashion from (stone) cist graves in the EBA I-II to chamber tombs in the EBA II-III, as seen at places such as Lidar Höyük and Titriş Höyük (Sagona & Zimansky 2009, 217). Despite these regional and temporal differences there is one common feature: most of the graves were not sealed permanently and were re-used (Bachhuber 2015, 84).

Metal artefacts become an important and widespread part of mortuary contexts as witnessed in the cemeteries of Sarıket (Demircihöyük), Karataş, Göndürk Höyük, and Bakla Tepe (Bachhuber 2014, 146-147; Şahoğlu 2005, 341).

Climatic changes:

Examining the climatic conditions of the region is of some worth as this would have had some impact on the subsistence strategies of settlement's populations. There is a variation in precipitation quantities across Anatolia, with the Plateau receiving the least (200-400 mm per annum), the northern and southern coastal regions (i.e. between the mountain ranges and the seas) receiving the most (1000-1500 mm per annum), with western Anatolia receiving 600-700 mm per annum (Bachhuber 2015, 34). Miller & Marston (2012, 98) include a table with site-specific annual precipitation levels. The sites of Gritille (500 mm), Kurban Höyük (473 mm), Cafer (400 mm), and Hacınebi (368 mm) (Miller & Marston 2012, 98) are most useful to this research as they are all in south east Turkey in relatively close proximity to Titriş Höyük. There have been established changes in climatic conditions with a progressive aridification from c.2500 BC onwards in the Near East, culminating in droughts between 2200 and 1900 BC (Massa 2015, 38). More intense climate changes towards aridity are shown to have begun around 2250 cal. BC with a significant drop in rainfall observed in the second half of the 3rd millennium BC (Fiorentino *et al* 2008, 56). Riehl *et al* (2014, 12350) demonstrated by analysing the $\delta^{13}C$ values of samples of barley from the Khabur region, along the Middle Euphrates, and the Levant that there was an increase in aridity in the second half of the 3rd millennium BC and many of the barley samples (especially from the inland sites) exhibited isotopically visible signs of drought stress. The numerous collapses witnessed at the end of the 3rd millennium BC are believed to be related to this increasing aridity (often known as the '4200 BP event'), as well as economic and/or political factors (Riehl 2009, 94;

Riehl *et al* 2014, 12348). The prospective effect and role of climatic change on subsistence practices and dietary habits in EBA Anatolia will be further discussed in Chapter 6.2 and Seven.

1.3 Dietary Habits

The analysis of dietary habits can give insights into subsistence patterns, resource utilisation, and measure inter- and intra-group variations in dietary composition (Turner *et al* 2007, 2). Palaeodiet analyses can be used to examine the relationships between age, and sex, social status, and health related factors, as well as the relationship between isotopic indicators of diet and other methods such as tooth wear, dental caries, food remains, written texts (when and where present), and to examine changes in diet of site specific populations over time as well as shifts in diet over long distances and time scales; e.g. from the Mesolithic to the Neolithic (Schwarcz & Schoeninger 2011, 734). A key component in the study of complex societies is the degree to which they are characterised by social and economic stratification. The social distinctions between 'elites' and 'commoners' are well established characteristics of archaic [and general] statehood (Somerville *et al* 2013, 1539) - see also Bourdieu 1984 for a general approach to this notion. These distinctions are often made through the analysis of burial patterns (location/grave goods etc.), as well as by examining diet, health, and cultural modifications to the body through osteological, palaeopathological, and stable isotope analyses (Somerville *et al* 2013, 1359). The identity of consumer or social groups is closely linked to patterns in dietary choices, in other words there can be a link between diet and social group (Bourdieu 1984; Somerville *et al* 2013, 1539; Ünlü 2016, 345-346). Furthermore, it can be stated that "food items themselves can play a huge role in the negotiation of status and power" with elites and commoners often having access to different food types which may correspond to their quality or social desirability, and elites may enjoy greater access to particular items, non-local foods for example (Somerville *et al* 2013, 1539-1540). Food plays a dynamic role in the negotiation and formation of cultural identity and social relations as well as in the characterisation and management of power (Cultraro 2013b, 103; Ünlü 2016, 346). Food can be used to maintain social boundaries, can be related to culture/cultural identity, and can be restricted by factors such as social organisation and the physical environment (Stonge 2012, 2 & 61). The foods which are consumed are related to and constrained by environmental factors and social dynamics, and as such access to specific foods can be limited by geographic location, temporal provenance, social status, sex, and age (Stonge 2012, 5 & 48). Climatic factors have considerable influence on the potential vegetation (Fiorentino *et al* 2008, 52). By analysing dietary habits at a population level this can provide insights into subsistence patterns, status and health differences, animal management practices, and even information about the palaeoenvironment as well as investigating the impact of climate change and socio-political factors (Stonge 2012, 2; Thompson *et al* 2005, 452).

Archaeologists use many different sources of information to reconstruct ancient diets including faunal, macro-botanical remains, pollen and phytoliths, pottery residues, coprolites, skeletal pathologies, dental wear patterns, artistic depictions and ethnographic observations (Tykot 2004, 433). However, palaeodiet reconstruction studies are traditionally focused on the study of the traces of consumed foods, such as bones, shells, seeds, pollen etc. (Schwarcz & Schoeninger 2011, 727). These methods can often only determine the menu, without quantitative estimation of the importance of their components; something stable isotope analysis is able to do (Makarewicz & Sealy 2015, 151; Tykot 2004, 433). Stable isotope analysis can provide information as to which items of an archaeological food assemblage were actually consumed, and refine the estimates of relative importance of various foods enabling more accurate interpretations of the effects of a changing diet on health and demography (Katzenberg 2008, 431; Makarewicz & Sealy 2015, 151). This point is particularly relevant for many of the aspects discussed in Chapters Five, Six and Seven. For example, even though palaeobotanical and archaeozoological research may suggest something, such as homogeneity of available food resources, stable isotope analysis is necessary to demonstrate this homogeneity in consumption/the dietary habits of individuals and/or populations.

1.4 Research Objectives

The aim of this research is bioarchaeological in nature. Bioarchaeology encompasses the common interests and goals of anthropologists with the training and skills of biological/physical anthropology (also known as osteoarchaeology), and archaeology (Ambrose & Krigbaum 2003, 193). Analyses involving human bone have the advantage that the results are for individuals, and therefore comparisons can be made between individuals of different ages, sexes, and socio-economic status as well as between sites and over multiple time periods (Katzenberg 2008, 431; Tykot 2004, 434). This means that whilst stable isotope analyses are used to draw conclusions about individuals and populations dietary habits, this is done in conjunction with many other forms of evidence including burial patterns, osteological analysis, settlement organisation, archaeobotanical research, archaeozoological research, and analysis of exchange and contact networks across Anatolia and the Near East. One of the important roles of archaeobiology is to illuminate the connections between people, plants, and animals (Miller 2013, 247). Isotope analyses should therefore be conducted and interpreted in the context of the entire reconstructed record of a site and its population/inhabitants (Makarewicz & Sealy 2015, 154; Schwarcz & Schoeninger 2011, 734). By combining biochemistry and bioarchaeology, scholars can examine different events of an individual's life history, including palaeodiet (Knudson *et al*, 435; Reitsema 2015, 601). In other words, to provide a 'big picture' interpretation based upon several smaller scaled specialist avenues of research and analysis.

Studying emerging urban communities can be useful for understanding the development and consequences of specific strategies of agricultural intensification (White *et al* 2014, 364). The Anatolian EBA marks the first time that some settlements and populations which could be considered as 'urban' are witnessed in this region of the Near East. From the discussion in section 1.3 it is clear that the EBA is a time of change and increased social complexity and conflict. Did this affect or have an influence on dietary habits? Especially from the earlier part of the 3rd millennium to the latter half when evidence for a substantial increase in inter-group conflict, technological advances, and exchange and contact networks is observed. Did these factors result in differing or changing subsistence and resource utilisation practices with regards to individual and population dietary habits? It has been argued that major political and environmental events (wars, alliances, droughts, and famines) would have had significant repercussions for diets across the social spectrum (Somerville *et al* 2013, 1540). Furthermore, bone biochemistry, when applied to a period of intense cultural change and social pressure can provide insights on social inequality and differential food access (Reitsema & Vercellotti 2012, 590), and the study of past populations affected by social and/or political change has the potential to provide information relevant to modern society (Stonge 2012, 1).

This chapter has provided a background to the use of stable isotope analysis for reconstructing palaeodiets and the importance and usefulness of doing so, as well as providing a general overview of the characteristics of the EBA of Anatolia. Chapter Two lays out a summary of the sample sites, addressing their geographical and temporal locations, architectural layouts and features, material culture, evidence of exchange and trade, burial habits, local environmental conditions, and their available and potentially exploited food resources. Chapter Three then delivers an introduction to stable isotopes, the theory behind them and how this can then be applied to palaeodietary studies. Chapter Four discusses the materials, the sampling strategies determining their selection, and how they were prepared for analysis. In Chapter Five, the results of the osteological analyses and the population demographics of each sample population are presented and discussed. The data for each sample population from the stable isotope analyses of carbon and nitrogen are also presented in this Chapter and discussed on an intra-site basis. Chapter Six then offers a larger discussion examining inter-site and inter-population comparisons, as well as how the data and interpretations fit into the wider scope of prehistoric Anatolia and the EBA of western Asia, i.e. expanding the scale of analysis and interpretation on both a geographical and temporal level. Chapter Seven gives a concluding synthesis of the thesis, the results of the analyses, and the interpretations of those results.

Chapter Two: Sample Sites

2.1 Introduction

In total four sites from across Anatolia were chosen to analyse the dietary habits of the inhabitants (see Figure 11). The sites were selected in part out of pragmatism as these were sites that had available skeletal material that could be sampled, as discussed further in Chapter Four. However, the sites were also chosen so as to deliberately gain information from a varied range of altitudes, environmental and geographical areas/zones, ecosystems, internal and coastal environments, settlements of differing sizes and external influences, burial habits, and cultural practices/zones. This was partly to see if any differences could be discerned between not only the settlements themselves, but also the regions, for example if dietary habits were different between the people inhabiting northern and southern Anatolia, west and south east, north and west, and so on. Put more simply, to examine whether there are regional and population specific socio-cultural and socio-economic differences. It was also done to examine how much the environment would affect not only the results themselves but also the decisions people of the past had made regarding arable agriculture and animal husbandry. For example, if all the sample sites were from one particular area and the results of the stable isotope analyses turned out to be the same or very similar it could logically be argued that the local environmental and ecological conditions could have influenced and determined the available dietary resources and henceforth the decisions regarding this resources and the dietary habits of the settlement's inhabitants. By choosing sample sites from different environmental and ecological regions, for example from coastal sites and inland sites, from sites at low and high elevations etc., this bias should be avoided and furthermore, any patterns between the sites should in turn bear more weight to them.

To properly contextualise and understand the results of the isotopic analyses a comprehensive understanding of the sample sites is necessary. This chapter aims to examine the published data to provide background information for all of the sample sites; their geographical locations, occupation history, architectural and cultural practices, evidence of trade and cultural exchange and contact, burial habits, environments, and economies.

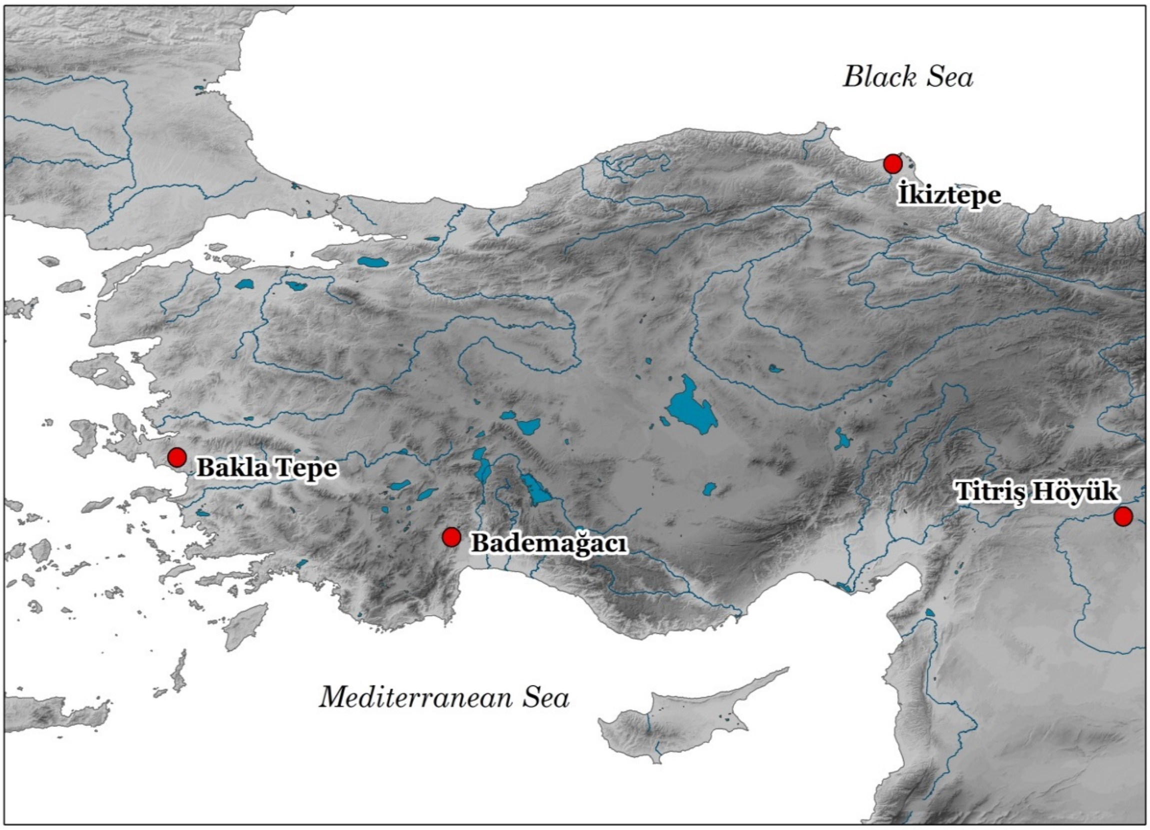


Figure 11: Map showing location of sample sites. Map produced by M. Massa

With regards to this research the burial habits, local palaeoenvironmental and ecological conditions, and economies are of particular importance. Unfortunately, for some of the sites specialised research (e.g. archaeobotany, archaeozoology, and palaeomorhpology) was either conducted on a very small scale or not at all, which results in gaps not only in this chapter but in the overall data available, and thereby information known about the sites. This is especially true for Bakla Tepe and Bademağacı where there is a lack of data available about the botanical and faunal remains from these sites. Also, at the aforementioned sites very little or no work has been done with regards to reconstructing the prehistoric local environment.

2.2 İkiztepe Höyüğü

İkiztepe is located in the province of Samsun on the Bafra Plain ca. 7km northwest of the modern town of Bafra, and today lies approximately 1.5km west of the Kızılırmak River and 7km from the Black Sea coast (see Figures 12 and 13) (Bilgi 2005b, 15-16; Erdal 2005, 102;

Eroğlu & Erdal 2006, 42; Kunç 1986, 99; Özdemir & Erdal 2010, 495; Özdemir & Erdal 2012, 283; Welton 2010, 42). Due to alluvial processes, during the EBA İkiztepe was likely to have been located directly on the coast of the Black Sea as well as on the riverbank of the Kızılırmak (see Figure 14) (Özdemir & Erdal 2012, 290; Turoğlu 2010, 99; Welton 2010, 33 & 42). The Pontic Mountains to the south of İkiztepe form a natural barrier meaning that natural routes of communication run east-west rather than north-south (Welton 2010, 32; Winfield 1977, 158). The environment of the Black Sea coast where İkiztepe is situated has a milder, wetter climate than the Central Anatolian Plateau with higher rainfall and more moderate temperature variations, yet is generally cooler than the Mediterranean coast in the south (Doonan 2004, 17; Welton 2010, 31). With the exception of the alluvial plains there is a restricted area of land between the foothills of the Pontic Mountains and the Black Sea coast (Welton 2010, 31-32). In prehistory the foothills of the Pontic Mountains would have been very heavily forested and today includes species such as beech, chestnut, hornbeam, oriental spruce, yew, and alder (Burney 1956, 178; Welton 2010, 32). These tree species form the lower belt of the Euxinian forest, spanning from sea-level to 1000m, above which coniferous species become dominant along the southern coast of the Black Sea (Welton 2010, 32; Van Zeist 2003, 548). The surrounding region would have been densely vegetated and this is partly seen by the extensive use of wood in the settlement (Özdemir & Erdal 2012, 290). The pollen record for the surrounding region (from cores taken from the Tatlı Göl 15km away) not only gives us an indication as to which species would have been present in the region but also indicate their reduction around 5500 years ago, most likely due to human impact, such as deforestation for the use of timber as fuel and for construction, as well as possibly for forest clearing for grazing and agriculture (Özdemir & Erdal 2012, 291). During the EBA the Bafra Plain was likely to have been a lot smaller than it is presently as the majority of the alluviation of the plain has happened in the last 5000 years, resulting in İkiztepe likely being located on the coast as mentioned above (Özdemir & Erdal 2012, 290; Welton, 2010, 33). The land of the Bafra Plain was also likely to have been marshy and it has been argued that as a result of these natural factors that viable agricultural land in the immediate vicinity of the settlement may have been limited (Özdemir & Erdal 2012, 291; Welton 2010, 33).

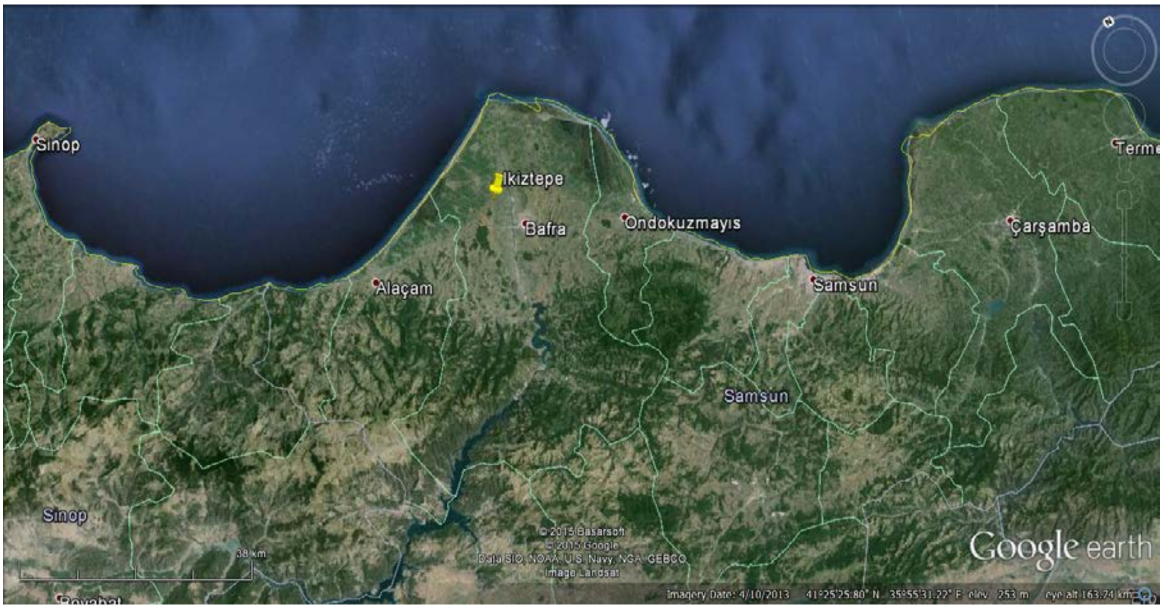


Figure 12: Regional view of İkiztepe location. Adapted from Google Earth

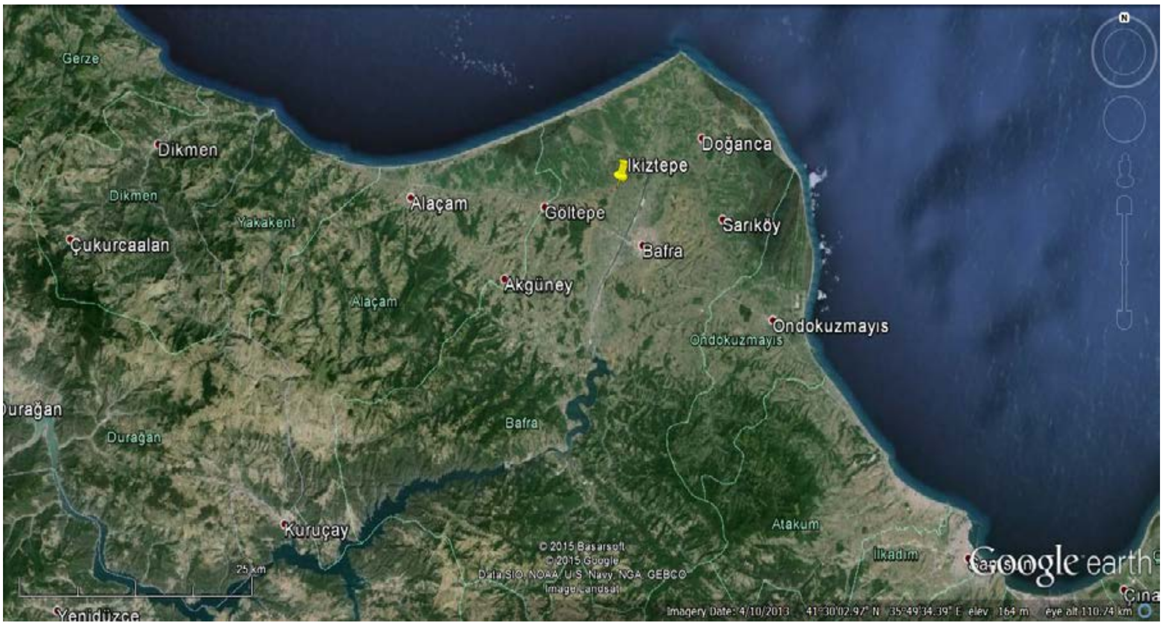


Figure 13: Location of İkiztepe on the Bafra Plain. Adapted from Google Earth

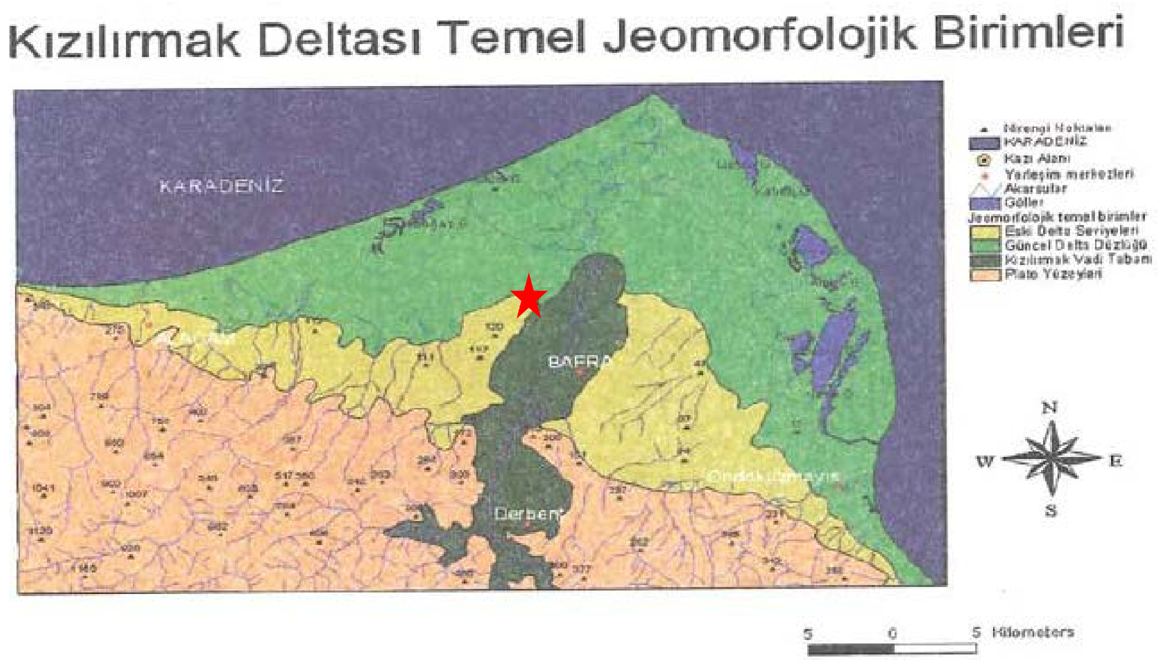


Figure 14: Geomorphological map of the Kızılırmak Delta. Note: red star is location of İkiztepe, the yellow area is the level of the prehistoric delta, the green area is the current/modern delta, the dark green area is the valley base of the Kızılırmak, and the pink area is the geological plate. Adapted from Turoğlu 2010, 108

Excavations at İkiztepe first began in 1974 under the direction of Uluğ Bahadır Alkım before his death in 1981, after which they were continued under the direction of Önder Bilgi (Istanbul University) (Erdal 2005, 102; Eroğlu & Erdal 2006, 42; Özdemir & Erdal 2012, 283; Schoop 2011b, 160; Welton 2010, 42). The excavations were begun with the intention of analysing and reconstructing the life of the settlement, and due to its size and location it was seen as having crucial importance to understanding the cultural dynamics in the prehistoric Pontic region (Backofen 1987, 175; Zimmermann 2007, 30).

There are some issues and discussion regarding the chronology of İkiztepe, which will be discussed in greater depth later in this chapter. The chronology initially presented here immediately below is what is commonly found in the published literature; principally that the prehistoric occupation of İkiztepe has been dated to the EBA (i.e. 3rd millennium BC) preceded by a Late Chalcolithic period dated to the second half of the 4th millennium BC (Schoop 2011b, 160; For a tabular view of İkiztepe's chronology based on Bilgi's relative dating see Table 2.1 in Welton 2010, 43). Many of the EBA levels at İkiztepe have produced only fragmentary remains of structures and architecture including beaten earth floors and burnt remains of wooden timbers and pisé fragments (Welton 2010, 49).

Late Chalcolithic - The first levels of occupation at the site are during the Late Chalcolithic (4000-3200 BC), and were located on Mound II (grouped together as Level III, Mound II) where it was discovered the settlement of this period was founded on virgin soil (Alkım *et al* 1988; Bilgi 2001, 76-77; Schoop 2011b, 160; Welton 2010, 42). This settlement period has eight architectural phases with buildings being constructed of timber and wattle-and-daub (Mellink 1992).

EBA I-II - The Chalcolithic settlement on Mound II was destroyed in its final phase and the mound was re-occupied in the EBA I (3200 BC-2700BC) and EBA II (2700 BC), and the earliest evidence of occupation of Mound I has been dated to the EBA I period (3200-2700 BC) where it also continued through to the EBA II (2700-2300 BC) (Alkım *et al* 1988; Alkım *et al* 2003; Bilgi 2001; Welton 2010, 42-43). The EBA I levels (as designated by Bilgi, 2001) are Level III, Mound I and Level II, Mound II (Welton 2010, 43). Total evidence of EBA II occupation were discovered and identified on Mounds I, II, and III and the levels (as designated by Bilgi, 2001) for the EBA II phase are as follows: Level II, Mound I; Level I, Mound II; and Level III, Mound III (Welton 2010, 42-43).

The EBA I levels on Mound II have revealed the extensive presence of refuse pits (Alkım *et al* 2003, 65-66; Welton 2010, 63). Structures at İkiztepe in the EBA I and EBA II periods appear to have been freestanding and constructed without foundations, with the space in-between timber frames being filled with mud plaster (i.e. wattle and daub) (Sagona & Zimansky 2009, 170; Welton 2010, 48). Houses are generally rectangular in shape and structures with up to eight rooms were discovered, and often included ovens made from clay on a plastered platform (Bilgi 1987, 174; Sagona & Zimansky 2009, 170; Welton 2010, 48-49). The EBA II remains from Mound II were highly eroded due to their location near the surface and the phases of this level were all heavily burnt, but architectural remains were revealed of wattle and daub with evidence of burnt fragments of pisé and wooden beams and floors of mud plaster or beaten earth (Alkım *et al* 1988, 156-160; Welton 2010, 63).

EBA III - At the end of the EBA II and the beginning of the EBA III a significant change is observed with Mound I being abandoned and instead used as an extramural cemetery (Bilgi 1984, 96; Erdal 2005, 102; Eroğlu & Erdal 2006, 42; Özdemir & Erdal 2010, 495; Welton 2010, 45). The levels for the EBA III phase of occupation, as designated by Bilgi (2001), are: Level II, between Mounds I & II; and Level II, Mound III with the graveyard occupying Mound I during this phase as previously mentioned (Welton 2010, 43). The EBA III settlement contemporary to the cemetery discovered on Mound I was found on Mound III of the site (Welton 2010, 45). However, as will be discussed in more detail below these 'EBA' dates are contentious and have been challenged and re-thought.

On Mound III layers dated to the EBA III period were discovered revealing architectural construction techniques similar to those seen in other parts of the site with buildings constructed of timber and wattle and daub with beaten earth floors (Bilgi 1999, 201; Welton 2010, 77). These buildings are generally rectangular with either one or two rooms and the 'complexes' have courtyards with features that were interpreted as hearths or kilns (Bilgi 1999, 201; Bilgi 2000, 316; Welton 2010, 78).

After the EBA period the settlement continued to be occupied into the Transitional/Early Hittite period, where levels of occupation were discovered on Mound I, III, and IV: Level I, Mound I; Level I, between Mounds I & II; Level I, Mound III; and Level I, Mound IV (Alkım *et al* 2003, 33-34; Özdemir & Erdal 2010, 495; Welton 2010, 43 & 46). After the Bronze Age the site was left unoccupied until the Iron Age and Hellenistic period, where the bulk of these later remains were discovered on Mound III, with some slight remains being found on Mound I, mainly a Hellenistic tomb (Bilgi 1984 & 1999; Welton 2010, 46).

As is obvious from what has been written just above, despite the name İkiztepe meaning 'twin mounds' in Turkish, the site actually consists of four mounds, two larger and two smaller (see Figure 15) (Eroğlu & Erdal 2006, 42; Kunç 1986, 99; Özdemir & Erdal 2010, 495; Özdemir & Erdal 2012, 283; Welton 2010, 42). The overall size of the settlement is estimated to be ca. 7 ha (Massa 2015, 372 - Figure 1.16). When assessing the population size of ancient settlements using persons per hectare there have been many differing published figures (for a summary see Table 1. in Zorn 1994, 34), if we take the average of the published numbers (361 persons per hectare) then a rough estimation of the population of İkiztepe would be 2527. However, this calculation does not take into account the density, or otherwise, of the settlement with regards to factors such as space within the settlement taken up by non-residential public buildings, storage buildings, courtyards and working spaces within households, the number of people per household, the number of households, or non-residential buildings such as workshops. Therefore the population is likely to have been lower (using a reduced density coefficient of 200 persons per hectare), more likely ca. 1400 people. Massa (2015, 41) uses an estimate of 300 people/ha to estimate population size meaning a total of 2100 inhabitants at the site. Due to the low density of İkiztepe (see discussion about architecture and layout below), a density coefficient of 200 or 300 people/ha is more likely meaning that the population was likely to have been between ca. 1400-2100 people. The settlement size (in ha) and the population size means that İkiztepe is above average for time period with a typical EBA Anatolian settlement being between 0.3 and 3 ha with a population of 100-1000 people (Massa 2015, 41).

It has been suggested that textile production played an important role at the site due to the large number of loom weights discovered in buildings at İkiztepe (Bilgi 1987, 174; Özdemir & Erdal 2012, 290; Welton 2010, 49). Large ovens are also witnessed from the EBA I, II, and III periods at the settlement, often in association with what have been termed workshops, and it has been hypothesised that in some cases these ovens may have been kilns for pottery or other specialised production (Bilgi 1999, 204; Bilgi 2000, 317-318; Bilgi 2005a, 30; Bilgi 2006, 117-118; Welton 2010, 49 & 78).

Pottery

Welton (2010, 49-81) provides an in depth analysis of the ceramic assemblage from İkiztepe, but it will not be dealt with quite so comprehensively here. It has been proposed that the pottery at İkiztepe is all locally made and that there are no imports, with the pottery in general being grey/black on the exterior and reddish on the interior due to firing techniques, although there are some examples where this colour pattern is reversed (Welton 2010, 50-51). Forms include simple and carinated bowls with inturned or simple rims and flat or ring bases and they often have knobs around the carination or the rim as well as in some cases knobs or tabs that extend upwards from the rim, and also double horizontally pierced lugs are sometimes present (Alkım *et al* 2003; Bilgi 1990; Welton 2010, 52). The bowls are often decorated with bands of white painted lines running obliquely and crossing each other (Bilgi 1990; Welton 2010, 52). Other forms include jars, small necked jars, shallow and deep bowls, goblets, simple straight sided mugs and pedestal bases (Alkım *et al* 2003; Welton 2010, 52-54).

The ceramic assemblage has also raised some contentious issues about the relative dating of the settlement (Schoop 2011b, 160; Welton 2010, 60). Studies by Thissen (1993), Parzinger (1993), and Schoop (2005) have reconsidered the ceramic assemblage from the first volume of excavation results published in 1988 (Alkım *et al* 1988) to discuss the chronology of Mound I and have all suggested that the material from the different excavation areas and different areas of the site have not been linked together correctly (Welton 2010, 60; Zimmermann 2007, 30).

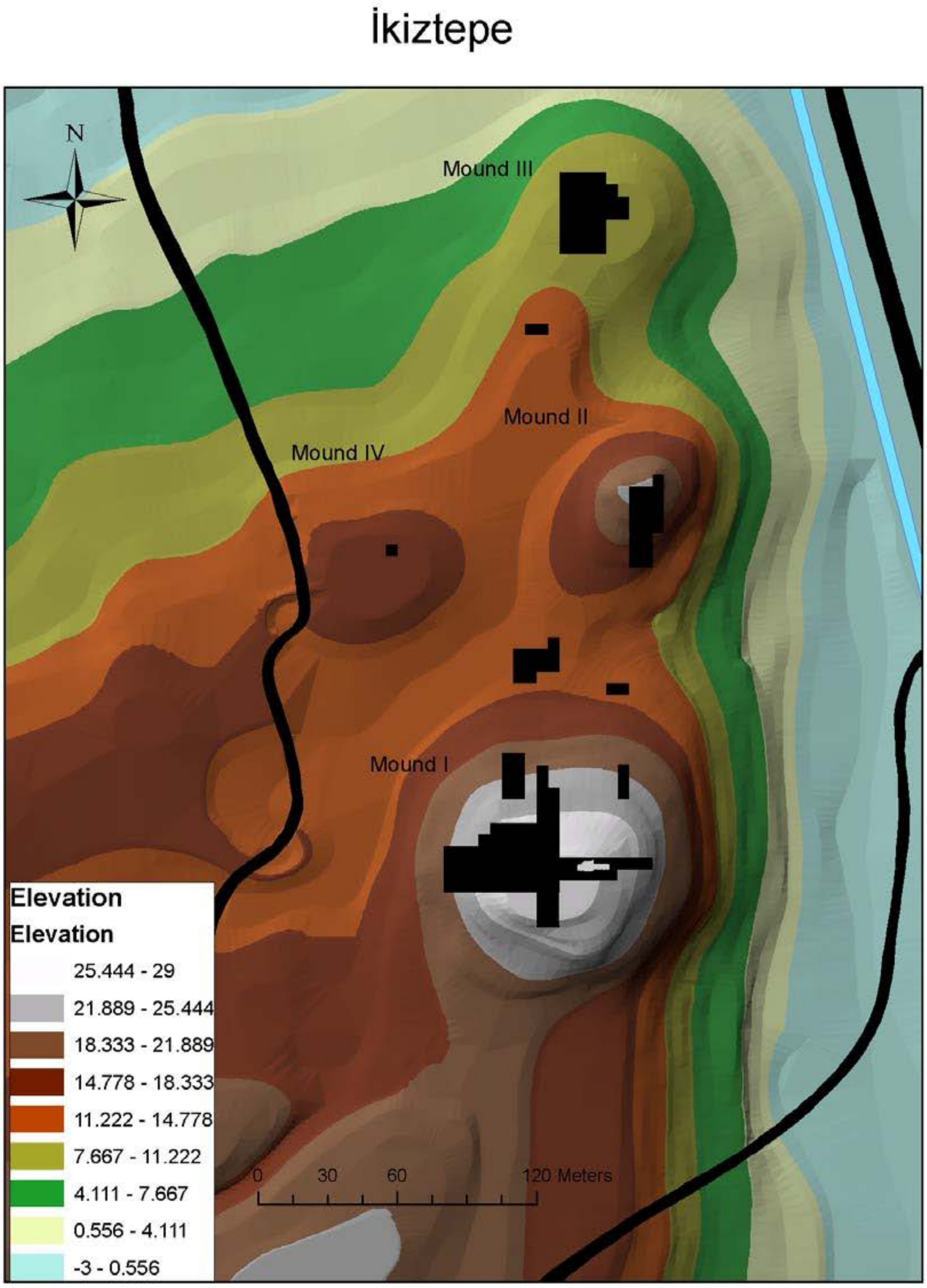


Figure 15: Topographical map of İkiztepe. Adapted from Welton 2010, 144

Thissen (1993, 222) has suggested that the sequence on Mound II should actually be shifted to an earlier time period, that the EBA I layers should instead be given a date in the range of Early-Middle Chalcolithic. Parzinger (1993) agreed with Thissen and he concluded that the sequence on Mound II should be given a pre-Bronze Age date (Welton 2010, 65; Zimmermann 2007, 30). The most complete reconsideration of the ceramic assemblage from Mound II was conducted by Schoop (2005), and he also places most of the ceramic assemblage from Mound II in the Chalcolithic period (Welton 2010, 65 & 67).

Absolute dating at İkiztepe

There have been radiocarbon dates published from İkiztepe but these have often been considered to be inconsistent and problematic due to calibration issues (for example it seems as if some of the published dates were simply 'calibrated' by converting BP to BC – i.e. subtracting 1950 years) and the source of the sample is often not known (i.e. whether they were short-lived or long-lived samples) (Welton 2010, 82). Due to the large presence of wooden architecture at the site it would suggest that the dates come from long-lived samples, yet the source of the timber and ring from which the sample was taken is not known (Welton 2010, 82). For a tabular compilation of all published radiocarbon dates from İkiztepe see Welton (2010, Table 2.2, 85-87). Radiocarbon dates from Mound I come from Levels I and II (Early Hittite and EBA respectively) (Welton 2010, 82-83). The majority of dates from Level I indicate an acceptable date in the early part of the 2nd millennium BC, but some of an unknown context source within Level I give dates ranging from the late 4th millennium to the mid-8th millennium BC which in some cases are older than any of the other dates from the site, and without further information about their context they cannot be reconciled into any sequence of Mound I, or indeed the entire site (Welton 2010, 82-83). The dates from Level II on Mound I suggest a range from the late 5th millennium BC to the late 4th millennium BC (Welton 2010, 83). Again, there are some dates from samples of unknown provenance which give much earlier dates of the mid-6th and early 5th millennium BC, but it may be possible that these samples came from a lower level, hence the earlier date (Welton 2010, 83). The dates for Level II are certainly much earlier than the previous dates proposed for this level which is usually dated to the EBA II (Welton 2010, 83). The radiocarbon dates for Level II on Mound I actually correspond well with the suggestions by Thissen (1993), Parzinger (1993), and Schoop (2005) for re-classifying this level as pre-Bronze Age after studying the ceramic assemblage from the level (Welton 2010, 84). There are also radiocarbon dates from Mound II taken from levels III and II (Late Chalcolithic and EBA I respectively) (Welton 2010, 84). The dates suggest a range of late 5th to early 4th millennium BC with some dates suggesting a range from late 4th millennium to early 3rd millennium BC (Welton 2010, 84). As with the radiocarbon results from Mound I, those from Mound II would suggest shifting the sequence to an earlier date, so the 'EBA I' levels (Level II) should actually be Late Chalcolithic and the Late Chalcolithic levels (Level III) should be considered to be Middle Chalcolithic (Welton 2010, 84). Due to the overlapping of the radiocarbon dates from Mound II it has been suggested that the occupation of this area was not as widely spaced out over time as previously thought and can be compressed into the period from Mid-Late Chalcolithic (Welton 2010, 84). As part of her doctoral research Welton (2010, 103) obtained radiocarbon dates from two samples from human skeletal remains (ITSK 643 and ITSK 602) from the external cemetery on Mound I. The two dates obtained suggest a date for the cemetery in the region of 3500-3000 cal. BC, i.e. the end of the Late Chalcolithic (See Table 1) (Welton 2010, 103-104).

Table 1: Radiocarbon dates for skeletal material from İkiztepe. Adapted from Welton 2010, 103

Skeleton No.	Years BP ± 1σ	Calibrated Results (cal. BC)
ITSK 602	4620 ± 61	3629-3585 (4.6%) **3531-3311 (74.1%)** 3295-3286 (0.5%) 3275-3265 (0.6%) 3239-3105 (15.5%)
ITSK 643	4457 ± 57	**3347-3007 (87.6%)** 2988-2931 (7.8%)

The radiocarbon dates obtained by Welton (2010, 103-104) are comparable with the suggestions following the discussions above about shifting the occupation sequence of İkiztepe to dates earlier than previously thought. Her dates would suggest that the cemetery on Mound I at İkiztepe should be considered to date to the Late Chalcolithic-EBA I transition period rather than the previously thought EBA II-III period (2400-2100 BC).

In Anatolia, following current terminology, the Late Chalcolithic is determined to have ended in 3000 BC with the beginning of the EBA (Schoop 2011, 30). The ARCANE (Associated Regional Chronologies for the Ancient Near East and the Eastern Mediterranean) Project aims to produce a reliable relative and absolute chronology of the Near East based on the synchronisation of regional chronologies for the third millennium BC (http://www.arcane.uni-tuebingen.de/presentation.html - last accessed 04/03/2016). Their new periodisation table (see Figure 16) quantifies what has previously been determined as 'EBA I' in Anatolia as "Early Anatolia I", covering both West and Central Anatolia as determined by the regional distribution map arranged by the ARCANE project (see Figure 17) (http://www.arcane.uni-tuebingen.de/EA-EM-EL_phasing_v5-4-6.pdf - last accessed 04/03/2016). This period begins in ca. 3100 BC and lasts until 2800 BC in Central Anatolia and a little after in Western Anatolia. The periodisation of the third millennium BC in Anatolia by the ARCANE Project approximately resembles the more commonly used EBA I-III periods but takes into account regional differences within Anatolia, with the Early Anatolian II period being longer in duration in Central Anatolia than Western Anatolia resulting in a longer Early Anatolia III in Western Anatolia than Central Anatolia as well as further splitting this period into a, b, and c (with 'c' only being present in Central Anatolia). The ARCANE Project also includes a 'transitional' period at the end of the third millennium BC which they call Early Anatolia IV. The radiocarbon dates from Welton (2010, 103) would therefore indicate that the İkiztepe cemetery should be considered to be pre-Early Anatolian I according to the ARCANE Project periodisation. For a discussion on EBA chronology and terminology see Chapter 1.2.

Metallurgy

A large number of metal artefacts were excavated from İkiztepe, primarily made of arsenical copper (with arsenic being a deliberate addition) and not bronze as is seen in the rest of Anatolia during the EBA period (Kunç 1986, 100; Özdemir & Erdal 2010, 496; Özdemir & Erdal 2012, 290; Welton 2010, 57). This has been another reason put forward to argue for a pre-EBA date for İkiztepe, that the nature of the metal objects in being made of arsenical copper is archaic for the EBA period in Anatolia (Zimmermann 2007, 30). And furthermore, some of the metal objects themselves have been used to argue for a pre-EBA date. The presence of Balkan style 'ring-idols' would suggest a temporal context of the mid-late fourth millennium BC (Zimmermann 2007, 30). It has been argued, despite the extremely sparse evidence for it (no concentrations of slags, and one single crucible found), that the metal artefacts were produced on-site and that the copper came from the Bakırçay (near Merzifon) and the arsenic came from the Pırasakaya ores on Bakacak Tepe in the Peynirçay Vadisi (Bilgi 2001, 35; Özdemir & Erdal 2010, 496; Özdemir & Erdal 2012, 290; Welton 2010, 57 & 78).

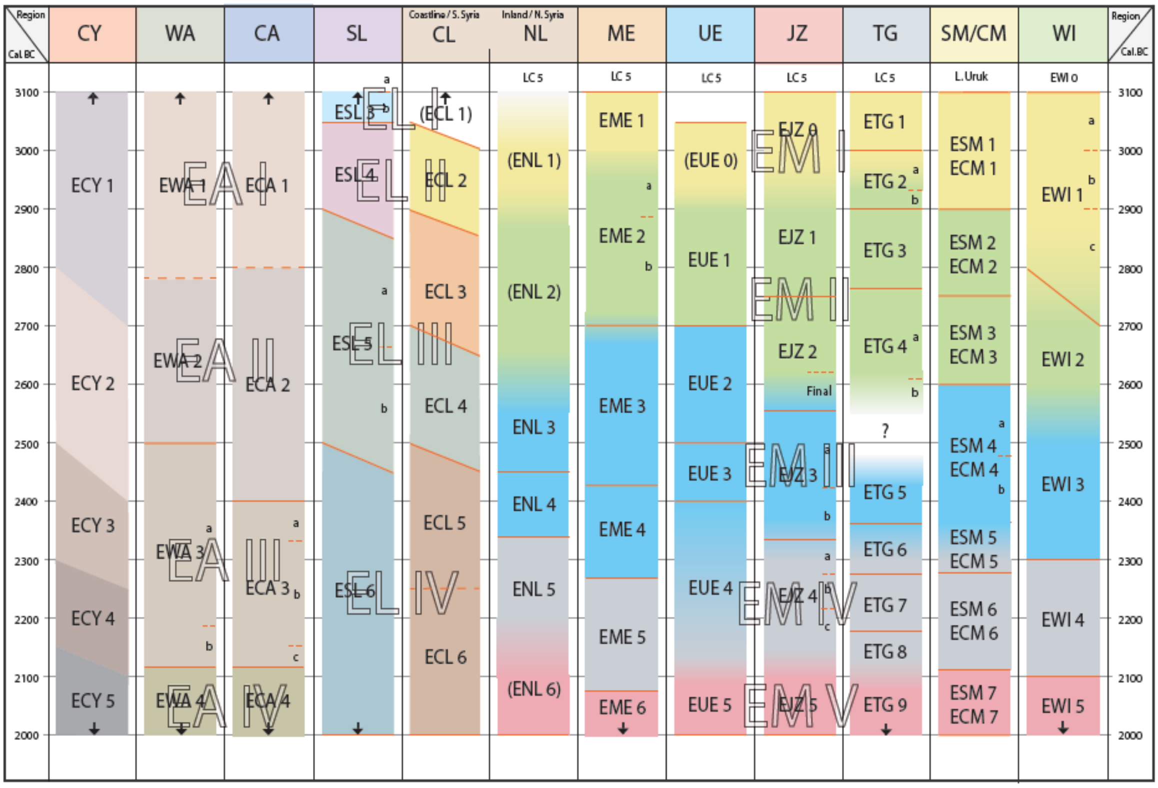


Figure 16: ARCANE Project periodisation table of third millennium BC regional chronologies of the Near East. Adapted from http://www.arcane.uni-tuebingen.de/EA-EM-EL_phasing_v5-4-6.pdf - last accessed 04/03/2016. Note: EA = Early Anatolian, EL = Early Levantine, EM = Early Mesopotamian, E = Early, CY = Cyprus, WA = Western Anatolia, CA = Central Anatolia, SL = Southern Levant, CL = Central Levant, NL = Northern Levant, ME = Middle Euphrates, UE = Upper Euphrates, JZ = Jezirah, TG = Tigridian Region, SM = Southern Mesopotamia, CM = Central Mesopotamia, WI = Western Iran.

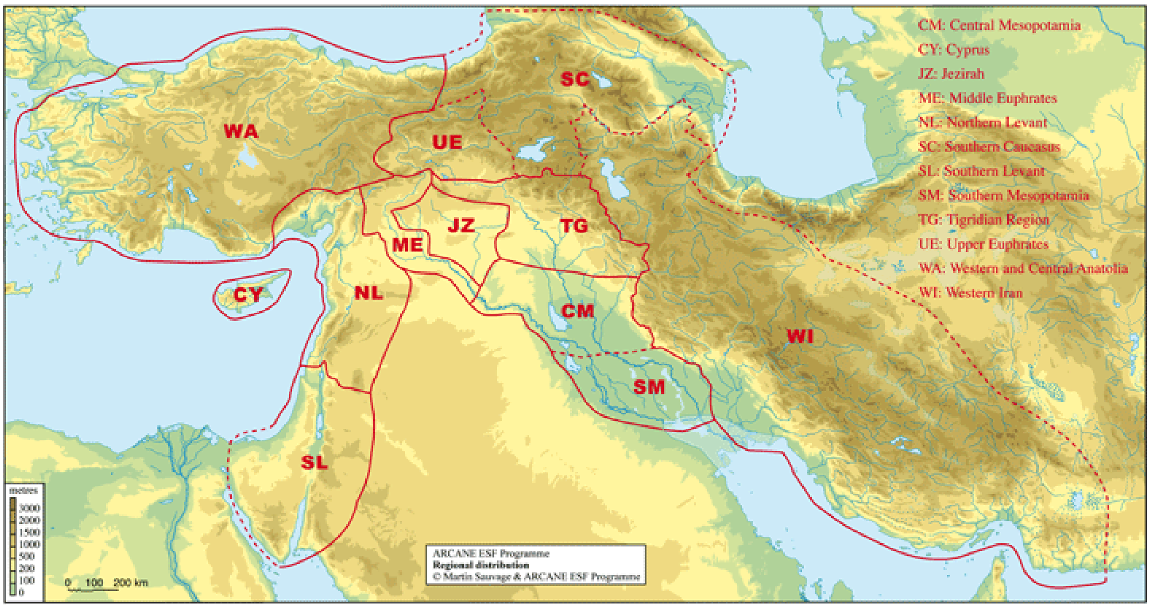


Figure 17: Regional distribution map of the ARCANE Project, 2011. Adapted from http://www.arcane.uni-tuebingen.de/arcanemap.html - last accessed 04/03/2016

There has been much debate about the metal artefacts and metallurgy at İkiztepe. The majority of the metal assemblage finds no parallels outside of the Central Black Sea region and this has been suggested to be evidence for a local metal industry at İkiztepe as proposed by Bilgi (2001), whilst others (notably Yakar, 1985) have argued that it is this lack of parallels combined with the fact the metals are of arsenical copper rather than tin bonze that suggests the metal artefacts came from outside and were introduced to the area and settlement (Welton 2010, 99-100). It seems to be generally accepted today that due to the lack of evidence for the large scale metal production required to produce the volume of metal artefacts found at İkiztepe that the metal artefacts were in fact imported (Özdemir & Erdal 2010, 502), although these imported artefacts may have been produced locally within the Black Sea region (Özdemir & Erdal 2012, 290; Welton 2010, 100).

<u>Burial patterns</u>

The main cemetery for İkiztepe (and where all of the sampled skeletal material for this study comes from) is located on Mound I and has produced ca. 766 individuals (see Figure 18) (Doğan 2006, 37; Özdemir & Erdal 2012, 283; Welton 2010, 106 & 215).

As discussed above about the chronological problems and radiocarbon results from the site, the date for the cemetery on Mound I is not quite as clear as originally thought and put forward by Bilgi and generally accepted until the work of Thissen and Parzinger in 1993, Schoop in 2005, and Welton in 2010. The main part of the cemetery was originally dated, and is still officially classified, as being of the late third millennium BC (EBA III) (Zimmermann 2007, 29). However, the occupation phases of Mound I should be considered earlier than previously thought (dating to the Early-Late Chalcolithic). Therefore, the cemetery which overlies the settlement phase does not necessarily date to the EBA III; instead, because of stratigraphical and relative dating relationships, it can only be said with certainty that the cemetery post-dates these earlier Early-Late Chalcolithic periods and is from some point in the 3rd millennium BC (Welton 2010, 88). Moreover, following the radiocarbon dates obtained by Welton (2010), the cemetery should actually be considered to have a Late Chalcolithic-EBA I date rather than the previously thought date of EBA II-III. The cemetery shows several levels of burial activity which suggests that it was in use for several generations (Welton 2010, 106). Fluoride dating of individuals from the cemetery suggests that there were two main phases of use; an earlier moderate phase of use followed by a later more intensive use (Welton 2010, 524). It seems that the earliest part of the cemetery to be used was the central southern part and that later burials filled in the spaces between the earliest burials and then gradually spread northwards (Welton 2010, 526). Furthermore, the results of the fluoride dating for the skeletons that make up the earliest use of the cemetery pre-date the earliest radiocarbon date from the skeletal remains, in effect meaning that this earliest phase of use is pre-3500 cal. BC (Welton 2010, 529). The graves are practically all simple earthen burials with the individual placed in a supine position; on its back with legs extended and the arms beside the body (Bilgi 2005b, 15; Özdemir & Erdal 2010, 495-496; Welton 2010, 106 & 109). In terms of a direction of burial there appears to be no pattern in their orientation other than the burials were placed so as to lie parallel to the ancient slope of the mound (Welton 2010, 109-110). Some of the graves were also determined to have wooden planks placed under and covering the bodies (Doğan 2006, 116; Welton 2010, 114). This burial phenomenon may have been more common than the evidence from excavation indicates as the low number (20) of burials with this feature may be the result of preservation conditions or excavation techniques (Doğan 2006, 116; Welton 2010, 114-115).

İkiztepe, Mound I

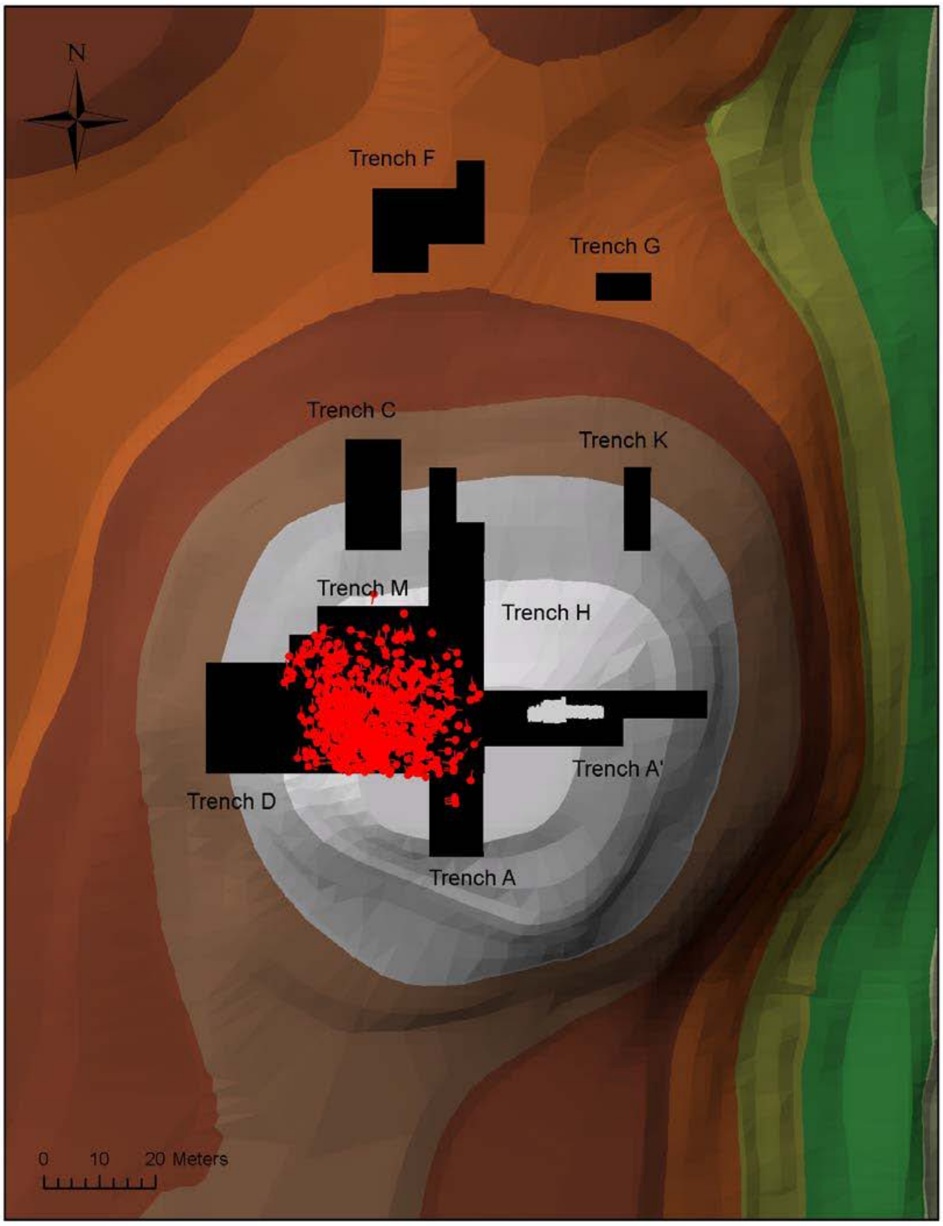


Figure 18: Topographical map of Mound I at İkiztepe showing the cemetery (Note: red dots are individuals). Adapted from Welton 2010, 145

In 11 cases there was evidence of red colouring on the skeletal remains which can tentatively be hypothesised as treatment of deceased individuals with red ochre, or it may simply be staining from the brunt red earth in which the burials were dug (Bilgi 1990, 165; Welton

2010, 115). Mound burials dating to 4000 BC in the eastern, south central, and coastal parts of Bulgaria as well as from Late Chalcolithic (4500-4000 BC) Varna and Durankulak in Bulgaria also have individuals treated with red ochre (Bailey 2000, 223; Clifford 2012, 182; Price 1997, 74 & 120-121 & 192). The vast majority of graves are single inhumations, but some multiple inhumations were also discovered (Doğan 2006, 39; Welton 2010, 114). However, it has been suggested by Welton (2010, 114), that the number of multiple inhumations has been overestimated and many of the multiple inhumations are the result of older graves being cut into by newer inhumations and scattering during excavation. The burial practices seen at İkiztepe do not fit in with any other so-far known Anatolian Chalcolithic or EBA burial practices (Bilgi 2005b, 18; Welton 2010, 132). Chalcolithic burials tend to be intramural - both in terms of within the boundary of a settlement as well as within houses, beneath floors etc. - (Massa 2014, 88), whilst the burials at İkiztepe are in a large extramural cemetery. However, it may be worth considering that the Chalcolithic extramural cemeteries have just not been found as adult remains are often conspicuous in their absence at Chalcolithic period sites (Welton 2010, 133). The majority of intramural Chalcolithic burials that have so far been discovered in Anatolia tend to be of young sub-adults (Massa 2014, 88; Schoop 2015, 58-59); one exception being the Chalcolithic (early fourth millennium BC) cemetery at Ilıpınar that was most likely extramural (Roodenberg 2008, 316 & 320). Extramural cemeteries are in general much more common/usual in the EBA periods in Anatolia (Sagona & Zimansky 2009, 213; Welton 2010, 133). However, unlike the EBA cemeteries where a predominance of *pithos* graves and a mix of cist, *pithos*, and pit graves are witnessed, all of the graves at İkiztepe are pit burials (Welton 2010, 133). Furthermore in the cases of pit burials from the Chalcolithic and EBA periods the individuals in pit burials are inhumed in a contracted/Hocker position (such as at Ilıpınar – Roodenberg 2008, 317), whereas those at İkiztepe are supine in position (Welton 2010, 133). Interestingly the cemetery and burial practices seen at İkiztepe finds a most similar correlation with the burial practices witnessed in Balkan coastal sites, such as the Late Chalcolithic cemeteries at Varna and Durankulak in Bulgaria and Cernovoda in Romania (Welton 2010, 135-137 & 141-142). However, a more local burial tradition may have been in place as witnessed in similar burial practices at the sites of Tekeköy, Dündartepe, and Kavak in the Black Sea region (Bilgi 2005b, 18; Welton 2010, 207). There are also some supine pit graves observed in the Chalcolithic graves of the cemetery at Kalınkaya near Alaca Höyük (Zimmermann 2007, 28-29).

Grave goods

From the graves of the cemetery on Mound I a great number of metal artefacts were recovered, including jewellery, tools, and weapons such as daggers, spearheads, and arrowheads (Bilgi 2005b, 16; Özdemir & Erdal 2010, 496; Welton 2010, 56-57). Many of the graves can be considered rich in grave goods, and apart from the metal objects items in the grave good assemblage also include ceramic vessels and statuettes, and objects made of bone and stone (Bilgi 2005b, 16). Bilgi (2005b) identified 46 graves as being 'distinguished' due to the richness of the graves. These graves belonged to 36 males, 5 females, 3 children, and 2 infants (Bilgi 2005b, 16). A total of 304 objects were found across these 'distinguished' burials and consisted of 275 metal items (250 of arsenical copper, 16 of lead, 6 of silver, and 3 of gold), as well as items of baked clay, stone, frit or shell (Bilgi 2005b, 16). The metal objects from these 'distinguished' burials were divided by classification into weapons (n=74), tools (n=81), jewellery (n=90), symbols (n=19), spiral wires (n=9), a set of decorative plaques and one vessel (Bilgi 2005b, 16). Bilgi (2005b, 17) has argued that these 'distinguished' burials belong to the ruling elite/leaders of the settlement and their families. Rich infant graves are often seen to be indicative of inherited wealth since young sub-adults would not be able to accumulate wealth or status through their own actions in their lifetime (Conneller 2013, 348). Indeed it has been observed in cultural anthropological studies that a child from the "richest decile is about 16 times more likely to remain there than a child from the poorest decile" in pastoral and agricultural societies and that wealth transmission from parent to offspring is markedly higher for material wealth as opposed to embodied and relational wealth (Smith *et al* 2010; 85 & 88). Following Backofen's research (1987) it was determined that the overwhelming majority of graves contained at least one grave good and male burials tended to be richer than those of females and sub-adults. Welton's research (2010, 209) determined this to be true and significant for adult males, with male burials having the highest average number of grave goods. An age-correlation with grave goods was also determined, with the number of grave goods argued to increase with increasing age (Backofen 1987, 178; Welton 2010, 111). Infants show the lowest average number of grave goods and also the most number of individuals with no grave goods at all (Welton 2010, 209). Doğan's (2006) doctoral research into the İkiztepe cemetery and burial practices found the same patterns as Backofen had regarding male burials being richer and there being a correlation between number of grave goods and age (Welton 2010, 112). However, Doğan also revealed a different pattern, with the burials of young children (1-6 years old) containing more grave goods than adults, except for old adults (50+ years) (Doğan 2006, 237). This pattern is also observed in the number of metal grave goods in burials, with older adults (50+ years) demonstrating the highest average occurrence of these objects followed by younger children (1-6 years) (Doğan 2006, 244). Welton (2010), using a larger sample size than Doğan (2006) revealed slightly different patterns regarding age and burial goods. She discovered that children had a higher average number of grave goods than adult females (Welton 2010, 209). And, furthermore, that younger children had a higher average number of grave goods than older children and additionally that younger children have a higher average number of grave goods than both adolescents and young adults (Welton 2010, 209). Welton (2010, 209) also demonstrated that the average number of grave goods increases from adolescence through to middle adult, followed by a slight decrease in old adults. Sex differentiation is observed with regards to the types of grave goods. Males are more commonly buried with metal weaponry and tools and idols and ornamental spirals, and amulets only occur with males (Backofen 1987, 177; Doğan 2006, 255 & 313-315 & 318). Females are more commonly buried with pottery and jewellery, but some of their burials also contain weapons and tools (Backofen 1987, 177; Doğan 2006, 255; Welton 2010, 111). Whilst the presence of women with weapons and tools may be related to a misidentification of the sex of the skeletal remains, it is more likely that there is another, cultural and/or societal reason for this phenomenon. It should be remembered that sex (biologically determined) and gender (often culturally/socially determined) are two different things. The presence of weaponry and tools with females determined by sex may reflect their gender role, or assignment within the society rather than their biological one. For example it has been argued, although still not definitively proven, that women may also have held roles as warriors in medieval Viking society (see Gardela 2013). There is also the problem that we do not conclusively know if the objects in the grave belong to the deceased (i.e. were owned and used by them in life) or to those who performed the funerary act, and even if the objects reflect the status of the deceased (or those burying them), or indeed whether the objects had another symbolic meaning (Gardela 2013, 297, Williams 2006, 29). Jewellery was most commonly found in the burials of sub-adults (Doğan 2006, 255). Doğan (2006, 243) discovered that males are more commonly buried with metal objects than females (251 objects for males, 145 for females). The presence of weapons increases with age for males, with a significant jump seen between young adult males (12-20 years old) and middle adult males (20-50 years old), when the number of metal weapons as part of their associated grave good assemblage more than triples (Welton 2010, 210). The average number of tools as grave goods was found to increase continually with age, with tools being more frequent in the graves of middle and old adults (Welton 2010, 210). There is also a pattern regarding grave goods when seen in correlation with the relative temporal use of the cemetery. The earliest graves show a moderate number of grave goods, and then the later more intensively used period of the cemetery can be split into two sub-periods; a middle one where the number and presence of grave goods increases dramatically before tailing off at the end of the cemetery's use when the average number of grave goods decreases and more individuals without grave goods are witnessed (Welton 2010, 527 & 537). This, therefore, means that differences in grave goods/grave good assemblages could be related to chronological patterns rather than age and/or sex. However, some of the correlations between age and/or sex are significant enough (particularly regarding males and younger children and old adults) to override merely a chronological factor effecting these correlations. These differences in age groups and sexes are also seen with regards to the layout of the cemetery. The idea that males were buried closer to the centre of the cemetery, with females and sub-adults more commonly found on its periphery, was first put forward by Doğan (2006, 28-29). This hypothesis was tested by Welton (2010, 149-152 & 208) who showed this hypothesis to be true and that distance to the centre decreased with an increase in age, but only infants were shown to be statistically significantly more likely to be buried on the periphery of the cemetery than any other group. In addition to these patterns in the cemetery Welton (2010) also examined whether there was evidence of kin-based burial practices using phenotype analysis. She determined that there was no evidence to suggest that the population of İkiztepe practiced kin-based burial and that the cemetery is likely to have been organised around other principles and criteria (Welton 2010, 281). Welton (2010) also conducted stable isotope analyses of strontium (Sr) and oxygen (O) to examine population mobility at İkiztepe. The results of the stable isotopic analysis of Sr revealed that 12.5% of the sampled population (9 out of 72) were non-locals, with two of them being long-distance migrants (Welton 2010, 436 & 443). For these non-local individuals no patterns with regards to burial practices, grave goods, sex or age could be established, and the same lack of patterns was also seen with the results from the oxygen stable isotope analysis (Welton 2010, 441-443 & 456). Additionally, the individuals of the sample population which were deemed to be local had a very narrow range in O and Sr isotopic values which suggests that they were very sedentary with limited mobility (Welton 2010, 462). The results of Welton's stable isotopic analyses (of Sr and O) impacted on some of the sample selection criteria as discussed in Chapter 4.1.1 and 4.2.2, and her results will be discussed in greater detail in relation to the results of this study in Chapter 5.2.1.

Traumatic injuries

There is a relatively high incidence of cranial traumatic injuries at İkiztepe; 16-18% of the overall population, 25-29% for adults and the incidence is significantly higher among males than females (32-43% to 10-12% respectively) (Erdal 2005, 107; Özdemir & Erdal 2010, 502; Welton 2010, 226). Both peri- and ante-mortem (i.e. healed) cranial traumatic injuries have been found in the population (Erdal 2005, 107). It has been suggested that these cranial traumatic injuries in the İkiztepe population are indicative of organised inter-personal conflict (Erdal 2005, 107; Özdemir & Erdal 2012, 290; Welton 2010, 226). Cases of trephination have also been identified at İkiztepe, 5 cases were described by Erdal (2005), but Doğan (2006, 103) observed two extra ones and a total of 7 cases.

Economy

Subsistence in the region around İkiztepe, it has been argued, is likely to have consisted of fishing, animal husbandry and small-scale, non-intensive arable agricultural cultivation (Welton 2010, 35). It has also been argued that due to its location that the inhabitants of İkiztepe would have had access to a rich and diverse variety of food resources (Özdemir & Erdal 2012, 290-291). Trace element analysis conducted on some of the human and animal remains from İkiztepe revealed that the inhabitants consumed a relatively balanced diet of plants and animals but that meat would have contributed a large part of the diet of the inhabitants (Özdemir & Erdal 2012, 288-289). Archaeobotanical research has suggested that the main crop cultivated at İkiztepe in the 'EBA' period was *Triticum dicoccum* (Emmer wheat) with *Triticum monococcum* (Einkorn) and *Hordeum vulgare* (barley) being minor crops (Ioannidou 2011, 257; Özdemir & Erdal 2012, 291). In terms of pulses the most common find was that of *Vicia ervilia* (bitter vetch) followed by *Lens culinaris* (lentil) with small amounts of *Lathyrus sativus* (grass pea) and *Pisum sativum* (pea) also being found (Ioannidou 2011, 257). *Linum usitatissimum* (flax) was also reported from İkiztepe, but in small amounts (Ioannidou 2011, 257). The presence of weed species that grow in wet areas, found together with the crops, has been used as evidence to suggest that the location of at least some of the fields were close to marshy areas or perhaps on the banks of the Kızılırmak River (Ioannidou 2011, 257). One interesting patterns regarding the crops are the use of hulled wheats at İkiztepe. This contrasts with the rest of Anatolia where naked wheats were cultivated from the Neolithic period and in-fact hulled wheats disappear from the record from

3000 BC onwards, particularly in southeast Turkey (Ioannidou 2011, 257). However, hulled wheats are still preferred to be cultivated, to an extent, by modern Black Sea farmers as they are more resistant to fungal diseases that accompany the warm and wet summers common for the region and this may also have been the case at prehistoric İkiztepe (Ioannidou 2011, 257). There is a complete lack of chaff from the crop remains at İkiztepe which indicates that the cereal crops were processed elsewhere up to the stage of cleaned/semi-cleaned crops of either seeds or seeds enclosed in the glumes (Ioannidou 2011, 258). The crops were then stored like this and the final stage of removing the husks would most likely have been carried out on a daily basis (Ioannidou 2011, 258). The reason for storing the cereals like this was most likely to protect the grain from the wet and fungi attack, or possibly to save time during the harvest period (Ioannidou 2011, 258). Fruits and nuts were also discovered through the archaeobotanical analyses and include *Ficus carica* (fig – probably wild rather than domesticated), *Vitis vinifera* (wild grape), *Quercus* sp. (oak), *Corylus* sp. (hazel), *Cotoneaster* sp. (cotoneaster), *Crataegus pentagyna* and *monogyna* (hawthorn), *Berberis* sp. (barberry), *Sambucus nigra* (elder), *Rubus* sp. (bramble), and *Physalis alkekengi* (Chinese lantern) (Ioannidou 2011, 257). The proximity of İkiztepe to the Black Sea coast as well as being on the banks of the Kızılırmak River has been one of the main arguments to suggest that marine and freshwater resources would have played a key role in the dietary habits of the population, combined with the results of soil sieving at the site which produced some fish remains (Alkım *et al* 2003, 175-177; Özdemir & Erdal 2012, 290; Welton 2010, 434). Studies on the faunal remains have revealed the exploitation of both wild and domesticated species, including red deer, fallow deer, roe deer, fish, birds, cattle, sheep, goat, wild boar and domesticated pig (Özdemir & Erdal 2012, 290). It has also been hypothesised that subsistence patterns at İkiztepe were seasonal and that pastoralism was practiced (Welton 2010, 35). Welton (2010, 447-448) found some variability in her results from the Sr stable isotope analysis (see Figure 6.33 in Welton 2010, 447) which may be indicative of 'mobile' people and seasonal transhumance practices and the movement of some of the population for the purpose of pasturing animals. This aspect about pastoralism and the movement of animals will be further discussed in Chapter 5.2.1, and Chapter 6. However, in the later periods of İkiztepe, what was originally classed as the EBA III period, pig appears to have played a key role with 42% of the faunal assemblage being of pig remains whilst *ovis capra* and cattle comprise 28% and 29% of the assemblage respectively (Ioannidou 2011, 259; Özdemir & Erdal 2012, 290).

2.3 Titriş Höyük

Titriş Höyük is located within the Karababa basin on a tributary of the Euphrates River (Allentuck & Greenfield 2010, 13). It is located 45 km north of the modern city of Şanlıurfa (also known as Urfa) in the south east of Turkey (see Figures 19 and 20) (Allentuck & Greenfield 2010, 13; Erdal 2012, 2; Hald 2010, 70; Laneri 2007, 244; Matney & Algaze 1995, 33). The site and its immediate locale was surveyed (in 1991 and 1992) and then excavated over the course of eight season between 1991 and 1999 by a team led by Guillermo Algaze (University of California – San Diego) and Timothy Matney (University of Akron) with the aim of exposing large areas from different spatial contexts and in particular the non-elite domestic and production elements of an early urban settlement (Algaze & Pournelle 2003, 108; Allentuck & Greenfield 2010, 13; Erdal 2012, 2; Hald 2010, 70; Hartenberger *et al* 2000, 51; Laneri 2007, 244; Matney *et al* 2012, 339). The actual höyük at the centre of the centre of the settlement which contained the remains of the elite and administrative buildings was not excavated (Allentuck & Greenfield 2010, 13).

Figure 19: Map showing regional location of Titriş Höyük. Adapted from Google Earth

Figure 20: Titriş Höyük as seen from above in the present day with the Tavuk Çay visible to its immediate south. Adapted from Google Earth

Palaeobotanical and geomorphological analysis indicates that during the mid-late EBA the area around Titriş Höyük would have been significantly more forested than at present and that the settlement would have been surrounded by streams on three sides with an actively aggrading floodplain (Algaze & Pournelle 2003, 116; Trella 2010, 227). The environment during the mid-late EBA would have been a lot moister and more heavily vegetated than at present and the valley bottoms would have contained fertile moist soils providing high yields for cereal or horticultural products as a result of the actively aggrading floodplains (Algaze & Pournelle 2003, 117; Matney & Algaze 1995, 47). In the later periods of occupation (during the EBA III) evidence indicates strong flooding and an incisive fluvial regime that were most likely the result of human factors such as the stripping of vegetation for agriculture, grazing, fuel, or construction, and/or environmental factors such as a more erratic rainfall pattern which resulted in periods of drought punctuated by heavy storms (Algaze & Pournelle 2003, 117; Matney & Algaze 1995, 47; Trella 2010, 216 & 227). A hastily constructed wall in the late EBA at the foot of the slope of the northern edge of the Outer Town suggests that periodic flooding may have been a problem for the inhabitants of the Outer Town during its final urban phase (Algaze & Pournelle 2003, 117; Trella 2010, 227). As mentioned above human factors were the most probable reason/main factor in the degradation of the environment around the settlement (Matney & Algaze 1995, 47). One of these activities with a significant environmental impact would have been the large scale quarrying of limestone for building material ca. 1km from the settlement that would have caused accelerated erosion resulting in silting of the stream downslope of the quarry (the Titriş Çay) affecting, altering, and making its flow less manageable (Algaze & Pournelle 2003, 120). Another human factor that would have significantly affected the local environment in a negative manner would have been large scale deforestation for building materials and fuel, as well as clearance for agricultural and grazing purposes (Algaze & Pournelle 2003, 120-123; Trella 2010, 216-217). This local intensification of local resource extraction and grazing would have stripped soil holding protective cover resulting in rain wash down slope and erosion and flooding (Algaze & Pournelle 2003, 124-125; Trella 2010, 217). As a result the selective advantages of the settlement (year-round water sources, multiple cultivable plains, local timber and stone sources, and local wild staples) would have diminished over time and resulted in deteriorating agronomic productivity (Algaze & Pournelle 2003, 125).

The earliest documented occupation of the settlement was during the early EBA (ca. 3000-2700 BC), but it would likely have been a very small village-sized settlement (Algaze & Pournelle 2003, 109; Laneri 2007, 245; Laneri 2013, 45; Matney & Algaze 1995, 46). The settlement in general was inhabited only for a relatively short period, and peaked in size (to 43 ha) during the middle period of the EBA (ca. 2700-2300 BC), first growing into the Lower Town and then expanding into the Outer Town, as well as up to nine 'suburb' areas (Algaze & Pournelle 2003, 107; Allentuck & Greenfield 2010, 13; Erdal 2012, 2; Hald 2010, 70; Laneri 2007, 246; Laneri 2013, 45; Matney & Algaze 1995, 33, 35 & 46; Matney *et al* 2012, 338; Wilkinson 1990, 99 – survey publication). The population of Titriş Höyük can be very approximately estimated using the total site area. When we attempt to estimate the size of ancient settlements using persons per hectare there are varying published figures (for a summary see Table 1. in Zorn 1994, 34). If we take the average of the published numbers (361 persons per hectare) then a rough estimation of the population of Titriş Höyük at its peak would be 15523. Massa (2015, 41) uses an estimate of 300 people/ha in his thesis to estimate population size meaning a total of 12900 inhabitants at the settlement. However, these calculations do not take into account the density, or otherwise, of the settlement with regards to factors such as space within the settlement taken up by monumental buildings (most probably with a low population density), non-residential public buildings, storage buildings, barracks (where the number of persons per m^2 is likely to have been greater), courtyards and working spaces within households, the number of people per household, the number of households, or non-residential buildings such as workshops. Therefore the population is likely to have been lower (using a reduced density coefficient of 200 persons per hectare), more likely ca. 8000-10000 people. The settlement size (in ha) and the population size means that Titriş Höyük is well above average for time period with a typical EBA Anatolian settlement being between 0.3 and 3 ha with a population of 100-1000 people (Massa 2015, 41). Titriş Höyük can actually be considered to be one of the largest settlements of the EBA. Matney and Algaze (1995, 48) estimate the population of the site in the middle EBA to have been ca. 5000-10000 people which fits relatively well with the density coefficient calculation. In the late EBA the settlement contracted to 35 ha with a high population density in the main city (meaning the population figure would not have altered or reduced significantly) after the abandonment of the suburbs and the construction of a large (3-3.5 m thick) mud-brick fortification wall upon a stone foundation with a moat system (Algaze & Pournelle 2003, 112 & 115; Erdal 2012, 2; Hartenberger *et al* 2000, 52; Laneri 2007, 247; Laneri 2013, 46; Matney & Algaze 1995, 43; Matney *et al* 2012, 338). During the late EBA – MBA transition period occupation was restricted to the high mound/Höyük part of the settlement (Algaze & Pournelle 2003, 115) after the city collapsed and the majority of its population dispersed into the surrounding countryside (Erdal 2012, 2; Matney & Algaze 1995, 47; Matney *et al* 2012, 339). Titriş Höyük was most likely an urban centre and regional capital (Algaze & Pournelle 2003, 107; Allentuck & Greenfield 2010, 13; Laneri 2007, 244; Matney & Algaze 1995, 33 & 50; Trella 2010, 149). However, its territorial breadth was likely to have been restricted to the Karababa basin and it is more likely to have been a local, indigenous centre like other urban centres in north-western Syria (Allentuck & Greenfield 2010, 27; Laneri 2007, 244; Matney & Algaze 1995, 50). Its greatest period of economic power and territorial expansion was during the middle-late EBA (Laneri 2007, 247; Laneri 2013, 45). Titriş is located in a strategically important position for controlling the long distance commercial routes and networks that extended between Urfa and Harran to the south and east of the settlement (probably following the Euphrates) and those from/to Lidar and Samsat to the north and west (Algaze & Pournelle 2003, 107 & 124; Hald 2010, 70; Laneri 2007, 245; Laneri 2013, 45; Matney & Algaze 1995, 50; Matney *et al* 2012, 338). It is located on the Tavuk Çay (a tributary of the Euphrates which survey and geomorphological research has suggested that during the EBA this would have been wider than presently and directly connected to the Euphrates) and would have been able to control the natural ways of communication along this water way which was an ideal conduit for the movement of commercial goods to and from the centre (Algaze & Pournelle 2003, 107; Allentuck & Greenfield 2010, 13; Laneri 2007, 244-245; Matney & Algaze 1995, 33). This was complemented by a network of roads that led to Titriş and facilitated overland trade (Allentuck & Greenfield, 2010, 13). There are many different ways of identifying routes; in the Khabur basin (south/south east of Titriş Höyük) 6000 km of dirty roads ('hollow ways') were discovered using analysis of satellite images (Massa 2015, 60; Menze & Ur 2012, 785; Ur 2003, 102-103; see also Wilkinson 1993). Long distance trade (most likely initiated in the mid-third millennium) is witnessed by the presence at Titriş Höyük of many imports including *depas amphikypellon* (from the Aegean/western Anatolia regions), Syrian bottles, Karaz Ware, 1-*mana* stone weight inscribed in old Akkadian, four-lugged jars, and 'violin-shaped' human figurines made of marble stone (Abay 2007, 407; Laneri 2007, 253; Matney & Algaze 1995, 47-48). These finds indicate trade networks connecting Titriş Höyük with west Anatolia, the Aegean and Cycladic regions, central Anatolia, and Mesopotamia.

The site is composed of a central Höyük of 3 ha in area on a raised acropolis 22 m in height and a large lower city (35 ha) which is divided into a Lower and Outer Town (see Figure 21) (Algaze & Pournelle 2003, 107; Allentuck & Greenfield 2010, 13; Matney & Algaze 1995, 35). It has been suggested, as well as debated, that the Lower Town was probably of higher status than the Outer Town as it contained more massive architecture, had wider streets, was closer to the central höyük, and was unaffected by an occupational hiatus between the middle and late EBA (Algaze *et al* 1995, 38; Allentuck & Greenfield 2010, 13 & 23). However, some have argued and incorporating the evidence from the analysis of animal product distribution suggests that there is no, or a negligible, difference between the two neighbourhoods (Allentuck & Greenfield 2010, 27).

It is likely that some of the extramural settlement areas during the middle EBA were devoted to specialised craft and work activities, for example a flint workshop specialising in the mass production of Canaanean blades was discovered approximately 400 m east of the limits of the Outer Town (Algaze & Pournelle 2003, 111; Hartenberger *et al* 2000, 52; Laneri 2007, 246; Laneri 2013, 45; Matney & Algaze 1995, 46).

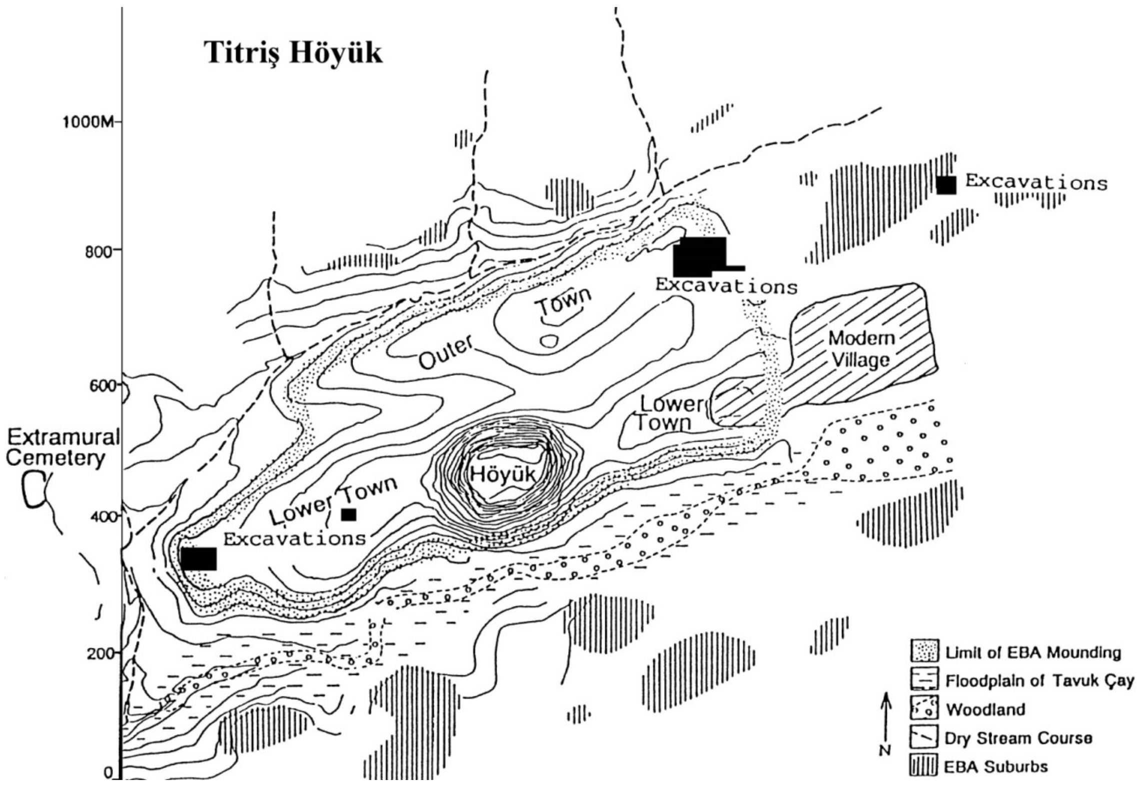


Figure 21: Map of Titriş Höyük showing town zones and excavated areas. Adapted from Laneri 2007, 246

During the late EBA it is clear that the settlement was planned by a centralised authority with precise urban regularity; wide streets and alleyways, dwellings built upon terraces, and a standardised size and architectural style of domestic structures (Algaze & Pournelle 2003, 114-115; Hald 2010, 70; Laneri 2007, 247; Laneri 2013, 46; Matney & Algaze 1995, 40, 42, 48 & 49). Domestic households in the Outer Town were built of mud-brick on stone foundations with earth or plaster floors and contained features such as hearths, ovens, pits, grinding stones and a variety of pottery (Hald 2010, 70; Matney & Algaze 1995, 40). These non-elite houses were relatively large, being rectangular in shape and having 15 to 20 rooms of varying sizes (Matney & Algaze 1995, 40; Nishimura 2007, 55). Residential dwellings often had more than one entrance from the main street(s) and were organised around a central courtyard (likely the centre of daily activities for the household inhabitants) that was linked to residential, cooking, storage, and work areas (Laneri 2007, 247; Matney & Algaze 1995, 40-42; Nishimura 2007, 55). The size of the rectangular rooms of the houses ranged from 1.28 square metres to 48 square metres; the larger rooms were often used as food preparation/kitchen areas as witnessed by the significant correlation between large rooms and the presence of a hearth or oven; although these fire installations may have been to provide heat rather than directly used for cooking (Nishimura 2007, 55). Some of the larger rooms had cobbled floors which suggest that some areas may have been unroofed (Nishimura 2007, 55). Other large rooms of the houses seem to have been used as living and sleeping areas whilst there is also a significant correlation between the use of large rooms as workshops for activities such as flint knapping and weaving etc. (Nishimura 2007, 55). After the abandonment of the suburbs in the late EBA it is likely that specialised activities were transferred from the outer areas to within the main site, and most probably to within private dwellings (Laneri 2007, 247; Laneri 2013, 46). This point is supported by the *in situ* discovery by archaeologists of work-related objects and tools such as plaster basins (for grape processing), looms and spindle whorls, stone tools, and storage jars in domestic/household contexts (Laneri 2007, 247; Laneri 2013, 46). Nishimura (2007, 55) argues that the organisation and use of space across non-elite houses at Titriş Höyük was consistent which indicates social homogeneity for the non-elite neighbourhoods, and that furthermore this would suggest that elite and non-elite residential quarters were segregated. As a demonstration of the homogeneity in buildings, the Canaanean blade workshop is architecturally very similar to the domestic areas in the rest of the town, being of rectangular rooms of mud-brick built upon a cut-stone foundation (Hartenberger *et al* 2000, 53).

Burial patterns

With regards to the burial practices of Titriş, during the middle EBA some extramural cemeteries were in use outside of the town and on the fringes of the Lower and Outer Towns, including one large one discovered 400 m west of the settlement (Algaze & Pournelle 2003, 110; Erdal 2012, 5; Laneri 2007, 246-247 & 249; Laneri 2013, 45; Matney & Algaze 1995, 36 & 46). The majority of graves in the western extramural cemetery are cist graves (n=41) with a few pithoi graves (n=3) (Erdal 2012, 5; Laneri 2007, 249; Laneri 2013, 45; Matney & Algaze 1995, 46). In general the cist graves are 1 x 1.5 m in size, with an exception being a large chamber tomb measuring 2.75 x 5 m with a semi-circular shaped entrance *dromos* and a few steps leading down into the chamber (Laneri 2007, 249). This large funerary chamber is architecturally similar to the late EBA intramural burial chambers and is surrounded by a series of smaller cist graves (Laneri 2007, 249). Whilst the middle EBA graves in the cemetery were often in a poor state of preservation some general assumptions were made: most of the tombs show evidence of multiple deposition, the ceramic vessels funerary goods are typical of the mid-third millennium horizon of the Syro-Anatolian Euphrates Valley, grave goods also consisted of bronze pins and bronze and silver bracelets as well as bone rings, earrings, and necklaces with semi-precious stone beads of carnelian, agate, and quartz, as well as ‘violin-shaped’ figurines of humans made of stone that demonstrate a link between this region and mid-third millennium western and central Anatolia, and the Aegean (Laneri 2007, 250; Laneri 2013, 46; Matney & Algaze 1995, 46). However, as previously mentioned, Titriş Höyük sees a change in socio-economic organisation in the late EBA (Laneri 2007, 250). This is also seen in a change in burial practices in the late EBA with inhumations in extramural cemeteries being replaced by intramural funerary depositions within the houses in funerary chambers, pithoi, and ceramic vessels/pots (Erdal 2012, 5; Laneri 2007, 248; Laneri 2013, 46; Matney *et al* 2012, 338). The private dwellings of the late EBA usually contained at least one funerary chamber, either constructed in a single room or inside the house’s main courtyard (Laneri 2007, 248; Matney & Algaze 1995, 42; Matney *et al* 2012, 339). These funerary chambers range in size from 1 x 1.5 m to 2.9 x 3.5 m (Laneri 2007, 251; Laneri 2013, 47). Due to the similarity in constructional form, it is believed that the stone-built funerary chambers are the typological successors of the stone-cist graves (Yılmaz 2006, 72). As mentioned above, stone-built chamber tombs were not limited exclusively to intramural contexts within households; some chamber tombs were also discovered in the extramural cemetery of Titriş Höyük (Laneri 2007, 249; Yılmaz 2006, 73). This phenomenon is also found at EBA Gedikli Höyük (Gaziantep province, south east Turkey), where chamber tombs were discovered in the extramural cemetery, separated from other grave types by a wall (Yılmaz 2006, 73). There is also a chamber tomb complex at EBA Gre Virike (Period IIA) on the eastern bank of the Euphrates 10km north of Carchemish (Ökse 2005). Architecturally most of the intramural funerary chambers have an entrance *dromos* with a few steps cut into the virgin soil that served as a passageway and each chamber was covered by a series of stone slabs which were placed horizontally next to each other overlaying the entire chamber (Erdal 2012, 5; Laneri 2007, 252; Laneri 2013, 47; Matney & Algaze 1995, 42; Matney *et al* 2012, 339) (see Figure 22). Stone-built chamber tombs are a commonly found grave type of EBA (3^{rd} millennium BC) southeast Anatolia and north Syria, specifically in the Middle Euphrates River Basin (Ökse 2005, 37; Yılmaz 2006, 73-76). The intramural funerary chambers of the late EBA at Titriş Höyük show evidence of multiple-deposition, containing more than one skeleton (Erdal 2012, 5; Laneri 2007, 252; Matney & Algaze 1995, 42; Matney *et al* 2012, 339) (see Figure 23). In one case up to 8 individuals were interred in succession within a single one of these residential funerary chambers (Matney *et al* 2012, 339). The skeletons are either articulated (i.e. primary deposition) or disarticulated which is most likely related to the practise of secondary deposition (Laneri 2007, 252). Overall it seems clear that when depositing an individual in the chamber the bones and grave goods of the other individuals were moved to the side of the chamber, or removed to make room whilst always leaving the skulls, as witnessed in many of the chambers where the last individual to be buried is found in an articulated flexed position on top of the scattered bones of the previous occupants (Laneri 2007, 252; Laneri 2013, 47; Matney *et al* 2012, 339). In general it seems that multiple-deposition and a long use-life are common aspects of the EBA stone-built chamber tombs of the Middle Euphrates River Basin (Yılmaz 2006, 76-78 & 80).

Whilst there appears to be no sex or age related differences or distinctions in burial patterns, one factor of note is the increased mortality rates for young adults in the late EBA when compared with the middle EBA correlating with a doubling in the mean rate of cranial traumatic injuries from 6.7% to 14.3% from the early/middle EBA to late EBA (Erdal 2012, 9; Laneri 2007, 252). In terms of grave goods the vast majority of the funerary assemblage in the intramural chambers consists of ceramic vessels, predominantly bowls and cups (Laneri 2007, 253; Matney *et al* 2012, 339). These vessels are a mixture of 'local' Syro-Anatolian styles found along the Euphrates River Valley such as mass-produced corrugated goblets and cups of the 'Caliciform' assemblage, Spiral-Burnished ware, and pottery with incised and painted patterns typical of local forms as well as imported items such as *depas* (Laneri 2007, 253; Matney *et al* 2012, 339). Other grave good associated with the late EBA funerary chambers include bronze toggle-pins (likely used to fasten cloaks/clothing), bronze and silver rings and earrings, semi-precious stone necklaces and in a few cases bronze weapons (Laneri 2007, 254; Laneri 2013, 48; Matney *et al* 2012, 340). Laneri (2007) argues that the cause for this change in burial habits from the extramural cemeteries of the middle EBA to the intramural funerary chambers of the late EBA is related to the socio-economic changes and differences seen between these two periods at the settlement and the increased role of the individual households within a society. Specifically he argues that the increasing social differentiation of "competing groups for the acquisition of the productive resources both within the site and within a broader, regional, socioeconomic environment" drove these changes (Laneri 2007, 262; Laneri 2013, 50).

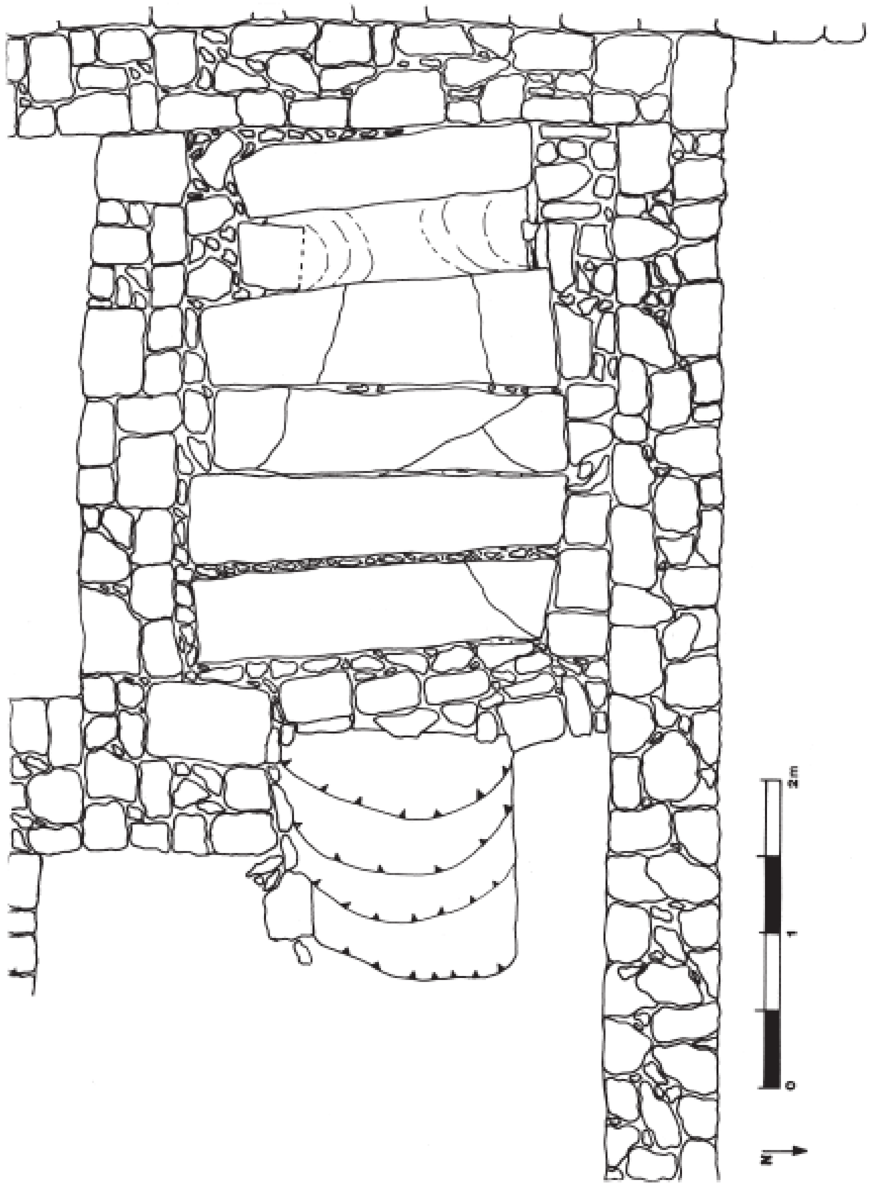


Figure 22: Plan of an intramural residential funerary chamber of the late EBA, showing stone slabs used to roof the chamber. Adapted from Laneri 2013, 47

He hypothesises that these intramural chambers were family/lineage tombs and that the purpose of these intramural chambers was likely related to reinforcing the transformation of economic and political power to within households with long lineages and strengthening the role of individual households within society, emphasising the residence of the family, the household's property rights and its transmission amongst the kin of the family/household (Laneri 2007, 262-263; Laneri 2013, 50). The northern Mesopotamian socio-political system was centred on the secular authority of a royal family as well as selected families who also had some control over land-use and other economic activities (Laneri 2007, 243). This means that family and its lineage and thus its rights and powers within society would have had extra importance and accordingly the underlining of it too. We know from some of the ritual texts found in the royal archive of Ebla's Palace G that new royal couples undertook a pilgrimage to a mausoleum containing previous kings and queens to emphasise lineage and ancestry (Laneri 2007, 261). Indeed, at Ebla kinship relations were of supreme importance for the organisation of the kingdom and most likely defined the political nature of the settlement (Pfoh 2016, 99). Texts from Ebla further emphasise the importance of family and kinship as they make mention of the *kam –mu*, which whilst being a term meaning family are clearly an institutional group, as well as *damu-damu* which is a pluralised version of the term for 'blood', which in this context is indicative of kinship/familial ties and lineage (Porter 2012,234 & 239). Both groups appear to have had preferential ties to the royal family and performed tasks on behalf of the palace (Porter 2012, 239). Furthermore, that the interment of only certain individuals in these intramural funerary chambers was aimed at asserting their authority and reinforcing the memory of selected ancestors with the purpose of stabilising a lineage's descent indicative of an ascribed social status and the reinforcement of hereditary forms of leadership (Laneri 2007, 263; Laneri 2013, 50). Simply put, the use of intramural funerary chambers displays a movement away from communal and centralised burial habits (in extramural cemeteries) to a more insulated one emphasising kin-based households (Laneri 2007, 264; Matney & Algaze 1995, 42).

There is one unique funerary deposition associated with late EBA Titriş Höyük; the 'Plaster Basin' burial (Burial Feature B98.87). This deposition was located in the corner of Room 13 in House 2 of the Outer Town close to the fortification wall at the intersection of two streets (see Figure 26) and consists of a pile of post-cranial bones on a plaster basin with a ring of skulls around its edge without any grave goods present (see Figure 27) (Erdal 2012, 3; Laneri 2007, 255; Matney *et al* 2012, 341). Of interest is the fact that towards the end of its use-life of this house Room 13 underwent modifications; internal doorways were blocked with mud-bricks resulting in the room becoming an attached yet separate part of the house which could only be accessed from the street (Erdal 2012, 4; Matney *et al* 2012, 341). The fact that the deposition is located in a room that would have been accessible directly from a street that led to the fortification wall, combined with the position of the building and the fact that the burial feature would have been visible from the street point to a ritual aspect for this feature (Erdal 2012, 4 & 16; Laneri 2013, 49).

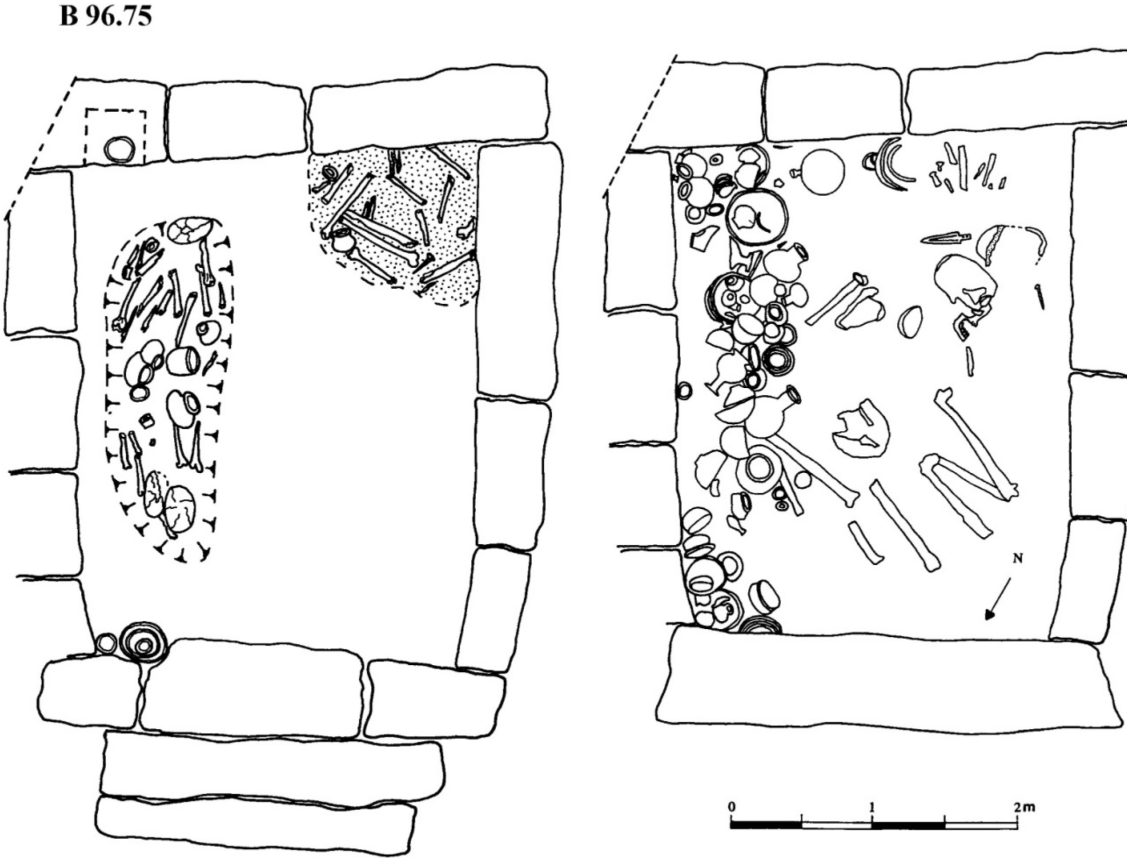


Figure 23: Late EBA intramural funerary chamber from Titriş Höyük. Adapted from Laneri 2007, 251

The skulls and bones belong to 19 individuals in total and are mostly of young adult males (Erdal 2012, 4; Laneri 2007, 256; Laneri 2013, 49). The osteological analysis by Dr. Ö. D. Erdal shows that of the 19 individuals 12 are young adult males (all with cranial traumatic injuries), three are young adult females (one with cranial traumatic injuries), one is an unspecified young adult (with cranial traumatic injuries), two are children (one of 4 years old, the other of 9-11 years, both with skulls missing), and one is an infant (of 2 years old with the skull missing) (Erdal 2012, 4; Laneri 2013, 49; Matney *et al* 2012, 342). Furthermore, due to the comingled and disarticulated nature and arrangement of the skeletal elements and the absence many small post-cranial bones (e.g. ribs and phalanges) it is believed that the deposition is a secondary burial and the skeletons would have been devoid of flesh when deposited (Erdal 2012, 3-4). Clear signs of cranial traumatic injuries are seen on 81.3% (13 out of 16) of the adult crania, with only two of them being healed and a total of 26 of them being peri-mortem in nature made by sharp-edged weapons such as spears and axes (see Figure 24 for two examples) (Erdal 2012, 7 & 13; Laneri 2013, 49; Matney *et al* 2012, 342). Due to the distribution and location of the traumatic injuries it has been proposed that they were not the result of active inter-personal conflict, but of a massacre with the individuals being immobilised at the time of the blows were administered (Erdal 2012, 15-16; Matney *et al* 2012, 342). The incidence of peri-mortem cranial traumatic injuries seen on the individuals of the 'Plaster Basin' burial is significantly higher than that of the common late EBA burials (mean of 14.3%), and also of the preceding early and middle EBA periods at the settlement (mean of 6.7%) (Erdal 2012, 9; Matney *et al* 2012, 342).

The plaster basin itself is not unusual within the settlement (see Figure 25), with similar ones being found in private dwellings of both the Outer and Lower Towns (Erdal 2012, 3; Laneri 2007, 256; Laneri 2013, 49; Matney & Algaze 1995, 41). It is hypothesised that these plaster basins formed part of the daily activities of the inhabitants and were most likely related to grape processing and the production of wine, demonstrated by the presence of tartaric acid following analysis of a sample from the surface of one (Erdal 2012, 3; Laneri 2007, 256; Laneri, 2013, 49; Matney & Algaze 1995, 41; Matney *et al* 2012, 341; Nesbitt & Samuel 1996, 96). The exact reason for this unique deposition is still not entirely clear (Laneri 2007, 256). Laneri (2007, 256), suggests that due to the high number of young adult males present in the deposition as well its location close to the fortification wall it may be the result of a "dramatic military event", but that it was clearly a ritualised event and that the use of the basin with its connection to wine production may have had symbolic importance such as the process of purifying the human bodies. However, an aDNA study of individuals from Titriş Höyük, including those from the 'Plaster Basin' burial, showed that the individuals deposited in this feature had a homogeneous genetic makeup and, furthermore, shared a very similar genetic makeup to those from the common burials and that they therefore should not be considered to have been foreigners/non-local of the region and settlement, but rather that they should be considered to have been natives/members of the city's population (Erdal 2012, 13; Matney *et al* 2012, 348). The inclusion of females and sub-adults in the burial deposition, combined with the distribution of cranial traumatic injuries (as discussed above) would also suggest that active inter-personal violence such as hand-to-hand combat was not the cause of the deaths of the individuals in this feature. If the individuals deposited on the plaster basin were not outsiders (i.e. people attacking or threatening the settlement) or warriors involved in a battle, then two main explanations remain; that they were massacred victims of an attack on the city by external elements, or that they were killed as a result of internal strife/conflict. This point is discussed further in conjunction with the results from the stable isotope data in Chapter 5.2.2.

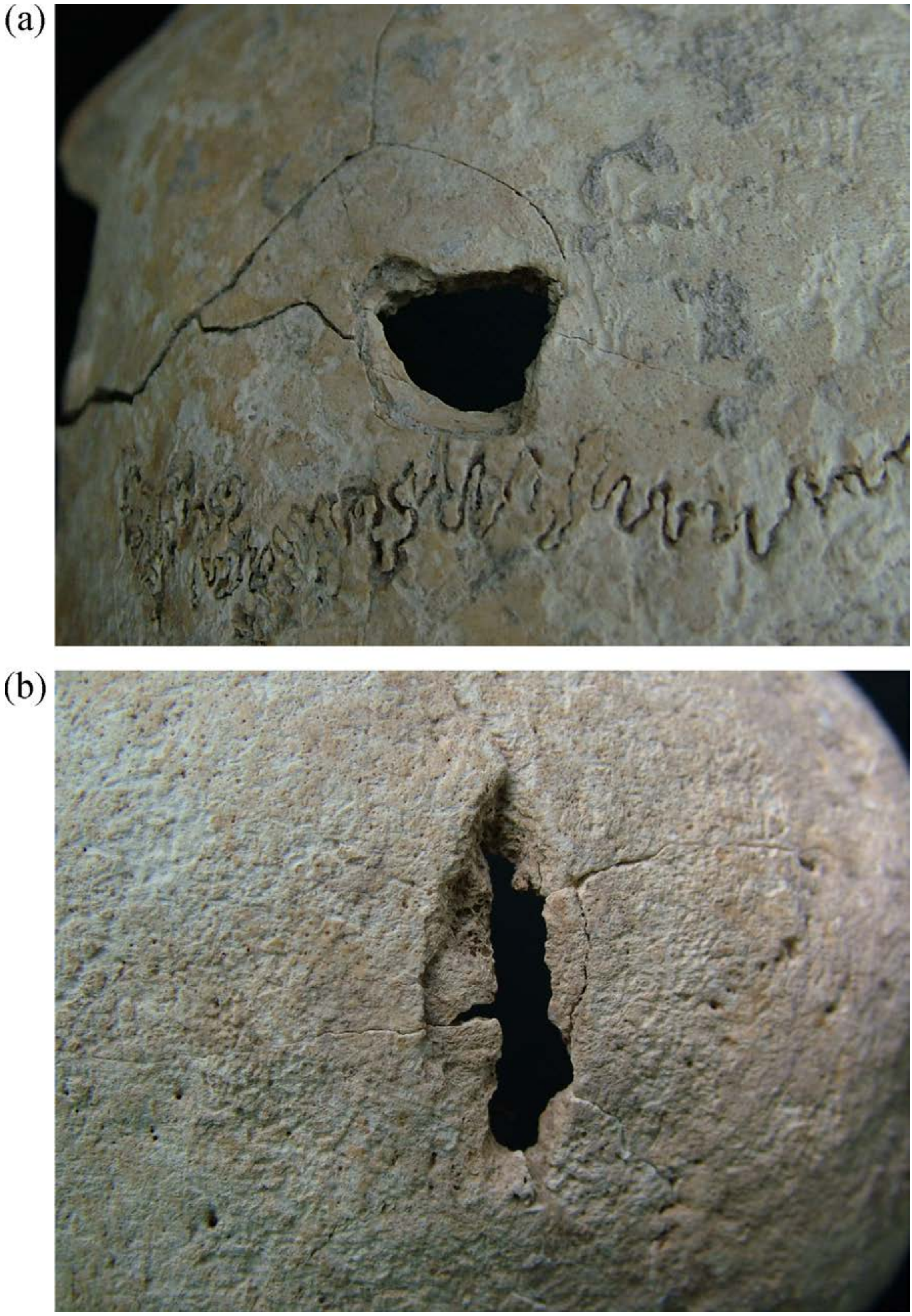


Figure 24: Two examples of penetrating peri-mortem cranial traumatic injuries on individuals from the ‘Plaster Basin’ burial – (a) is the external view of a puncture wound with fracture lines caused by a sharp or projectile weapon on a Middle Adult Male, TH 80073. (b) is the external view of a cleft wound made by a sharp weapon such as a spear head/axe on an Old Adult Male, TH 80079. Adapted from Erdal 2012, 10

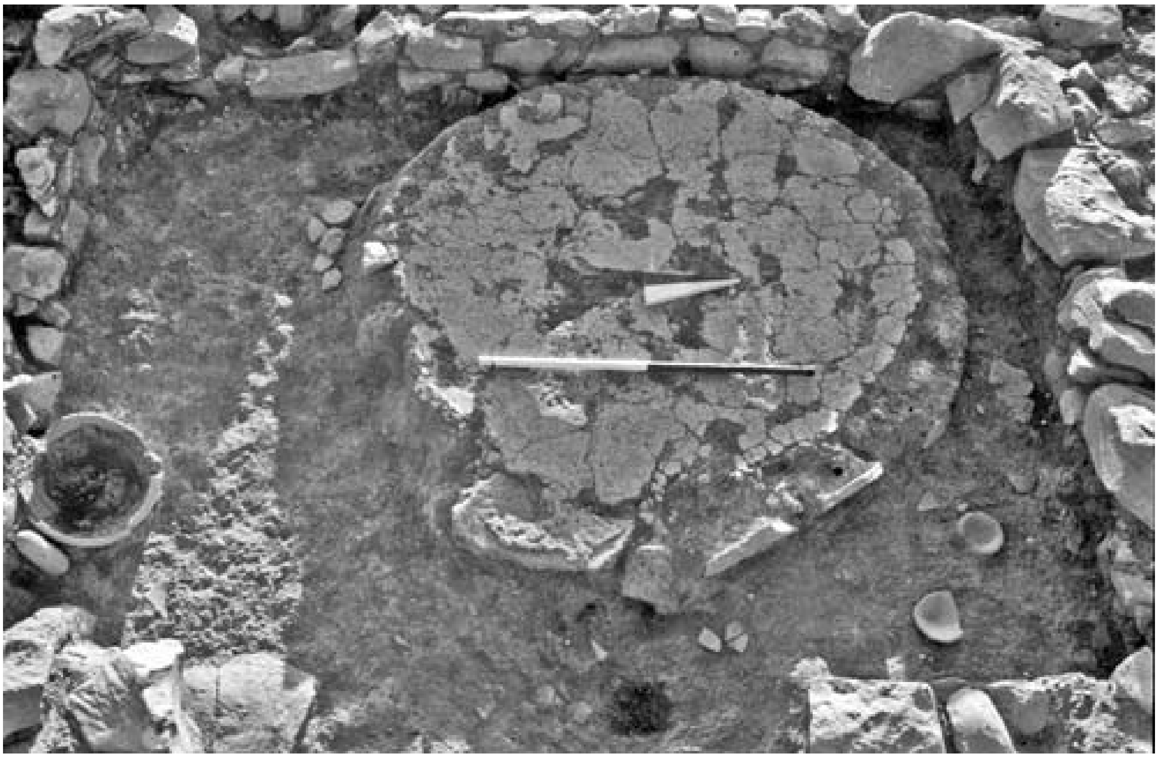


Figure 25: A typical plaster basin from a late EBA house. Adapted from Matney et al 2012, 341

Economy

Evidence from methods such as remote sensing and archaeobotanical data for the economy at Titriş Höyük indicates that land-use was focused primarily on arable agriculture (i.e. crop cultivation), mainly barley followed by wheat (Allentuck & Greenfield 2010, 15; Laneri 2007, 262). The main crops at Titriş Höyük were cereals, primarily two-row hulled barley (*Hordeum distichum*), emmer wheat (*Triticum dicoccum*), legumes (primarily bitter vetch/grass pea – *Vicia/Lathyrus* sp.), and grapes (*Vitis vinifera*) (Hald 2010, 71; Nesbitt & Samuel 1996, 96). The evidence from archaeobotanical analysis of households of the Outer Town show that they are dominated by barley and wheat grains (Hald 2010, 72).

Furthermore the analysis shows that there is a similarity in the types and relative proportions of crops found there and that the inhabitants of the Outer Town did not seem to have had access to a different or more varied plant diet than others (Hald 2010, 74). There would have been the presence of year-round cultivable floodplains suitable for garden crops and broad rain-fed arable tracts suitable for grain cultivation (Algaze & Pournelle 2003, 124).

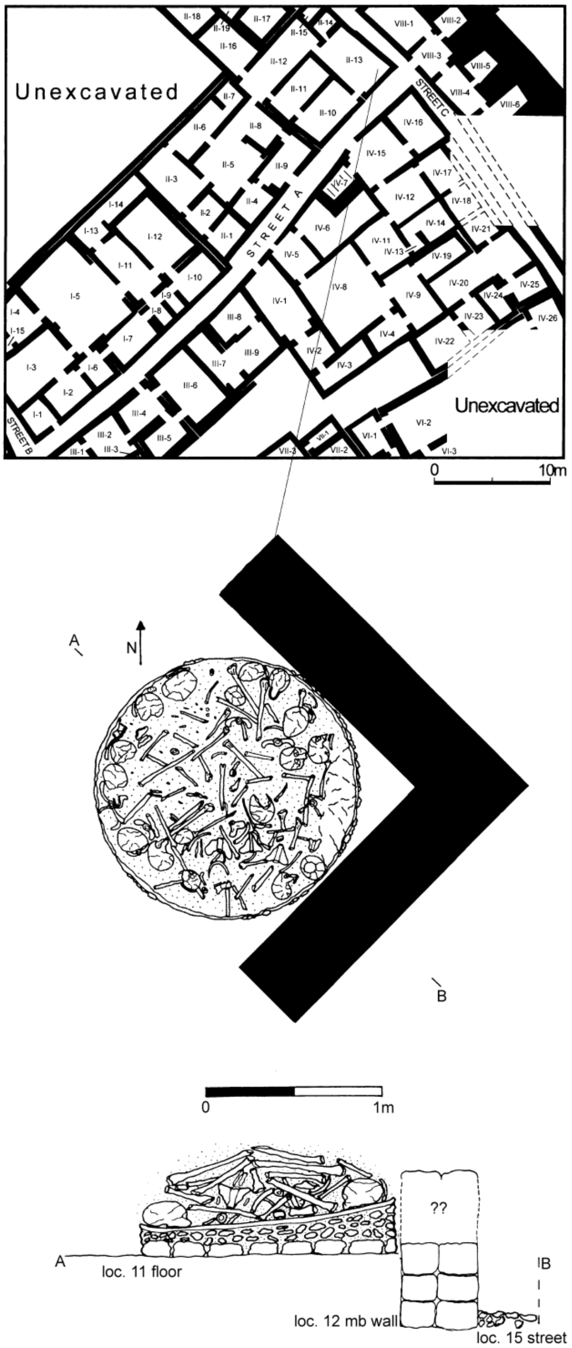


Figure 26: The ‘Plaster Basin’ funerary deposition and its location. Note: the drawing does not show the modifications made to Room 13 of House 2, resulting in access exclusively from the street. Adapted from Laneri 2007, 257

Figure 27: Photograph of the ‘Plaster Basin’ burial. Adapted from Erdal 2012, 3

Evidence, from survey and palaeobotany analyses, was found of the manuring of fields in the immediate surroundings of the site to increase the yields of grain crops (Matney & Algaze 1995, 47). The survey evidence for manuring comes from T. J. Wilkinson’s surveys from 1989-90 of sherd scatters in Iran, Syria, Turkey, and Iraq which are argued to be evidence of deliberate fertilisation of fields neighbouring settlements using settlement debris and waste (Miller & Gleason 1994, 37, see also Wilkinson 1989, 1990, and 1990b). It is, however, also generally accepted that agricultural yields during the middle-late EBA would have been stressed due to a period of increasing aridity and that the forests around the settlement were cleared in favour of more agricultural fields and grazing lands (Algaze & Pournelle 2003, 117 & 120-123; Allentuck & Greenfield 2010, 13; Matney & Algaze 1995, 47; Trella 2010, 210 & 217). The increase in agricultural intensity in the middle EBA at Titriş Höyük is logical as it was during this period that the population and overall settlement size boomed with an influx of people into the city from dispersed villages as the city became an urban centre, and therefore more arable areas and crops would have been needed to feed this enlarged population (Hartenberger *et al* 2000, 56; Matney & Algaze 1995, 47; Trella 2010, 214-215). This can be seen in the establishment of the Canaanean blade workshop in the middle EBA, mass producing these blades to satisfy the increased demand for agricultural tools, as these blades are most often used as sickle blades (Hartenberger *et al* 2000, 56). There would also have been easily accessible cultivable wild plant species such as acorns, pistachios, and vetches, as well as gentle limestone slopes suitable for viticulture and slopes suitable for olive cultivation within an hour's walk of the settlement (Algaze & Pournelle 2003, 124; Matney & Algaze 1995, 47). Hald's archaeobotanical research (2010, 71) demonstrates the presence of olives (*Olea* sp.), pistachio nuts (*Pistacia* sp.), acorns (*Quercus* sp.), and hawthorn (*Crataegus* sp.) as well as wild grasses such as *Lolium* sp., *Aegilops* sp., and *Galium* sp. (bedstraw), as well as small legumes such as *Trigonella* sp. and *Trifolium/Melilotus* sp. Despite some rooms from their size and layout having been suggested as storage rooms, no large concentrations of crops have been found and therefore from an archaeobotanical point of view no areas can definitively be identified as storage spaces (Hald 2010, 72). Interestingly Hald's analysis (2010, 74) demonstrated that there is very little chaff present and therefore that the crops seem to have been brought into the settlement almost fully cleaned of their chaff (i.e. that they were processed elsewhere, outside of the settlement). This factor (similar level of external crop processing), combined with the similarities in variety and relative proportions of crops points to a common source and thereby can be considered indicative of a central distribution system for crops (Hald 2010, 74-75). A slightly different interpretation might be that there were communally used spaces and tools and methods for processing these products. Either way, a certain degree of control and organisation of the population/sections of the population is suggested. It has also been argued that the agricultural output of the area immediately surrounding the settlement would have been inadequate to feed the population and therefore centralised control over surplus grain production of nearby 'satellite' towns and villages would have been necessary (Matney & Algaze 1995, 48; Trella 2010, 153). It has been suggested that the surplus of agriculture produce at Demircihöyük may have been sent to a larger regional centre settlement (Massa 2015, 99). As will be discussed further in Chapter 5.2.2, the protein intake (indicated via $\delta^{15}N$ values) at Titriş Höyük is slightly lower than the other sites, but this was likely not related to endemic hunger as there are no indications of nutritional deficiency, but more to do with a greater reliance on crops. The idea of Titriş Höyük receiving surplus food resources from 'satellite' towns and villages is still feasible though due to the suggestion of settlement hierarchies and Titriş Höyük's role as a regional centre, as will be further discussed in Chapter 6.2 and Chapter Seven.

Animal husbandry also played an important role at the settlement. Titriş produced its own domestic animals, but may also have required the import of surplus pastoral stock from satellite communities (Allentuck & Greenfield 2010, 27; Trella 2010, 282). This pastorally focused animal economy is reflected in the fact that the majority of identified species are from domesticates rather than wild fauna (89%:11% respectively) (Allentuck & Greenfield 2010, 14). Furthermore it seems that relatively few animal taxa were exploited at Titriş, with the focus being on three main domesticates; sheep, goat, and cattle (Allentuck & Greenfield 2010, 22; Trella 2010, 251). Moreover, the diversity of exploited species declines from the early EBA to the middle and late EBA (Trella 2010, 252). The main domesticates at Titriş are *ovis/capra* with a ratio of 2.4:1 against domesticate cattle, and there were more sheep than goat identified, with a ratio of 1.5:1 (Allentuck & Greenfield 2010, 14). The evidence also suggests that there was an intensification of pastoral production with *ovis/capra* becoming more dominant in terms of number from the early EBA to the middle and late EBA and furthermore, that when examining the ratio of sheep:goat, the ratio of sheep:goat increases from 2:1 to 3.4:1 from the early EBA to the middle/late EBA suggesting an increased emphasis on sheep (Trella 2010, 250-251). This increase in sheep may be related to textile industry at the settlement, spindle whorls, stone loom weights, and bronze needles were discovered in household contexts (Nishimura 2007, 55). It is well known from the textual evidence of late 3rd millennium BC Mesopotamia (Ur III and Ebla) and MBA Anatolia that textiles were important in exchange networks (Massa 2015, 201). The importance of the textile industry would have relied upon and required large herds of wool bearing sheep, and this increase in the number and ratio of sheep may be related to this (see Chapter Six section 6.2 for a further discussion on this point). The archaeozoological analyses conducted at the nearby 3rd millennium BC village of Gritille in the Karababa basin of the Euphrates valley in south east Turkey discovered a similar pattern as to that at Titriş Höyük (Stein 1987). It was noted at Gritille that there is a predominance of *ovis/capra* (63.7% of all identified faunal fragments) and that when the two species could be separated there was a sheep:goat ratio of 2.16:1 (Stein 1987, 104-105). However, unlike at Titriş Höyük the second most common animal at Gritille are pigs (17.6% of identified faunal fragments), followed by cattle (11.5% of identified faunal fragments) (Stein 1987, 105). The cattle at Titriş Höyük appear to have been reared close to or within the settlement, most likely at a household level whilst sheep and goats would have been reared and herded at a greater distance from the settlement (Allentuck & Greenfield 2010, 14-15; Trella 2010, 256). This is similar to Tell Barri in north east modern Syria, where it seems that *ovis/capra* were fed on more distant pastures on the dry steppe away from the settlement (Soltysiak & Schutkowski 2015, 176). It has been proposed that there is a change in pastoralist strategy from the early EBA to the middle/late EBA at Titriş Höyük. During the early EBA it seems evident that livestock was herded within a relatively close proximity to the settlement, but that in the middle and late EBA with the increased intensification of agriculture and the expanded size of land area devoted to arable production livestock was pushed further away from the centre (Trella 2010, 314-315). This change in pastoralist strategy may not only have resulted in the segregation of pastoral and agricultural production into two specialised components of an overall system but that animal manure was removed from the agricultural fields specifically at a time when it was needed most with the intensification of arable agriculture (Trella 2010, 318 & 320) The domesticate pig remains from Titriş are very rare and indicate that they played a very minor role in the economy and subsistence of the inhabitants of Titriş (Allentuck & Greenfield 2010, 15; Trella 2010, 251). Allentuck & Greenfield (2010, 19 & 27), after studying cull age patterns have suggested that the inhabitants employed a mixed meat and milk exploitation strategy for sheep. However, as will be discussed in Chapter Six, section 6.2, I will instead argue that these age cull patterns are a result of, and an indication of the move towards keeping sheep for wool production. In contrast they argue that the later cull age pattern for goats suggests that they were primarily exploited for their secondary products (i.e. milk and hair) (Allentuck & Greenfield 2010, 21 & 27). For cattle their sample size was too small to make any firm conclusions, but they hypothesise that like the sheep they were most likely raised for meat and milk exploitation (Allentuck & Greenfield 2010, 21 & 27). It is also possible they may have been used for traction and/or draught purposes as well. At Gritille the cull pattern suggests that their inhabitants practiced local subsistence of *ovis/capra* (i.e. herding and butchering for their own consumption), but may have also supplied a larger regional settlement (perhaps Titriş Höyük) with young caprines (Stein 1987, 108). With regards to the distribution of the animals the evidence suggests that sheep and goat were controlled centrally and distributed indirectly to the inhabitants through specialised and centralised channels (i.e. through the equivalent of state owned/run butchers/meat markets) whilst cattle were raised and exploited individually at household level without state intervention (Allentuck & Greenfield 2010, 23 & 27; Trella 2010, 256 & 280-281). The narrow range of domesticate species combined with similar animal parts found in households, and similar butchering marks found on the animal bones, in the same respect of a narrow range of crops found fully cleaned in the households point to a centrally organised distribution system for dietary resources (Allentuck & Greenfield 2010, 27; Hald 2010, 75; Trella 2010, 255-256 &

280-281). A lower diversity of animal (and crop) species increases provisioning efficiency by reducing the number of producers to be negotiated with to procure resources. Furthermore, by ensuring dependency on a narrow range of centrally distributed resources, the provisioners can maximise control over consumers (Zeder 1991, 39).

2.4 Bademağacı Höyük

Bademağacı Höyük is located in the province of Antalya in the southern part of the Lake District in south-western Turkey, about 50 km north of the city of Antalya (see Figure 28) and 2 km north of the modern Bademağacı village near the modern town of Döşmealtı (see Figure 29) (De Cupere *et al* 2008, 368; Duru & Umurtak 2010, 16; Duru & Umurtak 2011, 31). The settlement lies on a small plain surrounded on all sides by mountains 780m above sea level along the modern Antalya – Burdur highway, and is located 5km north of the Çubuk Beli pass which is a natural gorge between the Taurus Mountains and the flat coastal plain of Antalya (De Cupere *et al* 2008, 368; Duru & Ummurtak 2015, 71).

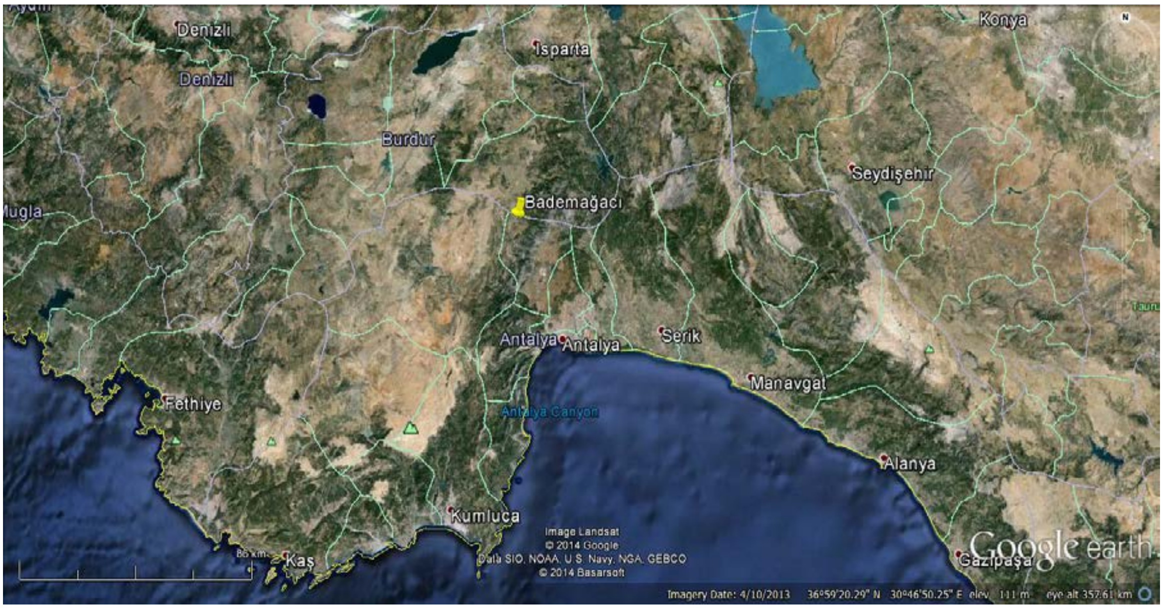


Figure 28: Regional location of Bademağacı Höyük. Adapted from Google Earth

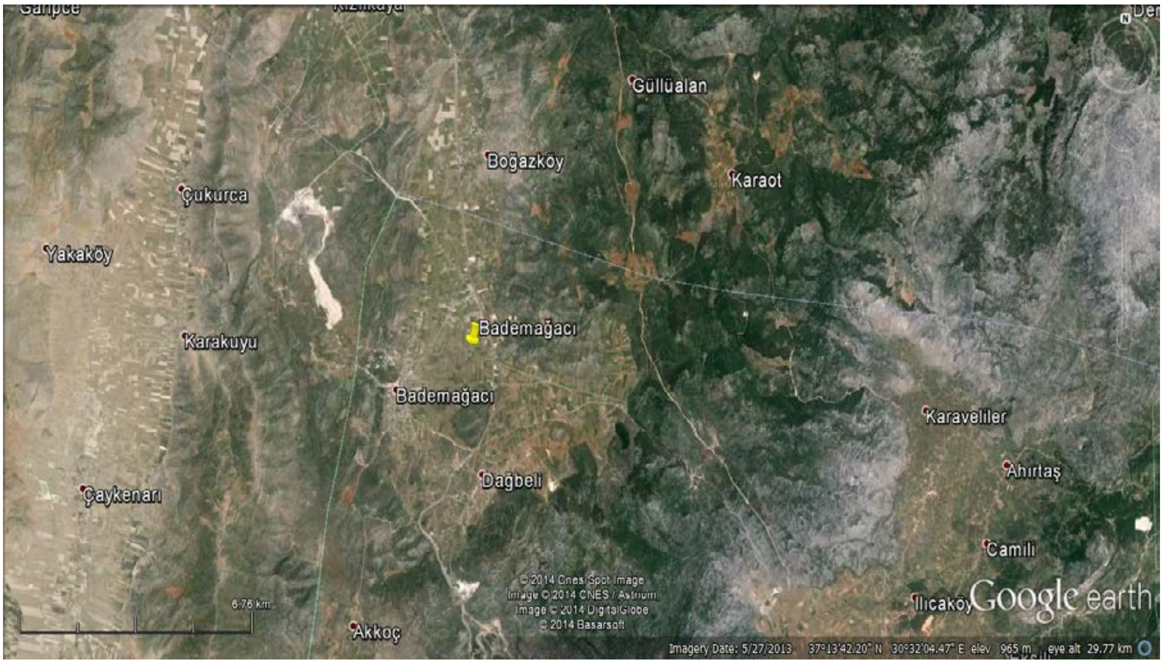


Figure 29: Location of Bademağacı Höyük on the plain. Adapted from Google Earth

Excavations at Bademağacı lasted for 18 years between 1993 and 2010 under the direction of Refik Duru (Istanbul University) and Gülsün Umurtak (Istanbul University) (De Cupere *et al* 2008, 369; Duru & Umurtak 2010, 15; Duru & Umurtak 2011, 31). Almost the entire surface area of the mound was excavated, except for a small section in the east part of the mound, and virgin soil was reached in some parts 9.30 m below the mound's summit (Duru & Umurtak 2010, 16).

The earliest evidence of occupation at the site is from the Neolithic period, around 7100 cal. BC following radiocarbon dating (De Cupere *et al* 2008, 370; Duru & Umurtak 2015, 71), with architectural remains and associated finds such as ceramic vessels, clay human and animal figurines, a clay stamp-seal, bone tools, polished stone axes/chisels and beads being discovered (De Cupere *et al* 2008, 369-370; Duru & Umurtak 2010, 16-20). The settlement appears to have been occupied into the Early Chalcolithic period, although only artefacts and the remains of some foundations were found related to this period, and this phase of occupation ended around 5800/5700 BC (Duru & Umurtak 2010, 16 & 20). The next major phase of inhabitation at the settlement has been dated to the early EBA II period (ca. 2800 BC), and apart from some very short-lived and small-scale MBA finds and the remains of a small church (dating to ca. 500/600 AD) on top of the mound it appears that the site was never fully inhabited after the EBA II period (De Cupere *et al* 2008, 369; Duru & Umurtak 2010, 16; Duru & Umurtak 2011, 31; Duru & Umurtak 2015, 75).

The settlement is relatively small with the oval-shaped mound (see Figure 30) being 7-9 m in height and 200 m long and 90-120 m wide (De Cupere *et al* 2008, 368; Duru & Umurtak 2010, 16; Duru & Umurtak 2011, 31). The population of Bademağacı can be very approximately estimated using the total site area, which using the site dimensions we can calculate to be ca. 2 ha. When estimating population size of ancient settlements using persons per hectare there are a range of published figures (for a summary see Table 1. in Zorn 1994, 34). The average of the published numbers is 361 persons per hectare, if we use this then a rough estimation of the population of Bademağacı at its peak would be722. Massa (2015, 41) uses an estimate of 300 people/ha to estimate population size meaning a total of 600 inhabitants at the settlement. However, these calculations do not take into account the density, or otherwise, of the settlement with regards to factors such as space within the settlement taken up by structures with a lower population density such as monumental buildings, non-residential public buildings, storage buildings, working spaces within households, the number of people per household, the number of households, or non-residential buildings such as workshops. The population, therefore, is likely to have been lower (using a reduced density coefficient of 200 persons per hectare), more likely ca. 400 people. The settlement size (in ha) and the population size means that Bademağacı is average for the time period with a typical EBA Anatolian settlement being between 0.3 and 3 ha with a population of 100-1000 people (Massa 2015, 41). The excavators estimated that the settlement would have consisted of around 90-140 structures and estimate that there were 6-7 people per house and therefore a population of around 700 people (Duru & Umurtak 2011, 34; Duru & Umurtak 2015, 78) which is at the higher end of my calculated estimates.

The EBA II occupation of the settlement began in around 2800 BC (Duru & Umurtak 2011, 31; Duru & Umurtak 2015, 75). Evidence from the settlement suggests that the inhabitants survived earthquakes, fires, and conflict, rebuilding the architectural features of the settlement and remaining there until about 2000 BC, although only architecture and material culture belonging to the EBA II were discovered (Duru & Umurtak 2011, 31; Duru & Umurtak 2015, 75). The EBA settlement was built over the ruins of the Neolithic period buildings, and it seems likely that the building of the EBA settlement followed a pre-conceived radial plan; i.e. the settlement was architecturally well organised and its construction was centrally planned and organised (Duru & Umurtak 2007, 11; Duru &

Umurtak 2011, 31 & 34; Duru & Umurtak 2015, 75; Umurtak 2010, 22). This type of settlement pattern is common in Anatolia and has been suggested to be an Anatolian settlement pattern (Erarslan 2008, 177). Parallels can be found at other Anatolian EBA sites such as Bakla Tepe, Liman Tepe, Troy I, Demircihöyük, and Küllüoba (Erarslan 2008, 178-180). It has been argued that Bademağacı was centrally controlled (i.e. by a leader/leading class) and its role was as an important small regional centre with control over the surrounding area (De Cupere *et al* 2008, 369; Duru & Umurtak 2011, 34; Duru & Umurtak 2015, 78).

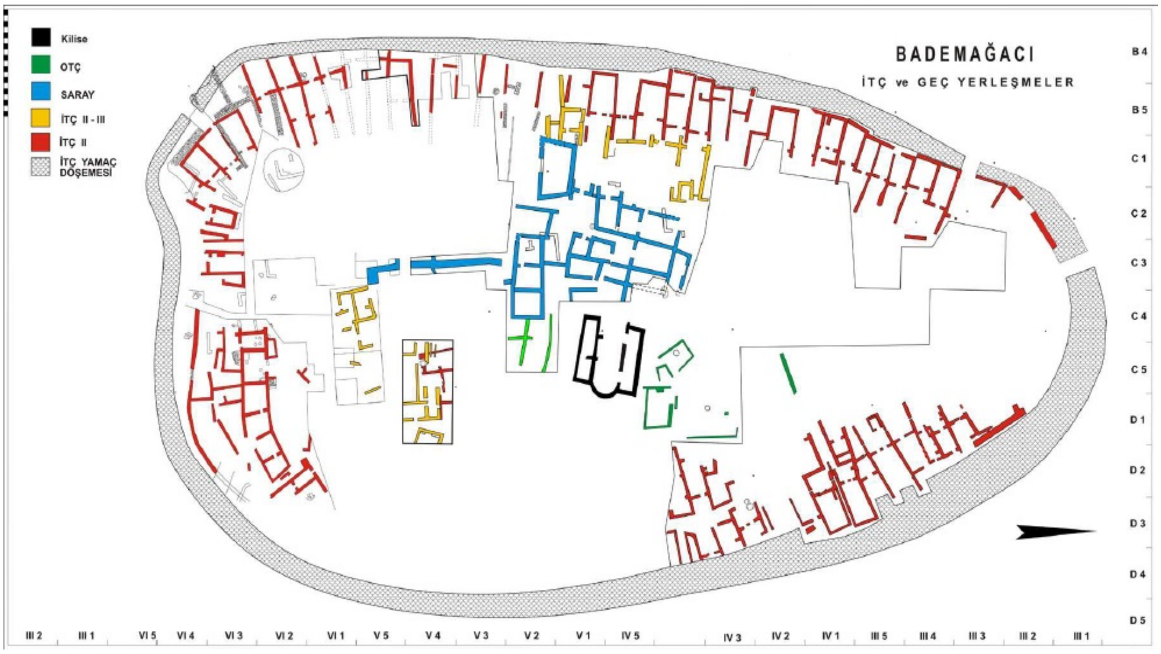


Figure 30: Plan of the EBA settlement of Bademağacı – the 'palace' buildings are shown in blue, the EBA II-III settlement in yellow, and the EBA II settlement in red. The MBA remains in green and the church in black are also shown. Adapted from Duru & Umurtak 2011, 31

Part of the boundary of the settlement (especially on the east and west edges) was formed by the construction of a row of one or two roomed terraced houses (De Cupere *et al* 2008, 369; Duru & Umurtak 2011, 32; Umurtak 2010, 20). The effect of this terracing of the houses was that the houses themselves formed the outer wall of the city preventing easy access to its centre. On each side (one east and one west) one of the terrace buildings had narrower rear walls than the others with an opening and Duru and Umurtak (2011, 32) hypothesise that these buildings served as gate-houses. The terraced houses in general were box-shaped and ranged in size between 10-19 m by 3.5-4.5 m with their doors opening into the inner/central part of the settlement where the outer walls of the buildings were extended by a few metres so as to form a semi-enclosed area at the front of the building (De Cupere *et al* 2008, 369; Duru & Umurtak 2010b, 21; Duru & Umurtak 2011, 32). The buildings of the settlement, as is reasonably common for the EBA of Anatolia, were erected with a superstructure of mud-bricks upon a stone foundation (Perello 2011, 190 & 192). The northern end of the settlement was planned in a different way to its eastern and western sides. Here the terraced housing ends and the outer boundary of the settlement is instead formed by a 1m thick wall intersected at two points by 3-4m wide gateways (Duru & Umurtak 2011, 32). The excavators think that, as this northern part of the settlement was devoid of architectural structures (except for the outer wall), this area was where the inhabitants of the settlement brought and kept their animals either at night or when there were external extra-mural dangers present (Duru & Umurtak 2010b, 22; Duru & Umurtak 2011, 32-33). At the southern end of the settlement the preservation of the architectural remains was not very good so it has been difficult to ascertain whether the radial terraced plan of the east and west continued at this end, or whether this area was occupied by box-like spaces, it does seem clear however that the main city gate was located at this end of the settlement (Duru & Umurtak 2009, 19; Duru & Umurtak 2011, 33). There is also evidence in some of the rooms of the buildings at the southern end of the settlement of partial destruction by fire (Umurtak 2010, 20). The entire settlement was surrounded by a 4-8m wide paved slope (see Figure 31), and whilst its exact purpose is not known, it seems unlikely to have been related to defence and instead was perhaps built to prevent erosion of the outer houses and to protect against rising water levels and waterlogged ground, especially during the rainy seasons (De Cupere *et al* 2008, 369; Duru & Umurtak 2006, 14; Duru & Umurtak 2011, 33; Umurtak 2010, 22).

In the centre of the settlement a large multi-roomed building with a complex layout was discovered, the directors of the excavation referred to this building as the ‘Palace’ (Duru & Umurtak 2008, 18; Duru & Umurtak 2011, 33; Umurtak 2010, 22). In total 17 rooms of this large building were excavated, full excavation of the building was impossible as the church was built over part of it, but it was estimated that there would have been at least 10 more rooms as part of this structure (Duru & Umurtak 2011, 33-34; Duru & Umurtak 2015, 76). Whilst its plan is not completely understood due to its only partial excavation it appears that the entrance was from the west and pottery remains in some of the rooms suggest that there were food storage areas present (Duru & Umurtak 2011, 34; Duru & Umurtak 2015, 76).

Figure 31: Photograph showing part of the paved slope that surrounds the settlement. Adapted from Duru & Umurtak 2011, 32

This complex structure had extensions built onto it in the later part of the EBA II period when other changes are also seen at the settlement (Duru & Umurtak 2011, 34). There is evidence of partial destruction during this period and some of the terraced buildings of the eastern and western edges were abandoned whilst others were extended and continued to be occupied (Duru & Umurtak 2011, 34).

In terms of mobile finds, the most numerous are ceramic vessels, with those with a red slip being most common, and some vessels being decorated and of a very high quality (Duru & Umurtak 2011, 35; Umurtak 2010, 22). The most common ceramic forms are bowls and pots, but plates, jugs, *amphorae*, and *pithos* jars of various sizes were also found (Duru & Umurtak 2015, 79). Red-slipped wheel thrown pottery was also discovered (Duru & Umurtak 2015, 79; Umurtak 1998, 2). Other finds included clay beads and many spindle whorls as well as clay stove supports/pot stands, simple clay idols (some with incised lines that most likely represented clothes), whilst one 'violin-shaped' marble idol was discovered demonstrating a link with the Aegean and/or western Anatolia (Duru & Umurtak 2008, 19; Duru & Umurtak 2009, 20; Duru & Umurtak 2011, 35-36; Duru & Umurtak 2011b, 14; Umurtak 2010, 22).

Many stamp seals (N = 120) were also discovered, most made of clay but some made from stone or metal, as well as clay numerical tablets, and a *bulla* with a seal impression (Figure 32) that are suggestive of authority, property ownership, trade and the development and establishment of social, economic, official and administrative systems (Duru & Umurtak 2011, 35-36; Duru & Umurtak 2011b, 14; Umurtak 2010, 19-20 & 23). It has been suggested that this *bulla* would have either been attached to a piece of cloth that covered a storage jar or *pithos* perhaps as an indicator of contents, or attached to a wooden tablet as a record keeping device (Umurtak 2009, 21-22). The *bulla* found at Bademağacı is comparable to the *bullae* with impressed stamp seals found at Karataş, Demircihöyük, Troy IIb, and EBA II Tarsus (Bachhuber 2015, 77). Several metal artefacts were also unearthed during excavation (the exact locations for all of the metal artefacts are not published, but presumably they are from non-burial contexts as the only grave good items mentioned in the reports are small beak-spouted pitchers – see below) including bronze daggers, arrowheads, spearheads, axes, piercers and pins, bangles/bracelets, as well as silver pins with enlarged decorated heads, golden ear plugs, and a silver plate/bowl (Duru & Umurtak 2009, 20; Duru & Umurtak 2010b, 24-25; Duru & Umurtak 2011, 37; Duru & Umurtak 2011b, 14; Duru & Umurtak 2015, 80; Umurtak 2010, 22). Examples of similarly stylised silver pins come from nearby Semayük, but so far no parallel in Anatolia for the silver bowl has been found (Duru & Umurtak 2011b, 15). The only published location for metal artefacts is from a building complex on the southern slope/edge of the settlement with a large number of complete and *in-situ* pots, some of which contained a large number of bronze items (beads, a pin with an enlarged head, a seal, a spearhead, and an axe), silver pins with decorated heads, the silver bowl, and one of the golden ear plugs (Duru & Umurtak 2011b, 12 & 14-15). The excavators could not come up with an explanation as to why so many precious metal artefacts were discovered in this location, but it may be possible that it is a cache/hoard as found at other EBA settlements in Anatolia such as Troy, Poliochni, Eskiyapar, and Mahmatlar (Massa 2015, 176).

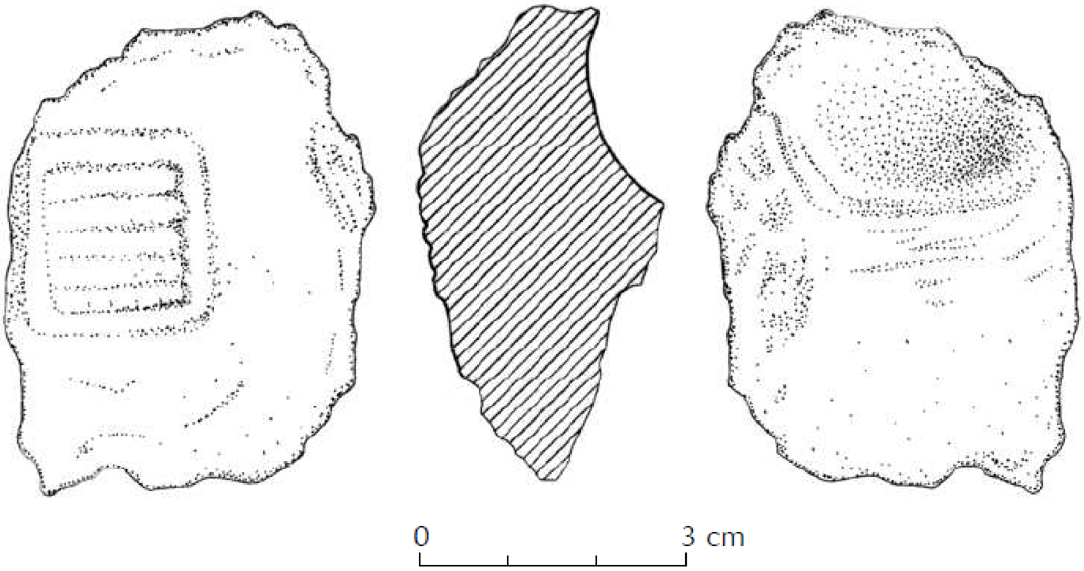


Figure 32: Bulla with stamp seal impression from EBA II Bademağacı. Adapted from Umurtak 2009, 26

Burial patterns

An extramural graveyard for Bademağacı was never discovered (Duru & Umurtak 2015, 78) and relatively few graves were found within the settlement dated to the EBA period. All of the graves (N = 10) discovered were intramural, under the streets outside houses/buildings or under the floors of houses/buildings (Duru & Umurtak 2011, 34-35; Duru & Umurtak 2015, 78). The number of intramural burials discovered during excavation probably represents the actual number of intramural burials at the site, with the others being part of an extramural cemetery that, as mentioned previously, has so far not been discovered – although see the small discussion below on the stone circle grave markers. Many of the burials were located in the southern section/neighbourhood of the settlement, and were surrounded by a single row of stones forming a circle (Duru & Umurtak 2011b, 13). These stone circles may have acted as grave markers. Interestingly, eight other circles made with a single row of stones of the same diameter (1-2 m) were discovered in the northern and central areas of the *höyük* but did not contain graves (Duru & Umurtak 2011b, 13). Unfortunately the excavators do not hypothesise as to why some circles were empty and others contained *pithos* graves, and despite seeming to make a connection between these features and graves they denote that one of them was investigated as a possible round building (Duru & Umurtak 2011b, 13). However, it may be suggested that either the *pithos* graves were not located as they were at a depth greater than the 1m investigated by the excavators, or that at some point in the past they were removed/moved for an unknown reason. Intramural burials are highly unusual for the time period in the area when almost the entireties of (at least adult) graves are found in extramural cemeteries (Massa & Şahoğlu 2011, 167; Wheeler 1974, 415; Yaylalı 2002, 114 – Also see discussion on Anatolian EBA burial patterns in Chapter 1.2). Whilst being highly unusual, there are actually a few other contemporary examples of intramural burials like those seen at Bademağacı; for example at some of the *insulae* of Troy IIf-III, two examples from the EBA III citadel of Kültepe, and from the MBA in some of the merchant houses of the lower town of Kültepe-Kaniš (Bachhuber 2015, 178). Less unusually for the time period in this area is the actual burial manner, with individuals being buried in *pithoi,* the opening of which was covered with a flat stone (Duru & Umurtak 2011, 35; Duru & Umurtak 2015, 78). Grave goods were sparse, with only a small beak-spouted pitcher being sometimes left with the body in the *pithos* (Duru & Umurtak 2010b, 24; Duru & Umurtak 2011, 35; Duru & Umurtak 2015, 78). The burial patterns do, however, find a parallel outside Anatolia with those of Middle Helladic (2100-1700 BC) Lerna in Greece where the burials were intramural between houses and under floors with pit, cist, and *pithoi* mostly single inhumations sometimes accompanied with artefacts such as vases (Triantaphyllou *et al* 2008, 3028).There has been very little published on the burial habits and grave good assemblages from Bademağacı. Some of the information (such as the location and grave type as seen in Appendix A) comes from the information tags in the bags with the skeletal material which were written during the excavation and removal of the skeletons and are therefore unpublished.

Economy

A decrease is seen in the size of sheep and cattle in the EBA period and it has been hypothesised that this was the result of a loss of vegetation and ecological deterioration as a result of human impact on the plain, such as overgrazing and an increased intensity of arable agriculture (De Cupere *et al* 2008, 386). However, as no palynological research has been conducted it is difficult to prove this (De Cupere *et al* 2008, 386). It has also been suggested that the plain would have been considerably wetter than it is today, and would have been water-logged or even marshy in some places. This has in part been suggested due to the building of the paved section around the settlement which it has been advocated was built to protect the settlement, its inhabitants and their houses/buildings from wet and waterlogged ground, especially during wet/rainy seasons (De Cupere *et al* 2008, 369; Duru & Umurtak 2011, 33; Umurtak 2010, 22).

During the Neolithic period of the settlement it appears that the inhabitants exploited domesticated cattle, sheep, goats, and pigs, and that there was domesticated dog present (Duru & Umurtak 2010, 20). They also appear to have hunted wild cattle, ox, fallow, red, and roe deer, boar, horse, rabbit, hare, fox, wild cats, and bear (De Cupere *et al* 2008, 371-372; Duru & Umurtak 2010, 20). In terms of plant remains the evidence suggests that the Neolithic inhabitants cultivated emmer and einkorn wheat , rye, barley, vetch, lentils, peas, and chickpeas which were supplemented with wild plants such as apples, pears, plums, peanuts, hawthorn, elm, legumes, and flax (Duru & Umurtak 2010, 20). It seems clear that in all phases of occupation, from the Neolithic through to the EBA, that the main animals exploited were domesticates and that hunting played only a very minor role in the subsistence of the inhabitants (De Cupere *et al* 2008, 383). In the EBA period a change is seen in the relative ratios of *ovis/capra* and cattle with the relative amount of cattle bones almost doubling at the expense of *ovis/capra* (De Cupere *et al* 2008, 384). Sheep dominated during the Neolithic period and sheep and goat were discovered in relatively equal ratios for the EBA period whilst pig remains decrease through time with less than 10% of the faunal assemblage being of pig in the EBA (De Cupere *et al* 2008, 384). This decrease in dominance of sheep over time with an increase in the ratio of goat may be explained by the increase in the number of cattle; as a larger cattle herd would have required an increased grazing area around the settlement this would have resulted in competition with the sheep (and goats) resulting in them being forced further away from the settlement to be grazed on the surrounding mountains where the rougher environment would have been more favourable to goats (De Cupere *et al* 2008, 385-386). During the EBA period the majority of domesticated cattle remains are those of females, with a ratio of 6:1, and that cattle were kept to a very old age (De Cupere *et al* 2008, 382). This would suggest that cattle were exploited for their secondary products (such as milk and as draught animals) as well as for meat (De Cupere *et al* 2008, 386). A large proportion of the *ovis/capra* were also kept to maturity which suggests that they were also kept for their secondary products (i.e. milk and/or wool) rather than for meat alone (De Cupere *et al* 2008, 385-386).

2.5 Bakla Tepe Höyüğü

Bakla Tepe is located near the town of Menderes in the province of İzmir in western Anatolia close to the southern end of the fertile Cuma Ovası plain (see Figures 33 and 34) (Erkanal & Özkan 1999, 12; Erkanal 2008, 166; Erkanal 2011, 130; Erkanal & Şahoğlu 2012, 91; Şahoğlu 2008, 484; Şahoğlu & Tuncel 2014, 68; Yaylalı 2002, 113). Bakla Tepe is located on the Gediz River valley which passes through central western Anatolia and its position would have allowed it to control the fertile plain and this strategically important route linking the Anatolian hinterland and the coastal regions of the Aegean Islands (Erkanal & Özkan 1999, 12; Erkanal & Şahoğlu 2012, 91; Şahoğlu & Tuncel 2014, 68; Yaylalı 2002, 116). The Aegean Sea is easily reachable from Bakla Tepe via its narrow valley (Şahoğlu 2005, 347). As can be seen in Figure 35, the area around the site is extremely rich in metal sources with important copper, lead, silver, and gold resources within easy reach of the site (Erkanal 2008, 168; Şahoğlu & Tuncel 2014, 68).

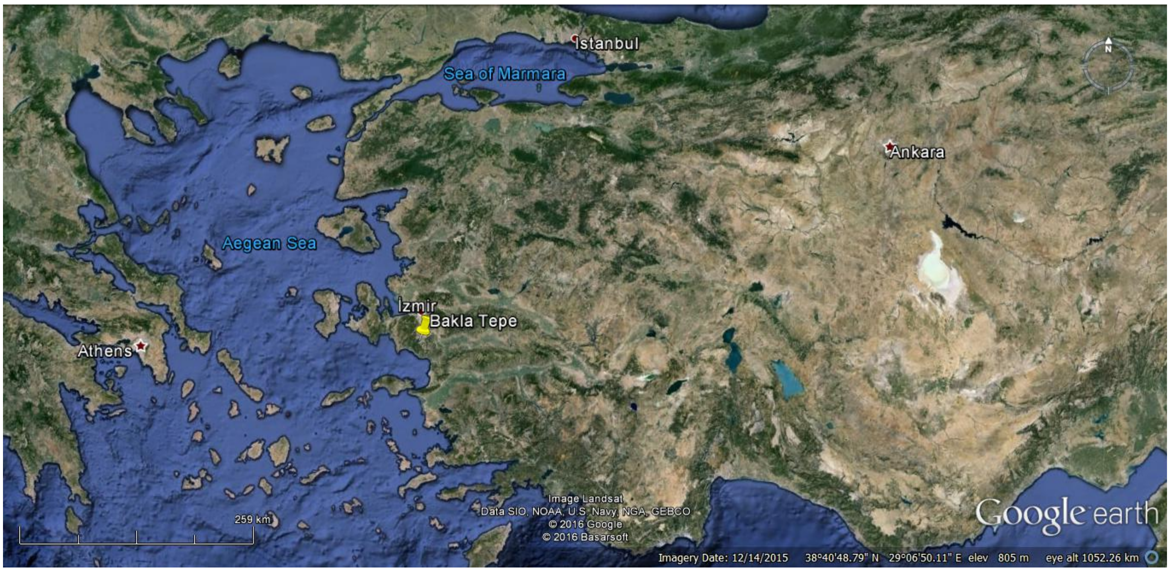


Figure 33: Location of Bakla Tepe in Anatolia. Adapted from Google Earth

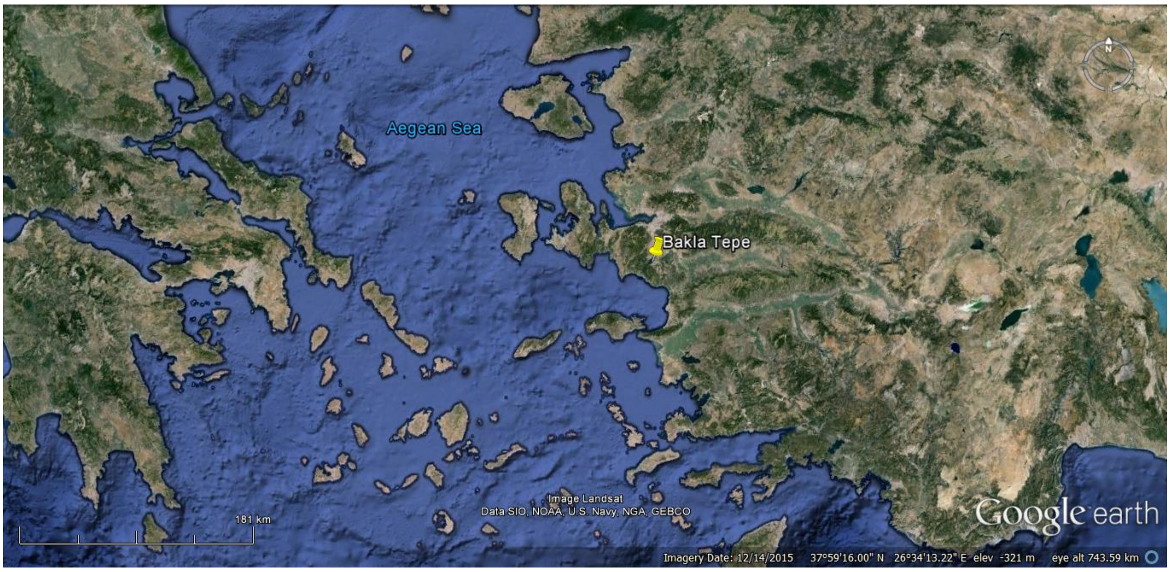


Figure 34: Bakla Tepe, western Anatolia and the Aegean. Adapted from Google Earth

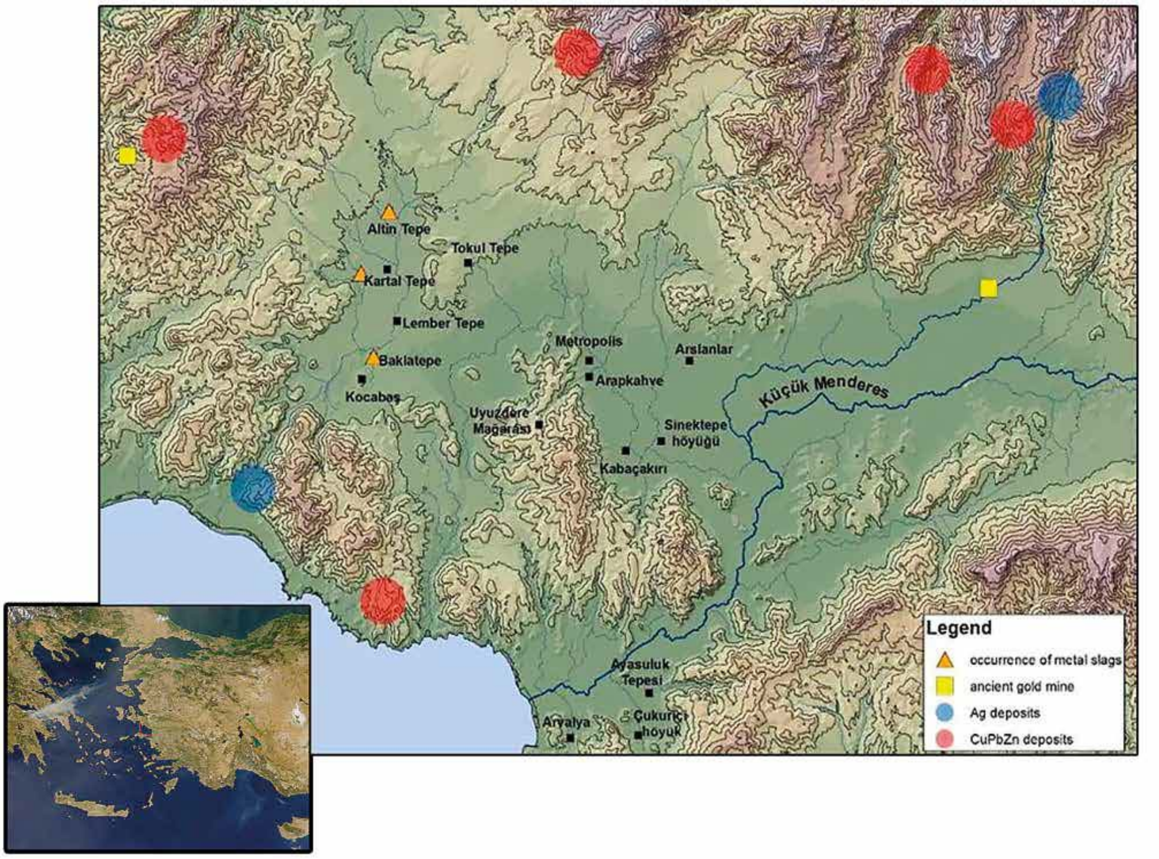


Figure 35: Evidence of metallurgy and metal ore sources in the vicinity of Bakla Tepe. Adapted from Erkanal-Öktü & Erkanal 2015, 201

Excavations were carried out between 1995 and 1998 and again in 2000-2001 within the framework of the İzmir Region Excavations and Research Project (IRERP) under the direction of Hayat Erkanal (previously of Ankara University) and Turhan Özkan (formerly the Directory of the İzmir Archaeological Museum) as part of the Tahtalı Dam Salvage Project (Erkanal 2008, 165-166; Erkanal & Şahoğlu 2012, 91; Kolankaya-Bostancı 2006, 222; Şahoğlu & Tuncel 2014, 68; Yaylalı 2002, 113). The site is now underwater following the completion of construction of the dam (Şahoğlu 2008, 484).

Five main levels have been identified at the site, from the Late Chalcolithic through to the Romano-Byzantine period (Erkanal & Özkan 1999, 13; Erkanal 2008, 166; Erkanal & Şahoğlu 2012, 91; Kolankaya-Bostancı 2006, 222; Şahoğlu 2008, 484; Yaylalı 2002, 113). The settlement was inhabited with some discontinuity from the second half of the 4th millennium BC to the third quarter of the 3rd millennium, with two different settlements and cemeteries belonging to the first and second half of the 3rd millennium BC respectively having been excavated (Şahoğlu & Tuncel 2014, 68). There also seems to possibly be a gap between the EBA I and (late) EBA II period at the site (Şahoğlu 2008, 486). The later periods are limited to a chamber tomb and *pithos* grave of the Late Bronze Age and Roman/Byzantine graves on the EBA I mound (Erkanal & Özkan 1999, 13-16; Erkanal 2008, 166; Şahoğlu & Tuncel 2014, 68).

The site consists of two mounds, a lower mound which is larger and flatter with the Late Chalcolithic settlement, and a smaller higher mound with the EBA I settlement on it (see Figures 36 and 37) (Erkanal-Öktü & Erkanal 2015, 187-188; Şahoğlu & Tuncel 2014, 68). The Late Chalcolithic settlement covers an area 300m in diameter whilst the EBA I settlement extends over and area roughly 100m in diameter (Erkanal 2008, 167-168; Şahoğlu 2008, 484-485; Şahoğlu & Tuncel 2014, 68). As with many settlements in Anatolia radical changes and social transformation are seen at the beginning of the 3rd millennium BC, at Bakla Tepe the EBA I settlement decreases in size from 300m in diameter to 100m in diameter but would have been more densely occupied and was surrounded by a robust fortification wall of mud-brick on a large stone foundation, with a corresponding ditch dug into eastern slope of the mound (Erkanal 2011, 130; Erkanal & Şahoğlu 2012, 93; Kolankaya-Bostancı 2006, 222; Şahoğlu 2008, 485; Şahoğlu & Tuncel 2014, 71 & 77-78).

The population of Bakla Tepe can be very approximately estimated using the total site area, which using the site dimensions we can calculate to be ca. 0.8 ha. When estimating the population size of ancient settlements using persons per hectare there have been numerous published figures (for a summary see Table 1. in Zorn 1994, 34), which if we take the average of the published numbers at 361 persons per hectare then a rough estimation of the population of Bakla Tepe in the EBA I would be 289. Massa (2015, 41) uses an estimate of 300 people/ha to estimate population size meaning a total of 240 inhabitants at the settlement. However, these calculations do not take into account the density, or otherwise, of the settlement with regards to factors such as space within the settlement taken up by monumental buildings (most probably with a low population density), non-residential public buildings, storage buildings, working spaces within households, the number of people per household, the number of households, or non-residential buildings such as workshops.

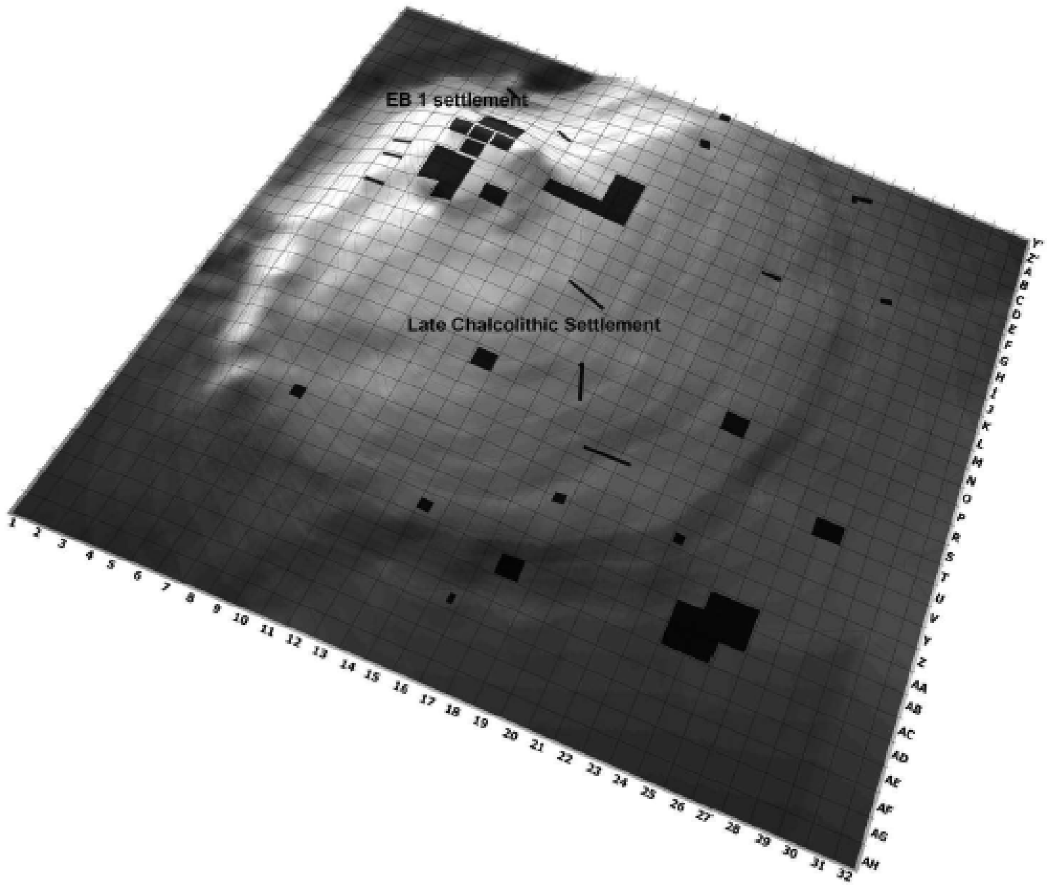


Figure 36: Topographical map of Bakla Tepe showing the location of excavation trenches and the position of the Late Chalcolithic and EBA I settlements. Adapted from Şahoğlu & Tuncel 2014, 67

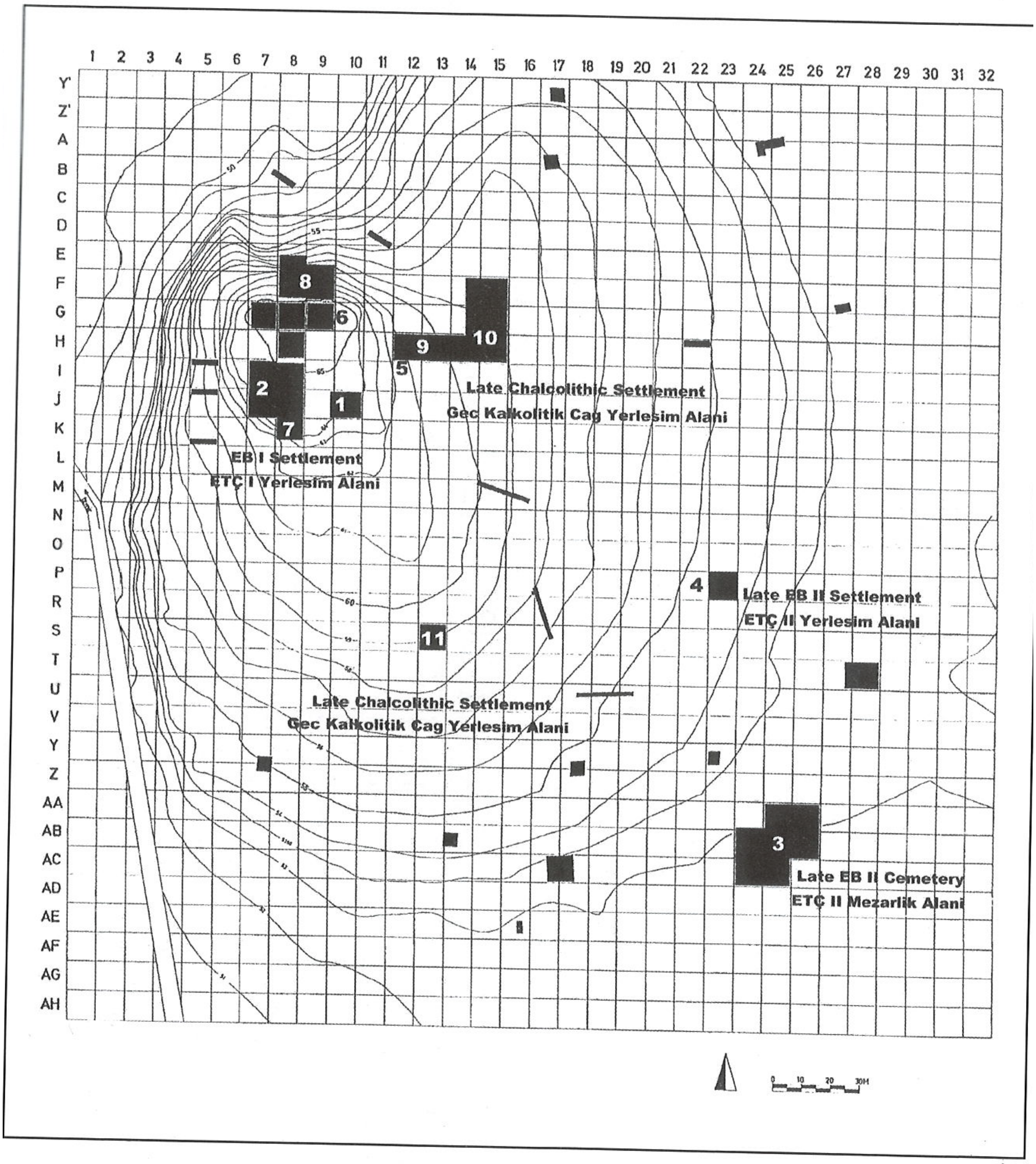


Figure 37: Topographical plan of Bakla Tepe showing Late Chalcolithic and EBA settlements and EBA II/III cemetery. Adapted from Erkanal and Özkan 1999,169.

By using a reduced density coefficient of 200 persons per hectare, the population of Bakla Tepe is more likely to have been lower, ca. 160 people. However, the density of the settlement means that, like at Bademağacı which has a similar settlement layout, the population is more likely to have been at the higher end of the estimation, therefore ca. 240-289 inhabitants. The settlement size (in ha) and the population size means that Bakla Tepe is average for the time period with a typical EBA Anatolian settlement being between 0.3 and 3 ha with a population of 100-1000 people (Massa 2015, 41).The changes of the transition from the Late Chalcolithic to the EBA I period are also reflected in the architecture of Bakla Tepe with evidence of communal effort and organisation and buildings being constructed of a mud-brick super structure built upon thick stone foundations (Erkanal & Şahoğlu 2012, 93; Şahoğlu 2008, 485; Şahoğlu & Tuncel 2014, 77-78). The use of stronger building materials than those in the Late Chalcolithic period, the building of a fortification wall and ditch, and a change in the layout and organisation of the settlement have been argued to be an indication of rising inter-community conflict at the beginning of the 3rd millennium (Şahoğlu & Tuncel 2014, 78). The buildings also change from free-standing ones in the Late Chalcolithic to blocks of long-houses sharing common walls that opened up onto paved streets in the EBA creating a radial pattern (Erkanal 2008, 167; Erkanal 2011, 130; Erkanal & Şahoğlu 2012, 93; Kolankaya-Bostancı 2006, 222; Şahoğlu 2008, 487; Şahoğlu & Tuncel 2014, 77). This type of settlement pattern is very similar to that of Bademağacı, Troy I, Demircihöyük, Küllüoba, and Liman Tepe for example (Erarslan 2008, 178-180). These long-houses were ca. 20m in length and 4.5m wide, with the internal space sometimes partitioned and containing features such as hearths, storage areas, and working areas (Erkanal 2008, 167; Erkanal 2011, 130; Kolankaya-Bostancı 2006, 222). This change in settlement model seen at Bakla Tepe in the EBA I is not related to the arrival of a new ethnic group or similar as there is no cultural interruption in the transitional period, rather it must be explained by the changing social and political structure of the region as similar changes/settlement patterns are also seen at the nearby and contemporary Liman Tepe (Erkanal 2011, 131). Structures defined as communal storage areas are also in evidence during the EBA I at Bakla Tepe (Şahoğlu & Tuncel 2014, 78). There is evidence of specialised craft production with a small obsidian workshop present in southern part of the EBA I settlement, and imported Melian obsidian (from Melos – the most south-westerly island of the Cyclades) continues to be used alongside local flint in the EBA (Kolankaya-Bostancı 2006, 222-223; Erkanal-Öktü & Erkanal 2015, 187; Şahoğlu & Tuncel 2014, 72 & 78). At the nearby and contemporary settlement of Liman Tepe lithic tools of Melian obsidian were found in large numbers from every house (Erkanal & Şahoğlu 2016, 161). The presence of obsidian from Göllü Dağ and Nenezi Dağ in eastern Anatolia (8% of chipped stone assemblage) are further indications of long distance contact and exchange at Bakla Tepe (Massa 2015, 161). There is evidence of rich and advanced metallurgical activity at the settlement including metal burial goods and slags, crucibles, and moulds found in the settlement which all point to a society involved in metallurgical activities and probably related trade (Erkanal 2008, 168; Şahoğlu & Tuncel 2014, 78).

Material culture, interaction, and exchange

In terms of pottery and the ceramic assemblage at Bakla Tepe, the EBA I period sees the emergence and domination of new shapes such as thickened rim bowls with a red/brown slip, and in some cases the apex of the rim is decorated with white painted geometric designs (Şahoğlu 2008, 486). Contact, trade, and cultural interactions with other contemporary sites across Anatolia are witnessed through obsidian (as mentioned above), the ceramic teapots found in the graves at Bakla Tepe, and the presence of fragments of Cycladic 'frying pan' style ceramic items which is an Aegean style that seems to have influenced the potters of Bakla Tepe as well as many of the grave goods from the EBA II graves (discussed in more detail below) which demonstrate a link with both the Aegean and Cyclades, and inner Anatolia (Erkanal 2008, 167; Erkanal & Şahoğlu 2012, 94; Massa 2015, 161, Şahoğlu 2005, 347-349; Şahoğlu 2008, 487; Yaylalı 2002, 117). It has been argued that Bakla Tepe played a key role in the Anatolian Trade Networks of the EBA II-III, acting as a key pivot in the flow of trade and exchange (Şahoğlu 2016, 176).

Figure 38: Bakla Tepe and other regionally important sites (place names with a * are modern settlements). Adapted from Erkanal 2008, 171

The EBA II period at Bakla Tepe is the latter part of the period and into the EBA III period, and the evidence from the site reflects a scattered settlement character (Şahoğlu 2008, 490). There is very little evidence of a late EBA II settlement presence at Bakla Tepe apart from on the eastern end of the Late Chalcolithic mound where a thin layer of occupation succeeding the Late Chalcolithic level was found consisting of the remains of a rectangular structure with a stone foundation (Erkanal 2008, 167; Erkanal & Şahoğlu 2012, 95; Şahoğlu 2008, 490). Trenches excavated on the mound east of the EBA I settlement revealed no architectural features but a lot of fine quality ceramic ware including Western Anatolian fine ware tankards, bell shaped cups, two handled cups, beak spouted jugs and teapots as well as a large number of bronze needles and ceramic idols dated to the late EBA II/early EBA III period (Şahoğlu 2008, 490). Apart from the foundations and the deposit of fine ceramic ware, and the cemetery (discussed below) there is as previously mentioned, very little evidence for late EBA II settlement presence at Bakla Tepe which would suggest a small and dispersed settlement during this period (Şahoğlu 2008, 490-491). As mentioned above, it has been suggested that there is actually an interruption in occupation at the site between the EBA I and late EBA II periods, and it has been hypothesised that the inhabitants of the settlement abandoned it for some reason and moved to another local settlement (possibly Lembertepe or Kocabaş Tepe) but used the area sporadically, and mainly as a cemetery (Erkanal & Şahoğlu 2012, 95).

<u>Burial patterns</u>

The EBA I cemetery is an extramural one located on the eastern/south eastern slope of the mound outside of the fortification ditch (Erkanal 2008, 167; Erkanal & Şahoğlu 2012, 94; Şahoğlu 2008, 485; Şahoğlu & Tuncel 2014, 78). This cemetery was dug into the preceding Late Chalcolithic settlement layers (Şahoğlu 2016, 169). Three different types of grave exist in the EBA I cemetery; pit graves, *pithos* graves, and stone cist graves (Erkanal & Şahoğlu 2012, 94; Massa & Şahoğlu 2011, 167; Şahoğlu 2008, 485; Şahoğlu & Tuncel 2014, 78). The *pithoi* graves (see Figure 39) involve *pithoi* of ca. 1.5m in height with the openings always being faced east and covered with either a large pot sherd or ceramic bowl (as seen at Bademağacı and others – see discussion in Chapter 1.2) and the individuals inhumed in a contracted position with their head towards the east and grave goods always being present (Erkanal 2008, 168; Şahoğlu 2008, 485-486). The *pithoi* do not display any great variation apart from their dimensions, and as can be seen from Figure 39 five vertical handles are placed on both sides of the *pithoi* (Şahoğlu 2016, 170). Another common feature of the *pithoi* burials of the EBA I cemetery are the scattering of cereal grains in the *pithoi* (Şahoğlu 2016, 170).

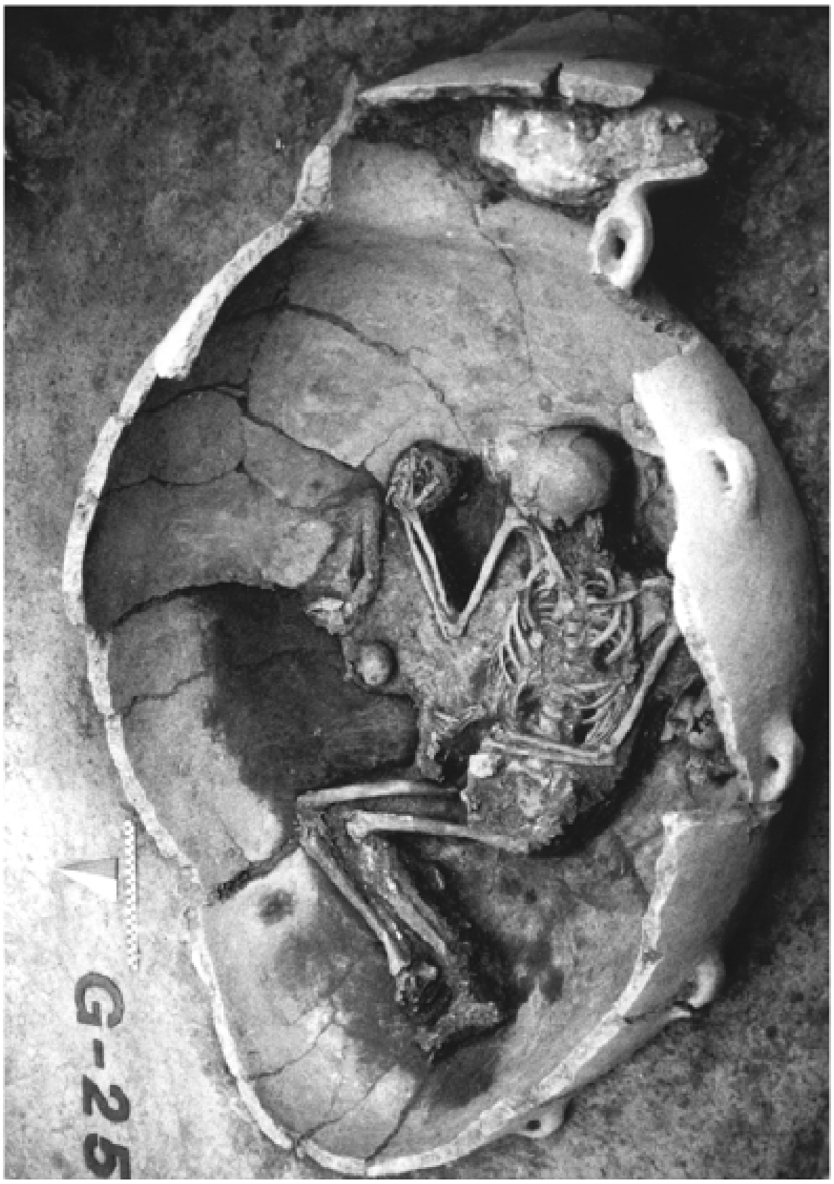


Figure 39: Example of a pithos grave from the EBA I cemetery of Bakla Tepe. Adapted from Erkanal 2008, 175

The cist graves consist of a rectangular stone-lined cist and flat capstones accompanied with vertical standing *pithoi* filled with stones that may have acted as grave markers or had a post-burial ritual purpose (Erkanal 2008, 168; Massa & Şahoğlu 2011, 166; Şahoğlu 2008, 486;

Şahoğlu 2016, 170 & 172). The simple pit graves were sometimes bordered with rows of stones, and like the stone-cist graves and *pithos* graves the individuals were buried in a contracted position with their heads towards the east. Also, like many of the other graves from the EBA I cemetery, the bodies lay upon a layer of sand placed in the bottom of the grave and cereal grains were scattered in the grave (Şahoğlu 2016, 170). However, unlike the other grave types the simple pits were only used once (Erkanal 2008, 167-168; Şahoğlu 2008, 486; Şahoğlu 2016, 172). Şahoğlu thinks that the variation in grave types may be related to the presence of differing cultural traditions within the settlement and an indication of changing political and/or socio-economic conditions with the onset of the EBA as there appears to be no differentiation between the age groups, or sexes, or richness of the burials (Şahoğlu 2008, 486; Şahoğlu 2016, 177; Şahoğlu & Tuncel 2014, 78). Potential stable isotope values and therefore dietary differences between the different grave types of the EBA I cemetery will be examined and discussed in Chapter 5.2.4.

The grave good assemblage in this cemetery is rich (see Figure 40 for a selection of artefacts from the grave good assemblages of both cemeteries), including pearls, black polished ceramic jugs, necklaces of various stones and metal artefacts such as silver and bronze jewellery (earrings and bracelets), bronze needles, bronze daggers, and gold, silver and lead ring idols (Bachhuber 2014, 147; Erkanal 2008, 167-168; Erkanal & Şahoğlu 2012, 94; Erkanal-Öktü & Erkanal 2015, 190; Şahoğlu & Tuncel 2014, 78). The ring idols are of particular importance as they are reminiscent of those found from Central Europe to the Caucasus and demonstrate long-range contact and exchange at Bakla Tepe (Erkanal-Öktü & Erkanal 2015, 190; Şahoğlu 2016, 171). It also seems to be clear that the ceramic vessels found as part of the burial assemblage in the EBA I cemetery were produced solely with the purpose of being grave goods and not meant for every-day use (Erkanal & Şahoğlu 2012, 94).

There is also a late EBA II period cemetery at the site, located to the south/south east of the mound and a shift in burial practices is witnessed as practically all of the inhumations are in *pithoi* facing east, a practise that is common for western Anatolia during this period (Erkanal 2008, 166; Erkanal & Şahoğlu 2012, 95; Massa & Şahoğlu 2011, 167; Şahoğlu 2008, 491; Wheeler 1974, 415; Yaylalı 2002, 114). The mouths of the *pithoi* all face east and were closed with stones (either stone slabs or smaller stones) and some stones were also placed along the side of the *pithoi*; features which when considered along with the fact that most of the graves were re-used and contain multiple inhumations would suggest that the graves were at least partially visible on the surface and/or that the capstones acted as grave markers (Erkanal 2008, 167; Erkanal & Şahoğlu 2012, 95; Şahoğlu 2008, 491; Şahoğlu 2016, 174). As mentioned above, many of the graves include multiple inhumations, and when this is the case the skeletal elements of the previous occupant(s) were pushed to the side of the *pithos* to make room for the next individual, and those individuals which were the final inhumation or those containing single inhumations show that the individuals were buried in a crouched/contracted position (Erkanal 2008, 167; Erkanal & Şahoğlu 2012, 95). It is worth noting that the late EBA II-early EBA III cemetery shows a homogeneity in burial practices which differs from the EBA I cemetery and that this may indicate social or political changes at the settlement in the late EBA II period (Şahoğlu 2008, 491). It must also be noted that the grave goods of the EBA II-III cemetery reflect stronger links with Central Anatolia unlike the preceding phase (Şahoğlu 2016, 177). Grave goods are often quite rich in these graves and include ceramic teapots with basket handles which are relatively common for the time period, and into the following periods, with stylistically comparable examples being found from Troy, Yortan, Aphrodisias, Karataş-Semayük, Polatlı, Demircihöyük-Sarıket, Tarsus, Alaca Höyük, Boğazköy, Kültepe, and Titriş Höyük (Erkanal 2008, 167; Yaylalı 2002, 114 & 117). At Bakla Tepe these teapots are only found in graves and are absent from domestic contexts suggesting they were not used in daily life but instead that their use was limited solely to mortuary practices (Şahoğlu & Tuncel 2014, 78; Yaylalı 2002, 120). Other grave goods include other ceramic items from both the late EBA II and EBA III periods (three-legged bowls, face pots, *depas*, tankards, anthropomorphic vessels, zoomorphic vessels, Western Anatolian red slipped wares, black slipped and burnished wares, and fine wheel-made grey burnished wares), bronze, gold, and silver jewellery (pins, rings, and bracelets), bronze pins and needles, a unique instance of a bird shaped bone seal of a-typical Anatolian shape, and small bronze daggers, razors, and axe heads (Erkanal 2008, 167; Erkanal & Şahoğlu 2012, 95; Massa & Şahoğlu 2011, 168; Şahoğlu 2008, 491; Şahoğlu 2016, 175). There has currently been no comprehensive study of the grave assemblages and the human remains published for either the EBA I or EBA II/III cemeteries. This means it is difficult to assess the presence of different groups based on factors other than grave type, and in the cases of the sample population analysed by myself, sex, age, and traumatic injuries. The only individual who has so far been identified as a possible member of an elite/different socio-/political group is the young adult female of G-296, who will be discussed further in Chapter 5.2.4.

Figure 40: An assortment of artefacts of the grave good assemblages from both EBA cemeteries of Bakla Tepe. Adapted from Erkanal-Öktü & Erkanal 2015, 191

Economy

Bakla Tepe’s economy appears to have depended on agriculture and animal husbandry in the EBA (Erkanal & Şahoğlu 2012, 93; Şahoğlu & Tuncel 2014, 78). The soils of the surrounding environment would have been very fertile and suitable for arable agriculture (Erkanal & Özkan 1999, 35). Although there has been no published archaeobotanical report from Bakla Tepe, initial observations reported the presence of mostly einkorn and emmer wheat as well as some legumes, mostly lentils, and traces of rye (Erkanal & Özkan 1999, 35). In terms of fruit the remains of grapes and figs were discovered, and it has been suggested that olive oil and wine were produced at the site (Erkanal & Özkan 1999, 35). In the Late Chalcolithic (4^{th} millennium BC) layers of Bakla Tepe it is known that hulled wheats were the dominant crops (Oybak-Dönmez 2005, 46).

Similarly there have been no archaeozoological studies published from Bakla Tepe but the presence of many spindle whorls and tools associated with weaving and textile production indicate the importance of this technology and suggest the presence of wool bearing sheep at Bakla Tepe (Erkanal & Özkan 1999, 35). Also, from the sampling of faunal remains from inclusions in grave contexts (see Chapter 4.1.1) indicates the presence of *ovis/capra* and *Bos taurus* at the site.

This chapter has established information for each site regarding location, size, stratigraphy, architecture, trade, material culture, burial habits (and where applicable, skeletal trauma and burial goods/assemblage), the local natural environment, and economy (subsistence production). These kinds of particulars are crucial as they provide the context for the skeletal sample population and the resulting stable isotope data which will be approached and discussed in Chapters Five and Six.

It should be clear from this chapter that there are many differences between the selected sites ranging from the obvious such as size - Titriş Höyük for example is much larger than the other three - to differences in settlement layout, local environment, and a range of burial patterns. There are also similarities, such as the presence of metals, similar forms/types in the ceramic assemblage, interconnectivity by long distance trade and exchange, and subsistence practices which are focused on mixed arable and livestock agriculture.

Chapter Three: Theory and Application of Methodology

3.1 Introduction to Isotopes

Stable isotopes have many applications in several different fields, and even within archaeology there are numerous applications including climate and environmental reconstruction (Fiorentino *et al* 2008, 51; Szpak *et* al 2013, 1; Thompson *et al* 2005, 452; Trella 2010, 292), reconstruction of dietary habits and subsistence patterns (Choy *et al* 2015, 314; Knudson *et al* 2012, 435; Pollard *et al* 2007, 21; Reitsema & Vercellotti 2012, 589; Slovak & Paytan 2011, 253; Stonge 2012, 26; Szpak *et al* 2013, 1; Thompson *et al* 2005, 452; Trella 2010, 292) and mobility (Knudson *et al* 2012, 435; Pollard *et al* 2007, 21; Reitsema & Vercellotti 2012, 590; Stonge 2012, 26; Szpak *et al* 2013, 1). The reconstruction of dietary habits and subsistence patterns are the most important to this thesis and therefore will be dealt with and discussed below in the most detail.

Following on from Chapter 1.1 which provided a concise history to stable isotope research and its application in archaeological studies, this chapter will outline a brief background to what stable isotopes are, how they function (i.e. the theoretical understanding behind them) as well as how the analysis of stable isotopes can be applied to research questions in archaeology, such as dietary habits in the context of this research.

Before the application of stable isotopes to research can be understood, stable isotopes themselves must first be understood. In any atom of a given element there are several components; protons, electrons, and neutrons, the number of each are what give the atom (and element) their individual properties (Pollard *et al* 2007, 33). The number of protons and electrons (all atoms have equal numbers of each) is known as the ‘Z’ number, the number of neutrons is known as the ‘N’ number, and the atomic mass (‘A’ number) can be calculated by ‘Z+N’ (Faure & Mensing 2005, 5; Stonge 2012, 26). Atoms with the same ‘Z’ number (number of protons), but different ‘N’ numbers (number of neutrons) are called isotopes (Faure & Mensing 2005, 5; Hoefs 1997, 1; Stonge 2012, 26). The result being that the isotopes have (more often than not) the same chemical and physical properties as the element, but different masses (Faure & Mensing 2005, 5; Stonge 2012, 26). Many elements have two or more naturally occurring isotopes (Faure & Mensing 2005, 5). Isotopes can either be stable (300 in number), or unstable (over 1200 in number) (Hoefs 1997, 1). Unstable isotopes are simply those isotopes whose nuclei change spontaneously, i.e. they are radioactive (Pollard *et al* 2007, 124).

The most effective way to measure the ratios of stable isotopes is mass spectrometry (Hoefs 1997, 19; Pollard *et al* 2007, 160). Mass spectrometry is the measurement and interpretation of certain elements in natural materials by measuring their masses and abundances (Faure & Mensing 2005, 64). Mass spectrometry as such relies on an isotope's differing masses and is performed using a mass spectrometer, which is "an instrument designed to separate charged atoms and molecules on the basis of their masses based on their motions in magnetic fields" (Faure & Mensing 2005, 64). A mass spectrometer has four main parts: an inlet system, an ion source, a mass analyser and an ion detector (Hoefs 1997, 19). A mass spectrometer works by releasing ionised molecules into a beam which is then collected through a magnetic field which deflects ions into circular paths whose radii are proportional to the masses of the isotopes – the heavier ones are deflected less than the lighter ones (Faure & Mensing 2005, 64-65). In other words an isotope mass spectrometer is used to measure the relative differences in isotopic ratios; the ratio of heavy to light is then expressed as a value relative to a set standard (O'Leary 1981, 553; Stonge 2012, 27). The resulting signal from the mass spectrometer consists of a series of peaks and troughs that form the mass spectrum of the element, with the height of the peaks being proportional to the relative abundances of the isotopes (Faure & Mensing 2005, 64-65).

As detailed below in the following sections of this chapter the ratio of stable isotopes is expressed using the delta sign (δ) and measured as parts per-mil (‰) (Pollard *et al* 2007, 170; Tykot 2004, 434). A positive δ value indicates that the sample has a greater heavy to light isotope ratio than the standard and vice-versa (Pollard *et al* 2007, 170; Stonge 2012, 28). For example if a sample has a $\delta^{13}C$ value of -13.2‰ this means that is has a ^{13}C:^{12}C ratio 13.2‰ lower than the standard (Stonge 2012, 28).

3.2 Methods of Assessing Diet

Dietary habits can be analysed using many methods but this study concentrates on methods using stable isotope analysis. Whilst methods like the analysis of ethnographic, textual records, archaeozoological and archaeobotanical remains can tell us what resources were available, stable isotope analyses provides a direct measure of the broad categories of foods that were actually exploited (Stonge 2012, 2; Thompson *et al* 2005, 452). Stable and radiogenic isotope analysis can be used to reconstruct palaeodiet over the course of an individual's lifetime (Choy *et al* 2015, 314; Knudson *et al* 2012, 438) – "Stable isotope analysis of protein [collagen] extracted from human bone provides direct information on the diet people had during their lifetime" (Triantaphyllou *et al* 2006, 629). The chemical composition of bones is determined by the foods we eat: there is a linear relationship between the isotopic composition of a consumer's tissues and their diet (Tykot *et al* 2009, 157). In general 'you are what you eat, plus or minus a few mill' (Hoefs 1997, 138). The two stable isotopes primarily used for dietary reconstruction are those of carbon (C) and nitrogen (N) as the C and N isotopic compositions of consumer tissues are directly related to the C and N isotopic composition of the foods consumed (Ingvarsson-Sundström *et al* 2009, 2; Knudson *et al* 2012, 438; Szpak *et al* 2013, 1). Increasingly sulphur (S) is also being used in palaeodietary studies, especially to supplement the isotopic measurements of C and N (Nehlich 2015, 2; Richards *et al* 2003, 38). Sulphur can be utilised in palaeodietary reconstruction studies as the stable isotope composition ($\delta^{34}S$) of sulphur in human and animal tissues reflects the $\delta^{34}S$ values of the foods consumed (Richards *et al* 2003, 37). As shall be discussed below, for C and N the estimation of dietary reconstruction relies on the different isotopic values/signals provided by differing sources and abundances of C and N in dietary intake. These differing signals can also be a result not only of the dietary intake but also of factors such as breastfeeding and weaning (Reitsema & Vercellotti 2012, 590; Stonge 2012, 26; Turner *et al* 2007, 2) and terrestrial vs. marine resources (Knudson *et al* 2012, 438; Somerville *et al* 2013, 1541). Carbon and nitrogen isotope ratios vary by food category and these differences are recorded in human body tissue (Slovak & Paytan, 2011) and it is these, often, distinctly different ranges that enable an accurate and reliable estimation of an individual's diet over their lifetime (Reitsema & Vercellotti 2012, 590). In essence C and N isotope analyses of archaeological skeletal remains are based on the well tested premise and understanding that isotopic ratios in human bones and teeth will reflect the isotopic composition of an individuals' diet (Britton *et al* 2008, 2112; Slovak & Paytan 2011, 253; Somerville *et al* 2013, 1540). More recent feeding experiments under controlled conditions have shown that there is a quantitative relationship between the C and N isotopic content of the tissues of a terrestrial mammal and its average diet (Drucker & Bocherens 2004, 163). However, it is accepted that there is some variation and range in the differences between the isotopic signature of an animal and its average diet: for example under experimental conditions a range of 3.7 to 6.0‰ was found for the $\delta^{13}C$ values between diet and collagen and a range of 1.7 to 6.9‰ for the $\delta^{15}N$ values (Drucker & Bocherens 2004, 163-164). It should also be noted here that the limitation of stable isotope analysis of bone collagen is that it provides an *overview* of an individual's diet, but cannot provide the specific composition (i.e. individual meals/particular food stuffs) of the diet. Furthermore, stable isotope analysis of bone collagen is most effective when used on a comparative basis. This includes utilising stable isotope analyses in conjunction with other forms of data (e.g. archaeobotany, archaeozoology, and osteoarchaeology) to provide contextual information for the isotope data to help build up a food web of possibly exploited resources to aid in making inferences and drawing conclusions. Furthermore, stable isotope analysis is most effective when used comparatively in large datasets – the stable isotope data from one individual may be interesting but in reality provides little information to assist in solving intra- and inter-population questions. These caveats will be discussed and approached in more depth in Chapters Five to Seven.

3.2.1 Carbon Stable Isotope Analysis

Carbon is present in five main states - reduced form in organic compounds and coal, oxidised state (mainly CO_2), carbonate ions in aqueous solutions, carbonate minerals, and graphite and diamonds (Hoefs 1997, 38; Stonge 2012, 28-29). Carbon has two stable isotopes; ${}_{6}^{12}C$ and ${}_{6}^{13}C$ (Faure & Mensing 2005, 619; Hoefs 1997, 38) with a relative natural abundance of 98.89%:1.11% (O'Leary 1981, 553; Stonge 2012, 29). The ratios of these two stable isotopes can be used to examine the carbon source intake of animals and humans. The isotopic composition of C is expressed by the ${}^{13}C/{}^{12}C$ ratio (R) which can be measured using a mass spectrometer (Faure & Mensing 2005, 619). The value of ordinary terrestrial C is 0.01112 ($R = \frac{1.10}{98.90}$), but as this is quite an awkward number it is instead expressed by the $\delta^{13}C$ parameter defined as the per-mill difference between the isotope ratios of the sample and a set C standard: i.e. $\delta^{13}C‰ = (\frac{Rspl - Rstd}{Rstd}) \times 10^3$ (where *Rspl* = Ratio of the sample and *Rstd* = Ratio of the standard) (Faure & Mensing 2005, 619; O'Leary 1981, 553). In other words, the C isotopes in bones (and teeth) are expressed as $\delta^{13}C$ and reflect the abundance of ${}^{13}C$:${}^{12}C$ in the diet (Turner *et al* 2007, 2). In the case of C the ratios ($\delta^{13}C$) are expressed relative to the Peedee Belemnite (PDB) standard, which is a Belemnite fossil from the Pee Dee formation in South Carolina (Choy *et al* 2015, 316; Fiorentino *et al* 2012, 329; O'Leary 1981, 553; Somerville *et al* 2013, 1542; Stonge, 2012). The isotope ratio for the PDB is $\delta^{13}C$ 0.01124 (O'Leary 1981, 553). The $\delta^{13}C$ values in most biological systems are negative; i.e. depleted in ^{13}C compared to the PDB (O'Leary 1981, 553; O'Leary 1988, 328; Stonge 2012, 28). As a result, a less negative figure means that the sample is richer in ^{13}C (O'Leary 1981, 553).

Using the ratio of the stable isotopes of C relies primarily on the differing fractionation processes during photosynthesis (Szpak *et al* 2013, 4; Vogel 1980, 112), which is one of the primary natural ways of fractionation of C along with exchange reactions between different inorganic C compounds (Stonge 2012, 29). Fractionation is when the heavier mass of an isotope means that it is less likely to take part in processes such as photosynthesis or evaporation (Pollard *et al* 2007, 170). If we take evaporation as an example, the remaining liquid will be slightly enriched in the heavier isotope whilst the resulting vapour will be depleted in the same isotope (Pollard *et al* 2007, 170). The process of photosynthesis produces biologically synthesised organic compounds that are depleted of ^{13}C to varying degrees (Stonge 2012, 29). Plants preferably absorb $^{12}CO_2$ from the atmosphere during photosynthesis and discriminate against the heavier $^{13}CO_2$ (Faure & Mensing 2005, 619; Lee-Thorp *et al* 2003, 105; O'Leary 1981, 553; O'Leary 1988, 328; Szpak *et al* 2013, 4). This ultimately means that due to the fractionation of C isotopes during photosynthesis that plant tissues are depleted in ^{13}C relative to the $^{12}CO_2$ of the atmosphere (Faure & Mensing 2005, 619; Stonge 2012, 29). Furthermore the different ways in which different types of plants metabolise CO_2 during photosynthesis produce distinctly different ranges of $\delta^{13}C$ values (Bourbou & Richards 2007, 63; Budd *et al* 2013, 862; Choy *et al* 2015, 315; Hoefs 1997, 134; Ingvarsson-Sundström *et al* 2009, 2; Knudson *et al* 2012, 438; O'Leary 1981, 558; Somerville *et al* 2013, 1541; Stonge 2012, 29; Szpak *et al* 2013, 4; Thompson *et al* 2005, 452; Triantaphyllou *et al* 2006, 630; Vogel 1980, 112) which enables analysis and estimation of the different types and abundances of vegetation intake in the diet. As the C isotopic signatures of all consumers originate from plants as they are the base of all terrestrial food-webs (Stonge 2012, 32), the $\delta^{13}C$ values can be either as a result of direct consumption or via a vector such as an animal; herbivores incorporate consumed plant carbon into their tissues, which then reflects the proportion of C3 and C4 plants eaten (Lee-Thorp *et al* 2003, 105). Therefore, plants account for the majority of $\delta^{13}C$ variation of human collagen, and some of the $\delta^{15}N$ variation (Schwarcz & Schoeninger 2011, 729). The relative differences can be seen below in Table 2 in the example of the range of $\delta^{13}C$ values of carbon-bearing compounds in nature:

Table 2: Range of δ13C ‰ values for carbon-bearing compounds in nature. Following Faure & Mensing 2005, 620

Compound in Nature	***$\delta^{13}C$ ‰ (relative to the PDB standard)***
Land Plants (C3)	-35 to -20
Land Plants (C4)	-12 to -10
Collagen, Animal Bone	-20 to -18

As can be seen from Table 2 there are two main groups of terrestrial plants; C3 and C4. There is a variability in the $\delta^{13}C$ values of C3 and C4 plants due to several factors including environmental ones (CO_2 concentration, water availability, precipitation, atmospheric humidity, sunlight, temperature, and soil pH), growth form (e.g. deciduous or coniferous), and genetics (Fiorentino *et al* 2008, 51; Fiorentino *et al* 2012, 328; Stonge 2012, 31). Well-nourished plants can show more positive $\delta^{13}C$ values than those deficient in nitrogen or potassium for example (O'Leary 1981, 555). As a result $\delta^{13}C$ values can vary between 3 and 12‰ within a single species of plant (Stonge 2012, 31). There is also a variation in the $\delta^{13}C$ values amongst the different parts of the plant, i.e. between the leaves, stem, and root (Stonge 2012, 31); however, averaged out of the course of an individual's dietary consumption this difference is negligible. The most common (over 90% of all plants) (Hoefs 1997, 41) terrestrial plants (including most cereals such as wheat and barley, rice, legumes, all root crops, vegetables, nuts, honey, and fruits) belong to the C3 group, and they metabolise CO_2 using the Calvin cycle (Faure & Mensing 2005, 755; Ingvarsson-Sundström *et al* 2009, 2; Knudson *et al* 2012, 438; Somerville *et al* 2013, 1541; Stonge 2012, 29; Szpak *et al* 2013, 4; Thompson *et al* 2005, 452). The C3 group of plants discriminates against $^{13}CO_2$ more than C4 plants (Lee-Thorp *et al* 2003, 105; O'Leary 1981, 564). They have $\delta^{13}C$ values that range from -20‰ to -35‰ relative to the PDB with a mean of roughly -27‰ (Faure & Mensing 2005, 755; Fiorentino *et al* 2008, 53; Hoefs 1997, 41; Ingvarsson-Sundström *et al* 2009, 2; Lee-Thorp *et al* 2003, 105; O'Leary 1981, 554; Slovak & Paytan 2011, 255; Stonge 2012, 30; Szpak *et al* 2013, 4; Thompson *et al* 2005, 452). Plants in the C4 group utilise the so called Hatch-Slack pathway to metabolise CO_2 and include aquatic, desert/arid adapted, saltmarsh, and tropical grasses (Faure & Mensing 2005, 755; Ingvarsson-Sundström *et al* 2009, 2; Lee-Thorp *et al* 2003, 105; Knudson *et al* 2012, 438; Somerville *et al* 2013, 1541; Stonge 2012, 30; Szpak *et al* 2013, 4; Thompson *et al* 2005, 452). C3 plants tend to be more environmentally sensitive than C4 plants (Stonge 2012, 31). C4 plants tend to generally be more abundant at lower altitudes and areas with/receiving low amounts of rainfall (Szpak *et al* 2013, 17). The most commonly known domesticated C4 plants (especially regarding prehistoric diet) are maize and sugarcane (Knudson *et al* 2012, 438; Somerville *et al* 2013, 1541; Szpak *et al* 2013, 4). However as they are often referred to as 'New World' crops owing to their geographic origins they are of little significance to this study. But there are some wild grasses present in ancient (and modern) Anatolia which are from the C4 group as well as the crop grasses sorghum (*Sorghum bicolor*) and millet (*Panicum miliaceum*) (Choy *et al* 2015, 316; Ingvarsson-Sundström *et al* 2009, 2; Reitsema & Vercellotti 2012, 597; Soltysiak & Schutkowski 2015, 178; Stonge 2012, 30; Szpak *et al* 2013, 4). Millet is known to have become a main arable domesticate in the LBA and Iron Ages (Gurova 2014, 344; Nesbitt & Summers 1988, 87 & 92; Riehl 2009, 112; Soltysiak & Schutkowski 2015, 176; Stika & Heiss 2013, 361-362). The presence of C4 signals in an EBA diet can perhaps give indications of a preliminary introduction/consumption of these crops as well as animal grazing habits and wild vs. domesticate plant intake. The $\delta^{13}C$ values of animal food resources (such as mutton, beef, and dairy) will reflect the carbon stable isotope ratios of the animal's dietary inputs (Chesson *et al* 2011, 708). The analysis of $\delta^{13}C$ values are often used in conjunction with $\delta^{15}N$ values to reconstruct dietary habits from the isotopic analysis of skeletal collagen, and combined they can be a very powerful tool (Pollard *et al* 2007, 172). High $\delta^{13}C$ values, and relatively low $\delta^{15}N$ values, may be indicative of C4 plants in the diet, or consumption of animals foddered on C4 plants (Reitsema & Vercellotti 2012, 597). Plants in the C4 group are less depleted in $\delta^{13}C$ than C3 plants and therefore have less negative $\delta^{13}C$ values (O'Leary 1981, 554) between -6‰ and -23‰ with a mean of -13‰ (Faure & Mensing 2005, 755; Ingvarsson-Sundström *et al* 2009, 2; Lee-Thorp *et al* 2003, 105; O'Leary, 1981; Slovak & Paytan 2011, 255; Stonge 2012, 30; Szpak *et al* 2013, 4; Thompson *et al* 2005, 452). There has however been a decrease in the $\delta^{13}C$ values of C3 and C4 plants of approximately 1.5‰ over the last 150 years since the industrial revolution due to an increase in CO_2 in the atmosphere as a result of fossil fuels which are depleted of ^{13}C relative to the atmospheric CO_2 (Stonge 2012, 31). This means that in order to compare archaeological and modern plant data $\delta^{13}C$ values must be increased by 1.5‰ (Stonge 2012, 31).

Whilst the (relatively) distinctive values of C3 and C4 plants enable differentiation to be made when estimating dietary plant sources there is a slight enrichment that one has to be aware of. In terrestrial ecosystems C isotope values in bone collagen will be roughly 4‰ more positive than the $\delta^{13}C$ (‰) values of the plants consumed, and in carnivores this enrichment is approximately 1.5‰ more positive than the prey they consume (Drucker & Bocherens 2004, 164; Hoefs 1997, 137; Slovak & Paytan 2011, 255). Overall, the $\delta^{13}C$ values of collagen are generally observed to be ca. 2-3‰ higher than the bulk tissue of the diet (Schwarcz & Schoeninger 2011, 728). However, $\delta^{13}C$ values are not seen as an accurate indicator of trophic level (i.e. position in the food chain) as the enrichment is not only very small between trophic levels (only 0 to 2‰), but can also be variable (McCutchan *et al* 2003, 381; Stonge 2012, 32). Instead, as will be discussed in 3.2.2, N isotopic signatures are used for distinguishing and examining trophic levels, their enrichments and differences, and how these can be used in dietary habit analyses. Overall an individual consuming predominantly terrestrial C3 plants and the meat and/or milk of animals consuming the same terrestrial C3 plants should have bone collagen $\delta^{13}C$ values of approximately -20 to -21‰ (Budd *et al* 2013, 862). Values for individuals in northern Europe are approximately 1-2‰ lower than those in southern Europe (Budd *et al* 2013, 862). This is because on a global scale the $\delta^{13}C$ values of Holocene bone collagen, charcoal, and wood samples across Europe vary from north to south and east to west, which has been explained by latitudinal differences and oceanic influences on climate (Pollard *et al* 2007, 178). For example, with bone collagen, the average $\delta^{13}C$ value for archaeological samples from Spain is -18.9‰ whilst they are -20.8‰ from Sweden (Pollard *et al* 2007, 178).

Carbon isotopes can also be used to identify the input of marine resources in the diet as there are significant differences between the C isotopic values of marine and terrestrial resources (Bourbou & Richards 2007, 63; Budd *et al* 2013, 862; Choy *et al* 2015, 316; Hoefs 1997, 133; Knudson *et al* 2012, 438; O'Leary 1981, 555; Reitsema & Vercellotti 2012, 598; Stonge 2012, 32; Thompson *et al* 2005, 452). Mammals consuming only marine protein have a $\delta^{13}C$ enrichment of 7‰ as opposed to those consuming a solely terrestrial diet (Choy *et al* 2015, 316; Schwarcz & Schoeninger 2011, 732; Triantaphyllou *et al* 2006, 630). This is because the main C source for marine plants and animals (dissolved CO_2) has a $\delta^{13}C$ value of approximately 0‰, whereas atmospheric CO_2 (main source of C for terrestrial organisms) has a $\delta^{13}C$ value of -7‰ (Triantaphyllou *et al* 2006, 630). This means that protein derived from marine resources should have collagen $\delta^{13}C$ values of approximately -12‰ ± 1 (Budd *et* *al* 2013, 862). However, as discussed below it can be easier and more accurate to use δ^{15}N values to distinguish between marine and terrestrial diets, and even more so for sulphur. Distinguishing between terrestrial and freshwater resources is notoriously tricky using C and N alone as the values mimic those of terrestrial δ^{13}C values, but with high δ^{15}N values like marine organisms (Triantaphyllou *et al* 2006, 631). However, this means that a freshwater consumer may look like that of a terrestrial plant consumer with a marine protein component in their diet. The introduction of sulphur isotopic analysis has begun to solve this problem and bridge this gap of anomaly.

The values of δ^{13}C can also be used to determine the environmental conditions in which the plants grew in. For example low growing plants under dense forest canopy/cover tend to exhibit lower (more negative) δ^{13}C values than canopy plants (Ambrose & Krigbaum 2003, 196; O'Leary 1981, 553; Szpak *et al* 2013, 4) and those growing in a more open environment with the differences ranging between 2 and 5‰, which can be used to reflect the use of closed and open habitats (Szpak *et al* 2013, 4). For C3 plants water availability is negatively correlated with the C isotopic composition of plants (Fiorentino *et al* 2012, 328; Szpak *et al* 2013, 4). Furthermore foliar δ^{13}C values tend to increase with increasing altitude (Szpak *et al* 2013, 4). Also, due to the fact that photosynthesis in plants is affected by temperature and relative humidity δ^{13}C values tend to be more negative in hot and dry conditions and more positive in cool and/or wet conditions (Trella 2010, 292). Whilst these factors are in general more useful for environmental, ecological and climatic reconstructions it is useful for those analysing dietary habits utilising stable isotopes to be aware of such influences as the δ^{13}C values of the consumers/individuals' tissue will reflect/are influenced by the proportions of those plant categories consumed as a dietary source in life (Somerville *et al* 2013, 1541).

Finally, C ratios and values can be dependent on human biological and physiological characteristics. There are two main components that make up human bone; collagen, 90% of the organic component, (30-40% by weight in living bone), and hydroxyapatite, the inorganic part, (70% by weight) (Schwarcz & Schoeninger 2011, 717; Slovak & Paytan 2011, 255; Somerville *et al* 2013, 1541; Stonge 2012, 40). Collagen is formed from three non-essential amino acids: glycine, proline, and hydroxyproline (Stonge 2012, 40). Non-essential amino acids can be synthesised from other biochemical precursors whereas essential amino acids cannot be synthesised by the organism and must be obtained from the diet (Stonge 2012, 40). Essential amino acids account for 22.3% of C atoms in collagen and must be derived solely from dietary protein (Stonge 2012, 40). Carbon isotopes from apatite and collagen provide different information on the consumers' diet (Somerville *et al* 2013, 1541). There are three main macronutrients in foods between which ^{13}C varies; carbohydrates, lipids (which are depleted in ^{13}C relative to carbohydrates by 2‰), and proteins (which are typically enriched in ^{13}C relative to carbohydrates by 4‰) (Hoefs 1997, 42; Stonge 2012, 41). Collagen, as aforementioned, is comprised of amino acids that derive from ingested food and preferentially reflects the protein component of the human diet as C from protein is preferentially routed to bone collagen when sufficient protein is available (Budd *et al* 2013, 862; Knudson *et al* 2012, 438; Reitsema & Vercellotti 2012, 597-598; Slovak & Paytan 2011, 255; Somerville *et al* 2013, 1541; Stonge 2012, 42; Thompson *et al* 2005, 452; Triantaphyllou *et al* 2006, 630; Turner *et al* 2007, 15). At least 51.3% of dietary proteins are routed to bone collagen (Stonge 2012, 42). A low protein diet will result in an increased synthesis of non-essential amino acids which will in turn produce a collagen $\delta^{13}C$ value less similar to the actual protein portion of the diet than a high protein diet would (Stonge 2012, 42). Carbon isotope values in bone collagen reflect the lifespan of C atoms in collagen which is approximately the last 10-30 years of life (Budd *et al* 2013, 862; Schwarcz & Schoeninger 2011, 733; Slovak & Paytan 2011, 255; Thompson *et al* 2005, 452); in other words a lifetime average (Britton *et al* 2008, 2112; Nehlich 2015, 8; Stonge 2012, 48; Turner *et al* 2007, 18). One of the downsides of this long term averaging effect due to the slow turnover rate of (adult) organic bone components is that cyclical variations between C3 and C4 plants is not very visible in the $\delta^{13}C$ values of bone collagen (Turner *et al* 2007, 6). Carbon isotope values in hydroxyapatite reflect carbon sources of the whole diet (Balasse 2002, 155; Knudson *et al* 2012, 438; Slovak & Paytan 2011, 255; Somerville *et al* 2013, 1541; Stonge 2012, 47-48; Tykot *et al* 2009, 160). Carbon atoms from all macronutrients, including protein, carbohydrates and lipids are utilised to synthesise mineral apatite, while 3/5 of C atoms in collagen are routed from dietary protein, the remainder coming from other macronutrient sources (Slovak & Paytan 2011, 255; Somerville *et al* 2013, 1541; Tykot *et al* 2009, 160).

3.2.2 Nitrogen Stable Isotope Analysis

Nitrogen occurs in biogenic organic molecules, including amino acids and proteins (Faure & Mensing 2005, 803). It has two stable isotopes; ^{14}N and ^{15}N with a natural abundance of 99.64%:0.36% (Faure & Mensing 2005, 805, Hoefs 1997, 44; Stonge 2012, 34). Nitrogen is most common as the diatomic molecule N_2 present in the atmosphere and oceans (Hoefs

1997, 43; Stonge 2012, 34). In soils and aqueous environments N occurs as nitrate (NO_3), ammonium (NH_4), ammonia (NH_3), oxides (NO_2, NO, N_2), and as amino acids (Stonge 2012, 34).Nitrogen in lakes and rivers takes the form of ammonia, protein, nitrate, and amino acids in solution (Stonge 2012, 35). N_2 is the least reactive form of N and therefore must be fixed for use in biological systems by microorganisms into useable forms such as nitrate and ammonium (Hoefs 1997, 44; Stonge 2012, 35). As with C, N isotopic values are expressed as a ratio between the two stable isotopes ^{15}N and ^{14}N ($\delta^{15}N$) and expressed in parts per mill. They are also expressed relative to a standard, in this case AIR (Ambient Inhalable Reservoir) which has a value of 0‰ (technically 0.003675‰) (Choy *et al* 2015, 316; Fiorentino *et al* 2012, 329; Somerville *et al* 2013, 1542; Stonge 2012, 28). The $\delta^{15}N$ values in most biological systems are positive (Stonge 2012, 28).

The isotopic composition of N in animals is affected by their diets and depends on the balance between inputs (i.e. food) and outputs (i.e. waste excretion through urination, and defecation as well as being eaten or milked) of N-bearing compounds (Faure & Mensing 2005, 808). Animal tissue is enriched in ^{15}N relative to dietary inputs; ^{15}N enrichment is propagated up the food-chain and may also increase with the age of the animal (Faure & Mensing 2005, 808). As such $\delta^{15}N$ values reflect the trophic level effects in protein intake associated with the position of organisms in food webs (Bourbou & Richards 2007, 63; Hoefs 1997, 138; Ingvarsson-Sundström *et al* 2009, 2-3; Reitsema & Vercellotti 2012, 590; Schoeninger & DeNiro 1984, 633; Somerville *et al* 2013, 1541; Thompson *et al* 2005, 452; Turner *et al* 2007, 2; Tykot *et al*, 2009). Furthermore the enrichment in $\delta^{15}N$ values is a stepwise increase with the ascending positions in the trophic system (Budd *et al* 2013, 863; Choy *et al* 2015, 316; Somerville *et al* 2013, 1541; Stonge 2012, 38; Tykot *et al* 2009, 160). This ultimately means that N isotope ratios ($\delta^{15}N$) in bone collagen reflect the contribution and source of dietary protein (Ingvarsson-Sundström *et al* 2009, 2-3; Somerville *et al* 2013, 1541; Turner *et al* 2007, 15). The $\delta^{15}N$ values of herbivores for example are enriched by 2-5‰ relative to their diet as the bonds of amino acids containing ^{14}N break more readily than those with the heavier ^{15}N isotope, meaning a preferential excretion of ^{14}N over ^{15}N (Budd *et al* 2013, 863; Drucker & Bocherens 2004, 164; Somerville *et al* 2013, 1541; Stonge 2012, 38; Thompson *et al* 2005, 452). This in due course results in the consumer having a higher ratio of ^{15}N:^{14}N than the food it consumes (Somerville *et al* 2013, 1541). As with herbivores and their food, each step-wise enrichment up the trophic levels is roughly 2-5‰, so therefore carnivores will have 2-5‰ higher enrichment levels than their prey in terms of their $\delta^{15}N$

values (Budd *et al* 2013, 863; Choy *et al* 2015, 316; Hoefs 1997, 138; Richards *et al* 2005, 392; Somerville *et al* 2013, 1541; Stonge 2012, 38; Thompson *et al* 2005, 452). Controlled feeding experiments conducted by McCutchan *et al* (2003, 383) discovered that the average trophic shift for N was +2‰ and that the trophic shift for N was higher for carnivores and consumers with high-protein diets. Knowing this aspect and enrichment value is particularly useful when reconstructing palaeodietary habits as one can not only determine that an individual had higher meat/animal protein consumption than another owing to their relative δ^{15}N values (Somerville *et al*¸2013), or whether the majority of their protein came from terrestrial animal, marine, or plant food (Bourbou & Richards 2007, 63; Ingvarsson-Sundström *et al* 2009, 2-3) but also, if contemporary animal remains have been isotopically analysed to obtain a baseline then the main animal consumed can also be determined (Drucker & Bocherens 2004, 164; Triantaphyllou *et al* 2008, 3030). The δ^{15}N signature of protein from dairy (milk, eggs, cheese) does not significantly differ from those of meat (Reitsema & Vercellotti 2012, 596). Conversely it can therefore also be noted that low δ^{15}N values can be associated with a low consumption of animal protein and a heavy consumption of plant based protein (Ingvarsson-Sundström *et al* 2009, 3; Triantaphyllou *et al* 2008, 3031). To complicate matters slightly, a variability in N fractionation between trophic levels can result not only from dietary protein intake, but also nutritional/protein stress, disease (which as discussed in Chapter 4 makes it important to try and select individuals that according to their macroscopically visible status were healthy), environment, and pregnancy (Stonge 2012, 38). However, as the dietary isotopic signature from collagen is a long term average these factors have to be chronic or consistent over a period of time for them to affect the isotopic signature.

The analysis of δ^{15}N values can not only give insights into the sources and contribution of dietary protein, but also isotopic markers of dietary composition for gender and/or age differences/variation (Turner *et al* 2007, 2). For example one of the most common aspects that this is applied to is to examine culturally specific weaning practices (Soltysiak & Schutkowski 2015, 178). This is possible to perform as infants subsisting on primarily human/herbivore milk have enriched δ^{15}N values of as much as 3-5‰, and the weaning period demonstrates an enrichment of δ^{13}C values and a depletion of δ^{15}N values with the introduction of supplementary foods (Turner *et al* 2007, 2).

Due to N isotopic values varying according to the trophic level in a food chain, N is particularly useful for identifying marine food consumption (Hoefs 1997, 138; Knudson *et al*

2012, 438; Pollard *et al* 2007, 172; Somerville *et al*, 2013; Thompson *et al* 2005, 452; Walker & DeNiro 1986, 51). Individuals who eat marine foods tend to exhibit more enriched $\delta^{15}N$ values than those on a terrestrial diet (Budd *et al* 2013, 863; Knudson *et al* 2012, 439; Pollard *et al* 2007, 172; Slovak & Paytan 2011, 255; Somerville *et al*, 2013; Triantaphyllou *et al* 2006, 630). This is not only because there are more trophic levels in a marine ecosystem, which thereby means more levels of N enrichment (Knudson *et al* 2012, 439; Stonge 2012, 39), but also because the $\delta^{15}N$ values of marine plants tends to average at around 7‰ which is slightly higher than the average terrestrial plant value (Stonge 2012, 39). Marine vertebrates tend to be typically 6-9‰ more enriched in ^{15}N than their terrestrial counterparts (Slovak & Paytan 2011, 255; Schoeninger & DeNiro 1984, 631; Somerville *et al*, 2013; Tykot 2004, 436). Therefore, as is to be expected, being lower in the trophic system, marine shellfish have significantly lower $\delta^{15}N$ values than marine vertebrates (Slovak & Paytan 2011, 256). A consumer of marine resources tends to have $\delta^{15}N$ values in the range of 12-20‰ (Budd *et al* 2013, 863; Reitsema & Vercellotti 2012, 596; Slovak & Paytan 2011, 255; Tykot 2004, 436) but sometimes up into, and even above, the region of 20‰ (Triantaphyllou *et al* 2006, 630). $\delta^{15}N$ values can also be used (perhaps tentatively) to identify freshwater resource consumption in an individual's diet with their bone collagen $\delta^{15}N$ values tending to be around 12‰ ±2 (Budd *et al* 2013, 863). There is a high variability in the stable isotope ratios of freshwater fish owing to the fact that aquatic plants have access to different sources of CO_2 and that the fish themselves experience different habitats and trophic levels during even their own lifetime (Drucker & Bocherens 2004, 169; Reitsema & Vercellotti 2012, 596). This means that, as inferred above, a consumer of a moderate amount of terrestrial protein resources could have similar $\delta^{15}N$ values as an individual consuming freshwater food resource, especially when this is combined with the fact that freshwater resources/species are not necessarily so enriched in ^{15}N compared to terrestrial resources (Drucker & Bocherens 2004, 169; Reitsema & Vercellotti 2012, 596). This means that therefore unless other methods such as sulphur isotopic analysis, or a site located by a freshwater source combined with archaeozoological evidence of freshwater food resources it can be difficult to implicitly determine the consumption of freshwater resources (Budd *et al* 2013, 861 & 863).

Enriched $\delta^{15}N$ values are not only the result of consuming marine resources, high protein intake, and breastfeeding. They can also be the result of farming practices, for example manuring and fertilising of crops (Fiorentino *et al* 2012, 328; Ingvarsson-Sundström *et al* 2009, 6; Stonge 2012, 36-37) and/or working of the soil which disturbs the nitrogen cycle

(Ingvarsson-Sundström *et al* 2009, 6), as well as if livestock are grazed on fields that are artificially and manually manured/fertilised (this increases the $\delta^{15}N$ values of the soil and plants more than solely by defecation of grazing animals) which will result in increased animal $\delta^{15}N$ values and thereby human consumer values (Ingvarsson-Sundström *et al* 2009, 6; Trella 2010, 292-293 & 310). Hot and arid environments can also result in enriched $\delta^{15}N$ values being exhibited (Knudson *et al* 2012, 439; Stonge 2012, 37; Thompson *et al* 2005, 452). In arid environments it has been noted that $\delta^{15}N$ values increase when the amount of rainfall decreases (Schwarcz & Schoeninger 2011, 732). This is due to organisms experiencing water stress (Stonge 2012, 37-38). Plants growing in saline soils or with guano will have very high $\delta^{15}N$ values (Stonge 2012, 37).

Nitrogen isotopic values are not only a result of animal protein intake, but plant protein intake habits can also be observed (Somerville *et al*, 2013). Therefore the intake of particular types of plants over an individual's lifetime can influence their $\delta^{15}N$ values. For example, leguminous plants (which are all C3 plants) exhibit $\delta^{15}N$ values close to 0‰ as they acquire nitrogen by directly fixing atmospheric N_2 (which by definition has a $\delta^{15}N$ value of 0‰) (Somerville *et al*, 2013; Triantaphyllou *et al* 2006, 630). Leguminous plants (e.g. beans, peas, peanuts, and clover) have a symbiotic relationship with 'Rhizobium' bacteria which directly fix atmospheric N_2 making it readily available for the plant (Stonge 2012, 35). Most other plants obtain nitrogen from nitrate and ammonium ions in the soil and are generally enriched 3-7‰ relative to atmospheric $\delta^{15}N$ (Somerville *et al*, 2013; Stonge 2012, 36) and prior to chemical fertilisers likely had $\delta^{15}N$ values of around 9‰ (Stonge 2012, 36). This means that if an individual is consuming a lot of leguminous plants in the course of their lifetime they may exhibit unexpectedly low $\delta^{15}N$ values, even if they also consume animal protein as part of their diet (Ingvarsson-Sundström *et al* 2009, 3; Triantaphyllou *et al* 2006, 630). Furthermore, factors such as a positive correlation between mean annual temperature and $\delta^{15}N$ values, and a negative correlation between local precipitation and/or water availability and $\delta^{15}N$ values should be considered when performing these types of studies (Szpak *et al* 2013, 8). Ultimately, it is necessary to consider the possible $\delta^{15}N$ values of plants and animals when reconstructing ancient human diets (Stonge 2012, 37).

As mentioned above in 3.2.1 the physiology of human bone (notably between collagen and apatite) can affect the isotopic values of C, and this is also true for $\delta^{15}N$ values. As with C, the $\delta^{15}N$ composition of collagen mostly reflects that of the sources of dietary protein eaten over many years (Budd *et al* 2013, 862; Reitsema & Vercellotti 2012, 597; Thompson *et al* 2005, 452; Triantaphyllou *et al* 2006, 630).

Chapter Four: Materials and Methods

4.1 Introduction

The selection of human and faunal osteological material for this project was the result of intentional strategizing but also pragmatism. In the same way that the sample site settlements were deliberately chosen from across different areas of Anatolia (as detailed in Chapter 2.1), encompassing a varied range of altitudes, environments, ecosystems, internal vs. coastal, of differing sizes and external influences, the sample material for analysis went through several selection rigours. Of course, the selection of the sample sites ultimately meant the selection of the osteological material from those sites. There was furthermore also an element of pragmatism about the initial selection procedure; only what was available could be sampled – particularly what was available in the laboratory of the Anthropology Department of Hacettepe University, Ankara. For example, there were intentions to sample material from Karataş (following, notably, the publication of Angel, 1976) and Kültepe (following personal discussions; however the EBA cemeteries at the time of writing had not been (fully) excavated) but the material could not be located or simply did not exist. Despite a once thriving academic atmosphere for Anatolian EBA sites, (think of Alaca Höyük, Karataş, Ahlatlı Tepecik, amongst others) much of the material is unfortunately not in existence today and the Anatolian EBA is still relatively marginalised (Massa 2015, 29). And whilst the EBA in Anatolia seems to find itself having a resurgence in fame and fortunes with a more comprehensive and holistic approach to Anatolian EBA archaeology in the last 10 years (Bachhuber 2015, 2; Massa 2015, 30), there is still very little, or no, actual published material and information from a lot of these sites yet; especially in terms of specialist reports such as archaeobotany, and archaeozoology, and skeletal material and information (Bachhuber 2015, 57-58).

This chapter outlines the selection procedures and methods for sample selection; what was chosen, and why. It then moves on to cover the methods behind the osteological analysis performed on the skeletal material, before finishing with the laboratory methods for collagen extraction and stable isotope analysis.

4.1.1 Sample Selection

As there are hundreds of skeletons from the selected sites it is impossible to sample every one of them for analysis. In general across all four sites a set of guidelines was implemented for sampling (where feasible). These included sampling only ‘healthy’ individuals, i.e. those not showing evidence of chronic or acute pathological conditions which could have had an impact not only on the dietary habits of the individual such as being on a different diet due to an illness, but also on metabolic processes. Elevated $\delta^{15}N$ values were found in nutritionally stressed birds which suggest that nutritional stress or diseases that affect metabolism may result in stable isotope ratios which are not characteristic of the individual’s long-term diet (Katzenberg & Lovell 1999, 316). Further to this osteoporotic bones and pathological bones have been shown to exhibit elevated $\delta^{15}N$ values relative to normal bone (Stonge 2012, 47).

Adults were preferably selected as this would provide a better overall picture of the average diet of the population. Sub-adults (particularly babies and young children) are likely to have their isotopic signatures (primarily an enriched $\delta^{15}N$ signal) affected by breastfeeding and weaning practices (Ingvarsson-Sundström *et al* 2009, 9; Triantaphyllou *et al* 2006, 631; Turner *et al* 2007, 2). It may also have been possible that children’s diet varied when compared to that of the adults (Bourbou & Richards 2007, 65-66; Slovak & Paytan 2011, 258; Turner *et al* 2007, 2-3) and whilst this would make for an interesting topic in itself, it is not the focus of this project. Furthermore, due to modelling (formation of new bone in response to loading) and remodelling (maintenance, replacement, and repair of bone) much of the bone collagen formed during younger years disappears with time (Reitsema & Vercellotti 2012, 590). This is emphasised in sub-adults when collagen turnover rates are much higher than those of adults due to osteoblastic (replacement) rates outweighing osteoclastic (removal) rates in the remodelling of bones (Stonge 2012, 46). This can result in the likely loss of dietary isotopic signatures and thereby dietary information for the sub-adult phase of an individual, meaning that it is best to compare adults with adults. The complete remodelling of adult bone takes around 10-20 years (Budd *et al* 2013, 862; Stonge 2012, 47), although some bones have higher turnover rates than others (see below).

Some sub-adults were sampled as their samples could also help to provide extra $\delta^{13}C$ values where necessary as breastfeeding infants tend to have the same signal as their mother (Turner *et al* 2007, 2). However, even though the demographic information of the sampled sub-adults can be found in Appendix A and their stable isotope data can be found in Appendices F, H, I, and K, in general only the adults will be dealt with in Chapters Five and Six when discussing the results of the osteological and stable isotope analyses. It was attempted as much as possible to sample from individuals who had two elements that could be taken, a slow turnover bone (long bone, e.g. femur), and a fast turnover bone (e.g. rib). This aspect is further discussed below. Predominantly only individuals whose sex and age had been determined were selected. This is to enable biological aspects with social implications such as sex and age to be examined for dietary habits both at an intra- and inter-site level. In the same way, only individuals whose archaeological provenance was known with a relative degree of certainty were selected. This included not only spatially within a grave, cemetery and/or settlement but also temporal determination. This is of course, above all, to ensure that all samples are from the EBA, and to be able to determine which period of the EBA is also somewhat essential as one of the research objectives is to examine whether there are any differences/changes in dietary habits between the EBA I and EBA III (see Chapter 1.4). When it was possible an even number/ratio of individuals were sampled from the EBA I and EBA III periods so as to compare and contrast them, whilst in some cases individuals from the EBA II were also sampled. This is because (as explained in Chapter 1.2) it is between these periods that the greatest changes in social and urban structure and the increase in interpersonal trauma rates are seen. This was not always possible though due to the material available; for example at Bademağacı only individuals from EBA II were located and excavated, whilst at Titriş Höyük the majority of individuals come from EBA III. Also being able to locate a sampled individual within a grave, cemetery and/or settlement will enable firmer conclusions to be drawn from the results regarding certain aspects such as male vs. female, differences in ages, foreigner vs. local, 'rich' vs. 'poor', differences in burial practices etc. A 50:50 sample split between male and female was aimed for, if not for all sites reachable. Also, a spread through the ages (from Young Adult to Old Adult) was aimed for when selecting individuals to be sampled, but once again this was not always realistically attainable. This would be so that conclusions drawn from the results could be more accurate and reliable; it is difficult to discuss the differences between male and female dietary habits when the male:female ratio of analysed samples is significantly biased to one of the sexes. Similarly the aim was to be that the overall number of sampled individuals by site should be parallel. Again, whilst this was not always achievable in practical terms, it can be considered important not only to ensure that conclusions could be more reliably drawn as well as being able to perform meaningful numerical and statistical analysis, but also to ensure that inter-site comparison and analysis would lead to a fruitful discussion.

Whilst these general guidelines were applied to sampling from all the of the selected sample sites, there were some other criteria that were considered not only overall for every site but also on a site-by-site basis. These included sampling where possible at least some individuals who had peri- or ante-mortem traumatic injuries that could be considered to be the result of interpersonal violence. This is so it could be analysed whether these individuals had different dietary patterns on the assumption that this would show whether they were locals or foreigners and the implications that would accompany these determinations. For example samples from femurs associated with the ‘Plaster Basin’ (discussed in Chapter 2.3) deposition at Titriş Höyük were deliberately selected to further analyse this unique deposition of human bones to examine some of the hypotheses concerning it. Furthermore, some individuals from burials which were large, locally different/unique (in terms of grave or burial style and body placement), or rich (i.e. a large amount of grave goods, or relatively wealthy objects) were chosen. This was done on the assumption that the individuals buried in these types of graves would be different either socially and that this might be exhibited in the relevant stable isotopic signals. For example the female individual (G-296) with a trephination and buried with a razor and bird-shaped bone seal (see Chapters 2.4 and 5.2.4) from Bakla Tepe was deliberately chosen to be sampled not only for the uniqueness of her trephined skull and grave goods but also the size of her grave which was larger than the others; all of which may indicate a difference in status.

Following the work done by Welton (2010) at İkiztepe for her doctoral thesis, some individuals were selected to be sampled to collaborate with and complement her results. Individuals that she had marked out as ‘foreigners’ or likely to have been more mobile were (where possible) selected for carbon and nitrogen stable isotope analysis to examine if their dietary habits were similar or different from those individuals she determined as local.

After the selection of individuals, skeletal elements were chosen. As mentioned above, where possible two skeletal elements were sampled; a long turnover bone element, and a short/fast turnover element. Where possible, to maximise consistency and thereby reliability, a section of femoral cortical bone, and a rib/section of rib was chosen. However if these elements were not present, in too poor a condition, or to prevent unnecessary destruction if the bone was complete, the slow turnover element of a femur was replaced with that of a tibia, fibula, or even humerus and the fast turnover element was replaced with a hand phalanx. This was partly to ensure the maximum chance of obtaining collagen of both good quality and quantity; i.e. the loss of one bone element due to diagenesis (see below) etc. would not result in the loss of an individual for analysis. It was also due to the fact that bone is not a static reservoir of chemical signatures (Reitsema & Vercellotti 2012, 590). It is therefore possible to analyse dietary changes over an individual's lifetime due to the different modelling and remodelling rates of different types of bone (cortical and trabecular) and, for this study, the different remodelling rates of different skeletal elements (Balasse *et al* 1999, 593; Knudson *et al* 2012, 441; Mulhern, 2000; Mulhern & Van Gerven, 1997; Reitsema & Vercellotti 2012, 590; Stonge 2012, 47). Apart from between the different skeletal elements, bone remodelling rates have been shown to also vary due to sex, age, ancestry/genetics, activity level, nutrition/diet, and pathology (Katzenberg & Lovell 1999, 316 & 323; Knudson *et al* 2012, 439; Stonge 2012, 47). However, Stonge (2012, 47) has argued that higher turnover rates of bone do not necessarily result in different stable isotope values of those tissues. Indeed Walker & DeNiro (1986, 54) found there to be only ca. 1‰ difference in $\delta^{13}C$ and $\delta^{15}N$ values between and among skeletal elements from the same individual. However, there has been shown to be a slight difference in turnover rate between the cortical bone of long bones such as the femur, tibia, fibula, and humerus, and that of bones such as the phalanges and ribs. Cortical bone turnover from the tibia is roughly the same as that of the femur, at 1.5% - 3% per year (Knudson *et al* 2012, 441); whilst cortical turnover is approximately 4% per year for ribs (Knudson *et al* 2012, 441).

Whenever possible the bone samples for analysis were selected from the mid-shaft region of the bone, again to ensure consistency and thereby comparability of samples. It has been argued however that isotopic signatures do not vary significantly between different segments of a single bone (Stonge 2012, 72).

Skeletal elements were also preferentially selected that exhibited intact, thick, and pale cortical bone. This is because it is more likely that good collagen (in terms of quality and quantity) can be extracted from these types of bone. Along similar lines, bones that exhibited macroscopical evidence of diagenesis or destruction were not selected for analysis. Diagenesis is the chemical alteration of bone as a result of exposure to the physical and chemical conditions of the post-mortem depositional environment (Safont *et al* 1998, 23; Stonge 2012, 66). It can be the result of soil Ph. levels, temperature, micro-organism invasion, leaching by groundwater and rain, bone size, bone porosity, and differential metabolism and biochemistry (Stonge 2012, 66). Collagen diagenesis is the result of organic contamination from the burial environment or structural degradation caused by protein denaturation, hydrolysis, or oxidation (Stonge 2012, 67). The main limiting factor in using bone collagen is preservation, but pre-treatment methods have been developed to remove organic contamination (see section 4.2) (Stonge 2012, 67). There are also methods for assessing collagen preservation and diagenetic affects which will be further discussed further below in 4.2.1.

As mentioned above individuals showing signs of chronic pathology were excluded from selection. Similarly bones exhibiting pathological lesions such as non-specific infection and peri or ante-mortem fractures were also avoided, or at least sampled away from the site of pathological lesion. This is because pathological lesions can alter and affect the isotopic composition of bone (Katzenberg & Lovell 1999, 323; Stonge 2012, 71-72). However, nutritional stress is not always visible in the archaeological record and pathologies are not always macroscopically/grossly visible (Katzenberg & Lovell 1999, 323).

Human skeletal is not the only aspect to be sampled and analysed in this project; faunal remains from the sample sites were also selected and analysed. As was discussed in more detail in Chapter Three it is important to include faunal remains of a site in the analyses to obtain base levels for mobility analysis and to construct a food web for the analysis of a population's dietary habits. Unfortunately access to the whole range of excavated faunal remains of the sample sites was not always possible due to geographical and time constraints (the material was stored elsewhere), or the fact that the material's location was unknown or missing, see Table 3. This meant that all of the faunal material analysed in this project came from inclusions with the human skeletal material, i.e. inclusions in the grave fill which were mistakenly bagged as human during excavation and extraction on-site. Faunal samples from these contexts were only selected when it could be ascertained that they were not deliberate inclusions, i.e. grave goods; for example if the bone appeared to have been worked or could have been part of a personal ornamentation item such as a necklace, and only from bones that were free of pathologies and evidence of cooking such as burning. As with the human material, samples from the bones of juvenile animals were preferably not chosen due to the enriched $\delta^{15}N$ effects on the isotopic signals of suckling animals (Reitsema, 2013).

As wide and varied a range of faunal material as possible was taken to ensure better accuracy when reconstructing the dietary habits of a population. This included sampling material from (when available) the four main species of domesticated fauna in mixed-subsistence communities: *Bos Taurus* (domestic cow), *Sus scrofa* and *Sus scrofa domesticus* (wild and domestic pig – as the level of pig domestication at many of the sample sites is arguable), *Ovis* *aries* (domestic sheep), and *Capra aegagrus hircus* (domestic goat). The last two due to their similarity and difficulty in distinguishing, especially from isolated elements, are often grouped together as *ovis/capra*.

Table 3: Existence, availability, and accessibility of faunal material

Site	Existing	Location	Sampled?	Sample Method
İkiztepe	Yes	Unknown	Partly	Grave Inclusions
Titriş Höyük	Yes	Some Unknown; Some in the Anthropology Department of the University of California, San Diego, and some at the University of Manitoba	No	N/A
Bademağacı	Yes	Unknown	Partly	Grave Inclusions
Bakla Tepe	Yes	Urla, Turkey	Partly	Grave Inclusions

There may be some chronological complications associated with this sampling strategy at Bakla Tepe where the EBA II/III cemetery cut through Late Chalcolithic layers (YS Erdal, personal communication). However, due to the Late Chalcolithic - EBA I cultural continuity at the site (Şahoğlu & Tuncel 2014, 78-79; YS Erdal, personal communication), it is possible that the faunal remains from the EBA II/III graves can be used in conjunction with the faunal material of the EBA I graves to help construct a food web for the EBA I period.

Ultimately the sample strategy applied for the faunal material is not ideal, and can be considered a weakness of this project. The small sample sizes means that the food webs are not as complete, accurate, or as representational as they should be, perhaps showing positive or negative bias to certain animal species. An absence of domestic dog (*Canis lupus familiaris*) is disappointing as their δ^{13}C and δ^{15} values are often close to humans due to their close proximity habitation and feeding habits (they generally eat similar foodstuffs as the humans they live with) (Koster, 2008; Tankersley & Koster, 2009; White *et al*, 2001). Their inclusion would enable a better overall dietary picture of the population of a settlement. The lack of wild animal taxa is also of concern as their δ13C and δ15 values tend to be different from those of domesticates which would provide a clearer picture of dietary resources in the area of the settlement as well as permitting a better reconstruction of the local 'isoscape'. Furthermore it has been hypothesised that in some cases a significant inclusion of wild taxa in human diet can be an indication of status with those people tending to be of lower status, or members of a society's fringe having to supplement their diet with hunting (Allentuck & Greenfield, 2010).

Whilst the data obtained from this study can be said to be as reasonably accurate and reliable as possible, it could be even more so with the inclusion of a larger number and range of faunal material, as well as an expansion of skeletal material. This is something that any future work that expands this project should and will address.

4.1.2 Osteological Analysis

A portion of the skeletal material stored in the laboratory of the Anthropology Department of Hacettepe University, Ankara had been previously analysed by Professor Dr. YS Erdal and Doç. Dr. ÖD Erdal and their students and research team. This included all of the individuals from Titriş Höyük, and the vast majority of individuals from İkiztepe and Bademağacı, and some from Bakla Tepe (only the EBA I graves). The result being that there were reliable lists available with age at death, sex, and basic pathologies such as fractures, traumatic injuries, and infections. This meant that the sampling strategies outlined above could be employed via the lists and individuals located and sampled. However, some of the individuals from İkiztepe and Bademağacı and the majority of those from Bakla Tepe, including all of the EBA II/III graves had not even been cleaned and sorted. Osteological analysis had not been conducted either. Along with the collecting of samples this was completed on two separate research trips to Ankara in 2014 and 2015.

As there were far more individuals/grave bags than time available, some of the sample selection guidelines were applied to the unwashed material, such as preliminary examination to see if sex and age could be approximately estimated (to prevent time spent washing and analysing only males etc.), or if the burial context warranted further examination. Once an individual or grave bag had been selected, the bones were cleaned using tap water, a tooth brush, and a fine mesh sieve before being left to naturally air dry on a fine-meshed drying tray. Once dry the bones were sorted by skeletal element, restored where possible and appropriate using superglue, and anatomically sided and identified. Where necessary bones were identified and sided using White and Folkens (2005). Basic osteological analysis was then employed on the individuals; analysing and recording age at death, sex, basic pathologies when present such as peri- and ante-mortem fractures and injuries, non-specific infections, nutritional deficiencies (e.g. cribra orbitalia, porotic hyperostosis, rickets etc.), and arthritis. All analysis was done macroscopically under natural and artificial light, with the use of a hand-lens at times.

To ensure consistency across the sample assemblage the same methods as utilised by Professor Dr. YS Erdal and his team were used for the osteological analysis; sex, age at death, and pathology determination. Sex determination was achieved using the standards set out by Walker in Buikstra and Ubelaker (1994), namely the sexually dimorphic features of the cranium, pelvis and limb bones: - the nuchal crest, mastoid process, supraorbital margin, and supraorbital ridge/glabella of the cranium, and the mental eminence, ramus angle, and other sexually dimorphic features of the mandible. For the pelvis the main feature for sex determination is the sciatic notch, as well as the post and pre-auricular sulcus amongst others. For limb bones general robusticity and size as well as of features such as proximal and distal ends and condyles, the linea aspera of the femur, and the angle of the femoral neck were used. Estimation of age at death was achieved using epiphyseal fusion closure as set out by McKern and Stewart (1957), and Buikstra and Ubelaker (1994); macroscopic analysis of the pubis symphysis following Todd (1920) and Brooks and Suchey (1990); macroscopic analysis of the auricular surface of the ilium as set out by Lovejoy *et al* (1985); and sternal rib end metamorphosis as described by Işcan and Loth (1986). Estimation of age at death for sub-adults was achieved using fusion closure according to McKern and Stewart's criteria (1957), Buikstra and Ubelaker (1994), and fusion closure and limb bone length following Scheuer and Black (2000); and dental eruption and formation (Van Beek 1983). To further ensure consistency and comparability of results the same age categories were applied to the analysed individuals as those used by YS Erdal and his team. These are as follows[1]: Foetus (pre-birth), Baby (0-2.5 years), Child (2.5-15), Young Adult (15-30), Middle Adult (30-45), and Old Adult (45+). The results of the osteological analysis can be found in Appendix A and are dealt with in terms of population demography in Chapter 5.1.

[1] The term 'sub-adult' is used throughout this thesis yet 'sub-adult' is not one of the age categories utilised in the osteological analysis. 'Sub-adult' simply refers to all individuals who are not adults; i.e. Babies and Children

Faunal material as discussed above came from the same bags as the human skeleton material. Therefore it was also washed along with the human material before being separated during the sorting, restoration and analysis stage. Generally all animal bones that did not exhibit macroscopic evidence of diageneses, destruction, cooking, or burning were selected as samples. At a later date they were analysed by Dr. Jennifer Jones of the University of Cantabria to determine species and age.

4.2 Initial Sample Preparation

In the laboratory of the Anthropology Department of Hacettepe University, Ankara the individuals were selected, washed, sorted, and analysed as detailed above. Once samples were chosen they were collected and put in small, labelled zip lock bags. All samples; slow turnover bone and fast turnover bone were, where possible, selected from fragmented or loose pieces so as to avoid unnecessary destruction of skeletal elements and material. However, unfortunately in some cases, segments of bone had to be mechanically removed for sampling. This was primarily done using a Dremel with a flexi extension and a cutting wheel attachment. The machine was cleaned between uses and a fresh cutting wheel was always used.

4.2.1 Carbon and Nitrogen Isotope Analysis: Preparation and Procedures

As discussed in Chapter 3 stable isotope analysis can be performed either on the inorganic part of the bone (hydroxyapatite) or the organic part (collagen) (Pollard *et al* 2007, 21; Somerville *et al*, 2013). Collagen was chosen not only because the mass spectrometers at the Max Planck Institute in Leipzig were set up for analysis of collagen samples but also because there is less chance of diagenesis with collagen as opposed to apatite (Nehlich 2015, 8; Pollard *et al* 2007, 21 & 182). Prior to collagen extraction the samples were cleaned of external dirt and contaminants using an air-powered abrasion machine utilising aluminium oxide powder. Collagen extraction followed the procedures outlined by Richards and Hedges (1999) with an extra ultrafiltration step added (Brown et al, 1988). Between 0.5 g and 1 g of bone was weighed out into test tubes and immersed in 0.5M hydrochloric acid (HCl) and refrigerated. The acid was changed daily to encourage faster demineralisation, and in some instances the samples were left out of the refrigerator in room temperature to further encourage and increase the speed of demineralisation. Once the bone was fully demineralised it was rinsed (3 times) with double-distilled H2O to neutral pH. Diluted (0.5M) HCl was then added to achieve pH3 before heating at approximately 70°C for 48 hours in a heater block to gelatinise the samples. The gelatinous solution was then filtered through an EZee filter before ultra-filtration.

The solutions were then transferred to a plastic Eppendorf tube, frozen for 24 hours and then freeze-dried until dry (48 hours).

Between 0.5 and 1 mg of collagen was weighed out into tin capsules (4x6 mm) before being run through the stable isotope ratio mass spectrometer (a ThermoFinnigan Delta XP equipped with a Flash EA). When weighing out samples, each sample was weighed out twice so that there was an (a) and a (b) run and each run was put through the mass spectrometer on separate days; this not only increases reliability but also decreases the chance of an issue with the mass spectrometer affecting the output data and results.

In stable isotope analysis for palaeodiet reconstruction using C and N the reliability and accuracy of the data obtained from the extracted collagen must be assessed. Stable isotope analysis of bone relies on the assumption that the chemical composition of archaeological bone reflects the diet and not the burial environment (Stonge 2012, 67). There are established standards that are used to examine this reliability and accuracy and they are based on the chemical composition of the extracted collagen; mainly %C, %N, and C/N ratios, as well as collagen yield (Britton *et al* 2008, 2112; Stonge 2012, 68-69; Turner *et al* 2007, 7). Any bone sample that produces a collagen yield greater than 5% is indicative of good preservation, and rates below this number are indicative of post-mortem chemical alteration and poor bone preservation. Any sample producing less than 1% collagen yield should definitely be discarded (Stonge 2012, 68-69; Turner *et al* 2007, 7). Despite some samples being discarded after being run through the mass spectrometer due to them failing the quality criteria outlined below (discussed further on a site-by-site basis in Chapter Five), only two samples were lost prior to this stage. One was from a pig scapula (associated with the grave of Sk 698 from İkiztepe), and the other was the femoral sample from individual ’94 TH 7556 from Titriş Höyük. Both samples were abandoned due to not enough collagen being extracted from them (i.e. a less than 1mg and 1% of collagen yield). To be considered reliable for stable isotopic measurements the values of the chemical composition of collagen must be similar to those of collagen extracted from fresh bone (DeNiro 1985, 807-808). The atomic C/N ratio, which measures the amount of carbon atoms present within a sample relative to nitrogen atoms, can be used to establish this (Stonge 2012, 69). As collagen has a defined chemical formula the C/N ratio can therefore be used to prove if the sample is actually collagen (Stonge 2012, 69). It has been well established that collagen with atomic C/N ratios lower than 2.9 or higher than 3.6 is altered, contaminated, affected by diagenesis and should be discarded from future study (DeNiro 1985, 807-808). The samples outside this range should be rejected on the basis that the collagen has undergone post-mortem diagenesis and is indicative of severe degradation or contamination which has either introduced or removed carbon and/or nitrogen (Stonge 2012, 69; Thompson *et al* 2005, 456). The concentration of carbon in a sample (%C) should also be used to assess the integrity of the extracted bone collagen, with it being between 15.3% and 43.2% in modern mammalian bones, and in general anything below 30% one should be wary of and anything below 10% should not be further used (Britton *et al* 2008, 2114; Stonge 2012, 69).

As was discussed above the extracted collagen from each skeletal element of an individual was run twice (an (a) and a (b) run) so as to improve reliability and lessen the chance of samples being lost (i.e. if an (a) run did not work for whatever reason data may still be obtained from the (b) run). This was successful as in some cases one of the runs did not work whilst the other did, meaning that data could still be obtained from the collagen of a particular skeletal element for an individual. When both runs were successful a mean average was taken so that a single figure was obtained as this makes plotting and analysing the data and comparing much simpler and easier. Once a single figure was obtained for each single skeletal element of the sampled individuals for both $\delta^{13}C$ and $\delta^{15}N$ of a site, these numbers were plotted on an X Y scatter graph. However, due to (in almost all cases) two skeletal elements (a slow and fast turnover bone) being sampled from each individual this meant that each individual would appear on the graph with two points. It was not deemed acceptable to merge these two numbers and use a mean as it has been shown that there are differences in bone turnover rates between the two types of bone (Knudson *et al* 2012, 441), and furthermore that it would be interesting to see if any differences could be observed between the isotopic signatures of the two skeletal elements. Therefore a code was established to make viewing and understanding the scatter graphs (found in Chapters Five and Six) easier: Plotted points of the same shape and pattern are from a single individual, e.g. two triangular points with a solid fill are the two skeletal elements of one individual. Points that are red are the slow turnover bone (i.e. femur or other long bone) and dark blue is for the fast turnover bone (i.e. rib or phalange). Means with standard deviation error bars were also plotted for the site sample populations as a whole as well as for different intra-site categories such as sex, age group, time period, trauma presence and absence etc. in order to enable a closer investigation of the data. The means are an amalgamation of all of the adult data. Faunal remains were also sampled and as two runs of each sample were also performed, a mean average was taken so that only one point would be plotted. A code was also devised when plotting the animal data points; diamonds are *ovis/capra* (sheep/goat), triangles are *Capra aegagrus hircus* (domestic goat), squares are *Bos Taurus* (domestic cow), and circles are *Sus scrofa* and *Sus scrofa domesticus* (wild and domestic pig). When plotted with the human data the *ovis/capra* are green diamonds, the *Bos Taurus* are orange squares, and the *Sus scrofa* and *Sus scrofa domesticus* are purple circles.

Statistical analyses were performed on the obtained stable isotopic data following those laid out in Sokal and Rohlf (2012). The statistical analyses performed were a one way ANOVA and a two-tailed t-test with accompanying 'box and whisker' plots in some cases to better visualise the results. The accepted level of statistical significance for all conducted tests was $p = 0.05$. These statistical analyses were done using Microsoft Excel with the XLSTAT add-on, and in some cases the results were checked by hand using the formulae in Sokal and Rohlf (2012).

Chapter Five: Analysis and Results

This chapter deals with the results and analysis of the sampled material and has been split into two sections. The first section (5.1) deals by site with the results of the osteological analysis of the sampled skeletal individuals and gives an overview of the sample population demographics. This includes a breakdown of sex, age and age groups, and traumatic injuries. The second section (5.2) contains the results of the stable isotope analysis for dietary habits (i.e. of $\delta^{13}C$ and $\delta^{15}N$). The data from the stable isotope analysis are dealt with by site and are plotted on XY scatter graphs with the application of statistical analyses and the results of these are discussed and interpreted. The aim of this second section is to put the isotopic data into a wider picture at an intra-population/site level by examining how population demographics may have had an effect on dietary habits at a site, as well as how the results may be interpreted at a tangible level with relation to the archaeology of the settlement.

5.1 Population Demographics

As discussed earlier in Chapter 4.1.2 an attempt was made to obtain equal sample population demographics with regard to age, sex, and time period (i.e. all from the Anatolian EBA period, 3000-2000 BC). The full overview for all of the sampled individuals can be found in Appendix A. This includes details of not only the determined age and assigned age group, and determined sex of the sampled individuals, but also burial type and context (if known), details of grave goods (if any/if known), noted pathologies and traumatic injuries as well as other information about the individual. What follows in Chapter 5.1 is more specific to the sites' sampled intra-population demographics, and will refer to their demographic distribution as well as the frequency of traumatic injuries. Individual details can be found in Appendix A. Overall across the four sites a total of 94 individuals were sampled, comprised of

- 44 males (46.8%), 50 females (53.2%);
- in age categories: 33 young adults (35.1%), 40 middle adults (42.6%), 14 old adults (14.9%), seven adults of undetermined age (7.5%);
- in chronological categories: 14 from EBA I (14.9%), 14 from EBA II (14.9%), 8 from an EBA II/III transitional period (8.5%), and 19 from EBA III (20.2%).

It should be noted that the reduced number of identifiable individuals from the different time periods can be accounted for by the fact that none of the individuals from İkiztepe could be assigned to a specific time period within the EBA, and their actual date is contentious (see Chapter 2.2 for a more detailed discussion on this point). Within the total sample population (n=94) 29 (30.9%) individuals had traumatic injuries, of which 20 (21.3%) are cranial and 14 (14.9%) are post-cranial, with some individuals having both cranial and post-cranial traumatic injuries. There are 3 (3.2%) peri-mortem traumatic injuries and 28 (29.8%) ante-mortem, i.e. healed, traumatic injuries, and as with cranial and post-cranial injuries, some individuals had both ante- and peri-mortem traumatic injuries. One individual (G-296 2001 from Bakla Tepe) had a trephination (see Figure 44 below). There were also 13 individuals of unknown age and sex (all of them femur samples from the Plaster Basin burial deposition at Titriş Höyük), and as they have no sex or age classification, these have not been included in the counts above for the total number of sampled individuals and do not contribute to the counts for the age, sex, or time period. Some sub-adults were sampled from the four sites, but as was discussed earlier in Chapter 4.1.2 they will only be mentioned in a cursory manner in this chapter and the next and are not included in the counts above. However, for further details about the sub-adults one is referred to Appendix A and Appendices F, H, I, and K.

5.1.1 İkiztepe Höyüğü

A total of 38 adult individuals were sampled from İkiztepe, as well as 18 sub-adults who will not be discussed in depth any further. The age and sex distribution of the İkiztepe sample population is given below in Table 4. There is an equal number of males and females (n=19, 50% for each), but the age distribution is unequal (see Figure 41) with middle adults comprising the largest number of the adult sample population (n=16, 42.1%). This is followed closely by young adults (n=14, 36.8%), with old adults being the fewest in number (n=8, 21.1%).

Table 4: Age and sex distribution of the İkiztepe sample population

Age Group	Sub-Adult	young adult (15-30)		middle adult (30-45)		old adult (45+)		
Sex	n/a	Male	Female	Male	Female	Male	Female	Total
Total	18	7	7	7	9	5	3	56

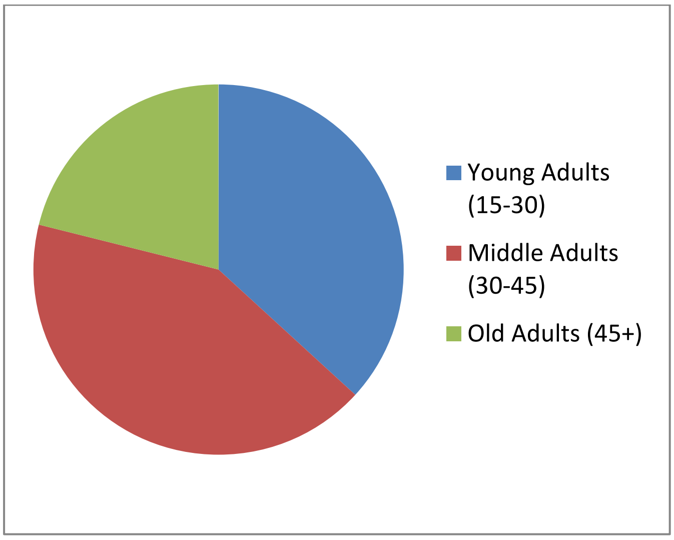


Figure 41: Pie chart showing age group distribution of İkiztepe adult sample population

There are several incidences of trauma and pathologies within the İkiztepe sample population, details of which can be found in the Appendices; Appendix A for descriptions and specifics and Appendix B for photographs of the traumatic injuries. A total of 13 individuals (34.2%) of the İkiztepe adult sample population have at least one traumatic injury (see Table 5), of which 10 (26.3%) are cranial traumatic injuries. Males have the most traumatic injuries, with 10 (26.3%) individuals as opposed to females who only have three (7.9%) individuals with traumatic injuries.

Table 5: Trauma frequency amongst the İkiztepe sample population

Age Group	Sub-Adult	young adult (15-30)		middle adult (30-45)		old adult (45+)			
Sex	n/a	Male	Female	Male	Female	Male	Female	Total	%
Total Trauma Frequency		3	2	5	1	2		13	34.2

5.1.2 Titriş Höyük

A total of 16 adults were sampled from Titriş Höyük as well as two sub-adults who will not be included in the following demographic figures and statistics for the site. The sample population size from Titriş Höyük is not as large as would be expected due mainly to the state of preservation of the skeletal remains, which is quite poor. Skeletal elements in a poor state of preservation often do not contain adequate amounts of collagen to perform stable isotope analysis. Even for the elements that were deemed to be sample worthy, their preservation is not great and many of the samples were discarded after failing an assessment of their quality criteria (see section 5.2.2). The distribution of age, sex, and time periods for Titriş Höyük is listed below in Table 6. In terms of sex distribution, there are more females than males in the sample population; 10 females (62.5%) and six males (37.5%). Within the age groups, the sample population shows a slight bias to young adults (n=6, 37.5%), followed by middle adults (n=4, 25%), then old adults (n=3, 18.8%), and there are also three (18.75%) adults of an undetermined age. The adult sample population shows a bias to individuals sampled from the EBA III (n=11, 68.8%) with only two individuals (12.5%) from the EBA I, and three (18.8%) from the EBA II. There are 13 individuals sampled from the Plaster Basin burial deposition (from the EBA III period), but as these samples are only from femurs, they have not been included in the overall demographic statistics. Owing to the fact that their ages and sex could not be determined, one can only propose that they are all from adults.

Table 6: Age, Sex, and Time Period distribution of the Titriş Höyük sample population

Age Group	Sub-Adult	young adult (15-30)		middle adult (30-45)		old adult (45+)		Adult (15+)		
Sex	**n/a**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Total**
EBA I					1	1				2
EBA II					1			1	1	3
EBA III	2	1	5		2	2		1		13
Total	2	1	5		4	3		2	1	18

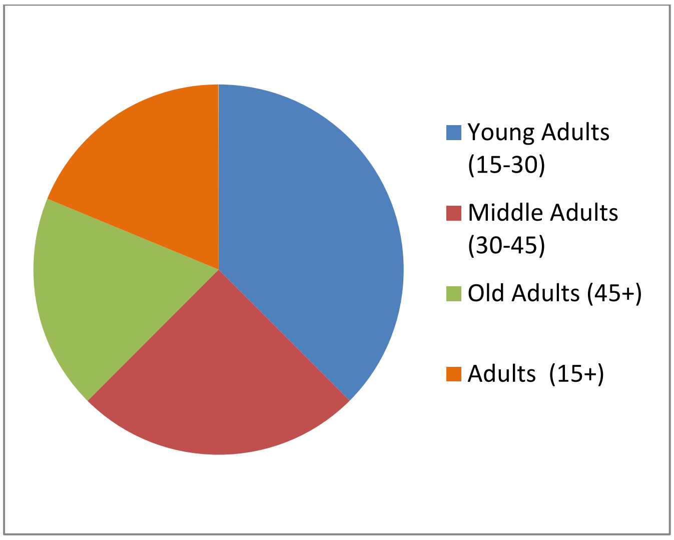


Figure 42: Pie chart showing age group distribution of the Titriş Höyük adult sample population

There are two adults (12.5%) with traumatic injuries in the adult sample population (as can be seen in Table 7 below). Whilst one is on an adult male, and the other is a young adult female, both have cranial traumatic injuries and both are on individuals from the EBA III period. The trauma frequency of the adult sample population agrees quite well with the overall population trauma rate discovered for common burials from the EBA III period of 14.3% (Erdal 2012, 9). Details of the traumatic injuries and photographs can be found in Appendices A and C respectively.

Table 7: Trauma frequency amongst the Titriş Höyük sample population

Age Group	Sub-Adult	young adult (15-30)		middle adult (30-45)		old adult (45+)		Adult (15+)			
Sex	n/a	Male	Female	Male	Female	Male	Female	Male	Female	Total	%
EBA I											
EBA II											
EBA III			1					1		2	12.5
Total			1					1		2	12.5

5.1.3 Bademağacı Höyüğü

Bademağacı Höyüğü has the smallest sample population with a total of seven adult individuals and 4 sub-adults (see Table 8 below). All of the sampled individuals come from the EBA II period as this is not only the solitary period from which individuals were discovered, but also the period which is most definitively present in terms of architecture and material culture at the site (see Chapter 2.4). There are also biases regarding the distribution of age groups amongst the adult sample population with more than half of the individuals being young adults (n=4, 57.1%), followed by middle adults (n=2, 28.6%), and then a solitary old adult (n=1, 14.3%). There is also only a single male in the adult sample population from Bademağacı.

Table 8: Age, Sex, and Time Period distribution of the Bademağacı sample population

Age Group	Sub-Adult	young adult (15-30)		middle adult (30-45)		old adult (45+)		Adult (15+)		
Sex	n/a	Male	Female	Male	Female	Male	Female	Male	Female	Total
EBA II	4	1	3		2		1			11
Total	4	1	3		2		1			11

There is only one (14.3%) individual with traumatic injuries at Bademağacı (see Table 9 below), and this is the male individual. Despite there only being one individual (Sk 2009 No.6) with traumatic injuries, they are on the individual's cranium and are quite spectacular (ante- and peri-mortem cranial traumatic injuries, including a longitudinal healed fracture line across the frontal bone ca. 12cm in length, an oval shaped penetrating peri-mortem injury ca. 5cm in length, and a roughly triangular shaped peri-mortem injury ca. 1cm by 1cm displaying crushing and depression of the outer table into the diploë; details of the individual with the traumatic injuries can be found in the Appendices; Appendix A for the particulars and Appendix D for photographs of the traumatic injuries.

Table 9: Trauma frequency amongst the Bademağacı sample population

Age Group	Sub-Adult	young adult (15-30)		middle adult (30-45)		old adult (45+)		Adult (15+)			
Sex	n/a	Male	Female	Male	Female	Male	Female	Male	Female	Total	%
EBA II		1								1	14.3
Total		1								1	14.3

5.1.4 Bakla Tepe Höyüğü

The sample population from Bakla Tepe consists of 25 adults and no sub-adults (see Table 10). In total there are 13 males (52%) and 12 females (48%) and 12 individuals from the EBA I period of the site and 13 individuals from the EBA II/III period. Therefore, there appears to be a very even split between the sexes and time periods, however, there is a bias of sex in each time period. From the EBA I period there are 10 males and only two females whilst the almost exact reverse is true for the EBA II/III period from which there are 11 females and only two males. This was not intentional and attempts were made to avoid this scenario, but when analysing and sampling the skeletons, this was the bias present in the excavated skeletal population for each time period. Interestingly, this may actually tell us something about the composition and layout of the cemeteries. The EBA I and EBA II/III cemeteries are separated and only parts of them were excavated, and by chance it appears that the excavators may have excavated the areas reserved mostly for males in the EBA I cemetery and for females in the EBA II/III cemetery. There is also an unequal bias between the age groups in the Bakla Tepe adult sample population (see Figure 43) with middle adults being over-represented (n=15, 60%), with young adults (n=5, 20%) and adults of an undetermined age (n=4, 16%) under-represented, but not as much as old adults of which there is only one individual (4%) in the sample population. Again, whilst attempts were made to avoid this kind of misrepresentation, this may be indicative either of mortality rates and demonstrating that most of the population died in middle adulthood with few reaching old age, or it may again be as a result of the parts of the cemetery that were excavated that comprised of mostly middle aged adults. There were sub-adults present amongst the excavated skeletal population in the lab but because of time constraints it was decided not to sample them due to the fact that all of the Bakla Tepe skeletons had to be washed as well. Conducting a full osteological analysis on the sub-adult skeletons often takes longer to process due to their fragile nature and abundant skeletal elements.

Table 10: Age, Sex, and Time Period distribution of the Bakla Tepe sample population

Age Group	Sub-Adult	young adult (15-30)		middle adult (30-45)		old adult (45+)		Adult (15+)		
Sex	**n/a**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Total**
EBA I		2		6	1			2	1	12
EBA II/III		1	2	1	7	1			1	13
Total		3	2	7	8	1		2	2	25

There are 10 (40%) individuals in the adult sample population with traumatic injuries (see Table 11). These are split evenly between post-cranial injuries (n=5, 20%) and cranial traumatic injuries (n=5, 20%). Bakla Tepe has the highest frequency of traumatic injuries amongst the four sample populations, although the frequency of cranial injuries at İkiztepe is greater (İkiztepe: n=10, 26.3%). Several of the Bakla Tepe post-cranial injuries are fractures of the hand phalanges and lower arm bones (radius and ulna) and are most likely related to work or other accidents. All of the traumatic injuries are ante-mortem, meaning that they have healed and did not cause or contribute to the immediate death of the individual. See Appendix A for details of the traumatic injuries and Appendix E for the photographs of them.

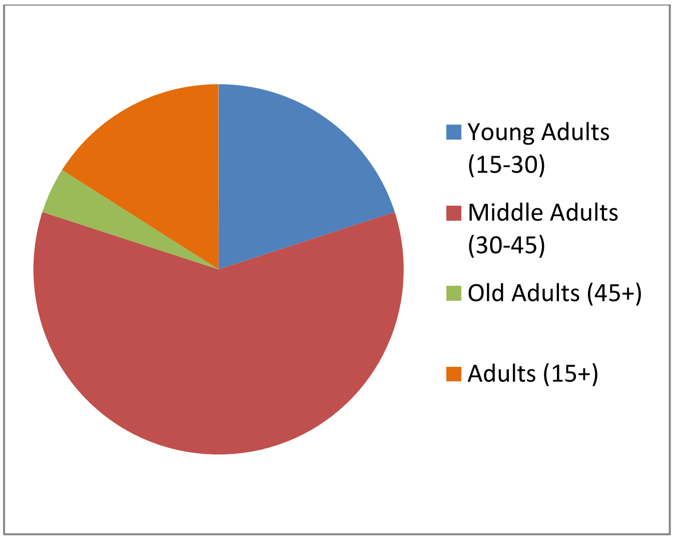


Figure 43: Pie chart showing age group distribution of Bakla Tepe adult sample population

Table 11: Trauma frequency amongst the Bakla Tepe sample population

Age Group	Sub-Adult	young adult (15-30)		middle adult (30-45)		old adult (45+)		Adult (15+)			
Sex	**n/a**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Total**	**%**
EBA I		1		1				1		3	25
EBA II/III				1	5				1	7	54
Total		1		2	5			1	1	10	40

Similar to Titriş Höyük, the frequency of traumatic injuries from the early EBA (I) to the late EBA (II/III) increases more than twofold (from 12% to 28%), although care must be taken when defining conclusions from these numbers as these figures come only from the sampled adult population rather than the entire excavated skeletal population which would give a better overall indication of trauma rates in the ancient population. Interestingly, at Bakla

Tepe, females have more traumatic injuries, including cranial traumatic injuries, than males (n=6:4, 24%:16%). This may be due to the biases in the sample population explained earlier, with there being significantly more females from the EBA II/III period. Or it may actually be representative of the trauma rates at Bakla Tepe, and demonstrate that there are more females with traumatic injuries than males. It has generally been accepted (see Chapter 1.2) that in the late EBA in Anatolia an increase in interpersonal and inter-population conflict occurred (Erdal & Erdal 2012, 89; Massa 2014b, 107; Schoop 2011, 31) and therefore it would be logical to assume that individuals from this period at Bakla Tepe would have a higher frequency of traumatic injuries than those from the earlier period regardless of their sex. It may also be that Bakla Tepe, for whatever reason, was a violent society with a high incidence of intra-population violence at a domestic household level, or simply that life was tough for the population resulting in more injuries from accidents as a result of habitual and economic practices. There is one, so far, unique 'trauma' from Bakla Tepe which is the trephined cranium (see Figure 44) of a middle adult female (G-296 2001) from the EBA II/III cemetery whose grave was larger than the others, was a single inhumation, and had rich grave goods (see also Appendix A).

5.2 Results of Carbon and Nitrogen Stable Isotope Analysis ($\delta^{13}C$ and $\delta^{15}N$)

The displayed and analysed data in this chapter are all those which have passed the quality criteria tests discussed in Chapter 4.2.1. Those which did not meet the quality requirements were discarded; in some cases this meant only the loss of a particular run, an entire skeletal element, and in some cases an entire individual. In each of Chapter Five's sub-sections it will be noted that the full list of isotopic output data for each site can be found in an accompanying Appendix.

Figure 44: Trephined cranium of middle adult female (G-296 2001) from the EBA II/III cemetery of Bakla Tepe; viewed from the occipital. Photograph by author.

5.2.1 İkiztepe Höyüğü

Of the individuals sampled from İkiztepe not a single one was discarded or rejected following the assessment of the quality criteria discussed in Chapter 5.2. This is not surprising, as the macroscopic bone preservation at İkiztepe is exceptional. However, two faunal samples were rejected, but as these were only the (a) run, and the (b) run results were accepted, this meant that the data from those animals was not lost. For a table containing the complete output data from İkiztepe see Appendices F and G.

Some of the faunal remains sampled from İkiztepe have relatively high $\delta^{15}N$ values (expected $\delta^{15}N$ value for terrestrial C3 herbivores is around 5-6‰ – see Figure 46 and Richards *et al* 2005, 392), especially for herbivores like *ovis/capra*, which could be explained by livestock farming practices such as penning or foddering/grazing on manured plants which can both increase the N values of the animals' collagen (Budd *et al* 2013, 863; Müldner *et al* 2014, 329). However, in this case a probable explanation could be the proximity of the site to the coast and the Black Sea (see discussion on this matter further below). The absolute $\delta^{15}N$ values of animal tissues can vary, even within the same trophic level, due to baseline variation within, and even across different biomes (Müldner *et al* 2014, 324). This in turn means that faunal remains exhibiting a lower $\delta^{15}N$ value may have been herded away from the main settlement and further inland and can be suggestive of pastoralism taking place at and around the site. This is with the exception of the *ovis/capra* metacarpal from context Sk 678 which came from a young juvenile animal, and therefore the high $\delta^{15}N$ value is due to the trophic level effect of suckling.

When the humans and animals are plotted together (Figure 48 – note the fauna in this Figure are the same as those of Figure 45 and this is the case for all of the sample sites in the following sections; the faunal data points on the human and fauna charts are the same as those on the only faunal remains chart) it can be seen that the humans' relatively high $\delta^{15}N$ values are most likely the result of the values of the animals, this is particularly noticeable for the two pigs (purple circles) and a few of the *ovis/capra* (green diamonds). The consumption of animals with high $\delta^{15}N$ values can in turn result in high $\delta^{15}N$ of the human consumers. The pig phalanx from context Sk 645 has possible butcher/cut marks on it suggesting it was prepared for possible consumption. A general rule when considering repetitive consumption (i.e. not a singular or isolated event of consumption) is that due to the trophic level effect the consumer should be above (i.e. ca. 2-3‰ greater for $\delta^{15}N$) and slightly to the right (i.e. ca. 1

to 2‰ more positive for δ^{13}C) of the consumed (Schwarcz & Schoeninger 2011, 731) - see Figure 47.

However, it appears that not all of the animals were being consumed by the human population. Admittedly the faunal sample size is quite small to be drawing firm conclusions from but it can help to give us an indication. It seems as if that particular cow (orange square) was not consumed (for meat, blood, or milk/dairy products) by any of the sampled human population which may suggest that it was kept for other purposes such as traction, or perhaps as the sex is unknown, it may have been for breeding purposes.

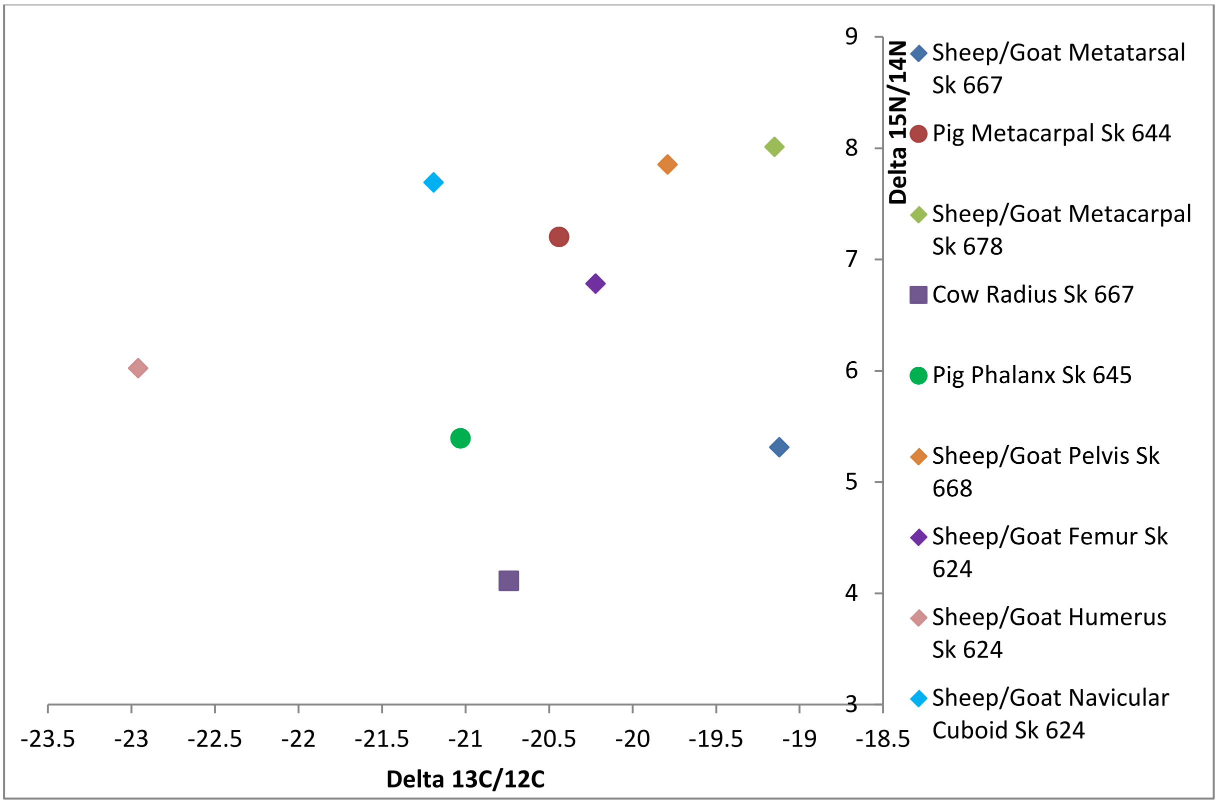


Figure 45: Faunal samples from İkiztepe plotted for δ13C and δ15N

But as there is only one specimen it is impossible, and would be unwise, to make any conclusion about the overall pattern of use of domesticated cattle at the site. What is interesting is the three *ovis/capra* that appear as 'outliers'; the one to the far left of the chart and the two to the lower right of the human sample population. These were definitely not consumed (for meat, blood, or dairy products) by the human sample population and may have had other roles for the human population (see Chapter 6.2).

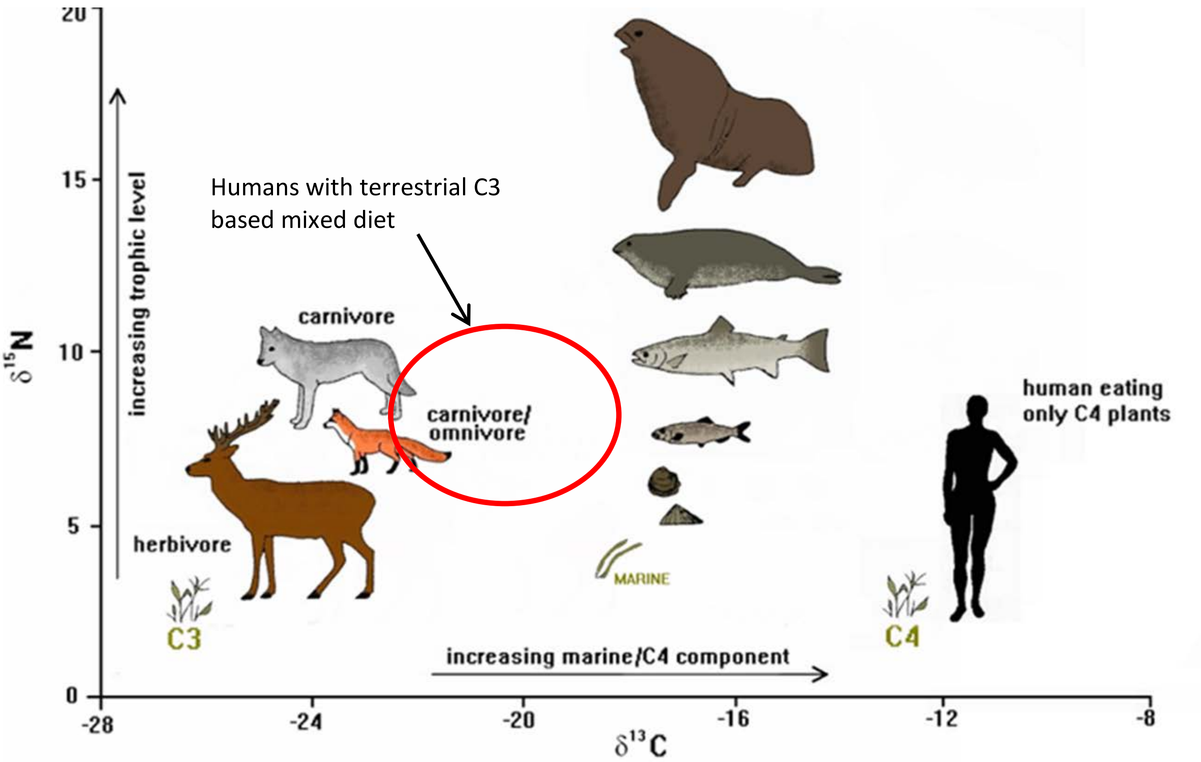


Figure 46: Typical δ13C and δ15N values in terrestrial and marine food-chains, also showing expected range of values for a human subsisting on a terrestrial C3 based mixed diet. Adapted from Schulting 1998, 205.

However, one of the *ovis/capra* to the right of the human sample population (with a δ^{15}N value of 8‰) is from a young juvenile animal, and it would seem likely that due to the young age of this animal that it died of natural causes (perhaps disease or weather related), or killed for a purpose other than consumption (e.g. sacrifice) and therefore would be unlikely to have been consumed. The *ovis/capra* on the far left of the chart is indicative of a very terrestrial C3 herbivorous diet which would suggest (if the above hypothesis about coastal grazing/living is followed) that before its death it was herded far from the site and the coastal region. The ongoing sulphur isotopic analysis will help to give a better indication of the herding and pastoral patterns of the livestock from İkiztepe by identifying relative distance from the coast. One further thing to note is that the faunal remains cluster less closely than the humans.

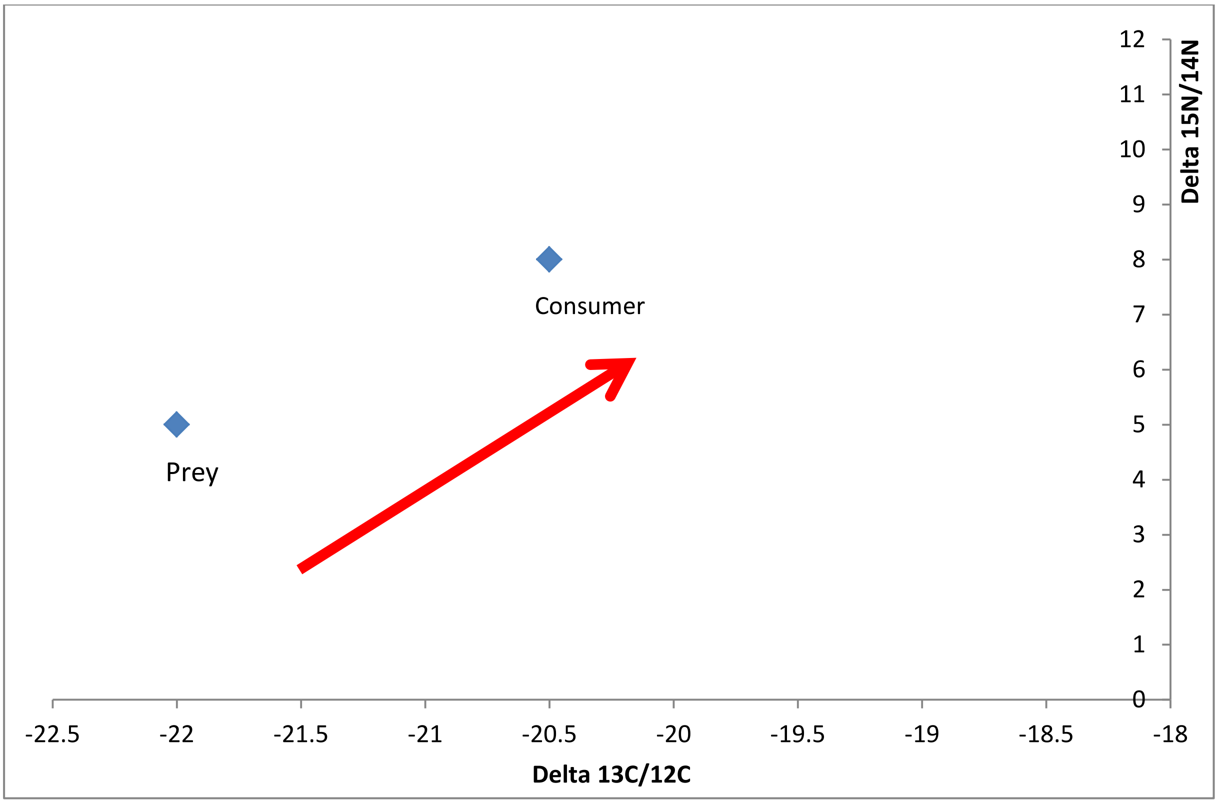


Figure 47: Chart to demonstrate relationship of isotopic signals between prey and consumer. Red arrow indicates expected change in stable isotopic signals from prey to consumer tissue

This may be indicative of the geographic range from which animals came to the settlement or where they were herded and kept (perhaps evidence of pastoralism). However, it may be the result of a small sample size and a larger sample size would show more animals clustering close together with a few outliers (i.e. a larger sample size may result in less variance from a mean).

Figure 49 displays all of the adults from İkiztepe plotted together on a scatter graph for $\delta^{13}C$ against $\delta^{15}N$. It can be seen rather instantaneously that all of the adult individuals and their respective sampled skeletal elements cluster together rather closely for both carbon and nitrogen. There is a maximum $\delta^{13}C$ value of -19.4‰ and a minimum of -20.8‰, and the mean is -20‰. The maximum $\delta^{15}N$ value is 10.1‰ with a minimum of 7.4‰ and a mean of 8.9‰. This range of values is indicative of a terrestrial C3 based mixed diet. For $\delta^{15}N$, human consumers of terrestrial plants and animals typically have values from bone collagen of 6-10‰ (Tykot 2004, 436).

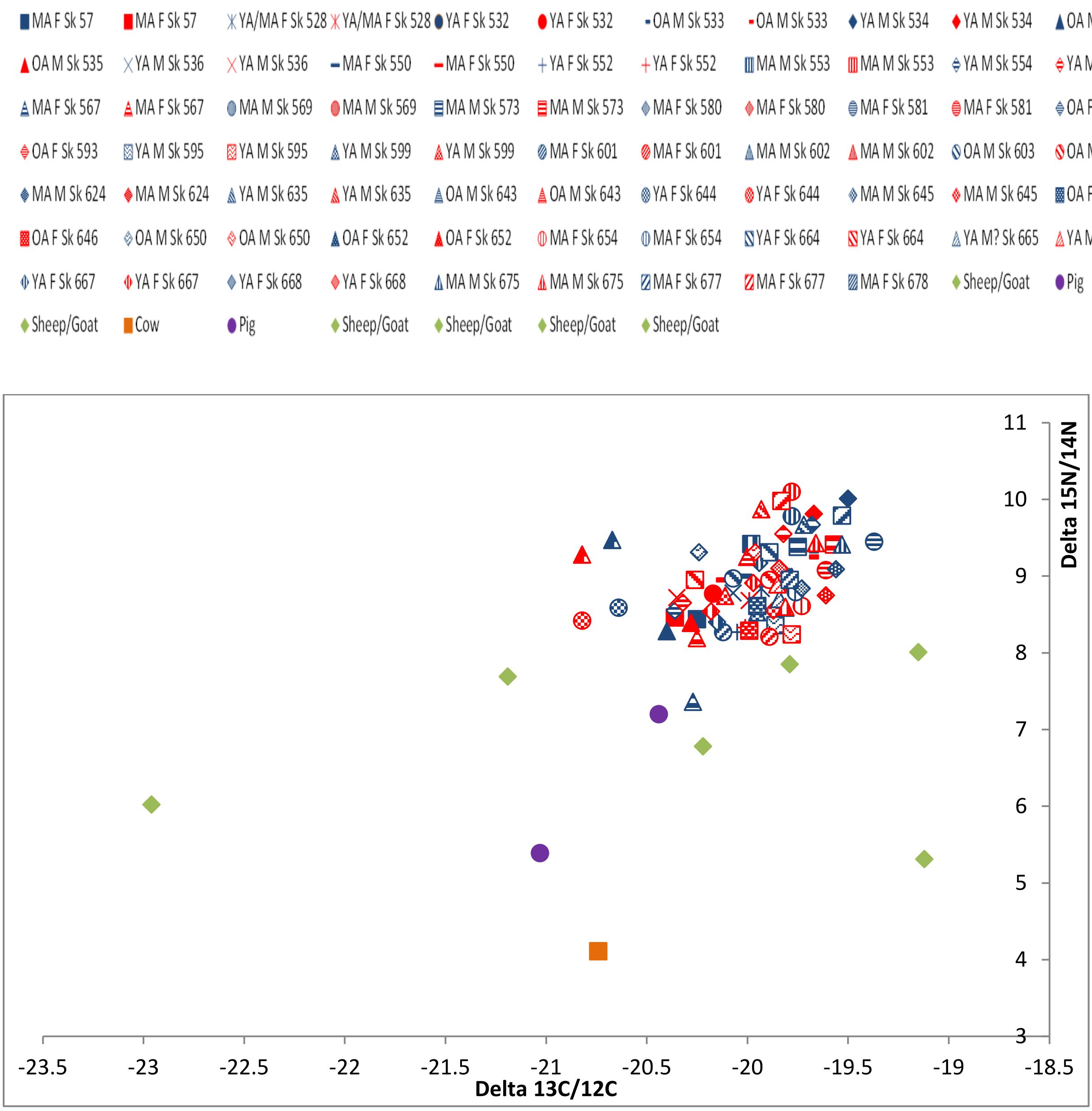


Figure 48: Faunal and human samples from İkiztepe plotted together for δ13C and δ15N. Legend for Figure 48 shown above chart.

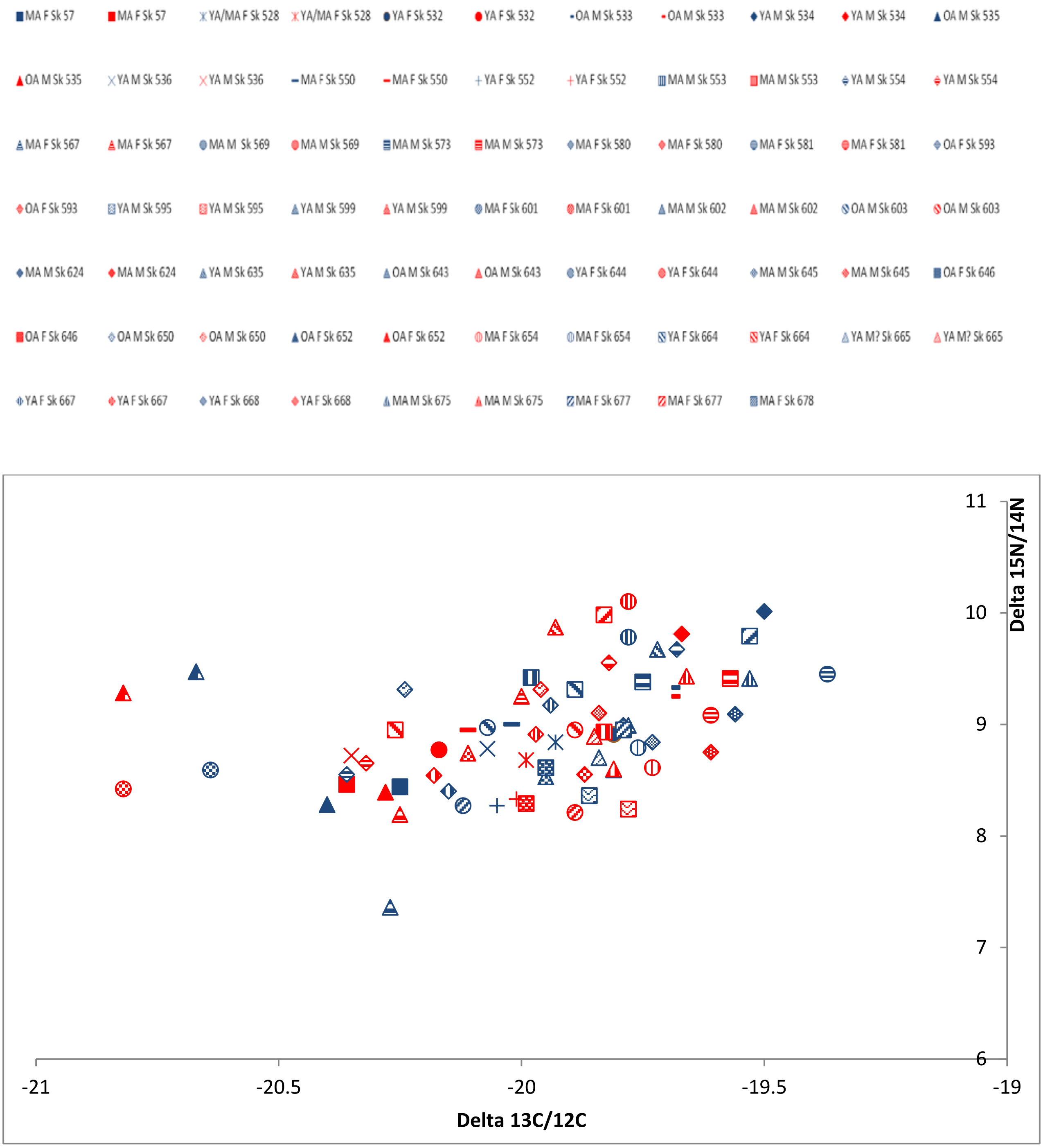


Figure 49: İkiztepe adults plotted for δ13C and δ15N. Legend for Figure 49 shown above chart.

The relative closeness of the points suggests that the dietary habits of the population were consistent and homogeneous; low isotopic variability is usually an indication of more stable/consistent dietary habits (Reitsema & Vercellotti 2012, 597). However, this was further tested by plotting means with standard deviation error bars and applying statistical models to sub-groups within the adult sampled population. It can be observed visually that there are two individuals to the left of the graph who appear to be anomalous and separate from the rest of the population. However, their $\delta^{13}C$ are within 1‰ of the population mean and within 1‰ (above and below) of the mean for $\delta^{15}N$. As will be discussed later, these ranges of difference are marginal and isotopically insignificant. This means that although the two individuals may appear to be outliers, the actual difference in their lifetime diet would have been minor compared to the rest of the population. Despite this, we can say that they are still detached from the majority of the population, and so despite the differences being minor, there may have still been differences.

One of the commonly hypothesised socio-cultural differences in dietary habits in ancient populations is between the sexes, and this was examined within the İkiztepe adult sample population. As can be seen from Figure 50, the means of males ($\delta^{13}C$: -19.9‰, $\delta^{15}N$: 9.1‰) and females ($\delta^{13}C$: -20.1‰, $\delta^{15}N$: 8.8‰) from İkiztepe plot very closely together and the standard deviation bars for both carbon and nitrogen overlap. Due to the trophic stepwise enrichment and fractionation of carbon and allowing for laboratory error (i.e. the mass spectrometry machines are not 100% accurate), it is generally accepted that any points within 1-2‰ are not deemed to be significantly different, and likewise for nitrogen anything within 2-3‰ is not deemed to be significantly different due to the factor of step-wise trophic enrichment for nitrogen (originally discussed in Chapter 3). Most modern mass spectrometers have an accuracy/precision of ±0.1‰ for $\delta^{13}C$ and ±0.2‰ for $\delta^{15}N$ (Katzenberg 2008, 422). The laboratory error of standards at the MPI in Leipzig where the stable isotope analysis was performed is ±0.1‰ for $\delta^{13}C$ and ±0.2‰ for $\delta^{15}N$ (Choy *et al* 2015, 316). This means that anything within these values can be ignored as potential laboratory error rather than an actual difference in stable isotopic signatures of the human bone collagen. It could be stated that due to the means of both groups being well within 1‰ for both $\delta^{13}C$ and $\delta^{15}N$ and only just outside of the laboratory errors that there is no significant difference between males and females at İkiztepe. This hypothesis was tested using a two-tailed t-test for both the $\delta^{13}C$ and $\delta^{15}N$ means. The t-tests, however, demonstrated that there is a statistically significant difference between males and females for carbon (p = 0.00) and for nitrogen (p = 0.01). What the statistical analysis demonstrates is that there are consistent differences between males and females for both carbon and nitrogen input in the diet.

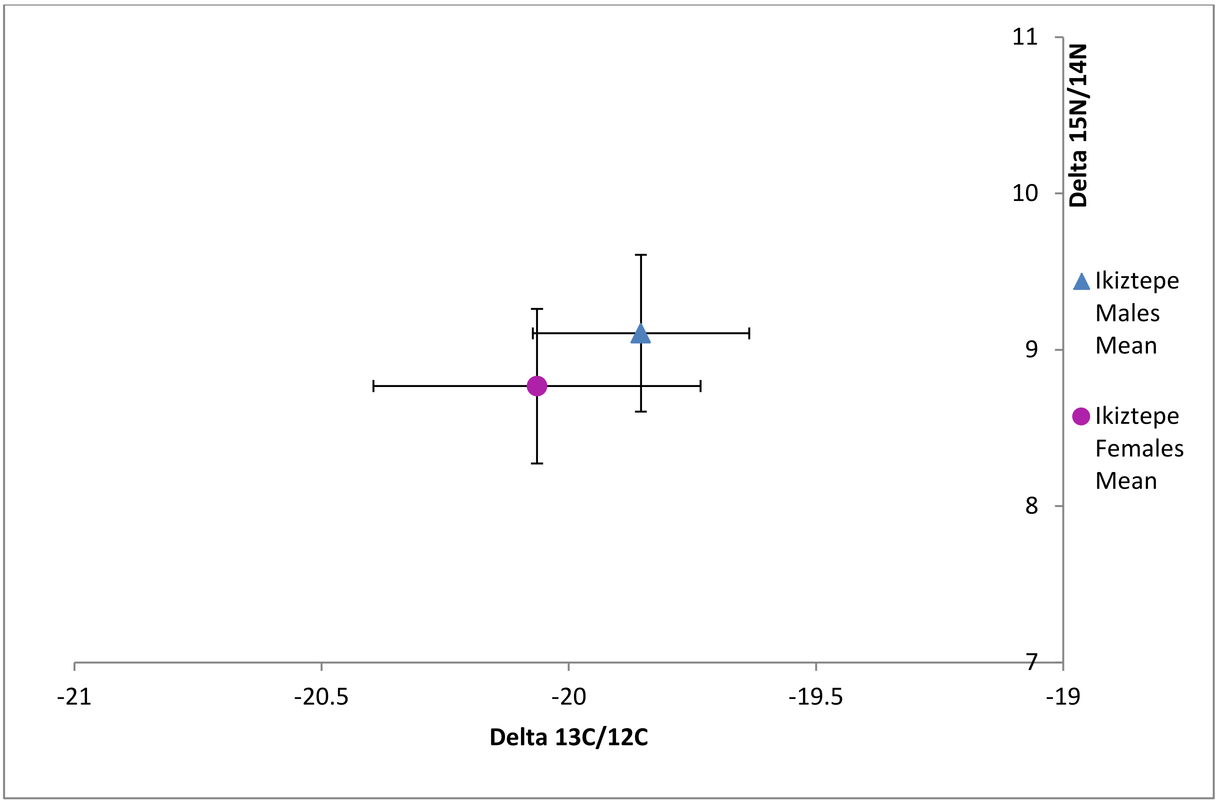


Figure 50: Means with standard deviations plotted for İkiztepe adult males and females

However, these differences are arguably on a small and unimportant scale. In other words, there are statistically significant differences but that these are not *significant* on a larger scale and more general picture. One possible explanation for such small differences in stable isotopic values could, in part, be the result of laboratory error. For illustration, an (a) and a (b) run of the extracted collagen from a single skeletal element from one individual should theoretically be exactly the same, but if we examine the data from the femur of G-275/3 2001 from Bakla Tepe, for example, it is observed (see Appendix K) that for $\delta^{13}C$ the (a) run is -20.4‰ and the (b) run is -20.1‰ and for $\delta^{15}N$ the (a) run is 7.7‰ and the (b) run is 7.5‰. Therefore if we expand this reasoning across a sample population it should be understood that in the majority of cases a difference within 1-2‰ may not be significant as it could simply reflect minor fallibilities of the laboratory procedure. Of course consistent differences in the data within a population may actually be indicative of differences in dietary habits. In this case it may be that males were consuming slightly more protein in their diet, that females consumed more processed milk products with a reduced/small protein content such as butter, cream/cream cheeses (Pickard *et al* 2016, 304), or physiological effects such as the influence of childbirth and/or nursing. But it is difficult to say any of things with a high degree of certainty. And even if we did accept this, at this level of discrepancies between the data, the differences in the actual dietary habits of the individual would be minor over the course of their lifetime. Slight differences in the data could also be attributed to pathologies and/or aspects of an individual's lifestyle that either cannot be observed macroscopically on the skeletal remains, or leave no trace (Katzenberg & Lovell 1999, 323). Therefore, to say that an individual(s) was likely to have had differing dietary habits the differences in the data of the stable isotope analyses must be large enough that we can say this with certainty. This ensures that our conclusions are as reliable as possible. However, one of the problems with examining and comparing the means of two variable/groups of data is that fine details within the data can often be lost or obscured. In an attempt to address this issue in the instances where the results of the statistical analyses are dismissed as being insignificant, the data will be further examined using a scatter graph of the sub-groups to examine all of the data points and their cloud/cluster and/or box and whisker plots.

Therefore when the males and females from İkiztepe are examined in their entirety (Figure 51) it can be observed that whilst the majority of males and females plot together in a cluster approximately between -19.5‰ and -20.5‰ for $\delta^{13}C$ and between 8‰ and 9.5‰ for $\delta^{15}N$ there are some outliers. There is a greater spread in the range of values of $\delta^{13}C$ and $\delta^{15}N$ amongst the females and there are fewer females with $\delta^{15}N$ above 9.5‰ than males. These factors are in themselves interesting and would also explain why a statistically significant difference was found between the two groups for both $\delta^{13}C$ and $\delta^{15}N$. What this suggests is that there was greater variability in the dietary habits of females and, furthermore, whilst the majority of males had the same dietary habits as the average female, there are some males who consumed a greater amount of protein in their diet. However, despite there being a few outliers and a trend for females to have generally lower $\delta^{15}N$ values the differences are on a minor scale. In terms of the actual dietary habits of the individuals there would have only been small differences between the sexes, although it may be argued that on average males, or at least some males in the population, were more likely to consume a slightly greater amount of protein in their diets. Whilst it should be stated that these differences, both in terms of the data and real world dietary habits, are generally insignificant, laboratory error and factors such as physiology, genetics, pathologies etc. cannot explain them away entirely as they are not random but instead have a pattern to them. And so, it may be relevant here to raise some initial ideas of taste versus nutrition. It has been demonstrated that different groups within a population (e.g. sex, gender, age, socio- and socio-political, 'class') identify and distinguish themselves through tastes in their dietary habits (see Bourdieu 1984, 180-195 for a detailed examination of this concept). Nutritionally the meals may be similar in terms of proportions of meat and vegetables etc. they can, nonetheless, be very different with regards to composition (e.g. types/cuts of meat), preparation, and consumption. At İkiztepe, whilst nutritionally the differences between the sexes are minor (the data infers that they both consumed approximately the same relative proportions of protein), there may have been larger differences exhibited through taste (the types/forms of protein consumed) which may account for these small differences in the stable isotope data. As was explained in more depth in Chapter Three, stable isotopes analysis of extracted bone collagen is not refined enough to accurately pick up on and extricate these more subtle nuances of an individual's diet. In summary of this small section, it can be said that whilst the differences between males and females should not be over exaggerated, they should also not be dismissed in entirety. There are consistent differences between at least some males and the average member of the population related to δ^{15}N values, and therefore protein intake.

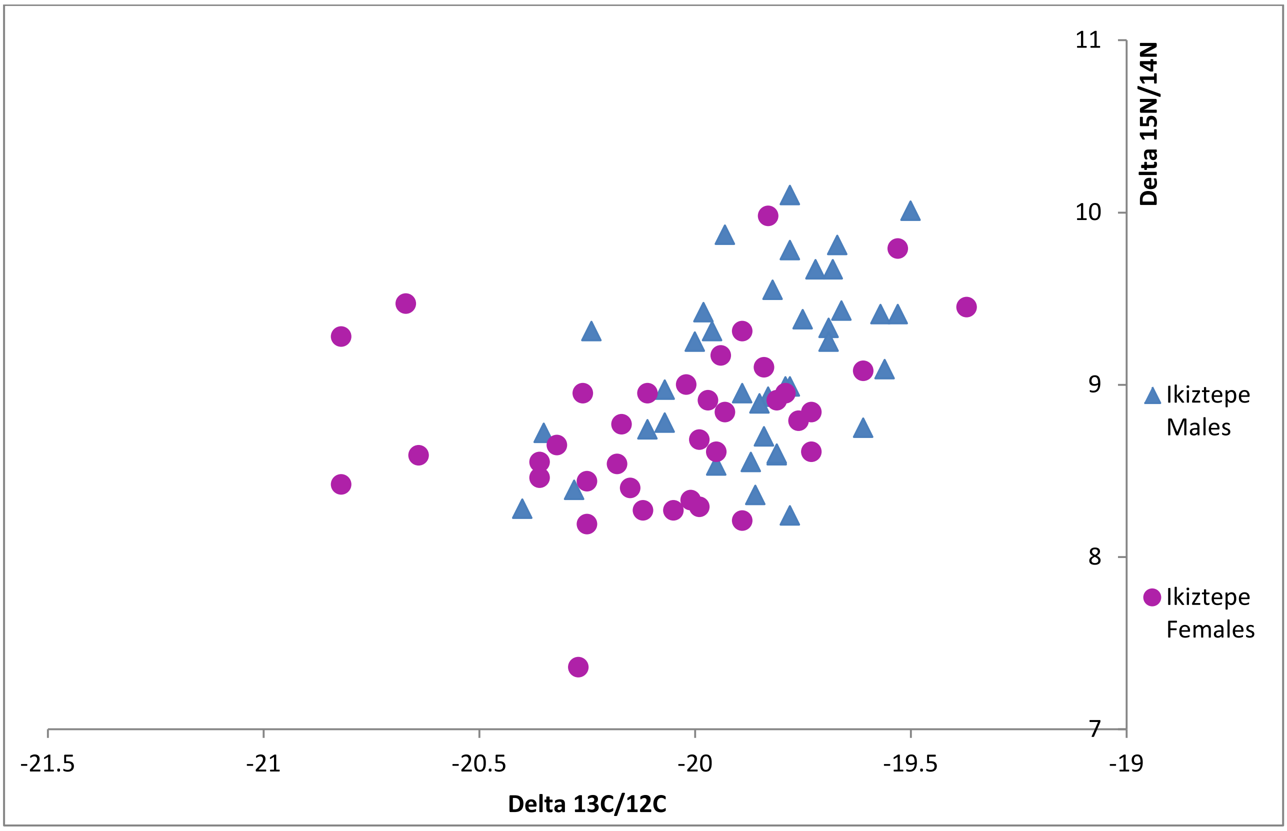


Figure 51: Females and males from İkiztepe plotted for δ13C and δ15N

As well as examining for potential differences between the sexes, this reasoning was also applied to between the age groups (young adult, middle adult, and old adult) with the means and standard deviation error bars for all three age groups plotted (see Figure 52).

As with the sexes, there appears to be no significant difference between the age groups at İkiztepe with all of the means for both carbon (YA = -20‰, MA = -19.8‰, OA = -20.1‰) and nitrogen (YA = 8.9‰, MA = 9‰, OA = 8.9‰) being within the insignificant range of each other and the standard deviations overlapping. Again, to test the hypothesis of no significant difference between the age groups statistical analysis was performed; in this case a single factor ANOVA was used separately for carbon and nitrogen. A statistically significant difference was found between the age groups for carbon (p = 0.00), but no statistically significant difference for nitrogen (p = 0.91).

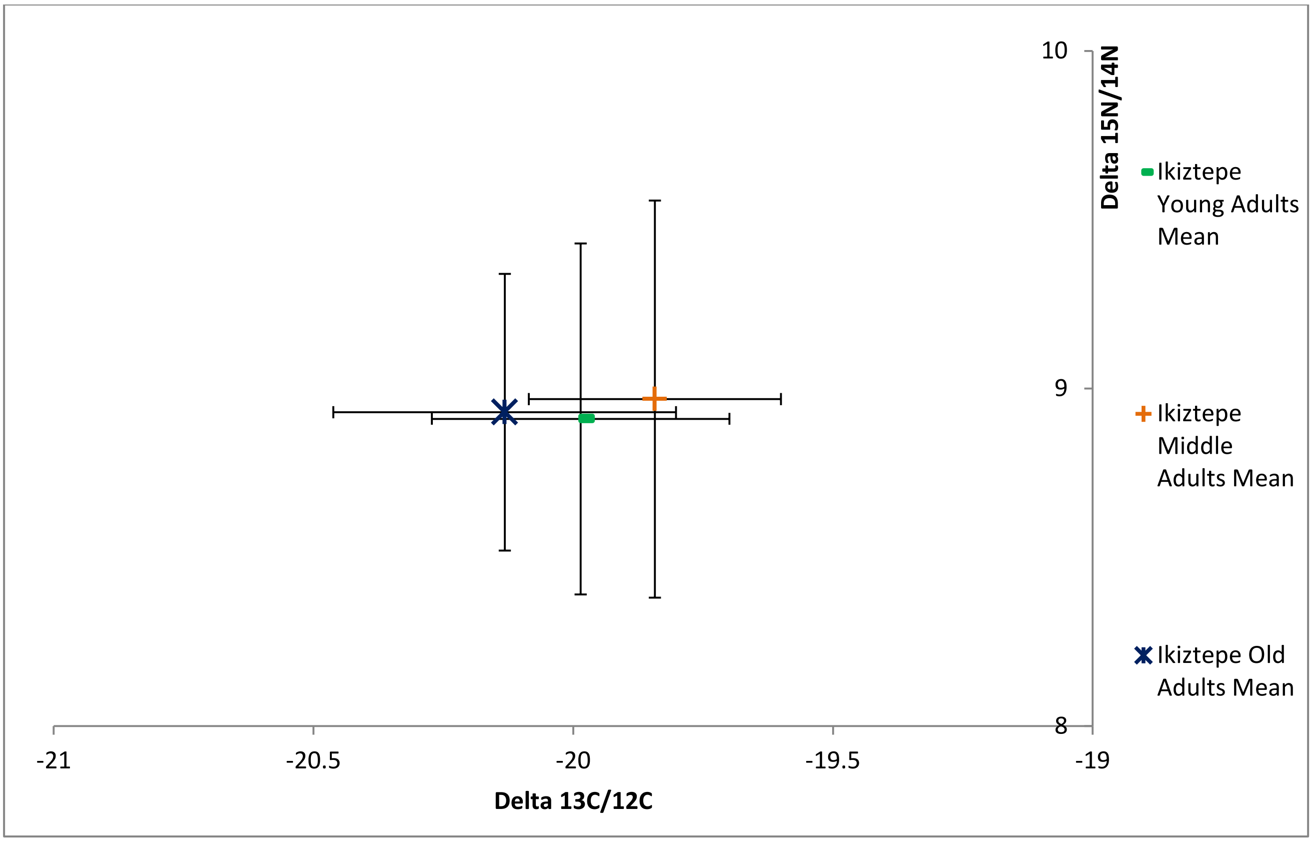


Figure 52: Means with standard deviations plotted for adult age groups at İkiztepe

Despite the single factor ANOVA showing that there is a statistically significant difference between the age groups for the carbon source of the diet, this significance is on an insignificant scale. To enable a better visualisation of the data and to better understand the statistical analysis results, box and whisker plots were prepared (see Figure 53 for carbon, and Figure 54 for nitrogen). The box and whisker plots show quite clearly that whilst there is some difference between the age groups for the $\delta^{13}C$ values, these differences are on an overall insignificant level. Whilst it may seem like the statistical analyses are being dismissed, it should actually be regarded as very interesting and informative as it demonstrates to us subtle differences that may not be instantly observable. The statistical analysis demonstrates that whilst in some cases there are significant differences, and that these differences are consistent throughout the analysed sample population sub-group, these differences are too small to say with any certainty that there would actually have been quantifiable and identifiable differences in the dietary habits of these sub-groups in pre-history, at least in terms of nutrition as has been discussed above. Therefore, whilst the subtle and minute differences should not be dismissed completely and examined and considered, as discussed earlier they are often on too fine a scale to make any definite conclusions and therefore in many cases it is better to err on the side of caution. That either these statistically significant differences are within the 'buffer zone' of laboratory and machinery error, or that they are sometimes as a result of a couple of outliers anomalous to the population majority and thereby norm, which can be lost when examining only the means and the statistical analyses following them.

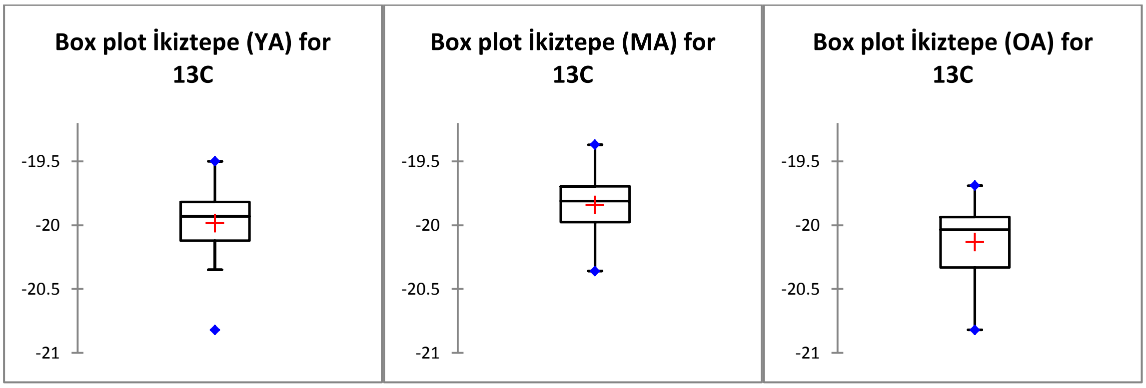


Figure 53: Box and whisker plots of δ13C values of adult age groups (YA, MA, and OA) at İkiztepe. Numbers on scale are δ13C values in ‰

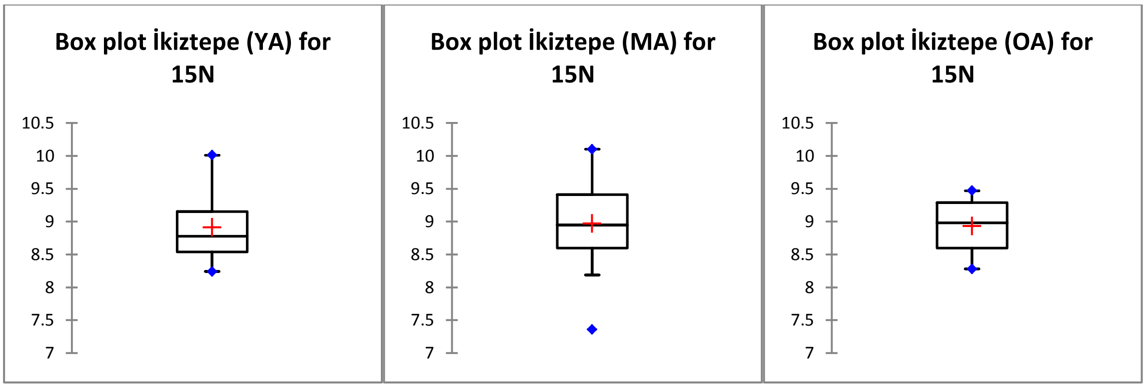


Figure 54: Box and whisker plots of δ15N values of adult age groups (YA, MA, and OA) at İkiztepe. Numbers on scale are δ15N values in ‰

It was observed, in Chapter 5.1.1, that a total of 34.2% of the İkiztepe adult sample population have at least one traumatic injury. Despite there being no observable difference in grave type, location, or grave assemblage (see Chapter 2.2) between individuals with trauma and those without, suggesting that there was no socio-economic/socio-political difference between the two groups, this was further examined from the perspective of the stable isotope data (see Figure 55). As with all the other sub-groups in the İkiztepe adult sample population the means for both carbon (with trauma = -19.9‰, without trauma = -20‰) and nitrogen (with trauma = 9.1‰, without trauma = 8.8‰) are close together and within the insignificant range. These means were tested statistically using a two-tailed t-test for the $\delta^{13}C$ and $\delta^{15}N$ values which showed that there is no statistically significant difference (p = 0.06) between the groups (individuals with traumatic injury/injuries and individuals without traumatic injury/injuries) for carbon, but there is a statistically significant difference for nitrogen (p = 0.03). Once again, whilst there is a statistically significant difference between the two groups this is on a minor and arguably insignificant scale. To examine further this statistically significant difference the data point 'clouds' for individuals with and without trauma were plotted (Figure 56). The points plot very similarly to those for males and females. This is not surprising though as there are more males than females with traumatic injuries in the sample population. As a result, it is most likely this factor that is causing the statistically significant difference. It was discussed earlier how the majority of females had a lower $\delta^{15}N$ value than the males, and this can also be observed in the graph for individuals with traumatic injuries and those without.

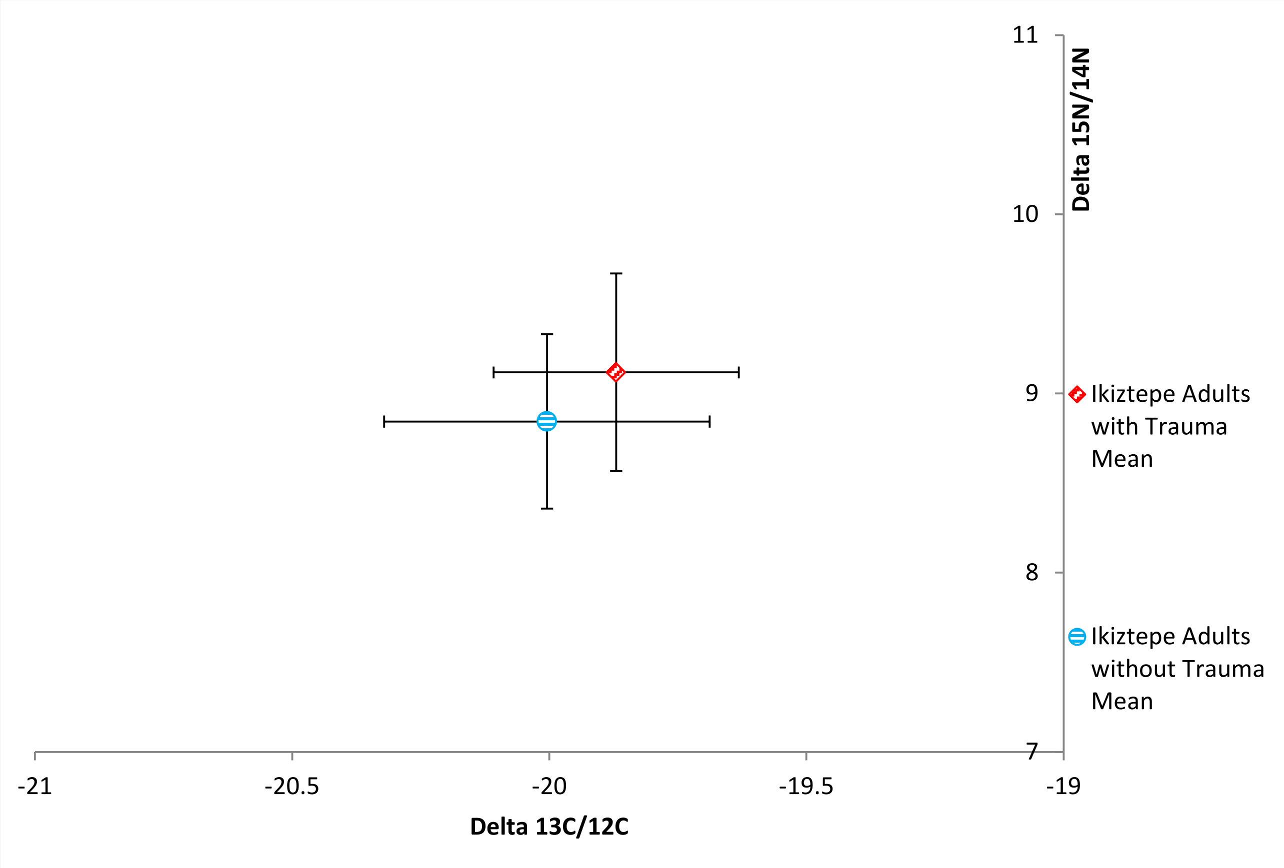


Figure 55: Means with standard deviations plotted for adults with trauma and those without within the İkiztepe sample population

Therefore it would seem to indicate that a difference between the two groups is related to the sex of the individuals. To expand on this it can therefore be expressed that there is a co-occurrence and connectivity between males and in particular those males with a marginally higher protein intake, and those individuals with traumatic injuries.

Welton's doctoral thesis examined the mobility of sampled individuals from the İkiztepe skeletal population and she found that some individuals were mobile, including some that were most likely to have been long distance migrants (see Chapter 2.2). Her Sr (strontium) data and analyses of the cemetery and graves, especially for the long distance migrants seems to suggest that the mobile and non-local individuals were fully integrated into the society, at least in terms of burial habits, location, and burial assemblage (Welton 2010, 443).

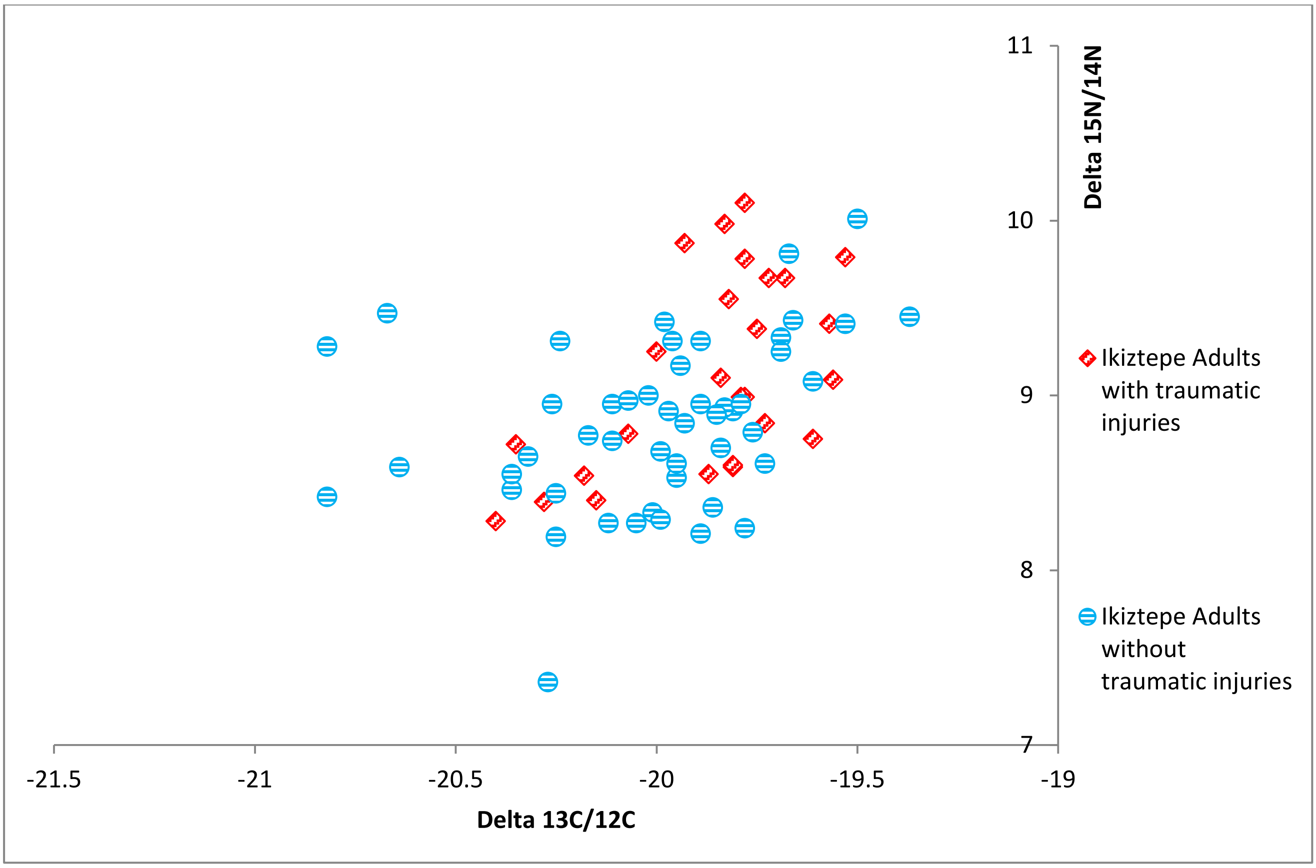


Figure 56: Adults from İkiztepe with and without traumatic injuries plotted for δ13C and δ15N

Welton also investigated possible phenotype differences between individuals in the cemetery and her research showed no difference in phenotypes of the non-locals, or of the mobile individuals which would suggest that they did not remain genetically isolated but instead that they interbred with the local population contributing to its gene pool (Welton 2010, 455-456). If the hypothesis is that non-local and/or mobile individuals were fully integrated at EBA İkiztepe then it would be expected that no (or at best small) difference should be observed in their dietary habits either, as they would be eating the same kind of foodstuffs in the same relative quantities. The means of the individuals who were known to be non-local (sample size n = 6 individuals) following Welton's (2010) research who were also sampled for this doctoral research were plotted against those individuals who were deemed local, or at least not non-local (sample size n = 32 individuals) (Figure 57).

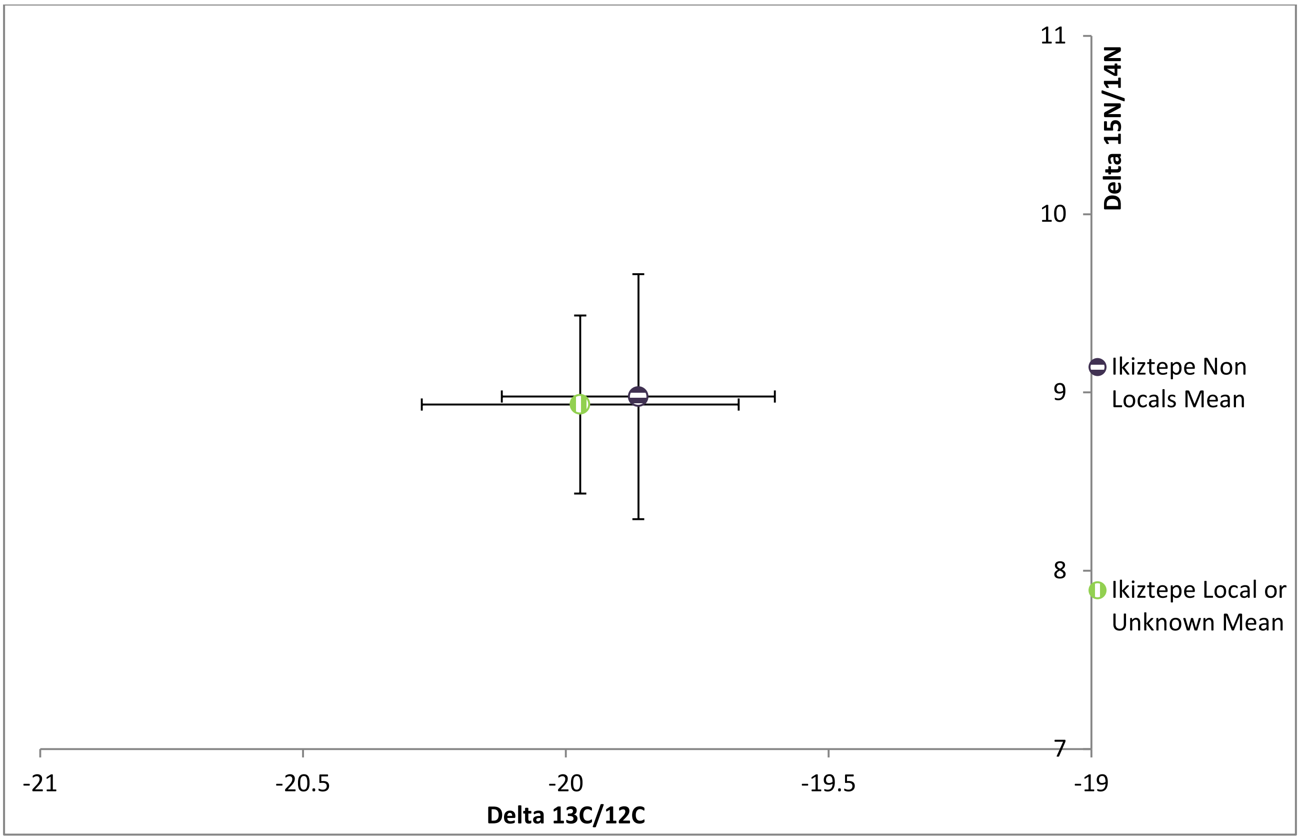


Figure 57: Means with standard deviations plotted for non-locals and locals/undetermined at İkiztepe

One of the obvious biases in the analysis of this sub-group is that the 'local' group is simply undetermined as being non-local or mobile. Welton did not sample and analyse all of the individuals from the İkiztepe skeletal population. There are individuals within my sample population that she did not analyse for mobility; these may in fact be non-local or mobile individuals but have been included in the 'local' group in this analysis causing a contamination of the numbers (i.e. the scatter plots and statistical analysis of locals may actually include non-locals and thereby potentially obscure any patterns or anomalies). However, by examining the means and the range of values one may get an indication as to whether this has happened, and indeed if the hypothesis is correct it should not matter if the 'local' group contains non-locals as they will all have similar δ^{13}C and δ^{15}N values. The non-local individuals (following Welton 2010) have a range of -20.3‰ to -19.5‰ with a mean of -19.9‰ for δ^{13}C and a range of 7.4‰ to 9.4‰ with a mean of 9‰ for δ^{15}N. The 'local'/undetermined individuals have a range of -20.8‰ to -19.4‰ with a mean of -20‰ for δ^{13}C and a range of 8.2‰ to 10.1‰ with a mean of 8.9‰ for δ^{15}N. The ranges, minimums, maximums, and means are within a very close range within and between the groups. Two tailed t-tests were performed on the $\delta^{13}C$ and $\delta^{15}N$ mean values and neither shows statistical significance (p = 0.19 and p = 0.86 respectively). This indicates that the null hypothesis is correct and that there is no difference between non-local and/or mobile individuals and others; the former were integrated into the general population in terms of burial and dietary habits, although – as discussed above – some caution must be taken when reviewing these results.

Bilgi (2005b, 17) identified some individuals' burials from the İkiztepe cemetery to be 'distinguished' (see Chapter 2.2). A group (n = 8) of these distinguished burials were sampled as part of this research (Sk 554, 569, 573, 580, 581, 602, 603, and 645). The argument put forward for the individuals in these burials is that they belonged to the ruling elite and their families (Bilgi 2005b, 17). Therefore, it can be anticipated that if these individuals were part of a higher socio-political and socio-economic group, then their dietary habits could also have been different. This hypothesis was tested by plotting the means and standard deviations of the individuals from these burials along with those from the 'common' graves (n = 30) (Figure 58) and performing two tailed t-tests on the $\delta^{13}C$ and $\delta^{15}N$ means.

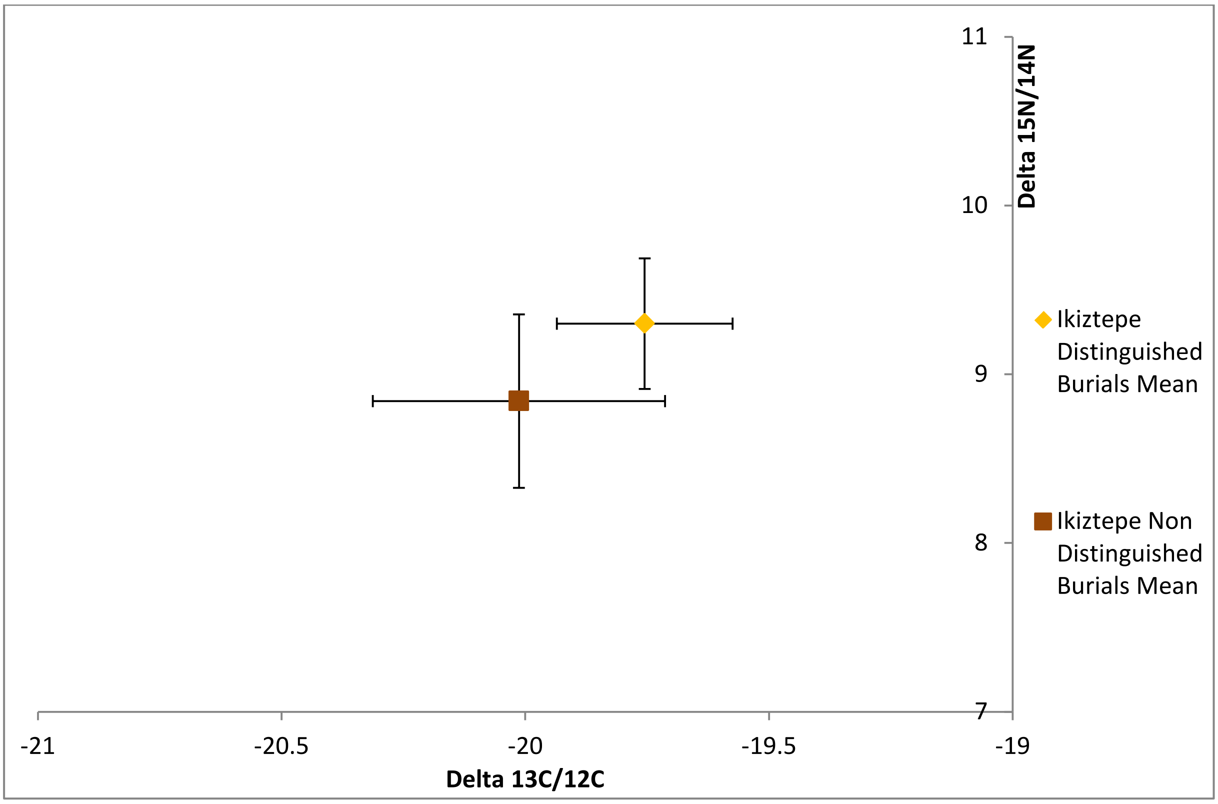


Figure 58: Means with standard deviations plotted for distinguished burials and 'common' burials at İkiztepe

The means for the distinguished burials are -19.8‰ for $\delta^{13}C$ and 9.3‰ for $\delta^{15}N$, and -20‰ ($\delta^{13}C$) and 8.8‰ ($\delta^{15}N$) for the 'common' burials. Whilst these means are very close to each other, the two tailed t-tests demonstrated that there is a statistically significant difference for both carbon ($p = 0.00$) and nitrogen ($p = 0.00$) between the two groups. Once more, whilst the statistical analysis indicates that there is a consistent significant difference between the two groups, this is on a very small scale.

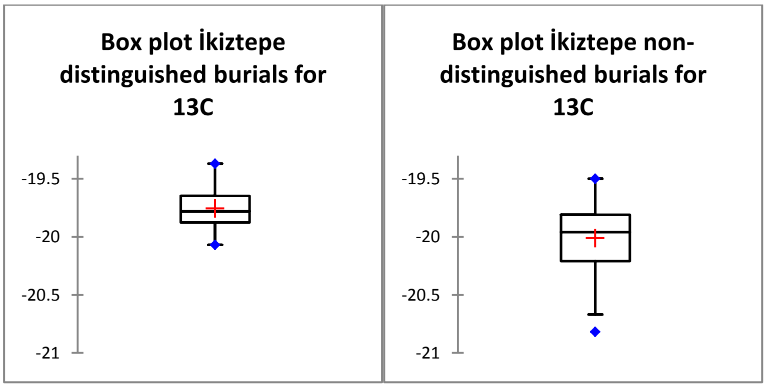


Figure 59: Box and whisker plots of δ13C values of distinguished and 'common' burials at İkiztepe. Numbers on scale are δ13C values in ‰

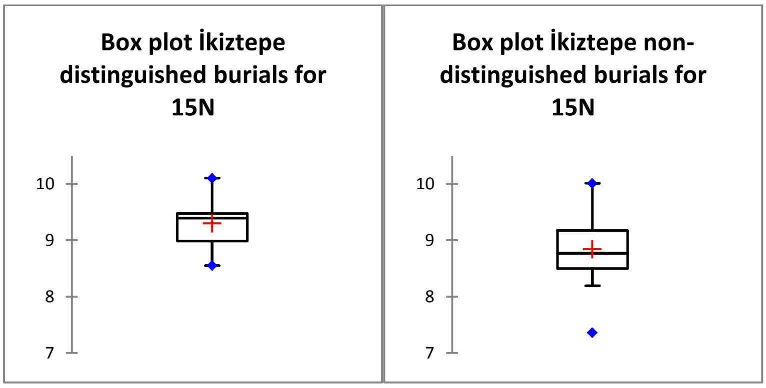


Figure 60: Box and whisker plots of δ15N values of distinguished and 'common' burials at İkiztepe. Numbers on scale are δ15N values in ‰

The box and whisker plots (Figures 59 and 60) demonstrate that there are some subtle differences between the two groups and that there is a greater range in values amongst the non-distinguished burials with there being generally more positive $\delta^{13}C$ and $\delta^{15}N$ values for the individuals from the distinguished graves. The smaller range may be related to the small size of the sample group relative to the ‘common’ burials. When all of the data points for both groups are plotted as a ‘cloud’ (Figure 61) these differences can be seen more visibly. Overall it can still be ascertained that there is arguably no significant difference between the two groups due to the scale of the differences. But it can be stated that the individuals from the distinguished burials have generally more positive $\delta^{13}C$ and $\delta^{15}N$ values than the majority of those from the ‘common’ graves. However, there are several individuals from the ‘common’ graves who also plot in this area of the graph which would suggest either that the dietary habits of the individuals from the distinguished burials were not that different or distinct or that these individuals were of the same or similar group but their graves have not been identified as such. The more positive $\delta^{13}C$ and $\delta^{15}N$ values are on a very small scale, but they are generally consistent. This may suggest that there was some distinction in dietary habits, albeit minor or averaged out over the course of the individuals’ lifetimes. The data indicates that this difference would most likely have been a small, but consistent, greater protein intake, or that these individuals may have consumed small amounts of marine resources (perhaps shellfish), or consumed marine resources irregularly (see debate later in this section). The isotope data and subsequent plots for the distinguished and ‘common’ burials are similar in pattern to those for males and females, and individuals with and without trauma. With particular reference to the discussion about the male and female results from İkiztepe and the notion of nutrition and taste, something similar may be applicable here. The subtle, yet consistent, differences between the two groups which were acknowledged by the statistical tests may be the result differences in taste rather than nutritional input. However, in my opinion the differences between the two burial types are less obvious and more random and marginal than those exhibited in the data between males and females, and individuals with and without trauma. This would suggest that dietary habits (by either nutrition or taste) played a minor role in distinguishing how an individual was buried and was instead determined by some other factor.

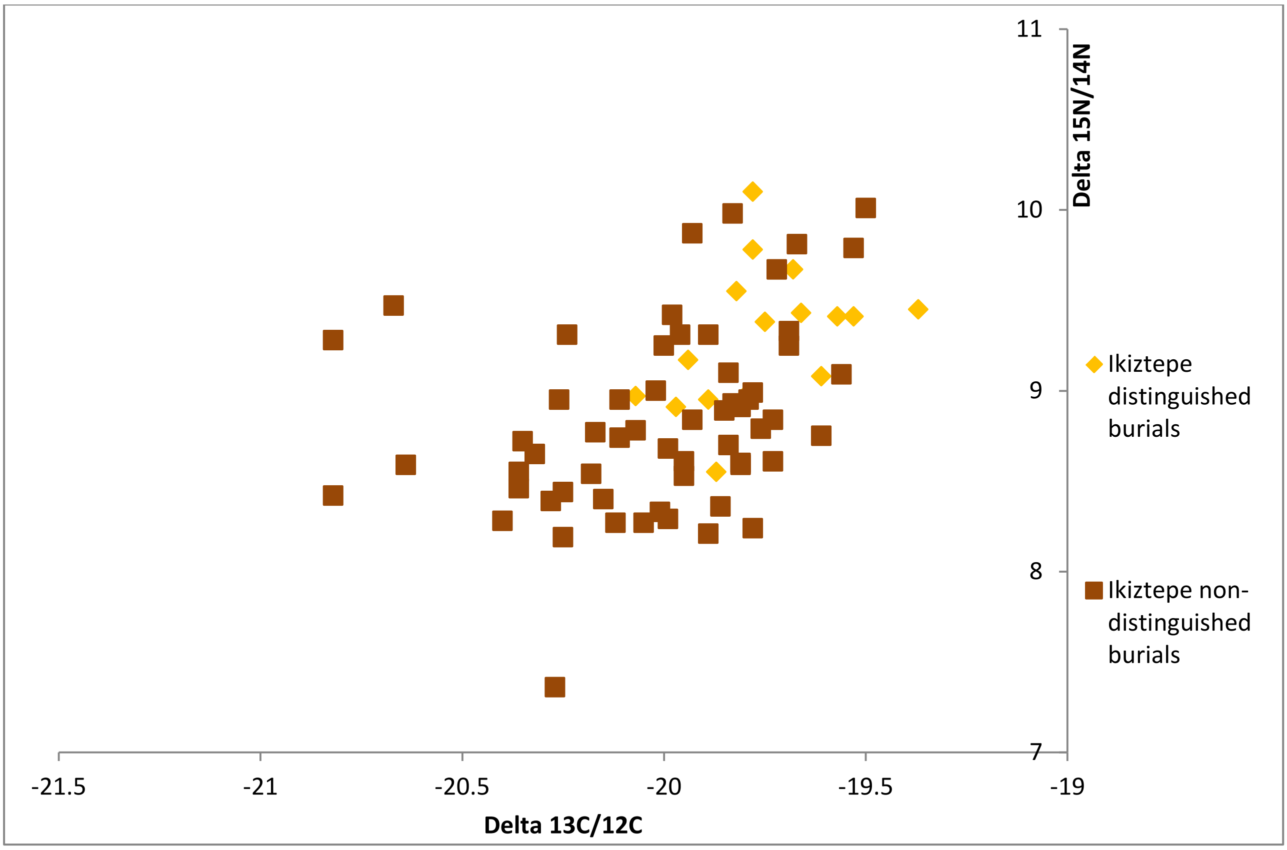


Figure 61: Distinguished and 'common' burials of adults from İkiztepe plotted for δ13C and δ15N

One of the interesting things to come out of this research is the lack of marine resources in the diet. It has long been believed that fishing and marine resources played a substantial role in the dietary habits of the EBA population owing to the location of the settlement, the presence of bronze 'harpoons' (see below), and some fish bones discovered during excavation (YS Erdal, personal communication). However, the stable isotopic data has not shown this and has instead shown that the population subsisted on a terrestrial C3 based diet with no visible traces of marine input. It has been established that the $\delta^{15}N$ values of piscivorous marine fish are ca. 12‰ with a range of ca. 11‰ to 16‰ and those of shellfish are ca. 8‰ (Richard *et al* 2005, 393; Schoeninger & DeNiro 1984, 631). Due to the trophic step-wise enrichment of $\delta^{15}N$ values, if the humans of İkiztepe were regularly eating either of these marine resources, their $\delta^{15}N$ values should be expected to be between 10 and 19‰ at least, whilst the highest $\delta^{15}N$ value in the sample is actually 10.1‰. Furthermore, the $\delta^{13}C$ values of individuals consuming predominantly marine resources is around -12‰ (Ingvarsson-Sundström *et al* 2009, 2). Even allowing for lower $\delta^{13}C$ values in individuals with a mixed diet containing terrestrial and marine resources the highest $\delta^{13}C$ value from

İkiztepe is -19.4‰ which suggests marine input in the diet is highly improbable. For example, the stable isotope signals of a human from Umingmak (on Banks Island of the North West Territories of Canada) who was interpreted to have consumed a mixed terrestrial and marine diet but with a high contribution of marine resources had a $\delta^{13}C$ value of -17.2‰ and a $\delta^{15}N$ value of 18.7‰ (Bocherens *et al* 2016, 703). Previous studies into marine consumption have demonstrated that $\delta^{15}N$ values of 21.7‰ ± 2.1‰ and $\delta^{13}C$ values of -11.4‰ ± 0.6‰ are suggestive of a diet heavily reliant on marine protein (Andrade *et al* 2015, 6), and that human consumers of marine resources typically have $\delta^{15}N$ values ranging between 15‰ and 20‰ (Tykot 2004, 436). It is clear that none of the İkiztepe sample population have values anywhere near those. One line of evidence that has led people to believe that fishing played a role in the subsistence of the population is the discovery during excavation of what were termed as harpoons and fish-hooks. However, on reassessment of the material it can be argued that the finds which were previously determined as such might have had a different function. The 'fish-hooks' (see Figure 62) do not appear to resemble any other prehistoric fish-hooks in the literature and appear to be missing the shape, angle, and 'sharpness' to fulfil their supposed function. However, it could be argued that those found at İkiztepe were fish-hooks of a rudimentary and basic nature.

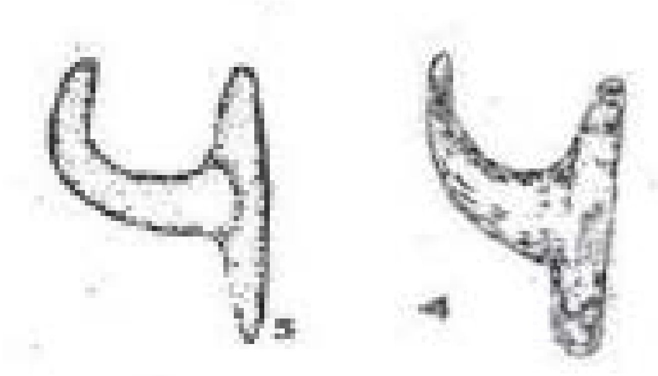


Figure 62: Fish-hooks from İkiztepe. Adapted from Bilgi 2005b.

The 'harpoons' (see Figure 63) lack barbs and seem far too small (although there is no scale on the original drawings of them in Bilgi 2005b, and the objects on each plate do not appear to be to scale/relative to a scale) to be effectively used as harpoons, even for relatively small sized fish. Instead they are far more reminiscent of 'copper perforators' (Figure 64) from the

Late Chalcolithic site of Çamlıbel Tarlası, inland near Boğazkale in north central Anatolia which were most likely used in the working of animal hide or cloth (Schoop 2011c, 62).

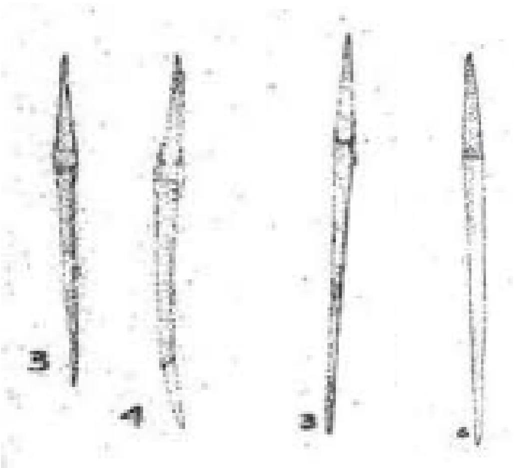


Figure 63: ‘Harpoons’ from İkiztepe. Adapted from Bilgi 2005b.

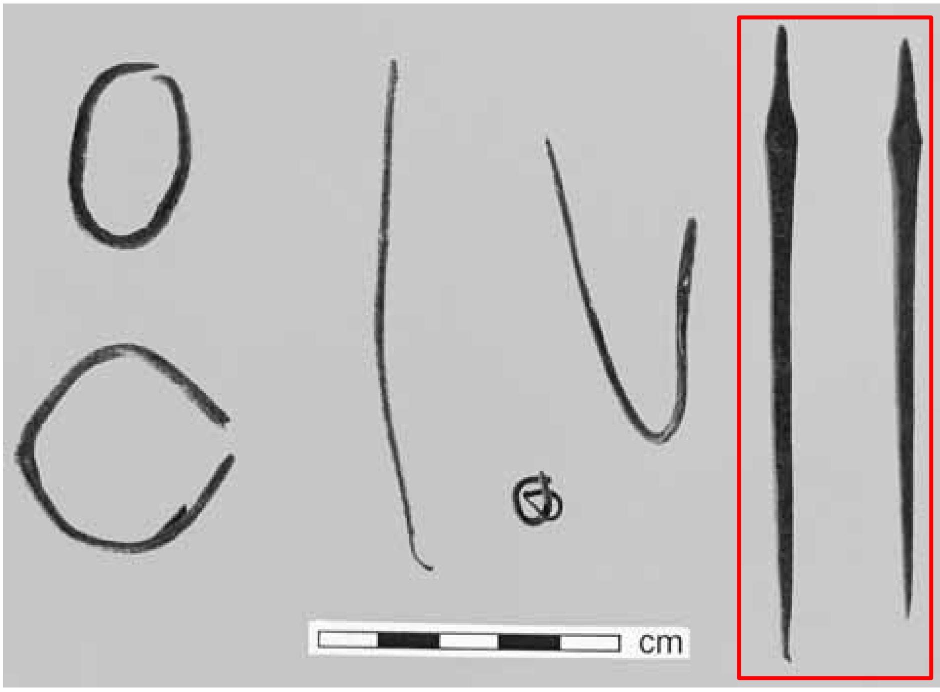


Figure 64: Collection of copper items from the Late Chalcolithic site of Çamlıbel Tarlası; the copper perforators have been highlighted. Adapted from Schoop 2011c

However, despite the above debate, we cannot completely rule out the consumption of marine resources at İkiztepe. It is possible that the inhabitants were involved in seasonal fishing or that marine resources only played a very small role in their dietary habits. In neither of these scenarios would results show up in the stable isotope analysis of the human bone collagen due to the averaging out factor of dietary input due to the remodelling and modelling nature of living bone (see Chapter 3). It is also possible that the inhabitants of İkiztepe had an estuarine or freshwater resource input into their diet rather than a marine one, which would explain the presence of fish bones (their species has not been identified). Freshwater resources cannot be identified using stable isotopes of carbon and nitrogen alone as their signals overlap with terrestrial ones. There is currently ongoing analysis of the İkiztepe sample population using stable isotopes of sulphur and the results of this further research will help to determine whether there is any marine input in the diet, and if there is any freshwater resource input as well. Whilst the $\delta^{15}N$ values of the İkiztepe sample population are relatively high (compared to the other sampled populations – see Chapter 6.1), they are not high enough to suggest a significant marine input in their diet. This may be due to a factor such as seasonal fishing/marine consumption and/or the consumption of freshwater or estuarine resources instead, or it may be to do with the relatively high $\delta^{15}N$ values of the animals at İkiztepe (see Figure 45). This in itself may be because of the settlement's location in close proximity to the Black Sea coastline and Kızılırmak estuary. Coastal/saline soils and environments have elevated $\delta^{15}N$ values due to the enrichment of soil nitrogen ^{15}N by the input of ocean-derived nitrate from sea-spray and the effects of salinity on the processes of nitrification, denitrification, and ammonium absorption (Britton *et al* 2008, 2112). This results in elevated $\delta^{15}N$ values (without necessarily affecting the $\delta^{13}C$ values) of plants growing in these environments, with this elevation then being passed up the food chain through herbivore tissues, and ultimately to human consumers (Britton *et al* 2008, 2112 & 2115; Müldner *et al* 2014, 324). A study by Britton *et al* (2008, 2115) demonstrated that cattle grazing on the Severn Estuary in the UK had statistically enriched $\delta^{15}N$ values compared to animals from other inland sites, with an average enrichment of 2‰. Salinity can also lead to elevated $\delta^{13}C$ values as it reduces discrimination against ^{13}C during C3 plant photosynthesis (Müldner *et al* 2014, 327). A study by Müldner *et al* (2014, 327) on domesticated herd animals (sheep and cattle) from coastal Belgium discovered, in some cases, an elevation of $\delta^{13}C$ values in correlation with elevated $\delta^{15}N$ values. They suggest that this may have been due to salinity effects, or from the consumption of ^{13}C enriched seaweed (Müldner *et al* 2014, 327-328). Two of the sheep/goat isotopic signals from İkiztepe witness slightly enriched $\delta^{13}C$ as well as $\delta^{15}N$ values – see the data points for Sk 668 and Sk 678 on Figure 45. The same may therefore be applicable at İkiztepe, where the proximity to the coast resulted in enrichment of the $\delta^{15}N$ (and potentially $\delta^{13}C$) values of plant and thereby animal consumer tissues, which in turn cause an enrichment of the human tissues which could be mistaken as a marginal marine resource input in the diet. This 'hidden' marine component in human diet might instead be the result of the effects of sea-spray on terrestrial plants and animal isotope values (Britton *et al* 2008, 2116). Again, this issue will be resolved by the ongoing sulphur isotopic work on the İkiztepe sample population material.

In conclusion it can be stated that the results of the stable isotope analysis on the human sample population from İkiztepe demonstrates that the individuals consumed a diet predominantly based on terrestrial C3 resources. This diet was also quite rich in protein as demonstrated by relatively high $\delta^{15}N$ values, although this may be the result of a very slight/inconsistent marine input but more likely the location of the settlement population and its plant and animal resources within close proximity to the Black Sea coast.

5.2.2 Titriş Höyük

The macroscopic bone preservation from Titriş Höyük was not as good as at İkiztepe and as a result of the individuals sampled from Titriş Höyük, following the assessment of the quality criteria discussed in section 5.2, a total of 10 samples were discarded which equated to five entire skeletal elements, one (b) run of a skeletal element, and two individuals (i.e. four skeletal elements, two from each individual). For a table containing the complete output data from Titriş Höyük see Appendix H.

The adult sample population from Titriş Höyük (Figure 65) have a $\delta^{13}C$ range of -20.7‰ to -19‰ with a mean of -19.8‰ and $\delta^{15}N$ range of 5.8‰ to 7.9‰ with a mean of 7.1‰. The reasonably low range for $\delta^{13}C$ and $\delta^{15}N$ values suggests relatively consistent and homogeneous dietary habits amongst the sample population. Overall the stable isotope signals are indicative of a terrestrial C3 based mixed diet, but with a relatively low protein intake evident in their low $\delta^{15}N$ values. They have the lowest mean $\delta^{15}N$ value of all four sample sites (see Chapter 6.1).

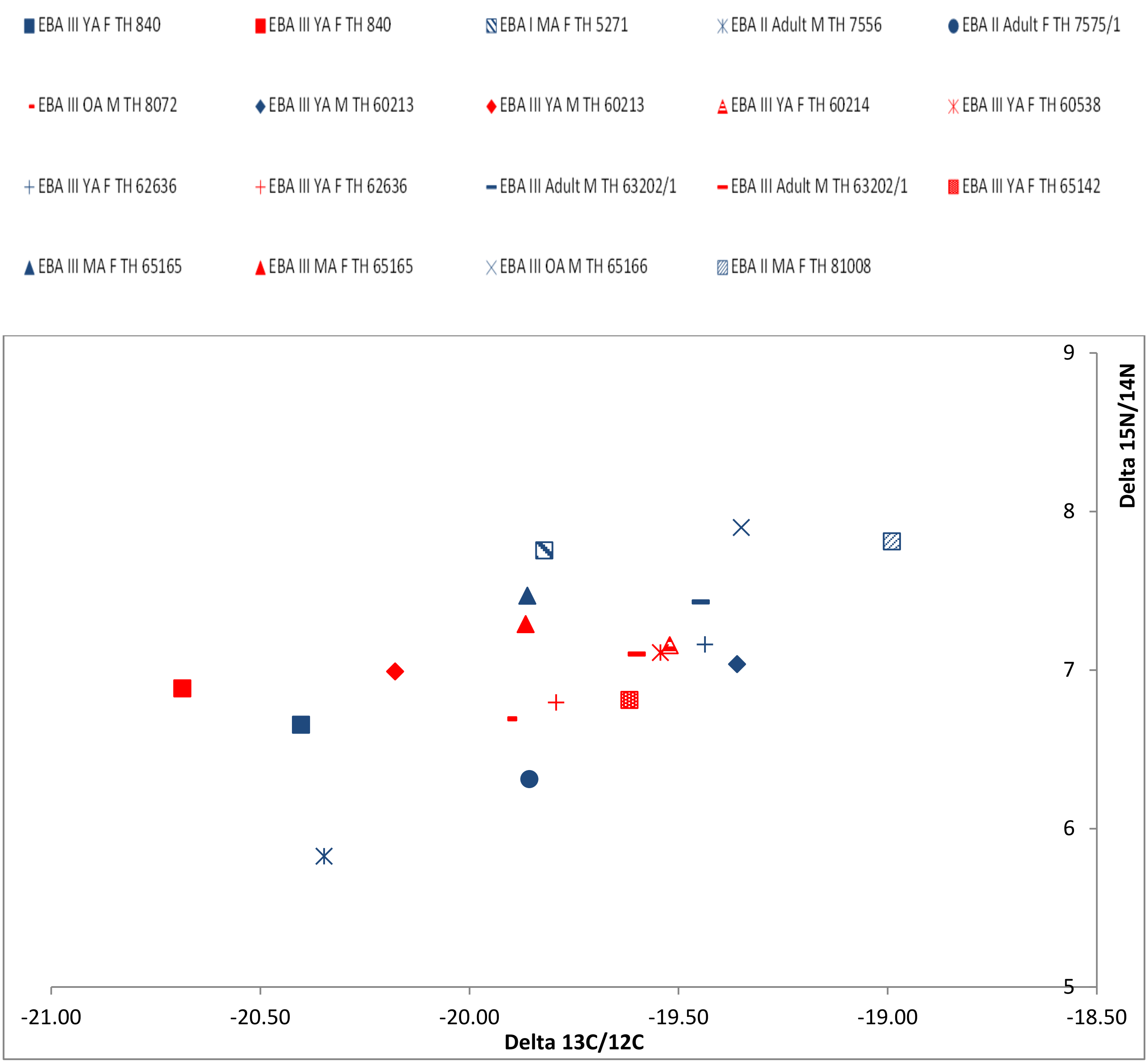


Figure 65: Titriş Höyük adults plotted for δ13C and δ15N. Legend for Figure 65 is above chart.

The suggested consistency and homogeneity of the dietary habits of the sample population could be explained by the centralised distribution of food resources (see Chapter 2.3) at the settlement. The same types and relative proportions of domestic crops were found in the households of the settlement, with no difference between the Outer and Lower Towns (Hald 2010, 74). This has been one of the aspects to argue for the centralised distribution of crops at Titriş Höyük, and in itself can give us an indication as to why the isotopic signals for dietary habits are so similar. Equal availability of types of crops increases the probability of the inhabitants eating the same thing in the same proportions, and thereby obtaining the same input of carbon and nitrogen into their bone collagen.

When males and females are examined (Figure 66) there appears to be no significant difference immediately observable; their ranges and means are very similar for $\delta^{13}C$ (males: -20.4‰ to -19.4‰ with a mean of -19.7‰; females: -20.7‰ to -19‰ with a mean of -19.8‰) and $\delta^{15}N$ (males: 5.8‰ to 7.9‰ with a mean of 7‰; females: 6.3‰ to 7.8‰ with a mean of 7.1‰).

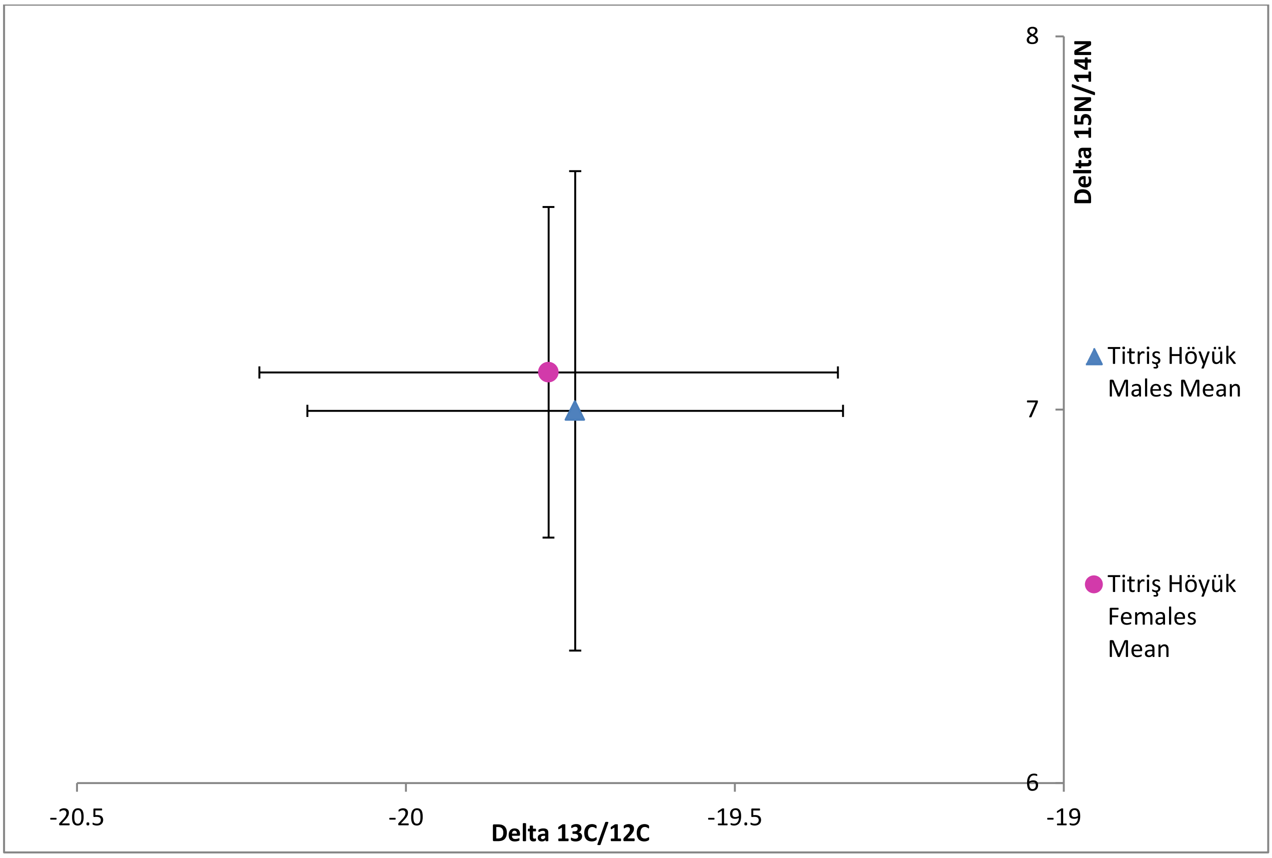


Figure 66: Means and standard deviations plotted for males and females from Titriş Höyük

When a two tailed t-test is applied to the values for males and females the hypothesis of no difference is confirmed as no statistically significant difference is found for either $\delta^{13}C$ (p = 0.30) or $\delta^{15}N$ (p = 0.80). This demonstrates that there is no statistically significant difference in the dietary habits of males and females in the sample population from Titriş Höyük. This is in contrast to İkiztepe where there are some small differences between males and females, particularly in terms of protein intake ($\delta^{15}N$ values). The implication being that, at least regarding dietary habits and sex, there is a social and cultural difference between the two populations.

The plotting of the means and standard deviations of the different age groups at Titriş Höyük (Figure 67) would visually appear to suggest that there may be a slight difference between young adults (YA) and Adults, and middle adults (MA) and old adults (OA) as they produce two clusters. Furthermore, it would appear that those individuals who were designated as adults of an undetermined age are most probably YA as they plot similarly. However, the apparent difference is very small and within the isotopically insignificant range.

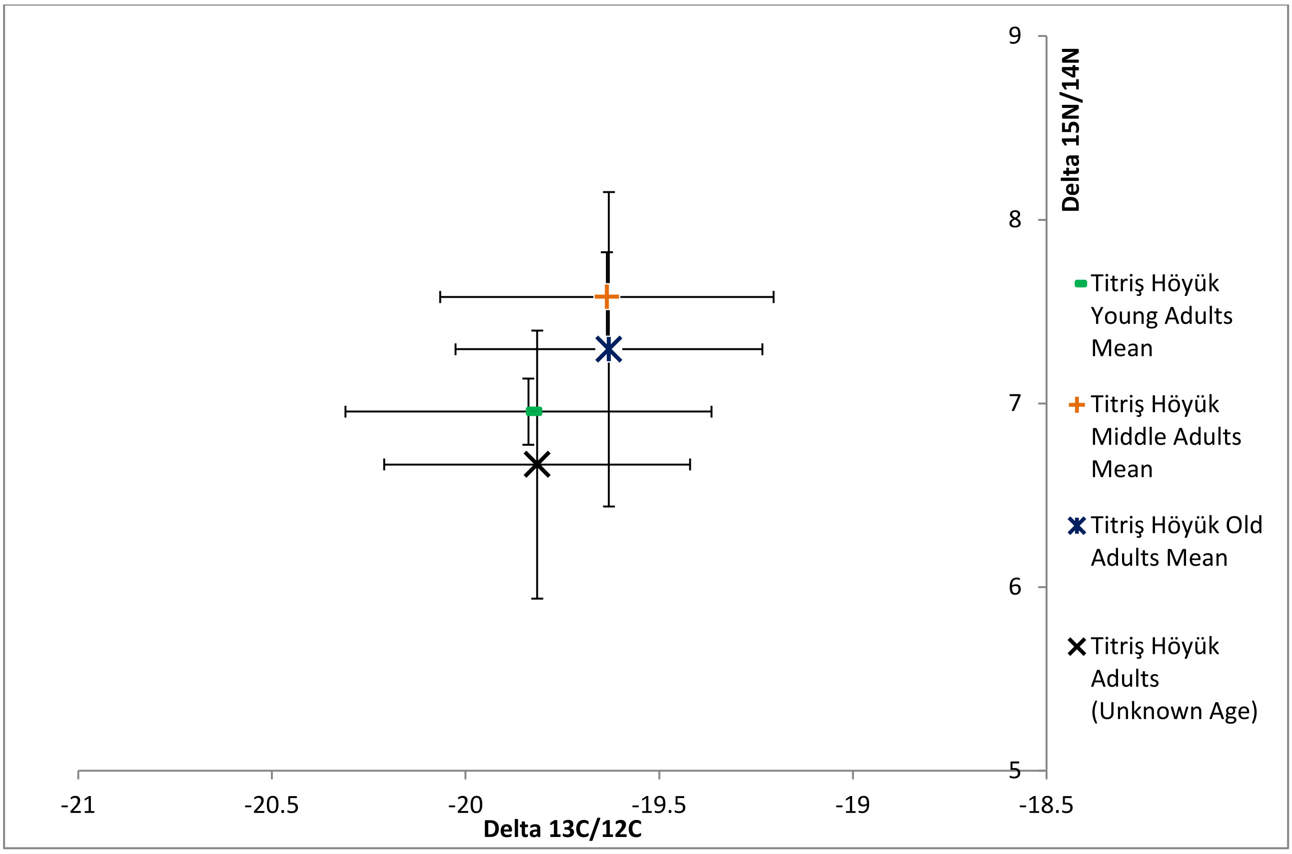


Figure 67: Means and standard deviations plotted for adult age groups from Titriş Höyük

A single factor ANOVA was conducted on the age group values, but only on the three determined age groups (YA, MA, and OA) and not on the Adults of undetermined age. This is because that group may contain adults belonging to several age groups and would thereby taint the test and data. The single factor ANOVA determined that there was no statistically significant difference for $\delta^{13}C$ ($p = 0.70$), but that there was one for $\delta^{15}N$ ($p = 0.02$). Whilst the ANOVA test determined a statistically significant difference for $\delta^{15}N$, and whilst differences are apparent when box and whisker plots are conducted (Figure 68), the difference is within an insignificant range as all of the means (YA = 7‰; MA = 7.6‰; OA = 7.3‰) are actually within 1‰ which is not deemed significant for $\delta^{15}N$ values.

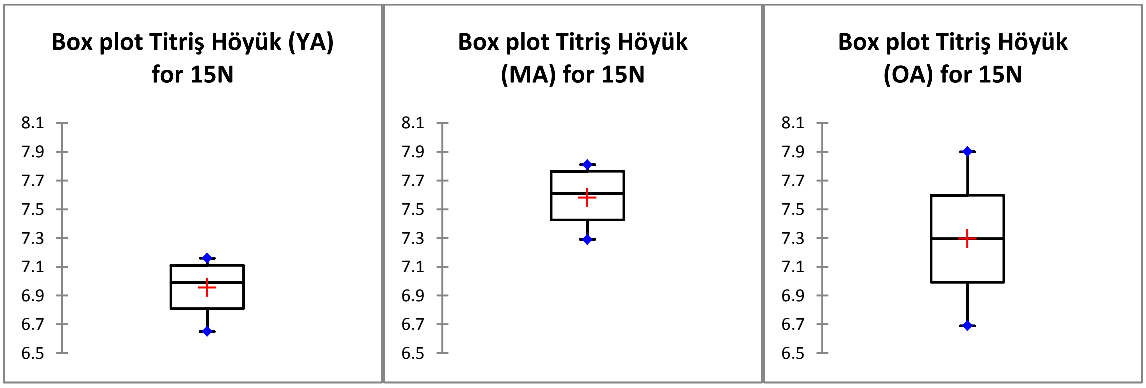


Figure 68: Box and whisker plots of δ15N values of adult age groups (YA, MA, and OA) at Titriş Höyük. Numbers on scale are δ15N values in ‰

When all of the individual points of the age groups are plotted together in a 'cloud' (Figure 69) the differences observed in the 'box and whisker' plots can be observed here as well. With reference to the statistically significant differences in $\delta^{15}N$ values between the identified age groups (i.e. YA, MA, and OA) it is clear to see that the $\delta^{15}N$ values for YA are lower than those for MA. It is difficult to discuss with any certainty a pattern regarding OA as there are only two points available for this age group; however it may be possible to tentatively say that there is a bigger spread in $\delta^{15}N$ values within this age group than the other two. When the data for the age groups is plotted like this the factor of consistent but small differences in data resulting in a statistically significant difference can be witnessed clearly. There is a clear and consistent difference between the $\delta^{15}N$ values for YA and MA with YA having values consistently lower than those of the MA. However, this difference is mainly within 1‰ and even the most extreme difference is only 1.2‰. This difference is at a very low and isotopically insignificant level, but the fact that it is consistent within the sample population, and that there is no overlap between the two age groups in terms of $\delta^{15}N$ means that it can be argued that in real terms (i.e. the dietary habits of the individuals) that there would have been a difference in the dietary habits in terms of protein intake of YA individuals and MA individuals, even if this difference was only a small or subtle one. These differences could be the result of the amount of protein input, or the source of protein input in the diet. For example it may have been that YA consumed less meat/dairy products than MA, and/or that they received more of their protein from plants and/or plant based food resources. Unlike at İkiztepe, where sex(/gender) determined differences in dietary habits, the data from Titriş Höyük seems to suggest that age, and thereby ancestry and generations, was the determining factor. This actually corresponds well with the research into burial patterns at Titriş Höyük and the change to intramural chamber tombs in the EBA III period which scholars, notably Laneri (2007, 262-263; 2013, 50), have suggested was related to the increased importance of kin/family groups and the identification and emphasis of ancestry and lineage. Whilst the stable isotope data adds weight to this idea reasonably well, it is almost impossible to say whether this difference in dietary habits was exhibited as a 'richer/better' food resources or different food items. However, as there has been no discernible differences discovered between types and relative proportions and frequencies of crops or meat (cuts) at the settlement (Hald 2010, 74) the differences in dietary habits (exhibited by the stable isotope data) for MA individuals was most likely related to a greater relative proportional input of protein.

An attempt was made to examine if there was any difference in dietary habits, through differences in $\delta^{13}C$ and $\delta^{15}N$ values, in individuals from different time sub-periods within the EBA. There is a bias as there is only one individual from the EBA I period (the other sampled EBA II individual was discarded as the data from the extracted collagen did not meet the quality criteria assessment), three from the EBA II period, and 10 from the EBA III period (one individual was discarded as the quality criteria were not met). This means the sample population is heavily weighted towards those from the EBA III period and this should be, and was, taken into account when examining the plotted means (Figure 70) and statistical analysis.

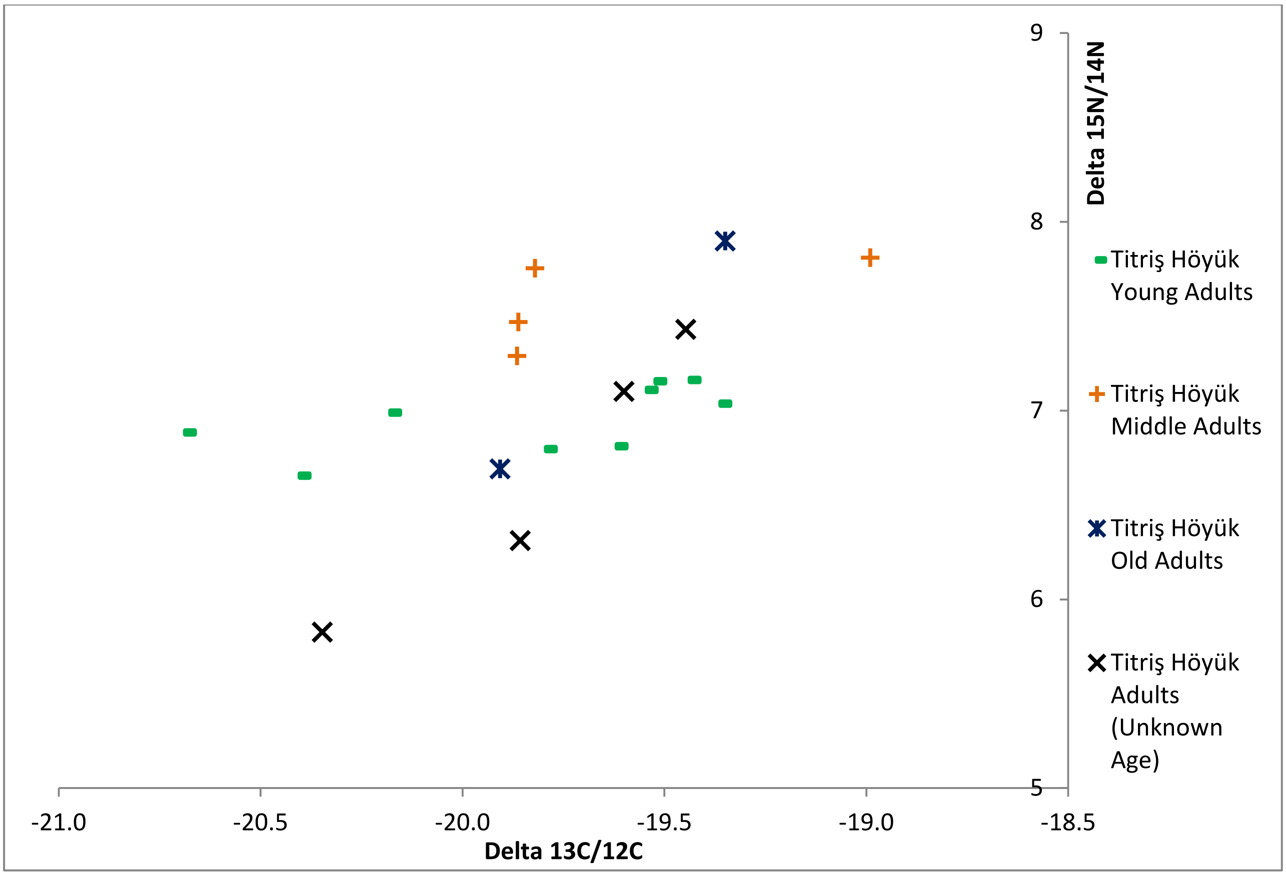


Figure 69: Adult age groups from Titriş Höyük plotted for δ13C and δ15N

It is nearly impossible to make any comparison between the individuals from the other time periods and the one from the EBA I as it is a solitary individual. Therefore the solitary EBA I individual was excluded from statistical analysis and a pair of two tailed t-tests were conducted on the $\delta^{13}C$ and $\delta^{15}N$ values of the individuals from the EBA II and EBA III periods. The means for $\delta^{13}C$ (EBA II = -19.7‰; EBA III = -19.8‰) and $\delta^{15}N$ (EBA II = 6.7‰; EBA III = 7.1‰) of both time periods are very close together and no significant difference was expected. This t-tests for $\delta^{13}C$ (p = 0.89) and $\delta^{15}N$ (p = 0.53) confirmed this demonstrating that there was no statistically significant difference between the two time periods.

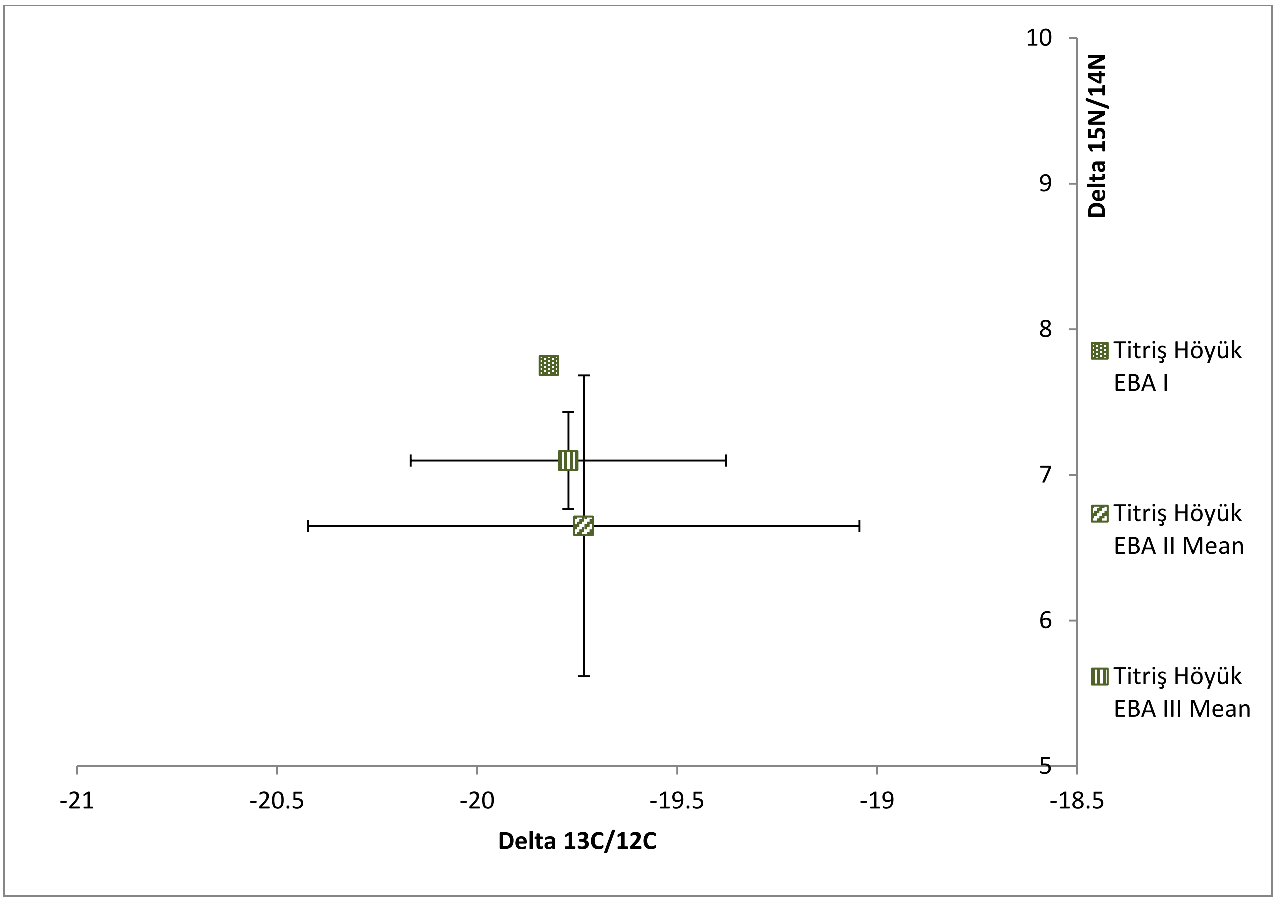


Figure 70: Means and standard deviations plotted for adults of different time periods from Titriş Höyük

The trauma rates for Titriş Höyük have been discussed in Chapter 2.3 and Chapter 5.1.2. In the adult sample population from the 'common' graves (i.e. not from the Plaster Basin burial deposition) there are two adults (12.5%), both cranial traumatic injuries, on an adult male and a YA female from the EBA III period. These two individuals were compared with the rest of the sample population to see if there were any differences in the $\delta^{13}C$ and $\delta^{15}N$ values. Their means and standard deviations were plotted together to compare them visually (Figure 71). The means for $\delta^{13}C$ were very close (-19.6‰ for the individuals with trauma, and -19.8‰ for those without), as were those for $\delta^{15}N$ (7.1‰ for the individuals with trauma, and 7.1‰ for those without). As such it would be expected that no statistical significance would be observed between the two groups for $\delta^{13}C$ and $\delta^{15}N$. A two tailed t-test was conducted to see if there was any statistical significance between the groups, and none was demonstrated for either $\delta^{13}C$ ($p = 0.28$) or $\delta^{15}N$ ($p = 0.80$).

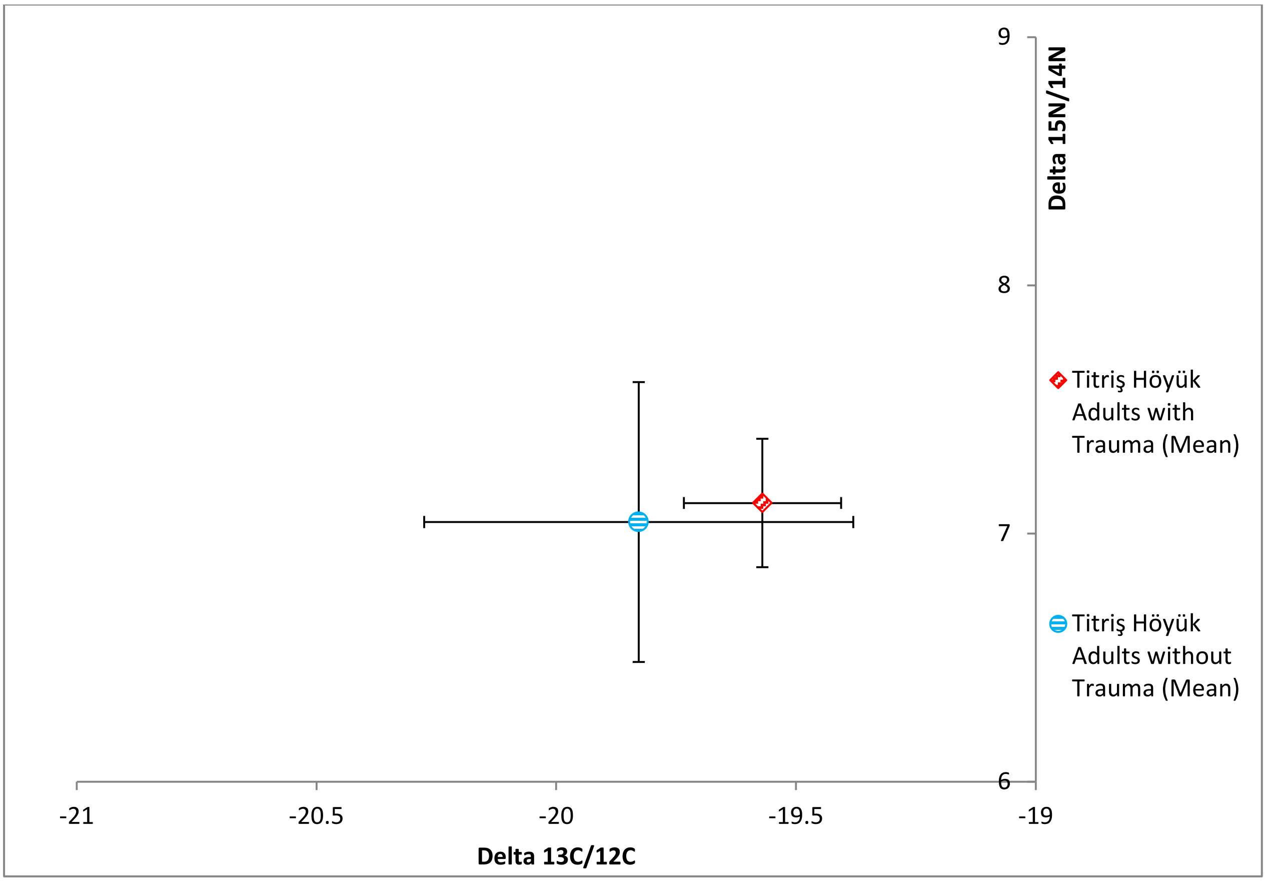


Figure 71: Means and standard deviations plotted for adults with and without traumatic injuries from the 'common' graves at Titriş Höyük

The femurs sampled from the Plaster Basin burial deposition could not be assigned a sex or definite age (other than adult), nor linked with any of the crania from the feature which were aged, sexed and many of which had had traumatic injuries. Therefore no means could be plotted or statistical analyses performed to examine if there were any differences between the dietary habits within the skeletal population of the Plaster Basin burial feature. Nor could they be compared by these criteria (age, sex, or trauma) with the individuals from the sample population from the 'common' graves. However, the sampled femurs could be compared with the adult individuals from the EBA III period to see if there was any general difference in dietary habits between the individuals of the Plaster Basin burial feature and 'common' graves in this time period. When plotted it shows (Figure 72) their isotopic signals approximately in the same range and cluster. There is a slightly greater range in δ^{13}C values for the adults from the 'common' graves (-20.7‰ to -19.4‰) than for the femurs from the Plaster Basin burial feature (-20.4‰ to -19.6‰). Conversely there is a greater range in δ^{15}N values in the Plaster Basin femurs (5.6‰ to 7.7‰) than in the adults from the 'common' graves (6.7‰ to 7.9‰).

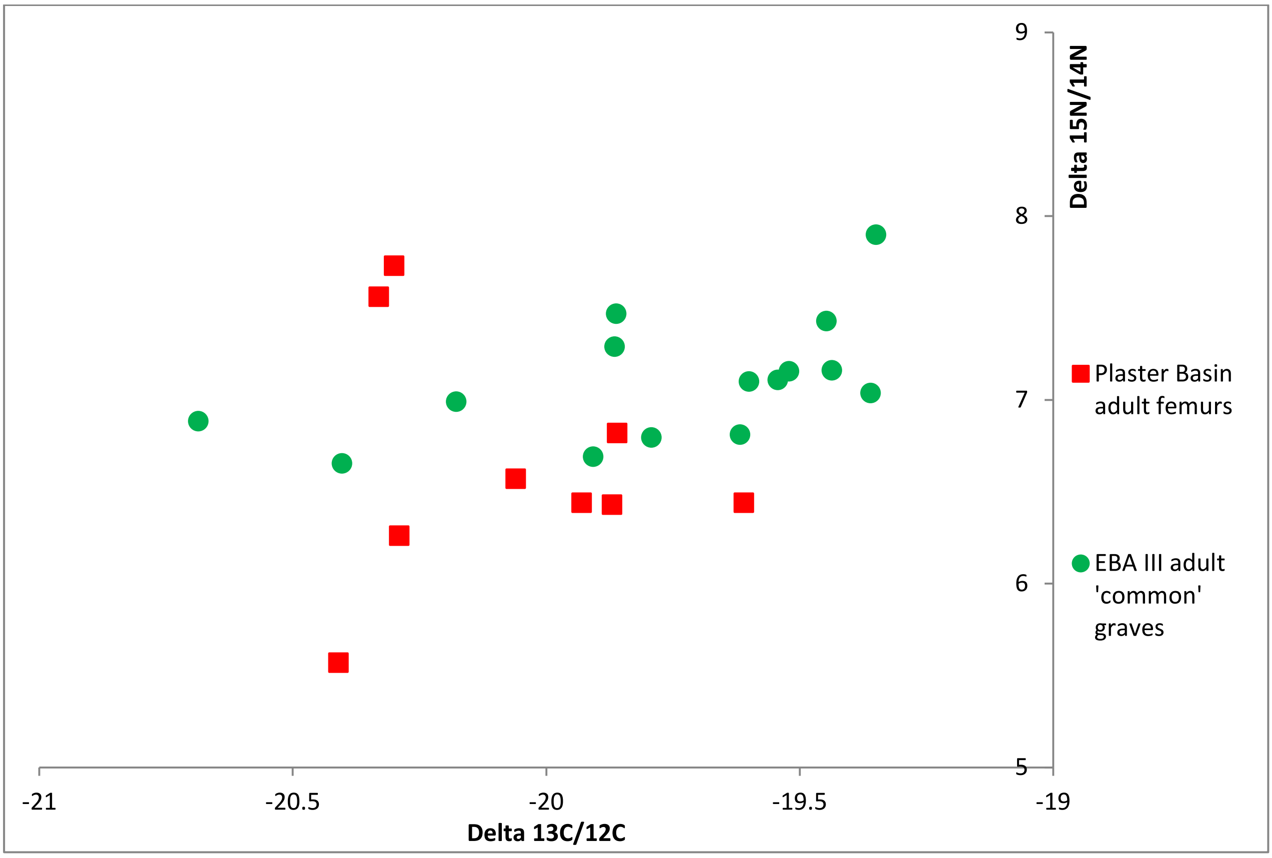


Figure 72: Femurs from the Plaster Basin burial feature and adults from the EBA III 'common' graves of Titriş Höyük plotted for δ13C and δ15N

However, these ranges are small and within the isotopically insignificant range. When the means and standard deviations of both groups are plotted together (Figure 73) this small range of difference can be seen more clearly. Two tailed t-tests were conducted for $\delta^{13}C$ and $\delta^{15}N$ on the two groups to see if a statistical difference could be observed. There was none for $\delta^{13}C$ (p = 0.06), but a statistically significant difference was found between the two groups for $\delta^{15}N$ (p = 0.04). This demonstrates that there is a consistent difference in the data between the two sample populations for $\delta^{15}N$, but that this difference is on an arguably insignificant scale. This would mean that in real terms there would have been a negligible difference in the dietary habits of the two groups.

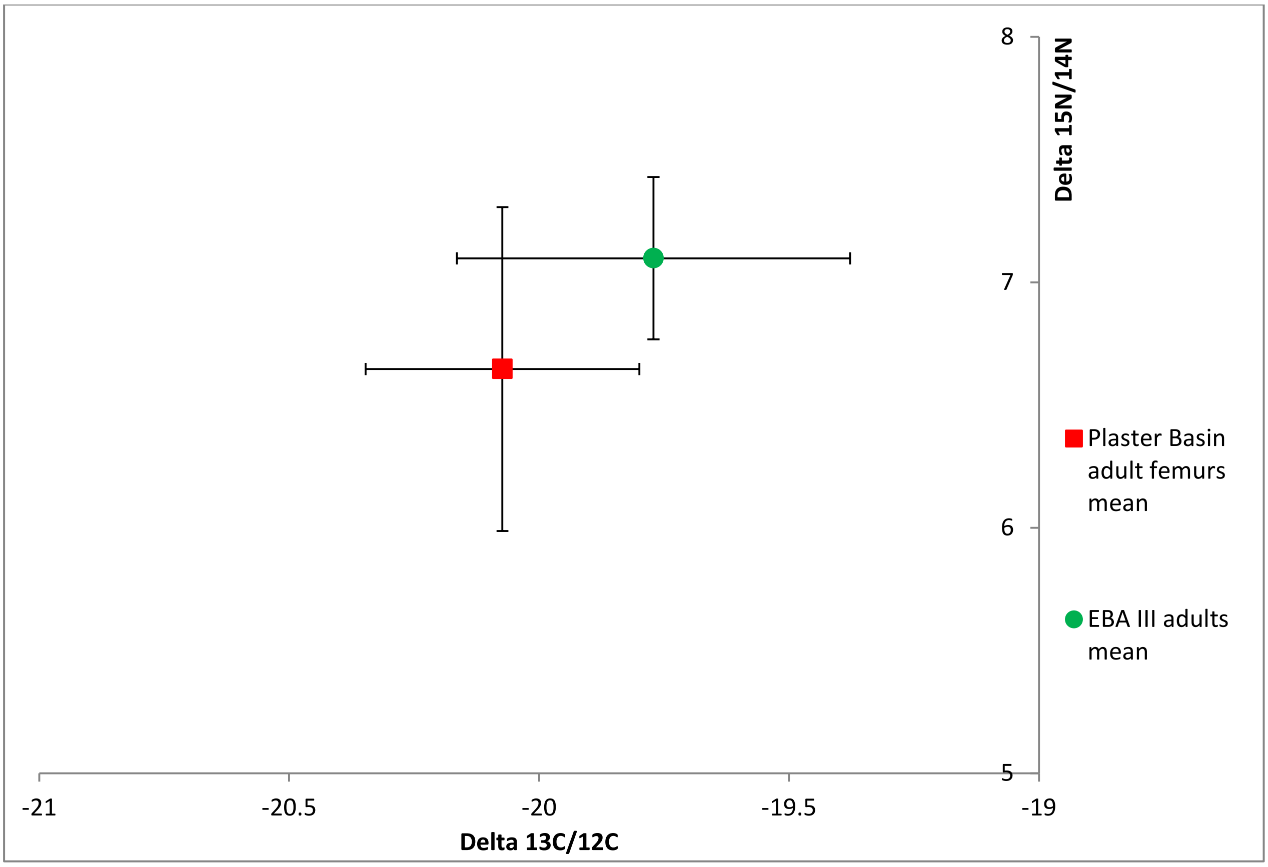


Figure 73: Means and standard deviations of femurs from the Plaster Basin burial feature and adults from the EBA III 'common' graves of Titriş Höyük

However, one may argue that due to the consistent nature of the differences that there was a consistently (if very minor) lower protein intake in the diets of the majority of the individuals in the Plaster Basin. The difference between the means of the two groups for $\delta^{15}N$ is 0.45‰, well within an isotopically insignificant range for $\delta^{15}N$ values. Even when the data points for the two groups are plotted as a 'cluster' (Figure 72) and it can be seen that the femurs from the Plaster Basin (apart from two) generally have lower $\delta^{15}N$ values than the individuals from the 'common' graves, this difference is very small. However, the fact that it is generally a consistent feature (apart from the two 'anomalous' femurs) would help to explain why a statistically significant difference was found. So as determined above, the data is (relatively) consistently different but on a very small and arguably isotopically insignificant scale. The purpose of comparing the two groups is to examine if isotopically, and therefore in terms of dietary habits/food consumption, any differences can be seen between the two groups that may give some indication about the identity of the individuals in the Plaster Basin burial feature. Several hypotheses have been put forward (see Chapter 2.3 for initial discussion on this feature) about the identity of these individuals and why they met with such a violently brutal end. It has been suggested that they were possibly captured 'non-locals' who attacked the settlement or that had been brought back after a raid on another settlement, or similar such military event. However, an aDNA study on the individuals showed them to be genetically homogeneous with the inhabitants of the city and should therefore be considered to be natives of the settlement (Erdal 2012, 13; Matney *et al* 2012, 348). The stable isotope data does not contradict this research as it suggests that the individuals within the Plaster Basin feature had been consuming the same food resources and had very similar dietary habits to individuals from the rest of the population. Whilst there are some subtle differences as discussed above, namely that the majority of the femurs from the Plaster Basin have generally and consistently lower δ^{15}N values, the differences are not great enough to distinguish them as a distinct group determined by their dietary habits. This would suggest some sort of cultural and local homogeneity and continuity, especially when one considers the averaging effect of dietary habits over the course of an individual's lifetime when viewed through the δ^{13}C and δ^{15}N values of bone collagen. In other words it seems unlikely that the individuals in the Plaster Basin burial feature came from elsewhere, or that they had been captured and brought to the settlement, unless they were ca. 10 years before their death, which seems unlikely. Rather, it would seem much more likely that the individuals in the Plaster Basin feature were natives and locals of Titriş Höyük. It would not be unreasonable to suggest that the particular burial feature was the result of an internal power and/or political struggle, in this case arguably an issue of 'class struggle'. It has been reasoned that Upper Mesopotamian polities (to which group Titriş Höyük arguably belongs) were not strictly hierarchical, but more heterarchical with power belonging to various components of the polity (Chaves Yates 2014, 4 & 344-345; Trella 2010, 163). Furthermore, that these ancient states were platforms for ongoing social conflict and opposing 'pull' factors, witnessed by the growth of the state and centralisation parallel with the growth of the 'commoner' in terms of the development of a wealthy middle class with their aspiration for greater kin-based autonomy and power (Trella 2010, 163). Hypothetically speaking, the individuals in the Plaster Basin burial feature may have been a prominent family being deposed and displayed so as to assert the claim of dominance of the usurpers (possibly a parallel group competing for power), or conversely that they were a 'troublesome' family/kin group that had attempted to raise their standing and control within the city but had been foiled and their bodies displayed as a warning to others who may attempt similar actions, much like the heads on spikes outside of European Medieval castles. But whilst this is conjecture, one must also be careful about definitively stating that the individuals in the Plaster Basin burial feature were locals of the city when examining the stable isotope values for diet. As we shall see in Chapter 6.2, in the EBA in Anatolia exactly how local is *local* when referring to diet? The argument that because they had the same diet as the local inhabitants they were also local could simply mean they were from any part of EBA Anatolia, and more arguably EBA north Mesopotamia in this case. In a less extreme scenario they could have been from within the locale of the settlement, but not from the actual settlement itself, as the environment and available food resources and dietary habits would have been near identical. However, in this case, the similarity of the dietary isotopic signals (they are more definitely 'Titriş' in nature than 'İkiztepe' for example) in conjunction with research such as the aDNA analysis and facts like the absence of settlement destruction in relation with this deposition and that they are displayed would suggest that they were local inhabitants who were massacred by local enemies (Laneri 2013, 49; Matney *et al* 2012, 348). In general the inhabitants of Titriş Höyük appear to have been a closely related maternal kin group with very similar dietary habits demonstrating homogeneity in genetics and diet.

Unfortunately no faunal remains were sampled from Titriş Höyük (the location of the faunal remains in Turkey was unknown and the faunal remains at the University of California, San Diego could not be obtained in time), so we cannot compare human and animal isotopic signals to examine what kind of domestic animals were more likely to have been consumed. But their relatively low $\delta^{15}N$ signals would suggest that animal protein did not play a significant role in the dietary habits of the population and the main source of protein for them was plants. However, the low $\delta^{15}N$ values may be the result of the animals themselves having low $\delta^{15}N$ values. In the EBA II and III periods the animal and thereby human $\delta^{15}N$ values may have decreased for two reasons. One is that with rapid expansion of the settlement there was a corresponding expansion of arable farmland, but this expanded so rapidly that the concentration of manure was severely diluted (which in itself would lower the $\delta^{15}N$ values of the crops and thereby human consumers), meaning that animals grazing in these areas would have lower $\delta^{15}N$ values due to the lower $\delta^{15}N$ values of the soil and plants (Trella 2010, 309). Also, and most probably as well, because of the expansion in arable farming area the herding and grazing of animals was pushed further away from the settlement into areas where there was no manuring (i.e. artificial nitrogen enhancement of the soil) which would lead to lower $\delta^{15}N$ values of the grazing animals (Trella 2010, 309), and thereby the human consumers. High $\delta^{15}N$ values may actually have been expected, especially in the EBA III period due to increased aridification of the environment and reduced rainfall (see Chapter 3.2.2). The converse of this may suggest that the effect of aridification was not as pronounced or problematic as previously hypothesised, or was on a shorter time scale which would not show up in $\delta^{15}N$ signals from the extracted human bone collagen.

In summary it can be said that the dietary habits are terrestrial C3 based mixed diets, however, with a low protein intake – the δ15N values of the population are low (a mean of 7.1‰). This may either be an indication of low animal protein consumption, so not much meat or milk/dairy produce in the diet, or a high relative consumption of legumes (such as lentils) which can result in lower δ15N values and can even mask the real proportional consumption of animal protein (further discussed in Chapter Six). In my opinion, I think it may partly be this, but more likely to be related to the fact that the main food source in the day-to-day dietary habits were crops and that meat was not regularly consumed, or not in great quantities.

The dietary habits of the population were consistent and homogeneous. The same types and relative proportions of domestic crops were found in the households of the settlement, with no difference between the Outer and Lower Towns. It has also been suggested that food resources (crops and animals) may have been centrally controlled and distributed at Titriş Höyük, and this may account for the homogeneity in the dietary habits of the population; i.e. the same food resources in approximate same proportions/amounts. Equal availability of types of crops increases the probability of the inhabitants eating the same thing in the same proportions, and thereby obtaining the same input of carbon and nitrogen into their bone collagen.

There is no difference in dietary habits between males and females – this was also proved statistically using a two-tailed t-test.

The δ13C values between the age groups are very similar meaning the source of plant dietary carbon was from the same source (i.e. all ate C3 plants and/or animals grazed or foddered on C3 plants). There was a slight difference between the age groups for δ15N, and this was mainly between young adults and middle adults. Whilst the different was very small, it was consistent enough in the data to suggest that middle adults perhaps had a greater protein input in their diet than young adults.

Only one individual was sampled from the EBA I period and therefore it was difficult to make comparisons across the whole 3rd millennium. However, there is no difference in dietary habits between the EBA II and EBA III individuals – once again supported by a two-tailed t-test.

Two of the individuals from the 'common'/regular graves (i.e. not from the Plaster Basin deposition) had cranial traumatic injuries. There was no difference in dietary habits found between these individuals and the rest of the sampled population.

Thirteen femurs from the Plaster Basin feature were sampled. Unfortunately no sex, age, determination of traumatic injuries etc. could be determined and/or assigned. The data from these femurs was compared with that of the 'general' population from the EBA III period. No statistically significant difference was found for δ13C, but one was found for δ15N. However, on examination of the plotted data and the plotted means the difference is very small, and I would argue insignificant. Most of the Plaster Basin femurs have lower δ15N values than the rest of the 'general' sample population, and this consistency in the data has probably resulted in the statistically significant difference. However, two of individuals from the Plaster Basin have some of the highest δ15N values across all of the sample population meaning that we cannot say that all of the individuals deposited in the Plaster Basin had a diet with lower protein content. Following this interpretation, that the dietary habits of the individuals from the Plaster Basin are essentially the same as the rest of the population, and in conjunction with the results of the aDNA analysis, I would suggest that the individuals in the Plaster Basin are definitely local/natives of Titriş Höyük and that their deaths were likely the result of an internal power struggle.

5.2.3 Bademağacı Höyüğü

Following the assessment of the quality criteria discussed in Chapter 5.2, only a (b) run of one skeletal element was discarded meaning that no skeletal elements, and thereby individuals were lost. For a table containing the complete output data from Bademağacı see Appendices I and J.

A total of 15 faunal samples were taken comprising of two *sus scrofa/sus scrofa domesticus* (pig), three *Bos Taurus* (domestic cow), nine *ovis/capra* (sheep/goat) and one identified *Capra aegagrus hircus* (domestic goat). When they are plotted (Figure 74) it can be observed that there is quite a large spread of values for both $\delta^{13}C$ (-20.8‰ to -16.2‰) and $\delta^{15}N$ (3.8‰ to 7.6‰) which can be considered to be isotopically significant. The relatively low $\delta^{15}N$ values of the pigs suggest that they were either wild or 'free-range', roaming away from the settlement. They are omnivores and more likely to have values similar to the human population if kept in closer proximity to the settlement/human population where they would have fed on food waste and scraps. Conversely it can be said that two of the cows were probably kept in close proximity to the settlement, or perhaps even within the settlement walls, and human population as their $\delta^{15}N$ values are above 7‰ and quite close to the human values. The excavators hypothesised that the northern part of the settlement was an area where animals were kept (Duru & Umurtak 2011, 32-33). Despite the geographic distance and likely cultural and urban organisational differences, a similar thing is witnessed at Titriş Höyük in the EBA II and III periods where domestic cows were kept at a household level (Allentuck & Greenfield 2010, 23 & 27). At Demircihöyük the livestock was probably kept in close proximity/within the immediate vicinity of the settlement in pens, but with the possibility of seasonal transhumance (Massa 2015, 93). One interesting point for all of the faunal remains is that their $\delta^{13}C$ values are close to the limit of an herbivorous C3 based diet (the range for C3 based diet for herbivores is normally -23‰ to -21‰). This would suggest that there may be a slight input of C4 plants in the diet (either through grazing or foddering) of the domestic animals. This is especially true for the goat and one of the cows as their $\delta^{13}C$ signals are quite positive (-17.4‰ and -16.2‰ respectively) compared with the rest of the faunal sample population. This may suggest that either their diets were very different to the other domestic animals of the settlement, or that they are not local and instead are imported/come from a different area, or were grazed in a different area with plants with more positive $\delta^{13}C$ values (either very positive C3 or more likely a C4 inclusion in the diet). The slight inclusion of C4 plant resources may be from open grasslands (as many grasses are C4 plants) where C4 species such as sedges and Poaceae grasses grow (Budd *et al* 2013, 863; Schoeninger & DeNiro 1984, 635). The hypothesis of the these animals being non-local can also be supported by the fact that $\delta^{13}C$ values can be affected by the local climate and environment, and the relatively large differences in $\delta^{13}C$ values for these animals would suggest that their environment was not the same as that for the rest of the faunal sample population. In general though, a heterogeneous diet in grazing animals is usually indicative of the exploitation of wider territories with a wider range of vegetation (Sandias 2011, 339). However, it should be noted that both these animals (the goat from context 2010 Sk 1, and the cow from context 2009 Sk 6) are from juveniles and it may be that their $\delta^{13}C$ values are a result of the trophic effect of suckling or perhaps indicative of a rearing practice in which a differentiated foddered diet for young animals was employed.

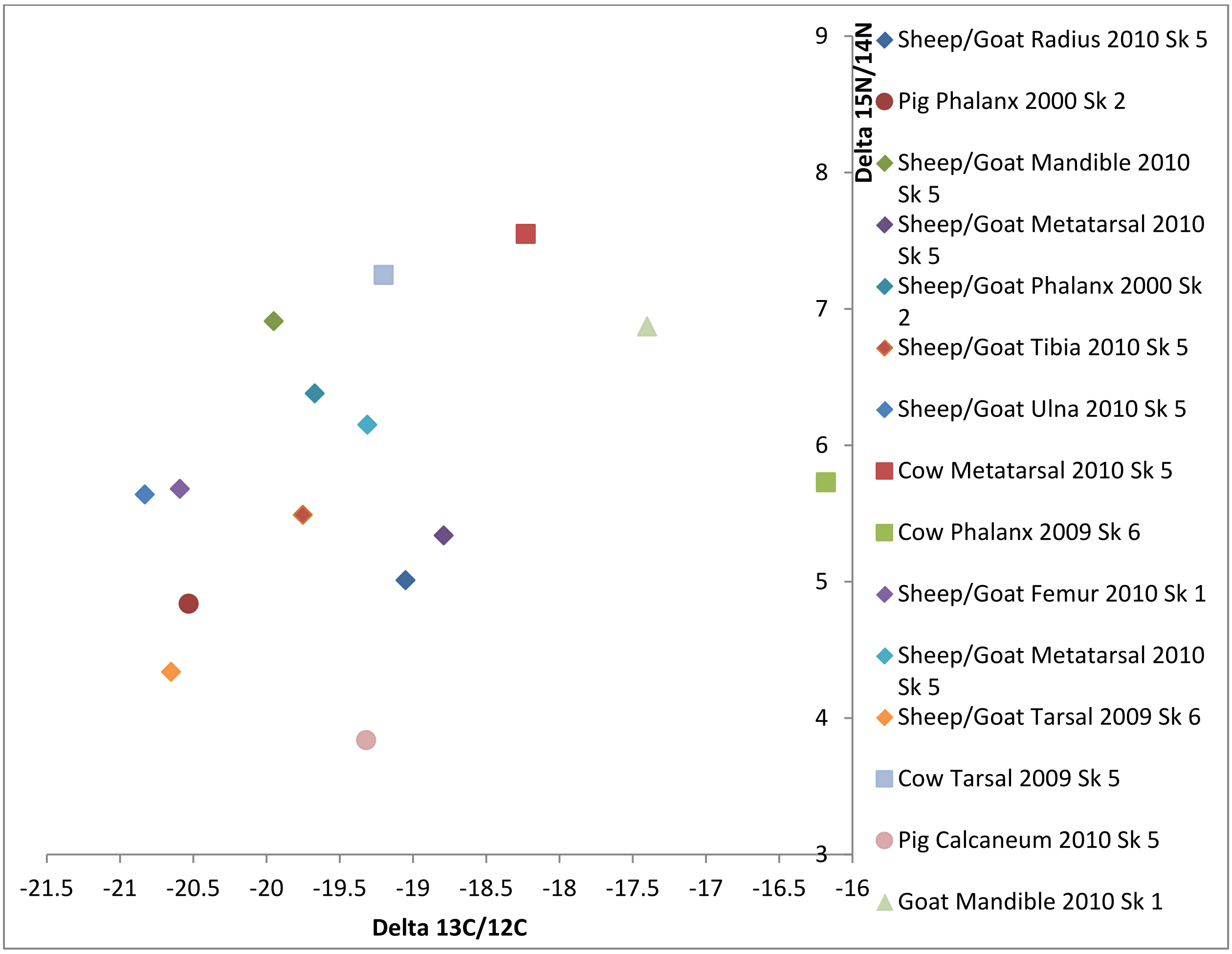


Figure 74: Faunal remains from Bademağacı plotted for δ13C and δ15N

Despite the human sample population being quite small, and undoubtedly only a small percentage in reflection of the entire potential skeletal population, when the humans and animals are plotted together for δ^{13}C and δ^{15}N (Figure 75) it becomes clear, as at İkiztepe, that not all of the animals are being consumed by the humans, moreover one could argue that ca. half of the sampled faunal species played no role in the dietary habits of the human sample population. This is most clear for the cow and goat with relatively high δ^{13}C values discussed above, as well as one of the other cows. The third cow (the tarsal from grave context 2009 Sk 5) has a butcher mark on it which would suggest consumption. On observing the stable isotope data it appears as if this cow was not consumed. However, as is discussed below the exact consumption of a specific animal is impossible to tell, especially by specific individuals. It may be that this cow was consumed by the sample population but in a one-off event such as a feast and therefore its influence on the stable isotope signals of the humans has been lost in the averaging out affect over time. Or it may be that a segment of the population that was not recovered (e.g. from a hypothesised but so far undiscovered extramural cemetery) was consuming cattle, and therefore this absence of data makes it appear as if the cattle were not consumed. Relative to the human sample population it also appears that some of the *ovis/*capra were not being consumed and that pigs probably played a minor role in the dietary habits of the population. However, despite stating that not all of the *ovis/capra* were likely to have been consumed, *ovis/capra* are the most commonly consumed domestic animal species at the settlement. What must be remembered, and this is true for all of the sample sites with human and faunal sample populations, is that potentially none or all of the faunal sample population could have been consumed by the human sample population. It is almost impossible to determine whether individual 'A' consumed sheep 'B' for example, to use arbitrary designations. What the stable isotope data can suggest is patterns and overall generalisations. If a cluster of sheep have similar isotopic signatures, this would indicate that they were perhaps from a herd. Then if this herd/group is within a 'consumable' isotopic range of the humans then we can reasonably infer that those animals or animals from that herd were being consumed by the humans, even if the actual individual animals which were sampled were not consumed specifically by the sampled humans. Furthermore, it is very difficult to completely rule out the consumption of anomalous animals. The consumption of one animal outside of the 'consumable' range of the human sample population will not alter the isotopic composition of the human tissue due to the averaging effect of dietary habits on consumer tissues. Much in the same way stable isotopes cannot determine an individual meal but instead provide an average of an individual's dietary habits over the course of their lifetime. However, we can reasonably argue that an animal with a distinctly anomalous isotopic signature would in probability not have been consumed by the general population. This especially true if there is a cluster of anomalous animals; this would be the opposite side of the same coin of the argument above about a grouping of animals within an isotopically 'consumable' range of the human sample population.

If so many of the domestic animals were not being consumed then the question as to why they were being kept has to be asked, as it would be unlikely that time and energy investment was put into keeping animals that had no purpose or role at the settlement. The role of *ovis/capra* in EBA Anatolia will be discussed in more depth in Chapter 6.2, and as for the cattle at Bademağacı it can be argued that they were instead used for traction purposes; either pulling ploughs or carts. If the hypothesis about the cow with the very positive $\delta^{13}C$ values being from a different location is true then it might be argued that this animal was involved in trade. That it was engaged in carrying or pulling a cart of goods before it died at the settlement, and therefore why it appears to have such a different isotopic signal from the rest of the faunal sample population and has played no role in the dietary habits of the human sample population.

When plotted (Figure 76), the adults from Bademağacı cluster relatively closely together suggesting a degree of homogeneity in dietary habits at the settlement. However, there are two potential 'anomalies'; the rib of the YA male, who is also the only individual with traumatic injuries (see discussions later), and a YA female (see discussion below), who unfortunately only had one skeletal element (part of a femur) sampled due to an absence of fast-turnover bones. It can also be observed that the isotopic signals of the adult sample population are indicative of a terrestrial C3 based mixed diet. With the exception of the anomalies mentioned above, and especially the YA male, most of the adult sample population had a very consistent homogeneous diet as indicated by the closeness in the signals of their slow and fast turnover bones; notice especially the individual represented by Xs and the one by circles.

The sampled individuals, and indeed the entire excavated skeletal population come from a single time period (EBA II), and therefore no further analysis could be performed regarding temporal differentiation. Despite the sample size being small, age groups and any potential differences between them in isotopic values and dietary habits could be examined. When the means for each age group (YA, MA, and OA) are plotted with their standard deviations (Figure 77) it can be observed that the means of all of the age groups are very close and similar (range of 0.3‰ for $\delta^{13}C$ and 0.4‰ for $\delta^{15}N$), although the range of all their values and their standard deviations are variable.

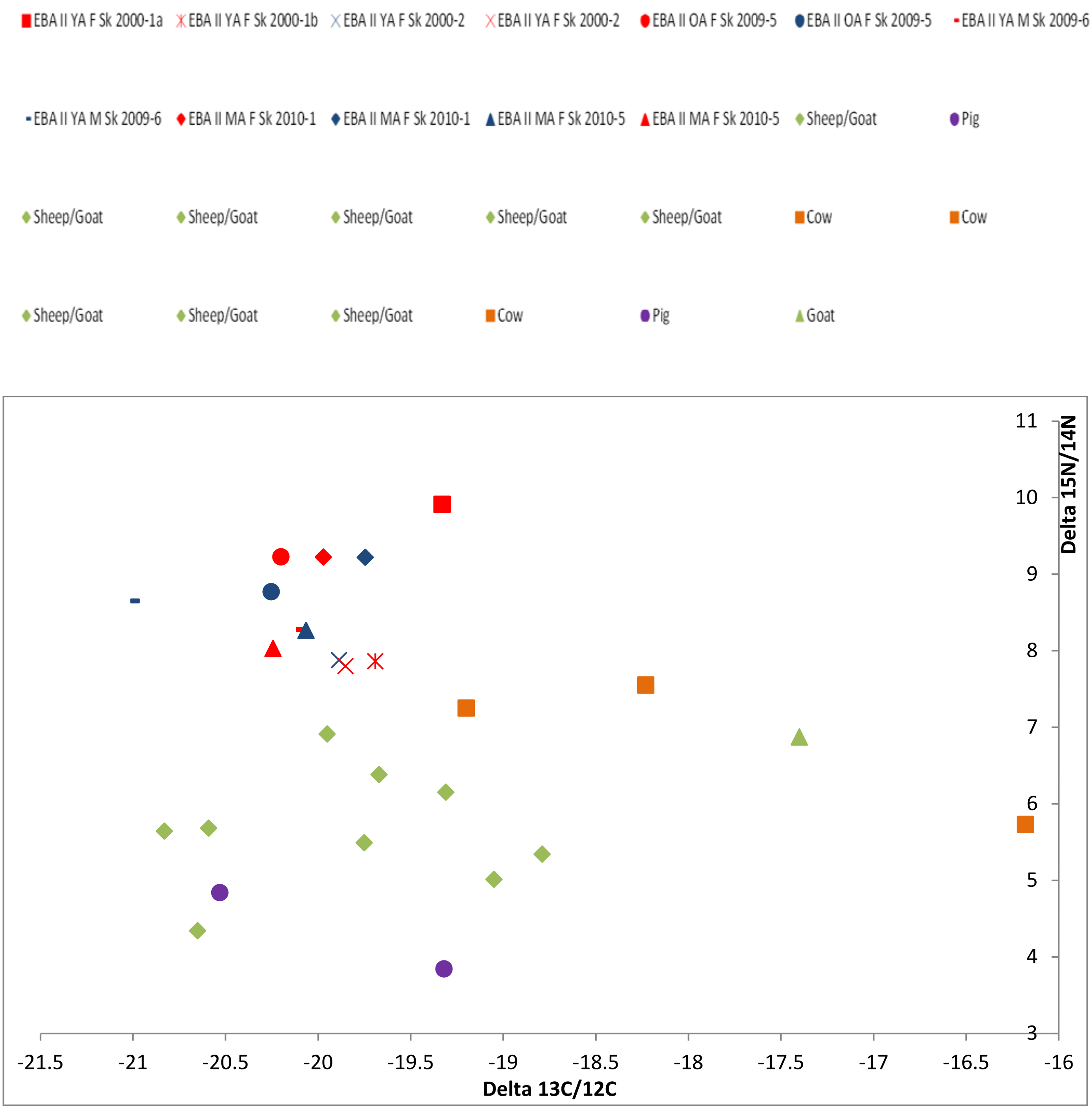


Figure 75: Humans and faunal remains from Bademağacı plotted together for δ13C and δ15N. Legend for Figure 75 is above chart.

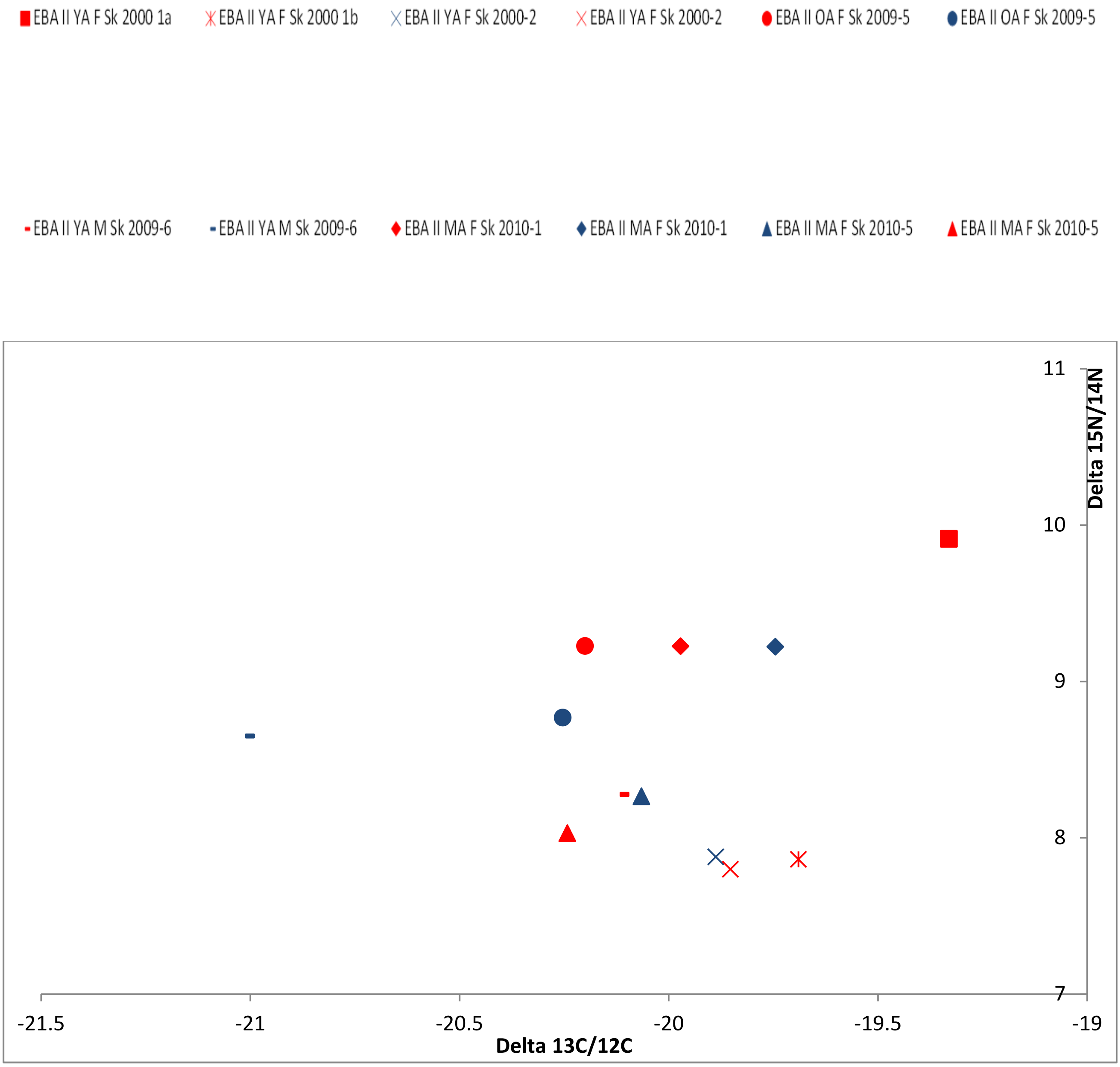


Figure 76: Bademağacı adults plotted for δ13C and δ15N. Legend for Figure 76 is above chart.

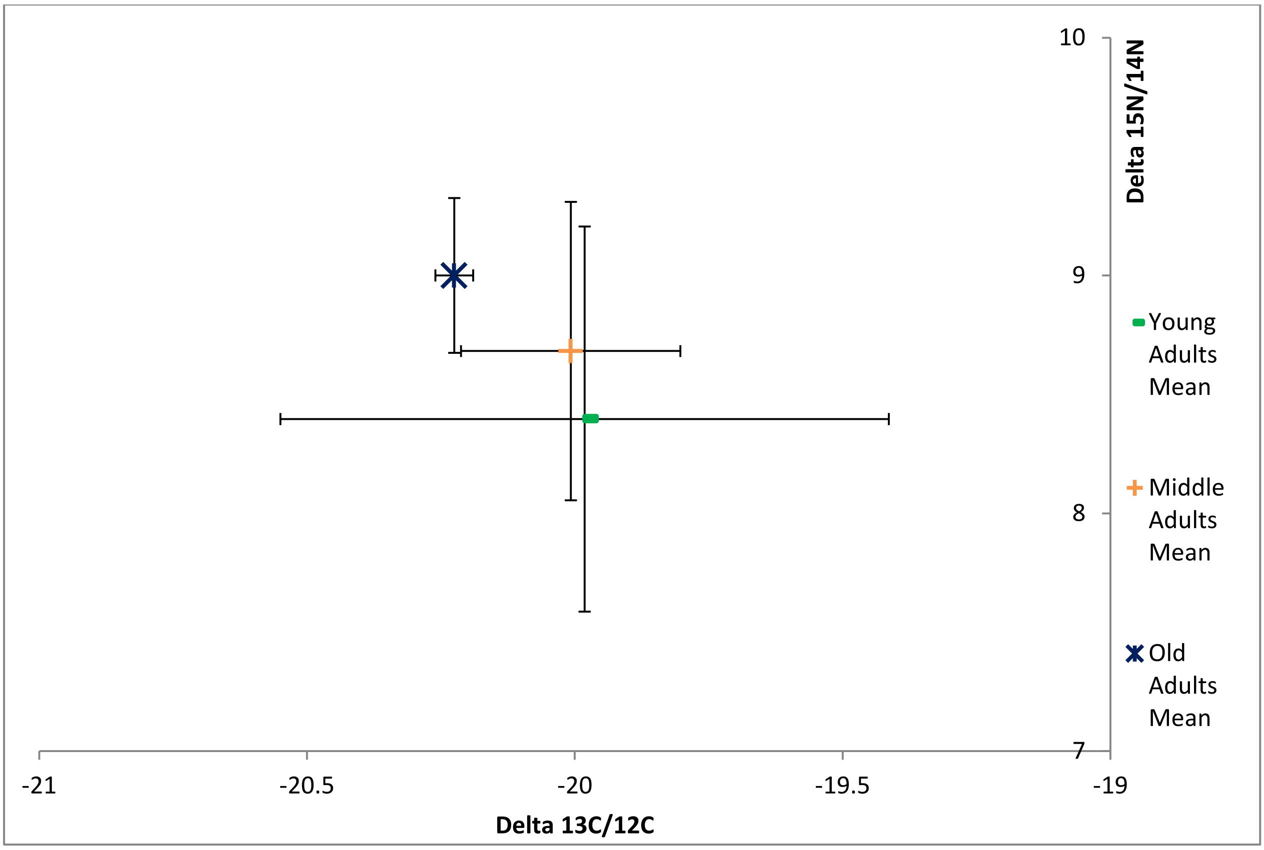


Figure 77: Means and standard deviations plotted for adult age groups from Bademağacı

A single factor ANOVA was conducted to see if there was any statistically significant difference between the groups for both $\delta^{13}C$ and $\delta^{15}N$. The tests showed that there was no statistically significant difference for $\delta^{13}C$ ($p = 0.79$) or $\delta^{15}N$ ($p = 0.58$). This is not surprising due to the closeness in the means of the all of the age groups[2].

There was only one male in the sample population so there is a distinct bias in terms of the female:male ratio. The means of males and females were plotted (Figure 78) as the male had two skeletal elements. However, the range and standard deviation for the male whilst seeming quite large is because of the pronounced difference between the signals between the two skeletal elements of the male (discussed below in more detail). Therefore, the statistical tests should be treated with caution. A two tailed t-test was conducted on the two sex groups and it was found that for $\delta^{15}N$ there was no statistically significant difference ($p = 0.79$), but

[2] Despite the closeness in means and no statistically significant difference, it is noticeable when MA and OA are grouped together that they have consistently greater $\delta^{15}N$ values than YA – a pattern similar to that observed in the age groups from Titriş Höyük (see 5.2.2). Whilst these differences are slight, they may be meaningful. However, a grater sample size would be needed to further examine this at Bademağacı.

that there was one for $\delta^{13}C$ ($p = 0.04$). This statistically significant difference for $\delta^{13}C$ is most likely explained by the difference in $\delta^{13}C$ values for the two skeletal elements of the male individual which has skewed the mean for this individual as his slow turnover bone values (-20.1‰ for $\delta^{13}C$ and 8.3‰ for $\delta^{15}N$) are similar to the mean of the females (-19.9‰ for $\delta^{13}C$ and 8.6‰ for $\delta^{15}N$). And furthermore, the actual differences between the mean for the male and the females are within an isotopically insignificant range.

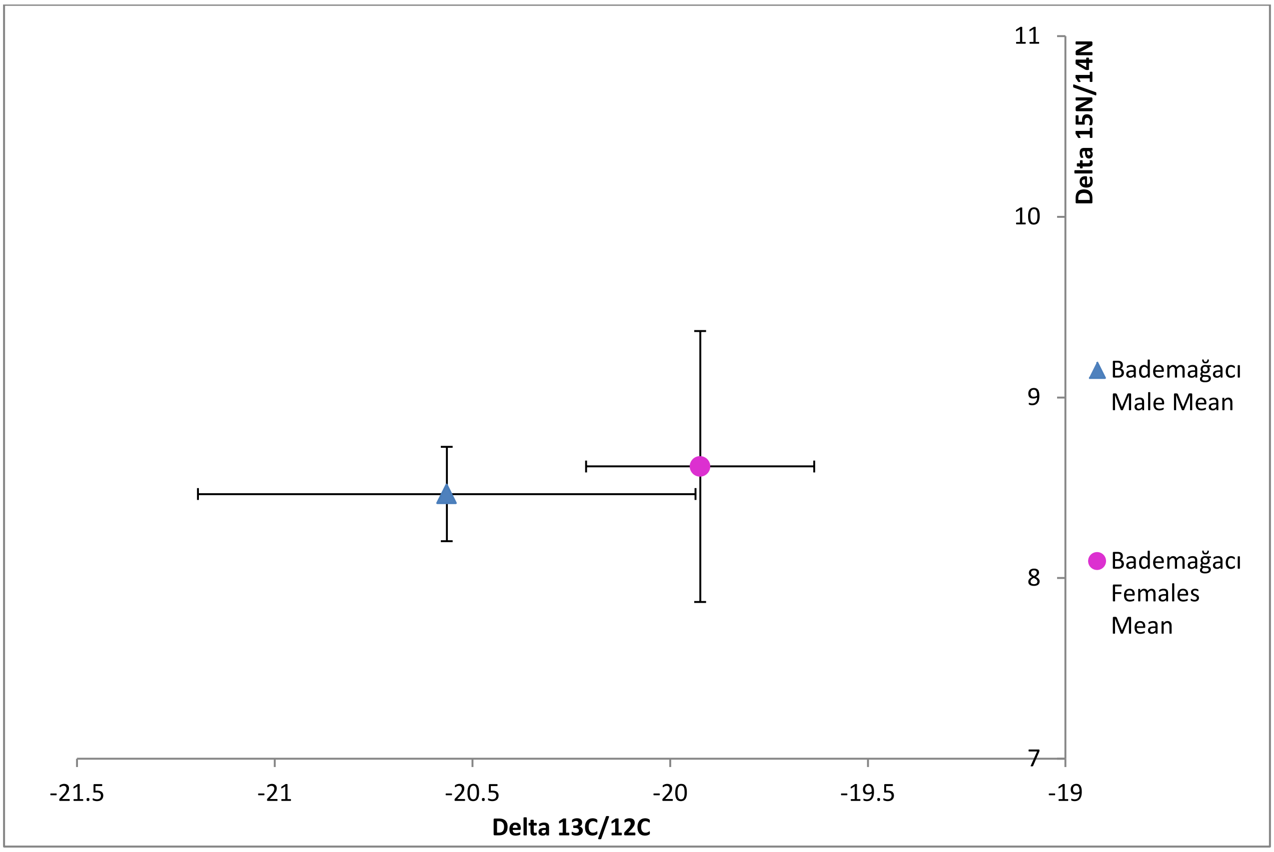


Figure 78: Means and standard deviations plotted for adult male and females from Bademağacı

The male individual is also the only individual with traumatic injuries, so the scatter plot for the means and standard deviations of the individual with trauma and those without will be the same as the one for the sexes above. For the same reason no statistical analyses were conducted as this would have the same result as those done for examining differences between the sexes. As has been briefly mentioned, there is a visually pronounced difference in the isotopic values, especially for $\delta^{13}C$, between the slow and fast turnover bones from this male individual (see Figure 79). This difference for $\delta^{13}C$ can be considered to not be isotopically significant as it is 0.9‰, however this difference cannot be tested to check for statistical difference. What is interesting about this ‘anomaly’ is that it is his fast turnover bone which is different from the population mean, his slow turnover bone plots within the rest of the sample population. This suggests that for the majority of his life (ca. 10 years) he was a local native member of the settlement with the same dietary habits, but that in the last ca. 5-7 years of his life he either changed his dietary habits to be increasingly based on a C3 source, or altered his location which may have affected his dietary habits and thereby isotopic signals. He had a mixture of quite severe ante- and peri-mortem cranial injuries (see Appendices A and D), and it can therefore be hypothesised that this change in diet towards the end of his life was as a result or consequence of the injuries, or that he was a ‘soldier’ who had been away on campaign for a while before returning to the settlement where he died. The fact that his injuries were peri-mortem and most likely fatal would suggest that perhaps he was from elsewhere (i.e. non-local) and was attacked at or near Bademağacı on arrival, or that he was a local who had left and was attacked on his return. However, due to him having the same burial patterns as the rest of the sample population and being buried with apparent effort and care in a *pithos* within the south west part of central megaron of the settlement this would indicate that it would be more likely that he sustained his injuries from outsiders rather than insiders.

There is a YA female (Sk 2000 1a) who has a slightly higher $\delta^{15}N$ signal (9.9‰) than the rest of the population as well as a slightly more positive $\delta^{13}C$ value (-19.3‰); she has been highlighted in Figure 80. Her more positive $\delta^{13}C$ single may be indicative of more C4 based carbon in her diet, or the combination of her more positive $\delta^{13}C$ value and her higher $\delta^{15}N$ values may be indicative of a slight marine component in her diet. These signals are not highly suggestive of a marine diet as her isotopic signals are still within a C3 based terrestrial diet. However, as the skeletal element sampled is a slow turnover bone (femur) which has a relatively greater averaging effect on dietary habits it may be possible that earlier in her life (say before ca. 8-10 years before her death) she lived nearer the coast or had a greater marine input in her diet, the signal for which became diluted and ‘averaged out’. If sampling and analysis of a fast turnover bone from this individual had been done and had isotopic signals more similar to the rest of the sample population (i.e. the opposite of the scenario discussed above for the YA male) then it might be easier to argue this point. It may also be possible that her ‘different’ isotope signature is the result of her being part of a ruling elite with different dietary habits such as a greater consumption of protein. However, this seems unlikely as, despite the small sample size, no other differences within the rest of the sample population were observed and there appears to be very little if any differentiation in dietary habits based on socio-economic and socio-political status in the EBA in Anatolia (see discussion in Chapter 5.2.4 about the female individual from G-296, and in Chapter 6). Also, it must be remembered that although visually different, the difference in actual values between this female and the rest of the population is on an isotopically insignificant scale.

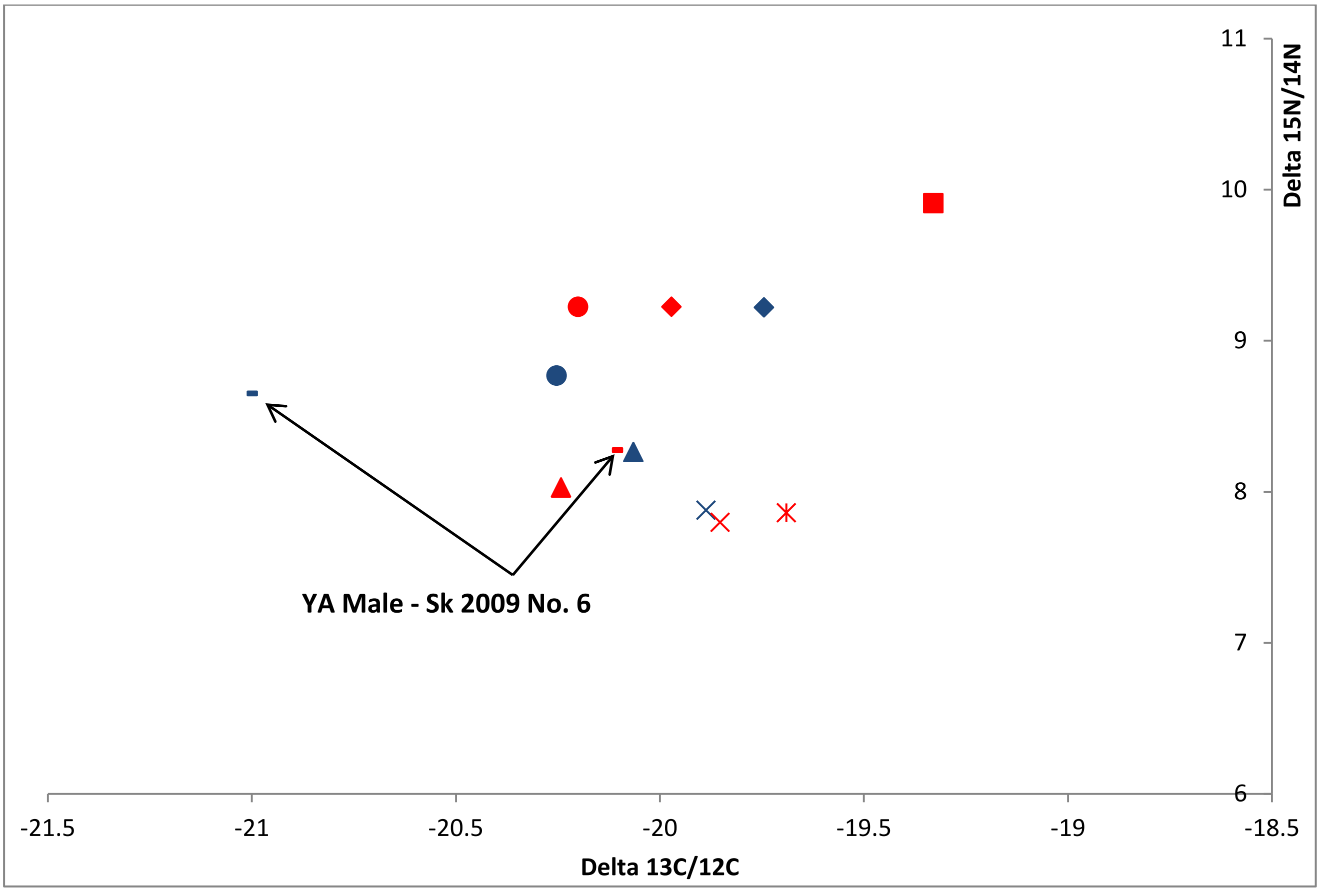


Figure 79: Adult individuals from Bademağacı plotted for δ13C and δ15N with YA male Sk 2009 No. 6 highlighted. See Figure 76 for legend.

Although it is difficult to draw definitive conclusions due to the small size and biased nature of the sample population, the stable isotope data from Bademağacı suggests that, like at İkiztepe, not all of the domesticated animals reared at the settlement were directly consumed/kept for primary consumption. Furthermore, there is a spread in the $\delta^{13}C$ values of the faunal samples which suggests differing animal management practices, most likely indicative of pastoral herding. With regards to the stable isotope data from the humans, it is indicative of a terrestrial C3 based mixed diet with generally very little variation, suggesting a homogeneous diet. There is one interesting slightly anomalous individual, the male (Sk 2009 No. 6) who warrants being investigated further to examine mobility over the course of his life. The female individual (Sk 2000 No. 1a) would also be interesting to examine for mobility to determine whether her somewhat different stable isotope signature was due to a slightly different local diet, or related to a diet consumed earlier in her life in a different location, perhaps in closer proximity to the coast.

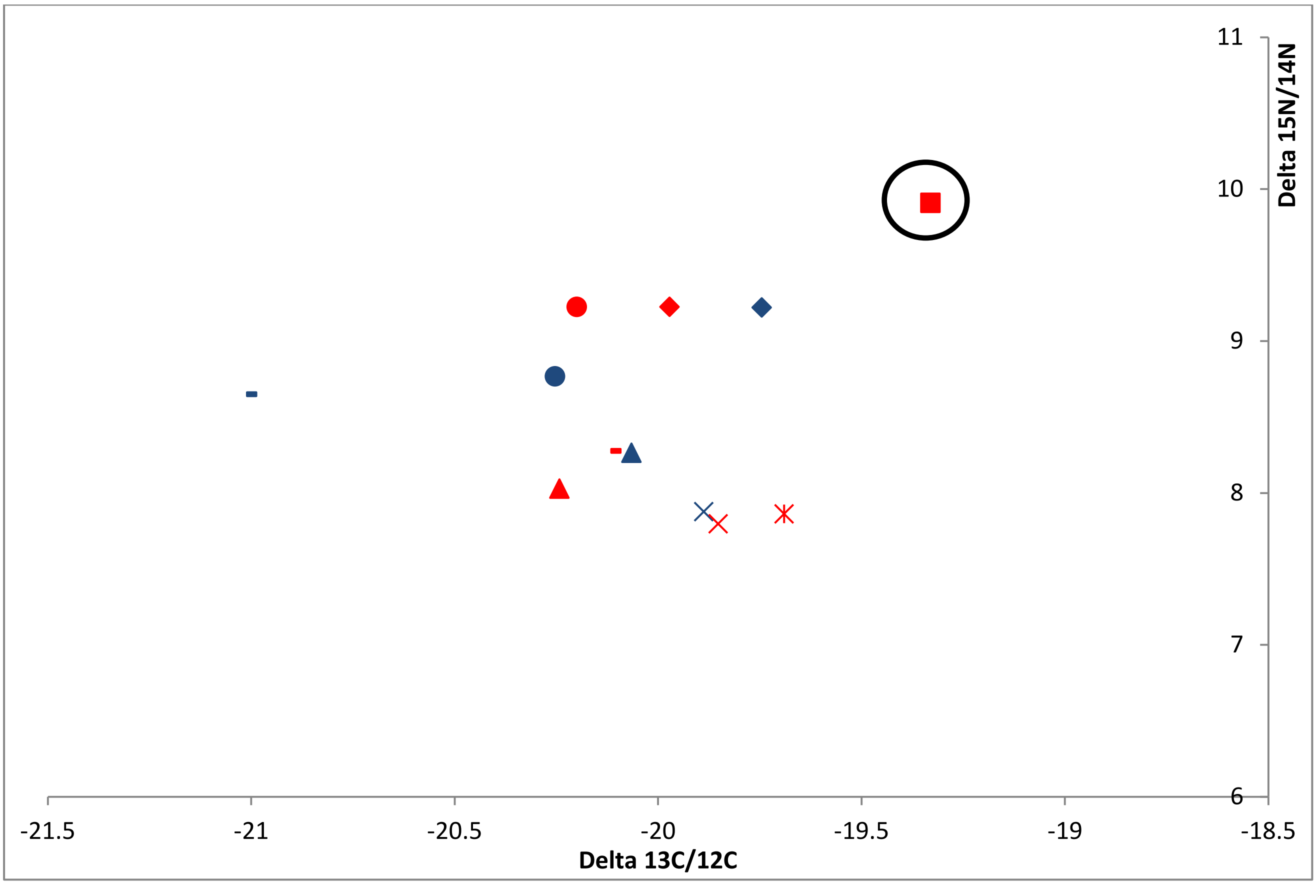


Figure 80: Adult individuals from Bademağacı plotted for δ13C and δ15N with YA female Sk 2000 1a highlighted. See Figure 76 for legend.

5.2.4 Bakla Tepe Höyüğü

Following the assessment of the quality criteria discussed in Chapter 5.2, a total of 11 samples were discarded. These included two skeletal elements (the rib samples from G-296 and G-62), the (a) run of one skeletal element (the (a) run for the phalanx sample from G-243/2), one individual (G-244), and two cow bone samples. For a table containing the complete output data from Bakla Tepe see Appendices K and L.

In total eight faunal remains were sampled from Bakla Tepe, but unfortunately the samples for the two cows were discarded resulting in the faunal sample population consisting entirely of *ovis/capra*. When these are plotted (Figure 81) it is clear that there is an isotopically significant spread and range for both $\delta^{13}C$ and $\delta^{15}N$ values. The $\delta^{13}C$ values range from -20.7‰ to -17.6‰ and the $\delta^{15}N$ values range from 5.4‰ to 8‰. Whilst in general it can be said that the *ovis/capra* from Bakla Tepe subsisted on a terrestrial C3 based diet there are a few animals that could be considered anomalous. Following on from the discussion earlier about how low and high $\delta^{15}N$ values in faunal remains could indicate the proximity of an animal to the settlement; the stable isotope signals for the faunal remains from Bakla Tepe suggest that animals were herded in different ways and in different locations around the settlement. The *ovis/capra* with the high $\delta^{15}N$ value (8‰) could possibly have been herded close to the settlement, perhaps grazing on manured fields or foddered on manured plants. The rest of the faunal sample population were probably herded further away from the settlement, but one could argue that as their $\delta^{15}N$ values are higher than expected for an herbivore they were not herded a great distance from the settlement and the extent of the arable land-use. There are two *ovis/capra* that are slightly anomalous in terms of their $\delta^{13}C$ values; the two on the right of the chart with more positive $\delta^{13}C$ values. Their isotopic signals would suggest that either they were herded at a greater distance from the settlement in an area with C4 grasses/plants present or a different environment and/or climate, or that they were foddered in a different way than the other animals of the faunal sample population. It has been suggested that in areas where agricultural fields occupy the land around a settlement that animals were stall-fed so as to limit the places the animals could trample (Miller 1997, 128). The idea of mixed herd management practices finds comparisons at EBA Demircihöyük where it appears that the livestock was most likely kept in close proximity/within the immediate vicinity of the settlement in pens, but with the possibility of seasonal transhumance (Massa 2015, 93). Ethnographic research close to the city of Van in eastern Turkey revealed that animal herds (cattle and sheep/goat) are grazed on pastures from April through to the end of October, and sometimes into December if the weather allows it, and are kept in stables in the intermediary period (Çevik & Erdem 2015, 313).

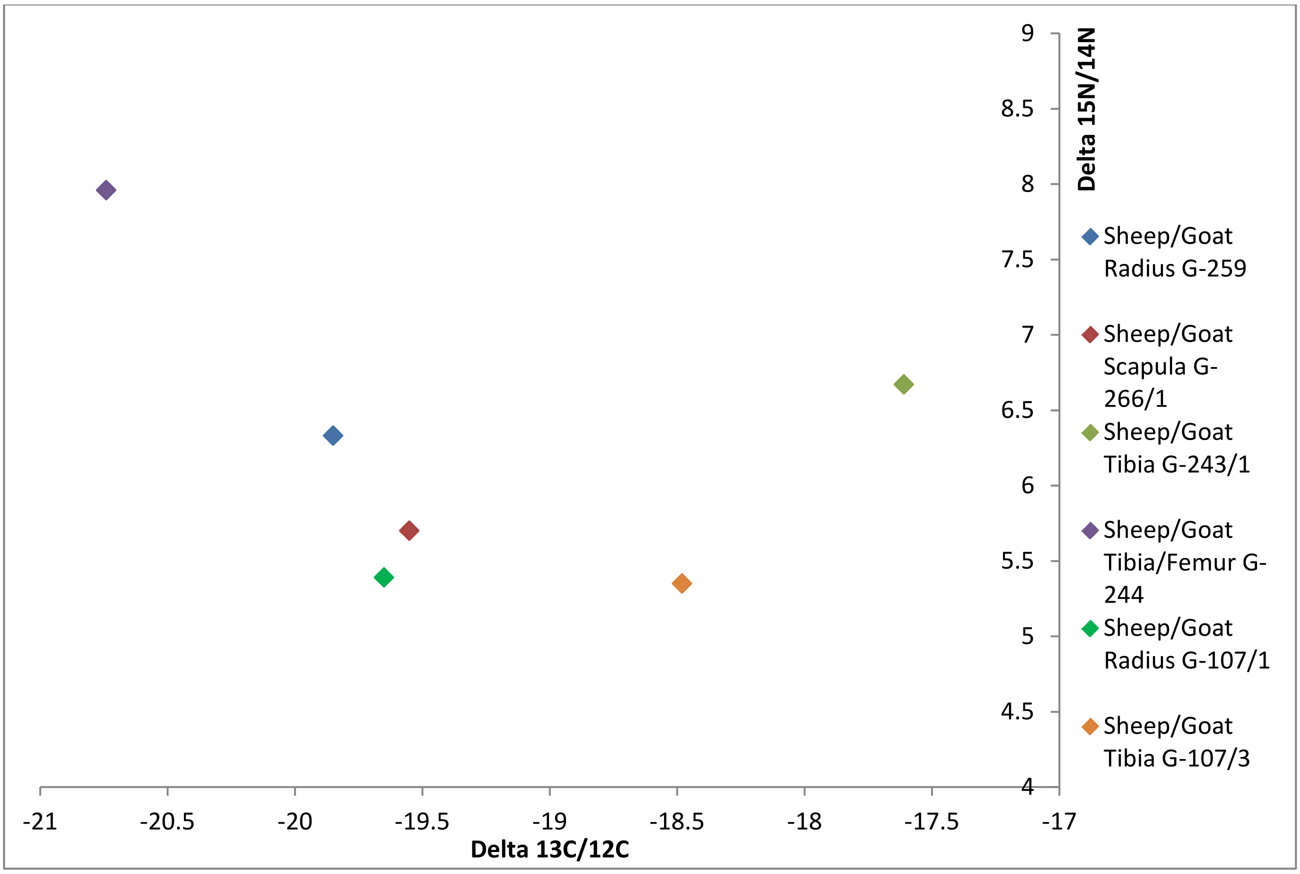


Figure 81: Bakla Tepe faunal sample population plotted for δ13C and δ15N

When the adult human and faunal sample populations are plotted together (Figure 82) a similar pattern can be observed as is seen at the other settlements with faunal samples. This being that a percentage of the livestock was not being consumed by the human sample population. At Bakla Tepe it is clear that the two *ovis/capra* with 'anomalous' $\delta^{13}C$ values were likely not consumed by the human sample population. Again, as has been previously discussed, to be more clear what I mean is that these two animals provide a general indication suggesting that not all animals were consumed/or for direct consumption of the human population. These two *ovis/capra* may well have been consumed at the end of their lives, but as an immediate and direct relationship of consumption cannot be obtained from this data, we can simply say that the anomalous nature of their isotopic values in comparison with the human population would infer that not all animals were reared for primary consumption at Bakla Tepe. It is interesting that a similar pattern emerges from several Anatolian EBA sites with different environmental conditions, and it would be reasonably safe to say that there is a definite pattern here. As has previously been mentioned this notion will be discussed in more depth in Chapter 6.2. It also easy to see when the human and faunal sample populations are plotted together that the *ovis/capra* δ^{15}N (and δ^{13}C) signals are quite close to the human signals which could be an indication of close proximity herding of the livestock as discussed above.

When the δ^{13}C and δ^{15}N values of the human adult sample population are plotted together (Figure 83) it can be observed that they plot reasonably tightly together, within an isotopically insignificant range (1.36‰) for δ^{13}C from –20.5‰ to -19.1‰ with a mean of –19.6‰. The range for δ^{15}N is greater (2.8‰), and can be considered to be potentially isotopically significant between the minimum (6.8‰) and maximum (9.6‰) values with a mean of 8.3‰. Overall these values can be considered to be indicative of a terrestrial C3 based mixed diet. The fairly compact range in δ^{13}C and δ^{15}N values would also suggest that the dietary habits of the sample population were consistent and that there was a reasonable degree of homogeneity in the sample population’s dietary habits, although there is a bit of variation within the δ^{15}N values which potentially suggests variability in protein intake within the sample population. There is also one individual (G-275/3), an Adult female from the EBA II/III cemetery who exhibits markedly different δ^{13}C values between her slow (-20.5‰) and fast (-19.4‰) turnover bones, much like the YA male Sk 2009 No. 6 from Bademağacı. The difference in δ^{13}C values between her two bone elements is 1.1‰, which is actually greater than the difference observed in Sk 2009 No. 6 from Bademağacı. This difference is still on an arguably insignificant scale, although statistical testing cannot be applied. However, it is great enough that it merits a mention here. Conversely, in the instance of G-275/3 from Bakla Tepe, it is her slow turnover bone (femur) which is ‘anomalous’. It plots on the outer reaches of the δ^{13}C values, and is actually the most negative value in the sample population, whilst her fast turnover bone (rib) plots within the general population values. Therefore the opposite logic would apply to her – that she changed her dietary habits within the final 5-7 years of her life from heterogeneous to homogeneous. The implication is that she changed her diet for some reason (e.g. social/cultural), or was originally a non-local with slightly different dietary habits to the general sedentary population of Bakla Tepe. The increased positivity in the δ^{13}Cvalue of her rib, compared to her femur, is accompanied by a very slight increase in her δ^{15}N value (of 0.8‰).

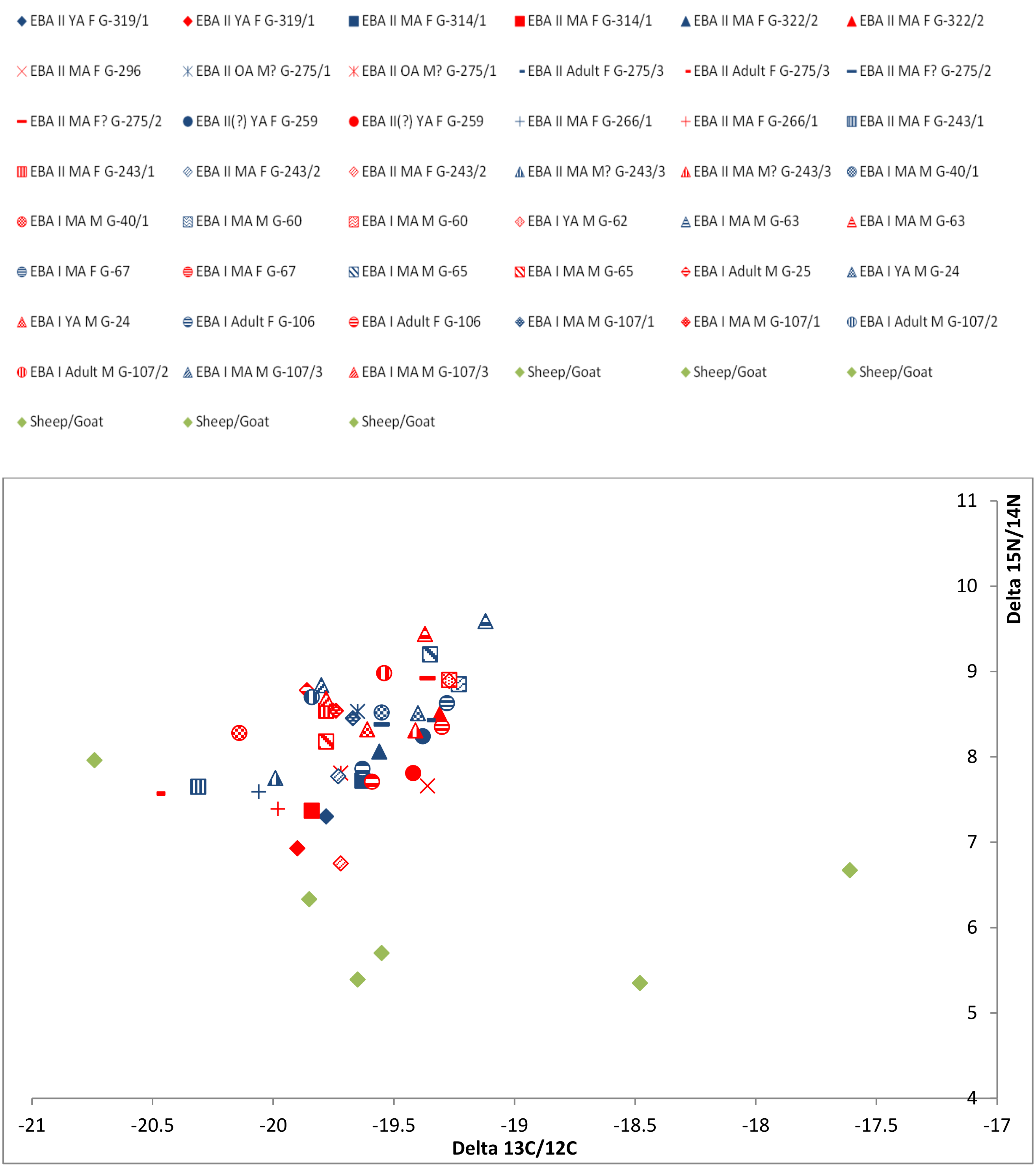


Figure 82: Adult human and faunal sample populations from Bakla Tepe plotted together for δ13C and δ15N. Legend for Figure 82 is shown above chart.

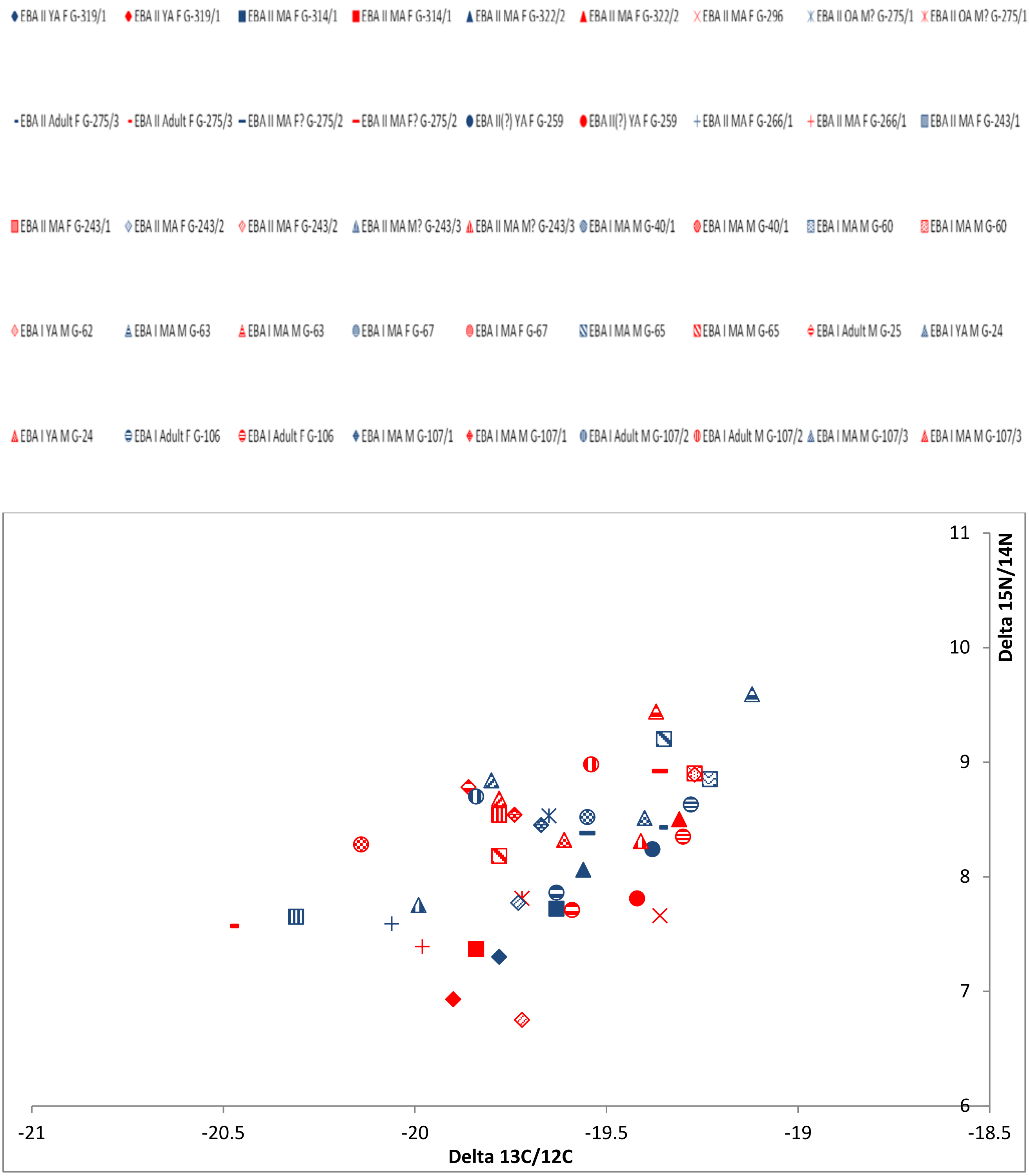


Figure 83: Bakla Tepe adults plotted for δ13C and δ15N. Legend for Figure 83 is above chart.

The increase in δ^{15}N is very minor, but in combination with the increased positive δ^{13}C value may suggest a difference in protein source perhaps incorporating more C4 plants, either directly or more likely though an animal vector. Because the δ^{13}C value of her femur is somewhat 'anomalous' compared to the mean of the overall population I would suggest that she is possibly a foreigner who moved to Bakla Tepe from elsewhere towards the end of her life; during which time her dietary habits - and thereby stable isotope signals - became more parallel to the general population. However, this cannot be said with certainty without performing mobility or genetic analyses.

When the means and standard deviations of the sexes at Bakla Tepe are examined (Figure 84) it can be seen that visually, and on an isotopically significant scale, that there is very little difference in δ^{13}C and δ^{15}N values between the males and females of the sample population. The males have a mean of -19.6‰ for δ^{13}C and 8.6‰ for $\delta^{1\%}$N, with the females having a mean of -19.7‰ for δ^{13}C and 7.9‰ for δ^{15}N. Therefore, when statistical analysis was applied it was expected that no statistically significant difference would be discovered. This proved to be the case with the two tailed t-test for δ^{13}C ($p = 0.43$). However, the result of the test for δ^{15}N ($p = 0.00$) showed a very strong statistically significant difference between males and females. However, this is another case where the difference in the data values between the two groups is pronounced and consistent; however, it is on a very small scale. To examine further the statistically significant difference in δ^{15}N values between males and females the individual data points for each group were plotted together (Figure 85). Here it can clearly be observed that whilst there is some overlapping in values at ca. the 8-8.5‰ values, males in general have consistently higher δ^{15}N values than females. There is roughly the same range in values for both males and females (ca. 2‰ between the maximum and minimum δ^{15}N values), but there is a greater spread in the females and the males are more consistent in their spread with the majority being within 1‰ of each other. These observations allow us to better understand the statistical significance indicated by the two tailed t-test. Whilst the means and standard deviations of males and females plot quite close together and thus indicate no significant difference, or at least a difference on an insignificant scale, when the data is viewed as a cloud it is clear to see that there is a significant difference between males and females.

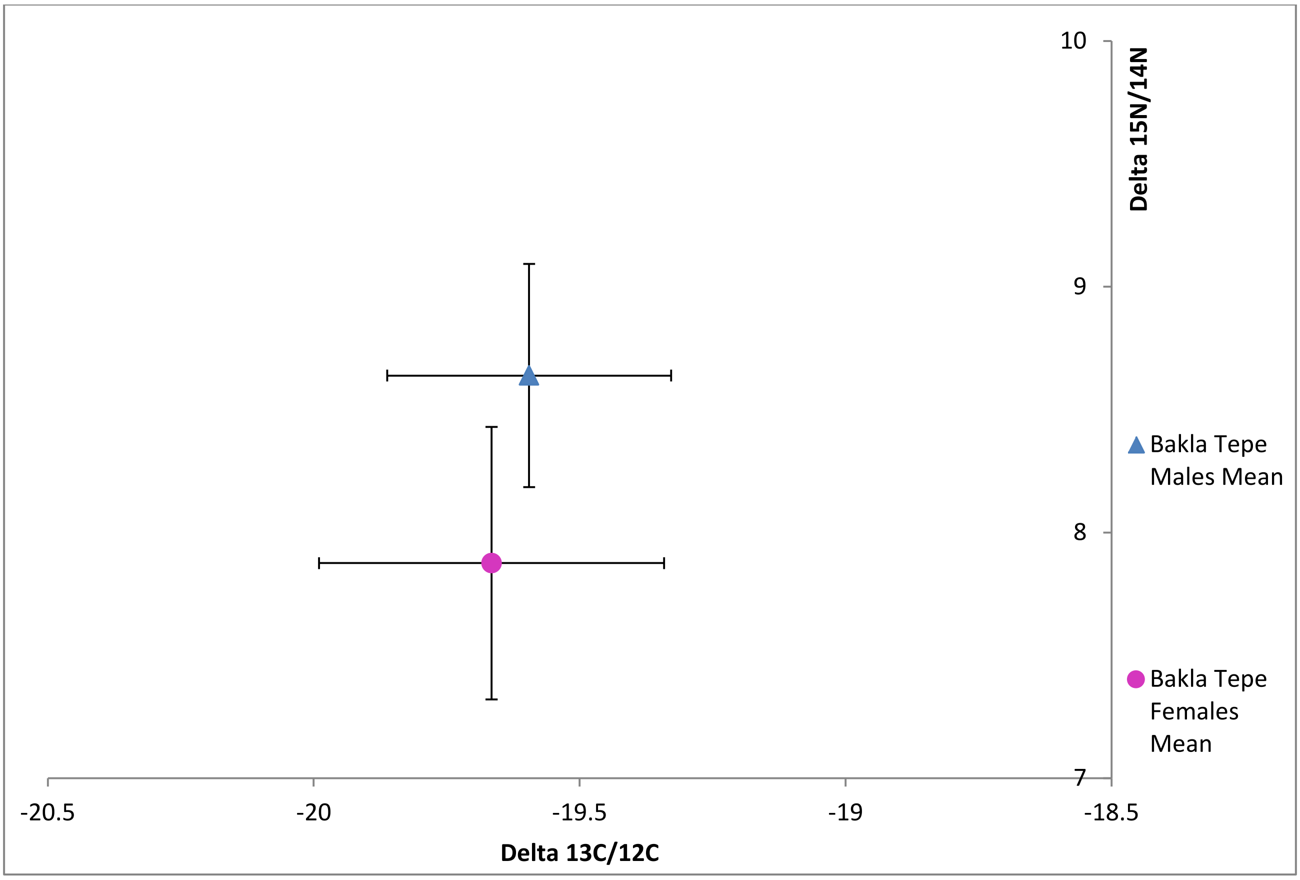


Figure 84: Means and standard deviations of males and females from Bakla Tepe

The males of the Bakla Tepe sample population had a consistently greater protein input in their diets than the females. This is similar, if more pronounced, to the results from İkiztepe. However, as has been mentioned there is an overlap between the female with higher $\delta^{15}N$ values and the males with lower $\delta^{15}N$ values. This would perhaps indicate that there was an inequality/difference in protein input into the diet based on factors other than sex.

The adult individuals sampled from Bakla Tepe came from the two cemeteries of differing time periods; one dated to the EBA I period and the other to a ‘transitional period’ at the end of EBA II and the beginning of EBA III. Because of the clear and well established differentiation in time periods and the fact that the sample population from each period came from separate and exclusive cemeteries, which has led to hypotheses of population replacement between the two periods at the settlement, it was deemed worthwhile to further investigate if there were any isotopic indicators of a change or difference in dietary habits.

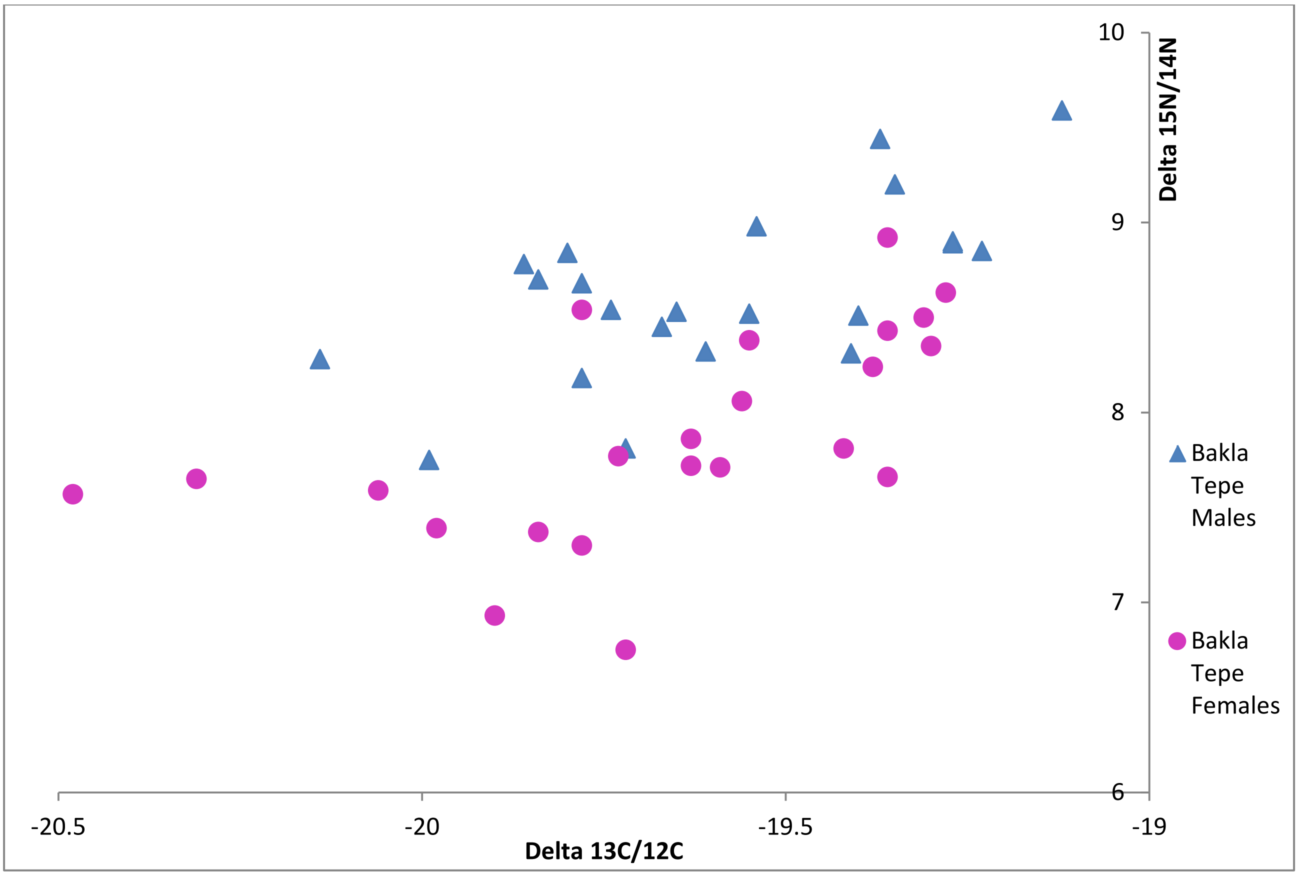


Figure 85: Males and Females from Bakla Tepe plotted for δ13C and δ15N

The means and standard deviations for both time periods were first plotted (Figure 86). The means for $\delta^{13}C$ are very close (-19.6‰ for the EBA I individuals, and -19.7‰ for those from the EBA II/III period), and whilst there is slightly more of a difference in the $\delta^{15}N$ values (8.6‰ and 7.9‰ respectively) this is still on a very isotopically small scale. The two-tailed t-tests produced similar results to those examining the difference between sexes with no statistically significant difference for $\delta^{13}C$ (p = 0.08) between the EBA I and EBA II/III adult individuals, but a very strong statistically significant difference for $\delta^{15}N$ between the two groups (p = 0.00). However, once again, whilst there is a statistically significant difference for the $\delta^{15}N$ values indicating a consistent difference in the data, this difference is very small. It is interesting that similar results, in terms of both the means and the statistical analysis results, were discovered when examining potential differences between the sexes and the time periods.

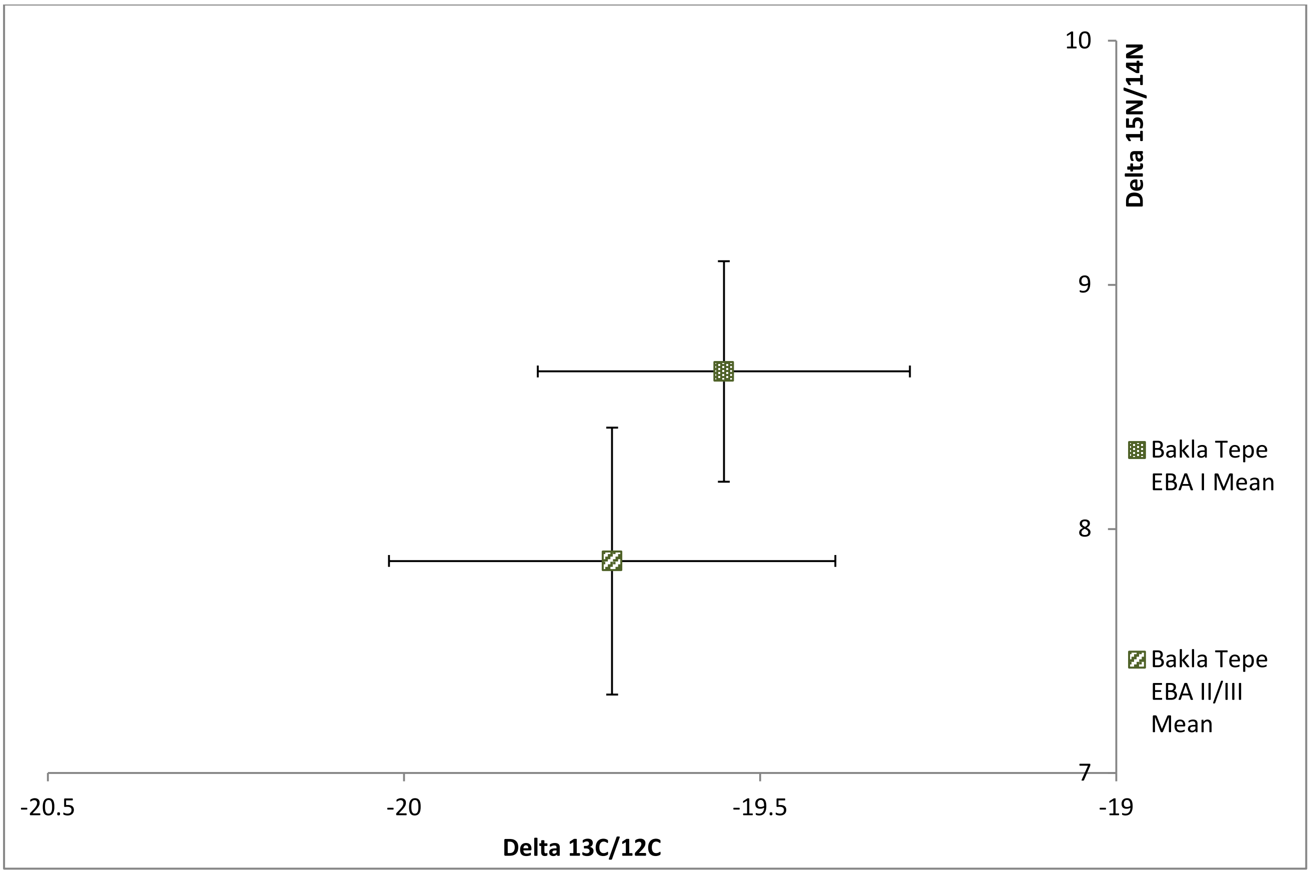


Figure 86: Means and standard deviations for adults of different time periods from Bakla Tepe

Therefore differences between the sexes within the two time periods were examined to see if this might be the cause of the above results or not. When the means and standard deviations for males and females from each time period (Figure 88) are plotted it can be witnessed that the values for the males and females from the EBA II/III period are nearly identical whilst there is a slight difference in values between males and females from the EBA I period. This suggests that in the EBA II/III period dietary habits were more consistent and homogeneous than in the EBA I period with regards to the sexes. Two-tailed t-tests were conducted to examine if there were any statistically significant differences between males and females within the time periods. In the EBA I period no statistically significant difference was found between males and females for $\delta^{13}C$ (p = 0.32), but one was found for $\delta^{15}N$ (p = 0.01). In the EBA II/III period no statistically significant difference was found between males and females for either $\delta^{13}C$ (p = 0.92) or $\delta^{15}N$ (p = 0.36). Whilst there is a statistically significant difference for $\delta^{15}N$ between males and females of the EBA I period this is on a very small scale. However, this result would explain why a statistically significant difference is observed between males and females when both periods are lumped together. These analyses and the ones discussed earlier for males and females at Bakla Tepe complement each other. Whilst the difference between the means for males and females may be considered to be on an insignificant/small scale it has been shown above that there is in fact a consistent and significant difference between males and females. Furthermore, this supports the idea that in the EBA II/III period at the site dietary habits were more consistent and homogenous, at least between males and females. In effect we can argue that during the EBA I period there was more of a difference in dietary habits between people, and this was likely based on sex. And in the EBA II/III period these differences were not so pronounced, or even did not exist. This corresponds well with the stable isotope data from EBA III Titriş Höyük which also demonstrated homogeneity between males and females. The idea that this may be a phenomenon present in several Anatolian populations of the late 3rd millennium BC will be further discussed in Chapter Six.

There is a greater heterogeneity in the grave types of the EBA I cemetery, with a mix of *pithoi*, stone-cist, and pit graves (see burial patterns discussion in Chapter 2.5). It has been hypothesised that the mixed nature of grave types in the cemetery may be related to presence of differing cultural traditions and social groups at the settlement (Şahoğlu 2008, 486; Şahoğlu & Tuncel 2014, 78). This means that there may have existed different dietary habits related to these group variations. This was examined by examining the stable isotope values of individuals from the different grave types in the EBA I cemetery. However, unfortunately the majority of the individuals form the EBA I cemetery come from an unknown grave type (see Appendix A) and therefore it was difficult to conduct this analysis properly and deduce interpretations. But it would appear that grave type did not determine the dietary habits of an individual (see Figure 87). The data points labelled as a secondary deposition outside a stone cist grave come from two individuals (G-107/2 and G-107/3) which were found immediately outside of the stone cist grave of G-107/1. It is likely that these secondary depositions were originally inside the stone cist grave but were removed to make room for subsequent inhumations, the last of which was G-107/1 (Şahoğlu 2016, 170). Therefore, they can probably be included in the data group for the stone cist graves. The range in $\delta^{13}C$ values of known grave types is 0.7‰ and also 0.7‰ for $\delta^{15}N$, both of which are minute. The range is larger when including the unknown grave types, but this range in values (specifically $\delta^{15}N$) is most likely related to sex differences as previously discussed.

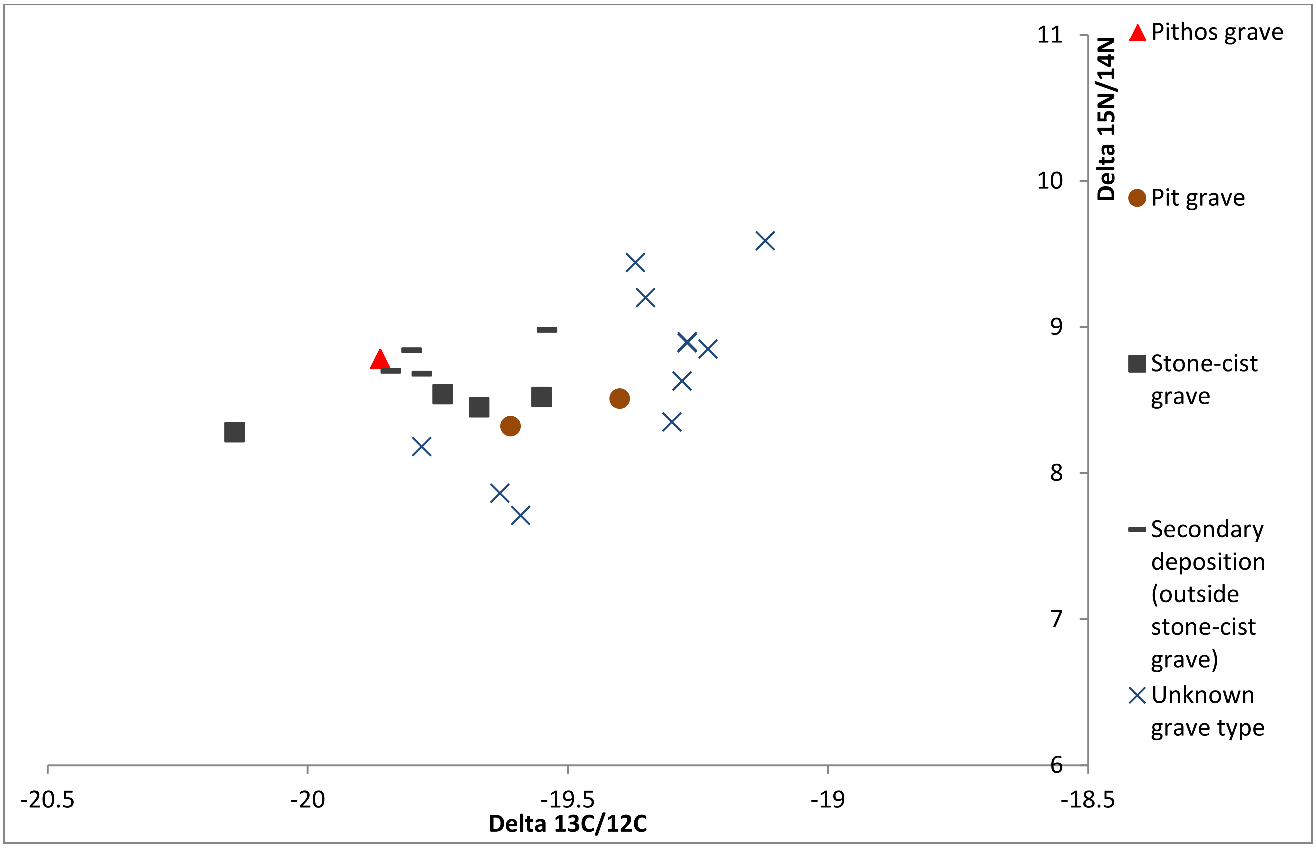


Figure 87: δ13C and δ15N values for the different grave types of the Bakla Tepe EBA I cemetery

Possible differences between the age groups at Bakla Tepe was also examined and the means and standard deviations for YA, MA, OA, and Adults of an undetermined age were plotted (Figure 89). All of the age groups plot very closely together and no difference can be initially observed. Single factor ANOVA tests were conducted for YA, MA, and OA for both the $\delta^{13}C$ and $\delta^{15}N$ values to test if any difference could be found. Adults of an undetermined age were omitted from the statistical analysis as this group could contain adults belonging to one or more of the other age groups and thereby skew the data. The results for $\delta^{13}C$ and $\delta^{15}N$ discovered no statistically significant difference between the age groups (p = 0.74 and 0.55 respectively). This demonstrates that there is no significant difference in isotopic values and thereby dietary habits between the age groups within the adult sample population.

With regards to traumatic injuries at Bakla Tepe no isotopically significant differences could be observed between individuals with traumatic injuries, and those without, nor between individuals with cranial traumatic injuries and those with post-cranial traumatic injuries (Figure 90). Indeed, the mean isotopic values of $\delta^{13}C$ and $\delta^{15}N$ for individuals with cranial and post-cranial traumatic injuries are almost identical, suggesting that there is no isotopic or dietary difference between individuals with each type of traumatic injury.

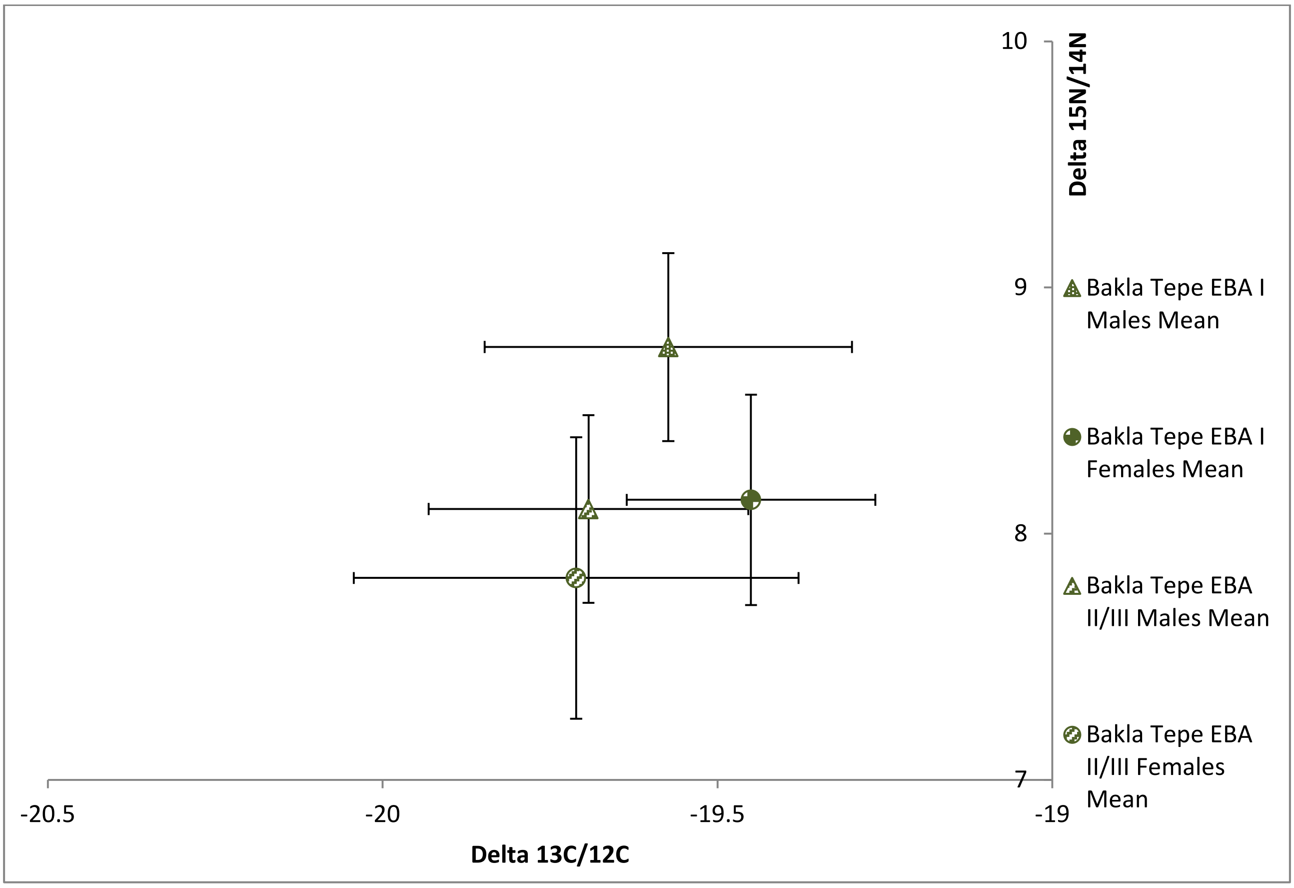


Figure 88: Means and standard deviations plotted for males and females within the two separate time periods from Bakla Tepe

When two tailed t-tests were performed to examine if there was a statistically significant difference between individuals with and without traumatic injuries none was found for $\delta^{13}C$ (p = 0.20), but there was one observed for $\delta^{15}N$ (p = 0.04). Once again, whilst there is a statistically significant difference, this is on an isotopically very small scale. Additionally, this statistically significant difference for $\delta^{15}N$ may be explained by the fact that more females were observed with traumatic injuries in the sample population and statistically significant differences were found for the $\delta^{15}N$ values of the males from EBA I as discussed above. One interesting comparison to make is that unlike at İkiztepe where the identifiable pattern is one of males with a higher protein intake in their diets being involved in violent inter-personal altercations, at Bakla Tepe the converse is true; females with a lower protein intake are more likely to be involved in violence.

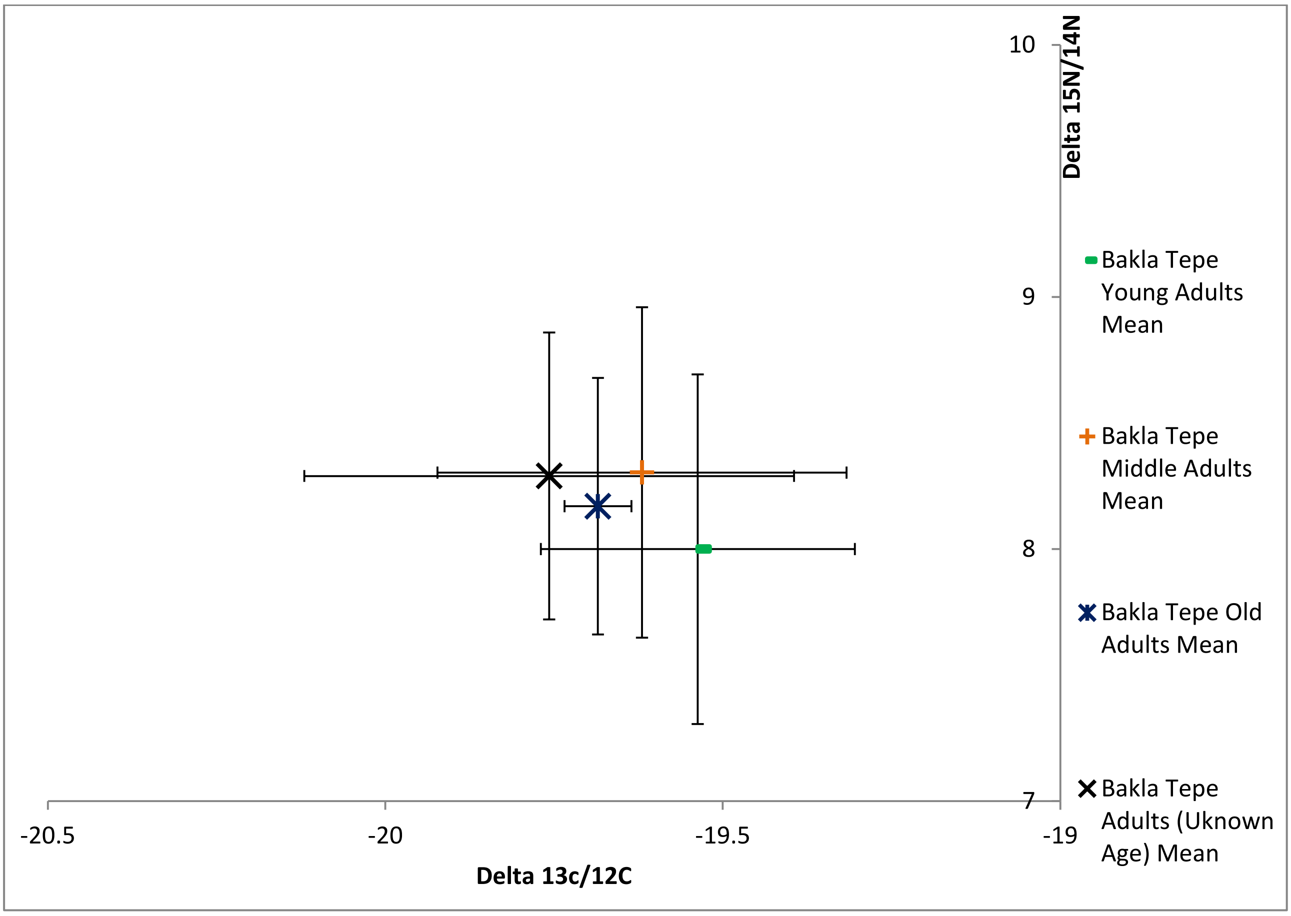


Figure 89: Means and standard deviations plotted for Bakla Tepe adult age groups

To make sense of these opposing patterns social factors should be considered. On Figure 90 the female individual (G-296) with the trephination has also been plotted. It has been reasonably hypothesised that due to this individual having a trephination, a larger grave than the rest of the skeletal population with fine grave goods, that she may have been 'special' in some way (e.g. perhaps a shaman or other such ritualistic functionary) or part of a ruling elite at the settlement. The presence of a bone seal in the shape of a bird as part of G-296's grave assemblage (the only seal to be found in a grave) has been one of the main factors to argue that this individual was a member of an elite at the settlement, or at least had special status (Şahoğlu 2016, 176). Seals throughout history have often been considered to be indicators of administration, control, and power (Şahoğlu 2016, 176). Consequently, it has also been hypothesised that if this is the case then she may have had different dietary habits from the rest of the skeletal population which could be observed in her isotopic signals. Whilst this individual may appear to be slightly different to the means of the individuals with and without traumatic injuries, the differences are very small for both $\delta^{13}C$ and $\delta^{15}N$ and can be considered to be isotopically insignificant and furthermore she does not appear as an outlier in the graph where all individuals are plotted. Two tailed t-tests for $\delta^{13}C$ and $\delta^{15}N$ were performed to see if any statistically significant difference could be observed between this individual and the rest of the population. None was found for either $\delta^{13}C$ or $\delta^{15}N$ (p = 0.36 and 0.35 respectively). This indicates that the female individual with the trephination (G-296) did not have different dietary habits to the rest of the population. This indicates that if she was a member of the settlements elite then there were no dietary differences between the elite and the 'commoners'. However, with only one individual who could arguably belong to an elite being sampled this cannot be said with any certainty. Taking into account the stable isotope values of the female individual G-296 the social factors related to the opposing patterns observed at Bakla Tepe and İkiztepe may now be discussed further. Initially the pattern at Bakla Tepe, with violence against females with a low protein intake in their diets may be suggestive of domestic abuse, or perhaps even indicate the presence of servants/slaves, whilst at İkiztepe it would suggest the presence of a 'warrior class' with a greater dietary protein input/greater 'taste' for protein. However, these female individuals at Bakla Tepe are buried within the main cemetery and show no differential treatment in death. Furthermore, individual G-296 has a relatively low $\delta^{15}N$ value, which when taking into account her large grave and rich assemblage that indicate she held some sort of special status within the settlement's society would suggest that females with lower $\delta^{15}N$ values, and thereby lower protein intake, are most likely not societal 'outsiders' as servants and slaves would likely be. Therefore, to explain the converse pattern regarding males and females and traumatic injuries to that observed at İkiztepe, it could be that protein had a lesser/different symbolic value at Bakla Tepe – possibly that it was not the status or prestige foods source that it may arguably have been at İkiztepe. The homogeneity between males and females from the EBA II/III cemetery would also support this notion.

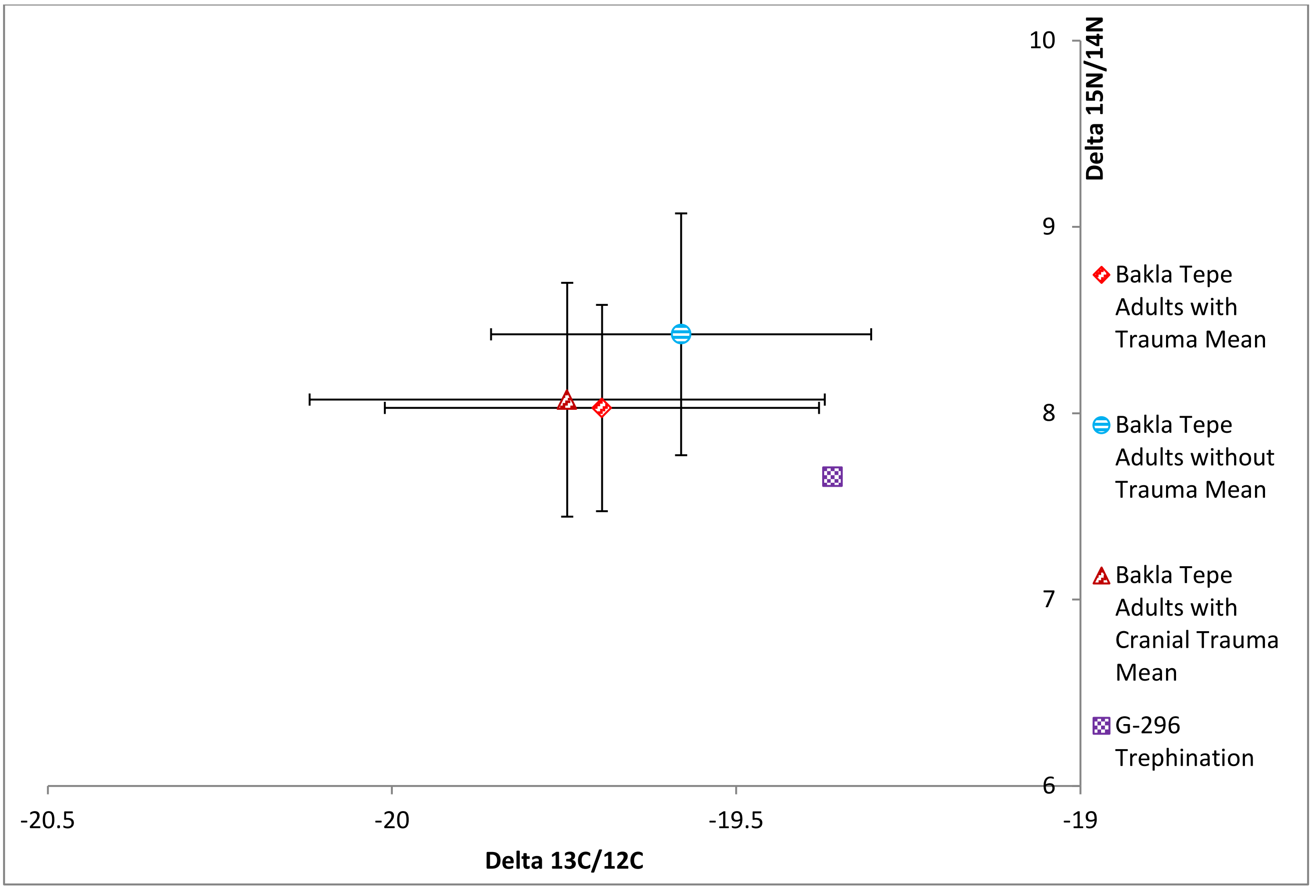


Figure 90: Means and standard deviations of adult individuals from Bakla Tepe with and without traumatic injuries. Female individual (G-296) with trephination has also been plotted

The results of the stable isotope analysis from Bakla Tepe indicate that the inhabitants subsisted on a terrestrial C3 based mixed diet with milk/meat from *ovis/capra* appearing to provide the majority of their protein input. Due to the paucity and bias of the faunal samples (i.e. only *ovis/capra*) caution should be taken as it is very difficult to say anything definitive about primary animal exploitation at the site. The non-consumption of outlying faunal remains would, however, suggest the exploitation of these animals for their secondary products, in this case most probably their wool due to the species and the evidence for textile production at the site. Whilst dietary habits did not differ between adults of different ages/age groups, a slight difference was found between males and females, with males having a slightly greater protein intake in their diets. However, this was only found for individuals of the EBA I cemetery. Whilst there is very little difference in isotopic signatures, and therefore dietary habits, between the EBA I and EBA II/III sample populations which supports the idea of cultural continuity at the site as suggested by Erkanal (2011, 131) and discussed in Chapter

2.5, there is also greater dietary homogeneity suggested for the latter part of the 3rd millennium BC. The stable isotope analysis also suggests that there was no differentiation in dietary habits between élites and non-élites. However, further dietary analysis should be conducted on other individuals identified as 'élite' to confirm or deny this. It may also be possible that the female individual of G-296 was not a member of a traditionally imagined socio-economic/socio-political élite but perhaps of another group/societal role perhaps with special status which enabled differentiation in burial practices but not dietary habits. There is also one individual, an Adult female (G-275/3) who exhibits differences in the $\delta^{13}C$ values of her slow and fast turnover bones. The conclusion I have drawn from these differences is that she may possibly have moved to Bakla Tepe within the last 5-7 years of her life from a different region/settlement, but that this remains only a hypothesis without further examination (i.e. mobility of genetic analyses).

As a final point in this chapter, it can be said that in the instances where statistical significance has been found they are very subtle ones in terms of the actual stable isotope data numbers and generally accepted 'stable isotope significance'. This suggests that although there are undeniable and acknowledged differences in the dietary habits of certain groups (e.g. sex) within populations, these differences could possibly be relatively minor, or at least not exceptionally distinctive, and may be related to sophisticated differences in dietary habits - perhaps associated with 'taste' rather than (overall) nutrition. That is not to say they should be dismissed or ignored, far from it as it is often in the details where the most interesting and informative information lies. These subtleties should be examined and pursued, but at the same time we must be aware of the limitations and not to try and over-reach the capacity of stable isotope analysis and its interpretation in conjunction with the available data. Ultimately, it was anticipated that distinct and possibly dramatic differences would be observed on both intra- and inter-population levels, but the differences are on a micro rather than macro level – "Anatolia is a region where the differences between settlements are small but [they do] exist" as so eloquently put by one of my supervisors, Erdal Y. (personal communication). These factors will be addressed, and further discussed in Chapter Six where inter-population analysis will also be conducted.

Chapter Six: Discussion

6.1 Intra and Inter Site Comparison

Following on from the analysis and presentation of the results of the stable isotope analyses in Chapter Five it can be determined that the dietary habits of the human sample populations from all of the sample sites are terrestrial C3 based. Furthermore, across all of the sample populations at an intra-site level there is very little variation in the values for $\delta^{13}C$ and $\delta^{15}N$ indicating a high degree of homogeneity in dietary habits. However, at some of the sites (as discussed and dealt with earlier in Chapter Five) statistically significant differences were found within the populations for either or both $\delta^{13}C$ and $\delta^{15}N$. For the sample sites that provided faunal remains for stable isotope analysis a pattern also seems to emerge that during the EBA period in Anatolia not all of the animals present at a site were being consumed by the human population. This aspect will be further discussed in section 6.2 below. As mentioned above at some of the sites there were some statistically significant differences resulting from consistent patterns of difference in the data. At İkiztepe and Bakla Tepe the intra-population differences are related to sex and trauma, although not in the same ways. At İkiztepe males, and more specifically a proportion of the male population, had a greater protein in their diets than the rest of the population. Furthermore, males with a higher protein input were more likely to have traumatic injuries as a result of inter-personal violence on their skeleton. At Bakla Tepe males had a marginally greater protein input in their diets than females, but only in the EBA I period. In the EBA II/III period the stable isotope values, and therefore the dietary habits, become very homogeneous with no difference observed between males or females. Also, in contrast to İkiztepe, at Bakla Tepe females with a lower protein input were more likely to be involved in violence and have traumatic injuries on their skeletons. At Titriş Höyük differences were observed not by sex but by age, with MA having a greater protein input to their diets than YA in particular. No discernible patterns could be observed at Bademağacı, but this may be related to a small sample size more than anything. What these site-specific differences demonstrate is that there are locally explicit differences. This is not entirely surprising though; despite there arguably being an increase in cultural homogenisation in the EBA of Anatolia there would have been reasonably distinct regional/local flavours in many aspects, including dietary habits. This idea will be further explored and discussed in the rest of this chapter.

When the data for $\delta^{13}C$ and $\delta^{15}N$ of each sample site are plotted together (Figure 91) we can observe that there is not a great variation in $\delta^{13}C$ values, but more so for $\delta^{15}N$. The range for $\delta^{13}C$ values at each of the sample sites is also quite consistent as well as narrow with it being 1.5‰ at İkiztepe (-19.4‰ maximum and -20.1‰ minimum), 1.8‰ at Titriş Höyük (-19‰ maximum and -20.7‰ minimum), 1.7‰ at Bademağacı (-19.3‰ maximum and -21‰ minimum), and 1.4‰ at Bakla Tepe (-19.1‰ maximum and -20.5‰ minimum). This demonstrates a consistency in the carbon source of the dietary habits within the sample populations, even if there is some very slight variation between the sites. It is clear that the dietary habits of the people at Bademağacı and İkiztepe included a higher protein input than those at the other sites. Also, that Titriş Höyük has the lowest protein intake of the four sample sites. Bakla Tepe's $\delta^{15}N$ values sit in between these two 'groupings' but have the greatest range in values (if only by a very small amount). The range in $\delta^{15}N$ values for the respective sites is 2.7‰ at İkiztepe (10.1‰ maximum and 7.4‰ minimum), 2.1‰ at Titriş Höyük (7.9‰ maximum and 5.8‰ minimum), 2.1‰ at Bademağacı (9.9‰ maximum and 7.8‰ minimum), and 2.8‰ at Bakla Tepe (9.6‰ maximum and 6.8‰ minimum). However, despite Bakla Tepe having the greatest range in $\delta^{15}N$ values which may tempt one to suggest a greater variability in protein intake within the population when compared to the other sites, as with $\delta^{13}C$, the $\delta^{15}N$ ranges are quite consistent and narrow (all between 2 and 3‰). This actually suggests a high degree of consistency in the amount of protein intake in the dietary habits within the sample populations even if there is a noticeable difference between the sites.

These potential differences in the $\delta^{13}C$ and $\delta^{15}N$ values between the sample sites were further examined by plotting their means and standard deviations (Figure 92). Whilst this may arguably eliminate individual differences, anomalies, and outliers, it allows us to observe a clearer and more easily understood overall picture of dietary habits at the sample sites as well as for comparison. We can now very certainly see that there is a narrow range in $\delta^{13}C$ values for all of the sample sites which suggests that, despite the slight differences between the populations, overall the source of carbon in the dietary habits of the four sample sites was likely to have been very similar. The difference between the sample sites $\delta^{15}N$ values can now also be observed more definitively. It also becomes clear that the $\delta^{15}N$ values on average at Titriş Höyük are markedly different from those of the other sites. This indicates that at least in terms of protein intake there was something different happening there.

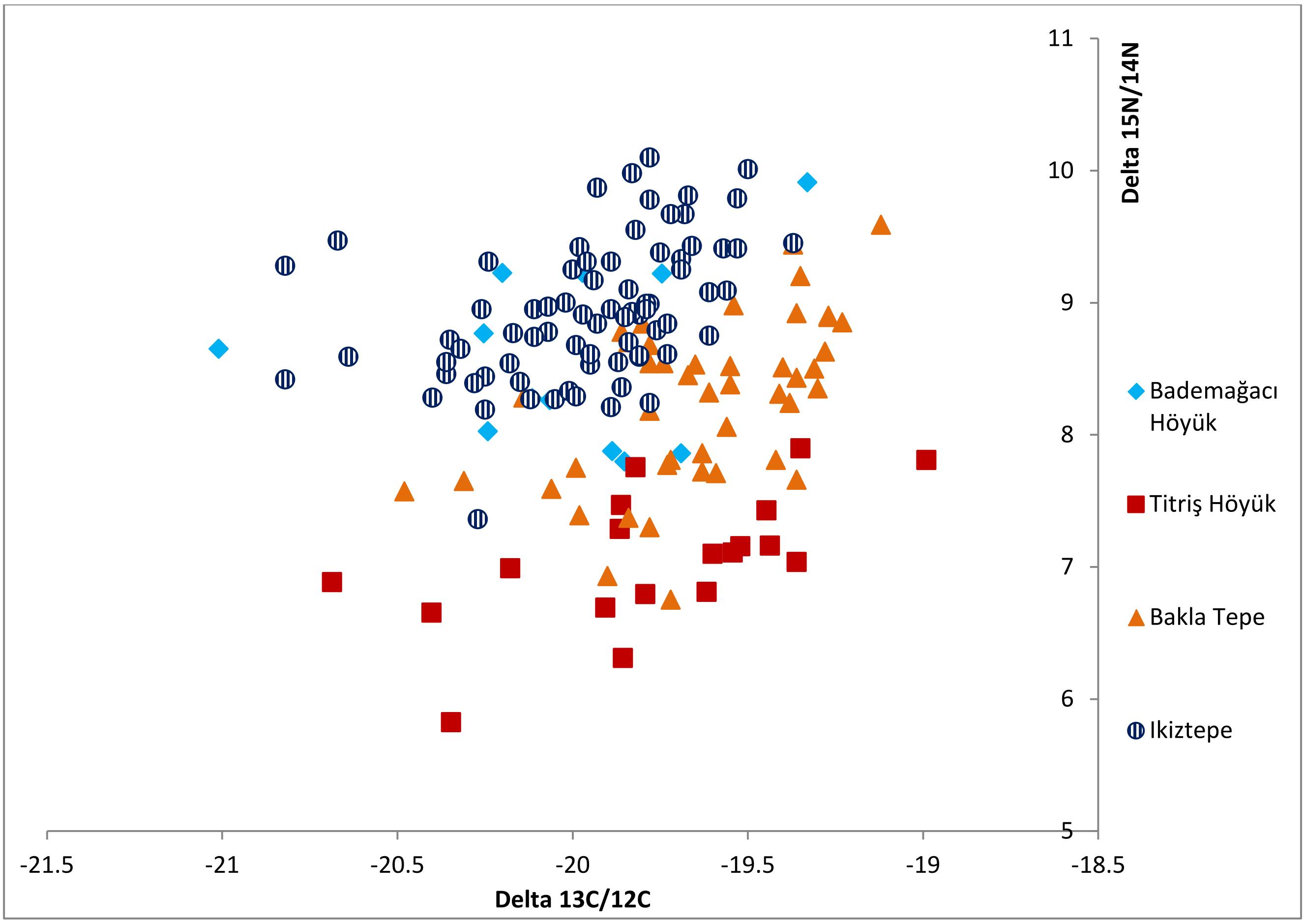


Figure 91: δ13C and δ15N values plotted for adults from all sample sites

To further test these observations, made 'by eye', statistical analyses were conducted. A single factor ANOVA was conducted on all four sample sites for $\delta^{13}C$ and $\delta^{15}N$. For carbon a strong statistically significant difference between the groups was found (p = 0.00). This is very interesting as the range of $\delta^{13}C$ values between the sites (as discussed above) is undeniably narrow. When the means are compared (-20‰ for İkiztepe, -19.8‰ for Titriş Höyük, -20‰ for Bademağacı, and -19.6‰ for Bakla Tepe) we see that between the four sites there is a range of 0.4‰ (between maximum and minimum mean). This is very small and on an isotopically insignificant scale.

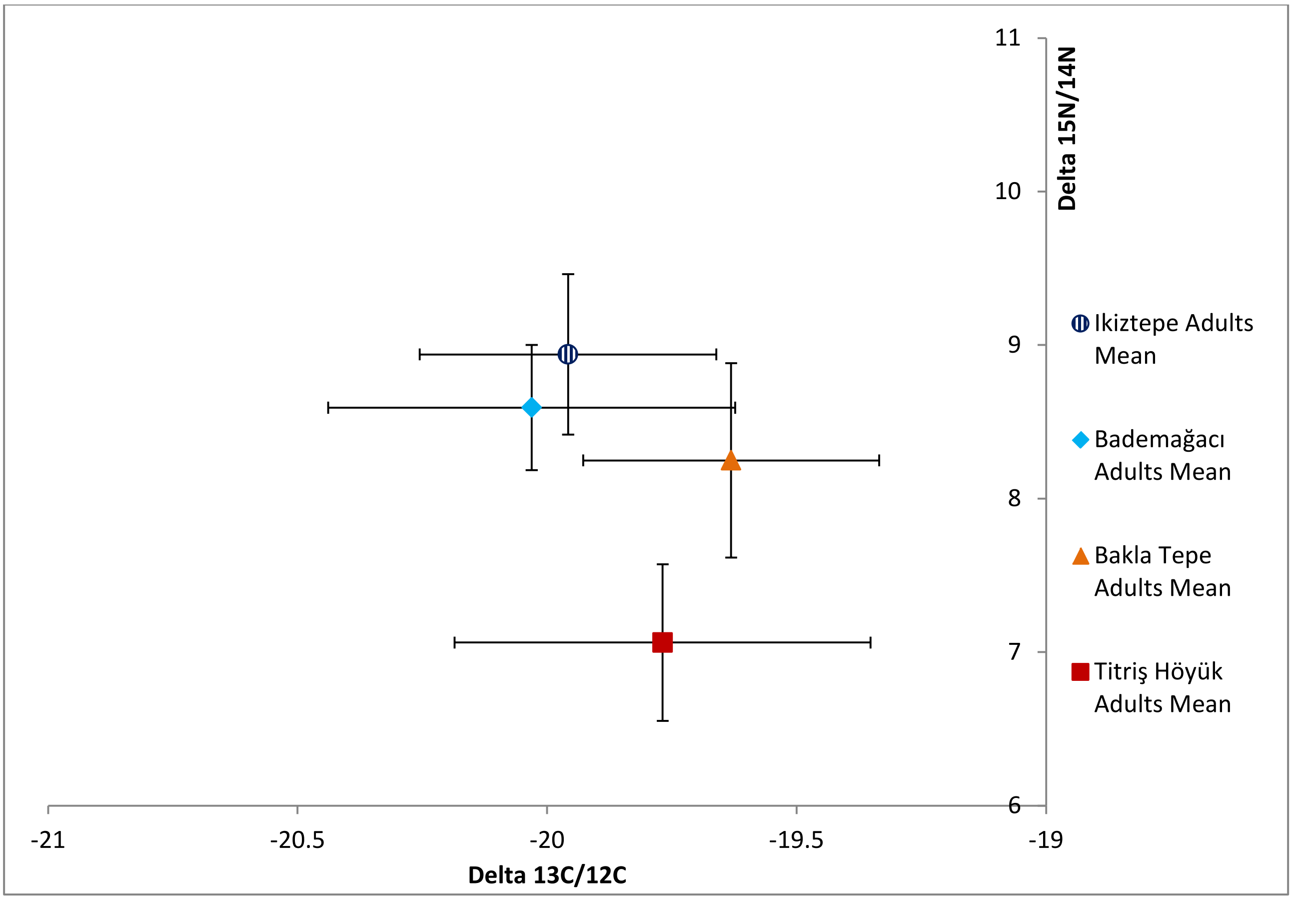


Figure 92: Means and standard deviations of δ13C and δ15N for adults from all sample sites

When we take into account all of the data points and examine them as a whole, the range is 2‰ (maximum δ^{13}C value minus the minimum). This range is on an isotopically significant scale and helps to understand the statistically significant difference. When examining the δ^{13}C data for all individuals (Figure 91), it is clear that whilst the average and majority of individuals are within a small range, which we then see more clearly in Figure 92, there are some outliers from each population which stretch out the range creating differences. So ultimately what we can say is that with regards to δ^{13}C values, and thereby the carbon source of the individual and population diets is that overall and on average they are very similar, but there are some differences individually. In other words, outliers outside of the 'normal' population range create a statistically significant difference when comparing the populations. This factor can be expressed more clearly when the data for each site's δ^{13}C values are viewed as 'box and whisker' plots (Figure 93). The 'box and whisker' plots demonstrate that whilst all four sample populations exhibit very similar means, medians, and variances, there are differences in the minimum and maximum values and outliers within each population.

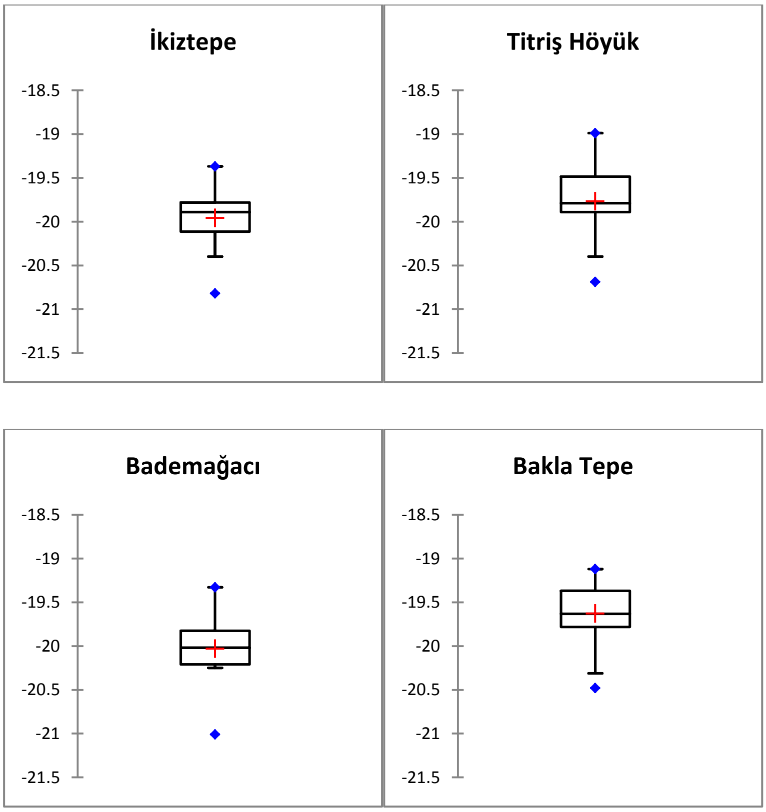


Figure 93: Box and whisker plots of δ13C values of adults from all sample sites. Numbers on scale are δ13C values in ‰

The single factor ANOVA conducted on the $\delta^{15}N$ values also uncovered a very strong statistically significant difference between the populations (p = 0.00), although as discussed earlier this could already be observed and was to be expected. The strength of this statistical difference could possibly be because of the $\delta^{15}N$ values from Titriş Höyük which as previously discussed are distinctly different to those of the other sample sites. This is because visually when the data points for all sample sites are plotted (Figure 91) and also when their means and standard deviations are plotted (Figure 92) the other three sites plot closer together, and indeed İkiztepe and Bademağacı look very similar. The similarity for İkiztepe and Bademağacı was confirmed by a two-tailed t-test which demonstrated no statistically significant difference between the two populations for either $\delta^{13}C$ or $\delta^{15}N$ (p = 0.56 and 0.12 respectively). To test if Titriş Höyük's $\delta^{15}N$ values were so distinct that they were affecting the statistical analysis a single factor ANOVA was conducted on the three other sample sites without Titriş Höyük for $\delta^{15}N$. This also produced a strong statistically significant difference (p = 0.00). Further to this when a two-tailed t-test was conducted to compare the $\delta^{13}C$ and $\delta^{15}N$ values of Titriş Höyük and Bakla Tepe no statistically significant difference was found for $\delta^{13}C$ (p = 0.20), but a strong statistically significant difference was found for $\delta^{15}N$ (p = 0.00). This demonstrates that there is actually a strong statistically significant difference between Titriş Höyük and Bakla Tepe for $\delta^{15}N$ and combined with the single factor ANOVA test reveals that for $\delta^{15}N$, Bakla Tepe and Titriş Höyük are statistically significantly different to the other two populations. This indicates that protein intake in the dietary habits of those two sample populations was different from the others. This can also clearly be observed when we compare the $\delta^{15}N$ data for the sample sites as 'box and whisker' plots (Figure 94).

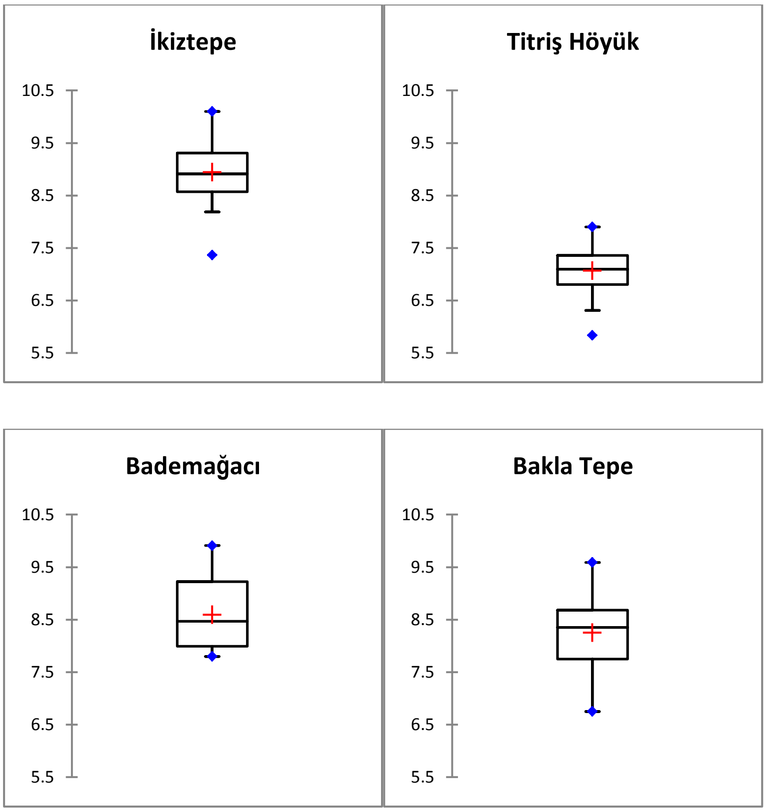


Figure 94: Box and whisker plots of δ15N values of adults from all sample sites. Numbers on scale are δ15N values in ‰

There is also a correlation observable in the data between the $\delta^{13}C$ and $\delta^{15}N$ values. This has been highlighted in Figure 95, where it can be observed that higher (more positive) $\delta^{13}C$ values correlate with an increase in $\delta^{15}N$ values. An r^2 correlation coefficient was calculated to further examine and compare the strengths of these correlations. The results were: İkiztepe; 0.4 which demonstrates a weak to moderate positive correlation, Titriş Höyük; 0.6 which is a moderate to strong positive correlation, Bademağacı; 0.2 which indicates a very weak positive correlation, and Bakla Tepe; 0.5 which demonstrates a moderate positive correlation. Therefore, the correlation between δ^{13}C and δ^{15}N values is greatest for Titriş Höyük, followed by Bakla Tepe, and then İkiztepe, with Bademağacı having the weakest correlation. Such correlations are often suggestive of marine consumption in the diet. However, as was discussed in Chapter Five, and will be discussed further below in this chapter, the stable isotope data from all of the sample populations are very indicative of a terrestrial C3 based mixed-diet. Furthermore, the population with the strongest correlation is Titriş Höyük which actually has the lowest δ^{15}N values of all the sample populations and therefore it can be confidently determined that these correlations are not the result of marine input in the diet. These correlations are instead possibly related to temperature and factors such as local climate and environmental locale. This may appear to contradict statements elsewhere about the results, where it has been indicated that the local environment and climate has little to no effect on the stable isotope values. To clarify, as will be discussed later, it should be expected that the local environment and climate likely does affect the dietary habits and subsistence practices/choices of the settlements' populations, but not in any great or drastic way and this is observed in the stable isotope data. Whilst the correlations are present, they are not particularly strong. An increase in δ^{13}C values may be to do with the location of Anatolia in the southern/south eastern part of Europe where it has been demonstrated that delta 13C isotopic values are higher than in northern Europe (Budd *et al* 2013, 862; Pollard *et al* 2007, 178). Additionally, animals in hotter drier environments have higher δ^{13}C values (Schwarcz & Schoeninger 2011, 731). Correspondingly, the correlated increase in δ^{15}N may be because in hotter environments the δ^{15}N of plants can be higher (see Chapter 3.2.2). This observed correlation may be the result of consuming C4 plants (either directly, but more probably through consumption of animals herded away from the settlements on pastures including wild C4 grasses) in a warm environment. It may also be possible that C4 plants (which have δ^{13}C values close to -10‰) also have higher δ^{15}N values, but that is not well established (M. Richards, personal communication). In general it seems as if there is a contribution of some kind of protein that has a higher δ^{13}C and δ^{15}N value, but it is subtle and hard to know definitively what it might be.

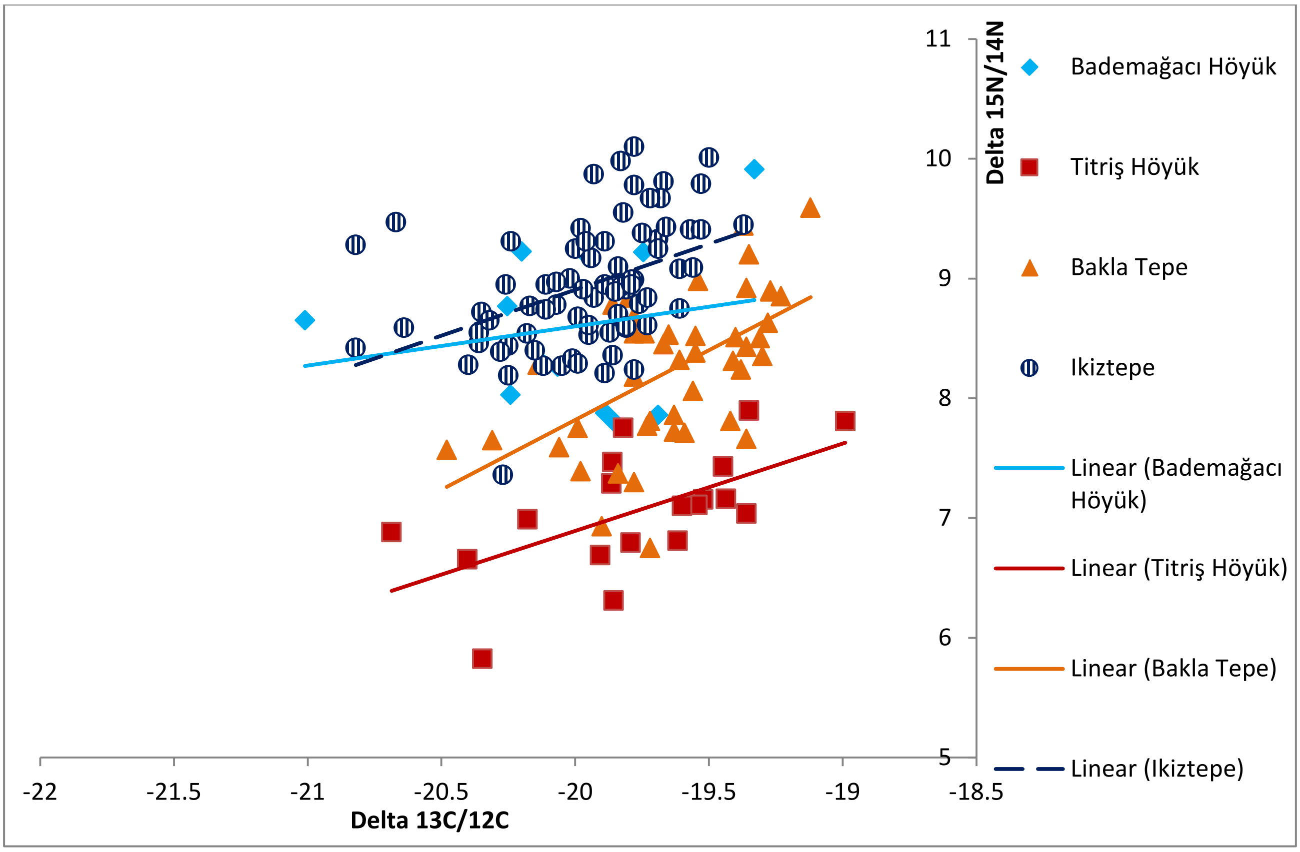


Figure 95: Linear correlation between the sample sites' δ^{13}C and δ^{15}N values

Following on from this discussion above about correlations, and as conferred in Chapter 3.2.2, δ^{15}N values can be affected by the local climatic conditions and water availability with water stress potentially resulting in elevated δ^{15}N values (Knudson *et al* 2012, 439; Stonge 2012, 37; Thompson *et al* 2005, 452). During the EBA, and especially the later EBA (i.e. end of the third millennium BC), Titriş Höyük would arguably have been the most arid of the four sample sites and its human, and animal, population would have been most likely to encounter and suffer water stress (i.e. a shortage of water). This therefore could have resulted in elevated δ^{15}N values, but as has been discussed above and further in Chapter 5.2.2, the human population of Titriş Höyük has very low δ^{15}N values. This suggests either that the hypothesised increased aridity of the region during the end of the third millennium BC (Algaze & Pournelle 2003, 126; Fiorentino *et al* 2008, 56; Kuzucuoğlu 2007, 460 & 474-476; Marro & Kuzucuoğlu, 586-587) was not as great as previously thought, and/or that people were able to cope with it so that it did not affect them much. Indeed, more recent thoughts on this episode have suggested that the 2200 BC climate event did not have uniform and clear-cut effects over all of west Asia (Abay 2007, 410; Balossi *et al* 2007, 377-378; Kuzucuoğlu

2007, 474-476; Lawrence *et al* 2016, 2 & 7; Marro 2007, 396-398; Marro & Kuzucuoğlu 2007, 585-589; Miller 2013, 252). And indeed, at Titriş Höyük itself it has been argued that the settlement would actually have been quite well watered with access to year-round water sources as there are nearby springs and the settlement was surrounded on two sides by tributaries of the Euphrates; the Tavuk Çay directly to the south, and the Titriş Çay directly to the north (Algaze & Pournelle 2003, 108 & 123). The fact that the population of Titriş Höyük has such low δ^{15}N values also means that the effects of local climatic conditions can be dismissed as a factor in the differences in δ^{15}N values between the sample populations. Thereby this means that the observed differences in δ^{15}N values are the result of differing dietary and/or subsistence practices. However, this is not to say that local climatic and environmental conditions had no impact on the availability and amount of protein intake in the diet. This may include the ability to maintain large herds of animals, the types of animals kept (for example cows will generally produce higher δ^{15}N values in consumers than sheep or goats), and the availability and use of the settlement's livestock (e.g. the livestock herd may have been primarily for secondary products as will be discussed later in this chapter, and/or that the livestock was herded over large distances in a pastoral manner, so that it was less readily available). Human influences can also have an effect on the δ^{15}N values of dietary resources and thereby the human consumer tissues, for example manuring, fertilising, and/or the tilling of the soil increase the δ^{15}N values of the soil, and thereby the plants and animals consuming those plants, and consequently human consumers of both resources (Fiorentino *et al* 2012, 328; Ingvarsson-Sundström *et al* 2009, 6). However, what does seem certain with regard to protein intake is that the consumption of marine resources played very little, if any role, in the dietary habits of all the sample populations.

The sample population from Titriş Höyük has different (lower) δ^{15}N values than the other sample populations as previously discussed. These lower δ^{15}N values would suggest a greater reliance on crops with little animal protein input in their diet. These differences, however, are not entirely unexpected as environmentally and culturally, Titriş Höyük can be considered to be different to the other sample sites. For one it is a much larger urban settlement than the others, and it has also been argued to be less Anatolian but more Mesopotamian in nature (Sagona & Zimansky 2009, 178-179). The fact that it is a much larger urban settlement with a much larger population could also be an indication for a greater reliance on crops, as visible in the dietary habits of this settlement's population. Arguably, it is easier to feed a large population with crops than animals/animal protein as livestock require more land, energy, and water resources (Pimentel & Pimentel 2003, 662). One other argument for lower $\delta^{15}N$ values is a high intake of legumes in the diet which can actually result in lowered $\delta^{15}N$ values in consumer tissues and mask the complete contribution of protein from animals not consuming leguminous plants and grasses (Ingvarsson-Sundström *et al* 2009, 3; Pickard *et al* 2016, 304; Triantaphyllou *et al* 2006, 630). It has been established that there are high concentrations of leguminous crops at Titriş Höyük (Hald 2010, 71) and this may be one factor which has contributed to the lower $\delta^{15}N$ values of this population.

One interesting factor when reviewing the stable isotopic data of the sample populations is that Bademağacı and İkiztepe plot very similarly for $\delta^{13}C$ and $\delta^{15}N$. These two sites are on opposite sides of the Anatolian landmass and have very different environmental and climatic conditions. These conditions were discussed in more depth in Chapter Two, but in general it can be said that İkiztepe is a low lying coastal settlement in an area of high rainfall and moderate average temperatures whilst Bademağacı is an inland settlement on an elevated plateau with cooler average temperatures and more seasonally distinct weather than southern Anatolia in general owing to its altitude. Their only similarity is that the areas around the settlements are believed to have been wet, and at times even waterlogged and marshy. This factor may have influenced the types of crops that could be grown and the types of animals that could be kept as well as influencing their herding and rearing strategies, and resulting in similar patterns at both settlements with regard to agriculture and agricultural subsistence strategies. This in turn would have resulted in similar dietary patterns as they would have had the same nutritional resources available, and thereby resulting in similar isotopic values for the populations. However, this is simply one hypothesis to explain the similarities; and it may actually be the result of an equifinality effect. The notions of similar subsistence practices and agricultural resources, and the effects of climate will be further discussed in Chapter 6.2 and Chapter Seven.

The analysis of dietary habits using stable isotopes in Anatolia is presently quite sparse, especially concerning the EBA period with nothing published for this time period at the time of writing. This means that currently there is nothing contemporary to compare my data with. The time period in Anatolia that is arguably chronologically the closest to the EBA with published stable isotope data is the Chalcolithic. There are two sets of published data, one from the Early Chalcolithic (5736-5635 cal. BC) cemetery at Aktopraklık in the Marmara region (Budd *et al* 2013) and the other from the Late Chalcolithic (3650-3375 cal. BC) settlement of Çamlıbel Tarlası in north-central Anatolia (Pickard *et al* 2016). The means and standard deviations of the data from these two sites are plotted alongside the means and standard deviations of the EBA sample populations in Figure 96 below. The stable isotope data from both Aktopraklık and Çamlıbel Tarlası indicate that adult dietary habits were based upon terrestrial C3 resources (Budd *et al* 2013, 860; Pickard *et al* 2016, 305) much like that of the EBA sample populations. Also of note is the fact that at Aktopraklık the dietary habits are terrestrial C3 based despite the availability in close proximity of freshwater and marine resources (Budd *et al* 2013, 865). Thus, there is a parallel and precedent for this kind of subsistence strategy in Anatolia that agrees with the analysis and interpretation of results from İkiztepe. Other parallels for coastal societies/populations not exploiting marine resources come from Mesolithic, Neolithic, and Bronze Age Grotta dell'Uzzo in Sicily, Arene Candide in Italy, and from sites on Malta and Crete (Tykot 2004, 441). This was also the case at Neolithic (mid-5th millennium BC) Varna and Durankulak on the Bulgarian Black Sea coast, where the inhabitants do not appear to have utilised marine resources, and their dietary habits were instead terrestrial C3 based (Honch *et al* 2013, 157-158). At EBA Poliochni, which is a coastal settlement on the Aegean island of Lemnos, despite fish and mollusc remains being found it has been argued that marine resources did not contribute greatly to the daily diet of the inhabitants (Cultraro 2013b, 107). In evaluating possible marine consumption at EBA Poliochni, Cultraro (2013b, 107) draws parallels with the Late Neolithic humans from Gerani on Crete and Alepotrypa on the Peloponnese where stable isotope analyses produced no evidence that fish formed part of their dietary habits despite their proximity to the coast. Parallels may now also be drawn with a settlement closer temporally in the Late Chalcolithic/EBA I inhabitants of İkiztepe. There is also a close clustering of the stable isotope data from Aktopraklık and no significant difference between males and females which indicates homogeneity in the subsistence and dietary habits of its population (Budd *et al* 2013, 864-865) which is also observed within the EBA sample populations. However, despite there being many similarities in the results there are also differences. For instance the Aktopraklık population has a very slightly higher mean (9.2‰) and standard deviation range of $\delta^{15}N$ values, although this difference is very small, and is most likely caused by the fact that one individual in the sample population has a $\delta^{15}N$ value of 10.5‰ whilst the rest of the sample ranges between 8.7 and 9.2‰ (Budd *et al* 2013, 862). Budd *et al* 2013) offer no suggestion as to the reason for this individual having a distinctly high $\delta^{15}N$ value. However, it may be hypothesised that for some reason that individual (with the higher $\delta^{15}N$ value of 10.5‰) had a higher protein intake than the rest of the population. This may be related to a factor such as different and perhaps elevated social group within the population. Also the $\delta^{13}C$ values of the Aktopraklık sample population are more typically C3 than the EBA sample populations, but again this difference is very small. The $\delta^{15}N$ stable isotope values from Çamlıbel Tarlası are very similar to those of the EBA sample populations (except Titriş Höyük) with a mean $\delta^{15}N$ value of 8.4‰ and a range of 6.9-10‰ (Pickard *et al* 2016, 300). However, the $\delta^{13}C$ values from the sample population of Çamlıbel Tarlası are distinct from those of the EBA sample populations, being slightly more positive with a mean of -19‰ although there is some overlap when considering individual values. This would suggest a difference as a result of climatic and environmental factors, or a greater inclusion of C4 plant resources in the diet, either directly or via an animal proxy. Like the EBA sample populations the stable isotope values from Çamlıbel Tarlası demonstrate homogeneity with regards to $\delta^{13}C$ but more variation in $\delta^{15}N$ values indicating that differences in dietary habits would have been related to protein intake. Pickard *et al* (2016, 305) have suggested that this variation in $\delta^{15}N$ values is related to varying proportions of animal protein and that some individuals subsisted mainly on plant foods, or that the total contribution of animal protein to the diet may be masked by the consumption of $\delta^{15}N$ depleted pulses in the diet – as suggested at Titriş Höyük and others (see below).

As well as the Chalcolithic period there is dietary stable isotope data for some other time periods in Anatolia; namely the Neolithic, the Classical-Hellenistic period, the Roman period and the Byzantine period. The data comes from several published papers on a variety of sites and locations across Anatolia (see Figure 97) including pre-pottery Neolithic (8720-7470 cal. BC) Nevalı Çori in south east Anatolia, not far from Titriş Höyük, (Lösch *et al* 2006), Neolithic (8300-7900 BP) Çatalhöyük in south central Anatolia (Richards *et al* 2003b), Classical-Hellenistic (400-200 BC), Late Imperial Roman (300-450 AD), and Middle Byzantine (800-1200 AD) Sagalassos in south western Anatolia (Fuller *et al* 2012), and Roman (100-300 AD) Ephesus, western Anatolia (Lösch *et al* 2014).

Figures 98 and 99 show the mean values with standard deviation for $\delta^{13}C$ and $\delta^{15}N$ respectively for all adults from the above mentioned sites that have dietary stable isotope data. Figures 100 and 102 have all of the data values plotted in a linear manner for $\delta^{13}C$ and $\delta^{15}N$ respectively for all adults from those sites and Figures 101 and 103 are the box and whisker plots of the data for $\delta^{13}C$ and $\delta^{15}N$, except in the instance of Sagalassos where only mean values are available. What is observable is when the data across time are plotted is that after the Neolithic periods there is much less variation in $\delta^{15}N$ values, but it is not until the EBA that a greater degree of homogeneity in $\delta^{13}C$ values is observed. The reason for the greater range and variability in the $\delta^{13}C$ and $\delta^{15}N$ values of the Neolithic is because regional differences would have been more pronounced during this period. With farming still in its infancy there would have been a greater variance in what was grown and reared agriculturally as well as a greater input of wild plant and faunal resources in individuals' diets than in later periods.

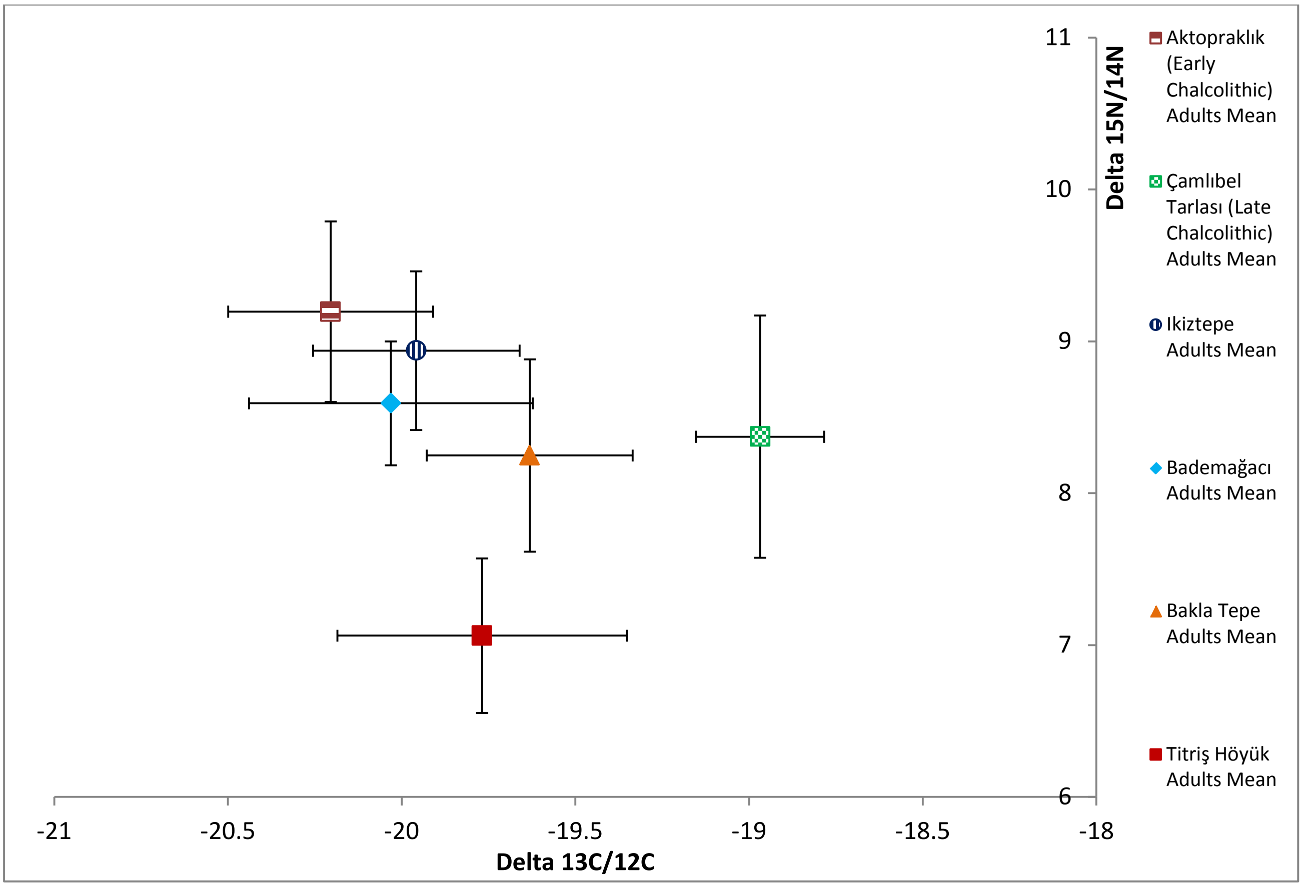


Figure 96: Means and standard deviations of EBA sample populations and Early Chalcolithic Aktopraklık (following Budd et al 2013) and Late Chalcolithic Çamlıbel Tarlası (following Pickard et al 2016)

This would result in human consumer tissue isotopic signals having a greater range and variability not only at an intra-site level, but especially at an inter-site level as it would reflect the greater range and variance of available food resources and their respective local isotopic signatures. The authors of the research of the Nevalı Çori population data have argued that the low $\delta^{15}N$ values are probably due to the consumption of leguminous pulses (Lösch *et al* 2006, 190). This argument was also used to explain the relatively (when compared with other

Roman sites) low $\delta^{15}N$ values at Ephesus (Lösch *et al* 2014, 9). I have also put forward this argument to help explain the low $\delta^{15}N$ values in the Titriş Höyük sample population.

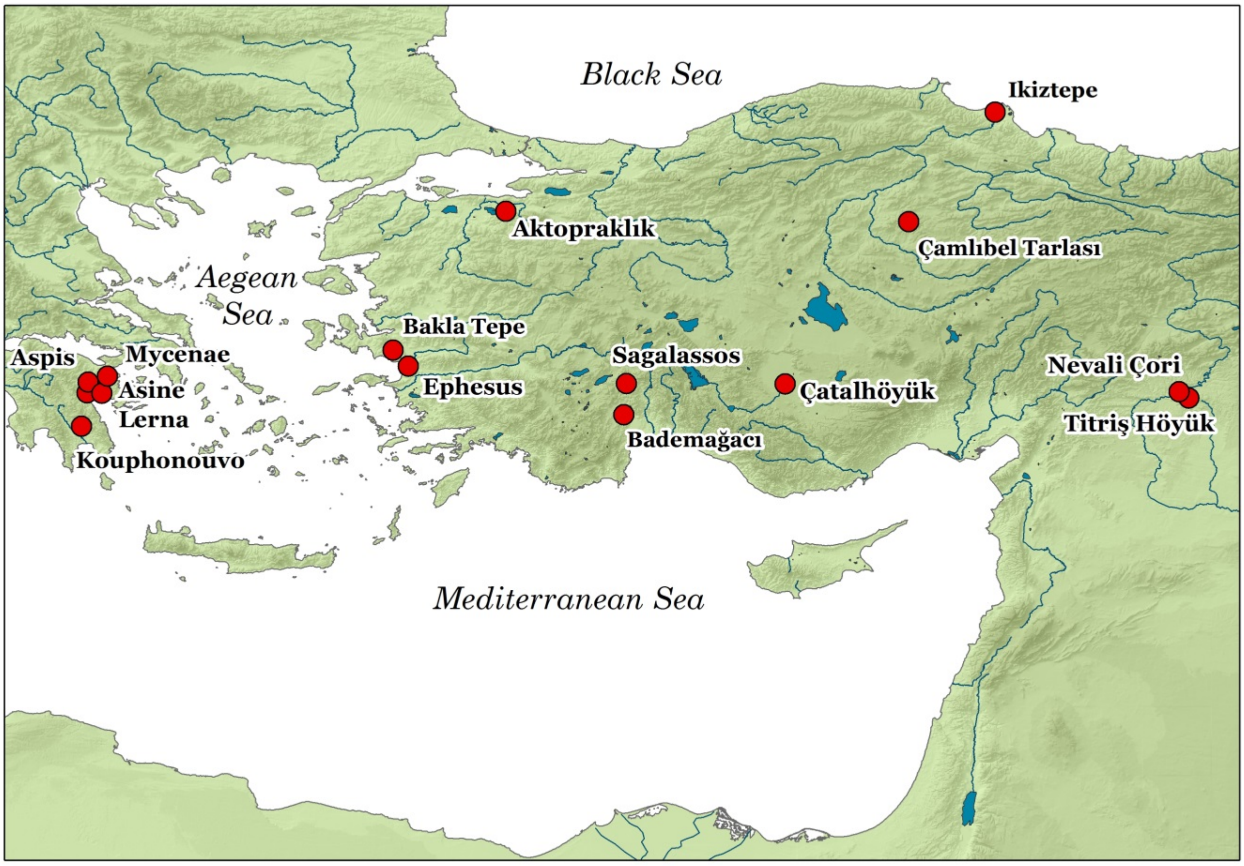


Figure 97: Map showing EBA sample sites as well as location of other Anatolian and MH Greek sites with published dietary stable isotope data. Map produced by M. Massa

This is despite the environment around Titriş Höyük in all likelihood being the most arid of the sites, where it would be expected that legumes would not have been grown so intensively due to the poor drought resistance of them and their high water needs (see discussion in Chapter Seven). However, as previously discussed above and further discussed in Chapter Seven, the effect of aridity in this region and on the settlement in the EBA III can be considered to have not been as dramatic as previously thought, and indeed the settlement itself and its immediate vicinity may actually have been quite well watered. One interesting aspect is that Nevalı Çori and Titriş Höyük are very close to each other (ca. 8km apart) and both have the lowest $\delta^{15}N$ values of all the available stable isotope data. This may indicate that this region is an 'isozone' that produces low $\delta^{15}N$ values; however, I would argue that it is more likely to be related to the dietary habits (and thereby subsistence patterns and choices) of the populations with low animal protein intake and a high consumption of leguminous plants. This is not to say that the local environment/'zone' may have influenced those subsistence strategies to some extent. The $\delta^{13}C$ values from Neolithic Çatalhöyük, Late Chalcolithic Çamlıbel Tarlası, and historical Sagalassos and Ephesus are more positive than those of the other sites and are suggestive of a C4 component in their dietary habits. For the historical periods this is not unexpected as it has been well established that in Anatolia (and across the Near East) C4 crops such as sorghum and millet became widely used as both a food resource and animal foddering from the Middle Bronze and Iron Ages onwards (Gurova 2014, 344; Nesbitt & Summers 1988, 87 & 92; Soltysiak & Schutkowski 2015, 176; Stika & Heiss 2013, 361-362). It is slightly more surprising to see this effect therefore in an Anatolian Neolithic population. However, Richards *et al* (2003b, 75) have suggested that this C4 component in the human tissues at Çatalhöyük likely came via the consumption of animals which had been consuming wild C4 plants available on grazing pastures. A similar thing can be seen and argued for in some EBA individuals, but not as distinctly as at Çatalhöyük, suggesting a more marginal consumption of animals that had consumed C4 plants. This relates to arguments in Chapter Five which reason that animals with anomalous more positive C4 looking $\delta^{13}C$ values are likely to have been herded at a greater distance from the settlement (on wild grasslands) than those with more negative, C3 looking $\delta^{13}C$ values, especially those that cluster more closely to each other. As will be further discussed in section 6.2 this may be to do with the exploitation of sheep for wool. It has been suggested that greater land requirements would have been necessary for keeping herds for wool; especially if a mixed herd management strategy was employed i.e. rearing some for wool and others for meat (Bachhuber 2015, 43). This expansive use of land could have resulted in some herds being shepherded further away from the settlement. At Tell Toqaan (Syria) it has been noted that some flocks of sheep would travel as far as 60-70km whilst the village flocks and cattle herds would stay in the village (Miller 1997, 128). A similar pattern of mixed herd management is possibly also the case in the EBA of Anatolia which explains why some of the sampled animals have differing isotopic signals. Domestic animals with similar $\delta^{13}C$ and $\delta^{15}N$ values that cluster together are evidence of those animals being herded or kept in the same areas or enclosures eating similar foods (Fuller *et al* 2012, 157). When we look at the means, and even the individual data values, it is arguably very clear that the EBA stable isotope signatures are distinct from other Anatolian populations from differing time periods. There are some similarities, especially regarding $\delta^{15}N$ values, with the Chalcolithic populations as discussed earlier, and even with later historical periods. However, with the limited available data it is clear that there is a typical 'EBA range' of stable isotope values for $\delta^{13}C$ (averaging between -19‰ and -20.5‰) and $\delta^{15}N$ (averaging between 7‰ and 10‰).

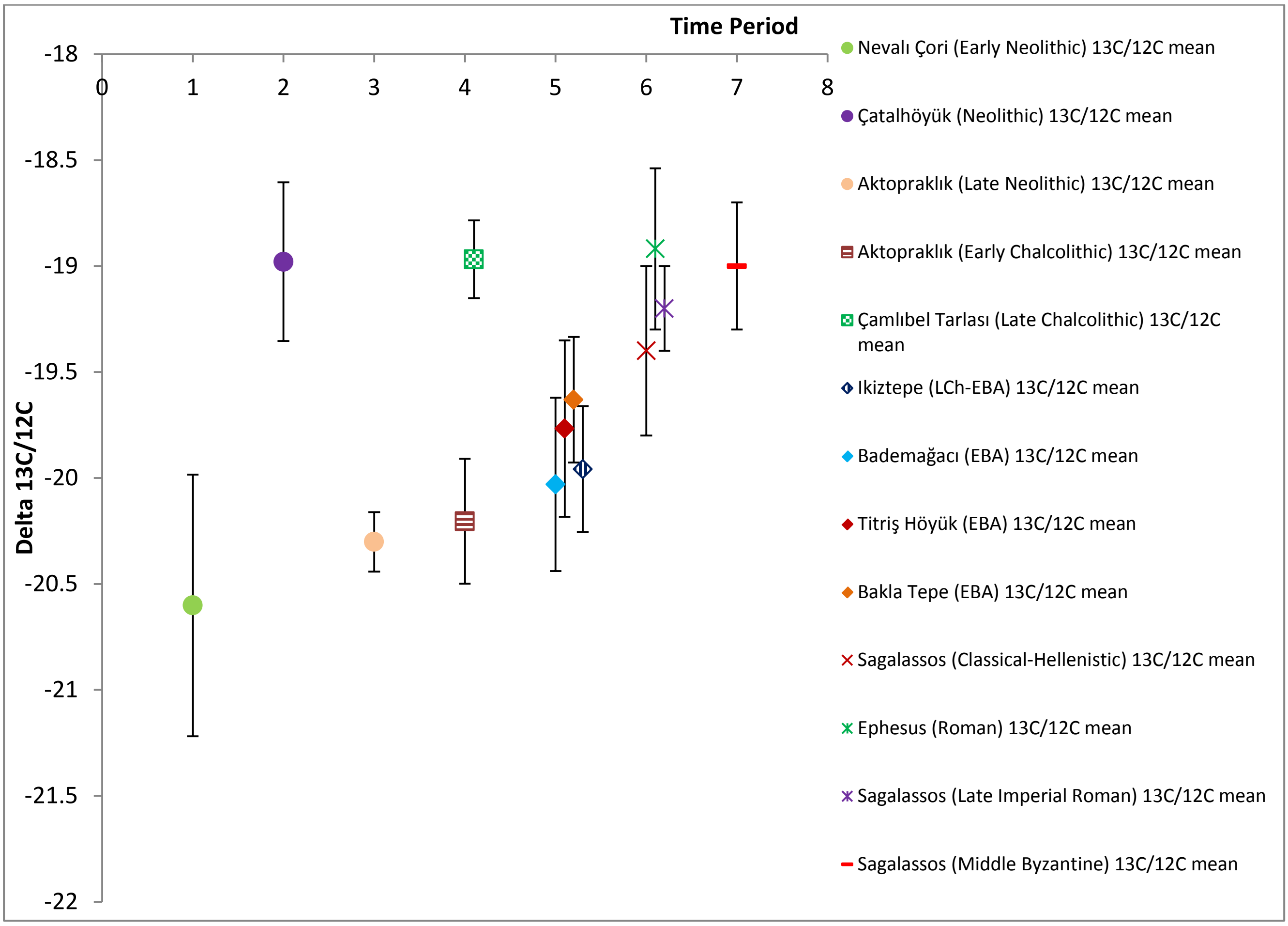


Figure 98: Means and standard deviations of δ13C values for all adults from Anatolian sites with stable isotope data (following Lösch et al 2006, Richards et al 2003b, Budd et al 2013, Pickard et al 2016, Fuller et al 2012, and Lösch et al 2014). Note: for Time Period 1 = Early Neolithic, 2 = Neolithic, 3 = Late Neolithic, 4 = Chalcolithic, 5 = Early Bronze Age, 6 = Classical-Hellenistic and Roman, 7 = Byzantine

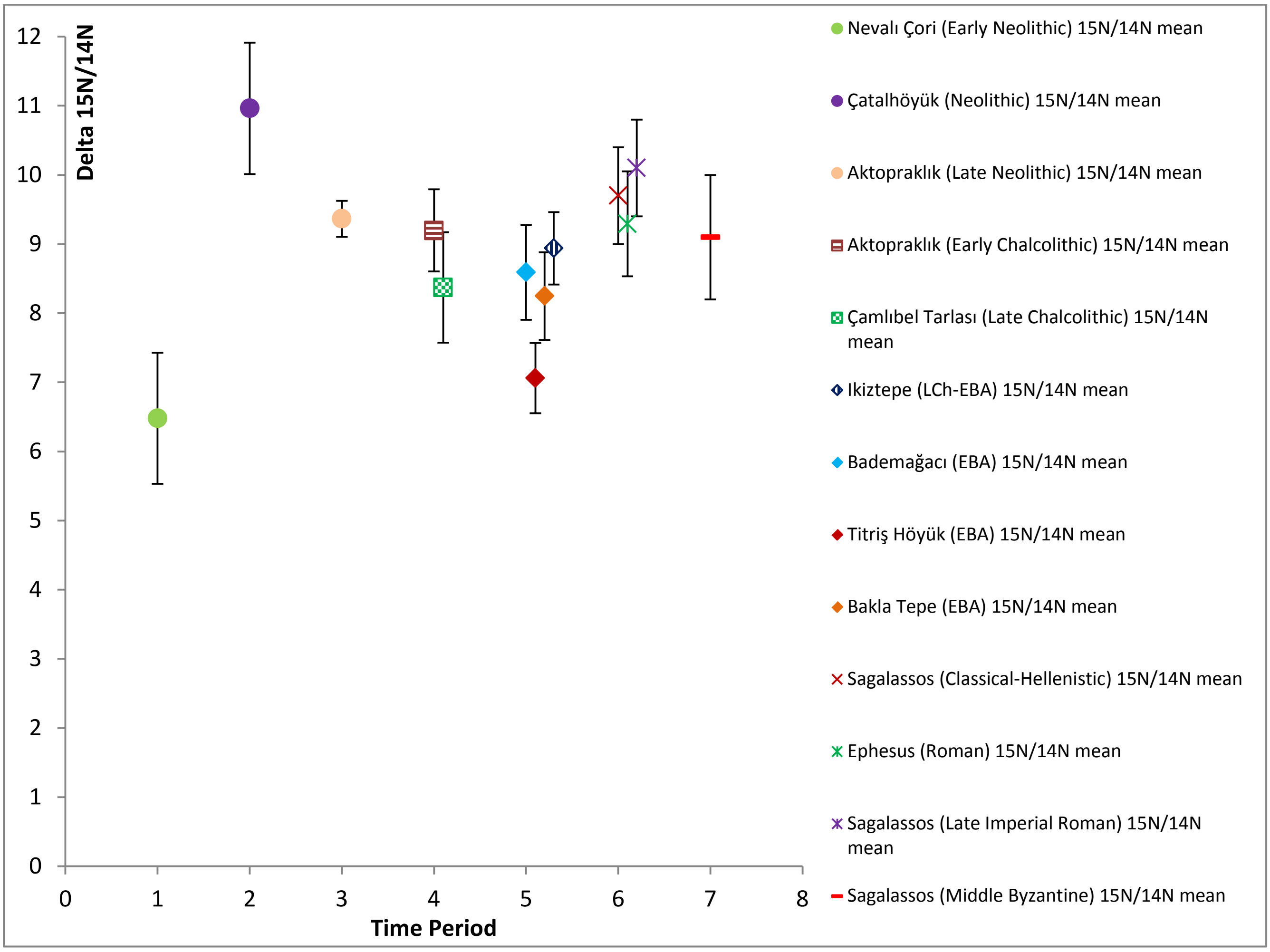


Figure 99: Means and standard deviations of δ15N values for all adults from Anatolian sites with stable isotope data (following Lösch et al 2006, Richards et al 2003b, Budd et al 2013, Pickard et al 2016, Fuller et al 2012, and Lösch et al 2014). Note: for Time Period 1 = Early Neolithic, 2 = Neolithic, 3 = Late Neolithic, 4 = Chalcolithic, 5 = Early Bronze Age, 6 = Classical-Hellenistic and Roman, 7 = Byzantine

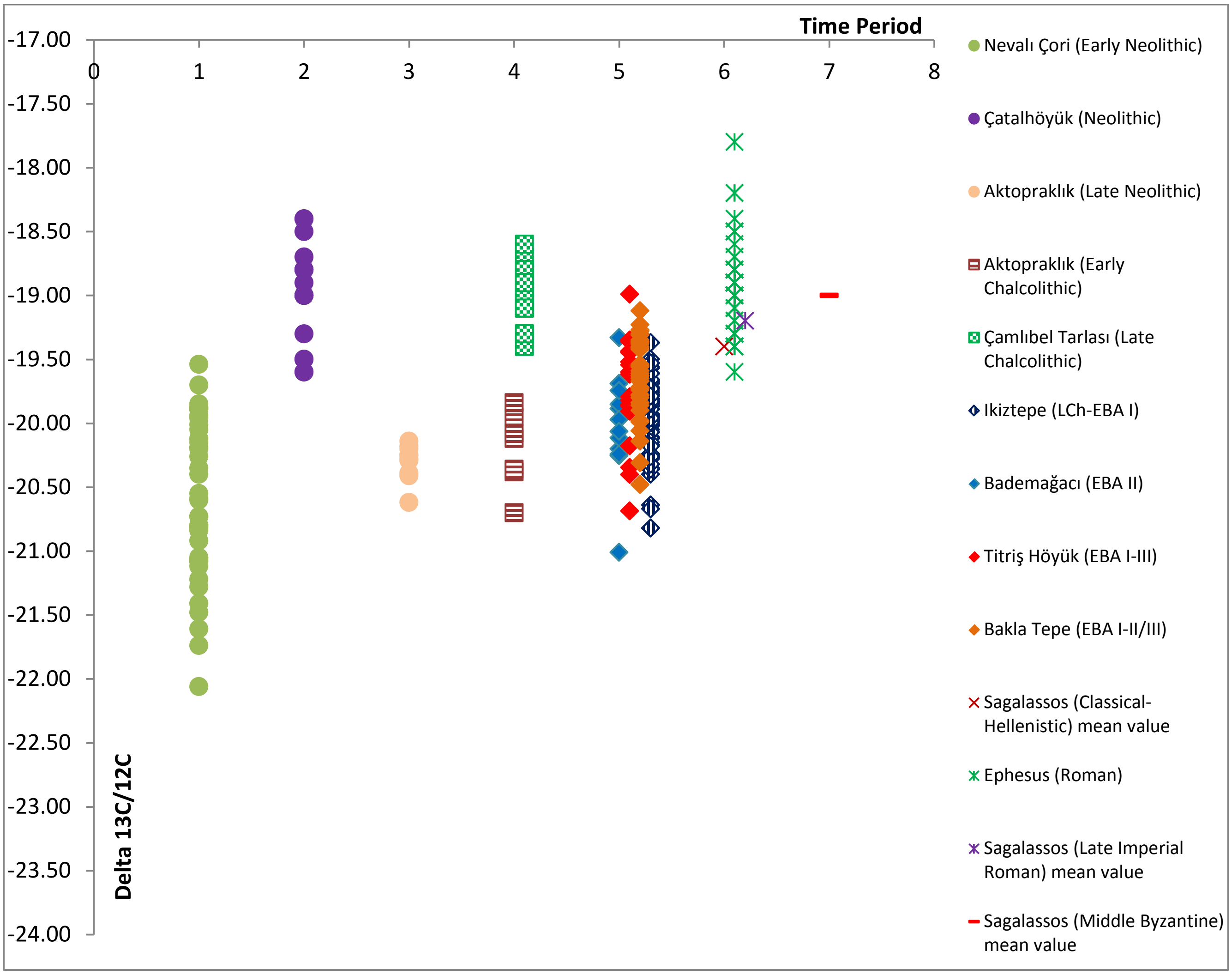


Figure 100: Stable isotopic values of δ13C for all adults from Anatolian sites with stable isotope data (following Lösch et al 2006, Richards et al 2003b, Budd et al 2013, Pickard et al 2016, Fuller et al 2012, and Lösch et al 2014). Note: for Time Period 1 = Early Neolithic, 2 = Neolithic, 3 = Late Neolithic, 4 = Chalcolithic, 5 = Early Bronze Age, 6 = Classical-Hellenistic and Roman, 7 = Byzantine

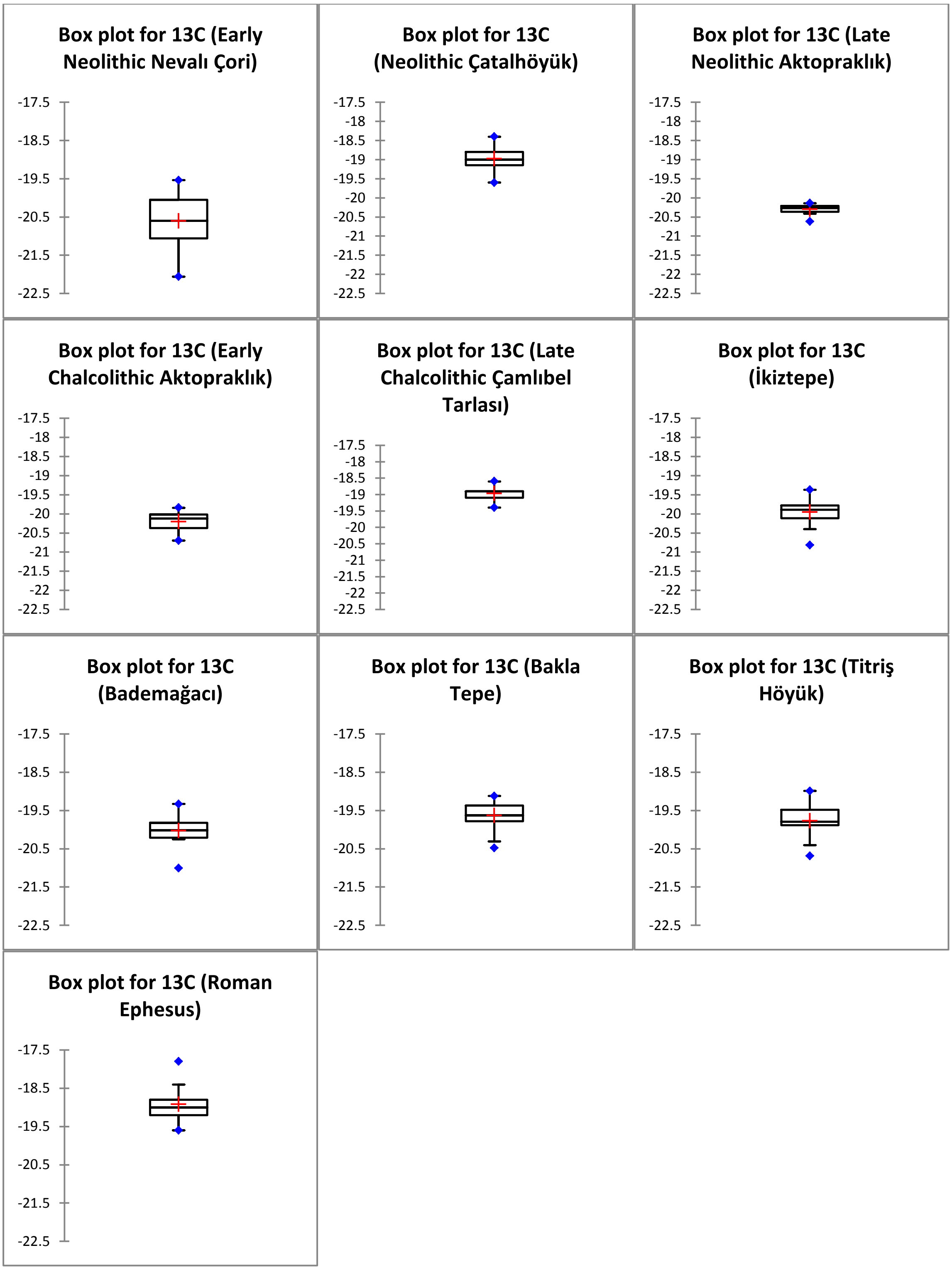


Figure 101: Box and whisker plots of δ13C values of adults from Anatolian sites. Numbers on scale are δ13C values in ‰

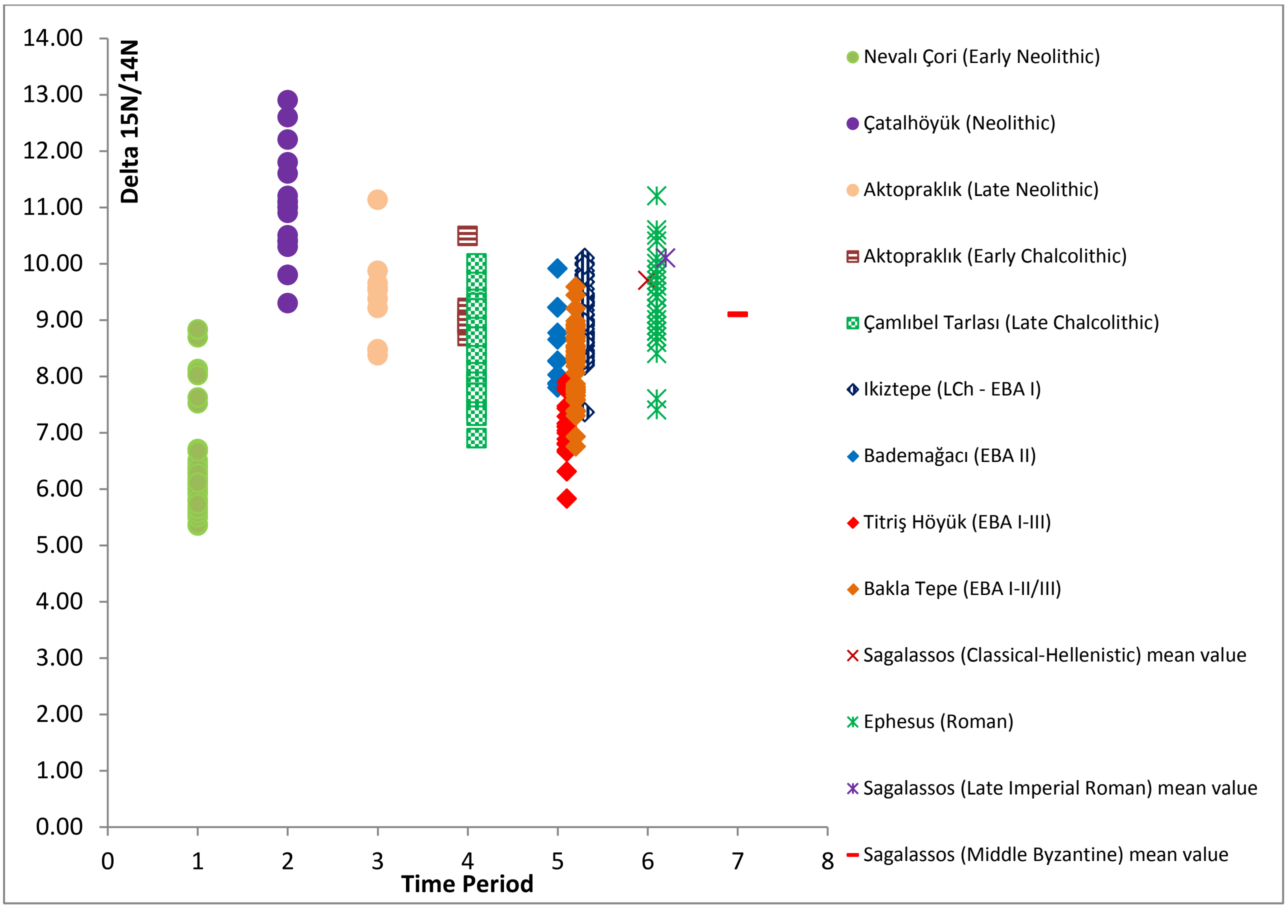


Figure 102: Stable isotopic values of δ15N for all adults from Anatolian sites with stable isotope data (following Lösch et al 2006, Richards et al 2003b, Budd et al 2013, Pickard et al 2016, Fuller et al 2012, and Lösch et al 2014). Note: for Time Period 1 = Early Neolithic, 2 = Neolithic, 3 = Late Neolithic, 4 = Chalcolithic, 5 = Early Bronze Age, 6 = Classical-Hellenistic and Roman, 7 = Byzantine

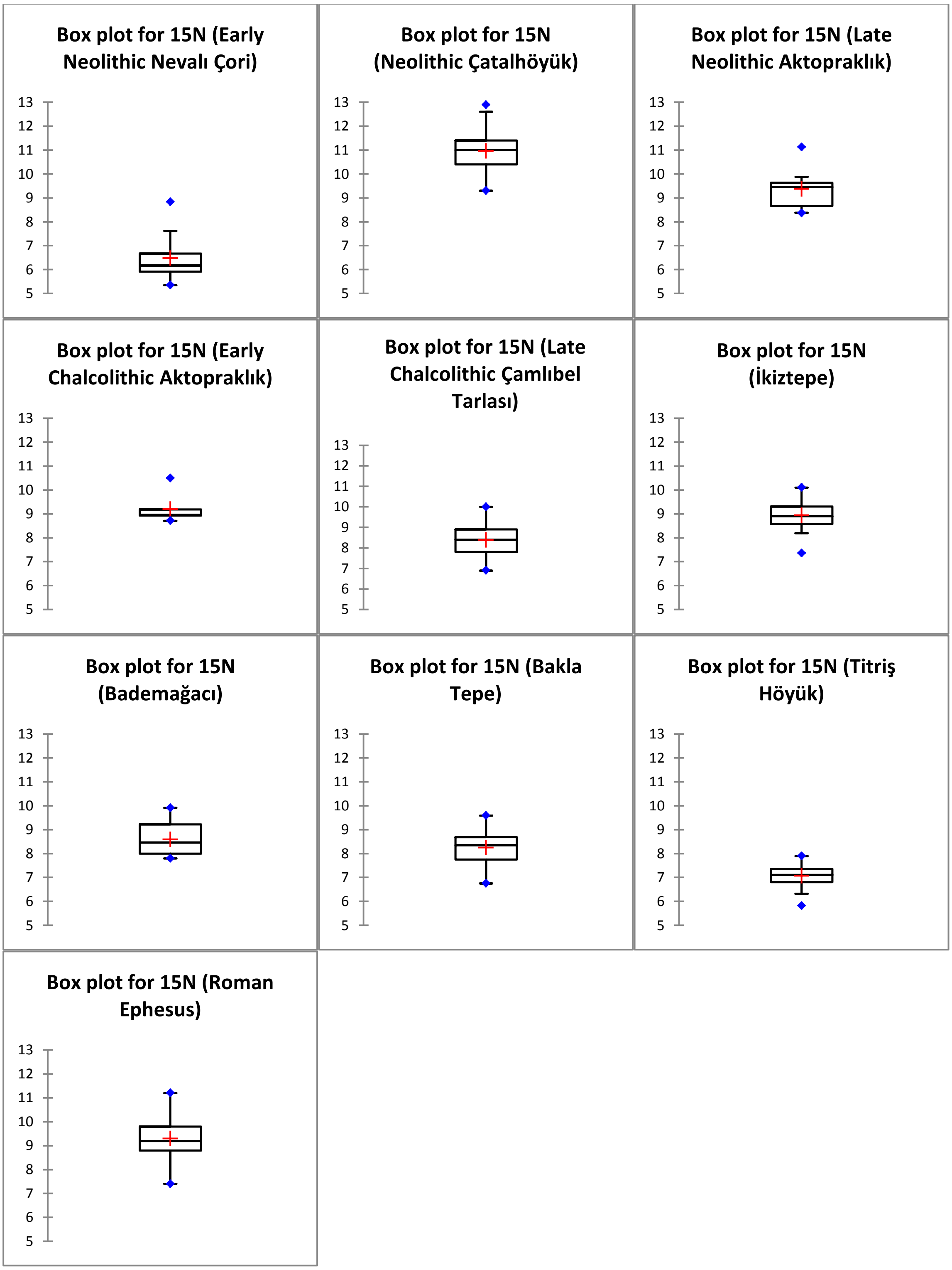


Figure 103: Box and whisker plots of δ15N values of adults from Anatolian sites. Numbers on scale are δ15N values in ‰

Overall what the results of this research demonstrate is that across the sample sites there are minor differences at an intra-site level within the sample populations. However, some of these differences are consistent throughout the data which is potentially indicative of subtle or small differences in dietary habits, but differences which were consistent throughout the population, or between social groups (sex, age etc.), over the course of those individuals' lifetimes. Furthermore, when differences are found they are more commonly with due to protein intake than to the source of carbon in the diet. At an inter-site level it can be said that there are differences in the $\delta^{13}C$ values and especially the $\delta^{15}N$ values, but with the exception of the $\delta^{15}N$ values, and those from Titriş Höyük in particular, these differences are not very large or pronounced. The low $\delta^{15}N$ values at Titriş Höyük suggest a diet rich in crops and leguminous plants, as well as low in animal protein. Differences between the sample sites were expected owing to the different environmental, climatic, and ecological regional zones of each sample site which can affect not only the stable isotope values themselves, but also have an impact on subsistence strategies, choices, and habits. Differences were also expected to be observed at Titriş Höyük compared to the other sample sites as the site is culturally, regionally, and in scale different from the others. However, what was not expected was the overall degree of homogeneity not only at an intra- but also inter-site level (when examined in the larger scale of temporal comparison). Greater differences were initially expected with greater variability between social, socio-political, and socio-economic groups within a settlement as well as between the settlements. However, this homogeneity, despite its unexpectedness, is fascinating and provokes exciting and stimulating questions which will be discussed further in 6.2 below. When plotting the EBA stable isotope results into an 'isotopic dietary habits timeline' of Anatolia and comparing them to data from other time periods we see a narrowing in the range of isotopic values in the EBA, with a lot less variability than the Neolithic in particular. They cluster together quite closely and are arguably distinctive. However, it is also apparent that there are similarities in many ways with dietary stable isotope data from the Chalcolithic. This point will be discussed further below in 6.2, but is quite a nice detail as it complements many of the other parts of the evolution from the Chalcolithic to the EBA in Anatolia where in general it can be said that in various ways the Chalcolithic is a precursor and prototype of the EBA (Schoop 2001, 30).

6.2 EBA Dietary Package

As has been shown the stable isotope results from the EBA sample populations overall cluster together in a similar range. Admittedly, as has been demonstrated, there are some small differences between groups at an intra-site level in some cases, and at an inter-site level there are also differences between the populations, notably between Titriş Höyük and the others for $\delta^{15}N$. These differences have furthermore in some cases been shown to be statistically significant, and therefore should not be dismissed or brushed aside. However, when the stable isotope values of $\delta^{13}C$ and $\delta^{15}N$ are compared with other Anatolian populations from different time periods it is clear that those of the EBA populations are relatively distinct and within a particular, more narrow range as discussed in section 6.1. There are some similarities in stable isotope values between those of the EBA and other time periods, mainly with the Chalcolithic sites, and this will be discussed further below. So whilst there are actually differences at an intra- and inter-site level in the EBA of Anatolia, when these sample populations are compared to other Anatolian populations, and on a thereby larger scale it is clear to see that the stable isotope values are relatively similar and distinct. A small deviation must be made here to discuss the issue of scale. Scale in quantitative archaeology is still equated with the 'dimensions' of time, space, and form as first put forward by Spaulding in 1960 (Lock & Molyneaux 2006, 4). More recently a fourth 'dimension' has been added, that of social form and whether the context of a study involves an individual group, community, or 'society' (Lock & Molyneaux 2006, 4). In this chapter I utilise two time scales, that of the EBA (3rd millennium BC), and an 'other', principally not EBA (e.g. Anatolian EBA compared to the Neolithic, Chalcolithic, etc.). There are also two spatial scales employed. The local one, at an intra-site, intra-population and 'local' regional level, and the other is on a larger scale across Anatolia (inter-site, inter-population, inter-/pan-regional), and to a certain extent further beyond the 'borders' of Anatolia to the Aegean and mainland Greece, and northern Mesopotamia. This is because from stable isotope analyses time scales can be variable; a single human biography may be determined, or more general and longer-term trends may also be observed (Gosden & Kirsanow 2006, 32). Ultimately, in very simplified terms these different scales are 'small' and 'large'. Time and time scales tend to only be understood by metaphors (long-time scale, short-term, the deep past etc.), but the range and compatibility of these metaphors should be better addressed and determined (Gosden & Kirsanow 2006, 35). Therefore, with this this in mind I shall employ the metaphors of 'small/smaller' and 'large/larger' when referring to scales of time and space. When utilising the 'small' temporal scale (within the EBA), a 'larger' spatial scale is also employed when examining patterns at an inter-site and inter-regional level, but within the same temporal scale. When the 'larger' temporal scale is employed (i.e. examining comparisons in dietary habits from the Neolithic to Middle Byzantine period), the 'small' spatial scale itself becomes enlarged to discuss comparison across the pan-region of Anatolia, and then even larger when examining Anatolia vs. neighbouring geographical regions. On the first and 'smaller' scale there are some differences noted in dietary habits within and between populations, but on the second and larger temporal and spatial scale the dietary habits of the EBA sample populations are more similar and distinct in their nature as observed through the stable isotope data.

The fact that when the EBA sample sites are compared to other Anatolian populations, from not only different regions but also different times (i.e. on a larger scale), they are seemingly distinct in their values has resulted in the development of a hypothesis regarding the existence of an 'EBA dietary package'. In other words, during the EBA in Anatolia (and potentially further afield as discussed further below) there was a standardised assemblage of food resources that were exploited and standardised practices regarding arable and livestock agriculture. Furthermore, that there is a narrowing in the range and variation of the exploited food resources, i.e. indicating that only certain crops were grown, and only certain animals were kept and in a certain way (Tables 12 and 13 provide a summary of the crops and livestock, respectively, at sites mentioned in the following section of text for ease of reference; both tables are ordered by chronology and then spatially from West to East). It has previously been noted from examining the faunal and botanical assemblages of EBA Anatolia that there appears to have been shared farming practices and diet, with the same types of crop and animal agriculture (Bachhuber 2015, 14 & 35). This would help to explain the relatively close clustering of the stable isotope values suggestive of a relatively homogenous diet. A study by Riehl (2014, 61) demonstrated that the crop assemblages of the EBA are dominated by barley and free-threshing wheat and are relatively distinct from other time periods of Anatolia, especially the Neolithic and Pre-Pottery Neolithic (PPN) in particular. Indeed, at some EBA sites barley dominates the crop assemblages by up to 90% (Riehl 2014, 66).

Table 12: Tabular summary of the main crops at sites mentioned and discussed in Chapter Six

Site Name	Time Period	Location	Main Crops - in ranked order	Reference
Kumtepe A	Neolithic - Chalcolithic	West Turkey (The Troad)	Lentils and Bitter Vetch	Oybak-Dönmez 2005
Korucutepe	Mid-LCh (4500-3000 BC)	East Turkey	Emmer Wheat, Barley, Lentils, Bitter Vetch, Pea, and Chick Pea	Van Zeist & Heeres 1974
Kumtepe B	LCh (3400 BC)	West Turkey (The Troad)	Emmer Wheat, Einkorn Wheat, Barley	Oybak-Dönmez 2005
Kuruçay	LCh (4th millennium BC)	South West Turkey (Burdur region)	Emmer Wheat, Barley, Einkorn Wheat, Lentil, Pea, Chick Pea, Grass Pea, and Flax	Nesbitt & Samuel 1996
Hacınebi	LCh (4th millennium BC)	South East Turkey (Şanlıurfa region)	Barley, Hulled Wheats, and Naked Wheats	Miller 1997; Stein *et al* 1996
İkiztepe	LCh – EBA (I)	North Turkey (Samsun region)	Emmer Wheat, Einkorn Wheat, Bitter Vetch, Lentils, and Barley	Ioannidou 2011; Nesbitt & Samuel 1996
Kazane Höyük	LCh - EBA	South East Turkey (Urfa region)	Cereals (mostly Wheat)	Nesbitt & Samuel 1996
Ras an-Numayra	EBA (local phase IB – 3350-2910 cal. BC)	West Jordan	Two-Row Barley, Twisted Six-Row Barley, and Emmer Wheat	White *et al* 2014
Sos Höyük	LCh – EBA I/II (3100-2600 BC)	North East Turkey	Wheat, Barley, and Naked Wheats (i.e. Durum/Bread Wheat)	Longford *et al* 2009
Sotk 2	LCh - EBA (I-II)	East Armenia	Barley, Wheat	Hovsepyan 2013

Table 12 continued

Kurban Höyük	LCh (late 4th millennium BC) – EBA/MBA (late 3rd/early 2nd millennium BC)	South East Turkey	Barley and Wheat	Miller 1997
Poliochni	EBA (I)	Northern Aegean (on the Island of Lemnos)	Glume Wheat, Barley, Lentils, and Grass Pea	Cultraro 2013b
Yenibademli	EBA	Northern Aegean (on the Island of Gökçeada	Legumes (Fava Bean, Lentils, Bitter Vetch, Grass Pea, and Garden Pea) and Cereals (Einkorn and Emmer Wheat, and Barley)	Oybak-Dönmez 2005
Troy	EBA (I-III)	West Turkey	Emmer Wheat, Einkorn Wheat, Barley, and Lentil	Riehl & Marinova 2016
Liman Tepe	EBA (I-II)	West Turkey	Einkorn and Emmer Wheat, Barley, Legumes (Lentil, Bitter Vetch, Grass Pea, and Garden Pea)	Oybak-Dönmez 2006
Dilkaya	EBA	East Turkey (Van region)	Wheat and Two-Row Hulled Barley	Nesbitt & Samuel 1996
Korucutepe	EBA (II)	East Turkey	Two-Row Barley, Wheat, Lentil, and Chick Pea	Van Zeist & Heeres 1974
Arslantepe	EBA (II – 2750-2500 cal. BC)	East Turkey (Malatya region)	Barley, Chickpeas, Emmer Wheat	Persiani 2008; Sadori *et al* 2006
Titriş Höyük	EBA (I-III)	South East Turkey (Şanlıurfa region)	Barley, Emmer Wheat, Legumes	Hald 2010
İmamoğlu Höyük	EBA (III – 2300-2000 BC)	South East/East Turkey (Malatya region)	Barley, Pea, Lentils, and Vetch	Oybak & Demirci 1997
Tell Barri	EBA (3rd millennium BC)	North East Syria	Wheat, Barley, and Legumes	Soltysiak & Schutkowski 2015

Table 12: continued

Tell es-Sweyhat	EBA/MBA (late 3rd/early 2nd millennium BC)	North Syria	Barley and Wheat	Miller 1997
Sos Höyük	MBA (2580-2340 cal. BC)	North East Turkey	Wheat and Barley	Longford *et al* 2009

At Titriş Höyük there is no difference in the variety or relative proportions of crops between households, and the assemblage is dominated by barley and emmer wheat followed by legumes (Hald 2010, 74). Also in the EBA (3600-2500 cal. BC) of the South Caucasus (Armenia) a limited range of crops has been noted, being dominated by cereal cultivation, notably barley and wheat (Hovsepyan 2015, 80). Furthermore, in this region there is a narrowing in the range of arable agriculture from a diverse range of plants in the Late Neolithic and Chalcolithic to a monotonous and specialised range of cultivated plants in the EBA (Hovsepyan 2015, 69-70). For example at EBA (ca. 3500-2500 BC) Sotk 2 (east Armenia) the botanical assemblage is dominated by barley followed by wheat (Hovsepyan 2013, 95). In Anatolia the main crops at Late Chalcolithic (4th millennium BC) Kuruçay (Burdur region) were emmer wheat, barley, einkorn wheat, lentil, pea, chick pea, grass pea, and flax (Nesbitt & Samuel 1996, 92). The main crops at İkiztepe were emmer wheat, einkorn wheat, bitter vetch, lentils, and barley, with small amounts of grass pea, pea, and flax, as well as fruits such as grape, fig, blackberry and elder (Ioannidou 2011, 257; Nesbitt & Samuel 1996, 93). At Late Chalcolithic and EBA Kazane Höyük (Urfa region) the crop assemblage is dominated by cereals, mostly wheat (Nesbitt & Samuel 1996, 95), and the botanical assemblage of EBA Dilkaya (Van region) is dominated cereals, in particular wheat and two-row hulled barley (Nesbitt & Samuel 1996, 96). At Mid-Late Chalcolithic (4500-3000 BC) Korucutepe in eastern Anatolia the botanical assemblage consists of mostly emmer wheat, and barley with lentils, bitter vetch, pea, chick pea, as well as some flax and wild grape, pistachio, and hawthorn (Van Zeist & Heeres 1974, 113-114). In the EBA (2600-2300 BC) period of the site the botanical assemblage narrows to comprise of two-row barley and wheat, with some lentil and chick pea also present (Van Zeist & Heeres 1974, 114). The botanical assemblage of late EBA (2300-2000 BC) İmamoğlu Höyük (in the Euphrates basin, ca. 15 km north of Malatya and ca. 65 km from Korucutepe) is dominated by barley (*Hordeum* L.) and domesticated pea (*Pisum sativum* L.) with minor amounts of lentils (*Lens* *culinaris* Medik.) and vetch (*Vicia* L.) (Oybak & Demirci 1997, 173-175). A Late Chalcolithic (3100-2600 cal. BC) botanical sample from the floor of a Transcaucasian house at Sos Höyük (northeast Turkey) revealed a crop assemblage with wheat, barley, and naked wheats (such as durum/bread wheat) being the most abundant (Longford *et al* 2009, 124-125). A MBA (2580-2340 cal. BC) botanical sample from a plastered rubbish pit at the same site consisted of wheat and barley, including hulled barley (Longford *et al* 2009, 124-125). In the EBA II (2750-2500 cal. BC) phase of Arslantepe a heap of charred seeds of mostly barley (71%) and chickpeas (24%), with small amounts of emmer wheat (4%) and trace amounts of peas, grapes, and lentils were found in building A607 (Persiani 2008, 170; Sadori *et al* 2006, 207 & 210-211). The same type of barley, two-rowed with symmetrical and hulled grains, as found in building A607 were also found at 3rd millennium BC Korucutepe, Tepecik, and Pulur Sakyol (Sadori *et al* 2006, 210). In the Late Chalcolithic (4th millennium BC) botanical assemblages of Hacınebi barley is the most common followed by hulled wheats (*Triticum monococcum* and *Triticum dicoccum*) and naked wheat (*Triticum aestivum* or *Triticum durum*) (Stein *et al* 1996, 107). The frequency of barley at Hacınebi is 95% and 90% for wheat, and the ratio between the two is 73%:27% (Miller 1997, 126-127). Whilst wheat and barley dominate the botanical assemblage from Kurban Höyük (south east Turkey), differences in frequencies and relative amounts of each vary slightly through time. In the late 4th millennium BC the frequency of barley and wheat is 85% and 80% respectively with a ratio of 57%:43%, in the early 3rd millennium the frequency is 95% for each with a ratio of 45%:55%, in the mid-3rd millennium the frequency is 75% for barley and 70% for wheat with a ratio of 68%:32%, and in the late 3rd millennium/early 2nd millennium the frequency is 65% for barley and 50% for wheat with a ratio of 78%:22% (Miller 1997, 126-127). This actually demonstrates that at Kurban Höyük the dominance of barley and wheat actually reduced over the course of the 3rd millennium, but that the ratio of barley to wheat increases significantly from the middle of the 3rd millennium BC. Archaeobotanical investigations from the EBA I and II layers of Liman Tepe have revealed an economy based around the cultivation of domesticated crops including cereals (including einkorn, emmer, bread, and pasta/macaroni wheats), barley, legumes (lentil, bitter vetch, grass pea, and garden pea), and small amounts of fig and grape (Oybak-Dönmez 2006, 542-543). The archaeobotanical assemblage from Liman Tepe (but especially from the EBA II period) is dominated by wheat, mainly einkorn and emmer (Oybak-Dönmez 2006, 550-553). The prominence of wheat at the settlement is further emphasised by the abundance of rye grass, which grows as a weed in wheat fields, and is indicative of open areas of land which were likely used for arable crops (Oybak-

Dönmez 2006, 544-545). The Neolithic and Chalcolithic levels of Kumtepe A (in the Troad) reveal small-scale agriculture based around domesticated legumes (lentils and bitter vetch) and fig trees, whilst during Kumtepe B (ca. 3400 BC) cultivation suggests specialisation revolving around emmer, and to a lesser extent einkorn and barley (Oybak-Dönmez 2005, 42 & 46). The archaeobotanical assemblage of EBA Troy is dominated by domesticated cereals throughout the 3rd millennium BC, specifically by emmer wheat, with other main crops including einkorn wheat, barley, lentil, fig and grape (Riehl & Marinova 2016, 324). In the northern Aegean at the site of Poliochni (on the island of Lemnos) the archaeobotanical assemblage from the EBA I period consists of glume wheat, barley (*Hordeum* v. *vulgare*), lentils (*Lens culinaris*), and grass pea (*Lathyrus Sativus*) (Cultraro 2013b, 107). The archaeobotanical assemblage from EBA Yenibademli (on the island of Gökçeada off the western coast of the Troad) is dominated by domesticated legumes followed by cereals and very few fruits and seeds of weedy taxa indicative of intensive crop production (Oybak-Dönmez 2005, 42). Cereal and legume species discovered include einkorn (*Triticum monococcum* L.), emmer (*Triticum dicoccum* Schübl.), barley (*Hordeum* L.), bitter vetch (*Vicia ervilia* (L.) Willd.), fava bean (*Vicia faba* L.), grass pea (*Lathyrus sativus* L./L. *cicero* L.), Spanish vetchling (*Lathyrus clymenum* L.), garden pea (*Pisum sativum* L.), lentil (*Lens culinaris* Medik), and clover (*Trifolium* L.) (Oybak-Dönmez 2005, 42). It has been suggested that the discovery of a cache of clover seeds in a broken jug at Yenibademli indicates that this plant was grown for fodder and this cache represents storage of seeds for sowing (Oybak-Dönmez 2005, 47). Clover has been discovered in abundance at EBA Troy in burnt animal dung, and also at EBA Liman Tepe further suggesting its role as animal fodder in the EBA (Oybak-Dönmez 2005, 47). Fruit species at Yenibademli are limited to grape vine (*Vitis sylvestris* Gmelin/*Vitis vinifera* L.), and it is probable although not certain that the seeds come from domesticated grapes (Oybak-Dönmez 2005, 42 & 47). A similar pattern to that of Anatolia in the character of botanical assemblages is also seen in northern Mesopotamia in the 3rd millennium at the site of Tell Barri (in north east modern Syria) where the main crops were wheat, barley, and legumes (Soltysiak & Schutkowski 2015, 176). This is also seen at late 3rd/early 2nd millennium BC Tell es-Sweyhat (northern Syria) where the main crops are barley and wheat with a predominance of barley with these two crops having a frequency of 100% and 60% respectively with a ratio to each other of 96%:4% (Miller 1997, 126-127). Indeed research has shown that barley was the common crop throughout the Bronze Ages of the Middle and Northern Euphrates (Paulette 2013, 102; Riehl 2009, 100). Two-rowed barley in particular has been shown through archaeobotanical evidence to be an important crop in

Anatolia, Syria, and Mesopotamia in the 3rd millennium BC (Sadori *et al* 2006, 210). The same is also true for late 4th millennium, early 3rd millennium (3350-2910 cal. BC) Ras an-Numayra in Jordan where the most abundant crops were two-row barley (*Hordeum vulgare* L.subsp. *distichum*), and twisted six-row barley (*Hordeum vulgare* L.subsp. *vulgare*), followed by emmer wheat (*Triticum turgidum* Schrank subsp. *dicoccum*) (White *et al* 2014, 365). The crops from this site were also fully processed (White *et al* 2014, 365) as similarly witnessed at Titriş Höyük for example. As was first mentioned in this discussion it is generally accepted that the main cereal crops of the Near Eastern Bronze Age were wheat and barley. Indeed it has previously been believed that the agricultural economy of the Bronze Age [Eastern] Mediterranean relied upon the triad of cash crops - cereals (wheat and barley), vine, and olive (Oybak-Dönmez 2005, 46). However, Sarpaki (1992) has suggested that this triad is actually a quartet and legumes should be included. The examination of many of the published archaeobotanical studies for the Eastern Mediterranean/Near East (Chalcolithic to) Bronze Age (as laid out above) certainly seems to support this suggestion. Legumes seem to have been an important crop, even if the ratio and frequency varies from site-to-site; as an example EBA Troy and Liman Tepe have a smaller occurrence of legumes than EBA Yenibademli (Oybak-Dönmez 2005, 46).

A note must be made here about the development of horticulture that first emerged in Anatolia in the 3rd millennium BC, namely the domestication and cultivation of wine grapes, figs, and olives (Bachhuber 2015, 36; Miller 2008, 937; Oybak-Dönmez 2005, 47). Wine seems to definitely have been stored and consumed, as suggested by pottery forms such as 'Syrian bottles' and *depas amphikypellon* (Bachhuber 2015, 36). The ethanol of wine isotopically has a C3 signal (reflecting the signal of the grapes - *Vitis vinifera*) with a $\delta^{13}C$ value of ca. -26‰ and a range of -26‰ to -24‰ for modern wines from Turkey (Christoph *et al* 2015, 5; Martin & Thibault 1995, 946). Therefore wine consumption will not have any effect in altering the observed stable isotopic signals (specifically $\delta^{13}C$ values) of the sampled populations (i.e. if they were consuming wine their isotopic values would not be different from what was discovered). This also therefore means that wine consumption cannot be determined through carbon (and nitrogen) stable isotope alone as it will be masked by domestic C3 crop consumption. Also, it has been suggested that wine consumption may have been an aspect of ritual feasting in an elite context (Schoop 2011, 34) so may not necessarily have been performed by the entirety of a settlement's population, or perhaps performed on an irregular basis.

Furthermore, it has been noted that there is homogeneity in domestic animals as well as crops (see Table 13 for a summary). In the EBA of Anatolia is has been shown that generally by weight cattle are the biggest source of protein, then *ovis/capra*, followed lastly by pigs (Bachhuber 2015, 37). However, it should be noted that this partition is made by weight, and cattle bones weigh a lot more than those of *ovis/capra*, and as shall be demonstrated below *ovis/capra* dominate in terms of frequency at many Anatolian EBA settlements.

Table 13: Tabular summary of the main domestic livestock species at sites mentioned and discussed in Chapter Six

Site Name	Time Period	Location	Main Domestic Livestock – in ranked order	Reference
Kurban Höyük	LCh (Late 4th millennium BC)	South East Turkey	Pig, Cattle, *Ovis/Capra*	Miller 1997
Hacınebi	LCh (LC B and Uruk phases	South East Turkey (Şanlıurfa region)	*Ovis/Capra*	Stein *et al* 1996
İkiztepe	LCh – EBA (I)	North Turkey (Samsun region)	Pig, Cattle, *Ovis/Capra*	Ioannidou 2011
Arslantepe	LCh – EBA I (3250-2900 BC)	East Turkey (Malatya region)	*Ovis/Capra*, Cattle, Pig	Crisarà 2013; Marro 2011; Palumbi 2010
Sos Höyük	LCh – EBA (I/II)	North East Turkey (Erzurum region)	*Ovis/Capra*, Cattle	Longford *et al* 2009; Marro 2011; Palumbi 2010
Poliochni Blue	EBA (I – 3200-2700 BC)	Northern Aegean (on the Island of Lemnos)	*Ovis/Capra*, Cattle, Pigs	Cultraro 2013b
Kurban Höyük	EBA (I-II)	South East Turkey	*Ovis/Capra*	Miller 1997

Table 13: continued

Gelinciktepe	EBA (II)	East Turkey (Malatya region)	Goat, Sheep, Cattle	Persiani 2008
Yenibademli	EBA	Northern Aegean (on the Island of Gökçeada)	*Ovis/Capra*	Oybak-Dönmez 2005
Karataş	EBA	South/South West Turkey	*Ovis/Capra*	Massa 2015
Titriş Höyük	EBA (I-III)	South East Turkey (Şanlıurfa region)	Sheep, Goat, and Cattle	Trella 2010
Tell Barri	EBA (3^{rd} millennium BC)	North East Syria	*Ovis/Capra*, Cattle, Pigs	Soltysiak & Schutkowski 2015
Korucutepe	EBA (II-III – 2600-2300 BC)	East Turkey	*Ovis/Capra*, Cattle, Pigs	Boessneck & von den Driesch 1974
Acemhöyük	EBA (III – late 3^{rd} millennium BC)	South Central Turkey	*Ovis/Capra*, Cattle, Pigs	Arbuckle 2013
Tal-e Malyan	EBA (II/III)/MBA (2400-1800 BC – Kaftari Period)	South West Iran	*Ovis/Capra*	Zeder 1991

The archaeozoological analyses performed at Titriş Höyük demonstrated that there is very little diversity in the animal taxa and was focused on the main three domesticates of sheep, goat, and cattle which account for 94.7% of all identified faunal bones (Trella 2010, 251-252). A similar pattern is also seen at EBA (2600-2300 BC) Korucutepe, eastern Anatolia, where faunal remains are dominated by domesticates (85%) and the three main domesticates which in order of frequency are *ovis/capra*, cattle, and then pigs with the ratio of *ovis/capra*:cattle being 2.2:1 (Boessneck & von den Driesch 1974, 109-110). At EBA (late 3^{rd} millennium) Acemhöyük *ovis/capra* dominates the faunal assemblage followed by cattle, with pigs being extremely rare (only 2% of the EBA faunal assemblage) (Arbuckle 2013, 56-57). At Karataş 75% of the faunal assemblage are from *ovis/capra* (Massa 2015, 104). In the latter Late Chalcolithic phases of Hacınebi in south east Turkey (LC B and Uruk phases) a similar figure is observed, with *ovis/capra* representing 72% of the faunal assemblage (Stein *et al* 1996, 108). At late 4th millennium BC Kurban Höyük pig remains dominate the assemblage with cows and *ovis/capra* having roughly similar numbers (ratio of 51%:21%:28%), however, from the early 3rd millennium BC *ovis/capra* dominate the faunal assemblage comprising 82% of the faunal assemblage in the early 3rd millennium and 74% of it in the mid-3rd millennium (Miller 1997, 129-130). The domestic triad of animals is also seen at Tell Barri where the most common domestic animals were *ovis/capra*, cattle, and pigs (Soltysiak & Schutkowski 2015, 176). This pattern is also seen in the EBA of the northern Aegean on the island of Lemnos as the main animals in the faunal assemblage of Poliochni Blue are *ovis/capra*, cattle, and pigs (Cultraro 2013b, 105). For the assemblage from Poliochni Blue some interesting details as to possible methods of animal consumption are given, with cut-marks characteristic of skinning, dismembering, and filleting being noted, as well *ovis/capra* long bone fragmentation patterns which suggest they were intentionally opened to extract the marrow (Cultraro 2013b, 106). Fish remains (mainly *Scombridae* – family of mackerel and tuna, and *Sparidae* – sea bream) and marine molluscs (*Patella sp.* – limpets, *Cardium edule* – cockle, and *Ostrea edulis* – common oyster) were discovered at EBA Poliochni, but it has been suggested that marine resources did not contribute a considerable part of the daily diet (Cultraro 2013b, 107). The preliminary studies of the faunal remains from EBA Yenibademli demonstrate the presence of at least *ovis/capra* (Oybak-Dönmez 2005, 47). At Kaftari period (2400-1800 BC) Tal-e Malyan in the Kur River Basin of Iran 94% of all identified faunal bones are from *ovis/capra* (Zeder 1991, 180). The change to a predominance of *ovis/capra* in the faunal assemblage is witnessed at Arslantepe. In the last quarter of the 4th millennium the herding strategies change with *ovis/capra* becoming predominant at the expense of cattle and pigs (Marro 2011, 301; Palumbi 2010, 151). By the first EBA I period (Period VI B1- 3000-2900 BC) of the settlement *ovis/capra* account for 70% of the faunal assemblage with a ratio of sheep:goat of 5:1, with a frequency of 18.3% for cattle, and only 1.2% for pig (Crisarà 2013, 186; Palumbi 2010, 161). There is also an unusually high frequency of dog remains (10.5%) which may indicate the presence and importance of sheep dogs (Palumbi 2010, 161). At Arslantepe, less than 10% of the faunal assemblage is made up of wild animal bones (Persiani 2008, 171). The faunal remains from nearby EBA II Gelinciktepe (less than 1 km from Arslantepe) are fairly similar, being dominated by *ovis/capra* (50% of the bone fragments), although most were probably goat, as well as small sized cattle being present (28% of bone fragments) (Persiani 2008, 171). This trend of specialised herding favouring sheep and goat at Arslantepe lasts well into the 3rd millennium BC, and the radical nature of the change suggests it was a culturally determined choice rather than an environmentally driven change as the environmental conditions remain stable and consistent (Frangipane *et al* 2009, 13; Marro 2011, 301). Whilst some have argued that this change in herding strategies at Arslantepe would be related to nomadism, the change actually occurs in Period VIA of the settlement which is exactly the time when Arslantepe appears as a major sedentary polity characterised by a centralised economy and administration (Marro 2011, 301-302). Therefore it should be considered that this change in herding practices is related to a change in economic rather than subsistence strategies correlating with the increasing demand for secondary products (i.e. wool and milk/dairy) as an important resources for internal distribution and/or commercial exchange (Frangipane *et al* 2009, 15; Marro 2011, 302). This relates well with what is witnessed at other EBA settlements in Anatolia with an increased importance in keeping animals for their secondary products and the increased importance of the textile industry witnessed, as will be discussed further below. However, at other contemporary sites in the Erzurum region a balance between cattle and *ovis/capra* is observed. At Sos Höyük *ovis/capra* account for 56% of the faunal assemblage, and cattle account for 42% of the assemblage (Marro 2011, 302). Whilst there isn't a predominance of *ovis/capra* at Sos Höyük, *ovis/capra* are the most common animals in the EBA faunal assemblage (Longford *et al* 2009, 131). However, Palumbi (2010, 159) states that the frequency of *ovis/capra* at Sos Höyük in the Late Chalcolithic was 73.6% with a sheep:goat ratio of 4:1 and this remained unchanged into the EBA I period. A reason for this discrepancy in the figures could not be found, although both Palumbi's and Marro's figures demonstrate that *ovis/capra* was the most common domesticate at the settlement. This pattern still correlates with the faunal composition of EBA sites, as the overwhelming majority of the faunal assemblage is comprised of domestic animals and especially *ovis/capra* and cattle. Pig play a very marginal role at Sos Höyük comprising only 0.3% of the faunal assemblage (Marro 2011, 302), and this means that the domestic triad of *ovis/capra*, cattle, and pig accounts for 98.3% (using the figures from Marro 2011) of the faunal assemblage of the settlement; a pattern replicated across the Anatolian (and indeed Near Eastern) EBA.

For Titriş Höyük (simply as an example as indeed this pattern is present across the EBA of Anatolia and the Near East as discussed above) this demonstrates that all households, and thereby the population as a whole, would have had access to and would have consumed the same types and proportions of plant and animal resources in their diets. This can actually be seen for all of the sample sites in Table 14 where all of the information from published resources for the main agricultural assemblage of each site has been collated. Unfortunately there is no published work on the EBA plant remains from Bademağacı, and none published for either the plant or faunal remains from Bakla Tepe. However, there is a limited indication of the agricultural produce at Bakla Tepe in an article by Erkanal & Özkan (1999, 35), and following the sampling and identification of faunal remains from grave deposits at Bakla Tepe it is clear that *ovis/capra* and *Bos taurus* were present. What Table 14 shows is that at all of the sample sites almost exactly the same species of domestic crops and animals are present, albeit in slightly different proportions. This fits in well with the idea of an 'EBA dietary package'. The idea of this package being standardised and consistent across Anatolia (and northern Mesopotamia) during the 3rd millennium BC can also be seen in the arguments of those who suggest that, at particularly the larger urban sites, the centralised authority would have required the centrally administered acquisition of agricultural produce from outside the immediate catchment area of the settlement (Hald 2010, 69). At Demircihöyük it has been argued that the storage bins would have held a considerable amount of surplus not required by the population, and one theory is that this surplus was sent to larger settlement centres (Massa 2015, 99). The storage bins at Demircihöyük have been described as granaries and the largest could hold 3800-4000 kg (Bachhuber 2015, 64). Many of the other EBA Anatolian settlements have areas of centralised storage that either indicates a redistributive system on an intra-site scale (i.e. within the settlement population), an inter-site scale (i.e. to other settlements, most likely higher up the hierarchical chain), converted into capital for exchange, or possibly several of these options. At Karataş there is evidence of centralised food storage, for example in Storage shed 71-2 which contained six storage jars, and in the EBA I-II Central Complex of the settlement (Bachhuber 2015, 74). Similar arrangements are also seen at contemporary Thermi Town I, the EBA I-II citadel of Poliochni Blue, storage *pithoi* in each of the six *insulae* of Poliochni Yellow, as well as the central building complexes of EBA I-II Küllüoba and Bademağacı containing storage bins and magazines with *pithoi*, and 600 storage jars which were recovered from the buildings of Troy IIf-III (Bachhuber 2015, 76 & 126). At Yenibademli Höyük *pithoi* containing stores of crops such as bitter hulled wheats, legumes, and barley were discovered in several buildings associated with a socio-economic organisation of the population (Oybak-Dönmez 2005, 46). These phenomena are not restricted to western Anatolia with storage jars containing barley discovered in Building ABC at Alaca Höyük, as well as later EBA III architecture at the settlement featuring granaries (Bachhuber 2015, 94). In northern Mesopotamia many of the large urban centres that emerged in the 3rd millennium BC such as Tell Leilan, Tell Mozan, Tell Beydar, Tell Brak, Ebla, and Kazane Höyük have evidence for institutional-scale grain storage (Paulette 2013, 106). Furthermore, the stamp sealed *bullae*, jars, and weights from places such as EBA I-II Karataş, EBA II Tarsus, Troy IIb, Poliochni Blue, and late EBA I-II Bademağacı suggest the use of stamp seals for recording and storing information related to the transaction of things; i.e. suggesting they were logged, organised, and (potentially) transported (Bachhuber 2015, 127). Due to a small and similar variety of agricultural produce being found at the settlements, this would suggest that *if* agricultural produce was imported from elsewhere then it was also likely to have been of the same type of produce, which in turn would suggest that these settlements providing the agricultural produce were either producing the same things themselves independently, or had been instructed to do so. If we think of this pattern being replicated across Anatolia then it is not difficult to fathom the idea of a standardised and consistent 'EBA dietary package'. Even if the agricultural produce was redistributed on an intra-site level then this would also provide an explanation as to the homogeneity of dietary habits within a population as this would mean that the population were all receiving the same types of food, probably in similar relative quantities. In addition, a low diversity of domestic animal assemblages is often indicative of a central distribution system as the central authority tends to impose some degree of standardisation on the livestock available and distributed to the population of a settlement (Trella 2010, 253). Palumbi (2010, 152) has suggested that in the latter quarter of the 4th millennium BC the move to a specialised rearing of *ovis/capra* was a general trend of the period (although specifically in eastern/south eastern Turkey and Mesopotamia). Furthermore, this movement to a sheep dominated animal rearing economy as witnessed from Uruk to Tal-e-Malyan, Šarafabad, Jebel Aruda, Habuba Kabira, Tell Sheikh Hassan, el Kowm and along the Euphrates to Zeytinli Bahçe and Hacinebi has generally been related to the establishment and consolidation of a centralised economy (Palumbi 2010, 152). In these regions (south of the Taurus) in the EBA I period these specialised rearing practices with a dominance of *ovis/capra* are consolidated and widespread and potentially managed in connection with the production of secondary products even more so than in the previous period (Palumbi 2010, 162). Whilst the sites listed immediately above are not from Anatolia (more specifically the Anatolian peninsula west of the Taurus Mountains), a similar pattern in a move to a dominance of *ovis/capra* is also witnessed in the Anatolian peninsula. Also, trade and exchange links have been established between eastern Anatolia/the Upper Euphrates and Central Anatolia and it has been suggested that these commercial trade routes may have been used for other economic purposes such as seasonal transhumance, thereby further strengthening the links between the two regions (Palumbi 2010, 157-158). This in turn may have resulted in an exchange or movement of practices, which shall be discussed further later in this chapter and in Chapter Seven. Therefore, it may be possible to argue that an 'EBA dietary package' was actually intentional, organised, and structured; a by-product of the development of urbanised, centrally planned and controlled settlements and agriculture typical of the 3rd millennium BC. The changes in livestock management are, additionally, in line with the "broader process of economic restructuring in the craft sectors, towards increasing specialisation" (Palumbi 2010, 153). Furthermore, it has been suggested that during stable environmental conditions agricultural decision-making is mainly based on economic or political grounds (Riehl 2009, 96). With the exception of south east Anatolia/northern Syria in the second half of the 3rd millennium and potentially all of the Near East at the very end/last quarter of the millennium, the climatic and environmental conditions during the EBA were relatively stable (Fiorentino *et al* 2008, 56, Riehl 2009, 94).

Table 14: Key domestic crops and livestock in proportionally ranked order from each sample site following Allentuck & Greenfield 2010, De Cupere et al 2011, Erkanal & Özkan 1999, Hald 2010, Ioannidou 2011, and Nesbitt & Samuel 1996

Site	**Key Crops**	**Key Livestock**
İkiztepe	emmer wheat, einkorn wheat, legumes (bitter vetch and lentils), barley	pig, cattle, *ovis/capra*
Titriş Höyük	barley, emmer wheat, legumes (bitter vetch and lentils)	sheep, goat, cattle
Bademağacı	Unknown – no published data	cattle, *ovis/capra*, pig
Bakla Tepe	No specialist published data but presence of emmer and einkorn wheat, legumes (lentils), and rye is noted	Unknown – no published data. Presence of *ovis/capra* is inferred through textile production and confirmed through faunal remains in grave deposits, as was cattle

What the stable isotope data demonstrate is that not all of the animals present at the sites were likely to have been (consistently) consumed. This especially true for *ovis/capra* where variation in their isotope values suggests variable herding/rearing practices and also variation in their consumption by humans (at least of the sample population; i.e. some were eaten, but not all). This is also the case for cattle at the sites (İkiztepe and Bademağacı) from which I sampled cattle remains. At these sites the stable isotope data suggests that cattle were not being consumed by humans but instead kept for other purposes. This idea, at least at Bademağacı, has been complemented by the archaeozoological work conducted. De Cupere *et al* (2011, 386) noted that the cattle remains were from older animals which suggested that they were kept not for consumption but for other purposes. Also, at Karataş 60% of the *ovis/capra* were kept until maturity (Massa 2015, 104) suggesting the exploitation of their secondary products (likely wool) rather than for primary consumption. Domestic animals are not kept in agricultural societies unless they have a purpose, the most elementary of which is consumption of their meat. Following the 'secondary products revolution' (discussed in greater depth below) domestic animals were kept for the other products they could provide without killing the animal. In the case of larger animals like cattle this could be as draught animals and/or for milk/dairy products, and for *ovis/capra* this could be for wool, hair, hide, and/or milk/dairy products. From the stable isotope data it can be observed that during the EBA period δ^{15}N values are (on average at a population level) lower than those of populations from other time periods (with the exception of early Neolithic Nevalı Çori), and this temporal 'dip' in δ^{15}N values could hypothetically be the result of animals being kept mainly for their secondary products rather than primarily/solely for consumption. The inference being that access to meat/animal protein became more controlled as a result and thereby more restricted with a greater amount of dietary protein coming from plants (i.e. crops) which have lower δ^{15}N values than herbivorous domestic animals. It has been previously hypothesised that surpluses of farming (food, alcohol, oils, and textiles) would have been converted into forms of social capital for exchange and consumption (Bachhuber 2015, 124). Thus, I would argue that *ovis/capra* would have been more important as a commercial livestock crop than for their meat in the EBA, with large herds kept for their wool and hair which could be sold raw or as a processed product such as spun wool or cloth.

Ethnographic research in eastern Turkey has demonstrated that sheep are rarely butchered for fresh meat consumption unless they are sick, and instead are kept to maturity to be exploited for their milk and wool (Çevik & Erdem 2015, 314 & 316). Indeed it has been suggested that *ovis/capra* rearing for EBA societies may have been a "structural activity underlying their social and territorial organisation" (Palumbi 2010, 162). From the huge amounts of spindle whorls found at places like Troy (II-III) for example it seems evident that textile production was surplus to local needs and instead was involved in trade (Massa 2015, 205). A surplus of woollen textiles would have been manufactured for export (Bachhuber 2015, 139). It is well known from written records that in the late fourth millennium and third millennium of Mesopotamia and late third millennium of Mesopotamia and Anatolia wool and woollen textiles were important commodities and that huge herds of sheep and goat were kept predominantly for their wool and hair and viewed as an important livestock crop with economic value (Arbuckle 2014, 211 & 214; Bachhuber 2012, 585; Bachhuber 2014, 149; Massa 2015, 201; Trella 2010, 143 and 246). Indeed in the MBA, Anatolian citadels (i.e. the ruling elites of settlements) invest a lot of economic and social capital in woollen textiles (Bachhuber 2015, 138). From the tablet archives of Ebla it is known that places like Ebla and Carchemish were involved in the regional exchange of textiles in the 3rd millennium BC, and this was possibly also the case in Anatolia (Bachhuber 2015, 138). I would certainly suggest that this practice was already present in the EBA in Anatolia and performed on a scale equal to that described in later periods. It now seems to be evident that there is greater continuity between the EBA and MBA than previously thought (Marro 2011, 304; Massa 2015, 89), and this may be an example of this continuity. Indeed Bachhuber (2015, 136) has already suggested that the ascendance of citadels (i.e. elites) in the EBA I-II to EBA III transition was bound up in the production, exchange, and consumption of wool and woollen textiles. This is not to say that livestock were not eaten at all, the cull patterns at 3rd millennium BC Gritille in south east Anatolia close to Titriş Höyük indicate that *ovis/capra* were most likely kept for their meat (Stein 1987, 108), and at late 4th to early 3rd millennium BC Sos Höyük the cull pattern suggests a mixed strategy of meat and secondary products, perhaps even geared towards the production of meat (Palumbi 2010, 159). Indeed much of the stable isotope evidence (as seen in Chapter Five) suggests that protein came predominantly from *ovis/capra* in the 3rd millennium BC. However, I would argue that the herd sizes of *ovis/capra*, especially at larger settlements (Gritille is a village and likely a 'satellite' settlement) were surplus to the requirements for subsistence alone and that they were viewed as an important commercial crop.

It is much more labour intensive to fodder animals than it is to let them graze (Miller 1997, 128). It is also expensive, in terms of the amount of food needed rather than financially, to fodder animals. Over a period of four months the amount of fodder per head of cattle kept in a stable is ca. 7-8 tonnes of hay/straw and 600-700 kg of barley, and for a sheep/goat it is 150 kg of hay and 10 kg of barley (Çevik & Erdem 2015, 313). However, if the local landscape is covered by agricultural fields (as would have been the case at most EBA sites) careful control would have to be exercised over where animals roamed and it is likely that flocks may have been stable-fed (Miller 1997, 128). In these cases the cost of herd management must be offset by the value of the herds (Miller 1997, 128). In the stable isotope data of sampled animals from the EBA sample sites it seems to be apparent that there is some variety in the food sources of the animals (notably *ovis/capra*) which may be indicative of different herd management practices (i.e. differing ranges of herding and/or feeding/foddering). If it can be suggested that certain flocks were foddered/stable-fed then this would suggest that either the value of those flocks offset the cost of their/or another flock's management. In the context of the above discussion it may therefore be suggested that this value was their wool (and the resulting woollen textiles). Additionally, Miller (1997, 128; 2013, 251) has suggested that in the Near East barley is grown primarily for fodder. Thereby the dominance of barley in EBA botanical assemblages, as discussed above, may reflect this increased need for fodder for supporting the presence of high value flocks. I would suggest, however, that as barley occurs in such great frequencies it would not have been grown for fodder alone, but also consumed by the human populations. At 3rd millennium BC Malyan in south west Iran, carbonised barley grains were found in a latrine as direct evidence of human consumption (Miller 1982, 238). Modern barley typically has a $\delta^{13}C$ range of -28‰ to -25‰ (Riehl *et al* 2014, 12348). Following the fractionation effects resulting in enrichment (as discussed in Chapter 3.2.1), direct consumption of predominantly barley should result in human collagen $\delta^{13}C$ values of ca. -26‰ to -21‰. The actual range of $\delta^{13}C$ values for all of the sample populations combines is -21‰ to -19‰. Whilst this may actually seem to suggest that barley was probably not consumed directly in large proportions, these values would be accurate only if an individual had consumed almost exclusively barley during their lifetime and it must be remembered that the $\delta^{13}C$ values given are for modern plants and ancient crop plants will likely have differed slightly. In addition, the $\delta^{13}C$ values may have been affected by regional climatic and environmental differences, and in a mixed diet (which all of the sample populations practised) the effects of consuming other plants with varying $\delta^{13}C$ values as well as animals that may have consumed C4 plants with more positive $\delta^{13}C$ values will result in varying $\delta^{13}C$ values of the human collagen. Therefore, it is difficult to definitively say whether barley was consumed, but as argued, it would seem probable. Barley (and especially two-row barley due to its high starch content) may also have been consumed in the form of beer (Cultraro 2013b, 110; Miller 1982, 236; Miller 2013, 251). Textual evidence from Mesopotamia suggests that beer played an important role in Mesopotamian society being drunk during ritual events and feasts, as well as in private households and taverns (Paulette 2013, 102). Furthermore, the textual evidence also suggests that there was a shift from food to drink in the use of barley between the mid-3rd millennium BC (Sargonid Period) and the late 3rd to early 2nd millennium BC (Third Dynasty of Ur) (Miller 1982, 236). This may also have been the case in Anatolia, as it is generally agreed that the consumption of alcohol became an important (ritual) activity in the 3rd millennium BC (Bachhuber 2014, 143-144; Cultraro 2013, 179; Massa 2015, 144; Schoop 2011, 34; Şahoğlu 2005, 354; Ünlü 2016, 346). However, most scholars have regarded wine to be the alcohol in question (Bachhuber 2012, 583; Bachhuber 2015, 155; Cultraro 2013, 179; Miller 2008, 944). Beer is attested more frequently than wine in Hittite (MBA and LBA) texts, but as a less exclusive beverage (Bachhuber 2012, 583; Bachhuber 2015, 131). The production and consumption of beer seems to be attested through residue analysis of ceramics in the EBA of mainland Greece and the Insular Aegean (Cultraro 2013b, 110). Cultraro (2013, 179; 2013b, 110) also suggests that from EBA Poliochni (on the island of Lemnos) a barrel-shaped ceramic vessel may have contained fermented liquids based on milk and honey/mead, and that large shallow ceramic bowls with holes pierced round the rim and with a solid vertical handle may have been involved in the fermenting of beer. However, so far no evidence of brewing has been found or suggested in the EBA of Anatolia. For example, at Arslantepe Sadori *et al* (2006, 210) specifically mention that despite the large concentrations of barley found in the EBA II layers of the settlement there is no evidence for beer brewing as the barley caryopses were not germinated and there is no evidence of beer-flavouring plants. Nevertheless, this absence of evidence does not mean that beer and brewing did not exist in Anatolia. Owing to the exchange network connections across the Eastern Mediterranean and Near East (see Chapter 1.2, later in this chapter, and Chapter Seven) during the 3rd millennium BC and that beer production and consumption has been attested on the southern and western frontiers of Anatolia and in the following millennium, it would seem unlikely that beer was not produced or consumed in the Anatolian EBA.

One may counter-argue the above points about variable consumption of domestic animals, and *ovis/capra* in particular. Specifically it could be argued that the reason for observing non-consumption of domestic animals at the sample sites may simply be the result of not sampling the entire dead population of the settlement and thereby missing important sets of data. It can also be argued that even if animals were not kept primarily for consumption, what would happen when they died? Were they not consumed and was good meat simply wasted? Of course these are both valid points and should be addressed. Due to the fact that at each of the sample sites there is a relatively narrow range of isotopic values, it can be argued that if every individual of the settlement's dead population was sampled there may be more outliers, or even groups of outliers, but in general it would be expected that the majority of sampled individuals would have stable isotope values which would plot closely around the population mean and within the average population range. Therefore, the data from the sample populations provide a very good indication of the stable isotope values for the entire population and therefore their dietary habits. It may also be that different groups within the populations varied in the way they consumed meat. For example elites may have consumed more meat over a lifetime, but on an infrequent time-scale such as in feast contexts. Due to the averaging effect of dietary inputs in human collagen (see below) this would not be observable in the stable isotope data. Also, the patterns of animal protein consumption cannot be observed; i.e. if elites ate better cuts of meat or if certain groups consumed greater proportions of milk/dairy resources than those who relied more on meat. This is because, as determined in Chapter Three, stable isotope ratios provide the relative proportions of food resource (e.g. protein) intake but cannot pinpoint specific 'meals'. With regards to the second point, of course animals that died were probably eaten, and indeed in all probability cattle and *ovis/capra* were consumed more than the isotope data suggests. This is partly due to the relatively small numbers of faunal samples. A larger sample population (i.e. more faunal samples = more animals) of a greater range of species would result in more data, which means a bigger data cloud to draw interpretations and conclusions from. This means that conceivably more animals than currently would plot in the 'consumed' range, perhaps even a majority of the faunal sample population from a settlement. Also, the averaging effect of stable isotope values within human collagen would mean that if animals were infrequently consumed (such as when they died, rather than being systematically butchered for consumption) this would not show up in the stable isotope data. This would also be the case for specific 'small' scale periods of consumption, such as feasting which it has been argued became an important activity in the EBA although probably restricted to elites (see discussion in Chapter 1.2, and also above about elite consumption of meat). However, this averaging effect and thereby the absence of specific 'meals' of animal consumption supports the argument for variable and infrequent consumption of those animals. Therefore, overall, it would appear safe to suggest that there was an infrequent and variable consumption of some domestic animals (namely cattle and *ovis/capra*) and that this is likely related to the exploitation and use of them for their secondary products rather than their primary ones like meat. It was discovered at Banesh period (3400-2800 BC) Tal-e Malyan in the Kur River Basin of Iran that the utilisation of sheep for dairy products and woollen textile production would have reduced the supply of sheep for meat provisioning (Zeder 1991, 163). This is because by delaying the age of culling to ensure secondary product exploitation the caloric value of their meat would have been reduced (Zeder 1991, 163-164). A similar limitation is true for cattle as well. The production of cattle primarily for meat is not compatible with one that exploits cattle as a draught animal, and therefore if cattle are primarily used as an animal for labour then the supply of cattle for meat will be limited (Zeder 1991, 165).

The idea of the 'EBA dietary package', at least in terms of domestic livestock, goes hand-in-hand with the idea of the 'secondary products revolution' as touched on above. The idea of the 'secondary products revolution' was first put forward by Andrew Sherratt in the early 1980s (1981 and 1983) and is arguably as significant as the primary stage of domestication and provided another package of economic, cultural, and technological changes (Greenfield 2010, 29; Sagona & Zimansky 2009, 212). The use of animals for draught power enabled new techniques in cultivation (i.e. the plough), and in combination with the domestication of the donkey, increased mobility thereby increasing the range and productivity of trade and exchange networks, and in conjunction with the wheel revolutionised transport and warfare (Arbuckle 2013, 58; Greenfield 2010, 30; Massa 2015, 71 & 89; Sagona & Zimansky 2009, 211-212). Donkey and/or mule remains have been tentatively identified at EBA I-II Küllüoba and EBA I-II Kaman Kalehöyük (Bachhuber 2015, 40). This animal driven increase in mobility also played a part in the construction and establishment of permanent routes and roads of communication across Anatolia (Bachhuber 2014, 140; Massa 2015, 153; Zimmermann 2007b, 65-66, 68, & 72). The exploitation of wool and hair diversified the textile industry expanding the range of material culture (Arbuckle 2014, 213; Greenfield 2010, 30; Sagona & Zimansky 2009, 212; Trella 2010, 143). In turn the use and application of secondary products in conjunction with new technologies, enhanced farming techniques, and increased mobility allowed elites to develop and further increase their control of power and wealth (Bachhuber 2014, 151; Sagona & Zimansky 2009, 212). For example, texts from Ur III demonstrate the presence of 'royal flocks' suggesting central control and regulation of herds, especially when combined with the demand for wool and the important and burgeoning woollen textile industry, which would further the implication that a greater level of state control existed over flocks, and specifically those of wool-producing sheep (Zeder 1991, 27-28). Zeder (1991, 28) suggests that the overall management of these flocks would have been of little concern to the Ur III administrators, however, they would have had ownership of these herds, control of the lands for pasture, and had the right to take caprids from private herders, and it is these factors which would have allowed elites to develop and further increase their control of power and wealth. Cattle, which require more water and fodder than *ovis/capra* and are therefore more likely to have been kept in closer proximity to settlements, are more likely to have been centrally controlled (Zeder 1991, 29). Indeed, textual evidence from Ur III implies that cattle herding was an important activity conducted closer to the settlement and with a greater degree of administrative control, than caprid herding with a hierarchy of specialists - breeders, stable chiefs, stewards, and a 'Minister of Livestock' (Zeder 1991, 29-30). This is especially true in instances when cattle are kept as draught animals, as they require more complex and specialised management practices such as foddering and stabling (owing to them being kept in close proximity to the settlement) as well as keeping a higher proportion of castrated males alive for longer – i.e. managing culling strategies (Zeder 1991, 29). At Titriş Höyük though, it has been suggested that cattle were kept on a household level and thereby independent from the state (Allentuck & Greenfield 2010, 14-15; Trella 2010, 256). This is not to say the two may be exclusive, cattle may have been kept at a household level (one or two cows to provide milk/dairy products for a family/social/kin group), and also centrally controlled to provide animals for draught power. Evidence for the use and exploitation of animal secondary products in Anatolia suggests that its significant intensification began about 3500 BC (Arbuckle 2014, 213; Sagona & Zimansky 2009, 210). This included the exploitation of cattle for milk products as well as traction and as a beast of burden, as well as exploiting sheep for milk and selectively breeding them increased the growth of their woolly layer (Greenfield 2010, 35 & 39-40; Sagona & Zimansky 2009, 210). Widespread and intensive wool production in Anatolia has been dated to the mid-fourth millennium BC and has been indicated by the sharp increase in the number of bronze clothes pins which are more suited to open weave woollen garments than linen clothes spun from flax with a dense weave and leather items, the increased number of older sheep in faunal assemblages, as well as an increase in the number of spindle whorls and loom weights (Arbuckle 2014, 212-213; Bachhuber 2015, 158; Greenfield 2010, 37; Sagona & Zimansky 2009, 211). Faunal studies analysing the cull patterns of sheep have suggested that wool production was being practiced at Late Chalcolithic Hacınebi (south east Anatolia) and Late Chalcolithic Çadır Höyük (north central Anatolia) (Arbuckle 2014, 213 & 220). Even though spindle whorls and loom-weights are used in the processing of flax linen as well as wool, the significant increase in the toolkit of textile production, (for example a large number, > 8000, were found at EBA Troy II-III) suggests that textile production became an important and organised activity (Bachhuber 2014, 150; Bachhuber 2015, 137; Massa 2015, 205; Sagona & Zimansky 2009, 211). Loom installations have been preserved in-situ in destroyed buildings of EBA Anatolia providing further evidence of textile production at settlements (Bachhuber 2015, 61). Examples of in-situ discovered looms come from Troy IIg and EBA III Aphrodisias (Bachhuber 2015, 137; Massa 2015, 204). At EBA Demircihöyük a woollen textile industry has been inferred by the presence of warp-weighted loom contexts, large numbers of spindle whorls, and the presence of wool bearing species of sheep with an older kill off pattern (Bachhuber 2014, 149; Bachhuber 2015, 42; Massa 2015, 93). Indeed, at Demircihöyük over 50% of the *ovis/capra* lived to maturity, which has been inferred as evidence that they were managed for wool (Bachhuber 2015, 42). Evidence of carding, spinning, dyeing, and weaving can also be inferred by the assemblages at Demircihöyük; such as the presence of spindle whorls in several longhouses (Bachhuber 2015, 65-66). At Karataş the presence of >100 spindle whorls and 40 loom-weights as well as the majority (60%) of *ovis/capra* being kept until maturity is indicative of a textile industry (Bachhuber 2015, 74; Massa 2015, 104). In the VI B period (3000-2750 BC) of Arslantepe spindle whorls probably used for spinning wool were recovered (Frangipane *et al* 2009, 16; Laurito 2012, 324). Furthermore, from period VI B the use of animal fibres for producing textiles became more common (Laurito 2012, 326). Also, at Arslantepe, a piece of textile on a metal bowl (sample 086/2002) from the 'Royal Tomb' of period VI B was determined as being constructed of fine animal fibre, probably sheep's or goat's wool (Frangipane *et al* 2009, 19-20). Overall it has been noted that loom-weights and spindle whorls represent a large proportion of the mobile finds of EBA Anatolia (Massa 2015, 201). It has also been suggested that the deposition of tools in the graves at Karataş and Demircihöyük (and presumably other EBA Anatolian sites as well) may suggest the identity of an individual's occupation in life (Massa 2015, 113). The most common tool items in the grave assemblages are spindle whorls, awls, and needles (Massa 2015, 113), which following the suggested logic would imply that many of the individuals were involved with the textile industry. At the very least it would indicate the importance of the textile industry at those settlements. The woollen textile industry is pervasive; in the Southern Caucasus, a specialised pastoral economy possibly based around wool production has been suggested from evidence at the 4th millennium BC site of Godedzor (Southern Armenia). Here a marked dominance of *ovis/capra* over other domestic species was discovered as well as a large number of weaving tools (spindle whorls, needles, and bone combs) which is most likely indicative of wool processing and textile production (Palumbi 2010, 159).

Woollen textiles may have become an important commodity as it could more easily be dyed and patterned than linen, and could therefore be decorated to demonstrate particular identity/identities (Bachhuber 2015, 156). As a result of pigments found in EBA contexts possibly associated with woollen textile industry, and from MBA texts it has been suggested that textiles would have been dyed red (Bachhuber 2015, 156). When the artefactual evidence (clothing pins, spindle whorls, and loom weights) is combined with the altered phenotype of sheep (more woolly), animal mortality profiles, and stable isotope data it becomes clear that from the late 4th millennium BC and throughout the 3rd millennium BC sheep would have been predominantly raised and exploited for their secondary rather than primary products. However, despite the previous discussion and the suggestions of textile production in EBA Anatolia it has been argued that there is at present no compelling evidence for highly specialised workshops (as seen in the MBA), and that textile production was more likely an production activity performed at a household/community level (Frangipane *et al* 2009, 25; Massa 2015, 206). Yet, I would argue that although the scale may not be as impressive as witnessed in the MBA, the early stages of that kind of textile industry with surplus production of a commercial product as a key component in settlement industrial economy and trade networks would have been present in the EBA. That it was the foundations of this industry established in the 3rd millennium BC which allowed the massive intensification of it as witnessed in the following millennium in Anatolia. Another explanation, especially at places in south eastern Anatolia like Titriş Höyük with close and strong connections to Mesopotamia where this kind of woollen textile industry was already quite well established, is that wool may have been transported as an unfinished raw product to the textile workshops of Mesopotamia in places like Ebla. It is known that in the beginning of the 2nd millennium BC Anatolian produced wool was one of the essential commodities in exchange networks, including those of Assyrian merchants (Bachhuber 2015, 43). This would help to explain why the textile industry may not appear as refined and intensely developed in Anatolia as in those regions and later periods.

Beginning in the Chalcolithic, and significantly developed during the EBA we observe the pattern at sites of animals being kept but not for consumption. Animals were no longer just for eating. There are many examples of evidence from sites in Anatolia to support this. At Early Chalcolithic Aktopraklık the stable isotope data indicates that the human population were not consuming cattle and it has been argued that they were instead kept for milk and dairy resources and traction (Budd *et al* 2013, 865). Residue analysis on pottery sherds from Barcın Höyük (ca. 6500 BC), Late Chalcolithic Çamlıbel Tarlası, and from İkiztepe provide clear evidence for milk fats (Budd *et al* 2013, 865; Pickard *et al* 2016, 298; Türkekul-Bıyık & Özbal 2008 256). Also at Çamlıbel Tarlası large pottery containers with low-lying spouts have been identified as churns (Pickard *et al* 2016, 298; Schoop 2015, 59). Furthermore, chemical analyses on perforated shallow pan pottery forms from the Chalcolithic site of Yarikkaya (central Anatolia) and late Poliochni Blue indicated that these ceramic items were used in the production of cheese (Cultraro 2013, 160 & 180). Also at Poliochni (in the Green and Red periods of occupation; 4th-3rd millennium BC) the presence of bones of calves and young sheep (8013 months) suggests the slaughtering of young animals to maintain milk production (Cultraro 2013, 180; Cultraro 2013b, 105). Barrel-shaped vessels from EBA central and western Anatolia (Troy, Kaklik Mevkii, Demircihöyük, and Karataş), some of the northern Aegean Islands (Poliochni on Lesbos and Thermi on Lemnos), and mid-3rd millennium BC Crete (from Lebena and Koumasa) have been interpreted as churns for producing butter (Cultraro 2013, 158, 161 & 175). Preliminary chemical analysis on a specimen from Poliochni discovered the presence of animal fat (Cultraro 2013, 179). Research has also demonstrated evidence for very early milking from the 7th millennium BC at Fikirtepe, Pendik, Aşaği Pinar, Toptepe, and Yarımburgaz (Budd *et al* 2013, 865, Evershed *et al* 2008). The exploitation of animals' secondary products was not necessarily a new phenomenon but this took on an increased and accelerated intensification in the 4th millennium and into the 3rd millennium BC. At Chalcolithic Ilıpınar the evidence suggests that cattle were kept and used as traction animals and that their dung was used as a fuel source (Budd *et al* 2013, 865; Cappers 2008, 120). It has also been suggested that cattle were used for traction at EBA Demircihöyük (Bachhuber 2014, 149) and evidence for the use of dung as fuel was found at EBA Dilkaya in the Van region of eastern Anatolia (Nesbitt & Samuel 1996, 96). The 'secondary products revolution' was not limited to Anatolia either, with evidence of it being found in the Philia culture of Cyprus (Bachhuber 2014, 148). The idea of the 'secondary products revolution' is not a new one, but the stable isotope analyses of human dietary habits in this research have further supplemented, supported, and developed these ideas and have allowed the observation of them with new scientific quantifiable data. Detecting the use of secondary products is difficult and has so far relied upon mainly mortality statistics of faunal remains and the study of pottery types, ceramic implements such as spindle whorls, as well as the analysis of lipid and protein residues on ceramics (Sagona & Zimansky 2009, 210-211). Stable isotope analysis provides a very effective and useful way of analysing exploitation strategies of animals, and is a useful complement when combined with the aforementioned techniques.

The human remains from the cemetery at İkiztepe are not actually EBA (see Chapter 2.2), but more correctly from the Late Chalcolithic-EBA I transitional period. This means it can be argued that the idea of an 'EBA dietary package' is not strictly limited to the EBA of Anatolia but first commenced in the Chalcolithic period and then developed during the 3rd millennium BC to become firmly established and the standard model. Unfortunately there is very little stable isotope data from the Anatolian Chalcolithic at present to definitively assess this argument. But what there is, as discussed in Chapter 6.1, is in many ways similar to that of the EBA Anatolian populations. In fact Budd *et al* (2013, 865) came to very similar conclusions as my own when analysing and interpreting their stable isotope results from Early Chalcolithic Aktopraklık. They argued that the Chalcolithic population at Aktopraklık was consuming a very narrow range of dietary proteins despite the availability of a wide range of wild resources (such as freshwater and/or marine resources), instead focussing on exploiting the terrestrial C3 resources of their established farming subsistence strategy (Budd *et al* 2013, 865). Furthermore, they also suggest that the population was predominantly reliant on sheep/goat for animal protein and was not consuming large quantities of cattle, instead keeping those animals for secondary products such as milk and dairy resources, traction, and dung for fuel (Budd *et al* 2013, 865). This is remarkably similar to what we see in the stable isotope data of the EBA, leading to the suggestion that similar agricultural subsistence strategies existed. The pattern of a narrow range of particular of domestic animals and crops also has visible origins in the Chalcolithic period (see discussion on botanical and faunal assemblage composition of Near East settlements earlier in this section) and the early stages of the exploitation of animals for their secondary products, albeit on a less standardised pan-regional scale. Therefore, it should not be entirely surprising that the dietary habits as observed through the stable isotope analyses indicating relative dietary input should both be similar to those of the EBA.

The stable isotope results from the Anatolian EBA sample populations are very similar to those of Middle Helladic (2000-1550 BC) Greece. Published stable isotope data for these Greek sites (see Figure 104 for map of sites) comes from Middle Helladic (MH) Aspis (Triantaphyllou *et al* 2006), MH (2100-1700 BC) Lerna (Triantaphyllou *et al* 2008), MH (2100-1700 BC) Asine (Ingvarsson-Sundström *et al* 2009), MH Kouphovouno (Lagia *et al* 2007), and Mycenae Grave Circle B (Richards & Hedges 2008).

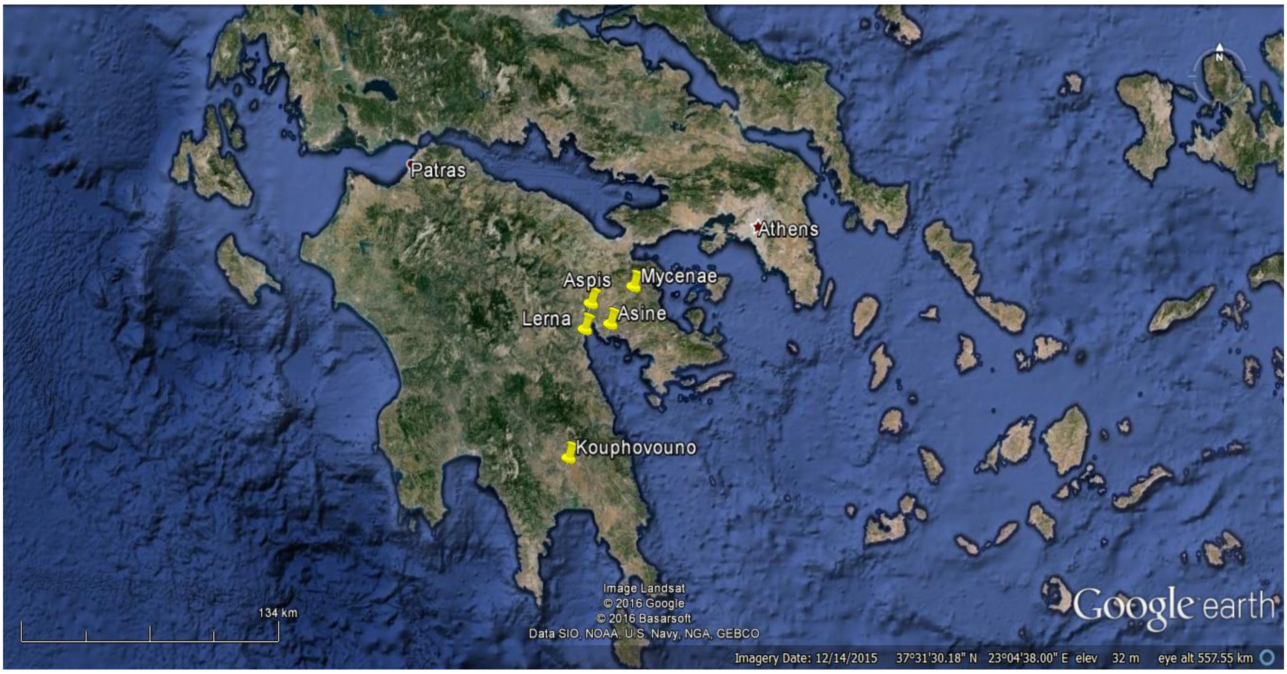


Figure 104: Map of Middle Helladic Greek sites with stable isotope data discussed in the text

As can be seen in Figure 105 the stable isotope values for the EBA Anatolian populations and MH Greek populations plot very closely together and are similar for both $\delta^{13}C$ and $\delta^{15}N$ indicating that their dietary habits were similar. The MH Greek populations shown in Figure 105 exhibit dietary habits typical of terrestrial C3 based diets like those of EBA Anatolia. Furthermore the majority of isotope data for Bronze Age Greece suggests a terrestrial C3 based diet with $\delta^{13}C$ values around -20±1‰ (Bourbou & Richards 2007, 66) very much like the EBA Anatolian populations. The only exception is the high status Grave Circle A at

Mycenae (not shown) which shows evidence of the consumption of marine protein (Bourbou & Richards 2007, 66). The stable isotope evidence from Lerna found no significant changes in diet over time and indicated that mixed farming was practised, much like the evidence from the EBA Anatolian populations (Triantaphyllou *et al* 2008, 3032). Furthermore, the botanical assemblages of Lerna correspond well to EBA Yenibademli Höyük, and Kastanas (Macedonia) (Oybak-Dönmez 2005, 46). Also, at Lerna, despite its proximity to aquatic resources, the evidence from the stable isotope analyses seems to suggest that marine resources were not an important component of the population's dietary habits (Triantaphyllou *et al* 2008, 3032), much like at İkiztepe and to some extent Baka Tepe. Because the stable isotope values are so similar it can be hypothesised that the idea of an 'EBA dietary package' not only began in the Chalcolithic period, but also stretched beyond Anatolia from (northern) Mesopotamia to the Greek mainland, and perhaps beyond. At Tell Barri in northern Mesopotamia (north east modern Syria) the results of stable isotope analysis suggested that the population subsisted on a terrestrial diet based on C3 plants with varying input from animal derived foodstuffs (Soltysiak & Schutkowski 2015, 179), which is the same as the interpretation for the data from the EBA Anatolian sample sites. Furthermore, during the EBA (2800-2200 BC) at Tell Barri the range of $\delta^{13}C$ values is -20.4‰ to -19.3‰ with a mean of -19.7‰, and the range of $\delta^{15}N$ values is 6.5‰ to 10.9‰ with a mean of 9‰ (Soltysiak & Schutkowski 2015, 180). From the EBA of Italy (late 3rd to early 2nd millennium BC) stable isotope analyses to examine dietary habits at the site of Arano di Cellore (near Verona in northern Italy) discovered a homogeneous diet with a narrow range of isotopes values based on terrestrial C3 food resources (Varalli *et al* 2016, 110-111). Also the range of $\delta^{13}C$ values is -20.9‰ to -19.7‰ with a mean of -20.2‰ and the range in $\delta^{15}N$ values is 6.9‰ to 8.9‰ with a mean of 7.9‰ (Varalli *et al* 2016, 107). Additionally, at Aran di Cellore the researchers suggested that the data from some of the sampled faunal remains indicates the consumption of C4 plants and that not all of the animals were consumed by the sample population (Varalli *et al* 2016, 108), which are also suggestions indicated by my data for the Anatolian EBA sample populations. The ranges and means of these other examples are very close and similar to those of EBA Anatolia and MH Greece. Varalli *et al* (2016, 110) also note that the isotopic data from Arano di Cellore is similar to other EBA sites of southern Europe and the Mediterranean from Greece to southern France and the Balearic Islands of Spain. This ties in with the idea of a Mediterranean quartet of crops (barley, wheat, legumes, vine grapes, and olives) as proposed by Sarpaki (1992). However, as a caveat, it should be noted that it is very difficult to compare stable isotope values across large trans-continental distances. Therefore, the comparisons and similarities discussed above, despite the resemblance in stable isotope values, should be regarded more as hypothetical possibilities. The greater the distance, the greater effect variables like climate and environment have on stable isotope signals thereby increasing the risk of similar values being the result of baseline effects rather than dietary habit ones, and thereby a greater risk of equifinality affecting the data.

Despite it being a greater distance from the research area than the other examples given here, palaeobotanical evidence from Central Asia may also provide evidence to support the idea of an expansive permeating 'EBA dietary package'. At Bronze Age (3000-1700 BC) Anau South (Turkmenistan), Gonur (Turkmenistan), and Djarkutan (Uzbekistan) the main crops were barley and wheat with barley predominant; 85-90% of the identified cereal remains from Anau, Gonur, and Djarkutan (occupation debris) were barley, and 99% from bowls in grave contexts at Djarkutan (Miller 1999, 16). Also, at the 3rd millennium BC site of Malyan (south west Iran) the predominant subsistence grains were wheat and barley (Miller 1982, 250). This demonstrates a monoculture of cereal crops with a predominance of barley that is witnessed at most of the other Bronze Age Near Eastern/west Asian sites discussed earlier. Furthermore, Miller (1999, 17) hypothesises that the presence of naked wheat (*Triticum aestivum* s.l.) in Turkmenistan may be the result of trade and exchange with northern Iran, or Pakistan or Afghanistan, or the arrival of settlers from these regions bringing the cereal with them.

The hypothesis of an expansive range for an 'EBA dietary package' is not implausible as it is known that there were connections between these regions in terms of cultural influences and trading of resources and material goods (Şahoğlu 2005, 341 & 353), and therefore there may also have been an exchange of agricultural practices and commodities resulting in a wide-reaching standardisation of dietary habits. Lerna actually has many similarities to Anatolian settlements such as its architectural layout with a fortified citadel with monumental building complexes, as well as the discovery of Anatolian style *bullae* with seal impressions (Şahoğlu 2005, 353). Very simply the Bronze Ages of these regions saw the development of central control, urbanisation, long-distance trade and exchange networks, and intensive agriculture, and what we might be seeing is a common approach employed by successions of neighbouring populations due to the success, benefits, and/or efficiency of the subsistence practices used. Following the arguments of Pauketat (2000, 123-124), we may also consider that an 'EBA package' and common agricultural practices of the Anatolian 3rd millennium BC were the result of social compliance. Utilising Pauketat's proposal, it could be that smaller populations were ‘coerced’ into an economic food producing system, initially instigated by larger settlements with greater hierarchical systems and more prominent ‘elites’, that produced the greatest output whilst also allowing the greatest control over both resources and (thereby) the populations. Once this style of economic food producing system had been established and other smaller contemporary settlements had been “constrained by the spaces and practices” of these new systems the ability to “objectively resist domination…would have been inhibited”, resulting in those settlements at a certain point having no choice but to switch to, and become locked into, those economic agricultural systems (Pauketat 2000, 123). In the EBA of Anatolia the sites were often very close together; during the mid-EBA of Anatolia it has been estimated that the average distance between mounded settlements in the valleys was 3-6 km (Massa 2015, 41). The settlements therefore should not be viewed in isolation as they were (in the majority) far from isolated. The short distance between settlements suggests intensive interaction with their neighbours, with the transfer of technological knowledge and cultural behaviours mostly from one individual to another, and one village to another (Massa 2015, 115 Ünlü 2016, 348). Therefore, it is not so hard to imagine common patterns of agricultural subsistence as a local exchange of ideas, practices, and methods becoming regional and then pan-regional. Furthermore, as Chapters One (section 1.2) and Two have demonstrated, there were many common and shared cultural aspects of EBA Anatolian settlements. Indeed, the material culture of the Anatolian EBA demonstrates a trend towards homogenisation (Bachhuber 2015, 14). It has been shown that more culturally similar interacting groups are more likely to accept a particular innovation (Massa 2015, 56 & 64). At Karataş, for example, which shares many of the same cultural features of other EBA Anatolian settlements it is likely that wheel-made pottery and metallurgy was imported to the settlement (Massa 2015, 105). In addition the presence of ‘colonies’ at some EBA sites such as Kanlıgeçit, Kastri, Ayia, Photia, and Manika has been suggested (Massa 2015, 252). It is feasible to argue that the members of these colonies would have brought cultural and technological practices of their home with them to their new locations, possibly including agricultural practices. In the later part of the 3rd millennium BC especially, many basic commodities (copper, stone artefacts, some vessel types) start circulating in large quantities and across larger distances reaching even relatively isolated locations/settlements (e.g. Karataş) demonstrating a wide range and permeability of material culture, goods, and technologies across EBA Anatolia (and further afield) (Massa 2015, 112). As with the exchange of material culture and technology (e.g. finished objects, wheel-made pottery, metals etc.) agricultural practices can potentially be considered to be as much a part of the EBA trade networks as those other goods and technologies. Additionally it has been suggested that there would have been a movement of specialists (traders, builders, potters, weavers, and metal workers) in the EBA, although not necessarily over large distances (Massa 2015, 251-252). This may also include the movement of farmers or agricultural specialists. It has also been suggested that in the latter half of the 3rd millennium BC western Anatolian sites such as Troy and Bakla Tepe intensified their contacts with communities to the east, from Mesopotamia and (likely via) Central Anatolia (Şahoğlu 2016, 177; Ünlüsoy 2016, 402). Ünlüsoy (2016, 402) has suggested that evidence for direct contacts with the Mesopotamian elite culture via inner-western Anatolian communities at Troy can be observed through the presence of tin bronzes, wheel-made pottery, and prestige goods produced with non-local materials. At Troy this change in focus affected all aspects of daily life and the social, economic, and political organisation were drastically transformed (Ünlüsoy 2016, 402). It is therefore feasible to suggest that material culture (metals, ceramics etc.) were not the only things to be transported along this south east-north west vector. It is also very possible that agricultural and subsistence practices such as a narrow range of crops and an increased emphasis on herds composed of *ovis/capra* all controlled by a centralised authority which are currently more commonly associated with Mesopotamia (see Paulette 2013 & 2016) would have also been 'conveyed' westwards and adopted by the communities of Anatolia. Further to this discussion one question which is often overlooked is that of what happened to the people from the numerous small farming villages when a reduction in the number of settlements is observed from the EBA I-II to EBA III. Bachhuber (2015, 176) suggests four possibilities; they were killed or starved to death, they were absorbed by larger settlements, they became more mobile pastoralists, they migrated (for example to Cyprus where many Anatolian characteristics are witnessed in the Philia culture of the late 3rd millennium). Apart from the scenario where they all die, the other three involve the movement of groups of people, either on a small spatial scale (to the nearest large settlement), across an area (mobile pastoralism), or larger distances (to another region). It is logical to assume that these people would have taken their practices and traditions (including agricultural practices and dietary habits amongst others) with them where they went, and this may have also played a role in the dissemination of particular agricultural practices resulting in a general homogenisation. Whilst there are currently no stable isotope data from the Cyclades for the 4th to early 2nd millennium BC, or from 3rd millennium BC Cyprus it would be very surprising if their isotopic signals were not very similar to those of EBA Anatolia and MH Greece. This hypothesis can only be confirmed with certainty once more stable isotope work to examine dietary habits has been conducted on further populations in the areas from the Balkans to Mesopotamia.

Whilst I have tried in the latter part of this chapter to provide logical and reasonable explanations for the spread and permeation of this ‘dietary package’ on both local regional and larger pan-regional scales, I can provide no definitive explanation as to its origin. This may also be answered by further research; by examining a greater number and scale of populations of the eastern Mediterranean and Western and Central Asia an origin ‘hot spot’ may be revealed. However, I doubt that this phenomenon has a single point of origin (either spatially or temporally) but instead was something that developed progressively before being adopted and adapted by others. Furthermore, it likely developed both in conjunction with, and as a result and progeny of other societal and cultural developments such as the development of central control, urbanisation, long-distance trade and exchange networks, and intensive agriculture with many of these factors in effect having a virtually reciprocal and indeed in some cases, a trajectorially linear relationship with each other.

In its simplest form (at least in terms of socio-economic driving forces) the EBA is a time of agriculture, metal, and wool. The Ebla texts reveal an economy based on agriculture, viticulture, animal husbandry, and textile and metallurgical activities (Bachhuber 2015, 159). Whilst this textual evidence comes from EBA northern Mesopotamia, the situation in Anatolia would have probably been very similar. The stable isotope data, in conjunction with the data and information from other specialist researches would appear to suggest and support the idea of a time of agriculture and wool. Therefore, the idea of an ‘EBA dietary package’ is one that is both rational and appealing to researchers of prehistoric Anatolia. It follows from and develops the idea of a secondary products revolution of the Chalcolithic of the Near East and goes hand-in-hand with the increased control in the EBA of populations (organisation of labour, specialists, agricultural surplus and distribution) by emerging elites, trade and exchange networks, urban planning and construction, the environment, and agriculture. In general the EBA is a time of increase and also of development towards what one might argue to be increased standardisation and regulation of architecture, funerary habits, metallurgy, textile and ceramic production and craft specialisation, and in these respects the dietary habits of the populations are no different.

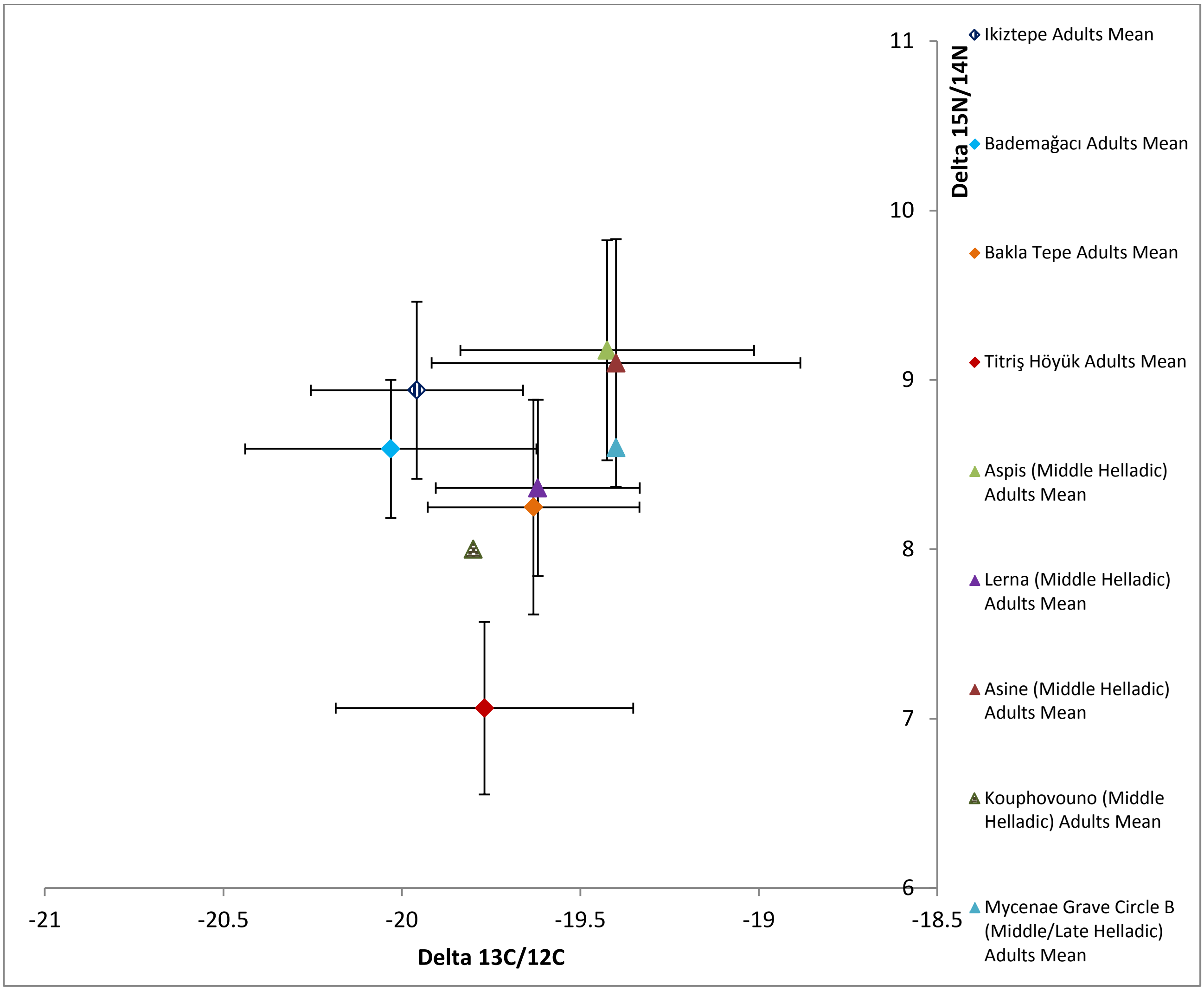


Figure 105: Mean δ13C and δ15N values of adults from EBA Anatolian populations and Middle Helladic Greek populations

Chapter Seven: Conclusion

Interpreting the dietary habits of individuals and populations using stable isotope analysis can be tricky, especially when populations employ mixed feeding habits (i.e. various resource inputs), and furthermore, there is not a simple and easily interpreted correspondence between diet and isotopic composition (Schwarcz & Schoeninger 2011, 732). Moreover, as stable isotope analyses cannot determine exactly how food was prepared and what meals were eaten, the reconstruction of ancient diets through stable isotope analysis should not be performed in isolation and requires an understanding of the possible food choices available to past humans (Makarewicz & Sealy 2015, 154; Stonge 2012, 48). Isotope analyses should be conducted and interpreted in the context of the entire reconstructed record of a site and its population/inhabitants (Makarewicz & Sealy 2015, 154; Schwarcz & Schoeninger 2011, 734). This is why it is important to ensure that as much data as possible is gathered about the sampled and analysed population from several other different specialist methods and fields of research. Without the work of archaeobotanists, archaeozoologists, specialists in crafts and industry (pottery, metallurgy, stone tools, textiles etc.), as well as an overall archaeological synthesis of the settlement it is almost impossible to make definitive conclusions about the dietary habits and subsistence patterns of ancient people.

In a terrestrial food web expected isotopic signals for carnivores are ca. -25‰ for $\delta^{13}C$ and ca. 8-12‰ for $\delta^{15}N$ with omnivores exhibiting an intermediate trophic level effect between carnivores and herbivores (Schwarcz & Schoeninger 2011, 732). In Chapter Five it was established that the means of $\delta^{13}C$ and $\delta^{15}N$, respectively, are -20‰ and 8.9‰ for İkiztepe, -19.8‰ and 7.1‰ for Titriş Höyük, -20‰ and 8.6‰ for Bademağacı, and -19.6‰ and 8.3‰ for Bakla Tepe. The range of $\delta^{13}C$ values in the data from all sample sites is 2‰ (-21‰ to -19‰), and for $\delta^{15}N$ it is 4.3‰ (5.8‰ to 10.1‰). The range in isotopic values is very narrow, particularly for $\delta^{13}C$, and as will be discussed in more depth below this was unexpected as one of the hypotheses of this research was that the dietary habits of different sites would be distinct from each other. It was expected that there would be regional dissimilarities as well as noticeable intra-population variations and distinctions, particularly between the sexes, age, and socio-economic/political groups. As was demonstrated in Chapter 5.2 on a site-by-site basis these distinct intra-population differences were on the whole absent for all of the sample populations, with even statistically significant differences being subtle and minor. However, one is referred back to the discussions in Chapters Five and 6.1 about subtle differences not being disregarded entirely in some cases owing to them manifesting as consistent patterns, and the possible relationship with ideas of taste and nutrition etc. Whilst the stable isotope data generally confirmed null hypotheses it should be considered to be anything but monotonous and bland. The homogeneity of the data is in some ways more stimulating as it was completely unexpected and allows a re-imagining of EBA dietary habits and subsistence patterns in Anatolia, which can have implications on a societal and population level. At İkiztepe it was anticipated that the stable isotope data would indicate marine consumption by the population, however this hypothesis was contradicted by the $\delta^{13}C$ and $\delta^{15}N$ values. Whilst this was surprising, it is interesting and finds similarities when studied in conjunction with archaeological evidence and stable isotope data from other coastal populations such as Grotta dell'Uzzo on Sicily, Arene Candide in Italy, the Neolithic of the Bulgarian Black Sea coast, Poliochni on Lemnos, and Aktopraklık in north west Anatolia (see discussion in Chapter 6.2) which also indicate an absence of marine consumption. This should provoke us into re-assessing coastal population subsistence patterns and the assumption that populations in close proximity to the sea must have relied in a major way upon marine resources, or even consumed them at all. Another interesting result of the stable isotope data is the noticeably low $\delta^{15}N$ values of the individuals from Titriş Höyük (see Chapter 5.2.2). These stable isotope values are the one data-set that can be considered to be significantly different from the other sample populations, although - as will be discussed below - they are still within an Anatolian EBA 'range'. This is particularly noticeable for $\delta^{13}C$ where the range in values for the sample sites is distinct from published values of other sites from differing time periods in Anatolia. In Chapters 5.2.2 and 6.2 some suggestions were put forward as to why these $\delta^{15}N$ values could be so low, such as a greater dietary input and consumption of vegetal matter (crops) in general with little animal protein consumption, or a greater dietary input and consumption of legumes which can result in reduced $\delta^{15}N$ values. Unfortunately Titriş Höyük is the one sample population without accompanying faunal stable isotope data so it is difficult to assess fully whether the low $\delta^{15}N$ values are the result of dietary input composition or simply low baseline faunal values. At İkiztepe (Chapter 5.2.1) I suggested that one of the reasons for the high $\delta^{15}N$ values of the human sample population could be the result of consuming fauna with high $\delta^{15}N$ values, possibly as a result of a 'salt-marsh'/marine proximity factor. Therefore, at Titriş Höyük the opposite may be true; low $\delta^{15}N$ values may the result of consuming fauna with low $\delta^{15}N$ values rather than low relative animal protein consumption. Future work on analysing the stable isotope values of faunal remains from Titriş Höyük will aim to address this issue. Overall the stable isotope values of the sample populations generally agree with the expected signals of omnivores consuming a mixed diet. Thus, in conclusion it can be said that the dietary habits of EBA Anatolian populations were terrestrial C3 based mixed diets, as demonstrated by the results of the stable isotope analyses, with an emphasis on a narrow range of domestic crops and animals, notably emmer and einkorn wheat, barley, legumes such as lentils and bitter vetch, *ovis/capra*, cattle, and pigs with a very marginal to negligible inclusion of wild animals and plants. The results derive from data from the stable isotope analyses in conjunction with other specialist analyses, i.e. archaeobotany and archaeozoology.

Whilst the crops listed above are predominantly consumed directly by humans it has been suggested that bitter vetch (and possibly other leguminous plants such as clover) at 3rd millennium sites would have been used as a fodder plant for feeding animals or grown to improve soil fertility (as they are leguminous plants) as a risk-buffering measure rather than for human consumption (Miller & Enneking 2014, 261; Oybak-Dönmez 2005, 46-48). This is arguably because the need for protein from plants was no longer as necessary due to the consumption of animal protein (meat and milk/dairy). And furthermore, as bitter vetch has to be treated to remove toxins the processing cost for preparing it for human consumption was no longer deemed viable (Miller & Enneking 2014, 261). Bitter vetch is also a stress and pest resistant crop (Miller & Enneking 2014, 264) which may have made it an attractive option for people wanting a low risk crop option for fodder, or even possibly as food (see discussion below). The lack of wild animals in faunal assemblages, and from the stable isotope analyses, may in some way be answered by the suggestion that in the EBA hunting may have been a leisure activity rather than to supplement the diet (Bachhuber 2015, 37). However, as discussed in Chapter 6.2 the lack of wild fauna in the dietary habits is more likely to have been due to the foremost reliance on domestic animals (for primary and secondary products) than anything else. Related to this point, the lack of wild fauna may be an indication of the effectiveness of provisioning/distribution systems; the less effective those systems are then the more likely it is that the consumer will supplement the resources with hunted game species (Zeder 1991, 39). Furthermore, there are very little differences at an intra-population level with many populations demonstrating a moderate to high degree of consistency and homogeneity in dietary habits across the course of the 3rd millennium BC and between different social groups (age, sex, elite and commoner etc.). However, there are some differences at an intra-population level, and whilst in cases this has been demonstrated to be statistically significant a lot of the differences are quite small, yet consistent, in terms of actual 'real world' dietary habits and are generally related to variation in $\delta^{15}N$ (i.e. protein consumption) values. Greater differences occur at an inter-site/population level; again this is related to $\delta^{15}N$ values. The $\delta^{13}C$ values at both an intra- and inter-site level are remarkably similar and within a narrow range that is arguably distinct to the EBA. When the results from EBA Anatolia are compared with other Anatolian sites from different periods, and thereby on a larger (temporal) scale, it is observed that the EBA values are distinct in their homogeneity (see discussion around Figures 98-103 in Chapter 6.1). It is thereby hypothesised following the results of the stable isotope analysis in conjunction with other avenues of evidence from the sample sites as well as throughout EBA Anatolia that there existed a standardised 'EBA dietary package' related to subsistence choices which complements the general pattern of standardisation of the 3rd millennium in Anatolia. It has been noted that the farming practices of EBA Anatolia appear to have more in common with those of the 2nd millennium BC than the Neolithic, which is an implication of continuous (possibly elite, at least in terms of agricultural organisation) behaviour, and something distinctly 'Bronze Age' (Bachhuber 2015, 33). The EBA is preceded by the Chalcolithic period, but as was discussed in Chapter 1.2, there are many cultural similarities between the 4th and 3rd millennia BC in particular. Furthermore, as was discussed in Chapter 6.2 similarities in exploited crops and animals, and in some cases stable isotope signals, has been noted and discovered between these two periods. Therefore, whilst there is a distinct difference between the Neolithic and Bronze Ages, the distinctions between the 4th millennium BC and the following two millennia are less clear. This is applicable not just for dietary habits and subsistence strategies but, as was discussed at the beginning of Chapter 1.2, also to some extent material culture, funerary practices, and technology. The 3000 BC beginning of the EBA in Anatolia is in many ways an artificial construct, and therefore the formative years of the EBA and phenomena of the 3rd millennium should be viewed as beginning in the Late Chalcolithic and particularly the 4th millennium BC.

The homogeneity/similarity of dietary habits is an unexpected result with a much smaller variability on both intra- and inter-population levels than anticipated. This is in part due to the fact that the EBA of Anatolia is one of conflict and flux as conferred in Chapter 1.2, with this flux expected to also be embodied in the dietary habits of the EBA populations. At an intra-population level much has been discussed previously (see Chapter 1.2) about the emergence of social complexity in the 3rd millennium BC, and therefore it was expected that differences in dietary habits between social groups such as men and women and socio-economic groups should have been evident and visible. It was also expected that there would have been greater regional heterogeneity and variability in dietary habits, partly due to climatic/environmental factors, but also cultural factors (e.g. although there is evidence of contact and some shared material culture, Titriş Höyük and Bakla Tepe, for example, are very different settlements and populations in terms of settlement size and layout, and burial habits, amongst other things). Furthermore, despite the dietary habits of Titriş Höyük being the most different from the other three sample sites, the stable isotope data was still more distinctly 'EBA' than not, with its values being more similar to the other EBA sites than those from other temporal periods, particularly for $\delta^{13}C$. It must therefore be considered as to why dietary habits are so similar and consistent, when a lot in the Anatolian EBA is apparently not. However, more recently it has been shown that there are actually many similarities in material culture witnessed throughout Anatolia in the EBA. As determined in Chapter 1.2 these similarities include aspects such as a radial settlement plan with a central communal space witnessed from western to eastern Anatolia, the presence of large administration buildings, a 'citadel' area distinct and separated from the rest of the settlement, the use of *pithoi* in burial practices, and the use of the potter's wheel. In Chapter 6.2 I also demonstrated that there is a similarity across Anatolia in the types and proportions of crops and livestock, which in turn infers a similarity of subsistence practices. Therefore, maybe we should reconsider the EBA of Anatolia in the sense that there are actually more similarities/consistencies and less variability and heterogeneity across the region than previously thought. For example, the results of my research suggest that there is very little or no distinction in dietary habits between social groups (including males and females, and elites and commoners). Consequently, perhaps it should now be considered that the traditional 'complexity' and 'prestige/elite' aspects of the EBA have been previously over exaggerated, and need revision; at least in terms of dietary habits. In Chapter 5.2.1 it was demonstrated that there was no difference in $\delta^{13}C$ and $\delta^{15}N$ values, and therefore dietary resource input, between individuals in 'prestige burials' and those in common burials. In Chapter 5.2.4 it was also established that there was no difference in stable isotope values of $\delta^{13}C$ and $\delta^{15}N$ between individuals from different grave types. Furthermore, an individual (G-296 from Bakla Tepe) who it was suggested was part of a societal 'elite' had very similar stable isotope signals of $\delta^{13}C$ and $\delta^{15}N$ as the rest of the population. This is not to say that there was no differentiation within populations of differing socio-economic and socio-political groups, but that this differentiation was not determined by, or did not determine one's quotidian dietary habits. However, it must be noted here that stable isotope analyses only allow us to get an indication of the dietary habits and relative proportions of resources in the diet and do not allow us to differentiate between meals or outright food items. Therefore, it may be that dietary habits were different between socio-economic/socio-political groups but that this was at a meal or specific food item level. For example, elites may have eaten better cuts of meat, something which stable isotope analyses alone cannot distinguish nor determine. The elites may also have been involved in, or sponsored, feasts which would not be frequent enough to affect the stable isotope composition of the bones of the involved individuals. Additionally, it should not necessarily be expected that conflict would affect dietary habits, at least in the long term. The diet of an individual, as indicated by the stable isotope composition of human bone collagen, represents a long term average. Therefore, unless warfare/inter-population conflict was chronic (of which there is no evidence so far), then any effects of conflict (e.g. the destruction of crops and/or livestock) would likely have been short term (even if they resulted in famine/shortage severe enough to cause death), and unobservable in the stable isotope data obtained from the extracted collagen. Also, conflict would not necessarily have affected subsistence practices. Just because a group is in conflict with another does not mean that different crops are grown or different animals are reared. Increased conflict would have impacted local economies, but it would not have changed the production processes (Schoop 2011, 35). Furthermore, (following on from the evidence discussed in Chapter 1.2) it would seem that conflict would more likely have been related to the control of trade and resources rather than agriculture. But it has also been suggested that the control of land, for growing crops and/or herding large wool-producing herds, may have been a source of conflict between groups (Bachhuber 2015, 175). The homogeneity of dietary habits may, however, simply be a result of pragmatism and an exception to the flux of the period. It could be that the dietary habits of the EBA populations are similar because the subsistence practices are similar, and the subsistence practices are similar because they are the most useful/efficient way of doing things. Just as with the Mesolithic-Neolithic transition when people realised the benefits of becoming sedentary agriculturalists as opposed to mobile hunters and foragers. In the EBA, this form and method of agriculture was the best and most efficient way of providing nutrition for a population and marks a refinement of agricultural practices. It may also simply be due to the previous approaches to studying the EBA of Anatolia, and that in the past few works have been holistic in their approach and therefore these patterns (a greater homogeneity in aspects of the Anatolia EBA) have been unobserved.

By the 4th millennium BC plant and animal husbandry were fully integrated into the economies of central and west Asia (Miller 2013, 250), and indeed crops such as emmer and einkorn wheat, barley, leguminous pulses (notably bitter vetch, lentil, pea, and chick pea) were staples from the Neolithic, and continue to be so today (Bachhuber 2015, 35; Miller & Marston 2012, 99: Oybak-Dönmez 2005, 42). They were not 'new' crops of, and restricted to the EBA. The staples of the domestic crop assemblage in Anatolia remain relatively consistent from the EBA throughout the MBA, and it is not until the LBA and Iron Age that the introduction and addition of millet and sorghum into the domestic crop assemblage produces increasing variety. The introduction of an expanded range of crops in later periods, and especially the Iron Age and Medieval periods when cotton, sesame, pomegranate, cucumber, and rice appear as well as millet is probably an indication of the development of intensive irrigation (Miller & Marston 2012, 102; Riehl 2009, 112). In a time of increase and flux with socio-economic and socio-political developments a familiarity of knowledge regarding arable agriculture would have been important and necessary. The extreme example of this is that during the political crises of the MBA and LBA (2nd millennium BC) of Mesopotamia, such as an internal political change with the settling of the Amorites, barley became the main domestic crop (Riehl 2009, 94, 100 & 111; White *et al* 2014, 374-375), perhaps indicating that the crop assemblage was determined by what was known and experienced and what could be relied upon. In times of hardship people tend to rely on the familiar, and hardy barley (discussed below) was a high yield, low risk option (Miller 1997, 130). Climate may also have been a factor in determining subsistence strategies and thereby dietary habits which leads us to the question: Is the predominance of barley, and to a certain extent emmer wheat, in EBA crop assemblages related to it being drought resistant? Barley is highly tolerant of drought and salinity stress, and hulled emmer wheat is also resistant to drought (Riehl 2009, 100; Riehl 2014, 67). It has been suggested that the monoculture of barley particularly in northern Mesopotamia may be related to a lowest risk-maximum yield strategy (Riehl 2014, 66). There is a variation in precipitation quantities across Anatolia, with the Plateau receiving the least (200-400 mm per annum), the northern and southern coastal regions (i.e. between the mountain ranges and the seas) receiving the most (1000-1500 mm per annum), with western Anatolia getting 600-700 mm per annum (Bachhuber 2015, 34). Miller & Marston (2012, 98) include a table with site-specific annual precipitation levels. The sites of Gritille (500 mm), Cafer (400 mm), Kurban Höyük (473 mm), and Hacınebi (368 mm) (Miller & Marston 2012, 98) are most useful to this research as they are all in south east Turkey in relatively close proximity to Titriş Höyük. Furthermore, it has been demonstrated that there is increased aridification in the Near East from 2500 BC onwards with periods of drought (Fiorentino *et al* 2008, 56; Riehl 2009, 94). Indeed Riehl *et al* (2014, 12350) demonstrated by analysing the $\delta^{13}C$ values of samples of barley from the Khabur, along the Middle Euphrates, and the Levant that there was an increase in aridity in the second half of the 3rd millennium BC and many of the barley samples (especially from the inland sites) exhibited isotopically visible signs of drought stress. This may suggest that crop choice may have been pragmatic more than anything, employing high yield, low risk strategies to feed growing populations and ensure surplus to supply an increased number of (craft) specialists. When the predominant and most common crops (wine grape – *Vitis vinifera* L. – despite its economic importance has been omitted as it is more regionally dependent and therefore not common across all of the area) of the Bronze Age of the Near East are analysed for drought tolerance and economic value (Table 15) it can be seen that, with the exception of einkorn wheat, they all have good to high drought resistance and high economic and dietary values. Also, barley has a shorter growing season (Miller 1997, 128). However, despite substantial changes in the 3rd millennium, and even within the millennium, dietary habits seem to have hardly been affected by events that have been argued to have a great effect, i.e. increased inter-group conflict, and environmental and climatic changes. The dietary habits and available and exploited food resources remain consistent and relatively homogeneous. Also, despite the differences in annual precipitation the crop assemblages are pretty consistent across differing regions of Anatolia (however, see discussion below). I would even go as far as to argue that events such as increased inter-group conflict and climatic changes would not have been the main driving force for choices in subsistence patterns and dietary patterns, and actually played a very minor role, leaving these factors more or less untouched and unaffected. Instead it seems more likely that increased urbanisation and social complexity of both a socio-political and socio-economic nature, including the emergence of elites and specialists, and the intensification of trade and exchange networks creating a 'small world' phenomenon would have been the main driving forces. By a 'small world' phenomenon I mean the intensification of trade and exchange networks, and also possibly increased social complexity and the emergence of elites which resulted in communities becoming 'closer' culturally, as opposed to geographically (see Watts & Strogatz 1998 for a general discussion on the 'small world' phenomenon and see Gamble 1998 for a discussion from an archaeological perspective; see also Barceló & Del Castillo 2016, 56; Bentley & Maschner 2008, 252; Bintliff 2012, 111; and Collar 2013, 225) There may have been a pragmatic approach to the subsistence strategies (crop and livestock selection and management) and thereby dietary habits, but this would have been related to the factors I have just mentioned, i.e. enabling a surplus of agricultural produce for feeding specialists and elites who played no part in agriculture as well as growing populations. Factors determining the allocation of space and time to farming and herding include the potential productivity and biological requirements of the plants and animals (water, pasture, and fodder) as well as social ones (community mobility, territorial control, trade and exchange, and warfare) (Miller & Marston 2012, 99). The most important sources of carbohydrate for the growing populations were emmer wheat and barley and therefore these were the most intensely cultivated crops (Bachhuber 2015, 35). Barley may also have been grown for use as animal fodder as discussed in Chapter 6.2. This conclusion is supported by Miller's (1997) examination of subsistence and crop patterns at Kurban Höyük. She discovered that barley production at the site expanded in the early and mid-3rd millennium BC, not in the latter part of the millennium as might be expected in response to increasing aridity and possible drought (Miller 1997, 130). And furthermore that "climate did not dictate the economic choices made over time by the ancient people of Kurban" (Miller 1997, 130).

With regards to the preparation of crops such as barley, as an example, at late 4th millennium/early 3rd millennium (3350-2910 cal. BC) Ras an-Numayra in Jordan barley was processed into groats (coarsely ground barley) which are mainly used in making bread, bulgur, and a simple porridge, and it seems evident that the majority of the inhabitants of the settlement would have based their daily meals on barley groats (White *et al* 2014, 371-372). Also, from the textual evidence from Bronze Age Mesopotamia we know that barley (and wheats) were consumed in a variety of forms including soups, porridges, cakes, breads, and beers (Paulette 2013, 102). It is arguable that a very similar situation would have been present at the EBA Anatolian sample sites. At EBA I (3000-2750 BC) Arslantepe, for example, the analysis of cooking-wares discovered pots with a capacity of 16-20 litres and burning residues suggestive of cereal pre-cooking such as in the preparation of bulgur (Crisarà 2013, 187-188). Even today, bulgur (made from either emmer or einkorn wheat, or barley) remains a common ingredient in recipes from Greece, Turkey, North Africa, and the Near East (Valamoti 2011, 26). Furthermore, at Ras an-Numayra some carbonised lumps of barley groats were very similar to those from EBA Greece where it was suggested that the roughly ground grain was boiled in milk, hand rolled into lumps, and dried for long term storage (Valamoti 2011, 27-29; White *et al* 2014, 371).

Table 15: Agronomic properties for the main crop species of the Bronze Age of the Near East. Following Riehl 2009, 98

Crop species	**Drought tolerance**	**Economic value**
Two-row barley (*Hordeum vulgare* convar. *distichon* L.)	High	High (higher yields and starch content than six-row barley)
Six-row barley (*Hordeum vulgare* convar. *vulgare* L.)	High	High (higher protein content than two-row barley)
Emmer wheat (*Triticum turgidum* subsp. *dicoccon*)	High (high resistance to poor soils and fungal diseases if stored within the glumes)	Hulled wheat, labour-intensive in processing for consumption
Einkorn wheat (*Triticum monococcum* subsp. *monococcum* L.)	Low (drought susceptible)	Hulled wheat, labour-intensive in processing for consumption, low yield
Lentil (*Lens culinaris*)	Moderate	High economic and dietary value
Bitter vetch (*Vicia ervilia* L.)	High	Needs processing to remove toxins if used as human food

This hypothetically could demonstrate a common subsistence and dietary practice all the way from Greece to Mesopotamia, and therefore it is reasonable to assume that due to the strong connections Anatolian settlements had with regions to the east and west that a similar practice could have been present in EBA Anatolia as well. Indeed, in modern times groats prepared in this way are found across the Mediterranean, Turkey, and the Near East. In Greece they are known as *trachanas* or *trachanos*, as *chachla* on the island of Lesbos, as *xinochondros* on the island of Crete, as *tarhana* in Turkey, and as *kishk* in Jordan and other Near Eastern countries such as Egypt and Lebanon (Valamoti 2011, 27). Products similar to *trachanas*, *tarhana*, and *kishk* have a wide range and are found today in communities from Algeria to Nepal, and northwards from Hungary to Finland (Valamoti 2011, 29). Ethnographic information suggests that these foodstuffs are consumed mostly as the basis of a broth or stew either plain simply with warm water, or as part of more elaborate recipes including meat, fish, and vegetables (Valamoti 2011, 30-31).

A hierarchy of settlements has been noted in EBA Anatolia, especially for trade networks with large sites which were hubs and regional network centres on trunk roads/'highways' suggesting dendritic and inter-centre interaction (Massa 2015, 257-259). However, the dietary habits and therefore subsistence practices are alike at all sites (some of the sample sites are only small and not necessarily large hub centres) which demonstrates complete permeation on a pan-regional scale, more like wave interaction, but possibly with elements of dendritic interaction especially if in some places the smaller sites were agricultural suppliers of the regional centres/larger hub sites (see discussion on interaction terminology in Massa 2015, 65). It has been noted that changes in subsistence practices and dietary habits occur when rural populations are drawn into industrialised food markets (Riehl 2009, 111). In the case of EBA Anatolia, these changes in subsistence practices and dietary habits were an increase in homogeneity as the smaller and more rural settlements and their populations were drawn into an increasingly standardised and homogeneous Anatolian EBA character (see also discussions about increased homogeneity in Anatolian EBA material culture in Chapter 1.2). Interaction between EBA settlements would have involved the exchange of information, although this cannot be demonstrated archaeologically (Massa 2015, 253-254 Ünlü 2016, 348). This is because, often, an economic praxis activated by social forces within a community can stimulate wider cultural interactions (Kouka 2016, 204). Furthermore, a large proportion of potentially exchanged items are perishable/leave no archaeological trace including timber and/or wooden objects, basketry, salt, textiles, livestock agricultural produce, dairy products, cosmetics, spices, and drugs, many of which we know were traded commodities according to Old Assyrian texts (Massa 2015, 253). In the EBA it seems probable that livestock, timber, and agricultural products would have been circulated in large quantities (Massa 2015, 255). Crops are an often documented means of payment, although they were often restricted to intra-state measures or as parts of redistribution systems (Riehl 2014, 59). Crops may well have been involved in long distance trade but in the absence of textual information there is very little archaeological and archaeobotanical evidence for this, and therefore its role is obscure (Riehl 2014, 59). At 3rd millennium BC Malyan (south west Iran) despite dates not growing in that region, two date pits were found which may provide tentative evidence for the movement/exchange of botanical food resources (Miller 1982, 243-244). However, for the EBA of Anatolia, I would argue that the homogeneity of domestic crops was more related to the exchange of information (i.e. the methods of arable agricultural subsistence), rather than the physical exchange of crops. And actually, Riehl (2014, 68) studying the potential exchange of crops suggests it is unlikely that crops were subjected to organised trade. The idea of subsistence strategies being exchanged, transmitted, or transported is possibly supported by the 4th millennium Uruk settlement of Hassek Höyük (south east Turkey, to the south of the Euphrates). It has been suggested, following an examination of the botanical assemblage and the identification of a lack of wheat in an area (Northern Mesopotamia/southern Anatolia) where wheat was popular, that the Uruk settlers of Hassek Höyük may have brought some of their food habits with them as they came from Southern Mesopotamia where wheat was not grown due to the lower annual rainfall of that region (Miller 1997, 131). It has also been advocated that the commercial trade routes (for ceramics and metals etc.) connecting Central Anatolia and the Upper Euphrates may have also been routes used for pastoralism/seasonal transhumance (Palumbi 2010, 158) which may have aided in the distribution and movement of livestock management practices. All of these factors combined would help explain why agricultural resources and subsistence strategies are so homogeneous in the EBA. It may, however, be reasonably suggested that agricultural resources and subsistence strategies are not quite as homogeneous as I have suggested. For example with regards to livestock there are differences in the ratio of the domesticated animal species; some sites have a dominance of cattle, whilst others have a dominance of *ovis/capra*, and there are varying ratios and percentages of pig remains in the faunal assemblages. For crops as well some sites have a predominance of wheat, and even demonstrate differing ratios of the species of wheat between emmer and einkorn, whilst at others barley is the dominant crop, and the sites exhibit varying frequencies and species of legumes. However, this should be expected due to the wide range of environmental and climatic conditions across the Near East. Also, despite a general standardisation of many cultural features (architecture, settlement layout, burial habits etc.) in EBA Anatolia there are many regional and site-specific differences. It has been noted that external elements are often modified to be better integrated with local traditions/practices (Massa 2015, 254). This is almost definitely the case regarding agricultural resource choices and subsistence strategies. So whilst the overall agricultural assemblage is homogeneous - the crops and livestock may appear in differing frequencies and ratios but they are all existent - there are certain regional adaptations that are most likely environmentally, climatically, and culturally determined. Crop choices are influenced by the environment, but also by social and economic factors (Miller 1997, 131). Furthermore, the actual meals would probably have varied somewhat from region to region, site to site, and even from household to household. Unfortunately stable isotope analysis is not precise enough to determine exactly how food was prepared and what meals were eaten, instead providing a lifetime average of the types of food eaten and relative inputs of those food resources - i.e. generally speaking the source and types of plant material, and amount, type, and source of protein (Reitsema 2015, 600). Stable isotope analysis can only be used to estimate dietary proportions of known nutrients; it cannot alone tell us what people were eating (Schwarcz & Schoeninger 2011, 738). This also is a limitation when discussing nutrition (what people need to eat) and taste (what people choose to eat) as stable isotope analysis of extracted bone collagen cannot differentiate between the two. Nutrition and taste are two very different things; taste can be a method employed by people to separate themselves from others, as well as being involuntarily forced upon people as an imposed diet or a restriction of access to certain foods/foodstuffs. This is particularly important when reviewing the results discussed in Chapters Five and Six. Taste may help to explain those statistically significant differences of consistent differences in some of the data which I explained as insignificant. If these minor differences in the isotopic data are approached from an idea of taste rather than nutrition, then what on a dietary *nutritional* level are very subtle differences, could in fact be major differences when viewed via dietary *taste*. Also, in the instances of undeniable homogeneity, it may also be considered that this is the result of an imposed or restricted diet. For example, at Titriş Höyük it has been suggested, and I would argue has been supported by my data, that the homogeneity in dietary resources and habits may be the result of centralised control. This would be an example of taste being rather than a matter of choice, quite the opposite, a lack of choice and an imposed diet. The discussion between nutrition and taste in dietary habits further emphasises the importance of using stable isotope analyses in conjunction with other sources. When stable isotope analysis is combined with the known available food resources determined from archaeobotanical and archaeozoological evidence amongst others, and stable isotope analysis is performed on those food resources to achieve food chain baselines then intelligent inferences can be made about individual and population dietary habits. In prehistoric societies before the advent of writing, faunal and botanical analyses provide us with a list of ingredients, stable isotope analysis provides us with information as to which ingredients were consumed and to some extent in what relative amounts, but the recipe of those ingredients still eludes us.

In conclusion it can be stated that this thesis is the result of large scale, holistic bioarchaeological research. Primarily it has produced an important and relatively unique dataset with accompanying conclusions, many of which have been unexpected and have resulted in many more questions being asked than were originally set out to answer, as well as provoking thought and discussion. The data and research has revealed a time when people subsided on a narrow range of domesticated terrestrial resources indicating a high degree of agricultural specialisation and intensification. This has, in turn, contributed to discussions about agricultural specialisation on a wider societal scale, rather than simply a dietary habits one. It seems to be clear that agricultural specialisation in the EBA was as much linked to, and was a key component of, the economy of settlements/people as it was to merely feeding them. This intensification and specialisation of agriculture resulting in a narrow range of dietary resources combined with other socio-economic factors (i.e. greater centralisation and urbanisation) created homogeneity in dietary habits, at least by nutrition if not necessarily taste. This homogeneity in dietary habits raises the issue that we should now potentially reassess the EBA of Anatolia, particularly regarding societal divisions which until now may have been over-emphasised. Whilst homogeneity of dietary habits was initially unexpected and surprising, when viewed in the context of current research and thought into the Anatolian EBA - and especially the latter half of the 3rd millennium BC – the data and conclusions of this research actually fit well. As was discussed in Chapters 1.2, Six, and this final chapter there is a visible increase in the homogenisation of material culture, technology, and habitual practices in the EBA of Anatolia. Bachhuber (2015, 14) sums it up best when he states that "Shared farming practice and diet can be reconstructed in faunal and botanical assemblages, as well as similar technologies of textile manufacture, similar kinds of personal adornment, taste for foreign-inspired objects and materials, and technologies of accountancy that reveal, at the very least, shared regimes of value. Material culture in this region from ca. 2600–2200 BC represents an unprecedented trend towards homogenization. It was not monolithic, but it was part of a historically contingent process through which the inhabitants of these places began to identify with a pan-regional social group."

This thesis provides important information for researchers and significantly contributes to the academic record. Furthermore, this research has demonstrated the importance of inter-disciplinary research as well as showing that holistic approaches are necessary and appropriate in the field of archaeology. Stable isotope analyses and data in isolation are not a particularly strong and effective tool, falling into the category of 'data for the sake of data'. However, when utilised in conjunction with other specialist research, and when all these different datasets are combined, very potent and applicably useful information can be obtained. Despite producing a large volume of raw data and conclusions, further work and research is absolutely necessary to test hypotheses and develop and expand on ideas raised from this research – this should only be the beginning of investigating dietary habits in the EBA/3rd millennium BC of Anatolia and its neighbours (both temporally and spatially).

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Summary of the results

Analysis of carbon and nitrogen stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) was employed on bone collagen from ca. 200 human and faunal osteological samples taken from the laboratory of the Anthropology Department of Hacettepe University, Ankara Turkey. Collagen extraction and the stable isotope analyses were conducted at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany.

The results show that during the EBA in Anatolia there was a general degree of homogeneity in dietary habits at an intra- and inter-site and regional level and across the millennium of the EBA with diets being predominantly terrestrial C3 based. The means of $\delta^{13}C$ and $\delta^{15}N$, respectively, are -20‰ and 8.9‰ for İkiztepe, -19.8‰ and 7.1‰ for Titriş Höyük, -20‰ and 8.6‰ for Bademağacı, and -19.6‰ and 8.3‰ for Bakla Tepe. The range of $\delta^{13}C$ values in the data from all sample sites is 2‰ (-21‰ to -19‰), and for $\delta^{15}N$ it is 4.3‰ (5.8‰ to 10.1‰). Furthermore, the results, in conjunction with published archaeobotanical and archaeozoological research, suggest that we can now begin to discuss about an 'EBA package' with regards to food resources; not only of Anatolia but of the entire Eastern Mediterranean and Near East region. This hypothesis suggests that the narrow and consistent range of stable isotopic data is a result of homogeneity in exploited food resources. This comes from a standardisation of agricultural and subsistence practices. Arable agriculture was based on a narrow range of crops consisting primarily of wheat and barley, with legumes having more variable importance. Caprids and cattle were the most common domesticated animals reared by EBA populations, but these species were increasingly reared and exploited for their secondary products rather than for primary consumption.

Zusammenfassung der Ergebnisse

Analysen von stabilen Kohlenstoff- und Stickstoffisotopen (δ13C und 15N) wurden aus Knochenkollagen von ca. 200 human- und faunal-osteologischen Proben am Labor des Archäologischen Instituts der Hacettepe Universität in Ankara (Türkei) entnommen. Die Extraktion der Kollagen und die Analyse der stabilen Isotope erfolgten am Max-Planck-Institut für evolutionäre Anthropologie in Leipzig.

Die Ergebnisse zeigen, dass während des frühen Bronzezeitalters in Anatolien ein hoher Grad an Homogenität bei den Ernährungsgewohnheiten auf lokalem und regionalem Level vorherrschte sowie über das Jahrtausend hinweg eine auf terrestrischem C3 basierende Ernährung dominierte. Die Mittelwerte von $\delta^{13}C$ und $\delta^{15}N$ betragen in İkiztepe -20‰ bzw. 8,9‰, in Titriş Höyük -19,8‰ bzw. 7,1‰, in Bademağacı -20‰ bzw. 8,6‰ und in Bakla Tepe -19,6‰ bzw. 8,3‰. Die Bandbreite an $\delta^{13}C$-Werten aller untersuchten Orte beträgt 2‰ (-20‰ bis 19‰) und bei $\delta^{15}N$ 4,3‰ (5,8‰ bis 10,1‰). Darüber stimmen die Ergebnisse mit denen von veröffentlichten archäobotanischen und archäozoologischen Untersuchungen überein. Sie können als Grundlage für die Diskussion eines "frühbronzezeitlichen Ernährungsmusters" dienen, nicht nur in Anbetracht der Nahrungsressourcen in Anatolien, sondern des gesamten östlichen Mittelmeerraums sowie des Nahen Ostens. Diese Hypothesen weisen darauf hin, dass die geringe Variabilität bei den Werten der stabilen Isotopen das Ergebnis einer standardisierten Ernährung ist, welche auf die landwirtschaftlichen Fortschritte dieser Zeit zurückgeführt werden kann. Ackerbau konzentrierte sich auf eine geringe Bandbreitevon Ackerfrüchten, hauptsächlich bestehend aus Weizen und Gerste, mit einer variierenden Bedeutung von Leguminosen. Ziegen und Rinder bildeten den größten Anteilder von Menschen der frühen Bronzezeit gezüchteten Tieren. Ihr hauptsächlicher Nutzen bestand jedoch in ihren Sekundärprodukten und nicht in ihrem primären Konsum.

Curriculum Vitae

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Publications:

Irvine B., Thomas J-L., and Schoop U-D. 2014. A macroscopic analysis of human dentition at Late Chalcolithic Çamlıbel Tarlası, North Central Anatolia, with special reference to dietary and non-masticatory habits. *IANSA* 5(1) : 19-30

Conference papers:

Irvine, B. 'Multi-isotopic investigations of diet in Anatolian Early Bronze Age populations' – Paper presented at ASOR (The American Schools of Oriental Research) 2016; 16th-19th November 2016, San Antonio Texas, USA

Irvine B. 'Multi-isotopic investigations of diet in Anatolian Early Bronze Age populations' – Poster presented at 22nd annual meeting of the EAA (European Association of Archaeologists); 31st August-3rd September 2016, Vilnius Lithuania

Irvine B. 'Stable isotopic analysis of dietary habits at Early Bronze Age Bakla Tepe' – Paper presented at 38. Uluslararası Kazı, Araştırma ve Arkeometri Sempozyumu; 23rd-27th May 2016, Edirne Turkey

Irvine B 'Dietary habits of Early Bronze Age Ikiztepe using stable isotope analysis: Preliminary Results' – Paper presented at VI Ulusal Biyolojik Antropoloji Sempozyumu; 26-28th October 2015, Ankara Turkey

Irvine B. 'An isotopic analysis of dietary habits in Early Bronze Age Anatolia: Preliminary results from Titriş Höyük and Bademağacı' – Invited talk for the BIAA (British Institute at Ankara); 5th March 2015, Ankara Turkey

Irvine B. 'Isotopic analysis of dietary habits in Early Bronze Age Anatolia: Preliminary results from Titriş Höyük' – Paper presented at Day of the Dead; 18th-19th October 2014, Belfast UK

Irvine B. 'A macroscopic analysis of human dentition At Çamlıbel Tarlası, North Central Anatolia' – Paper presented at BANEA (British Association for Near Eastern Archaeology) 2013; 3rd-5th January 2013, Cambridge UK. Conference funding awarded

Carbaugh A., Gomez Martinez R., Langstaff H., Irvine B., Thiemann N., and Kranioti E.F. 'Dental analysis of two cemetery populations (Via Punica 34 and Joan Planells) from Ibiza, Spain' – Paper at 13th annual BABAO (British Association for Biological Anthropology and Osteoarchaeology); 2nd-4th September 2011, Edinburgh UK

Appendices

Appendix A: *Osteological and burial data for all sampled individuals (following Bilgi 2005b, Doğan 2006; Erdal ÖD unpublished data and personal communication; Erdal YS 2005, Erdal YS unpublished data and personal communication; Irvine unpublished data; Şahoğlu 2016; the Titriş Höyük database – courtesy of T. Matney; Welton 2010)*

Site	Skeleton Number	Sex	Age (years)	Age Group	Pathologies	Traumatic Injuries	Grave Goods	Grave Type	Skeletal Elements Sampled	Additional Comments
İkiztepe	Sk 57	Female	30-34	Middle Adult	None	None	Yes, metal object (x1)	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 528	Female	24-34	Middle Adult	Possible evidence of tumour on occipital bone	None	Yes, (x2) metal objects	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 532	Female	18-23	Young Adult	None	None	Yes, (x2) metal objects	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 533	Male	43-55	Old Adult	None	None	Yes, (x2) metal objects	Unknown	Rib Tibia	
İkiztepe	Sk 534	Male	25-34	Young Adult	None	None	Yes, (x2) – Spearhead and unknown metal object	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 535	Male	40-55	Old Adult	None	Colle's fracture of left radius	None	Supine in earthen pit	Rib Radius	

Appendix A: *continued*

İkiztepe	Sk 536	Male	26-39	Young Adult/Middle Adult	Non-specific infection proximal end of right fibula shaft	Cranial injuries: x4 peri-mortem penetrating injuries on frontal squama, superior part of frontal bone, left parietal, and right parietal	None	Supine in earthen pit	Rib Femur	Red ochre on some skeletal elements
İkiztepe	Sk 548	N/A	12	Child	None	None	None	Hocker in earthen pit	Rib	
İkiztepe	Sk 550	Female	33-46	Middle Adult	None	None	Yes, (x1)	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 552	Female	19-21	Young Adult	None	Possible well healed BFT to right of sagittal suture	Yes, (x3)	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 553	Male	35-39	Middle Adult	None	None	Yes, (x1) – spearhead	Supine in earthen pit	Rib Femur	Non-local (according to Welton 2010)
İkiztepe	Sk 554	Male	24-30	Young Adult	None	Healed cranial injuries (x2) on frontal bone	Yes, (x11) – spearhead x2, quadruple spiral plaque, metal bracelets x2, spiral wires x2, 'harpoons' x2, horned plaque	Supine in earthen pit	Rib Femur	'Distinguished' burial according to Bilgi 2005b
İkiztepe	Sk 567	Female	24-46	Middle Adult	None	None	Yes, (x1) – 'harpoon'	Supine in earthen pit	Rib Femur	Non-local (according to Welton 2010)

Appendix A: *continued*

İkiztepe	Sk 569	Male	39-44	Middle Adult	None	Cranial injuries: x1 healed on right parietal, x2 peri-mortem penetrating on posterior part of left parietal and on right parietal	Yes, (x11) - spearhead x2, razorblade, dagger, 'harpoon' x2, earrings, bracelets x2, ring shaped lead pendant, horned plaque	Supine in earthen pit	Phalanx Femur	Red ochre on some skeletal elements. 'Mobile' individual (according to Welton 2010) 'Distinguished' burial according to Bilgi 2005b
İkiztepe	Sk 573	Male	33-44	Middle Adult	None	Healed fracture distal end of left radius. Healed cranial injuries (x2) – left supraorbital margin and left frontal	Yes, (x6) – spearheads x2, dagger, 'harpoon', whetstone, razorblade	Supine in earthen pit	Rib Femur	Non-local: long distance immigrant (according to Welton 2010) Distinguished burial according to Bilgi 2005b
İkiztepe	Sk 580	Female	33-46	Middle Adult	None	None	Yes, (x12) – spearhead, 'harpoon', lead earrings set x5, bronze earrings set x2, bracelets x2, frit necklace	Supine in earthen pit	Rib Femur	Distinguished burial according to Bilgi 2005b

Appendix A: *continued*

İkiztepe	Sk 581	Female	39-44	Middle Adult	None	Possible small healed cranial injury on left parietal	Yes, (x8) – dagger x2, ‘harpoon’, disc-shaped pendant, gold earrings x2, frit necklace, ceramic bowl	Supine in earthen pit	Rib Femur	‘Distinguished’ burial according to Bilgi 2005b
İkiztepe	Sk 593	Female	43-58	Old Adult	None	None	Yes, (x2) – earrings and ‘harpoon’	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 595	Male	16-20	Young Adult	None	Possible healed cranial SFT on left frontal	Yes, (x1) - necklace	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 599	Male	20-22	Young Adult	None	None	Yes, (x1) – ‘harpoon’	Supine in earthen pit	Rib Fibula	‘Mobile’ individual (according to Welton 2010)
İkiztepe	Sk 601	Female	25-29	Middle Adult	None	None	Yes, (x2) – x2 earrings	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 602	Male	40-44	Middle Adult	None	None	Yes, (x3) – spearhead, dagger, earring	Supine in earthen pit	Rib Femur	Non-local (according to Welton 2010) Distinguished burial according to Bilgi 2005b
İkiztepe	Sk 603	Male	45-49	Old Adult	Healed non-specific infection on right fibula. Several bands of enamel hypoplasia on mandibular canines.	None	Yes, (x7) – spearhead, earring, ‘harpoons’ x2, ‘fish hook’, axe-head, bone idol	Unknown	Phalanx Tibia	Slight evidence of red ochre on some skeletal elements Distinguished burial according to Bilgi 2005b

Appendix A: *continued*

İkiztepe	Sk 604	N/A	0.08	Baby	None	None	None	Unknown	Rib	
İkiztepe	Sk 609	N/A	0.75	Baby	None	None	Yes, (x1) - bracelet	Supine in earthen pit	Rib	
İkiztepe	Sk 616	N/A	1	Baby	None	None	None	Supine in earthen pit	Rib	
İkiztepe	Sk 624	Male	33-44	Middle Adult	Slight osteoma on right frontal. Slight non-specific infection on lower limbs (mainly fibulae and tibias). Possible evidence of cyst on right ilium fossa next to auricular surface	Cranial injuries: x1 (BFT?) on right parietal, x2 (BFT?) on left parietal, x1 (SFT?) transecting right side of superior nuchal line. Healed fracture of distal end of right ulna (‘parry’ fracture). Healed and remodelled oblique fracture of left clavicle.	None	Unknown	Rib Femur	
İkiztepe	Sk 635	Male	33-49	Young Adult	None	Possible healed Colle’s fracture of left radius. Healed cranial (SFT?) injuries (x2) on left and right parietals	Unknown	Unknown	Rib Fibula	
İkiztepe	Sk 636	N/A	2.25	Baby	None	None	Unknown	Unknown	Rib	
İkiztepe	Sk 637	N/A	0.8	Baby	None	None	Unknown	Unknown	Cranium	
İkiztepe	Sk 639	N/A	0.08	Baby	None	None	Unknown	Unknown	Rib	
İkiztepe	Sk 640	N/A	1.75	Baby	None	None	Unknown	Unknown	Cranium	

***Appendix A:** continued*

İkiztepe	Sk 643	Male	43-55	Old Adult	None	Healed cranial (BFT?) injuries x5 – x3 on right parietal, x2 on left parietal	Yes, (x1) – bronze needle	Hocker on left side in earthen pit	Rib Femur	Non-local (according to Welton 2010)
İkiztepe	Sk 644	Female	19-21	Young Adult	None	None	None	Supine in earthen pit	Rib Fibula	
İkiztepe	Sk 645	Male	35-39	Middle Adult	None	Partly healed cranial injury on left part of occipital planum	Yes, (x3) – dagger, spearhead x2	Unknown	Phalanx Femur	Red ochre on some skeletal elements Distinguished burial according to Bilgi 2005b
İkiztepe	Sk 646	Female	43-59	Old Adult	None	None	Yes, (x6) – x2 copper earrings left ear, x3 copper earrings right ear, bronze bead	Supine in earthen pit	Rib Humerus	
İkiztepe	Sk 650	Male	54-64	Old Adult	None	None	Unknown	Unknown	Rib Femur	
İkiztepe	Sk 652	Female	43-58	Old Adult	None	None	Unknown	Unknown	Rib Femur	
İkiztepe	Sk 654	Female	33-46	Middle Adult	None	None	Unknown	Unknown	Rib Tibia	Red ochre on some skeletal elements
İkiztepe	Sk 656	N/A	2	Baby	None	None	Unknown	Unknown	Rib	
İkiztepe	Sk 659	N/A	3.25	Child	None	None	Yes, (x6) – x2 bracelets, x4 earrings	Supine in earthen pit	Rib	
İkiztepe	Sk 662	N/A	4.5	Child	None	None	Yes, (x2) – x2 earrings	Supine in grave with wood flooring and red paint/ochre	Rib	Red ochre on some skeletal elements, especially skull

Appendix A: *continued*

İkiztepe	Sk 664	Female	18-21	Young Adult	None	None	Yes, (x1) – white and blue stone bead necklace	Unknown	Rib Fibula	
İkiztepe	Sk 665	Male (?)	15-16	Young Adult	None	None	None	Supine in earthen pit	Rib Femur	
İkiztepe	Sk 667	Female	24-34	Young Adult	None	Healed fracture of right clavicle: re-union not complete	Unknown, possibly x2 earrings	Unknown	Rib Femur	
İkiztepe	Sk 668	Female	20-30	Young Adult	None	Possible healed fracture of right ischiopubic ramus with callous formation. Healed cranial (BFT?) injury on frontal bone	Yes, (x2) – necklace, and ring(s)	Supine in earthen pit	Rib Tibia	
İkiztepe	Sk 671	N/A	0.5	Baby	None	None	None	Unknown	Rib	
İkiztepe	Sk 675	Male	33-44	Middle Adult	None	Possible signs of muscle/tendon trauma or calcification of tendon attachment on left humerus. Cranial injury: x1 healed on left part of frontal bone, also possible healed injury on superior part of frontal bone	Yes, (x2) – 'harpoon', necklace	Unknown	Rib Fibula	Possible δO^{18} outlier (according to Welton 2010)

Appendix A: *continued*

İkiztepe	Sk 677	Female	33-46	Middle Adult	None	Healed rib fractures x6. Ante-mortem rib fracture with non-union.	None	Unknown	Rib Femur	
İkiztepe	Sk 678	Female	33-46	Middle Adult	None	None	Unknown	Unknown	Rib	No long bones present for sampling
İkiztepe	Sk 698	N/A	6	Child	None	None	Unknown	Unknown	Phalanx Femur	
İkiztepe	ITN 103	N/A	0.5	Baby	None	None	Unknown	Unknown	Rib	
İkiztepe	ITN 117	N/A	0.29	Baby	None	None	Unknown	Unknown	Rib	
İkiztepe	ITN 122	N/A	1.5	Baby	None	None	Unknown	Unknown	Rib	
İkiztepe	ITN 123	N/A	0.29	Baby	None	None	Unknown	Unknown	Rib	
İkiztepe	ITN 298	N/A	1.75	Baby	None	None	Unknown	Unknown	Rib	
Titriş Höyük	’91 TH 159	N/A	2	Baby	None	None	Unknown	Pot grave	Rib	
Titriş Höyük	’91 TH 840	Female	-	Young Adult	None	None	Unknown	Pot grave	Phalanx Femur	
Titriş Höyük	’91 TH 848	Female	35-45	Middle Adult	None	None	Unknown	Pot grave	Femur	No short turnover bones available for sampling
Titriş Höyük	’93 TH 5271	Female	38-42	Middle Adult	None	None	Unknown	Cist grave	Rib Femur	
Titriş Höyük	’94 TH 5520	Male	41-50	Old Adult	Possible osteoma on superior part of left parietal	None	Unknown	Cist grave	Rib Femur	
Titriş Höyük	’94 TH 7104	N/A	4	Child	None	None	Unknown	Cist grave	Rib	
Titriş Höyük	’94 TH 7556	Male (?)	-	Adult	None	None	Unknown	Cist grave	Rib Femur	
Titriş Höyük	’94 TH 7575/1	Female	-	Adult	None	None	Unknown	Cist grave	Rib Femur	

Appendix A: *continued*

Titriş Höyük	’94 TH 8072	Male (?)	49-50	Old Adult	None	None	Unknown	Unknown	Femur	No short turnover bones available for sampling
Titriş Höyük	’96 TH 60213	Male	-	Young Adult (?)	None	None	Unknown	Cist grave	Phalanx Ulna	
Titriş Höyük	’96 TH 60214	Female	-	Young Adult	None	None	Unknown	Cist grave	Phalanx Humerus	
Titriş Höyük	’96 TH 60538	Female	-	Young Adult	None	None	Unknown	Pit grave	Rib Femur	
Titriş Höyük	’96 TH 63202/1	Male	-	Adult	None	Healed cranial injury	Unknown	Cist grave	Phalanx Femur	
Titriş Höyük	’96 TH 65142	Female	-	Young Adult	None	None	Unknown	Cist grave	Femur	No short turnover bones available for sampling
Titriş Höyük	’96 TH 65165	Female	40-45	Middle Adult	None	None	Unknown, although presence of x2 Syrian bottles amongst other unspecified objects	Intramural tomb grave	Rib Femur	From same tomb (B96.65) as TH 65166. This tomb contained eight adult individuals, and also two pot graves of sub-adults in total.

Appendix A: *continued*

Titriş Höyük	'96 TH 65166	Male	46-47	Old Adult	None	None	Unknown, although presence of x2 Syrian bottles amongst other unspecified objects	Intramural tomb grave	Rib Femur	From same tomb (B96.65) as TH 65165. This tomb contained eight adult individuals, and also two pot graves of sub-adults in total.
Titriş Höyük	'96 TH 62636	Female	15-16	Young Adult	None	Slight healed injury on frontal bone	Yes – x1 cup (ceramic?), x4 bronze earrings	Cist or pot grave (two halves of a storage jar placed over articulated skeleton)	Rib Fibula	Skull to the west, facing north east
Titriş Höyük	'98 TH 80090	-	-	Adult	-	-	-	Plaster Basin	Femur	x13 femurs of the Plaster Basin deposition
Titriş Höyük	'98 TH 81008	Female	33-46	Middle Adult	None	None	Unknown	Cist grave	Rib Tibia	
Bademağacı	Sk 2000 No. 1a	Female	25-30	Young Adult	None	None	Unknown	Unknown	Fibula	Multiple grave – shared with Sk 2000 No. 1b
Bademağacı	Sk 2000 No. 1b	Female	20-25	Young Adult	None	None	Unknown	Unknown	Tibia	Multiple grave – shared with Sk 2000 No. 1a
Bademağacı	Sk 2000 No. 2	Female	15-30	Young Adult	None	None	Unknown	Under stone floor	Phalanx Femur	
Bademağacı	Sk 2004 No.3	N/A	3	Child	None	None	Unknown	Jar grave	Rib	Grave from inside Megaron

Appendix A: *continued*

Bademağacı	Sk 2008 No. 1	N/A	1.5-2	Baby	None	None	Unknown	Jar grave	Rib	
Bademağacı	Sk 2008 No.3	N/A	9	Child	None	None	Unknown	Pithos grave	Rib	Grave from inside a room
Bademağacı	Sk 2009 No. 5	Female	45-55	Old Adult	None	None	Unknown	Pithos grave	Phalanx Tibia	
Bademağacı	Sk 2009 No. 6	Male	24-34	Young Adult	Non-specific infection on posterior sides of lower limb bones	Ante- and peri-mortem cranial traumatic injuries	Unknown	Pithos grave	Rib Tibia	Grave was from inside Megaron (south-west part)
Bademağacı	Sk 2010 No. 1	Female (?)	30-45	Middle Adult	None	None	Unknown	Unknown	Rib Femur	
Bademağacı	Sk 2010 No. 4	N/A	0.67	Baby	None	None	Unknown	Jar grave	Rib	
Bademağacı	Sk 2010 No. 5	Female	30-35	Middle Adult	None	None	Unknown	Unknown	Rib Femur	
Bakla Tepe	1996 G-24	Male	28.3	Young Adult	None	Healed fracture of a distal phalanx.	Unknown	Possible earthen pit grave	Rib Femur	

Appendix A: *continued*

Bakla Tepe	1996 G-25	Male	-	Adult	Osteoma on frontal bone	Healed cranial fracture on left parietal.	Yes, (>4) – x2 small bronze daggers, x2 black slipped beak spouted jugs, copper rods with curved ends (necklace beads?)	Pithos grave	Femur	No short turnover bones present for sampling. Large pithos grave. Layer of sand immediately under skeleton. Disarticulated remains of a child also found in this pithos.
Bakla Tepe	1997 G-40/1	Male	37.25	Middle Adult	Slight lipping on some vertebrae	Healed cranial injuries – frontal bone and left parietal	Yes, (x5) – flaring beak-spouted jar, small bronze dagger, x2 necklace beads, metal borer	Stone cist grave	Rib Tibia	Layer of sand immediately under skeleton. Disarticulated remains of a child also found in this cist grave
Bakla Tepe	1997 G-60	Male	37	Middle Adult	None	None	Unknown	Unknown	Rib Fibula	
Bakla Tepe	1997 G-62	Male	26.75	Young Adult	Joint disease on distal end of right ulna	None	Unknown	Unknown	Rib Femur	
Bakla Tepe	1997 G-63	Male	37	Middle Adult	None	None	Unknown	Unknown	Rib Femur	

Appendix A: *continued*

Bakla Tepe	19997 G-65	Male	41.75	Middle Adult	Arthritis on some vertebrae. TMJD on left mandibular condyle. Sever dental attrition, wear, and AMTL of mandibular molars. Some pronounced muscle markers.	None	Unknown	Unknown	Rib Tibia	
Bakla Tepe	1997 G-67	Female	35-44	Middle Adult	None	None	Unknown	Unknown	Rib Femur	
Bakla Tepe	1998 G-106	Female	-	Adult	None	None	Unknown	Unknown	Rib Tibia	
Bakla Tepe	1998 G-107/1	Male	32.5	Middle Adult	None	None	Unknown	Stone cist grave	Phalanx Femur	Layer of sand immediately below skeleton. G-107/2 and G-107/3 found as a secondary deposition outside of this grave – likely moved to make room for G-107/1
Bakla Tepe	1998 G-107/2	Male	-	Adult	None	None	Unknown	Secondary deposition – probably previously inside stone cist grave	Rib Tibia	Found immediately outside of stone cist grave of G-107/1 and next to G-107/3

Appendix A: *continued*

Bakla Tepe	1998 G-107/3	Male	34	Middle Adult	None	None	Unknown	Secondary deposition – probably previously inside stone cist grave	Rib Femur	Found immediately outside of stone cist grave of G-107/1, next to G-107/2
Bakla Tepe	2000 G-243/1	Female	37	Middle Adult	Slight non-specific infection on left tibia and fibula shaft.	None	Unknown	Pithos grave	Rib Tibia	Multiple grave – also contained G-243/2 and G-243/3
Bakla Tepe	2000 G-243/2	Female	44.75	Middle Adult	Possible evidence indicative of having given birth	Fracture of left mandible angle/ramus with corresponding affected area on left parietal/mastoid area	Unknown	Pithos grave	Phalanx Femur	Multiple grave – also contained G-243/1 and G-243/3
Bakla Tepe	2000 G-243/3	Male (?)	42	Middle Adult	Arthritis (lipping) on some vertebrae. Lipping and eburnation on distal end of left radius (ulna notch). Slight lipping on proximal end of right ulna. Moderate-severe lipping on proximal end (joint surface) of left ulna. Eburnation on distal end (capitulum) of left humerus.	Healed 'parry' fracture, distal end of left ulna. Healed rib fractures.	Unknown	Pithos grave	Rib Femur	Multiple grave – also contained G-243/1 and G-243/2

Appendix A: *continued*

Bakla Tepe	2000 G-244	Male	-	Young Adult	None	None	Unknown	Pithos grave	Phalanx Femur	
Bakla Tepe	2001 G-259	Female	19	Young Adult	None	None	Unknown	Pithos grave	Rib Femur	
Bakla Tepe	2001 G-266/1	Female	37.4	Middle Adult	Arthritis on right patella. Severe caries on many of the dentition. Slight non-specific infection on fibulae and tibias.	Fractured distal end of phalanx	Unknown	Pithos grave	Rib Femur	
Bakla Tepe	2001 G-275/1	Male (?)	47	Old Adult	Infection on right tibia and fibula – possibly osteomyelitis. Problematic shape and angle of femoral heads and necks.	None	Unknown	Pithos grave	Phalanx Tibia	Multiple grave – also contained G-275/2 and G-275/3
Bakla Tepe	2001 G-275/2	Female (?)	40	Middle Adult	Cribra Orbitalia present. Anklyosis on first couple of thoracic vertebrae as well as lipping and arthritis on other vertebrae.	Healed rib fracture	Unknown	Pithos grave	Rib Tibia	Multiple grave – also contained G-275/1 and G-275/3
Bakla Tepe	2001 G-275/3	Female	25-40	Adult	None	Healed cranial injury (BFT?) on frontal bone	Unknown	Pithos grave	Rib Femur	Multiple grave – also contained G-275/1 and G-275/2

Appendix A: *continued*

Bakla Tepe	2001 G-296	Female	41	Middle Adult	None	Trephination	Yes, (x5) – battle axe, ‘razor’/knife, x2 spouted jugs, ceramic vessel, bone seal in shape of a bird	Pithos grave (single inhumation)	Rib Tibia	Grave larger than other individuals from the same site
Bakla Tepe	2001 G-314/1	Female	39.5	Middle Adult	Severe dental attrition and loss	Healed fracture of distal end of left ulna and distal end of right radius	Unknown	Pithos grave	Phalanx Tibia	
Bakla Tepe	2001 G-319/1	Female	27.5	Young Adult	None	None	Unknown	Pithos grave	Rib Fibula	
Bakla Tepe	2001 G-322/2	Female	30-45	Middle Adult	Enamel hypoplasia, especially on mandibular teeth. Osteoarthritis (lipping and eburnation) on right patella.	Healed cranial injury on posterior part of left parietal	Unknown	Pithos grave	Rib Tibia	

Appendix B: *Figures of a selection of traumatic injuries from İkiztepe. Each image is numbered and captioned for ease*

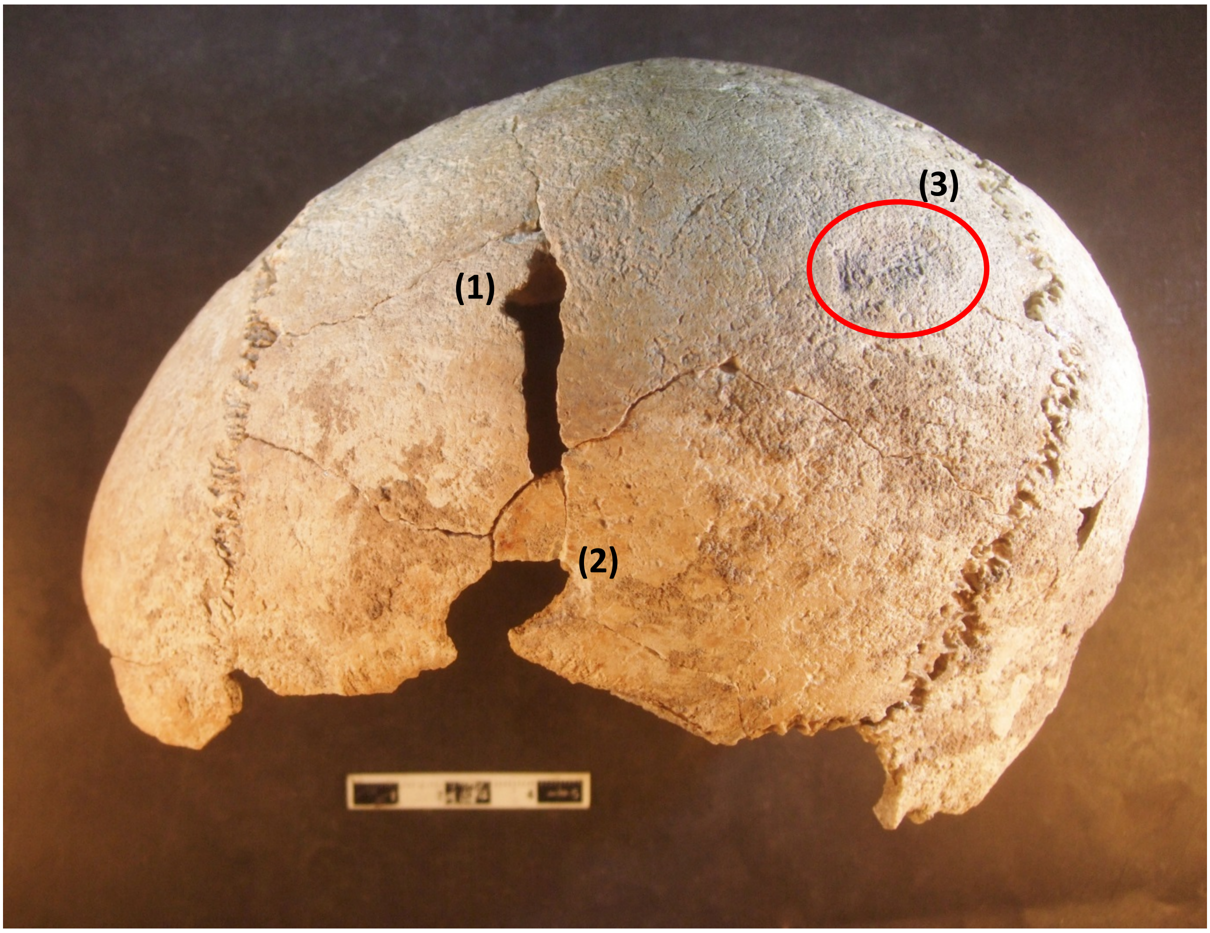
B.1: Healed fracture on right clavicle of Sk 667 (YA Female)

B.2: Perimortem penetrating cranial injuries on right parietal (left image) and posterior part of the left parietal, just above the lambdoid suture (right image) of Sk 569 (MA Male)

B.3: Healed ‘parry fracture’ (highlighted with arrow) on distal end of right ulna, Sk 624 (MA Male)

Appendix C: *Figures of a selection of traumatic injuries from Titriş Höyük. Each image is numbered and captioned for ease*

C.1: Perimortem penetrating cranial injury on left frontal of TH 80073 (MA Male from the Plaster Basin burial feature)



C.2: Perimortem penetrating cranial injuries (1) and (2), and healed possible BFT (3) on left parietal of TH 80084 (MA Male from the Plaster Basin burial feature)

Appendix D: *Figures of a selection of traumatic injuries from Bademağacı. Each image is numbered and captioned for ease*

D.1: Perimortem cranial injuries (highlighted with arrows) on parietal of Sk 2009 No. 6 (YA Male)

Appendix E: *Figures of a selection of traumatic injuries from Bakla Tepe. Each image is numbered and captioned for ease*

E.1: Healed cranial trauma on frontal bone of G-40/1 (MA Male from the EBA I cemetery)

E.2: Healed cranial fracture on right parietal of G-25 (Adult Male from the EBA I cemetery). Second image shows fracture highlighted in red

E.3: Healed 'parry fracture' (highlighted with arrow) on distal end of left ulna of G-243/3 (MA Male from the EBA II/III cemetery)

Appendix F: *Output data of stable isotope analysis of humans from İkiztepe. Note: those in italics are samples which were discarded*

Skeleton #	Sex	Age Group	Skeletal element	(a) or (b) run	%C	%N	C:N	$\Delta^{13}C$ (‰)	$\Delta^{15}N$ (‰)
Sk 57	F	MA	Rib	a	43.9	16	3.2	-20.2	8.5
Sk 57	F	MA	Rib	b	44.5	16.2	3.2	-20.3	8.4
Sk 57	F	MA	Femur	a	38.6	14.1	3.2	-20.3	8.6
Sk 57	F	MA	Femur	b	38.5	14.2	3.2	-20.4	8.4
Sk 528	F	MA	Rib	a	45.2	16.2	3.3	-19.9	8.9
Sk 528	F	MA	Rib	b	44.4	16	3.2	-20	8.8
Sk 528	F	MA	Femur	a	44.3	15.7	3.3	-20	8.7
Sk 528	F	MA	Femur	b	44.5	15.8	3.3	-20	8.7
Sk 532	F	YA	Rib	a	45.3	16.7	3.2	-19.8	8.9
Sk 532	F	YA	Rib	b	44.6	16.4	3.2	-19.8	8.9
Sk 532	F	YA	Femur	a	47.4	15.7	3.5	-20.2	8.8
Sk 532	F	YA	Femur	b	44.5	15.8	3.3	-20.2	8.8
Sk 533	M	OA	Rib	a	44	16	3.2	-19.6	9.3
Sk 533	M	OA	Rib	b	44.1	16	3.2	-19.7	9.3
Sk 533	M	OA	Tibia	a	46.7	17.1	3.2	-19.7	9.2
Sk 533	M	OA	Tibia	b	45.7	16.7	3.2	-19.7	9.2
Sk 534	M	YA	Rib	a	44.1	15.9	3.2	-19.5	10.1
Sk 534	M	YA	Rib	b	43.7	15.8	3.2	-19.5	10
Sk 534	M	YA	Femur	a	45	16.3	3.2	-19.6	9.8
Sk 534	M	YA	Femur	b	45.4	16.5	3.2	-19.7	9.8
Sk 535	M	OA	Rib	a	40.4	14.5	3.3	-20.4	8.3
Sk 535	M	OA	Rib	b	40	14.4	3.3	-20.4	8.2
Sk 535	M	OA	Radius	a	44	15.8	3.3	-20.2	8.5
Sk 535	M	OA	Radius	b	43.5	15.5	3.3	-20.3	8.3
Sk 536	M	YA/MA	Rib	a	26.5	9.8	3.1	-19.9	8.7
Sk 536	M	YA/MA	Rib	b	45.1	16.5	3.2	-20.2	8.8
Sk 536	M	YA/MA	Femur	a	45.2	16.6	3.2	-20.3	8.7
Sk 536	M	YA/MA	Femur	b	44.5	16.3	3.2	-20.4	8.8
Sk 548	-	Child (12 years)	Rib	a	47	16.9	3.3	-20.4	8.4

Appendix F: *continued*

Sk 548	-	Child (12 years)	Rib	b	45.6	16.4	3.2	-20.2	8.6
Sk 550	F	MA	Rib	a	46	16.9	3.2	-20	9
Sk 550	F	MA	Rib	b	45.9	16.7	3.2	-20.1	9
Sk 550	F	MA	Femur	a	43.5	15.5	3.3	-20.1	9
Sk 550	F	MA	Femur	b	43.4	15.4	3.3	-20.2	8.9
Sk 552	F	YA	Rib	a	46.2	16.7	3.2	-20	8.3
Sk 552	F	YA	Rib	b	45.7	16.5	3.2	-20.1	8.3
Sk 552	F	YA	Femur	a	45.2	16.2	3.3	-20	8.4
Sk 552	F	YA	Femur	b	45.1	16.3	3.2	-20	8.3
SK 553	M	MA	Rib	a	45.5	16.6	3.2	-20	9.4
Sk 553	M	MA	Rib	b	45	16.4	3.2	-20	9.4
Sk 553	M	MA	Femur	a	47.4	15.9	3.5	-19.8	9
Sk 553	M	MA	Femur	b	45.3	15.9	3.3	-19.9	8.9
Sk 554	M	YA	Rib	a	46.9	17	3.2	-19.7	9.6
Sk 554	M	YA	Rib	b	46.4	16.7	3.2	-19.7	9.7
Sk 554	M	YA	Femur	a	44.6	16	3.3	-19.8	9.6
Sk 554	M	YA	Femur	b	45.1	16	3.3	-19.8	9.6
Sk 567	F	MA	Rib	a	43.7	15.9	3.2	-20.2	7.4
Sk 567	F	MA	Rib	b	43.1	15.7	3.2	-20.3	7.4
Sk 567	F	MA	Femur	a	45.3	16.5	3.2	-20.3	8.2
Sk 567	F	MA	Femur	b	43.7	15.8	3.2	-20.2	8.2
Sk 569	M	MA	Phalange	a	43.9	16.1	3.2	-19.8	9.7
Sk 569	M	MA	Phalange	b	44.6	16.1	3.2	-19.8	9.9
Sk 569	M	MA	Femur	a	43.1	15.6	3.2	-19.8	9.9
Sk 569	M	MA	Femur	b	43.5	16.2	3.1	-19.8	10.3
Sk 573	M	MA	Rib	a	46.6	16.8	3.2	-19.7	9.4
Sk 573	M	MA	Rib	b	46.3	16.5	3.3	-19.8	9.4
Sk 573	M	MA	Femur	a	43.2	15.7	3.2	-19.6	9.4
Sk 573	M	MA	Femur	b	42.7	15.4	3.2	-19.6	9.4
Sk 580	F	MA	Rib	a	45.5	16.5	3.2	-20	9.2
Sk 580	F	MA	Rib	b	45.3	16.3	3.2	-19.9	9.2
Sk 580	F	MA	Femur	a	46.9	16.2	3.4	-20	9
Sk 580	F	MA	Femur	b	44.7	16.3	3.2	-20	8.9
Sk 581	F	MA	Rib	a	43.8	16.1	3.2	-19.4	9.5

Appendix F: *continued*

Sk 581	F	MA	Rib	b	44.3	16.3	3.2	-19.4	9.4
Sk 581	F	MA	Femur	a	43	15.8	3.2	-19.7	9.1
Sk 581	F	MA	Femur	b	43.3	15.9	3.2	-19.6	9.1
Sk 593	F	OA	Rib	a	43.6	16	3.2	-20.3	8.5
Sk 593	F	OA	Rib	b	44.1	16.1	3.2	-20.4	8.6
Sk 593	F	OA	Femur	a	47	15.8	3.5	-20.3	8.7
Sk 593	F	OA	Femur	b	45.2	15.8	3.3	-20.3	8.6
Sk 595	M	YA	Rib	a	45.9	16.4	3.3	-19.9	8.3
Sk 595	M	YA	Rib	b	45.4	16.1	3.3	-19.9	8.4
Sk 595	M	YA	Femur	a	44.7	15.4	3.4	-19.8	8.3
Sk 595	M	YA	Femur	b	43.8	15.8	3.2	-19.8	8.2
Sk 599	M	YA	Rib	a	41	14.6	3.3	-19.9	8.6
Sk 599	M	YA	Rib	b	41	14.6	3.3	-20	8.4
Sk 599	M	YA	Fibula	a	38.5	13.6	3.3	-20.1	8.7
Sk 599	M	YA	Fibula	b	38.2	13.4	3.3	-20.1	8.8
Sk 601	F	MA	Rib	a	43.7	15.8	3.2	-20.1	8.3
Sk 601	F	MA	Rib	b	43.4	15.5	3.3	-20.1	8.2
Sk 601	F	MA	Femur	a	41.3	15.1	3.2	-19.9	8.3
Sk 601	F	MA	Femur	b	41.2	14.9	3.2	-19.9	8.2
Sk 602	M	MA	Rib	a	43.7	15.8	3.2	-19.5	9.4
Sk 602	M	MA	Rib	b	43.3	15.4	3.3	-19.6	9.4
Sk 602	M	MA	Femur	a	45.2	16.2	3.3	-19.7	9.5
Sk 602	M	MA	Femur	b	45	16	3.3	-19.6	9.4
Sk 603	M	OA	Phalange	a	44.9	16.3	3.2	-20.1	8.9
Sk 603	M	OA	Phalange	b	44.2	15.8	3.3	-20.1	9.1
Sk 603	M	OA	Tibia	a	44.2	16	3.2	-20	8.9
Sk 603	M	OA	Tibia	b	44	15.8	3.2	-19.8	9
Sk 624	M	MA	Rib	a	44.7	16.3	3.2	-19.6	9.1
Sk 624	M	MA	Rib	b	44.4	16.1	3.2	-19.6	9.1
Sk 624	M	MA	Femur	a	44.8	16.4	3.2	-19.6	8.8
Sk 624	M	MA	Femur	b	45	16.4	3.2	-19.6	8.9
Sk 635	M	YA	Rib	a	45.6	16.7	3.2	-19.7	9.8
Sk 635	M	YA	Rib	b	45.2	16.4	3.2	-19.7	9.6
Sk 635	M	YA	Fibula	a	47.4	16.3	3.4	-20	9.9
Sk 635	M	YA	Fibula	b	45	16.1	3.3	-19.9	9.9
Sk 643	M	OA	Rib	a	45.7	16.7	3.2	-19.7	9

Appendix F: *continued*

Sk 643	M	OA	Rib	b	44.9	16.2	3.2	-19.8	9
Sk 643	M	OA	Femur	a	41.6	15	3.2	-20	9.3
Sk 643	M	OA	Femur	b	41	14.7	3.3	-20	9.2
Sk 644	F	YA	Rib	a	44.1	15.8	3.3	-20.6	8.6
Sk 644	F	YA	Rib	b	44	15.6	3.3	-20.7	8.5
Sk 644	F	YA	Fibula	a	44.3	15.9	3.3	-20.8	8.4
Sk 644	F	YA	Fibula	b	44.1	15.7	3.3	-20.8	8.4
Sk 645	M	MA	Phalanx	a	45	16.3	3.2	-19.8	8.9
Sk 645	M	MA	Phalanx	b	45.2	16.3	3.2	-19.8	9.1
Sk 645	M	MA	Femur	a	44	16	3.2	-19.8	8.4
Sk 645	M	MA	Femur	b	44.4	15.9	3.3	-19.9	8.7
Sk 646	F	OA	Rib	a	42.3	15.2	3.2	-20	8.6
Sk 646	F	OA	Rib	b	41	14.6	3.3	-19.9	8.6
Sk 646	F	OA	Humerus	a	39.5	14.1	3.3	-20	8.3
Sk 646	F	OA	Humerus	b	38.5	13.7	3.3	-20	8.3
Sk 650	M	OA	Rib	a	44	15.6	3.3	-20.3	9.3
Sk 650	M	OA	Rib	b	43.7	15.4	3.3	-20.2	9.3
Sk 650	M	OA	Femur	a	43.8	15.9	3.2	-19.9	9.3
Sk 650	M	OA	Femur	b	44.1	15.9	3.2	-20	9.3
Sk 652	F	OA	Rib	a	39.7	14.4	3.2	-20.6	9.5
Sk 652	F	OA	Rib	b	39.8	14.3	3.2	-20.7	9.4
Sk 652	F	OA	Femur	a	43.7	15.4	3.3	-20.8	9.3
Sk 652	F	OA	Femur	b	44.1	15.6	3.3	-20.8	9.2
Sk 654	F	MA	Rib	a	44.6	16.8	3.2	-19.8	8.8
Sk 654	F	MA	Rib	b	44	16	3.2	-19.7	8.8
Sk 654	F	MA	Tibia	a	44.3	16.2	3.1	-19.7	8.5
Sk 654	F	MA	Tibia	b	45	16.3	3.2	-19.7	8.7
Sk 662	-	Child (4.5 years)	Rib	a	43.2	15.7	3.2	-20.5	8.9
Sk 662	-	Child (4.5 years)	Rib	b	43.8	15.8	3.2	-20.5	8.9
Sk 664	F	YA	Rib	a	44.7	16.4	3.2	-19.9	9.3
Sk 664	F	YA	Rib	b	45	16.5	3.2	-19.9	9.3
Sk 664	F	YA	Fibula	a	48.4	16.4	3.4	-20.4	9

Appendix F: *continued*

Sk 664	F	YA	Fibula	b	45.3	16.4	3.2	-20.1	8.9
Sk 665	M(?)	YA	Rib	a	44.1	16.3	3.2	-19.8	8.7
Sk 665	M(?)	YA	Rib	b	44.7	16.4	3.2	-19.9	8.7
Sk 665	M(?)	YA	Femur	a	47.9	16.2	3.5	-19.8	8.9
Sk 665	M(?)	YA	Femur	b	4	15.8	3.3	-19.9	8.9
Sk 667	F	YA	Rib	a	44.1	16.3	3.2	-20.2	8.3
Sk 667	F	YA	Rib	b	44.8	16.2	3.2	-20.1	8.5
Sk 667	F	YA	Femur	a	47.2	15.6	3.5	-20.1	8.5
Sk 667	F	YA	Femur	b	45.2	15.6	3.4	-20.2	8.5
Sk 668	F	YA	Rib	a	44.2	16.1	3.2	-19.6	8.8
Sk 668	F	YA	Rib	b	44.8	16.3	3.2	-19.8	8.9
Sk 668	F	YA	Tibia	a	42.7	16.2	3.1	-19.9	9
Sk 668	F	YA	Tibia	b	44.1	16	3.2	-19.8	9.2
Sk 675	M	MA	Rib	a	44.4	16.3	3.2	-19.8	8.6
Sk 675	M	MA	Rib	b	45	16.5	3.2	-19.9	8.6
Sk 675	M	MA	Fibula	a	45.3	16.6	3.2	-19.9	8.5
Sk 675	M	MA	Fibula	b	44.9	16.2	3.2	-19.8	8.7
Sk 677	F	MA	Rib	a	43.9	16.2	3.2	-19.5	9.8
Sk 677	F	MA	Rib	b	44.4	16.4	3.2	-19.6	9.8
Sk 677	F	MA	Femur	a	48.4	16.2	3.5	-19.8	10
Sk 677	F	MA	Femur	b	45	15.7	3.4	-19.9	9.9
Sk 678	F	MA	Rib	a	42.9	15.7	3.2	-19.8	9
Sk 678	F	MA	Rib	b	43.4	15.8	3.2	-19.8	9
Sk 698	-	Child (6 years)	Phalanx	a	41	15.8	3	-19.7	8.3
Sk 698	-	Child (6 years)	Phalanx	b	44.7	15.9	3.3	-19.6	8.6
Sk 698	-	Child (6 years)	Femur	a	43.7	15.7	3.3	-19.6	8.3
Sk 698	-	Child (6 years)	Femur	b	43.8	15.6	3.3	-19.7	8.3

Appendix G: *Output data of stable isotope analysis of faunal remains from İkiztepe. Note: those in italics are samples which were discarded*

Skeleton #	Animal Species	Skeletal element	(a) or (b) run	%C	%N	C:N	$\Delta^{13}C$ (‰)	$\Delta^{15}N$ (‰)
Sk 624	Sheep/Goat	Femur	a	49	16	3.6	-20.4	6.8
Sk 624	Sheep/Goat	Femur	b	45.2	15.8	3.3	-20.1	6.8
Sk 624	*Sheep/Goat*	*Humerus*	*a*	*47.6*	*15.4*	*3.6*		
Sk 624	Sheep/Goat	Humerus	b	45	15	3.5	-23	6
Sk 624	Sheep/Goat	Navicular cuboid	a	47.4	15.9	3.5	-21.3	7.7
Sk 624	Sheep/Goat	Navicular cuboid	b	44.7	16.1	3.3	-21.1	7.7
Sk 644	Pig	Metacarpal	a	39.6	13.9	3.3	-20.4	7.2
Sk 644	Pig	Metacarpal	b	39.3	13.7	3.3	-20.4	7.3
Sk 645	Pig	Phalanx	a	33.4	11.6	3.4	-21.1	5.2
Sk 645	Pig	Phalanx	b	37.2	12.6	3.4	-21	5.6
Sk 667	Sheep/Goat	Metatarsal	a	47.1	15.6	3.5	-19.3	5.3
Sk 667	Sheep/Goat	Metatarsal	b	45.2	16.1	3.3	-19	5.3
Sk 667	Cow	Radius	a	43.8	16.1	3.2	-20.8	4.1
Sk 667	Cow	Radius	b	44	16.1	3.2	-20.7	4.1
Sk 668	*Sheep/Goat*	*Pelvis*	*a*	-	-	-	-	-
Sk 668	Sheep/Goat	Pelvis	b	41	14.4	3.3	-19.8	7.9
Sk 678	Sheep/Goat	Metacarpal	a	40.1	14.3	3.3	-19.2	8
Sk 678	Sheep/Goat	Metacarpal	b	40.2	14.3	3.3	-19.1	8

***Appendix H:** Output data of stable isotope analysis of humans from Titriş Höyük. Note: those in italics are samples which were discarded*

Skeleton #	Sex	Age Group	Skeletal element	(a) or (b) run	%C	%N	C:N	$\Delta^{13}C$	$\Delta^{15}N$
’91 TH 159	-	*Baby (2 years)*	*Rib*	*a*	*41.6*	*14.6*	*3.3*	*-19.5*	*9.4*
’91 TH 159	-	Baby (2 years)	Rib	b	40.3	14.2	3.3	-19.3	9.4
'91 TH 840	F	YA	Phalanx	a	31.5	11.2	3.3	-20.5	6.6
'91 TH 840	F	YA	Phalanx	b	31.8	11.4	3.3	-20.3	6.7
'91 TH 840	F	YA	Femur	a	29.6	9.8	3.5	-20.7	7.0
'91 TH 840	F	YA	Femur	b	24.3	8.1	3.5	-20.7	6.8
'91 TH 848	*F*	*MA*	*Femur*	*a*	*47.2*	*0.3*	*191.1*	*-34.6*	*-0.4*
'91 TH 848	*F*	*MA*	*Femur*	*b*	*0.0*	*0.4*	*0.0*	*0.0*	*-0.3*
'93 TH 5271	F	MA	Rib	a	23.3	8.2	3.3	-20.0	7.7
'93 TH 5271	F	MA	Rib	b	29.0	10.5	3.2	-19.7	7.8
'93 TH 5271	*F*	*MA*	*Femur*	*a*	*54.9*	*0.3*	*192.1*	*-34.6*	*6.9*
'93 TH 5271	*F*	*MA*	*Femur*	*b*	*0.0*	*0.4*	*0.0*	*0.0*	*7.4*
'94 TH 5520	*M*	*OA*	*Rib*	*a*	*4.5*	*1.3*	*3.9*	*-20.9*	*7.3*
'94 TH 5520	*M*	*OA*	*Rib*	*b*	*5.0*	*1.5*	*3.9*	*-20.5*	*5.7*
'94 TH 5520	*M*	*OA*	*Femur*	*a*	-	-	-	-	-
'94 TH 5520	*M*	*OA*	*Femur*	*b*	-	-	-	-	-

Appendix H: *continued*

'94 TH 7104	-	*Child (4 years)*	*Rib*	*a*	-	-	-	-	-
'94 TH 7104	-	*Child (4 years)*	*Rib*	*b*	-	-	-	-	-
'94 TH 7556	M (?)	Adult	Rib	a	36.8	12.0	3.6	-20.4	5.8
'94 TH 7556	M (?)	Adult	Rib	b	37.0	13.1	3.3	-20.3	5.8
'94 TH 7556	*M (?)*	*Adult*	*Femur*	*a*	-	-	-	-	-
'94 TH 7556	*M (?)*	*Adult*	*Femur*	*b*	-	-	-	-	-
'94 TH 7575/1	F	Adult	Rib	a	26.9	9.1	3.5	-19.8	6.4
'94 TH 7575/1	F	Adult	Rib	b	28.7	10.1	3.3	-19.9	6.3
'94 TH 7575/1	*F*	*Adult*	*Femur*	*a*	*2.7*	*0.8*	*4.1*	*-22.5*	*4.3*
'94 TH 7575/1	*F*	*Adult*	*Femur*	*b*	*4.6*	*1.3*	*4.3*	*-21.2*	*4.8*
'94 TH 8072	M (?)	OA	Femur	a	40.7	13.9	3.4	-19.9	6.7
'94 TH 8072	M (?)	OA	Femur	b	38.2	13.3	3.3	-19.9	6.7
'96 TH 60213	M	YA	Phalanx	a	42.2	16.1	3.1	-19.3	7.1
'96 TH 60213	M	YA	Phalanx	b	40.9	14.9	3.2	-19.4	7.0
'96 TH 60213	M	YA	Ulna	a	12.3	4.1	3.5	-20.3	7.0
'96 TH 60213	M	YA	Ulna	b	11.7	4.1	3.3	-20.1	7.0
'96 TH 60214	*F*	*YA*	*Phalanx*	*a*	*1.7*	*0.4*	*5.0*	*-25.0*	*6.3*
'96 TH 60214	*F*	*YA*	*Phalanx*	*b*	*0.0*	*0.5*	*0.0*	*0.0*	*5.8*

Appendix H: *continued*

’96 TH 60214	F	YA	Humerus	a	41.3	14.4	3.3	-19.5	7.2
’96 TH 60214	F	YA	Humerus	b	41.9	14.9	3.3	-19.5	7.1
'96 TH 60538	*F*	*YA*	*Rib*	*a*	*6.3*	*2.0*	*3.7*	*-21.5*	*6.1*
'96 TH 60538	*F*	*YA*	*Rib*	*b*	*7.8*	*2.4*	*3.8*	*-21.5*	*6.3*
'96 TH 60538	F	YA	Femur	a	32.3	11.3	3.4	-19.5	7.1
'96 TH 60538	F	YA	Femur	b	31.0	10.9	3.3	-19.6	7.1
'96 TH 62636	F	YA	Rib	a	43.0	15.9	3.2	-19.3	7.2
'96 TH 62636	F	YA	Rib	b	41.3	14.8	3.3	-19.5	7.1
'96 TH 62636	F	YA	Fibula	a	42.1	15.8	3.1	-19.9	6.8
'96 TH 62636	F	YA	Fibula	b	41.9	15.9	3.1	-19.7	6.8
'96 TH 63202/1	M	Adult	Phalanx	a	39.2	13.5	3.4	-19.4	7.5
'96 TH 63202/1	M	Adult	Phalanx	b	38.7	13.9	3.3	-19.5	7.4
'96 TH 63202/1	M	Adult	Femur	a	31.6	11.9	3.1	-19.6	7.1
'96 TH 63202/1	*M*	*Adult*	*Femur*	*b*	-	-	-	-	-
'96 TH 65142	F	YA	Femur	a	44.7	16.8	3.1	-19.6	6.8
'96 TH 65142	F	YA	Femur	b	44.0	16.7	3.1	-19.7	6.8
'96 TH 65165	F	MA	Rib	a	43.2	15.2	3.3	-19.8	7.5
'96 TH 65165	F	MA	Rib	b	42.8	15.0	3.3	-19.9	7.4

Appendix H: *continued*

'96 TH 65165	F	MA	Femur	a	43.5	16.3	3.1	-19.8	7.3
'96 TH 65165	F	MA	Femur	b	42.6	16.0	3.1	-19.9	7.3
'96 TH 65166	M	OA	Rib	a	39.9	15.1	3.1	-19.5	8.1
'96 TH 65166	M	OA	Rib	b	66.6	23.9	3.3	-19.2	7.7
'96 TH 65166	*M*	*OA*	*Femur*	*a*	-	-	-	-	-
'96 TH 65166	*M*	*OA*	*Femur*	*b*	*1.0*	*0.2*	*6.3*	*-25.7*	*-3.1*
’98 TH 80090	-	Adult	Femur – PB #1	a	37.7	14.1	3.1	-19.9	6.9
’98 TH 80090	-	Adult	Femur – PB #1	b	36.2	12.8	3.3	-19.8	6.8
’98 TH 80090	-	Adult	Femur – PB #2	a	14.3	5.1	3.3	-20.5	6.5
’98 TH 80090	-	Adult	Femur – PB #2	b	11.4	3.9	3.4	-20.1	6.0
’98 TH 80090	-	*Adult*	*Femur – PB #3*	*a*	*1.9*	*0.5*	*4.2*	*-23.8*	*5.9*
’98 TH 80090	-	*Adult*	*Femur – PB #3*	*b*	*2.2*	*0.6*	*4.1*	*-22.7*	*3.4*
’98 TH 80090	-	*Adult*	*Femur – PB #4*	*a*	*11.1*	*3.5*	*3.7*	*-21.1*	*8.3*
’98 TH 80090	-	Adult	Femur – PB #4	b	10.6	3.6	3.5	-20.3	7.7
’98 TH 80090	-	Adult	Femur – PB #5	a	34.3	11.1	3.6	-20.6	7.7
’98 TH 80090	-	Adult	Femur – PB #5	b	33.8	11.6	3.4	-20.1	7.5
’98 TH 80090	-	Adult	Femur – PB #6	a	32.8	10.9	3.5	-19.8	6.5
’98 TH 80090	-	Adult	Femur – PB #6	b	31.1	10.9	3.3	-19.4	6.4

Appendix H: *continued*

'98 TH 80090	-	*Adult*	*Femur – PB #7*	*a*	*2.8*	*0.8*	*3.9*	*-22.9*	*4.8*
'98 TH 80090	-	*Adult*	*Femur – PB #7*	*b*	*2.8*	*0.9*	*3.5*	*-21.6*	*4.9*
'98 TH 80090	-	Adult	Femur – PB #8	a	34.5	12.3	3.3	-20.0	6.5
'98 TH 80090	-	Adult	Femur – PB #8	b	31.9	11.4	3.3	-19.8	6.3
'98 TH 80090	-	*Adult*	*Femur – PB #9*	*a*	*4.5*	*1.5*	*3.5*	*-21.2*	*5.9*
'98 TH 80090	-	*Adult*	*Femur – PB #9*	*b*	*4.3*	*1.4*	*3.5*	*-20.9*	*5.3*
'98 TH 80090	-	*Adult*	*Femur – PB #10*	*a*	*0.0*	*0.4*	*0.0*	*0.0*	*0.4*
'98 TH 80090	-	*Adult*	*Femur – PB #10*	*b*	*1.3*	*0.3*	*4.9*	*-23.3*	*3.3*
'98 TH 80090	-	Adult	Femur – PB #11	a	15.1	5.4	3.3	-20.1	6.6
'98 TH 80090	-	Adult	Femur – PB #11	b	13.3	4.7	3.3	-19.8	6.3
'98 TH 80090	-	Adult	Femur – PB #12	a	16.8	5.9	3.3	-20.4	5.8
'98 TH 80090	-	Adult	Femur – PB #12	b	16.8	5.8	3.4	-20.4	5.4
'98 TH 80090	-	Adult	Femur – PB #13	a	14.1	5.1	3.2	-20.2	6.7
'98 TH 80090	-	Adult	Femur – PB #13	b	15.5	5.4	3.3	-19.9	6.5
'98 TH 81008	F	MA	Rib	a	33.4	12.3	3.2	-18.9	7.8
'98 TH 81008	F	MA	Rib	b	31.0	11.6	3.1	-19.1	7.8
'98 TH 81008	*F*	*MA*	*Tibia*	*a*	*4.0*	*1.2*	*3.8*	*-21.7*	*5.8*
'98 TH 81008	*F*	*MA*	*Tibia*	*b*	*3.8*	*1.1*	*3.9*	*-21.6*	*6.5*

Appendix I: *Output data of stable isotope analysis of humans from Bademağacı. Note: those in italics are samples which were discarded*

Skeleton #	Sex	Age Group	Skeletal element	(a) or (b) run	%C	%N	C:N	$\Delta^{13}C$	$\Delta^{15}N$
2000 Sk 1a	F	YA	Fibula	a	40.8	15.0	3.2	-19.4	9.9
2000 Sk 1a	F	YA	Fibula	b	39.9	15.2	3.1	-19.3	9.9
2000 Sk 1b	F	YA	Tibia	a	41.8	15.4	3.2	-19.7	7.8
2000 Sk 1b	F	YA	Tibia	b	39.9	15.0	3.1	-19.7	7.9
2000 Sk 2	F	YA	Phalanx	a	36.7	12.5	3.4	-19.8	7.9
2000 Sk 2	F	YA	Phalanx	b	38.1	13.8	3.2	-20.0	7.9
2000 Sk 2	F	YA	Femur	a	38.8	14.3	3.2	-19.8	7.8
2000 Sk 2	F	YA	Femur	b	36.4	13.8	3.1	-19.9	7.8
2004 Sk 3	-	Child (3 years)	Rib	a	40.6	15.3	3.1	-19.9	9.2
2004 Sk 3	-	Child (3 years)	Rib	b	38.5	14.9	3.0	-20.1	9.3
2008 Sk 1	-	Baby (1.5-2 years)	Rib	a	39.4	14.8	3.1	-19.3	12.5
2008 Sk 1	-	Baby (1.5-2 years)	Rib	b	38.2	14.7	3.0	-19.2	12.5
2008 Sk 3	-	Child (9 years)	Rib	a	36.7	14.1	3.0	-20.0	8.9
2008 Sk 3	-	Child (9 years)	Rib	b	35.9	14.1	3.0	-20.3	8.9
2009 Sk 5	F	OA	Phalanx	a	38.5	14.6	3.1	-20.2	8.8

Appendix I: *continued*

2009 Sk 5	F	OA	Phalanx	b	37.0	14.5	3.0	-20.3	8.8
2009 Sk 5	F	OA	Tibia	a	37.4	14.2	3.1	-20.3	9.2
2009 Sk 5	F	OA	Tibia	b	36.8	14.4	3.0	-20.1	9.3
2009 Sk 6	M	YA	Rib	a	10.7	3.6	3.5	-21.0	8.6
2009 Sk 6	*M*	*YA*	*Rib*	*b*	*10.2*	*3.2*	*3.7*	*-21.1*	*8.5*
2009 Sk 6	M	YA	Tibia	a	41.4	15.9	3.0	-20.1	8.3
2009 Sk 6	M	YA	Tibia	b	40.1	15.1	3.1	-20.2	8.3
2010 Sk 1	F (?)	MA	Rib	a	41.5	15.6	3.1	-19.8	9.2
2010 Sk 1	F (?)	MA	Rib	b	40.7	15.2	3.1	-19.7	9.2
2010 Sk 1	F (?)	MA	Femur	a	38.6	14.0	3.2	-20.0	9.2
2010 Sk 1	F (?)	MA	Femur	b	37.3	13.7	3.2	-19.9	9.2
2010 Sk 4	-	Baby (8 months)	Rib	a	39.5	14.1	3.3	-18.9	10.9
2010 Sk 4	-	Baby (8 months)	Rib	b	37.8	13.7	3.2	-19.0	11.0
2010 Sk 5	F	MA	Rib	a	39.6	14.4	3.2	-20.1	8.3
2010 Sk 5	F	MA	Rib	b	38.6	14.3	3.1	-20.0	8.3
2010 Sk 5	F	MA	Femur	a	36.7	13.7	3.1	-20.2	8.0
2010 Sk 5	F	MA	Femur	b	36.6	14.1	3.0	-20.2	8.1

Appendix J: *Output data of stable isotope analysis of faunal remains from Bademağacı. Note: those in italics are samples which were discarded*

Skeleton #	Animal Species	Skeletal element	(a) or (b) run	%C	%N	C:N	$\Delta^{13}C$	$\Delta^{15}N$
2000 Sk 2	Sheep/Goat	Phalanx	a	40	14.6	3.2	-19.3	6.3
2000 Sk 2	Sheep/Goat	Phalanx	b	40.9	14.9	3.2	-20	6.4
2000 Sk 2	Pig	Phalanx	a	15.6	5.8	3.1	-20.7	4.9
2000 Sk 2	Pig	Phalanx	b	16.7	5.8	3.4	-20.4	4.8
2009 Sk 5	Cow	Tarsal	a	38.5	12.7	3.5	-19.3	7.3
2009 Sk 5	Cow	Tarsal	b	37.3	13.1	3.3	-19.1	7.2
2009 Sk 6	Cow	Phalanx	b	14.7	4.9	3.5	-16.2	5.7
2009 Sk 6	Sheep/Goat	Tarsal	a	37	14.6	3	-20.7	4.2
2009 Sk 6	Sheep/Goat	Tarsal	b	42	14.7	3.3	-20.6	4.5
2010 Sk 1	Goat	Mandible	a	44	15.9	3.2	-17.4	6.7
2010 Sk 1	Goat	Mandible	b	44	15.5	3.3	-17.4	7
2010 Sk 1	Sheep/Goat	Femur	a	48.2	15.6	3.6	-20.6	5.8
2010 Sk 1	Sheep/Goat	Femur	b	45.9	15.8	3.4	-20.5	5.6
2010 Sk 5	*Sheep/Goat*	*Radius*	*a*	-	-	-	-	-
2010 Sk 5	Sheep/Goat	Radius	b	43.9	16.1	3.2	-19.1	5
2010 Sk 5	Sheep/Goat	Mandible	a	43.9	15.7	3.3	-20.1	6.9

Appendix J: *continued*

2010 Sk 5	Sheep/Goat	Mandible	b	44	15.7	3.3	-19.8	6.9
2010 Sk 5	Sheep/Goat	Metatarsal	a	43.1	15.8	3.2	-18.9	5.4
2010 Sk 5	Sheep/Goat	Metatarsal	b	42.5	15.7	3.2	-18.7	5.5
2010 Sk 5	Sheep/Goat	Tibia	a	47.9	15.8	3.5	-19.8	5.5
2010 Sk 5	Sheep/Goat	Tibia	b	45.1	15.8	3.3	-19.7	5.4
2010 Sk 5	Sheep/Goat	Ulna	b	22.7	7.9	3.4	-20.8	5.6
2010 Sk 5	Cow	Metatarsal	a	42.6	15.7	3.2	-18.4	7.4
2010 Sk 5	Cow	Metatarsal	b	43.7	15.5	3.3	-18.2	7.7
2010 Sk 5	Sheep/Goat	Metatarsal	a	43.4	15.8	3.2	-19.3	6
2010 Sk 5	Sheep/Goat	Metatarsal	b	43.7	15.7	3.3	-19.3	6.3
2010 Sk 5	Pig	Calcaneum	a	38.5	13.8	3.3	-19.4	3.8
2010 Sk 5	Pig	Calcaneum	b	38.8	13.9	3.3	-19.2	3.9

Appendix K: *Output data of stable isotope analysis of humans from Bakla Tepe. Note: those in italics are samples which were discarded*

Skeleton #	Sex	Age Group	Skeletal element	(a) or (b) run	%C	%N	C:N	$\Delta^{13}C$	$\Delta^{15}N$
G-24	M	YA	Rib	a	38.2	13.9	3.2	-19.4	8.5
G-24	M	YA	Rib	b	37.9	13.8	3.2	-19.4	8.5
G-24	M	YA	Femur	a	35	12.5	3.3	-19.6	8.4
G-24	M	YA	Femur	b	35.5	12.7	3.3	-19.6	8.3
G-25	M	Adult	Femur	a	40.6	14.3	3.3	-19.9	8.8
G-25	M	Adult	Femur	b	40.3	14.3	3.3	-19.8	8.7
G-40/1	M	MA	Rib	a	30.2	10.9	3.2	-19.4	8.6
G-40/1	M	MA	Rib	b	45.4	16	3.3	-19.7	8.4
G-40/1	M	MA	Tibia	a	12.1	4.2	3.3	-20.1	8.3
G-40/1	*M*	*MA*	*Tibia*	*b*	-	-	-	-	-
G-60	M	MA	Rib	a	37	13.3	3.2	-19.3	8.8
G-60	M	MA	Rib	b	36.6	13.1	3.3	-19.3	8.9
G-60	M	MA	Fibula	a	39.3	14.1	3.2	-19.3	8.9
G-60	M	MA	Fibula	b	39.4	14	3.3	-19.3	8.9
G-62	*M*	*YA*	*Rib*	*a*	*3.7*	*1*	*4.6*	*-22.1*	*7.9*
G-62	*M*	*YA*	*Rib*	*b*	-	-	-	-	-
G-62	M	YA	Femur	a	39.8	13.7	3.4	-19.3	9
G-62	M	YA	Femur	b	39.2	13.5	3.4	-19.2	8.8
G-63	M	MA	Rib	a	42.8	15.4	3.2	-19.1	9.6
G-63	M	MA	Rib	b	42.7	15.2	3.3	-19.1	9.6
G-63	M	MA	Femur	a	26.3	9.4	3.3	-19.4	9.4
G-63	M	MA	Femur	b	26.4	9.4	3.3	-19.3	9.5
G-65	M	MA	Rib	a	30.3	10.9	3.2	-19.4	9.2
G-65	M	MA	Rib	b	28.8	10.4	3.2	-19.3	9.2
G-65	M	MA	Tibia	a	34	12.1	3.3	-19.8	8.3
G-65	M	MA	Tibia	b	32.3	11.5	3.3	-19.7	8.1
G-67	F	MA	Rib	a	40.9	14.6	3.3	-19.3	8.6
G-67	F	MA	Rib	b	41.6	14.8	3.3	-19.3	8.7
G-67	F	MA	Femur	a	39.2	14	3.3	-19.3	8.4
G-67	F	MA	Femur	b	39.6	14.3	3.2	-19.3	8.3
G-106	F	Adult	Rib	a	20.3	7.2	3.3	-19.7	7.8
G-106	F	Adult	Rib	b	21.4	7.6	3.3	-19.6	7.9
G-106	F	Adult	Tibia	a	38.7	13.6	3.3	-19.7	7.9

Appendix K: *continued*

G-106	F	Adult	Tibia	b	25.5	9	3.3	-19.5	7.6
G-107/1	M	MA	Phalanx	a	39.1	14.1	3.2	-19.7	8.5
G-107/1	M	MA	Phalanx	b	38.9	14	3.2	-19.7	8.4
G-107/1	M	MA	Femur	a	40.3	14.4	3.3	-19.7	8.6
G-107/1	M	MA	Femur	b	39.9	14.3	3.3	-19.8	8.5
G-107/2	M	Adult	Rib	a	31.3	11.1	3.3	-19.8	8.8
G-107/2	M	Adult	Rib	b	31.1	11.1	3.3	-19.9	8.6
G-107/2	M	Adult	Tibia	a	20.1	7.1	3.3	-19.6	8.9
G-107/2	M	Adult	Tibia	b	22	7.7	3.4	-19.5	9
G-107/3	M	MA	Rib	a	34.9	12.5	3.3	-19.7	8.8
G-107/3	M	MA	Rib	b	34	12.1	3.3	-19.9	8.8
G-107/3	M	MA	Femur	a	25	8.9	3.3	-19.7	8.7
G-107/3	M	MA	Femur	b	24.4	8.6	3.3	-19.8	8.6
G-243/1	F	MA	Rib	a	10	3.4	3.4	-20.4	7.5
G-243/1	F	MA	Rib	b	10.7	3.6	3.4	-20.2	7.8
G-243/1	F	MA	Tibia	a	34.1	12.3	3.2	-19.8	8.6
G-243/1	F	MA	Tibia	b	33.1	12	3.2	-19.7	8.5
G-243/2	*F*	*MA*	*Phalanx*	*a*	*9.8*	*3.5*	*3.2*	*-20*	*7.8*
G-243/2	F	MA	Phalanx	b	10.1	3.6	3.2	-19.7	7.8
G-243/2	F	MA	Femur	a	33.5	11.9	3.3	-19.7	6.8
G-243/2	F	MA	Femur	b	32.5	11.7	3.3	-19.7	6.7
G-243/3	M (?)	MA	Rib	a	15.2	5.4	3.3	-20	7.7
G-243/3	M (?)	MA	Rib	b	14.8	5.2	3.3	-20	7.7
G-243/3	M (?)	MA	Femur	a	29.9	10.7	3.3	-19.3	8.3
G-243/3	M (?)	MA	Femur	b	30.4	10.9	3.3	-19.5	8.3
G-244	*M*	*YA*	*Phalanx*	*a*	*2.8*	*0.8*	*4.3*	*-22.9*	*6.6*
G-244	*M*	*YA*	*Phalanx*	*b*	*3.3*	*0.9*	*4.6*	*-22.6*	*5.7*
G-244	*M*	*YA*	*Femur*	*a*	*7.5*	*1.7*	*5.2*	*-22.7*	*8.3*
G-244	*M*	*YA*	*Femur*	*b*	*7.8*	*1.7*	*5.4*	*-22.8*	*7.2*
G-259	F	YA	Rib	a	22.2	7.9	3.3	-19.4	8.2
G-259	F	YA	Rib	b	22.8	8.1	3.3	-19.4	8.3
G-259	F	YA	Femur	a	30.6	10.9	3.3	-19.4	7.9
G-259	F	YA	Femur	b	31.2	11.2	3.3	-19.4	7.7
G-266/1	F	MA	Rib	a	17.4	6.3	3.2	-20.1	7.6
G-266/1	F	MA	Rib	b	16.6	6	3.2	-20.1	7.5
G-266/1	F	MA	Femur	a	31	11	3.3	-20	7.4

Appendix K: *continued*

G-266/1	F	MA	Femur	b	30.8	11.1	3.2	-20	7.4
G-275/1	M (?)	OA	Phalanx	a	24.9	8.8	3.3	-19.7	8.5
G-275/1	M (?)	OA	Phalanx	b	24.3	8.5	3.3	-19.6	8.5
G-275/1	M (?)	OA	Tibia	a	21.7	7.6	3.3	-19.8	7.8
G-275/1	M (?)	OA	Tibia	b	21.3	7.4	3.3	-19.6	7.8
G-275/2	F (?)	MA	Rib	a	23.4	8.2	3.3	-19.6	8.3
G-275/2	F (?)	MA	Rib	b	24.3	8.6	3.3	-19.5	8.5
G-275/2	F (?)	MA	Tibia	a	39	13.5	3.4	-19.3	8.9
G-275/2	F (?)	MA	Tibia	b	38.8	13.6	3.3	-19.4	8.9
G-275/3	F	Adult	Rib	a	15.7	5.7	3.2	-19.2	8.3
G-275/3	F	Adult	Rib	b	22.2	7.9	3.3	-19.5	8.6
G-275/3	F	Adult	Femur	a	27	8.9	3.6	-20.4	7.7
G-275/3	F	Adult	Femur	b	25.5	8.6	3.5	-20.1	7.5
G-296	*F*	*MA*	*Rib*	*a*	*5.2*	*1.8*	*3.3*	*-19.8*	*7.3*
G-296	*F*	*MA*	*Rib*	*b*	*5.9*	*2*	*3.4*	*-19.7*	*7.6*
G-296	F	MA	Tibia	a	26.4	9.2	3.4	-19.3	7.7
G-296	F	MA	Tibia	b	33.3	11.7	3.3	-19.4	7.7
G-314/1	F	MA	Phalanx	a	30	10.7	3.3	-19.7	7.7
G-314/1	F	MA	Phalanx	b	29.7	10.6	3.3	-19.6	7.7
G-314/1	F	MA	Tibia	a	24.3	8.7	3.3	-19.6	7.4
G-314/1	F	MA	Tibia	b	26.5	9.2	3.4	-20.1	7.3
G-319/1	F	YA	Rib	a	20.2	7.3	3.2	-19.8	7.3
G-319/1	F	YA	Rib	b	20.2	7.3	3.3	-19.8	7.3
G-319/1	F	YA	Fibula	a	24.9	8.9	3.3	-19.9	7
G-319/1	F	YA	Fibula	b	25.2	9.1	3.2	-19.9	6.9
G-322/2	F	MA	Rib	a	18.6	6.7	3.2	-19.6	8.2
G-322/2	F	MA	Rib	b	16.3	5.9	3.2	-19.5	8
G-322/2	F	MA	Tibia	a	37.6	13.5	3.3	-19.3	8.5
G-322/2	F	MA	Tibia	b	38.2	13.9	3.2	-19.3	8.5

Appendix L: *Output data of stable isotope analysis of faunal remains from Bakla Tepe. Note: those in italics are samples which were discarded*

Skeleton #	Animal Species	Skeletal element	(a) or (b) run	%C	%N	C:N	$\Delta^{13}C$	$\Delta^{15}N$
G-107/1	Sheep/Goat	Radius	a	39.3	14.1	3.2	-19.6	5.4
G-107/3	Sheep/Goat	Tibia	a	35.6	12.8	3.2	-18.4	5.4
G-107/3	Sheep/Goat	Tibia	b	36.5	13.1	3.2	-18.5	5.3
G-243/1	Sheep/Goat	Tibia	a	29.3	10.3	3.3	-17.6	6.7
G-244	*Cow*	*Humerus/Femur*	*a*	*3.4*	*1.0*	*4.0*	*-18.6*	*5.2*
G-244	*Cow*	*Humerus/Femur*	*b*	*3.5*	*1.0*	*4.0*	*-18.7*	*5.3*
G-244	*Cow*	*Long bone*	*a*	*28.6*	*0.2*	*213.7*	*-35.7*	*5.5*
G-244	*Cow*	*Long bone*	*b*	*30.7*	*0.1*	*259.0*	*-35.5*	*1.2*
G-244	Sheep/Goat	Femur/Tibia	a	16.2	5.4	3.5	-20.7	8.0
G-259	Sheep/Goat	Radius	a	20.8	7.2	3.4	-19.8	6.5
G-259	Sheep/Goat	Radius	b	20.5	7.2	3.3	-19.9	6.1
G-266/1	Sheep/Goat	Scapula	a	30.2	10.5	3.3	-19.7	5.7
G-266/1	Sheep/Goat	Scapula	b	29.9	10.4	3.4	-19.4	5.7