Plant Economy of the Kura-Araxes.

A comparative analysis of agriculture in the Near East from the Chalcolithic to the Middle Bronze Age.

Volume 1

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Abstract

This thesis investigates the nature of the Kura-Araxes cultural horizon by examining archaeobotanical evidence from sites across the Near East from the Chalcolithic to Middle Bronze Age. Using the concept of food as material culture, this thesis explores the cultural integrity of the Kura-Araxes horizon and the extent of mobile pastoralism in the Kura-Araxes economy.

This thesis presents a detailed archaeobotanical study of a Kura-Araxes site, Sos Höyük from northeastern Anatolia, which dates from the Late Chalcolithic to Middle Bronze Age (3500-1500B.C.). From the archaeobotanical evidence, Sos Höyük appears to have been a settled agro-pastoral community. The thesis also investigates the Kura-Araxes cultural horizon through a comparative analysis of crop remains from Kura-Araxes and other Near Eastern sites from 6100-1500B.C. Crop data from 117 sites, including 21 Kura-Araxes sites, are compared using correspondence analysis.

Over the period studied there is a decline of in the proportion of glume wheat at sites across the Near East. In some regions this is accompanied by an increase in barley remains and in other areas by an increase in free threshing wheat remains. The shift from glume wheat to barley at sites in low rainfall areas appears to have been related to climatic change at c.2200B.C.. The increase in free threshing wheat appears directly related to the spread of the Kura-Araxes cultural horizon. At Kura-Araxes sites there is a preference for hexaploid free threshing wheat that distinguishes Kura-Araxes sites from non-Kura-Araxes sites in every region that Kura-Araxes material culture is present. The distinctive crop signature of Kura-Araxes sites supports the interpretation of the Kura-Araxes horizon as a shared cultural identity. Archaeobotanical evidence also indicates that the Kura-Araxes practiced settled agro-pastoralism rather than transhumant pastoralism. The expansion of the Kura-Araxes across the Near East may have been motivated by the search for new agricultural land.

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“I think it could be plausibly argued that changes of diet are more important than changes of dynasty or even of religion… Yet it is curious how seldom the all-importance of food is recognized. You see statues everywhere to politicians, poets, bishops, but none to cooks or bacon-curers or market gardeners.”

George Orwell
The Road to Wigan Pier 1937

“The History of every major Galactic Civilization tends to pass through three distinct and recognizable phases, those of Survival, Inquiry and Sophistication, otherwise known as the How, Why, and Where phases. For instance, the first phase is characterized by the question 'How can we eat?*' the second by the question* 'Why do we eat?' *and the third by the question* 'Where shall we have lunch?*’”*

Douglas Adams
The Restaurant at the End of the Universe 1980

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Chapter 1: Introduction

1.1 Food and culture

'Tell me what you eat, and I will tell you what you are.' Written in 1825 by Jean Anselme Brillat-Savarin, this idea, that food helps frame human identity, is an enduring concept that underpins a large amount of anthropological and archaeological theory. Food is essential for basic survival, but it is also imbued with cultural and social significance. What and how we eat is determined by who we are, where we are and who we want to become (Douglas 1972; Goody 1982; Messer 1984; Mennell 1996; Bell and Valentine 1997; Scholliers 2001b; Parker Pearson 2003; Twiss 2007a). As an expression of identity, food can reveal the group which a person belongs to but can also be an exclusionary tool to emphasise cultural and social difference. In anthropology, cultural identity is recognised as a dynamic and multi-layered concept that is defined both by how a group views themselves and how they are viewed by others (Barth 1969). This is expressed through patterns of behaviour, the physical traces of which are found in the archaeological record.

In archaeology, the identification of cultural groups is a contentious issue. The identification of archaeological cultures has often been viewed as anachronistic in Processual and Post-Processual archaeological frameworks (B. Roberts and Vander Linden 2011). This was in part a reaction against the Culture Historical tradition of the early twentieth century where each distinct archaeological assemblage was classified as an ethnic group and change in the archaeological record was wrought primarily through either migration or diffusion of ideas (Binford 1965; Clarke 1968). Despite the rejection of archaeological cultures as a framework in Anglo-American theoretical discourse since the 1960s, the identification of archaeological cultures in prehistoric and Near Eastern archaeology is still widespread. This is because, as an investigative concept, archaeological cultures "enable patterns of similarities and differences in the archaeological record to be identified and discussed and no other framework has supplanted them in this regard" (B. Roberts and Vander Linden 2011, 5).

Investigation of archaeological cultures relies on multiple strands of evidence to reveal patterns in past human behaviour that may be indicative of cultural relationships. To recognise shared cultural identities in the archaeological record, archaeologists are increasingly looking beyond the artefactual assemblage to the concepts embodied in the way an object is made (Pfaffenberger 1992; B. Roberts 2011), how space is structured (Parker Pearson and Richards 1994) or food is eaten (Dietler 1996; Bray 2003), in order to emphasise communal similarity and difference (Emberling 1997; Lucy 2005). Archaeological evidence of food, what was being eaten and how it was prepared and consumed, is seen as deeply reflective of group identity, being the product of multiple unconscious decisions and actions that were framed by shared cultural parameters (Emberling 1997; Gumerman 1997; Hamilakis 1999; Meskell 2001; Dietler and Hayden 2001; Parker Pearson 2003; Twiss 2007a, 2012). Food, in relation to cultural identity in archaeology, can be investigated through the material assemblage of food production and consumption (Dietler 2007; Pollock 2003; Beaudry 2013), the isotopic signatures of culturally specific diets in human bones (Barrett *et al.* 2001; Mundee 2009; Muldner 2013), and through the traces of food itself: plant and animal remains (Crabtree 1990; Scott 1996; Bigelow 1999; Fairbairn 2007; Kim 2014).

Archaeobotanical research has traditionally concentrated on investigating ancient economies and the environment. As the importance of food in structuring and reflecting social and cultural identity has been realised in archaeology, plant remains have been used to study different aspects of cultural identity (Hastorf 1991; Palmer and Van der Veen 2002; Bakels and Jacomet 2003; Van der Veen 2003, 2007, 2008; Jamieson and Sayre 2010; Fuller and Rowlands 2011; Livarda 2011, 2013). Within the framework of food as an embodiment of material culture (Dietler 2007; Van der Veen 2008), this thesis will investigate an archaeological culture, the Kura-Araxes culture of the Near East, using archaeobotanical evidence.

1.2 The Kura-Araxes culture

Marked by its distinctive red-black burnished pottery, the Kura-Araxes cultural horizon is the most geographically widespread cultural phenomenon in Near Eastern prehistory. It is thought to have originated in the mid fourth millennium, c.3500B.C., in the Southern Caucasus. By the early third millennium, c.2800B.C., Kura-Araxes material culture had spread east into northern Iran, west through eastern Anatolia and across to the Euphrates, then south into the Amuq and the Levant. In eastern Anatolia, the Kura-Araxes phenomenon is thought to have lasted for approximately two thousand years from 3500-1500B.C. (Sagona 2000).

Spread across many different countries, and separated by different modern archaeological traditions, the characteristic burnished ware representing a distinct archaeological horizon has been described differently in each region. In parts of Transcaucasia it is the Kura-Araxes culture (Kuftin 1944), in Northwestern Armenia the Shengavit culture (Baiburtyan 1938), the Karaz culture in central Anatolia (Koşay and Turfan 1959), the Outer Fertile Crescent Culture in southeastern Anatolia (Kelly-Buccellati 1980), the Yanik culture in northwest Iran (Dyson 1968; Burney 1969, 1970), the Red Black Burnished Ware culture in the

Amuq (Phase H) (Braidwood and Braidwood 1960), the Khirbet Kerak culture in the Levant (Amiran 1965) and, as an overarching term, the Early Transcaucasian Culture (Burney and Lang 1971). In general, the Kura-Araxes and Early Transcaucasian Culture (ETC) are the most common terms used in archaeological literature when discussing this material culture horizon and its pottery assemblage, encompassing all the regional variations. Following Sagona (1984), Kura-Araxes will be the preferred term used throughout this thesis.

Essential for researching the Kura-Araxes phenomenon is an understanding of what is signified by the repetitive combination of cultural assemblages found in sites from the Caspian to Mediterranean Sea. The red-black burnished pottery that is used as a symbol of the Kura-Araxes culture is just one element of the Kura-Araxes cultural package, but one that is so easily recognisable and distinctive that it is used to help identify the Kura-Araxes horizon across the Near East. What the Kura-Araxes horizon represents culturally or socially, however, is still not fully understood (A. T. Smith 2005b; A. T. Smith *et al.* 2009). While it is too simplistic a notion to equate pots with people (Kramer 1977), the remarkable similarity of architecture and artefacts over such an extensive geographical area, often appearing intrusively in new regions, leads many researchers to recognise this as a manifestation of some sort of interrelated group identity (Burney and Lang 1971; Esse 1991, 171; Kushnareva 1997; Rothman 2005, 2003; Batiuk 2005; Palumbi 2008; Kohl 2009; Greenberg 2007; Sagona 2011, 2014; Greenberg *et al.* 2014). Nonetheless, within this broadly shared material culture tradition, the Kura-Araxes horizon was not uniform. There are many regional variations of the Kura-Araxes cultural assemblage but at their core they all maintain certain features. These shared traits consist of:

> "rectilinear, subrectangular and circular houses built of mud brick or wattle and daub; portable and fixed hearths that are often anthropomorphic or zoomorphic in style; a wide range of hand built burnished pottery often displaying a contrasting colour scheme of black, grey, brown and red, and sometimes bearing elaborate ornamentation; well-crafted bone implements; standardised horned animal figurines; a simple range of metal objects most of which may be classed as arsenical bronzes; and a standardised stone tool repertoire that is manufactured primarily from obsidian in the eastern areas." (Kiguradze and Sagona 2003, 38)

Sagona (2014, 43) has added that it is not just this distinctive material cultural package that characterises the Kura-Araxes phenomenon, but it is also the repetitive structuring of architectural space, houses with central hearths and benches along the wall opposite the entrance, no matter the method of construction, that suggests the Kura-Araxes horizon represented a shared cultural identity.

The spread of the Kura-Araxes horizon across the Near East has most commonly been attributed to either the migration of Kura-Araxes groups to new regions (Hood 1951; Amiran 1952; Burney and Lang 1971; Sagona 1984; Rothman 2003; Summers 2004; Batiuk 2005; Kohl 2007; Greenberg and Goren 2009; Sagona 2011) or the wanderings of transhumant pastoralists and traders (Todd 1973; Kelly-Buccellati 1980, 1990; Akkermans and Schwartz 2003; Frangipane and Palumbi 2007). Very little is known about subsistence practices at Kura-Araxes sites. The Kura-Araxes economy, however, is often described as having been based on mobile pastoralism (Sagona 1993; Kushnareva 1997; Shimelmitz 2003). The identification of the Kura-Araxes as mobile pastoralists underpins many models for the expansion of the Kura-Araxes phenomenon (Sagona 1984, 1993; Rothman 2003; Frangipane and Palumbi 2007; Palumbi 2012; Frangipane 2014).

A. T. Smith (2005b, 258) proposes that there are two fundamental issues in archaeological study of the Kura-Araxes phenomenon that need to be addressed. Firstly, what did the Kura-Araxes horizon represent: was it the distribution of a ceramic package or a shared cultural identity? Secondly, what was the mechanism behind the spread of the Kura-Araxes horizon across the Near East? To these questions a third can be added: what was the nature of the Kura-Araxes economy? This thesis will attempt to address these issues by examining the plant remains from Kura-Araxes and other Near Eastern sites to answer the following research questions:

1) Can Kura-Araxes sites be distinguished from other contemporary Near Eastern communities on the basis of archaeobotanical remains?
2) Did Kura-Araxes communities share a common crop preference that provides evidence as to whether the material culture package of the Kura-Araxes horizon represents a distinct cultural identity?
3) Was the Kura-Araxes economy based on transhumant pastoralism or mixed agro-pastoralism, and what are the implications for understanding the spread of the Kura-Araxes cultural horizon?

These questions will be approached in two ways. The first approach will be a detailed archaeobotanical study of an individual Kura-Araxes site, Sos Höyük, from the Late Chalcolithic to the Middle Bronze Age (3500-1500B.C.). The second approach will provide a broader view of the Kura-Araxes phenomenon through a comparative analysis of crop assemblages from Kura-Araxes and other Near Eastern sites from the 6100-1500B.C.. The comparative nature of this thesis is important, since the identification of a distinct characteristic requires an alternative sample population with which to compare. Moreover, cultural identities are shaped as much by differences between groups as they are by shared cultural traits (Barth 1969; Emberling 1997). The broad temporal span of this study enables both the comparison of crop assemblages at Kura-Araxes sites with other contemporary Near Eastern sites and also with Near Eastern sites that predate the Kura-Araxes period to give a chronological context to the analyses.

1.3 Structure of this thesis

The next chapter, Chapter 2, presents the chronology and archaeological context of the Kura-Araxes culture by reviewing the Kura-Araxes cultural horizon in each region of the Near East. This chapter will outline some of the theories for explaining the expansion of the Kura-Araxes phenomenon across the Near East and what is known about Kura-Araxes subsistence strategies. Chapter 2 will conclude with a description of Sos Höyük, the site which is the focus of the detailed archaeobotanical study. The methods used in this thesis will be described in Chapter 3. Methods relating to the recovery, identification and statistical analysis of the Sos Höyük plant remains will be presented first. This will be followed by the methodology used for the comparative analysis of Near Eastern crop assemblages. In Chapter 4 the results and discussion of the archaeobotanical material from Sos Höyük will be presented. Chapter 5 presents the results of the comparative analysis of crop assemblages from Kura-Araxes and other Near Eastern sites from 6100-1500B.C.. These results will be discussed in Chapter 6 with particular reference to what the Kura-Araxes horizon represents in light of the archaeobotanical evidence for crop choices and the nature of the Kura-Araxes economy. Finally, in Chapter 7 general conclusions will be drawn and directions for future research suggested.

Chapter 2: Archaeology of the Kura-Araxes Culture

First uncovered in the Gyandja province of Azerbaijan in 1869 (Areshian 2005), it was not until the 1940s, when Kuftin (1944) undertook a regional synthesis of extant Transcaucasian data, that the term Kura-Araxes originated to describe the black burnished ware found in the land between the Kura and Araxes rivers. At the same time, Kosay excavating Karaz in Eastern Turkey in 1942 and 1944, identified a similar red and black burnished pottery previously unknown in Anatolia (Koşay 1948). Not long after, grey-black burnished sherds were found at Goey Tepe in northwest Iran by Burton-Brown in 1948, and were followed by the recognition of a red black burnished ware on the Amuq plain on British and American excavations (Hood 1951; Braidwood and Braidwood 1960). Comparisons began to be made between Khirbet Kerak Ware present in the southern Levant and the burnished Anatolian wares by Amiran (1952), who later redefined the connection to link Khirbet Kerak Ware with the burnished wares of eastern Anatolia, Transcaucasia and Iran (Amiran 1965). Thus, almost one hundred years after its first discovery, the Kura-Araxes horizon was revealed across the Near East.

This chapter first outlines and reconciles the chronologies used in Kura-Araxes studies. Next, the material culture, settlement patterns and architecture of the different Kura-Araxes regions are described, highlighting in detail certain sites in each area. Following these regional reviews, the various models explaining the expansion of the Kura-Araxes cultural horizon are outlined, many of which are based on the theory that the Kura-Araxes economy was based on transhumant pastoralism. This leads into a brief review of what is known about Kura-Araxes subsistence, with particular reference to the plant economy. The chapter concludes with a detailed description of Sos Höyük, the site that is the focus of the archaeobotanical analysis in Chapter 4.

2.1 Chronology of the Kura-Araxes cultural horizon

Just as terminology relating to the Kura-Araxes cultural horizon differs between researchers and regions, so too does chronology. Any attempt to create a unifying chronology for the Kura-Araxes period spanning such a large geographic area is extremely problematic. Reconciling a Transcaucasian Early Bronze Age I to an Anatolian or Syrian equivalent is difficult, especially when the internal periodisation for the regions themselves is not determined (Rothman 2003; Batiuk 2005), although recent attempts have been made (see Marro and Hauptmann 2000). Sagona (1984) completed a comprehensive survey of the then known

Kura-Araxes material from the Caucasus, eastern Anatolia, Iran, the Amuq and the Levant and created a tripartite cultural periodisation of the Kura-Araxes based on ceramic typologies and architecture that can be used to aid comparisons between regions. A comparative chronological scheme is provided in Figure 2.1, showing the varying terminology and temporal relationships between each region. This highlights the differences in relative chronologies between the regions. Issues in the chronology of the southern Caucasus and eastern Anatolia are elaborated in detail, since they pertain directly to the archaeobotanical material being investigated in this study. A map showing some of the locations mentioned in this chapter is provided in Figure 2.2.

In Caucasian archaeology, the term Eneolithic is often used to describe the period preceding the Bronze Age in which copper technologies were developed that elsewhere is called the Chalcolithic. A number of different chronologies are available for the Kura-Araxes in the Transcaucasus (for review see: Eden 1995; Kushnareva 1997, 44-54; Palumbi 2008, 12-14; A. T. Smith *et al.* 2009, 35-38; Palumbi and Chataigner 2014). A single Transcaucasian chronology is hampered by the lack of a suite of trustworthy calibrated radiocarbon dates and the reliance on the presence of the distinctive red-black burnished pottery as a chronological marker for the Kura-Araxes, since its appearance and disappearance across the region may not be uniform (Piro 2009). Recent research has begun to rectify this situation, with new projects in the region generating new series of radiocarbon dates for Georgia (Rova 2014; Sagona 2014) and Armenia (Badalyan 2014). Traditionally, debate centres on the timing of both the beginning and end of the Kura-Araxes phenomenon. Researchers disagree over whether the origin of the Kura-Araxes should be placed in the Late Chalcolithic (Kiguradze 2000; Sagona 2000; Kiguradze and Sagona 2003) or signal the beginning of the Early Bronze Age (Kushnareva 1997; A. T. Smith 2005b; Kohl 2007), and how far the Kura-Araxes phenomenon extends into the Middle Bronze Age (Sagona 2000; A. T. Smith *et al.* 2009). Although these terms convey meaning with regards to cultural and technological development and are useful heuristic devices for organising large datasets, with the increased availability of stratigraphically precise radiocarbon dates, as Sagona (2014, 26) suggests, it may be more expedient and less confusing to dispense with these relative terms and rely directly on absolute chronologies.

Excavations at Sos Höyük in northeastern Anatolia have led to the development of a new regional chronology, based on a long stratigraphic series of radiocarbon dates (Sagona *et al.* 1995; Sagona *et al.* 1996; Sagona *et al.* 1997; Sagona *et al.* 1998; Sagona and Sagona 2000; Sagona 2000). Occupation at Sos Höyük appears unbroken from the Late Chalcolithic through to the end of the Middle Bronze Age (c.3500-1500 B.C.), and each periodisation is securely anchored by a sequence of calibrated radiocarbon dates (Sagona 2000).[1] Using ceramic typology, burial practices, radiocarbon dates and parallels with the regional Kura-Araxes chronology, Sagona (2000) has determined that the Kura-Araxes culture was at Sos throughout these periods (Table 2.1).

Sos Höyük provides some of the earliest evidence for the Kura-Araxes culture, typified by the Red Black Burnished Ware, in the Late Chalcolithic Sos Va deposits at 3500/3300 - 3000B.C. (Sagona and Sagona 2000; Kiguradze and Sagona 2003; Palumbi 2003). This is contemporary with the earliest findings of red-black burnished pottery from Transcaucasia (Chernykh 2011; Sagona 2014; Badalyan 2014; Rova 2014; Lyonnet 2014). Early Bronze Age tombs at Horom and Talin, together with the settlement at Arapan III, all suggest that the Kura-Araxes cultural horizon was well established by 3350B.C. (Palumbi 2003; A. T. Smith 2005b; Badalyan *et al.* 1994). From the ceramic assemblage present in Sos VA, a developmental sequence has been derived for the burnished pottery, including a 'proto-Kura-Araxes' ware, that suggests the red black colour scheme may have been developed in Eastern Anatolia before spreading to the southern Caucasus (Kiguradze and Sagona 2003; contra A. T. Smith 2005b, 257-258). This theory has been supported by Palumbi (2003, 2008; Frangipane and Palumbi 2007) who also found that the red-black coloured pottery appeared first in Anatolia and later in the Caucasus. However, this does not necessarily mean that the Kura-Araxes horizon began in Eastern Anatolia, nor that there was a single homeland for the Kura-Araxes (Sagona and Zirmansky 2009, 166-168; Sagona 2011, 692). The distinctive colouring may have come from Anatolia and spread eastwards along the Araxes but the handles, biconical pottery forms and metallic burnishing were more likely Transcaucasian contributions (Frangipane and Palumbi 2007, 250-252; Palumbi 2008; Sagona 2011). What this represents instead was a complex interplay of intense communication across the highland communities of Eastern Anatolia and Transcaucasia that distilled into the Kura-Araxes cultural 'package' (Palumbi 2008; Sagona 2011).

Recent discoveries at Areni-1 Cave in Armenia (Areshian *et al.* 2012; K. Wilkinson *et al.* 2012) and Ovçular Tepe in Nakhichevan (Marro *et al.* 2009, 2011) have again stirred debate about the origins of the Kura-Araxes phenomenon. From both sites, excavators claim that

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[1] Sagona (2014) has recently mooted reclassifying the first period at Sos Höyük, Va, as being Early Bronze to realign the site with the southern Caucasian chronology. A new periodization for Sos Höyük has not yet been developed so this thesis will continue to use the chronological scheme detailed in Sagona (2000).

Kura-Araxes ceramics were found in layers dating to around 4000B.C.. This earlier dating for the beginning of Kura-Araxes cultural horizon has been cautiously noted by other researchers but further evidence is required to confirm the new dating (Badalyan 2014; Sagona 2014). At Areni-1 Cave the stratigraphy appears quite complex and the relationship between layers in different sections of the cave is not clearly defined (Badalyan 2014; Marro *et al.* 2014). The upper layer appears to contain a few typical Kura-Araxes ceramics and is dated to around the mid fourth millennium B.C. 3700-3400 B.C., roughly contemporary with other early Kura-Araxes sites in the Caucasus (A. Smith *et al.* 2014; Zardaryan 2014). Earlier horizons, dating from 4300-3800B.C., do not contain the distinctive red-black burnished vessels but may have ceramics reflecting the Caucasian precursors of the Kura-Araxes vessel shape (Zardaryan 2014; cf. Palumbi 2003; Palumbi 2008). Moreover the upper layers with Kura-Araxes type ceramics, appear to have been eroded and reworked by water action (A. Smith *et al.* 2014). At Ovçular Tepe, a few typical Kura-Araxes red-black burnished ceramics were found in a house, a grave and a pit from Chaff Faced Ware horizons radiocarbon dated to c.4300-4000B.C. (Marro *et al.* 2014). Later Kura-Araxes occupation layers, radiocarbon dated to 3200-2400B.C., overlaid the fifth millennium B.C. Chaff Faced Ware settlement at the site (Marro *et al.* 2014). At both Areni-1 Cave and Ovçular Tepe, however, the red-black burnished pottery is found in isolation, without any other elements of the architectural or material assemblage that defines the Kura-Araxes cultural horizon (see Chapter 1.2). Further evidence is required to corroborate this extended timescale for origin of the Kura-Araxes in the Caucasus and therefore, in this study, Ovçular Tepe and Areni-1 Cave will not be classified as Kura-Araxes sites for the analysis of crop choices in the Near East discussed in Chapter 5.

At the other extreme, traditional chronologies in the south Caucasus terminate the Kura-Araxes at the beginning of the Middle Bronze Age with the advent of the early kurgan cultures of the Martkopi, Bedeni and Tiraleti horizons (Eden 1995; Kushnareva 1997; A. T. Smith *et al.* 2009) . At Sos Höyük however there is evidence of considerable overlap between elements of these later groups and the Kura-Araxes material culture throughout the Middle Bronze Age (Sagona 2000). The persistence of Kura-Araxes architectural and household assemblages, including red black Late Gritty ware, into the second millennium B.C., contemporary with and overlaying burials derived from the early kurgan tradition, has shifted the end of the Kura-Araxes period to the mid second millennium B.C. at this site (Sagona 2000, 2011). Whether this extended Kura-Araxes chronology is reflected elsewhere in the region, or is a localised phenomenon to northeast Anatolia, is uncertain. It does, however, indicate that the final phase of the Kura-Araxes period was more complicated and nuanced than initially understood.

While Sagona's (2000) chronology for the Kura-Araxes horizon does not resolve the debates over the timing of its beginning and end, it is based on a tight stratigraphic sequence of over 50 radiocarbon dates from secure contexts that fix the different phases of material culture observed. As a comparable and consistent scheme, it is used by other researchers in the field of Kura-Araxes studies as a regional chronological framework (cf. Batiuk and Rothman 2007; Piro 2009; Rothman 2011). This study will use Sagona's (2000) chronology since the archaeobotanical material analysed is from Sos Höyük and the site is well dated and secure stratigraphically. Where comparison with, or discussion of, other sites occurs dates as well as period title will be used.

The following sections will outline the main features of the Kura-Araxes horizon in each region, discussing in detail the archaeology of key sites, to provide the archaeological background for investigating the Kura-Araxes economy.

2.2 Southern Caucasus

Before discussing the Kura-Araxes period in Transcaucasia, the preceding periods are briefly summarised. Relatively little is known about Transcaucasia in the Neolithic and Chalcolithic periods. The Shulaveri-Shomutepe horizon dates from the late sixth to fifth millennium, and was found mostly in the lowlands at several key sites including Shomu Tepe in Azerbaijan, and Shulaveris Gora and Imiris Gora in Georgia (Kushnareva 1997). This Neolithic horizon is characterised by round beehive-like mud brick domestic architecture arranged in circular or oval compounds which, in later phases, had courtyards with curvilinear walls attached and a material culture rich in bone and antler (Sagona 1993; Kiguradze 2000; Kiguradze and Menabde 2004). Aratashen and Aknashen-Khatunarkh in Armenia may represent a southern variant of the Shulaveri-Shomutepe culture, distinguished by their use of *pisé* rather than mud brick as a construction technique, which was more related to southeastern Transcaucasia (Kultepe in Nakhichevan) and northeastern Mesopotamia (Hajji Firuz, Tilki Tepe) than the Kura basin (Badalyan *et al.* 2004; Badalyan *et al.* 2010). The Shulaveri-Shomutepe-Aratashen sites are viewed as sedentary agricultural villages with subsistence based a range of crop species, hulled and naked wheat and barley, lentil, and bitter vetch (Hovsepyan and Willcox 2008). In western Georgia, the Neolithic animal economy was based on hunting and supplemented by keeping domesticated cattle and pigs (Kiguradze and Sagona 2003). In the Kura basin and southern Transcaucasia, domesticated animals predominated, with the proportions of sheep and goat higher in the southern Caucasus (Kiguradze and Menabde 2004; Piro 2009). Almost all the Shulaveri-Shomutepe sites were abandoned at the end of the fifth millennium B.C., and new settlements with Sioni material culture appeared in the lowlands and also spread to the high plateaux (Kiguradze 2000; Badalyan *et al.* 2010).

The Sioni culture, from the late fifth to mid fourth millennium B.C., differed from the Shulaveri-Shomu culture in the more varied altitudinal zones they occupied, the lack of an elaborate bone and antler assemblage and a change in architecture (Kiguradze 2000). A few sites, Alikemek Tepe, Aratashen and Aknashen-Khatunarkh, have Sioni cultural material stratified above Shulaveri-Shomu-Aratashen layers (Kiguradze 2000; Badalyan *et al.* 2004; Badalyan *et al.* 2010). Sioni sites, unlike the multilayer Shulaveri-Shomu villages with domed mud brick dwellings, are mostly single period flat settlements with few traces of architecture, and were instead dominated by pits (Kiguradze and Sagona 2003). At the type site of Sioni, c.4800-4000B.C., the only piece of permanent architecture was a large circular wall with stone foundations (Kiguradze and Sagona 2003). At other sites, Tsopi, Treli, Delisi, and Khizanaant Gora, fragments of wattle and daub were found together with postholes and pits whereas, at Gramakhevistavi, Alazani I-II, Damtsvari Gora and in the Aragvi Valley, only pits were found (Kiguradze and Sagona 2003). The apparently transient nature of sites and their location on highland pasturage has led some researchers to suggest the Sioni were transhumant pastoralists (Kiguradze and Sagona 2003). Analysis of Sioni grinding and pounding tools from the Aragvi valley suggests there was a decrease in cereal processing in the Chalcolithic in comparison to the Shulaveri-Shomu period, which may have reflected a shift away from settled agriculture (Hamon 2008). Archaeobotanical and archaeozoological analysis of Sioni period sites has not yet been conducted to investigate issues of subsistence and mobility. Even at Aknashen-Khatunarkh, where the Neolithic layers yielded well preserved charred plant remains and animal bones, bioeconomic remains from the Sioni horizon were very scarce (Hovsepyan and Willcox 2008; Badalyan *et al.* 2010).

Sioni pottery was characterised by its decorated rims, rows of impressions created by a shell or stick pressed into the upper rim to give a comb effect, and often made from micaceous clay with grit or chaff tempering (Kiguradze and Sagona 2003). Late Sioni ware was found at Sos Höyük, in northeastern Anatolia, in period Va (c.3500-3000B.C.) together with Proto Kura-Araxes ceramics (Kiguradze and Sagona 2003). This level had a monumental circular stone boundary wall surrounding the core of the settlement which had remnants of round mudbrick buildings (Sagona and Sagona 2000). A public building and massive boundary wall, similarly suggesting Sioni communal activities, were found at Berikldeebi in Shinda Kartli in period V2 (c. 4000-3200/3000B.C.) (Kiguradze and Sagona 2003). The rectangular multicellular mud brick public buildings at Berikldeebi and Leilatepe have also been interpreted as a north Mesopotamian influence together with chaff rich pottery found at Kultepe I, Ovçular, and Hanago which has been equated to the Amuq F Chaff-Faced ware (Marro 2005, 2007; Bakhchaliyev *et al.* 2009) although the nature of this connection is uncertain (Sagona 2011). The Sioni culture has been suggested as the antecedent of the Kura-Araxes culture (Kushnareva 1997; Kiguradze 2000; Kiguradze and Sagona 2003).

The majority of Kura-Araxes sites in the Transcaucasus appear either on sterile layers or virgin soil (Sagona 1984) although recent work at Kultepe (Ristvet *et al.* 2011) and Ovçular (Ashurov 2005; Marro *et al.* 2014) in Nakhichevan may be beginning to clarify the connections between the Chalcolithic and Kura-Araxes layers. Kura-Araxes sites are found in diverse ecological zones from the lowlands of the Kura and Araxes river plains up into highland regions in excess of 2000m above sea level across Armenia, Azerbaijan, and Georgia, except for the western plain along the Black Sea (A. T. Smith *et al.* 2009). A northern variant was present at Velikent, Daghestan (Kohl 2007; Kohl and Magomedov 2014). The earliest levels at Kura-Araxes sites in Georgia, Beerikldeebi (c.3600-3400B.C.), Samshvilde, Treli, and Grmakhevistavi all had monochrome and black burnished pottery in the traditional Kura-Araxes shapes and traces of wattle and daub circular structures but not the distinctive red-black burnished ware that later characterised the Kura-Araxes horizon (Palumbi 2008). At Chobareti, the same monochrome and black burnished pottery was found together with a few Chaff Faced Ware sherds in four terraced stone lined houses built into the limestone bedrock and radiocarbon dated to 3300-2900B.C. (Kakhiani *et al.* 2013). As well as monochrome black, grey and brown pottery, the Red-Black Burnished Kura-Araxes Ware appears in the earliest levels at Kultepe 2, 3335-3093 B.C. (Ristvet *et al.* 2011) slightly later than the early material at Sos Höyük. Elsewhere in Transcaucasia red-black burnished Kura-Araxes pottery first appeared at Didube, and in graves at Horom, Arapan III and T'alin contemporary with the finds at Kultepe c.3300B.C. (Palumbi 2003). Palumbi's (2008) study, based on architecture and pottery, created a provisional sequence beginning c.3600B.C. with Berikldeebi IV, Gramakhevistavi, Treli and Samshvilde I older than Khizanaant Gora E, Samshvilde II, Didube and Mokhrablur when red-black burnished pottery entered the Kura-Araxes assemblage c.3300B.C.. Red-black burnished ware with prominent handles, large-necked carinated jars, pierced Nakhichevan lugs and incised and relief animal-like or spiral shaped decorations was thereafter the dominant pottery type in Transcaucasia, but became black on all surfaces by the Middle Bronze Age (Sagona 1984, 2004a).

As well as distinctive ceramics, the Kura-Araxes had a varied artifactual assemblage that defined their horizon. A key characteristic of Kura-Araxes sites was their fire installations. Fixed hearths were usually placed in the centre of the main room, as at Kvatskhelebi, Khizanaant Gora, Tsikhiagora, and Shengavit, where circular hearths with a tri-leaf shaped hole were found (Palumbi 2008). Andirons, portable hearth stands for supporting vessels above a raised fire, had two main forms, either rectangular with horn-like projections or horseshoe shaped (Smogorzewska 2004). Horseshoe shaped andirons were often anthropomorphic with a human face in the centre, and ends shaped like feet, like those found at Kultepe (Ristvet *et al.* 2011), Amiranis-Gora (Kushnareva 1997) and Garni (Palumbi 2008) or zoomorphic such as those found at Shengavit (Smogorzewska 2004), Kharnut and Arich (Palumbi 2009), with horned animal heads, possibly rams, at the ends. Flint sickle blades were found at Kvatskhelebi, Khizanaant Gora, and Tsikhiagora in Georgia (Palumbi 2008) and Garni in Armenia (Badalyan *et al.* 2008). Metal ornaments were often found in graves. The most common types were long pins for fastening clothes with broad, flat double spiral heads, spiral bracelets and earrings/hair rings with one and a half coils (Sagona 2004a). Metal objects were made of arsenical bronze (Kohl 2007). Due to the portable nature of Kura-Araxes material culture – the transportable andirons, ceramics with lids and large handles – and the assumed temporary nature of wattle and daub building, the Kura-Araxes culture has been interpreted as highly mobile with a significant transhumant pastoralist component (Cribb 1991; Sagona 1993; Kushnareva 1997, 192-196; Palumbi 2003; Rothman 2003; Frangipane and Palumbi 2007; Kohl 2007, 95-96; contra Sagona and Zirmansky 2009, 191-190; Sagona 2014; Summers 2014). Recent archaeozoological research is beginning to revise this model, suggesting a more diversified and settled agricultural economy (Howell-Meurs 2001b; Monahan 2007; Piro 2009). The Kura-Araxes economy will be discussed further in section 2.10.

Kura-Araxes sites appear to have been undifferentiated settlements of freestanding nuclear households with no obvious social hierarchy. On the Ararat Plain in Armenia, the sites of Norabats and Mokhrablur had large circular mud brick houses with central round hearths (Areshian 2005). Well preserved wattle and daub freestanding rectangular buildings with rounded corners were found at Kvatskhelebi and Khizanaant Gora in Georgia, all with standardised central round hearths and benches against the back wall (Sagona 1993). At Kultepe 2 and Maxta in Nakhichevan, round houses made of *pisé* or mud brick with circular or rectangular annexes were present in the early layers and, at Kultepe 2 in later levels, houses become rectangular in shape (Ristvet *et al.* 2011). At Gegharot on the Tsaghkahovit Plain in Armenia, the earliest levels (c.3500/3350-2900B.C.) had rectilinear dry stone walled houses containing red-brown pottery, horned andirons, circular ovens and flint sickle blades (Badalyan *et al.* 2008). Even in sites where building size varied, such as Kultepe 2, the household assemblage remained consistent, suggesting an egalitarian community (Ristvet *et al.* 2011).

Funerary practices also show no social stratification, either in grave goods or construction (Palumbi 2007). Kura-Araxes burials were either in earthen pits, stone-lined cists or horseshoe shaped tombs, and would hold either communal or single burials; often all types were present in the same cemeteries at the same time, such as at Elar or Kiketi (Palumbi 2007). Communal burials, like those at Aradetis Orgora, Kiketi and Samshvilde, all have accumulations of skeletons in the corners of tombs, as previous burials were pushed aside when new burials were interred, a practice demonstrating the importance of horizontal social relations (Palumbi 2007, 2008). Evidence of organised communal activity, however, is seen in the production of monumental mud brick and stone boundary walls (at Mokhrablur, Adablur, Shengavit and Aragacotin), terracing (at Gegharot and Amiranis Gora) for supporting agriculture and settlements, a granary (at Kultepe 2), a massive six metre tall tower with basalt obelisk (at Mokrablur) and settlements and irrigation systems with dykes and dams (at Mokrablur and Shengavit) (Kushnareva 1997; Areshian 2005; Badalyan *et al.* 2008; Ristvet *et al.* 2011).

The Kura-Araxes cultural horizon is generally thought to have ended by the close of the third millennium B.C. in Transcaucasia (Kohl 2007; Sagona 2011). Different dates are assigned to the decline of the Kura-Araxes depending on how researchers classify the Early Kurgan period, the transitional phase between the Early and Middle Bronze Ages in Transcaucasia (see A. T. Smith *et al.* 2009, 52 ff). The Early Kurgan phase is distinguished by the appearance of kurgan style burials – pit or stone cist tombs covered by an earthen or stone cobble mounds (A. T. Smith 2005b). Rich kurgan burials begin in Transcaucasia during the later phases of the Kura-Araxes culture from c.2300 B.C. (Sagona 2004a). The early kurgan cultures which overlapped with the Kura-Araxes are named after the major sites where they were found, Martkopi, Bedeni and Trialeti, each with a different material assemblages, primarily characterised by differing pottery styles. Kurgans represented a change in burial practices where the individual was afforded a more elaborate funerary ritual, buried with richer grave goods, and interred beneath a mound, the size and internal structure of which changed according to the status of the dead (Sagona 2011). These kurgans contained burials or cremations with bronze weapons, bronze, silver and gold jewellery, semi-precious beads and parts of, or entire, four-wheeled carts (Eden 1995; Sagona 2011). Early Kurgan metalwork included tin-bronzes which were found alongside the arsenical bronzes more common in Kura-Araxes metallurgy (Sagona 2004a).

Very few Bedeni, Martkopi or early Trialeti settlements have been excavated in the Southern Caucasus, the two main Bedeni settlements known are at Berikldeebi and Natsargora in Georgia (Rova *et al.* 2011; M. Puturidze and Rova 2012). Early Kurgan ceramics are often present however, in late Kura-Araxes sites including Tsikhiagora, Shengavit IV, Dvin and Amiranis Gora (Sagona 2004a; A. T. Smith *et al.* 2009). Similarities between the Early Kurgan Martkopi and early Trialeti pottery and late Kura-Araxes wares, each exhibiting fine incised triangular decorations and high carinated profiles, suggest a connection between the material assemblages (A. T. Smith 2005b; Sagona 2011; contra M. Puturidze 2003). Indeed, discoveries at Sos Höyük indicate a continuity between, and perhaps integration of, Kura-Araxes and Early Kurgan material culture into the second millennium B.C. in northeastern Anatolia (Sagona 2000). Although no kurgans were found at Sos Höyük, two intramural burials of the Martkopi and Trialeti traditions were found contemporary with, and followed by, Kura-Araxes houses with the full late Kura-Araxes assemblage (Sagona 2011). The decline of the Kura-Araxes in Transcaucasia may therefore also have been more complex and later than currently dated. Sagona (2004a) suggests that the ‘invisibility’ of Early Kurgan settlements may instead reflect a chronological misunderstanding that artificially separates the two horizons. It may have been Kura-Araxes communities who were the builders of at least some of the Martkopi, Bedeni and Trialeti kurgans. Chronological resolution of the late Early Bronze and following Middle Bronze Age is highly problematic; the few carbon dates available from the Early Kurgan and Trialeti periods in Transcaucasia have very broad confidence intervals, which means that dating relies on ceramic typology from mortuary contexts (A. T. Smith *et al.* 2009).

Most Kura-Araxes settlements in Transcaucasia are thought to have been abandoned at the end of the Early Bronze Age c.2100B.C.. Evidence of the following late Trialeti culture, 2100-1700B.C., is gained primarily from large rich kurgans; few settlements are known (M. Puturidze 2003). The largest Trialeti phase kurgan at Tsnori was an earthen mound 140m in diameter and eleven metres high covered with a layer of stones (Kushnareva 1997). In the burial chamber there were four human skeletons, one ornamented with gold suggesting it was the main occupant. Kurgans on the Tsalka plain in Georgia have stone lined procession ways over 100 metres long (Kohl 2007). Trialeti kurgans contained an elaboration of the rich grave goods found in the Early Kurgan Culture with an emphasis on gold and silver jewellery, tin-bronze weapons, carts, wagons, and ox and horse sacrifices, that A. T. Smith (2005b) and Kushnareva (1997) both interpret as representing a mobile cattle breeding society with warrior elites.

The transition from a dense distribution of Kura-Araxes settlements in the third millennium, to a proliferation of monumental kurgan burials without associated settlements in the Middle Bronze Age is often assumed to be the result of an economic shift from an agro-pastoral to a more nomadic lifestyle in the Trialeti period (Kushnareva 1997; Kohl 2007; A. T. Smith *et al.* 2009). It has been suggested that this theoretical shift in the economy occurred because of climatic aridification (Kushnareva 1997, 208; Areshian 2005), land degradation due to over cultivation (Kikvidze 1988 cited in A. T. Smith *et al.* 2009) or the need to pasture animals in the high plateaux after the adoption of cattle breeding (M. Puturidze 2003, 125). Palynological investigation on the Tsalka Plateau in Georgia shows that an open oak savannah spread as temperatures decreased into the second millennium B.C., conditions not consistent with either aridification or land degredation (Connor and Sagona 2007). Nor is it certain that the Middle Bronze Age was a period of nomadic pastoralism. As M. Puturidze (2003) herself contrarily observes, the reconstruction of ancient economies solely based on mortuary offerings without settlement data is problematic. Analysis of animal bones from Middle Bronze Age Didi-gora in the Georgian lowlands indicates that the animal economy was based on cattle but both the slaughter pattern and isotope signatures demonstrate settled year round occupation of the site with no seasonal animal transhumance (Knipper *et al.* 2008; Uerpmann and Uerpmann 2009). Similarly, at some sites, such as Horom in Armenia where a cyclopean stone boundary wall is dated to 1970-1630 B.C. (Badalyan *et al.* 1993), and the defensive wall at Uzerlik Tepe (Kushnareva 1997), there are rare signs of permanent architecture during the Middle Bronze Age. The rarity of settlement architecture in the archaeological record may instead be due to a change in construction techniques and materials (Uerpmann and Uerpmann 2009). Bronze wood working tools - axes, chisels, and adzes - were prestige goods in the Trialeti kurgans. Kurgan tombs often had the dead laid out in a wooden chamber in the centre of the mound which may have been a reflection of contemporary log houses that were not preserved archaeologically (Eden 1995). As mentioned in the previous section, the relationship between the late Kura-Araxes and the Early Kurgan/Trialeti horizons at Sos Höyük is causing the reassessment of the Early-Middle Bronze Age transition at the head waters of the Araxes River. The Middle Bronze Age Kura-

Araxes/Trialeti at Sos Höyük, based on stratified calibrated radiocarbon dates, spans the period from c.2200-1500B.C. and overlaps with the Trialeti horizon in Transcaucasia (Sagona 2000). The ramifications of this extended northeast Anatolian Kura-Araxes sequence for the southern Caucasus are uncertain, but the continued occupation of Sos Höyük into the mid second millennium demonstrates that sedentism was not incompatible with Trialeti burial practices.

2.3 Eastern Anatolia

In the highlands of eastern Anatolia, Kura-Araxes sites have been found in three regions: around Lake Van, in Muş province and in the northeastern mountain valleys near Erzurum. Around Lake Van, sixteen Kura-Araxes sites have been identified, mostly on the plains along the northern and eastern edge of the lake (Çevik 2005). Only Dilkaya and Karagündüz have been excavated, Karagündüz having a depth of c.7-6m of Kura-Araxes related deposits. At Dilkaya, circular and rectangular mudbrick houses built on stone foundations were uncovered in the earliest period (2600-1900B.C.) (Çilingiroğlu 1993). These appear to have been undifferentiated freestanding domestic buildings with typical Kura-Araxes ceramics. At Karagündüz, rectilinear mudbrick buildings, lacking stone foundations, were aligned along two sides of a five metre wide street in a radial pattern around a central open area (Kozbe 2004). At the end of the street, a circular building, estimated at 7.5m wide, was partially exposed, and has been interpreted as a communal granary or public building (Çevik 2005; Kozbe 2004). All the rectangular structures appear domestic in function with evidence for household food preparation, consumption and storage, textile working, obsidian and bone tool production and leather working (Kozbe 2004). Plentiful Kura-Araxes black-burnished pottery, with crudely fashioned incised spiral patterns, suggesting household production, was found. Although no portable hearths were found, fixed rectangular and circular hearths were present in the Karagündüz houses, the circular hearths were always in the centre of the room. No designated space for animal keeping was discovered at the site either between the buildings or within the house courtyards.

In the Muş region, survey along the Murat river and northern mountains identified eighteen Kura-Araxes sites from the Early Bronze Age, 2700-2200B.C., three of which were on previously occupied Late Chalcolithic settlements (Rothman and Kozbe 1997). The ceramics from the Murat river valley show a blending of Late Chalcolithic pastes and Kura-Araxes techniques and designs, which Rothman (2005) has interpreted as a mixing of local and Kura-Araxes populations.

Further to the north, in the Erzurum region of Anatolia, several Kura-Araxes sites are located. Karaz was first investigated in the 1940s, and gave its name to the black-burnished ware found in this region. The nearby sites of Pulur and Güzelova were also dug by Koşay, and all three sites had Kura-Araxes material culture deposits of c.9-10m depth, although the stratigraphy and settlement plans of the sites were poorly recorded (Sagona 1984). At both Karaz and Güzelova, stones were used as foundations for the houses which, at Karaz, were rectangular in shape. Circular hearths with three central horns were found at Karaz, and portable hearths were present at Güzelova. Sos Höyük was excavated by Sagona from 1994-2000, and has produced an unbroken sequence of rich Kura-Araxes deposits from the Late Chalcolithic to the end of the Middle Bronze Age (Sagona *et al.* 1995; Sagona *et al.* 1996; Sagona *et al.* 1997; Sagona *et al.* 1998; Sagona and Sagona 2000; Sagona 2000). The archaeology of Sos Höyük will be discussed in further detail at the end of this chapter.

2.4 Northwest Iran

Kura-Araxes material was first uncovered at Geoy Tepe near Lake Urmia in Northwestern Iran (Burton-Brown 1951). Excavations by Charles Burney at Yanik Tepe (Burney 1961b, 1962, 1964) and later at Haftavan (Burney 1975) led him to identify a local variant of the Kura-Araxes horizon, Yanik Culture, in this region during the Early Bronze Age. Yanik culture sites have been discovered further southeast along the Zagros mountain range at Godin Tepe in the Kangavar Valley (Young 1969, 2004; Rothman 2011), and further east in the highlands bordering the Caspian Sea in Gilan (Fahmi 2005), the Qazvin plain (Fazeli Nashli and Sereshti 2005) and at its most easterly extent on the Central Iranian Plateau near Qom (Azamoush and Helwing 2005). Surveys around Lake Urmia identified another twenty-seven settlements, including Tappeh Gijlar, west of the lake (Pecorella and Salvini 1984) and in the Kangavar Valley a further fourteen sites were found (Young 2004). In total about ninety Yanik culture sites have been identified in northwest Iran (Muscarella 2003, 128). Indeed, there is a virtually continuous distribution of Yanik culture sites along the Zagros Mountains between Yanik and Godin Tepe (Azamoush *et al.* 2006) demonstrating that these were not isolated occurrences but part of a greater pattern in the Early Bronze Age.

At Yanik tepe, the Kura-Araxes horizon marks a clear break from the previous Late Chalcolithic occupation at the site, with different styles of domestic architecture and ceramics (Burney 1964). Two phases of architecture were identified at the site: an Early Bronze I wattle and daub round house style followed by more substantial mud brick rectilinear houses that mark the Early Bronze II (Burney 1962). Summers' (1982, 2004, 2014) study of the excavation records identified 14 levels of round houses before four levels of rectilinear houses, although a possible overlap between the two styles cannot be completely rejected. The initial circular houses were small but over time gradually became larger, and developed in interior complexity with elaborate kitchen fittings (benches, hearths, ovens and bins). Despite successive periods of rebuilding, there was considerable continuity in the location of the round houses over consecutive levels, with the addition of external walled yards, housing built-in storage bins. There is no sign of any designated areas for keeping animals within the site and, by the end of the Early Bronze I, movement would have been very restricted between the enlarging hut circles (Summers 2004). All the round houses seem fairly uniform in construction and content, which suggests the settlement was made up of egalitarian family units (Summers 2004), although there are two examples of some sort of communal activity. In level 4B, a large circular structure was uncovered situated on the highest point on the site and made of two concentric high walls that, in the inner circle, had been divided to make four sections (Burney 1961a). Access was via the roof or high in the wall, and quern stones were found in one of the four compartments which led Burney to call this the Granary. The other communal structure was a mud brick town wall with undressed stone around the gate, built perhaps for defence or as an animal barrier. Kura-Araxes pottery at Yanik in the Early Bronze I period, Yanik Ware, was a black to grey burnished ceramic often embellished by incisions or excisions that were sometimes in-filled with a white lime powder to create contrasting decorative motifs (Burney 1961b).

In the following period, Early Bronze II, rectilinear mudbrick houses replaced the circular huts, and the incised/excised pottery decoration disappeared, but the continuity in the spatial division of dwellings and complexity of kitchen fixtures as well as artefact types shows that there was no major cultural transition at the site (Burney 1964). Storage in Early Bronze I and II was in above ground storage bins; no pits were used and, in each period, storage bins proliferated over time.

The archaeology of the contemporary periods at Haftavan remains unpublished but there was a comparable transition from round to rectilinear houses over the Early Bronze Age, with a similar type of material culture as found at Yanik Tepe, although the pottery was decorated by dimples and grooves rather than incisions (Summers 2004).

At Godin Tepe, the first Yanik Ware appeared in period Godin VI:1 when the site was part of the Late Uruk exchange network (see Figure 2.1 for chronology). This period, VI:1, was originally phased as V during the excavations but later evaluation of the stratigraphy led to its reclassification as the final part of the Late Chalcolithic VI period (Young 2004) which places it in the last quarter of the fourth millennium (Rothman and Badler 2011). In period VI:1, there was a large oval compound with defensive walls on the high point of the mound, which was composed of several separate buildings around a central courtyard. The presence of Uruk influenced pottery, including bevel rimmed bowls, seals and tablets, indicates that Godin was within the Uruk sphere, although the exact nature of the Mesopotamian involvement at the site is uncertain. Young (2004) interprets the oval compound as an Uruk trading colony whereas Rothman and Badler (2011) view this compound as the residence of the local elites who were controlling and facilitating trade with lowland Uruk.

While the discovery of Yanik Ware shows that there was contact between the VI:1 inhabitants of Godin and the Kura-Araxes, it was not until the oval compound was abandoned for a time that the mound was resettled in period IV (2900-2600B.C.), by people with the material culture and architecture of the Kura-Araxes. Godin period IV has been split into IV:2, the earliest phase, followed by IV:1b and then IV:1a, although the exact dates of these periods are not certain (Rothman 2011). Unlike Yanik and Haftavan, no round houses were found. The initial buildings at Godin IV:2 were undifferentiated rectangular wattle and daub households that, similar to Yanik Tepe, appear to represent an egalitarian settlement of family units (Rothman 2011). These houses contained a suite of Kura-Araxes artefacts; equipment for food processing, Yanik type cooking and serving dishes, evidence for metalworking, animal figurines, and lithics, although no andirons were found. In the next phase, IV:1b, small mudbrick houses were built containing many storage bins, horseshoe shaped hearths and household assemblages similar to those of the initial IV dwellings. A large rectangular building, 3, with two rooms was constructed in this period, possibly communal in function and similar to a building found at Pulur (Saykol) in the Keban region of Anatolia (Rothman 2011). It appears to have been used for public feasting, and suggests a level of social organisation. The first room had black painted benches along the walls and a raised platform in the middle with a great quantity of animal bones and serving and eating vessels, whereas the adjoining smaller room had tools and vessels for food preparation. In the following IV:1a phase, the building was slightly remodelled, with the addition of fire installations, but continued to be used for feasting, with similar amounts of animal bones found. Houses at this time were reorganised to have courtyards with cooking hearths but maintained their Kura-Araxes assemblage and appearance.

In the surrounding Kangavar Valley and nearby highlands, new sites were established which were dominated by Godin Tepe IV material culture. These sites are thought to have developed separately alongside the pre-existing VI villages rather than displacing them from the Valley (Young 2004).

2.5 Upper Euphrates

In the Upper Euphrates region of east central Anatolia, there are several important sites which show the spread of Kura-Araxes horizon to the west and interactions with the local Syro-Mesopotamian cultures. The building of the Keban Dam in the 1960s led to extensive surveys and rescue excavations in the Altınova and Elazıg Plains along the Murat River. Several significant settlements were investigated, Norşuntepe (H. Hauptmann 1982), Korucutepe (Van Loon 1978), Tepecik (Esin 1971), Değirmentepe (Duru 1979), Aşvan Kale (French 1973; Sagona 1994), Taşkun Mevkii (Sagona 1984, 1994), Han Ibrahim Şah (Ertem 1972), and Pülür-Saykol (Koşay 1972), all of which had Kura-Araxes levels. Conti and Persiani (1993) have devised a regional chronology for the Upper Euphrates and noted that there was a proliferation of new sites and reoccupation of abandoned sites in Early Bronze II (c.2800-2500B.C.) at the time when Syro-Mesopotamian influences waned and Kura-Araxes features increased.

Arslantepe, in the Malatya region of the Upper Euphrates, has a long sequence spanning the Chalcolithic and Bronze Age, and has been excavated by Italian teams since 1961, led by Palmieri in the 1980s and later by Frangipane (Batiuk 2005). The chronological periodisation of Arslantepe is provided in Figure 2.1. In the latter half of Period VII (c.3650-3300B.C.) at Arslantepe, a centralised administrative system was developing and this was demonstrated in the construction of monumental buildings and proliferation of clay sealings (Frangipane 2001). These buildings contain evidence of centralised storage and distribution of goods, and craft working as well as possible ceremonial activities (Frangipane 2012b). Large quantities of mass produced Chaff Faced Ware bowls were found in the monumental buildings, which reveal a level of craft specialisation, aimed at speed and economy, as well as centralised organisation within the Period VII society (Palumbi 2003). The Chaff Faced Ware horizon, characterised by standardised mass produced bowls with abundant straw inclusions, is found across Syria, northern Mesopotamia, the Upper Euphrates and southeastern Anatolia in the period equating to Amuq F, and is thought to have developed somewhere in the highlands between the Euphrates and southern Caucasus (Marro 2010). It signifies a structural reorganisation of societies for a specialised production of goods that occurred alongside the gradual development of social stratification (Sagona and Zirmansky 2009).

In this period, the upper portion of Period VII, Kura-Araxes style Red-Black, Monochrome and Black Burnished Ware first appeared at Arslantepe. A handful of sherds were found in the ceremonial building: only eighty-three pieces, representing 0.48% of the assemblage which was primarily made up of Chaff Faced Ware (Palumbi 2003). In the multiroom complex, a slightly higher proportion, 1.8%, of the ceramics were Red-Black, Monochrome or Black Burnished Wares. Since proportionately more of the three burnished wares were found in the multiroom complex, and due to the closed mouth shape of their vessels, these wares are thought to have been involved in the storage of food, rather than the distribution and consumption activities conducted in the ceremonial building (Palumbi 2003). Arslantepe in this period was connected both to the emerging administrative polities of the Syro-Mesopotamian region and was beginning to engage with communities in the northeast Anatolian highlands with connections to Transcaucasia.

In the final third of the fourth millennium B.C., contacts with Syro-Mesopotamia increased and Arslantepe was absorbed into the Late Uruk exchange network. Arslantepe in Period VIA (3400-3000B.C.) was a local centre, heavily influenced by Late Uruk culture adopting and elaborating Mesopotamian models but did not contain an Uruk trading outpost (Frangipane 2001). Administrative consolidation, begun in Period VII, increased in this period. Economic centralisation is indicated by the finding of over 300 different types of seal impressions and over 2000 sealings indicating the involvement of many individuals in a sophisticated bureaucracy relating to an internal movement of foodstuff (Frangipane 2010). These sealings were not randomly discarded across the palace but preserve the administrative system at the time of the palace’s collapse. In one storeroom, A340, some sealings were found *in situ* near the objects they once sealed, and show signs of being removed and reattached quite frequently, while others were found placed in a corner after recent use, prior to being discarded in neat dumps (Frangipane 2010). Coarse mass produced bowls, first produced in period VII, continued to be manufactured in period VIA. Centralised intervention in economic activities has also been inferred from the substantial increase in ovicaprid remains (75-80% in VIA compared to 40-45% in VII), to sustain both a palatial wool trade and intensified meat production (Bokonyi 1983; Frangipane and Siracusano 1998; Frangipane and Palumbi 2007; Bartosiewicz 2010). Crop husbandry also is interpreted as being administered by the palatial authorities due to the dominance of 6-row barley in the VIA assemblage (Balossi

Restelli *et al.* 2010). This form of barley produces higher yields than 2-row barley but requires greater quantities of water that in this region necessitates irrigation, the labour for which may have been organised through the centralised palatial economy (Balossi Restelli *et al.* 2010).

While Arslantepe in VIA was part of the Syro-Mesopotamian cultural sphere, there was an increase in Kura-Araxes style material at the site during this period. Red-Black, Monochrome and Black Burnished Wares were found in both the palatial complex and the northern residential buildings. In Temple A, 10% of the pottery was Red-Black Burnished Ware and this was mostly in the form of fruitstands (high stemmed bowls) which could have had a cultic function as containers for liquid offerings or burners (Palumbi 2008). Temple B had one large red-black burnished pithos located close to the altar (Frangipane 1997) although only one storage room contained Red-Black Ware (Frangipane and Palumbi 2007). In the residential area, Red-Black Burnished Ware was more common, primarily in the form of jars, and constituted 9% of the total assemblage (Palumbi 2008). The Red-Black Burnished Ware at Arslantepe differed slightly from that of northeastern Anatolia through the patterning of the red and black surfaces. Kura-Araxes ware from Sos Höyük, and later the Caucasus, was fired to have a black outer surface and red inner colouring, irrespective of vessel type. Arslantepe Red-Black Burnished Ware had black on the outside of closed mouth vessels, like jars and jugs, but black on the inside of open mouth vessels including fruitstands and bowls, so that black burnished surface was on the most visible face depending on the shape of the vessel (Palumbi 2003). The Red-Black Burnished Wares in both the ceremonial and residential sections of the mound were finely made pieces, luxury ware that had become integrated into the ceramic repertoire of Arslantepe perhaps through trade. Transcaucasian links were also present in metalwork found in the palace. A hoard of weapons from storeroom A113 was chemically analysed, and identified as copper arsenic alloys with an isotope signature similar to ores in the eastern Black Sea (A. Hauptmann *et al.* 2002). Some of the spearheads had close parallels to Caucasian spearheads and the design of a spiral pendant was similar to examples in Georgia (Palumbi 2008; A. Hauptmann *et al.* 2002). Connections to northeastern Anatolia and the Caucasus, as shown by the red-black burnish pottery and metalwork, were developing over Period VIA even as Arslantepe was engaged in the Uruk exchange network.

The palatial complex at Arslantepe was destroyed and abandoned at c.3000B.C., after the collapse of the central economic system. Similar economic collapse occurred at other Uruk related sites in Syro-Anatolia at this time (Frangipane 2009). Period VIB (3000-2750 B.C.) is split into two phases, VIB1 and VIB2, although the exact periodisation of the two levels is uncertain. A village of freestanding wattle and daub huts, square in shape with rounded corners, made of walls supported by poles set into channels and slightly sunken floors, was built on the VIA destruction level in VIB1, subperiod (S), sometime after fire destroyed the palace complex (Frangipane 2000; Frangipane and Palumbi 2007). These huts were loosely grouped together in individual clusters which were linked by rows of postholes that may have been fences for livestock pens (Frangipane and Palumbi 2007). It is suggested that these wattle and daub buildings represent a series of overlapping layers of frequent seasonal occupation (Frangipane and Palumbi 2007) but there is no evidence for cross cutting structures to support this position. In the subsequent VIB1 level, subperiod (R), mudbrick buildings were made, one a circular structure that may have been a kiln and another an enigmatic long, slightly curved 20m building with four rooms positioned linearly against each other (Palumbi 2008, 225). This building had small buttresses on the exterior walls, the floor was made of untempered mudbrick, and benches lined the walls (Palmieri 1981).

Material from this period shows a blending of traditional Kura-Araxes and pre-existing local styles. The ceramic assemblage of the VIB1 huts was fairly homogenous, almost exclusively handmade Kura-Araxes style Red-Black/Monochrome/Black Burnished Ware; only 4% (44 sherds) were of non-local wheelmade Plain Simple ware found across Syro-Mesopotamia (Palumbi 2008). Circular red-black potstands first appear in VIB1 (Palmieri 1981). When found, hearths in the VIB1 huts are reminiscent of the Chalcolithic hearths found at Arslantepe, which were partly sunken into the floor with a central ash pit, but no portable trefoil Kura-Araxes hearths were uncovered (Frangipane and Palumbi 2007). Overall this period represents a realignment of Arslantepe from the Syro-Mesopotamian network to the Transcaucasian interaction zone. Whether the abundance of Kura-Araxes material in VIB1 resulted from the resettlement of the mound by Kura-Araxes groups or the adoption of Kura-Araxes material culture by local people, this change signalled the incorporation of Arslantepe into the Kura-Araxes cultural sphere.

In VIB2 the settlement changed. A monumental mud brick wall, 4m thick on 5m wide stone foundations, was built around the upper section of the mound separating it from the lower village. Pit digging in later phases at the site obliterated the remains of any possible VIB2 structures inside the walled enclosure on the upper mound. Exterior to the wall, rectangular mudbrick buildings with stone foundations were built along two narrow streets. Circular hearths similar to those in VIB1 were present in the centre of the houses which often had benches lining the walls in the main room and a narrow side room for storage and food processing (Palumbi 2008). The full suite of domestic activities was conducted in the houses with evidence of independent household level food storage and processing, in direct contrast to the centralised economic administration of VIA. Inside two of the houses studied, wheelmade Plain Simple Ware derived from the Late Uruk pottery of VIA was the main ware type (55%) although considerable quantities of the local handmade Kura-Araxes style, Red-Black, Monochrome and Black Burnished Ware, were also present (27%) (Palumbi 2008). Arslantepe in period VIB2 was a hybrid of contrasting cultures. There were reintroduced VIA elements, the Plain Simple Ware with connections to Syro-Mesopotamia but, in terms of settlement structure, household economy and domestic features, period VIB2 appears Transcaucasian.

The Kura-Araxes influence in VIB affected the most fundamental of cultural traditions at Arslantepe, funerary customs. Dated to VIB, the 'Royal Tomb' was discovered on the highest point of the mound overlaying the VII monumental public building. In the upper pit chamber, four sacrificed adolescents were buried with a mix of local Kura-Araxes jars and Late Uruk derived Reserved Slip Ware jars. Their bodies were lying on top of the stone lined cist grave of a 30-40 year old man (Frangipane *et al.* 2001). With the man were Reserved Slip jars, delicate Kura-Araxes jugs and bowls, and a rich array of sixty-four metal objects, made of arsenical copper, gold, silver and silver-copper alloy (Frangipane *et al.* 2001). The arsenical copper spearheads were identical to the Caucasian models found in the VIA storerooms and the use of this alloy is typical of Kura-Araxes metalwork. The silver and silver copper alloy bracelets, rings, spirals, pins and diadems all have close parallels to items found in Kura-Araxes graves in the Caucasus (Frangipane 2000; Frangipane *et al.* 2001; Palumbi 2008). Copper tools, axes, chisels and gauges are similar to those found in the north Caucasus in early Maikop kurgans (Palumbi 2008). The wealth of the metal grave goods together with the four human sacrifices suggests that the cist tomb's occupant was person of prestige and rank. This is the earliest stone cist grave found in the Upper Euphrates and represents a complete break with Chalcolithic burial traditions (Frangipane *et al.* 2001). Stone cist graves were rather a Georgian and Armenian tradition common from the last quarter of the fourth millennium, although Kura-Araxes burials did not show such social stratification (Palumbi 2007). The exact date of the tomb is uncertain. Carbon dating places it some time in VIB but, based on the blending of VIA and VIB2 ceramic traits, it is thought to be early in the VIB2 period, contemporary with the monumental wall (Frangipane 2007/08). The tomb preserves links to the past with Late Uruk derived jars in what was otherwise a Kura-Araxes context, with Transcaucasian style pottery, metalwork and grave type signifying the cultural alignment of Arslantepe.

After the VIB2 mudbrick settlement was burnt down c.2800B.C., wattle and daub architecture returned to the site in the terminal VIB2 phase, the houses had plastered floors and the pottery was exclusively Kura-Araxes style with incised geometric designs (Palumbi 2008). The following VIC (2750-2500B.C.) period had two phases of occupation. The first was of wooden and rectangular mudbrick houses surrounded by straw lined storage pits and sunken plastered circular activity areas which may have been for crop processing (Persiani 2008). The internal arrangement of the houses was similar to that in VIB2 and they had central circular hearths resembling those from VIB1/2 (Persiani 2008). These houses appear short-lived; repeatedly abandoned, destroyed, pits filled with rubbish, and new buildings cut into their remains although never rebuilt in the same position (Sadori *et al.* 2006). The wheelmade Syro-Mesopotamian related Plain Simple and Reserved Slip Wares of VIB2 were no longer present in the ceramic assemblage which was dominated by Kura-Araxes Red-Black Burnished Ware (Conti and Persiani 1993). The later levels of VIC show a more stable settlement structure that continued into VID (2500-2000B.C.). At the end of the VIC period, a mudbrick building built on a stone terrace was made up of square houses in a linear alignment, with courtyards containing ovens off to the side (Persiani 2008). Inside the houses large central hearths made by horseshoe shaped andirons dominated the room, benches lined the walls, and mortars and grinding stones were fixed in platforms and work benches (Sadori *et al.* 2006; Persiani 2008). In one room, A607, thirty-four vessels were found, predominantly Kura-Araxes style jars, pithoi, kitchen pots and large bowls, with one painted Gelinciktepe jar and two possibly imported Syrian Metallic Ware jars, together with a large amount of charred cereals and pulses (Sadori *et al.* 2006; Persiani 2008). This building complex was rebuilt in VID and enlarged with more rooms all bearing similar functional and cultural attributes (Persiani 2008). At the end of VID, a large fortification wall was built around the settlement, and buildings constructed of wattle and daub and round houses, some with sunken floors, appeared (Persiani 2008). In VIC-D, Arslantepe became fully integrated into the Kura-Araxes tradition in terms of building methods, settlement structure and material culture.

To summarise, at Arslantepe, the nature of Kura-Araxes presence appears to have become stronger over time. In VII, the rare Kura-Araxes sherds probably represented contact between the gradually urbanising Arslantepe and neighbouring Kura-Araxes communities. This contact apparently increased in VIA, when Arslantepe was a large administrative centre with monumental buildings, as part of the Late Uruk exchange network, and is suggested to be due to Kura-Araxes involvement in the pastoral economy of Arslantepe. After the collapse of the VIA palace, the wattle and daub VIB1 settlement had strong Kura-Araxes components with

Syro-Mesopotamian elements but the VIB2 mudbrick village had more Syro-Mesopotamian traits. The 'Royal Tomb' indicates that a new political structure was present at Arslantepe in VIB2. Prestige was marked by Transcaucasian metalwork in a burial that blended Kura-Araxes and Late Uruk features. In the following period, VIC-D, the Syro-Mesopotamian influence at the site seemed to cease and Arslantepe became seemingly Kura-Araxes in character.

2.6 The Amuq

In the Amuq region, the local variant of the Kura-Araxes ceramic wares is termed Red-Black Burnished Ware and the associated cultural horizon is called Amuq H. In the 1930s, a team from the Oriental Institute at Chicago conducted surveys in the Amuq Plain near Antakya in Turkey and excavated five sites, Tell Judeideh, Tell Tayinat, Çatal Höyük, Tell Dahab and Tell Kurdu, to help create a chronology for the region (Braidwood and Braidwood 1960). These were complemented by British excavations at Tell esh-Sheik, Tabara al-Akrad and Tell Atchana (Hood 1951; Woolley 1953). Braidwood identified several phases, F to J, relating to the Late Chalcolithic and Early Bronze Age of the Amuq Plain (Braidwood and Braidwood 1960). Amuq F was characterised by the Chaff Faced Ware, pottery with lots of chaff temper, which was first described in the Amuq. This horizon spreads from the Amuq across eastern Anatolia and northern Syria into the Caucasus (Marro 2007). Amuq G equates to the period of Late Uruk expansion. Late Uruk related Reserved Slip Ware, which has strong parallels to pottery from Arslantepe VIA, has been found at several sites in the Amuq, although only a limited section was exposed at Tell Judeideh (Braidwood and Braidwood 1960; Yener *et al.* 2000a; Yener 2005). Red-Black Burnished Ware first appeared as isolated sherds in the upper levels of Late Uruk Amuq G at Tell Judeideh (Braidwood and Braidwood 1960). There was a continuation of Amuq G Plain Simple Ware into phase H, although with the difference that Red-Black Burnished Ware dominated the assemblage, constituting 52-55% of sherds collected (Braidwood and Braidwood 1960). Red-Black Burnished Ware from the Amuq had either the typical Kura-Araxes colour patterning of red inside and black exterior, or an all over red-orange colouring (Braidwood and Braidwood 1960; Sagona 1984). Typologically the Red-Black Burnished Ware is similar to both the Kura-Araxes material in the Upper Euphrates and Khirbet Kerak Ware in the southern Levant, and appears transitional between the two (Batiuk 2005). Amuq H levels were also found at Dahab, Çatal Höyük, Tell Tayinet, Tabara al-Akrad and Tell es-Saluq (Woolley 1953; Braidwood and Braidwood 1960).

Amuq H architecture is very poorly known, partly due to the limited excavations conducted. In phase H at Judeideh, an almost complete rectangular room with lime plastered mudbrick walls on stone foundations was found with clay benches, ovens, storage bins, horseshoe shaped hearths, anthropomorphic tri-horned andirons and animal figurines (Braidwood and Braidwood 1960). At Tabara al-Akrad the Red-Black Burnished Ware levels were marked by pits, possibly grain stores, with only one room uncovered with a circular hearth (Hood 1951). Red-Black Burnished Ware continued into Amuq I although in lesser proportions together with a new Simple Ware. The cessation of Red-Black Burnished Ware marks the beginning of Amuq J, which was predominantly painted Simple Ware.

Forty-three sites with Red Black Burnished ware were found in the Braidwoods' (1960) survey. Investigation of the Amuq Plain was rekindled in the mid 1990s with new excavations and extensive surveys (Yener *et al.* 2000a; Yener 2005). A further twenty-eight sites with Red-Black Burnished Ware have been recognised bringing the total to seventy-one as of the 2002 survey (Batiuk 2005). The introduction of Red-Black Burnished Ware coincides with a reorganisation of the settlement patterns. Amuq G settlements were located in the middle of the plain whereas smaller phase H settlements were dispersed around the edge of the valley outside of the Amuq G system and along major routeways (Batiuk 2007). Only fourteen out of twenty-six Amuq G settlements continued to be occupied in the Amuq H. Despite the abandonment of the remaining sites the total number of settlements virtually tripled in Amuq H (Batiuk 2005). The new sites on the edge of the plain were almost exclusively associated with Red-Black Burnished Ware, and this, together with the abandonment of the central plain in phase H, led Batiuk to suggest that phases G and H may overlap since it is only the presence of Red-Black Burnished Ware that distinguishes the two phases (Batiuk 2005). Petrographic analysis of the Red-Black Burnished Ware from both the earlier and recent excavations, and survey of the Amuq, has determined that it was all produced locally and, moreover, the different fabrics were probably the result of independent household production within each settlement (Batiuk 2005).

Since the initial excavations by Braidwood and Braidwood (1960), Hood (1951) and Woolley (1953), there have no published excavations of sites with Amuq H cultural layers. Most new data on the spread of the Red-Black Burnished Ware horizon in the region is the result of intensive surveys. While this provides information on settlement patterns in the region, the lack of data from excavated Amuq H sites, in relation to architectural styles and material assemblages, inhibits a more complete understanding of the Kura-Araxes cultural horizon in this region, which is an important zone linking the Upper Euphrates and Southern Levant. Renewed excavations at Tell Tayinet may help clarify the chronology and nature of the Red-Black Burnished Ware horizon in the Amuq. At the end of the 2010 season Amuq level J had been reached (Welton *et al.* 2011).

2.7 The Levant

In the Levant, red black burnished pottery was first found at Tel Beit Yerah (Khirbet Kerak) in the 1920s by Albright (1926) and assigned by G. E. Wright (1937) to the Early Bronze III period (see Figure 2.1). Subsequent researchers recognised a connection between the Khirbet Kerak Ware, named after the type site, and the Red-Black Burnished Ware of Anatolia and Transcaucasia (Amiran 1952, 1965; Burney and Lang 1971; Sagona 1984). The appearance of Khirbet Kerak Ware in the Levantine sequence, dated to c. 2850B.C. (Greenberg *et al.* 2012; Regev *et al.* 2012), 2800B.C. (Phillip 1999) or 2700-2600B.C. (de Miroschedji 2000), is often used to signify the beginning of the Early Bronze III period (Greenberg 2007) although Phillip (1999, 35) warns against this convention.

In the Early Bronze II (3100-2850B.C.), Tel Beit Yerah was a planned fortified settlement encircled by a 7m high mudbrick wall (Greenberg *et al.* 2012). Stone built houses were aligned along gridded streets and these cobbled streets were kept clean of refuse, which indicates a level of centralised urban organisation (Greenberg *et al.* 2012). At the beginning of the Early Bronze III (2850-2500B.C.) construction began on a monumental stone building, the Circles Building, that is thought to have been designed as a granary (Mazar 2001; Greenberg *et al.* 2014). This building seems to have been abandoned shortly after it was constructed or left in an unfinished state and Khirbet Kerak Ware appears intrusively in the upper levels of the Circle Building and across the site at this time (Greenberg *et al.* 2012). The abandoned Circles Building and neighbouring earthen plaza were reorganised into an industrial area for food and Khirbet Kerak Ware production with very limited evidence of local ceramic traditions remaining (Greenberg *et al.* 2014). These Khirbet Kerak Ware users have been interpreted as 'squatters' occupying Tel Beit Yerah in the Early Bronze III, who had a material culture package more akin to the Kura-Araxes of Anatolia and the Caucasus than the Early Bronze II inhabitants of the site (Greenberg *et al.* 2014). In the Early Bronze III deposits in the abandoned Circles Building at Tel Beit Yerah, a zoomorphic circular hearth with two rams' heads was found (Mazar 2001). Tri-horned portable andirons and anthropomorphic andirons, reminiscent of Kura-Araxes examples in Anatolia, were also present at Tel Beit Yerah (Paz 2009). Andirons were also found in Khirbet Kerak levels at Beth Shean and Tell esh-Shunah (Novacek 2007, 600). Domestic architecture at Tel Beit Yerah also differed between houses, with differing proportions of Khirbet Kerak Ware. Houses of Khirbet Kerak Ware users were built of wattle and daub and clay lined installations were used for storage which contrasted with the Early Bronze II constructions which were all stone built (Greenberg *et al.* 2014). Khirbet Kerak Ware-rich houses were larger with more open spaces possibly for communal activities (Paz 2009).

Khirbet Kerak Ware has been found at a number of key sites in the southern Levant, including Hazor in the Hula Valley, Beth Shean, Yaqush and Tell esh-Shunah in the northern Jordan Valley, ʻAfula and Tel Qishyon in the Jezreel Valley, as well as Tel Beit Yerah on the Sea of Galilee (Zuckerman *et al.* 2009). These sites were deemed the core Khirbet Kerak Ware sites due to the high proportion of Khirbet Kerak Ware in the site assemblages (de Miroschedji 2000). At Beth Shean, Yaqush and Tell esh-Shunah, Khirbet Kerak Ware came to outnumber the local Early Bronze II type ceramics (Greenberg and Goren 2009). This was particularly noticeable at Yaqush, where the ubiquitous Early Bronze II serving platters disappeared over the Early Bronze III. Khirbet Kerak Ware large heavy kraters and bowls replaced the local serving platters (Novacek 2007, 587), which Paz (2009) interprets as a change in consumption practices to an emphasis on communal eating. At Tel Beit Yerah, 25-30% of the ceramic assemblage from the Early Bronze III period is Khirbet Kerak Ware, although in some contexts Khirbet Kerak Ware makes up 50% of the pottery, particularly at the beginning of the period (Greenberg 2007). Khirbet Kerak Ware ceramics have clear morphological parallels to Kura-Araxes wares and, more closely, to the Red-Black Burnished Ware of the Amuq with the sinuous sided bowls, deep kraters, lids, potstands and use of geometric incised decorations (Greenberg 2007). Comparison of Khirbet Kerak Ware and local Levantine production methods suggests that there was a different operational sequence and underlying mindset between the two ceramic traditions (Iserlis 2009). Local ceramics were wheel-made, and the production emphasis was on collecting suitable clays (Iserlis 2009). For the handmade Khirbet Kerak Ware however, the priority was on the surface treatment (burnishing) of the vessel (Iserlis 2009), which was also a characteristic of Kura-Araxes ceramic manufacture at Aparan and Karnut in the Kura-Araxes homeland and is suggestive of a diaspora community rather than an emulation of ceramic wares (Iserlis *et al.* 2010).

Outside of the core Khirbet Kerak Ware zone, Khirbet Kerak Ware has been found at sites as far south as Har Hemar on the edge of the Dead Sea (Yekutieli 2009) and Jericho (Nigro 2009). At these sites, there were fewer Khirbet Kerak Ware functional types and sherds found than in the core Khirbet Kerak Ware region (Zuckerman *et al.* 2009). Petrographic analysis of ceramics from the core Khirbet Kerak Ware region, and the more distant sites to the south where rare Khirbet Kerak Ware sherds were found, confirms two things: firstly that Khirbet Kerak Ware ceramics were being produced within the southern Levant and, secondly, that, while some Khirbet Kerak Ware ceramics were being produced in the core Khirbet Kerak Ware region and distributed south, at other sites outside of the core area, Khirbet Kerak Ware was being made locally to the sites where they were found (Zuckerman *et al.* 2009). The widespread production of Khirbet Kerak Ware in the southern Levant and its longevity (c.300 years) is regarded as indicative of a distinct cultural phenomenon and was the furthest extension of the Kura-Araxes horizon (Novacek 2007; Greenberg 2007; Greenberg and Goren 2009; Greenberg *et al.* 2012; Greenberg *et al.* 2014).

2.8 Summary of Kura-Araxes regional archaeology

Chronologically, the consensus is that the Kura-Araxes cultural horizon originated in the Transcaucasus and northeastern Anatolia in the mid fourth millennium, then spread west to the Upper Euphrates and south east into the Zagros Mountains of Iran by the beginning of the third millennium B.C.. The appearance of Kura-Araxes material, primarily distinctive red black burnished ceramics, in these regions, occurred first when the both the Upper Euphrates and Zagros mountains were part of the Syro-Mesopotamian cultural sphere, and increased in the Late Uruk period. By c.2800B.C. Kura-Araxes material and sites proliferated in the Upper Euphrates region and became the dominant cultural type. From the Upper Euphrates, the Kura-Araxes horizon spread to the Amuq and from there to the southern Levant by c.2800 B.C.. The Kura-Araxes horizon faded from the southern Zagros Mountains c.2600B.C. from the southern Levant c. 2400B.C., from the Amuq, c.2200B.C., and from the Upper Euphrates by c.2000B.C.. In Transcaucasia, the Kura-Araxes period appears to have ceased by the end of the third millennium although the presence of Kura-Araxes material into the second millennium at Sos Höyük may indicate its extended existence in northeastern Anatolia.

Spread across the Near East, the Kura-Araxes horizon appears quite heterogeneous and yet a number of common traits emerge. Within each of these regions, the Kura-Araxes are recognised by the similarity of the prominent red-black burnished pottery together with the use of portable hearths and andirons. Indeed the centrality of the household hearth is a key feature of the Kura-Araxes in Transcaucasia, eastern Anatolia, the Upper Euphrates and Iran. In these areas, settlement architecture indicates that Kura-Araxes sites were egalitarian arrangements of nuclear households, although communal organisation and labour for the production of monumental boundary walls, granaries, towers and irrigation systems has been found in each region. Another common trait was the distribution of sites with Kura-Araxes material in intermontane zones across the arc of the Taurus and Zagros ranges skirting the edge of the Fertile Crescent and into the arable plains of the Amuq and Levant. One problem that arises, however, when trying to compare the different regions of the Kura-Araxes horizon, is the lack of excavation data from the Amuq region, which has primarily been investigated through surveys. This prevents full integration of the Amuq into an analysis of the cultural traits of the Kura-Araxes horizon and misses an important stage for understanding the appearances of the Kura-Araxes horizon in the southern Levant.

2.9 The expansion of the Kura-Araxes cultural horizon

Theories for the expansion of the Kura-Araxes cultural horizon will be briefly discussed in this section. The spread of the Kura-Araxes phenomenon across the Near East was initially regarded as an invasion of the Amuq and Levant by 'barbarians from the north' (Woolley 1953, 31; see also Hood 1951; Amiran 1952; Burney and Lang 1971). Todd's influential paper "Anatolia and the Khirbet Kerak Problem" challenged this correlation between a widespread suite of similar red-black burnished ceramic wares with the existence of an archaeological people that migrated on mass across the Near East (Todd 1973; Batiuk 2005). For many years the concept of migration in Anglo-American archaeological discourse was rejected as being theoretically and methodologically unsound, too closely allied to the 'pots equal people' construct of Culture Historical archaeology (Anthony 1990; Burmeister 2000; van Dommelen 2014). In this milieu, migration as an explanation for the spread of the Kura-Araxes was questioned and discarded in favour of an economic model where the Kura-Araxes horizon was principally the diffusion of a ceramic style by itinerant potters, traders or metalsmiths (Todd 1973; Kelly-Buccellati 1990; de Miroschedji 2000). Since the 1990s, however, the concept of migration, as an explanatory process in archaeology, has been revived (Anthony 1990; Burmeister 2000; Batiuk 2005; van Dommelen 2012; T. C. Wilkinson 2014). Many scholars interpret the spread of the Kura-Araxes cultural horizon as the gradual migration and resettlement of Kura-Araxes groups across the Near East (Sagona 1993; Rothman 2003; Summers 2004; A. T. Smith 2005b; Batiuk 2005; Batiuk and Rothman 2007; Novacek 2007; Greenberg and Goren 2009; Paz 2009; Kohl 2009; Greenberg *et al.* 2014; T. C. Wilkinson 2014; Palumbi and Chataigner 2014).

Migration is thought to depend on the interplay between competing push and pull factors to motivate movement to new regions (Anthony 1990). Rothman (2003, 99) has proposed a model for the spread of the Kura-Araxes horizon as like 'ripples in a stream', involving multiple waves of small scale movement over several generations, each ripple having a different motivating factor. Many theories of Kura-Araxes migration rely on mobile pastoralism within the Kura-Araxes economy to initiate exploration and movement into new areas (Rothman 2003, 2005; Batiuk and Rothman 2007; Frangipane and Palumbi 2007; Palumbi 2008, 2012; Palumbi and Chataigner 2014). It has been suggested that migration may have been motivated by the need to search for new lands to pasture animals or cultivate crops because of climatic change, land degradation or overpopulation (Sagona 1993; Kushnareva 1997; Kohl 2007). While there is no evidence for land degradation in the Caucasus in the Kura-Araxes period (A. T. Smith 2005b), there are some signs of short-term climatic fluctuations which may have caused localised agricultural instability and encouraged movement to new regions (Connor and Kvavadze 2014). Initial expansion of the Kura-Araxes has also been connected to the search for new trading markets or metal sources which encouraged later resettlement (Rothman 2003; Marro 2010). Others have suggested that the collapse of the Late Uruk system encouraged predatory Kura-Araxes expansion into prosperous but vulnerable regions (Kavtaradze 2004); however, there is little evidence linking the spread of Kura-Araxes material culture with destruction of sites across the Near East (A. T. Smith 2005b; Summers 2014). Batiuk (2005, 232) proposes that new communities might have been founded by those seeking to create new hierarchies to enhance their economic and social status as leaders of new groups. Alternatively, Batiuk (2013) also suggests that the Kura-Araxes may have been specialist vini- and viticulturalists who were able to occupy underexploited economic niches in new regions. Whatever the reasons for the spread of the Kura-Araxes phenomenon the prevalence of two wheeled wagon models at Kura-Araxes sites indicates that there was potentially a high level of mobility available to groups of the Kura-Araxes cultural horizon (Sagona 2013; Greenberg 2014).

Alternatively, Phillip (1999) has suggested that the spread of the Khirbet Kerak horizon in the Southern Levant may have represented communities 'opting out' of specialised economic production and refocusing on household production. Similarly, Frangipane and Palumbi (2007) have suggested that the spread of the Kura-Araxes cultural horizon in the Upper Euphrates may have been due to indigenous communities shifting to a more mobile pastoral economy after the Uruk collapse c.3000B.C. and adopting the material cultural package of the neighbouring Kura-Araxes mobile pastoralists (Palumbi 2010, 2012; Frangipane 2012a, 2014).

2.10 Kura-Araxes Economy

The Kura-Araxes economy has often been assumed to have been based on pastoral transhumance and this has influenced explanations for the expansion of Kura-Araxes material culture. This long held belief stems from the apparent temporary nature of Kura-Araxes architecture and the potential portability of their material culture, which suggests to researchers that many Kura-Araxes sites were seasonal camps of mobile pastoralists (Burney and Lang 1971; Sagona 1984, 1993; Cribb 1991, 220-223; Kushnareva 1997; Shimelmitz 2003; Palumbi 2003; Rothman 2003, 2005; Frangipane and Palumbi 2007; Palumbi 2010; Isikli 2012; Frangipane 2014).

This notion has begun to be challenged through archaeozoological studies at the Kura-Araxes sites of Sos Höyük, Gegharot, Mokhra Blur and Natsargora, and Kura-Araxes levels at Arslantepe and Godin Tepe (Bokonyi 1983; Howell-Meurs 2001a, 2001b; Monahan 2007; Piro 2009; Bartosiewicz 2010; Rova *et al.* 2011; Crabtree 2011). These analyses indicate that at Kura-Araxes sites cattle, sheep/goat, pigs and a variety of wild resources were exploited. The analyses of age mortality profiles from animal bones from Sos Höyük has demonstrated that there was year round occupation of the site and that the animal economy was geared towards risk minimisation though diversification and conservative production strategies (Howell-Meurs 2001b, 2001a; Piro 2009). The Gegharot (Monahan 2007) and Mokhra Blur (Piro 2009, 279-282) Early Bronze age archaeozoological assemblages were dominated equally by cattle and sheep/goat remains. At Natsargora initial analyses show that cattle was the dominant species at the site followed by sheep/goat and pig and that the emphasis was on mixed food production (Rova *et al.* 2011). At Godin Tepe in phase IV sheep/goats dominate the assemblage and their mortality profile shows both year round Kura-Araxes presence at the site; herding strategies may have been directed towards meat and wool production due to the amount of mature and elderly sheep/goats killed (Piro 2009, 283-287; Crabtree 2011). In Kura-Araxes levels at Arslantepe, sheep/goats were the most abundant animals although the relative abundance of cattle and pigs increased over the Kura-Araxes period (Frangipane and Siracusano 1998). The animal taxa proportions from Arslantepe phases VIB and VID have been used by researchers at the site to argue for a specialised sheep/goat pastoral transhumance strategy focused on meat and wool production (Frangipane and Siracusano 1998; Palumbi

2010). The animal taxa proportions at Arslantepe are, however, very similar to the taxa distributions at Sos Höyük which has been identified as a settled mixed economy, and animal mortality profiles do not distinguish between the Late Uruk and Kura-Araxes periods at Arslantepe, so further economic comparisons cannot be made (Frangipane and Siracusano 1998, 243). From the archaeozoological analyses at these sites it is clear that the Kura-Araxes did not have a uniform pastoral economy; the emphasis on sheep/goat and cattle varied according to site, which may reveal localised preferences. Apart from Sos Höyük (Howells-Meurs 2001; Piro 2009) and Godin Tepe (Piro 2009; Crabtree 2011) there has been little analysis of the age of mortality profiles of animal bone assemblages from Kura-Araxes sites to indicate the season of site use or the type of herding strategies pursued. At Sos Höyük and Godin Tepe where animal mortality profiles have been studied, the Kura-Araxes' economy appears to have been based on settled mixed agro-pastoralism using a diversity of animal resources.

Very little is known about agricultural production at Kura-Araxes sites. Lisitsina and Prischepenko (1977) conducted a review of archaeobotanical finds from multiple sites excavated during the Soviet period in the Caucasus and reported many species of wheat, primarily free threshing varieties, and barley, both two row and six row, as well as millet and grape at Kura-Araxes sites. In the Caucasus, evidence for agricultural activities is also provided through finds of stone and bronze sickle blades, models of plough boards, traces of threshing sledges, grinding stones and pits for food storage at many Kura-Araxes sites (Kushnareva 1997). Nevertheless, until recently our understanding of plant economies at Kura-Araxes sites has been hampered by a lack of archaeobotanical data. In the Caucasus, archaeobotanical analyses have now been performed at several Kura-Araxes sites: Velikent (Gadzhiev *et al.* 1997), Gegharot (Badalyan *et al.* 2008), Aparan-III (Hovsepyan 2010a), Maxta (Ristvet *et al.* 2011), Kultepe (Ristvet *et al.* 2011), Tsaghkasar (Hovsepyan 2011), and Chobareti (Kakhiani *et al.* 2013; Messager *et al.* 2015). Outside of the Caucasus archaeobotanical data is available from some Kura-Araxes sites in eastern Anatolia: Korucutepe (Van Zeist and Bakker-Heeres 1975), Tepecik (Van Zeist and Bakker-Heeres 1975), Arslantepe (Follieri and Cocccolini 1983; Sadori *et al.* 2006; Balossi Restelli *et al.* 2010; Sadori and Masi 2012; Masi 2012), Imamoğlu (Oybak and Demirci 1997) and Dilkaya (Nesbitt 1991); Iran: Haftavan (Summers 1982) and Tappeh Gijlar (Constantini and Biasini 1984); and the Southern Levant: Jericho (Hopf 1983), Tel Beth Shean (Simchoni and Kislev 2012; Simchoni *et al.* 2007) and Tel Beit Yerah (Berger 2013). In order to discover more about Kura-Araxes agriculture, a synthesis and analysis of current archaeobotanical data is needed. This thesis will therefore investigate trends in Kura-Araxes agriculture by comparing crop choices at Kura-Araxes and other Near Eastern sites. In addition, a new Kura-Araxes archaeobotanical assemblage from the site of Sos Höyük is included in the analysis. The environmental setting and archaeology of Sos Höyük is described in the next section.

2.11 Sos Höyük and the village of Yiğittaşi

Sos Höyük, a mound site, is located in the village of Yiğittaşi (Figures 2.2 and 2.3). It lies on the southern bank of the Çoğender stream which is a tributary of the Aras River in the Pasinler Valley (Figure 2.4). The site is at an altitude of 1771 meters above sea level and is 24 km east of the town of Erzurum in Eastern Turkey. The Pasinler Valley is a broad plain flanked by the Karapazarı mountains to the north, the Palandöken Mountains in the south and the Deve Boyun ridge in the west (Figure 2.5). This valley is the main east-west route through the northeastern mountains of Anatolia, linking central Turkey with the Caucasus and Iran. The restricted pass of the Deve Boyun ridge, at the western edge of the Pasinler Valley, forms a natural boundary in the landscape. This region has been recorded as a frontier zone since antiquity when the Deve Boyun ridge marked the border of the Persian 19th and 18th satrapies of Eastern and Western Armenia, in the 5th century BC (Sagona 2004b). In the middle of the valley, the rural town of Pasinler, Medieval Hasankale or ancient Basen (Sagona 2004c), sits at the base of a long rocky spur. Today in the Pasinler Valley, there are 30 villages in the western half of the valley where Yiğittaşi is located, most positioned in the foothills of the mountain ranges to the north and south of the valley.

Sos Höyük lies in the northern part of the plain and, at its core, is 1.2 hectares in size but extends further beneath the village of Yiğittaşi to the west, south and east (Sagona *et al.* 1995). The mound rises 12m above the plain. The village today encroaches on the site with houses, some subterranean, built on top of and into the mound on the southern, eastern and western sides. Today, the village is inhabited by about 300 people from 40 different households (Hopkins 2003). The name Sos Höyük is thought to relate to the Armenian word *saws* for plane or poplar tree (Sagona 2004c). The *saws* trees were trees of divination and prayer in Anatolia and the Caucasus in antiquity and so Sos Höyük may have been the site of a sacred grove (Sagona 2004c).

2.11.1 Climate of the Pasinler Valley

Eastern Anatolia is characterised by an extremely harsh continental climate with long cold winters and dry hot summers. In the Erzurum region, including the Pasinler Valley where Sos Höyük is located, frosts begin in October and heavy snow covers the ground from November to March or April (Yakar 2000). The average temperature from December to March ranges from -1 to -16^{o}C and may drop as low as -37^{o}C (Bulut *et al.* 2010). In summer the average temperature ranges from 15 ^{o}C in June to 19 ^{o}C in August but can reach as high as 34^{o}C on hot days (Hopkins 2003; Bulut *et al.* 2010). Even in summer sudden cold changes can drop the temperature to less than 5 ^{o}C and snow often remains on the high peaks surrounding the Pasinler Valley throughout the year. Annually, the Pasinler Valley receives approximately 430mm of rain (Hakgoren 1972). The dry season lasts from late June to late September. Most rain falls towards the end of autumn and at the beginning of spring, and the spring rains are supplemented by the snow melt.

2.11.2 Flora of the Pasinler Valley

The Pasinler Valley lies at the border of the Euro-Siberian and Irano-Turanian floristic regions (Davis 1965-1988; M. Zohary 1973). Today, the Pasinler Valley is a broad flat treeless plain with rocky hillocks rising above the cultivated fields, dry stream beds and occasional marshy ground. Trees are limited to village margins, roadsides and river banks. Villagers plant poplars (*Populus*) and birches (*Betula*) near their homes for their own use and sometimes plant stands of poplars when a girl is born as a slowly maturing investment to harvest and help pay for her wedding when the time comes (Hopkins 2003). In May and June, alpine wild flowers bloom, creating a rich carpet of colour on the valley floor (Figure 2.6). Along a vegetation transect of the northern Pasinler Valley, Newton (2004) observed many herbaceous perennials and grasses suited to surviving in dry summer conditions on the rocky slopes, herbivory resistant taxa, such as *Astragalus* and *Eryngium,* in pasture zones and frost-tolerant species at high altitudes. The most abundant taxa along the length of the transect were members of the Poaceae, Asteraceae and Fabaceae families. Surveys of weeds present in wheat fields of the Pasinler Valley identified that *Convolvulus arvensis, Sinapis arvensis, Avena fatua, Chenopodium album, Anchusa azurea, Vaccaria pyramidata, Cirsium arvense, Fallopia convolvulus, Cephalaria syriaca, Atriplex patula* and *Centaurea depressa* were the most common and abundant species (Kaya and Zengin 2000). A range of weedy cereals, both

Triticum and *Hordeum*, are found in grasslands across the Valley and may represent relicts of past cultivation (Bardsley 2001).

The past vegetation of the Pasinler Valley can be reconstructed through historical descriptions, pollen cores and wood charcoal analysis. Historical sources provide some idea of the past environment of the Pasinler Valley. The earliest account of the region is by Xenophon. Writing in the fourth century BC of his escape from Persia to the Black Sea with 10,000 men, he is thought to have retreated through the Pasinler Valley and across the Erzurum plain (Sagona 2004b). He describes that it was winter, the snow was six feet deep, the villages were well provisioned and on the Erzurum plain '…there was wood in abundance' for the Greek soldiers to cut and burn for warmth (Xenophon, IV.IV.5). By the time Joseph Pitton de Tournefort, a French botanist, travelled from Erzurum to Kars through the Pasinler Valley in 1702AD the landscape had been deforested (Figure 2.7). *Quercus* and *Pinus* were known to grow in the region but were each found 6 and 3 days distant from the city of Erzurum (Tournefort 1741).[2] Describing the Pasinler Valley, Tournefort writes 'There is not a Tree to be seen in all this part of the Country, which otherwise is flat, well cultivated and water'd as abundantly as the Fields of Erzeron [Erzurum]' (Tournefort 1741, 121). Between Xenophon's march and Tournefort's journey the countryside had been deforested, although the timing of the forest clearance is uncertain.

Two pollen cores are available from the Pasinler Valley. One undated core from the archaeological site of Bulemaç, has evidence of grassland steppe with high amounts of Amaranthaceae pollen at the base of the core and increasing proportions of *Pinus* pollen towards the top of the sequence (Collins *et al.* 2005). Another core, from north of Yiğittaşi on the slopes of the Karapazari range, records the last 700 years (620 ±60BP) and has very little arboreal pollen although it does indicate that there were isolated stands of *Pinus* and *Betula* nearby during this time (S. Connor cited in Longford *et al.* 2009). Anthracological analysis of Sos Höyük charcoals has suggested that in the Late Chalcolithic and Bronze Age an open *Quercus* woodland may have covered the valley and a *Pinus sylvestris* forest may have been present on the Karapazarı Mountains slopes with *Betula* stands at the treeline (Longford *et al.* 2009). By the early Iron Age the charcoal record indicates that the *Quercus* woodland was depleted near to Sos Höyük. Archaeozoological remains of wild animals from Sos Höyük

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[2] The Pasinler Valley was within a day's journey of Erzurum according to Tournefort '... the Baths of Assancala [Pasinler], built very neatly on the Banks of the Araxes, a small day's journey from Erzeron [Erzurum]'(Tournefort 1741, 220). These woods therefore were at least 1-5 days away from the Pasinler Valley.

similarly indicates a mosaic of open and wooded habitats interspersed with marshland in the Early Bronze Age (Howell-Meurs 2001b). By the Iron Age there was a loss of woodland species, bison, wild pig, brown bear and red deer (Howell-Meurs 2001b), which may suggest a reduction in woodland cover in and around the Pasinler Valley between the Bronze and Iron Ages.

Remnants of this open *Quercus* woodland are present further to the west in Erzurum province (Atalay *et al.* 2014) and stunted stands of *Quercus* trees were found towards the top of the Karapazarı Mountains near to Yiğittaşi (Sagona *et al.* 1996). Pollen cores from Lake Van indicate the presence of a similar open *Quercus* woodland from the Chalcolithic onwards (6000BP) which began to decline in the second millennium BC and was finally cleared in the last 600 years (Van Zeist and Woldering 1978; Wick *et al.* 2003). Much of the East Anatolian highlands, including the Pasinler Valley, are thought to have been deforested during the last 500 years as permanent settlements increased in this region (McNeill 1992). Indeed, Ottoman tax records indicate that the nearby population of Erzurum increased two thousand fold in the 16th Century after frontier wars had decimated the local population (Jennings 1976). In the neighbouring province of Bingöl, south of Erzurum province, half of the *Quercus* forests have been deforested in the last 30 years, their leaves extensively used as goat fodder over winter in this region (Atalay 2001). Final deforestation of the Pasinler Valley could therefore have occurred in the historic period. In the Kura-Araxes period of the Chalcolithic and Bronze Ages, however, it is likely that an open *Quercus* woodland was present above the alpine steppe. Today, the Euro-Siberian *Quercus* woodland has been completely depleted, probably through grazing and deforestation, leaving only shrubby hawthorns (*Crataegus*) and rose bushes (*Rosa*) scattered amongst the Irano-Turanian herbaceous steppe and alpine grassland (Newton 2004).

2.11.3 Agricultural economy of Yiğittaşi

In the village of Yiğittaşi, modern Sos Höyük, wheat, barley, potatoes, lentils, sunflowers, sugar beet, capiscums and garden vegetables are grown (Hopkins 2003). A local landrace of *Triticum aestivum*, known as Kirik, is cultivated in Yiğittaşi. Kirik is a facultative wheat, meaning it can be sown in either spring or autumn and still produce good yields, and has a high cold tolerance (Bardsley 2001). It is preferred by local farmers over modern commercial varieties because of its facultative nature, its white glutinous flour well suited for local bread making, and because it is awnless with tall straw which is good for animal foddering (Bardsley and Thomas 2005; Caglar *et al.* 2011a). Kirik produces the greatest yields when it is sown in early autumn (Ozturk *et al.* 2006). Cereal crops near to the village are often sown in the spring, however, and harvested in the autumn, because the cultivation of commercial crops, such as potatoes and sugar beets, extends into the autumn and impinges on the optimum sowing time of cereal in this region (Caglar *et al.* 2011b). Irrigation is practiced near to the village using water diverted from the Dere Suyu several kilometres upstream (Hopkins 2003). The fields are left fallow when possible to restore moisture and nutrients to the soil, but increasing agricultural and commercial demands often mean that fallowing cannot be practiced and crops are instead rotated to preserve soil productivity (Hopkins 2003).

Animal husbandry is the main economic concern of the village. In Erzurum province, sheep are the most common livestock reared and chickens are the second most abundant species (Howell-Meurs 2001b). Sheep, goats and cattle are the dominant herd animals in Yiğittaşi (Hopkins 2003). Some animals are sold for meat and the sheep are shorn for their wool, but the animals are primarily kept for their milk production, which is either sold as milk or turned into cheese as a year-round protein source (Hopkins 2004). During the summer, the animals are taken out to pasture each morning and returned after a day's grazing to be milked and stabled in the households' barns. Some sheep and goats are kept overnight during summer in a circular stone sheepfold one kilometre from the village. Over winter, animals are kept in households' barns and fed fodder which was harvested over the summer. Two forage crops are utilised in Yiğittaşi. Wild grasses from fallow fields and marginal land are harvested for fodder and the legumes *Trifolium* and *Medicago* are specifically grown as fodder crops but need to be fully ripened and dried before being fed to animals (Hopkins 2003). Livestock dung is collected, dried and used as fuel for heating and cooking in the village (Hopkins 2004).

In modern times, two different transhumant groups visit the Pasinler Valley during the summer months (Hopkins 2003). The alpine wild flowers of the Pasinler Valley attract beekeepers from Ordu on the Black Sea coast, who summer in the open land near to Yiğittaşi with their Caucasian bees to produce honeycomb. Transhumant pastoralists come from Bitlis, south of the Palandöken Mountains, in the summer to graze their livestock on the foothills of the Karapazarı mountains to the north of Yiğittaşi. The villagers of Yiğittaşi do not practise transhumance and are able to graze their livestock locally within the Pasinler Valley and on the slopes of the Karapazari Mountains.

2.11.4 Archaeology of Sos Hoyuk

Excavations at Sos Höyük were conducted by a team from the University of Melbourne led by Professor Antonio Sagona and Dr Claudia Sagona from 1994-2000 (Sagona *et al.* 1995; Sagona *et al.* 1996; Sagona *et al.* 1997; Sagona *et al.* 1998; Sagona and Sagona 2000, 2004). Three study seasons were held on site from 2001-2003. This excavation was part of the North East Anatolia Archaeology Project which began in 1988 with investigations at Büyüktepe Höyük in Bayburt Province (Sagona *et al.* 1991, 1992, 1993). Initial excavations at Sos Höyük were initiated by a team from Atatürk University, Erzurum, who dug into the Medieval and Post-Achaemenid layers on top of the mound in 1987 (Sagona and Sagona 2003). An archaeological survey identified 57 sites in the Pasinler Valley from the Chalcolithic to Ottoman periods, with a proliferation of settlements from the Iron Age and Medieval periods (Sagona 1999). The Kura-Araxes sequence at the site spans 2000 years from the Late Chalcolithic to end of the Middle Bronze Age (Sagona 2004a). An extensive series of 70 radiocarbon dates from secure contexts has created a chronological sequence for Sos Höyük spanning the Late Chalcolithic through to the Medieval period (Table 2.1) (Sagona 2000, 2014). While Sagona (2014) has recently mooted re-classifying the Late Chalcolithic (Va) at Sos Höyük to be part of the Early Bronze Age, which would make Sos Höyük conform to the chronological scheme of the Southern Caucasus, this thesis will use the existing chronology from Sagona (2000) since a revised periodization for the site has not yet been finalised.

Excavations by the University of Melbourne team were focused on the summit of the mound where the 1987 excavations had occurred, a trench on the north western slope and an area lower down the mound on the north eastern edge (Figures 2.8). The archaeological features of the Kura-Araxes period at Sos Höyük are described in detail below. After the Kura-Araxes period, the mound continued to be occupied from the Late Bronze Age through to the Post-Achaemenid period before being abandoned in 200BC. Early Iron Age levels revealed a burnt room sealed by roof collapse. On the plaster floor were well preserved carbonised basketry, matting, rope, a twine sandal and burnt furniture (Sagona *et al.* 1996; Sagona and Sagona 2000). Sos Höyük was re-occupied in the Medieval period before being vacated again and finally repopulated sometime in the last 500 years (Sagona and Sagona 2004).

Late Chalcolithic 3500-3000BC

Sos Höyük was first occupied in the mid fourth millennium BC (Sagona 2000). At least ten building levels constitute the Late Chalcolithic phase. Above natural gravels, a number of burnt floors were found associated with a double-horned portable hearth and well used stone blade. Shortly after this initial settlement, in c.3300BC a large stone wall, 2.5m across and 1.75m in height in places, was built around the centre of the settlement, with houses on either side, and does not appear to have been defensive in nature (Sagona *et al.* 1997; Sagona *et al.* 1998; Sagona and Sagona 2000). Four building levels are associated with the large stone wall, the houses all have stone foundations and prominent portable andirons or fixed circular hearths that were superimposed over each other in the last two levels (Kiguradze and Sagona 2003). After the wall collapsed in c.3100BC the inhabitants built houses over and around the wall, including one building with an insulated floor made out of crushed pottery sherds on top of a layer of sand that surrounded the circular hearth. Overlaying this was a rectilinear house with a central circular hearth inset into a lime plaster floor and stone bench along the back wall (Sagona and Sagona 2000). This house was itself replaced by a freestanding circular mudbrick building with central circular hearth and portable hearths, ceramic vessels and flaked obsidian blades (Sagona 2014). After the round house burnt down at c.3000BC, the large stone wall was rebuilt although it seems the wall collapsed shortly after construction at the end of the Late Chalcolithic. The ceramics in this period were all handmade, one ware type is similar to the Sioni wares of Georgia, another type was mottled grey-brown drab ware, but the main ware type is an early form of Kura-Araxes pottery (Proto-Kura-Araxes). These are well burnished black or grey vessels, with scratched designs, rounded bodies and tall swollen necks but lack the characteristic red-black colouring of later Kura-Araxes ceramics (Sagona 2014). U-shaped portable hearths, typical of Kura-Araxes contexts, appear in the assemblage towards the end of this period.

Early Bronze Age 3000-2200BC

The Early Bronze I strata lay directly above the collapsed Late Chalcolithic wall. Only one building was found in this period, although several floor levels containing hearths were uncovered separate to this single roomed structure. Within the stone based building, a fixed circular hearth was present and was overlain by later hearths of subsequent floor levels. An ornate circular hearth with geometric motifs on the surface was found nearby (Sagona and

Sagona 2000). The Early Bronze I ceramic assemblage was similar to the Late Chalcolithic assemblage, with some Sioni and drab wares, but the majority were Kura-Araxes biconical shaped vessels either mottled or with the typical red-black colouring (Sagona 2000).

In the Early Bronze II layers, two single-roomed rectilinear houses with curved corners, made of stone foundations topped by mud brick walls and containing circular hearths and clay storage bins were excavated (Sagona *et al.* 1997; Sagona 2000). In one of the houses, immediately in front of a bench that extended along the back wall, was a fixed circular hearth, with central uprights for pot supports and double spirals decorations around the edge (Sagona and Sagona 2000). Ceramics in the Early Bronze II were all standard Kura-Araxes wares, black burnished on the exterior with occasional prominent relief decorations, tall straight necks and thickened walls (Sagona 2000).

In Early Bronze III levels, two burials, a number of pits and a mud brick or wattle and daub rectangular building with rounded corners were found (Sagona and Sagona 2000; Sagona 2000). Near to a hearth two small horned animal figures were uncovered (Sagona and Sagona 2000; Sagona *et al.* 1998). The Early Bronze III graves included elements of Early Kurgan culture material. One burial, burial 3, was a simple pit burial in the Kura-Araxes tradition but contained a Bedeni vessel (highly burnished black vessels with silver graphite sheen), the other was a deep shaft burial capped with stones, more similar to Early Kurgan than Kura-Araxes in style, that contained an early Trialeti/Martkopi style vessel (black with incised pendant triangles) (Sagona *et al.* 1998; Sagona 2000, 2004a). Aside from the two burial vessels, ceramics in Early Bronze III contexts were standard Kura-Araxes wares with tall straight necks, prominent angular shoulders and thick walls (Sagona 2000).

Middle Bronze Age 2200-1500BC

In the Middle Bronze I layers, a two-roomed rectangular building built with stone foundations was uncovered (Sagona and Sagona 2000). Both rooms had circular hearths set into the floors. The hearth in the larger room was well made and positioned in front of a lime plastered bench which ran along a wall. U-shaped and twinned horned portable hearths were found in the building together with red-black burnished Kura-Araxes ceramics. After the building was abandoned this area of the mound was covered by plaster floors and pits. Contemporary with the building were three burials which combined Kura-Araxes and Trialeti traditions. Burial 1 was a small pit grave, Kura-Araxes in nature, with a bronze hair ring next to the crouched skeleton and a black incised early Trialeti/Martkopi style jar that had been burnt on the inside and capped by a stone (Sagona *et al.* 1997; Sagona 2004a). Burial 2, a deep shaft grave with a skeleton bound hand and foot, contained an early Trialeti/Martkopi jar and had clear parallels to the Early Kurgan cultures (Sagona *et al.* 1997). As well as early Trialeti/Martkopi jars in the graves there were some lustrous Bedeni sherds and a new brown gritty Bedeni ware found in this period, but the majority of Middle Bronze I ceramics were typical Kura-Araxes vessels which only differ slightly from earlier vessel because of their grit inclusions (Sagona 2000, 2004a). These Kura-Araxes Late Gritty vessels are typologically indistinguishable from the Early Bronze Kura-Araxes wares, except for the presence of white grit inclusions in their fabric (Sagona 2000).

In the Middle Bronze II layers, two sub-rectangular wattle and daub structures, a large mud brick building with four rooms and a round house with stone foundations were uncovered (Sagona 2000). In the four-roomed building, each room, apart from the central one, had a fixed circular hearth in the lime plaster floor and one room had a bench against the back wall. The hearth in the western room had three central ceramic projections similar to the Early Bronze II hearth with spiral designs. After this building was abandoned, the area was covered by a succession of plaster lined pits and ashy lenses; there were no buildings in this area of the mound until the Iron Age (1000BC) (Sagona and Sagona 2000). Kura-Araxes Late Gritty was the dominant ceramic type in the Middle Bronze II which also had brown gritty Bedeni wares and a few Late Trialeti fragments (Sagona 2000, 2004a). The mixing of Kura-Araxes and Bedeni, Trialeti and Martkopi ceramics and burial styles from the Early Bronze III to Middle Bronze II periods, in contexts contemporary with typical Kura-Araxes architecture and household assemblages, has led Sagona (2000, 2004a, 2011) to suggest that the Kura-Araxes horizon continued until the c.1500B.C. at Sos Höyük (see also section 2.1 and 2.2 for further discussion).

When Sos Höyük was first excavated it was interpreted as a site intermittently occupied by Kura-Araxes transhumant pastoralists (Sagona *et al.* 1996). The wattle and daub architecture and the frequent pit phases were seen as signs of temporary occupation of the site. However, archaeozoological analyses, by Howell-Meurs (2001b, 2001a) and Piro (2009), of sheep/goat mortality profiles has indicated that Sos Höyük was probably permanently inhabited throughout the year and that the economy was most likely based on settled mixed farming rather than specialised transhumant pastoralism. This has led to Sos Höyük being reinterpreted as a stable agro-pastoral community (Sagona 2011, 2014). Specialist analyses has also been undertaken on the human remains from the Early Bronze III and Middle Bronze I graves (Parr *et al.* 1999), the Kura-Araxes obsidian lithic assemblage (Sagona *et al.* 1997; Sagona *et al.* 1998; Kobayashi and Sagona 2007), and the petrography and geochemistry of the Kura-Araxes and Bedeni ceramics (Kibaroglu *et al.* 2011). An ethnoarchaeological study was conducted at Yiğittaşi village to provide a potential interpretive approach for understanding the archaeology of Sos Höyük (Hopkins 2003, 2004). An extensive geomorphology and environmental survey of the Pasinler Valley was conducted by Newton (2004). Other than initial observations by Dr Mark Nesbitt, recorded in Newton (2004), and preliminary study of a few Middle Bronze and Iron Age samples (Longford 2007), very little analysis has been conducted on the archaeobotanical assemblage from Sos Höyük. This thesis will therefore investigate the Kura-Araxes plant economy of Sos Höyük through the analysis of the archaeobotanical assemblage.

The next chapter will outline the methods used in both the archaeobotanical analysis of the Sos Höyük assemblage and the comparative analysis of Kura-Araxes and other Near Eastern sites.

Chapter 3: Methods

This thesis investigates the Kura-Araxes cultural horizon through both a detailed study of the archaeobotanical assemblage from Sos Höyük, a Kura-Araxes site, and a comparative analysis of crop remains found at Kura-Araxes and other Near Eastern sites. This chapter will first detail the methods used for the recovery, laboratory analysis and statistical interrogation of the Sos Höyük assemblage. The second stage of this study involved the creation of a large archaeobotanical dataset incorporating published and unpublished research. The methods of data collection and management of the Near Eastern archaeobotanical assemblages and the organisation of the data for multivariate analysis will therefore be presented.

3.1 Sos Höyük Archaeobotanical analysis

3.1.1 On site methodology

Sos Höyük was excavated from 1994 to 2000 under the direction of Professor Tony and Dr Claudia Sagona as part of the University of Melbourne's Northeastern Anatolia Project (Sagona *et al.* 1995; Sagona *et al.* 1996; Sagona *et al.* 1997; Sagona *et al.* 1998; Sagona and Sagona 2000). The site was excavated based on a 10m grid labelled west to east by letter, and south to north by number (Sagona *et al.* 1995). This grid system covered the whole territory of Yiğittaşi village and area of excavation on the mound was between gridlines H-N and 18-13 (see Figure 2.8a). For excavation, each 10m square was subdivided into four 5 x 5m squares, labelled a, b, c and d, and this designation (for example, L17b) formed the initial trench location for the finds and archaeobotanical samples. In each trench, the excavation teams were comprised of workmen from the village of Yiğittaşi under the supervision of two members of the project. Trenches were dug in 10cm units but recorded by archaeological contexts. Each trench was subdivided into a number of loci, where each loci represented a different archaeological context or feature, inside/outside a building for example, which were further separated into baskets as an arbitrary fraction of each loci.

Samples for archaeobotanical analysis were taken in every season of excavation from all archaeological periods. Only recognised floor levels rich in organic material, within 10cm of the floor, were sampled to avoid the mixed fill between layers. Soil samples were collected randomly from the floor level of each basket targeted, with hearths being preferentially sampled. The targeted sample size was approximately 60 litres of soil, three bucketloads, although individual soil volumes were not recorded. The soil was floated using a modified

Ankara flotation machine (French 1971; Nesbitt 1995) and additional agitation was provided by a propeller attached to a stick to release the buoyant organics (A. Sagona pers. comm.). The floated material was collected in cloth chiffons and, after being air dried in cloth bags, most archaeobotanical samples were stored on site in the excavation depot in Yiğittaşi village. The heavy residue was wet sieved and manually sorted at the site to collect organic remains, which were combined with the flotation samples when dry. The bulk of the Sos Höyük archaeobotanical samples were taken to the University of Melbourne in 2003 and transported to the archaeobotany laboratory in the Department of Archaeology at the University of Sheffield in 2009. A selection of archaeobotanical samples, primarily from Iron Age contexts, were sent to Dr Mark Nesbitt at the Royal Botanical Gardens, Kew UK, in 2000 for initial analysis. Dr Nesbitt kindly gave me these samples for my MSc dissertation in 2007 at the University of Sheffield.

3.1.2 Off site sample selection, subsampling and sorting

A total of 185 archaeobotanical samples were collected over the course of the excavations at Sos Höyük. Of these, 116 samples were from the Kura-Araxes period, dating from the Late Chalcolithic to Middle Bronze II (Sos Va to Sos IVb) (see section 2.11.4 and table 2.1). In the archaeobotany laboratory at the University of Sheffield, these 116 samples were scanned by eye to estimate sample richness and diversity of plant remains. Van der Veen and Fieller (1982, 296) recommended that samples need to have a minimum number of c.300-500 identifiable/quantifiable crop remains to reach a 5% accuracy rate for the percentage composition of crop types or crop parts in samples with an estimated volume of 1000 or more seeds. A target sample size of 300 crop items was set for this study. Initial scanning of the Sos Höyük samples, however, suggested that they were not very rich in crop remains, so as a minimum level, samples with at least 100 or more cereal items were prioritised for analysis. Also included were poorer samples from contexts of potential archaeobotanical interest such as hearths. In total, 70 samples from the Kura-Araxes period were designated for full analysis on the basis of sample richness and context. The list of samples analysed, including archaeobotanical sample number, which will be used when referring to the samples in Chapter 4, and contextual information, as provided by the excavator Professor Tony Sagona, is recorded in Table 3.1. Of the 70 samples, 17 were from the Late Chalcolithic, 25 were from the Early Bronze Age and 28 were from the Middle Bronze Age. A summary of sample distribution by individual period is included in Table 3.2.

Samples were sieved into coarse, >1mm, and fine, >0.3mm, fractions by use of 1mm and 0.3mm geological sieves. Where necessary, coarse fractions with large volumes were subsampled using a riffle-box, to create a subsample with approximately 300 crop items. Subsampling, by continuously splitting one half fraction of a sample using a riffle-box, is a technique that has been demonstrated to produce representative, even and random subsamples (Van der Veen and Fieller 1982). Fine fractions were subsampled using a riffle–box to be no smaller than one eighth of the coarse fraction. This was to maintain the statistical integrity of the species composition so that finds were not multiplied by a large factor which would introduce inaccuracies into the calculated numbers of each taxon. Most coarse fractions, 77% of samples, were sorted in their entirety in an attempt to reach 300 crop items per sample.

Coarse and fine sample fractions were sorted under a Leica MZ6 stereomicroscope with a magnification of up to x63. Crop seeds, cereal chaff, wild seeds and plant parts, dung fragments and wood charcoal were all sorted from the coarse fraction. The volume of wood charcoal and non-charred items was recorded. From the fine fraction, only crop remains and wild seeds were collected from the fraction. Virtually all the crop items were found in the coarse fractions and, in most samples, the coarse fraction was also very rich in wild seeds.

3.1.3 Identification

After sorting was complete, the plant material from each sample was separated into categories (cereal grain, cereal chaff, wild seed and plant parts), and material from within a category was identified at the same time to ensure consistency in identifications between samples. The plant remains were identified using comparative modern material kept in the reference collection of the Department of Archaeology at the University of Sheffield. Seed atlases (Bejerinik 1947; Berggren 1969, 1981; Anderberg 1994; Cappers *et al.* 2006; Neef *et al.* 2012) and illustrative archaeobotanical texts by Van Zeist and Bakker-Heeres (1985, 1986, 1988) were also consulted as an aid to identification. Specific criteria for cereal grain and chaff identification are provided in Hillman (2001) and the manual by Jacomet (2006) and for pulses in Van Zeist and Bakker-Heeres (1985). More detailed criteria used for identifying each crop taxon are provided in Chapter 4.1. Cereal nomenclature follows the traditional binomial system for *Triticum* and *Hordeum* taxa as outlined in D. Zohary *et al.* (2012, 29, 57) rather than modern classifications based on genetic relationships. This system was chosen because the traditional species names reflect morphological characteristics that are relevant for investigating crop processing techniques and these names are used most commonly by archaeobotanists (Nesbitt 2001; A. Smith 2005a). Nomenclature for wild taxa follows the *Flora of Turkey* by Davis (1965-1988).

Where possible, taxa were identified to species, otherwise to genus or family level. Intermediate identification levels (including cf. categories) were employed to accommodate plant remains that did not conform to all the criteria used for identification of a taxon or if comparative reference material was not available to confirm identifications based solely on published descriptions. Wild seed and plant parts that were not initially recognised were grouped into distinct types. Common types, those in more than 10% of samples, were identified further. Once these types were assigned to a possible genus or groups of genera, the identification process was refined by listing species found currently in a 200km radius of Sos Höyük, zones A8, A9, B8 and B9 of the *Flora of Turkey* (Davis 1965-1988), and in floristic surveys of the Pasinler Valley (Kaya and Zengin 2000; Newton 2004).

3.1.4 Quantification

In archaeobotanical assemblages, plant remains are often found fragmented. If the same plant part is recorded more than once it can skew the count of plant items present in a sample. It is therefore necessary to choose a quantification method that ensures a minimum number of plant parts are recorded (G. Jones 1990, 1991). The plant parts counted need to be unique and also robust enough to survive in an identifiable state after charring and burial. G. Jones (1990, 92; 1991, 65-66) suggested that minimum numbers of plant parts could be achieved by counting embryo ends of cereal grains and grass seeds for recording whole seeds, glume bases of glume wheats and the tops of rachis internodes for counting cereal chaff, and culm nodes and culm bases for tallying straw amounts. This quantification method was followed and adapted for certain taxa and plant parts.

Cereal embryo ends were counted as whole seeds, cereal chaff was counted by individual rachis internodes and glumes bases. Spikelet forks were counted as two glume bases but terminal spikelet forks were counted as one whole spikelet and half a terminal spikelet fork as a half. Pulse fragments were recorded by hilum counts or, in samples where no fragments with hila were present, the total number of pulses was estimated from the number of fragments. For wild seed taxa, grass embryo ends were counted to represent whole seeds. In many samples, Polygonaceae, Cyperaceae, and indeterminate *Chenopodium*/*Atriplex* endosperms were found detached from their seed coat, and being more robust, the endosperms were counted rather than the seed coat. The basal ends of

Lallemantia seeds, with two depressions either side of the ridge, were counted and whole numbers estimated. *Galium* seeds were recorded by counting fragments with the distinctive round concavity and calculating the minimum number of seeds present.

For each sample the presence of amorphous dung fragments and silicified straw or phytolith accretions was noted. The number of sheep/goat and rodent faecal pellets was also counted in each sample.

3.1.5 Standardisation of data

Before the assemblage could be investigated statistically the data needed to be standardised to reduce the number of variables without compromising the sample scores. The Sos Höyük sample identifications were entered directly into Microsoft Excel and this program was also used to standardise the data. The fine fraction counts were added to the coarse fraction counts after first multiplying the fine fraction by the subsample denominator to equalise it with the coarse fraction. That is, if the fine fraction represented an eighth of the coarse fraction the sample counts were multiplied by 8, or if the fine was a quarter of the coarse fraction the fine fraction counts were multiplied by 4. As mentioned earlier in 3.1.2, fine fraction subsamples were never smaller than one eighth of the coarse fraction. Where the total amount of a sample sorted was a subsample of the original flot, the plant item counts were not multiplied up to estimate what would be in the whole sample. Instead, the proportion of the sample sorted was recorded and the plant item counts reflect what was present in the fraction so as not to artificially inflate the numbers of the archaeobotanical assemblage studied. The sample scores based on minimum number of plant items are presented in Appendix A. No soil sample volumes were recorded in the field, so density measures could not be calculated to compensate for any potential variation in the assemblage due to differences in original soil sample sizes.

The assemblage was further standardised by amalgamating or proportionally splitting indeterminate plant identification categories to reduce the amount of variables before data analysis. These indeterminate and ‘cf.’ identifications are more often a product of differential preservation than morphological characteristics related to species differences and so were amalgamated or split to minimise statistical noise (Colledge 2001, 183; Hald 2008, 31). Some of the initial identification categories were combined if it was likely that they represented the same taxon. For example *Triticum aestivum* rachis internodes, *T.* cf. *aestivum* rachis internodes and *T. aestivum/durum* rachis internodes were combined, since no *T. durum* rachis internodes were positively identified at the site. Similarly, for statistical analyses all *Hordeum* rachis internodes and grains were categorised as *H. distichum* (see 4.1 for rationale of crop taxa classification). Item counts in a category like *Triticum/Hordeum* grain were split proportionately between the different *Triticum* and *Hordeum* species' grain groupings in each sample. Wild taxa were also amalgamated using the two same criteria. If indeterminate seeds of one genus were identified and one species from that genus was also present in the samples, and was very abundant, then the indeterminate seeds were also grouped with the identified species or, if the genus designation was more abundant, the species were reclassified to the genus. For example, *Chenopodium* sp. and *Chenopodium album* were amalgamated to become *Chenopodium* cf. *album* for statistical analysis, whereas *Trigonella astroites* and *Trigonella* sp. were combined to be *Trigonella* sp.. Amalgamated identification categories of crop items are presented in Table 3.3 and wild/weedy item amalgamations are listed in Table 3.4.

3.1.6 Interpretive methods

The Sos Höyük archaeobotanical assemblage was interpreted using descriptive and analytical techniques. In Excel, summary charts and tables were produced both to present the Sos Höyük results and to prepare the data for processing in other computer programmes discussed below. Descriptive ecological data (flowering/fruiting time, habitat, plant height, germination time, and life history) relating to wild/weedy taxa occurring in more than 10% of samples was derived from Davis (1965-1988) and specific information on plant germination in Erzurum sowing trials, 25km west of Sos Höyük, was taken from Çoruh and Bulut (2008) and Bulut *et al.* (2010). For taxa that were identified to genus level, the ecological information is a combination of data from all species of the genus that are found in the zones A8, A9, B8 and B9 of the *Flora of Turkey* (Davis 1965-1988). This is recorded in Table 4.6 of the next chapter.

3.1.6.1 Pattern searching using Correspondence Analysis

Patterns in sample composition were investigated using correspondence analysis of crop items and seeds of wild/weedy taxa. For a detailed discussion of correspondence analysis see Shennan (1997, 308-360) and Bogaard (2004, 92-94), sources on which this section is based. Correspondence analysis is a multivariate statistical technique that identifies differences in samples on the basis of their species composition and plots the resulting sample and species distributions on a two dimensional grid. The first axis, horizontal, accounts for the most variation in the data and the second axis, vertical, identifies further variation between samples or species. Additional axes can be plotted and each additional axis explains a smaller amount of variation in the data. The origin, the point at which the axes intersect, is the neutral part of the plot. Samples or species that plot at the origin do not provide much of the variation in the data, they are usually species which are ubiquitous in samples or samples composed of common species. Differences between samples or species are shown by the direction in which they plot from the origin and their degree of divergence is shown by their distance from the origin (Bogaard 2004, 93). In general, species that commonly occur together plot near to each other, and likewise, samples with similar compositions plot close together on the axes. Correspondence analysis is a commonly employed pattern searching technique in archaeobotany and has been used on Near Eastern assemblages from the Levant (Colledge 1998, 2001), Tell Brak (Charles and Bogaard 2001; Hald 2008), the Euphrates (Riehl and Bryson 2007) and Çatalhöyük (Bogaard *et al.* 2013) and more generally in archaeobotany by G. Jones (1991) and Bogaard (2004, 2011).

Correspondence analysis was performed using Canoco for Windows 4.5 and CanoDraw for Windows to draw the plots (ter Braak and Smilauer 2002). For clarity, species and sample plots are always presented separately. Rare taxa and types occurring in less than 10% of samples were removed from the analysis, since they often act as outliers in correspondence analysis and obscure any patterns in the data (G. Jones 1984, 48-49; 1991, 68; Van der Veen 1992, 25). Unless otherwise specified, the first axis is always plotted horizontally and the second axis is plotted vertically. In the Sos Höyük correspondence analysis, crop and wild/weedy assemblages are analysed separately. In each analysis, samples with less than 30 items were excluded.

By coding species or samples' data points by variables pertinent to the archaeological investigation, the underlying trends in the assemblage can be dissected and potentially explained. Samples' data points can be coded by archaeological feature, or turned into pie charts showing species composition or proportions of species with certain ecological traits. Species' data points can similarly be coded to show ecological characteristics. In the Sos Höyük correspondence analysis samples are coded by context, chronological period, presence of dung and as pie charts of species composition and the proportions of wild/weedy taxa from different habitats.

3.1.6.2 Analysis of crop processing stages

To identify the crop processing stages represented in each Sos Höyük sample, two different approaches were employed. The first approach is based on weed composition and compares the Sos Höyük samples to an ethnographic study of the physical characteristics of weed seeds found in the processing products and by-products of free threshing cereals and pulses from the Island of Amorgos, Greece (G. Jones 1984, 1987). The four main crop processing stages, winnowing by-products, coarse sieving by-products, fine sieving by-products and fine sieve products are distinguished by three physical characteristics: seed size ‘big/small’ (relevant to fine sieving), retention of seeds in heads or spikes after threshing, ‘headed/free’ (relevant to coarse sieving) and aerodynamic properties including buoyancy and weight, ‘light/heavy’ (relevant to winnowing) (G. Jones 1984). Six different types of weed seed groups were found in the ethnographic crop processing samples from Amorgos and certain physical traits were found to be preferentially associated with different crop processing stages (see Table 3.5). Jones’ (1984, 1987) approach uses discriminant analysis based on the combination of weed seed characteristics to differentiate between the four crop processing stages. Discriminant analysis searches for the most effective grouping of variables (the discriminant functions) to distinguish between predefined groups (Bogaard 2004, 91). The discriminant functions obtained in the original analysis can then be used to classify samples from unknown groups into the predefined groups. In this instance, the discriminant functions extracted to distinguish the modern ethnographic groups can be used to classify the archaeobotanical samples from Sos Höyük into one of the crop processing stages based on the similarity of their wild seed characteristics.

All potential weed seeds from Sos Höyük were coded according to their physical characteristics based on data in G. Jones (1984, 1987), Hynd (1997), Charles and Bogaard (2001), Hald (2008) and personal observation in the laboratory. Seeds were classed as big if they were greater than 2mm in size. The classification of the Sos Höyük wild seeds by physical categories relevant to crop processing analysis is presented in Table 4.8. Samples with less than 10 classifiable wild seeds were excluded from the analysis (G. Jones 1987). Discriminant analysis was performed using IBM SPSS Statistics for Windows 19 (IBM 2010). All variables were transformed to their square roots to make the data more normally distributed before being entered into SPSS using the direct method, where the ethnographic crop processing samples from Amorgos acted as control groups (G. Jones 1984). The discriminant functions then classified the Sos Höyük samples according to their proportions of different wild seed types (big free heavy, small headed light, etc.).

The second approach to crop processing is to compare archaeobotanical samples to the known the combination of cereal grains, cereal chaff and wild seeds in ethnographic samples of crop processing. Jones (1990) collected samples from different crop processing stages of free threshing cereals which had been processed using traditional methods on the Island of Amorgos, Greece. The proportions of cereal grain, rachis internodes and wild seeds were calculated and plotted for each sample from the four different crop processing stages present at Amorgos (G. Jones 1990). Each product or by-product from the different stages is represented by varying proportions of cereal grain, chaff and wild seeds, since each crop processing stage is designed to remove different harvested elements from the grain, for example winnowing separates the chaff and fine sieving eliminates the small seeds. Comparison of archaeological samples with the known proportions of cereal grain, rachis internode and weeds seeds found in the Amorgos samples (G. Jones 1990, Figure 14) gives some idea of what should be expected in material from the different crop processing stages. The processing of glume wheats differs from that of free threshing cereals; chaff of free threshing cereals is removed earlier than the chaff of glume wheats and therefore only samples rich in free threshing cereal remains should be compared to the Amorgos ethnographic stages of crop processing (G. Jones 1990). Sos Höyük samples with more than 25% *T. dicoccum* content were therefore excluded. Only samples with more than 30 free threshing cereal items and 30 wild seeds were included in this analysis. The proportions of free threshing cereal grain, chaff and wild seeds were standardised as percentages for each Sos Höyük sample and the samples were plotted on a triangular diagram using Tri-Plot for Microsoft Excel (D. Graham and Midgley 2000).

3.1.6.3 Ratios for fuel use analysis

In order to compare portions of dung fuel cake residues and wood charcoal in the assemblage, simple ratios were used, derived from Miller (1984, 1997a, 1998, 2010). Miller uses two ratios and averages them for each site phase to make inferences on potential : 1) wild seed/Charcoal (#:g) which compares the number of wild seeds with the weight of charcoal found in samples and 2) seed/charcoal (g:g) which compares the weight of seeds larger than 2mm (cereal grains) with the weight of wood charcoal in a sample. For these ratios the weight of wood charcoal for each Sos Höyük sample was determined by converting the volume measure recorded into grams, by multiplying the volume by density of charcoal (d=w/v). The wood density used in each conversion was 0.4g, based on data in Thery-Parisot *et al.* (2010). Similarly the weight of cereal grains was determined by multiplying the amount of cereal grains in each sample by the average weight of a charred cereal grain, 0.0125g, which was derived from Miller (1990).

The Sos Höyük archaeobotanical assemblage and results of these analyses are discussed and presented in Chapter 4.

3.2 Comparative analysis of Kura-Araxes and other Near Eastern archaeobotanical site assemblages.

3.2.1 Data collection

This thesis investigates the Kura-Araxes phenomenon through a comparative analysis of plant remains from Kura-Araxes and other Near Eastern sites. This relied on the collection of published archaeobotanical data as well as the Sos Höyük archaeobotanical assemblage, which was studied as part of this thesis and is discussed in Chapter 4. Unpublished archaeobotanical data for sites in the Aşvan region of eastern Anatolia was kindly provided by Dr Mark Nesbitt from the Royal Botanical Gardens, Kew. Online archaeobotanical bibliographies maintained and compiled by Dr Naomi Miller[3] and Dr Simone Riehl[4] were consulted in the initial stages of data collection. Archaeobotanical data was entered into a database created for this thesis to enable standardisation and management of the data.

The geographical range of this research was restricted to the Near East and was designed to encompass both the area of the Kura-Araxes cultural horizon and neighbouring regions to enable comparison of archaeobotanical data. The Kura-Araxes material culture is present in an arc that spreads from the Caucasus southeast into Iran and southwest to Israel. The region of study was therefore defined as being from the western coasts of Turkey, Syria, Lebanon and Israel to as far east as the eastern edge of the Caspian Sea in Iran, and in the north from the coastal plain of Dagestan in the Caucasus to as far south as the Gulf of Aqaba and the Persian Gulf.

The chronological scale of investigation was 6100-1500B.C.. This broad temporal span was needed so that archaeobotanical data from both the Kura-Araxes period, c.3500-1500 B.C. as determined at Sos Höyük (Sagona 2000), and from before the Kura-Araxes presence in each region could be included. In particular, this extended chronology enabled comparison between Kura-Araxes and non-Kura-Araxes contexts in the Southern Caucasus. The temporal range of this thesis, 6100-1500B.C., is equivalent to the beginning of the Chalcolithic to the end of the Middle Bronze Age in Anatolia (Yakar 2011). From the 6th millennium, only sites regarded as Chalcolithic were included in the data collection, to avoid the inclusion of culturally Neolithic sites, when agriculture and settled communities were being developed and established, which could have introduced additional variables that this study was not seeking to investigate. In this instance, Halaf sites are regarded as Early Chalcolithic in accordance with Anatolian criteria (Sagona and Zirmansky 2009; Ozbal 2011) rather than the Syrian Late

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[3] http://www.sas.upenn.edu/~nmiller0/

[4] http://www.ademnes.de/

Neolithic criteria (Campbell 2007; Akkermans 2013). An exception was made, however, for the Southern Caucasus where, in order to provide pre-Kura-Araxes sites for comparison, two Neolithic sites were included in the analysis.

In total, archaeobotanical data from 117 sites was collected for this study, 21 of these sites have plant remains from Kura-Araxes contexts. These sites are listed in Table 3.6 and sites with archaeobotanical material from Kura-Araxes contexts are marked with an asterisk. Figure 3.1 shows the location of all the sites included in this thesis. Sites are coded by the geographical groupings used for analysis and the justification for these classifications is discussed in section 3.2.4.1. Maps of each individual region with site locations are provided for the Amuq-Orontes in Figure 3.2, Central Western Anatolia in Figure 3.3, Iran and Southern Mesopotamia in Figure 3.4, the Khabur in Figure 3.5, the Middle Euphrates in Figure 3.6, the Southern Caucasus in Figure 3.7, the Southern Levant in Figure 3.8 and the Upper Euphrates and Upper Tigris in Figure 3.9.

Site chronologies, as recorded in the archaeological or archaeobotanical reports, are presented by region, the Amuq-Orontes in Figure 3.10, Central Western Anatolia in Figure 3.11, Iran and Southern Mesopotamia in Figure 3.12, the Khabur in Figure 3.13, the Middle Euphrates in Figure 3.14, the Southern Caucasus in Figure 3.15, the Southern Levant in Figure 3.16 and the Upper Euphrates and Upper Tigris in Figure 3.17. Periods with Kura-Araxes cultural assemblages at each site are highlighted in orange and those with occasional Kura-Araxes ceramic sherds are shaded pink. Project phase groupings are also indicated in each figure and this phasing is explained in section 3.2.4.1. These figures do not represent the complete chronologies of these sites, just the periods with archaeobotanical material included in this study. Archaeobotanical data collection was as thorough as possible but was constrained by the practicalities of what has been retrieved, analysed and published. Several sites in the database, such as Godin Tepe and Tell Tayinat, have had Kura-Araxes cultural horizons uncovered during the course of excavations, but no archaeobotanical material has so far been published from the corresponding periods. If the archaeological record is by its nature fragmentary, then, as a whole, the archaeobotanical record is often a fortuitous collection of disjointed snapshots. A map showing which sites contain archaeobotanical material from Kura-Araxes contexts and which have sites have Kura-Araxes cultural assemblages but no contemporary archaeobotanical data is presented in Figure 3.18.

3.2.2 Data management

In order to synthesise the large amount of archaeobotanical data collected, a relational database was created using Microsoft Access. The database design was influenced by the examples of archaeobotanical databases in A. Smith (2005a) and Livarda (2008).[5] Data storage was organised into a series of interlinked tables (Figure 3.19) which permitted effective recovery of data through queries. Examples of the table forms are provided in Figures 3.20, 3.21 and 3.22. The database was designed with the flexibility to cope with differences in sampling, level of analysis and the method of data recording between archaeobotanical publications, without losing the required level of integrity and efficiency. Data was entered by sample and the sample table, Figure 3.20a, formed the core of the database from which all tables were connected. This maintained the archaeobotanical sample as the unit of analysis (G. Jones 1991). In the sample table, information about archaeological context, sample recovery methods and wood and dung content was recorded. Cultural affiliation of the samples, particularly whether the sample was from a Kura-Araxes context, was noted in the sample table. The sample table was directly linked to the site, phase, reference and species tables.

Information about each site, including location, site altitude, modern annual rainfall, the archaeobotanists who worked on the material and the references for the archaeobotanical data, was recorded in the site table, Figure 3.20b, and is presented in Table 3.6. Site latitudes and longitudes were recorded as decimal degrees. Where possible, location data, including altitude, was retrieved from the archaeobotanical and archaeological reports relating to each site. When no published geospatial co-ordinates were available for a site, open access Google Earth satellite imagery was used to determine site location and retrieve latitude, longitude and altitude information. Each published site location was also confirmed using Google Earth. Modern annual precipitation levels were collected from individual site and archaeobotanical reports when it was present or estimated based on site location from isohyetal maps in Riehl and Bryson (2007) and Riehl (2009, 2012). Chronological information for each site period is contained in a separate phase table, Figure 3.21a. This table records the period dates, description of period and method of dating, and links directly to the sample table. The phase table is also used to categorise samples into chronological groups for the statistical analysis described in section 3.2.4.2 and the results of which are presented in Chapter 5.

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[5] These databases were used as examples since they store archaeobotanical data by taxa counts for each sample. The Tubingen Archaeobotanical Database was not used as an example because it presents archaeobotanical data as an abundance measure for each taxon by site phase

All archaeobotanical assemblage data from each site were included in the database, both cultivated and wild/weedy taxa. Each archaeobotanical item in each sample was entered as a separate record in the species table, Figure 3.21b, maintaining the original taxon and plant part identification as detailed in the published report. When archaeobotanical data from the same sample was present in multiple reports, the most recent publication was used as the source of taxon counts and identifications. The preservation state and quantification method used to record each archaeobotanical item was noted in the species table and an eMNI, equivalent minimum number of individuals (items), was calculated for each entry. Examples of how the eMNI was calculated for the different ways data is presented in Near Eastern archaeobotanical reportsand are discussed in section 3.2.3.3. General archaeobotanical and ecological information concerning each plant taxon included in the database, such as plant height, flowering time and crop processing seed code (BFH, SFH etc.) from the literature cited in 3.1.6.2, was stored in a separate taxa table (Figure 3.22). Plant taxonomic identifications were standardised using a table linking the taxa names in the species table to the project taxa name in the taxa table. This ensured that when querying the database, each plant taxon was represented by one uniform name, despite any possible variations in nomenclature between site reports. Criteria for the standardisation of plant identifications from different archaeobotanical reports are mentioned in 3.2.3.2.

3.2.3 Standardisation of the data entered into the database

One of the greatest difficulties encountered when trying to synthesise the large amount of data required for this study was reconciling the different methods of data recording and quantification used in archaeobotanical reports.

3.2.3.1 Entering of sample data

Most publications presented assemblage data on a sample-by-sample basis; at some sites however, data from multiple samples was grouped by chronological period or context type. This type of merged data recording was found to be used for 18% of sites collected for this thesis. Although this study aimed to analyse the data through individual sample units where possible, rather than omit sites with combined sample data, the amalgams were entered as individual samples and the number of individual samples represented by each combined entry was noted in the database. While this reduces the contextual integrity of the sample information, it was deemed not to interfere with the intended aims of this analysis, to explore patterns in crop choices in the Near East from 6100-1500B.C. with particular reference to possible crop preferences at Kura-Araxes sites. Table 3.7 lists the sites included in this study with archaeobotanical data published as combined context or period summaries.

3.2.3.2 Standardisation of plant identification

For wild plants the nomenclature of the *Flora of Turkey* (Davis 1965-1988) and the *Flora Palaestina* (M. Zohary 1966-1986) was used and crop nomenclature followed the traditional taxonomy outlined in D. Zohary *et al.* (2012). Appendix B lists the project taxa names used in the database that replace the varying plant names in archaeobotanical reports, together with the taxa names that were superceded. Where possible, when entering assemblage details of crop species in the database only identifications based on anatomical characteristics were used rather than those based on assumed past plant distributions. For example, Van Zeist recorded free threshing wheat rachis internodes at Hammam et-Turkman and Tell Raqa'i and suggested, based on ecological grounds that *Triticum durum* was the most likely species present, but described the rachis internodes sharing many hexaploid and tetraploid identification criteria (Van Zeist 2003b, 67; 2003c, 10). In this case the Hammam et-Turkman and Tell Raqa'i rachis internodes were included as *T. aestivum/durum*. Similarly, determining which species of *Hordeum* was present at each site was complicated by the varying nomenclature used to classify *Hordeum* remains in archaeobotanical reports with little clarification as to whether *H. distichum* (2-row barley) or *H. vulgare* (6-row barley) was present. If a clear statement was made in a report indicating whether *H. distichum* or *H. vulgare* was present either through the description of rachis internode morphology or mentioning the proportion of straight and/or twisted grains, the identification was recorded accordingly. If no differentiation was made between *H. distichum* or *H. vulgare* the remains were entered as indeterminate *H. distichum/vulgare.* Most reports indicated whether the *Hordeum* grains were hulled or naked. If this was not mentioned the grains were classified as *H. distichum/vulgare* and assumed to be hulled.

3.2.3.3 Standarisation of quantification methods

To be able to compare between multiple archaeobotanical assemblages where sample data was recorded using different methods, either by presence/absence scores, scales of abundance, weight, percentage, site ubiquity or as item counts, an equivalent minimum number of individuals score, eMNI, was calculated for each plant item. To perform these calculations, species data was entered into Microsoft Excel, the eMNI determined and the information imported into the Access database. In most archaeobotanical reports, data was presented as item counts which could be used directly as an eMNI. The only change applied in these cases was the conversion of glume wheat spikelet forks into glume base counts (one spikelet fork to two glume bases). Of the sites included in the database, 90% of sites had some or all of their archaeobotanical data recorded as minimum number of items. Many sites, 37% of sites in the database, have data recorded using more than one method of quantification. Table 3.8 shows the method of archaeobotanical data recording at different sites where minimum number of item counts were not used or were not the only quantification strategy employed.

At 30% of sites, a proportion of archaeobotanical data were recorded through presence indicators. This includes sites - such as Areni-1 Cave, Hirbet ez-Zeraquon and Tell es-Sa'idiyeh, where plant taxa found at the site are discussed in the text of the publication but no assemblage table is provided. A presence score was entered as an eMNI of one into the database. Scales of abundance were used at 17% of sites for some or all of the samples. For some sites, including Maxta and Kultepe, a quantitative scale was provided for the abundance measures and this was used to produce an eMNI for each taxon using the lowest number in each interval. For example, if an abundance scale stated that 'XX' indicated between 10-25 items, then an eMNI of 10 was assigned to taxa scored with 'XX'. When no guide for the abundance scale was specified, for instance for Kuruçay, an eMNI corresponding to the amount of 'X's was used, since that was the only numerical position offered. Crop seeds and fruit and nut fragments were recorded by weight at 15% of sites, often when the archaeobotanist deemed the remains were too plentiful to count or difficult to quantify. For taxa with average seed, fruit or nut weights available in published literature, the weight measures were converted into eMNIs using the weight ratios in Miller (1990), Kroll (2003), Ristic and Iland (2005) and Margaritis and Jones (2008). Where no average seed or fruit weights were available for calculations, sample taxa amounts indicated by weight were recorded with an eMNI of one. At Korucutepe, Kenan Tepe, and Kurban Höyük, some archaeobotanical data was quantified as a percentage of each sample or as a ubiquity score for each phase. In these cases, the taxon percentage or ubiquity score was used as the eMNI.

3.2.4 Interpretive methods

The sample data were investigated by correspondence analysis to search for trends in crop selection at Kura-Araxes and other Near Eastern sites. GIS was also used to explore spatial patterns in the food choices at sites across the Near East from 6100-1500B.C.

3.2.4.1 Organisation of the data into geographical regions and chronological phases for analysis

In order to analyse the large dataset accumulated and search for patterns in crop preferences at Kura-Araxes and other Near Eastern sites, the assemblage was divided into eight geographical regions and six chronological phases. The regional site groupings are based both on proximity of the sites to each other, with the hope that this would minimise variation in the data based on local ecological or environmental factors, and the geographic spread of the Kura-Araxes material culture. The regions relevant to the Kura-Araxes cultural horizon will be described first.

In this study, the Southern Caucasus encompasses the Transcaucasus north into the Dagestan coastal plain, north western Iran around Lake Urmia, and eastern Anatolia from Lake Van to the Black Sea, and includes 17 sites (see Figures 3.7 for map and 3.15 for chronology). This was the region in which the Kura-Araxes phenomenon developed in the fourth millennium B.C., and most sites are at high altitudes apart from the eastern sites on the Kura and Araxes plains. Multiple archaeobotanical assemblages from Kura-Araxes sites are included for analysis. The Kura-Araxes cultural horizon spread into the Upper Euphrates and Upper Tigris region (Figures 3.9 and 3.17) in the early third millennium B.C.. This area of eastern Anatolia contains 14 sites from the Aşvan, Altınova, Malatya and southeastern Anatolian plains which are all above the 400mm isohyet. Archaeobotanical data from Kura-Araxes contexts is only available from sites in the north of this region. The Southern Levant region includes 21 sites (Figures 3.8 and 3.16) located mostly in Israel and along the Jordan Valley to the Dead Sea. In the northern Jordan Valley and Galilee, Kura-Araxes material culture was found at many sites in levels dating from the early third millennium B.C. which is often interpreted as occupation by Kura-Araxes settlers (Greenberg and Goren 2009). One site in the Southern Levant, Tel Beit Yerah, provides archaeobotanical data from Kura-Araxes contexts and non-Kura-Araxes contexts.

The other five regions either lack archaeobotanical data from sites with Kura-Araxes cultural horizons or have limited evidence for Kura-Araxes contact. The Amuq-Orontes region contains 11 sites (Figures 3.2 and 3.10). This area incorporates the Amuq region on the Turkish Mediterranean coast, where extensive Kura-Araxes cultural horizons were excavated at a number of sites, the Syrian and Lebanese coasts and inland along the Orontes River. Occasional Kura-Araxes sherds were found at a number of these inland sites, but none of the Amuq-Orontes sites offer archaeobotanical material from Kura-Araxes contexts. The Iran and Southern Mesopotamian region consists of ten sites (Figures 3.4 and 3.12), none of which provide plant remains from Kura-Araxes contexts. The Kura-Araxes cultural horizon did extend into north western Iran as far as Godin Tepe, but the archaeobotanical data from this site is from an earlier period, the time of Late Uruk contact. The Central West Anatolian grouping includes nine sites, and spans from the Central Anatolian Plateau to the Aegean coast (Figures 3.3 and 3.11). There is little evidence for any Kura-Araxes material culture in this region apart from a few black burnished sherds at Çadir Höyük in the fourth millennium B.C., although these may represent elements of the Central Anatolian ceramic tradition that were shared with the Early Kura-Araxes ceramic repertoire (Palumbi 2008). For this study the Khabur region includes 16 sites from north eastern Syria and neighbouring Iraq, along the Balikh River, Khabur River and into the foothills of the Taurus Mountains (Figures 3.5 and 3.13). A few Kura-Araxes sherds have been found at the larger sites in the Khabur, at Tell Brak and possibly Tell Mozan (Batiuk 2005). The Middle Euphrates region includes 18 sites, Figures 3.6 and 3.14, primarily along the Euphrates River in northern Syria and southern Turkey from between the 400mm and 200mm isohyets. Occasional Kura-Araxes ceramic sherds were found at sites excavated in this zone (Batiuk 2005).

The entire archaeobotanical assemblage was divided into six chronological phases using absolute dates and each site period in the database was assigned to a phase grouping. This was to enable comparisons between sites at similar timescales based on radiocarbon dates and therefore reconcile the conflicting regional chronological classifications so that the Southern Caucasian Early Bronze I could be grouped with the Mesopotamian Late Chalcolithic and Levantine Early Bronze II in a chronologically defined phase. Each phase was designed to be analytically useful for investigating potential trends in crop choices related to the spread of the Kura-Araxes phenomenon. The phasing used in this study is indicated on the site chronologies for each region in Figures 3.10-3.17. These phases are summarised below:

Phase 1 - 6100-4300B.C. Equates to the Early and Middle Chalcolithic of Anatolian chronological schemes and includes the Halaf and Ubaid traditions (Yakar 2011). This phase provides the background to agricultural choices in the Southern Caucasus prior to the emergence of the Kura-Araxes cultural horizon.

Phase 2 - 4300-3600B.C. The initial Late Chalcolithic with the Late Ubaid, and Early and Middle Uruk periods in Mesopotamia (Rothman 2004).

Phase 3 – 3600-3000B.C. The period of Kura-Araxes development in the Southern Caucasus, including the first phase at Sos Höyük. This is the period of Late Uruk expansion from Mesopotamia into the Upper Euphrates (Arslantepe) and western Iran (Godin Tepe).

Phase 4 - 3000-2700B.C. Late Uruk system collapses at c.3000B.C. This is the period of Kura-Araxes expansion from the Southern Caucasus west into the Upper Euphrates, and then south into the Amuq and Southern Levant, and to the east into Iran.

Phase 5 – 2700-2200B.C. Maximum extent of the Kura-Araxes cultural horizon.

Phase 6 - 2200-1500B.C. Possible end of the Kura-Araxes period in the Southern Caucasus with the advent of the Early Kurgan Cultures (A. T. Smith 2005b), but there was continued Kura-Araxes presence at Sos Höyük (Sagona 2004a). This is the period of the Middle Bronze Age across the Near East. The Akkadian collapse in north Mesopotamia occurred around 2200B.C. possibly due to climatic aridity (H. Weiss *et al.* 1993; H. Weiss 2012).

Each site period was assigned to one, or at most two, of the 6 broad project phases. This phase designation was entered into the site period table in the database which automatically placed all the archaeobotanical samples into a project phase. If more than 75% of a site period was within one phase, then the site period was allocated to that phase. Alternatively if a site period was evenly spread across a phase boundary, it was allocated to both phases. Any site periods that were spread across 3 phases were excluded from the analysis since their periodization was too vague to permit temporal investigation. This eliminated all of the Jericho and Mentesh Tepe samples and several of the Kamiltepe and Farukabad samples from the analysis. The most problematic period allocation was that of the Early Bronze IV c. 2400-2000BC of many Amuq-Orontes (Figure 3.10) and Middle Euphrates (Figure 3.14) sites since they evenly crossed the Phases 5/6 boundary. For a project focusing on the Kura-Araxes, the North Levantine/Syrian Early Bronze IV period could not be used as an analytical phase since it crosses the terminal Kura-Araxes boundary of many Southern Caucasian and Upper Euphrates sites at 2200BC.

Counts of the number of site assemblages included in each geographical region and phase grouping are presented in Table 3.9. A summary of the amount of samples present in each phase, grouped by geographical region, is recorded in Table 3.10. Phase 5 has the highest number of sites included within it of any phase, whereas Phase 6 has the greatest number of samples for analysis. In total, 3212 samples from 115 sites can be included in the analysis. Table 3.11 details the number of samples in each site assemblage according to project phase.

3.2.4.2 Pattern searching with correspondence analysis

Variations in crop choices between Kura-Araxes and other Near Eastern sites were investigated using correspondence analysis. The data was analysed separately for each phase and by each region. The results of the six phase and six regional analyses are discussed in Chapter 5. Only the regions in which Kura-Araxes samples were present (Southern Caucasus, Upper Euphrates and Tigris and the Southern Levant) and the regions in between these zones (Amuq-Orontes, Middle Euphrates and Khabur) were included as separate regional analyses in section 5.1.2. Correspondence analysis was performed using Canoco for Windows 4.5 and CanoDraw for Windows to draw the plots (ter Braak and Smilauer 2002) (see section 3.1.6.1 for more details).

Only cereal and pulse taxa were included in the analyses. Amalgamations of 'cf.' identifications and splitting of indeterminate categories based on sample species proportions occurred in Excel after the assemblage data was exported from the Access database. The pulse taxa included in the analysis were *Cicer*, *Lathyrus*, *Lens*, *Pisum*, *Vicia ervilia* and *V. faba*. Cereal identifications were amalgamated into broad groups consisting of *Hordeum*, glume wheat and free threshing wheat, with each separated into grain and chaff categories, as well as cereal culm node and bases. While this approach of grouping different species of cereals together by broad descriptive categories potentially homogenizes the data, it was deemed appropriate for this analysis because of the many indeterminate species identifications recorded at sites. Combining all *Hordeum* identifications together (*H. distichum, H. vulgare*, hulled and naked), all glume wheat identifications together (*Triticum monococcum* and *T. dicoccum*) and all free threshing wheat identifications together (*T. aestivum, T. durum, T. aestivum/durum, T. compactum,* and *T. parvicoccum*) rather than attempting to maintain individual species integrity, ensured that more samples and a greater number of crop items could be included in the analysis. For example, the use of separate cereal species categories (e.g. *T. aestivum, T. monococcum, H. distichum* etc.) resulted in an average loss of 27% of crop items per sample and 4.5% of samples because of the difficulties in splitting indeterminate identifications (e.g. *T.monococcum/T.dicoccum* glume bases) in samples where these were the only forms of identification recorded. In contrast, by using the broad cereal amalgams (glume wheat glume bases, glume wheat grains etc..) there was only an average loss of 7% of crop items per sample which resulted in a loss of 0.68% of samples overall; therefore these broad categories were used in the analysis.

Several different minimum thresholds for sample size were applied during data analysis but the correspondence plots changed very little irrespective of whether the minimum number was set to 100 or 30. A minimum threshold of 30 crop items per sample was therefore applied to permit more samples and sites to be included in the analyses. Out of the 115 sites that were able to be used in these analyses, 101 sites contained samples with more than 30 crop items. A total of 1574 samples was included in the analyses.

For each phase and regional correspondence analysis, species and sample data were plotted separately for clarity. Unless otherwise stated the first axis is always plotted horizontally and the second axis is always plotted vertically. Sample data points were represented as pie charts of crop items and were also coded by cultural grouping, site, site altitude, modern annual rainfall and free threshing wheat type. The site altitude and modern annual rainfall information is recorded in Table 3.6 and the cultural affiliation of each site phase is shown in the regional chronologies (Figures 3.10-3.17). In the phase-by-phase analyses, sample data points were also coded by region, and in the region-by-region analyses sample data points were coded by phase. If a sample had been allocated to two phases due to the breadth of the site period, the sample was included in both phase analyses.

3.2.4.3 Investigating crop and grape distribution at sites across the Near East using GIS

Digital mapping and database visualisation was performed using ArcGIS, ArcMap 10.1 (ESRI 2010) a geographic information system (GIS). The database, supplied as an Excel spreadsheet, was imported and georeferenced using the x & y (longitude & latitude) co-ordinates of each dataset to the World Geodetic System 1984 (WGS_1984). The georeferenced site data werevisualised using the World Physical Map; an ArcGIS basemap representing the Natural Earth at 1.24km per pixel and credited to the US National Park Service. Due to the number and spatial distribution of the full site dataset, visualisation was set to the scale of 1:11,863,735.

Spatial patterning of crop choices across the Near East was examined through GIS maps of pulse and cereal proportions at each site in every phase. Separate maps were made showing pie charts of total site pulse (*Cicer*, *Lathyrus*, *Lens*, *Pisum*, *Vicia ervilia* and *V. faba)* and cereal (*Hordeum* grain/rachis internode, glume wheat grain/glume base and free threshing wheat grain/rachis internode) compositions at each site. The information was displayed by site cultural grouping and multiple pie charts were used for the same site if more than one cultural group is recorded for a site phase. A minimum threshold of 30 cereal items was enforced for each site cultural phase and no minimum threshold was employed for the pulse composition of sites. Site locations were represented as pie charts accompanied by an abbreviation of the site name. Within areas of dense site occupation, the pie charts were off-set and linked by arrows to the site location.

The distribution and ubiquity of grape seeds, skin and pedicels was also investigated and presented using GIS maps of each phase. Grape ubiquity was determined for each site in every phase, by counting the number of samples in each site phase in which grape remains were present, and recording the plant parts found at the site. Sites with grapes were represented by a data point colour coded to indicate the plant part or combination of plant parts present (seed, skin or pedicel) and the ubiquity of grape was shown by the size of the data point.

The results of the comparative analysis of Kura-Araxes and other Near Eastern crop choices are presented in Chapter 5.

Chapter 4: Sos Höyük Archaeobotanical results and discussion

This chapter presents the results of the archaeobotanical analysis of the Sos Höyük samples. The archaeobotanical identifications are presented in Appendix A as counts of the minimum number of seeds, grains or other plant parts of each taxon for each sample. This chapter focuses first on the crop taxa and their chronological trends followed by an examination of crop processing stages and the variation in the wild/weedy taxa. These analyses enable a discussion of crop selection, sample taphonomy, seasonality and fuel use over time at Sos Höyük

4.1 Crops at Sos Höyük

Throughout the sequence at Sos Höyük the most common cereal crops were *Triticum aestivum* L. (bread wheat)*, T. dicoccum* Schübl (emmer wheat), and *Hordeum distichum* L. (two-row barley). Although no food storage contexts were found at Sos Höyük, these cereals all commonly occur throughout the sequence and, in certain samples, are the dominant component, which indicates that they were grown as crops. The only clear minor crop is the oil plant, *Camelina sativa* (L.) Crantz. (gold of pleasure) which was found in high concentration in a rather pure sample. Other possible crops include *Panicum millaceum* L. (broomcorn millet)*,* and the pulses, *Lens* cf*. culinaris* Medik. (lentil)*, Pisum sativum* L. (pea)*, Lathryus* sativus L. (grass pea) and *Vicia ervilia* (L.) Willd. (bitter vetch). There is no definitive evidence that these taxa were deliberately cultivated at Sos Höyük since they were only minor elements of the assemblage and do not form the dominant component of any sample. Nevertheless, all of these taxa are known to have been cultivated in the Near East at this time (D. Zohary *et al.* 2012) and may represent the residues of small scale cultivation (see 4.1.4 and 4.1.5 for further discussion). Figure 4.1 summarises the distribution of crop taxa by period at Sos Höyük.

4.1.1 Free threshing wheat – bread wheat (Triticum aestivum L.)

T. aestivum (bread wheat) is the most ubiquitous crop type in the Sos Höyük assemblage, present in more than 98% of samples. *T. aestivum* grains are found in 94% of samples and rachis internodes in 96% of samples. In the Late Chalcolithic period, *T. aestivum* is the dominant crop. *T. aestivum* drops to 25% of the crops identified in the Early Bronze I but is as common as *H. distichum* until the final phase of the Early Bronze period when it again dominates the assemblage. In Middle Bronze I, *T. aestivum* is the most numerous crop taxon but in Middle Bronze II it is the second most common crop found at Sos Höyük (see Figure 4.1).

There are two types of free threshing wheats: tetraploid wheat (*T. durum*-type) and hexaploid wheat (*T. aestivum*-type). These wheat differ genetically, tetraploid wheats contain 28 chromosomes and all share the AABB genetic construction, whereas hexaploid wheats have 42 chromosomes and all share the AABBDD chromosome constitution (Nesbitt 2001). Based on grain morphology, tetraploid and hexaploid free threshing wheat are indistinguishable but differences in rachis morphology enable differentiation between wheat types (Hillman 2001). Virtually all the identifiable free threshing wheat rachises (1650 in total) were categorised as hexaploid *T. aestivum*; only four possible tetraploid rachis internodes were found in the whole assemblage. Those that were classed as indeterminate *T. aestivum/durum* internodes were deemed intermediate primarily due to poor preservation of the material, which obscured the distinctive features. Similarly, some rachis internodes appeared to be from the base of the ear and so were squatter and more robust, and could not confidently be assigned to either category. Hexaploid rachis internodes were recognised by their 'shield' shape, longitudinal furrows on the surface of the internode and concave dehiscence scars where the glume bases had become detached. Within these parameters, however, rachis internode morphology varies greatly, as Figure 4.2 demonstrates, possibly due to internode positioning within the ear. Based on the ratio of positively identified hexaploid rachis internodes to indeterminate free threshing wheat internodes (2:1), and the lack of securely identified tetraploid rachis internodes, the free threshing wheat remains, both grain and rachis remains, from Sos Höyük are interpreted as bread wheat, *T. aestivum*. *T. aestivum* grains from Sos Höyük are shown in Figure 4.3.

The ratio of *T. aestivum* rachis internodes to grains in whole ears is expected to be approximately 1:3 (0.3). In the Late Chalcolithic, rachis internodes greatly outnumber grains (Table 4.1). Rachis remains are more plentiful than grain in almost all Early Bronze Age I-II samples, but by Early Bronze III the ratio of rachis internodes to grains approaches that expected for whole ears in some samples. In the Middle Bronze Age samples, the *T. aestivum* rachis internode to grain ratio is more varied especially in the Middle Bronze II where in some samples there are more rachis internodes than expected for whole ears and in others there are more grains than rachis internodes.

4.1.2 Glume Wheat – emmer (Triticum dicoccum Schübl)

At Sos Höyük, *T. dicoccum* is relatively rare compared to *T. aestivum* and *H. distichum*. It was found in 37 samples out of the 70 sample assemblage and present as grain in 35% of samples and as glume bases in 42% of samples. *T. dicoccum* grain and glume bases make up 2% or less of the crop items in the Late Chalcolithic and Early Bronze periods and only begin to increase in proportion in the Middle Bronze I phase (Figure 4.1). In the Middle Bronze II period, glume wheat increases to 14% of the crop assemblage, three quarters of this being glume bases. Until the Middle Bronze Age there were only sporadic finds of glume wheat, and grains and glume bases were often found in samples independently of each other (Appendix A).

The glume wheats at Sos Höyük (Figure 4.4) were identified as *T. dicoccum* through comparison of their spikelet fork morphology with the criteria outlined in G. Jones *et al.* (2000). Sos Höyük is located near to the Caucasus where a number of cultivated glume wheats are known to have been grown in the recent past, namely *T. macha* and *T. timopheevi* (D. Zohary *et al.* 2012), and it is also possible that the archaeologically identified 'new glume wheat' (identified by Jones *et al.* 2000) may have been present in this region in the past although the ancient distribution of the new glume wheat is uncertain. Unlike *T. timopheevi*, *T. monococcum* and the new glume wheat, the primary keel of the Sos Höyük samples arises below the rachis disarticulation scar and is angled outwards, towards the lateral side of the glume (Figure 4.4a), a characteristic of *T. dicoccum* (G. Jones *et al.* 2000). The secondary keel on the Sos Höyük glume bases is not particularly well defined (Figure 4.4b), which is characteristic of *T. dicoccum,* in comparison to *T. timopheevi* or the new glume wheat glume bases which have a prominent vein on this keel (G. Jones *et al.* 2000). The glume bases at Sos Höyük differ from the glumed hexaploid wheats, *T. spelta* and *T. macha*, in the angle between the adaxial and lateral glume face. In hulled hexaploid wheats this angle is obtuse (G. Jones *et al.* 2000) whereas in the Sos Höyük examples this angle is sharp at 90^{o} (Figure 4.4c-d) as with *T. dicoccum* glume bases. The glume bases of hexaploid wheats also lack a well defined primary keel (Hillman 2001) which is present in the Sos Höyük glume bases. This, together with the adaxial-lateral glume face angle and the lack of a strong vein on the secondary keel indicates that the Sos Höyük glume bases are *T. dicoccum* (emmer).

For *T. dicoccum,* the expected ratio of glume bases to grains in whole ears is approximately 1:1. In the Middle Bronze Age samples, glume bases greatly outnumbered grains in half the samples in which they were present (Table 4.2). *T. dicoccum* grain was not present in great quantity in any one sample and was usually only tentatively identified (see Appendix A).

Narrow spikelet forks that lack rachis detachment scars were found throughout the assemblage (Figure 4.5). For this study they have been termed *Triticum* terminal spikelet forks and treated separately from other wheats in statistical analyses because their taxonomic identity is uncertain. These terminal spikelet forks lack prominent primary and secondary keels, and appear to have two obtuse angles on the lateral to abaxial/adaxial glume faces. Terminal spikelet forks are always found in samples with *T. aestivum* rachis internodes but only 58% of samples containing terminal spikelet forks also contain *T. dicoccum* glume bases. These may represent *T. aestivum* or *T. dicoccum* terminal spikelet forks. *Triticum* terminal spikelet forks have been identified at eight other Near Eastern sites from the Chalcolithic to Middle Bronze Age period. At Domuztepe (Kansa *et al.* 2009), KamanKale Höyük (Nesbitt 1993), Tell Brak (Colledge 2003; Hald 2008), Titris Höyük (Hald 2010) and Wadi Fidan 4 (Meadows 2001) the spikelet forks were interpreted as *T. dicoccum* terminal spikelet forks. At Tell Mozan (Riehl 2010b) terminal spikelet forks were recorded as being from free threshing wheat, either tetrapoid or hexaploid, whereas at Dilkaya (Nesbitt 1991) and Haftavan (Summers 1982) they were regarded as being from either free threshing wheat or *T. dicoccum*.

4.1.3 Barley - two-row hulled barley (Hordeum distichum L.)

Hordeum is the most plentiful crop in the Sos Höyük assemblage. It is present in 67 of the 70 samples, and grains are more ubiquitous than rachis internodes, appearing in 94% of samples while rachis internodes are present in 81%. In the Late Chalcolithic, *Hordeum* is the second most numerous crop (after *T. aestivum*) but it is the dominant crop in the Early Bronze I period (Figure 4.1). In the following two phases *Hordeum* is as common as *T. aestivum*, although by the Early Bronze III it is again less frequent than *T. aestivum*. By the Middle Bronze II, *Hordeum* remains are the most numerous crop component in the Sos Höyük assemblage.

There are two main types of cultivated barley, *H. vulgare* (six-row) or *H. distichum* (two-row) both of which can be either hulled or naked. *H. distichum* and *H. vulgare* can be easily distinguished by examining their rachis nodes. In the case of *H. vulgare*, all three spikelets at each rachis node are fertile and produce a grain whereas, with *H. distichum*, the two lateral spikelets at each rachis node are sterile and only the central spikelet produces a grain. In *H. distichum*, the hollow pedicels ('stalks') of the lateral spikelets are visible either side of the rachis node, (Figure 4.6) often as two small round scars flanking the large central grain detachment scar. With three grains, *H. vulgare* has three approximately equal sized grain detachment scars at the rachis node. Almost all the identifiable barley rachis internodes from Sos Höyük, 99%, were recognised as two-row barley, *H. distichum*. Those that were classed as indeterminate *H. distichum/vulgare* were indistinguishable due to poor preservation of diagnostic features.

The two barley types can also be differentiated by comparing the ratio of symmetric to asymmetric grains, although this can be confounded by charring distortions. *H. vulgare* has three grains at a single rachis internode, the two lateral grains are asymmetrical while the central grain is symmetrical, giving a ratio of 2:1 asymmetric to symmetric grains for *H. vulgare* (Figure 4.7). Having only one grain at each node, *H. distichum* grains are all symmetrical. At Sos Höyük, 95% of the classifiable barley grains were classed as symmetrical (Figure 4.8). Although a high proportion of the grains were of indeterminate symmetry because they were too damaged, very few, 2.1% of barley grains, were categorised as asymmetrical. The identification of asymmetric grains indicates that *H. vulgare* was present at Sos Höyük but that it may have been a commensal weed of *H. distichum* rather than a purposefully cultivated cereal crop. Based on the dominance of symmetrical grains and *H. distichum* rachis internodes, the barley remains from all periods at Sos Höyük were identified as predominantly *H. distichum*.

Virtually all the grain at Sos Höyük was recognised as being hulled, either by the traces of the palea and lemma remaining on the grain or from the angular shape of grains after the palea and lemma had burnt away (Figure 4.8). Only 1% of *H. distichum* grains have been tentatively identified as being possibly naked. The Sos Höyük rachis internodes resemble modern hulled *H. distichum* rachis internodes which have very few traces remaining of the paleas and lemnas at each central grain detachment scar (Cappers and Neef 2012, p. 275; Neef *et al.* 2012, Figs. 19472, 29771; see also Valamoti 2004, 29 for a discussion of hulled and naked rachis internodes morphology). *Hordeum* grain and rachis internodes at Sos Höyük were therefore classed as hulled *H. distichum.*

The rachis internode to grain ratio of *H. distichum* is 1:1. Very few samples from the Sos Höyük sequence came close to the expected ratio (Table 4.3). Overall there were no clear period differences in the *H. distichum* internode to grain ratio but, in the Later Chalcolithic, Early Bronze and Middle Bronze I there was a propensity for more rachis internodes than grain to be present in samples. In the Middle Bronze II samples, grain is regularly more plentiful than chaff except in four samples (SOS56, SOS57, SOS58, and SOS70) which are all from one building in trench L16 (see section 4.2).

4.1.4 Millet – broomcorn millet (Panicum miliaceum L.)

Millet grains are very rare in the Sos Höyük crop assemblage, present in only 10% of samples. These grains, shown in Figure 4.10, were identified as *Panicum miliaceum* based on their pointed distal and blunt proximal ends and the short,wide embryo scar (Hunt *et al.* 2008; Nesbitt and Summers 1988). Almost all the *P. miliaceum* grains at Sos Höyük were found in the Middle Bronze II period (Figure 4.1). Only three grains were found in one sample (SOS26) from the Early Bronze I/II period and of the six Middle Bronze II samples with *P. miliaceum*, only two (SOS64 and SOS67) contained more than ten grains (Appendix A).

P. miliaceum and *Setaria italica* (foxtail millet) were first domesticated in China in the sixth millennium BC and introduced to Europe and Western Asia (D. Zohary *et al.* 2012). The timing of the westward spread of the millets is not clear. There are sporadic occurrences of *Panicum* and *Setaria* in sixth millennium BC European, Caucasian and Near Eastern sites (Hunt *et al.* 2008). Recent dating of European Neolithic *P. miliaceum* grains, however, has demonstrated that they are much younger than the sixth millennium BC, the oldest 'Neolithic' grain is carbon dated to 1600BC (Motuzaite-Matuzeviciute *et al.* 2013). In the Near East, *Panicum turgidum* is recorded in Egypt and *Setaria* in Syria during the eighth millennium BC (Hunt *et al.* 2008). Indeterminate *Panicum/Setaria* grains are described at late fourth millennium Wadi Fidan 4 (Meadows 2001) and Jerablus Tahtani (Kabukcu 2012) and early third millennium Tell Brak (Colledge 2003). The Sos Höyük *P. miliaceum* grains from Early Bronze I/II (3000-2500BC) represent the earliest identified *P. miliaceum* grains in the Near East (Nesbitt and Summers 1988; D. Zohary *et al.* 2012). Taking into account the tendency of *P. miliaceum* seeds to be found in layers older than their origin, as demonstrated by radiocarbon dating of the 'Neolithic' European millet grains (Motuzaite-Matuzeviciute *et al.* 2013), until the Sos Höyük seeds are carbon dated[6] their age must be treated with caution. Another early find of *P. miliaceum* is at the Kura-Araxes site of Velikent in the mid to late third millennium BC (Kohl and Magomedov 2014). *P. miliaceum* becomes more common in the Middle Bronze Age in the Near East, recorded at Kinet Höyük (Hynd 1997), Maylan (Miller 1982) and Haftavan (Summers 1982) where it is thought to have been cultivated as a crop in the second millennium BC (Nesbitt and Summers 1988).

Based on the low quantities of *P. miliaceum* grains in the Sos Höyük samples the status of millet, whether it is a crop in its own right or a commensal of other crops, is uncertain. *P. miliaceum* is not native to Anatolia and needed to be introduced into the Pasinler Valley. Its increased frequency in Middle Bronze II samples at Sos Höyük, contemporary with initial cultivation of *P. miliaceum* at other sites in the Near East, may indicate that it was cultivated at Sos Höyük, but there is no conclusive evidence for this.

4.1.5 Pulses – lentil (Lens cf. culinaris Medik.), bitter vetch (Vicia ervilia (L.) Willd.), pea (Pisum sativum L.), grass pea (Lathyrus sativus L.)

At Sos Höyük pulses are rare in the archaeobotanical assemblage (Figure 4.1). As a group, pulses appear in 30% of samples but pulses represent only 0.5% of the total crop items (Appendix A). *Lens* sp., probably *L. culinaris*, is the most common and most numerous pulse. It is present in 12% of samples overall, that being made up of three samples from the Late Chalcolithic, four from the Early Bronze Age and two from the Middle Bronze Age. It is impossible to distinguish cultivated *L. culinaris* from the wild *L. esculenta* but it is assumed here that *L. culinaris* is the mostly likely *Lens* variety to be present based on its association with other crop items. *Pisum sativum* is in 7% of samples, three samples from the Late Chalcolithic and two from the Middle Bronze Age. *Vicia ervilia* is found in two Early Bronze Age samples and one Middle Bronze II sample. *Laythrus sativus* is present in only two samples from the Early Bronze Age. These pulses were all domesticated in the Neolithic of the Near East (Zohary *et al*. 2012). None of the individual pulse taxa dominate a sample. At Sos Höyük it is unclear whether these species were cultivated in their own right or were contaminants of cereal crops.

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[6] At the time of writing, the three Early Bronze I/II *Panicum miliaceum* grains and four Middle Bronze II grains have been sent for radiocarbon dating as part of the ORIMIL 'Millet crop cultivation in the Pre and Protohistorical Caucasus: Origin and development' project led by Dr Estelle Herrscher and funded by the French Agence Nationale de la Recherche.

4.1.6 Oil seeds - gold of pleasure (Camelina sativa (L.) Crantz.) and Lallemantia iberica/peltata/canescens

Camelina sativa is an oil rich seed from the Brassicaceae family that is thought to have been a secondary domesticate from cereal and flax cultivation (D. Zohary *et al.* 2012). In the Sos Höyük assemblage, *C. sativa* was identified in 11% of samples. It was first found in Early Bronze III and it appears in small amounts in three out of the eight samples in this period. A quantity of *C. sativa* is present in one Middle Bronze I sample (SOS49), a considerable number was found in one Middle Bronze II sample (SOS62), and minor amounts in three other samples from the same period. These seeds (Figure 4.10) were identified on the basis of their size (1.5-2mm in length), their protruding radicle, papillose surface texture and ovoid shape which distinguishes them from other Brassicaceae oil rich seeds such as *Lepidium sativum, Brassica rapa* and *Descurainia sophia* (D. Zohary *et al.* 2012; Cappers *et al.* 2006; Bouby 1998). The protruding radicle which extends the length of the whole seed and size differentiates *C. sativa* from other members of the genus (Cappers and Neef 2012).

To identify *C. sativa* cultivation, Bouby (1998) suggests that the seeds need either to be found in a storage context or in large, relatively pure concentrations. However, a concentration of seeds may also indicate a deliberate collection of wild resources. The quantity of *C. sativa* seeds found in sample SOS 62, where it represents the bulk of the items, suggests it was either deliberately collected or cultivated. *C. sativa* has been identified in late third millennium Troy as a mixed oil crop with linseed (Riehl 1999), and isolated finds were present in fourth millennium Kuruçay, where it was a weed of flax (Nesbitt 1996), third millennium Demircihüyük (Schlichtherle 1977) and second millennium Kinet Höyük (Hynd 1997). A wild relative of *C. sativa, Camelina microcarpa,* was found at Neolithic Aknashen and Aratashen in Armenia with both seeds and capsules preserved in mudbrick (Hovsepyan and Willcox 2008), and charred seeds were found at second millennium Tell Mozan (Riehl 2010b). At Sos Höyük, no flax was found in the plant assemblage and so *C. sativa* is unlikely to represent a weed of flax production. Instead it may have been specifically collected or possibly cultivated as an oil crop in the Middle Bronze Age at Sos Höyük.

Another oil rich seed was present in the assemblage although it was possibly a weed or grown together with *C. sativa*. These seeds are elongated, approximately 3mm in length, rounded in cross section and parallel sided or tapering towards the base (Figure 4.11). Their apices are curved and their bases have two depressions either side of a central ridge that extends along one quarter of the seed length at most. The seed surfaces are shiny and have regular indentations. Based on their overall shape, these seeds closely resemble members of the Lamiaceae family from the *Lallemantia, Ziziphora* or *Dracocephalum* genera. The Sos Höyük seeds are larger than *Ziziphora* seeds and narrower compared to their length than *Dracocephalum* seeds. The Sos Höyük seeds are very similar to *Lallemantia* seeds identified at Bronze Age sites in Northern Greece (G. Jones and Valamoti 2005). Three species of *Lallemantia* are native to Anatolia, *L. peltata, L. canescens* and *L. iberica*, all of which are found at altitudes in Eastern Anatolia equivalent to the Pasinler Valley (Davis 1965-1988) and *L. canescens* is a weed of wheat in the Erzurum region (Çoruh and Bulut 2008). *L. canescens* seeds are broader at the apex than the base, *L. peltata* seeds are parallel sided and *L. iberica* seeds can be both parallel sided and tapering towards the base (G. Jones and Valamoti 2005). Based on the criteria for distinguishing *Lallemantia* species, the Sos Höyük seeds resemble all three *Lallemantia* species since both parallel-sided seeds and seeds tapering from a broad apex to a narrow base are present in each sample. Charring distortion of the seeds and the variability of seed shape makes accurate identification difficult so the seeds are classified as *L. iberica/peltata/canescens*.

L. iberica/peltata/canescens was found in 29% of Late Chalcolithic samples, 76% of Early Bronze Age and 54% of Middle Bronze Age samples (Appendix A). The status of *L. iberica/peltata/canescens* at Sos Höyük is unclear. It was never the dominant component of a sample but it was found in quantity in two samples with high amounts of *C. sativa*. In one of these samples, SOS62, *L. iberica/peltata/canescens* was the second most common taxon after *C. sativa*, which suggests that this taxon may have been a commensal of *C. sativa,* either deliberately or accidently collected or cultivated as an oil seed together with *C. sativa*. At Sos Höyük, *L. iberica/peltata/canescens* is more often found, however, in small quantities in samples without *C. sativa*. This indicates that *L. iberica/peltata/canescens* was also present as a crop contaminant or wild plant independent of *C. sativa* and is therefore treated as a wild plant in analyses of the Sos Höyük assemblage.

4.2 Trends in crop taxa

In order to examine trends in the Sos Höyük crop assemblage the samples were analysed by correspondence analysis, using CANOCO as described in section 3.1.6.1. Crop items included in the analyses, together with the codes used, were *T. aestivum* grain (FTWGr), *T. aestivum* rachis internodes (AesRa), *T. dicoccum* grain (EmGr), *T. dicoccum* glume bases (EmGl), *H. distichum* grain (HDGr), *H. distichum* rachis internodes (HDIn), cereal culm nodes (CuNo), cereal culm bases (CuBa), *Panicum miliaceum (*Millet*)*, *Lens cf. culinaris (*Lens*)*, *V. ervilia* (Vicia), *Pisum sativum* (Pisum), *Lathyrus sativa* (Lath) and *C. sativa* (CamSat). Only samples with more than 30 crop items were included in the correspondence analysis of the crop assemblage. This resulted in 61 samples being included in the analysis and nine samples excluded due to their lack of crop remains. Samples and species from the same analysis are plotted separately for clarity. Unless otherwise indicated, the first axis is plotted horizontally and the second axis vertically.

In a correspondence analysis of all samples with more than 30 crop items (Figure 4.12), the two samples mentioned above (SOS62 and SOS49), with high amounts of *C. sativa,* are located towards the positive (right) end of the first axis and the remainder of the samples are clustered towards the negative (left) end. In order to display the variation in cereal and pulse crops, *C. sativa* was omitted from further analyses (Figure 4.13). Samples with significant quantities of *T. dicoccum* glume bases plot towards the positive (right) end of the first axis and the negative (bottom) end of the second axis (Group 1). Samples rich in *H. distichum* grain plot positively on both axes (top right) and these samples are also distinguished by small quantities of *Panicum miliaceum* (Group 2). A large cluster of samples, dominated by *T. aestivum* and *H. distichum* rachis internodes and cereal culm nodes and bases, plot negatively on the first axis (left) and in a neutral position on the second axis (Group 3). A loose group of samples, with a mixture of *T. aestivum* grain and *T. dicoccum* glume bases, are located slightly positively on the first axis (Group 4).

In order to investigate variation in the samples of Group 3, the third axis (vertical) was plotted against axis 1 (horizontal) (Figure 4.14). On the third axis, samples with high amounts of *T. aestivum* rachis internodes (Group 3a) plot positively and separately from samples rich in *H. distichum* rachis internodes and culm nodes which are negatively placed on the third axis (Group 3b). Samples with high amounts of *H. distichum* grain or *T. dicoccum* glume bases are situated negatively on the third axis and positively on the first axis. Table 4.4 lists the samples by crop compositional group.

When samples are coded by archaeological period, Figure 4.15a, it is apparent that most Middle Bronze II samples plot positively on the first axis and are clearly distinct from earlier samples. This is because these later samples either contain significant amounts of *T. dicoccum* glume bases or are dominated by *H. distichum* grain. Conversely, the majority of samples from the Late Chalcolithic to Middle Bronze I periods plot negatively on the first axis because they are rich in *T. aestivum* or *H. distichum* rachis internodes and cereal culm nodes and bases. A separate cluster of Middle Bronze II samples is located negatively on the first axis with these older samples. Five of these Middle Bronze II samples that are rich in *T. aestivum* and *H.distichum* rachis internodes are from a single building located in trench L16[7] (Figures 4.15b and 4.16) and the sixth is from a pit. When the samples are coded by context, Figure 4.17, it can be seen that samples from occupation floors and graves plot negatively on the first axis and are composed of mixed *H. distichum* and *T. aestivum* rachis internodes and culm nodes and bases. Samples from other context types are spread widely across the plot but the *T. dicoccum* glume base rich samples are all from pits (bottom right of the plot). No clear patterns relating to chronology or context type are apparent on the third axis (plots not shown).

4.3 Wild plants at Sos Höyük

At Sos Höyük seeds from 26 different plant families were identified (see Appendix A for full assemblage details). In total, 18,403 wild items were recorded for the entire Sos Höyük assemblage, and of these 25% of items were identified definitely or tentatively to species or as indeterminate between two species. A further 15% were recognised to genus level and 36% to at least family or a group of genera. Table 4.5 lists the ubiquity of wild items identified in 10% or more of samples in the Late Chalcolithic, Early Bronze Age and Middle Bronze Age at Sos Höyük. The Fabaceae family was the most common family overall with *Trifolium/Melilotus/Medicago* (small-seeded legumes) representing 20% of the wild seed assemblage and present in 93% of samples. Large *Galium* seeds (>1mm in size) were the second most ubiquitous seeds, appearing in 70% of Late Chalcolithic, 84% of Early Bronze Age and 92% of Middle Bronze Age samples. Most taxa found in more than 10% of samples are present in all three phases, but, *Silene* types 1 and 2*, Lithospermum officinale*, and *Hyoscyamus niger* are not found in the Late Chalcolithic samples, appearing from Early Bronze I onwards. Small *Galium* spp. seeds (<1mm) are first found in Early Bronze II, and *Kochia prostrata/scoparia* occurs only in the Middle Bronze Age. Of the taxa identified in less than 10% of samples, *Agrimonia* cf. *eupatoria* and *Ajuga* sp. first appear in Early Bronze I and *Fumaria* sp. in the Early Bronze II. Almost all items increase in ubiquity over the assemblage apart from *Lallemantia iberica/peltata/canescens* and *Bromus* cf. *japonicus* which increase

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[7] At the time of writing, trench plans for Sos Höyük showing sample locations are not available for spatial analysis of the archaeobotanical samples. The Sos Höyük final site report is in preparation for publication in 2015/16. The only relevant published plan is of trench L16.

from 29% and 59% of samples respectively in the Late Chalcolithic to 76% and 92% in the Early Bronze Age and then decrease to 54% and 43% of samples in the Middle Bronze Age.

4.4 Exploring variation in sample composition

Correspondence analysis, performed using CANOCO (ter Braak and Smilauer 2002), was employed to examine variation in the Sos Hoyuk weed assemblage using the methods described in section 3.1.6.1. Only samples with 30 or more wild seeds were used, which reduced the number of samples to 61. Three Late Chalcolithic, two Early Bronze I/II, two Middle Bronze I and one Middle Bronze II sample were excluded because they did not meet the minimum threshold for inclusion. Taxa included in the analysis were those that were present in a minimum of 10% of samples and were identified to at least genus or type. Table 4.6 lists the wild taxa used in this chapter, together with the code used in the correspondence analysis and the ecological information associated with each taxon. Items identified only as Cyperaceae were included since they represent a relatively homogeneous ecological group. Samples and species from the same analysis are plotted separately for clarity. Unless otherwise indicated, the first axis is plotted horizontally and the second axis vertically.

In a correspondence analysis of all samples with more than 30 seeds of wild taxa (Figure 4.18), one sample, SOS52, is strongly positively placed on the first axis with high amounts of *Buglossoides arvensis* and *Eleocharis* sp.. On the second axis, samples SOS49 and SOS57, are pulled towards the positive end due to their *Hyoscyamus niger* content and are separated from the bulk of the samples which cluster around the origin. These three samples were removed to make variation in the rest of the assemblage more visible (Figure 4.19 and 4.20). Without SOS49, SOS52 and SOS57, samples rich in *Trifolium/Medicago/Melilotus* are located positively on the first axis. Samples with high amounts of *Chenopodium album* or *Atriplex cf. lasiantha* are located towards the negative end of the first axis. Samples containing *Lolium* cf. *perenne/multiflorum* are situated towards the positive end of the first axis. On the second axis, samples containing *Atriplex cf. lasiantha* are located towards the positive end and samples with high amounts of *Chenopodium album* or *Trifolium/Medicago/Melilotus* are located towards the negative end of the second axis. Samples containing *Galium* tend to be located negatively on the second axis.

When coded by archaeological period, it is apparent that Middle Bronze II samples are the most widely distributed samples across the plot (Figure 4.21a). Early Bronze I/II and Middle Bronze I samples are located positively on the first axis due to their high *Trifolium/Medicago/Melilotus* content. Some Middle Bronze II samples and one Early Bronze

III contain high quantities of *C. album* and plot negatively on both axes. Only some samples from the Late Chalcolithic and Middle Bronze II are rich in *Atriplex cf. lasiantha* and are located negatively on the first and positively on the second axes. The samples from the Middle Bronze II building in trench L16 plot negatively on the first axis because they contain *A. cf. lasiantha* and/or *C. album* in higher proportions than *Trifolium/Medicago/Melilotus* (Figure 4.21b). No clear pattern of sample distribution based on wild seed content is related to sample context type (Figure 4.22).

4.5 Sources of plant remains

4.5.1 Formation of Near Eastern archaeobotanical assemblages

Archaeologically, charred plant remains may be derived from a variety of sources relating to crop production, crop storage, food preparation, animal foddering, waste disposal, fuel consumption and building construction (Cappers and Neef 2012). Of these, two important sources of plant material for Near Eastern archaeobotanical assemblages are crop processing and the burning of animal dung as fuel (Bogaard *et al.* 2013). This is particularly true of samples that contain residues of repetitive household activities rather than primary deposits of *in situ* charring (Fuller *et al.* In press). In the following sections, the possible influence of these two activities on the Sos Höyük assemblage will be discussed.

Cereal processing, separating grains from chaff and weeds, is seen as a major contributor of plant remains to the archaeobotanical record. Crop processing has been studied ethnographically by Hillman (1984a) in Anatolia and G. Jones (1984, 1987, 1990) on the Aegean Island of Amorgos to identify the products and by-products of each crop processing stage. A general model for the processing of free threshing cereals and pulses is provided by the analysis of samples collected from different processing stages on the Aegean island of Amorgos (G. Jones 1984, 1987, 1990). After harvesting and threshing, the free threshing cereals and pulses were winnowed to separate the grain (and by association the heavier weed seeds and chaff fragments) from the lighter chaff and straw fragments. The heavier items are then sometimes sieved with a coarse mesh sieve to remove items larger than the grain. The material passing through the sieve (or the unsieved grain) was then sieved with a fine meshed sieve which retains the grain for use allowing small weed seeds to pass through. Glume wheats require an extra stage of pounding to release the grain from the spikelets (Hillman 1984a). In the Near East, residues of crop processing have been identified at Tell Brak (Charles and Bogaard 2001; Hald 2008), Catalhöyük (Bogaard *et al.* 2013) and Troy (Riehl 1999) and stores of cleaned agricultural products have been found at several sites including Yenibademli (Oybak Donmez 2005), Imamoğlu (Oybak and Demirci 1997), Arslantepe (Sadori *et al.* 2006) and Tell Qarqar (A. Smith 2005a).

The contribution of animal dung to the archaeobotanical record of western and central Asia has been widely recognised over the last thirty years, with dung material identified at Malyan (Miller and Smart 1984), Selenkahiye (van Zeist and Bakker-Heeres 1988), Dilkaya (Nesbitt 1991), Kaman-Kalehöyük (Nesbitt 1993), Sweyhat (Miller 1997c), Abu Salabikh (Charles 1998), Jeitun (Charles and Bogaard 2005), Tell Leilan (Wetterstrom 2003), Tell Abu en-Ni'aj (Klinge and Fall 2010), Gordion (Miller 2010), and Catalhöyük (Bogaard *et al.* 2013). In particular, ruminant dung is thought to have been burnt as fuel in arid regions where wood supplies were scarce (Miller and Smart 1984), the dung being collected, dried, mixed with cereal chaff and made into fuel cakes for burning as still occurs in western and central Asia today (Miller 1984; S. Anderson and Ertuğ-Yaraş 1998; Gur-Arieh *et al.* 2013). Dung is used in the village of Yiğittaşi, modern Sos Höyük, in the form of fuel cakes for cooking, especially bread, and heating, and also as a building material to provide insulation and waterproofing in roof construction (Hopkins 2003). Historically, dung fuel burning was described by Joseph de Tournefort, who travelled through the Pasinler Valley in 1702, commenting that 'you see neither tree nor bush; and their common fuel is cow's dung, which they make into turfs… 'Tis almost inconceivable what a horrid perfume this dung makes in the houses, which can be compar'd to nothing but fox-holes, especially the country-houses'(Tournefort 1741, 95).

Charred archaeological plant remains derived from these two principal sources, may be deposited in a number of different ways. They may represent grain-rich crop processing products, or processing by-products composed of straw, chaff and/or weeds. These may be accidently charred or burnt in household fires. Alternatively, charred plant remains could derive from dung burnt as fuel and containing plants eaten by animals, which in turn could come from grazed plants (mostly wild plants) or fodder derived from crops. Cereal or pulse fodder could be the grain-rich crop processing product or the by-products of processing, rich in straw, chaff and/or weeds. There are also a number of ways in which plants derived from different sources can become mixed: for example, dung from animals fed on both (wild) grazed plants and (crop-derived) fodder; crop processing by-products mixed (in dung fuel cakes) with dung (which itself may derive from graze or fodder or both); or crop processing products, by-products (or both) accidentally mixed with dung (which again may derive from graze or fodder or both) during deposition.

4.5.2 Comparison of the Sos Höyük samples with criteria for identifying dung derived material

In order to identify dung related material in archaeobotanical assemblages, Charles (1998) proposed four criteria: 1) the presence of recognisable animal dung in archaeological samples; 2) the incompatibility of wild plants with the harvested crop on the basis of plant ecology and biology; 3) discrepancy between the wild taxa and the expected (by-) products of crop processing; and 4) combination of crop taxa and plant parts indicating a mixture of crop processing stages. These criteria can be used to assess the likelihood of samples being derived from crop processing residues as well as animal dung since criteria two, three and four directly compare the assemblage's compatibility with crop processing. The first three criteria can be applied to the Sos Höyük material to investigate sources of plant material. The final criterion, however, is not relevant to the Sos Höyük assemblage because, apart from three Middle Bronze II samples, the samples are dominated by free threshing cereals (*T. aestivum* and *H. distichum*) with rare inclusions of glume wheat.

Recognisable animal dung, either fragmented or in pellets, is found in the majority of Sos Höyük samples. Sheep and goat were the main animals identified at Sos Höyük throughout the Kura-Araxes period together with cattle and a small proportion of pigs in each phase (Table 4.7) (Piro 2009; Howell-Meurs 2001b). Fragments of sheep/goat faecal pellets are present in two Middle Bronze II samples and are easily identifiable due to their characteristic pinched end and surface texture (Figure 4.23a). Amorphous dung fragments are found in 59% of samples throughout the assemblage (Appendix A). These appear to be pieces of charred dung because of their dark brown to black colouring, and the assortment of compacted broken plant matter, usually silicified straw and vegetative tissue, embedded within an unstructured organic matrix (Figure 4.23b). Some of the amorphous dung fragments from Sos Höyük contain charred seeds (Figure 4.23c). These amorphous dung pieces may represent the interiors of sheep/goat faecal pellets, fragments of burnt dung fuel cakes or burnt stable waste. Dung fragments were also observed adhering to wild seeds and chaff, particularly *Hordeum distichum* rachis internodes, throughout the assemblage. Clumps of white compacted silicified plant matter were present in 30% of samples, occurring with amorphous dung fragments in 42% of these samples (Appendix A). These white straw clumps may be the remnants of dung burnt to ash similar to ashy traces of burnt dung found at Kaman-Kalehöyük (Nesbitt 1993). Lack of faecal pellets or dung fragments does not preclude a sample from being derived from dung (Charles 1998); the amorphous dung matrix may have been burnt to ash or alternatively, if incompletely charred, the dung matrix may have disaggregated during water flotation (Nesbitt 1991). Comparing the cultivated taxa and wild seed composition of samples with amorphous dung fragments and/or silicified straw clumps with those without physical traces of dung, it is apparent that samples with no visible dung are compositionally similar to samples with dung, and so might also be dung derived (Figure 4.24).

Charles' (1998) second criterion for identifying archaeological dung is the presence of seeds from wild plants that could not have been harvested with the crop on the basis of plant ecology and biology. Based on plant fruiting times, virtually all the wild seed taxa found at Sos Höyük could have been harvested with the cereal crops. The long period of snow cover in the Pasinler Valley results in a very restricted plant growing season from April through to November. In the Erzurum region, the province where Sos Höyük is located, the timing of the cereal harvest varies according to whether the crops are autumn or spring sown. If the cereal crops are autumn-sown then they are harvested in July/August whereas spring-sown cereals are harvested in October (Hopkins 2003; Bardsley 2001; Aycicek and Yildirim 2006). Virtually all of the taxa identified in the Sos Höyük assemblage have a flowering/fruiting period which overlaps with the summer harvest and some continue to flower into the late harvest period (see Table 4.6 and Figure 4.25) (Davis 1965-1988). According to the *Flora of Turkey* (Davis 1965-1988), the only species that may be inconsistent with the cereal harvest are a group of early flowering wild species, including *Buglossoides arvensis, Thlaspi arvense*, and *Adonis* spp., that should finish flowering prior to the summer harvest. Seeds of these wild taxa are found, however, in summer harvested wheat from Erzurum fields near to the Pasinler Valley (Bulut *et al.* 2010), so the truncated growing season at these high altitudes may delay the flowering/fruiting period of these early flowering taxa. The seasonality of wild taxa does not therefore provide a means of differentiating between seeds from crop processing and dung fuel.

Similarly, based on habitat, the majority of Sos Höyük wild taxa grow in both arable and ruderal locations as well as the surrounding steppe and so may be weeds of crops or grazed wild plants (table 4.6; Figure 4.26). Seeds from wetland or damp meadows, such as *Bolboschoenus maritimus*, Cyperaceae, *Eleocharis* sp., *Persicaria* sp. and *Rumex* sp., may be indicative of dung from animals grazing marshy areas but may also represent crop weeds from damp fields or field margins. Neither the habitat nor the seasonality of wild taxa can therefore be used to identify likely crop processing or dung fuel use.

Charles' (1998) third criterion compares the combination of the non-crop seeds in samples with the products and by-products of crop processing stages. In order to test this criterion, the Sos Höyük samples were compared with Jones' ethnographic samples of free threshing cereals and pulses on the basis of the physical characteristics of weed seeds found in their processing products and by-products (G. Jones 1984, 1987). The physical characteristics relevant to each crop processing stage are: seed size (relevant to fine sieving), tendency to remain in heads or spikes etc. despite threshing (relevant to coarse sieving) and aerodynamic properties including density and shape (relevant to winnowing) (G. Jones 1984, 1987). This approach uses discriminant analysis based on a combination of these weed seed characteristics to discriminate between the four known crop processing groups from Amorgos (see Chapter 3.1.6 and Table3.5 for further information). The discriminant functions extracted to distinguish these ethnographic groups were then used to classify each of the archaeological samples from Sos Höyük into one of the processing groups according to the similarity of their wild seed characteristics. Table 4.8 lists the Sos Höyük wild taxa according to the physical characteristics of their seeds. Samples with less than ten classifiable weed seeds were excluded from the analysis, following G. Jones (1987), which resulted in 65 out of the 70 Sos Höyük samples being included in the analysis. Five wild taxa in Table 4.8 were categorised as indeterminate between two categories, Small Free and Heavy (SFH) and Small Headed and Heavy (SHH). The analysis was performed twice with these taxa assigned first to SFH then to SHH. In both analyses (Figure 4.27a), all the Sos Höyük samples were classified as fine sieving by-products with a high probability (p>0.9 for 98% of samples). While some samples plot within the known fine sieve by-product sample distribution from Amorgos, most samples plot more negatively on the first discriminant function than the Amorgos fine sieve by-products. This suggests that the Sos Höyük samples contained a greater proportion of small, free, heavy weed seeds than the Amorgos fine sieving by-products.

The positioning of the Sos Höyük samples at the small, free, heavy seed extreme of the discriminant functions is also seen in other archaeological samples classified as fine sieve by-products, e.g. from Assiros (G. Jones 1987) and Tell Brak (Hald 2008) (Figure 4.28a). The samples from Tell Brak and Assiros were not interpreted as being dung related. It could be that charring and archaeological recovery favours the survival of small, free, heavy seeds in archaeobotanical samples. Alternatively, the Sos Höyük samples may have been more thoroughly sieved to remove small seeds than the Amorgos samples or there could have been more small-seeded wild plants growing with the crops at Sos Höyük than there were in the fields at Amorgos. Then again, the Sos Höyük assemblage may represent the mixing of crop processing remains with material from other sources dominated by small-seeded taxa, such as animal dung.

To investigate criterion three further, the Sos Höyük samples were treated as a separate group along with the Amorgos ethnographic crop processing groups in a discriminant analysis, following Charles (1998). This approach does not identify dung samples directly because the physical attributes of the wild seeds used in the discriminant analysis relate specifically to their performance at different crop processing stages rather than their likely occurrence in dung. Instead it tests the cohesiveness of the archaeobotanical samples as a group and determines whether the weed seed characteristics differ significantly from the Amorgos crop processing (by-)products. When a discriminant analysis was conducted with the Sos Höyük samples as a fifth group (Figure 4.27b), the group integrity of the Sos Höyük samples is high, 92% of samples were re-classified into the Sos Höyük group, with high probability (p>0.9 for 82% of samples), and 8% were reclassified as fine sieving by-products.

Although the orientation of the crop processing groups in the discriminant plot shifts on the axes when Sos Höyük is classed as a separate group, the arrangement of the crop processing groups is not altered. This is different to the radical changes observed in the overall positioning of crop processing groups when samples from Abu Salabikh and Jeitun (Figure 4.29) were entered as separate groups into the discriminant analyses (Charles 1998; Charles and Bogaard 2005). These significant variations implied that many of the wild seeds at these sites were derived from a source not related to crop processing. This, together with the improbability of the wild taxa fruiting at harvest time at these sites, suggested animal dung as the source of the wild seeds. The Sos Höyük samples behave more similarly to the Çatalhöyük (Bogaard *et al.* 2013) samples when analysed as a separate group. In both cases the samples form a coherent group but the arrangement of the crop processing groups relative to one another is not affected; it is just their positions on functions 1 and 2 that changes. The Çatalhöyük samples were interpreted as containing both dung remains, due to the presence of dung pellets/fragments, and fine sieve by-products from crop processing. Moreover, when the Tell Brak samples, which had been interpreted as fine sieving by-products (Hald 2008), were entered in the discriminant analysis as a fifth group, they also formed a coherent group; 83% of samples were reclassified into the Tell Brak group (Figure 4.28b). As with the Sos Höyük and Çatalhöyük discriminant analysis, treating the Tell Brak samples as a separate group shifted the alignment of the crop processing groups on the discriminant functions but the original configuration remained unchanged. Thus, based on the discriminant analysis using ethnographic crop processing groups, the Sos Höyük samples appear to represent fine sieving by-products. However, these samples contain a greater proportion of small-seeded wild taxa than would be expected if they were all weeds of crops (*cf.* Bogaard *et al.* 2013).

From comparison with Charles' (1998) dung recognition criteria, it appears that the Sos Höyük samples probably include dung derived material, due to the presence of amorphous dung fragments and silicified clumps of straw. These samples also seem to contain weed seeds from fine sieving by-products of crop processing and so may represent a mixture of crop processing residues and dung.

4.5.3 Seed survival through animal digestion.

Having determined in the previous section that most of the Sos Höyük samples are probably a mixture of dung and crop processing residues, this section will assess which plant material could have entered the archaeobotanical assemblage as a product of animal dung. Only material found within a faecal pellet can be confidently categorised as being derived from dung (Charles 1998). No seeds were visible in the sheep/goat faecal pellets from Sos Höyük, although charred seeds, of *Chenopodium album, Persicaria* sp*., Polygonum arenastrum/bellardii, Trifolium/Melilotus/Medicago,* indeterminate Cyperaceae and Poaceae as well as *H. distichum* rachis internodes, were found embedded within amorphous dung fragments or had traces of dung attached to their surface (see Figure 4.23c). It cannot be confirmed that these plant remains came through animal digestive systems but it is clear that the seeds and chaff were burnt with the dung. At other archaeological sites in the Near East, charred seeds of *Suaeda, Aeluropus, Cyperus, Carex*, indeterminate Fabaceae, *Bolboschoenus, Sporobolus, Crypsis* and *Polygonum aviculare* have all been found either in dung pellets or with dung remains attached to them (Charles and Bogaard 2005; Miller and Smart 1984; Bogaard *et al.* 2013).

The dispersal of seeds through animal digestion and dung deposition has been studied extensively in ecology and zoology. Janzen (1984) theorised that seed survival in ruminant dung is dependent on seed size (Ghassali *et al.* 1998), shape (Pakeman *et al.* 2002), seed coat hardness and permeability (Gardener *et al.* 1993) and the quantity of seeds ingested (Bonn 2004; Bruun and Poschlod 2006). Thus, smaller, rounder, tougher and more abundant seeds are more likely to pass through the ruminant digestive system. In particular, small-seeded legumes (*Trifolium/Melilotus/Medicago*), Amaranthaceae and Cyperaceae seeds are able to survive the sheep/goat digestive tract (Table 4.9). Larger seeds are more able to survive the cattle digestive system than the sheep/goat digestive system. *Triticum aestivum* grains, for example, have been found in cattle dung (Malo and Suarez 1995). Many of the wild seeds which dominate the Sos Höyük assemblage, particularly *Chenopodium album, Atriplex* cf.

lasiantha and *Trifolium/Melilotus/Medicago* (see Figure 4.20), have high gut survivability rates (Table 4.9). Nonetheless, because no seeds were found inside dung pellets from Sos Höyük it is not possible to determine whether these taxa were derived from animal dung or from crop processing by-products which had been mixed with dung. Small quantities of *Chenopodium album, Bolboschoenus maritimus*, *Carex* spp. and *Cyperus* spp. were found with other wild taxa in samples with almost pure *T. aestivum/durum* grain concentrations from a burnt Iron Age house at Sos Höyük (Longford 2007). These samples contained no traces of dung, very few rachis internodes and the wild taxa, including the *Chenopodium album* and Cyperaceae, are interpreted as crop weeds.

Feeding trials using sheep and goats have demonstrated that cereal grain almost never survives digestion irrespective of whether it is hulled (e.g. *H. vulgare*), encased in spikelets (e.g. *Triticum monococcum*), or dehusked (Valamoti and Charles 2005; Wallace and Charles 2013). Cereal chaff has a similarly low survival rate; the few rachis internodes and glume bases that passed through sheep or goat digestive tracts were badly damaged in the process and would be difficult to identify archaeobotanically (Wallace and Charles 2013; Valamoti 2013). The epidermal layers of *T. monococcum* glume bases digested by a goat appear shredded and pitted when examined microscopically (Valamoti 2013). It is therefore unlikely that the well preserved *T. aestivum* and *H. distichum* rachis internodes found throughout the assemblage could have passed through sheep or goat digestive tracts. However, the *H. distichum* rachis internodes in Figure 4.5, while bearing traces of delicately charred hairs and lateral spikelets, also have fragments of dung attached to them. Cereal chaff and grains found with dung traces may instead represent the mixing of crop processing by-products with dung in fuel cake production or possibly fodder and animal pen material collected along with dung.

None of the Sos Höyük plant material can be unequivocally identified as having entered the assemblage via animal dung. The few dung pellets present in the assemblage contained no identifiable seed material. Of the wild taxa that could have survived animal digestion, all are possible crop weeds and, in particular, weeds of fine sieving by-products. At the site of Jeitun it was possible to identify dung derived taxa since there was a clear distinction, based on the seasonality of wild plant fruiting and the timing of the crop harvest, between seeds that could have entered the assemblage through crop processing and those that related to animal dung (Charles and Bogaard 2005). This allowed an investigation of animal diet at Jeitun but this is not possible at Sos Höyük because none of the plant remains can be proven to be dung derived. It is clear however that the seeds of wild/weedy species, cereal grains and chaff in the Sos Höyük assemblage were burnt together with dung either in dung cakes or as rubbish thrown onto fires.

4.5.4 Dung Fuel Cakes

Ethnographic accounts of dung cake fuel production from Iraq (Charles 1998), Turkey (S. Anderson and Ertuğ-Yaraş 1998), Iran (Miller 1984) and India (Reddy 1998) are fairly consistent and mention the inclusion of cereal chaff as a binding agent in fuel cake production. In the village of Yiğittaşi, where Sos Höyük is located, dung cakes are made from sheep, goat and cattle dung collected on barn floors throughout the year which is shovelled out to dry on dung heaps located near to each house (Hopkins 2003) (Figure 4.30). Straw, either harvested or a winnowing by-product, is added to the dung to improve consistency and the dung is compacted and cut into bricks to dry before burning (Figures 4.31 and 4.32).

The composition of the Sos Höyük samples is consistent with the production of dung fuel cakes. Wild/weed seed evidence from discriminant analysis using ethnographic processing stages, indicates that fine sieve by-products are present in the samples (Figure 4.27a). However, the ratios of *T. aestivum* and *H. distichum* rachis internodes to grain in tables 4.1 and 4.2 are high which indicates that the remains of early stage crop processing are potentially present in samples (van der Veen and Jones 2007). Another way to assess crop processing stages is to compare archaeobotanical samples with the known proportions of cereal grain, chaff and wild seeds in ethnographic samples of crop processing products and by-products. The proportion of grain, rachis internodes and wild seeds in the Sos Höyük samples were therefore compared with those in crop processing samples from free threshing cereals at Amorgos (G. Jones 1990) (Figure 4.33). There is a higher proportion of rachis internodes in the Sos Höyük samples than in the Amorgos fine sieving by-products of free threshing cereals, suggesting that the Sos Höyük fine sieving by-products have become mixed with additional cereal chaff. This could result from depositional mixing of by-products from early and late stages of crop processing but it is more likely that most of these samples result from dung cake production because wild taxa and rachis internodes were either embedded in dung fragments or had clumps of dung adhering to their surface.

Dung fuel cakes made from the dung of cows and sheep fed by grazing, foddering or both, were collected from two Central Anatolian villages and analysed for their broad compositional elements (S. Anderson and Ertuğ-Yaraş 1998). Depending on the food source of the livestock, dung fuel cakes were composed of varying proportions of wild seeds, grain, cereal culm nodes and rachis internodes. On average, dung from grazing animals had a high wild seed component while fodder-fed animals produced dung richer in cereal chaff and grain. In these villages, straw was not purposefully added to the dung during cake manufacture but may have been incorporated through the production of cakes on straw lined surfaces, the spillage of cereal fodder into the dung or from material passing through the animals' guts, although feeding trials have shown that the passage of intact grain and chaff through the animal digestive tract is rare (Wallace and Charles 2013). Comparing the amounts of free threshing cereal rachis internodes, culm nodes, grains and seeds of wild taxa in the uncharred dung cakes in the Central Anatolian study (S. Anderson and Ertuğ-Yaraş 1998, Fig 1.) with the Sos Höyük samples, it is clear that the Sos Höyük samples have high amounts of cereal chaff and seeds of wild taxa, similar to the dung cakes in the ethnographic study (Figure 4.34). Virtually all the dung cakes in the Central Anatolian study contained cereal culm nodes irrespective of the animals' diets (S. Anderson and Ertuğ-Yaraş 1998). Cereal culm nodes were also consistently found together with burnt dung fragments in archaeobotanical samples from the site of Hut in Pakistan but were less common in samples without dung (Fuller *et al.* In press). Most Sos Höyük samples contain culm nodes and bases (Figure 4.14 and 4.34) which may be another indication of dung cake use, as dung fragments are also found in many of these samples. The presence of cereal culm bases may additionally indicate that the Sos Höyük cereals were harvested by uprooting the whole plant.

All the modern uncharred dung cakes in the Central Anatolian examples had a low proportion of cereal grain, generally less than 25% of items. Some of the Sos Höyük samples contain more than 25% cereal grain. Ethnographic work in India on dung fuel use showed that the ashes of domestic hearths often had a higher proportion of cereal grains and chaff than was present in the dung cakes when crop processing remains were being directly discarded into the fire (Reddy 1998). The Sos Höyük samples with high amounts of grain may therefore be a mix of crop processing by-products burnt independently of dung together with dung cakes containing crop processing residues.

It seems, therefore, that the Sos Höyük samples, with their combination of dung fragments, fine sieving by-products, free threshing cereal rachis internodes, culm nodes and bases, and grain, most likely represent the remains of dung fuel cakes. This would account for the mixing of crop processing by-products (chaff and wild seeds) and dung fragments, which may contain seeds of grazing wild plants or fodder (cereal grain, chaff and weed seeds). In addition, some samples may also contain crop processing by-products that were burnt directly in fires.

4.6 Fuel use

Access to trees for firewood is limited in the modern Pasinler Valley. Most of the land has been converted to agricultural fields and trees are limited to riversides, along roads and around villages. The surrounding mountains are similarly devoid of trees except at high altitudes in the Southern Palandöken range. Today, the Pasinler Valley is covered by Irano-Turanian herbaceous steppe and flanked by mountain grasslands but is in an area that was potentially forested in the past (Colak and Rotherham 2006). In a preliminary analysis of the Sos Höyük charcoals, *Pinus sylvestris, Salix/Populus* and *Quercus* fragments were identified in the Late Chalcolithic and *Pinus sylvestris, Salix/Populus, Quercus, Betula, Ulmus* and *Acer* were identified in the Middle Bronze Age samples (Longford *et al.* 2009) which suggests that there may have been *Quercus* and *Pinus sylvestris* woodlands near to the site. *Pinus sylvestris* and *Populus tremula* forests are present in the Karapazari mountain ranges far to the north of Sos Höyük (Atalay 1982) and these forest types may have covered the nearby slopes. In the valley itself, an open *Quercus* woodland may have been present*,* similar to plant communities identified in pollen cores near Lake Van in eastern Anatolia (Van Zeist and Woldering 1978; Bottema 1995) and the Tsalka Plateau in southern Georgia (Connor and Sagona 2007) during the Early Bronze Age. Remnants of this heavily depleted *Quercus* woodland are found in the south west of Erzurum province, over the mountains from the Pasinler Valley (Atalay *et al.* 2014).

The extent of dung fuel burning is thought to reflect the availability of wood resources at a site, with more dung fuel being used as a landscape was deforested (Miller and Smart 1984; Miller 1996; Miller and Marston 2012). In samples interpreted as containing dung material, comparison of the ratio of charred seeds to wood charcoal may indicate the relative abundance of dung to wood fuel (Miller 1997a). This assumes that all the material in the sample was purposefully burnt as a source of fuel and that all the charred seeds were incorporated into dung fuel. Most of the Sos Höyük material is thought to be derived primarily from dung cake fuel (see 4.5.4). Miller uses two ratios to assess the extent of dung fuel burning, the ratio of crop grain to wood charcoal and the ratio of wild seeds to wood charcoal. The former ratio can be used as well as the latter at Sos Höyük because the dung cake fuel apparently includes crop processing by-products that may have been mixed with dung in cake manufacturing and is not reliant on material surviving sheep/goat digestion (Table 4.10) (Miller 2010; see Wallace and Charles 2013). In this analysis, higher wild seed or grain to charcoal values reflect greater use of dung relative to wood fuel. Comparison of the Sos Höyük wild seed/grain to charcoal ratios (Table 4.10) with ratios from sites in Anatolia and Syria (Table 4.11) indicates that a high amount of wood relative to dung fuel was consumed throughout the Kura-Araxes period. These proportions are similar to the low ratios at Gordion and suggest, just as at Gordion, that dung fuel was a supplement to wood burning and that there was a continuous supply of wood available at the site (Miller *et al.* 2009). The low average wild seed and grain to charcoal ratios are consistent with the Pasinler Valley being covered by an open woodland with a steppe understorey. This woodland does not appear to have been depleted over this period. Indeed, there is no indication of overgrazing in the wild seed assemblage to suggest over-exploitation of the vegetation. Many healthy steppe indicator taxa, including *Kochia, Ajuga, Salsola, Thymelaea, Medicago* and *Trigonella* (Miller 2010; Marston and Miller 2014), are present in the Sos Höyük samples from the Late Chalcolithic to Middle Bronze Age (Table 4.5).

The use of dung cake fuel when wood resources appear to have been readily available may relate to fuel preferences for certain activities. In Neolithic northern Greece, dung fuel was similarly identified in a period when wood resources were plentiful, and it has been suggested that specialised fuel was used at different fire installations at Makri and Makriyalos (Valamoti 2004). Ethnographic studies have shown that in some cultures dung fuel is preferred for cooking and wood is chosen for household heating (Joon *et al.* 2009), or that dung fuel is used for pottery production (Sillar 2000; Zapata Pena *et al.* 2003), or that certain dung fuels are restricted to external use because they produce acrid smoke (S. Anderson and Ertuğ-Yaraş 1998). Cultural taboos based on whether dung fuel is perceived as 'unclean' also determine whether and how it is used (Gur-Arieh *et al.* 2013; Shahack-Gross *et al.* 2004). Burning qualities may vary between dung fuel cakes and wood but experimental work has demonstrated that there is little difference in fuel efficiency when used in traditional ovens; both fuels can be employed for the same tasks (Gur-Arieh *et al.* 2013). Different types of dung fuel also burn differently. Less dense cattle dung is often used to start fires whereas compacted sheep/goat dung fuel is preferred for sustained burning (S. Anderson and Ertuğ-Yaraş 1998). In Yiğittaşi, although gas and electricity are available, dung fuel is preferred for cooking, especially bread, and for heating over winter (Hopkins 2003). When pottery was being made in Yiğittaşi during the 1970s, dung fuel in domestic pit ovens was used to fire the pots (Bakir 2004).

Similarly, the use of dung cakes may not relate to the actual abundance of wood surrounding the site but to periods of restricted access to wood resources. Winter in the Pasinler Valley is extremely harsh, with deep snow cover, often greater than a metre in depth, from November through to March or April (Hopkins 2003; Newton 2004). It may not have been possible to collect wood over winter nor store enough wood to last throughout the snow season. Dung, if made into a beehive like structure which self-seals as the outer layer decays, can be stored outside throughout winter and still be usable as a fuel (Hopkins 2003). Thus dung and wood fuel may have been used in different proportions throughout the year because of periodic scarcity of wood and the samples from Sos Höyük may represent a mixing of remains from multiple fires.

4.7 Seasonality

The Kura-Araxes economy has traditionally been thought to be based on transhumant pastoralism (Sagona 1993; Kushnareva 1997; Rothman 2005; Palumbi 2010) and Sos Höyük was itself initially interpreted as being a transhumant campsite (Sagona *et al.* 1996). Archaeozoological studies of livestock age-at-death distributions from Sos Höyük have demonstrated, however, that the site was occupied year round throughout the Kura-Araxes period (Piro 2009; Howell-Meurs 2001a). The archaeobotanical data complements the archaeozoological findings.

4.7.1 Dung fuel cakes

The use of animal dung as fuel has implications for determining seasonality of site occupation. For animal dung to be an abundant and viable fuel resource at Sos Höyük, livestock must have been kept either on site or in close proximity to the site for at least part of each year. Miller (1997b) describes a missionary's ethnographic account of Iraqi villagers collecting sheep dung from grazing animals in the field and bringing it back to the settlement for cake manufacture. The seasonality of this occupation may be inferred from scheduling of dung cake making activities. Manufacture of dung cake fuel in Central and Eastern Anatolia commonly occurs over spring and summer, when winter stable waste is processed and dried over a three to four month period before being cut into cakes and stored (Hopkins 2003; S. Anderson and Ertuğ-Yaraş 1998). Today in the village of Yiğittaşi, animal dung is accumulated primarily during winter stabling of animals, the floors of barns being designed to collect animal droppings and channel them to a hollow in the floor for later retrieval (Hopkins 2003). Additionally, the use of dung as fuel in some regions is limited to winter when access to wood is restricted (Gur-Arieh *et al.* 2013). The apparent availability of wood resources in the Pasinler Valley throughout the Kura-Araxes period (see 4.6) may have meant that dung fuel cakes were a seasonal fuel source preferentially used when winter snows restricted the collection of firewood and movement in the region. From the seasonal cycle of dung fuel collection and manufacture, the use of dung fuel may indicate occupation of Sos Höyük from at least November, when the snow begins, isolating communities and livestock is stabled indoors producing dung that accumulates through to August for the drying of dung cakes.

4.7.2 Crop sowing time

Insight into the possible timings of crop sowing and harvest can be gained by examining the modern agricultural calendar in the Pasinler Valley. At Sos Höyük, *Triticum aestivum* was the most common crop in the assemblage. A local variety of *T. aestivum*, Kirik, is grown in the village of Yiğittaşi and is a traditional variety widespread in the Erzurum region (Bardsley 2001). This landrace is a facultative wheat, meaning it can be sown in either autumn or spring but rather than being a true winter wheat requiring vernalisation before germination, it is a hardy wheat tolerant of cold conditions. Growing trials of Kirik have shown that it is most productive if sown in early September and therefore able to germinate before the winter snows cover the fields (Ozturk *et al.* 2006). The modern cultivation of the cash crops, potatoes, sunflowers and sugar beet, in the Erzurum region often means that the harvest is delayed until October and so the wheat cannot be sown until late October, just as the snow begins to fall, or is delayed until the following spring (Caglar *et al.* 2011b; Hopkins 2003). With late autumn sowing, known as *dondurma* (freezing) sowing, the seeds stay in the frozen earth until the snow melts in the spring and the wheat begins to germinate. Freezing sowing of Kirik produces greater yields than spring sowing although this is not as productive as autumn sown wheat (Ozturk *et al.* 2006). Kirik sown in November (freezing sowing) can be harvested by August the following year (Aycicek and Yildirim 2006) and wheat fields planted at this time contain fewer weeds than spring-sown fields (Bulut *et al.* 2010). In Yiğittaşi, the fields close to the village are used for the cultivation of both cereals and cash crops, and Kirik is generally sown in the spring (late April/early May) and harvested in October (Hopkins 2003). Cereals in these fields require irrigation since they are planted after the spring snow melt, whereas fields further from the village, on the uplands, are sown with Kirik in October/November and are not irrigated since they benefit from the spring snow melt the following year (Bardsley 2001).

In comparison, anecdotal evidence from Narman, located 50km NE of Yiğittaşi at an altitude of 1640m, provides details of a crop cycle where separate winter and summer cereal varieties are used (B. Selvi 2014, pers comm, 22 July)[8]. Winter wheat and barley are sown towards the end of October and into the first week of November before the snow falls. Winter barley is harvested in early July and winter wheat is harvested in mid-July. In the spring, cereals are sown at the end of March after the snowmelt, and the barley is harvested at the end of July and the wheat in the first half of September.

From these modern accounts it is apparent that autumn and spring sown crops have very distinct seasonal characteristics in the Pasinler Valley. If a wheat or barley crop is sown in autumn or early winter, the crop should be harvested in the following summer. This would mean that the seeds collected with the crop would be from summer fruiting weeds. Alternatively, at Yiğittaşi/Sos Höyük if a wheat crop is spring sown, it would be harvested in the autumn and should be accompanied by late fruiting weeds and irrigation indicators; because the crop would have required additional water input since it germinated after the spring rains and snow melt.

In section 4.5.2 it was concluded that the Sos Höyük samples probably contain crop processing by-products mixed with animal dung to make dung cake fuel. The mixing of crop processing by-products into dung cakes means that inferences about crop husbandry reliant on analyses of the relative proportions of wild taxa would be unsound since seeds of wild species may have entered the assemblage through animal dung as well as crop processing. Nevertheless, it may be possible to argue against one husbandry practice or another on the basis of the absence of certain wild taxa in mixed samples, which would mean that these taxa were absent in both the animal dung and the crop processing by-products.

Harvesting time can potentially be identified from the flowering and fruiting times of the weed species accompanying crops (Wasylikowa 1981; M. Jones 1981; Behre and Jacomet 1991; G. Jones 1992; Charles *et al.* 1997; Bogaard *et al.* 1999; Bogaard *et al.* 2001; Bogaard *et al.* 2005). So if seeds from wild taxa that fruit during the summer harvest are missing from the assemblage, it would indicate that crops were not harvested in the summer and, similarly, if no wild taxa that fruit in the autumn are present, autumn harvest would be unlikely. However, although all of the wild taxa in the Sos Höyük samples *can* flower and fruit early (between April

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[8] Bengi Selvi from Bitlis Eren Üniversitesi interviewed farmers in Narman, Erzurum (40°20’50”N 41°52’06”E in July 2014 on my behalf

and June) and there are no taxa that flower *only* in the late summer to autumn (between August and September) (Table 4.6, Figure 4.25), most samples contain taxa with long flowering periods that set seed from summer to autumn. It is therefore not possible to exclude either of the crop cultivation cycles on the basis of the flowering and fruiting times of wild taxa: seeds from some of the wild taxa could have been collected with an autumn harvest of crops sown in spring, and all could have been collected with summer harvested crops sown in the previous autumn. Crop sowing time can also be inferred from the germination period of weed species (Charles *et al.* 1997; Bogaard *et al.* 2001; Bogaard 2004). However, based on the taxa for which germination time is available (Table 4.6), both autumn and spring germinating taxa are present amongst the Sos Höyük taxa, so neither autumn-sown nor spring-sown crop cultivation cycles can be excluded. These autumn, autumn/spring and spring germinating taxa were found throughout the assemblage, with no variation between the Late Chalcolithic, Early and Middle Bronze.

Unfortunately, because of the probable mixing of dung derived material with crop processing by-products, the evidence available from the wild taxa for determining crop sowing and harvesting times at Sos Höyük is inconclusive and cannot be applied to identify autumn or spring sowing cycles. Some idea of seasonality also can be gained from the modern crop cycles. While it cannot be assumed that the cereal taxa grown at Sos Höyük from the Late Chalcolithic to Middle Bronze Age would have had exactly the same growth patterns as the modern winter/spring cereals or the facultative Kirik, these crop cycles provide a guide for the possible sowing and harvesting times in the Pasinler Valley, constrained as they are by the long heavy snow season. Both cycles indicate occupation of Sos Höyük during autumn, since autumn would have been the season for sowing or harvesting of crops, and either summer harvesting or spring sowing of crops dependant on the cycle. In both crop cycles, to sow their crops people would have needed to be at Sos Höyük in autumn until just before winter snows began or in spring immediately as the snows melted. If Sos Höyük were a summer pastoral camp this would have necessitated attempting to travel through the snow filled mountain passes in late autumn or early spring which does not match the model for transhumant pastoralism (Cribb 1991).

4.8 Discussion

Few of the Sos Höyük archaeobotanical samples appear to represent primary deposits of material. Even though there are samples from diverse context types, hearths, pots, pits, graves and floors, there is no variation in compositional content according to sample context (Figure 4. 17). Floor samples are not distinguishable by crop assemblage from general debris or grave fill. Nor is there contextually derived variation in the wild seed assemblage (Figure 4.22). Many samples may instead be characteristic of the background archaeobotanical debris created by multiple hearth residues, dung fuel sweepings, stabling refuse, eroded mud bricks, and crop processing wastes (Figure 4.35a). Samples from within building contexts may also contain evidence of the post-occupation use of the structure. In Yiğittaşi, modern Sos Höyük, when a house is no longer occupied, the rooms are first converted into store rooms and then to stables (Hopkins 2003). In Dzveli, southern Georgia, some rooms of an abandoned house are used to grow garden vegetables while manure and household rubbish is collected and burnt in another derelict room (pers. obv. Figure 4.35b). The broad origin of the Sos Höyük material does not undermine the interpretive importance of these samples. While they cannot be related to specific events, these slowly accumulating deposits from multiple sources are indicative of long term archaeobotanical trends and are representative of the diversity of taxa present during at Sos Höyük (*cf*. Asouti and Austin 2005).

4.8.1 Arable agriculture at Sos Hoyuk

At Sos Höyük, *T. aestivum*, bread wheat, and *H. distichum*, two-row hulled barley, are the main crops cultivated throughout the Kura-Araxes period. This is consistent with findings at other Kura-Araxes sites in Eastern Anatolia and the Caucasus where free threshing wheat, *T. aestivum* (when identified), and hulled barley, either *H. distichum* or *vulgare*, are the dominant crops (Van Zeist and Bakker-Heeres 1975; Nesbitt 1991; Hovsepyan 2011, 2010a). Nesbitt and Samuel (1996) and Riehl (2014a) have all noted that in Eastern Anatolia the transition from the glume wheats (*T. dicoccum, T. monococcum*) to free threshing wheat (*T. aestivum/durum*) occurred during the Early Bronze Age which was earlier than elsewhere in Anatolia. The relationship between the Kura-Araxes and free threshing wheat, particularly *T. aestivum*, has not been investigated previously and this will be the focus of Chapters 5 and 6.

The maintenance of two cereal crops, *T. aestivum* and *H. distichum*, at Sos Höyük would have mitigated crop failure and may have been a deliberate risk avoidance strategy throughout the Late Chalcolithic to Middle Bronze Age. Cultivating two crops with differing environmental requirements and seasonality offers some protection against crop failure. *H. distichum* is more drought tolerant and has a shorter growing period than *T. aestivum* (Hadjichristodoulou 1976, 1982; Acevedo *et al.* 1991), and so when one crop is adversely affected by weather conditions the other may be less affected (G. Jones and Halstead 1995). It is also possible that the two elements of the economy, crop and animal husbandry, were integrated, which could have reduced risk (Halstead and Jones 1989). The use of cereals for fodder is a way of mitigating risk in agricultural societies. While dung pellets in the Sos Höyük archaeobotanical assemblage provide no evidence for animal diet, it is known that hulled *Hordeum* is often grown as a fodder crop, the extra processing required to dehusk hulled grain making it less desired than *Triticum* for human consumption (Halstead and Jones 1989; Miller 1997a). In times of shortage, *Hordeum* grains can be incorporated into human diet and animals can be fed chaff and straw (Halstead and Jones 1989). Alternatively, feeding livestock excess *Triticum* grain not needed for human consumption can be a method of investing grain in meat and milk production during periods of agricultural plenty in a form of indirect storage (Halstead 1990).

4.8.2 Transhumant pastoralism or mixed farming?

Traditionally the Kura-Araxes economy was interpreted as being based on pastoral transhumance (Burney and Lang 1971; Kushnareva 1997; Frangipane 2000; Rothman 2003; Shimelmitz 2003; Frangipane and Palumbi 2007). Within this framework, Sos Höyük was initially interpreted as a transhumant pastoral camp (Sagona *et al.* 1996). In a mobile pastoralist model, Sos Höyük would represent a summer grazing camp for herders based either south or north of the mountain ranges (Piro 2009; cf. Cribb 1991). This interpretation has been revised by two recent archaeozoological studies which have argued against specialised pastoral production at the site, and instead proposed that Sos Höyük was a settled agropastoral community that minimised risk through resource diversification (Howell-Meurs 2001b; Piro 2009; Sagona and Zirmansky 2009, 191). This interpretation was based on the presence of cattle and pigs in the assemblage and the age at death determinations of sheep/goat from tooth eruption and wear data, epiphyseal fusion data and the presence of foetal and neonate bones (Howell-Meurs 2001a; Piro 2009). Taking the sheep/goat evidence, if lambing occurred in the spring then the death of juveniles at 5-6 and 9-12 months shows animals at the site in autumn, late winter and early spring; foetal and neonatal bones indicate pregnant ewes and newborn lambs over the winter and spring (Piro 2009).

The archaeobotanical evidence supports the interpretation that Sos Höyük was not a purely pastoral community. The abundance of *T. aestivum* and *H. distichum* rachis internodes and culm nodes/bases in samples throughout the Kura-Araxes period indicates local cultivation of cereals. Sites of agricultural production are characterised by a high proportion of early stage crop processing by-products (Hillman 1981, 1984a). In all periods at Sos Höyük the *T. aestivum* rachis internode to grain ratio is considerably higher than that expected for whole ears, ranging from an average 3 to 35 times the expected ratio for each period and indicat a significant contribution of early crop processing by-products (Table 4.1). This strongly suggests that Sos Höyük was an agro-pastoral settlement, where the inhabitants cultivated free threshing cereals, throughout the Kura-Araxes period.

The archaeobotanical assemblage at Sos Höyük may also indicate year round use of the site. Although the wild taxa evidence was inconclusive for identifying the timing of the crop cycle, modern analogues suggest either autumn sowing and summer harvesting of cereals or spring sowing and autumn harvesting of crops may have occurred at Sos Höyük. The use of dung cake fuel at Sos Höyük would require a potentially prolonged period of dung accumulation, probably over winter when the animals were stalled, and a period of dung cake manufacture over the warm summer months. The use of dung fuel, if practiced on a large enough scale, would have facilitated winter occupation in the Pasinler Valley when access to dry wood fuel could have been limited by heavy snow. From November to March, heavy snow fall in the Erzurum highlands, including the Pasinler region, makes the mountain passes impenetrable and some villages inaccessible (Yakar 2000, 392-398). If Sos Höyük was a summer camp, pastoralists would need to leave the Pasinler Valley before the late autumn snow falls blocked the high mountain passes to the south or north, which conflicts with both of the currently practiced cultivation cycles, that is with both autumn sowing (and summer harvest) or autumn harvest (with spring sowing). Their return would have not been possible until after the snow melt in early April, which would have delayed spring sowing until after the spring rains and required irrigation of the crops. In cold years snow can remain on the high mountain passes for many months; Pollington (1840) recorded snow still covering the high roads to the south of Pasinler as late as June. Today, pastoralists bringing their flocks to the Pasinler Valley from south of the Palandöken Mountains can arrive as late as June for summer grazing (pers. obv. Pasinler Valley 2002). The scheduling of activities related to dung fuel manufacturing and the cultivation of crops, and the available window for transhumance therefore strongly argues against Sos Höyük as a purely summer grazing camp, but rather supports the year round occupation at the site. This permanence of occupation extends into the second millennium BC when other Eastern Anatolian and Southern Caucasian settlements are thought to have been abandoned (A. T. Smith 2012b; Ozfirat 2005). The settled versus transhumant nature of Kura-Araxes economies across the Near East will be discussed further in Chapter 6.5.1.

4.8.3 Change and continuity in the agricultural economy

On the whole, there is only slight variation in the Sos Höyük crop assemblage over the period studied (Figure 4.1). In the Late Chalcolithic and Early Bronze Age, the samples are dominated by *T. aestivum* and *H. distichum*, often with more rachis internodes than grain in the samples. Throughout the assemblage, occasional pulses (*Lens* cf. *culinaris, Vicia ervilia, Pisum sativum* and *Lathyrus sativus*) were identified. While overall the crop assemblage of the Middle Bronze I was consistent with the earlier phases, *Camelina sativa* was introduced as an oil seed crop and there was an increase in *T. dicoccum* glume bases which were previously only a minor element of the assemblage. These two new trends continue into the Middle Bronze II, and there was an increase in the frequency of millet, *Panicum milaceum*, in the assemblage.

The later periods at Sos Höyük, the Early Bronze III-Middle Bronze II (2500-1500B.C.) (Table 2.1), are important for understanding the terminal phase of the Kura-Araxes horizon. In the Caucasus, the Kura-Araxes cultural period is thought to have ended around c.2400BC as Martkopi/Bedeni and then Trialeti cultural material appears in the archaeological record (Eden 1995; Kushnareva 1997; A. T. Smith 2005b; Kohl and Trifonov 2014). This period of the 'Kurgan Cultures' is known for the elaborate Martkopi/Bedeni and Trialeti funerary practices, burials underneath stone and earthen barrows, or kurgans, often with rich grave goods, and is marked by a lack of settlement sites (Rubinson 1977; M. Puturidze 2003; A. T. Smith *et al.* 2009). Whether these Kurgan Cultures were a development of the Kura-Araxes horizon or symbolised the introduction of new elements into the region is uncertain (Sagona 2004a).

At Sos Höyük, however, the Kura-Araxes and Kurgan Culture material appears to coincide and be integrated. Burials of the Martkopi/Bedeni and early Trialeti traditions, identified by grave type and ceramics, were found in Early Bronze Age III deposits dated to 2500-2200B.C. (Sagona *et al.* 1998; Sagona 2000). Later burials in the Middle Bronze I (2200-

2000B.C.) contained both Kura-Araxes and Trialeti elements (Sagona *et al.* 1997; Sagona 2004a, 2000). These graves were both contemporary with and overlain by Kura-Araxes houses with the typical Kura-Araxes spatial organisation, central circular hearths, benches and red-black Kura-Araxes pottery (Sagona 2011). The latest Kura-Araxes buildings found at Sos Höyük in the Middle Bronze II (2000-1500B.C.) were a mix of rectangular mudbrick and circular wattle and daub structures and contain both Kura-Araxes and Bedeni ceramics (Sagona 2004a, 2000). This suggests that the Kura-Araxes horizon continued to the end of the Middle Bronze Age in north eastern Anatolia, c.1500B.C., and may have wider implications for understanding the relationship between Kura-Araxes settlements and Kurgan Culture burial mounds in the Caucasus and the apparent abandonment of settlements in the second millennium BC (see section 2.1). Variations or similarities in the archaeobotanical record that coincide with the appearance of Martkopi/Bedeni and Trialeti elements at Sos Hoyuk are important for assessing the cultural continuity of the Kura-Araxes throughout the Early and Middle Bronze Ages.

The introduction of *C. sativa* and increase in *P. miliaceum* and *T. dicoccum* during the Middle Bronze Age may reflect the diversification in burial traditions and ceramic repertoire at Sos Höyük in this period. Just as elements of material culture varied with the inclusion of Trialeti and Martkopi/Bedeni features so too did the range of cultivars, but these variations only represent slight changes to the agricultural economy at Sos Höyük. There is considerable continuity in crop taxa through the Late Chalcolithic, Early Bronze Age and the Middle Bronze Age. Martkopi/Bedeni and Trialeti style burials first appear in the Early Bronze III but there is no change in the crop assemblage in this period (see 4.2, Figures 4.13 and 4.15). Similarly, the majority of Middle Bronze I and some Middle Bronze II samples are rich in *T. aestivum* and *H. distichum* rachis internodes as are the earlier samples. The remaining Middle Bronze II samples are richer in *H. distichum* grain and *P. miliaceum* or *T. dicoccum* glume bases. The greater proportion of the *H. distichum* grain suggests a difference in the type of deposit sampled rather than a change in the crops cultivated. When looking at the wild taxa, all of the Middle Bronze I and Middle Bronze II samples have a similar wild taxa composition to the earlier samples and are either rich in *Trifolium/Melilotus/Medicago, Chenopodium* cf. *album or Atriplex* cf. *lasiantha* (see 4.4, Figures 4.20 and4.21). This implies that irrespective of the variation in crop assemblage, the underlying cultivation, crop processing or dung fuel related processes were unchanged in these Middle Bronze Age samples. The archaeobotanical assemblage therefore shows no strong evidence of discontinuity in agricultural practice between the Early and Middle Bronze Ages, supporting the idea of cultural continuity at Sos Höyük throughout the Kura-Araxes period.

While there is overall similarity in the samples, there is a slight variation in crop taxa between the majority of the assemblage and some of the Middle Bronze II samples. The Middle Bronze II can be split into a house phase and final pit phase (Sagona and Sagona 2000). All but one of the Middle Bronze II samples that are rich in *T. aestivum* and *H. distichum* rachis internodes, like earlier samples, are floor samples from the same Kura-Araxes mudbrick building in trench L16c which dates to the initial phase of the Middle Bronze II (Figures 4.15b and 4.16). After this building was abandoned, there was no permanent structure in this area of the mound until the Iron Age (Sagona and Sagona 2000). The remainder of the Middle Bronze II samples, which show minor variation in crop composition, that is a slight increase in *T. dicoccum* glume bases and *P. miliaceum* and the *C. sativa* rich sample, are from the later pit phase which was sealed by a thick plaster surface at the end of the period (Figures 4.13 and 4.15) (Sagona and Sagona 2000). These pits contained considerable quantities of Kura-Araxes 'Late Gritty' ceramics and appeared consistent in material culture with earlier Middle Bronze Age assemblages (Sagona and Sagona 2000). The difference in context type and the lack of architecture in this area of the mound for several hundred years may in part explain the variation between the late Middle Bronze pit phase samples and the rest of the assemblage. These samples may not be composed of the general background mix of archaeobotanical remains present in the majority of samples. The lack of permanent architecture in the excavated area of the mound from the late Middle Bronze II suggests that, unlike the rest of the assemblage, these pits may represent discrete depositional events and thus contain material from various short-term activities. This may partly explain the heterogeneous crop assemblages of the late Middle Bronze II samples.

This pit phase may also have coincided with a period of climatic deterioration. The first half of the second millennium, the Middle Bronze II (2000-1500B.C.), was a period of climatic oscillation, fluctuating between cool summers and warm winters over multi-annual cycles (Fairbridge *et al.* 1997), which could have varied the onset and length of the growing season and made agriculture unpredictable. The Lake Van pollen core in Eastern Anatolia shows a decrease in oak woodland due to drier conditions in the second millennium BC, primarily through a reduction in the spring rainfall (Wick *et al.* 2003). Pollen cores from two lakes on the Tsalka Plateau in southern Georgia, at an equivalent altitude to the Pasinler Valley, indicate that there was a climatic cooling towards the mid second millennium which led to the replacement of open oak woodlands by open coniferous woodlands (Connor and Sagona 2007). A climatic cooling in high altitude regions, like the Pasinler Valley, would have lowered the snowline and shortened the growing season which would have negatively impacted on agricultural productivity (Newton 2004). Thus the increased crop diversity of the late Middle Bronze II pit phase may also have been a response to increased agricultural risk within the Kura-Araxes plant economy, necessitating the cultivation of a broader crop selection including *T. dicoccum* and *P. miliaceum* together with *T. aestivum* and *H. distichum*.

Apart from these slight variations in the pit phase, there was considerable compositional uniformity between the Late Chalcolithic to early Middle Bronze II samples at Sos Höyük. Martkopi, Bedeni and Trialeti influences first appeared at Sos Höyük in the Early Bronze III and continued into the Middle Bronze Age. No marked change in the archaeobotanical sample composition coincided with the inclusion of Kurgan Culture material at Sos Höyük, suggesting that there was little alteration in agricultural practice at this time. The slight increase in *T. dicoccum* and *P. miliaceum* in the late Middle Bronze II may have been due to changes in depositional contexts or fluctuations in climate. The archaeobotanical evidence supports the interpretation that there was cultural continuity during the Kura-Araxes period at Sos Höyük.

4.9 Summary

Throughout the Kura-Araxes period at Sos Höyük, from the Late Chalcolithic to Middle Bronze Age, *T. aestivum,* bread wheat, and *H. distichum,* 2-row barley, were the main crops cultivated. There is little evidence of pulse cultivation at Sos Höyük. The agricultural economy varied little over this period although in the Middle Bronze Age the crop spectrum was more diverse and included *C. sativa*, an oil plant, and possibly *P. miliaceum*, broomcorn millet. The remnants of dung cake fuel were ubiquitous throughout the assemblage. Dung fuel was probably burnt as a supplement to wood fuel and perhaps as a winter fuel source when access to wood supplies was restricted by snow. Occupation of the site appears to have been permanent throughout the year, with cereal crops either sown in the autumn and harvested in summer or sown in the spring and harvested in the autumn. The dominance of free threshing cereal chaff throughout the sequence indicates that crops were most likely cultivated locally to the site. Sos Höyük appears to have been a settled mixed farming community with an integrated agro-pastoral economy that may have minimised agricultural risk in the harsh highland environment.

The next two chapters examine the agricultural economies of Kura-Araxes sites, including Sos Höyük, in the context of Near Eastern archaeobotanical assemblages from the Chalcolithic to Middle Bronze Age.

Chapter 5: Near Eastern Archaeobotanical Assemblages (6100-1500B.C.) Results of Analyses by Phase and Regional grouping.

This chapter presents the results of the comparative analysis of Kura-Araxes and other Near Eastern sites from 6100-1500B.C.. The first section presents phase-by -phase and region-by-region correspondence analyses of crop items in samples from Kura-Araxes and other Near Eastern sites. Maps showing site pulse and cereal composition are included in the phase-by-phase results sections. The phase-by-phase analysis enables geographic variation within each phase to be explored and the region-by-region analysis enables chronological patterns to be investigated within each region. The second section presents distribution maps by phase of grape ubiquity at sites and indicates the type of grape remains present at each site. The phase and regional groupings are explained in section 3.2.4.1. The abbreviations used for each site are listed in Table 3.6.

5.1 Phase and regional analysis of crop composition for Near Eastern Archaeobotanical Assemblages.

The crop component of the archaeobotanical samples from each phase and region were analysed using correspondence analysis, performed by CANOCO, as described in Chapter 3 (see 3.1.6.1). Crop items included in the analyses and their codes were *Hordeum* grain (HordGR), *Hordeum* rachis internodes (HordIN), glume wheat grains (GLWGR), glume wheat glume bases (GLWGL), free threshing wheat grain (FTWGR), free threshing wheat rachises (FTWRA), seeds of *Lens* (Lens), *Pisum* (Pisum), *Lathyrus* (Lath), *Cicer* (Cicer), *Vicia ervilia* (Vicia E), *Vicia faba* (ViciaF) and cereal culm nodes and bases (Culm). Subsets of these items were used in analyses when necessary to explore variation in species composition that was not apparent in the analysis of all crop items. Several thresholds for sample size were tried during the initial data analyses and the correspondence plots changed little whether the minimum threshold was set at 30 or 100 items. A minimum threshold of 30 items was used for the analyses presented here since it enabled more samples and sites to be included in the analyses than a higher threshold.

Samples were coded by cultural grouping, site, site altitude, site modern annual rainfall level, free threshing wheat type and region in the phase-by-phase analyses or phase in the region-by region analyses. Information used for coding the samples is detailed in section 3.2.4.2 and included in Table 3.6. Not every region was subject to an in-depth investigation by correspondence analysis. Only the regions in which Kura-Araxes samples were present (Southern Caucasus, Upper Euphrates and Tigris, and the Southern Levant) or the regions in between these zones (Middle Euphrates, Khabur and Amuq-Orontes) were analysed. Analyses of these regions are discussed in order from north to south beginning with the Southern Caucasus and concluding with the Southern Levant. Samples and species from the same analysis are plotted separately for clarity. Unless otherwise indicated, the first axis is plotted horizontally and the second axis vertically.

For each phase, maps with pie charts showing total site pulse and cereal compositions are included as a separate figure. The information is displayed by site cultural affiliation for each phase. Where more than one cultural description is recorded for a site phase, multiple pie charts for the same site are included. A minimum of threshold of 30 cereal items for each site cultural phase is used and no minimum threshold is enforced for the pulse composition of sites.

5.1.1 Phase-by-phase analysis

5.1.1.1 Phase 1 (6100-4300B.C.)

Out of a total of 367 samples in Phase 1, only 174 samples from 22 sites containing 30 or more crop items were used in the analysis. In Figure 5.1, the first axis separates samples with free threshing grains (*Hordeum* and/or *Triticum aestivum/durum*) and the pulses, towards the positive (right) end of the axis, from glume wheat grains which plot slightly positively on the first axis and cereal chaff (glume wheat glumes bases and *Hordeum* rachis internodes) and cereal straw (culm nodes and bases), which plot towards the negative (left) end. Samples with pulse seeds (especially *Vicia ervilia*) are separated, towards the positive (top) end of the second axis, particularly from samples with glume wheat grains towards the negative (bottom) end of the axis.

When the sample points are coded by broad geographical region (Figure 5.2a), a number of geographic trends are noticeable. The South Caucasian samples are located positively on the first and second axes, as they contain quantities of free threshing cereal grain, with *Lens* seeds in a few samples. Samples from the Upper Euphrates and Tigris are scattered across the plot, and many of these, rich in *Lens* and *Vicia*, are located towards the positive end of axis 2. A single pulse-rich (*Vicia* and *Lens*) sample from Central-West Anatolia is also located positively on axis 2. In a plot where sample points are coded by archaeological culture (Figure 5.2b), it is clear that most of the pulse-dominated samples are shown as being from the Halaf culture and plot positively on both axes. Samples from other sites (both Halaf and Ubaid) are located towards the negative ends of either axes due to the relative rarity of pulses in these samples. The Halaf samples that lack pulses, are rich in glume wheat and plot either negatively on the first axis if they are dominated by glume bases or negatively on the second axis if they are rich in grain, irrespective of their geographic region. Most of the Ubaid samples are dominated by glume wheat and plot more negatively on the first axis, while some are rich in *Hordeum* and located in the upper right quadrant towards the positive end of both axes. When the sample points are coded by site (Figure 5.3a), it is apparent that the pulse-rich Upper Euphrates and Tigris Halaf samples that plot positively on both axes are from a single site, Girikihaciyan (GRK). Samples from the site of Tell Sabi Abyah (SAB), where rainfall is low (Figure 5.3), are rich in glume wheat grain and glume bases with very few *Hordeum* grains and plot more negatively on the second axis. Samples from areas where rainfall is high (>400mm) contain a mixture of cereal types and pulse and plot across the axes.

The map with pie charts showing the pulse composition at each site (Figure 5.4) shows that *Lens* is the most widely distributed pulse species and that *Lathyrus* and *V. ervilia* are more common in northern regions and *Pisum* is more common in southern regions of the Near East. In the map showing cereal distribution (Figure 5.5), the regional division is apparent between the Southern Caucasus and the rest of the Near East due to the higher proportion of *Hordeum* and free threshing wheat grains at sites in the Southern Caucasus. Free threshing wheat is also present at Chagar Bazar (CGB) in the Khabur and Tall-e Jari (JAR) in Iran. Glume wheat remains dominate at most sites outside of the Caucasus.

5.1.1.2 Phase 2 (4300-3600B.C.)

Out of the 170 samples in Phase 2, only 79 samples from 12 sites had more than 30 crop items. In Figure 5.6, the first axis separates samples with *Hordeum* rachis internodes and culm nodes/bases towards the positive end of the axis from samples rich in glume wheat (glumes bases and grain), *Hordeum* grain, free threshing wheat grains and pulses that plot more negatively on the first axis. Samples with free threshing wheat grain and glume wheat grain plot together and are the most negatively placed on the first axis. Only samples dominated by glume wheat glume bases plot positively on the second axis, whereas those samples rich in either *Hordeum* grain or rachis internodes are located towards the negative end of this axis.

Samples from the Southern Levant (Figure 5.7a), represented by the single site of Shiqmim (SQM) (Figure 5.8a), are located positively on the first axis due to their high proportion of *Hordeum* rachis internodes. Those from the Khabur plot towards the negative end of the first axis but are more positively placed on the second axis because of their glume wheat glume base composition, whereas samples from Iran-South Mesopotamia are mostly negatively located on both axes due to their higher wheat grain content. Middle Euphrates and Upper Euphrates and Tigris samples plot negatively on the first axis, although those from the Middle Euphrates are more positively placed due to their higher *Hordeum* grain content compared with the Upper Euphrates and Tigris samples which have a higher glume and free threshing wheat grain content. Samples from both these regions are distributed along the second axis; some samples plot positively on the second axis due to their high proportion of glume wheat glumes while others plot negatively because of their higher proportions of wheat and *Hordeum* grain. When highlighted by cultural group (Figure 5.7b), it is apparent that Ubaid samples either plot positively on both axes if they are dominated by glume wheat glume bases plot or negatively on the second axis if they are rich in *Hordeum* grains. Similarly, Uruk samples nearly all plot negatively on the first axis and plot positively on the second axis due to a mixing of glume wheat glume bases and *Hordeum* grain. Using modern annual rainfall averages to code samples (Figure 5.8b), samples from sites receiving less than 250mm of precipitation each year plot positively on the first axis and are dominated by glume wheat glume bases or *Hordeum* (rachis internodes or grains).

The map of pulse distribution (Figure 5.9) shows that *V. ervilia* is mostly found at sites in the Upper Euphrates and Tigris and that *Lens* is the most widespread pulse. The map of cereal distribution (Figure 5.10) shows that glume wheat is the dominant cereal at most sites, apart from Shiqmim (SQM) and Tell el’Oueili (OUE) where *Hordeum* dominated. Small amounts of free threshing wheat are present in sites from the Upper Euphrates and Tigris but these sites are primarily glume wheat rich.

5.1.1.3 Phase 3. (3600-3000B.C.)

Out of the original 605 Phase 3 samples, only 275 samples from 33 sites contained 30 or more crop remains. In Figure 5.11, samples containing *Lens, Vicia faba* or *Cicer* plot strongly towards the positive end of the first axis. C*icer*-rich samples, which plot positively on the second axis, are separated from samples dominated by *Lens* that plot negatively on this axis. Cereal-rich samples cluster near to the origin of the plot.

When coded by geographical region and site (Figures 5.12a and 5.13), it is apparent that the two *Cicer*-rich samples that are strongly positive on both axes are from Tel Beth Shean (TBS) in the Southern Levant. The majority of *Lens* dominated samples, which are positively placed on the first axis, are culturally Uruk (Figure 5.12b), although some Uruk samples also cluster near the origin because they are rich in cereal items. The relationship between high *Lens* content and Uruk samples is based on samples from several different sites in the Iran-South Mesopotamia and the Khabur regions (Tell Brak (TBK), Godin Tepe (GDT), Sarafabad (SFB) and Tell Karrana 3 (KAR)) (Figures 5.12 and 5.13).

Virtually all of the sample variation on the first axis is due to pulse content. By removing the pulses from the analysis, the differences in sample cereal content can be examined. Of the 275 samples included in the total crop analysis, 266 samples contained more than 30 cereal items and were retained for this analysis. In Figure 5.14, samples dominated by cereal chaff (glume wheat glume bases, *Hordeum* and free threshing wheat rachis internodes) are located positively on the first axis whereas those rich in *Hordeum* and glume wheat grain are negatively placed. On the second axis, samples with a high proportion of free threshing wheat rachis internodes are located towards the positive end. Samples with high amounts of *Hordeum* grain and those containing *Hordeum* rachis internodes, or culm nodes/bases are located slightly positively on the same axis, while samples rich in glume wheat grain are negatively placed. Samples containing free threshing wheat grains plot along both axes.

On the basis of axes one and two, samples containing free threshing wheat grain plot across both axes, while samples with free threshing rachis internodes are located towards the positive end of axis 2. To investigate the distribution of free threshing wheat grain, the third axis was plotted against the second axis (Figure 5.15). Most samples with free threshing wheat grain and/or rachis internodes plot positively on the second axis and, if grain is present, plot negatively on the third axis, while samples rich in *Hordeum* rachis internodes plot the most positively on the third axis. Samples dominated by *Hordeum* grain or glume wheat glume bases plot near to the origin and samples with glume wheat grains plot negatively on the third axis.

When coded by region and cultural group (Figure 5.16) it is clear that the samples containing free threshing wheat grain and rachis, which are nearly all positive on the second axis, are almost all Southern Caucasian/Kura-Araxes samples (Figure 5.22). Southern Caucasian/Kura-Araxes with a higher proportion of *Hordeum* grain or rachis internodes plot positively on the third axis and those with a greater proportion of free threshing wheat grain plot more negatively on the same axis. Some Southern Caucasian/Kura-Araxes samples plot with the *Hordeum* grain rich samples near to the origin. All these Kura-Araxes grain-rich samples are, however, positioned more positively on axis 2 than other *Hordeum* rich samples due to their free threshing wheat grain content. Three non-Kura-Araxes samples also contain free threshing wheat rachis and so plot together with the Kura-Araxes samples. Most samples from other regions and cultural groups plot near to the origin because they are rich in glume wheat glume bases and *Hordeum* grain. Samples from the Khabur and Southern Levant that are rich in *Hordeum* rachis internodes plot more positively on axis three and samples from the Upper Euphrates and Tigris, Central West Anatolia, and a few samples from the Khabur and Iran-Southern Mesopotamia, plot negatively on both axes because they are rich in glume wheat grains. Uruk samples are mostly dominated by glume wheat glume bases and plot slightly positively on axis three and plot neutrally on the second axis, although they show a mixing of *Hordeum* and glume wheat grain and glume bases.

When coded by site (Figure 5.17a), it is apparent that samples from several Kura-Araxes sites (Sos Höyük (SOS), Chobareti (CHB), Velikent (VLK), and Tsaghkasar (TGK)) are rich in free threshing wheat rachis internodes and grains and plot positively on the second axis and plot more negatively on the third axis with higher proportions of free threshing wheat grain. Coding the samples according to free threshing wheat rachis type (Figure 5.17b), shows that only hexaploid rachis internodes have been identified, all plotting positively on the second axis, and these are from samples of the Kura-Araxes cultural group, at a number of sites in the Southern Caucasus, and two samples from the non-Kura-Araxes site of Tepe Hissar (HIS). No clear pattern emerges when samples are coded by annual rainfall (Figure 5.18a). Samples from both high (>400mm) and low (<200mm) rainfall areas are distributed across the plot and contain free threshing wheat, although samples from low rainfall areas, which are positive on the third axis, are not rich in glume wheat grains despite containing glume wheat glume bases. When coded by site altitude (Figure 5.18b) it is apparent that most free threshing rachis internode rich samples, which plot positively on the second axis and mostly plot negatively on the third axis, are from high altitude sites (>1000m). Samples with free threshing wheat grain are from a wide range of site altitudes; the Kura-Araxes site of Velikent (VLK) is located at less than 150m above sea level and samples from this site, which plot negatively on both axes, are rich in free threshing wheat grain, as are samples from the high altitude (>1000m) Kura-Araxes sites of Sos Höyük (SOS) and Tsaghkasar (TGK) that plot negatively on the third and positively on the second axis.

The map of pulse distribution (Figure 5.19) shows that *Lens* is the most widespread pulse and that *V. ervilia* is more common in northern regions of the Near East during Phase 3. The map of cereal composition (Figure 5.20) shows that, in the Caucasus, where all the sites are from the Kura-Araxes cultural group, free threshing wheat is the dominant wheat type, except at Chobareti (CHB). Free threshing wheat is present in small quantities at other (non-Kura-Araxes) sites in the Near East but is less dominant than glume wheat at all sites except Tepe Hissar (HIS) in Iran. Glume wheat is the most dominant cereal across the Near East.

5.1.1.4 Phase 4 (3000-2700B.C.)

Out of the 422 samples in Phase 4, 216 samples from 30 sites had more than 30 crop items. In Figure 5.21, most variation on axes 1 and 2 is derived from pulse content. Samples dominated by *Pisum* are located towards the positive end of the first axis. On the second axis, samples rich in *V. ervilia* plot strongly towards the positive end of the axis but slightly negatively on the first axis. Samples containing *Lathyrus* plot slightly positively on the first and second axes. The remainder of samples, which are primarily cereal dominated, plot near to the origin.

When highlighted by region (Figure 5.22a), most of the *Pisum, Lathyrus* or *Vicia ervilia* rich samples are revealed to be from Central-West Anatolia. One sample from the Upper Euphrates and Tigris is dominated by *Pisum*. Two Southern Levant samples plot slightly positively on the first axis because they contain small quantities of *Pisum*. The remainder of samples from each region plot near to the origin and are rich in cereal items. Similarly, cultural grouping of samples, in Figure 5.22b, provides no pattern of crop content although one Kura-Araxes sample is rich in *Pisum* seeds.

Most of the variation on the first and second axes is caused by pulse content. To explore variation in the cereal distribution, the analysis was repeated using only cereals. The first axis was dominated by three Yenibademli samples, YNB4, YNB6, and YNB7, which have tens of millions of *Hordeum* and glume wheat grains recorded (not shown). Excluding these samples, the plot becomes more readable (Figure 5.23). Samples dominated by chaff plot more positively on the first axis than grain rich samples. Samples containing free threshing wheat rachis internode are the most positively positioned on the first axis and plot negatively on the second axis together with samples rich in *Hordeum* rachis internodes and culm node/bases. Samples with abundant glume wheat grains plot positively on both axes. Samples containing glume wheat glume bases also plot positively on both axes unless they contain other chaff items. Grain-rich samples composed of *Hordeum* or free threshing wheat tend to be located negatively on the first axis, and positively placed on the second axis if they are wheat-rich, or negatively if they are dominated by *Hordeum* grains.

Because samples containing free threshing wheat grain plot across both the first and second axes, the third axis was plotted (vertical) against the first axis to explore variation due to free threshing wheat content (Figure 5.24). Samples containing free threshing wheat grain plot strongly positively on the third axis and samples containing free threshing wheat rachis internodes also plot positively on the third axis but less strongly. Samples rich in culm node/base and *Hordeum* rachis internode rich samples tend to be more positively placed on the third axis but, if found in combination with glume wheat glume bases, they plot negatively on the this axis. Samples containing *Hordeum* grain, glume wheat grain and glume wheat glume bases all plot negatively on the third axis unless they are in samples with free threshing wheat crop items.

When coded by region (Figure 5.25a), most Southern Caucasian samples plot positively on both axes due to their free threshing wheat rachis internode content. Only two Southern Caucasian samples plot negatively on the first axis because they are rich in free threshing wheat or *Hordeum* grain. Upper Euphrates and Tigris samples are all, except for one, grain rich and therefore plot negatively on axis 1, and are either positively located on the third axis if the samples have free threshing wheat grain, or negatively if the samples are *Hordeum*-dominated. Southern Levantine samples are split into three groups: the first cluster plots positively on both axes because the samples contain free threshing grain, the second plots negatively on both axes due to the samples being solely composed of *Hordeum* grain and the third group is located positively on the first axis and negatively on the third axis since the samples contain high proportions of glume wheat grain and glume bases. Most Khabur samples are positioned positively on the first and negatively on the third axis due to their high glume wheat content. The few Khabur samples that plot slightly positively on the third axis contain free threshing wheat or *Hordeum* rachis internodes but most lack free threshing wheat grain apart from one grain-rich sample. Middle Euphrates samples plot along the first axis and mostly plot negatively on the third axis due to their glume wheat and *Hordeum* grain content, although four samples are more positively placed on the third axis because they contain free threshing wheat grain/rachis internodes. All Iran-Southern Mesopotamian and Central-West Anatolian samples plot along the first axis and negatively on the third axis being composed of glume wheat grain and glume bases and *Hordeum* grain.

Highlighting samples by cultural group (Figure 5.24b), it is apparent that the bulk of samples that plot positively on the third axis, due to their high free threshing wheat content, are from the Kura-Araxes cultural group. This association between Kura-Araxes samples and free threshing wheat was also noticeable in Phase 3, especially for free threshing wheat rachis internodes (*cf*. Figures 5.15 and 5.16b). Kura-Araxes samples plot either positively on the first axis because they contain free threshing wheat rachis internodes or negatively if they are rich in free threshing wheat and/or *Hordeum* grain. This applies to Kura-Araxes samples from all regions in which they are present (Southern Caucasus, Upper Euphrates and Tigris and the Southern Levant). Only one Kura-Araxes sample from the Southern Levant plots negatively on the third axis as it is rich in glume wheat and lacking free threshing wheat. Mixed Kura-Araxes/Local samples plot negatively on both axes and are dominated by *Hordeum* grain. Ninevite V samples, which are from the Khabur, plot along the first axis and negatively on axis 3 because they are mostly rich in glume wheat (grain/chaff) and *Hordeum* grain, apart from a few samples that are positive on the third axis and contain *Hordeum* and free threshing wheat rachis internodes.

Coding samples by archaeological site (Figure 5.26a), shows that samples from the Kura-Araxes sites of Sos Höyük (SOS), Tel Beit Yerah (TBY), Tappeh Gijlar (TPG), Velikent (VLK), Tepecik (TPK), and Taşkun Mevkii (TMK) plot positively on the third axis because of their free threshing wheat content. Non-Kura-Araxes samples from Leilan (LLN), Mezraa Höyük (MZR) and Tell Shiyukh Tahtani (TST) also contain free threshing wheat grain and plot positively on the third axis and so do Tell Kerma (TKM) samples which are rich in free threshing wheat rachis internodes. Most samples from the same site plot together, having similar cereal content, apart from samples from Tel Beit Yerah, Taşkun Mevki, Velikent and Tepecik, all of which are Kura-Araxes sites. Tepecik, Velikent and Taskun Mevkii samples are grain rich and vary in their *Hordeum* and free threshing wheat grain proportions, so are dispersed positively along the third axis. The Tel Beit Yerah samples that contain free threshing wheat grain and plot positively on the third axis are from Kura-Araxes contexts and those that only contain glume wheat grain/chaff and *Hordeum* grains are from non-Kura-Araxes contexts (*cf.* Figure 5.25b). Focusing on the free threshing wheat composition of samples, the type of free threshing wheat rachis internode identified is indicated in Figure 5.26b. Hexaploid rachis internodes were identified at Sos Höyük, (the only Kura-Araxes site at which the two types of free threshing wheat rachis internodes were differentiated) so samples containing hexaploid free threshing wheat rachis internodes plot positively on the third axis with other Kura-Araxes samples rich in (undifferentiated) free threshing wheat (*cf*. Figure 5.25b). Samples with tetraploid rachis internodes tend to plot more negatively on the third axis and are all from non-Kura-Araxes sites (three Khabur sites Leilan, Tell Kerma and Tell 'Atij (TAJ) and one Middle Euphrates site Tell Shiyukh Tahtani (*cf*. Figure 5.25)). . Where differentiated, Kura-Araxes free threshing wheat rachis internodes are hexaploid type (*cf*. Figure 5.25b). All the non-Kura-Araxes samples that plot positively on axis 3 contain tetraploid rachis internodes (where this is known), and hexaploid wheat was found in only one non-Kura-Araxes sample (from Tepe Hissar (HIS)). This again repeats the pattern of Phase 3: in both phases, the Kura-Araxes culture is associated with hexaploid free threshing wheat; other cultural groups are associated with tetraploid wheat (except for the site of Tepe Hissar).

Based on modern annual precipitation levels (Figure 5.27a), it is apparent that free threshing wheat grains and rachises are primarily found in samples from sites that receive more than 250mm of rainfall. Apart from one sample, all samples from areas that receive less than 250mm of annual precipitation plot more negatively on the third axis and are dominated by *Hordeum* and/or glume wheat grain and chaff. Conversely samples from sites with the highest yearly rainfall (>600mm) are composed almost entirely of glume wheat grains and glume bases. When coded by altitude (Figure 5.27b), it is noticeable that high altitude samples (>500m), which are also almost all Kura-Araxes samples, have a greater proportion of free threshing wheat rachis internodes/grains and *Hordeum* grains than lower altitude samples which contain more glume wheat items. This altitudinal pattern applies to all samples apart from samples rich in free threshing wheat grain from Velikent, a Kura-Araxes site which lies close to sea level, and Kura-Araxes samples from Tel Beit Yerah which is situated below sea level (*cf*. Figures 5.25b and 5.26a).

The only sample coding that matches the distribution of samples containing free threshing wheat grain and rachis on the third axis is that of cultural grouping, specifically samples from Kura-Araxes sites (see Figures 5.24 and 5.25b).

The map of pulse distribution (Figure 5.28), shows that *Lens* is the most common pulse taxon, and that *V. faba* is dominant at Yenibademli (YNB) and Arslantepe (ARS). The map of cereal distribution (Figure 5.29) shows that free threshing wheat is present in most Kura-Araxes sites and is the dominant wheat at Velikent (VLK), Sos Höyük (SOS), Taskun Mevkii (TMK) and Tepecik (TPK). At Tel Beit Yerah (TBY) in the Southern Levant Kura-Araxes contexts contain free threshing wheat grain whereas non-Kura-Araxes contexts lack free threshing wheat remains. *Hordeum* appears to be more prevalent in the Upper and Middle Euphrates, Khabur and Iran-Southern Mesopotamia than it was in phase 3 (*cf*. Figure 5.20).

5.1.1.5 Phase 5 (2700-2200B.C.)

Out of 913 samples, only 591 samples from 43 sites contained 30 or more cereal or pulse items. In Figure 5.30, samples with high *Pisum* content are positioned towards the positive end of axis 1. All other samples are negatively placed on the first axis. Samples with a large amount of *V. ervilia* plot strongly negatively on the first axis and samples with a high proportion of *Lathyrus* plot slightly negatively on the same axis. On the second axis, samples dominated by *V. ervilia* plot strongly towards the positive end. Samples that are rich in cereal remains plot near to the origin. When samples are coded by region (Figure 5.31a), some samples from Central-West Anatolia, the Khabur and the Upper Euphrates and Tigris are rich in *Pisum* and plot positively on both axes. Only Central-West Anatolian samples are dominated by *V. ervilia* and plot negatively on the first axis and positively on the second axis. Some Southern Levant and Middle Euphrates samples contain *Pisum* seeds and plot more positively on the first axis, although most are composed of cereal items and plot near the origin. When coded by cultural grouping (Figure 5.31b) no association with a specific cultural group is apparent.

To explore variation in the cereal distribution, the analysis was repeated using only the cereals (and excluding the Yenibademli samples with more than a million cereal items, YNB 4, 6, 7, 8). This reduced the number of samples containing 30 or more items from 591 to 572. In Figure 5.32, samples rich in glume wheat grain and glume bases are the most positively placed on the first axis and most negatively placed on the second axis. Samples containing free threshing wheat grain and rachis internodes, culm nodes/bases and *Hordeum* rachis internodes plot positively on the first axis. Free threshing wheat grain dominated samples also plot strongly towards the positive end of the second axis. Samples with free threshing wheat rachis internodes also plot positively, but less strongly, on the second axis. *Hordeum* grain-rich samples plot slightly negatively on both axes.

When samples are coded by region (Figure 5.33a) several clear patterns emerge. All Southern Caucasian samples plot positively on both axes and are rich in free threshing wheat grain and/or rachis internodes. Upper Euphrates and Tigris samples are split into two groups: 1) grain rich, ranging from *Hordeum* to free threshing wheat dominated,plot towards the positive end of the second axis;2) mixed *Hordeum* and glume wheat grains and chaff which plot positively on the first and negatively on the second axis. Almost all Middle Euphrates and Amuq-Orontes samples plot near to the origin because they are rich in *Hordeum* grain, some with small quantities of glume wheat grain or *Hordeum* rachis internodes. Samples from Central-West Anatolia are rich in glume wheat grains and glumes and plot towards the positive end of the first axis. Most Southern Levantine samples plot positively on the first and negatively on the second axis due to their high proportion of glume wheat glume bases or *Hordeum* grains apart from a small cluster of samples that plots more positively on axis 2 because of their free threshing wheat grain content. Similarly, Khabur samples are rich in *Hordeum* grains and glume wheat glume bases and plot negatively on the second axis, although some isolated samples also contain free threshing wheat grain or rachis internodes and plot positively on the second axis.

When samples are coded by cultural grouping (Figure 5.33b), it is apparent that most Kura-Araxes samples plot positively on the second axis due to their free threshing wheat content or negatively on both axes due to high *Hordeum* grain content. Kura-Araxes samples from the Upper Euphrates and Tigris (see Figure 5.33a) are rich in either free threshing wheat or *Hordeum* grain and lack glume wheat remains (group 1 above), whereas samples from non-Kura-Araxes sites in the Upper Euphrates and Tigris contain glume wheat grains and glume bases and plot positively on the first and negatively on the second axis (group 2 above). Kura-Araxes samples from the Southern Levant are more negatively located on the second axis (nearer to the Mixed Kura-Araxes/Local samples from the same region) because they are rich in glume wheat grains and glume bases, though they also contain free threshing wheat grain. Thus the association of free threshing wheat with the Kura-Araxes culture, noted for Phase 3 and 4, persists into Phase 5. Ninevite V samples plot positively on the first axis, due to the presence of *Hordeum* rachis internodes, culm nodes/bases and/or glume wheat grain and, if they contain free threshing wheat rachis internodes, are also positively placed on the second axis. Akkadian samples are a mix of *Hordeum* grain or rachis internodes with glume wheat glume bases and plot negatively on the second axis.

When coded by site (Figure 5.34a), it is apparent that samples from multiple Kura-Araxes sites (Tappeh Gijlar (TPG), Dilkaya (DKY), Kultepe (KLT), Sos Höyük (SOS), Velikent (VLK), Tel Beit Yerah (TBY), Arslantepe (ARS), Tepecik (TPK), Aşvan Kale (AVK), Korucutepe (KCT)) are rich in free threshing wheat grains and rachis internodes and plot positively on the second axis. For samples where the type of free threshing wheat rachis internodes has been differentiated (Figure 5.34b), those with hexaploid rachis internodes are located positively on both axes and are all from two Kura-Araxes sites (Sos Höyük (SOS) and Dilkaya (DKY)) in the Southern Caucasus, except one non-Kura-Araxes sample (from Qatna (QTN)) in the Amuq-Orontes region (see also 5.34a and Figure 5.33). Samples containing tetraploid free threshing wheat rachis internodes are located more negatively on axis 2, and are all from non-Kura-Araxes sites in the Khabur region (Tell Brak (TBK), Tell Kerma (TKM), Leilan (LLN) and Tell Mozan (TMZ)) and one site in the Amuq-Orontes (Qatna). Samples from Qatna, located near to the origin of the plot, contained proportionally more tetraploid than hexaploid wheat rachis internodes. Again the association of hexaploid free threshing wheat with the Kura-Araxes culture, and tetraploid free threshing wheat with other cultural groups, is largely maintained throughout Phases 3 to 5.

Based on modern annual precipitation levels (Figure 5.35a), samples from sites receiving less than 250mm of precipitation plot negatively on the second axis because they are mostly dominated by *Hordeum* grain or rachis internodes. Four samples from low rainfall areas of the Khabur contain free threshing wheat grain or rachis internodes and plot positively on the second axis. Samples, from locations with higher annual rainfall (more than 300mm) show no compositional patterning and are distributed across the axes. When coded by site altitude (Figure 5.35b), is clear that samples from high altitude (above 1000m), which are all also Kura-Araxes in culture, are all rich in free threshing wheat grain and rachis internodes and plot positively on both axes. Samples from sites at 500-999m above sea level, which includes Upper Euphrates and Tigris as well as Central West Anatolian and Middle Euphrates samples, are split between those that are rich in *Hordeum* and free threshing wheat grain, which plot more positively on the second axis, and those that plot negatively on the second axis because they contain glume wheat grains and glume bases. The bulk of samples from lower altitude

(<500m) sites plot negatively on the second axis because they are rich in *Hordeum* or glume wheat grain and chaff. Samples from Velikent (VLK) and Tel Beit Yerah (TBY), however, both Kura-Araxes sites from low altitudes (<150m to below sea level), contain free threshing wheat grain and plot more positively on the second axis.

A map of site pulse distribution (Figure 5.36) shows that *Lens* was the most common pulse in Phase 5 sites. *Lathyrus* seeds were primarily found at Khabur, Middle Euphrates and Upper Euphrates and Tigris sites. *Cicer* was rare in the archaeobotanical record but present at some Upper Euphrates and Tigris and Southern Levant sites. A map of cereal distribution (Figure 5.37) shows that free threshing wheat was the dominant wheat type at Kura-Araxes sites in the Southern Caucasus and Upper Euphrates. Free threshing wheat was also found in a few Middle Euphrates and Khabur sites and the Kura-Araxes contexts at Tel Beit Yerah in the Southern Levant. *Hordeum* was the most common cereal in the Middle Euphrates and Khabur regions. In the Southern Levant glume wheats were the dominant cereal found.

5.1.1.6 Phase 6 (2200-1500B.C.)

Out of 1126 Phase 6 samples only 545 samples from 36 sites contained 30 or more crop items. In Figure 5.38, samples containing high amounts of *Pisum* are located towards the positive end of axis 1, whereas samples containing *V. faba* plot extremely positively on the second axis and slightly negatively on the first axis. All other samples cluster near to the origin. To investigate pulse variation further the third axis was plotted against the first axis (Figure 5.39). On the third axis samples with *V. ervilia* are located towards the positive end of the axis, and those rich in *V. faba* or *Pisum* are positioned weakly positively on the same axis. Cereal-rich samples plot slightly negatively on the third as well as first axis. With samples coded by region and site (Figure 5.40) it is apparent that the *Pisum* rich samples, which plot towards the positive end of the first axis, are mostly from the Central West Anatolian site of Troy (TRY) and also one sample is from Middle Euphrates Tell-es Sweyhat (SWY). The *V. faba* dominated samples that plot negatively on the first axis are from Tell Ifshar (TIF) in the Southern Levant. Almost all the *V. ervilia* dominated samples are from the Amuq-Orontes region, principally from Tell Qarqur (TQQ) with a few samples from Tell Tayinat (TAY) and these plot positively on the third axis.

Most of the variation on the first three axes was related to pulse content. To explore variation in cereal distribution, the analysis was repeated using only cereal items which reduced the number of samples containing 30 or more cereal items to 499. In Figure 5.41, samples containing glume wheat grains and glume bases are the most positively located on the first axis, those that are grain-dominated plot negatively on the second axis and those with high quantities of glume bases plot slightly positively on the second axis. Samples rich in *Hordeum* grain plot negatively on both axes and samples rich in *Hordeum* rachis internodes plot slightly positively on both axes. Samples rich in free threshing wheat grain and rachis internodes plot strongly towards the positive end of axis 2 but are positioned only slightly positively on the first axis. On the first two axes, samples rich in *Hordeum* rachis internodes and free threshing wheat grain/rachis internodes are clustered together making it difficult to disentangle the cereal composition of samples. By plotting the second (horizontal) and third (vertical) axes (Figure 5.42), wheat items are more clearly separated. Samples rich in glume wheat glume bases are located negatively on the third axis and clearly separated from samples rich in free threshing wheat and glume wheat grains which are located towards the positive end (already distinguished from one another on the second axis). Samples with free threshing rachis internodes are located in an intermediate position on the third axis.

When coded by region (Figure 5.43a), the majority of Khabur samples plot positively on the second axis and are rich in *Hordeum* rachis internodes and culm node/bases. Some Khabur samples also contain glume wheat glumes and plot more negatively on the third axis, whereas others plot more positively since they are *Hordeum* and free threshing wheat grain-rich. Samples from the Middle Euphrates mostly plot slightly negatively on the third axis and plot slightly negatively to more positively on the second axis because they range from being either *Hordeum* grain-rich to being *Hordeum* rachis internode-rich. The few Upper Euphrates and Tigris samples in the analysis are dominated by *Hordeum* or free threshing wheat grains and plot positively on the third axis. Central West Anatolian samples are mostly dominated by glume wheat glume bases and plot negatively on the third axis and slightly positively on the second axis, although five samples from this region are rich in free threshing wheat (grains/chaff) and plot positively on both axes. Amuq–Orontes and Southern Levant samples almost all plot negatively on the second and positively on the third axis due to being composed of either *Hordeum* or glume wheat grains. Most samples from the Southern Caucasus, which are also the only Kura-Araxes samples in this phase (Figure 5.43b), are rich in free threshing wheat and *Hordeum* grains and rachis internodes and plot positively on both axes. A few Southern Caucasian/Kura-Araxes samples plot slightly negatively on the third axis because they also contain glume wheat glume bases. Samples from Hittite contexts are strongly positive on the third axis due to their glume wheat and free threshing wheat grain content and Assyrian samples are positive on both axes because they are rich in free threshing wheat grain. The association between Kura-Araxes samples and free threshing wheat, observed in Phases 3-5, is maintained in Phase 6. In this phase however, a variety of non-Kura-Araxes samples from several regions, particularly the Khabur, and Central-West Anatolia, are also rich in free threshing wheat grains and rachis internodes.

When coded by site, Figure 5.44a, it is apparent that most of the Khabur samples that plot positively on both axes, because they are rich in free threshing wheat grain as well as *Hordeum* grain, are from Tell Mozan (TMZ). The samples from Central-West Anatolia that plot positively on both axes because they are rich in free threshing wheat items are from Kaman Kale Höyük (KKH). The few Amuq-Orontes samples that plot positively on both axes due to having high proportions of free threshing wheat grain are from Tell Tayinat (TAY) or Tell Qarqur (TQQ) and. Conversely, the Khabur samples from Tell Brak (TBK) and Hammam et-Turkman (HET) which are rich in *Hordeum* rachis internodes and in some cases also in glume wheat glume bases, plot positively on the second and negatively on the third axis. Both Kura-Araxes sites, Dilkaya (DKY) and Sos Höyük (SOS), are rich in free threshing wheat and *Hordeum* grain and rachis internodes and plot positively on both axes, apart from the few Sos Höyük samples that contain glume wheat glume bases and plot slightly negatively on the third axis.

When coded by free threshing rachis internodes type (5.44b), it is apparent that, when the rachis internode type was identified, hexaploid rachis internodes are dominant in samples from Kura-Araxes sites in the Southern Caucasus (Sos Höyük (SOS) and Dilkaya (DKY)) and non-Kura-Araxes sites in Iran-South Mesopotamia (Tepe Hissar (HIS)) and Central-West Anatolia (Kaman-Kalehöyük (KKH)). Tetraploid free threshing wheat rachises are predominant in non-Kura-Araxes samples from the Khabur (Leilan (LLN), Tell Mozan (TMZ) and Tell Brak (TBK)) and Amuq-Orontes (Qatna (QTN)). The association between Kura-Araxes sites and hexaploid free threshing wheat, identified in Phases 3-5, is continued in Phase 6. Just as a greater number of non-Kura-Araxes sites are rich in free threshing wheat remains in this phase, two non-Kura-Araxes sites also are predominantly composed of hexaploid free threshing wheat rachis, although the majority of non-Kura-Araxes sites are tetraploid free threshing wheat dominated.

When coded by site modern annual rainfall (Figure 5.45), almost all samples from regions that receive less than 300mm of precipitation a year are dominated by *Hordeum* grain and rachis internode and plot slightly negatively on the third axis and either plot near to the origin if they are grain-rich or more positively on the second axis if they are chaff rich. Samples from sites in rainfall areas that do not follow this trend are from Tell el-Hayyat (HYY) in the

Southern Levant which plots positively on the third axis because the samples are rich in glume wheat and free threshing wheat grain, while some Tell Brak (TBK) samples contain glume wheat glume bases and plot more negatively on the third axis. Most samples with free threshing wheat grains or rachis internodes are from sites that receive more than 300mm of rain and plot positively on both axes. Samples from sites in the highest annual rainfall regions (>600mm) are rich in glume wheat grains and glume bases and plot more negatively on the second axis.

A map of pulse distribution by site (Figure 5.46) shows that *Lathyrus* was most common in the Khabur and Middle Euphrates but that *Lens* was the most common pulse overall. Compared to phase 5, *Vicia ervilia* was present in higher proportions at more sites across the Near East. The map of site cereal composition (Figure 5.47) indicates that *Hordeum* is the most ubiquitous cereal, especially in Middle Euphrates, Khabur and Upper Euphrates and Tigris sites. Glume wheat dominates some Southern Levant and Amuq-Orontes sites. Across the Near East, free threshing wheat is more common in phase 6 than in previous phases. Free threshing wheat is present in all regions and is often present in greater quantities than glume wheat at both Kura-Araxes and non-Kura-Araxes sites.

5.1.1.7 Phase-by-Phase summary

In Phases 1 and 2 most samples are dominated by glume wheat and *Hordeum* remains. Samples from the Southern Caucasus in Phase 1 also contain free threshing wheat grains. In Phase 3 Kura-Araxes samples from the Southern Caucasus are differentiated from non-Kura-Araxes samples in the phase due to their free threshing wheat content. In Phase 4 and 5, Kura-Araxes samples from the Southern Caucasus, Upper Euphrates and Tigris and the Southern Levant contain free threshing wheat grains and rachis internodes which distinguishes these samples from non-Kura- Araxes samples in the same and other regions. At Tel Beit Yerah in particular, the presence of free threshing wheat grain in Kura-Araxes samples separates these samples from non-Kura-Araxes samples at the same site in Phases 4 and 5. Free threshing wheat remains are more plentiful in Phase 6 and found at Kura-Araxes and non-Kura-Araxes sites. In Phase 6 the proportion of glume wheat items decreases and the proportion of *Hordeum* remains increases in samples from sites in the Middle Euphrates and Khabur. Hexaploid free threshing wheat is the only free threshing wheat type identified at Kura-Araxes sites and it is also present at Tepe Hissar in Phases 3, 4 and 6, Qatna in Phase 5 and Kaman

Kalehöyük in Phase 6. Tetraploid free threshing wheat is identified at non-Kura-Araxes sites in Phases 4, 5 and 6. In Phase 3, 4, and 5 free threshing wheat is found at Kura-Araxes sites at altitudes ranging from >1000m to below sea level and at sites with modern annual rainfall greater than 250mm.

5.1.2 Region-by-Region Analysis

5.1.2.1 Southern Caucasus

Out of the 219 samples record for the Southern Caucasus only 107 samples from 14 sites contained 30 or more crop items. In Figure 5.48, samples rich in glume wheat glumes bases plot positively on the first axis and negatively on the second axis. Samples with free threshing wheat rachis internodes, culm nodes/bases and *Hordeum* rachis internodes plot positively on both axes and of these, samples dominated by culm node/base and *Hordeum* rachis internode plot strongly towards the positive end of axis 2. The few samples with glume wheat grain plot positively on the first axis but negatively on the second axis. *Hordeum* grain dominated samples plot negatively on the first axis whereas samples with greater amounts of free threshing wheat grain are more positively positioned on both axes. Samples containing *Lens* plot positively on the first axis. The majority of samples are dominated by *Hordeum* or free threshing wheat grain.

When coded by phase (Figure 5.49a) no clear temporal patterning of crop content emerges, although the Phase 1 samples plotting more negatively on axis 1 because they are rich in *Hordeum* and free threshing wheat grain. Almost all Southern Caucasian samples are from the Kura-Araxes culture and are dominated by free threshing wheat and *Hordeum* items and plot across the axes (Figure 5.49b). The non-Kura-Araxes samples are rich in *Hordeum* and free threshing wheat grains and plot negatively on the first axis and one sample plots positively on both axes because it is *Lens* dominated. When coded by site it is apparent that samples containing glume wheat grain and glume bases that plot positively on axis 1 and negatively on axis 2 are all from Chobareti (CHB), Tappeh Gijlar (TPG), Tsaghkasar (TGK), Aknashen (AKN) and phase 6 Sos Höyük (SOS) (Figure 5.50). Only samples from Sos Höyük and Dilkaya (DKY) plot strongly towards the positive end of both axes because they are rich in *Hordeum* rachis internodes, culm node/bases and free threshing wheat rachis internodes. The majority of samples from other sites are *Hordeum* and free threshing grain rich only and plot near to the origin or slightly negatively on the first axis.

5.1.2.2 Upper Euphrates and Tigris

Out of the 418 Upper Euphrates and Tigris samples that contained crop remains, only 236 samples from 13 sites contain 30 or more crop items. In Figure 5.51, on the first axis, a single *Pisum* dominated sample plots strongly towards the positive end and, on the second axis, a single *Lathyrus* rich sample plots strongly towards the positive end. All other samples cluster near to the origin. To explore more variation in sample content axis 3 was plotted against axis 1 (Figure 5.52) and *Cicer*-rich samples plot toward the positive end of the third axis and cereal rich samples clustered near the origin. When coded by cultural group and site (Figure 5.53) it is apparent that the *Pisum*-rich sample which plots at the positive end of axis 1 is from the Kura-Araxes site of Imamoğlu (IMM) and the *Cicer*-rich samples that plot strongly positive on the third axis are from the Kura-Araxes sites of Arslantepe (ARS) and Korucutepe (KCT). One Halaf sample from Girikihaciyan (GRK) plots positively on the third axis because it is *Cicer*-rich and the *Lathyrus*-rich sample which plots slightly positively on the first axis is from Titriş Höyük.

Variation on the first three axes was due to pulse content so the analysis was repeated including only samples with 30 or more cereal items. In Figure 5.54, samples rich in glume wheat glume bases plot towards the positive end of the first axis and negatively on the second axis, and samples dominated by glume wheat grains plot towards the positive end of axis 2. *Hordeum* grain rich samples are negatively positioned on both axes, and samples with high amounts of free threshing wheat grains plot towards the positive end of axis 2 and plot slightly negatively on the first axis. To separate samples that plot positively on the second axis, because they are rich in either glume wheat or free threshing wheat grains, the fourth axis was plotted against the first axis (Figure 5.55)[9]. Samples rich in free threshing wheat grain plot strongly towards the positive end of axis 4, as does a single sample rich in *Hordeum* rachis internodes. Glume wheat grain-rich samples plot negatively on the same axis, so the fourth axis separated the grain of these two wheat types more clearly than either axis 1 or 2.

When coded by phase (Figure 5.56a), it is apparent that phase 4 and younger samples are rich in free threshing wheat grain, (plotting towards the positive end of the fourth axis) and/or *Hordeum* grain (plotting towards the negative end of the first axis). Phase 1 samples are rich in glume wheat grain or glume bases (plotting towards the positive end of axis 1 and negative end of axis 4) though some are rich in *Hordeum* grain (plotting towards the negative

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[9] Plotting axis 3 against axis 1 (not shown), one sample, TPK1, plots strongly towards the positive end of the third axis (due to a high proportion of *Hordeum* rachis internodes) which reduces the rest of the samples to a tight cluster around the origin.

end of axis 1). Phase 2 and 3 samples also plot towards the negative end of axis 4 or in a neutral position and many are of mixed composition. When coded by cultural grouping (Figure 5.56b), it is clear that the Kura-Araxes samples all plot towards the positive end of axis 4, and are dominated by free threshing wheat grains, or to the negative end of axis 1, and are dominated by *Hordeum* grain, or contain a mixture of these two taxa and plot along the fourth axis. Mixed Kura-Araxes/local samples plot negatively on both axes and are dominated by *Hordeum* grain. Ubaid samples plot towards the negative end of axis 1 and are rich in glume wheat grain or chaff or *Hordeum* grain. Halaf samples plot towards the positive end of axis 1 and are dominated by glume wheat glume bases. The only samples younger than Phase 4 that are rich in glume wheat grain and plot negatively on both axes are from the non-Kura-Araxes sites of Titriş Höyük (TTS) and Kurban Höyük (KBH) (Figure 5.57) in Phase 5. The association between Kura-Araxes sites and free threshing wheat, noticed in the phase-by-phase analyses, is clear in the Upper Euphrates and Tigris region; only samples from Kura-Araxes sites are rich in free threshing wheat and *Hordeum* grain while contemporary non-Kura-Araxes sites (Titris Höyük and Kurban Höyük) are rich in glume wheat and *Hordeum* grain.

5.1.2.3 Middle Euphrates

Out of the 326 Middle Euphrates samples, only 197 samples from 17 sites have 30 or more crop items. In Figure 5.58, samples with high amounts of *Lathyrus* plot towards the positive end of the first axis and slightly negatively on the second axis. Variation on the first axis was due to *Lathyrus* content so plotting the third axis against the second (Figure 5.59) revealed variation due to cereal content. Samples rich in glume wheat grain plot positively on the second axis and negatively on the third. Samples rich in glume wheat glume bases plot positively on both axes. Many samples cluster near the origin of the axes and are rich in *Hordeum* grain and rachis internodes. Samples dominated by *Hordeum* rachis internodes plot slightly more positively than grain on the third axis. The few samples with free threshing wheat rachises plot slightly positively on both axes. *Lathyrus* rich samples are negative on both axes.

When coded by phase (Figure 5.60a), all of the samples rich in glume wheat remains are from phases 1 to 5 and plot strongly positively on the second axis and along the third axis (positively if they are rich in glume bases and negatively if they are rich in grains). Almost all Phase 5-6 and Phase 6 samples are *Hordeum* grain and rachis internode dominated and plot near to the origin. Two phase 6 samples are rich in free threshing wheat grain and also plot with the *Hordeum*-rich cluster near to the origin of the axes. *Lathyrus*-rich samples that plot negatively on both axes are also from Phase 6. The major cultural groups are poorly represented in the Middle Euphrates so samples were not coded by cultural affiliation. Similarly, coding samples by site did not correlate to variation in the sample crop distribution and so is not illustrated here.

When coded by modern annual rainfall (Figure 5.60b) it is apparent that almost all samples from sites in low modern annual rainfall areas (<300mm) are rich in *Hordeum* grain and rachis internode and plot near to the origin. Samples from sites that receive more than 300mm of annual rainfall are richer in glume wheat glume bases and grain and plot away from the origin towards the positive end of the second axis and along the third axis. Comparing the plots of samples coded by phase and modern annual rainfall, it is clear that samples from sites in low rainfall areas (<300mm) that are older than Phase 5-6 contain glume wheat and plot more positively on the second axis, samples from sites in low rainfall areas that are from Phase 5-6 or 6 are rich in *Hordeum* grain and rachis internode and plot near to the origin.

5.1.2.4 Khabur

Out of the 694 samples from the Khabur region, 505 samples from 14 sites contained 30 or more crop items. One *Pisum*-rich sample, TBK16, plotted extremely positively on both axes (not shown). With this outlier removed (Figure 5.61), samples containing *Lens* plot strongly positively on the second axis and the remaining samples cluster near to the origin. By plotting the third axis against the first (Figure 5.62) greater variation in crop distribution in visible. The first axis separates samples rich in glume wheat grain and glume bases, which plot towards the positive end of axis 1, from samples rich in free threshing wheat and *Hordeum* (grain/chaff) and *Lens* which plot negatively on the first axis. On the third axis samples rich in free threshing wheat and *Hordeum* rachis internodes plot strongly towards the positive end. *Hordeum* grain-rich samples plot the most negatively on both axes. Most samples with high proportions of free threshing wheat grains or *Lens* plot neutrally on the third axis. Samples dominated by glume wheat grain plot negatively on the third axis and glume wheat glume base samples plot slightly positively on both axes.

When coded by phase (Figure 5.63a), a distinct temporal trend is apparent on the first axis from older samples (towards the positive end), rich in glume wheat grains and glume bases, to younger samples (towards the negative end), rich in *Hordeum* rachis internodes and grains (or in some cases free threshing wheat grain and rachis internodes). Cultural affiliation of the samples reflects the phase distribution of the sites and so is not shown. When coded by site (Figure 5.63b) it is apparent that the amount of *Hordeum* relative to glume wheat increases at Tell Brak (TBK) between Phases 5 and 6, samples plotting more negatively on the first axis over time. Samples from Tell Sabi Abyah (SAB) and Tell Karrana 3 (KAR) plot positively on the first axis because they are glume wheat grain dominated and these are from early phases. Free threshing wheat grain appears mainly in Tell Mozan (TMZ) samples which plot negatively on the first axis. Hammam et-Turkman (HET) samples are rich in *Hordeum* rachis internodes and plot negatively on the first axis and positively on the third.

When coded by site modern annual rainfall (Figure 5.64), samples from sites in low rainfall areas (<300mm) are distributed across the axes and contain the full range of cereal items. However, it is mostly Phase 1 samples from lower rainfall areas that are rich in glume wheat grains (plotting positively on the first axis) and younger samples, from Phase 5 onwards, that are rich in *Hordeum* rachis internodes (plotting negatively on the first axis). This is particularly clear when comparing samples from the sites of Tell Sabi Abyah and Hamman et Turkman. These two sites are four kilometres apart on the banks of the Balikh River (see Figure 3.5 for map), which is in a low annual rainfall region, and yet at Tell Sabi Abyah in Phase 1 glume wheats were dominant (samples plotting positively on axis 1) and at Hamman et Turkman in Phase 5-6 *Hordeum* was the dominant cereal taxon (samples plotting negatively on axis 1). Samples from sites in high annual rainfall areas (>400mm) contain free threshing wheat grain and plot negatively on both axes.

5.1.2.5 Amuq-Orontes

Out of the 334 samples from the Amuq-Orontes region only 163 samples from 12 sites contained 30 or more crop items. In Figure 5.65, samples with *V. ervilia* plot strongly towards the positive end of the first axis and samples rich in cereal items plot at the negative end of the axis. On the second axis samples rich in glume wheat glume bases plot strongly towards the positive end of the axis, samples rich in *Hordeum* and free threshing wheat grains plot negatively and samples with glume wheat grains are located more neutrally. Nearly all the samples that contain *V. ervilia,* plotting positively on axis 1, are phase 6 samples from Tell Tayinat (TAY) and Tell Qarqur (TQQ) (Figure 5.66).

Since variation on the first axis was due to pulse content, the analysis was repeated using only cereal items. In Figure 5.67, samples dominated by glume wheat glume bases plot positively on the first and negatively on the second axis. Samples rich in glume wheat grain plot strongly towards the positive end of the second axis and slightly negatively on the first. *Hordeum* grain rich samples are located negatively on both axes. Samples containing free threshing wheat grain tend to plot slightly negatively on the first axis. In a plot of axis 1 against axis 3 (Figure 5.68), samples rich in free threshing wheat grains and rachis internodes and culm nodes/bases plot strongly towards the positive end of the third axis. When coded by phase (Figure 5.69a), it is apparent that Phase 1 samples plot positively on the first axis and neutrally on the third, because the samples are rich in glume wheat grain and glume bases. *Hordeum* grain dominated samples are from Phase 5 to 6 and plot negatively on both axes. Samples that contain free threshing wheat grain, and plot strongly towards the positive end of the third axis, are from Phases 5-6 and 6. Cultural affiliation of samples does not indicate any pattern in the crop distribution and is not shown. When coded by site (Figure 5.69b) it is noticeable that samples rich in free threshing wheat grain, plotting on the positive end of the third axis, are primarily from Tell Afis (TAF), Tell Tayinat (TAY), Tell Qarqur (TQQ) and Qatna (QTN). Coding samples by site modern annual rainfall (Figure 5.70) shows that samples from sites in high annual rainfall areas plot more positively on the first axis and are rich in glume wheat grains and glume bases. Samples from lower annual rainfall areas, receiving less than 400mm, plot towards the negative end of axis 1 because they are rich in *Hordeum* grain.

5.1.2.6 Southern Levant

Out of the 268 samples from the Southern Levant, only 213 contained 30 or more crop items. In Figure 5.71, samples rich in *V. faba, Cicer* or *Lens* plot positively on the first axis. On the second axis *Hordeum* grain rich samples, and those with free threshing wheat grain, plot towards the positive end and glume wheat grain dominated samples plot negatively, while samples rich in glume wheat bases plot more neutrally on the same axis. When samples are coded by phase (Figure 5.72a), no clear temporal pattern emerges, except that those samples dominated by *V. faba, Cicer* or *Lens*, plotting positively on the first axis, are from Phases 3 to 6. When samples are coded by cultural group (Figure 5.72b), Kura-Araxes and Mixed Kura-Araxes/Local samples plot negatively on the first axis and are not rich in *V. faba, Cicer* or *Lens*.

Since variation on the first axis was due to pulse composition the analysis was repeated and only samples with 30 or more cereal items were included. In Figure 5.73, samples rich in *Hordeum* and free threshing wheat grain plot positively on the first and negatively on the second axis. Samples rich in glume wheat grain plot negatively on both axes. Samples rich in either glume wheat glume bases or *Hordeum* rachis internodes plot positively on the second axis and neutrally on the first axis. By plotting the second against the third axis (Figure 5.74) samples rich in free threshing wheat grain plot strongly towards the positive end of the third axis and samples rich in *Horduem* rachis internodes plot towards the negative end of the same axis. Samples dominated by *Hordeum* and glume wheat grain and glume wheat glume bases are neutral on the third axis.

When coded by phase (Figure 5.75a), there is no clear temporal trend in the sample composition, although samples from Phase 6 tend to be dominated by free threshing wheat and *Hordeum* grain (plotting towards the positive end of axis 3 and negative end of axis 2). When coded by cultural grouping (Figure 5.75b), it is apparent that Kura-Araxes samples plot positively on the third axis due to their free threshing wheat grain content, although they do not contain as high a proportion of free threshing wheat grain as later Phase 6 non-Kura-Araxes samples. The Kura-Araxes samples are from Phase 4-5 at Tel Beit Yerah (TBY) (Figure 5.76a) and because of their free threshing wheat content they plot more positively on the third axis than the non-Kura-Araxes samples from the same site which are rich in glume wheat grains and glume bases and lack free threshing wheat grain. As noticed in the phase-by-phase analyses and the Southern Caucasian and Upper Euphrates and Tigris analyses, Kura-Araxes samples contain free threshing wheat, which differentiates Kura-Araxes samples from contemporary non-Kura-Araxes samples in every region where the Kura-Araxes cultural horizon appears. The other samples that contain free threshing wheat grain and plot positively on the third axis are from Phase 6 Tell el-Hayyat (HYY) and Phase 6 and 3 Tel Beth Shean (TBS). Samples from mixed Kura-Araxes and local contexts at Megiddo (MGD) are rich in glume wheat glumes and grains and plot with other non-Kura-Araxes samples from the site more neutrally on the third axis.

When coded by modern annual rainfall (Figure 5.76b), it is clear that samples from sites in low annual rainfall areas (<250mm) plot negatively on the third axis and are rich in *Hordeum* rachis internodes and grain or glume wheat glume bases. These samples from sites in low rainfall areas include samples from Phases 2 to Phases 5-6 and do not appear to follow the same chronological pattern as seen with samples from low rainfall areas in the Middle Euphrates and Khabur. Samples from sites in high annual rainfall areas (>300mm), plot positively on the third axis and are rich in free threshing wheat, *Hordeum* and glume wheat grain and glume wheat glume bases.

5.1.2.7 Region-by-region summary

In the regions of the Southern Caucasus, Upper Euphrates and Tigris and the Southern Levant, Kura-Araxes samples are differentiated from non-Kura-Araxes samples in Phases 3 to 5 due to their free threshing wheat content and/or lack of glume wheat remains. In Phase 6, free threshing wheat items are found in a number of samples from non-Kura-Araxes sites in all regions. In the Middle Euphrates and Khabur, there is a chronological trend affecting sites from low rainfall areas. In these regions, the proportion of glume wheat remains decreases while the proportion of *Hordeum* items increases in samples between Phases 5 and 6.

5.2 Grape distribution and ubiquity.

Grape distribution across the Near East from 6100-1500B.C. is shown by maps of each phase. The ubiquity of grape remains at sites in each phase is indicated by the size of the data point (the larger the point the higher the grape ubiquity in a site phase) and the colour shows what plant parts are recorded in each site phase. Red indicates that only grape seeds were found; orange indicates that grape seed and fruit skin were found; yellow indicates that grape seed and pedicels were present; green indicates that grape seed, fruit skin and pedicels were recorded; and blue indicates that only grape pedicels were found in a site phase. Site abbreviations are listed in Table 3.6. The only site cultural group indicated is site Kura-Araxes affiliation. Particular reference is made to sites where grape seed, fruit skin and pedicels are found together since this has implications for the identification of wine making residues (Margaritis and Jones 2006; Valamoti *et al.* 2007) which will be discussed further in Chapter 6.5.2.

The map of Phase 1 grape distribution (Figure 5.77) shows that grape remains were rare in the Near East during this period and only found at four sites. Grape remains were found at one site in the Southern Caucasus, one in Western Anatolia and two sites in the Amuq-Orontes. When present at sites, grape remains were found in a small proportion of samples and the type of grape remains found was mostly seeds.

The map of Phase 2 grape distribution (Figure 5.78) shows that grape remains were rare in the Near East, being found at only five sites, although, when present at a site, grape remains were more ubiquitous than in Phase 1. At Areni-1 Cave (ARN) in the Southern Caucasus, grape seeds, fruit skins and pedicels were found in more than 25% of samples. Grape seeds were found at one site in the Upper Euphrates and Tigris and in 100% samples at one site in the Middle Euphrates. Grape seeds and pedicels were present in one site in the Middle Euphrates and in 100% of samples at one site in the Amuq-Orontes.

The map of Phase 3 grape distribution (Figure 5.79) shows that grape remains were more widely distributed across the Near East than in Phases 1 and 2. Grape remains were found at 19 sites, six of which are in the Upper Euphrates and Tigris region, five in the Southern Levant, two in the Middle Euphrates, two in the Amuq-Orontes, two in Iran-Southern Mesopotamia and one in Western Anatolia. Grape seeds were present in at least 50% of samples from the Kura-Araxes site of Velikent (VLK) in the Southern Caucasus. Seeds, fruit skins and pedicels were found in 100% of samples from Ras an-Numayra (RAN) and more than 75% of Wadi Fidan 4 (WAD) samples in the Southern Levant.

The map of Phase 4 grape distribution (Figure 5.80) shows that grape remains were found at more sites across the Near East than in previous phases. Grape seeds were the most common plant part found. Grape remains were found at 23 sites, five sites in the Upper Euphrates and Tigris, five sites in the Middle Euphrates, five sites in the Southern Levant, two sites in Western Anatolia, two sites in the Amuq-Orontes, two sites in Iran-Southern Mesopotamia, one site in the Khabur, and one site in the Southern Caucasus. Grape seeds were present at three Kura-Araxes sites and found in least 50% of samples from Velikent, 25% of samples from Taşkun Mevkii (TMK) and 10% of samples at Tepecik (TPK). In Kura-Araxes contexts at Tel Beit Yerah (TBY) grape seeds and pedicels were found in at least 50% of samples.

The map of Phase 5 grape distribution (Figure 5.81) shows that in this phase grape remains were most widely distributed across the Near East, present at 37 sites, and most ubiquitous at sites in the periods studied. Grape remains were found in nine Middle Euphrates sites, eight Southern Levant sites, seven Khabur sites, six Upper Euphrates and Tigris sites, four Amuq-Orontes sites, two Western Anatolia sites and one Iran-Southern Mesopotamian site. Grape seeds, fruit skins and pedicels were present in more than 75% of Kurban Höyük samples, at least 50% of Jerablus Tahtani (JRB) and Qatna (QTN) samples and at least 25% of samples from Ebla (EBL). At Kura-Araxes sites in the Upper Euphrates and Tigris grape seed was found in a high proportion of Korucutepe (KCT) (100%) and Tepecik (75%) samples and in a lesser proportion of Arslantepe (ARS) and Aşvan Kale (AVK) samples. In the Southern Levant, grape seed and pedicel were found in 50% of Kura-Araxes contexts at Tel Beit Yerah.

The map of Phase 6 grape distribution (Figure 5.82), shows that grape remains were found at fewer sites in this phase than in Phase 5. Grape remains were present at 30 sites including nine Middle Euphrates sites, five Amuq-Orontes sites, five Southern Levant sites, four Khabur sites, two Iran-Southern Mesopotamian sites, two Central West Anatolian sites, two Upper Euphrates and Tigris sites and one Southern Caucasian site. Grape seeds, fruit skins and pedicels were present in more than 75% of samples from Qatna. Grape remains were not found at Kura-Araxes sites in this phase.

Phase 5 was the period with the highest amount of sites with grape remains, and grape material was also the most ubiquitous at sites in this phase. Most grape remains were found in the Middle Euphrates region. Kura-Araxes sites primarily contained grape seeds. Only eight sites had evidence for grape seed, fruit skins and pedicels, and only one of these was located in the Southern Caucasus, at Areni-1 Cave, which has possible links to the Kura-Araxes culture horizon (see 2.1).

5.3 Summary

From correspondence analysis of crop taxa by phase and region, and from maps by phase showing the crop composition at each site, it is apparent that there are two clear trends in the data. Over the period examined the amount and prevalence of glume wheat decreases in most regions of the Near East. This decrease in glume wheat is accompanied by an increase in the proportion and frequency of free threshing wheat and *Hordeum*. The increase of these taxa and decline of glume wheat appears to be the result of two different processes. In phases 3-5, the increase in free threshing wheat in the Southern Caucasus, Upper Euphrates and Tigris and the Southern Levant seems more related to the cultural affiliation of samples, particularly the spread of the Kura-Araxes horizon, than any other factor investigated. The shift from glume wheat to *Hordeum* dominance, however, in the Middle Euphrates and Khabur over phases 5 and 6 appears to be potentially linked to annual precipitation levels. Throughout the Chalcolithic to Middle Bronze Age, there is no pattern in the distributionof pulses which seems independent of any classification criteria applied to the assemblage. The next chapter will discuss the two trends identified in cereal agriculture. In particular it will examine the connection between free threshing wheat and the Kura-Araxes agricultural economy and the implications of this association for understanding the Kura-Araxes cultural phenomenon. The relationship between the spread of the Kura-Araxes cultural horizon and evidence for wine making in the Near East will also be discussed in the next chapter.

Chapter 6: Discussion of Near Eastern Archaeobotanical Assemblages (6100-1500B.C.): Kura-Araxes agriculture and its implications

Based on the analysis of Near Eastern crop assemblages described in the previous chapter, two overarching trends are apparent in the data. In the cereal assemblages from the Chalcolithic to the Middle Bronze age, the frequency and proportion of glume wheat grain and chaff in samples decreases in most regions by the end of the periods studied. In some regions, the decline of glume wheat was accompanied by an increase in barley grain and chaff and in other areas by an increase in free threshing wheat remains. In this chapter, it will be argued that this shift, from glume wheat to barley or free threshing wheat, was the result of two different processes: one regional and related to water availability; the other cultural and directly related to the spread of the Kura-Araxes cultural horizon.

As notions of cultural identity are closely tied to cuisine, and more broadly to food consumption and production, the preference for free threshing wheat at Kura-Araxes sites has implications for understanding the nature of the Kura-Araxes phenomenon. In this chapter it will be argued that the predominance of free threshing wheat at Kura-Araxes sites was a culturally specific crop signature and that the Kura-Araxes horizon therefore represented a shared cultural identity. This has ramifications for explaining the expansion of the Kura-Araxes phenomenon across the Near East and suggests that it was the result of gradual migrations of people and ideas.

6.1 Climatic change and barley

In the Middle Euphrates, and Khabur regions from c.2200 B.C. (Phase 6), the proportion of glume wheat found in archaeobotanical assemblages decreases and the proportion of barley remains increases over the period studied (Section 5.1.2.3 and 5.1.2.4). This appears to be a chronological pattern affecting sites in regions of low annual rainfall. This trend has been noted by archaeobotanists working in the region (van Zeist and Bakker-Heeres 1988; Miller 1997c; Van Zeist 2003d; Riehl and Bryson 2007) and it may be related to a climatic aridification around c.2200B.C. (Riehl and Bryson 2007; Deckers and Riehl 2007; Riehl 2008, 2009, 2012). Most of the sites in the Middle Euphrates and Khabur are today; in lands marginal for rain-fed agriculture, receiving between 200-300mm of rainfall per annum (van Zeist and Bakker-Heeres

1988). Climatic deterioration at c.2200B.C., the 4.2K yr BP event, was proposed by H. Weiss as an explanation for the collapse of the Akkadian Empire in Northern Mesopotamia (H. Weiss *et al.* 1993; H. Weiss 1997; H. Weiss and Bradley 2001; H. Weiss 2012). McCorriston and Wiesberg (2002), however, suggest that the decrease in glume wheat glume bases and increase in barley rachis internodes at sites in the Khabur may have been a result of changes in crop storage and processing practices at sites rather than climate change. Van Zeist (2003b) suggested that the increase in barley remains in this period at Hammam et-Turkman may have been due to the expansion of agriculture onto the arid plateau away from the floodplain of the Balikh River.

In the low rainfall regions of northern Syria, barley is the main cereal cultivated today, being well suited to this region due to the timing of early plant growth relative to the period of winter rains (Keatinge *et al.* 1986; Acevedo *et al.* 1991). Barley is a highly drought tolerant crop, more adapted to growing in low water conditions than modern wheats (Arnon 1972; Hadjichristodoulou 1976, 1982). In comparison, einkorn, *T. monococcum*, is a low yielding, drought susceptible glume wheat (Guzy *et al.* 1989; Riehl and Bryson 2007; Khazaei *et al.* 2009) that dramatically decreased in proportion over the Early Bronze Age (Phases 3, 4, and 5) and was extremely rare in the Middle Euphrates and Khabur after c.2200B.C. (Phase 6) possibly due to increased aridity (Riehl and Bryson 2007; Riehl 2009). Emmer, *T. dicoccum*, however, is a drought tolerant glume wheat (Percival 1921; Sairam *et al.* 2001; Konvalina *et al.* 2010) and yet it showed a marked reduction in proportion at low rainfall sites in both the Middle Euphrates and the Khabur Phase 6 (see 5.1.2.3 and 5.1.2.4) coincident with the climatic change at c. 2200B.C.. It may be that glume wheats declined at these sites in the Middle Euphrates and Khabur due to both increasing aridity and/or changes in agricultural processing and production strategies (McCorriston and Wiesberg 2002; Van Zeist 2003b; Riehl 2009).

Evidence for a possible climatic deterioration in the Near East at around c.2200B.C. is suggested by multiple climate proxies, but the temporal resolution of these studies makes identifying a specific aridity event problematic (Finne *et al.* 2011). A sediment core from the Gulf of Oman records a spike in eolian sedimentation at c.2200B.C. which suggests intense Mesopotamian aridity (Cullen *et al.* 2000). In Red Sea cores, the sudden appearance of oxygenated sediments at around 2200B.C. suggests increased evaporation of the Red Sea due to a major dry event in the Near East (Arz *et al.* 2006). Similarly, oxygen isotope levels preserved in speleothems of Soreq Cave, Israel, indicate that there was a long dry trend that peaked 4200-4050 years BP around the time of the suspected 2200B.C. aridity in Northern

Mesopotamia (Bar-Matthews and Ayalon 2011; Bar-Matthews *et al.* 2003). Although a little later, the Lake Van records also show a drop in water levels after c.2000B.C. which may have been related to aridity (Lemcke and Sturm 1997; Wick *et al.* 2003). These climate proxy studies therefore suggest that there may have been a major climatic aridification at c.2200. This could have led to increased cultivation of more drought tolerant cereals, especially barley, in the Middle Euphrates and Khabur at this time (Riehl and Bryson 2007).

In the Middle Euphrates, monocropping of barley may have been a risk minimisation strategy. The mass cultivation of a low yielding but drought tolerant crop, barley, in periods of fluctuating climatic aridity may have been more reliable than the cultivation of a broader range of cereals (Riehl and Bryson 2007; Riehl 2009). In the Khabur, many sites were abandoned in the late third millennium (Phase 6), possibly due to aridity (H. Weiss *et al.* 1993; Marro and Kuzucuoglu 2007; H. Weiss 2012). At the larger sites of Tell Brak, Tell Mozan and Leilan in the Khabur, while the proportions of barley increased in this period (Chapter 5.1.2.4), there were few other indicators of aridity, such as an increase in wild drought tolerant steppe taxa, in the archaeobotanical assemblages (Charles and Bogaard 2001; Riehl and Bryson 2007; Riehl 2010b). Additionally, at Tell Mozan and Leilan, both in a high rainfall zone of the Khabur (>400mm annual precipitation), though barley was still the dominant crop, the proportion of tetraploid free threshing wheat (*T. durum*), a less drought tolerant species than barley (Hadjichristodoulou 1976, 1982; Guzy *et al.* 1989), increased in the assemblage in Phase 6. This suggests that in the Khabur, crop diversification rather than barley monocropping, may have been a response to increased aridity (Riehl 2008).

The possible extent and effect of the c.2200B.C. climatic aridity in the rest of the Near East is less detectable than in the Khabur and Middle Euphrates. In high rainfall coastal areas of the Amuq, Southern Levant and Western Anatolia, glume wheats continued to be the main cereal crop after 2200B.C. (Section 5.1.1.6). In the Amuq-Orontes there is some evidence for crop changes after 2200B.C. (Phase 6): sites in areas receiving more than 600mm of annual rainfall cultivated a mix of barley, glume wheat and free threshing wheat, while sites such as Qatna and Ebla in inland areas receiving less than 400mm annual rainfall were more barley dominated (5.1.2.5). Indeed, isotopic analysis of barley grains from third millennium B.C. sites in the Near East indicates that barley grown at Mediterranean coastal sites showed little drought stress whereas barley from sites inland and along the Middle Euphrates and Khabur shows strong aridity signals (Riehl *et al.* 2014). This may indicate that at c.2200B.C., either climatic aridification was localised to the Middle Euphrates, Khabur and inland Amuq-Orontes and/or that sites in high rainfall regions were buffered against a more general climate deterioration in the Near East. Contemporary archaeobotanical data from other low rainfall areas, such as the Dead Sea region in the Southern Levant, is not available to compare with the results from the Middle Euphrates and the Khabur.

6.2 Free threshing wheat and the Kura-Araxes

Across the Near East crop there was a decline in glume wheat over time and a coinciding increase in free threshing wheat dominance. This increase in free threshing wheat through time appears more related to cultural affiliation, that is, the spread of the Kura-Araxes material culture horizon, than any other factor. In Phases 1 and 2 barley and glume wheat were the dominant cereals in the Near East apart from in the Southern Caucasus (see 5.1.1.1 and 5.1.1.2). In Phases 3, 4 and 5, Kura-Araxes contexts are characterised by the presence or dominance of free threshing wheat remains and/or the absence or paucity of glume wheat remains in samples (see 5.1.1.3, 5.1.1.4, 5.1.1.5). This occurs at all sites with Kura-Araxes material culture in the Southern Caucasus, Upper Euphrates and Tigris and the Southern Levant. Moreover, with the expansion of the Kura-Araxes cultural horizon, free threshing wheat became the dominant wheat type at new Kura-Araxes sites in previously glume wheat dominated regions. Kura-Araxes sites are located in a wide variety of environmental and climatic zones, all varying considerably in altitude and modern annual rainfall (see 5.1.1.3, 5.1.1.4, 5.1.1.5), and at each Kura-Araxes site, irrespective of geographic location, the proportion of free threshing wheat increased while the proportion of glume wheats decreased. At non-Kura-Araxes sites outside of the Southern Caucasus, for most of the period studied, glume wheats were the main wheat crop. In Phase 6, however, after the expansion phase of the Kura-Araxes phenomenon, the cultivation of free threshing wheat had become more widespread in the Near East and it was found as the dominant wheat type at some non-Kura-Araxes sites (see 5.1.1.6).

Both Nesbitt and Samuel (1996) and Riehl (2014a) have noticed that in Eastern Anatolia free threshing wheat replaced glume wheat as the dominant wheat type at the beginning of the Early Bronze Age, c.3000B.C., equivalent to Phase 4 of this study. Nesbitt and Samuel (1996, 75) relate this shift in crop choices to a possible increase in social complexity in the Near East during the Early Bronze Age that saw the development of ‘hierarchical societies and market economies’. This, they suggest, required intensified agricultural production which promoted the cultivation of free threshing wheat over glume wheat, since free threshing wheats are higher yielding, more responsive to fertiliser inputs during growth and are easier to process after harvest (Nesbitt and Samuel 1996). However, if the increase in free threshing wheat was part of a broader trend in the Near East towards greater agricultural productivity and social complexity, it could be expected that free threshing wheat dominance would have occurred more generally at sites from the Early Bronze Age onwards (Phase 4) irrespective of cultural affiliation. Moreover, if the development of complex societies was a stimulant for the switch to the cultivation of primarily free threshing wheat, sites which are thought to have signs of developed centralised administrative systems and hierarchical structures, such as Arslantepe in the Late Uruk period (Phase 3) (Frangipane 2010), Tell Brak in Phase 4 (Oates *et al.* 2001) and Titriş Höyük (Matney *et al.* 1999; Algaze *et al.* 2001) and Ebla (Matthiae and Marchetti 2013) in Phase 5, should perhaps show a dominance of free threshing wheat over glume wheat. At these site, however, glume wheats were the dominant wheats found during Phase 3, 4 and 5 (see 5.1.1.3, 5.1.1.4, 5.1.1.5). Instead, it was Kura-Araxes sites that had a preference for free threshing wheat. Kura-Araxes sites appear to have been small villages of agro-pastoralists, which were on average about 5 hectares in size and showed little social differentiation either in architecture, artefactual assemblage or burial types within each site (Summers 2004; Kohl 2007; Rothman 2011; Ristvet *et al.* 2011). These sites do not appear to be indicative of hierarchical societies or centralisation of authority. The increase in free threshing wheat noted by Nesbitt and Samuel (1996) and Riehl (2014a) could therefore have been more related to the spread of the Kura-Araxes culture than changes in social organisation requiring intensified agricultural productivity.

The Kura-Araxes culture is thought to have originated in the region of the Southern Caucasus around the middle of the fourth millennium BC, equivalent to the beginning of Phase 3 as used in this thesis (Sagona 2000; Palumbi 2003; A. T. Smith 2005b; Palumbi 2008; Badalyan 2014; Sagona 2014). In the Southern Caucasus, free threshing wheat was the dominant wheat type at Aknashen, Ovçular Tepe and Kamiltepe during the sixth and fifth millennia (Phase 1 see 5.1.1.1). Free threshing wheat was found at all Kura-Araxes sites in the Southern Caucasus in Phases 3, 4, 5 and 6, and it was the main wheat type at Sos Höyük, Velikent, Aparan-III, Maxta, Tsaghkasar, Kultepe, Gegharot, Haftavan and Dilkaya (see 5.1.2.1). During Phase 3 it was only at Kura-Araxes sites (in this period restricted to the Southern Caucasus) and Tepe Hissar in Iran that free threshing wheat was the dominant wheat type. The high proportion of free threshing wheat grain at Tepe Hissar may relate to its proximity to one of the proposed regions of early *T. aestivum* cultivation which is thought to be around the Caspian Sea and Caucasus (Dvorak *et al.* 1998; Nesbitt 2001) (see 6.3.3 for further discussion on the domestication of hexaploid free threshing wheat). As the Kura-Araxes cultural horizon expanded into new regions so too did the preference for free threshing wheat. In the Upper Euphrates and Tigris prior to the Kura-Araxes expansion, glume wheat was the dominant wheat type found at archaeological sites (See 5.1.1.3 and 5.1.2.2). At each new Kura-Araxes site in this region during Phases 4 and 5, Korucutepe, Tepecik, Aşvan Kale, Taşkun Mevkii, and Arslantepe, free threshing wheat became the dominant wheat type and was accompanied by virtually a complete decline in glume wheats, whereas at non-Kura-Araxes sites, Kurban Höyük and Titriş Höyük, glume wheats remained the main wheat crop (see 5.1.1.4, 5.1.1.5 Figures 5.29 and 5.37). In the Southern Levant free threshing wheat was found in Kura-Araxes contexts at Tel Beit Yerah whereas non-Kura-Araxes contexts at the site and other contemporary Southern Levant sites lacked free threshing wheat remains (see 5.1.2.6). Certain aspects relating to this pattern of free threshing wheat preference at Kura-Araxes sites in the Southern Caucasus, Upper Euphrates and Tigris and the Southern Levant will be discussed in more detail: the presence of glume wheat at two Kura-Araxes Southern Caucasian sites, the changing wheat preferences at Arslantepe and evidence from Tel Beit Yerah.

While free threshing wheat was the dominant wheat at most Kura-Araxes sites in the Southern Caucasus, glume wheat was more abundant than free threshing wheat at Phase 3 Chobareti and Phase 4/5 Tappeh Gijlar (see 5.1.2.1). However, the presence of free threshing wheat in samples from these sites still differentiated them from non-Kura-Araxes sites, and made them more similar to other Kura-Araxes samples in the same phase (see 5.1.1.3 to 5.1.1.5). The high proportion of glume wheat remains found at Chobareti may relate to the heterogeneous nature of the material culture assemblage of the Kura-Araxes phenomenon in its developmental period (Kiguradze and Sagona 2003; Palumbi 2008; Sagona 2014). The core Kura-Araxes cultural package was developed in the highlands of the Southern Caucasus in the mid-fourth millennium B.C. (Phase 3) (Kiguradze and Sagona 2003; Palumbi 2003, 2008; Marro 2011; Sagona 2014). In this formative phase during the mid-fourth millennium B.C., the Kura-Araxes ceramic assemblage in the Caucasus was somewhat heterogeneous. The colour scheme ranged from monochrome, burnished black to the traditional red-black which was introduced from Anatolia and established as the canonical colouring by the end of the millennium (Palumbi 2003; Sagona 2014). At Chobareti, an otherwise typical Kura-Araxes site in the late fourth millennium BC (Phase 3), the bulk of Kura-Araxes ceramics are monochrome rather than the characteristic red-black and there are a couple of Chaff Faced Ware sherds in the assemblage (Kakhiani *et al.* 2013; Sagona 2014). The archaeobotanical assemblage similarly shows variation from the typical Kura-Araxes crop choices. While hexaploid free threshing wheat was cultivated at the site there was a greater proportion of glume wheat remains in the samples than is typical for most Kura-Araxes sites (see 5.1.1.3, Figure 5.17). By the mid fourth millennium B.C., free threshing wheat was the dominant wheat crop at Kura-Araxes sites in Armenia, Nakhichevan and at Sos Höyük (See 5.1.1.3, Figure 5.20). It could be that, just as the ceramic assemblage was being gradually codified over the late fourth millennium, so too were the crop choices of the Kura-Araxes being refined in the highlands of the Southern Caucasus before the expansion of the Kura-Araxes in the early third millennium BC.

Similarly, at Tappeh Gijlar, the prevalence of glume wheat grains may reflect a south eastern or 'Yanik Culture' (Summers 2004) variant of the Kura-Araxes package in Phases 4 and 5 in Iran (see sections 2.4, 5.1.1.4, 5.1.1.5). At Haftavan, near to Tappeh Gijlar, however, free threshing wheat was the dominant wheat type although a small proportion of glume wheat chaff and grains was present (see 5.1.1.5). Only two Kura-Araxes sites from the Iranian region of the Southern Caucasus, Haftavan and Tappeh Gijlar, have published archaeobotanical reports so it is difficult to determine whether the crop assemblage at Tappeh Gijlar was an anomaly or if there was a regional variation in Kura-Araxes crop choices in northwestern Iran. Moreover, both these sites with high proportions of glume wheat remains, Chobareti and Tappeh Gijlar, are represented by few samples (five from Chobareti and two from Tappeh Gijlar) and further archaeobotanical work at Chobareti and at Kul Tepe (Hadishahr), near to Tappeh Gijlar in northwestern Iran (Abedi *et al.* 2014), may clarify the wheat preferences at these sites.[10]

The Upper Euphrates site of Arslantepe deserves particular attention for investigating the spread of the Kura-Araxes cultural horizon. Arslantepe provides a refined sequence of cultural interactions that clearly shows a relationship between the Kura-Araxes and a preference for free threshing wheat at the site. In Phase 3 Arslantepe was part of the Late Uruk cultural sphere and had a highly developed centralised palatial administrative system with monumental public buildings and store rooms (Frangipane 2012b) (see Chapter 2.5). At this time (Arslantepe VIA 3350-3000BC) the crop assemblage was dominated by *Hordeum* and glume wheat (see 5.1.1.3, Figure 5.20). After the destruction of the VIA palace and the

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[10] Currently only five samples from pits at Chobareti have been published (Messager *et al.* 2015). Excavations are continuing at the site and an extensive environmental sampling programme is being conducted. Future archaeobotanical investigations may clarify the relative importance of glume and free threshing wheats at the site since a large amount of grain has been recovered from structure 4 (Sagona 2014). At Kul Tepe (Hadishahr) archaeobotanical samples were taken in the 2010 season but no archaeobotanical report has been published (Abedi *et al.* 2014).

collapse of the Late Uruk society, in Phase 4 the site was initially occupied by people bearing Kura-Araxes cultural material (VIB1) and the later village contained a mix of Syrio-Mesopotamian and Kura-Araxes elements (VIB2). The Royal Tomb, with the elaborate Kura-Araxes and Syro-Mesopotamian grave goods dates to the late VIB1 or VIB2 period (Frangipane 2007/08, 2014). Little archaeobotanical material was found in VIB1, but in VIB2 plentiful charred plant remains were found. In this thesis these VIB2 remains were classified as being mixed Kura-Araxes and local in cultural affiliation because of the combination of Syrio-Mesopotamian and Kura-Araxes material. Samples from VIB2 were dominated by barley and glume wheats (see 5.1.1.4, Figure 5.29). In the following periods, VIC and VID (Phases 5 and 6), all Syrio-Mesopotamian influences were lost and the site appears Kura-Araxes in nature in terms of both settlement structure and ceramic assemblage (Conti and Persiani 1993, 2008). The archaeobotanical assemblage in these periods similarly matches that of other Kura-Araxes sites in the Upper Euphrates and Tigris and Southern Caucasus in Phases 5 and 6 with free threshing wheat as the dominant wheat type. These samples from the VIC Kura-Araxes house (2750-2500B.C., Phase 5) were dominated by barley but also contained free threshing wheat and lacked glume wheat (see 5.1.1.5, Figure 5.37). By period VID[11] at Arslantepe (2500-2000B.C., Phases 5 and 6), free threshing wheat was the main cereal in the assemblage, constituting over 70% of the crop remains (Sadori and Masi 2012). The transition from glume wheat to free threshing wheat preference at Arslantepe corresponds to the increase in dominance of Kura-Araxes material cultural at the site.

The Southern Levant was the southernmost extent of the Kura-Araxes cultural horizon. The Kura-Araxes culture is thought to have first appeared in the Southern Levant at about 2850BC (Phase 4) where it is found at Tel Beit Yerah, Tell Beth Shean and other sites in the north of Israel and Jordan Valley (Batiuk 2005; Greenberg *et al.* 2012) (see 2.7). In this region, the Kura-Araxes ceramic assemblage is termed Khirbet Kerak Ware after the site of Khirbet Kerak (Tel Beit Yerah) where it was first found. At Tel Beit Yerah initial Kura-Araxes occupation may have been contemporary with local habitation of the site, although how long the two groups co-existed at the site is uncertain (Greenberg *et al.* 2014). At virtually all sites in the Southern Levant, glume wheat and *Hordeum* are the dominant cereals, though free threshing wheat grains were present at Tell Beth Shean, Tell el-Hayyat and in Kura-Araxes contexts at Tel Beit Yerah (see 5.1.2.6). Although Tell Beth Shean has extensive layers of Kura-Araxes material culture (Iserlis *et al.* 2012), few Kura-Araxes contexts at the site have been sampled for

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[11] The archaeobotanical data from Arslantepe VID has not yet been published and so could not be incorporated into the analyses used in this thesis. It is summarised in Sadori and Masi (2012).

archaeobotanical remains, the free threshing wheat grains from Tell Beth Shean either pre-date or post-date the Kura-Araxes culture horizon in the Southern Levant, appearing in Phases 3 and 6 (Simchoni *et al.* 2007; Simchoni and Kislev 2012). Similarly at Tell el-Hayyat the free threshing wheat grains from Phase 6 date to after the end of the Kura-Araxes period in the Southern Levant.

Tel Beit Yerah has archaeobotanical samples from Kura-Araxes contexts in Phases 4 and 5 and non-Kura-Araxes contexts in Phases 3, 4 and 5. The Kura-Araxes samples from Tel Beit Yerah were from middens and floor accumulations in the Early Bronze III (Phases 4 and 5) courtyard. Within this courtyard, an abundance of Khirbet Kerak Ware sherds together with typical Kura-Araxes artefacts including andirons and animal figurines were found (Greenberg *et al.* 2014). The Kura-Araxes samples from Tel Beit Yerah in Phases 4 and 5 are rich in glume wheat remains but also contain free threshing wheat grain which differentiated them from the non-Kura-Araxes samples at Tel Beit Yerah (see 5.1.2.6). The non-Kura-Araxes samples from Tel Beit Yerah in Phases 4 and 5, which were contemporary with or just preceded the Kura-Araxes presence at the site, were retrieved from contexts that were dominated by local ceramics and a continuation of the local house style of the Early Bronze II (Phase 3) (Greenberg *et al.* 2012). These samples contained no free threshing wheat grain and are similar in content to other contemporary Southern Levant samples in Phases 4 and 5. At Tel Beit Yerah, although free threshing wheat was not the dominant wheat in Kura-Araxes samples, the proportion of free threshing wheat was enough to distinguish these samples from the non-Kura-Araxes contexts at Tel Beit Yerah and the rest of the Southern Levant and group them with the other Kura-Araxes samples from across the Near East.

One of the difficulties in charting the southern spread of the Kura-Araxes horizon and any associated changes in crop preference is that from the Amuq-Orontes, the key bridge between the Upper Euphrates and Southern Levant, there is no published archaeobotanical material at Early Bronze II/III (Phases 4 and 5) sites with known Kura-Araxes presence. Tell Tayinat and Tell Qarqur both have published archaeobotanical reports from the Early Bronze IV period (Phase 6) which is after the period of Kura-Araxes material culture at these sites (A. Smith 2005a; Batiuk 2005; Capper 2012). Some insight into the potential effect of Kura-Araxes occupation at the sites may therefore be gained from comparing these Phase 6 samples with other sites in the region. Both sites have free threshing wheat in Phase 6, and free threshing wheat is not present in other sites during earlier phases in the Amuq-Orontes region apart from Tell Afis which itself has some Kura-Araxes Red-Black Burnished Ware ceramics in Late

Chalcolithic contexts (Phase 3) (Mazzoni 2000) (see 5.1.1.6 Figure 5.47 and 5.1.2.5). Excavations are ongoing at Tell Tayinat and the immediately post-Kura-Araxes levels had been reached in 2010 (Welton *et al.* 2011), so future archaeobotanical research at the site should provide insight into Kura-Araxes agriculture and crop selection at the site and more broadly in the Amuq-Orontes region.

This preference for free threshing wheat at Kura-Araxes sites can be further refined. There are two types of free threshing wheat, hexaploid and tetraploid. Although the two types of free threshing wheat cannot be reliably distinguished on the basis of grain morphology, rachis internodes can be used to differentiate the hexaploid and tetraploid types following Hillman's criteria (Hillman 2001). At most sites, free threshing wheat rachis internodes were rarely found and, if present, were usually identified as indeterminate hexaploid/tetraploid type, but there were a few sites in the assemblage where the rachis internodes were differentiated. At Kura-Araxes sites, when identified, all free threshing wheat rachis internodes were hexaploid. These were found at Chobareti, Tsaghkasar, Sos Höyük and Dilkaya (see 5.1.1.3 to 5.1.1.6, Figures 5.17, 5.26, 5.34, and 5.44). Large quantities of hexaploid free threshing wheat rachis internodes were also identified at Phase 1 Çatalhöyük (Bogaard *et al.* 2013), Phase 3, 4 and 6 Tepe Hissar and Kaman Kalehöyük in Phase 6. Conversely, at non-Kura-Araxes sites in the Khabur, Middle Euphrates and inland regions of the Amuq-Orontes, including Tell Brak, Leilan, Tell Mozan, Tell Kerma, Qatna and Tell Shiyukh Tahtani, tetraploid free threshing wheat rachis internodes were the main free threshing wheat type in the assemblages in Phases 4, 5, and 6 (see 5.1.1.4 to 5.1.1.6 Figures 5.26, 5.34, 5.44). It could be that in these more arid areas of the Middle Euphrates, Khabur and Amuq-Orontes, tetraploid free threshing wheat, which is better adapted for dry Mediterranean growing conditions, was being cultivated whereas at the Kura-Araxes sites a hexaploid free threshing wheat was grown, which is more productive in cooler continental climates with cold winters and humid summers (Hadjichristodoulou 1982; Van Zeist 2003b; D. Zohary *et al.* 2012, 49).

The prevalence of hexaploid free threshing wheats at Kura-Araxes sites further differentiates the Kura-Araxes archaeobotanical assemblages from contemporary sites in the Near East. This is not to suggest that Kura-Araxes sites were the only sites cultivating hexaploid free threshing wheat in the Near East. As noted above, hexaploid rachis internodes were found at Çatalhöyük, Tepe Hissar and Kaman Kalehöyük. It signifies, however, that at Kura-Araxes sites hexaploid (rather than tetraploid) free threshing wheat was the preferred wheat. The link between the Kura-Araxes and free threshing wheat can therefore be further defined as a preference for hexaploid free threshing wheat.

In summary, free threshing wheat was the dominant wheat type at Kura-Araxes sites in Phase 3 in the Southern Caucasus. During this phase glume wheat was the dominant wheat at non-Kura-Araxes sites throughout most of the Near East. As the Kura-Araxes cultural horizon spread out from the Caucasus in Phases 4 and 5, free threshing wheat became the dominant wheat type at Kura-Araxes sites in the Upper Euphrates and Tigris, a region previously rich in glume wheat. Other sites in the Near East in Phases 4 and 5 were still barley and glume wheat dominated. In the Southern Levant free threshing wheat appeared in Kura-Araxes contexts at Tel Beit Yerah during these phases. After the period of Kura-Araxes expansion in the Near East, free threshing wheat replaces glume wheat as the dominant wheat at several non-Kura-Araxes sites. The Kura-Araxes preference for free threshing wheat appears to have been for hexaploid free threshing wheat, that is a *T. aestivum*-type wheat.

6.3 Kura-Araxes Plant Economy

This section will discuss Kura-Araxes agriculture by firstly considering what crops other than wheat were grown at Kura-Araxes sites and then by exploring possible reasons for the free threshing wheat prevalence at Kura-Araxes sites.

6.3.1 Barley

The main cereal found at Kura-Araxes sites across the Near East was barley. Both two-row barley *(H. distichum*) and six-row barley *(H. vulgare*) were cultivated at Kura-Araxes sites, although two-row barley appears to have been more common. At Sos Höyük, Dilkaya, Korucutepe, Tepecik, Arslantepe, Gegharot and Tel Beit Yerah hulled two-row barley was the main or only type of barley cultivated. It is only at Aparan-III and Tappeh Gijlar that hulled six-row barley has been positively identified, based on the proportion of asymmetric and symmetric grains, as the principal barley crop. At other Kura-Araxes sites, barley grains are listed as hulled but it is not specified whether two-row or six-row barley was present, nor were the few barley rachis internodes found at these sites identified to species. While it appears that two-row barley was the dominant barley species cultivated at Kura-Araxes sites, the taxonomic ambiguity relating to barley grains and rachis internodes in many archaeobotanical reports means that it is uncertain whether a clear preference for a specific type of barley at Kura-Araxes sites can be demonstrated.

6.3.2 Pulses

A limited amount of pulses have been recovered from Kura-Araxes sites. Hovsepyan (2010b, 2014) has noted that few pulses are found at Kura-Araxes sites in the Southern Caucasus which leads him to suggest that Kura-Araxes agriculture was based primarily on cereals with little pulse cultivation. This he places in stark contrast to findings from earlier periods, primarily the Neolithic site of Aknashen, and the post-Kura-Araxes periods, particularly the Iron Age in Armenia, when many different pulse species were cultivated at multiple sites (Hovsepyan and Willcox 2008; Hovsepyan 2014). Nevertheless, occasional seeds of *Lens* cf. *culinaris*, *Lathyrus sativus*, *Pisum sativum* and *Vicia ervilia* have been found at Kura-Araxes sites in the Southern Caucasus (see 5.1.1.3, 5.1.1.4, 5.1.1.5, Figures 5.19, 5.28, and 5.36), and large quantities of *Cicer arietinum* and *P. sativum* have been recovered in Kura-Araxes contexts at Arslantepe, Korucutepe and Imamoğlu in the Upper Euphrates and Tigris (see 5.1.2.2 and Figure 5.52 and 5.65). This suggests that pulses were not absent from the Kura-Araxes crop assemblage, but are just rare in the archaeological record.

The distribution of pulses across the region appears stochastic and was not influenced by cultural affiliation or chronological phase (see 5.1.1). Several sites, including Arslantepe, Imamoğlu, Godin Tepe, Yenibademli and Tell Qarqar, have samples with very rich and virtually pure concentrations of individual pulse species. At these sites pulse-rich samples were found in storage contexts. At Yenibademli hundreds of thousands of pulses were found in storage jars (Oybak Donmez 2005). In a Kura-Araxes building at Arslantepe thousands of *C. arietinum* seeds were found on the floor having spilled from two broken pithoi in a room used for food processing and storage (Sadori *et al.* 2006). Similarly at Tell Qarqar thousands of *V. ervilia* seeds were recovered from five broken jars in room possibly used as a kitchen (A. Smith 2005a). The rarity of pulses at Kura-Araxes sites in the Southern Caucasus may be more related to the scarcity of storage or food processing contexts that have been sampled for archaeobotanical remains than an absence of pulse cultivation in the Kura-Araxes culture. So far, in the Southern Caucasus, only one Kura-Araxes storage jar with charred plant remains has been excavated, sampled and reported but this jar, from Aparan-III, was used for cereal rather than pulse storage (Hovsepyan 2010a). So while cereals predominate in Kura-Araxes archaeobotanical assemblages, Kura-Araxes agriculture does not appear to exclude pulse cultivation.

6.3.3 Free threshing wheat

The reason for the preference for free threshing wheat, unique to the Kura-Araxes in the fourth and third millennia B.C., may be partly due to the geographical origin of hexaploid free threshing wheat and the different physical and nutritional properties of free threshing and glume wheats. Both free threshing and glume wheats have advantages and disadvantages to their cultivation and use which may have contributed to the Kura-Araxes preference for free threshing wheat. These traits may relate to production, exchange and consumption. While we cannot assume that modern wheat varieties accurately reflect the growing conditions, processing requirements and culinary properties of ancient wheats crops, comparison of modern free threshing and glume wheats may provide some insight into the Kura-Araxes preference for free threshing hexaploid wheat.

Free threshing and glume wheats have different environmental requirements and levels of agricultural productivity which may influence the choice of wheat for cultivation. In the modern agricultural economy, free threshing bread (*T. aestivum*) and durum (*T. durum*) wheats are the main cereal crops grown across the world. Today, glume wheats are usually cultivated in marginal environments, particularly in the mountainous regions of Turkey (Karagöz 1996; Ertuğ 2004; Giuliani *et al.* 2009; Filipovic 2012), the Caucasus (Hammer and Khoshbakht 2005; Akhalkatsi *et al.* 2012), Italy (Hammer and Perrino 1984; Perrino *et al.* 1982), northern Spain (Pena-Chocarro 1996), the Balkans, (S. Borojevic 1956; Ohta and Furuta 1993), Morocco (Pena-Chocarro *et al.* 2009) and Ethiopia (D'Andrea and Haile 2002). In these regions glume wheat, particularly landraces of emmer, is cultivated since it is higher yielding than free threshing wheat when grown in poor soils and under adverse climatic conditions (Hammer and Perrino 1984; Perrino *et al.* 1996; Giuliani *et al.* 2009). Emmer is more drought-tolerant than free threshing wheat and of these, tetraploid durum wheat requires less water than hexaploid bread wheat (Guzy *et al.* 1989; Khazaei *et al.* 2009; Konvalina *et al.* 2010). Emmer is also more resistant to powdery mildew and rust than free threshing wheats (Grama and Gerechter-Amitai 1974; Bennett 1984). Nevertheless, free threshing wheats particularly hexaploid species, are more productive of straw and grain than emmer and einkorn are under low stress growing conditions (Percival 1921; Hadjichristodoulou 1982; Konvalina *et al.* 2014). Moreover, field trials have shown that hexaploid free threshing wheat is higher yielding in response to nitrogen input than emmer (Konvalina *et al.* 2012b). Glume wheats, are more susceptible than hexaploid free threshing wheats to lodging with increased nitrogen or rainfall (Troccoli and Codianni 2005; Stehno *et al.* 2010; Marino *et al.* 2011; Konvalina *et al.* 2012a). Cultivation of glume wheat, particularly emmer, is advantageous in poor growing conditions especially with low input agricultural regimes, but free threshing, specifically hexaploid, wheats are higher yielding in stress alleviated environments and are more productive in response to agricultural inputs.

One of the differences between free threshing and glume wheats is that when threshed, free threshing wheats release free grain and chaff whereas the ears of glume wheats break up into spikelets with grain still encased by glumes. The additional step of having to free the grain from the spikelet, dehusking, makes glume wheat processing more labour intensive and time consuming than free threshing wheat processing. The ease of separating the grain from the chaff in free threshing wheat also means that it is easier to transport and less bulky to store grain, as removing the glumes reduces the volume and weight of the threshed product. In large-scale distribution networks, free threshing cereals are advantageous since they can be processed quickly and stored and transported in bulk (M. Jones 1981; Van der Veen and O'Connor 1998). Although making processing and transport easier, the lack of glumes surrounding the grain makes free threshing wheat inherently riskier to cultivate and store. While growing in the field, free threshing wheat is more susceptible to bird and insect predation, and grains are more easily lost in post-harvest transportation (Hillman 1985). Similarly, if stored in spikelets, glumes protect the grain from moisture, fungal and insect damage. The region of Kastamonu, in the mountains of central Anatolia, provides a modern example of the transition from glume wheat to free threshing wheat cultivation prompted in part by processing requirements. Although emmer is better adapted to the poor growing conditions under low input farming in Kastamonu, it is slowly being replaced by free threshing wheats as the mechanisation of grain milling discourages the processing of labour demanding glume wheats (Ertuğ 2004; Giuliani *et al.* 2009; Filipovic 2012).

Crops can also be selected based on issues of consumption, relating to taste and how the grain is used. The Kura-Araxes appear to have cultivated hexaploid free threshing wheat, which, if similar to modern bread wheats, may have been more suited to certain food products than tetraploid durum or emmer wheats. Molecular analysis of emmer grains has shown that they are very similar in starch and protein qualities to durum wheat grains and share comparable culinary properties (De Vita *et al.* 2006). In contrast to both tetraploid free threshing and glume wheats, bread wheat has higher protein and gluten content which is ideal for producing leavened bread (Schofield 1994; Tipples *et al.* 1994). There are hard and soft varieties of bread wheat that are processed differently to be used for either bread making (hard varieties) or baking (soft varieties) (Delcour *et al.* 2010). Starch granules in durum wheat, however, become damaged if the grains are milled into fine flour so durum grains are often ground into a coarse semolina for pasta or bulgur production (Delcour *et al.* 2010). The starches in bread wheat are more viscous in nature and gelatinise at lower temperatures than starches in tetraploid wheats which means bread wheat can be more easily made into a paste or used as thickener (Mohan and Malleshi 2006). The stronger crystalline structure of emmer starches also makes them harder to digest than bread wheat (Mohan and Malleshi 2006). The high viscosity and stickiness of bread wheat starches also makes bread wheat preferred for bread rather than pasta production whereas durum wheat starches are less viscous and better suited for pasta making (Delcour *et al.* 2010; Marti *et al.* 2013). Ethnographic studies in Turkey, however, have recorded emmer, durum and bread wheats being used to make bread, being eaten roasted, crushed and boiled as a porridge or gruel, included as additives in stews and soups, being consumed as bulgur or noodles and also used as animal fodder (Hillman 1984b, 1985; Ertuğ 2004; Giuliani *et al.* 2009).

From an analysis of the Kura-Araxes ceramic assemblage, which is dominated by large communal serving bowls and smaller juglets for individual consumption, it seems that in Kura-Araxes communities liquid foods such as stews or gruels may have been a common part of the diet (Paz 2009). T. C. Wilkinson (2014, 213) has suggested that the Kura-Araxes may have produced a fermented wheat drink which could have been served heated as a mulled beer. In the archaeobotanical assemblage from Sos Höyük, however, there is no evidence for malting of either *T. aestivum* or *H. distichum* grains to support this idea. No germinated embryos have been found at Sos Höyük to indicate that beer was being produced (see Van der Veen 1989; Van Zeist 1991; Stika 1996). Grinding stones and pestles are a common feature of the Kura-Araxes assemblage and are found across the Kura-Araxes horizon at Arlsantepe (Frangipane and Palmieri 1983, 530), Yanik Tepe (Burney 1961b, 148), Godin Tepe (Rothman 2011, 177), Chobareti (Sagona 2014, 38) and Tel Beit Yerah (Greenberg *et al.* 2014, 196-197). At Tel Beit Yerah these stone pestles are only found in Kura-Araxes contexts at the site and are indeed rare at other sites in the Southern Levant during the Early Bronze Age (Greenberg *et al.* 2014). Grinding and pounding of grain may indicate that hexaploid free threshing wheat grains were being ground into flour and prepared as bread or broken into groats to be included as thickeners in gruels or soups. It could be that the Kura-Araxes preference for hexaploid free threshing wheat was due to its taste and cooking qualities as well as its production and transportation properties.

When discussing choices in crop cultivation there is a tendency for certain cereals to be classified as ‘better’, in a form of retrospective agricultural determinism underpinned by the assumption that cereal production would inevitably ‘progress’ to cultivating the crops grown today, in particular *T. aestivum* (e.g. Van der Veen and O'Connor 1998, 130; Cappers and Neef 2012, 408). In the modern industrialised agricultural system *T. aestivum* is the main wheat crop grown across the world. It provides 20% of the calories consumed by humans and is preferred over other cereals for its high cultivation yield and gluten content for cooking and baking (Brenchley *et al.* 2012). In different periods and regions other traits may have been considered more desirable or advantageous for widespread cultivation. Indeed, in Hellenistic Egypt a ‘Syrian wheat’, believed to be a hexaploid free threshing wheat, was introduced for greater productivity by the Ptolemaic rulers but rejected by the local farmers because it did not produce the flat bread, made from durum wheat, that they were used to eating (Crawford 1979; Berlin *et al.* 2003). Preference for specific wheat varieties continues today in the Pasinler Valley where the farmers at Yiğittaşi, modern Sos Höyük, cultivate a local free threshing landrace, Kirik, despite being offered higher yielding free threshing wheats that have been bred to survive the harsh conditions of north eastern Anatolia (Caglar *et al.* 2011a). The local farmers refuse to change their traditional wheat variety because the recommended wheats produce the wrong colour flour, red rather than white, for the making of their village bread which they state tastes differently and are concerned that it will not be purchased by other villagers (Bardsley 2001; Bardsley and Thomas 2005; Caglar *et al.* 2011b). Farmers also prefer Kirik because it is a facultative wheat, it is awnless, so suitable as animal fodder and, since they are used to cultivating Kirik, they trust that it will grow in the harsh mountain conditions of the Pasinler Valley (Bardsley 2001; Bardsley and Thomas 2005). In both these examples, the wheats preferred were the crops that the groups were accustomed to cultivate, chosen on the basis of food production and agricultural reliability. The choice of wheat at Kura-Araxes sites may have similarly been influenced by agronomic familiarity with free threshing hexaploid wheat cultivation.

To investigate the link between the Kura-Araxes and free threshing wheat, consideration must be given to the origins of Kura-Araxes cultural horizon and the distribution of free threshing wheats in the Near East. Free threshing wheats, both hexaploid and tetraploid varieties, were present in the Near East from the Pre-Pottery Neolithic, soon after the domestication of the glume wheats *T. dicoccum* and *T. monoccum* (Nesbitt 2002). The tetraploid wheats, *T. dicoccum* and *T. durum*, contain 28 chromosomes and all share the AABB genetic construction, whereas hexaploid wheats, including *T. aestivum* and *T. spelta*, have 42 chromosomes and all share the AABBDD chromosome constitution (Nesbitt 2001). Tetraploid free threshing *T. durum*-type, is thought to have evolved from *T. dicocccum* and has been identified, by the rachis internode morphology, in 9th millennium B.C. contexts at Tell Aswad, Syria (Van Zeist and Bakker-Heeres 1985) and Aşikli Höyük, Turkey (Van Zeist and de Roller 1995). It had spread outside of the Near East to Central Europe by 4000B.C. (Maier 1996). Hexaploid free threshing wheats have a more complicated origin and are believed to have resulted from the hybridisation of a free threshing tetraploid wheat (AABB) with *Aegilops tauschii* (DD) (Dvorak *et al.* 2012). Based on the modern *Ae. tauschii* distribution, this hybridisation is thought to have occurred around the southern Caspian Sea or into Central Asia, although DNA analysis of the *Ae. tauschii* genome suggests that Armenia and northwest Iran are more likely locations (Dvorak *et al.* 1998; D. Zohary *et al.* 2012).

The earliest known hexaploid free threshing wheat rachis internodes have been identified at Abu Hureyra, Syria and, in Central Anatolia, at Çatal Höyük, Can Hasan III and Cafer Höyük in the 7th millennium B.C. (Nesbitt 2001, 2002; Bogaard et al 2013). Hexaploid free threshing wheat has been identified at third millennium B.C. sites in Central Asia at Anau North, Turkmenistan (Miller 2003), Sarazm, Tajikistan (Spengler and Willcox 2013) and possibly at Tasbas and Begash, Kazakhstan (Spengler *et al.* 2014b). In the Caucasus, both glume and free threshing wheats were identified at several Neolithic sites (Lisitsina and Prischepenko 1977). In general, free threshing wheats seemed to be more common than glume wheats in the Caucasus during the Neolithic, but whether they were tetraploid or hexaploid free threshing wheats is unknown (Nesbitt 2001). By the end of the 5th millennium B.C., free threshing wheat was more common than glume wheat at most sites in the Southern Caucasus (see 5.1.1.1, Figure 5.5). As the Kura-Araxes horizon developed in the 4th millennium, the cereals cultivated in earlier periods may have been incorporated into the cultural package of the Kura-Araxes. When the Kura-Araxes cultural horizon spread out from the Caucasus, a preference for hexaploid free threshing wheat may have been maintained as it was the main wheat in the Caucasus at this time. The dominance of free threshing heaxaploid wheat as a specific crop preference at Kura-Araxes sites, would have implications for interpreting the Kura-Araxes as cultural identity. It could be that at Kura-Araxes sites, free threshing hexaploid wheat was preferred because that was the wheat people were accustomed to eat and cultivate. The next section will explore notions of food, culture and identity in understanding the Kura-Araxes horizon.

6.4 Food, Culture and the Kura-Araxes

The link between Kura-Araxes sites and free threshing wheat has implications for understanding the nature of the Kura-Araxes horizon across the Near East. Since the recognition of a similar ceramic repertoire, characterised by distinctive red-black burnished biconical pots, connecting the Southern Caucausus, Eastern Anatolia, Northern Iran, the Amuq and Southern Levant, researchers have debated what the Kura-Araxes phenomenon represents. This debate has continued into recent scholarship where the Kura-Araxes horizon has been variously attributed to the distribution of a ceramic style either by trade or the spread of itinerant potters (Todd 1973; Akkermans and Schwartz 2003, 229), as being symbolic of a particular economic system adopted by neighbouring groups (Phillip 1999; Palumbi 2010, 2012) or a slow migration and settlement of Kura-Araxes communities in new regions (Rothman 2003, 2005; Batiuk 2005; Greenberg and Goren 2009; Kohl 2009; Sagona 2011, 2014; Greenberg *et al.* 2014; Summers 2014). In particular, Adam T. Smith, writing in 2005 and again in 2009, has questioned how the Kura-Araxes horizon should be interpreted in anthropological or sociological terms (A. T. Smith 2005b, 260; A. T. Smith *et al.* 2009, 26-27). He asks whether the Kura-Araxes package represents a particular 'technique of ceramic production' or 'a people, an ethnicity or a culture' (A. T. Smith *et al.* 2009, 25). This section will discuss the concept of food as material culture and show how the Kura-Araxes preference for free threshing wheat can be interpreted as a crop signature that helps to define the Kura-Araxes as a cultural entity. Food in this instance is defined broadly to encompass all the stages of food provisioning, including the raw ingredients, the by-products of processing and production, the prepared product ready for eating and the leftovers of consumption (Goody 1982, 37-38; Samuel 1999).

6.4.1 Food in anthropology

The importance of food in defining social and cultural identity is a concept enshrined in popular sayings from the French 'Tell me what you eat and I will tell you what you are' to the more widely known German adage 'We are what we eat' (Messer 1984; Parker Pearson 2003). Humans are omnivores, capable of eating a wide range of foods and yet no human group eats everything of potential nutritional value in their local environment (Mennell 2005). What people eat is a complex interplay of food availability, nutritional needs and social and cultural taboos and preferences. Anthropologists and sociologists have long recognised that food is more than a biological necessity (Levi-Strauss 1966; Douglas 1972; Goody 1982, 10-39). What people eat and the way people eat is a symbolic construct that is imbued by meaning relating to gender, ethnicity, social status, age, economy, religion, group memory and taboos (Fischler

1988; Mennell *et al.* 1992; Scholliers 2001b; Mintz and Du Bois 2002). Food preferences are partly determined by the diet developed in childhood which is framed by the cultural, economic and social milieu of the family unit that is embedded in a larger group identity (Mennell 1996, 4-6).

The way food is prepared, consumed and distributed can be used to affirm shared group identity or emphasise differences between groups. Because food is consumed and incorporated into the body, symbolically the properties of the food are likewise assimilated, integrating the eater into the culinary system embodied by the food (Fischler 1988; Meigs 1997). Food can be an integral marker of ethnic identity. In the modern world, different nationalities are often categorised by their national cuisines (Fischler 1988; Scholliers 2001a). For new immigrants, familiar foods are often sought out to provide comfort in an alien world despite the expense or difficulties in finding traditional ingredients and dishes (Matt 2007; Brown *et al.* 2010). In migrant communities, traditional foods can still be an important part of the regular diet even if, over time, the original language passes into disuse, or migrants actively assimilate into the host country (Atkins and Bowler 2001, 274; Choo 2004). Over many generations the consumption of ancestral foods may be gradually lost from the daily diet but they are preserved by culinary traditions on often religiously or socially significant days where there is a desire for an assertion of cultural connectivity and reawakening of collective memory. Conversely it is suggested that what people cultivate influences the psychological and cultural development of their society. Within China, rice growing, which requires communal labour and co-ordinated water management, is thought to promote an interdependent culture while wheat growing communities are more individually independent societies (Talhelm *et al.* 2014). Food studies are therefore crucial for understanding cultural and sociological differences.

6.4.2 Food in archaeology

In archaeology, and more particularly archaeobotany, the focus on food as a form of cultural expression is relatively recent (Gumerman 1997; Hamilakis 1999; Samuel 1999; Palmer and Van der Veen 2002; Parker Pearson 2003; Valamoti 2003; Van der Veen 2003; Livarda 2008; Twiss 2007b, 2012). Traditionally archaeobotany has focused more on the functionality of plant remains as an essential part of human diet (Van Zeist 1992; Behre 2008), as a proxy for agricultural processes (Charles *et al.* 1997; Bogaard 2004) or as an indicator of environmental change (Riehl 2009, 2012). In a different approach archaeobotanical remains have been used to investigate gender in Incan Peru (Hastorf 1991), economic and social status in the Roman world (Bakels and Jacomet 2003; Van der Veen 2007, 2008; Livarda 2011) and colonial interactions in the Americas (Jamieson and Sayre 2010). When investigating ethnic or cultural identities, archaeologists have suggested that food, in terms of how it is prepared, consumed and what is eaten, may be a strong marker of group similarity and difference (Emberling 1997; Meskell 2001; Lucy 2005). The notion of food as 'embodied material culture' in archaeology and archaeobotany is gaining prominence (Dietler 2007, 222; Van der Veen 2008; Livarda 2013). Like pottery and lithics, food is the product of human actions and therefore framed by culturally defined ideas (Mennell 1996; Meigs 1997; Twiss 2007a). Moreover since food is prepared and consumed daily it is the product of a myriad of repetitive unconscious actions and decisions that can reveal deeply embedded cultural traditions. Thus the presence, and often dominance, of free threshing wheat at Kura-Araxes sites from the mid fourth to mid second millennium BC, when other sites were glume wheat dominated, may be interpreted as a food signature that unifies the Kura-Araxes as a cultural group.

Crop remains can provide direct evidence of plant foods through the accidental charring of intended foodstuffs or ingredients or by-products of food processing. Only rarely are uneaten prepared foods, such as desiccated bread loaves in Pharonic Egypt (Samuel 1996) or the Neolithic seed cakes at Jerf el Ahmar (Willcox 2002), preserved in the archaeological record. Archaeobotanists usually deal with the remnants of initial stages of food production. For Levi-Strauss (1966) it was the transformation of the raw to the cooked that made food culturally significant. However, it can be argued that because food is produced and prepared before it is consumed, the cultural and societal parameters influencing culinary choices begin with the initial production of the ingredients, more specifically, the cultivation of crops (cf. E. Anderson 2005, 4; M. Smith 2006). The recognition of different crops being cultivated by different archaeological cultures may therefore emphasise underlying variations in food preference between groups and possible variation in agricultural practices. Food production in farming villages can be extremely conservative and risk averse since, in extreme circumstances, bad choices could ultimately lead to starvation. While quick to adopt cash crops, studies have shown that agricultural communities can be very resistant to varying their staple crops, even rejecting new varieties of cereals that they already cultivate (Bardsley and Thomas 2005; Caglar *et al.* 2011b). Any changes in crop preferences may therefore require strong motivating pressures. When crops are selected within rural economies, the risk of crop failure, yield stability and diversified crop use need to be weighed against the cultural and economic requirements of local culinary practices, demands and tastes.

Archaeobotanically there are a number of examples of cultural preference for specific crops in the Near East and Ancient Egypt. Three examples are presented here: crop choices in Ancient Egypt, Central Anatolia and Israel. In Ancient Egypt, hulled cereals, emmer (*T. dicoccum*) and 6-row barley (*H. vulgare*), were the dominant crops throughout the Pharaonic period from 2900 to 332B.C. (Murray 2000). The continued preference for emmer in Egypt, when neighbouring regions had adopted free threshing wheat as their dominant crop in the early Iron Age (1000B.C.), is interpreted as a cultural choice, possibly dictated by Egyptian dietary preferences, conservative traditional culture and religious requirements (Nesbitt and Samuel 1996; Murray 2000, 213). Indeed Herodotus, writing in the fifth century B.C., recorded that Egyptians regarded emmer as 'the only fit cereal for bread' (cited in Nesbitt and Samuel 1996, 77). It was only after Alexander the Great's conquest of Egypt that free threshing wheat, in this case tetraploid durum wheat, became the dominant wheat type in the Hellenistic period (Cappers and Neef 2012). Historical accounts reveal that the change from emmer to durum wheat was imposed by the ruling Ptolemaic dynasty to increase agricultural productivity and ease grain distribution, but, traditional demand for emmer bread lingered at Egyptian cultic sites for over 150 years after initial Greek occupation (Crawford 1979). Durum wheat remained the dominant wheat in Egypt for over two thousand years and was only replaced by bread wheat in the twentieth century AD as agriculture was industrialised (Cappers and Neef 2012). The evidence for crop cultivation from Ancient Egypt shows preferences for different wheats in Pharonic and Ptolemaic periods that were influenced both by cultural and economic factors.

The appearance of different crops has been associated with episodes of migration in the Near East. At Gordion in Central Anatolia, a discontinuity in architecture accompanied by the introduction of a different ceramic assemblage in the Early Iron Age is thought to mark the arrival of Phrygian migrants, which is attested by later Phrygian inscriptions at the site (Voigt and Henrickson 2000). In this same period there is an increase in einkorn (*T. monococcum*) grains and spikelet forks at Gordion (Miller 2010, 69). Although the exact geographical origin of the Phrygians is uncertain, it is believed that they migrated from the Balkans, possibly Macedonia or Thrace, to central Anatolia in the late second millennium BC (Roller 2011). In both Macedonia and Bulgarian Thrace, einkorn was the dominant glume wheat in the late second millennium BC (Popova 2010, 37-44; Valamoti 2011, 20). The correlation between the prominence of einkorn in the region of probable Phrygian origin and an increase in einkorn cultivation during the period of possible Phrygian arrival at Gordion supports the theory of Phrygian migration and indicates a cultural preference for einkorn.

In Israel, the identification of *Lathyrus* seeds at coastal sites in the Middle Bronze II and Iron Age is thought to show connections to Aegean traders and later migrants (Kislev *et al.* 1993; Mahler-Slasky and Kislev 2010). *L. clymenum* is not native to the Levant and was found in Middle Bronze Age II (1950-1750BC) storage jars at Tel Nami in Israel. This species is known to have been cultivated in the Aegean in this period and there is evidence for contact between the Aegean and the Levant through the presence of an imported Cretan Kamares ceramic and Minoan inspired wares at nearby Tel Hazor (Kislev *et al.* 1993; Dothan *et al.* 2000). This has led archaeobotanists to suggest that the *L. clymenum* finds may represent an exotic import for an Aegean trader or local inhabitant with connections to the Aegean (Kislev *et al.* 1993). The presence of *L. clymenum* at Tel Nami is an isolated find which appears to represent Aegean connections rather than a culturally related dietary preference. In the Iron Age, *L. sativa/cicera* is only found at Philistine sites in the Southern Levant and is similarly thought to be an Aegean introduction (Mahler-Slasky and Kislev 2010; E. Weiss *et al.* 2011; Maeir *et al.* 2013). The Philistines are thought to have migrated from the Aegean to the Southern Levant on the basis of similarities between Philistine and Late Bronze Age Mycenaean ceramics, architecture, feasting deposits, consumption practices and *L. sativa/cicera* cultivation, all of which is very different to neighbouring Canaanite sites, and indicates that the Philistines were culturally distinct from other Levantine groups (Ben-Shlomo *et al.* 2008; Faust and Lev-Tov 2011; Maeir *et al.* 2013). The Near East provides several examples archaeobotanical material culture, where different crops act as distinct agricultural signatures in Pharonic and Ptolemaic Egypt and for the Phrygians and Philistines in the Iron Age.

6.4.3 Defining the Kura-Araxes as a cultural group

The prevalence of free threshing, often hexaploid, wheat at Kura-Araxes sites may be seen as an economic marker for the Kura-Araxes culture. This agricultural signature is distinctive, since the appearance of the Kura-Araxes assemblage together with free threshing wheat occurs in regions that were previously dominated by glume wheat, and contrasts with the crops grown at non-Kura-Araxes sites. As mentioned earlier, choices in staple crops are fundamental to a community’s subsistence strategy and constitute the basic elements of cuisine. The regular occurrence of free threshing wheat at sites with Kura-Araxes material culture is suggestive of a common cultural identity. It may be that the Kura-Araxes continued to cultivate free threshing hexaploid wheat in new regions since this was the wheat they were accustomed to growing and preferred for reasons related to agricultural production, diet, and transportation. This is not to propose that the dominance of free threshing wheat, particularly hexaploid free threshing wheat, at a site can be used on its own to identify a Kura-Araxes site.

At Tepe Hissar in north eastern Iran, free threshing wheat is the dominant wheat type in Phases 3 and 6 (see 5.1.1.3 and 5.1.1.6) but Tepe Hissar is not part of the Kura-Araxes cultural horizon and shows strong cultural connections to Central Asia (Dyson and Howard 1989). Using archaeobotanical data as part of a broader analysis of material culture can help identify shared cultural connections. To apply Douglas' concepts on food more broadly, what distinguishes a culture is 'the patterning of a whole cycle of combinations' (Douglas 1984, 28) rather than one distinctive element in isolation. Identification of cultural connections between sites and the recognition of a shared archaeological culture can only be made by using multiple strands of evidence that reflect different aspects of life.

Based on the consistent features of Kura-Araxes material culture found at Kura-Araxes sites –the presence of characteristic red-black burnished ware, portable andirons, animal figurines, miniaturised wagons, uniform ceramic manufacturing techniques and household spatial arrangement – scholars have suggested that the Kura-Araxes horizon represents a defined cultural group (Kiguradze and Sagona 2003; Sagona 2011, 2014; Greenberg *et al.* 2014; Greenberg 2014). Within the Kura-Araxes assemblage there is a level of heterogeneity, subtle regional variations in ceramic decoration and house building materials, but overall the assemblage shares strong similarities in its core elements (Batiuk 2005; Sagona 2011, 2014). The crop preference for hexaploid free threshing wheat at Kura-Araxes sites is another common feature to unite the Kura-Araxes horizon and supports the identification of the Kura-Araxes phenomenon as a shared culture.

The repetitive spatial arrangement of Kura-Araxes houses, with central hearths and benches, sometimes topped by storage containers, along the back wall, is an especially important criterion that 'is a clear expression of social unity and a conservative building code' across the Kura-Araxes horizon (Sagona 2014, 43). Along with dietary practices, the spatial organisation of houses is reflective of daily activities, framed by deeply held cultural patterns which constitute the parameters of daily life (Meskell 2001; Lucy 2005). Similarly, the consistency of the Kura-Araxes ceramic repertoire from the Caucasus to the Southern Levant shows common food consumption practices. Ceramics, while decorative, are indicative through their form, of the manner in which food is eaten (Braun 1983; Bray 2003; Beaudry 2013). The typical Kura-Araxes ceramic assemblage is composed of large and small bowls which can be interpreted as a mix of large communal serving bowls and smaller dishes for individual consumption of shared meals possibly stews or soups (Paz 2009). In the Southern Levant, in particular, this Kura-Araxes tradition contrasted with the local non-Kura-Araxes communities' serving of possibly less soup-like food on large communal platters (Novacek 2007, 587-591). Petrographic analyses of ceramics from sites in the Caucasus (Hayrapetyan 2008), Iran (Mason and Cooper 1999), Eastern Anatolia (Batiuk 2000; Kibaroglu *et al.* 2011), the Upper Euphrates (M. Schwartz *et al.* 2009), the Amuq (Batiuk 2005) and the Southern Levant (Zuckerman *et al.* 2009; Iserlis 2009; Iserlis *et al.* 2010; Iserlis *et al.* 2012) has shown that pots were produced locally using clays near to each site. Greenberg *et al.* (2012) and Paz (2009) have suggested that the discontinuities in cultural assemblages between Kura-Araxes and pre-existing communities and the consistencies in ceramic manufacturing and uses across the Kura-Araxes horizon indicate the presence of a diaspora community rather than an adoption of foreign styles in new regions. Detailed analyses of ceramic manufacturing techniques using a chaîne opératoire approach has shown that the same intricate burnishing and firing methods were used to make Kura-Araxes wares in the Caucasus as in the Southern Levant, indicating that routine practices were shared across the Kura-Araxes horizon (Iserlis *et al.* 2010; Iserlis *et al.* 2012; Greenberg *et al.* 2014).

Therefore, as well as cultivating free threshing wheat, the Kura-Araxes were consuming their food, organising their household space and manufacturing their ceramics in a consistent manner, in a pattern of shared behaviours that embodies the Kura-Araxes as a cultural entity. The similarities of this Kura-Araxes cultural package over such a broad geographical area indicates that they probably shared a common cultural identity, especially since the core Kura-Araxes features, including the free threshing wheat preference, are maintained over hundreds of years. This would suggest that the expansion of the Kura-Araxes horizon was not the result of a diffusion of ceramic styles or trade but some form of population movement. The nature of this population movement and the possible factors facilitating the expansion of the Kura-Araxes culture will be discussed in the next section.

6.5 Kura-Araxes migration, mobility and economy

The two key questions relating to the Kura-Araxes horizon are what it represents and how it spread (A. T. Smith 2005b). In section 6.4, it was concluded that the Kura-Araxes horizon most likely represents a cultural group based partly on their preference for free threshing wheat. The expansion of the Kura-Araxes culture has been interpreted by many scholars as a gradual migration and resettlement of Kura-Araxes groups across the Near East (Rothman 2003, 2005; Batiuk 2005; Batiuk and Rothman 2007; Kohl 2007, 2009; Paz 2009; Iserlis *et al.* 2010; Sagona 2011, 2014; Greenberg *et al.* 2012; Greenberg *et al.* 2014; Summers 2014). This was not a mass movement of people that resulted in the depopulation of original Kura-Araxes areas, but rather it was an increase in Kura-Araxes presence across the Near East. Migration as an explanation for the Kura-Araxes expansion requires the presence of motivating 'push' and/or 'pull' factors to initiate and maintain a sustained population movement (Anthony 1990; Rothman 2003). This section will examine some of the theories for Kura-Araxes migration in relation to the evidence from the Kura-Araxes archaeobotanical study.

The Kura-Araxes horizon was initially interpreted as a catastrophic invasion of the Levant by northern Anatolians and Transcaucasians who were ancestral to the Hurrians or Hittites (Hood 1951; Amiran 1952; Woolley 1953, 31-37; Burney and Lang 1971, 51). Current models of Kura-Araxes migration are more nuanced and are underpinned by a more holistic understanding of migration theory in archaeology (Anthony 1990; Burmeister 2000; Rothman 2003; Batiuk 2005). Rothman (2003, 99) has described Kura-Araxes migration as like 'ripples in a stream', with multiple waves of movement flowing back and forth along the paths of migration, creating a series of nodes that retain connections and similarities with the hubs they fissioned from along the chain. Palumbi (2009, 2010, 2012) has emphasised the active assimilation of Kura-Araxes material culture, ideas and economic systems by local communities in the wake of the Uruk collapse at the end of the 4th millennium BC. While not diminishing the contribution of population movement in expanding the Kura-Araxes horizon, this theory highlights that 'it was possible to become a Kura-Araxes community and to acquire a Kura-Araxes identity without being either of Kura-Araxes descent or born in the 'homeland'' (Palumbi and Chataigner 2014, 256). Both of Rothman and Palumbi's models stress the importance of transhumant pastoralism to the Kura-Araxes economy and rely on the movement of transhumant Kura-Araxes pastoralists to initiate the migration of people and ideas into new regions. Palumbi in particular sees the adoption of Kura-Araxes culture by the inhabitants of Arslantepe as their integration into the mobile pastoral networks of the Kura-Araxes (Frangipane and Palumbi 2007; Palumbi 2012). Another suggested catalyst for Kura-Araxes migration was the desire of Near Eastern communities for specialist viti-and vinicultural knowledge which the Kura-Araxes could supply (Batiuk 2013). This section will assess the evidence for pastoral transhumance and viticulture within the Kura-Araxes culture and their potential as factors facilitating the Kura-Araxes expansion and conclude the chapter with a discussion of the relationship between the Kura-Araxes expansion and the cultivation of free threshing wheat.

6.5.1 Kura-Araxes and Transhumant Pastoralism.

The Kura-Araxes culture has been characterised as being based on, or at least containing a significant element of transhumant pastoralism. This interpretation was derived from the seemingly transient nature of their architecture and the portability of their material culture (Burney and Lang 1971; Sagona 1984, 1993; Cribb 1991, 220-223; Kushnareva 1997; Shimelmitz 2003; Palumbi 2003; Rothman 2003, 2005; Frangipane and Palumbi 2007; Palumbi 2010; Isikli 2012; Frangipane 2014).[12] The wattle and daub construction of Kura-Araxes houses is thought by some researchers to indicate temporary occupation and the internal arrangement and shape of Kura-Araxes houses is cited as being similar to nomadic tents (Cribb 1991, 222; Sagona 1993; Palumbi 2012). Similarly the portable andirons, hearths and Kura-Araxes ceramics with large lug handles are believed to indicate a mobile lifestyle (Kushnareva 1997; Shimelmitz 2003; Smogorzewska 2004). Transhumance within the Kura-Araxes culture has been assumed partly as an explanatory device because the wide distribution of the Kura-Araxes assemblage across the Near East is thought to require an element of mobility and the categorization of the Kura-Araxes as nomadic pastoralists provides this movement. This argument has been questioned by a re-examination of Kura-Araxes material culture, which has led to other scholars interpreting the Kura-Araxes as settled agro-pastoralists (Kohl 2007; Summers 2004, 2014; A. T. Smith 2005b; Sagona 2011, 2014).

Rothman (2003, 2005, 2011) suggests there was a duality to the Kura-Araxes culture, and that there were distinct communities of mobile pastoralists and settled agriculturalists within Kura-Araxes society. In his model, based on survey data from Muş in Turkey, transhumant Kura-Araxes pastoralists first entered new regions and grazed their flocks on

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[12] Sagona has since revised his opinion and regards the Kura-Araxes as settled agro-pastoralists (Sagona 2011, 2014).

marginal uplands and then the more settled agriculturalists followed and occupied the valley floors (Rothman and Kozbe 1997; Rothman 2003, 2005). Based on ethnographic work with many transhumant groups in the Caucasus and Central Asia, Khazanov (2009, 125) noted that the material culture of seasonal shepherds while they were away with their flocks was very different to the artefacts and architecture found in their permanent home settlements. Furthermore, Khazanov felt that the material culture of seasonal camps and permanent settlements would be so different that is would be difficult to know that they were two elements of the same culture. If Rothman's model of a Kura-Araxes mobile/settled dichotomy is correct then, according to Khazanov's ethnographic work, there should be a marked heterogeneity between Kura-Araxes groups whose lifestyles diverged between transhumant pastoralism and settled agriculture. The Kura-Araxes horizon across the Near East is, however, distinguished by its shared cultural traditions which accommodate variations derived from regional styles and household level production, but do not exhibit large differences which could be the product of a mobile and sedentary economic duality.

Architecture at Kura-Araxes sites was a mix of wattle and daub, mudbrick and stone. The variation in construction materials in part reflects the wide variety of ecological niches the Kura-Araxes inhabited and cannot reliably be used to infer permanence of occupation (Kohl 2009). Often different construction materials and techniques were used at the same site in the same period, as at Sos Höyük (Sagona and Sagona 2000) and Yanik Tepe (Summers 2004, 2014). Kohl (2007, 88) notes that the depth of Kura-Araxes archaeological deposits at many sites in Eastern Anatolia, the Southern Causcasus and Iran is in excess of 10m which is not consistent with temporary occupation events. The portability of Kura-Araxes andirons, hearths and ceramics may also have been over emphasised. While Kura-Araxes ceramics are characterised by wide Nakhichevan lug handles which could be used to attach ropes for carrying, the openness of the vessels and their bulk means they were unlikely to have been useful for transporting goods, although perishable items such as skins and basketry could have been used for this purpose (Piro 2009; T. C. Wilkinson 2014; Summers 2014). Kura-Araxes andirons and hearths appear to be designed for constant movement (Smogorzewska 2004), but they were still heavy and cumbersome for extended journeys. Their mobile nature may have been more related to the reorganisation of household space, moving cooking or heating installations from the interior to the exterior or between houses (Paz 2009; T. C. Wilkinson 2014), than to pastoral transhumance.

Transhumant groups require interaction with urban centres with which to trade their secondary animal products, cheese, milk, wool and hides, in return for agricultural products, particularly grain, and handicrafts (Khazanov 1994, 205; Halstead 1996). During the Kura-Araxes period large settled centres were present at Arslantepe, Godin Tepe and Tel Beit Yerah at the end of the fourth millennium B.C.. In the Late Uruk period at Arslantepe and Godin Tepe, evidence of possible contact with Kura-Araxes groups is shown by the presence of a small amount of Kura-Araxes ceramics in the Late Uruk administrative centres (Frangipane and Palumbi 2007; Rothman and Badler 2011). At each of these sites Kura-Araxes occupation occured after the collapse of the previous system, the Late Uruk at Arslantepe and Godin Tepe and the Early Bronze II urban development at Tel Beit Yerah (Greenberg 2007; Frangipane 2009; Rothman 2011). Moreover, these sites appear to have been abandoned and in the case of Arslantepe and Godin Tepe, partially destroyed, prior to Kura-Araxes settlement. In the Near East, the complex urban centres needed to support full nomadic pastoralism were possibly not present until the second or first millennium B.C. (Sevin 2004; Khazanov 2009; Summers 2014). In the fourth and third millennia B.C. the urban economic framework required to sustain transhumant pastoralism may not have existed, which weakens the argument for Kura-Araxes transhumance (Summers 2014).

Until relatively recently, discussions of the Kura-Araxes economy have all relied on indirect evidence of transhumance and rarely incorporated archaeozoological or archaeobotanical evidence from Kura-Araxes sites. This has partly been because of a lack of environmental studies at Kura-Araxes sites, but recent research has begun to provide the bioarchaeological evidence to inform economic interpretations. Archaeozoological analysis of material from Kura-Araxes sites in the Caucasus and Anatolia has shown that the Kura-Araxes exploited sheep, goats, cattle and pigs (Bokonyi 1983; Howell-Meurs 2001a, 2001b; Monahan 2007; Piro 2009; Bartosiewicz 2010; Rova *et al.* 2011; Crabtree 2011) (see 2.10). The presence and abundance of cattle and pigs at Sos Höyük (Howell-Meurs 2001b), Mokhra Blur (Piro 2009), Gegharot (Monahan 2007) and Natsargora (Rova *et al.* 2011) suggest that the Kura-Araxes economy was based on a broad pastoral strategy rather than a specialised form of sheep/goat transhumant pastoralism. Moreover, at Sos Höyük and Godin Tepe the analysis of animal mortality profiles has indicated that the site was occupied throughout the year and that the animal economy was geared towards risk minimisation though diversification of animal resources instead of specialised pastoral production (Howell-Meurs 2001b, 2001a; Piro 2009; Crabtree 2011). Overall, the archaeozoological data from these sites indicate that the Kura-

Araxes economy was not geared towards specialised transhumant pastoral production but was rather a settled agro-pastoral economy that probably included localised household herding.

Mobile pastoralism can be defined in slightly different ways depending on the parameters applied (Arnold and Greenfield 2004). Khazanov (1994, 19-25) defines different levels of pastoral mobility according to the relative importance of pastoral and agricultural subsistence in the economic system, whereas Cribb (1991, 15-20) uses the level of mobility within the society to categorise different types of transhumance. In both models, however, these two concepts are intricately related; the stronger the degree of pastoralism the greater degree the mobility, and pastoral nomadic societies are characterised by an absence of agriculture (Cribb 1991, 16; Khazanov 1994, 19). In specialised pastoral transhumant societies, therefore, cereal agriculture is not practiced and grains are gained through interaction with settled communities. As an example, in Central Asia where pure nomadic pastoral groups are thought to have existed from the fourth millennium B.C., evidence for agricultural production is extremely rare until the first millennium B.C. (Shishlina *et al.* 2008; Franchetti 2012; Motuzaite-Matuzeviciute *et al.* 2012; Ruhl *et al.* 2014). Trade between agriculturalists and pastoralists, rather than low investment cultivation by pastoralists, is thought to account for the agricultural products found at mobile pastoral sites in Central Asia because the grains are processed (Spengler *et al.* 2014a). Free threshing wheat and millet grains that were found in a cremation burial at third millennium Begash, Kazakhstan, are interpreted as ritual deposits of imported grains (Franchetti *et al.* 2010). It is only at Central Asian sites, such as Sarazm and Tasbas, where early stage crop processing by-products, *Hordeum* and *T. aestivum* rachis internodes, were found, that agriculture was thought to have been practised, which also indicates year round occupation at the sites (Spengler and Willcox 2013; Spengler *et al.* 2014b).

Applying this model to archaeobotanical remains from Kura-Araxes sites suggests that the Kura-Araxes practiced an agro-pastoral settled economy. Archaeobotanical analysis of material from Sos Höyük has indicated that crops were cultivated at the site and from the scheduling of crop sowing and harvesting times it was likely that the site was occupied throughout the year (see Chapter 4). Furthermore, free threshing wheat and barley rachis internodes have been recovered from several Kura-Araxes sites which suggest that there was local cultivation and processing of grain at these sites. At Chobareti, Dilkaya, Sos Höyük, and

Tsaghkasar in the Southern Caucasus and Aşvan Kale, Taskun Mevkii and Tepecik[13] in the Upper Euphrates free threshing wheat rachis internodes were identified and barley rachis internodes were also recovered from Asvan Kale, Sos Höyük, Taskun Mevkii and Tepecik. Both *T. aestivum/durum* and barley are free threshing cereals which means that the grains easily become separated from the chaff when threshed and therefore the presence of free threshing wheat and barley rachis internodes indicates the early stages of crop processing (Hillman 1981). Since free threshing cereals are usually processed before exchange or transportation to reduce the bulk, cereal cultivation was probably practiced at these sites (Hillman 1981; M. Jones 1981). Moreover, most Kura-Araxes sites are located in agriculturally productive land, often fertile intermontane valleys that are highly suited to cereal cultivation (Batiuk 2005). At Kura-Araxes sites in the Caucasus, artefacts provide extensive evidence of agricultural activities: clay models of plough boards, sickles made from obsidian, flint or bronze and quernstones are found at many Kura-Araxes sites throughout the Caucasus (Kushnareva 1997, 183-186). The lack of free threshing cereal rachis internodes at other Kura-Araxes sites may reflect the threshing and winnowing of cereals off-site (G. Jones 1984; Hillman 1984a). Archaeobotanical analyses suggest that crops were cultivated at Kura-Araxes sites and that these sites were sedentary agricultural communities which practiced mixed farming and localised herding.

The identification of the Kura-Araxes as transhumant pastoralists is a problem of definition. Having an animal economy based on sheep and goat does not automatically indicate that the Kura-Araxes were transhumant pastoralists. The level of mobility and extent of pastoral production within a community are concepts that are often mistakenly conflated in archaeological research (Halstead 1987, 1996). Archaeobotanical and archaeozoological evidence from Kura-Araxes sites indicates that the Kura-Araxes probably practiced settled mixed agro-pastoralism with localised household herding of animals together with crop cultivation. Both Rothman's (2003) theory of multiple ripples of migration back and forth between Kura-Araxes communities, and Palumbi's (2008) assertion that cultural identity can spread through active assimilation as well as migration, remain valid models for the Kura-Araxes expansion. Their reliance, however, on mobile pastoralism as a mechanism to explain the expansion of the Kura-Araxes horizon needs to be reconsidered.

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[13] At Asvan Kale, Taskun Mevkii and Tepecik the ploidy of free threshing wheat rachis internodes was not defined and so these sites were not mentioned in discussion of free threshing wheat ploidy in 6.2.2

6.5.2 The Kura-Araxes as Specialist Viticulturists

As part of their migration hypotheses both Batiuk and Rothman suggest that the initial stage of Kura-Araxes migration into an area would have involved the trading of goods and technical knowledge with local populations to gain access to land and goods (Rothman 2003; Batiuk and Rothman 2007, 16; Rothman 2011; Batiuk 2013). In particular, they suggest that specialist knowledge of grape cultivation and wine making were the skills that could have been traded (Batiuk 2013). Batiuk (2013, 473) proposes that Kura-Araxes expertise in viti- and viniculture was not the motivation for Kura-Araxes migration but that it might have facilitated their cultural longevity by providing them with an economic niche in some regions. This is an intriguing idea, but appears to be largely unsubstantiated, based primarily on the shared geographical location of early evidence for wine making and the origin of Kura-Araxes culture, and new finds from Areni-1 Cave in Armenia (Areshian *et al.* 2011; Areshian *et al.* 2012; A. Smith *et al.* 2014).

This section will first review the evidence for wine making and grape distribution across the Near East prior to the Kura-Araxes period. With reference to archaeobotanical data presented in Chapter 5.2 and archaeological reports, this section will then discuss the possible evidence for wine making at Kura-Araxes sites, particularly Areni-1 Cave, Arslantepe and Godin Tepe, and then examine the evidence for grape processing at non-Kura-Araxes sites. Evidence for wine making at Kura-Araxes sites would help to support the idea that the Kura-Araxes may have had specialist grape growing or wine making skills. Ethnographic and experimental research has provided criteria for interpreting archaeobotanical grape remains based on the combination of grape plant parts found and their quantities, which aids with the identification of wine making by-products (Margaritis and Jones 2006; Valamoti *et al.* 2007). According to Margaritis and Jones (2006), numerous mixed grape seeds, pressed skins, rachis and pedicels may represent wine making residues, numerous seeds but only occasional skins and pedicels may indicate wine dregs (especially if found in storage jars) and small quantities of loose grape pips may be the by-product of grape or raison consumption.

DNA evidence from modern grape cultivars (both chloroplast DNA and nuclear microsatellites) has indicated that Transcaucasia is the region of greatest grapevine genetic diversity and may have been the centre of grape domestication (Arroyo-Garcia *et al.* 2006; Vouillamoz *et al.* 2006). Chemical traces of wine have been identified on Neolithic jars from Shulavenis-Gora and Kharamis Didi-Gora in Georgia (McGovern 2009). Grape seeds have also been recovered in Neolithic levels at Shulavenis-Gora, Kharamis Didi-Gora and Shomu Tepe

(Lisitsina and Prischepenko 1977; Kiguradze and Menabde 2004). Just outside the Caucasus, at Hajj Firuz, in the northern Zagros Mountains of Iran, resinated wine residues were isolated from six large nine litre storage jars in a Neolithic 'kitchen' from c.5400-5000 B.C. (McGovern *et al.* 1996). While wild type grape seeds have been found at sites across the zone of probable wild grape distribution from the Palaeolithic onwards, the spread of domesticated grape is thought to have begun in the Early Bronze Age, when grape remains increased dramatically in frequency and quantity in the Near East (Miller 2008; D. Zohary *et al.* 2012). Prior to the Bronze Age there was a paucity of grape remains at sites across the Near East. From 3600 B.C. grape ubiquity increases at Near Eastern sites and grape remains are found at an increasing number of sites spread over a larger geographical area. Grape remains appear most plentiful in the middle of the third millennium, c.2700-2200 B.C. (see 5.2).

There is currently very little evidence, however, linking Kura-Araxes sites with specialist wine manufacture or grape growing. Grape seeds were found in Kura-Araxes levels at Khizanaant-Gora and Kvatskhela in Georgia[14] and at Velikent in Dagestan at c.3500 B.C., but have not been reported at other Kura-Araxes sites in the Caucasus during the Late Chalcolithic or Early Bronze Age (Lisitsina and Prischepenko 1977; Wasylikowa *et al.* 1991; Gadzhiev *et al.* 1997; Kushnareva 1997, 185; Hovsepyan 2010b). Based on their large size, the grape remains at Khizanaant-Gora were identified as being of the domesticated variety (Kushnareva 1997). These seeds may represent the consumption of grapes at these Kura-Araxes sites.

The site of Areni-1 Cave, Armenia, is mentioned by Batiuk (2013) as possible evidence for Kura-Araxes wine making and deserves particular attention. Preservation at Areni-1 is exceptional: a desiccated leather shoe stuffed with grasses was found in Trench 3 and is radiocarbon dated to the early Kura-Araxes period 3627-3377B.C. (Pinhasi *et al.* 2010). In Trench 1 a possible grape pressing installation was found with clay basins draining into semi-buried storage jars which were surrounded by a mass of desiccated grape seeds, stalks, pressed skins and vine wood (Areshian *et al.* 2011; Areshian *et al.* 2012; K. Wilkinson *et al.* 2012; A. Smith *et al.* 2014). Based on comparison with known length to breadth ratios of wild and domesticated grape seeds, the desiccated Areni-1 grape seeds appear indeterminate between wild and domesticated types (A. Smith *et al.* 2014). These grape remains have been radiocarbon dated to 4230-3790B.C. (A. Smith *et al.* 2014; K. Wilkinson *et al.* 2012). Organic residues from inside the storage vessels next to the pressing platform have traces of a red

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[14] These two sites are not included in the analyses of this thesis because no archaeobotanical assemblages have been published; botanical findings have only been mentioned in archaeological literature.

pigment found in grapes and pomegranates which may confirm that grape juice was kept in the jars (Barnard *et al.* 2011). However, the stratigraphy in Areni-1 Cave is quite complex and appears somewhat mixed so the association between strata in different trenches is not clear (Badalyan 2014). In parts of the cave the upper layers have been truncated by Medieval house construction and pit digging and either washed away or mixed with colluvium (A. Smith *et al.* 2014). Kura-Araxes ceramics are present in the upper Chalcolithic layers of the cave in Trenches 3, 4, 5, and 6, and date to 3700-3400B.C. (A. Smith *et al.* 2014; Zardaryan 2014) which is contemporary with other early finds of Kura-Araxes material in the Caucasus (Sagona 2014; Badalyan 2014). The ceramic assemblage found in Trench 1 with the possible grape processing station does not appear to include Kura-Araxes ceramics and has earlier Caucasian Chalcolithic ware types (Areshian *et al.* 2011; Areshian *et al.* 2012; contra K. Wilkinson *et al.* 2012; and Zardaryan 2014). Moreover, the discovery of a human tooth and femur mixed with desiccated grape remains inside one of the vats, and the presence of several human heads set into unbaked clay near to the grape pressing installation, suggests that the grape juice was not being used for regular consumption but for rituals relating to death and burial (Areshian *et al.* 2011; Areshian *et al.* 2012). Furthermore, it is not clear whether the grape juice was used to produce wine or vinegar, or whether the liquid was for drinking or preserving human remains or both. The data from Areni-1 Cave is somewhat unreliable as evidence of Kura-Araxes viniculture since the pressing installation both pre-dates the Kura-Araxes and may not have been used for wine production.

Outside the Southern Caucasus, finds of grape seeds and possible wine residues appear in the Late Uruk period, coincident with the first indications of Kura-Araxes presence in the areas. Batiuk (2013) refers to the site of Arslantepe as another example to link the Kura-Araxes culture with wine making. At Arslantepe, small amounts of charred grape seeds were found in storerooms and houses from the Late Uruk Period VIA (Phase 3) (see 5.2 Figure 5.79), mixed local-Kura-Araxes Period VIB2 building (Phase 4) (see 5.2 Figure 5.80) and in the Kura-Araxes house of VIC (Phase 5) (see 5.2 Figure 5.81) (Follieri and Cocccolini 1983; Belisario *et al.* 1994; Sadori *et al.* 2006; Balossi Restelli *et al.* 2010). Both domesticated and wild type grape seeds were identified using length and breadth ratios, although the reliability of differentiation between wild and domesticated charred grape seeds using measurement indices has been questioned (H. Smith and Jones 1990; Mangafa and Kotsakis 1996). In period VIA, when grapes first appeared at Arslantepe, Arslantepe was heavily influenced by Late Uruk culture, but showing increasing signs of Kura-Araxes presence. No Kura-Araxes pottery was found with the grape pips in the Period VIA storeroom A340; only local Uruk style vessels were present, including large Late Uruk jars suitable for liquids (Palumbi 2008; Algaze 1996). The grape seeds found with Late Uruk storage jars may represent dregs from wine jars (cf. Margaritis and Jones 2006). The later finds of grape seeds in Kura-Araxes levels at Aslantepe, VIB and VIC, may be the by-products of grape consumption.

Godin Tepe, Iran, like Arslantepe in this period, was within the Late Uruk sphere of influence, a local settlement with trading contacts to Uruk Mesopotamia but also beginning to interact with Kura-Araxes communities. At Godin Tepe, chemical analyses identified possible wine-related tartaric acid residues in Period VI:1a Late Uruk jars in the oval compound (3500-2900 B.C.) (McGovern and Michel 1996). Kura-Araxes pottery first appears at Godin Tepe in Period VI:1a, coincident with the Late Uruk period (Rothman and Badler 2011). No grape remains were found in Period VI although a possible wine making room was uncovered with empty 'wine' jars, a bin and a large funnel and lid that could have been used for pressing grapes (Badler 1996). The wine jars themselves were of local manufacture with an upside down U shaped rope decoration on the exterior that has parallels with other Late Uruk rope decorated pottery at the site (Badler 1996).

The juxtaposition of the initial evidence for grape or wine remains and the first traces of Kura-Araxes contact at both Arslantepe and Godin Tepe may be a coincidence resulting from these sites' involvement in the Late Uruk exchange network. The Kura-Araxes apparently engaged with the periphery of the Late Uruk world, although the nature of these interactions is unknown (A. T. Smith 2005b; Kohl 2007). Arslantepe and Godin Tepe were both located at the edges of the Late Uruk and Kura-Araxes zones in the late fourth millennium B.C. Uruk Mesopotamia was the land of beer and unsuited for grape cultivation (McGovern 2009). Algaze (1996) suggests that sites at the Uruk periphery, in northern Syria, southeastern Turkey and western Iran may have produced wine that was distributed south into Mesopotamia and north to sites such as Arslantepe. The presence of Uruk 'wine' jars at Arslantepe and Godin Tepe indicates that trade in liquid products, wine or oil, was part of the Uruk exchange network. On the other hand, the Kura-Araxes assemblage at these sites, and in general, appears devoid of liquid storage jars analogous to the Uruk wine jars, although perishable containers for wine may have existed (Palumbi 2008; Rothman 2011). The presence of grape seeds, possible wine residues and storage jars at both Godin Tepe and Arslantepe may therefore have been more related to Late Uruk influences than Kura-Araxes activities.

Evidence for grape pressing appears more common at non-Kura-Araxes sites. In the Southern Levant, grape seeds, pressed skins and pedicels were found in abundance at Ras an-

Numayra, where irrigation of vineyards may have been practiced (White *et al.* 2014), and at Wadi Fidan in the late fourth millennium B.C. (Phase 3) (see 5.2 Figure 5.79). Analysis of organic residues and ceramic provenancing of wine jars in Royal tombs at Abydos in Egypt has demonstrated that Levantine wine was being imported into Pharaonic Egypt during the Early Bronze I-II, 3600-2850B.C. (Cavalieri *et al.* 2003; McGovern *et al.* 2009). Later in the mid-second millennium B.C (Phase 5) (see 5.2 Figure 5.81), many sites along the Middle Euphrates have a high ubiquity of grape skins, seeds and pedicels,which may indicate wine making. Grape flesh, peduncles and seeds were highly ubiquitous at Kurban Höyük in the Early Bronze Age Kurban IV period (Phase 5), present in more than 75% of samples, suggesting the cultivation of grapevines nearby and the possible production of wine (Miller 2008; Algaze *et al.* 1986). Although a few Kura-Araxes sherds were found at the site in in the Early Bronze Kurban V period (3100-2800 B.C.), Kurban Höyük remained outside of the Kura-Araxes cultural zone (Algaze 1990, 260, 289; Batiuk 2005). Moreover, no Kura-Araxes sherds were found in the Kurban IV period , when grape cultivation and wine making are suggested at the site.

The identification of evidence for specialist knowledge within the archaeological record is extremely difficult. Based on archaeobotanical assemblages, there appears to be little or no association between Kura-Araxes sites and evidence for grape pressing and wine production. In Kura-Araxes contexts, the only grape remains are seeds which may indicate fruit consumption rather than wine making. The evidence from Areni-1 Cave does not seem to suggest Kura-Araxes involvement in wine making, nor does the presence of grape seeds and tartaric acid residues in Late Uruk contexts at Arslantepe and Godin Tepe appear to indicate Kura-Araxes were migrating winetraders. Nevertheless, as T. C. Wilkinson (2014) points out, the crucial feature of Batiuk's (2013) and Rothman's (2003) ideas is not whether the Kura-Araxes were skilled winemakers, but that it focuses attention on the importance of foodways in the Kura-Araxes culture. To adapt Batiuk's model, free threshing wheat, rather than grape, as a food preference of the Kura-Araxes may have been important for maintaining a distinct Kura-Araxes cultural identity in new lands and provided Kura-Araxes communities with an economic niche to exploit.

6.5.3 Free threshing wheat and the expansion of the Kura-Araxes

The Kura-Araxes preference for free threshing wheat continues for thousands of years throughout the extensive Kura-Araxes horizon. Similarly, the core characteristics of the Kura-Araxes cultural package, including ceramic manufacturing techniques, house spatial arrangement and hearth types, remain consistent over a vast geographic area and thousands of years. This has been ascribed to a deeply conservative and traditional nature within the Kura-Araxes culture which preserved these traits (Sagona 1984, 2011, 2014). Rothman's (2003) 'ripples in the stream' analogy of migration may also suggest that these similarities in cultural assemblage and crop choices were maintained by continual connections between Kura-Araxes communities. This section will discuss the idea of continued links between Kura-Araxes sites and how these networks may have been useful in mitigating against risk in Kura-Araxes agriculture. Finally, as an agro-pastoral society, the spread of the Kura-Araxes culture could have been partially motivated by individual Kura-Araxes groups seeking new lands to cultivate.

When studying modern foodways in Britain, anthropologists have noted that in some communities the retention of traditional foods is strongest in the first generation but that by the third generation assimilation is almost complete, with only a few dishes surviving as a cultural indicators; however, in other communities, preference for original cuisines lasted for many generations (Williams *et al.* 1998; Atkins and Bowler 2001, 274). E. Anderson (2005, 205-207) investigated this difference in food preference survival and observed that certain migrant communities in North America preserved their native foods only if their communities were constantly renewed by immigration and if they maintained large ethnic enclaves separate from the host community. These modern studies have shown that cultural conservatism and isolationism was not enough to maintain culinary traditions; there had to be an enduring physical connection to the original community. Ethnobotanical research into medicinal plant use in the Balkans has shown a similar connection between communities with strong cultural affinities, in this case religion. In Macedonia, these ethnobotanical studies have shown that Muslim Gorani and Albanians have a greater shared tradition of plant uses than either group has with the neighbouring Macedonian Christians (Rexhepi *et al.* 2013, 2014). Similarly, more shared medicinal plant use has been attested between more distant but ethnically similar Muslim communities in Kosovo and Albania than between geographically closer Christian Serbs and Muslim Kosovars who share the same ecological region (Mustafa *et al.* 2012). In both cases the shared plant uses and preferences have been attributed to continued intermarriage between the various Muslim communities in the Balkans which was more crucial for exchanging and maintaining plant knowledge than geographic proximity or linguistic connections between neighbouring but culturally different communities (Rexhepi *et al.* 2014). However, when isolated, for instance by the modern borders between the Albanian Muslims living either side of the Macedonian border at Mount Korab, the shared botanical knowledge between ethnically linked communities begins to decrease, and similarities increase between culturally distinct but nearby communities (Pieroni *et al.* 2013). Thus, ethnographic studies of both migrant communities and ethnically diverse regions indicate that consistency in food preferences and plant uses requires continued contact between either the migrants and their homeland or between groups of the same cultural affiliation.

From these modern examples, the shared cultural traditions and crop preferences for free threshing wheat at Kura-Araxes sites over thousands of years may indicate continued contacts between the Kura-Araxes communities as well as a conservative cultural tendency. This does not necessarily mean there was a constant flow of people back and forth from the Levant to the Caucasus but that there may have been chains of communication between adjoining Kura-Araxes communities which helped maintain their cultural identity. These connecting nodes, Rothman's (2003) intersecting 'ripples in the stream', can be seen through the subtle regional variations in ceramics and hearth decorations. Although all regions have variations in the Kura-Araxes style, the Southern Levant Kura-Araxes assemblage shares strong stylistic similarities with the Amuq region which itself is derived from the Upper Euphrates ceramic repertoire and from the Upper Euphrates to the Caucasus connections are clearly apparent in pottery decorations (Batiuk 2005; Greenberg 2007; Palumbi 2008; Greenberg *et al.* 2014). If connections were maintained between Kura-Araxes groups within and between regions, then this may have helped minimise agricultural risk within Kura-Araxes communities.

As mentioned in section 6.3.3, more risk is involved in the cultivation and storage of free threshing wheat than glume wheat, since free threshing wheat is more vulnerable to herbivory, insect and fungal attack without persistent glumes to protect the grains (Hillman 1984a, 1985). The ease of threshing is, however, a distinct advantage of free threshing wheat. It is a quicker crop to process, and once separated from the chaff, the grain is less bulky to store and transport (M. Jones 1981; Hillman 1981, 1985). By cultivating an easily transportable crop, such as free threshing wheat, Kura-Araxes communities may have been able to readily rely on a form of social storage within local Kura-Araxes networks at times of crop failure. Social storage operates on the basis of reciprocity between individual farmers or, depending on the scale of the crop failure, farming communities; the grain is exchanged by the donor in expectation for future assistance when they themselves may experience crop failure (Halstead and O'Shea 1982; Halstead 1989). Greek farmers in the twentieth century were known to utilise extended family and local village networks for the purchase or loan of food, or in exchange for labour (Halstead and Jones 1989, 52). In the past, these buffering networks may have been managed through the exchange of craft goods as tokens or through marriage between communities (Halstead 1989). The highly burnished Kura-Araxes fine wares or bronze metalwork could have acted as tokens for food exchange within the Kura-Araxes network. Marriage between members of neighbouring Kura-Araxes groups to affirm bonds of reciprocity may partly explain the distribution of regional ceramic styles between local Kura-Araxes communities. Based on ethnographic analogies, women may have been the Kura-Araxes pottery makers (Bakir 2004; Sagona 2014), so the transmission and maintenance of regional ceramic variants may have been facilitated by marriage exchanges.

Evidence for the Kura-Araxes ability to produce agricultural surpluses that could have been exchanged can be seen through the presence of several large storage pits containing grain at Elar, Baba-Dervish and Gudaberdka in the Caucasus (Kushnareva 1997, 185). A clay model of a building with three separate cone-shaped roofed structures, potentially an above-ground granary, was found at Teghutdzor, Armenia (Shanshashvili and Narimanishvili 2014). At Yanik Tepe, a Kura-Araxes site in northwestern Iran, a large circular building, divided into quarters with two concentric one meter high walls and no doors, has been interpreted as a storage structure, possibly a granary (Burney 1961b; Summers 2004). Transportation of clean free threshing wheat grain between communities may have been facilitated by wagons. At many Kura-Araxes sites clay wheels, animal figurines and occasional model carts have been found leading to speculation that they used two-wheeled wagons pulled by cattle (Sagona 2013; Greenberg 2014). The cultivation of free threshing wheat may have made it easier to move grain along interconnected Kura-Araxes buffering networks. These networks may have also served to maintain communication links between local Kura-Araxes communities and across neighbouring regions and thereby ensured continual sharing of core cultural traditions.

The possible existence of Kura-Araxes social storage and communication networks may also explain why in the Middle Bronze II period at Sos Höyük (2000-1500BC), emmer remains increased in the assemblage (section 4.1.2 and 4.8.3). If the Kura-Araxes culture was beginning to decline in this region during the Middle Bronze II period, with the increase in Martkopi, Bedeni and Trialeti influences in material culture, the local Kura-Araxes buffering networks may have been breaking down. In this period, together with a possibly deteriorating climate (Fairbridge *et al.* 1997; Wick *et al.* 2003; Newton 2004), the Kura-Araxes community at Sos Höyük may not have been able to rely on cultural networks for wheat supplies if crops failed. To minimise risk the farmers at Sos Höyük may have diversified their wheat production to include a hardier wheat, *T. dicoccum,* as well as their traditional *T. aestivum*. There are no other Kura-Araxes or Martkopi/Bedeni/Trialeti sites with archaeobotanical material from the second millennium B.C. in eastern Anatolia or the Caucasus which could be compared with the finds from Sos Höyük to test this idea. The archaeobotanical assemblage closest in date to that of the Middle Bronze II at Sos Höyük is from the Early Bronze III at Dilkaya, dated to 2200-1950B.C., and here *Hordeum* and *T. aestivum* continue to be cultivated but the amount of *T. aestivum* relative to *Hordeum* decreased from the Early Bronze II to Early Bronze III (Nesbitt 1991).

As agro-pastoralists, the migration of Kura-Araxes communities across the Near East may have been motivated by a search for more arable land (Kohl 2007). Sagona (1984, 128) proposed that population pressures and over grazing may have led to the Kura-Araxes seeking new pastures for their flocks. Similarly, Kushnareva (1997, 188) suggested that the movement of the Kura-Araxes from lowlands to highlands may have been caused by population increase combined with soil degradation and climatic aridity, and Rothman (2003, 109) also cites climate change as a push factor in Kura-Araxes' migrations. The evidence for a climatic deterioration in the Caucasus in the late fourth to early third millennium which could have prompted the Kura-Araxes spread across the Near East is mixed. Pollen analyses suggest a period of overall 'climatic optimum' in the fourth and third millennia (4000-2000B.C.) with higher humidity and rainfall than previously, facilitating the expansion of oak forests at high altitudes and oak woodland savannahs at lower altitudes across the Caucasus and Eastern Anatolia (Wick *et al.* 2003; Connor and Sagona 2007; Connor and Kvavadze 2014; Joannin *et al.* 2014). During the late fourth millennium, however, there were climatic fluctuations in the Caucasus and more broadly in the Eastern Mediterranean region which may indicate periodic, and sometimes localised, episodes of aridity (N. Roberts *et al.* 2011; Connor and Kvavadze 2014; Joannin *et al.* 2014). In a period climatically suited to good agricultural production in the highlands, with regular rainfall and warmer conditions (Connor and Kvavadze 2014), occasional periods of aridity may have prompted some Kura-Araxes farmers to seek new lands to cultivate. However, whether periods of occasional aridity could have initiated and sustained the extensive migration of Kura-Araxes over several centuries is uncertain.

There does seem to have been a proliferation of Kura-Araxes sites into unexploited areas which may possibly indicate an expansion in farming. As previously mentioned, Batiuk's (2005) survey of Kura-Araxes sites noted that virtually all Kura-Araxes sites were on good arable land suited to agricultural production. One characteristic of Kura-Araxes culture as it expanded was that these new settlements, in the Caucasus, Upper Euphrates, the Amuq or

Northwest Iran, were virtually all on virgin soil or at sites which were previously abandoned (Young 2004; Batiuk 2005; Persiani 2008; Sagona 2014). This may suggest that the Kura-Araxes were seeking out unoccupied land for agriculture. If, at this time, the highlands were undergoing a period of afforestation, the Kura-Araxes may have been ideally equipped for clearing forests for agriculture. Kura-Araxes metalsmiths had developed a wide range of woodworking tools. Use of the sturdy shaft-hole axes, characteristic of the Kura-Araxes bronze assemblage in the Caucasus, may have enabled Kura-Araxes communities to carve out new settlements and fields from the oak forests or open woodlands (Connor and Sagona 2007). The Kura-Araxes spread from the Caucasus into the Upper Euphrates and then to the Amuq, but avoided the Middle Euphrates, Khabur and Southeastern Turkey. Shimelmitz (2003), interpreting the Kura-Araxes as nomadic pastoralists, claims the avoidance of these regions was because the Kura-Araxes were unable to integrate into regions which already had sizeable pastoral economies. The absence of Kura-Araxes sites from these areas may instead have been because these regions were too arid for Kura-Araxes hexaploid free threshing wheat based-agriculture. Moreover, the cultivation of hexaploid cold-adapted free threshing wheats may possibly have eased the Kura-Araxes agricultural expansion into new regions. Modern studies have shown that cold tolerant hexaploid wheats planted as summer crops at high altitudes in Eastern Anatolia can produce higher yields when sown at lower altitudes (Gokgol 1939, 581; cited in Yakar 2000, 396). Whether this applied to the wheat varieties grown by the Kura-Araxes in the fourth and third millennium is unknown[15] but it is an intriguing possibility that may also have contributed to the Kura-Araxes preference for free threshing wheat.

6.6 Summary

The Kura-Araxes preference for free threshing (hexaploid) wheat is a crop signature that helps to distinguish the Kura-Araxes phenomenon as, in all likelihood, a shared cultural identity. The Kura-Araxes economy was most likely based on settled agro-pastoralism with integrated animal husbandry rather than transhumant pastoralism. The spread of the Kura-Araxes across the Near East throughout the late fourth and third millennia was probably a form of migration, perhaps stimulated by the search for new agricultural lands. The core cultural consistencies in the Kura-Araxes culture throughout the vast geographical region and over thousands of years may indicate that the Kura-Araxes were connected by a communication network that could have served to minimise agricultural risk in Kura-Araxes communities.

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[15] *T. aestivum* grains from Sos Höyük and Chobareti are being DNA sequenced as part of the Australian Research Council funded 'Reconstructing wheat evolution using ancient DNA' project (DP130104227) at the Australian Centre for Ancient DNA, University of Adelaide.

Chapter 7: Conclusion

7.1 Summary and general conclusions

In the ten years since A. T. Smith (2005b, 260) cautioned that researchers still did not fully understand what the Kura-Araxes horizon actually represented, great advances have been made in Kura-Araxes archaeology. A more holistic understanding of the phenomenon, using anthropological theories of identity, has moved discussions of the Kura-Araxes horizon beyond the distribution of a distinctive ceramic style, to a deeper awareness of the shared cultural traits that unite the Kura-Araxes as a cultural group.

This thesis has approached the issue of identifying archaeological cultures via the concept of food as material culture (Dietler 2007; Van der Veen 2008). By using archaeobotanical evidence to explore crop preferences at Kura-Araxes sites, this thesis has attempted to investigate the cultural integrity of the Kura-Araxes horizon. Archaeobotanical data from twenty Kura-Araxes and ninety-six other Near Eastern sites from 6100-1500B.C. were collected and the plant assemblage from the Kura-Araxes site of Sos Höyük, which is presented in Chapter 4, was studied to produce an enlarged dataset for this thesis. In Chapter 5, comparative analysis of Kura-Araxes and other Near Eastern archaeobotanical assemblages, using multivariate statistics, was able to distinguish between material from Kura-Araxes and contemporary non-Kura-Araxes sites on the basis of crop choices. At Kura-Araxes sites, free threshing wheat, particularly hexaploid *T. aestivum*-type, was the dominant wheat cultivated, together with *Hordeum*. Traces of the glume wheats, *T dicoccum* and *T. monococcum,* were mostly absent from Kura-Araxes sites. This preference for free threshing wheat was identified at Kura-Araxes sites in the Southern Caucasus in the late fourth millennium B.C. and later at new Kura-Araxes sites in the Upper Euphrates and the Southern Levant, regions that were glume wheat dominated prior to the expansion of the Kura-Araxes in the third millennium B.C.. Conversely, contemporary non-Kura-Araxes Near Eastern sites continued to cultivate glume wheats until at least the late third millennium B.C. and free threshing wheat remains were rarely found at non-Kura-Araxes sites.

The Kura-Araxes preference for free threshing wheat can be interpreted as a distinct agricultural signature that unifies the Kura-Araxes horizon. As food choices are intimately linked to notions of identity, this crop preference may indicate that the Kura-Araxes horizon represents a shared cultural identity. Integrating this economic signature with the other evidence of daily practices that form the basis of cultural expression, such as the consistencies in ceramic manufacturing techniques and household spatial organisation found at Kura-Araxes sites, strongly suggests that the Kura-Araxes phenomenon was actually a coherent cultural entity that expanded across the Near East through some kind of population movement.

In archaeological literature, the Kura-Araxes culture is often described as having been based on transhumant pastoralism, on the basis of the apparently mobile nature of their material culture (Kushnareva 1997; Shimelmitz 2003; Rothman 2003, 2005; Frangipane and Palumbi 2007; Palumbi 2003, 2010, 2012). Very little was known about the Kura-Araxes economy through direct analysis of animal and plant remains. Until this thesis there had been no integrated study of the Kura-Araxes plant economy. The detailed study of Sos Höyük provided in Chapter 4 is currently the largest Kura-Araxes archaeobotanical assemblage analysed. It also adds to the research corpus of Sos Höyük, which is one of the most comprehensively studied Kura-Araxes sites. Two archaeozoological investigations of Sos Höyük material have argued against transhumant pastoralism at the site and instead suggested that occupation was stable throughout the year and that the inhabitants had a mixed agro-pastoral economy to minimise risk (Howell-Meurs 2001b; Piro 2009). The archaeobotanical evidence from Sos Höyük, similarly indicates that settled agriculture was most likely practiced at the site. Crops appear to have been grown locally and the seasonality of crop production and dung fuel cake manufacturing indicates that Sos Höyük was probably permanently occupied. Archaeobotanical evidence from other Kura-Araxes sites also suggests that crops were widely cultivated and that the Kura-Araxes were not mobile pastoralists.

Mobile pastoralism has often been used as a mechanism to explain the expansion of the Kura-Araxes culture across the Near East (Burney and Lang 1971; Sagona 1993; Palumbi 2003; Rothman 2003, 2005; Frangipane and Palumbi 2007; Batiuk and Rothman 2007; Palumbi 2012). As discussed in Chapter 6, the reinterpretation of the Kura-Araxes culture as being composed of settled agro-pastoral communities means that the reliance of migration models on transhumant pastoralism needs to be reconsidered. The reasons behind the spread of the Kura-Araxes culture are still unclear. It may be that Kura-Araxes communities were searching for new agricultural land in periods of climatic uncertainty and that they were able to exploit underoccupied regions to cultivate their hexaploid free threshing wheat and barley crops. The deeply conservative traditions in Kura-Araxes material cultural and household organisation may indicate that there were chains of communication linking Kura-Araxes communities. These interconnecting networks may have enabled Kura-Araxes communities to minimise agricultural risk through social storage and thereby enhanced the bonds between neighbouring communities. This in turn may have helped maintain continuity in cultural traditions throughout the Kura-Araxes horizon.

7.2 Future research

Further archaeobotanical data would help to clarify, and hopefully confirm, the trends seen in the Kura-Araxes assemblages presented in Chapter 5. At present no archaeobotanical information is available from Kura-Araxes sites in the Amuq. This is an important region for understanding the connection between Kura-Araxes sites in the Southern Levant and the Kura-Araxes groups in the Upper Euphrates, Eastern Anatolia and the Caucasus. Evidence of Kura-Araxes crop preferences in the Amuq would be useful for examining the development of Kura-Araxes cultural traits, particularly the preference for free threshing wheat, outside of the highlands of Anatolia and the Caucasus. This would also shed light on the transmission of Kura-Araxes agricultural practices to sites further south in the Levant. Iran is another region that has very limited archaeobotanical data from Kura-Araxes sites. There are only two archaeobotanical reports, both based on 1970s excavations, providing information on the eastward spread of the Kura-Araxes culture. While these studies are valuable, it would be very helpful to have new data with which to compare crop preferences in the eastward and westward expansion of the Kura-Araxes culture. New archaeological excavations, with integrated sampling projects for archaeobotanical remains, are underway in the Caucasus (Rova *et al.* 2011; Ristvet *et al.* 2011; Lyonnet *et al.* 2012; Kakhiani *et al.* 2013; Messager *et al.* 2015), Iran (Abedi *et al.* 2014), and Israel (Greenberg *et al.* 2014) at Kura-Araxes sites. There is considerable scope for significant developments to be made in our understanding of Kura-Araxes agricultural preferences in future research.

This thesis has focused primarily on the crop choices at Kura-Araxes and other Near Eastern sites. Analysis of the crop assemblages from Kura-Araxes and other Near Easter sites in Chapter 5 was based on broad categorisations of plant remains, regions and time periods which could potentially have homogenised the data and masked the variation in the archaeobotanical assemblages. In this instance, a broad analysis was able to identify strong trends in the data, distinguishing Kura-Araxes samples from other Near Eastern samples on the basis of free threshing wheat content. As an initial study of variation in Near Eastern crop assemblages over a wide temporal and geographical range, this approach appears to have been successful in investigating the nature of the Kura-Araxes horizon through archaeobotanical evidence. Future analyses of the Near Eastern archaeobotanical assemblage, using individual crop taxa as data variables on a smaller temporal or geographical scale, may be able to identify more nuances in crop choices.

Apart from the analysis of the Sos Höyük assemblage in Chapter 4, wild and weedy taxa from Kura-Araxes or other Near Eastern sites were not interrogated. Further analysis of the non-crop taxa from archaeological sites in the Near East has great potential for investigating variations in agricultural strategies employed at sites in different regions and identifying any changes in agriculture over time, especially if a functional ecological approach is employed (Charles *et al.* 1997; Bogaard 2004, 2011). This could provide insight into the agricultural practices of Kura-Araxes farmers, especially in comparison to non-Kura-Araxes sites, and whether strategies varied between the differing environmental zones occupied by the Kura-Araxes culture. At Sos Höyük the archaeobotanical assemblage appears to be a mix of crop processing by-products and dung fuel residues, a combination that makes it very difficult to interpret the crop husbandry of the site. Therefore, in order to meaningfully investigate agricultural practices in the Near East, advances must be made in distinguishing dung fuel remains from crop processing residues in the archaeobotanical record.

More broadly, this study has demonstrated that comparative analysis of archaeobotanical data to explore food preferences can be used to investigate an archaeologically defined culture. This approach could be applied to other archaeological groups in the Near East and more generally in archaeology. The Halaf, for instance, is another Near Eastern archaeological group whose cultural integrity has been questioned in a manner reminiscent of the uncertainties surrounding the Kura-Araxes culture. Debate centres on whether the Halaf represents a coherent cultural group or a shared ceramic tradition in the Late Neolithic/Early Chalcolithic (Castro Gessner 2011). Such an investigation into the Halaf is beyond the scope of this thesis, but it is interesting to note that in the phase-by-phase analysis in Chapter 5 (section 5.1.1.1), Halaf sites appear to be unified by a preference for glume wheat and a distinct paucity of barley remains. There is potential that further analysis of archaeobotanical remains from Halaf sites, together with an integrated study of the repetitive patterns of behaviour in ceramic production, tool manufacturing and spatial organisation, might provide insight into the cultural integrity of the Halaf tradition. Employing this type of multifaceted investigative method may help clarify issues of cultural identity in the archaeological record.

7.3 Concluding remarks

The identification of free threshing wheat as a crop preference at Kura-Araxes sites contributes to the growing body of evidence indicating that the Kura-Araxes horizon most likely represented a shared cultural identity. There are many aspects of the Kura-Araxes culture, however, that are still not clearly understood. Although free threshing hexaploid wheat has been recognised as an agricultural signature of the Kura-Araxes and helps to identify them as a cultural entity, we do not know how the wheat was consumed. The grains may have been processed and eaten as a bread or porridge or gruel or as part of a stew. In Sherratt's parlance (1991) the Kura-Araxes are still eating species; as yet the ingredients have not been turned into a meal. Nor do we know what bound the Kura-Araxes together socially or if there was regular movement between regions. We do not know whether there was a shared religion or common language connecting the Kura-Araxes of the Caucasus with the Khirbet Kerak of the Southern Levant. However, we do know they were able to communicate on some level through their shared culture. It is tempting to speculate that if Kura-Araxes inhabitants from Sos Höyük were to have stepped into the settlement at Tel Beit Yerah, they may have recognised the burnished red-black pottery, the portable hearths, seen similar spiral headed pins to those they wore, entered a house they were familiar with, and perhaps also tasted the bread or gruel made from a well-known wheat.

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Appendix A

Table 1. Flotation sample contents from Sos Höyük based on mimimum number of items.

Sos Höyük archaeobotanical code	**SOS1**	**SOS2**	**SOS3**	**SOS4**	**SOS5**	**SOS6**	**SOS7**	**SOS8**	**SOS9**	**SOS10**	**SOS11**	**SOS12**
Trench	M17	M17	L17b	L17b	L17b	L17b	M17	M17	M17	L17d/M17c	M17	L17d/M17c
Loci	3764	3770	4294	4281	4247	4299	3755	3755	3769	4233	3771	4232
Basket	41	71	132	107	24	143	29	22	60	44	63	37
Sample	s.84		s.194	s.149	s.45	s.212	s.57	s.40	s.130	s.93	s.136	s.74
Period	LC	LC	LC	LC	LC	LC	LC	LC	LC	LC	LC	LC
Context	General debris	Floor level	Pit	Pit	Burn layer	Floor level	Floor level	Hearth contents	Hearth contents			Pit
Fraction analysed	1/2	1	1/2	1/2	1/16	1	1	1	1	1	1	1
Total wood charcoal volume (ml) >1mm	52	18	180	37	1180	17	25	32	104	30	60	7
Total non-charred volume (ml) >1mm	14	0	130	3	20	15	160	2	34	8	50	3
Total cereal grains	48	5	72	55	17	222	17	0	136	49	42	10
Total cereal chaff	156	47	109	104	94	102	67	4	401	173	101	45
Total wild seed items	62	97	355	1354	514	184	89	3	255	514	76	200
Total items	218	52	311	162	131	339	244	6	571	230	193	58
Cereal Grain												
Triticum dicoccum	2					3						
Triticum* cf. *dicoccum												
Triticum dicoccum/aestivum/durum					1	11			3			
Triticum aestivum/durum	13	3	15	12	6	108	4		24	8	6	
Triticum* cf. *aestivum/durum	6		3			10	4		8	5		1
***Tritcum* sp.**	9			7	1	34	1		21	8	2	
cf. *Triticum* sp.												
***Hordeum* hulled assymetric**												
***Hordeum* cf. hulled assymetric**	1										1	

Sos Höyük archaeobotanical code	**SOS1**	**SOS2**	**SOS3**	**SOS4**	**SOS5**	**SOS6**	**SOS7**	**SOS8**	**SOS9**	**SOS10**	**SOS11**	**SOS12**
Hordeum **hulled symmetric**	1	2	16	2	3	14	2		8	6	6	3
Hordeum **cf. hulled symmetric**												
Hordeum **hulled assymmetric/symmetric**	5		12	21	4	29			22	4	17	3
Hordeum **assymmetric/symmetric cf. naked**			1			2						
Hordeum **indeterminate**	7		5	12		8	3		14	10		
cf. ***Hordeum*** **sp.**			8	1	2				6			
Triticum/Hordeum	4		12			3	3		30	8	10	3
Secale **cf.** ***cereale***												
Cereal Chaff												
Triticum dicoccum (**glume base)**	1											
Triticum **cf.** ***dicoccum (*** **glume base)**	5			16					8			
Triticum **sp. (glume base)**		2										
Triticum aestivum **(rachis)**	29	9	17	11	3	33	30	1	146	20	40	2
Triticum **cf.** ***aestivum*** **(rachis)**	36			2				1	10			
Triticum **cf.** ***durum*** **(rachis)**												
Triticum aestivum/durum **(rachis)**	1	2	1	24	3	2	5		60	40	4	12
Triticum **cf.** ***aestivum/durum*** **(rachis)**									4	24	3	
Triticum aestivum/durum **(basal rachis)**	6	2	2	2	2	3			9	2		1
Triticum sp. **(terminal spikelet)**		2					1		10	1		
Hordeum vulgare **(internode)**	2		1						3	1		
Hordeum **cf.** ***vulgare*** **(internode)**												
Hordeum distichum **(internode)**	2	1	5	8	10	16	3		50	19	8	6
Hordeum **cf.** ***distichum*** **(internode)**	16	1							28	5	4	
Hordeum vulgare/distichum **(internode)**	4	2	2	33	33	1				16	6	
cf. ***Hordeum vulgare/distichum*** **(internode)**							8					16

Sos Höyük archaeobotanical code	**SOS1**	**SOS2**	**SOS3**	**SOS4**	**SOS5**	**SOS6**	**SOS7**	**SOS8**	**SOS9**	**SOS10**	**SOS11**	**SOS12**
Triticum/Hordeum **(internode)**	15	14	49		1	34	5		12	6	8	
Triticum/Hordeum **(basal rachis)**	4										4	
cf. *Secale* sp. (internode)												
Cerealia, Culm base	2											
Cerealia, root	8	2	3		14	5	2		24	12	1	2
Cerealia, culm node	25	10	29	8	28	8	13	2	37	27	23	6
Other crop/collected foods												
Lens cf.culinaris				1			2					
cf. *Lens sp.*												
Vicia ervilia												
Pisum sativum					1					10		
Lathyrus sativus												
Pulse indet				1					1			
cf. *Avena sp. (* floret base)												
Panicum miliaceum												
cf. *Panicum miliaceum*												
Camelina sativa												
cf. *Camelina sativa*												
Pistachia **sp.**										1		
Wild/Weedy items												
Amaranthaceae												
Indet Amaranthaceae pod											1	
Atriplex **cf. *lasiantha* (in bracts)**				2	26					3		
Atriplex **sp.**				42	106					8		

Sos Höyük archaeobotanical code	**SOS1**	**SOS2**	**SOS3**	**SOS4**	**SOS5**	**SOS6**	**SOS7**	**SOS8**	**SOS9**	**SOS10**	**SOS11**	**SOS12**
cf. *Atriplex* sp.		4			7							
***Beta vulgaris* (fruit)**												
Chenopodium album				5	24					8		4
Chenopodium foliosum												
***Chenopodium* sp.**		4		104			4					
***Chenopodium/Atriplex* spp.**				136	7	8						
***Kochia prostata/scoparia* (fruit)**												
cf. *Kochia prostrata/scoparia*												
Polycnemum arvense		4		72								
***Salsola* sp.**										6		
Apiaceae												
Apiaceae Type E												
Apiaceae Type F												
***Bupleurum* type**				1								
***Coriandrum* type**				2								
cf. *Caucalis platycarpos*												
Falcaria vulgaris												
Asteraceae		2		8						2		
Asteraceae Type C				16								
Asteraceae Type E												
***Anthemis* sp.**												
cf. *Artemesia* sp.			1									
***Aster* type**			1						1			
***Centaurea* sp.**												
***Crepis* sp.**												
Boraginaceae												

Sos Höyük archaeobotanical code	**SOS1**	**SOS2**	**SOS3**	**SOS4**	**SOS5**	**SOS6**	**SOS7**	**SOS8**	**SOS9**	**SOS10**	**SOS11**	**SOS12**
Buglossoides arvensis (mineralised)			1	1					3	1	1	
Lithospermum officinale (mineralised)												
Myosotis sp.												
Rochelia sp.												
Brassicaceae												
Brassicaceae pod B												
Brassicaceae type D/F						16						
Brassicaceae type E												
cf. _Alyssum_ sp.												
Brassica type												
Cardaria/Lepidium type			3		2				1	24		4
Euclidium syriacum (seed capsule)			1							6		
cf. _Euclidium syriacum_												
Thlaspi arvense			8									
Caryophyllaceae												
Gypsophila sp.												
Silene sp.												
Silene sp. type 1												
Silene sp. type 2												
Vaccaria pyramidata							1					1
Convolvulus sp.			1						1	8	1	
Cyperaceae	9	2	2	74	16		4		18	25		1
Bolboschenus maritimus	1			15	17	1	1		1	1		1
Carex spp.	4			4	1							
Cyperus spp.				6	1				2			
Eleocharis sp. (mineralised)												

Sos Höyük archaeobotanical code	**SOS1**	**SOS2**	**SOS3**	**SOS4**	**SOS5**	**SOS6**	**SOS7**	**SOS8**	**SOS9**	**SOS10**	**SOS11**	**SOS12**
Fabaceae				24								
Fabaceae long pod												
Astragalus **sp.**												
cf. Coronilla **sp.**												
Lathyrus **sp.**							1					
Medicago **cf.** ***papillosa*** **(pod)**												
cf. ***Onobrychis*** **sp.**												
Trifolium/Melilotus/Medicago	24	4	216	262	102	44	57		52	148	42	131
Trigonella astroites			1						1			
Trigonella **sp.**				17	1							12
Vicia/Lathyrus **sp.**			1	2								
Vicia/Pisum												
Geranium **sp.**					1							
Juncaceae seed head					1							
Juncus sp.												
Lamiaceae indet												
Ajuga/Teucrium **sp.**												
cf. Ajuga **sp.**												
Lallemantia iberica/canescens/peltata	1			6	10				3	1		
Nepeta **sp. type**					16							
Teucrium **sp.**										8		
cf. ***Bellevalia*** **sp.**												
Malva **cf.** ***neglecta***												
Malva **cf.** ***sylvestris*** **(pod)**												
Malva **sp.**			1			3			1			4
Fumaria **sp.**												

Sos Höyük archaeobotanical code	**SOS1**	**SOS2**	**SOS3**	**SOS4**	**SOS5**	**SOS6**	**SOS7**	**SOS8**	**SOS9**	**SOS10**	**SOS11**	**SOS12**
cf. *Plantago* sp.			1									
Poaceae	6	14	2	45	41	19	1		2	40		9
Poaceae chaff		6	1		8	8			9	40		
***Aegilops* sp.**												
Bromus* cf. *japonicus	5	4		1	1	19				21		5
Lolium perenne/multiflorum				3	8				18	25	1	3
cf. *Lolium* sp.		2	3						11	10		
Small seeded grass Panicoid												
Taeniatherum caput-medusae												
***Taeniatherum caput-medusae* (chaff)**												
cf. *Taeniatherum caput-medusae* (chaff)												
Fallopia convolvulvus				1	2				1			
***Persicaria* sp.**				8	5				8			
Polygonum arenastrum/bellardii	1		4	34	18		3		11	6	1	5
Polyonum* cf. *arenastrum/bellardii	2											
***Rumex* sp.**				1	8				1	1	6	
Polygonaceae/Cyperaceae endosperm	3	17	13	206	48	4	8		35	10	18	11
Polygonaceae/Cyperaceae indet												
***Adonis* sp.**												
Ranunculus* cf. *repens												
Rosaceae indet												
***Agrimonia* cf. *eupatoria* (fruit)**												
***Agrimonia* sp.**												
***Rosa* spp.**												
Asperula* cf. *involucrata			8	56	1	8				8		
***Asperula* sp.**									33			

Sos Höyük archaeobotanical code	**SOS1**	**SOS2**	**SOS3**	**SOS4**	**SOS5**	**SOS6**	**SOS7**	**SOS8**	**SOS9**	**SOS10**	**SOS11**	**SOS12**
cf. *Crucianella* sp.												
***Galium* spp. >1mm**	2	1	1	2	1	1			29	4		2
***Galium* spp. <1mm**												
cf. *Galium* sp. (mineralised)												
cf. *Verbascum* sp.					8							
Solanaceae indet												
Hyoscyamus niger												
Solanum* cf. *nigrum												
Thymelaea* cf. *passerina												
Valerianaceae						8						
Viola *sp.*					3							
Fruit tissue Type B		10			5							1
mini pine cone									2			
Type AE				40						16		
Pod A Indet												
Wild Seed indet	4	23	85	158	19	45	9	3	11	84	6	6
Indeterminate stalk					1							
Indeterminate bud		2	1		1							
Insect damage to cereal grain						y						
Rodent faecal pellets			4		3						2	
Sheep/goat faecal pellets												
Amorphous dung mass present	y	y	y	y	y	y			y	y	y	y
Straw/Phytolith clumps			y			y						y

Sos Höyük archaeobotanical code	**SOS13**	**SOS14**	**SOS15**	**SOS16**	**SOS17**	**SOS18**	**SOS19**	**SOS20**	**SOS21**	**SOS22**	**SOS23**	**SOS24**
Trench	L17b	L17b	L17d/ M17c	L17b	L17b	M16/ M15d	L17b	M17	L17b	M16/ M17	M16/ M15d	M16/ M15d
Loci	4269	4279	4219	4287	4279	3713	1590	3734	1599	3726	3715	3723
Basket	81	105	19	116	105	19	305	128	330	79	30	107
Sample	s.123	s.148	s.36	s.171	s.147	s.42	s.655	s.254	s.686	s.165	s.67	s.222
Period	LC	LC	LC	LC	LC	EB1	EB1	EB1	EB1	EB1	EB1	EB1
Context	Floor level	Hearth contents	Burnt soil	Pit	Hearth contents	Hearth contents	Floor level	Floor level	Pit	Floor level	General debris	General debris
Fraction analysed	1	1	1	1	1	1/2	1	1/2	1	1	1	1
Total wood charcoal volume (ml) >1mm	51	5	15	103	2	337	46	183	77	50	140	41
Total non-charred volume (ml) >1mm	0	7	15	105	1	2	3	45	19	6	0.5	3
Total cereal grains	0	30	28	69	9	93	3	53	20	71	117	28
Total cereal chaff	7	50	66	24	0	219	9	200	18	1582	297	113
Total wild seed items	28	61	283	276	8	222	39	231	485	144	616	135
Total items	7	87	109	198	10	314	15	298	57	1659	414.5	144
Cereal Grain												
Triticum dicoccum								1				
Triticum* cf. *dicoccum			1			4						
Triticum dicoccum/aestivum/durum											3	
Triticum aestivum/durum		13	6	4	7	10	1	14	8	3	16	5
Triticum* cf. *aestivum/durum								10			5	6
***Tritcum* sp.**		17				2	2	6	6	1	7	4
cf. *Triticum* sp.												
***Hordeum* hulled assymetric**				3		2				1		
***Hordeum* cf. hulled assymetric**											3	

Sos Höyük archaeobotanical code	**SOS13**	**SOS14**	**SOS15**	**SOS16**	**SOS17**	**SOS18**	**SOS19**	**SOS20**	**SOS21**	**SOS22**	**SOS23**	**SOS24**
***Hordeum* hulled symmetric**			7	31		16		7		23	27	3
***Hordeum* cf. hulled symmetric**												
***Hordeum* hulled assymmetric/symmetric**			4	31		11		4	4	43	27	1
***Hordeum* assymmetric/symmetric cf. naked**												
***Hordeum* indeterminate**					1	23		3			3	3
cf. *Hordeum* sp.											14	
Triticum/Hordeum			10		1	25		8	2		12	6
Secale* cf. *cereale												
Cereal Chaff												
***Triticum dicoccum (* glume base)**			2								1	
***Triticum* cf. *dicoccum (* glume base)**												
***Triticum* sp. (glume base)**						1			1		2	1
***Triticum aestivum* (rachis)**	5	13	22	4		10		11	1	144	40	19
***Triticum* cf. *aestivum* (rachis)**		2					8	8		18	4	
***Triticum* cf. *durum* (rachis)**												
***Triticum aestivum/durum* (rachis)**		8				21				45	8	3
***Triticum* cf. *aestivum/durum* (rachis)**												
***Triticum aestivum/durum* (basal rachis)**		5				6			1	47		3
***Triticum sp.* (terminal spikelet)**			2	4		1		4	1	4	1	
***Hordeum vulgare* (internode)**								1				
***Hordeum* cf. *vulgare* (internode)**												
***Hordeum distichum* (internode)**			7			19		13	1	636	58	13
***Hordeum* cf. *distichum* (internode)**			3							96	12	
***Hordeum vulgare/distichum* (internode)**			3			99		64		140	52	
cf. *Hordeum vulgare/distichum* (internode)		16	8					72				32

Sos Höyük archaeobotanical code	SOS13	SOS14	SOS15	SOS16	SOS17	SOS18	SOS19	SOS20	SOS21	SOS22	SOS23	SOS24
Triticum/Hordeum (internode)						7		13				4
Triticum/Hordeum (basal rachis)										15	3	8
cf. *Secale* sp. (internode)												
Cerealia, Culm base												
Cerealia, root	1	1	6	6				4	1	76	30	7
Cerealia, culm node	1	5	13	10		55	1	10	12	361	86	23
Other crop/collected foods												
Lens cf.culinaris								2				
cf. *Lens sp.*									8			
Vicia ervilia											1	
Pisum sativum				2								
Lathyrus sativus											1	
Pulse indet						1			2			
cf. *Avena sp. (* floret base)												
Panicum miliaceum												
cf. *Panicum miliaceum*												
Camelina sativa												
cf. *Camelina sativa*												
Pistachia sp.												
Wild/Weedy items												
Amaranthaceae												
Indet Amaranthaceae pod												
Atriplex cf. *lasiantha* (in bracts)						1					1	
Atriplex sp.						16					8	

Sos Höyük archaeobotanical code	SOS13	SOS14	SOS15	SOS16	SOS17	SOS18	SOS19	SOS20	SOS21	SOS22	SOS23	SOS24
cf. *Atriplex* sp.												
Beta vulgaris (fruit)												
Chenopodium album		1		8		8	8		66	20	138	
Chenopodium foliosum												
Chenopodium sp.			1			1						
Chenopodium/Atriplex spp.												
Kochia prostata/scoparia (fruit)												
cf. *Kochia prostrata/scoparia*												
Polycnemum arvense		8	2	1	1		8				8	8
Salsola sp.												
Apiaceae												
Apiaceae Type E												
Apiaceae Type F												
Bupleurum type												
Coriandrum type												
cf. *Caucalis platycarpos*												
Falcaria vulgaris										3		
Asteraceae							1					
Asteraceae Type C									8	1		
Asteraceae Type E												
Anthemis sp.												
cf. *Artemesia* sp.												
Aster type				1								
Centaurea sp.												
Crepis sp.				1								
Boraginaceae												

Sos Höyük archaeobotanical code	**SOS13**	**SOS14**	**SOS15**	**SOS16**	**SOS17**	**SOS18**	**SOS19**	**SOS20**	**SOS21**	**SOS22**	**SOS23**	**SOS24**
Buglossoides arvensis **(mineralised)**		3		14		1	3	14	18			
Lithospermum officinale **(mineralised)**									1	1		3
Myosotis **sp.**												
Rochelia **sp.**												
Brassicaceae											8	8
Brassicaceae pod B												
Brassicaceae type D/F			1	8								
Brassicaceae type E										5		
cf. *Alyssum* sp.												2
Brassica type												
Cardaria/Lepidium **type**			3	3		2		1		2	10	2
Euclidium syriacum **(seed capsule)**			7			2					5	
cf. *Euclidium syriacum*												
Thlaspi arvense	1			9								
Caryophyllaceae											48	
Gypsophila **sp.**												
Silene **sp.**												
Silene **sp. type 1**											16	
Silene **sp. type 2**							8				16	
Vaccaria pyramidata												
Convolvulus **sp.**				1								
Cyperaceae		1		16				8	12		12	
Bolboschenus maritimus									7		35	
Carex **spp.**												
Cyperus **spp.**												
Eleocharis **sp. (mineralised)**			1	1	1				8			

Sos Höyük archaeobotanical code	SOS13	SOS14	SOS15	SOS16	SOS17	SOS18	SOS19	SOS20	SOS21	SOS22	SOS23	SOS24
Fabaceae									16			
Fabaceae long pod												
Astragalus sp.												
cf. Coronilla sp.												
Lathyrus sp.									1			
Medicago cf. *papillosa* (pod)												
cf. *Onobrychis* sp.												
Trifolium/Melilotus/Medicago		18	102	85	1	40	1	106	61	9	60	7
Trigonella astroites												8
Trigonella sp.									8			
Vicia/Lathyrus sp.			1									
Vicia/Pisum								1				1
Geranium sp.												
Juncaceae seed head												
Juncus sp.												
Lamiaceae indet												
Ajuga/Teucrium sp.												
cf. Ajuga sp.										1		
Lallemantia iberica/canescens/peltata						33		4		19		8
Nepeta sp. type			9									
Teucrium sp.						1		1				1
cf. *Bellevalia* sp.												
Malva cf. *neglecta*												
Malva cf. *sylvestris* (pod)												
Malva sp.						1		1				
Fumaria sp.												

Sos Höyük archaeobotanical code	**SOS13**	**SOS14**	**SOS15**	**SOS16**	**SOS17**	**SOS18**	**SOS19**	**SOS20**	**SOS21**	**SOS22**	**SOS23**	**SOS24**
cf. *Plantago* sp.												
Poaceae		2	52	7	1			9	1		13	21
Poaceae chaff				1						8	1	
***Aegilops* sp.**												
Bromus* cf. *japonicus		10	8	5		11		2	10	24	46	8
Lolium perenne/multiflorum				5						10	2	
cf. *Lolium* sp.		9							1	3	5	
Small seeded grass Panicoid												
Taeniatherum caput-medusae												
***Taeniatherum caput-medusae* (chaff)**										2		
cf. *Taeniatherum caput-medusae* (chaff)												
Fallopia convolvulus			1					3	8		2	
***Persicaria* sp.**				1					30		1	
Polygonum arenastrum/bellardii	1		2	12	1			2	95	5	50	11
Polyonum* cf. *arenastrum/bellardii												
***Rumex* sp.**											1	2
Polygonaceae/Cyperaceae endosperm		2	10	22	2	2	2	1	9	13	52	17
Polygonaceae/Cyperaceae indet												
***Adonis* sp.**			1					2				
Ranunculus* cf. *repens												
Rosaceae indet												
***Agrimonia* cf. *eupatoria* (fruit)**								1				
***Agrimonia* sp.**												
***Rosa* spp.**		1										
Asperula* cf. *involucrata							8	16	40			
***Asperula* sp.**											8	

Sos Höyük archaeobotanical code	**SOS13**	**SOS14**	**SOS15**	**SOS16**	**SOS17**	**SOS18**	**SOS19**	**SOS20**	**SOS21**	**SOS22**	**SOS23**	**SOS24**
cf. *Crucianella* sp.			16							8		
***Galium* spp. >1mm**			2	17	1			24	3	1	1	4
***Galium* spp. <1mm**												
cf. *Galium* sp. (mineralised)												
cf. *Verbascum* sp.												
Solanaceae indet												
Hyoscyamus niger						1						
Solanum* cf. *nigrum												
Thymelaea* cf. *passerina			8						2			1
Valerianaceae												
Viola *sp.*												
Fruit tissue Type B		2	12	2				1			1	
mini pine cone	8										1	
Type AE				8					16			
Pod A Indet												
Wild Seed indet	18	4	44	48	0	102	0	34	64	9	67	23
Indeterminate stalk												
Indeterminate bud												
Insect damage to cereal grain			y							y		
Rodent faecal pellets								8				
Sheep/goat faecal pellets												
Amorphous dung mass present			y	y	y			y	y	y		
Straw/Phytolith clumps			y	y			y	y				y

Sos Höyük archaeobotanical code	**SOS25**	**SOS26**	**SOS27**	**SOS28**	**SOS29**	**SOS30**	**SOS31**	**SOS32**	**SOS33**	**SOS34**	**SOS35**
Trench	L17b	M16	M16	M16	M16	M16	M16	M15d	M15d	M15d	M16d
Loci	1595	3686	3693	3686	3692	3691	3691	1849	1848	1856	3642
Basket	311	81	87	74	86	83	83	158	156	195	271
Sample	s.665	s.192	s.212	s.175	s.206	s.195	s.95	s.399	s.392	s.483	s.570
Period	EB1	EBI/II	EBI/II	EBI/II	EBI/II	EBI/II	EBI/II	EBII	EBII	EBII	EBIII
Context	Hearth contents	General debris	Floor level	General debris	Floor level	Floor level	Floor level	General debris	General debris	General debris	Grave fill
Fraction analysed	1	1	1	1	1	1	1	1	1/4	1	1
Total wood charcoal volume (ml) >1mm	7	92	19	20	14	36	40	79	67	74	132
Total non-charred volume (ml) >1mm	3	9	1	1	0.5	4	1	0.5	3	0.5	13
Total cereal grains	2	78	28	18	17	25	18	44	44	44	111
Total cereal chaff	24	78	33	78	3	61	25	114	201	84	325
Total wild seed items	53	312	45	77	12	206	91	243	247	133	629
Total items	29	165	62	97	20.5	90	44	158.5	248	128.5	449
Cereal Grain											
Triticum dicoccum											9
Triticum* cf. *dicoccum		4								1	1
Triticum dicoccum/aestivum/durum								2	1	2	1
Triticum aestivum/durum	1	12	8	7	2	5	2	7	4	12	17
Triticum* cf. *aestivum/durum							2	8	4	2	
***Tritcum* sp.**			3		5	3	5	4	4	6	19
cf. *Triticum* sp.								3			
***Hordeum* hulled assymetric**											2
***Hordeum* cf. hulled assymetric**		6									4

Sos Höyük archaeobotanical code	**SOS25**	**SOS26**	**SOS27**	**SOS28**	**SOS29**	**SOS30**	**SOS31**	**SOS32**	**SOS33**	**SOS34**	**SOS35**
Hordeum **hulled symmetric**		31	4	7		3	3	5	20	10	19
Hordeum **cf. hulled symmetric**											3
Hordeum **hulled assymmetric/symmetric**		21		4	4	2	2	5	8	6	13
Hordeum **assymmetric/symmetric cf. naked**		2									
Hordeum **indeterminate**	1		4			5			3		16
cf. ***Hordeum*** **sp.**							2	3			
Triticum/Hordeum		2	9		6	7	2	7		5	7
Secale **cf.** ***cereale***											
Cereal Chaff											
Triticum dicoccum (**glume base)**								2	1		
Triticum **cf.** ***dicoccum (*** **glume base)**									1		
Triticum **sp. (glume base)**		2							1		
Triticum aestivum **(rachis)**	12	9	11	14		12	5	9	13	17	31
Triticum **cf.** ***aestivum*** **(rachis)**		20	1	8				8	9	3	1
Triticum **cf.** ***durum*** **(rachis)**									1		
Triticum aestivum/durum **(rachis)**		9	11	7		13	2	18	18	1	26
Triticum **cf.** ***aestivum/durum*** **(rachis)**	4										
Triticum aestivum/durum **(basal rachis)**		5	2	1			2	1	4	3	6
Triticum sp. **(terminal spikelet)**						1		1	1		
Hordeum vulgare **(internode)**							1			1	1
Hordeum **cf.** ***vulgare*** **(internode)**											
Hordeum distichum **(internode)**	1	6	5	18		1	4	6	38	20	57
Hordeum **cf.** ***distichum*** **(internode)**		8		2		5			24	3	14
Hordeum vulgare/distichum **(internode)**		4				9		25	3	3	8
cf. ***Hordeum vulgare/distichum*** **(internode)**	4			16							

Sos Höyük archaeobotanical code	SOS25	SOS26	SOS27	SOS28	SOS29	SOS30	SOS31	SOS32	SOS33	SOS34	SOS35
Triticum/Hordeum (internode)				3		8			2	2	40
Triticum/Hordeum (basal rachis)							3				
cf. *Secale* sp. (internode)											
Cerealia, Culm base											
Cerealia, root	1		1	4	1	4	3	21	29	20	32
Cerealia, culm node	2	15	2	5	2	8	5	23	56	11	109
Other crop/collected foods											
Lens cf.culinaris		1		3							
cf. *Lens sp.*											
Vicia ervilia											
Pisum sativum											
Lathyrus sativus											
Pulse indet											
cf. *Avena sp. (* floret base)											
Panicum miliaceum		3									
cf. *Panicum miliaceum*											
Camelina sativa											
cf. *Camelina sativa*											2
Pistachia sp.											
Wild/Weedy items											
Amaranthaceae										8	
Indet Amaranthaceae pod											
Atriplex cf. *lasiantha* (in bracts)				1							4
Atriplex sp.											

Sos Höyük archaeobotanical code	**SOS25**	**SOS26**	**SOS27**	**SOS28**	**SOS29**	**SOS30**	**SOS31**	**SOS32**	**SOS33**	**SOS34**	**SOS35**
cf. *Atriplex* sp.											
***Beta vulgaris* (fruit)**											
Chenopodium album								42	40	1	73
Chenopodium foliosum											
***Chenopodium* sp.**		32									
***Chenopodium/Atriplex* spp.**											
***Kochia prostata/scoparia* (fruit)**											
cf. *Kochia prostrata/scoparia*											
Polycnemum arvense				8							
***Salsola* sp.**											
Apiaceae											
Apiaceae Type E											
Apiaceae Type F											
***Bupleurum* type**											
***Coriandrum* type**											
cf. *Caucalis platycarpos*											1
Falcaria vulgaris											
Asteraceae		1									
Asteraceae Type C											
Asteraceae Type E											
***Anthemis* sp.**											1
cf. *Artemesia* sp.											1
***Aster* type**											
***Centaurea* sp.**											1
***Crepis* sp.**											
Boraginaceae											

Sos Höyük archaeobotanical code	**SOS25**	**SOS26**	**SOS27**	**SOS28**	**SOS29**	**SOS30**	**SOS31**	**SOS32**	**SOS33**	**SOS34**	**SOS35**
***Buglossoides arvensis* (mineralised)**		4	3	3	1	3	3	7	9	5	8
***Lithospermum officinale* (mineralised)**								2	2		1
***Myosotis* sp.**											
***Rochelia* sp.**											
Brassicaceae											
Brassicaceae pod B											1
Brassicaceae type D/F		8									
Brassicaceae type E								1			
cf. *Alyssum* sp.										1	1
Brassica type											
***Cardaria/Lepidium* type**	4	2					1	18			4
***Euclidium syriacum* (seed capsule)**								1		1	
cf. *Euclidium syriacum*											
Thlaspi arvense											
Caryophyllaceae		8									
***Gypsophila* sp.**											1
***Silene* sp.**											
***Silene* sp. type 1**	1							1			18
***Silene* sp. type 2**										8	10
Vaccaria pyramidata						1		1		2	11
***Convolvulus* sp.**								1		4	7
Cyperaceae		10				8		1	24	2	26
Bolboschenus maritimus						2				1	
***Carex* spp.**		1									2
***Cyperus* spp.**		1									
***Eleocharis* sp. (mineralised)**											

Sos Höyük archaeobotanical code	SOS25	SOS26	SOS27	SOS28	SOS29	SOS30	SOS31	SOS32	SOS33	SOS34	SOS35
Fabaceae											
Fabaceae long pod											
Astragalus sp.											
cf. Coronilla sp.											
Lathyrus sp.									1		
Medicago cf. *papillosa* (pod)								1			1
cf. *Onobrychis* sp.											
Trifolium/Melilotus/Medicago	20	74	2	37		43	8	57	12	22	164
Trigonella astroites					4						
Trigonella sp.			16			24					
Vicia/Lathyrus sp.		2							16	1	1
Vicia/Pisum											1
Geranium sp.											
Juncaceae seed head											
Juncus sp.											8
Lamiaceae indet											
Ajuga/Teucrium sp.				1							
cf. Ajuga sp.										1	
Lallemantia iberica/canescens/peltata	1	2				1	4	9	3	4	38
Nepeta sp. type											1
Teucrium sp.											
cf. *Bellevalia* sp.											
Malva cf. *neglecta*		1									
Malva cf. *sylvestris* (pod)											
Malva sp.				1							1
Fumaria sp.											

Sos Höyük archaeobotanical code	**SOS25**	**SOS26**	**SOS27**	**SOS28**	**SOS29**	**SOS30**	**SOS31**	**SOS32**	**SOS33**	**SOS34**	**SOS35**
cf. *Plantago* sp.											
Poaceae		11			1	13	5		13	4	3
Poaceae chaff											
***Aegilops* sp.**											2
Bromus* cf. *japonicus	4	1	1	1	1	2	1	5		3	6
Lolium perenne/multiflorum		6		4		19	5	18	3	2	
cf. *Lolium* sp.						15	13				
Small seeded grass Panicoid											
Taeniatherum caput-medusae											
***Taeniatherum caput-medusae* (chaff)**											
cf. *Taeniatherum caput-medusae* (chaff)											
Fallopia convolvulvus						1					3
***Persicaria* sp.**	1							1		2	
Polygonum arenastrum/bellardii		17		4		6		9	10	12	13
Polyonum* cf. *arenastrum/bellardii											12
***Rumex* sp.**									1		2
Polygonaceae/Cyperaceae endosperm	5	22	19	6	1	20	9	30	24	15	33
Polygonaceae/Cyperaceae indet							1				
***Adonis* sp.**				1							1
Ranunculus* cf. *repens											
Rosaceae indet											
***Agrimonia* cf. *eupatoria* (fruit)**		1									
***Agrimonia* sp.**											
***Rosa* spp.**		1					1	8	3		1
Asperula* cf. *involucrata		8				8	16				9
***Asperula* sp.**											

Sos Höyük archaeobotanical code	SOS25	SOS26	SOS27	SOS28	SOS29	SOS30	SOS31	SOS32	SOS33	SOS34	SOS35
cf. *Crucianella* sp.											
Galium spp. >1mm	1	10	1			6	10	5	32	5	64
Galium spp. <1mm									32		8
cf. *Galium* sp. (mineralised)											
cf. *Verbascum* sp.											
Solanaceae indet											
Hyoscyamus niger											5
Solanum cf. *nigrum*											
Thymelaea cf. *passerina*							8				
Valerianaceae											
Viola *sp.*											
Fruit tissue Type B											
mini pine cone											
Type AE						8					
Pod A Indet								1			1
Wild Seed indet	16	89	3	10	4	26	6	24	22	37	80
Indeterminate stalk	4										
Indeterminate bud											
Insect damage to cereal grain											y
Rodent faecal pellets											
Sheep/goat faecal pellets											
Amorphous dung mass present	y	y	y	y	y	y	y	y	y		
Straw/Phytolith clumps	y		y						y		

Sos Höyük archaeobotanical code	**SOS36**	**SOS37**	**SOS38**	**SOS39**	**SOS40**	**SOS41**	**SOS42**	**SOS43**	**SOS44**	**SOS45**	**SOS46**	**SOS47**
Trench	M15d	M16d	M15d	M16d/ N16c	M15d	M16bd/N16ac	M16bd/ N16ac	M16bd/ N16ac	L16	M16	L16	M16
Loci	1855	3642	1855	3640	1855	3640	3640	3635	4149	591	4154	591
Basket	212	272	211	266	206	274	273	240	47	174	57	174
Sample	s.534	s.574	s.530	s.563	s.514	s.580	s.575	s.513	s.95	s.306	s.130	
Period	EBIII	EBIII	EBIII	EBIII	EBIII	EBIII	EBIII	MBI	MBI	MBI	MBI	MBI
Context	Grave fill	Grave fill	Grave fill	General debris	General debris	General debris	General debris	Pit	Pit	Floor level	Pit	Floor level
Fraction analysed	1	1	1	1	1	1	1/4	1/4	1	1	1	1
Total wood charcoal volume (ml) >1mm	58	141	53	117	100	132	148	209	60	85	44	12
Total non-charred volume (ml) >1mm	5	10	7	39	7	18	32	30	10	3	25	0.25
Total cereal grains	47	89	52	79	106	18	51	53	19	12	33	5
Total cereal chaff	58	178	138	94	282	75	167	78	45	102	130	32
Total wild seed items	198	458	237	349	606	211	671	141	166	129	211	33
Total items	110	277	197	212	395	111	250	161	74	117	188	37.25
Cereal Grain												
Triticum dicoccum											1	
Triticum* cf. *dicoccum				4				2				
Triticum dicoccum/aestivum/durum	4	6		9	6							
Triticum aestivum/durum	12	18	22	28	35	3	24	18	5	3	18	
Triticum* cf. *aestivum/durum	3	11	7	8	11			6	3	2		
***Tritcum* sp.**	5	13	5		7		1	3	2		2	1
cf. *Triticum* sp.	2											
***Hordeum* hulled assymetric**												
***Hordeum* cf. hulled assymetric**						2	1					

Sos Höyük archaeobotanical code	SOS36	SOS37	SOS38	SOS39	SOS40	SOS41	SOS42	SOS43	SOS44	SOS45	SOS46	SOS47
Hordeum **hulled symmetric**	4	22	3	17	15	7	7	8		6	5	4
Hordeum **cf. hulled symmetric**				6								
Hordeum **hulled assymmetric/symmetric**	12	15	13		17		11	11	8	1	5	
Hordeum **assymmetric/symmetric cf. naked**												
Hordeum **indeterminate**					5	2					2	
cf. *Hordeum* sp.		4		7								
Triticum/Hordeum	5		2		10	4	7	5	1			
Secale **cf. *cereale***												
Cereal Chaff												
Triticum dicoccum (**glume base)**		2						22				
Triticum **cf. *dicoccum (*** **glume base)**												
Triticum **sp. (glume base)**			1	1	4			2				
Triticum aestivum **(rachis)**	3	11	9	8	28	17	56	6	7	4	29	
Triticum **cf. *aestivum*** **(rachis)**	3	8	20			6	16	3	4	3	8	1
Triticum **cf. *durum*** **(rachis)**				2						1		
Triticum aestivum/durum **(rachis)**			10	4	14		6			5	3	
Triticum **cf. *aestivum/durum*** **(rachis)**		8					4					
Triticum aestivum/durum **(basal rachis)**	2	2			5	1	4	3	1			
Triticum sp. **(terminal spikelet)**	1	16		8	9							
Hordeum vulgare **(internode)**	2				3	1						
Hordeum **cf. *vulgare*** **(internode)**					2							
Hordeum distichum **(internode)**	5	10	22	5	52	2		2		10	17	1
Hordeum **cf. *distichum*** **(internode)**		3			2		4			2		4
Hordeum vulgare/distichum **(internode)**		10	14	2	36	24			2	9	7	8
cf. *Hordeum vulgare/distichum* **(internode)**											3	

Sos Höyük archaeobotanical code	**SOS36**	**SOS37**	**SOS38**	**SOS39**	**SOS40**	**SOS41**	**SOS42**	**SOS43**	**SOS44**	**SOS45**	**SOS46**	**SOS47**
Triticum/Hordeum **(internode)**				2	5		40	9	16	2	30	8
Triticum/Hordeum **(basal rachis)**												
cf. ***Secale*** **sp. (internode)**												
Cerealia, Culm base												
Cerealia, root	17	37	15	13	30	6	16	6	5	22	14	2
Cerealia, culm node	25	71	47	49	92	18	21	25	10	44	19	8
Other crop/collected foods												
Lens cf.culinaris											1	
cf. ***Lens sp.***												
Vicia ervilia						1						
Pisum sativum												
Lathyrus sativus						1						
Pulse indet				1					1			
cf. ***Avena sp. (*** **floret base)**												
Panicum miliaceum												
cf. ***Panicum miliaceum***												
Camelina sativa												
cf. ***Camelina sativa***		2	1									
Pistachia **sp.**												
Wild/Weedy items												
Amaranthaceae								3	9			
Indet Amaranthaceae pod												
Atriplex **cf.** ***lasiantha*** **(in bracts)**												
Atriplex **sp.**		8	1			8			1			

Sos Höyük archaeobotanical code	**SOS36**	**SOS37**	**SOS38**	**SOS39**	**SOS40**	**SOS41**	**SOS42**	**SOS43**	**SOS44**	**SOS45**	**SOS46**	**SOS47**
cf. *Atriplex* sp.												
***Beta vulgaris* (fruit)**												
Chenopodium album	8	39	2		30		309	19	8		19	
Chenopodium foliosum												
***Chenopodium* sp.**			8			8						
***Chenopodium/Atriplex* spp.**					32							
***Kochia prostata/scoparia* (fruit)**								1		1		
cf. *Kochia prostrata/scoparia*								1	17		8	4
Polycnemum arvense									16			
***Salsola* sp.**												
Apiaceae												
Apiaceae Type E												
Apiaceae Type F												
***Bupleurum* type**		9										
***Coriandrum* type**												
cf. *Caucalis platycarpos*												
Falcaria vulgaris												
Asteraceae												
Asteraceae Type C												
Asteraceae Type E				1								
***Anthemis* sp.**												
cf. *Artemesia* sp.												
***Aster* type**												
***Centaurea* sp.**												
***Crepis* sp.**											1	
Boraginaceae												

Sos Höyük archaeobotanical code	**SOS36**	**SOS37**	**SOS38**	**SOS39**	**SOS40**	**SOS41**	**SOS42**	**SOS43**	**SOS44**	**SOS45**	**SOS46**	**SOS47**
***Buglossoides arvensis* (mineralised)**	4	5		18	11	11	34	2	5	3	3	1
***Lithospermum officinale* (mineralised)**	1	2		4		3	1				1	
***Myosotis* sp.**												
***Rochelia* sp.**												
Brassicaceae		16					1				2	
Brassicaceae pod B												
Brassicaceae type D/F				8								
Brassicaceae type E							1					
cf. *Alyssum* sp.												
Brassica type												
***Cardaria/Lepidium* type**	1	10			5			3			9	1
***Euclidium syriacum* (seed capsule)**			1		2					1	10	
cf. *Euclidium syriacum*									1	1	2	
Thlaspi arvense				8	1			1				
Caryophyllaceae												
***Gypsophila* sp.**												
***Silene* sp.**		16										
***Silene* sp. type 1**		1	1			1						
***Silene* sp. type 2**				8								
Vaccaria pyramidata	1	5		4	3	1	1	8		2	1	
***Convolvulus* sp.**	1	1			1							
Cyperaceae	2	16	4	11	1	2		1	1		2	
Bolboschenus maritimus			1	4		2	1		2	2	2	
***Carex* spp.**						8						
***Cyperus* spp.**												
***Eleocharis* sp. (mineralised)**								2				

Sos Höyük archaeobotanical code	**SOS36**	**SOS37**	**SOS38**	**SOS39**	**SOS40**	**SOS41**	**SOS42**	**SOS43**	**SOS44**	**SOS45**	**SOS46**	**SOS47**
Fabaceae												
Fabaceae long pod					1							
***Astragalus* sp.**				1	1							
***cf. Coronilla* sp.**					1							
***Lathyrus* sp.**												
***Medicago* cf. *papillosa* (pod)**												
cf. *Onobrychis* sp.												
Trifolium/Melilotus/Medicago	43	103	30	92	262	2	110	23	43	34	46	6
Trigonella astroites												
***Trigonella* sp.**									8	8	8	
***Vicia/Lathyrus* sp.**		8			1						1	1
Vicia/Pisum												
***Geranium* sp.**					1							
Juncaceae seed head												
Juncus sp.												
Lamiaceae indet												
***Ajuga/Teucrium* sp.**					1		8					
***cf. Ajuga* sp.**												
Lallemantia iberica/canescens/peltata	7	25	5	5	6	2	11	2		4	2	
***Nepeta* sp. type**												
***Teucrium* sp.**					1							
cf. *Bellevalia* sp.												
Malva* cf. *neglecta												
***Malva* cf. *sylvestris* (pod)**	1											
***Malva* sp.**	2			1		4	1	1		1	4	
***Fumaria* sp.**					1							

Sos Höyük archaeobotanical code	SOS36	SOS37	SOS38	SOS39	SOS40	SOS41	SOS42	SOS43	SOS44	SOS45	SOS46	SOS47
cf. *Plantago* sp.												
Poaceae		19		21	9	10	2	4	2	5	3	10
Poaceae chaff												
Aegilops sp.												
Bromus cf. *japonicus*	4	3	20	2	14	8	4	4				
Lolium perenne/multiflorum	4	2	3		6		1			1	1	
cf. *Lolium* sp.						4						
Small seeded grass Panicoid	2				2							
Taeniatherum caput-medusae												
Taeniatherum caput-medusae (chaff)												
cf. *Taeniatherum caput-medusae* (chaff)												
Fallopia convolvulvus		1		1			2					
Persicaria sp.		8	1		24	1	7	6				
Polygonum arenastrum/bellardii	6	8	14	11	13	10	18	18	5	1	6	1
Polyonum cf. *arenastrum/bellardii*												
Rumex sp.	1	1			1	2		2		5		
Polygonaceae/Cyperaceae endosperm	22	20	35	36	34	32	63	7	4	31	6	5
Polygonaceae/Cyperaceae indet		1								4	1	
Adonis sp.	2	2	3	2			1			1		
Ranunculus cf. *repens*												
Rosaceae indet												
Agrimonia cf. *eupatoria* (fruit)						1				1		
Agrimonia sp.												
Rosa spp.			1	13	3							
Asperula cf. *involucrata*		8		8					32		8	
Asperula sp.												

Sos Höyük archaeobotanical code	SOS36	SOS37	SOS38	SOS39	SOS40	SOS41	SOS42	SOS43	SOS44	SOS45	SOS46	SOS47
cf. *Crucianella* sp.	8		8		16	1						
Galium spp. >1mm	11	46	21	42	30	32	22	10	6		1	1
Galium spp. <1mm					16				8		8	
cf. *Galium* sp. (mineralised)	19		38		11							
cf. *Verbascum* sp.												
Solanaceae indet												
Hyoscyamus niger												
Solanum cf. *nigrum*												
Thymelaea cf. *passerina*					1	8					8	
Valerianaceae												
Viola *sp.*												
Fruit tissue Type B				1					3	5		
mini pine cone							1					
Type AE	8	16				1				8		
Pod A Indet		1	1		2							
Wild Seed indet	40	58	39	47	62	49	72	26	4	10	48	3
Indeterminate stalk											8	
Indeterminate bud					1							
Insect damage to cereal grain												
Rodent faecal pellets												
Sheep/goat faecal pellets												
Amorphous dung mass present		y	y	y			y	y	y		y	y
Straw/Phytolith clumps	y	y		y	y				y		y	

Sos Höyük archaeobotanical code	**SOS48**	**SOS49**	**SOS50**	**SOS51**	**SOS52**	**SOS53**	**SOS54**	**SOS55**	**SOS56**	**SOS57**	**SOS58**
Trench	L16	M16	M16bd/ N16ac	L16c	L16c	L16c	L16c	L16c	L16	L16	L16
Loci	4140	591	3635	4035	4012	4037	4034	4031	4115	4115	4117
Basket	24	174	239	60	23	63	56	49	179	187	186
Sample	s.62	s.307	s.507	s.166	s.62	s.169	s.151	s.126	s.413	s.427	s.424
Period	MBI	MBI	MBI	MBII	MBII	MBII	MBII	MBII	MBII	MBII	MBII
Context	Hearth contents	Floor level	Pit	General debris	Pit	Hearth contents	Hearth contents	Floor level	Pot contents	Floor level	Floor level
Fraction analysed	1	1/2	1/4	1	1	1	1	1	1	1	1
Total wood charcoal volume (ml) >1mm	24	180	297	38	19.5	8	35	20	57	239	58
Total non-charred volume (ml) >1mm	7	2	64	10	30	2	30	30	0.5	2.5	7
Total cereal grains	1	19	45	251	28	47	119	67	84	36	82
Total cereal chaff	4	146	113	47.5	7	12	29	17	444	177	489
Total wild seed items	75	235	330	200	349	44	112	42	306	314	603
Total items	12	167	222	308.5	65	61	178	114	528.5	215.5	578
Cereal Grain											
Triticum dicoccum				1							
Triticum* cf. *dicoccum			5	2			1	2			
Triticum dicoccum/aestivum/durum											
Triticum aestivum/durum		2	14	29	4	4	5	16	32	4	25
Triticum* cf. *aestivum/durum		4			8	3	5			2	7
***Tritcum* sp.**		1	4	5	1	5	3	4	19	3	18
cf. *Triticum* sp.											
***Hordeum* hulled assymetric**			2	6		1	1				
***Hordeum* cf. hulled assymetric**										1	

Sos Höyük archaeobotanical code	**SOS48**	**SOS49**	**SOS50**	**SOS51**	**SOS52**	**SOS53**	**SOS54**	**SOS55**	**SOS56**	**SOS57**	**SOS58**
Hordeum **hulled symmetric**		11	3	122	10	28	68	26	12	11	14
Hordeum **cf. hulled symmetric**											
Hordeum **hulled assymmetric/symmetric**	1	1	6	60	5	6	32	19	16	15	16
Hordeum **assymmetric/symmetric cf. naked**				8			1				
Hordeum **indeterminate**				11					5		
cf. ***Hordeum*** **sp.**											2
Triticum/Hordeum			11	7			3				
Secale **cf.** ***cereale***											
Cereal Chaff											
Triticum dicoccum (**glume base)**			13								
Triticum **cf.** ***dicoccum (*** **glume base)**							1		1		
Triticum **sp. (glume base)**											
Triticum aestivum **(rachis)**		3	22	19	1	3		3	90	4	94
Triticum **cf.** ***aestivum*** **(rachis)**				2	1		3		13	4	18
Triticum **cf.** ***durum*** **(rachis)**											
Triticum aestivum/durum **(rachis)**			6	16					7	2	48
Triticum **cf.** ***aestivum/durum*** **(rachis)**									12		15
Triticum aestivum/durum **(basal rachis)**		1	2						20	10	27
Triticum sp. **(terminal spikelet)**		1		2.5		9			1		9
Hordeum vulgare **(internode)**											
Hordeum **cf.** ***vulgare*** **(internode)**											
Hordeum distichum **(internode)**		15							38	38	49
Hordeum **cf.** ***distichum*** **(internode)**			5				8	8	2	4	6
Hordeum vulgare/distichum **(internode)**		48	6				2		6	2	58
cf. ***Hordeum vulgare/distichum*** **(internode)**		3							24	32	7

Sos Höyük archaeobotanical code	**SOS48**	**SOS49**	**SOS50**	**SOS51**	**SOS52**	**SOS53**	**SOS54**	**SOS55**	**SOS56**	**SOS57**	**SOS58**
***Triticum/Hordeum* (internode)**			32	8						11	
***Triticum/Hordeum* (basal rachis)**											5
cf. *Secale* sp. (internode)									2		
Cerealia, Culm base											
Cerealia, root	4	20	8		1		7	2	73	14	53
Cerealia, culm node		55	19		4		8	4	155	56	100
Other crop/collected foods											
Lens cf.culinaris											
cf. *Lens sp.*											
Vicia ervilia											
Pisum sativum		3									
Lathyrus sativus											
Pulse indet											
cf. *Avena sp. (* floret base)											
Panicum miliaceum				5	2		5				
cf. *Panicum miliaceum*											
Camelina sativa											
cf. *Camelina sativa*		32									
***Pistachia* sp.**											
Wild/Weedy items											
Amaranthaceae		16	2								
Indet Amaranthaceae pod											
***Atriplex* cf. *lasiantha* (in bracts)**									1	2	8
***Atriplex* sp.**									18	2	

Sos Höyük archaeobotanical code	**SOS48**	**SOS49**	**SOS50**	**SOS51**	**SOS52**	**SOS53**	**SOS54**	**SOS55**	**SOS56**	**SOS57**	**SOS58**
cf. *Atriplex* sp.					2			1		8	40
***Beta vulgaris* (fruit)**											
Chenopodium album				1	17			1	82	16	44
Chenopodium foliosum											8
***Chenopodium* sp.**		1									
***Chenopodium/Atriplex* spp.**											72
***Kochia prostata/scoparia* (fruit)**	8		2	3	3		1				
cf. *Kochia prostrata/scoparia*			18	8					8	8	
Polycnemum arvense					8						
***Salsola* sp.**											
Apiaceae											
Apiaceae Type E											
Apiaceae Type F									4		1
***Bupleurum* type**											
***Coriandrum* type**											
cf. *Caucalis platycarpos*											
Falcaria vulgaris											
Asteraceae											
Asteraceae Type C				8					8		
Asteraceae Type E											
***Anthemis* sp.**											
cf. *Artemesia* sp.											
***Aster* type**											
***Centaurea* sp.**									1		
***Crepis* sp.**											
Boraginaceae											

Sos Höyük archaeobotanical code	**SOS48**	**SOS49**	**SOS50**	**SOS51**	**SOS52**	**SOS53**	**SOS54**	**SOS55**	**SOS56**	**SOS57**	**SOS58**
Buglossoides arvensis **(mineralised)**		3	5	3	92	1	1		3	4	7
Lithospermum officinale **(mineralised)**		1									2
Myosotis **sp.**					1						
Rochelia **sp.**					27						
Brassicaceae		2									
Brassicaceae pod B											
Brassicaceae type D/F	16										
Brassicaceae type E											
cf. *Alyssum* sp.											
Brassica type		9			2						
Cardaria/Lepidium **type**				8	4		1		1	1	29
Euclidium syriacum **(seed capsule)**			1		1						1
cf. *Euclidium syriacum*		2									
Thlaspi arvense		8								8	
Caryophyllaceae				8							
Gypsophila **sp.**											
Silene **sp.**								8			
Silene **sp. type 1**			2		5				1	8	17
Silene **sp. type 2**				8	1						
Vaccaria pyramidata		1	6	10	3	1	2	3	3		3
Convolvulus **sp.**			1	1		1				1	
Cyperaceae		1	8		32		1		8		32
Bolboschenus maritimus		1	2							1	1
Carex **spp.**				2							
Cyperus **spp.**											8
Eleocharis **sp. (mineralised)**			8	1	64						8

Sos Höyük archaeobotanical code	**SOS48**	**SOS49**	**SOS50**	**SOS51**	**SOS52**	**SOS53**	**SOS54**	**SOS55**	**SOS56**	**SOS57**	**SOS58**
Fabaceae											
Fabaceae long pod											
***Astragalus* sp.**											
***cf. Coronilla* sp.**											
***Lathyrus* sp.**											
***Medicago* cf. *papillosa* (pod)**											
cf. *Onobrychis* sp.											
Trifolium/Melilotus/Medicago		20	47	31	2	24	56	4	44	46	110
Trigonella astroites											
***Trigonella* sp.**			8						8		
***Vicia/Lathyrus* sp.**		1					2			1	24
Vicia/Pisum											
***Geranium* sp.**											
Juncaceae seed head											
Juncus sp.											
Lamiaceae indet											
***Ajuga/Teucrium* sp.**											
***cf. Ajuga* sp.**											
Lallemantia iberica/canescens/peltata		14	12						7	11	19
***Nepeta* sp. type**											
***Teucrium* sp.**			1								
cf. *Bellevalia* sp.											
Malva* cf. *neglecta											
***Malva* cf. *sylvestris* (pod)**									1		
***Malva* sp.**						8				1	1
***Fumaria* sp.**											

Sos Höyük archaeobotanical code	**SOS48**	**SOS49**	**SOS50**	**SOS51**	**SOS52**	**SOS53**	**SOS54**	**SOS55**	**SOS56**	**SOS57**	**SOS58**
cf. *Plantago* sp.											
Poaceae		4	43	4	36	1		1	16	16	28
Poaceae chaff											
***Aegilops* sp.**											
Bromus* cf. *japonicus				2							2
Lolium perenne/multiflorum		2									3
cf. *Lolium* sp.				2							
Small seeded grass Panicoid											
Taeniatherum caput-medusae											
***Taeniatherum caput-medusae* (chaff)**											
cf. *Taeniatherum caput-medusae* (chaff)											
Fallopia convolvulus						1				1	1
***Persicaria* sp.**		1	1						1	2	2
Polygonum arenastrum/bellardii		3	16		3		1		13	17	26
Polyonum* cf. *arenastrum/bellardii											
***Rumex* sp.**		11	1	4					6	1	6
Polygonaceae/Cyperaceae endosperm		78	16	5	1	1	29	2	21	4	19
Polygonaceae/Cyperaceae indet			32	16							
***Adonis* sp.**			2						1	1	
Ranunculus* cf. *repens											
Rosaceae indet											
***Agrimonia* cf. *eupatoria* (fruit)**											
***Agrimonia* sp.**											
***Rosa* spp.**				1			8		1	1	
Asperula* cf. *involucrata									16	8	1
***Asperula* sp.**											

Sos Höyük archaeobotanical code	**SOS48**	**SOS49**	**SOS50**	**SOS51**	**SOS52**	**SOS53**	**SOS54**	**SOS55**	**SOS56**	**SOS57**	**SOS58**
cf. *Crucianella* sp.											
***Galium* spp. >1mm**		2	7	13	18	3	6	3	9	4	7
***Galium* spp. <1mm**											
cf. *Galium* sp. (mineralised)											
cf. *Verbascum* sp.											
Solanaceae indet											
Hyoscyamus niger		26							9	78	1
Solanum* cf. *nigrum								1			
Thymelaea* cf. *passerina											
Valerianaceae											
Viola *sp.*											
Fruit tissue Type B											
mini pine cone		10							4		2
Type AE								16		48	8
Pod A Indet										1	
Wild Seed indet	51	34	91	61	27	3	4	2	11	14	62
Indeterminate stalk											
Indeterminate bud		1						2			
Insect damage to cereal grain											
Rodent faecal pellets		8							2		
Sheep/goat faecal pellets											
Amorphous dung mass present				y	y	y		y	y	y	y
Straw/Phytolith clumps		y			y		y				

Sos Höyük archaeobotanical code	**SOS59**	**SOS60**	**SOS61**	**SOS62**	**SOS63**	**SOS64**	**SOS65**	**SOS66**	**SOS67**	**SOS68**	**SOS69**	**SOS70**
Trench	L16c	L16c	L16c	L16	L16c	L16c	L16c	L16c	L16c	L16c	L16	L16
Loci	4064	4070	4045	4123	4073	4035	4067	4064	4057	4054	4120	4117
Basket	67	111	83	204	74	71	61	67	30	24	197	188
Sample	s.187	s.236	s.236	s.459	s.207	s.188	s.154	s.177	s.75	s.62	s.447	s.433
Period	MBII	MBII	MBII	MBII	MBII	MBII	MBII	MBII	MBII	MBII	MBII	MBII
Context	Pit	Pit	General debris	Pit	Pit	General debris	Pit	Pit	Pit	Floor level	Floor level	Floor level
Fraction analysed	1	1	1/4	1/2	1/2	1	1	1	1/8	1/2	1	1
Total wood charcoal volume (ml) >1mm	128	97	446	285	193	29	338	52	362	759	25	79
Total non-charred volume (ml) >1mm	65	1.5	14	10	235	20	5	19	181	42	12	7
Total cereal grains	82	141	70	56	29	308	63	94	170	98	23	144
Total cereal chaff	323	142	27	18	104	44	23	247	136	41	59	253
Total wild seed items	774	340	203	231	265	165	86	914	186	374	64	441
Total items	470	284.5	111	84	368	372	91	360	487	181	94	404
Cereal Grain												
Triticum dicoccum	3			3	1			3	3	2		
Triticum* cf. *dicoccum	5	10	2		1	4	1		10	3		
Triticum dicoccum/aestivum/durum	2							6				
Triticum aestivum/durum	19	41	12	11	6	23	10	10	28	30	6	29
Triticum* cf. *aestivum/durum	6	10			2	4	8	4	22	5	4	15
***Tritcum* sp.**	10	17	1	6	1		6	24	28	15		29
cf. *Triticum* sp.												
***Hordeum* hulled assymetric**		2			1	8						
***Hordeum* cf. hulled assymetric**												

Sos Höyük archaeobotanical code	SOS59	SOS60	SOS61	SOS62	SOS63	SOS64	SOS65	SOS66	SOS67	SOS68	SOS69	SOS70
Hordeum **hulled symmetric**	8	28	22	8	9	185	10	12	25	9	6	22
Hordeum **cf. hulled symmetric**												
Hordeum **hulled assymmetric/symmetric**	18	29	30	9	8	74	8	31	40	34	7	19
Hordeum **assymmetric/symmetric cf. naked**						10						
Hordeum **indeterminate**	3	3	3	2			8		7			
cf. *Hordeum* sp.												
Triticum/Hordeum	8	1		17			12	4	7			30
Secale **cf. *cereale***		1										
Cereal Chaff												
Triticum dicoccum (**glume base)**	110	35	6	7	3	6	10	151	19	26		
Triticum **cf. *dicoccum (*** **glume base)**	40	52	1									
Triticum **sp. (glume base)**												
Triticum aestivum **(rachis)**	29		2	1	23	10		41	32	3	7	74
Triticum **cf. *aestivum*** **(rachis)**	4		1		3				8			
Triticum **cf. *durum*** **(rachis)**												
Triticum aestivum/durum **(rachis)**	9		1		2	3	2	3	1		2	26
Triticum **cf. *aestivum/durum*** **(rachis)**	16	1							3			
Triticum aestivum/durum **(basal rachis)**	28				9			2	4	1	3	4
Triticum sp. **(terminal spikelet)**	3							4	1			
Hordeum vulgare **(internode)**												
Hordeum **cf. *vulgare*** **(internode)**												
Hordeum distichum **(internode)**			1		22			5	32		16	44
Hordeum **cf. *distichum*** **(internode)**			8	2								
Hordeum vulgare/distichum **(internode)**			1				8				16	32
cf. *Hordeum vulgare/distichum* **(internode)**	16								3			

Sos Höyük archaeobotanical code	SOS59	SOS60	SOS61	SOS62	SOS63	SOS64	SOS65	SOS66	SOS67	SOS68	SOS69	SOS70
Triticum/Hordeum (internode)			1			8			1			3
Triticum/Hordeum (basal rachis)										8		
cf. *Secale* sp. (internode)									1			
Cerealia, Culm base												
Cerealia, root	25	24	2	5	15	4		8	2	1	1	18
Cerealia, culm node	43	30	3	3	27	13	3	33	29	2	14	52
Other crop/collected foods												
Lens cf.culinaris									4			
cf. *Lens sp.*									2			1
Vicia ervilia						1						
Pisum sativum								2				
Lathyrus sativus												
Pulse indet												
cf. *Avena sp. (* floret base)	1											
Panicum miliaceum			1			15			5			
cf. *Panicum miliaceum*									8			
Camelina sativa				74								
cf. *Camelina sativa*	1			72	1	2						
Pistachia sp.												
Wild/Weedy items												
Amaranthaceae									3	2		2
Indet Amaranthaceae pod												
Atriplex cf. *lasiantha* (in bracts)												
Atriplex sp.	27							8				2

Sos Höyük archaeobotanical code	SOS59	SOS60	SOS61	SOS62	SOS63	SOS64	SOS65	SOS66	SOS67	SOS68	SOS69	SOS70
cf. *Atriplex* sp.		16									6	
Beta vulgaris (fruit)										1		
Chenopodium album	78	8	40		16	8	8	289	16	40		178
Chenopodium foliosum												
Chenopodium sp.	136			16					1	1	4	2
Chenopodium/Atriplex spp.		24										
Kochia prostata/scoparia (fruit)	1	4				1	2		4	5		
cf. *Kochia prostrata/scoparia*			8									
Polycnemum arvense										1		
Salsola sp.												
Apiaceae								1				
Apiaceae Type E		1						2	2			
Apiaceae Type F												
Bupleurum type				2								
Coriandrum type												
cf. *Caucalis platycarpos*												
Falcaria vulgaris												
Asteraceae					1				1			
Asteraceae Type C		8										
Asteraceae Type E												
Anthemis sp.												
cf. *Artemesia* sp.												
Aster type												
Centaurea sp.								1				
Crepis sp.												
Boraginaceae									1			

Sos Höyük archaeobotanical code	**SOS59**	**SOS60**	**SOS61**	**SOS62**	**SOS63**	**SOS64**	**SOS65**	**SOS66**	**SOS67**	**SOS68**	**SOS69**	**SOS70**
Buglossoides arvensis (mineralised)	5		2	2	4		5	3		7		5
Lithospermum officinale (mineralised)					1						1	1
Myosotis sp.												
Rochelia sp.												
Brassicaceae		1				3						
Brassicaceae pod B												
Brassicaceae type D/F	48											
Brassicaceae type E												
cf. _Alyssum_ sp.												
Brassica type												
Cardaria/Lepidium type			1		2	1	1		1	9		
Euclidium syriacum (seed capsule)	3											
cf. _Euclidium syriacum_												
Thlaspi arvense												
Caryophyllaceae						2						
Gypsophila sp.												
Silene sp.												
Silene sp. type 1	16		1	3	24			24	1			8
Silene sp. type 2								24				8
Vaccaria pyramidata	2	1	6			9		9	1	1	1	2
Convolvulus sp.	9	2	1	2	4	2		17	1	1		1
Cyperaceae	17						2	34		18		
Bolboschenus maritimus		1		1	1	3	1	2	1			1
Carex spp.						1	2	17	9			21
Cyperus spp.									1			
Eleocharis sp. (mineralised)					1					16		

Sos Höyük archaeobotanical code	**SOS59**	**SOS60**	**SOS61**	**SOS62**	**SOS63**	**SOS64**	**SOS65**	**SOS66**	**SOS67**	**SOS68**	**SOS69**	**SOS70**
Fabaceae					8							
Fabaceae long pod												
***Astragalus* sp.**												
***cf. Coronilla* sp.**	1							5				
***Lathyrus* sp.**												
***Medicago* cf. *papillosa* (pod)**									7			
cf. *Onobrychis* sp.									1			
Trifolium/Melilotus/Medicago	141	49	7	48	35	47	17	178	41	119		88
Trigonella astroites					8			2				
***Trigonella* sp.**			1		8	8	8					
***Vicia/Lathyrus* sp.**	3	1					1	6		3	1	
Vicia/Pisum	2											
***Geranium* sp.**												
Juncaceae seed head												
Juncus sp.												
Lamiaceae indet									1			
***Ajuga/Teucrium* sp.**												
***cf. Ajuga* sp.**								1				
Lallemantia iberica/canescens/peltata	12			88	14			16		1	5	16
***Nepeta* sp. type**												
***Teucrium* sp.**	1											
cf. *Bellevalia* sp.										1		
Malva* cf. *neglecta												
***Malva* cf. *sylvestris* (pod)**												
***Malva* sp.**	16						1	24				9
***Fumaria* sp.**	1									1		

Sos Höyük archaeobotanical code	SOS59	SOS60	SOS61	SOS62	SOS63	SOS64	SOS65	SOS66	SOS67	SOS68	SOS69	SOS70
cf. *Plantago* sp.												
Poaceae	24	15	19	9	4	1			11	17	1	12
Poaceae chaff					8							1
Aegilops sp.												
Bromus cf. *japonicus*	3	1			6	1		15	4	1	2	1
Lolium perenne/multiflorum	19	4	1		1		1	6				
cf. *Lolium* sp.									6	10	1	
Small seeded grass Panicoid									4			
Taeniatherum caput-medusae					1							
Taeniatherum caput-medusae (chaff)												
cf. *Taeniatherum caput-medusae* (chaff)	2											
Fallopia convolvulvus										1		2
Persicaria sp.	2	1		1	1			2	2	4		2
Polygonum arenastrum/bellardii	12	23	5		5	5	1	69	2	20	6	9
Polyonum cf. *arenastrum/bellardii*												
Rumex sp.			3	1	4	4			14			4
Polygonaceae/Cyperaceae endosperm	60	31	23	14	5	7	11	42	22	43	22	8
Polygonaceae/Cyperaceae indet												
Adonis sp.									1			2
Ranunculus cf. *repens*						1						
Rosaceae indet												
Agrimonia cf. *eupatoria* (fruit)												
Agrimonia sp.			1									
Rosa spp.	2		1			1		2				
Asperula cf. *involucrata*								40				8
Asperula sp.												

Sos Höyük archaeobotanical code	**SOS59**	**SOS60**	**SOS61**	**SOS62**	**SOS63**	**SOS64**	**SOS65**	**SOS66**	**SOS67**	**SOS68**	**SOS69**	**SOS70**
cf. *Crucianella* sp.												8
***Galium* spp. >1mm**	17	17	10	6	27	19	7	7	18	15	3	5
***Galium* spp. <1mm**						16		40				
cf. *Galium* sp. (mineralised)												
cf. *Verbascum* sp.									8			
Solanaceae indet					1							
Hyoscyamus niger	16							9				25
Solanum* cf. *nigrum												
Thymelaea* cf. *passerina												
Valerianaceae												
Viola *sp.*												
Fruit tissue Type B			1									
mini pine cone												1
Type AE		16								32	8	
Pod A Indet	2											
Wild Seed indet	96	116	72	38	75	25	18	19	4	6	3	11
Indeterminate stalk		1										
Indeterminate bud		11										
Insect damage to cereal grain												
Rodent faecal pellets	2	4	1									
Sheep/goat faecal pellets					6	3						
Amorphous dung mass present	y	y			y	y		y	y		y	y
Straw/Phytolith clumps					y	y						

Appendix B.

Table B1 Project taxa name used in the database base on the International Plant Name Index and Zohary *et al*. (2012) and the alternative or superceded name from site reports.

Project taxa name	**Species name from reports**
Aegilops neglecta Req. ex Bertol.	*Aegilops ovata*
Aizoanthemum hispanicum (L.) H.E.K.Hartmann	*Aizoon hispanicum*
Alchemilla arvensis (L) Scop.	*Aphanes arvensis*
Alhagi maurorum Medik.	*Alhagi camelorum*
Amaranthaceae	*Chenopodiaceae*
Arabidopsis sp.	*Cardaminopsis*
Avena barbata Pott ex Link	*Avena wiestii*
Bolboschoenus maritimus (L.) Palla	*Scirpus maritimus*
Brachypodium distachyon (L.) P.Beauv.	*Trachynia distachya*
Bromus sp.	*Anisantha* sp.
Buglossoides arvensis (L.) I.M. Johnst.	*Lithospermum arvense*
Buglossoides tenuiflora (L.f.) I.M. Johnst.	*Lithospermum tenuiflorum*
Carex cuprina (Sándor ex Heuff.) Nendtv. ex A.Kern.	*Carex otrubae*
Cephaloceraton histrix (Bory & Durieu) Gennari	*Isoetes histrix*
Cota tinctoria (L.) J.Gay	*Anthemis tinctoria*
Crataegus azarolus L.	*Crataegus aronia*
Eremopyrum bonaepartis (Spreng.) Nevski	*Eremopyrum confusum*
Erucaria pinnata (Viv.) El Naggar	*Reboudia pinnata*
Erysimum sp.	*Cheiranthus*
Fallopia convolvulus (L.) A. Love	*Bilderdykia convolvulvus* *Polygonum convolvulus*
Galium verrucosum Huds.	*Galium tricorne*
Garhadiolus angulosus Jaub. & Spach	*Garhadiolus angulosus*
Glebionis coronaria (L.) Cass. ex Spach	*Chrysanthemum coronarium*
Halothamnus sp.	*Aellenia* sp.
Hordeum distichum L.	*Hordeum sativum* (hulled cf. straight) *Hordeum sativum* (hulled straight) *Hordeum sativum* var. *distichum* *Hordeum vulgare* (2 row)
Hordeum distichum/vulgare var. *nudum*	*Hordeum sativum* (naked indet.) *Hordeum* sp. *var nudum*
Hordeum murinum subsp. *glaucum* (Steud.) Tzvelev	*Hordeum glaucum*
Hordeum murium/marium	*Hordeum lepurinum/hystrix*
Hordeum sp. (hulled)	*Hordeum vulgare s.l.*

Project taxa name	**Species name from reports**
Hordeum spontaneum K.Koch	*Hordeum vulgare spontaneum*
Hordeum vulgare L.	*Hordeum hexastichum* *Hordeum* hulled assymmetrical grain *Hordeum sativum (*hulled twisted*)* *Hordeum sativum* cf. var. *hexastichum*
Hordeum vulgare var. *nudum* Doll	*Hordeum vulgare coeleste*
Hordeum vulgare/distichum	*Hordeum sativum (*indet.*)*
Isoetella duriei (Bory) Gennari	*Isoetes duriei*
Isolepis setacea (L.) R.Br.	*Scirpus setaceus*
Lepidium coronopus (L.) Al-Shehbaz	*Coronopus squamatus*
Medicago monantha (C.A.Mey) Trautv	*Trigonella monantha*
Medicago monspeliaca (L.) Trautv.	*Trigonella monspeliaca*
Melilotus indicus (L.) All.	*Trifolium melilotus*
Moraea sisyrinchium (L.) Ker Gawl.	*Gynandriris sisyrinchium*
Olea europaea subsp. *Cuspidata* (Wall. & G.Don) Cif.	*Olea cuspidata*
Persicaria lapathifolia (L.) Delarbre	*Polygonum lapathifolium*
Persicaria maculosa Gray	*Polygonum persicaria*
Plantago afra L.	*Plantago psyllium* type
Polygonum arenarium Waldst. & Kit.	*Polygonum arenaria* *Polygonum venantianum*
Prunus argentea (Lam.) Rehder	*Amygdalus argentea*
*Prunus dulcis (*Mill.) D.A. Webb	*Amygdalus communis* *Prunus amygdalus*
Prunus incana (Pall.) Batsch	*Cerasus incana*
Prunus scoparia (Spach) C.K.Schneid.	*Amygdalus scoparia*
Prunus sp.	*Amygdalus* sp.
Rostraria sp.	*Lophochloa* sp.
Salsola incanescens C.A. Mey.	*Salsola volkensii*
Schoenoplectus tabernaemontani (C.C.Gmel.) Palla	*Scirpus tabernaemontani*
Triticum aestivum L.	*Triticum aestivum* var *sphaerococcum* *Triticum aestivum* var *vulgare* *Triticum aestivum/compactum*
Triticum aestivum/durum	*Triticum turgidum/aestivum*
Triticum dicoccum Schrank	*Triticum dicoccon* *Triticum turgidum* ssp. *dicoccum*
Triticum durum Desf.	*Triticum turgidum* conv. *Durum*
Triticum free-threshing tetraploid	*Triticum turgidum,* free-threshing
Triticum spelta L.	*Triticum aestivum* ssp. *spelta*
Vitis vinifera L.	*Vitis vinifera* cf. ssp. *vinifera*
Vitis vinifera subsp. *sylvestris* (C.C. Gmel.) Hegi	*Vitis sylvestris*
Vitis vinifera/V vinifera subsp. *sylvestris*	*Vitis sp.*