The agricultural economies of early urban systems in the northern Fertile Crescent

Hyunyoung Kim

Hertford College and

School of Archaeology

University of Oxford

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Abstract

Archaeobotanical investigation of Neolithic-Bronze Age sites in the northern Fertile Crescent has mostly focussed on the Neolithic-Chalcolithic and also on the Euphrates valley. The aim of this study is instead the Bronze Age, especially the later Bronze Age of the second millennium BC. The three sites studied, Tell Mohammed ʻArab, Tell Brak and Tell Atchana, are distributed across the northern Fertile Crescent, in the Tigris, Khabur and Orontes valleys, respectively, and offer assemblages mostly dating to the Late Bronze Age. In conjunction with synthesis of previously published archaeobotanical data from the second millennium BC, this study contributes to a comprehensive overview of agriculture across the region, including its relationship with social complexity and climate change. The new data on crop spectra and associated arable weed/wild taxa is analysed using multivariate statistical approaches, ethnoarchaeological models, functional weed ecology and crop stable isotope analysis. The results reveal the major crop types used at each site, as well as pronounced regional variation in staple taxa; crop processing activities; and arable land management strategies. Overall, a strong correlation is observed among these different dimensions of agricultural activity, urbanisation cycles and scales and environmental settings.

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Chapter 1. Introduction

The northern Fertile Crescent witnessed a series of substantial changes in the Late Chalcolithic through to the Late Bronze Age (*c*. 3300-1200 BC). Ur (2010) has charted shifts between phases of dispersed, small-scale village settlements and phases of urban nucleation through this period in the region. Accompanying these changes in settlement pattern are presumed shifts in the economic basis from a relatively egalitarian system based on self-sustaining, subsistence farming to large-scale state-controlled systems capable of producing surpluses sufficient to maintain a large population not directly involved in food production. Within this broad context, Ur (2010) also recognises socio-political cycles, with phases summarised as original urbanism, de-urbanisation, re-urbanisation, collapse and regeneration, to which can be added the emergence of empires (Akkermans and Schwartz, 2003) (Figure 1.1).

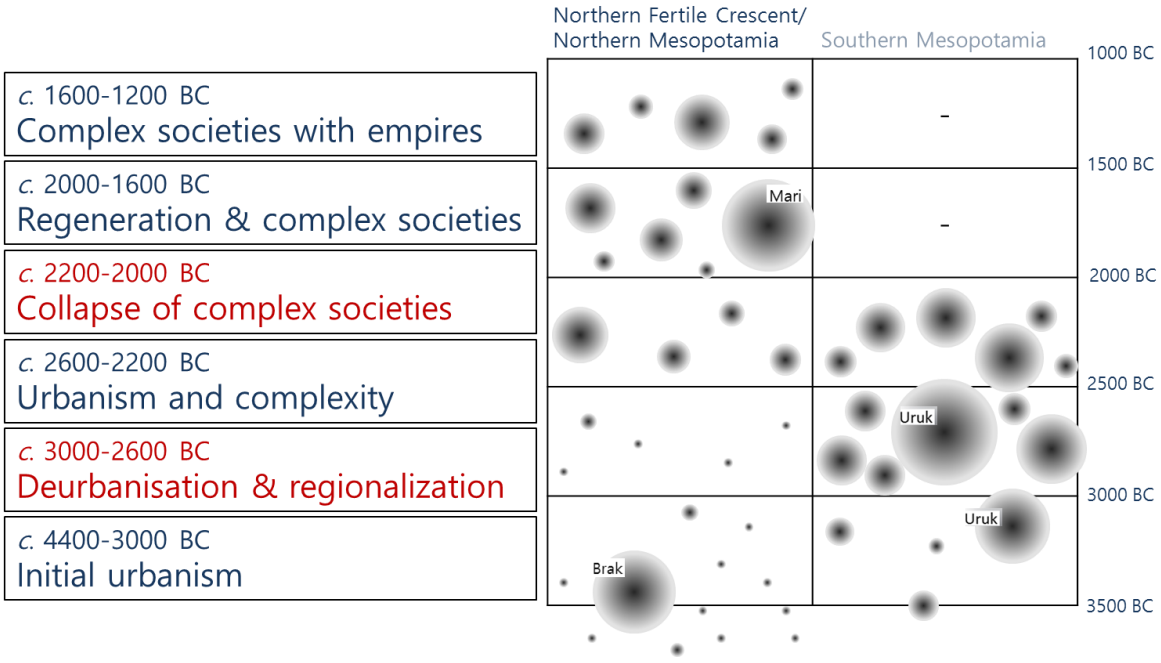


Figure 1.1 The scale and distribution of urban places in the northern Fertile Crescent, coinciding with northern Mesopotamia, in comparison to southern Mesopotamia based on Ur (2010) and Akkermans & Schwartz (2003).

These changes in socio-political organisation have been understood partially as the result of environmental change, to which this marginal region is particularly sensitive (Neumann and Parpola, 1987; Weiss, 1997; Kaniewski *et al.*, 2010; Kaniewski *et al.*, 2011; Drake, 2012; Kaniewski *et al.*, 2013; Langgut, Finkelstein and Litt, 2013; Riehl *et al.*, 2014). Moisture levels varied considerably in the past; for example, rainfall levels are, in general, considered to have halved between approximately 3000 and 1000 BC (Frumkin *et al.*, 1991; Bar-Matthews, Ayalon and Kaufman, 1997; Cullen *et al.*, 2000; Weiss and Bradley, 2001) (Figure 1.2). More specifically, when there were relatively moist conditions, urbanism and social complexity tended to increase in the northern Fertile Crescent. By contrast, when the climate was relatively arid, the archaeological record registers de-urbanisation or even collapse (Figure 1.2). However, it is plausible that there would have been regional differences in terms of the environmental change and social impact. A survey of cropping patterns and archaeobotanical cereal stable carbon isotope data by Riehl (2014), for example, suggests that the resilience of complex societies was affected by geographical and environmental differences as well as agronomic practices such as irrigation that buffered against drought stress. In particular, Riehl (2014) notes that sites located in the moister Mediterranean coastal region were more likely to be resilient in periods of aridification than sites in more marginal areas.

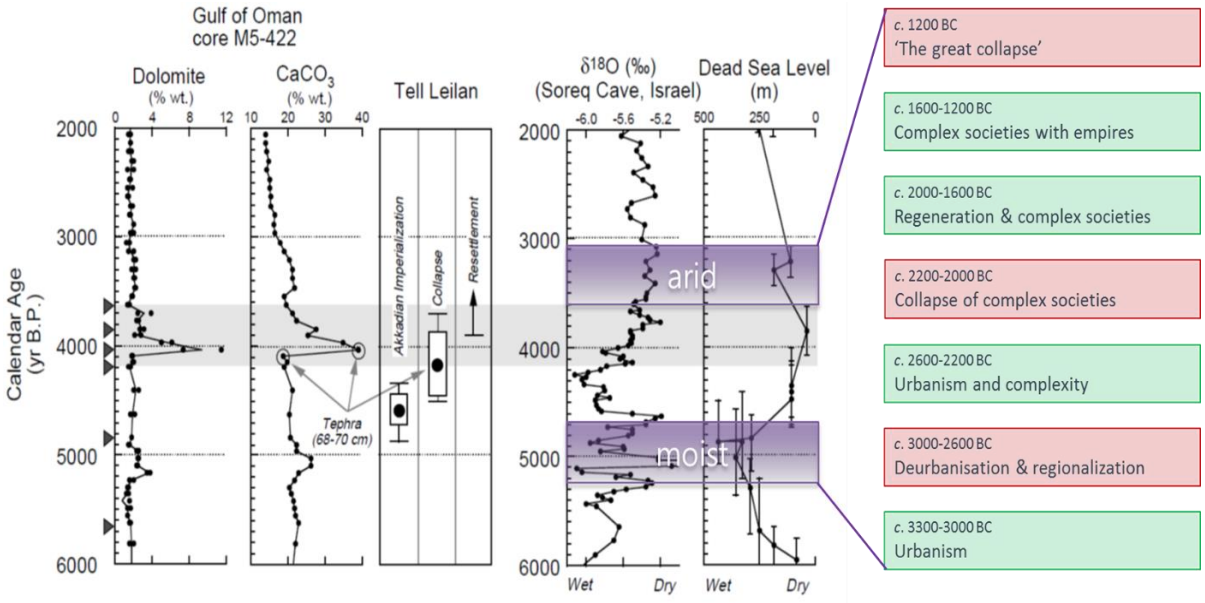


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Aside from the impact of climatic variations, urbanisation was also likely shaped by the large-scale consolidation of political organisation with the emergence of empires (Lawrence *et al.*, 2016). Lawrence *et al*. (2016) note that the first two cycles of urbanisation (i.e. *c*. 4400-3400 BC and 2600-2000 BC) in northern Mesopotamia occurred under climatically favourable conditions, with higher moisture levels enabling the emergence and maintenance of cities. After 2000 BC, however, urbanisation was 'decoupled' from climate change and more obviously linked to the trajectory of imperial powers and their impact on settlement structures (e.g. for agricultural production, military and specialisation), irrigation, agricultural intensification, transport, trade and political revenue including taxation (Lawrence *et al.*, 2016).

1.1. Advances in archaeobotanical research

Archaeological excavations in the northern Fertile Crescent have been extensively conducted for decades to date, particularly through dam salvage projects on the Euphrates and Tigris, though it

has been rather sparse recently on account of military engagements. In terms of the archaeobotanical aspect, sufficient excavation projects have included large-scale sampling flotation for a detailed evaluation of crop growing conditions to be carried out across the different climatic and geographic regions that make up the northern Fertile Crescent region. However, recovery of charred plant remains and related research are significantly concentrated on the Euphrates river and its tributaries, while those on the Tigris river and in western Syria have been relatively scarce to date. Furthermore, the collection of charred plant material from later sites (i.e. those from the Bronze Age onwards) is not as routine a procedure as it is with the earlier farming sites (i.e. those from the Neolithic and Chalcolithic) of the region. Despite the importance of agricultural production over this period, relatively little is known of the nature of farming that was carried out throughout the region, including how it fostered and responded to phases of urbanisation. The existing models require agricultural output to increase substantially over a period of several thousand years. With some recent exceptions (e.g. Styring *et al.*, 2017; Bogaard *et al.*, 2018), how this was achieved, whether by increasing the area of land under cultivation (extensification) or the amount produced per unit of land, by increasing inputs in terms of soil working, water and/or fertiliser (intensification), has not been established to any reasonable extent based on the remains of crop production themselves. Advances in the study of crop weed flora can provide direct evidence of crop growing conditions and consequently the nature of land management practices (Bogaard *et al.*, 2016a; Bogaard *et al.*, 2018), complementary to that provided by stable isotope analysis of crops (e.g. Riehl *et al.*, 2014; Wallace *et al.*, 2015).

1.2. The present research

1.2.1. Aim and research questions

The central aim of the current research is to analyse crop and weed/wild plant material from a series of archaeological sites in order to study the agricultural practices evidenced in different climatic zones across the northern Fertile Crescent, in present-day northern Syria, south-eastern

Turkey and northern Iraq (Figure 1.3) through a two thousand-year period focusing on the Late Bronze Age. Within the framework of this study, samples are analysed from Tell Mohammed ‘Arab (northern Iraq), Tell Atchana (south-eastern Turkey) and Tell Brak (north-eastern Syria), dating from a time period that spans both the Late Chalcolithic 5 and the Late Bronze Age (*c*. 3300 -1200 BC). The terms ‘northern Fertile Crescent’ and ‘northern Mesopotamia’ are here used interchangeably. The occupation periods of the three archaeological sites that are the focus of this study are shown in Table 3.1.

The primary research questions considered are:

What are the major crop types at the study sites?

What on-site activities do the plant remains represent at each site? Do they, for example, represent the residues of activities such as crop storage, processing and/or fuel use?

How are the crops being grown and used at each site?

How did these economies change through time and reflect changing social and environmental conditions?

How do agricultural activities at each site correlate with environmental variation and social complexity?

Finally, how site-specific are these agricultural strategies?

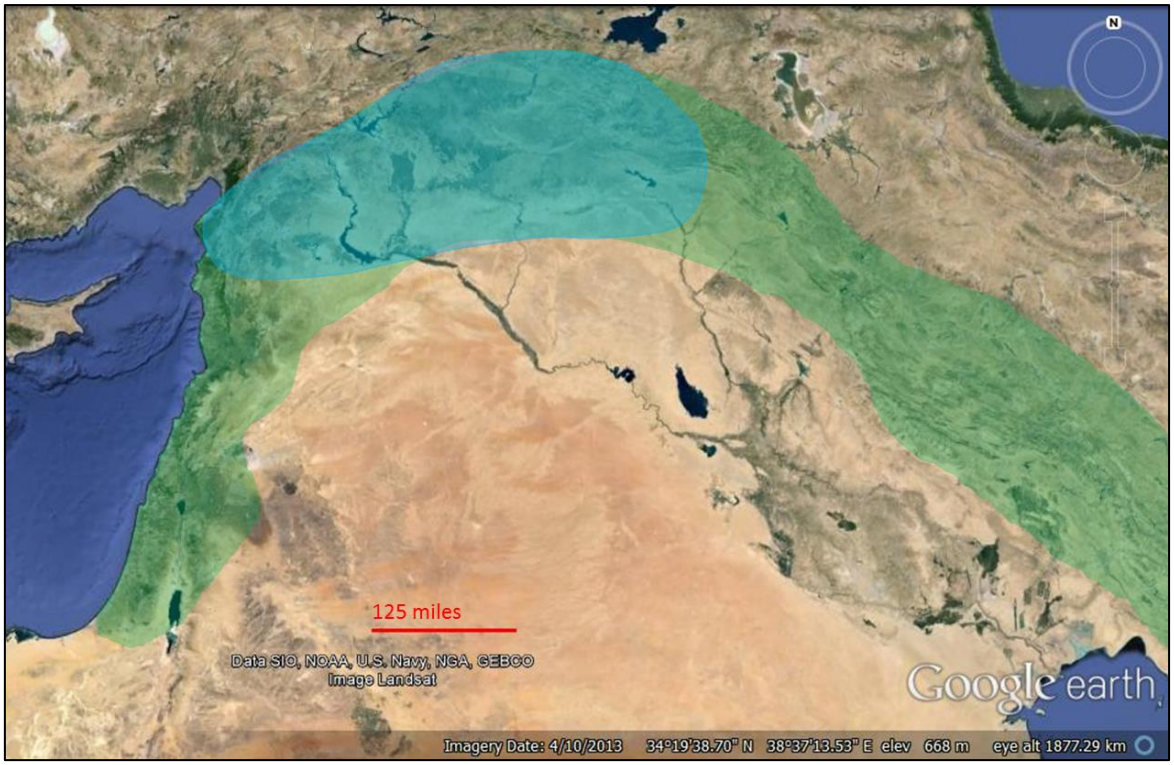


Figure 1.3 Map showing the area known as the Fertile Crescent, highlighted in green indicates the Fertile Crescent and that in blue presents the study area of northern Fertile Crescent.

1.2.2. Approaches to the research

The research questions will be addressed in three ways, principally focusing on primary archaeobotanical analysis. Firstly, variation in crop and wild plant composition within and across the archaeobotanical assemblages will be explored using multivariate statistics and relevant ecological traits of arable weed taxa. Once the primary identifications from the three sites are obtained, the data will be synthesised with already published assemblages from the northern Fertile Crescent in the second millennia BC in order to build a synthetic picture of agricultural practices in the northern Fertile Crescent from the late fourth to second millennia BC. The archaeobotanical data will be assessed against patterns in urbanisation and climatic variation through the region in order to shed light on the mutual relation of agricultural activities with social complexity and environmental conditions. By synthesising these approaches, agricultural change and continuity across the region and through time can be illuminated.

1.3. Archaeobotanical investigation in the northern Fertile Crescent from the late fourth to the second millennia BC

Archaeobotanical assemblages from various sites have previously been analysed and examined from the northern Fertile Crescent dating from the late fourth to second millennia BC (Figure 1.4). Their distribution is heavily concentrated on the Khabur River, a tributary of the Euphrates in north-eastern Syria, while relatively few sites have been investigated archaeobotanically on the Tigris in northern Iraq (Table 1.1).

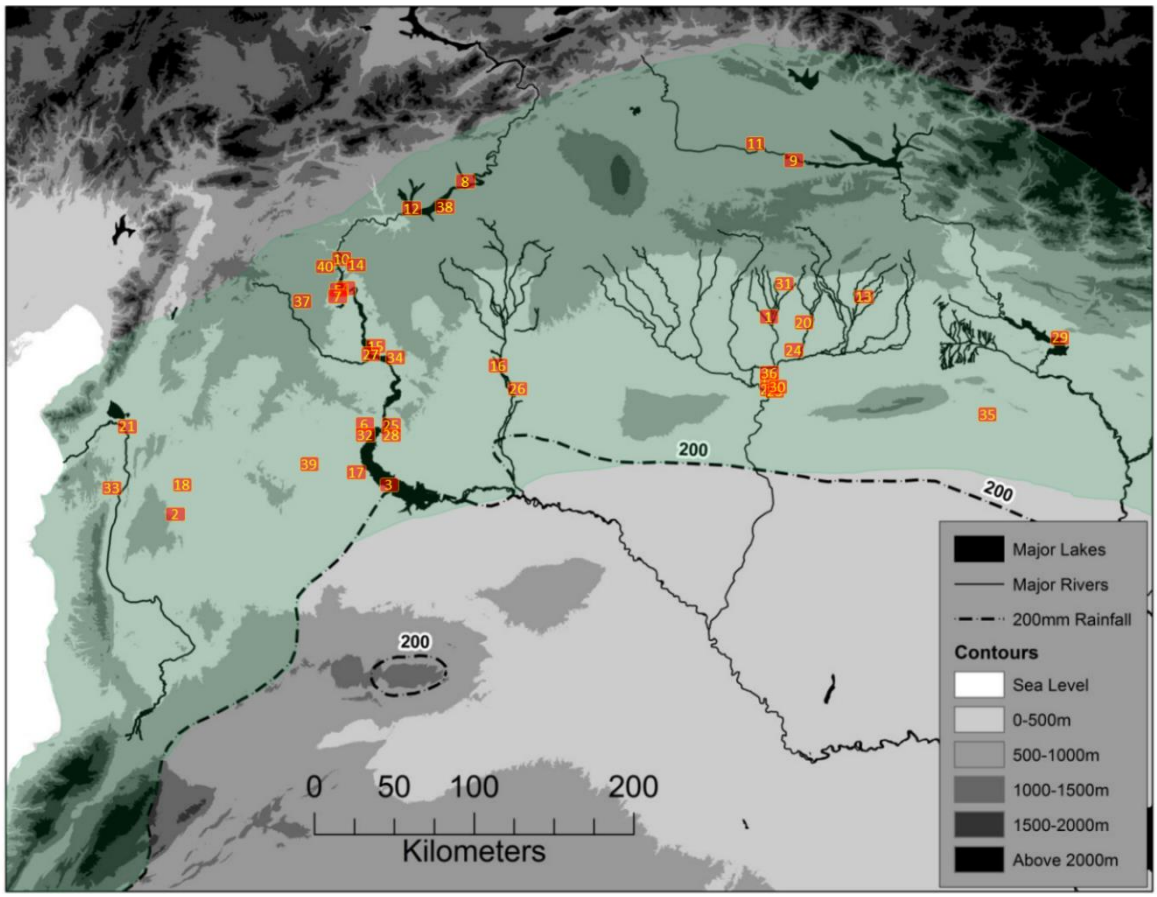


Figure 1.4 Map showing sites in the northern Fertile Crescent for which archaeobotanical data have been published and that date from the late fourth to the second millennia BC (map based on Lawrence, 2012). Green highlight indicates the Fertile Crescent region. 1. Chagar Bazar 2. Ebla 3. Emar 4. Gre Virike (overlapped with site no. 7) 5. Hacınebi (overlapped with site no. 7) 6. Hadidi 7. Hajji Ibrahim 8. Hassek Höyük 9. Hirbermerdon 10. Horum Höyük 11. Kenan Tepe 12. Kurban Höyük 13. Leilan 14. Mezraa Höyük 15. Qara Quzaq 16. Sabi Abyad 17. Selenkahiye 18. Tell Afis 19. Tell al-Raqa'i (overlapped with site no. 30) 20. Tell Arbid 21. Tell Atchana 22. Tell Atij (overlapped with site no. 30) 23. Tell Bderi (overlapped with site no. 30) 24. Tell Brak 25. Tell es-Sweyhat 26. Tell Hammam et-Turkman 27. Tell Jerablus Tahtani 28. Tell Jouweif 29. Tell Karrana 30. Tell Kerma 31. Tell Mozan (= Urkesh) 32. Tell Munbaqa 33. Tell Qarqur 34. Tell Shiyukh Tahtani 35. Tell Taya 36. Tell Zagan 37. Tilbeşar (=Tilbeshar) 38. Titriş Höyük 39. Umm el-Marra 40. Yarım Höyük.

Previously published archaeobotanical datasets indicate a certain spectrum of crops apparently typical of the region and period, featuring barley, free-threshing wheat, glume wheat and pulses. More specifically, barley, the commonest cultigen, was dominated by the two-row rather than six-row form on the majority of sites, while among the glume wheats emmer was more frequent than einkorn. Free-threshing wheat occurred on more sites than glume wheat, but in terms of the abundance of items (i.e. grains and chaff) it tends to occur at lower levels than emmer. With regard to pulses, lentil, grass pea and bitter vetch were relatively common, followed by pea and chickpea. In addition to these taxa, olive, flax and safflower are also recorded from the region, although their occurrence was relatively meagre in terms of frequency and abundance.

Table 1.1 Summary of crop taxa at sites with published archaeobotanical data in the northern Fertile Crescent during the fourth and the second millennia BC; p = present.

Site	Region	Period	Two-row barley	Six-row barley	Barley	Emmer	Einkorn	Glume wheat	Free-threshing wheat	Wheat	Lentil	Bitter vetch	Grass pea	Bitter vetch/grass pea	Common pea	Chick pea	Reference
Chagar Bazar	Khabur	4M	p			p	p		p				p		p		(Buxó 2006)
Ebla	NW Syria	2M	p	p		p	p		p		p	p					(Caracuta and Fiorentino, 2011)
Ebla	NW Syria	2M	p	p					p		p	p			p		(Fiorentino and Caracuta, 2010)
Emar	Euphrates	3M/2M			p				p		p						(Deckers and Riehl, 2007)
Emar	Euphrates	3M/2M	p	p		p											(Riehl, 2001; Riehl, 2010b)
Gre Virike	Euphrates	3M/2M			p	p			p		p		p				(Oybak, 2006)
Hacınebi	Euphrates	Chalcolithic	p	p		p	p		p		p		p				(Miller, 1994)
Hacınebi	Euphrates	Chalcolithic			p	p	p		p		p		p				(Stein *et al.*, 1996b)
Hacınebi	Euphrates	Chalcolithic		p		p	p		p		p		p				(Stein *et al.*, 1996a)
Hadidi	Euphrates	2M	p						p		p	p	p		p	p	(van Zeist, 1994)
Hadidi	Euphrates	3M	p						p		p	p	p		p	p	(van Zeist and Bakker-Heeres, 1985)
Hajji Ibrahim	Euphrates	3M/2M			p					p	p		p				(Miller, 1997)
Hassek Höyük	Euphrates	4M/3M			p		p				p						(Gregor, 1992)
Hirbermerdon	Tigris	2M			p			p	p		p	p					(Laneri *et al.*, 2008)
Horum Höyük	Euphrates	3M/2M			p					p							(Herveux, 2007)
Kenan Tepe	Tigris	4M/3M/2M	p							p		p		p			(Parker *et al.*, 2003)
Kurban Höyük	Euphrates	4M/3M			p			p			p	p	p		p	p	(Miller, 1986)
Leilan	Khabur	3M/2M			p	p	p		p		p		p		p	p	(Smith, 2012)
Leilan	Khabur	4M/3M		p		p			p		p	p	p		p	p	(Wetterstrom, 2003)
Mezraa Höyük	Euphrates	3M/2M			p	p	p		p		p	p	p		p		(Oybak, 2006)
Qara Quzaq	Euphrates	2M/1M	p			p			p		p				p		(Séiquer, Nuñéz and Obón de Castro, 2001)
Qara Quzaq	Euphrates	3M/2M	p			p			p		p	p			p		(Séiquer and Nuñéz, 1994)
Sabi Abyad	Balikh	2M			p				p								(van Zeist, 1994)
Selenkahiye	Euphrates	3M	p			p	p		p		p	p	p		p	p	(van Zeist and Bakker-Heeres, 1985)
Tell Afis	NW Syria	4M/3M/2M		p		p	p		p		p	p	p		p		(Wachter-Sarkady, 1998)
Tell al-Raqa'i	Khabur	3M			p	p	p		p		p		p		p		(van Zeist, 2015b)
Tell al-Raqa'i	Khabur	3M	p			p	p		p		p		p		p		(van Zeist, 2003b)

Site	Region	Period	Two-row barley	Six-row barley	Barley	Emmer	Einkorn	Glume wheat	Free-threshing wheat	Wheat	Lentil	Bitter vetch	Grass pea	Bitter vetch/grass pea	Common pea	Chick pea	Reference
Tell al-Raqa'i	Khabur	3M	p					p	p				p		p		(van Zeist, 2015a)
Tell Arbid	Khabur	3M/2M	p			p	p		p		p	p					(Wasylikowa and Koliński, 2013)
Tell Atchana	SE Turkey	2M			p			p	p		p	p					(Çizer, 2006)
Tell Atchana	SE Turkey	2M		p		p	p		p		p	p					(Riehl, 2010a)
Tell Atij	Khabur	3M	p	p		p	p		p		p		p		p		(McCorriston, 1995)
Tell Bderi	Khabur	3M/2M			p	p	p		p		p		p				(van Zeist, 2015b)
Tell Bderi	Khabur	3M/2M	p			p	p		p		p				p		(van Zeist, 2003a)
Tell Bderi	Khabur	3M/2M	p			p	p		p		p						(van Zeist, 2008)
Tell Brak	Khabur	4M			p			p	p								(Charles and Hald, 2003)
Tell Brak	Khabur	3M			p	p	p		p		p		p		p		(Charles and Bogaard, 2001)
Tell Brak	Khabur	4M			p			p	p								(Charles *et al.*, 2001)
Tell Brak	Khabur	4M/3M/2M			p	p	p		p		p	p	p		p	p	(Colledge, 2001)
Tell Brak	Khabur	4M/3M/2M			p	p	p		p		p	p	p		p	p	(Colledge, 2004)
Tell Brak	Khabur	3M	p			p	p		p		p		p		p		(Hald, 2001)
Tell Brak	Khabur	4M/3M			p			p			p			p	p		(Hald and Charles, 2007)
Tell Brak	Khabur	4M/3M	p			p			p		p						(Hald and Charles, 2008)
Tell Brak	Khabur	4M			p	p	p		p								(Hald, 2008)
Tell es-Sweyhat	Euphrates	3M/2M		p		p	p		p		p	p	p		p		(Miller, 1997)
Tell es-Sweyhat	Euphrates	3M	p						p		p	p	p		p		(van Zeist and Bakker-Heeres, 1985)
Hammam et-Turkman	Balikh	LC/EB/MB	p			p		p	p			p	p				(van Zeist, Waterbolk-van Rooijen and Bottema, 1988)
Hammam et-Turkman	Balikh	2M	p			p			p		p	p	p		p		(van Zeist, 1994)
Hammam et-Turkman	Balikh	3M	p					p	p								(van Zeist and Waterbolk-van Rooijen, 1992)
Hammam et-Turkman	Balikh	4M/3M/2M	p			p	p		p		p	p	p		p	p	(van Zeist *et al.*, 2003)
Jerablus Tahtani	Euphrates	4M/3M		p		p	p		p		p	p					(Peltenburg *et al.*, 1996)
Jerablus Tahtani	Euphrates	4M/3M			p	p			p		p		p				(Peltenburg *et al.*, 1995)
Tell Jouweif	Euphrates	2M			p						p		p				(Miller, 2004)
Tell Karrana	Tigris	3M	p	p		p	p		p		p						(Costantini and Biasini, 1993)
Tell Kerma	Khabur	3M	p	p		p	p		p				p				(McCorriston, 1995)
Tell Mozan	Khabur	3M/2M			p	p	p		p		p	p	p		p		(Deckers and Riehl, 2007)
Tell Mozan	Khabur	2M			p	p			p		p	p					(Riehl, 2000)

Site	Region	Period	Two-row barley	Six-row barley	Barley	Emmer	Einkorn	Glume wheat	Free-threshing wheat	Wheat	Lentil	Bitter vetch	Grass pea	Bitter vetch/grass pea	Common pea	Chick pea	Reference
Tell Mozan	Khabur	3M/2M	p			p	p		p		p	p	p		p		(Riehl, 2010c)
Tell Munbaqa	Euphrates	3M	p			p	p		p		p						(Küster, 1989)
Tell Qarqur	NW Syria	3M/2M		p		p	p		p		p	p					(Smith, 2005)
Tell Schech Hamad	Khabur	2M	p							p			p		p		(van Zeist, 2015b)
Tell Taya	Tigris	3M		p		p			p		p		p		p		(Waines, 1973)
Tell Zagan	Khabur	3M/2M			p	p	p										(Samuel, 1989)
Tilbeşar	Euphrates	3M/2M			p					p							(Herveux, 2007)
Titriş Höyük	Euphrates	3M	p			p								p			(Hald, 2010)
Titriş Höyük	Euphrates	3M			p	p			p		p		p				(Algaze *et al.*, 1995)
Umm el-Marra	NW Syria	3M/2M	p	p		p	p		p		p						(Schwartz and Miller, 2007)
Umm el-Marra	NW Syria	3M/2M			p				p		p		p			p	(Schwartz *et al.*, 2000)
Yarım Höyük	Euphrates	4M/3M		p		p	p				p						(Rothman *et al.*, 1998)

1.4. Previous archaeobotanical research at the three study sites

1.4.1. Tell Mohammed ‘Arab

At Tell Mohammed ‘Arab, charred plant samples were taken from 1982 to 1985 and preliminary assessment of a subset of samples was undertaken as part of a Masters’ thesis by Johnston (1996) under Charles’ supervision at the University of Sheffield. Archaeobotanical samples from Mohammed ‘Arab span the Late Uruk, Ninevite V and Middle Assyrian periods. The most common crop type was barley grain, followed by glume wheats (represented primarily as glume bases), both einkorn and emmer. Free-threshing wheat was also found but at lower levels (Johnston, 1996).

1.4.2. Tell Atchana

Archaeobotanical investigations have been undertaken as part of excavations of the Middle Bronze Age and Late Bronze Age sequence at Tell Atchana since 2003. Of the samples processed to date, those from the 2003 and 2004 excavation seasons (Çizer, 2006; Riehl, 2010a) and from the 2011 and 2012 excavation seasons (Stirn, 2013) have been reported.

The first archaeobotanical analyses were conducted by Çizer for her Master thesis; Simone Riehl subsequently identified the Late Bronze Age plant remains, most of which are from the end of the Late Bronze Age (Riehl, 2010a). The data show that the major crop types were free-threshing wheat and barley, mostly represented as grain (Riehl, 2010a). Lentil and bitter vetch also occurred frequently (Riehl, 2010a). Ecological analysis of weed/wild taxa and stable carbon isotope analysis of cereal grain indicate moist arable conditions at Tell Atchana. Moreover, stable carbon isotope values of free-threshing wheat and barley suggest that free-threshing wheat was grown in better watered conditions than barley (Riehl, 2010a).

Of the samples obtained from 2011 and 2012 excavations, 45 samples were analysed by Matthew Stirn (2013) for a Masters’ dissertation at the University of Sheffield, under the supervision of

Michael Charles. The plant assemblage shows a similar spectrum to that detected in previous research. The most common cereal was free-threshing wheat followed by barley. Bitter vetch was also frequent. 28 samples which Matthew Stirn dealt with in his research (2013) were included and reanalysed in current study with additional sorting and reidentification.

1.4.3. Tell Brak

Archaeobotanical remains from Tell Brak have been studied by a number of scholars, and a broad spectrum of crops has been documented (Charles *et al.*, 2001; Hald, 2001; Colledge, 2001; Charles and Bogaard, 2001; Charles and Hald, 2003; Colledge, 2004; Hald and Charles, 2007; Hald, 2008; Hald and Charles, 2008; Charles, Pessin and Hald, 2010). The crop types of the Late Chalcolithic period (fourth millennium BC) at Tell Brak includes two-row barley, glume wheats, primarily emmer, free-threshing wheat, pulses such as lentil and pea, and linseed, while *Aegilops* sp. was the most common weed type at the site, a mimic of cereal grains (Charles *et al.*, 2001; Charles and Hald, 2003; Colledge, 2004; Hald, 2008; Hald and Charles, 2008). The most abundant crop types, two-row barley and glume wheat, show an obvious contrast in terms of crop processing stages, being represented primarily as cleaned products from mainly storage contexts and by-product stages from disposal-related deposits, respectively (Charles *et al.*, 2001; Charles and Hald, 2003).

The range of crops used in the third millennium BC is similar to that of the fourth millennium BC. The dominant crop at the site was two-row hulled barley, mainly represented as grains, following by glume wheat and free-threshing wheat; utilisation of lentil and common pea was also attested (Colledge, 2001; Charles and Bogaard, 2001; Charles *et al.*, 2001; Colledge, 2004; Hald and Charles, 2008). As in the fourth millennium, *Aegilops* sp. was a frequent grass weed, alongside wild barley (*H. spontaneum*) (Charles *et al.*, 2001; Charles and Bogaard, 2001; Colledge, 2004).

Turning to archaeobotanical analyses of the second millennium BC, Hald and Charles (2007) examined plant material from second millennium BC trenches HHF and HNA in a preliminary report. In both areas barley, glume wheat and various pulses, chiefly lentil, were identified as the

major crops (Hald and Charles, 2007). A number of *Aegilops* and *Prosopis* seeds were also observed, as in the previous period, and their presence was linked with refuse material from fire installations (Hald and Charles, 2007). Another archaeobotanical study from Area HN in the second millennium BC was conducted by Colledge (2001). Research indicates that barley was by far the most frequent crop, followed by glume wheat and free-threshing wheat (Colledge, 2001). As for pulses, lentil, bitter vetch, grass pea and pea were documented (Colledge, 2001).

1.5. Thesis structure

Having outlined the research in Chapter 1, the next chapter explores the environmental settings of the northern Fertile Crescent region. Both past and present climate, vegetation and geography are considered. The archaeological background is also assessed, with particular attention to social complexity and urbanism. Finally, Chapter 2 presents general information on the three study sites such as their geographical locations, history of excavations and chronology of occupation. Methods used for the archaeobotanical investigation are described in Chapter 3. Chapter 4, 5, 6 and 7 discuss the results of the archaeobotanical interpretation using a series of statistical approaches. Chapter 4 gives a comprehensive overview of the archaeobotanical assemblages, while Chapter 5 assesses their taphonomy. In Chapter 6, the spatial distribution of charred plant samples is assessed in detail. Chapter 7 briefly reviews traditional crop husbandry regimes in the study region in recent decades before focussing on past crop husbandry practices at the study sites in the northern Fertile Crescent. Key results derived from these four chapters are combined together in Chapter 8 for discussion in order to clarify interaction among agriculture, social complexity and climate change. The comparison of agricultural activities in the different geographical and climatic zones through the northern Fertile Crescent are also presented in this chapter. The concluding section in this chapter provides a summary of the major findings and suggestions for future research.

Chapter 2. Background of archaeology and environment

This chapter introduces the general background of the three study sites at Tell Mohammed ʻArab, northern Iraq on the bank of Tigris, Tell Brak in the Khabur basin, northern Syria and Tell Atchana, south eastern Turkey, on the Mediterranean coast. The first part focuses on the individual sites with regard to the regional information in relation to the location, excavation history and chronology. The second half of the chapter deals with environmental settings in terms of the geographic makeup, climate, soils and vegetation of the region today and the body of palaeoenvironmental evidence for likely conditions in the past that would have impacted socio-economic life.

2.1. Archaeology

The sites considered here chart turbulent fluctuations in social complexity in the northern Fertile Crescent through the Late Chalcolithic to the Bronze Age (Table 3.1). The late fourth millennium BC (*c*. 3300-3000 BC, the Late Uruk and the Post Uruk) of northern Mesopotamia was an era of urbanisation featuring Uruk style southern Mesopotamian culture alongside indigenous material culture (Akkermans and Schwartz, 2003). Urban centres such as Tell Brak reached almost 48 hectares while there were a number of smaller-scale village settlements with some urban features at Hacinebi (4 ha) and Tell Jerablus Tahtani (13 ha) (Ur, 2010).

During the first half of the third millennium BC (Ninevite V) both local features and established Uruk alignments vanished, and cities and towns in the Khabur and northern Iraq reduced in size to small-scale scattered villages of no more than 15 to 25 ha with regionalised material culture (Schwartz, 1985; Ur, 2010). Most sites were unfortified and no visible trace of monumental architecture were revealed in this period (Schwartz, 1985). This downward trend ended with a dramatic shift in society in the second half of the third millennium BC. In the Khabur catchment of northern Syria, the size of sites soared from approximately 15 up to 120 ha in Tell Leilan, Tell Mozan and Hamoukar and that of Tell Brak increased to around 70 ha (Ur, 2010). Tell al-Hawa

(66 ha), Tell Taya (155 ha) and Tell Khoshi (90 ha) in northern Iraq and southern Turkey also significantly expanded at this time although there were middle-sized towns such as Titris Höyük and Tell Beydar ranged from 25 to 45 hectares (Ur, 2010). In the late third millennium BC (*c*. 2200-2000 BC), society disappeared in the region. Urban centres dwindled or were abandoned and the Akkadian empire collapsed. Sites in Khabur such as Leilan, Chuera, Beydar, Abu Hgaira were ruined with exception of Tell Brak and Tell Mozan (Akkermans and Schwartz, 2003). Demographic figures estimated by Wilkinson (2000; 1990b) also indicate that there was a marginal increase in the size of population, from about 25 persons per square kilometre in northern Jazira during the Ninevite V periods, increasing to almost 50 persons per square kilometre between the second half of the third millennium and the first half of the second millennium BC.

Tell Brak suffered from reduction in size in the first half of the Middle Bronze Age (*c*. 2000-1600 BC), however, most settlements reactivated to a certain degree with urban societies in the Middle Bronze Age (Akkermans and Schwartz, 2003). In the Late Bronze Age (*c*. 1600-1200 BC), three main empires were established: Mitanni in the central region, Hittite in the west and Assyria in the east of the northern Fertile Crescent. They competed with each other economically to occupy beneficial positions in international trade (Akkermans and Schwartz, 2003; Oliva, 2005; Genz, 2011). The settlements adjacent to the Euphrates such as Emar (*c*. 70 ha), Munbaqa (15 ha), Hadidi and Tell Bazi increased in size and were densely populated in this period, sharing concomitant features of defensive architecture and localisation (Akkermans and Schwartz, 2003). On the other hand, the cities of the Jazira region show depopulation and a decrease in size. Instead, elite architecture was replaced in part of the occupation at Hammam et-Turkman, Tell Brak (30 ha), Tell al-Hamidiya (20 ha) and Leilan (Akkermans and Schwartz, 2003; Ur, 2014). Hittite and Mitannian empires had relatively little impact in terms of the material culture on their regions, whereas there were remarkable changes in occupation type and culture in the Middle Assyrian period as this empire ruled the area directly (Akkermans and Schwartz, 2003). In the same period of time, the estimated population density shows a decrease to around 15 persons per square kilometre in north Jazira (Wilkinson, 2000). By about 1200 BC, the prosperous empires collapsed

and urban cities such as Emar, Hammam et-Turkman, Tell Brak and Atchana were abandoned (Akkermans and Schwartz, 2003).

2.1.1. Tell Mohammed ‘Arab

Tell Mohammed ‘Arab was as a small-scale village settlement occupied for approximately two millennia with intermittent gaps between the end of the incised Ninevite V and the beginning of the Middle Assyrian (Roaf, 1984) (Figure 2.4). In addition to this, small scale of pits and gully from the Hellenistic (*c*. 250-150 BC) and cemetery from the Sassanian (*c*. 300-500 BC) were exposed (Roaf 1984), which is not included in this study. The site is situated in the Upper Jazira, on the southeast bank of the Tigris River in northern Iraq, at an altitude of 250 to 300 m (Figure 2.1 and 2.2). Mosul, approximately 37 km south-east of the site, is the nearest city and is located in the same Nineveh district. The site extends approximately 150 metres along the river by 80 metres inland towards the south, making the site roughly 1.2 hectares in size (Figure 2.3). It was, however, assumed by Roaf and Killick (1983) that the mound would have been at least a half wider in width since the northern part of the site had been being eroded away by the watercourse into a steep precipice.

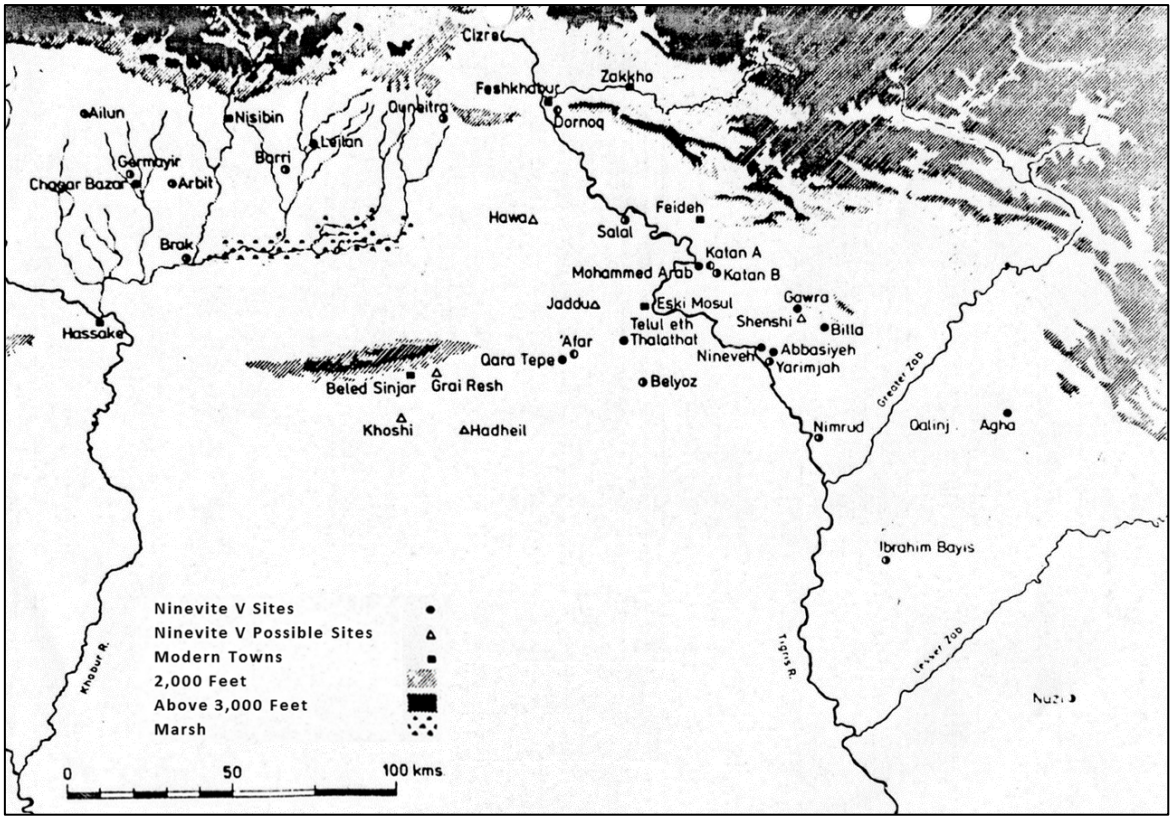


Figure 2.1 Map of the upper Jazira showing the location of Tell Mohammed ‘Arab and Ninevite V sites.

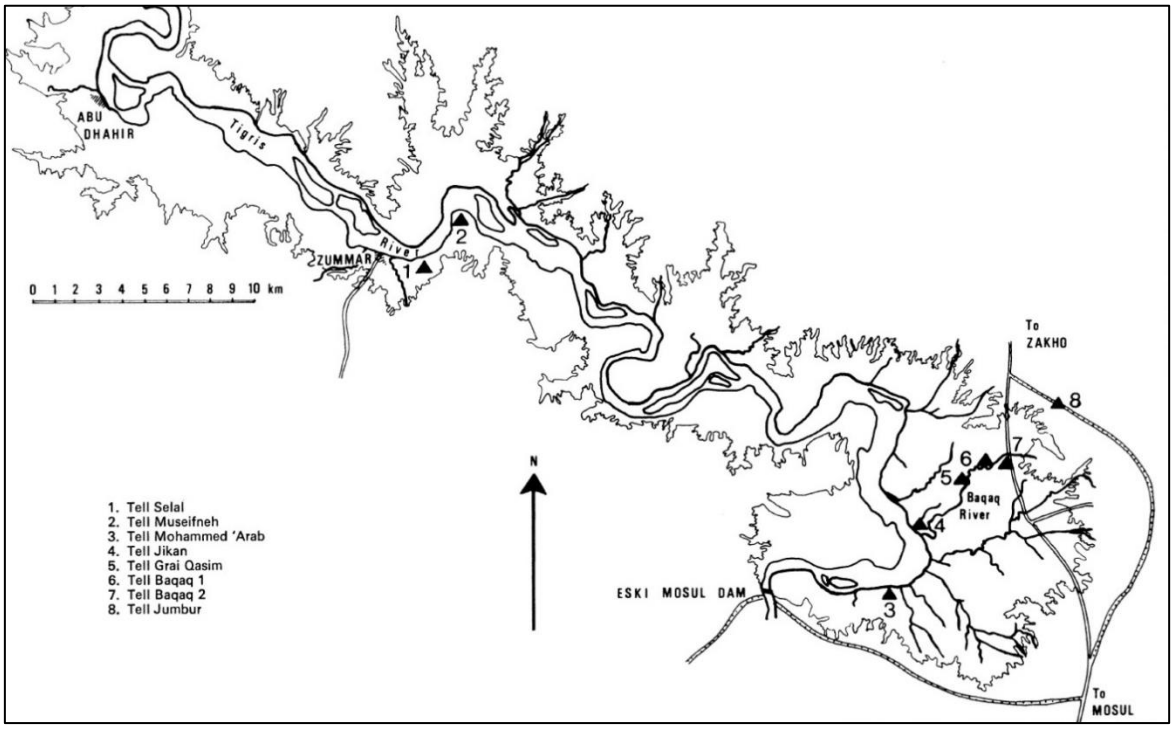


Figure 2.2 Map of the Eski Mosul region with Tell Mohammed ‘Arab and key sites indicated.

2.1.1.1. Excavation

Tell Mohammed ‘Arab was excavated by the British Archaeological Expedition to Iraq directed by Michael Roaf in the Eski Mosul Dam Salvage Project, arranged by the Iraqi State Organisation for Antiquities and Heritage from November 1982 to March 1985 (Killick and Roaf, 1983; Roaf, 1983a; Roaf, 1983b; Roaf, 1984; Ebeling *et al.*, 1997, p. 408). At the onset of the surface survey in March 1982, the team explored Tell Mohammed ‘Arab situated on the south-eastern part of the project region and decided to excavate it where both Middle Assyrian and painted and incised Ninevite V pottery sherds were revealed and a significant depth of deposit was secured (Roaf, 1983a). The site was submerged underwater in the spring of 1985 for the completion of Mosul Dam construction (Killick, 1986).

The excavation strategy of the first season (1982-1983) was to investigate the cliff section of the mound cut by the river down to the underlying natural soil. This section, of approximately 130 metres’, would provide the sequence of the site’ occupations (Roaf, 1983a) (Figure 2.3). The excavation subsequently progressed from top soil down to approximately, a maximum depth of, 6.5 metres of deposit (Killick, 1986) exploring two areas, namely, the Central Area and the Western Area (Ebeling *et al.*, 1997). In the former area, situated on the centre of the mound (Figure 2.3), all of the six occupation periods were investigated, whereas only the Middle Assyrian one was excavated in the Western Area (Ebeling *et al.*, 1997).

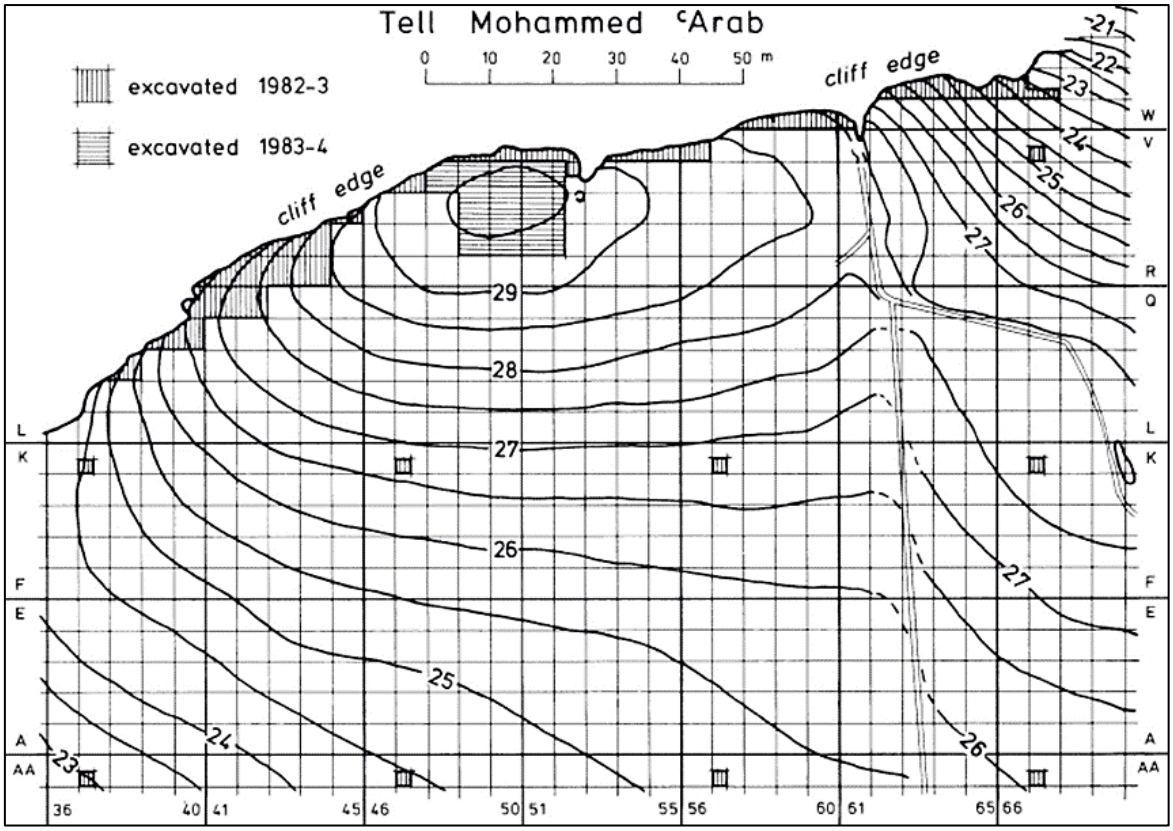


Figure 2.3 Contour plan of Tell Mohammed ʿArab showing the location of the main sounding and the cliff section (Roaf, 1984).

The level of Mohammed ʿArab I (Figure 2.4) is dated to the Late Uruk and here its building levels with mudbrick walls and pits and graves were revealed (Killick and Roaf, 1983; Roaf, 1984). Finds include a clay cylinder seal from a pit and two complete pots in one of the graves (Roaf, 1984). The pottery recovered in this level represents typical Late Uruk local styles such as bevelled-rim bowls, which are relatively infrequent, alongside more abundant ring-based carinated bowls, spouted jars and incised four-lugged jars, most of which are wheel-made with grit tempered (Killick and Roaf, 1983; Roaf, 1984; Killick, 1986; Roaf and Killick, 1987).

The Painted and Incised Ninevite V were defined as Mohammed ʿArab levels II and III, respectively. The term Ninevite V was first coined after a trench excavated by Max Mallowan at Nineveh, northern Iraq, where distinctive painted and incised ceramic types were retrieved, signifying both the period and culture spanning *c*. 3100-2550 BC (Akkermans and Schwartz, 2003, pp. 211-213). At Tell Mohammed ʿArab, it was found that the painted pottery precedes incised

pottery with little overlap in terms of the ceramic sequence (Killick, 1986, p. 242, cf. Fig. 5 & 6). At Tell Mohammed ‘Arab, pedestal jars and bowls, and large hollow-stemmed bowls that are painted with geometric patterns are representative of the earlier period (Roaf and Killick, 1987, p. 207). The majority of the pottery produced in this period was handmade, with vegetal temper (Killick, 1986, p. 207; Roaf and Killick, 1987). For the later period, incised and excised ware with repetitive and continuative motifs on the upper part of the body is typical (Roaf, 1983a). Architectural levels in the Ninevite V period encompasses multiple housing levels and courtyards/open areas (Roaf, 1983a). In the painted Ninevite V period, several building phases were exposed in trenches 49V to 51V (Roaf, 1983a), while there were six main house levels surrounded by mudbrick walls and courtyards in trenches 50T, 50U, 50V, 51T, 51U and 51V in the incised Ninevite V period (Roaf, 1983b). The Ninevite V artefacts at Tell Mohammed ‘Arab are predominantly of domestic type such as bone and metal pins, bone tools, flint sickle blades, spindle whorls, querns, obsidian blades and clay animal figurines (Roaf, 1984; Killick, 1986). Two clay stamp seals were also recovered (Roaf, 1984, Plate XIII a-d).

There is a prolonged period of occupation absence at the site until the Middle Assyrian period (*c*. 1400-1100 BC). These Mohammed ‘Arab IV phases, were excavated in both the Western and the Central Area, revealing a series of building phases (Roaf, 1984). A spacious stone paved courtyard associated with several rooms nearby was revealed in the Western Area and in the Central Area, house and burial levels were exposed (Roaf, 1984). Walls and rooms forming part of a huge elaborately designed structure with mudbricks three courses in thickness were investigated in the oldest level of the Central Area (Roaf, 1984). In the following upper building phase, one section (i.e. 52S) amongst complex building units exposed a couple of rectangular rooms. Several sandstone moulds for bronze axes were also found in this phase, which may indicate the possibility of metallurgical activities (Bolt, 1991). The youngest building level of this phase was rather inconspicuous, being revealed as only a trace of rectangular rooms (Roaf, 1984). The pottery sequence in this phase is rather uncertain compared to that of Late Uruk and Ninevite V. Jars which are not a typical Middle Assyrian style were recovered alongside typical Middle Assyrian

pots and ‘Nuzi ware’ (Roaf, 1984). The finds of cylinder seals in the Middle Assyrian occupation indicate that this village in the second half of the second millennium BC may have experienced two main periods of empirical influence, Mitannian followed by Assyrian (Collon, 1988). Three seals and a sealing impressed on a pot are archetypal Mitannian in style, dated approximately from 1450-1350 BC, while five cylinder seals and one sealing impression categorised into the second group are Assyrian types (Collon, 1988). It is well-known that the power of the Assyrian empire based on the city of Assur was expanded from the late fourteenth century (Akkermans and Schwartz, 2003, p. 348).

2.1.1.2. Chronology

Excavation revealed that the site was occupied intermittently for approximately four millennia, from the late fourth millennium BC to the late fourth century AD dividing the sequence into six principal periods, on the basis of the pottery: the Late Uruk (MA 1), Painted Ninevite V (MA 2), Incised Ninevite V (MA 3), Middle Assyrian (MA 4), Hellenistic and Sassanian (MA 5 and 6) (Figure 2.4). With regard to the phases of the Sassanian and Hellenistic, only graves for Sassanian and storages and rubbish for Hellenistic were exposed without any settlement levels recovered (Roaf, 1984, Table 1). Of these six phases, the Late Uruk, Painted and Incised Ninevite V and Middle Assyrian, which correspond to ‘village settlement’ (Roaf, 1984), are dealt with in this research.

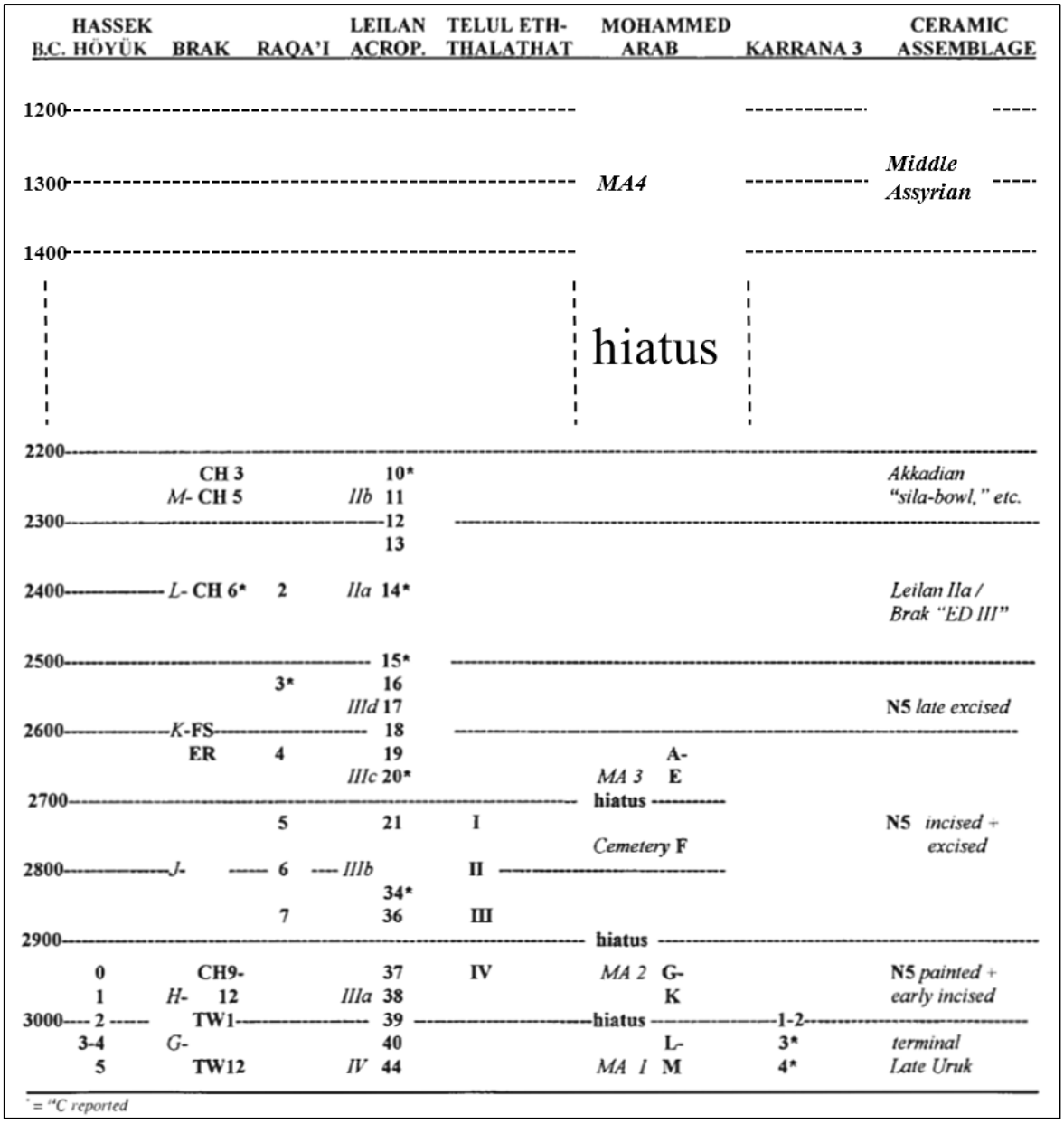


Figure 2.4 Chronology of Tell Mohammed ʻArab and key sites (after Weiss, 2003, p. 600).

2.1.2. Tell Atchana

Tell Atchana, ancient Alalakh, is located in the south eastern corner of Turkey some 75 km inland of the Mediterranean Sea. The site is just south of the Lake of Antioch and sits on the eastern bank of the Orontes river, in the administrative province of Hatay which is bordered by Syrian to the south and east (Figure 2.5, 2.6 and 2.7). The archaeological site is an elongated oval mound measuring 750 x 325 m, rising to 9 m in height at an altitude of approximately 90 to 95 m (Google

Map), and is thought to cover an area of approximately 22 hectares (Yener, 2010). The site is dated primarily to the Middle and Late Bronze Age (Yener, 2013c; Yener and Akar, 2013). Tell Tayinat a similar sized ancient city in two separate periods during the Early Bronze Age and Early Iron Age lies approximately 1 kilometre north. The nearest modern city is Antakya, approximately 20 kilometres to the west (Figure 2.6).

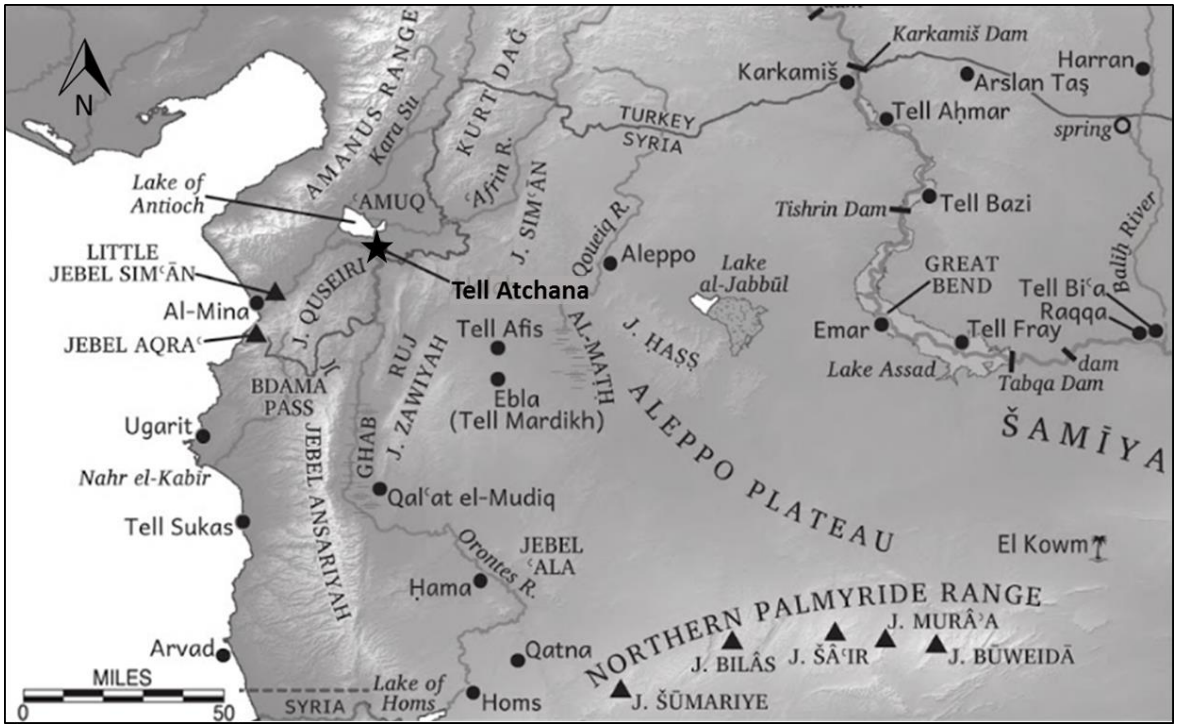


Figure 2.5 Map of the eastern Mediterranean and the eastern Syria showing the location of Tell Atchana and major archaeological sites (Younger, 2016).

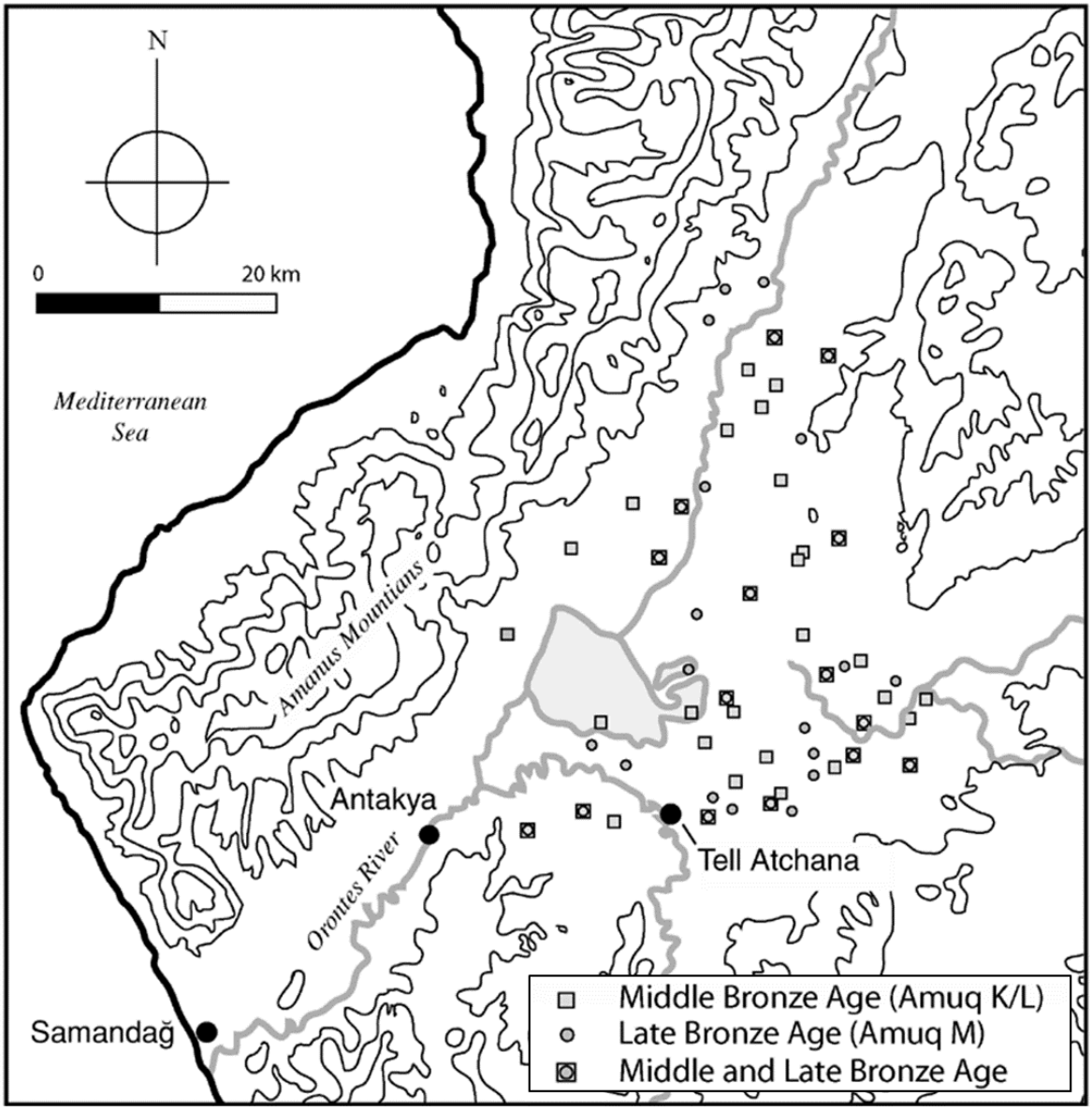


Figure 2.6 Map of the Amuq plain with Tell Atchana and the Middle Bronze and Late Bronze Age sites indicated.

2.1.2.1. Excavation

2.1.2.1.1. Previous excavation

Tell Atchana was reported and catalogued by Robert Braidwood on behalf of the Oriental Institute of the University of Chicago as part of the Amuq valley survey between 1932 and 1938 (Braidwood, 1937; Braidwood *et al.*, 1960; Yener and Wilkinson, 1996b; Yener *et al.*, 2000; Yener, 2005). The original excavation at Tell Atchana was carried out by Leonard Woolley from 1936 to 1939, and then from 1946 to 1949 after the Second World War (Woolley, 1936; Woolley,

1937; Woolley, 1938; Woolley, 1955; Yener, Schloen and Fink, 2004; Yener, 2010). It began with digging trenches (A-F) in 1936 and from the next season of 1938 expanded towards the west, where the palace area is located (Woolley, 1939). The excavation in 1939 exposed "the Palace of Yarim-Lim" and "the Temples" (Woolley, 1948). Due to the onset of the Second World War excavation ceased for three years, and were resumed in 1946 (Woolley, 1950). The excavation of "the Temples" and "the Palace of Yarim-Lim" continued in this season. In particular, the architectural structure of "the Temples" was identified as typically Hittite in style through all of the levels (level III to I) by Woolley at that time (Woolley, 1947, p. 60).

The area excavated was restricted to the north-eastern part of the mound and revealed 18 levels (XVII-0) of the second millennium BC (the Middle Bronze Age and the Late Bronze Age) including various structures and features such as temples, palaces, defences, private houses and graves; finds included cuneiform tablets (over 500 items in total in Hurrian, Akkadian, Hittite and Sumerian), the statue of Idrimi, seals and seal impressions, metal objects and pottery (Woolley, 1955). Chronology for these levels was initially postulated by Woolley (Woolley, 1947, p. 399; Woolley, 1955) and partially modified by Sidney Smith (1940) (Figure 2.7).

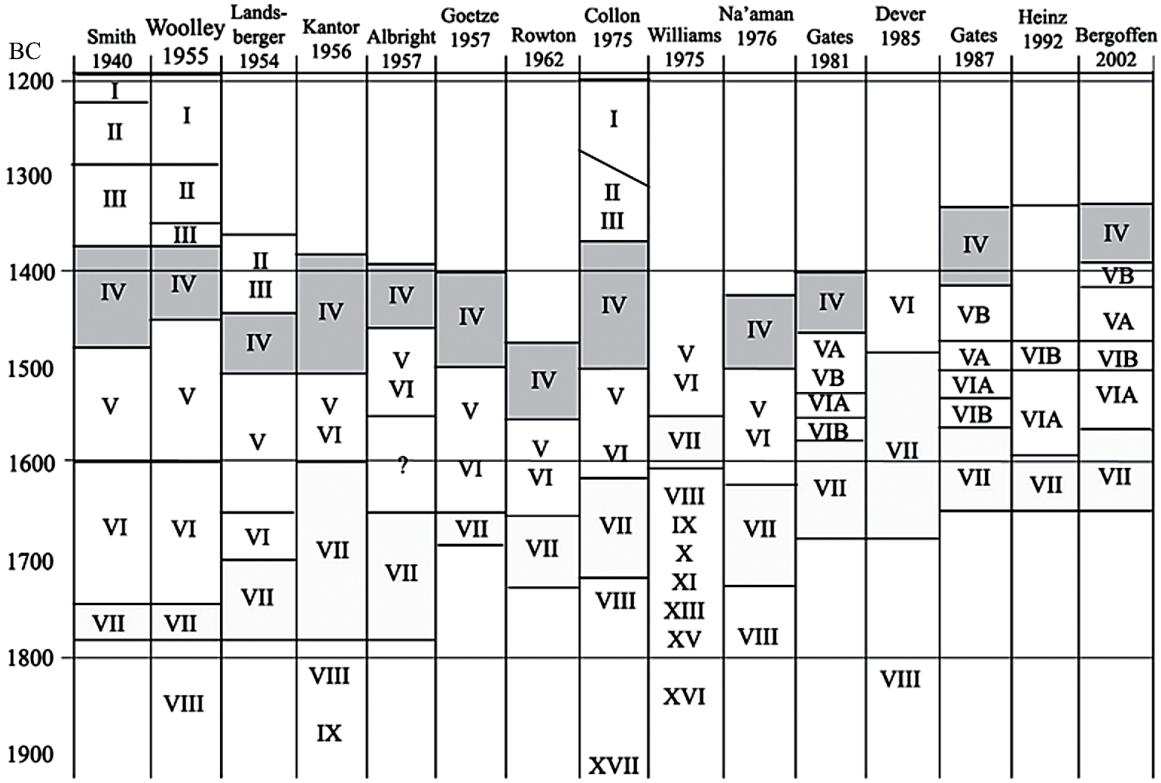


Figure 2.7 Different revisions of Tell Atchana chronology (Yener, 2013a, p. 29).

However, the conventional chronology and stratigraphy of Tell Atchana proved controversial (Figure 2.7) (Smith, 1940; Woolley, 1955; Albright, 1957; Collon, 1975; Collon, 1977; Na'Aman, 1979; Gates, 1981; Gates, 1987; Heinz, 1992; Novák, 2007; Fink, 2010). Recent work has included further refinement of chronology as part of the second excavation project, led by Yener (Yener, 2009; Yener, 2010; Yener, 2013a; Yener, 2013c).

2.1.2.1.2. Current excavation

The Amuq region was reinvestigated by the Oriental Institute as the Amuq Valley Regional Projects (AVRP) from 1995 to 2002 (Yener and Wilkinson, 1996a; Yener and Wilkinson, 1996b; Yener *et al.*, 1996; Yener and Wilkinson, 1997a; Yener and Wilkinson, 1997b; Yener and Wilkinson, 1998; Yener *et al.*, 2000; Yener, 2002; Yener, 2003; Yener, 2005; Casana and Wilkinson, 2005). Tell Atchana, one of the primary sites of the AVRP, was accordingly revisited. The surface survey of the site was conducted in both 2000 and 2002 and then the full-fledged

excavation was resumed in 2003 and continues to the present day, directed by Aslıhan Yener on behalf of the University of Chicago, Oriental Institute, funded mainly by Amuq Valley Archaeological Excavation (FAVAE) and the Institute for Aegean Prehistory (INSTAP) and since 2010 sponsored by Koç University, Istanbul (Yener, 2001; Yener, 2002; Yener, 2003; Yener, Schloen and Fink, 2004; Yener, 2005; Yener, Schoen and Fink, 2005; Yener, 2010; Yener, 2013b; Yener, 2013c; Yener and Akar, 2014a; Yener and Akar, 2014b). Excavation headquarters were established at the village of Tayfur Sökmen, about 2 miles away from Tell Atchana (Yener, Schoen and Fink, 2005), where the flotation area and main laboratory were also set up.

The current excavation has exposed the Middle Bronze, Late Bronze and Early Iron Age levels to date (Yener and Akar, 2014a). It was recently revealed that most of the city was destroyed between approximately 1300 to 1295 BC, with the exception of "the Ishtar Temple" (i.e. Woolley's temples), which continued into the Iron Age (Yener, 2013b; Yener and Akar, 2014a, p. 270).

The new excavations adopted a grid system. A series of Squares, each generally *c*. 10 x 10 m in size, were numbered in each area, i.e. Area 1, Area 2 and Area 3 (Figure 2.8). Within each Square, Locus numbers were assigned to each deposit/context. Area 1 was opened in the northernmost part of the mound, adjacent to Woolly's temple and palace zones ("Royal Precinct") (Yener, Schloen and Fink, 2004; Yener, 2010; Yener, 2013b). A number of squares was exposed since 2003; in particular, square 32.57 revealed monumental architecture, thick-walled mudbrick "apsidal buildings", tentatively identified as "a sanctuary or a sacred space" by Yener (2015a), from the Middle Bronze Age II through to the Late Bronze Age I (Yener, 2015a) (Figure 2.9). The earlier structure is large and elaborate whereas the later one is far more confined in size (Yener, 2015a). In squares 32.42, 42.29 and 42.10 of the same area, Iron Age phases were revealed by pottery assemblage and consequently it was confirmed that "the Ishtar Temple" was still occupied through the Late Bronze Age after the abandonment of the site at around 1300 BC (Yener, 2013b).

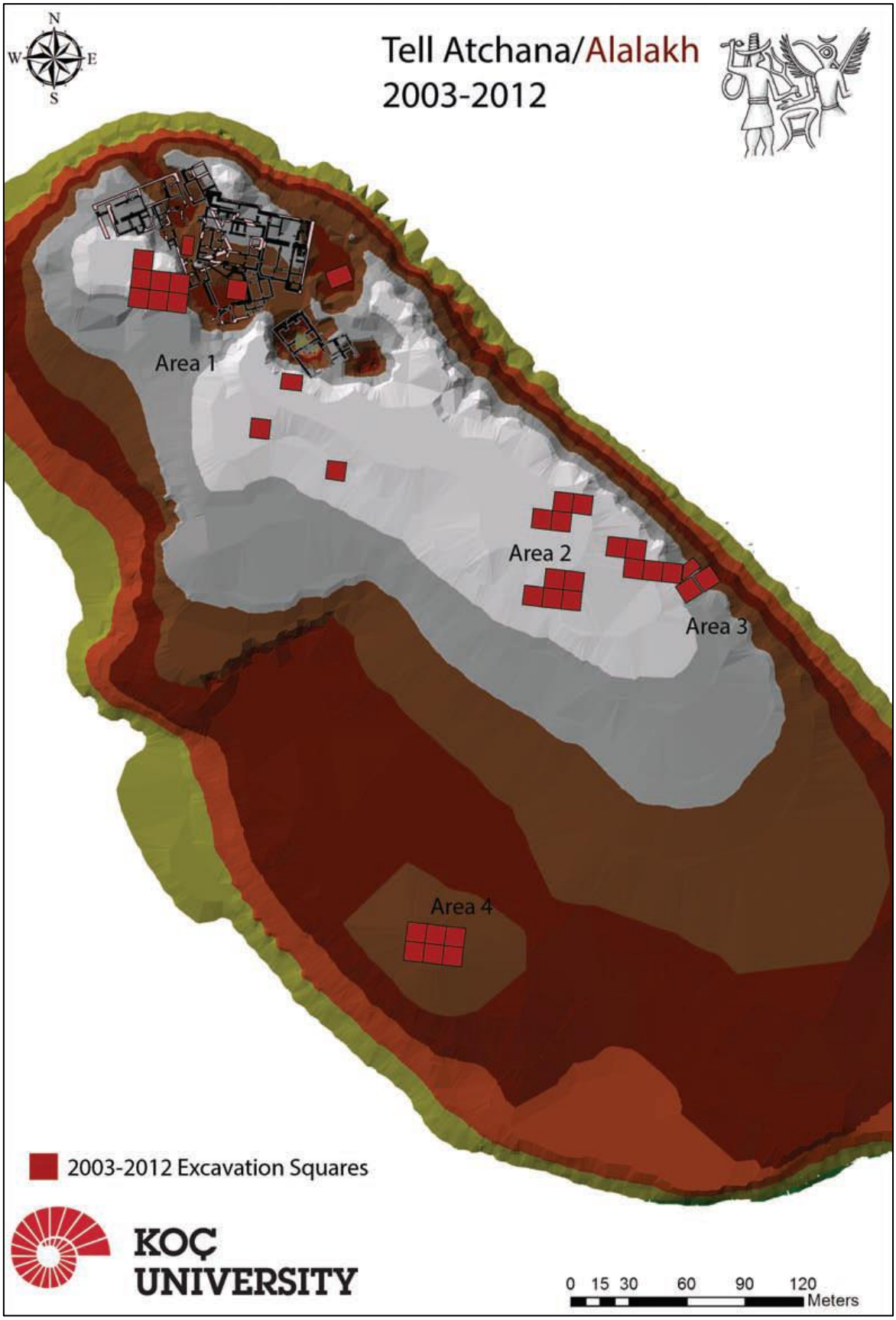
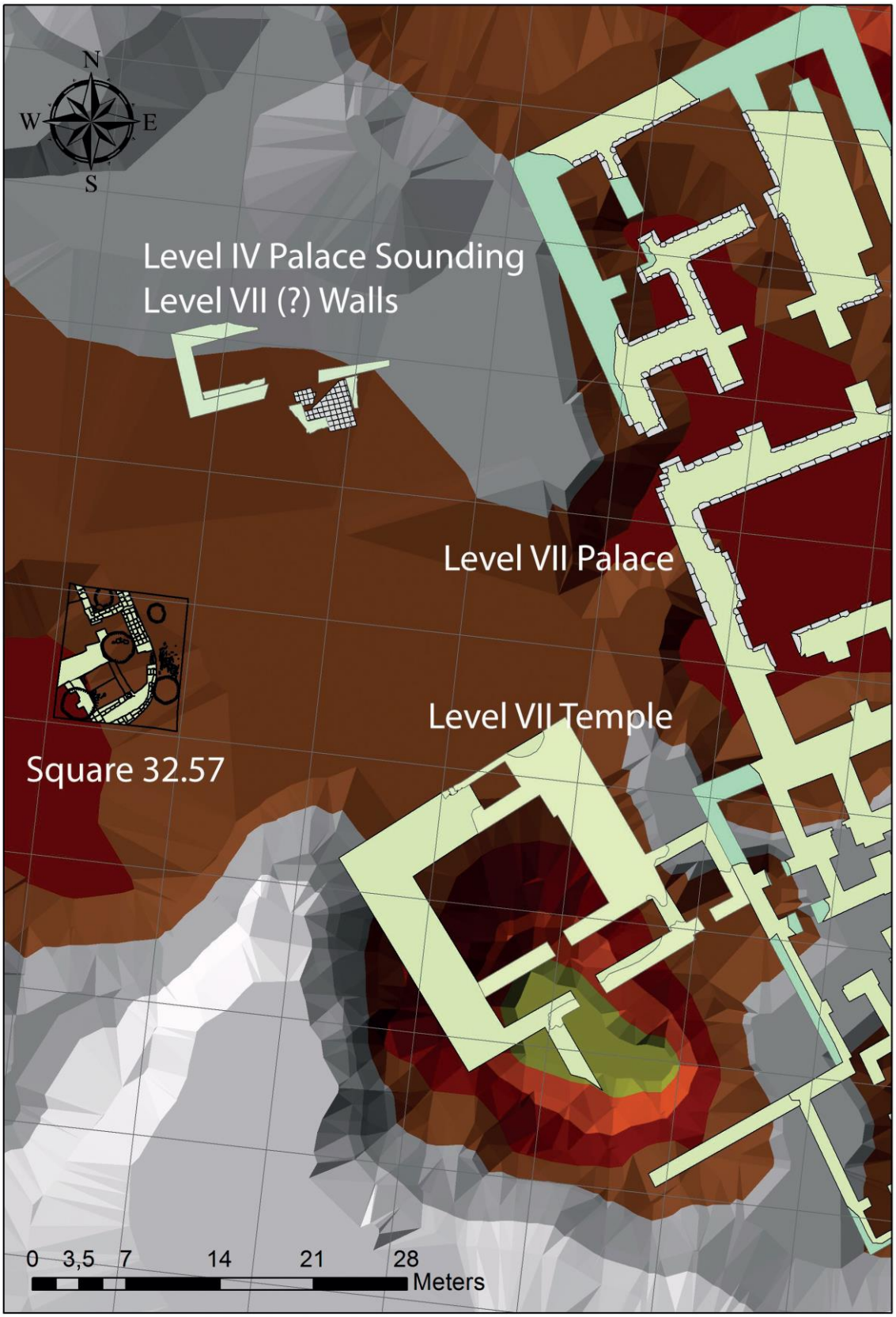


Figure 2.8 Topographic map of Tell Atchana showing the location of Areas.



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Figure 2.9 Plan of Area 1, Square 32.57 and Woolly's trenches at Tell Atchana (Yener, 2015b).

Area 2 and 3 adjoin each other in the eastern margin of the site, with Woolley's "Private Houses" to the north (Yener, Schloen and Fink, 2004; Yener, 2010). Craft areas were discovered in both areas which suggest large-scale specialised production (Yener, Schloen and Fink, 2004; Yener, Schoen and Fink, 2005). In addition to the workshop sectors, fortification structures were also explored in square 45.44 in Area 3, and a "necropolis" was excavated outside the defence facilities (Yener, 2013b). Located in the south-western part of the mound, Area 4 revealed workshop sectors containing hearths and storage structures through Local Phase 3 (Yener, 2013b).

2.1.2.2. Chronology

The principle target of the excavation has been the refinement of the second millennium BC chronology, and this process is still in progress (Yener, 2009; Yener, 2010; Yener, 2013a; Yener, 2013c). Figure 2.10 shows the preliminary site phasing of the Late Bronze and Iron Age levels (VI-O in the Woolley system). In this chart, Woolley's exposures and levels are presented in Roman numerals while Arabic numerals represent exposures and local phasing for the current excavation.

Up to date chronological study reveals that, under the 8 Period system, Period 3 to 1 refers to the Late Bronze Age II (ca. 1400-1300 BC), Period 6 to 4 refers to the Late Bronze Age I (ca. 1600-1400 BC) and Period 8 to 7 refers to the Middle Bronze Age II (1400-1300) and final results are awaited.

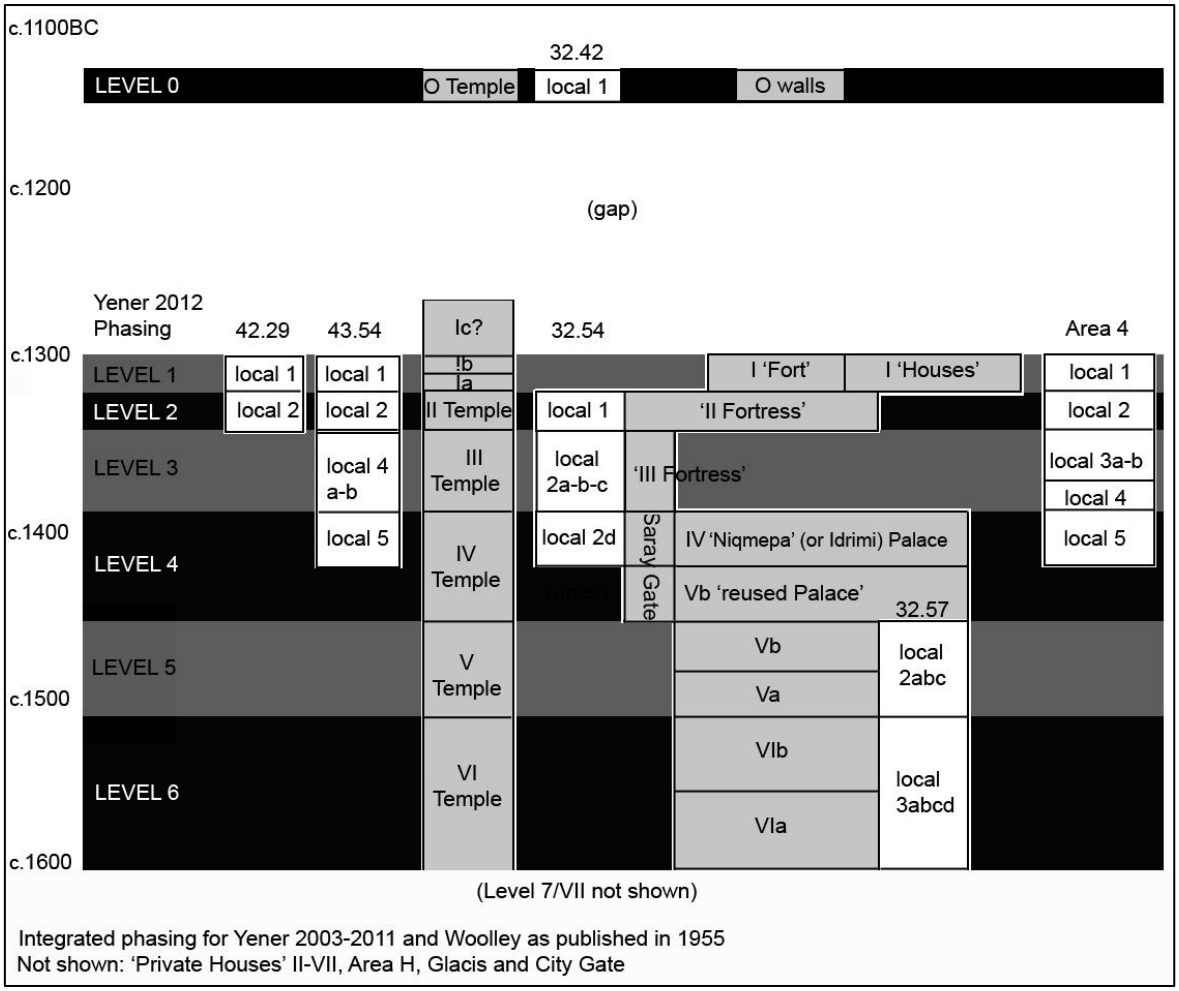


Figure 2.10 Preliminary phasing by Area and Square at Tell Atchana after Woolley (1955) and Yener (In prep.).

2.1.3. Tell Brak

Tell Brak, known as ancient Nagar/Nawar, is one of the earliest and largest archaeological sites in the upper Mesopotamia. The site is sit at an altitude of 340 to 370 m and its mound, at present, rises to 43 m with the extent of approximately 60 hectares (Sołtysiak, 2009). The site coverage once underwent substantial expansion up to 130 hectares in the Late Chalcolithic 3 (ca. 3800-3600 BC) and contraction under 20 hectares in the Old Babylonian times (McMahon, Sołtysiak and Weber, 2011, p. 203) within the longevity, spanning from, at least, the Neolithic (seventh millennium BC) through to the Middle Assyrian (second millennium BC) (McMahon, Sołtysiak and Weber, 2011; McMahon, 2013).

Tell Bark lies adjacent to the point where the water coarse of wadi Jaghjagh and wadi Radd interflow embraced by the upper Khabur catchment, which stem from the Euphrates, within the upper Jazira (Figure 2.11 and 2.12), and it is suggested that the wadis were running until the first millennium BC although they remain as drought today (McMahon, 2013, p. 67).

The nearest modern town is Hasakah, approximately 20 km to the southwest (Figure 2.11). Meanwhile, Tell Mozan and Tell Leilan are the closest archaeological sites towards the north and north east, respectively, sharing the occupations of the similar time to Tell Brak (Figure 2.12).

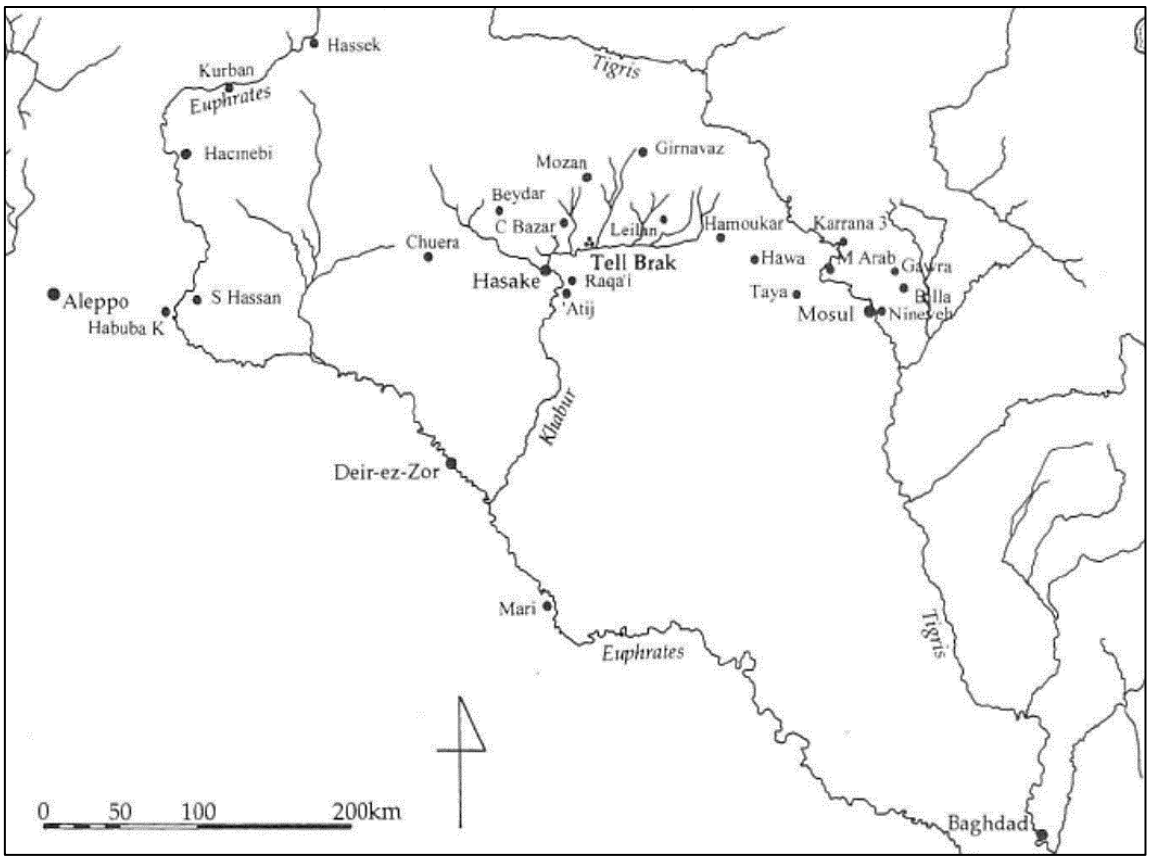


Figure 2.11 Map of the upper Mesopotamia showing the location of Tell Brak and major archaeological sites (Matthews, 2003).

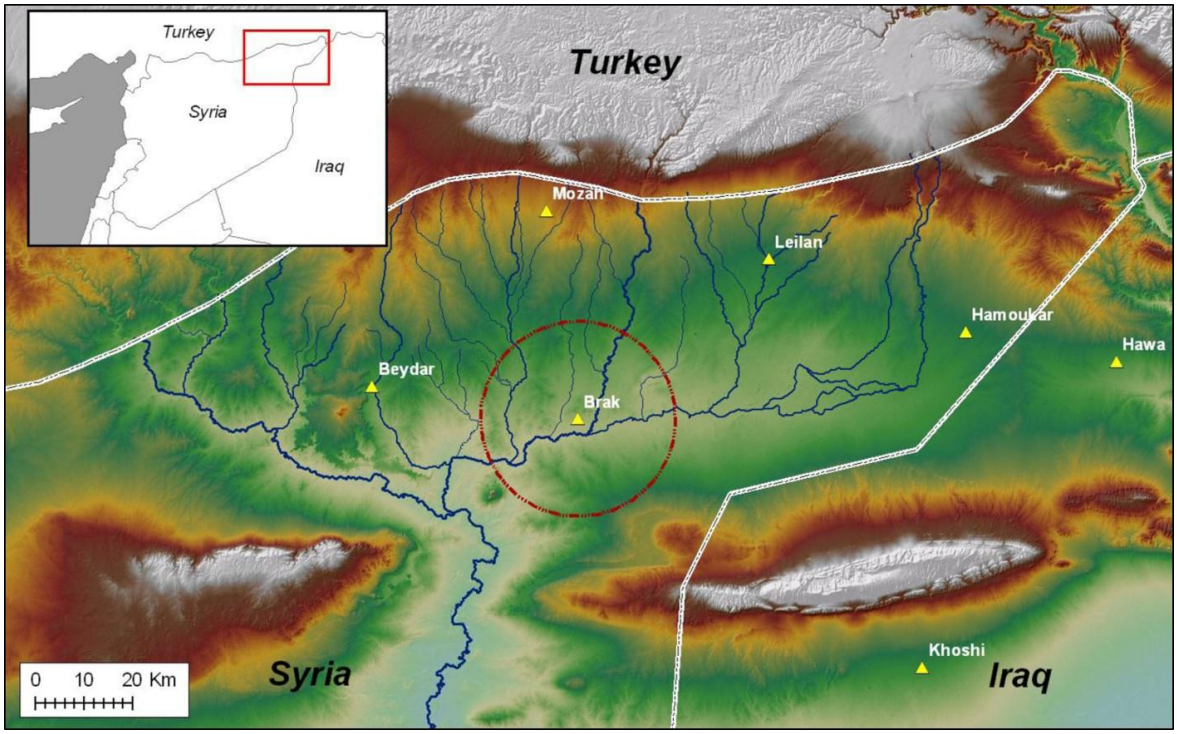


Figure 2.12 Map of the upper Khabur with Tell Brak and key sites indicated.

2.1.3.1. Excavation

Tell Brak was first excavated by Max Mallowan between 1937 and 1938 (Mallowan, 1947). Both locating in the southern part of the mound abut each other, the Eye Temple and the Naram-Sin Palace were monumental discoveries in his excavation (Mallowan, 1947). The former temple section, dating to the early fourth millennium BC (the Late Chalcolithic), was termed as the Eye Temple since the vast number of eye idols, primarily made of alabaster, were found in the sanctuary (Mallowan, 1947; Oates, 1982b; McMahon, Sołtysiak and Weber, 2011) (Figure 2.13). As to Naram-Sin Palace, where the name was revealed on some mudbricks impressed, Mallowan (1947) suggests that it was erected to control taxes by the ruler of Akkad in the third millennium BC (the Akkadian period) alluding to the linkage to southern Mesopotamian (Mallowan, 1947; Oates, 2005) and Oats also interpreted this as an administrative structure although she rather disagreed to name these buildings palaces (Oates, 1982b; Oates, 1985). Other than these two precincts, it might be worthwhile referring to Site HH investigated by Mallowan since it corresponds with Area HH of late excavations where archaeobotanical samples were taken next

here for current study. This area exposed private houses most of which underwent conflagration in the second millennium BC (Mallowan, 1947). It is notable that white painted Nuzi ware was recovered only in Site HH of the entire tell (Mallowan, 1947). Mallowan indicates that there was a considerable contraction in size at Tell Brak at this time (Mallowan, 1947).

It was in 1976, after the second world war, that the modern excavations were established under the direction of David Oats and Joan Oats (Oates, 1977; Oates, 1982c; Oates, 1982a; Oates, 1985; Jasim and Oates, 1986; Oates, 1987a; Oates, 1987b; Oates and Oates, 1991; Oates, 1993; Oates and Oates, 1993; Oates and Oates, 1994; Oates and Oates, 1997; Oates, Oates and McDonald, 1997; Oates, 2002; Oates, 2005; Oates *et al.*, 2007). The Mitanni Palace and Temple dated to the second millennium BC were excavated in Area HH at the northern highest ridge of the tell (Oates, Oates and McDonald, 1997). In this period, its southern part was found to be not occupied (Oates, Oates and McDonald, 1997). In the Palace, rooms including storage and workshops revealed a limestone statue, storage jars, ovens, fragments of glass, alabaster and pottery vessel, glass ingots and some cuneiform tablets (Oates, 2005). The Palace was destroyed and new residences were erected on it in the Middle Assyrian period (Oates, Oates and McDonald, 1997). In the Mitanni Temple, which was used and abandoned in the same time to the Palace, gold jewellery, glass bottles, alabaster vessels and ivory objects were retrieved and the wall was decorated by cones (Oates, Oates and McDonald, 1997). Towards further south from the Temple, more trenches from A to D were opened and here private buildings were exposed, however, only a few findings such as glass pottery, strainers and beakers were recovered in trench D (Oates, Oates and McDonald, 1997).

Meanwhile, excavations at Tell Brak were also conducted by Roger Matthews from 1994 to 1996 focusing on Area HS and HN spanning historically the Uruk, Ninevite V and Akkadian periods including the early second millennium BC (fourth to early second millennium BC) (Matthews, 1994; Matthews, Matthews and McDonald, 1994; Matthews, 1995; Matthews and Postgate, 2001; Matthews, 2004). Geoff Emberling contributed the excavations between 1998 and 2004 in the fourth and third millennium BC sequences mainly in Area TW and TC (Emberling *et al.*, 1999;

Emberling and McDonald, 2001; Emberling and McDonald, 2002; Emberling and McDonald, 2003).

Since 2006, the excavation was commenced under the field direction of Augusta McMahon of the University of Cambridge (McMahon *et al.*, 2007; McMahon, Sołtysiak and Weber, 2011; McMahon, 2012; McMahon, 2013). The excavation team continuously investigated Area TW, a sub-mound of Tell Majnuna and Area HH. The fifth through fourth millennia BC levels in TW include a "feasting hall" and workshops were opened, especially, in the so called "industrial" sectors, a number of ovens, whose purpose is uncertain, were excavated (McMahon *et al.*, 2007). The digging of Tell Majnuna located in the Outer Town of Tell Brak revealed "a series of mass graves" in the Late Chalcolithic 2 to 3 period (ca. 3800-3600 BC), implying violent conflict or battle. Area HH exposed Mitanni houses and a street which is linked towards the Mitanni Temple (McMahon *et al.*, 2007). It is notable that the Mitanni Palace shows the same style as the contemporary Tell Atchana Palace in construction (McMahon *et al.*, 2007). Unfortunately, the work has been suspended for an armed conflict within Syria.

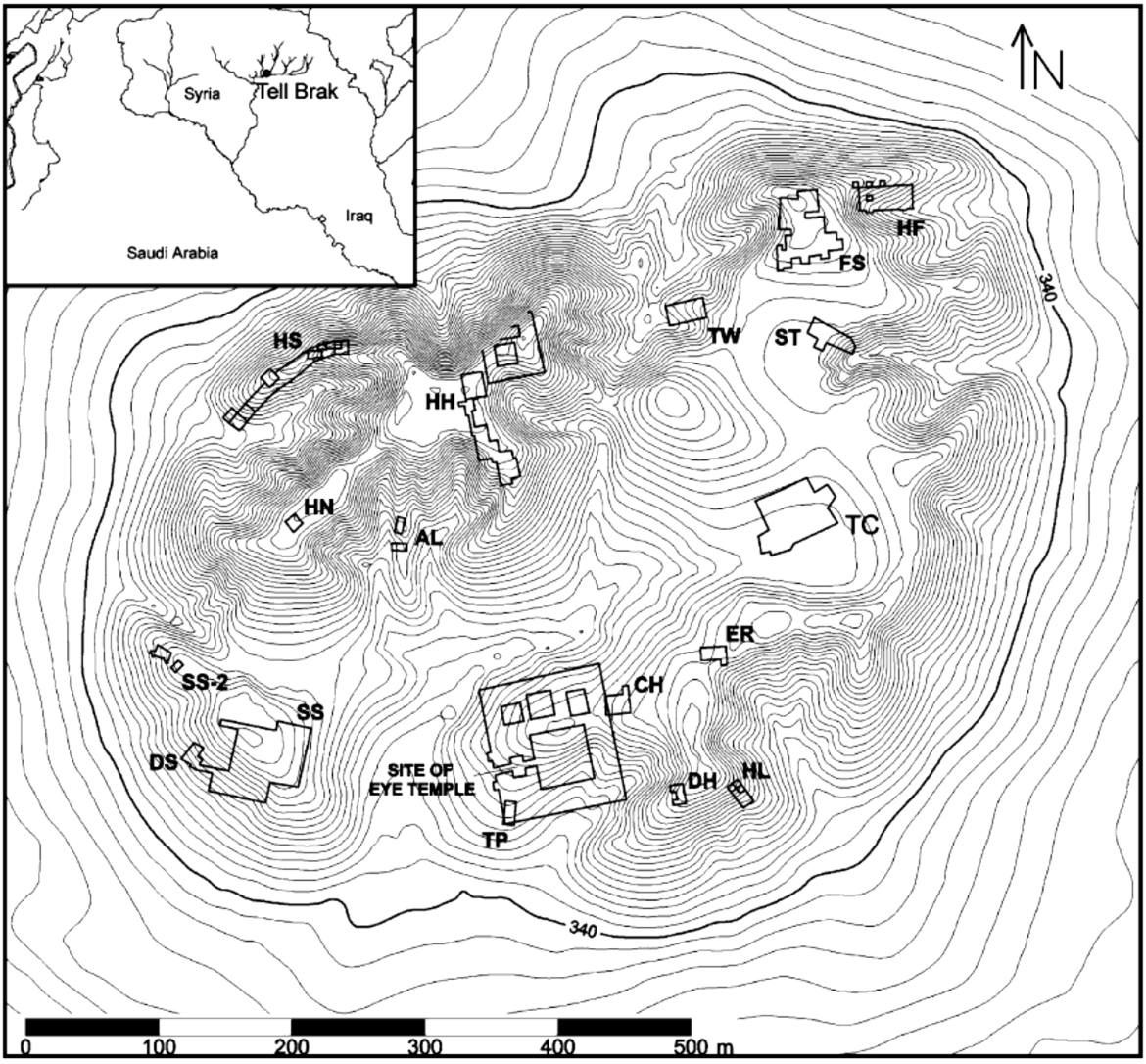


Figure 2.13 Topographic map of Tell Brak showing the location of Areas (Hald and Charles, 2008).

2.1.3.2. Chronology

Absolute dating of Tell Brak was gained based on the radiocarbon method and developed through the correlated trenches (Matthews, 2003). Tell Brak chronology borrows alphabetic system from A to T, which coincide with the Neolithic to Roman period (Oates, Oates and McDonald, 2001). As a multi-period site, the earliest levels of Tell Brak date to the seventh millennium BC (the Neolithic and Halaf) and the site kept occupying in the sixth millennium BC of the Ubaid period. The levels of the Late Chalcolithic 1/Late Ubaid were unearthed in Area CH, which contain the Eye Temple (Figure 2.14). Trenches were then concentrated in Area TW from the Late Chalcolithic 2 to Early

Jezirah II (the fourth to third millennium BC). Area HH, where the archaeobotanical samples was taken for the current study, spans from the Middle Bronze Age to the Iron Age (the third and second millennium BC) with 10 levels. HH 1 is from the Middle Assyrian, HH 2-7 are from the Mitanni and HH 8-10 are from the Old Babylonian (Oates, Oates and McDonald, 2001).

Date cal BC	Upper Mesopotamia regional designation	Lower Mesopotamia regional designation	Oates' letter designation	Oates' period designation	Tell Brak Oates' trenches	Tell Brak 1994-1996 trenches	Tell Leilan	Tell Beydar
800-900	Iron Age	Late Babylonian	S	Late Assyrian	HH			
1200	Late Bronze Age	Middle Babylonian	R	Middle Assyrian	HH1			
1275-1550	Late Bronze Age	Kassite	Q	Mitanni	HH2-7			
1600-1850	Middle Bronze Age	Old Babylonian	P	Old Babylonian	HH8-10	HN		
1950-2100	Early Jezirah V	Ur III Isin-Larsa	N	Hurrian	CH FS1-2			
2150	Early Jezirah IVb	Late Akkadian	M	Akkadian	FS3-5 SS3-5		IIb	IVb
2250	Earl Jezirah IVa	Early Akkadian				HS5 HP		IVa
2300-2400	Early Jezirah IIIb	Early Dynastic IIIb	L	Post-Ninevite 5-Pre-Akkadian	CH6-7 FS6 SS6-7	HS3	IIa	IIIb
2450-2599	Early Jezirah IIIa	Early Dynastic IIIa	K	Late Ninevite 5	ER ST	HF1 HS4:1-2 HL		IIIa
2600-2699	Early Jezirah II	Early Dynastic I-II	J	Early Ninevite 5	TW1 ST		IIId	II
2700-2899	Early Jezirah I	Early Dynastic I				HS4:1 HS2	IIIb-c	I
2900-2999	Early Jezirah 0	Jemdet Nasr	H	Post-Uruk-Pre-Ninevite 5	TW2-9	HP		
3000-3399	Late Chalcolithic 5	Late Uruk	G	Late Uruk	TW11-12			
3400-3599	Late Chalcolithic 4	Late Middle Uruk	F	Southern Middle Uruk	TW13		IV	
3600-3799	Late Chalcolithic 3	Early Middle Uruk		Northern Middle Uruk	TW14-17	HS1	V	
3800-3999	Late Chalcolithic 2	Early Uruk	E	Early Northern Uruk	TW18-19	HS6		
4000-4200	Late Chalcolithic 1	Late Ubaid	D	Terminal Ubaid	CH		VIb	

Figure 2.14 Chronology of Tell Brak in relation to the trenches (Matthews, 2003).

2.2. Environmental parameters

2.2.1. Geography

The northern Fertile Crescent is a horizontal band, around 1000 km long and 200 km wide, extending from the Mediterranean coast across northern Syria into Iraq up to the banks of the Tigris River (Figure 1.3). Much of the area lies between the Euphrates and Tigris rivers but it also includes land between the Euphrates and the Mediterranean coast. Though it is a wide area there are common features, principally the characterisation of the region today as one of rain-fed farming.

As for the eastern sector of the band of the study area, the northern Mesopotamia plateau known as the Jazira is spread throughout northern Iraq and north eastern Syria encompassing the two study sites, Tell Mohammed ʻArab and Tell Brak (Figure 2.15). The region lies across the Tigris and Euphrates running to the southeast from their headwaters in the Taurus mountains of south eastern Anatolia towards southern Mesopotamia. There are two high separate ridges adjacent to the two sites within 100 km on the Jazira plain. One is the Jebel Sinjar, which lies predominantly within northern Iraq, the other is the Jebel Abd al-Aziz in north eastern Syria. In the exception of these mountains, the land undulates from 100 to 450 m (Guest, 1966, pp. 71-2). The area is bounded by the Taurus and Zagros mountains to the north and east. To the west and southwest, it encounters the Syrian Desert. To the south, sub-desert of Southern Mesopotamia is unfolded with gradual slope down.

Along the Taurus mountains towards the west, the Amanus chains are rolling towards the south in parallel with the eastern Mediterranean coastal line (Figure 2.15). Inland towards the east, the Amuq plain (Antioch) is vastly opened covered by fertile arable fields for both irrigation and rain-fed agriculture, receiving considerable water supply. This valley is around 60-90 m in altitude (Google Map), embracing a series of archaeological sites in addition to Tell Atchana, which is located along the southern part of the plain. It is surrounded by three main mountains: the Amanus mountain range formed by intrusive igneous and sedimentary rocks to the northwest (Casana,

2003, p. 35), and two relatively lower mountains, the Kurt Dağ to the northeast and the Jebel al-Aqra to the south, formed of mainly basalt for the former range and of principally limestone and marlstone for the latter (Casana, 2003, pp. 35-6; Casana, 2009, p. 9). Originally rising from Lebanon, the Orontes flows right northwards across Syria to southern Turkey. Tell Atchana is located at a point where the river curves strongly westwards before discharging into the Mediterranean Sea. There are two tributaries of the Orontes from the northeast. One, the upper Kara Su, flows from between the Amanus and Kurt Dağ and the other, the Afrin river, flows from between the Kurt Dağ and Jebel Sim'ān; both run towards the centre of the Amuq plain. This water is released to the lower Kara Su river to the southwest and anastomoses along the Orontes river just before reaching the modern city of Antakya, the ancient city of Antioch.

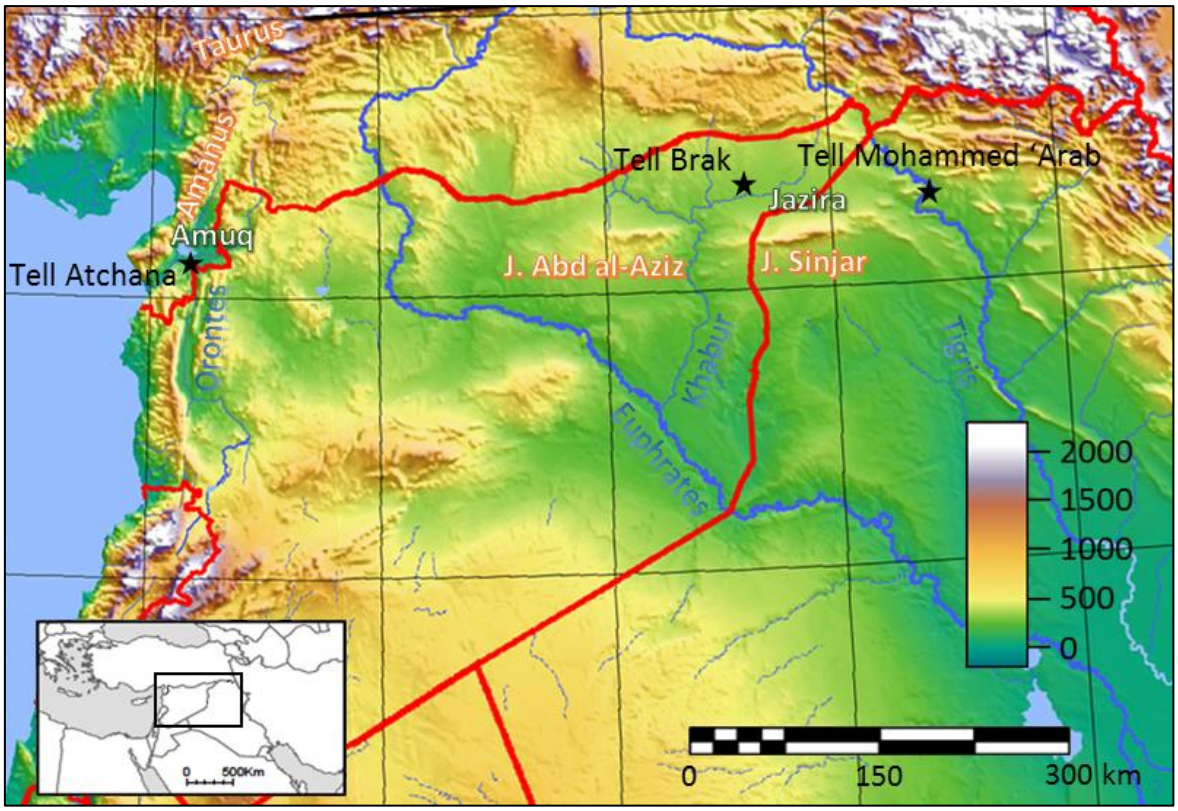


Figure 2.15 Topographic map of the three study sites across the northern Fertile Crescent.

2.2.2. Present-day setting

2.2.2.1. Climate

The biggest single factor in determining crop production in the region is the amount of precipitation. Rainfall levels in the northern Fertile Crescent vary substantially over relatively short distances. Namely, the precipitation declines gently from the Mediterranean coastal plain towards the Syrian Desert, whilst there is a rather steep decrease in rainfall in the north-south direction in the region (Figure 2.16). Even small changes in rainfall can, thus, have profound effects on the ability of communities to grow crops reliably. All three of the sites occur with the zone of rain-fed agriculture, that is, receiving over 250 mm rain per year (Jursa, 2012) but, there are differences among them in terms of mean annual rainfall. Tell Atchana falls within the most reliable rainfall zone, receiving more than 500 mm a year, followed by Tell Mohammed ʻArab, which receives more than 400 mm annual rainfall. Tell Brak is located in a more marginal environment for rain-fed farming, receiving some 300 mm per annum.

Across the area band of the northern Fertile Crescent, rainfall occurs typically from October/November through to May/June, including some snowfall in the winter months (Figure 2.17a, b and c). It is the duration of the wet season that corresponds with that of crop growth under the rain-fed agricultural system. Therefore, in spite of slight differences in harvesting time amongst the location of the sites and the time of a certain year according to the rainfall variability, this region traditionally has been suitable for winter crops, wheat and barley.

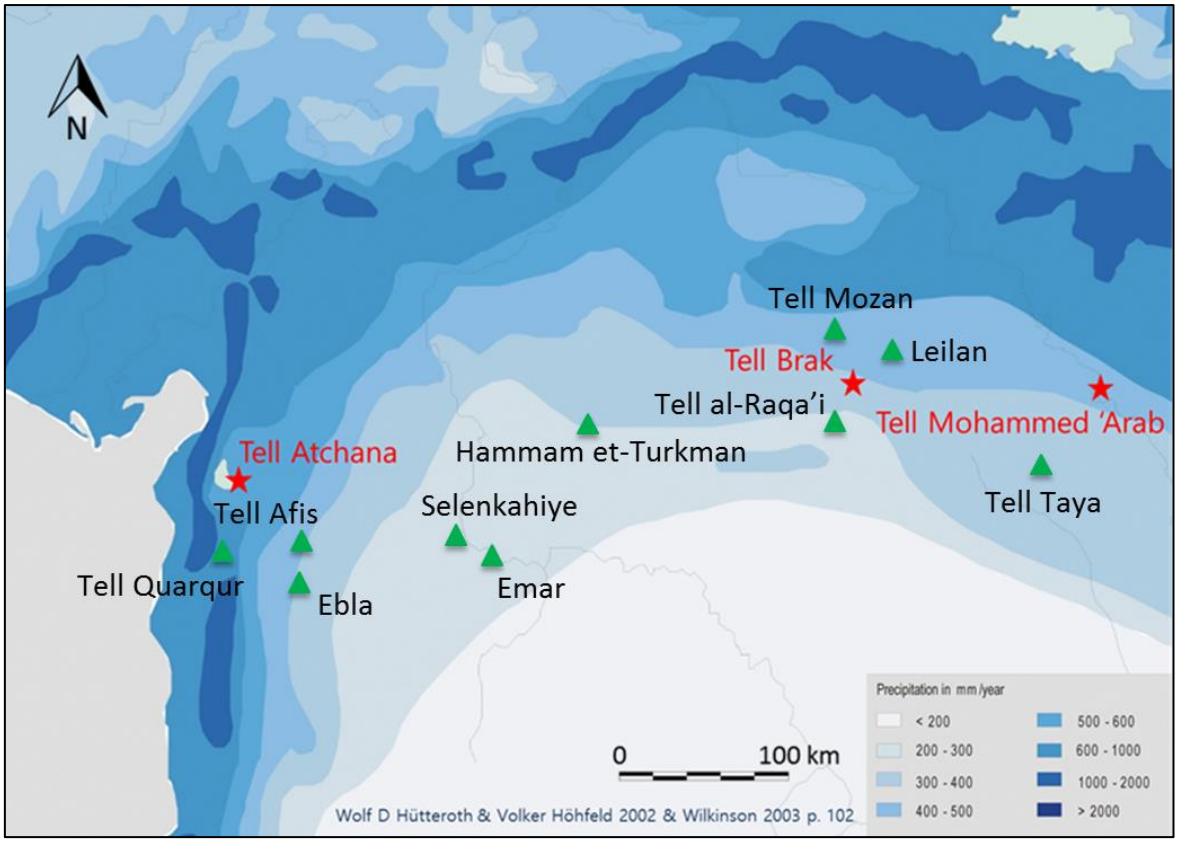
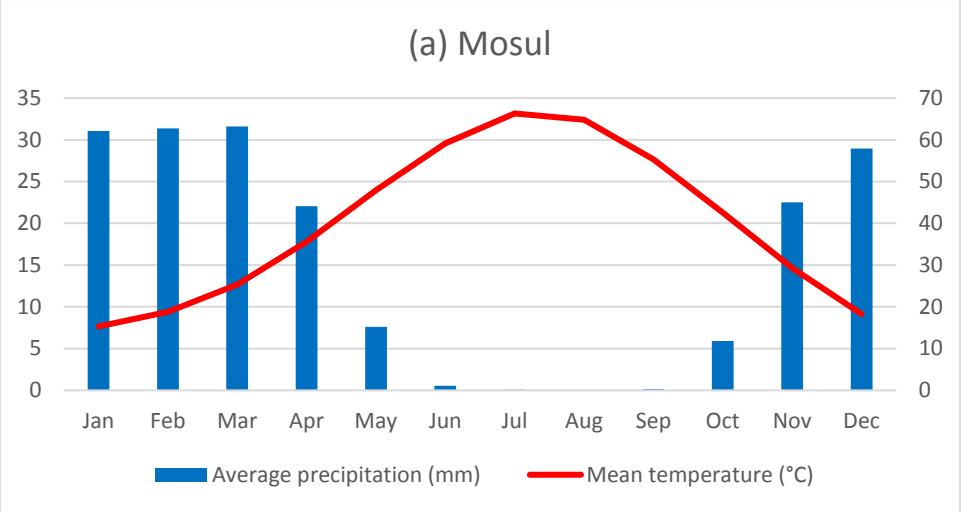
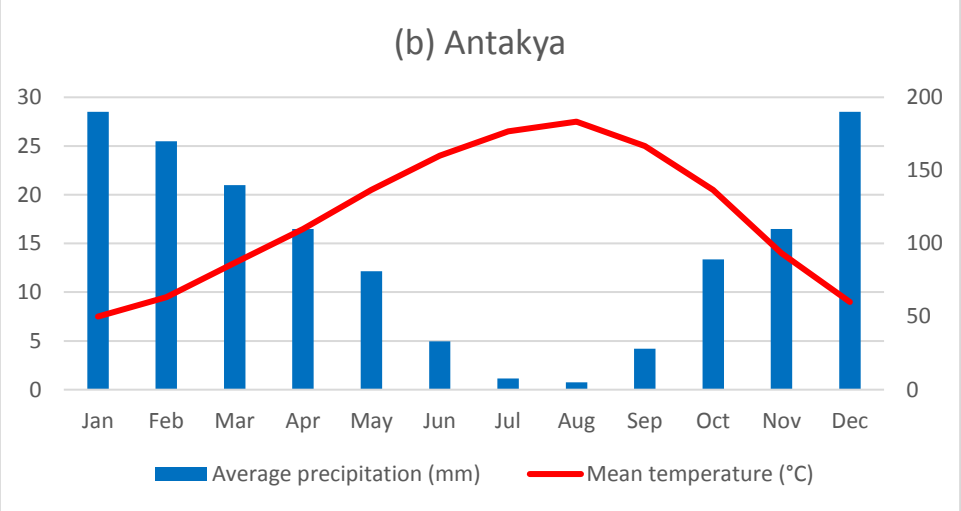


Figure 2.16 Map of the northern Fertile Crescent with isohyets for annual rainfall showing the study sites and key sites (after Hütteroth and Höhfeld, 2002; Wilkinson, 2003, p. 102)

The climate of the northern Fertile Crescent is diverse in accordance with differences in altitude landform and the distance from the sea (Figure 2.17). The cities of Mosul and Al-Hasakah, which are the closest to Tell Mohammed 'Arab and Tell Brak, respectively, in the Jazira plateau enjoy a semi-arid climate, with extremely hot dry summers and moderately cool wet winters (Guest, 1966). In contrast, Tell Atchana, adjacent to the city of Antakya, in the coastal eastern Mediterranean Sea is characterised by a typical hot summer Mediterranean climate with sub-humid to humid circumstances under the influence of Mediterranean (van Zeist and Bottema, 1991). Meanwhile, winters are mild wet although the coastal mountains, which are at altitudes above 1000 m, are extremely cold in winters falling to 20 degrees below zero (van Zeist and Bottema, 1991).





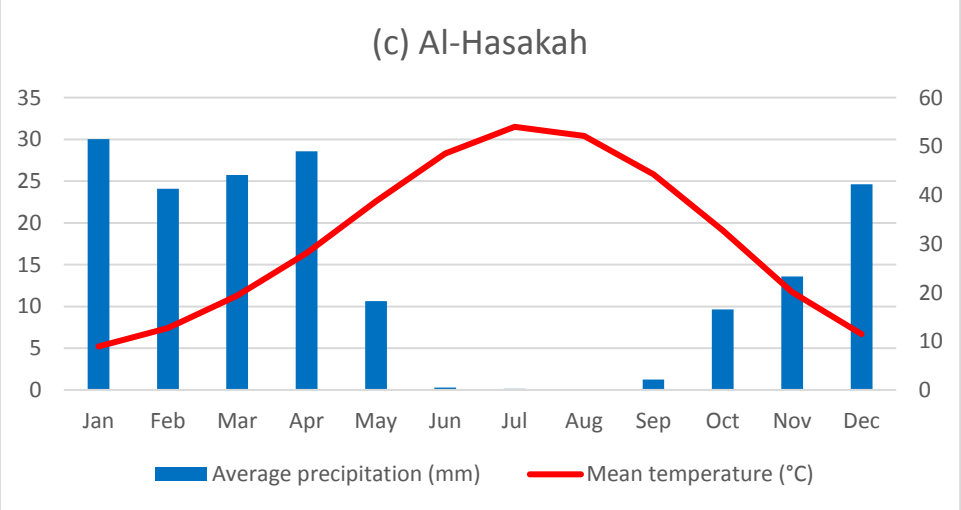


Figure 2.17 Diagrams of climate for (a) Mosul, (b) Antakya and (c) Al-Hasakah near each study site, Tell Mohammed ‘Arab, Tell Atchana and Tell Brak, respectively.

2.2.2.2. Vegetation

The distribution of the vegetation zones generally tends to coincide with the gradation of the elevation and precipitation (Charles, Pessin and Hald, 2010). Tell Mohammed ʻArab and Tell Brak both situated in the Jazira and its vegetation zone is defined as moist steppe or dwarf shrub formations (van Zeist and Bottema, 1991; Hütteroth and Höhfeld, 2002; Guest, 1966). Although the original scene of the moist steppe vegetation is expected to be comprised of *Ficus carica*, *Prunus microcarpa*, *Prunus Arabica*, *Pistacia atlantica* and xerophytic species on the natural grassland, long term of farming and pastoral activities have altered the common vegetation into *Peganum harmala*, *Prosopis* sp. and *Alhagi* sp. today (Buringh, 1960; Guest, 1966, p. 72; Engel, 1993; Charles, Pessin and Hald, 2010, pp. 186-7). Meanwhile, in the area out of human approach, *Quercetea brantii*, *Pistacia* sp. and *Amygdalus* sp. are still main components on the grass vegetation within the moist steppe region (513, 1943, pp. 92-4; Zohary, 1973, map 7; Charles, Pessin and Hald, 2010).

Moving into the western end of the northern Fertile Crescent, the formation is represented by the Amuq valley to Amanus mountain ranges (up to 2240 m). In the exception of the high upland of the Amanus, which is classified as the vegetation zone of cold resistant mixed leaved woodland or evergreen or deciduous closed coniferous and broad-leaved forest and is composed of evergreen forest (*Pinus brutia* and *Pinus nigra*) and deciduous Medio-European flora (*Carpinus orientalis*, *Buxus sempervirens*, *Ostrya carpinifolia*, *Quercus cerris* and *Fagus orientalis*), the sloping down Amuq plain, where Tell Atchana settles on, is termed as EU-Mediterranean vegetation or mixed formations of cultural landscape with shrub and woodland remnants (van Zeist and Bottema, 1991; Hütteroth and Höhfeld, 2002; Casana and Wilkinson, 2005; Deckers, 2010). The region was originally composed of a thick wood development along the mountainous foothills prior to the onset of artefact deforestation (Akkermans and Schwartz, 2003). However, the vegetational composition in the land today consists of maquis (scrubland vegetation), considered as an inevitable effect of the woodcutting. For the replacement, Ceratonio-Pistacionlentisci communities are reported as the major components in the region with various species such as *Pistacia lentiscus*,

Calycotome villosa, *Olea europaea*, *Spartium junceum* and *Erica verticillata* (van Zeist and Bottema, 1991).

2.2.2.3. Soil

The region of the three study sites are all covered by predominately Quaternary alluvial fans and by partially basalt lava to the northeast (Wilkinson, 1990a; Gutsuz *et al.*, 2017) and, in contrast to the southern Mesopotamia which is overlaid by alluvial soils, the soil type in the northern counterpart is represented as the Calcic Xerosols, Gypsic Xerosol and Vertisol (FAO-UNESCO, 1977; Wilkinson, 1990a). Of these, Tell Mohammed ʻArab and Tell Atchana are grounded on the soil type of Vertisols in common while Tell Brak on the Calcic Xerosols (Figure 2.18). Both types of soils known as relatively fertile for cereal cultivation, the Vertisols has a high potential of water holding capacity and the Calcic Xerosols is semi-arid (Wilkinson, 1990a; Philor, 2011). It is, however, notable that although the conditions of the soil in the northern Mesopotamia is generally fertile, the perpetual cultivation, animal pasture and woodcut for millennia have given rise to soil degradation (Buringh, 1960; Guest, 1966).

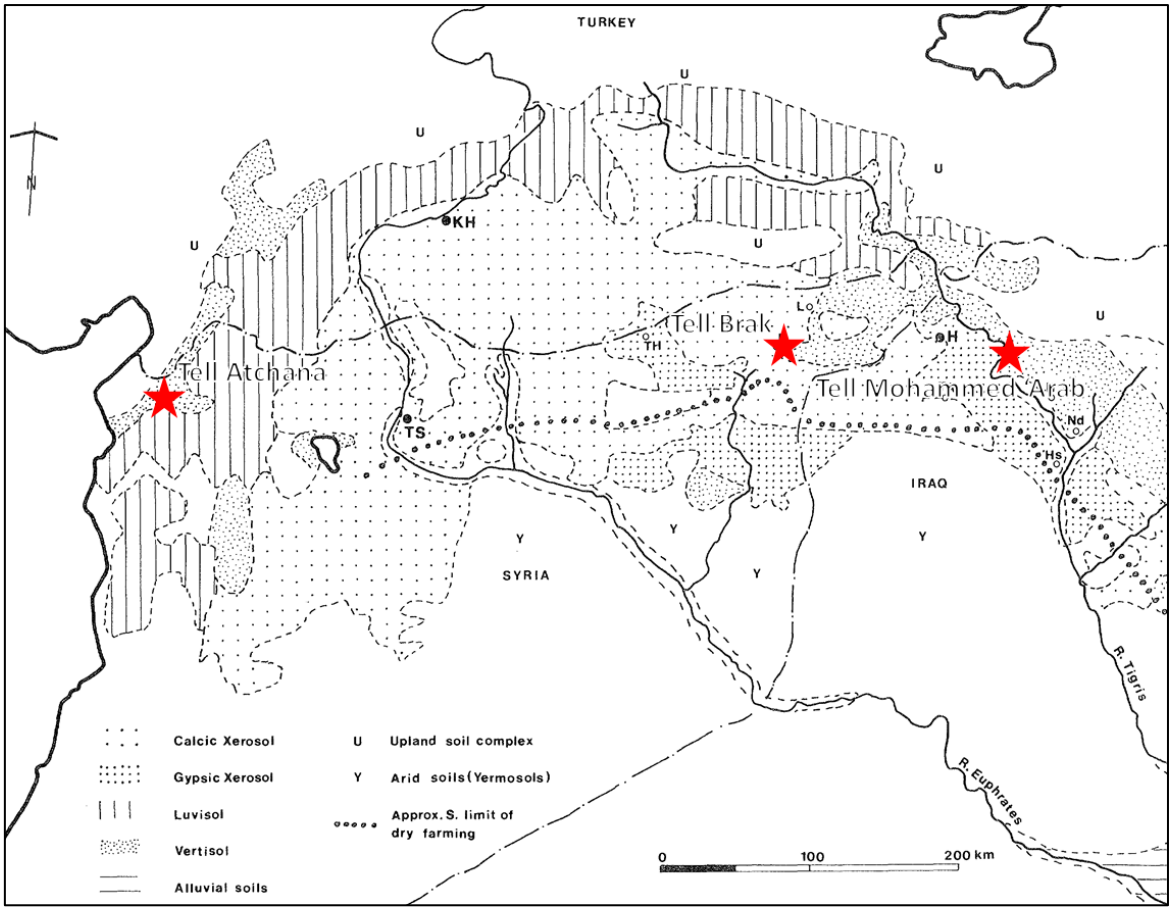


Figure 2.18 Dominant soil types in the study sites (after FAO-UNESCO, 1977; Wilkinson, 1990a).

2.2.3. Palaeoenvironmental record

The major sources for the reconstruction of past climate conditions have been supplied by cores taken from lakes in eastern Turkey and eastern Cyprus and from caves in Israel, which is applicable to the region of the northern Fertile Crescent. A series of the core sequences analysed for the multiproxy indicators includes pollen, stable isotopes, quartz, Mg/Ca ratio, Ca/Ti values, speleothems and charcoal (cf. Snyder *et al.*, 2001; Wick, Lemcke and Sturm, 2003). Study on oxygen stable isotope and speleothems from Soreq and Peqin Cave demonstrates that precipitation gradually declined and temperatures increased between 7000 yr and 500 yr BP, indicating arid conditions (Bar-Matthews, Ayalon and Kaufman, 1997; Bar-Matthews *et al.*, 2003). In the same period of time, the other palaeoclimatic evidence reports also overall moisture levels declined in

the study region (Neumann and Parpola, 1987; Weiss, 1997; Cullen *et al.*, 2000; Weiss and Bradley, 2001; Kaniewski *et al.*, 2013; Riehl *et al.*, 2014).

Past vegetational archives relevant to the study sites primarily rely on pollen and palynological cores from Lake Van in eastern Turkey for Tell Mohammed ʻArab and Tell Brak and from Ghab valley in north western Syria for Tell Atchana, which are sit on a close distance to each sites within available sources, and on anthracological research from Tell Atchana and Tell Brak. However, the reconstruction of vegetational history for the study sites is limited due to the sparse core sites and the lack of site based research. This factor cannot be ignored in that, other than environmental contribution for the formation of vegetation, human activities have a crucial impact that change vegetation in the region. In case of Tell Brak, where the regional evidence is available, the palynological analysis of Tell Brak is well developed but focused on the Late Chalcolithic (Charles, Pessin and Hald, 2010). The preliminary results of Tell Atchana anthracological study contribute a broad picture of the past vegetation at Tell Atchana (Deckers, 2010). Samples from Tell Atchana charcoal analysis is of more or less identical period (the Late Bronze Age) to those of current study.

The eastern Fertile Crescent in the Late Uruk, the Post Uruk and the Ninevite V (*c*. 3300-3000 BC, 3000-2900 BC and 2900-2600 BC)

The levels of moisture were rather optimised for human life during the Late Uruk through to Ninevite V overall, in the exception of a brief drought impact at around 5200 BP (Weiss and Bradley, 2001; Charles, Pessin and Hald, 2010). Records from oxygen isotope values from Soreq Cave in Israel implies dramatic fluctuations between wet and dry from *c*. 3300 to 2500 BC (Cullen *et al.*, 2000; Weiss, 2000). In particular, 5.2 K yr BP event is known as abrupt and extreme drought contributing one of the rapid climate change around the region, but with a relatively less magnitude compared to 4.2 K yr BP catastrophic episode. The sharp aridity has been underpinned by a plenty of palaeoclimatic proxies across the study region, proved by the analyses of quartz and oxygen

stable isotope data from Lake Van and Soreq Cave, respectively (Kay and Johnson, 1981; Cullen *et al.*, 2000; Weiss, 2016). Decreasing precipitation identified by accumulation of the Soreq Cave speleothems also support the severe dryness (Bar-Matthews *et al.*, 2003).

On the other hand, the evidence of Lake Van oxygen isotope values during the Ninevite V period implies wet and dry spells within a gradual arid condition (Cullen *et al.*, 2000; Weiss, 2000). However, there seems to be relatively mild conditions lasted without impressive change in terms of humidity in the Ninevite V period (Kay and Johnson, 1981).

The anthracological analysis of Tell Brak in the Late Uruk (*c*. 3300-3000 BC) and Post Uruk (*c*. 3000-2900 BC) periods exposes that the vegetation of open forest was composed of *Quercus*, *Pistacia* and *Fraxinus* while riverine forest was dominated by *Salix*, *Populus*, *Fraxinus*, *Ulmus* and *Phragmites*, and the ratio of *Pistacia* to *Quercus* and that of *Tamarix* to *Salix/Populus* suggest that the former period was characterised by dry with high human impact whereas the latter period was by moist and lower human impact (Charles, Pessin and Hald, 2010).

The north eastern Fertile Crescent in the Middle Bronze Age and the Late Bronze Age (*c*. 1800-1600 BC and 1600-1200 BC)

After the major 4.2 K yr BP event aridity continued across the region but without striking change (Weiss and Courty, 1993; Weiss *et al.*, 1993; Courty and Weiss, 1997; Cullen *et al.*, 2000; Weiss and Bradley, 2001; Wick, Lemcke and Sturm, 2003). Pollen, oxygen stable isotope data and Mg/Ca ratio from Lake Van suggests that the reduction of rainfall and the lake level, and aridification maintained, and thereby leading to opened woodlands, with the minor additional possibility of human induced, during both the Middle and Late Bronze Age (*c*. 1800-1200) but the Late Bronze Age enjoyed slightly wetter conditions (Lemcke and Sturm, 1997; Weiss and Bradley, 2001; Wick, Lemcke and Sturm, 2003). Overall, between the Late Uruk and the Ninevite V, the region of the north eastern Fertile Crescent had a relatively moister climate than in the Bronze Age, while the Middle and Late Bronze Age climate was dry, similar to today.

It is generally accepted that the vegetation of upper Jazira in the Bronze Age was more forested than in present day (Deckers and Pessin, 2010). The pollen evidence recovered from Lake Van shows that, in the area of the lake, there was a subtle decrease in *Quercus* in the Middle and Late Bronze Age (*c*. 1800-1200) compared to the previous era, more likely to be caused by the summer drought rather than human induced by cutting (Wick, Lemcke and Sturm, 2003), although, at Tell Mohammed 'Arab and Tell Brak, the human impact factor cannot be ruled out. The constant presence of *Plantago lanceolata* implies animal herding from around 1800 BC onwards (Wick, Lemcke and Sturm, 2003).

The north western Fertile Crescent in the Middle Bronze Age and the Late Bronze Age (*c*. 1800-1600 BC and 1600-1200 BC)

The paleorainfall studies of oxygen stable isotope and alkenone unsaturation ratios from the Levantine sea and of oxygen stable isotope and speleothems in Soreq and Peqin Cave, Israel prove that the amount of rainfall was slightly lower to the present day from 1800 to 1200 BC across the eastern Mediterranean region, and there were no significant differences between the Middle Bronze Age and Late Bronze Age in terms of the precipitation (Emeis *et al.*, 2000; Bar-Matthews *et al.*, 2003). Pollen sequences cored from Larnaca Salt Lake, Cyprus also records a decrease in moisture level during the Late Bronze Age (Kaniewski *et al.*, 2013). On the other hand, alluvial deposit cores taken from near the Gibala-Tell Tweini, Syria in the eastern Mediterranean indicates relatively moderate moisture conditions, especially, in comparison to the end of the Late Bronze Age through to the beginning of the Iron Age, for the Late Bronze collapse effect at around 3.2 K yr BP event (Kaniewski *et al.*, 2010). A sedimentary core sampled adjacent to Tell Atchana reveals extremely high values of Ca/Ti at around 1200 BC supporting the 3.2 k yr drought event (Avsar, Akar and Pearson, 2019). Meanwhile, carbon stable isotope analysis from Ebla-Qatna reveals clear dryness in the Middle Bronze Age II while there was a rather short and marginal wet term recorded at approximately 3600 BP within the Late Bronze Age (Caracuta and Fiorentino, 2015).

A series of pollen sequences from the Ghab valley indicates that *Quercus deciduous*, *Quercus evergreen* and *Pinus* started to decline, as well as the amount of charcoal starting in the Early Bronze Age, and continuing to the Middle Bronze Age and the Late Bronze Age in the region, implying human activity (Yasuda, Kitagawa and Nakagawa, 2000). Another study on pollen from Ghab valley supports that there was a remarkable decrease in the oak pollen between 4500 and 3500 BP, which may suggest deforestation (van Zeist and Bottema, 1991). On the other hand, it is interesting that olive pollen increased dramatically during the Middle Bronze Age through to the Late Bronze Age (Yasuda, Kitagawa and Nakagawa, 2000; Deckers, 2010).

The preliminary charcoal analysis from Tell Atchana shows that the vegetation was oak dominant in the Late Bronze Age (Deckers, 2010). The appearance of grape and olive charcoal suggests a sign of cultivation at Tell Atchana in the same time (Deckers, 2010). Meanwhile, riverine vegetation at Tell Atchana is represented by *Tamarix* and probably *Fraxinus* and *Platanus/Fagus* (Deckers, 2010). Taxa such as *Pinus brutia/halepensis*, *Taxus*, *Cupressus* and *Carpinus* that were found at the site indicate that they would have been brought from the Amanus mountains (Deckers, 2010). The core taken near Tell Atchana also evidences a large amount of charcoal fragments since 1750 BC, implying intensive agricultural activities with the onset of the Yarim-Lim dynasty at the site (Avsar, Akar and Pearson, 2019).

Chapter 3. Methodology

The following chapter describes the methods employed in this study, from on-site sample recovery to post-excavation laboratory procedures, and the standardisation of the datasets for subsequent analysis. It also sets out key analytical approaches including statistical techniques such as correspondence analysis and discriminant analysis and methods for assessing past crop growing conditions and husbandry practices: functional ecological analysis of weed assemblages, and stable carbon and nitrogen isotope analysis of crops remains.

3.1. On-site methods

3.1.1. Sample recovery

3.1.1.1. Tell Mohammed 'Arab

Samples for archaeobotanical analysis were collected during the 1984-5 excavation season and date from the Late Uruk to the Middle Assyrian period (*c*. 3300-1100 BC). The soil samples principally derived from the main sounding and the cliff section. Those samples taken from the Middle Assyrian period were the most abundant, followed by those from Incised Ninevite V, Painted Ninevite V and Late Uruk. Samples were taken from the majority of contexts excavated, but with particular preference for undisturbed deposits. The context types sampled include pots, hearths, ovens, ashy layers, courtyards, graves, pits, room fills, mudbricks and floors. A soil sample size of 30 to 40 litres was taken where possible. In addition, five handpicked samples (TM1, 7, 11, 12 and 13) were taken from visible seed concentrations in the Middle Assyrian period occupation. They were collected from visible concentrations. In total, 64 archaeobotanical samples were taken during the excavation 1984-5 season at Tell Mohammed 'Arab. The volume of soil samples processed in Tell Mohammed 'Arab ranges from less than 1 litre up to 132 litres, with an average volume of 24 litres and a standard deviation of 31 litres.

Soil samples were floated using a modified Ankara flotation system constructed for Tell Mohammed ‘Arab by Mike Charles based on original designs by French (1971). The floating material was caught in 1 mm and 0.5 mm sieves while the heavy “non-floating” material (heavy residue) was retained by 1 mm mesh.

Both flots and heavy residues obtained were completely dried in the shade. Fractions of the heavy residue, typically 100 percent of >1 cm material and 25 percent of <1 cm material, were sorted by local workers in order to recover non-floating plant remains as well as other categories of archaeological artefact and faunal remains. The flot material, however, was stored in the depot to be exported and processed in the laboratory.

3.1.1.2. Tell Atchana

The initial aim of the archaeobotanical programme of the 2011 and 2012 seasons at Tell Atchana was to maintain an adequate sampling strategy for archaeobotanical remains that would ensure maximisation of the potential information retrieved in the field. Research and transport permits for the archaeobotanical material were granted by the local authorities.

Bulk sediment samples were collected from Area 1, 2, 3 and 4 in the excavation seasons 2011 and 2012, from deposits dating to the Middle Bronze Age II and the Late Bronze Age I and II. In historical terms this period covers the Yamhad kingdom (*c*. 1800-1500 BC), the Mitannian (*c*. 1500-1300 BC), Hittite (*c*. 1600-1200 BC) and Middle Assyrian (*c*. 1400-1100 BC) in the region (Table 3.1).

For the sake of the retrieval of archaeobotanical material, a systematic sampling strategy was adopted at the site. One sediment sample was collected from the centre of each excavated context in order to estimate the status of the absence and/or presence of potential remains. Excavators sampled every possible contextual type including pits, floors, fills, ashy fills, fire installations, tandoors and postholes. When samples were transported to the flotation area, each was labelled with information such as the excavator, archaeological sample number, phase, area, locus, square,

lot and provisional context description. In the 2012 excavation season, additional sediment samples stored unprocessed from the 2006, 2008, 2009 and 2010 excavation seasons were also floated. The majority of sediment samples were taken from the Area 1 followed by the Area 4, Area 3 and Area 2.

The soil was dry-sieved on site to remove large bones, pottery and lithic material. The sieved soil was then processed by flotation. The volume of sediment requested from each context was *c.* 20-40 litres or the entire deposit from smaller deposits. The sediment volume per sample ranged from approximately 0.1 to 61 litres, with an average of 13.6 litres and standard deviation of 11 across total 171 samples.

Flotation was carried out using a modified version of the flotation system described by French (1971), at the dig house, approximately 2 miles from the excavation site, for a month in both 2011 and 2012 excavation seasons by the author. Fresh water was pumped to the flotation machine. Flots (floating organic material) were collected in chiffons lining a metal sieve, while the non-floating heavy residue was retained in a 1 mm mesh. Flots were scanned at the flotation area to provide a rough estimate of the frequency of charred material. Flots and heavy residues were dried in shade in order to protect samples from direct exposure to sunlight and potential damage. Once dry, heavy residues were sieved and sorted on-site in their entirety mainly by local assistants. Ecofacts (charred plant remains, bones and shells) and small artefacts (beads, obsidians, sherds and metals) were sorted in this procedure by the naked eye and then stored separately. Remaining heavy residues were stored at the depot on site. Flots were sieved using 4 mm (occasionally), 1 mm and 0.3 mm geological sieves, and placed sealed in the plastic bags. Those 1 mm flot samples from square 32.57 of Area 1 floated in 2011 were sorted and subjected to preliminary identification on site since this square was prioritised by the archaeologists for immediate feedback. All samples were exported to the United Kingdom in 2013. In total, 171 samples were floated during the 2011 and 2012 seasons at Tell Atchana (136 samples in 2011 and 35 samples in 2012), including an additional 21 samples from 2006, five samples from 2008 and 19 samples from the 2010 excavation season.

3.1.1.3. Tell Brak

Soil samples were collected from all archaeological contexts in Area HH from trenches HHE, HHF and HHG during the excavation seasons of 2006, 2007 and 2011. Their contexts include fire installations, jars, pits, bins, pots and floors in houses covering the Mitanni period.

Flotation was processed by Mette Marie Hald in 2006 and 2007 and by the author in 2011 behind the dig house, using a modified version of the flotation machine described by French (1971), adapted to recycle water, with the aim to minimise wastage and respect the scarcity of this resource in the area. In 2006 and 2007, the flot was collected in 1 mm and 0.3 mm sieves whereas in the year of 2011, chiffons with an aperture size of around 100 microns were used in a bottomless bucket in order to intercept the flot. In all the years of 2006, 2007 and 2011, the non-floating heavy residue was retained in a 1 mm mesh.

Flots were scanned at the flotation area to provide a rough estimate of the frequency of charred material. Flots and heavy residues were dried in shade in order to protect samples from direct exposure to sunlight and potential damage. Once dry, heavy residues were sieved and sorted on-site in their entirety, mainly by local assistants. Ecofacts (charred plant remains, bones and shells) and small artefacts (beads, obsidians, sherds and metals) were sorted in this procedure by the naked eye and then stored separately. Remaining heavy residues were stored at the depot on site. Flots were sieved using 4 mm (occasionally), 1 mm and 0.3 mm geological sieves, sealed in the plastic bags and packed in a box altogether.

Table 3.1 Chronology of Mesopotamia in terms of samples used in this study (grey shaded). TM: Tell Mohammed 'Arab, TA: Tell Atchana and TB: Tell Brak, ED: Early Dynastic and EJ/LC: Early Jazira/Late Chalcolithic (Based on Roaf, 1984; Charles, Pessin and Hald, 2010; Ur, 2010).

BC		**Northern Fertile Crescent**				
		Northern Mesopotamia			**Western Syria**	**EJ/ LC**
		Traditional	**TB**	**TM**	**TA**	
2nd	1200-1600	LBA/Middle Assyrian (*c*. 1400-1100 BC)/ Mitanni (*c*. 1500-1300 BC)/Hittite (*c*. 1500-1200)	Q	IV	I-VI	
	1600-1800	Middle Bronze II/Khabur	P		VII-IX	
	1800-2000	Middle Bronze I	N		X-XVII	
3rd	2000-2100	Post-Akkadian				EJ V
	2100-2300	Akkadian	M			EJ IV
	2300-2500	ED III b	L			EJ III
	2500-2600	ED III a	K			EJ II
	2600-2900	Incised Ninevite V (*c*. 2700-2450 BC)	J	III		EJ I
	2900-3000	Post-Uruk/Painted Ninevite V (*c*. 3000-2850 BC)	H	II		EJ 0
4th	3000-3300	Late Uruk	G	I		LC 5

3.1.2. Scanning and selection of samples

3.1.2.1. Tell Mohammed 'Arab

Of the 64 samples, 22 samples were sieved at 2 mm and 1 mm and scanned by Penny Johnston (1996) under a low-power microscope. Those samples containing 50 or more cereal items and/or more than 30 weed seeds were initially targeted. Using these criteria, 18 samples were selected for sorting (Johnston, 1996). In the present study, samples were rescanned using rapid quantification of plant categories (i.e. crop grain, crop chaff, pulses and weeds) and detailed information (e.g. sorted/unsorted, fractions sorted) were reported.

Forty-seven samples out of 64 samples were initially selected for analysis. They were either newly scanned or the 1 mm fraction only rescanned in order to score the level of richness on an ordinal '1' to '4' scale. These scores specified richness in cereal items (0-29, 30-49, 50-99, >100), and those samples scored '2' and above were additionally assessed in terms of richness in wild/weed

seeds (i.e. >30 wild/weed seeds or less). Twelve samples, two of which derive from a pure barley grain deposit, were selected for sorting in addition to those previously considered by Johnston (1996). The target for full analysis was 50 or more cereal items (i.e. samples scores of '3' or '4'), and/or 30+ weed seeds. Based on archaeobotanical scanning and the archaeological screening (i.e. contextual information), 27 samples were selected.

3.1.2.2. Tell Atchana

The 1 mm fraction of flots from all samples were scanned by estimating the abundance of charred crop items on a scale of abundance from 1 to 4 (1 = 0-29 items, 2 = 30-49 items, 3 = 50-99 items and 4 = greater than 100 items) in order to evaluate their richness in terms of archaeobotanical material. This was conducted either with the naked eye or a low-power microscope. Each sample containing greater than 50 items in total in both crop and weed items was selected in conjunction with consideration of their spatial (area and square) and temporal (phase) origin. Of the 51 samples selected, sample no. TA2006.99 was excluded in this analysis as this sample derived from topsoil and can be regarded as contaminated. The sediment volume per sample ranged from approximately 1 litre to 61 litres, with an average of 19.7 litres and standard deviation of 12.9 across 50 samples.

3.1.2.3. Tell Brak

Fifty-one sample flots from 2006 and 2007 and 24 sample flots from 2011 excavations in Area HH were scanned in order to determine an approximate number of crop items per sample and this was conducted by scoring each from '1' to '4'. These scores specified richness in cereal items (0-29, 30-49, 50-99, >100, respectively) based on the approximate number of crop plants per sample. The retrieval of a minimum number of *c.* 100 cereal items and 30 weed/wild seeds per sample was initially targeted for as the ideal sample (cf. van der Veen and Fieller, 1982, p. 296). However, the abundance of items did not generally meet these criteria. As a result, those samples scoring '3' and

above with the weed/wild seeds greater than 30 or less were selected. At this stage a total number of 33 samples was chosen.

The sediment volume per sample ranged from approximately 1 litre to 145 litres. Of 33 samples, the volume of soil floated in seven samples was not available. Otherwise, the average and standard deviation are 16.8 litres and 30.6, respectively.

3.1.3. Subsampling

Following the scanning process, large flots exceeding 500 items were randomly subsampled using a riffle box to extract a subsample yielding at least 300 crop and 30 weed seeds items, respectively (cf. van der Veen and Fieller, 1982). Relatively poor samples were sorted in their entirety. Van der Veen and Fieller (van der Veen and Fieller, 1982, p. 296) suggest that a minimum number of approximately 278 to 384 crop items is required assuming that the total number of seeds in the target population is 1000 or infinite (i.e. in the archaeological deposits/contexts) in order to obtain a 95 percent chance of accuracy within a 5 percent precision or tolerance. The number of items in the subsamples divided into fractions were later multiplied up as appropriate.

At Tell Mohammed ‘Arab, the number of plant items per litre of soil is generally low, and hence the majority of the samples was sorted in their entirety rather than subsampled, and multiplications by larger than four were avoided (cf. Valamoti, 2004, p. 26). Of the 27 samples extracted from the scanning process, nine were subsampled.

At Tell Atchana, subsampling further than one quarter was avoided. The >4 mm size fractions of flots were sorted in their entirety. Of the total number of 50 samples chosen from the scanning stage, eight samples were accordingly subsampled.

At Tell Brak, except in one case (TB07/10, >0.3 mm), no fractions were subsampled to below one eighth.

3.2. Laboratory procedures

3.2.1. Sorting

At this stage, the flots were generally sieved at (occasionally) 4 mm, 1 mm and 0.3 mm for the sake of rapid sorting. Crop grains and chaff, pulses, cereal/reed culm nodes, weed/wild seeds, fruit stones, nut shells, wood charcoal, tuber and dung material were distinguished from the other unidentifiable items under the microscope. This was conducted at the laboratory using a low-power microscope with magnifications of x6 to x40.

3.2.1.1. Tell Mohammed 'Arab

Eighteen samples from this site were previously sorted by a Master's student for her dissertation (Johnston, 1996), and in the current study, seven of them were further processed by sorting their unsorted fractions. Additionally, ten more samples were sorted. Both coarse (>1 mm) and fine (>0.3 mm) flots were sorted.

3.2.1.2. Tell Atchana

At the beginning of the excavation, samples from square 32.57 in Area 1 were prioritised by archaeologists and hence 1 mm flots recovered from that area in 2011 were sorted initially using a stereoscope with magnification ranging between x7 and x45 at the dig house laboratory in 2012. For the remaining samples, sorting was conducted at the archaeobotany laboratory of the School of Archaeology, University of Oxford using a low-power microscope. In total, both coarse and fine flots from 50 samples were sorted. A substantial amount of intrusive modern vegetation was removed at this stage.

3.2.1.3. Tell Brak

Twenty-four samples were already sorted by Godfrey (2009) for her Master's dissertation. In the current study, Godfrey' material was reprocessed, where necessary, and additional unsorted fractions were sorted. Additionally, ten more samples were sorted by the author.

3.2.2. Identification

The fundamental approach to archaeobotanical identification was to observe distinctive morphological aspects of the plant remains, including shape, surface pattern and size. Based on these factors, archaeological specimens were compared to relevant modern material (e.g. specimens, photos, drawings, descriptions and measurements) from various sources. Specimens were examined under a stereomicroscope at magnifications of x6 to x40.

Multiple sources such as modern seed reference collections, archaeological seed type specimens from previously studied assemblages in the region, seed atlases, archaeobotanical publications and online sources aided the identification of plant remains to family, genus or species levels, of specific plant parts. Modern seeds from reference collections were occasionally charred to be compared directly with archaeological specimens. Modern seeds were also ordered from botanical gardens in order to fill gaps in reference material wherever possible. SEM (scanning electron microscope) imaging was used where necessary to observe seeds at much higher magnification and resolution.

Archaeobotanical items were classified into appropriate plant categories in terms of their scientific names, specific plant parts and the degree of identification. Where identifications were plausible but not certain, "cf." was used to qualify the genus or species name, as appropriate. For example, items belonging to the category "Triticum cf. dicoccum spikelet forks" are identified as definite Triticum spikelet forks and probably dicoccum. In the same vein, "indet." and "/" stand for "indeterminate" and "or", respectively.

3.2.2.1. Identification of crops

Cultivated plant remains were compared with modern material in the reference collections at the University of Sheffield and the University of Oxford. In addition, illustrations from archaeobotanical publications (van Zeist and Bakker-Heeres, 1984b; Kroll, 1992; Jacomet, 2006; Charles and Bogaard, 2010; van Zeist and Bakker-Heeres, 2014) were consulted. Previous archaeobotanical reports directly relevant to the study sites, Tell Brak (Charles and Bogaard, 2001) and Tell Atchana (Riehl, 2010a), were also major sources. Criteria for identification were informed by Hillman *et al*. (1996), Kohler-Schneider (2003), Jones *et al*. (2000), Hillman (2001) and Jacomet (2006). Terminology for the cultivated seeds follows Charles (1984), Jacomet (2006) and Zohary *et al*. (2012).

Einkorn and emmer glume bases were often indistinguishable on account of poor preservation, in this case, they were identified as *Triticum monococcum*/*dicoccum*. Glume wheat from two- and one-grained spikelets were distinguished where possible. Occasional barley grains were identified as "cf. naked indet." and or "hulled cf. twisted", but these may reflect poor preservation and/or charring distortion of hulled two-row barley grains.

3.2.2.2. Identification of weed/wild taxa

Weed/wild taxa were separated from cultivars identified initially as broad types. Most of them were then readily identified to genus level, with fewer types identified to family (only) or to species level. For morphological identification, shape, structure and surface cell patterns of the archaeological seeds were observed. Size of, at least, three specimens per type were also measured in their length, breadth and thickness using an ocular graticule. The archaeological types were compared with modern material using the reference collections at the University of Sheffield and the University of Oxford and type specimens collected from the other Near Eastern sites. Illustrations from seed atlases (Berggren, 1969; Berggren, 1981; Hansen, 1991; Anderberg, 1994;

Cappers, Bekker and Jans, 2012; Neef *et al.*, 2012), archaeobotanical reports (Lange, 1979; van Zeist and Bakker-Heeres, 1984a; van Zeist and Bakker-Heeres, 1984b; van Zeist and Bakker-Heeres, 1985; Marinova and Riehl, 2009; Bona, 2013; van Zeist and Bakker-Heeres, 2014), previous archaeobotanical publications from Tell Brak (Charles and Bogaard, 2001) and Tell Atchana (Riehl, 2010a), the *Flora of Turkey* (Davis, 1965-1988; Davis, Miller and Tan, 1988; Güner *et al.*, 2001) and an online source (http://g.willcox.pagesperso-orange.fr) were all consulted.

Types were identified to species level where possible and worthwhile. Within the Fabaceae, for example, *Astragalus* not only occurs with approximately 116 species in Iraq (Townsend and Guest, 1974, p. 232) and with 380 species in Turkey (Davis, 1970), but also their ecological and biological features are relatively consistent, meaning that the identification is not only difficult but also largely redundant in ecological terms. Furthermore, species level identification was pursued where if the relevant type was present in at least 10 percent of samples.

Three aspects were important for identification: morphological traits, further biological and ecological data. For the physical examination, form, structure and cell patterns of the archaeological seeds were observed and then they were measured by length, breadth and thickness to be compared with modern seeds in detail. The wild taxa were compared with modern material, using the reference collections at the University of Sheffield and the University of Oxford, plus type specimens collected from other Near Eastern sites. Illustrations from seed atlases (Berggren, 1969; Berggren, 1981; Anderberg, 1994; Cappers, Bekker and Jans, 2012; Hansen, 1991; Neef *et al.*, 2012), archaeobotanical reports (van Zeist and Bakker-Heeres, 2014; van Zeist and Bakker-Heeres, 1984a; van Zeist and Bakker-Heeres, 1984b; van Zeist and Bakker-Heeres, 1985; Lange, 1979; Bona, 2013; Marinova and Riehl, 2009), previous archaeobotanical publications from Tell Brak (Charles and Bogaard, 2001) and Tell Atchana (Riehl, 2010a) and an online source (http://g.willcox.pagesperso-orange.fr) were also consulted. In addition to these, the *Flora of Iraq* (Guest, 1966; Townsend and Guest, 1974; Townsend, Guest and Omar, 1980; Guest and Townsend, 1980; Guest and Townsend, 1985; Bor and Guest, 1968; Ghazanfar and Edmondson, 2013; Anjani, 2010) was consulted for lists of relevant taxa.

Biological and ecological information was assembled followed by morphological identification. Biological information included life cycle (i.e. annual/biennial/perennial), plant height, flowering and fruiting time, while ecological characteristics included habitats, growing altitudes and vegetation zones. Biological and ecological information was primarily obtained from the *Identification Guide for Near Eastern Grass Seeds* (Nesbitt, 2006) for grass seeds, the *Nouvelle flore du Liban et de la Syrie* (Mouterde and Le Houérou, 1966), the *Flora of Iraq* (Guest, 1966; Townsend and Guest, 1974; Townsend, Guest and Omar, 1980; Guest and Townsend, 1980; Guest and Townsend, 1985; Bor and Guest, 1968) and the *Flora of Turkey* (Davis, 1965-1988; Davis, Miller and Tan, 1988; Güner *et al.*, 2001) for other taxa.

Nomenclature for wild taxa follows (Nesbitt, 2006) for grasses and the *Flora of Iraq* (Guest, 1966; Townsend and Guest, 1974; Townsend, Guest and Omar, 1980; Guest and Townsend, 1980; Guest and Townsend, 1985; Bor and Guest, 1968) and the *Flora of Turkey* (Davis, 1965-1988; Davis, Miller and Tan, 1988; Güner *et al.*, 2001) for other taxa.

3.2.2.2.1. Tell Mohammed ‘Arab and Tell Brak

The information of vegetation zone and altitude described in the *Flora of Iraq* provides a valuable foundation for the identification of weed/wild species since they confine the expected growing conditions of flora and refine the contenders of species.

Tell Mohammed ‘Arab is situated at an altitude of approximately 300 m, which falls in the moist steppe zone. For the purposes of compiling lists of potentially relevant weed/wild species for Tell Mohammed ‘Arab, the flora represented in the assemblage was assumed to represent a (generous) maximal range of 100 to 800 m altitude (Figure 3.1 and Table 3.2).

Tell Brak is located approximately 160 km away from Tell Mohammed ‘Arab and shares more or less the same vegetational and altitudinal features. Thus, the criteria used for Tell Mohammed ‘Arab were similarly applied to Tell Brak.

The altitude of Tell Brak is approximately 340 to 370 m, within the vegetation zone of moist steppe (Table 3.2). The archaeobotanical material recovered at Tell Brak was initially presumed to derive from a radius of about 80 km from the site, encompassing an altitude range of 300 to 450 m (up to 1000 m towards northern Mardin plateau). Based on the *Flora of Iraq*, this range falls within the moist steppe zone, with a wider total altitudinal range of 200 and 800 m (Figure 3.1). Consequently, an altitudinal range of 100 to 800 m was used in order to identify potential weed/wild plant species of relevance to the assemblage, for the purposes of taxonomic identification.

With the moist steppe as the 'primary' zone for both Mohammed Arab and Brak, a 'secondary' zone comprised of lower forest, foothills and dry steppe was also considered. For each site, those species occurring rarely or very rarely in the primary and secondary vegetation zones according to *Flora of Iraq* were excluded as contenders, unless the species was also reported to be present in the area of FNI (Nineveh District) or FUJ (Upper Jazira District), districts that cover Tell Mohammed 'Arab and Tell Brak, respectively.

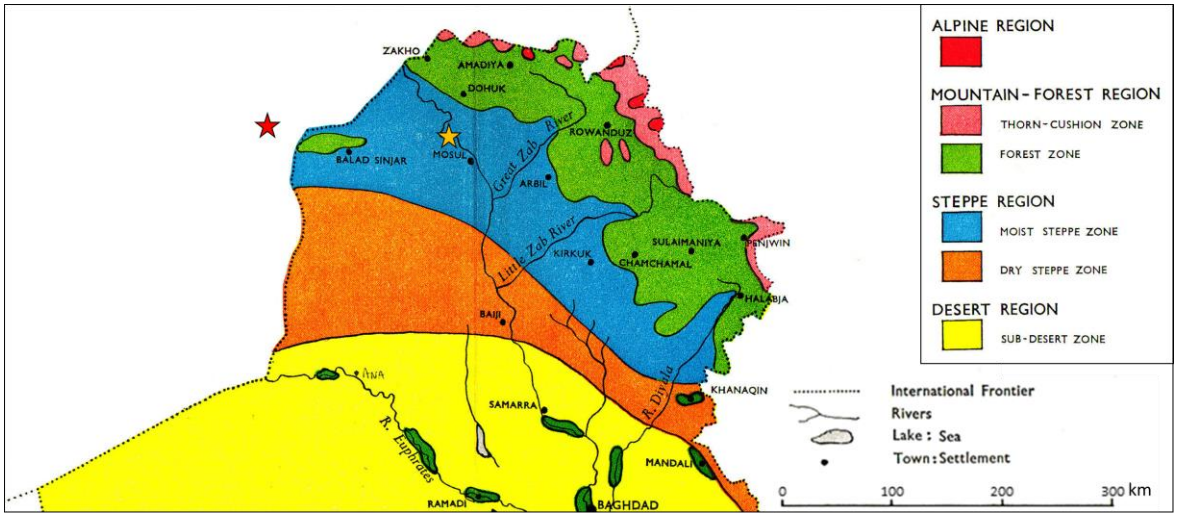


Figure 3.1 The vegetation map indicating Tell Mohammed 'Arab and Tell Brak based on Figure 15 in *Flora of Iraq*, vol. 1. Yellow star: Tell Mohammed 'Arab and red star: Tell Brak.

Table 3.2 Vegetation regions and zones in relation to Figure 3.1 (based on Figure 17 in *Flora of Iraq*, vol. 1, p. 67).

Region (*c.* area in sq. kms)	**Zone**	***c.* altitudinal limits (m)**
A. Desert Region (350,000-400,000)	1. (Desert Zone?) 2. Sub-desert Zone	(?)250-400 0-1000
B. Steppe Region (65,000)	3. Dry-steppe Zone **4. Moist-steppe Zone**	100-350 **200-800**
C. Mountain-Forest Region (30,000)	5. Forest Zone 6. Thorn-cushion Zone	500-1800 1700-3000
D. Alpine Region (100 ?)	7. Alpine Zone	2750-3730

Using the holistic approaches mentioned above a number of weed/wild species were identified. Amongst four *Lolium* species that occur in Iraq, *L. temulentum* is too different to be Tell Mohammed ʻArab *Lolium* type in morphological features. Another contender, *Lolium persicum* has been reported only in complete forest and alluvial desert occasionally (Bor and Guest, 1968). *Lolium perenne* is similar to *Lolium rigidum* in the shape and size; however, its occurrence in Iraq is rare and is restricted to full forest, dry steppe and sub-desert zones over 900 m in altitude (Bor and Guest, 1968). *Lolium rigidum* is, therefore, the most potential for Tell Mohammed ʻArab *Lolium* type. Based on the criteria of Charles & Bogaard (2001), the chaff of *Aegilops* sp. was identified further down to a species level, *Aegilops tauschii*. In one Tell Brak sample, *Malva* seeds were identified as *Malva parviflora* based on the attached pod and it is possible that this species perhaps occurs broadly across other Tell Brak samples.

3.2.2.2.2. Tell Atchana

Lists of potential species per genus were compiled based on the premise that Tell Atchana's plant assemblage consisted of species occurring in the vegetation zones and at the altitudes that are relevant to its wider region. *Flora of Turkey* vol. 1 (Davis, 1965) employs two major geographical approaches in order to define where specific plant species occur. One is to use a combined grid and Turkish province system, placing Tell Atchana into grid square "C6" and the "Hatay" administrative district (Davis, 1965, p. 2, Map 1). The other is to divide the Turkish territory into

six broad geographical divisions with further subdivisions (Davis, 1965, Map 2, Table 1). According to the latter system, Tell Atchana is affiliated to "South Anatolia" (or "Outer Anatolia") with the subdivision of "Amanus" (Davis, 1965, pp. 10-1, Map 2, Table 1). Overall, "South Anatolia" (or "Outer Anatolia"), grid no. "C6", "Hatay" and "Amanus" zones were all combined to delimit the relevant floristic region for Tell Atchana. Of these, "Amanus", "Hatay" and grid no. "C6" zones were established as a 'primary' zone and "South Anatolia" (or "Outer Anatolia") was as a 'secondary' zone. Plant species growing outside of these areas were excluded from consideration as candidate species.

The *Flora of Turkey* (Davis, 1965-1988; Davis, Miller and Tan, 1988; Güner *et al.*, 2001) also provides information on the altitude at which species occur. The mound of Tell Atchana itself is located at an altitude of approximately 90-95 m above sea level, and is surrounded by relatively flat plains and more distant mountain areas with altitudes up to around 800 m. Plant species growing above 800 m altitude were excluded (criterion: 0-800 m).

3.2.2.3. Identification of other material

Aside from crops and wild/weed seeds, the remains of fruits (collected taxa) and dung were also identified. Fig (*Ficus carica*) seeds were identified by their distinctive shape with a slightly protuberant hilum. The typical morphology of grape (*Vitis vinifera*) pips was also clearly recognisable (Smith and Jones, 1990). Sheep/goat dung pellets were also encountered. Type specimens of sheep/goat dung pellets and fragments were provided by Mike Charles. Mouse dung pellets were also observed and recorded.

3.2.3. Quantification

It is inevitable that charred material is damaged or fragmented during sample processing on- and off-site; it is also common that plant remains are retrieved in poor condition in terms of

preservation or distortion. As a result of the need for standardised quantification methods for plant fragments, Jones (Jones, 1990; Jones, 1991) proposed that 'minimum numbers' of plant parts be counted, and this approach is now widely used in archaeobotany. Jones (1991) suggests that a specific morphological region be the object of counting, a 'unit of observation' that tends to be well preserved, is clearly defined and taxonomically identifiable.

3.2.3.1. Quantification of crop material

For crop grains, embryo ends were counted. In the case of chaff units, rachis internodes for free-threshing wheat and barley, glume bases for glume wheats (a spikelet fork was counted as two glume bases) and culm nodes/bases for straw were counted. For pulses, intact radicles were counted. However, even if the unit for quantification (i.e. hilum ends) was missing, pulse fragments were assessed visually to determine whether or not they derived from a single pulse seed. Individual cotyledons of pulses were counted as pairs. Each node was counted for culm nodes. In certain samples from Tell Mohammed 'Arab, lumps of fused grain were found. They were recorded but could not be counted in terms of embryo ends.

3.2.3.2. Quantification of fruit

Figs (*Ficus carica*) and grapes (*Vitis vinifera*) were both well preserved and occurred as complete seeds/pips, which were counted. Fragments of grape pips were assessed visually to yield 'mni' estimates.

3.2.3.3. Quantification of weed and wild plants

Criteria for estimating 'mni' counts of weed/wild grass and pulse (e.g. *Prosopis* sp.) types were more or less the same as those for crop remains. Embryo/radicle ends were used as the counting unit for both types. For other wild taxa, visual inspection similarly yielded a 'minimum number' of

items. Weed taxa consisting of a core and seed coat such as Cyperaceae (cf. *Bolboschoenus glaucus*) and Polygonaceae (cf. *Rumex* sp.) were quantified by counting the kernel (i.e. inner core) when the testa (outer shells) were lacking. Seeds of *Galium* types were similarly quantified.

3.2.3.4. Quantification of dung

Dung material, including whole pellets as well as fragments, was quantified by volume (ml).

3.3. Data standardisation

When plant taxa/types were identified, the number of items was quantified and entered into relevant categories on a Microsoft Excel spreadsheet. These 'raw' data were further refined in order to interpret the general pattern of the assemblage and to perform statistical analyses such as correspondence analyses and discriminant analyses.

For samples that were subsampled prior to sorting and identification, the number of items in each fraction (e.g. 1/2 and 1/4) was multiplied by an appropriate factor (e.g. 2 and 4) to represent the maximum fraction sorted (e.g. 1/1). Items in each sieve size (e.g. >0.3 mm, >1 mm and >4 mm) per sample were then added altogether to arrive at the total for each sample. Density was computed by dividing the total number of items in a sample by the volume (litres) of sediment floated. The total number of items per sample is shown in Appendix I, II and III.

Overlapping categories of plant taxa were resolved by amalgamating them into integrated categories (Table 3.3). Einkorn grain and glume bases were identified only tentatively ('cf.') at low levels; therefore, categories including einkorn were amalgamated into emmer grain and glume bases. The presence of 'new type' glume wheat (Jones, Valamoti and Charles, 2000) was definite and hence new type grain and glume bases were initially kept separate from those of *Triticum dicoccum*. The category of '*Triticum dicoccum*/new type grain' was proportionally reassigned to either *T. dicoccum* or new type grain (more grains were reassigned to new type) and all the glume

wheat categories were eventually amalgamated as ‘glume wheat, grain’ or ‘glume wheat, glume bases’. The ‘pulse indet.’ category was proportionally assigned to the ‘bitter vetch’ category as results of morphological similarity and a clustering pattern of the two categories in the correspondence analysis.

Table 3.3 Plant taxa/types that amalgamated into broader units. *denotes proportionally reassigned on a sample by sample basis.

Site	Original category	Amalgamated category
TM	*Hordeum sativum* - hulled straight grain	Two-row hulled barley, grain
TM	*Hordeum sativum* - hulled cf. straight grain	
TM	*Hordeum sativum* - hulled indet. grain	
TM	*Hordeum sativum* - hulled cf. twisted grain	
TM	*Hordeum sativum* - cf. naked indet. grain	
TM	*Hordeum sativum* indet. grain	
TM	Cereal indet. grain*	
TM	*Hordeum sativum* two-row rachis	Two-row hulled barley, rachis
TM	*Hordeum sativum* cf. two-row rachis	
TM	*Hordeum sativum* indet. rachis	
TM	*Triticum durum/aestivum* grain	Free-threshing wheat, grain
TM	*Triticum* cf. *durum/aestivum* grain	
TM	*Triticum dicoccum/aestivum/durum* grain*	
TM	*Triticum* indet. grain*	
TM	Cereal indet. grain*	
TM	*Triticum aestivum* rachis internodes	Free-threshing wheat, internodes
TM	*Triticum* cf. *aestivum* rachis internodes	
TM	*Triticum aestivum/durum* internodes	
TM	*Triticum durum* rachis internodes	
TM	*Triticum* cf. *durum* rachis internodes	
TM	*Triticum monococcum* grain (1- or 2-grained spikelet)	Glume wheat, grain
TM	*Triticum monococcum* grain (1-grained spikelet)	
TM	*Triticum monococcum* grain (2-grained spikelet)	
TM	*Triticum* cf. *monococcum* grain (1-grained spikelet)	
TM	*Triticum* cf. *monococcum* grain (2-grained spikelet)	
TM	*Triticum monococcum/dicoccum* grain (1- or 2-grained spikelet)	
TM	*Triticum monococcum/dicoccum* grain (1-grained spikelet)	
TM	*Triticum monococcum/dicoccum* grain (2-grained spikelet)	
TM	*Triticum dicoccum* grain (1- or 2-grained spikelet)	
TM	*Triticum dicoccum* grain (2-grained spikelet)	
TM	*Triticum* cf. *dicoccum* grain (1-grained spikelet)	
TM	*Triticum* cf. *dicoccum* grain (2-grained spikelet)	
TM	new type grain	
TM	cf. new type grain	
TM	*Triticum dicoccum/aestivum/durum* grain*	
TM	*Triticum* indet. grain*	
TM	Cereal indet. grain*	
TM	*Triticum monococcum* glume base	Glume wheat, glume bases
TM	*Triticum* cf. *monococcum* glume bases	
TM	*Triticum monococcum* spikelet forks	
TM	*Triticum* cf. *monococcum* spikelet forks	
TM	*Triticum monococcum/dicoccum* glume bases	
TM	*Triticum* cf. *monococcum/dicoccum* glume bases	
TM	*Triticum monococcum/dicoccum* spikelet forks	
TM	*Triticum monococcum/dicoccum/spelta* glume bases	
TM	*Triticum monococcum/dicoccum/spelta* spikelet fork	
TM	*Triticum* glume bases	

Site	Original category	Amalgamated category
TM	*Triticum* spikelet forks	
TM	*Triticum* spikelet forks indet.	
TM	*Triticum dicoccum* glume bases	
TM	*Triticum* cf. *dicoccum* glume bases	
TM	*Triticum dicoccum* spikelet forks	
TM	*Triticum* cf. *dicoccum* spikelet forks	
TM	*Triticum dicoccum* spikelet forks terminal	
TM	New type spikelet forks	
TM	cf. new type spikelet forks	
TM	*Vicia ervilia/Lathryus sativus**	Bitter vetch
TM	*Vicia ervilia/Lathryus sativus**	Grass pea
TM	*Capparis spinosa*	*Capparis spinosa*
TM	cf. *Capparis spinosa*	
TM	*Bellevalia/Ornithogalum**	*Bellevalia* sp.
TM	*Bellevalia/Ornithogalum**	*Ornithogalum* sp.
TM	*Silene* sp.	*Silene* sp.
TM	*Silene dichotoma* yype (type 1)	
TM	*Lepidium* sp.*	*Lepidium sativum*
TM	*Lepidium* sp.*	*Lepidium draba*
TM	*Prosopis farcta*	*Prosopis farcta*
TM	*Prosopis farcta* (fragments)	
TM	*Avena* sp.	*Avena* sp.
TM	*Avena* cf. sp.	
TM	*Bromus* sp.	*Bromus* spp.
TM	*Bromus* type 1	
TM	*Bromus* type 2	
TM	*Hordeum spontaneum*	*Hordeum spontaneum*
TM	*Hordeum* cf. *spontaneum*	
TM	*Lolium* type 1 (*L. rigidum*)	*Lolium rigidum*
TM	*Lolium* type 2 (*L. rigidum*)	
TM	*Lolium* type 3	
TM	*Lolium* sp.	
TM	cf. *Lolium* sp.	
TM	*Adonis* sp.	*Adonis* spp.
TM	*Adonis* type 1	
TM	*Adonis* type 2	
TM	*Galium* sp.	*Galium spurium*
TM	*Galium* type 1 *(G. spurium)*	
TM	*Galium* type 2 *(G. spurium)*	
TM	*Galium* type 3 *(G. spurium)*	
TM	*Galium* type 4 *(G. spurium)*	
TA	*Hordeum sativum* - hulled straight grain	Two-row hulled barley, grain
TA	*Hordeum sativum* - hulled cf. straight grain	
TA	*Hordeum sativum* - hulled indet. grain	
TA	*Hordeum sativum* - hulled cf. twisted grain	
TA	*Hordeum sativum* - cf. naked indet grain	
TA	*Hordeum sativum* indet. grain	
TA	*Hordeum sativum* - hulled two-row rachis	Two-row hulled barley, rachis
TA	*Hordeum sativum* - hulled cf. two-row rachis	

Site	Original category	Amalgamated category
TA	*Hordeum* cf. naked two-row rachis	
TA	*Hordeum sativum* rachis	
TA	*Triticum aestivum/durum* grain	Free-threshing wheat, grain
TA	*Triticum* cf. *aestivum/durum* grain	
TA	*Triticum dicoccum/aestivum/durum* grain	
TA	*Triticum* indet. grain	
TA	Cereal indet. grain	
TA	*Triticum aestivum* rachis internodes	Free-threshing wheat, internodes
TA	*Triticum* cf. *aestivum* rachis internodes	
TA	*Triticum aestivum/durum* internodes	
TA	*Triticum durum* rachis internodes	
TA	*Triticum* cf. *durum* rachis internodes	
TA	*Triticum* cf. *monococcum* grain (1-grained spikelet)	Glume wheat, grain
TA	*Triticum* cf. *monococcum* grain (2-grained spikelet)	
TA	*Triticum monococcum/dicoccum* grain (1- or 2-grained spikelet)	
TA	*Triticum monococcum/dicoccum* grain (2-grained spikelet)	
TA	*Triticum dicoccum grain* (2-grained spikelet)	
TA	*Triticum* cf. *dicoccum grain* (2-grained spikelet)	
TA	new type grain	
TA	cf. new type grain	
TA	*Triticum dicoccum*/new type grain (2-grained spikelet)	
TA	*Triticum dicoccum* grain & spikelet fork	
TA	*Triticum monococcum/dicoccum* glume bases	Glume wheat, glume bases
TA	*Triticum* cf. *monococcum/dicoccum* glume bases	
TA	*Triticum monococcum/dicoccum* spikelet forks	
TA	*Triticum spikelet forks*	
TA	*Triticum* cf. *dicoccum* glume bases	
TA	*Triticum dicoccum* spikelet forks	
TA	*Triticum* cf. *dicoccum* spikelet forks	
TA	*Triticum dicoccum* spikelet forks terminal	
TA	new type spikelet forks	
TA	cf. new type spikelet forks	
TA	cf. new type glume bases	
TA	*Triticum dicoccum* grain & spikelet fork	
TA	*Avena* sp.	*Avena* sp.
TA	*Avena* cf. sp.	
TA	*Lathryus sativus*	Grass pea
TA	cf. *Lathryus sativus*	
TA	Pulse indet.*	Bitter vetch
TA	*Linum usitatissimum*	Flax
TA	*Linum usitatissimum*, bulb	
TA	*Olea europaea*	Olive
TA	*Olea* sp., fragment	
TA	*Vitis vinifera*	Grape
TA	*Vitis vinifera*, with skin	
TA	*Capparis spinosa*	*Capparis spinosa*
TA	cf. *Capparis spinosa*	
TA	*Cyperaceae*	Cyperaceae indet.
TA	*Cyperaceae/Polygonaceae* indet.	

Site	Original category	Amalgamated category
TA	*Astragalus/trigonella* sp.	Leguminosae, small seeded
TA	*Trifolium/melilotus*	
TA	*Medicago* sp.	*Medicago* sp.
TA	*Medicago* cf. *sheradii* (type 1, with pod)	
TA	*Prosopis farcta*	*Prosopis farcta*
TA	*Prosopis farcta*, fragments	
TA	*Bromus* sp.	*Bromus* spp.
TA	*Bromus* type 1	
TA	*Bromus* type 1.5	
TA	*Bromus* type 2	
TA	*Lolium temulentum*	*Lolium temulentum*
TA	*Lolium* type 2	
TA	*Lolium* sp.	
TA	*Galium spurium* type 1	*Galium spurium*
TA	*Galium spurium* type 2	
TA	*Bupleurum intermedium* type 1	*Bupleurum intermedium*
TA	*Bupleurum intermedium* type 2	
TB	*Hordeum sativum* - hulled straight grain	Two-row hulled barley, grain
TB	*Hordeum sativum* - hulled cf. straight grain	
TB	*Hordeum sativum* - hulled indet. grain	
TB	*Hordeum sativum* - hulled cf. twisted grain	
TB	*Hordeum sativum* indet. grain	
TB	Cereal indet. grain*	
TB	*Hordeum sativum* - hulled two-row rachis	Two-row hulled barley, rachis
TB	*Hordeum sativum* - hulled cf. two-row rachis	
TB	*Hordeum sativum* - hulled cf. six-row rachis	
TB	*Hordeum sativum* rachis	
TB	*Triticum durum/aestivum* grain	Free-threshing wheat, grain
TB	*Triticum* cf. *durum/aestivum* grain	
TB	*Triticum dicoccum/aestivum/durum* grain	
TB	*Triticum* indet, grain*	
TB	Cereal indet. grain*	
TB	*Triticum aestivum* rachis internodes	Free-threshing wheat, internodes
TB	*Triticum* cf. *aestivum* rachis internodes	
TB	*Triticum aestivum/durum* rachis internodes	
TB	*Triticum durum* rachis internodes	
TB	*Triticum* cf. *durum* rachis internodes	
TB	*Triticum monococcum* grain (1-grained spikelet)	Glume wheat, grain
TB	*Triticum monococcum* grain (2-grained spikelet)	
TB	*Triticum* cf. *monococcum* grain (2-grained spikelet)	
TB	*Triticum monococcum/dicoccum* grain (1- or 2-grained spikelet)	
TB	*Triticum monococcum/dicoccum* grain (2-grained spikelet)	
TB	*Triticum dicoccum* grain (1- or 2-grained spikelet)	
TB	*Triticum dicoccum* grain (2-grained spikelet)	
TB	*Triticum* cf. *dicoccum* grain (2-grained spikelet)	
TB	*Triticum dicoccum*/new type grain (2-grained spikelet)	
TB	*Triticum* indet, grain*	
TB	*Triticum monococcum* spikelet forks	Glume wheat, glume bases
TB	*Triticum* cf. *monococcum* spikelet forks	

Site	Original category	Amalgamated category
TB	*Triticum monococcum/dicoccum* glume bases	
TB	*Triticum* cf. *monococcum/dicoccum* glume bases	
TB	*Triticum monococcum/dicoccum* spikelet forks	
TB	*Triticum dicoccum* glume bases	
TB	*Triticum* cf. *dicoccum* glume bases	
TB	*Triticum dicoccum* spikelet forks	
TB	*Triticum* cf. *dicoccum* spikelet forks	
TB	*Triticum dicoccum* spikelet forks terminal	
TB	*Lens culinaris*	Lentil
TB	cf. *Lens culinaris*	
TB	*Pisum sativum*	Pea
TB	cf. *Pisum sativum*	
TB	*Capparis spinosa*	*Capparis spinosa*
TB	cf. *Capparis spinosa*	
TB	*Gypsophila* type 1	*Gypsophila* spp.
TB	*Gypsophila* type 2	
TB	*Silene* sp.	*Silene dichotoma* type
TB	*Silene dichotoma* type	
TB	*Lepidium* sp.	*Lepidium draba*
TB	*Lepidium draba* (= *Cardaria draba*)	
TB	*Prosopis farcta*	*Prosopis farcta*
TB	*Prosopis farcta*, fragments	
TB	*Aegilops tauschii*, grain	*Aegilops* spp./sp., grain
TB	*Aegilops* sp., grain	
TB	*Avena* sp.	*Avena* sp.
TB	cf. *Avena* sp.	
TB	*Bromus* sp.	*Bromus* spp.
TB	*Bromus* type 1 (blunt)	
TB	*Bromus tectorum* type	
TB	*Hordeum spontaneum*	*Hordeum spontaneum*
TB	*Hordeum* cf. *spontaneum*	
TB	*Lolium rigidum*	*Lolium rigidum*
TB	cf. *Lolium* sp.	
TB	*Ziziphora* type 1	*Ziziphora* sp.
TB	*Ziziphora* type 2	
TB	*Malva* sp.	*Malva* sp.
TB	*Malva parviflora* (with pod)	
TB	*Adonis aestivalis* type (type 1)	*Adonis aestivalis* type
TB	*Adonis* sp.	
TB	*Galium* sp.	*Galium spurium*
TB	*Galium spurium*	

3.4. Data analysis

3.4.1. Correspondence analysis

A multivariate ordination technique, correspondence analysis, was used in order to explore variation in the archaeobotanical composition of samples (Lange, 1990; Jones, 1991; Charles and Bogaard, 2001; Bogaard *et al.*, 2013). The results of correspondence analysis can be used to display the characteristic patterns of plant assemblages in two (three, occasionally) dimensional scatter plots.

Correspondence analysis was conducted using CANOCO (ter Braak and Smilauer, 2012), while CANODRAW (Smilauer, 1992) was used to plot the results. Axis 1 (horizontal) and axis 2 (vertical) were mainly used for coordinate plotting since these axes by definition account for the most variation. On occasion, the third axis was shown against the first axis or the second axis to detect additional patterns. Samples or species adjacent to the origin of the plot tend to be neutral. For example, samples near the origin tend to have a typical archaeobotanical composition, whereas species near the origin tend to occur in the majority of the archaeobotanical samples. The spatial association points of samples or species reflect the degree of similarity or difference among them.

3.4.2. Discriminant analysis

Discriminant analysis was conducted in order to separate modern pre-defined groups and then use the resulting discriminant function(s) to classify the archaeobotanical samples as unknown cases. Discriminant analysis was used in two contexts. Firstly, discriminant analysis was used to aid the identification of crop processing stages based on the method developed by Jones, incorporating ethnobotanical sampling of a 'traditional' free-threshing cereal processing sequence observed on the Greek island of Amorgos (Jones, 1983a; Jones, 1983b; Jones, 1984; Jones, 1987). Jones divided weed taxa into physical types based on their behaviour through the crop processing sequence, with particular attention to aerodynamic properties (light or heavy), headedness (headed

or free) and seed size (big or small). Accordingly, archaeobotanical weed taxa were classified into one of the six relevant categories (i.e. BHH, BFH, SHH, SHL, SFH and SFL).

Crop processing stages are well delineated by Hillman (Hillman, 1981; Hillman, 1984b; Hillman, 1985) and Jones (1984, p. 44). Of the four major crop processing stages, namely, winnowing by-product, coarse sieve by-product, fine sieve by-product and fine sieve product in order, 'light' aerodynamic properties are associated with winnowing by-product. In this stage, small and light (and winged) weed seeds are winnowed away along with light cereal components such as awn fragments and other light chaff. Headed weeds are sifted out with coarse straw nodes and culm bases in the next step, coarse sieving, while smaller weed seeds and cereal product material pass through the sieve. Fine sieving stage serves the purpose of removing small, heavy weed seeds from grain products. The plant material passing through the sieve, namely, fine sieve by-products, chiefly consists of small weed seeds, tail grain and rachis. Weed items retained by the sieve with grain products are 'big' in size, similar to grain products. Fine sieve products are eventually sorted by hand in the final step. This hand sorting process is conducted on a piecemeal basis.

Tell Mohammed 'Arab, Tell Atchana and Tell Brak weed seeds were classified according to the three relevant physical characteristics (Table 3.4). Fine sieve mesh sizes were estimated to be 1.5 mm and therefore weed seeds which would have been sifted down through it were smaller than 1.5 mm in diameter. Aerodynamic and headedness experiments were also conducted with material in the reference collection at the University of Oxford. In addition to personal observation, data on physical characteristics already accumulated through published works (Jones, 1984; Jones, 1987; Charles and Bogaard, 2001; Hald, 2008; Charles and Bogaard, 2010) were also considered.

Table 3.4 The classification of weed/wild taxa/type in terms of three characteristics i.e. size (small vs. big), headedness (free vs. headed) and aerodynamics (light vs. heavy) from the three sites.

Site	Classification	Code	Taxa/type
TM	Big-Headed-Heavy	BHH	*Prosopis farcta*
TM	Big-Headed-Heavy	BHH	*Scorpiurus muricatus*
TM	Big-Free-Heavy	BFH	*Bellevalia* sp.
TM	Big-Free-Heavy	BFH	*Vaccaria hispanica*
TM	Big-Free-Heavy	BFH	*Aegilops* sp.
TM	Big-Free-Heavy	BFH	*Avena* sp.
TM	Big-Free-Heavy	BFH	*Hordeum spontaneum*
TM	Big-Free-Heavy	BFH	*Lolium rigidum*, large (>1 mm)
TM	Big-Free-Heavy	BFH	*Rumex* sp.
TM	Big-Free-Heavy	BFH	*Galium spurium*
TM	Small-Headed-Heavy	SHH	*Silene dichotoma* Type
TM	Small-Headed-Heavy	SHH	*Medicago polymorpha*
TM	Small-Headed-Heavy	SHH	*Medicago* sp.
TM	Small-Headed-Heavy	SHH	*Malva nicaeensis*
TM	Small-Headed-Heavy	SHH	*Malva* sp.
TM	Small-Headed-Light	SHL	*Lolium rigidum*, small (<1 mm)
TM	Small-Free-Heavy	SFH	*Chenopodium* sp.
TM	Small-Free-Heavy	SFH	*Ornithogalum* sp.
TM	Small-Free-Heavy	SFH	*Centaurea* sp.
TM	Small-Free-Heavy	SFH	*Heliotropium* sp.
TM	Small-Free-Heavy	SFH	*Cephalaria* sp.
TM	Small-Free-Heavy	SFH	*Valerianella coronata*
TM	Small-Free-Heavy	SFH	*Valerianella dentata* Type
TM	Small-Free-Heavy	SFH	*Gypsophila* sp.
TM	Small-Free-Heavy	SFH	*Helianthemum* sp.
TM	Small-Free-Heavy	SFH	*Lepidium draba* (= *Cardaria draba*)
TM	Small-Free-Heavy	SFH	*Lepidium sativum*
TM	Small-Free-Heavy	SFH	*Bolboschoenus glaucus*
TM	Small-Free-Heavy	SFH	*Cyperus* sp.
TM	Small-Free-Heavy	SFH	*Coronilla scorpioides*
TM	Small-Free-Heavy	SFH	Leguminosae, small seeded
TM	Small-Free-Heavy	SFH	*Trigonella astroites*
TM	Small-Free-Heavy	SFH	*Hordeum murinum* type
TM	Small-Free-Heavy	SFH	*Phalaris* sp.
TM	Small-Free-Heavy	SFH	*Taeniatherum caput-medusae*
TM	Small-Free-Heavy	SFH	*Triticum boeoticum*
TM	Small-Free-Heavy	SFH	*Ajuga/Teucrium* sp.
TM	Small-Free-Heavy	SFH	*Ziziphora* sp.
TM	Small-Free-Heavy	SFH	*Plantago* sp.
TM	Small-Free-Heavy	SFH	*Androsace maxima*
TM	Small-Free-Heavy	SFH	*Adonis* spp.
TM	Small-Free-Heavy	SFH	*Sherardia arvensis*
TM	Small-Free-Heavy	SFH	*Thymelaea passerine/mesopotamica*
TM	Small-Free-Light	SFL	*Bromus* spp.
TA	Big-Headed-Heavy	BHH	*Hippocrepis unisiliquosa/ciliata/multisiliqusa*
TA	Big-Headed-Heavy	BHH	*Hymenocarpus circinnatus*, with pods
TA	Big-Headed-Heavy	BHH	*Prosopis farcta*

Site	Classification	Code	Taxa/type
TA	Big-Headed-Heavy	BHH	*Scorpiurus muricatus*
TA	Big-Free-Heavy	BFH	*Echium angustifolium/parviflorum*
TA	Big-Free-Heavy	BFH	*Pisum humile*
TA	Big-Free-Heavy	BFH	*Hordeum spontaneum*
TA	Big-Free-Heavy	BFH	*Lolium temulentum*
TA	Big-Free-Heavy	BFH	*Ranunculus arvensis*
TA	Big-Free-Heavy	BFH	*Galium* spp.
TA	Big-Free-Heavy	BFH	*Galium spurium*
TA	Big-Free-Heavy	BFH	*Bupleurum intermedium* (= *B. subovatum*)
TA	Big-Free-Heavy	BFH	*Rumex* sp.
TA	Small-Headed-Heavy	SHH	*Silene* sp.
TA	Small-Headed-Heavy	SHH	*Anthemis cotula*
TA	Small-Headed-Heavy	SHH	*Medicago* sp.
TA	Small-Headed-Heavy	SHH	*Malva sylvestris/neglecta*
TA	Small-Free-Heavy	SFH	*Phalaris aquatica*
TA	Small-Free-Heavy	SFH	*Chenopodium* sp.
TA	Small-Free-Heavy	SFH	*Ornithogalum* type 1
TA	Small-Free-Heavy	SFH	*Heliotropium* sp.
TA	Small-Free-Heavy	SFH	*Cephalaria* sp.
TA	Small-Free-Heavy	SFH	*Valerianella coronata* Type
TA	Small-Free-Heavy	SFH	*Valerianella dentata*
TA	Small-Free-Heavy	SFH	*Vaccaria pyramidata*
TA	Small-Free-Heavy	SFH	*Centaurea* sp.
TA	Small-Free-Heavy	SFH	*Bolboschoenus glaucus*
TA	Small-Free-Heavy	SFH	*Coronilla* sp.
TA	Small-Free-Heavy	SFH	*Hordeum murinum* type
TA	Small-Free-Heavy	SFH	*Ajuga/Teucrium* sp.
TA	Small-Free-Heavy	SFH	*Plantago* sp.
TA	Small-Free-Heavy	SFH	*Androsace maxima*
TA	Small-Free-Heavy	SFH	*Anagallis arvensis*
TA	Small-Free-Heavy	SFH	*Sherardia arvensis*
TA	Small-Free-Heavy	SFH	*Thymelaea passerine/gussonei/mesopotamia*
TA	Small-Free-Heavy	SFH	Leguminosae, small seeded
TA	Small-Free-Light	SFL	*Bromus* spp.
TB	Big-Headed-Heavy	BHH	Prosopis farcta
TB	Big-Headed-Heavy	BHH	*Scorpiurus muricatus*
TB	Big-Free-Heavy	BFH	*Adonis aestivalis* Type
TB	Big-Free-Heavy	BFH	*Aegilops* spp./sp. (grain)
TB	Big-Free-Heavy	BFH	*Avena* sp.
TB	Big-Free-Heavy	BFH	*Echium/Lithospermum* sp.
TB	Big-Free-Heavy	BFH	*Galium* cf. *tricornutum*
TB	Big-Free-Heavy	BFH	*Galium spurium*
TB	Big-Free-Heavy	BFH	*Hordeum spontaneum*
TB	Big-Free-Heavy	BFH	*Bellevalia* sp.
TB	Big-Free-Heavy	BFH	*Lolium rigidum*, large (>1 mm)
TB	Big-Free-Heavy	BFH	*Rumex* sp.
TB	Small-Headed-Heavy	SHH	*Malva* sp.
TB	Small-Headed-Heavy	SHH	*Medicago* sp.
TB	Small-Headed-Heavy	SHH	*Onobrychis* sp.

Site	Classification	Code	Taxa/type
TB	Small-Headed-Heavy	SHH	*Silene dichotoma* Type
TB	Small-Headed-Light	SHL	*Lolium rigidum*, small (<1 mm)
TB	Small-Headed-Light	SHL	*Papaver* sp.
TB	Small-Free-Heavy	SFH	*Triticum boeoticum*
TB	Small-Free-Heavy	SFH	*Androsace maxima*
TB	Small-Free-Heavy	SFH	*Bolboschoenus glaucus*
TB	Small-Free-Heavy	SFH	*Brassica* sp.
TB	Small-Free-Heavy	SFH	*Bupleurum intermedium* (= *B. subovatum*)
TB	Small-Free-Heavy	SFH	*Centaurea* sp.
TB	Small-Free-Heavy	SFH	*Coronilla scorpioides*
TB	Small-Free-Heavy	SFH	*Cyperus laevigatus/rotundus*
TB	Small-Free-Heavy	SFH	*Eremopyrum bonaepartis/distans*
TB	Small-Free-Heavy	SFH	*Erodium* sp.
TB	Small-Free-Heavy	SFH	*Fumaria parviflora* Type
TB	Small-Free-Heavy	SFH	*Glaucium* sp.
TB	Small-Free-Heavy	SFH	*Gypsophila* spp.
TB	Small-Free-Heavy	SFH	*Heliotropium* sp.
TB	Small-Free-Heavy	SFH	*Hordeum murinum* type
TB	Small-Free-Heavy	SFH	*Hyoscyamus* cf. *muticus*
TB	Small-Free-Heavy	SFH	*Lepidium draba* (= *Cardaria draba*)
TB	Small-Free-Heavy	SFH	*Ornithogalum* sp.
TB	Small-Free-Heavy	SFH	Leguminosae, small seeded
TB	Small-Free-Heavy	SFH	*Taeniatherum caput-medusae*
TB	Small-Free-Heavy	SFH	*Teucrium/Ajuga* sp.
TB	Small-Free-Heavy	SFH	*Thymelaea passerina/mesopotamica*
TB	Small-Free-Heavy	SFH	*Vaccaria hispanica*
TB	Small-Free-Heavy	SFH	*Valerianella coronata* Type
TB	Small-Free-Heavy	SFH	*Verbascum* sp.
TB	Small-Free-Heavy	SFH	*Ziziphora* sp.
TB	Small-Free-Light	SFL	*Bromus* spp.

Only samples that contain more than ten weed seeds were included in the analysis, and family-level categories were excluded. Discriminant analysis was performed using IBM SPSS version 25.0 for Windows.

With regard to the consideration of dung-derived remains, Charles' (1998) method was adopted (Charles and Bogaard, 2001; Charles and Bogaard, 2005; Charles and Bogaard, 2010). Animal dung was commonly used for fuel in arid regions particularly where trees for firewood were out of reach (Miller and Smart, 1984; Miller, 1984; Charles, 1998) and it was often mixed with by-product material in the form of cakes (Miller, 1996; Anderson and Ertug-Yaras, 1998). Archaeobotanical samples from each site were entered as a separate in the discrimination phase of

the analysis (i.e. group 5) in addition to Jones' four crop processing groups. This approach addresses one of the criteria Charles defined to identify dung-derived material (Charles, 1998).

A second use of discriminant analysis related to the identification of cultivation intensity. In order to understand whether cultivated fields was managed under intensive or extensive regimes, the weed functional attribute values of the archaeobotanical assemblages were compared with those of modern fields in Morocco, France, Spain and Greece (Charles, Jones and Hodgson, 1997; Jones *et al.*, 2000; Charles *et al.*, 2002; Jones, 2002; Jones *et al.*, 2005; Bogaard *et al.*, 2016b; Bogaard *et al.*, 2018). Surveys of modern arable field weed floras show that four functional ecological weed traits (i.e. specific leaf area, canopy diameter, leaf area to thickness and canopy height) successfully discriminate (with 94 % correct reclassification) between high- and low- input cultivation in terms of labour, manure and water availability, high input and low input are related to intensive and extensive farming, respectively (Bogaard *et al.*, 2018). Based on the functional trait data, and presence or absence of archaeological weed species, archaeobotanical sample averages for each attribute were calculated, as they were for the modern fields. Samples were then classified as either high- or low-input by the linear discriminant function extracted to distinguish the modern regimes (Bogaard *et al.*, 2018).

3.4.3. Stable isotope analysis of crop remains

Carbon and nitrogen stable isotope analysis provides direct evidence of crop water status and arable soil nitrogen, respectively (cf. Bogaard *et al.*, 2007; Fraser *et al.*, 2011; Wallace *et al.*, 2015; Bogaard *et al.*, 2016a; Styring *et al.*, 2017; Bogaard *et al.*, 2018). These stable isotope ratios are particularly affected in arable conditions by water management and manuring, respectively (Bogaard *et al.*, 2018).

Stable carbon and nitrogen isotope analysis in this study was carried out only on the Tell Mohammed 'Arab assemblage, as a pilot study. Crop species containing more than five well preserved grain/seed items were selected initially; their morphology conformed to that of modern

crop material charred under low-temperature, reducing conditions, with a small/known charring offset (Nitsch, Charles and Bogaard, 2015). In this way, three cereal species (barley, free-threshing wheat and glume wheat grain) were finally included in the analysis. The general appearance of the selected samples was recorded using a flatbed scanner in order to record preservation. Each grain was carefully examined; those which distorted by high-temperature charring, or encrusted with carbonates, were excluded. In total, 40 samples were selected for carbon and nitrogen isotope analysis from Tell Mohammed ʻArab (Table 7.11).

Pre-treatment is necessary prior to stable isotope analysis in order to eliminate potential contamination on charred plant remains from the burial environment. Carbonates, nitrates and humic acids are major contaminants that may alter isotope values (Vaiglova *et al.*, 2014). Cereal grains from 10 percent of the 40 selected samples (4) were used for the examination of possible contamination, which are barley grains from TM01 (TM44), glume wheat grains from TM02 (TM28), barley grains from TM03 (TM56) and free-threshing wheat grain from TM04 (TM35). Two grains from each of these samples were processed by removing visible sediment and crushing into powder and subsequently processed to assess carbonate, nitrate and/or humic acid contamination using FTIR (Fourier Transform Infrared Spectroscopy). The results of FITR screening show that there was no clear contamination recorded for nitrates and humic acids when the archaeological samples were compared to the modern nitrate and humic acid contamination spectra (Figure 3.3 and Figure 3.4). However, less than 5 percent carbonate contamination was detected in the wavelength at 870 cm^{-1} in one sample out of four (Figure 3.2). Weak acid pre-treatment was therefore selected for the removal of carbonate contamination from all of the samples (cf. Vaiglova *et al.*, 2014).

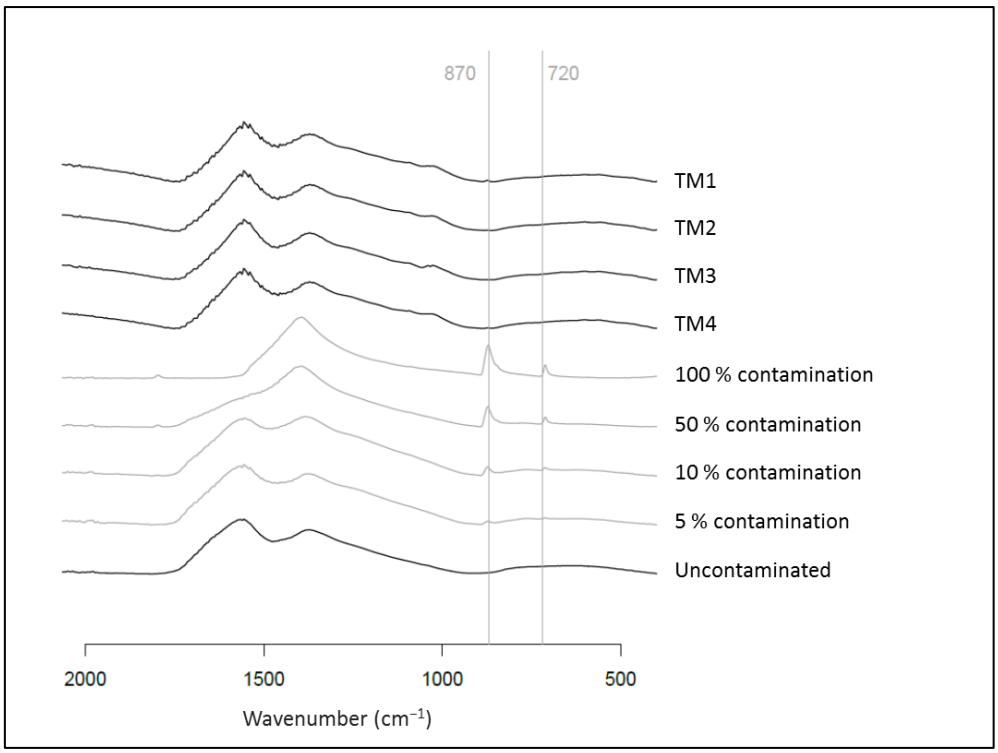


Figure 3.2 FTRI spectra of the four Tell Mohammed ‘Arab samples in comparison to modern carbonate contaminations.

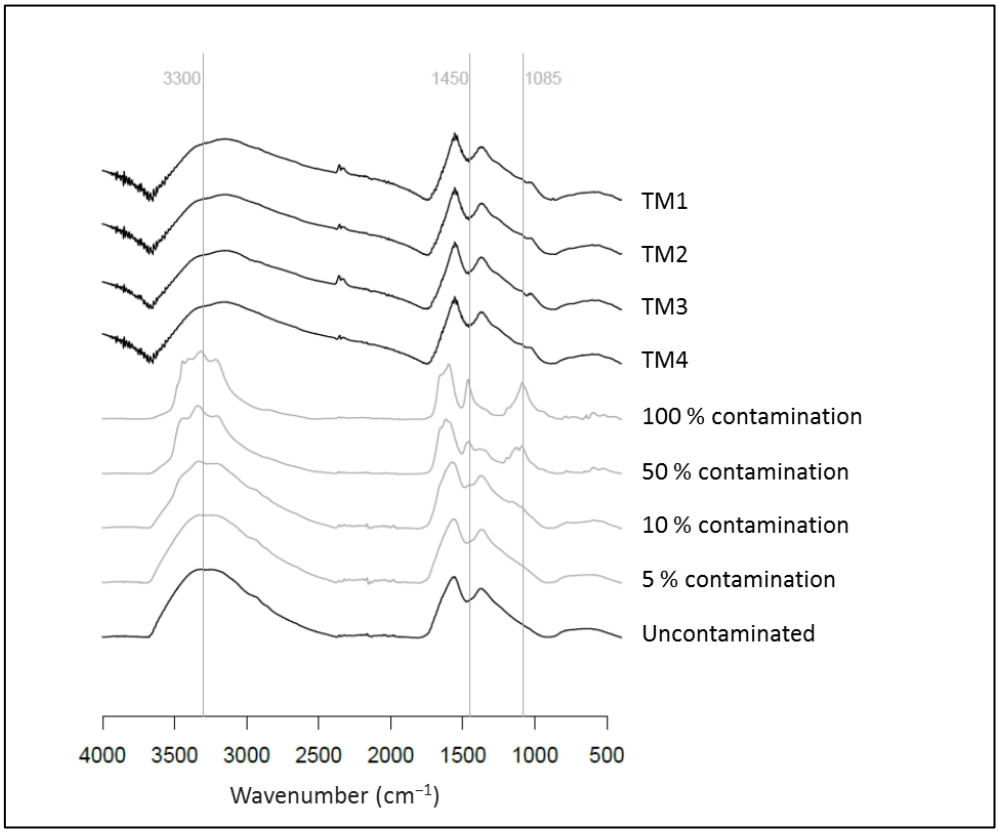


Figure 3.3 FTRI spectra of the four Tell Mohammed ‘Arab samples in comparison to modern nitrate contaminations.

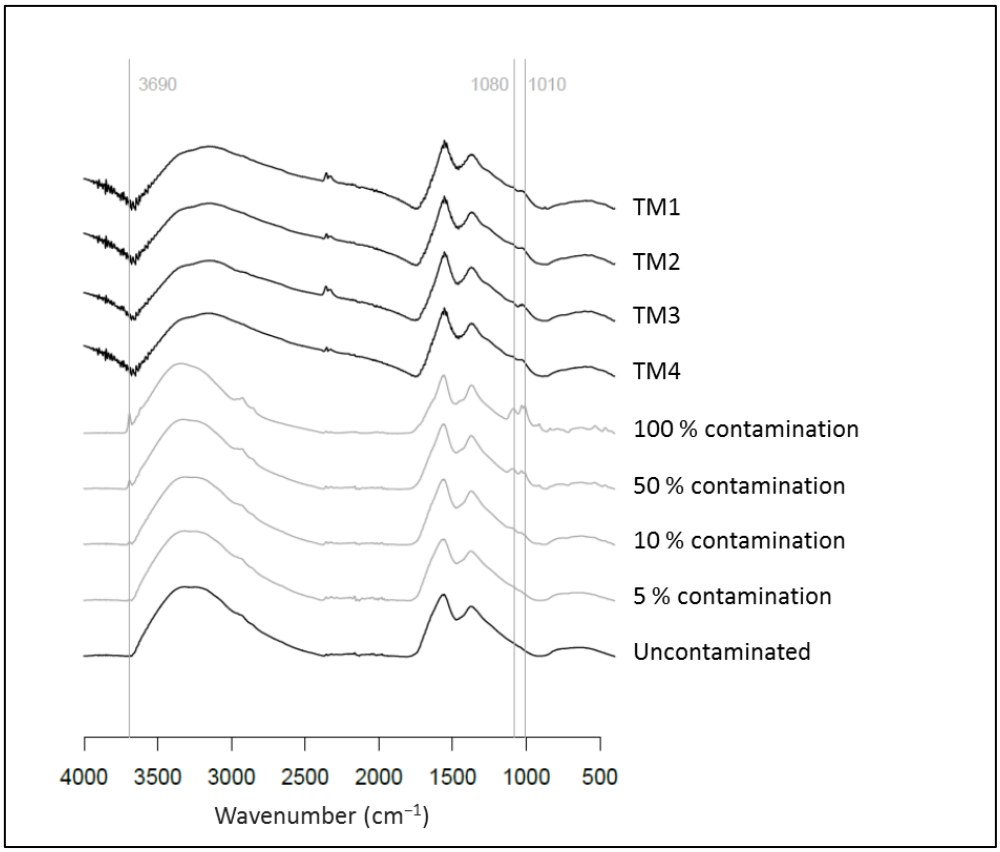


Figure 3.4 FTRI spectra of the four Tell Mohammed 'Arab samples in comparison to modern humic acid contaminations.

The acid pre-treatment was conducted based on Fraser *et al*. (2013) and Vaiglova *et al*. (2014). The condition of each sample was recorded from a-c for the degree of charring and from 0 to 3 for the degree of dirtiness on the seed surface. Each of samples was then scraped to remove dirt from grains as much as possible, crushed with mortar and pestle and weighed into the correct tubes. In each test tube of sample, approximately half the tube of 0.5M HCl was added, and they were heated at 70°C for 40 minutes, centrifuged to decant acid and rinsed by purified water three times until effervescing ceased. The water in tubes was drained out and sample tubes were frozen and dried in a vacuum to remove the frozen liquid completely. Freeze drying is a better approach than heating in that it is faster, safer and convenient.

The full mass of ground samples was measured after the pre-treatment again for the full-scale analysis. The $\delta^{13}C$ and $\delta^{15}N$ values were computed in separate runs on a SerCon EA-GSL mass spectrometer at the Research Laboratory for Art History and Archaeology, School of Archaeology, University of Oxford. An internal alanine standard was used for both $\delta^{13}C$ and $\delta^{15}N$. For the carbon stable isotope run, the standards IAEA-CH6 and IAEA-CH7 were used whereas for the nitrogen stable isotope run, IAEA-N2 and caffeine were used.

The $\delta^{13}C$ values of the Tell Mohammed 'Arab samples were converted into carbon discrimination ($\Delta^{13}C$) values in order to be compare them with stable carbon isotope values of modern cereals from known watering regimes (Wallace *et al.*, 2013). To convert $\delta^{13}C$ values into $\Delta^{13}C$ values, the equation below was used (Farquhar, Ehleringer and Hubick, 1989):

$$\Delta^{13}\mathrm{C} = \frac{\delta^{13}\mathrm{C\ air} - \delta^{13}\mathrm{C\ plant}}{1 + \delta^{13}\mathrm{C\ plant}/1000}$$

$\delta^{13}C_{air}$ refers to the $\delta^{13}C$ value of CO_2 in the air at the time the crops of archaeological sample were growing and $\delta^{13}C_{plant}$ refers to the value for each archaeological sample from Tell Mohammed 'Arab. The value of $\delta^{13}C_{air}$ was calculated using data provided from Ferrio *et al*. (2005): 6.49 ‰ for the Middle Assyrian, 6.34 ‰ for the Ninevite V and 6.35 ‰ for the Late Uruk.

Chapter 4. Overview of the assemblage

This chapter presents an overview of the archaeobotanical assemblages from Tell Mohammed ‘Arab, Tell Atchana and Tell Brak. The major components of these assemblages are assessed initially in terms of crop and weed/wild taxa. Subsequently crop composition is examined separately in order to assess the major crop types. The samples are grouped into crop-based categories and individual samples dominated by single crop types are identified. These crop-based categories inform the assessment of crop processing stages in Chapter 5 as well as subsequent assessment of crop husbandry practices in Chapter 7. Potentially collected plants such as fruits and nuts are also noted in this overview but tend to be minor components of the assemblages. Finally, this chapter provides an overview of the major weed/wild taxon composition of each site assemblage.

4.1. Tell Mohammed ‘Arab

Figure 4.1 shows the proportions of simplified plant categories in the Tell Mohammed ‘Arab samples, by major occupation period. Most of the samples are dominated by weed/wild items whilst a few samples are almost entirely composed of a single crop, two-row hulled barley. The role of glume wheat and free-threshing wheat appears to be relatively minor, and pulses are almost absent. Chronologically, Figure 4.1 shows two trends. First, samples from the earlier periods (Late Uruk and the Ninevite V) are dominated by weed/wild seeds followed by glume wheat; free-threshing wheat occurs in most samples but at low levels. Thus, it can be seen that these early periods show a relatively mixed composition. Secondly, in samples from the Middle Assyrian period, barley is dominant and other crop types are rare.

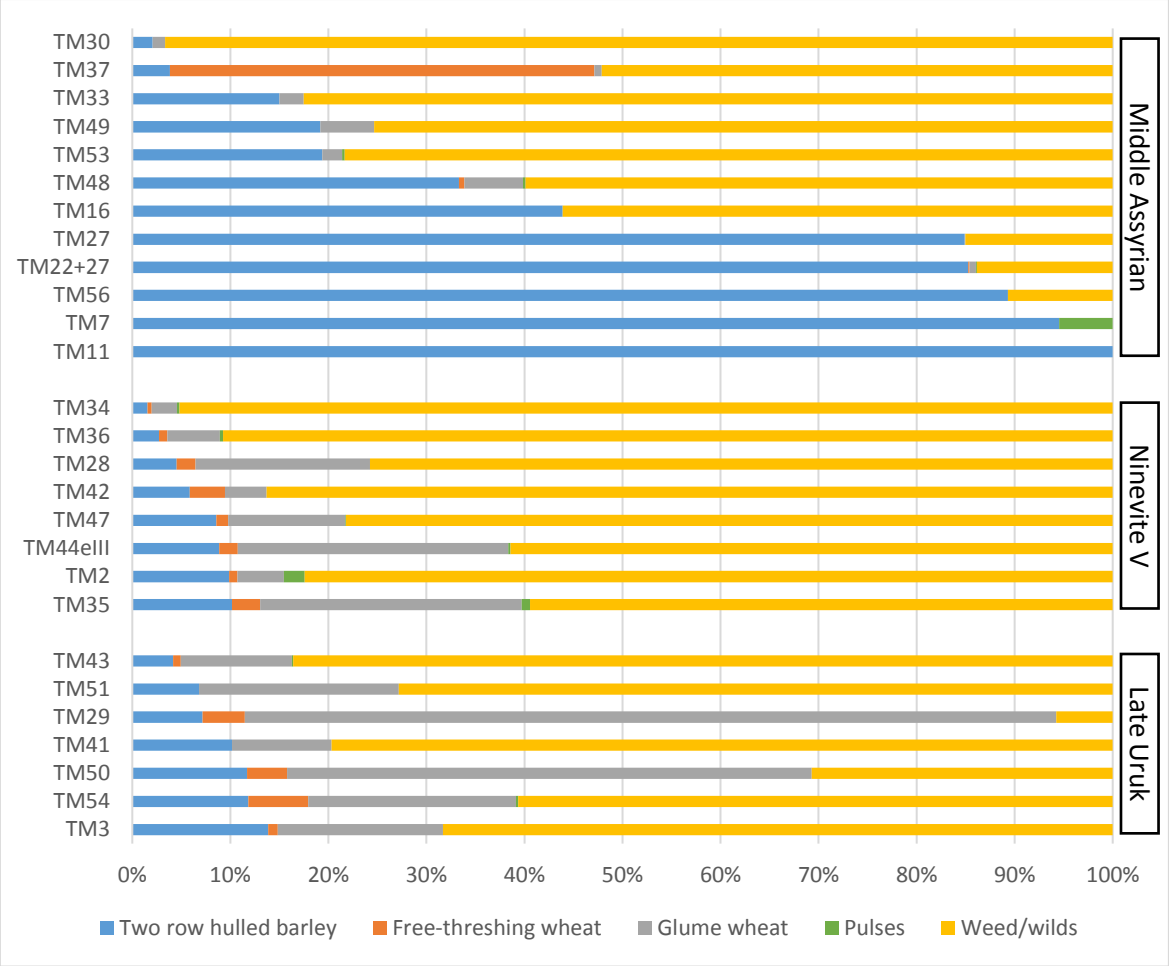


Figure 4.1 Proportions of major plant categories by period in the 27 Tell Mohammed ʻArab samples.

Table 4.1 presents the percentage composition of samples and classifies them according to their dominant component using an arbitrary 70 percent threshold. Samples containing more than 70 percent crop material were classified in the crop group, whereas those containing more than 70 percent weed/wild material were classified in the weed/wild group. Most Tell Mohammed ʻArab samples (21 out of 27) were classified as either weed/wild samples or of mixed (crop and wild) composition, with only six samples containing more than 70 percent crop items (Table 4.1).

Table 4.1 Proportions of major plant categories and plant group classification of the 27 Tell Mohammed ʻArab samples. *Hand-collected. The total number of items per sample in given in brackets.

Plant group	% Two-row hulled barley	% Free-threshing wheat	% Glume wheat	% Pulse	**% Crop**	**% Weed/wild**	**Sample**	**Period**
Crop	100 (100)	0 (0)	0 (0)	0 (0)	**100**	0 (0)	TM11*	Middle Assyrian
	95 (52)	0 (0)	0 (0)	5 (3)	**100**	0 (0)	TM7*	Middle Assyrian
	7 (15)	4 (9)	83 (173)	0 (0)	**94**	6 (12)	TM29	Late Uruk
	89 (192)	0 (0)	0 (0)	0 (0)	**89**	11 (23)	TM56	Middle Assyrian
	85 (2918)	0 (4)	1 (22)	0 (4)	**86**	14 (474)	TM22+27	Middle Assyrian
	85 (3156)	0 (0)	0 (2)	0 (0)	**85**	15 (559)	TM27	Middle Assyrian
Mixed plant	12 (170)	4 (59)	54 (777)	0 (0)	69	31 (446)	TM50	Late Uruk
	4 (10)	43 (113)	1 (2)	0 (0)	48	52 (136)	TM37	Middle Assyrian
	44 (36)	0 (0)	0 (0)	0 (0)	44	56 (46)	TM16	Middle Assyrian
	10 (145)	3 (41)	27 (381)	1 (12)	41	59 (848)	TM35	Ninevite V
	33 (123)	1 (2)	6 (22)	0 (1)	40	60 (221)	TM48	Middle Assyrian
	12 (436)	6 (224)	21 (780)	0 (8)	39	61 (2232)	TM54	Late Uruk
	9 (79)	2 (17)	28 (246)	0 (2)	39	61 (548)	TM44eIII	Ninevite V
	14 (14)	1 (1)	17 (17)	0 (0)	32	68 (69)	TM3	Late Uruk
Weed/wild	7 (24)	0 (0)	20 (72)	0 (0)	27	**73** (257)	TM51	Late Uruk
	19 (14)	0 (0)	5 (4)	0 (0)	25	**75** (55)	TM49	Middle Assyrian
	5 (21)	2 (9)	18 (83)	0 (0)	24	**76** (353)	TM28	Ninevite V
	19 (67)	0 (0)	2 (7)	0 (1)	22	**78** (271)	TM53	Middle Assyrian
	9 (94)	1 (13)	12 (131)	0 (1)	22	**78** (857)	TM47	Ninevite V
	10 (6)	0 (0)	10 (6)	0 (0)	20	**80** (47)	TM41	Late Uruk
	10 (23)	1 (2)	5 (11)	2 (5)	18	**82** (192)	TM2	Ninevite V
	15	0	3	0	18	**83**	TM33	Middle Assyrian

Plant group	% Two-row hulled barley	% Free-threshing wheat	% Glume wheat	% Pulse	**% Crop**	**% Weed/wild**	**Sample**	**Period**
	(6)	(0)	(1)	(0)		(33)		
	4 (140)	1 (27)	11 (383)	0 (4)	16	**84** (2822)	TM43	Late Uruk
	6 (18)	4 (11)	4 (13)	0 (0)	14	**86** (265)	TM42	Ninevite V
	3 (66)	1 (21)	5 (130)	0 (8)	9	**91** (2209)	TM36	Ninevite V
	2 (119)	0 (34)	3 (198)	0 (21)	5	**95** (7341)	TM34	Ninevite V
	2 (13)	0 (0)	1 (8)	0 (0)	3	**97** (607)	TM30	Middle Assyrian

Figure 4.2 illustrates the proportions of major crop categories in the 27 Tell Mohammed ‘Arab samples. It is clear that the grain of two-row hulled barley predominates, followed by glume wheat glume bases and smaller proportions of free-threshing wheat material across the assemblage. The proportions of the three cereals show chronological differentiation. In the Late Uruk and the Ninevite V, proportions of glume wheat exceeded those of barley. Conversely, barley was by far the most abundant cereal in the Middle Assyrian period. Free-threshing wheat was consistently a relatively minor crop, ranging from approximately 5 to 10 percent. Overall, glume wheat decreased whereas barley significantly increased through time.

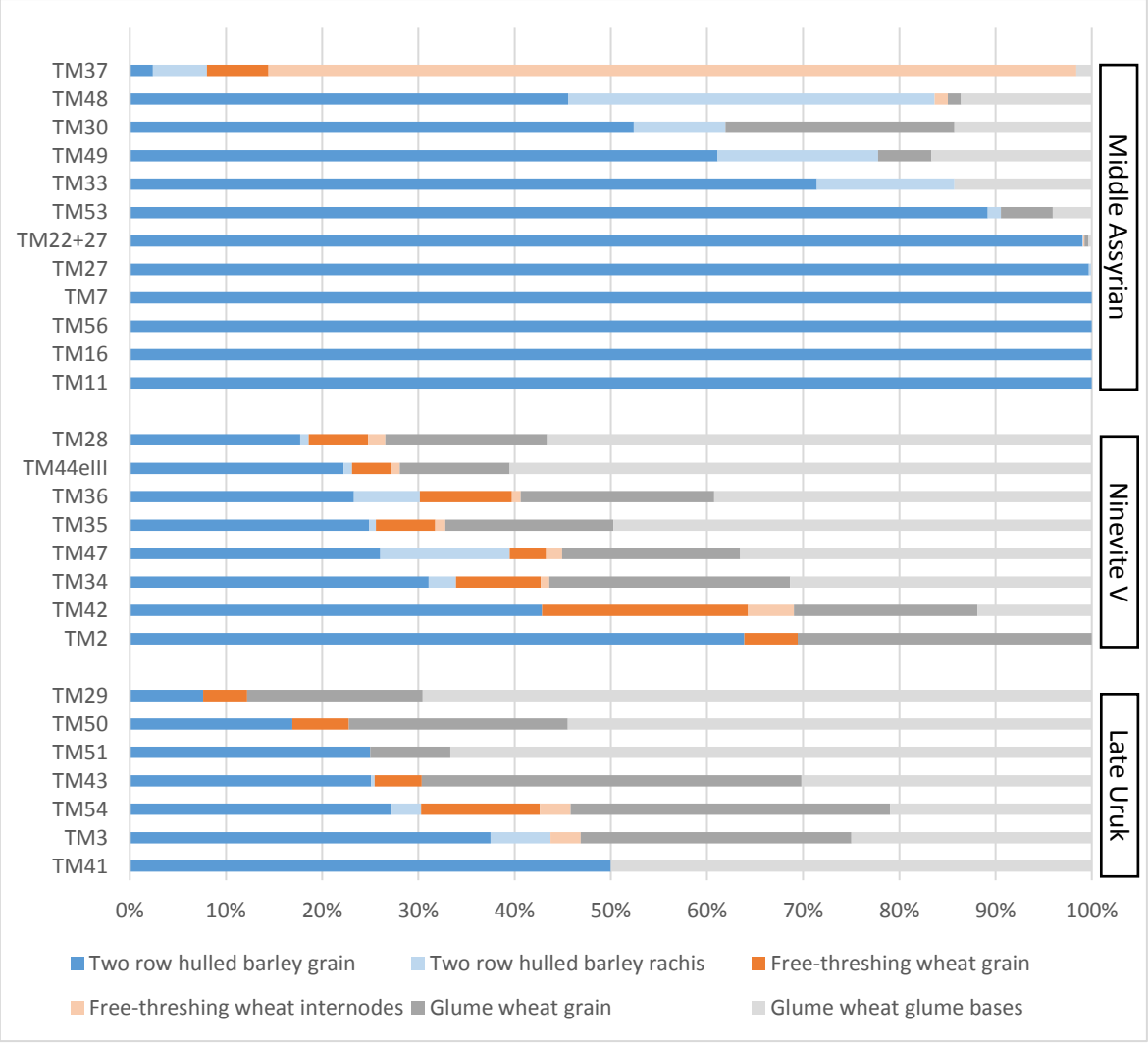


Figure 4.2 Proportions of major crop categories by period in the 27 Tell Mohammed ʻArab samples.

Samples were classified into crop type groups according to the dominant type, again using an arbitrary 70 percent threshold. Table 4.2 shows the proportions of major crop categories and crop type grouping, with ten samples in the two-row hulled barley group, five samples in the glume wheat group, a single sample in the free-threshing wheat group and 11 samples of mixed crop composition. As shown also in Table 4.2, the barley group is dominated by barley *grain*, whereas glume wheat *chaff* (glume bases) are most abundant in the glume wheat group. Rachis internodes are dominant in the single free-threshing wheat sample. The mixed crop group mainly contains a combination of glume wheat glume bases, glume wheat grain and two-row hulled barley grain. In terms of the differences between the periods, it is worth noting that barley group samples entirely

derive from the Middle Assyrian occupation, while the samples dominated by glume wheat material and of mixed crop composition are from both the Ninevite V and Late Uruk occupations.

The classifications presented above have identified those samples where an association between a particular crop and its associated weed flora is most plausible. This association is important for further analyses, focused on crop processing status and crop husbandry, in Chapters 5 and 7, respectively.

Table 4.2 Proportions of major crop categories and crop group classification of the 27 Tell Mohammed ʻArab samples. The total number of items per sample is given in brackets. *Hand-collected. M = Middle Assyrian, L = Late Uruk and N = Ninevite V.

Crop group	% Two-row hulled barley grain	% Two-row hulled barley rachis	**% Two-row hulled barley**	% Free-threshing wheat grain	% Free-threshing wheat internodes	**% Free-threshing wheat**	% Glume wheat grain	% Glume wheat glume bases	**% Glume wheat**	% Lentil	% Grass pea	**Sample**	**Period**
Barley	100 (100)	0 (0)	**100**	0 (0)	0 (0)	0	0 (0)	0 (0)	0	0 (0)	0 (0)	TM11*	M
	100 (36)	0 (0)	**100**	0 (0)	0 (0)	0	0 (0)	0 (0)	0	0 (0)	0 (0)	TM16	M
	100 (192)	0 (0)	**100**	0 (0)	0 (0)	0	0 (0)	0 (0)	0	0 (0)	0 (0)	TM56	M
	100 (3148)	0 (8)	**100**	0 (0)	0 (0)	0	0 (0)	0 (2)	0	0 (0)	0 (0)	TM27	M
	99 (2916)	0 (2)	**99**	0 (0)	0 (4)	0	0 (12)	0 (10)	1	0 (0)	0 (4)	TM 22+27	M
	95 (52)	0 (0)	**95**	0 (0)	0 (0)	0	0 (0)	0 (0)	0	0 (0)	5 (3)	TM7*	M
	89 (66)	1 (1)	**91**	0 (0)	0 (0)	0	5 (4)	4 (3)	9	0 (0)	0 (0)	TM53	M
	71 (5)	14 (1)	**86**	0 (0)	0 (0)	0	0 (0)	14 (1)	14	0 (0)	0 (0)	TM33	M
	45 (67)	38 (56)	**83**	0 (0)	1 (2)	1	1 (2)	14 (20)	15	1 (1)	0 (0)	TM48	M
	61 (11)	17 (3)	**78**	0 (0)	0 (0)	0	6 (1)	17 (3)	22	0 (0)	0 (0)	TM49	M
Free-threshing wheat	2 (3)	6 (7)	8	6 (8)	84 (105)	**90**	0 (0)	2 (2)	2	0 (0)	0 (0)	TM37	M
Glume wheat	8 (15)	0 (0)	8	5 (9)	0 (0)	5	18 (36)	70 (137)	**88**	0 (0)	0 (0)	TM29	L
	17 (170)	0 (0)	17	6 (59)	0 (0)	6	23 (229)	54 (548)	**77**	0 (0)	0 (0)	TM50	L
	25 (24)	0 (0)	25	0 (0)	0 (0)	0	8 (8)	67 (64)	**75**	0 (0)	0 (0)	TM51	L
	18 (20)	1 (1)	19	6 (7)	2 (2)	8	17 (19)	57 (64)	**73**	0 (0)	0 (0)	TM28	N
	22 (76)	1 (3)	23	4 (14)	1 (3)	5	11 (39)	60 (207)	**72**	0 (1)	0 (1)	TM44eIII	N
Mixed crop	25 (138)	0 (2)	25	5 (27)	0 (0)	5	39 (217)	30 (166)	69	0 (0)	1 (4)	TM43	L
	25 (141)	1 (4)	25	6 (35)	1 (6)	7	17 (99)	49 (282)	67	1 (4)	0 (0)	TM35	N
	22 (51)	7 (15)	29	9 (21)	1 (2)	10	19 (44)	38 (86)	57	2 (0)	2 (4)	TM36	N
	26 (62)	13 (32)	39	4 (9)	2 (4)	5	18 (44)	36 (87)	55	0 (0)	0 (1)	TM47	N
	27	3	30	12	3	16	33	21	54	0	0	TM54	L

Crop group	% Two-row hulled barley grain	% Two-row hulled barley rachis	**% Two-row hulled barley**	% Free-threshing wheat grain	% Free-threshing wheat internodes	**% Free-threshing wheat**	% Glume wheat grain	% Glume wheat glume bases	**% Glume wheat**	% Lentil	% Grass pea	**Sample**	**Period**
	(392)	(44)		(178)	(46)		(478)	(302)		(0)	(4)		
	30 (109)	3 (10)	32	8 (31)	1 (3)	9	24 (88)	30 (110)	54	4 (16)	0 (0)	TM34	N
	38 (12)	6 (2)	44	0 (0)	3 (1)	3	28 (9)	25 (8)	53	0 (0)	0 (0)	TM3	L
	50 (6)	0 (0)	50	0 (0)	0 (0)	0	0 (0)	50 (6)	50	0 (0)	0 (0)	TM41	L
	52 (11)	10 (2)	62	0 (0)	0 (0)	0	24 (5)	14 (3)	38	0 (0)	0 (0)	TM30	M
	43 (18)	0 (0)	43	21 (9)	5 (2)	26	19 (8)	12 (5)	31	0 (0)	0 (0)	TM42	N
	56 (23)	0 (0)	56	5 (2)	0 (0)	5	27 (11)	0 (0)	27	5 (2)	7 (3)	TM2	N

4.1.1. Cultigens

The assessment of the Tell Mohammed ‘Arab cultigens was assessed across the three occupation periods. Table 4.3 summarises the ubiquity and abundance of crop categories across the assemblage at Tell Mohammed ‘Arab, based on the 27 samples analysed.

With regard to the general pattern of crop composition, two-row hulled barley and glume wheat were the most ubiquitous crops, occurring in 27 and 23 samples out of 27 samples, respectively. Two-row hulled barley occurs in 100 percent of samples across all three periods and is represented exclusively as grain, while glume wheat material is dominated by glume bases. Barley grain in the Middle Assyrian outnumbers that of the other two periods in absolute terms.

Table 4.3 Summary of the ubiquity and abundance of crop categories across the assemblage at Tell Mohammed 'Arab, based on the 27 samples analysed. 'Max.' refers to the maximum number per sample.

	Late Uruk				**Ninevite V**				**Middle Assyrian**			
	Ubiquity		Abundance		Ubiquity		Abundance		Ubiquity		Abundance	
	No.	%	Sum	Max.	No.	%	Sum	Max.	No.	%	Sum	Max.
Cereal												
Two-row hulled barley grain	7	100	757	392	8	100	500	141	12	100	6607	3148
Two-row hulled barley rachis	3	43	48	44	6	75	65	32	8	67	80	56
Two-row hulled barley, total	**7**	**100**	**805**	**436**	**8**	**100**	**565**	**145**	**12**	**100**	**6687**	**3156**
Einkorn grain, one-grained	3	43	39	36	2	25	4	3	0	0	0	0
Einkorn grain, two-grained	5	71	314	120	8	100	111	29	3	25	7	4
Einkorn grain	**5**	**71**	**353**	**156**	**8**	**100**	**115**	**29**	**3**	**25**	**7**	**4**
Emmer grain, one-grained	1	14	4	4	1	13	1	1	0	0	0	0
Emmer grain, two-grained	6	86	617	322	8	100	224	72	4	33	17	8
Emmer grain	**6**	**86**	**621**	**322**	**8**	**100**	**225**	**72**	**4**	**33**	**17**	**8**
New type wheat grain	2	29	3	2	1	13	2	2	0	0	0	0
Glume wheat grain, total	**6**	**86**	**977**	**478**	**8**	**100**	**352**	**99**	**5**	**42**	**24**	**12**
Einkorn glume bases	5	71	240	120	3	38	149	87	3	25	12	10
Emmer glume bases	7	100	979	416	7	88	655	195	8	67	32	10
New type wheat glume bases	1	14	12	12	4	50	27	18	0	0	0	0
Glume wheat glume bases	**7**	**100**	**1231**	**548**	**7**	**88**	**841**	**282**	**8**	**67**	**44**	**20**
Glume wheat, total	**7**	**100**	**2208**	**780**	**8**	**100**	**1193**	**381**	**8**	**67**	**68**	**22**
Free-threshing wheat grain	4	57	273	178	8	100	128	35	1	8	8	8
Bread wheat rachis internodes	1	14	9	9	4	50	5	2	3	25	109	105
Macaroni wheat rachis internodes	2	29	38	37	7	88	17	6	1	8	2	2
Free-threshing wheat internodes	**2**	**29**	**47**	**46**	**7**	**88**	**22**	**6**	**3**	**25**	**111**	**105**
Free-threshing wheat, total	**5**	**71**	**320**	**224**	**8**	**100**	**148**	**41**	**3**	**25**	**119**	**113**
Pulse												
Grass pea	2	29	8	4	4	50	9	4	2	17	7	4
Lentil	0	0	0	0	5	63	27	16	1	8	1	1
Chickpea	0	0	0	0	2	25	13	8	0	0	0	0
Bitter vetch	1	14	4	4	0	0	0	0	1	8	1	1
Crop, other												
Safflower	1	14	1	1	0	0	0	0	0	0	0	0
Safflower, wild/cultivated	0	0	0	0	0	0	0	0	1	8	14	14

Emmer chaff was approximately four times as frequent as that of einkorn. This pattern was the same in terms of grain, with emmer grain dominant. 'New type' glume wheat grain and/or spikelet forks (Jones, Valamoti and Charles, 2000; Kohler-Schneider, 2003) were tentatively ('cf.') identified in six Late Uruk and Ninevite V samples. As described in the previous section (Figure 4.2), the Middle Assyrian period yielded much less glume wheat material than the early periods.

Free-threshing wheat material was a relatively minor category amongst the cereals at Tell Mohammed ʻArab, occurring in 16 samples (587 items) across the assemblage. Both bread wheat and macaroni wheat rachis internodes were identified, with 123 items and 57 items, respectively. Since morphological features of macaroni wheat (*Triticum durum*) and bread wheat (*Triticum aestivum*) grains overlap, they were identified as *Triticum aestivum/durum*. Free-threshing wheat is somewhat more abundant in the Late Uruk and Ninevite V periods, occurring in five samples with 320 items and eight samples with 148 items, respectively, whilst, in the Middle Assyrian, 119 items occurred in only three samples. The ubiquity and abundance of free-threshing wheat grain across the periods reflect more or less the same trend to those of total free-threshing wheat material. Most of free-threshing wheat grain was identified in the two early periods whereas there were only eight free-threshing wheat grains recovered from the Middle Assyrian period, in a single sample. In terms of rachis internodes, the Late Uruk and Ninevite V were both predominantly macaroni wheat, whereas bread wheat rachis was slightly more abundant than macaroni wheat in the Middle Assyrian. This might suggest that free-threshing wheat grain from the early periods is mainly composed of macaroni wheat whilst that the free-threshing wheat grain from the Middle Assyrian period is dominated by bread wheat, but the numbers involved are low.

Four pulse cultivars (i.e. grass pea, lentil, chickpea and bitter vetch) were recorded at the site, but their deliberate cultivation is uncertain due to the small number of items (Table 4.3). Of these, grass pea is the most common type, occurring across all three periods. This is followed by lentil, which was concentrated in the Ninevite V period, occurring in five samples (63 percent). Chickpea occurs only in the Ninevite V, in two samples. Bitter vetch was the rarest type, occurring in one Late Uruk and one Middle Assyrian sample.

Safflower seeds were recorded in a single sample of the Late Uruk period in the Tell Mohammed ʻArab assemblage. These seeds were classified into two types, *Carthamus tinctorius* and *C. tinctorius/oxyacanthus*, based on shape and size. Safflower may have been used for dyeing or oil, but this plant occurs only in a sample and in small quantities, rendering its cultivation status unclear (Table 4.3).

4.1.2. Fruits

The Tell Mohammed ‘Arab assemblage yielded a very limited range and abundance of fruit taxa: ten fig seeds (*Ficus carica*) in four samples, and one grape pip (*Vitis vinifera*) (Table 4.4). It is noticeable that fig was found only in the Late Uruk and Ninevite V occupations. The single pip occurred in a Middle Assyrian sample.

Table 4.4 Summary of the ubiquity and abundance of fruit categories across the assemblage at Tell Mohammed ‘Arab, based on the 27 samples analysed. ‘Maximum’ refers to the maximum number per sample.

	Late Uruk				**Ninevite V**				**Middle Assyrian**			
	Ubiquity		Abundance		Ubiquity		Abundance		Ubiquity		Abundance	
	No.	%	Sum	Max.	No.	%	Sum	Max.	No.	%	Sum	Max.
Fruit												
Fig	1	14	2	2	3	38	8	4	0	0	0	0
Grape	0	0	0	0	0	0	0	0	1	8	1	1

4.1.3. Weed/wild taxa

The weed/wild seeds at Tell Mohammed ‘Arab likely derive from at least two sources: dung-related material eaten by animals, and arable weeds harvested with crops. Leguminosae and especially small-seeded legumes including *Trigonella astroites* represent the commonest and most abundant seeds in the Tell Mohammed ‘Arab weed/wild assemblage (Table 4.5). These seeds could represent arable weeds in crop fields, or could be derived from animal dung material in addition to the other types such as *Bolboschoenus glaucus*, Cyperaceae, *Medicago* sp. and *Prosopis farcta* (cf. Charles, 1998); this will be investigated further for Mohammed ‘Arab in Chapter 5. These seeds are more abundant in the early periods but occur throughout the sequence.

Typical arable weed species were also frequent in the Tell Mohammed ‘Arab assemblage. *Lolium rigidum*, the second commonest wild/weed type, is present in 25 samples (2829 items) out of 27 samples. This taxon is abundant in the Late Uruk and, in particular, concentrated in one sample with an abundance of 1770 seeds. The identification of this taxon was based not only on the

physical morphology of the type, but also on the biology and ecology (see Chapters 2 and 3). The other weeds identified at Tell Mohammed ʻArab that are important in terms of their ubiquity and abundance include *Galium spurium* (418 items in 24 samples), *Hordeum murinum* type grain (225 items in 23 samples, excluding *H. spontaneum*) and both grain and chaff of *Aegilops* spp. (288 items in 21 samples). Although *Aegilops* spp. are frequently discovered in crop processing (by-)products as crop weeds, they are also used as animal fodder in Iraq (van Slageren, 1994).

Across the assemblage *Rumex* sp. and *Bolboschoenus glaucus* seeds are conspicuous for their ubiquity and abundance (Table 4.5) and almost always tend to co-occur. Meanwhile, an unusually high number of both occurred in a single Late Uruk sample (TM43) with 2151 and 390 items, respectively. In the Middle Assyrian, these taxa occur at lower levels. Both taxa are covered by a hard coat in common and might have been related to dung material (cf. Bogaard *et al.*, 2013).

Table 4.5 Summary of the ubiquity and abundance of weed/wild categories across the assemblage at Tell Mohammed 'Arab, based on the 27 samples analysed. 'Maximum' refers to the maximum number per sample.

	Late Uruk				**Ninevite V**				**Middle Assyrian**			
	Ubiquity		Abundance		Ubiquity		Ubiquity		Abundance		Ubiquity	
	No.	%	Sum	Max.	No.	%	Sum	Max.	No.	%	Sum	Max.
Weed/wild												
Leguminosae, small seeded	7	100	437	198	8	100	8100	6684	10	83	145	42
Lolium rigidum	7	100	2041	1770	8	100	663	218	10	83	125	28
Galium spurium	6	86	50	35	8	100	54	13	10	83	314	143
Hordeum murinum type	7	100	100	50	7	88	73	28	9	75	52	17
Aegilops sp.	4	57	30	8	8	100	83	23	9	75	59	28
Rumex sp.	6	86	2151	2034	8	100	90	24	5	42	19	8
Bolboschoenus glaucus	7	100	390	334	8	100	142	101	4	33	12	6
Grass weeds indet.	5	71	240	168	7	88	153	57	7	58	58	22
Phalaris sp.	5	71	67	26	7	88	146	101	6	50	21	8
Medicago sp.	4	57	40	20	8	100	94	20	2	17	5	3
Bellevalia sp.	3	43	6	3	4	50	10	4	6	50	445	248
Helianthemum sp.	4	57	9	4	7	88	267	92	2	17	9	7
Vaccaria hispanica	4	57	21	12	6	75	11	3	3	25	117	67
Aegilops sp., glume bases	2	29	12	10	5	63	34	24	6	50	37	12
Bromus spp.	3	43	17	12	6	75	28	12	4	33	24	9
Prosopis farcta	3	43	9	4	6	75	155	131	3	25	93	72
Malva sp.	3	43	7	3	5	63	25	17	4	33	25	15
Trigonella astroites	2	29	11	9	7	88	1854	1142	2	17	5	4
Aegilops tauschii, glume bases	2	29	4	3	3	38	9	5	6	50	29	12
Capparis spinosa	3	43	30	23	5	63	25	11	1	8	5	5
Adonis spp.	4	57	5	2	1	13	2	2	4	33	12	4
Silene dichotoma type	2	29	18	16	4	50	9	6	2	17	3	2
Hordeum spontaneum	1	14	13	13	5	63	12	5	2	17	2	1
Ajuga/teucrium sp.	3	43	14	10	4	50	12	4	1	8	1	1
Lepidium draba	3	43	16	10	4	50	126	51	0	0	0	0
Avena sp.	1	14	5	5	4	50	11	5	2	17	2	1
Centaurea sp.	0	0	0	0	4	50	5	2	2	17	6	4
Thymelaea passerine/mesopotamica	1	14	1	1	2	25	2	1	3	25	3	1
Taeniatherum caput-medusae	1	14	1	1	3	38	47	31	1	8	2	2
Gypsophila sp.	2	29	4	2	1	13	1	1	2	17	4	3
Heliotropium sp.	3	43	6	3	2	25	2	1	0	0	0	0
Lepidium sativum	2	29	12	11	0	0	0	0	2	17	532	529
Medicago radiata	0	0	0	0	4	50	133	127	0	0	0	0
Cephalaria sp.	0	0	0	0	2	25	11	8	2	17	6	3
Coronilla scorpioides	0	0	0	0	0	0	0	0	4	33	13	6
Valerianella coronata	1	14	1	1	2	25	6	5	1	8	1	1
Scorpiurus muricatus	1	14	2	2	1	13	4	4	2	17	2	1
Chenopodium sp.	1	14	1	1	2	25	2	1	1	8	3	3
Ornithogalum sp.	1	14	17	17	1	13	5	5	1	8	8	8
Triticum boeoticum	1	14	21	21	2	25	3	2	0	0	0	0

	Late Uruk				**Ninevite V**				**Middle Assyrian**			
	Ubiquity		Abundance		Ubiquity		Ubiquity		Abundance		Ubiquity	
	No.	%	Sum	Max.	No.	%	Sum	Max.	No.	%	Sum	Max.
Weed/wild												
Ziziphora sp.	1	14	1	1	1	13	6	6	1	8	1	1
Plantago sp.	0	0	0	0	1	13	1	1	2	17	2	1
Cyperus sp.	0	0	0	0	1	13	1	1	1	8	2	2
Medicago polymorpha	1	14	1	1	0	0	0	0	1	8	2	2
Bupleurum cf. intermedium	1	14	2	2	1	13	1	1	0	0	0	0
Valerianella dentata type	0	0	0	0	1	13	1	1	1	8	1	1
Androsace maxima	0	0	0	0	1	13	1	1	1	8	1	1
Carthamus tinctorius/oxyacanthus	0	0	0	0	0	0	0	0	1	8	14	14
Verbascum sp.	0	0	0	0	1	13	3	3	0	0	0	0
Carthamus tinctorius	1	14	1	1	0	0	0	0	0	0	0	0
Malva nicaeensis	0	0	0	0	1	13	1	1	0	0	0	0
Sherardia arvensis	1	14	1	1	0	0	0	0	0	0	0	0
CYPERACEAE indet.	4	57	53	40	6	75	96	60	4	33	18	8
UMBELLIFERAE indet.	1	14	4	4	4	50	13	8	4	33	57	40
CRUCIFERAE indet.	2	29	9	6	2	25	21	20	0	0	0	0
COMPOSITAE indet.	0	0	0	0	2	25	14	10	0	0	0	0
CARYOPHYLLACEAE type	0	0	0	0	1	13	4	4	0	0	0	0
Round grass indet.	0	0	0	0	1	13	2	2	1	8	2	2
Small *GRAMINEAE* indet.	1	14	4	4	6	75	28	8	2	17	12	11
Large legumes indet.	3	43	30	22	6	75	36	15	7	58	119	67

Several wild taxa that might have been collected for human consumption were reported at Tell Mohammed ‘Arab, namely *Capparis spinosa*, *Lepidium sativum* and *Bolboschoenus glaucus*. *Capparis spinosa* was ubiquitous and abundant in the Late Uruk and Ninevite V (three samples with 30 items and five samples with 25 items), whereas five seeds were identified in as single samples from the Middle Assyrian. The flower buds and fruits of *Capparis spinosa* might have been collected for seasoning and food. *Lepidium sativum* occurred in 11 samples with a total of 686 items and was concentrated primarily in three samples (TM 47, 36 and 28) in the Ninevite V and one sample (TM30) in the Middle Assyrian. This species may have been harvested with crop and/or the seeds collected as a condiment. *Bolboschoenus glaucus* was one of the most frequent and ubiquitous occurring species in the assemblage in the early periods; however, its frequency and abundance significantly declined in the Middle Assyrian (33 percent, 12 seeds). The use of both *Bolboschoenus glaucus* nutlets and tubers tends to be rather broad (e.g. consumed by humans as

well as animal as fodder/forage food, craft material etc.). Both nutlets and tubers of *Bolboschoenus glaucus* provide adequate nourishment and satisfy potential conditions as a human food (Wollstonecroft *et al.*, 2008; Wollstonecroft *et al.*, 2011).

4.2. Tell Atchana

The proportions of simplified plant categories in phasing order in the 50 Tell Atchana samples is summarised in Figure 4.3. The Tell Atchana assemblage is evenly comprised of both weed/wild and crop categories through the phases while the latest phase, phase 1-2, represented by two samples (TA2011.327 and 2011.330), is dominated by weed/wild material (Figure 4.3). Another exception is phase 5, which consists of a single sample (TA2006.96) composed entirely of olive stones. It seems that there is no clear chronological change across the phases; there is a smaller number of samples in later phases and a wide spectrum of plant components in phase 7-8. Free-threshing wheat is clearly the most common crop type, followed by barley and pulses.

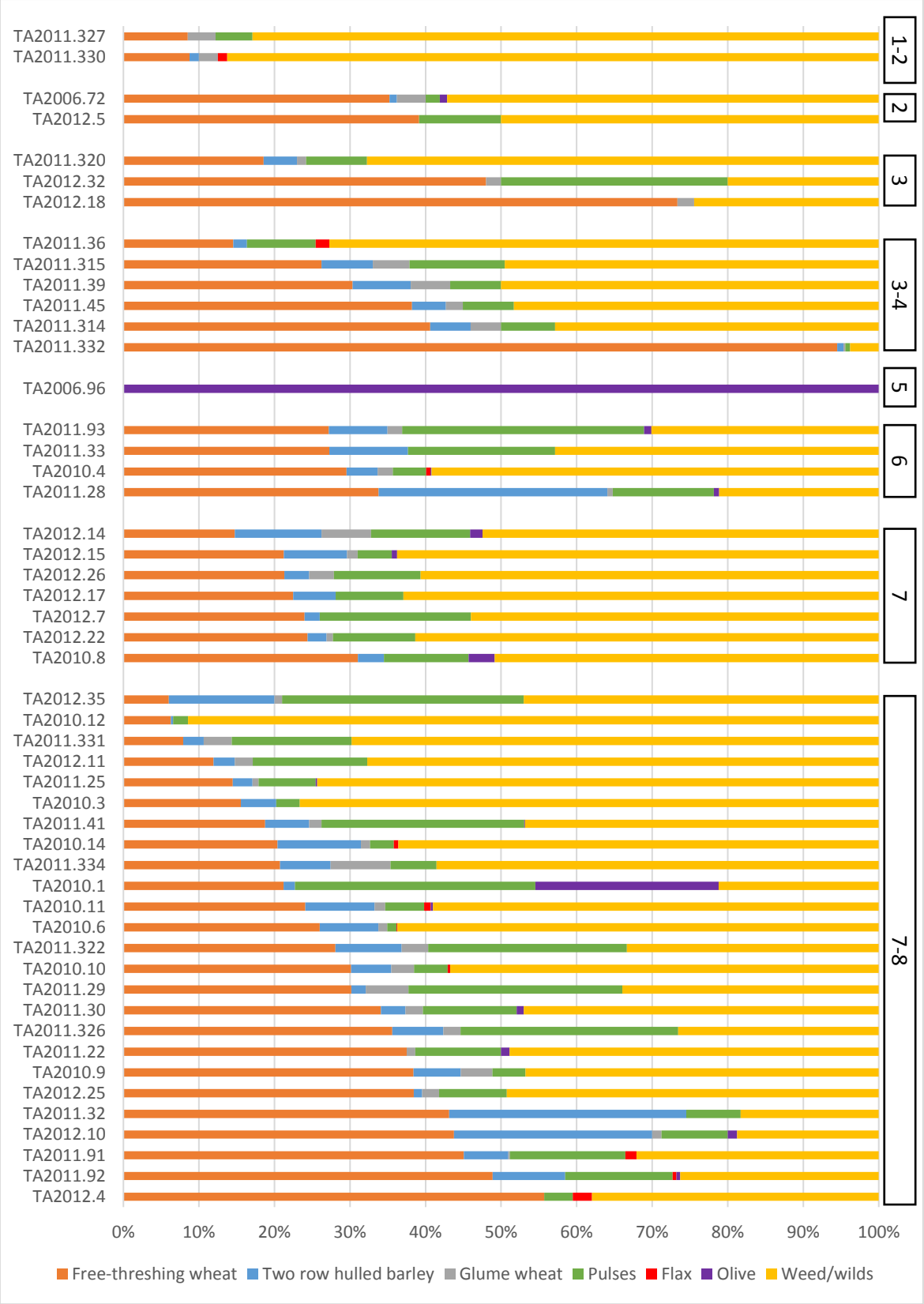


Figure 4.3 Proportions of major plant categories by phase in the 50 Tell Atchana samples. Phase 8-7 = Middle Bronze II (ca. 1800-1600 BC), Phase 6-4 = Late Bronze I (ca. 1600-1400 BC) and Phase 3-1 = Late Bronze II (ca. 1400-1300 BC).

In Table 4.6, categories displayed in Figure 4.3 were used to group samples into three classes, i.e. crop-rich, a mixture of crop and weed/wild material and weed/wild-rich, using an arbitrary 70 percent threshold. More than half of the samples are of the mixed type. Free-threshing wheat is the dominant crop in the crop-rich group. Change through the phases in terms of simplified plant groups is unclear, each phase being represented evenly by the three sample groups (Table 4.6).

Table 4.6 Proportions of major plant categories and plant group classification of the 50 Tell Atchana samples. The total number of items per sample is given in brackets.

Plant group	% Free-threshing wheat	% Two-row hulled barley	% Glume wheat	% Pulses	% Flax	% Olive	**% Crop**	**% Weed/wild**	**Sample**	**Phase**
Crop	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	100 (92)	**100**	0 (0)	TA2006.96	5
	95 (894)	1 (8)	0 (2)	1 (6)	0 (0)	0 (0)	**96**	4 (36)	TA2011.332	3-4
	43 (66)	31 (48)	0 (0)	7 (11)	0 (0)	0 (0)	**82**	18 (96)	TA2011.32	7-8
	44 (35)	26 (21)	1 (1)	9 (7)	0 (0)	1 (1)	**81**	19 (15)	TA2012.10	7-8
	48 (24)	0 (0)	2 (1)	30 (15)	0 (0)	0 (0)	**80**	20 (10)	TA2012.32	3
	34 (48)	30 (43)	1 1)	13 (19)	0 (0)	1 (1)	**79**	21 (30)	TA2011.28	6
	21 (14)	2 (1)	0 (0)	32 (21)	0 (0)	24 (16)	**79**	21 (14)	TA2010.1	7-8
	73 (33)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	**76**	24 (11)	TA2012.18	3
	49 (199)	10 (39)	0 (0)	14 (58)	0 (2)	0 (2)	**74**	26 (107)	TA2011.92	7-8
	36 (63)	7 (12)	2 (4)	29 (51)	0 (0)	0 (0)	**73**	27 (47)	TA2011.326	7-8
	27 (28)	8 (8)	2 (2)	32 (33)	0 (0)	1 (1)	**70**	30 (31)	TA2011.93	6
Mixed plant	45 (215)	6 (28)	0 (1)	15 (73)	1 (7)	0 (0)	68	32 (153)	TA2011.91	7-8
	28 (16)	9 (5)	4 (2)	26 (15)	0 (0)	0 (0)	67	33 (19)	TA2011.322	7-8
	30 (16)	2 (1)	6 (3)	28 (15)	0 (0)	0 (0)	66	34 (18)	TA2011.29	7-8
	56 (44)	0 (0)	0 (0)	4 (3)	3 (2)	0 (0)	62	38 (30)	TA2012.4	7-8
	41 (91)	5 (12)	4 (9)	7 (16)	0 (0)	0 (0)	57	43 (96)	TA2011.314	3-4
	27 (21)	10 (8)	0 (0)	19 (15)	0 (0)	0 (0)	57	43 (33)	TA2011.33	6
	38 (404)	6 (66)	4 (44)	4 (46)	0 (0)	0 (0)	53	47 (492)	TA2010.9	7-8
	34 (74)	3 (7)	2 (5)	12 (27)	0 (0)	1 (2)	53	47 (102)	TA2011.30	7-8
	19 (174)	6 (54)	2 (15)	27 (249)	0 (0)	0 (1)	53	47 (434)	TA2011.41	7-8
	6 (6)	14 (14)	1 (1)	32 (32)	0 (0)	0 (0)	53	47 (47)	TA2012.35	7-8
	38 (34)	4 (4)	2 (2)	7 (6)	0 (0)	0 (0)	52	48 (43)	TA2011.45	3-4
	38 (103)	1 (3)	2 (6)	9 (24)	0 (0)	0 (0)	51	49 (132)	TA2012.25	7-8

Plant group	% Free-threshing wheat	% Two-row hulled barley	% Glume wheat	% Pulses	% Flax	% Olive	**% Crop**	**% Weed/wild**	**Sample**	**Phase**
	38 (33)	0 (0)	1 (1)	11 (10)	0 (0)	1 (1)	51	49 (43)	TA2011.22	7-8
	39 (18)	0 (0)	0 (0)	11 (5)	0 (0)	0 (0)	50	50 (23)	TA2012.5	2
	30 (221)	8 (56)	5 (38)	7 (49)	0 (0)	0 (0)	50	50 (364)	TA2011.39	3-4
	26 (27)	7 (7)	5 (5)	13 (13)	0 (0)	0 (0)	50	50 (51)	TA2011.315	3-4
	31 (36)	3 (4)	0 (0)	11 (13)	0 (0)	3 (4)	49	51 (59)	TA2010.8	7
	15 (9)	11 (7)	7 (4)	13 (8)	0 (0)	2 (1)	48	52 (32)	TA2012.14	7
	24 (12)	2 (1)	0 (0)	20 (10)	0 (0)	0 (0)	46	54 (27)	TA2012.7	7
	35 (37)	1 (1)	4 (4)	2 (2)	0 (0)	1 (1)	43	57 (60)	TA2006.72	2
	30 (3604)	5 (636)	3 (360)	4 (532)	0 (40)	0 (0)	43	57 (6780)	TA2010.10	7-8
	30 (207)	4 (29)	2 (14)	4 (31)	1 (4)	0 (1)	41	59 (415)	TA2010.4	6
	24 (84)	9 (32)	1 (5)	5 (18)	1 (3)	0 (1)	41	59 (206)	TA2010.11	7-8
	21 (68)	7 (22)	8 (26)	6 (20)	0 (0)	0 (0)	41	59 (192)	TA2011.334	7-8
	24 (58)	3 (6)	1 (2)	11 (26)	0 (0)	0 (0)	39	61 (146)	TA2012.22	7
	21 (13)	3 (2)	3 (2)	11 (7)	0 (0)	0 (0)	39	61 (37)	TA2012.26	7
	22 (20)	6 (5)	0 (0)	9 (8)	0 (0)	0 (0)	37	63 (56)	TA2012.17	7
	26 (312)	8 (93)	1 (14)	1 (15)	0 (1)	0 (0)	36	64 (765)	TA2010.6	7-8
	21 (61)	8 (24)	1 (4)	5 (13)	0 (0)	1 (2)	36	64 (183)	TA2012.15	7
	20 (336)	11 (182)	1 (20)	3 (52)	1 (10)	0 (0)	36	64 (1048)	TA2010.14	7-8
	19 (46)	4 (11)	1 (3)	8 (20)	0 (0)	0 (0)	32	68 (168)	TA2011.320	3
	12 (30)	3 (7)	2 (6)	15 (38)	0 (0)	0 (0)	32	68 (170)	TA2012.11	7-8
Weed/wild	8 (64)	3 (22)	4 (30)	16 (128)	0 (0)	0 (0)	30	**70** (564)	TA2011.331	7-8
	15 (8)	2 (1)	0 (0)	9 (5)	2 (1)	0 (0)	27	**73** (40)	TA2011.36	3-4
	14 (140)	3 (25)	1 (8)	8 (73)	0 (0)	0 (2)	26	**74** (718)	TA2011.25	7-8
	16 (40)	5 (12)	0 (0)	3 (8)	0 (0)	0 (0)	23	**77** (197)	TA2010.3	7-8

Plant group	% Free-threshing wheat	% Two-row hulled barley	% Glume wheat	% Pulses	% Flax	% Olive	**% Crop**	**% Weed/wild**	**Sample**	**Phase**
	9 (7)	0 (0)	4 (3)	5 (4)	0 (0)	0 (0)	17	**83** (68)	TA2011.327	1-2
	9 (7)	1 (1)	3 (2)	0 (0)	1 (1)	0 (0)	14	**86** (69)	TA2011.330	1-2
	6 (22)	0 (1)	0 (0)	2 (7)	0 (0)	0 (0)	9	**91** (320)	TA2010.12	7-8

In Figure 4.4, the proportions of major crop categories in the 50 Tell Atchana samples are shown by chronological phase. The dominant crop type, free-threshing cereals, represented particularly by grain, is followed by a dominant pulse crop, bitter vetch. Little glume wheat material was recovered. Cereals are generally dominated by grain rather than chaff and there is a decrease in chaff material in the later phases. Free-threshing wheat co-occurs with bitter vetch in the vast majority of the Tell Atchana samples. Glume wheat plays a minor role at Tell Atchana. Olive stones are found in all periods at low levels (Middle Bronze II and Late Bronze I and II). The only slight chronological trend is that samples from the Middle Bronze II (phase 7 and 7-8) contain a relatively high proportions of cereal chaff material compared with samples from the Late Bronze I and II.

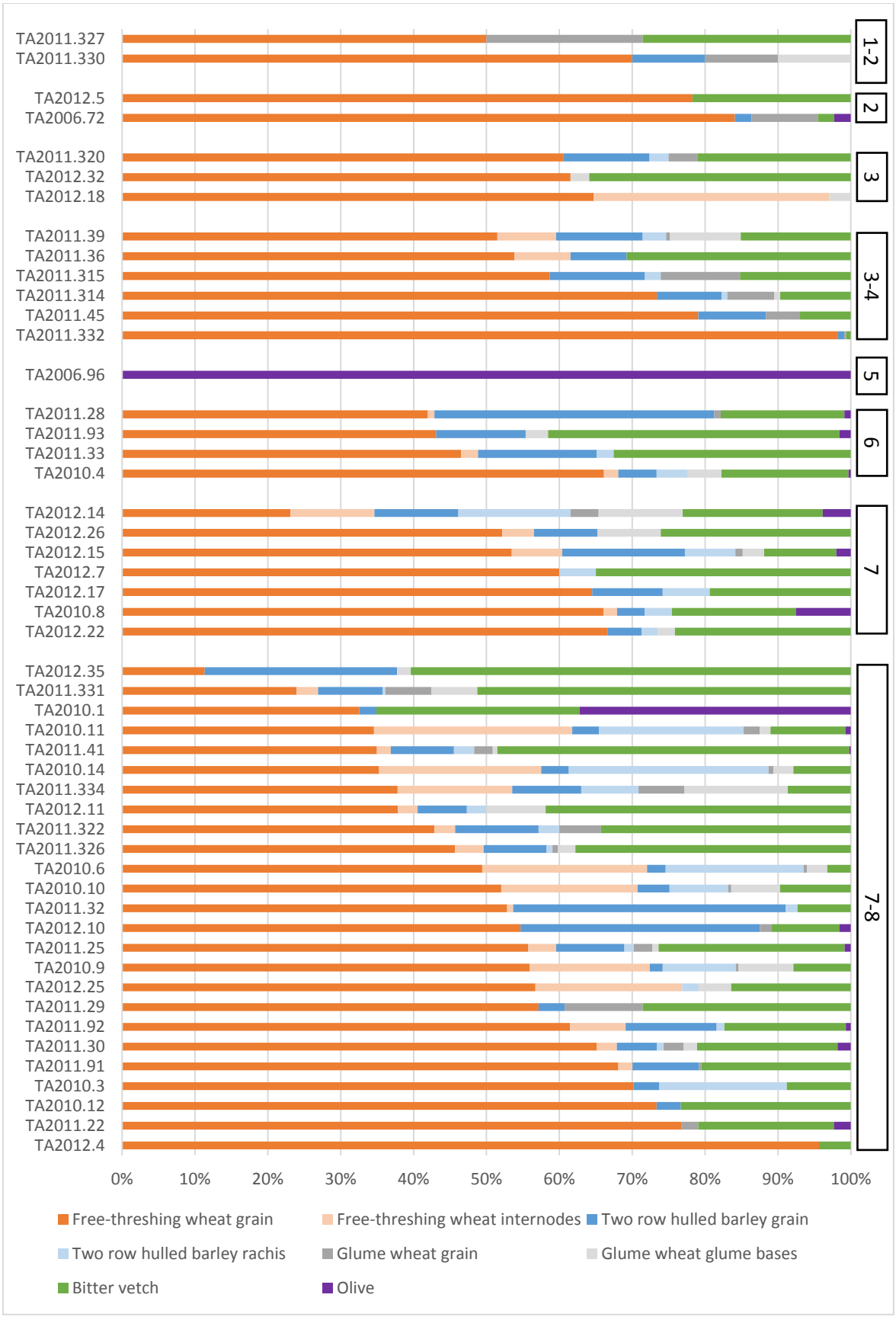


Figure 4.4 The proportions of major crop categories by phase in the 50 Tell Atchana samples. Phase 8-7 = Middle Bronze II (ca. 1800-1600 BC), Phase 6-4 = Late Bronze I (ca. 1600-1400 BC) and Phase 3-1 = Late Bronze II (ca. 1400-1300 BC)

Table 4.7 presents the proportions of major crop categories and the classification of crop type groups in the 50 Tell Atchana samples, using an arbitrary 70 percent threshold. At Tell Atchana, four groups were defined: a mixed crop group (19), a free-threshing cereal group (16), a free-threshing wheat group (14) and an olive sample (1).

Table 4.7 Proportions of major crop categories and crop group classification of the 50 Tell Atchana samples. The total number of items per sample is given in brackets.

Crop group	% Free-threshing wheat grain	% Free-threshing wheat internodes	**% Free-threshing wheat**	% Two-row hulled barley grain	% Two-row hulled barley rachis	**% Free-threshing cereals**	% Glume wheat grain	% Glume wheat glume bases	% Lentil	% Bitter vetch	**% Olive**	**Sample**	**Phase**
Free-threshing wheat	98 (894)	0 (0)	**98**	1 (8)	0 (0)	99	0 (2)	0 (0)	0 (0)	1 (6)	0 (0)	TA2011.332	3-4
	65 (22)	32 (11)	**97**	0 (0)	0 (0)	97	0 (0)	3 (1)	0 (0)	0 (0)	0 (0)	TA2012.18	3
	94 (44)	0 (0)	**94**	0 (0)	0 (0)	94	0 (0)	0 (0)	2 (1)	4 (2)	0 (0)	TA2012.4	7-8
	82 (37)	0 (0)	**82**	2 (1)	0 (0)	84	9 (4)	0 (0)	2 (1)	2 (1)	0 (1)	TA2006.72	2
	78 (18)	0 (0)	**78**	0 (0)	0 (0)	78	0 (0)	0 (0)	0 (0)	22 (5)	0 (0)	TA2012.5	2
	77 (34)	0 (0)	**77**	9 (4)	0 (0)	86	5 (2)	0 (0)	2 (1)	7 (3)	0 (0)	TA2011.45	3-4
	57 (76)	20 (27)	**77**	0 (0)	2 (3)	79	0 (0)	4 (6)	0 (0)	16 (22)	0 (0)	TA2012.25	7-8
	73 (22)	0 (0)	**73**	3 (1)	0 (0)	77	0 (0)	0 (0)	0 (0)	23 (7)	0 (0)	TA2010.12	7-8
	73 (33)	0 (0)	**73**	0 (0)	0 (0)	73	2 (1)	0 (0)	4 (2)	18 (8)	0 (1)	TA2011.22	7-8
	56 (312)	16 (92)	**72**	2 (10)	10 (56)	84	0 (2)	8 (42)	0 (2)	8 (44)	0 (0)	TA2010.9	7-8
	49 (214)	23 (98)	**72**	3 (11)	19 (82)	93	0 (2)	3 (12)	0 (1)	3 (14)	0 (0)	TA2010.6	7-8
	71 (91)	0 (0)	**71**	9 (11)	1 (1)	80	6 (8)	1 (1)	3 (4)	9 (12)	0 (0)	TA2011.314	3-4
	52 (2652)	19 (952)	**70**	4 (224)	8 (412)	83	0 (20)	7 (340)	1 (36)	10 (496)	0 (0)	TA2010.10	7-8
	70 (7)	0 (0)	**70**	10 (1)	0 (0)	80	10 (1)	10 (1)	0 (0)	0 (0)	0 (0)	TA2011.330	1-2
Free-threshing cereal	52 (65)	1 (1)	53	37 (46)	2 (2)	**91**	0 (0)	0 (0)	2 (2)	7 (9)	0 (0)	TA2011.32	7-8
	69 (40)	0 (0)	69	3 (2)	17 (10)	**90**	0 (0)	0 (0)	2 (1)	9 (5)	0 (0)	TA2010.3	7-8
	35 (206)	22 (130)	57	4 (22)	27 (160)	**88**	1 (4)	3 (16)	1 (6)	8 (46)	0 (0)	TA2010.14	7-8
	54 (35)	0 (0)	54	32 (21)	0 (0)	**86**	2 (1)	0 (0)	2 (1)	9 (6)	0 (1)	TA2012.10	7-8
	34 (47)	26 (37)	60	4 (5)	19 (27)	**83**	2 (3)	1 (2)	3 (4)	10 (14)	0 (1)	TA2010.11	7-8
	52 (54)	7 (7)	59	16 (17)	7 (7)	**82**	1 (1)	3 (3)	3 (3)	10 (10)	0 (2)	TA2012.15	7
	42 (47)	1 (1)	43	38 (43)	0 (0)	**81**	1 (1)	0 (0)	0 (0)	17 (19)	0 (1)	TA2011.28	6
	59	7	67	12	1	**80**	0	0	3	16	0	TA2011.92	7-8

Crop group	% Free-threshing wheat grain	% Free-threshing wheat internodes	**% Free-threshing wheat**	% Two-row hulled barley grain	% Two-row hulled barley rachis	**% Free-threshing cereals**	% Glume wheat grain	% Glume wheat glume bases	% Lentil	% Bitter vetch	**% Olive**	**Sample**	**Phase**
	(177)	(22)		(36)	(3)		(0)	(0)	(10)	(48)	(2)		
	66 (209)	2 (6)	68	9 (28)	0 (0)	**77**	0 (1)	0 (0)	3 (10)	20 (63)	0 (0)	TA2011.91	7-8
	65 (201)	2 (6)	67	5 (16)	4 (13)	**76**	0 (0)	5 (14)	2 (5)	17 (53)	0 (1)	TA2010.4	6
	61 (20)	0 (0)	61	9 (3)	6 (2)	**76**	0 (0)	0 (0)	6 (2)	18 (6)	0 (0)	TA2012.17	7
	51 (191)	8 (30)	60	12 (44)	3 (12)	**75**	1 (2)	10 (36)	0 (0)	15 (56)	0 (0)	TA2011.39	3-4
	58 (46)	0 (0)	58	11 (9)	3 (2)	**71**	4 (3)	0 (0)	5 (4)	20 (16)	0 (0)	TA2011.320	3
	62 (71)	3 (3)	64	5 (6)	1 (1)	**70**	3 (3)	2 (2)	5 (6)	18 (21)	0 (2)	TA2011.30	7-8
	61 (35)	2 (1)	63	4 (2)	4 (2)	**70**	0 (0)	0 (0)	7 (4)	16 (9)	0 (4)	TA2010.8	7
	63 (58)	0 (0)	63	4 (4)	2 (2)	**70**	0 (0)	2 (2)	5 (5)	23 (21)	0 (0)	TA2012.22	7
Mixed crop	53 (131)	4 (9)	56	9 (22)	1 (3)	67	2 (6)	1 (2)	5 (13)	24 (60)	0 (2)	TA2011.25	7-8
	35 (48)	15 (20)	50	9 (12)	7 (10)	66	6 (8)	13 (18)	7 (9)	8 (11)	0 (0)	TA2011.334	7-8
	45 (20)	2 (1)	48	16 (7)	2 (1)	66	0 (0)	0 (0)	2 (1)	32 (14)	0 (0)	TA2011.33	6
	52 (27)	0 (0)	52	12 (6)	2 (1)	65	10 (5)	0 (0)	12 (6)	13 (7)	0 (0)	TA2011.315	3-4
	50 (7)	7 (1)	57	7 (1)	0 (0)	64	0 (0)	0 (0)	7 (1)	29 (4)	0 (0)	TA2011.36	3-4
	50 (12)	4 (1)	54	8 (2)	0 (0)	63	0 (0)	8 (2)	4 (1)	25 (6)	0 (0)	TA2012.26	7
	60 (24)	0 (0)	60	0 (0)	0 (0)	60	0 (0)	3 (1)	3 (1)	35 (14)	0 (0)	TA2012.32	3
	45 (58)	4 (5)	48	8 (11)	1 (1)	58	1 (1)	2 (3)	2 (3)	37 (48)	0 (0)	TA2011.326	7-8
	52 (12)	0 (0)	52	0 (0)	4 (1)	57	0 (0)	0 (0)	13 (3)	30 (7)	0 (0)	TA2012.7	7
	39 (15)	3 (1)	42	11 (4)	3 (1)	55	5 (2)	0 (0)	8 (3)	32 (12)	0 (0)	TA2011.322	7-8
	21 (6)	10 (3)	31	10 (3)	14 (4)	55	3 (1)	10 (3)	10 (3)	17 (5)	0 (1)	TA2012.14	7
	50 (7)	0 (0)	50	0 (0)	0 (0)	50	21 (3)	0 (0)	0 (0)	29 (4)	0 (0)	TA2011.327	1-2
	39 (28)	0 (0)	39	11 (8)	0 (0)	50	0 (0)	3 (2)	10 (7)	36 (26)	0 (1)	TA2011.93	6
	46 (16)	0 (0)	46	3 (1)	0 (0)	49	9 (3)	0 (0)	20 (7)	23 (8)	0 (0)	TA2011.29	7-8

Crop group	% Free-threshing wheat grain	% Free-threshing wheat internodes	**% Free-threshing wheat**	% Two-row hulled barley grain	% Two-row hulled barley rachis	**% Free-threshing cereals**	% Glume wheat grain	% Glume wheat glume bases	% Lentil	% Bitter vetch	**% Olive**	**Sample**	**Phase**
	34 (165)	2 (9)	36	8 (41)	3 (13)	47	2 (12)	1 (3)	3 (17)	47 (228)	0 (1)	TA2011.41	7-8
	35 (28)	2 (2)	37	6 (5)	2 (2)	46	0 (0)	7 (6)	9 (7)	38 (31)	0 (0)	TA2012.11	7-8
	11 (6)	0 (0)	11	26 (14)	0 (0)	38	0 (0)	2 (1)	0 (0)	60 (32)	0 (0)	TA2012.35	7-8
	23 (57)	3 (7)	26	9 (21)	0 (1)	35	6 (15)	6 (15)	2 (6)	50 (122)	0 (0)	TA2011.331	7-8
	27 (14)	0 (0)	27	2 (1)	0 (0)	29	0 (0)	0 (0)	17 (9)	23 (12)	0 (16)	TA2010.1	7-8
Olive	0 (0)	0 (0)	0	0 (0)	0 (0)	0	0 (0)	0 (0)	0 (0)	0 (0)	**100** (92)	TA2006.96	5

4.2.1. Cultigens

Table 4.8 summarises the distribution of crop types in terms of frequency and abundance across the Tell Atchana assemblage based on the 50 samples. It demonstrates a relatively broad spectrum of crops. Of the cereals, free-threshing wheat is by far the most common and abundant at Tell Atchana, occurring in 98 percent of samples, followed by barley (86 percent) and glume wheat (70 percent). Amongst pulses, bitter vetch occurs in the majority of samples (94 percent), almost as many as free-threshing wheat, although the total number of bitter vetch items is markedly lower.

Table 4.8 Summary of the ubiquity and abundance of crop categories across the assemblage at Tell Atchana, based on the 50 samples analysed. 'Maximum' refers to the maximum number per sample.

	Ubiquity		Abundance	
	No.	%	Sum	Max.
Cereal				
Free-threshing wheat grain	49	98	6639	2652
Bread wheat rachis internodes	10	20	208	144
Macaroni wheat rachis internodes	26	52	1275	808
Free-threshing wheat internodes	**27**	**54**	**1483**	**952**
Free-threshing wheat, total	**49**	**98**	**8122**	**3604**
Two-row hulled barley grain	41	82	734	224
Two-row hulled barley rachis	29	58	835	412
Two-row hulled barley, total	**43**	**86**	**1569**	**636**
Einkorn grain	5	10	11	3
Emmer grain	19	38	55	11
New type wheat grain	15	30	49	20
Glume wheat grain, total	**28**	**56**	**117**	**20**
Emmer glume bases	23	46	499	332
New type wheat glume bases	8	16	35	8
Glume wheat glume bases	**25**	**50**	**534**	**340**
Glume wheat, total	**37**	**74**	**651**	**360**
Oat grain	17	34	45	8
Oat floret base	5	10	47	32
Pulse				
Bitter vetch	47	94	1673	496
Lentil	39	78	208	36
Grass pea	4	8	5	2
Crop, other				
Olive	16	32	129	92
Flax	10	20	71	40

At Tell Atchana, the chaff of all of the three cereals occurred at similar ubiquities across the samples, ranging from 50 to 58 percent. However, the numbers of free-threshing wheat rachis internodes (1483) and barley rachis internodes (835) were greater than that of glume wheat glume bases (534). With regard to grain, both ubiquity and abundance of free-threshing cereal grain (98 percent for free-threshing wheat and 82 percent for barley) were much higher than that of glume wheat grain (56 percent).

Free-threshing wheat rachis internodes were less ubiquitous than grain (98 percent), occurring in 54 percent of samples; macaroni wheat, the dominant type, occurred in 52 percent of samples. As for barley, the vast majority of the material at Tell Atchana appears to be a two-row hulled form (*Hordeum distichum*). Asymmetric grain of six-row barley, as well as naked grain/chaff remains, were hardly reported. The grain of two-row hulled barley occurred more frequently (82 percent)

than rachis (58 percent); nevertheless, the number of barley grain and rachis items was similar (734 and 835 items, respectively).

Glume wheat was a relatively minor occurrence at Tell Atchana. Overall, glume wheat grain and glume bases each occurred in around half of the samples (56 and 50 percent, respectively), though the absolute abundance of chaff remains was higher than that of grain. Emmer and 'new type' glume wheat were the only species to be confirmed in this category, which was chiefly dominated by emmer wheat (*Triticum dicoccum*).

Oat (*Avena* sp.) occurred in 40 percent of samples. Its grain occurred in 34 percent of samples, while its floret bases, all of which belong to the cultivated type (*Avena* cf. *sativa*), occurred in 10 percent. The floret bases of wild oat are distinguished from those of cultivated oat by a prominent (shattering) disarticulation scar, but cultivated type florest bases (lacking the scar) also occur in the upper florets of wild spikelets. Whether this cereal was grown as a cultivar at Tell Atchana or whether it occurred as a weed is uncertain.

Amongst the pulses, bitter vetch (*Vicia ervilia*) was the most common species, occurring in the vast majority of samples (94 percent), followed by lentil (*Lens culinaris*), with 78 percent. The abundance and ubiquity of grass pea is negligible across the assemblage.

The other potentially cultivated plants represented are olive (*Olea europaea*) and flax (*Linum usitatissimum*). Given the recorded abundance of these two species (129 and 71, respectively), both are likely to be used at the site. Olive stones were found in 32 percent of the samples at low levels in general, except for TA2006.96, which is comprised of 33 whole stones and 59 fragments in a pure concentration. This deposit could represent the by-product of olive oil extraction (Margaritis and Jones, 2008), suggesting that olives were used not only for the fruit but also as a source of oil. Finally, flax was found as both whole capsules and seeds in 20 percent of the samples. This also might have been used for oil as well as for fibre.

4.2.2. Fruits

Grape (*Vitis vinifera*) and common fig (*Ficus carica*) were found at similar ubiquities, with 34 and 28 percent, respectively, in the Tell Atchana assemblage (Table 4.9). The regular occurrence of these taxa likely reflects their importance in the Mediterranean climate of Atchana.

Table 4.9 Summary of the ubiquity and abundance of fruit categories across the assemblage at Tell Atchana, based on the 50 samples analysed. 'Maximum' refers to the maximum number per sample.

	Ubiquity		Abundance	
	No.	%	Sum	Max.
Fruit				
Grape	17	34	40	8
Fig	14	28	40	20

4.2.3. Weed/wild taxa

A total of 50 finally refined weed/wild taxon categories, including family level identifications, are listed with their ubiquity and abundance in Table 4.10. Gramineae and Fabaceae were the most dominant family groups in terms of the frequency and abundance in the Tell Atchana assemblage. Of the grass weed taxa, *Lolium temulentum*, *Bromus* and *Hordeum murinum* type are all common, likely as crop field weeds brought with harvested crops onto the site. Of these, *Lolium temulentum* was the most common (96 percent) and abundant (1598) taxon. This was followed by two other grass types, *Bromus* and *Hordeum*, which occurred at lower frequencies (32 percent and 26 percent, respectively) amongst the samples. A few wild barley seeds were identified as *Hordeum spontaneum,* whereas other wild/weed barely grains were identified as a small-seeded weedy form of barley, *Hordeum murinum* type. Bulbous canary-grass (*Phalaris aquatica*) is, on the other hand, widespread in arable fields and/or on 'damp soils' in Turkey (Davis, 1985). This type was almost as common as *Lolium temulentum* grains, occurring in 90 percent of samples, and with a relatively high total number of items (1513). Known as a native species of the Mediterranean and the Near East region, this is preferred by animals for grazing (Watson, McDonald and Bourke, 2000; USDA-ARS, 2015).

Table 4.10 Summary of the ubiquity and abundance of weed/wild categories across the assemblage at Tell Atchana, based on the 50 samples analysed. 'Maximum' refers to the maximum number per sample.

	Ubiquity		Abundance	
	No.	%	Sum	Max.
Wild/weed				
Leguminosae, small seeded	48	96	2914	936
Lolium temulentum	48	96	1598	332
Phalaris aquatica	45	90	1513	265
Grass weeds indet.	44	88	1682	1232
Rumex sp.	34	68	939	584
Scorpiurus muricatus	32	64	426	116
Galium spurium	31	62	72	12
Thymelaea passerine/gussonei/mesopotamia	30	60	651	408
Galium spp.	25	50	207	120
Coronilla sp.	21	42	2656	2132
Plantago sp.	20	40	94	22
Bromus spp.	16	32	107	44
Bolboschoenus glaucus	15	30	45	16
Hordeum murinum type	13	26	25	5
Anagallis arvensis	12	24	86	40
Prosopis farcta	12	24	42	23
Ranunculus arvensis	12	24	33	12
Bupleurum intermedium (= B. subovatum)	12	24	31	12
Echium angustifolium/parviflorum	11	22	34	11
Sherardia arvensis	10	20	27	12
Medicago sp.	9	18	24	8
Centaurea sp.	8	16	28	16
Valerianella dentata	8	16	26	8
Malva sylvestris/neglecta	8	16	15	4
Vaccaria pyramidata	7	14	17	6
Anthemis cotula	6	12	25	8
Hippocrepis unisiliquosa/ciliata/multisiliqusa	5	10	56	32
Silene sp.	5	10	9	4
Heliotropium sp.	4	8	21	16
Cephalaria sp.	4	8	19	16
Chenopodium sp.	4	8	8	4
Valerianella coronata type	3	6	13	6
Androsace maxima	2	4	5	4
Hordeum spontaneum	2	4	2	1
Ajuga/teucrium sp.	2	4	2	1
Adonis sp.	2	4	2	1
Capparis spinosa	2	4	2	1
Ornithogalum sp.	1	2	27	27
Hymenocarpus circinnatus, with pods	1	2	8	8
Capparis spinosa, bud	1	2	4	4
Bolboschoenus glaucus, tuber	1	2	2	2
Triticum boeoticum	1	2	2	2

	Ubiquity		Abundance	
	No.	%	Sum	Max.
Wild/weed				
Pisum humile	1	2	1	1
Aegilops sp.	1	2	1	1
Aegilops sp., glume bases	1	2	1	1
COMPOSITAE type 5	10	20	140	50
CRUCIFERAE indet.	3	6	7	5
CYPERACEAE indet.	6	12	70	40
ROSACEAE indet. (whole fruit)	1	2	1	1
UMBELLIFERAE indet.	9	18	34	8

Amongst the Fabaceae, small-seeded legumes (*Trifolium/Melilotus/ Astragalus/Trigonella*) occurred in nearly all of the samples (96 percent), with a large total number of items (2914). *Scorpiurus muricatus* occurred in over half of the samples (64 percent) with a moderate quantity of items (426). At Tell Atchana *Scorpiurus muricatus* were identified as var./subsp. *subvillosus*. Observed to grow on primarily limestone slopes and fallow fields in Turkey (Davis, 1970), this is also consumed by sheep/goat/cattle as a forage plant (Abbate *et al.*, 2010). *Coronilla* sp. was recorded with 2656 items but was less common, occurring in 21 samples out of 50 (42 percent). Other legume taxa, *Medicago* sp. and *Hippocrepis unisiliquosa/ciliata/multisiliqusa,* were the least frequently found, in 18 percent and 10 percent of samples, respectively. A few *Medicago* seeds were found attached or still encased in pods, and they were identified as *Medicago* cf. *shepardii* based on their morphological features.

Tell Atchana plant types within Rubiaceae, Polygonaceae and Thymelaeaceae were also of great importance in frequency and abundance across the assemblage. Within Rubiaceae, *Galium spurium* occurred in 62 percent of samples. *Sherardia arvensis*, another taxon in Rubiaceae, appeared in 20 percent of samples. *Rumex* was remarkable as a sole taxon in Polygonaceae with a ubiquity of 68 percent and an abundance of 939 items. The species of *Thymelaea* was not identifiable further than the category of *Thymelaea passerina/gussonei/mesopotamica*. These species are all annual and share the same fruiting time between April and August (up to September); it is possible that they were travelled with harvested crops as weeds (Davis, 1982).

Other plant taxa might also provide significant evidence for plant use in the past, including *Plantago* (40 percent) and *Bolboschoenus glaucus* (30 percent), *Bupleurum intermedium* (syn. *B. subovatum*) (24 percent). Although Umbelliferae species including a range used as condiments and flavourings, there are no known uses of *B. subovatum* as food. This taxon is known as a segetal weed fruiting from April to July (Davis, 1979). *Bolboschoenus glaucus* generally grows in wet environments such as marsh, swamp, stream or river side, beaches and edge of irrigation; this species is tolerant of saline conditions and flowers between May to September, which is slightly later than the conventional harvest time in the region (Davis, 1985), and may derive from a source other than crop harvesting, namely as mentioned in section 4.1.3, collected for consumption of humans and/or animals. The possibility of this is considered in the following chapter. As a potentially collected taxon, a limited number of *Capparis spinosa* seeds and buds were identified (two and eight items, respectively). Caper buds might have been used as human food. At Tell-es Sweyhat, a concentration of wild caper buds was found in a jar (Miller, 1997, p. 95).

4.3. Tell Brak

Figure 4.5 illustrates proportions of archaeobotanical categories in the 33 Tell Brak samples, and Table 4.11 presents simplified plant groups based on these categories. Two-row hulled barley is by far the most abundant crop type in the assemblage, with lower levels of free-threshing wheat, glume wheat and pulses. Twenty-five out of 33 Tell Brak samples represent a mixture of crop and weed/wild taxa, while six samples contain more than 70 percent crop items and two samples are dominated by weed/wild material.

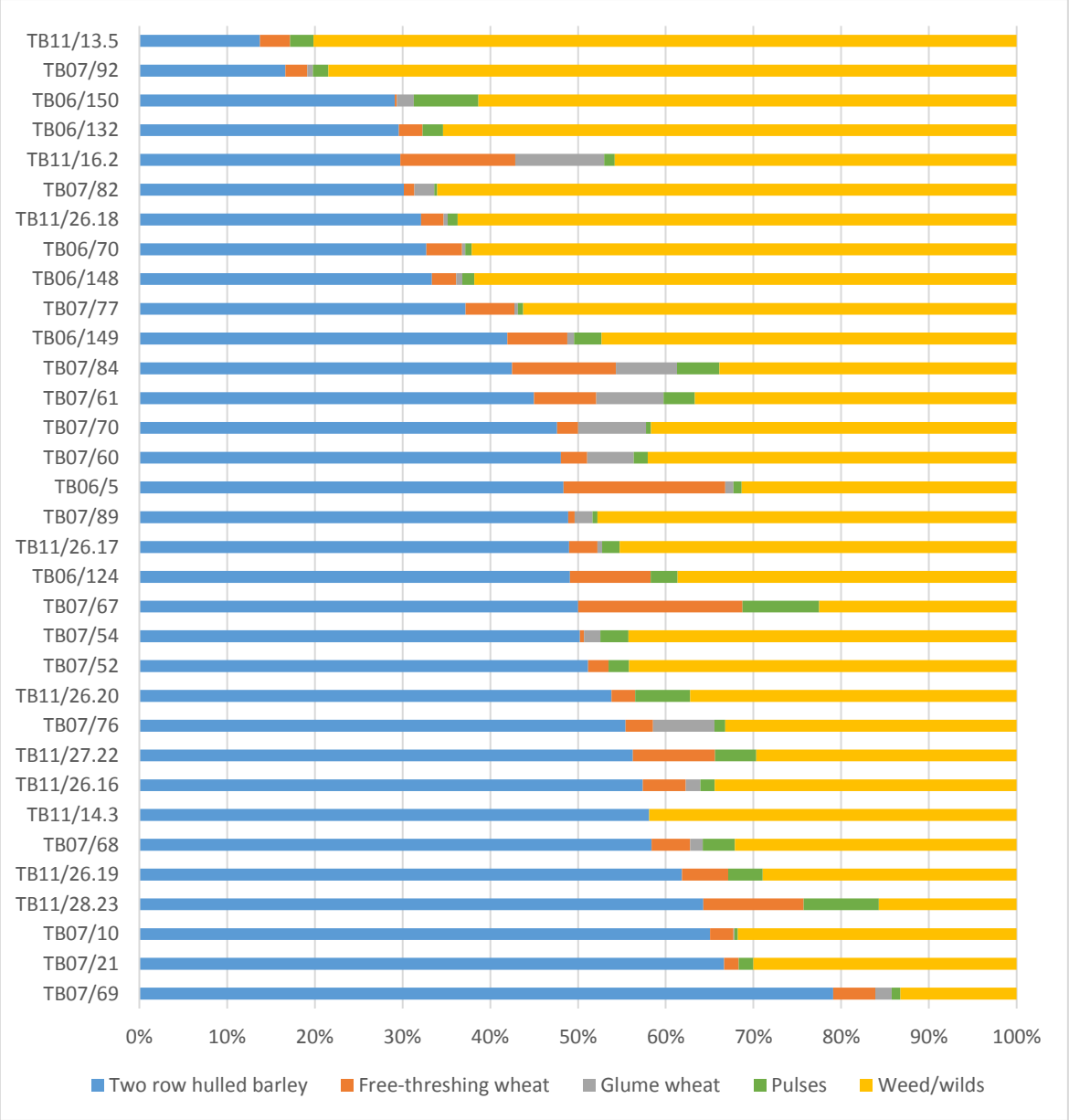


Figure 4.5 Proportions of major plant categories in the 33 Tell Brak samples.

Table 4.11 Proportions of major plant categories and plant group classification of the 33 Tell Brak samples. The total number of items per sample is given in brackets.

Plant group	% Two-row hulled barley	% Free-threshing wheat	% Glume wheat	% Pulse	**% Crop**	**% Weed/wild**	**Sample**
Crop	79 (1187)	5 (72)	2 (28)	1 (15)	**87**	13 (199)	TB07/69
	64 (45)	11 (8)	0 (0)	9 (6)	**84**	16 (11)	TB11/28.23
	50 (40)	19 (15)	0 (0)	9 (7)	**78**	23 (18)	TB07/67
	62 (47)	5 (4)	0 (0)	4 (3)	**71**	29 (22)	TB11/26.19
	56 (36)	9 (6)	0 (0)	5 (3)	**70**	30 (19)	TB11/27.22
	67 (40)	2 (1)	0 (0)	2 (1)	**70**	30 (18)	TB07/21
Mixed plant	48 (310)	18 (118)	1 (6)	1 (6)	69	31 (201)	TB06/5
	65 (1959)	3 (81)	0 (3)	0 (12)	68	32 (957)	TB07/10
	58 (80)	4 (6)	1 (2)	4 (5)	68	32 (44)	TB07/68
	55 (317)	3 (18)	7 (40)	1 (7)	67	33 (190)	TB07/76
	42 (79)	12 (22)	7 (13)	5 (9)	66	34 (63)	TB07/84
	57 (35)	5 (3)	2 (1)	2 (1)	66	34 (21)	TB11/26.16
	45 (76)	7 (12)	8 (13)	4 (6)	63	37 (62)	TB07/61
	54 (120)	3 (6)	0 (0)	6 (14)	63	37 (83)	TB11/26.20
	49 (80)	9 (15)	0 (0)	3 (5)	61	39 (63)	TB06/124
	48 (80)	2 (4)	8 (13)	1 (1)	58	42 (70)	TB07/70
	58 (68)	0 (0)	0 (0)	0 (0)	58	42 (49)	TB11/14.3
	48 (272)	3 (17)	5 (30)	2 (9)	58	42 (238)	TB07/60
	51 (66)	2 (3)	0 (0)	2 (3)	56	44 (57)	TB07/52
	50 (109)	0 (1)	2 (4)	3 (7)	56	44 (96)	TB07/54
	49 (365)	3 (24)	1 (4)	2 (15)	55	45 (337)	TB11/26.17
	30 (50)	13 (22)	10 (17)	1 (2)	54	46 (77)	TB11/16.2
	42 (227)	7 (37)	1 (4)	3 (17)	53	47 (256)	TB06/149

Plant group	% Two-row hulled barley	% Free-threshing wheat	% Glume wheat	% Pulse	**% Crop**	**% Weed/wild**	**Sample**
	49 (265)	1 (4)	2 (11)	1 (3)	52	48 (259)	TB07/89
	37 (261)	6 (39)	0 (3)	1 (4)	44	56 (395)	TB07/77
	29 (122)	0 (1)	2 (8)	7 (31)	39	61 (257)	TB06/150
	33 (48)	3 (4)	1 (1)	1 (2)	38	62 (89)	TB06/148
	33 (177)	4 (22)	0 (2)	1 (4)	38	62 (336)	TB06/70
	32 (200)	3 (16)	0 (3)	1 (7)	36	64 (397)	TB11/26.18
	30 (76)	3 (7)	0 (0)	2 (6)	35	65 (168)	TB06/132
	30 (552)	1 (22)	2 (42)	0 (6)	34	66 (1210)	TB07/82
Weed/wild	17 (207)	2 (31)	1 (8)	2 (22)	22	**78** (975)	TB07/92
	14 (36)	3 (9)	0 (0)	3 (7)	20	**80** (210)	TB11/13.5

Proportions of major crop categories in the 33 Tell Brak samples are shown in Figure 4.6. Two-row hulled barley is dominant and its grain and rachis maintain balanced proportions through the assemblage. Free-threshing wheat is more common than glume wheat. The crop-dominated group is comprised of barley and free-threshing cereal samples (Table 4.12). The great majority of the Tell Brak samples (29) is grouped into the barley crop group, with at least 70 percent of barley material. The Tell Brak free-threshing cereal crop group consists of four samples and these samples are composed predominantly of barley grain and/or chaff, with relatively small free-threshing wheat components.

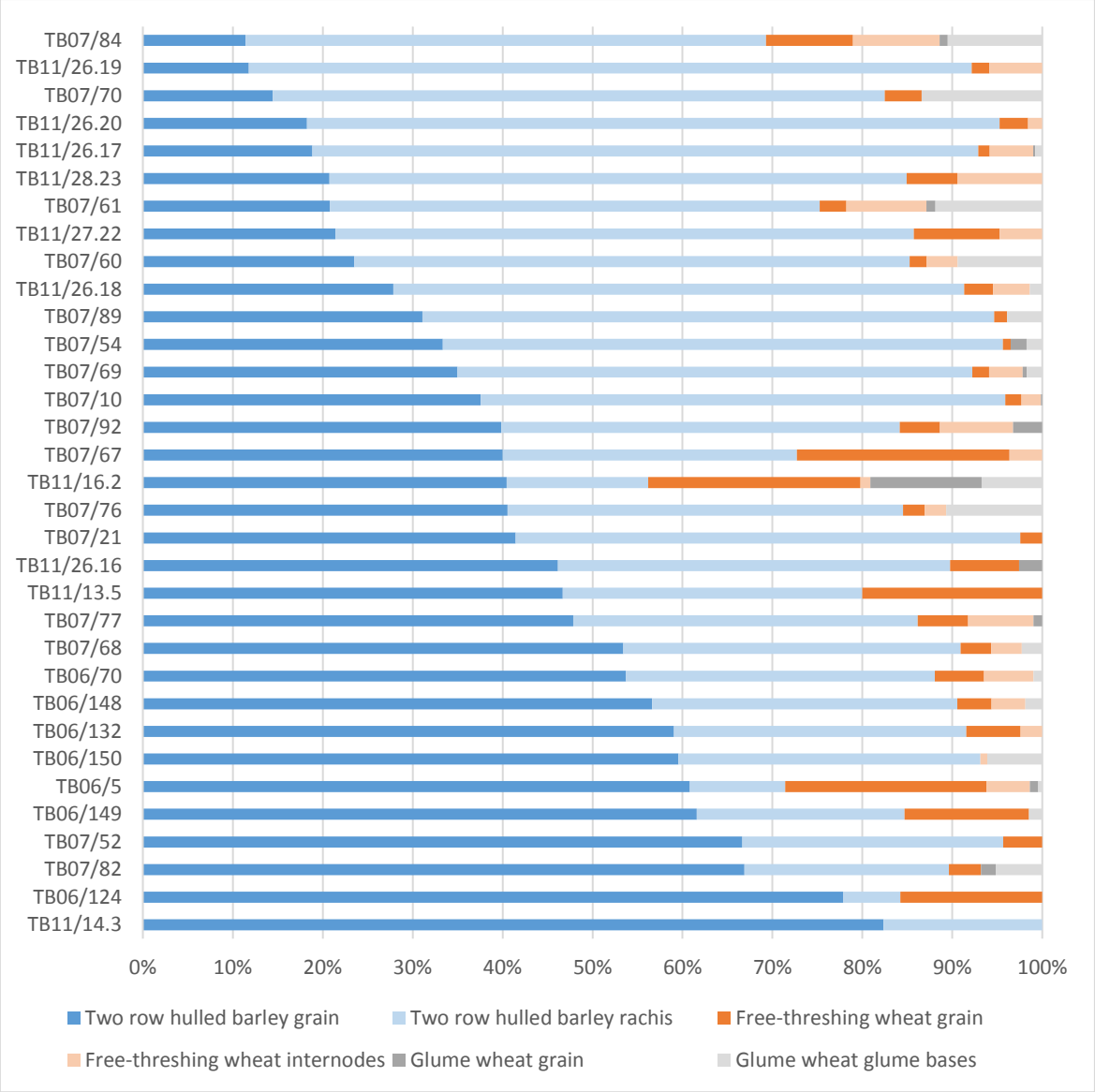


Figure 4.6 Proportions of major crop categories in the 33 Tell Brak samples.

Table 4.12 Proportions of major crop categories and crop group classification of the 33 Tell Brak samples. The total number of items per sample is given in brackets.

Crop group	% Two-row hulled barley grain	% Two-row hulled barley rachis	**% Two-row hulled barley**	% Free-threshing wheat grain	% Free-threshing wheat internodes	**% Free-threshing cereals**	% Glume wheat grain	% Glume wheat glume bases	% Lentil	% Bitter vetch	% Pea	**Sample**
Barley	82 (56)	18 (12)	**100**	0 (0)	0 (0)	100	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	TB11/14.3
	37 (767)	58 (1193)	**95**	2 (37)	2 (44)	99	0 (3)	0 (0)	0 (6)	0 (2)	0 (2)	TB07/10
	40 (17)	55 (23)	**95**	2 (1)	0 (0)	98	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)	TB07/21
	31 (87)	63 (178)	**94**	1 (4)	0 (0)	95	0 (0)	4 (11)	0 (0)	0 (0)	1 (3)	TB07/89
	64 (46)	28 (20)	**92**	4 (3)	0 (0)	96	0 (0)	0 (0)	3 (2)	1 (1)	0 (0)	TB07/52
	35 (450)	57 (737)	**91**	2 (24)	4 (48)	97	0 (6)	2 (22)	0 (5)	0 (2)	0 (5)	TB07/69
	57 (30)	34 (18)	**91**	4 (2)	4 (2)	98	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	TB06/148
	31 (38)	59 (71)	**90**	1 (1)	0 (0)	91	2 (2)	2 (2)	0 (0)	4 (5)	2 (2)	TB07/54
	18 (74)	71 (291)	**89**	1 (5)	5 (19)	95	0 (1)	1 (3)	0 (1)	2 (8)	1 (6)	TB11/26.17
	66 (412)	23 (140)	**89**	4 (22)	0 (0)	93	2 (10)	5 (32)	0 (0)	0 (2)	0 (2)	TB07/82
	27 (61)	62 (139)	**88**	3 (7)	4 (9)	96	0 (0)	1 (3)	0 (0)	3 (7)	0 (0)	TB11/26.18
	45 (18)	43 (17)	**88**	8 (3)	0 (0)	95	3 (1)	0 (0)	0 (0)	3 (1)	0 (0)	TB11/26.16
	56 (49)	31 (27)	**87**	6 (5)	2 (2)	95	0 (0)	0 (0)	0 (0)	2 (2)	2 (2)	TB06/132
	11 (6)	76 (41)	**87**	2 (1)	6 (3)	94	0 (0)	0 (0)	6 (3)	0 (0)	0 (0)	TB11/26.19
	53 (108)	34 (69)	**86**	5 (11)	5 (11)	97	0 (0)	1 (2)	1 (3)	0 (1)	0 (0)	TB06/70
	51 (47)	35 (33)	**86**	3 (3)	3 (3)	92	0 (0)	2 (2)	0 (0)	5 (5)	0 (0)	TB07/68
	16 (23)	69 (97)	**86**	3 (4)	1 (2)	90	0 (0)	0 (0)	1 (1)	3 (4)	6 (9)	TB11/26.20
	47 (145)	38 (116)	**85**	6 (17)	7 (22)	98	1 (3)	0 (0)	0 (0)	1 (2)	1 (2)	TB07/77
	40 (152)	43 (165)	**83**	2 (9)	2 (9)	88	0 (0)	10 (40)	1 (4)	1 (3)	0 (0)	TB07/76
	23 (75)	60 (197)	**83**	2 (6)	3 (11)	88	0 (0)	9 (30)	0 (0)	2 (5)	1 (4)	TB07/60
	20 (9)	61 (27)	**82**	9 (4)	5 (2)	95	0 (0)	0 (0)	0 (0)	2 (1)	2 (1)	TB11/27.22
	14	67	**82**	4	0	86	0	13	0	0	1	TB07/70

Crop group	% Two-row hulled barley grain	% Two-row hulled barley rachis	**% Two-row hulled barley**	% Free-threshing wheat grain	% Free-threshing wheat internodes	**% Free-threshing cereals**	% Glume wheat grain	% Glume wheat glume bases	% Lentil	% Bitter vetch	% Pea	Sample
	(14)	(66)		(4)	(0)		(0)	(13)	(0)	(0)	(1)	
	74 (74)	6 (6)	**80**	15 (15)	0 (0)	95	0 (0)	0 (0)	5 (5)	0 (0)	0 (0)	TB06/124
	58 (165)	22 (62)	**80**	13 (37)	0 (0)	93	0 (0)	1 (4)	1 (2)	3 (8)	2 (7)	TB06/149
	37 (98)	41 (109)	**77**	4 (22)	7 (20)	89	3 (8)	0 (0)	2 (5)	0 (0)	6 (17)	TB07/92
	19 (11)	58 (34)	**76**	5 (3)	8 (5)	90	0 (0)	0 (0)	0 (0)	10 (6)	0 (0)	TB11/28.23
	48 (78)	27 (44)	**75**	0 (0)	1 (1)	76	0 (0)	5 (8)	0 (0)	0 (0)	19 (31)	TB06/150
	20 (21)	51 (55)	**71**	3 (3)	8 (9)	82	1 (1)	11 (12)	1 (1)	0 (0)	5 (5)	TB07/61
	60 (264)	10 (46)	**70**	22 (97)	5 (21)	97	1 (4)	0 (2)	0 (0)	1 (3)	1 (3)	TB06/5
Free-threshing cereal	35 (22)	29 (18)	65	21 (13)	3 (2)	**89**	0 (0)	0 (0)	2 (1)	10 (6)	0 (0)	TB07/67
	40 (21)	29 (15)	69	17 (9)	0 (0)	**87**	0 (0)	0 (0)	4 (2)	10 (5)	0 (0)	TB11/13.5
	11 (13)	54 (66)	64	9 (11)	9 (11)	**82**	1 (1)	10 (12)	0 (0)	2 (3)	5 (6)	TB07/84
	40 (36)	16 (14)	56	23 (21)	1 (1)	**80**	12 (11)	7 (6)	1 (1)	0 (0)	0 (0)	TB11/16.2

4.3.1. Cultigens

Three cereal and five pulse types were identified in the Tell Brak assemblage (Table 4.13). Amongst the cereals, two-row hulled barley, free-threshing wheat, including both bread wheat and macaroni wheat, and glume wheat are present. Two-row hulled barley is the most ubiquitous crop in the assemblage, occurring in 100 percent of samples, with 7632 items in total. Both the grain and rachis are abundant in all the samples. One hulled barley rachis internode was tentatively ('cf.') identified as the six-row form of hulled barley.

Table 4.13 Summary of the ubiquity and abundance of crop categories across the assemblage at Tell Brak, based on the 33 samples analysed. 'Maximum' refers to the maximum number per sample.

	Ubiquity		Abundance	
	No.	%	Sum	Max.
Cereal				
Two-row hulled barley grain	33	100	3487	767
cf. Six-row hulled barley rachis	1	3	4	4
Two-row hulled barley rachis	33	100	4145	1192
Two-row hulled barley, total	**33**	**100**	**7632**	**1959**
Free-threshing wheat grain	31	94	393	97
Bread wheat rachis internodes	11	33	73	27
Macaroni wheat rachis internodes	21	64	184	44
Free-threshing wheat internodes	**22**	**67**	**257**	**48**
Free-threshing wheat, total	**32**	**97**	**650**	**118**
Glume wheat grain	12	36	51	11
Glume wheat glume bases	18	55	205	40
Glume wheat, total	**22**	**67**	**256**	**42**
Pulse				
Bitter vetch	23	70	83	8
Pea	18	55	108	31
Lentil	15	45	42	6
Grass pea	7	21	13	3
Chickpea	1	3	1	1
Crop, other				
Safflower	2	6	14	13

Free-threshing wheat is the next most frequent crop type across the samples (97 percent). However, the number of free-threshing wheat items is more than ten times lower than that of two-row hulled barley. The rachis internodes of free-threshing wheat are relatively rare compared to grain in terms of both ubiquity and abundance. Both species of free threshing wheat, bread wheat and macaroni wheat, were identified using internode morphology. Of these, the rachis internodes of macaroni wheat are far more ubiquitous and numerous than that of bread wheat across the assemblage.

Glume wheat is observed to occur less frequently than barley and free-threshing wheat, being present in 67 percent of the Tell Brak samples, with the lowest abundance (256) amongst the three cereal types. This is represented by glume wheat glume bases (18 percent and 205 items), while the grain occurs less frequently (12 percent) and with lower abundance (51).

Turning to the pulses, five taxa were recorded: bitter vetch, pea, lentil, grass pea and chickpea. Both bitter vetch and pea were represented by at least 80 items, occurring in 70 percent and 55 percent of samples, respectively. Safflower is present at much lower frequency, with only a few items.

4.3.2. Fruits

Fig and grape pips are present at much lower levels than crop material in the Tell Brak assemblage (31 and four items, respectively), both occurring in less than 20 percent of samples (Table 4.14).

Table 4.14 Summary of the ubiquity and abundance of fruit categories across the assemblage at Tell Brak, based on the 33 samples analysed. 'Maximum' refers to the maximum number per sample.

	Ubiquity		Abundance	
	No.	%	Sum	Max.
Fruit				
Fig	6	18	31	13
Grape	4	12	4	1

4.3.3. Weed/wild taxa

Table 4.15 provides the frequency and abundance of weed/wild categories across the Tell Brak assemblage, based on the 33 samples analysed. Of these, small-seeded legume taxa and indeterminate grasses were the most ubiquitous, occurring in 97 and 91 percent of samples and with 1012 and 445 items, respectively.

Table 4.15 Summary of the ubiquity and abundance of weed/wild categories across the assemblage at Tell Brak, based on the 33 samples analysed. 'Maximum' refers to the maximum number per sample.

	Ubiquity		Abundance	
	No.	%	Sum	Max.
Wild/weed				
Leguminosae, small seeded	32	97	1012	176
Grass weeds indet.	30	91	445	116
Hordeum murinum type	28	85	296	120
Malva sp.	27	82	478	66
Aegilops sp., glume bases	26	79	920	419
Aegilops spp./sp.	26	79	676	387
Coronilla scorpioides	25	76	390	149
Eremopyrum bonaepartis/distans	25	76	275	40
Lolium rigidum	25	76	170	24
Aegilops tauschii, glume bases	21	64	96	20
Echium/Lithospermum sp.	19	58	760	238
Lepidium draba (= Cardaria draba)	18	55	326	189
Bromus spp.	17	52	177	72
Silene dichotoma type	16	48	78	32
Galium spurium	15	45	70	22
Taeniatherum caput-medusae	14	42	91	28
Prosopis farcta	12	36	95	59
Ajuga/teucrium sp.	12	36	59	36
Hordeum spontaneum	12	36	41	12
Androsace maxima	9	27	56	32
Adonis aestivalis type	9	27	33	8
Cyperus laevigatus/rotundus	8	24	47	12
Fumaria parviflora type	7	21	17	4
Rumex sp.	7	21	13	4
Medicago sp.	6	18	14	4
Ornithogalum sp.	6	18	10	4
Ziziphora sp.	5	15	91	80
Bolboschoenus glaucus	5	15	36	26
Capparis spinosa	5	15	18	8
Vaccaria hispanica	5	15	12	4
Valerianella coronata type	5	15	7	2
Avena sp.	4	12	15	9
Hyoscyamus cf. *muticus*	4	12	10	4
Thymelaea passerina/mesopotamica	3	9	9	6
Gypsophila spp.	3	9	4	2
Centaurea sp.	3	9	3	1
Bellevalia sp.	2	6	2	1
Papaver sp.	1	3	74	74
Verbascum sp.	1	3	8	8
Brassica sp.	1	3	3	3
Erodium sp.	1	3	3	3
Galium cf. *tricornutum*	1	3	2	2

	Ubiquity		Abundance	
	No.	%	Sum	Max.
Wild/weed				
Heliotropium sp.	1	3	1	1
Bolboschoenus glaucus, tuber	1	3	1	1
Onobrychis sp.	1	3	1	1
Scorpiurus muricatus	1	3	1	1
Aegilops tauschii/speltoides, glume bases	1	3	1	1
Triticum boeoticum	1	3	1	1
Glaucium sp.	1	3	1	1
Bupleurum intermedium (= B. subovatum)	1	3	1	1
CHENOPODIACEAE indet.	2	6	2	1
CYPERACEAE indet.	7	21	13	4
Large legumes indet.	6	18	22	14
UMBELLIFERAE indet.	7	21	25	12

Other than family-level identification categories, the potential weed flora at Tell Brak is dominated by grass taxa. Weedy *Hordeum* (*H. murinum* type) are ranked the third in their frequency, with a moderate number of seeds (296). *Aegilops* sp. occurs in 79 percent of samples, with 676 grain seeds. This is represented by both its grain and glume bases including *Aegilops tauschii*. *Eremopyrum bonaepartis/distans* and *Lolium rigidum* were found in 76 percent of the samples, though the abundance of *Eremopyrum bonaepartis/distans* is far higher. Another common grass weed is *Bromus* spp. occurring in 52 percent of samples; grain morphology suggests that more than one *Bromus* species is represented. This is followed by *Taeniatherum caput-medusae* (42 percent) and *Hordeum spontaneum* (36 percent), both found in less than half of the Tell Brak samples. Among the grass weed types, *Avena* sp. is the rarest taxon in the assemblage accounting for 12 percent (15 grains).

Across the assemblage, *Malva* sp. (82 percent) and *Coronilla scorpioides* (76 percent), are dominant in terms of the ubiquity and abundance. In one sample, evident *Malva parviflora* was found and it is possible that this species perhaps occurs broadly across other Tell Brak samples. It is notable that *Malva* seeds are distributed rather evenly across the assemblage, while those of *Coronilla scorpioides* tend to be concentrated in specific samples.

Another type of weed occurring in at least half the samples is *Lepidium draba*, which is a common field weed (Qasem, 1994); the leaf and shoot are also edible (Dogan *et al*., 2004). Other common taxa in terms of the frequency and quantity include *Silene dichotoma* type (48 percent), *Galium spurium* (45 percent), *Prosopis farcta* (36 percent) and *Ajuga/teucrium* sp. (36 percent). Of these, *Prosopis farcta* is the only species that fruits after crop harvest (Townsend and Guest, 1974; Charles and Bogaard, 2001); the rest of them can be harvested in fruit with cereals as arable weeds.

In terms of probable field weeds with limited occurrence and quantity, *Androsace maxima*, *Adonis aestivalis* type, *Fumaria parviflora* type, *Vaccaria hispanica* and *Valerianella coronata* type were recorded. Other taxa, *Cyperus laevigatus/rotundus*, *Rumex* sp. and *Bolboschoenus glaucus*, which prefer wetter environments, might have been introduced in other routes rather than crop weeds (Townsend and Guest, 1974; Charles and Bogaard, 2001). Finally, while not providing direct evidence for human consumption since the quantity is limited, one taxon that was likely collected at Tell Brak is *Capparis spinosa*.

Chapter 5. Taphonomy of the archaeobotanical assemblages

This chapter investigates the taphonomic origin of archaeobotanical assemblages from Tell Mohammed ‘Arab, Tell Atchana and Tell Brak. Archaeobotanical samples selected for analysis are entirely composed of charred plant material from archaeological contexts caused by artificial or accidental combustion. The original source(s) of the charred plant remains is to be interpreted in the context of human activities related principally to harvested material from crop cultivation and animal husbandry. In addition, collected plants for human and/or animal consumption could also play a contributing role. Crop harvesting produces not only the grain product for human consumption but also by-products that can be used for fuel, fodder, construction and crafts. Animal keeping can leave the vestiges of plants animals consumed as fodder or forage, and plant seeds embedded in dung pellets are a valuable source of information on the husbandry system. These potential contributing factors can be assessed in terms of analyses designed to identify crop processing stages and plant remains derived from animal dung analyses, as discussed in the next sections.

This chapter therefore traces the taphonomy of plant remains, mainly focusing on crop processing stages after harvest and the possibility of dung-derived plant material. With regard to crop processing, only samples identified as being dominated by a single crop type in the previous chapter (e.g. barley group or glume wheat group) are considered; samples of mixed crop composition are excluded.

The classification of crop processing stages was explored using three approaches. Firstly, the relative proportions and the ratios of cereal grain and chaff per sample were calculated from the three archaeological sites and compared to Jones’ (1990) modern ethnographic data (Table 5.1) in order to consider which crop processing stage(s) each sample resembled. Only samples including at least 30 crop items were considered. Secondly, the relative proportions of three components – grain, rachis internodes and weed items – in samples from each archaeological site were compared

with those in ethnobotanical samples from a traditional crop processing sequence observed on the Greek island of Amorgos (Jones, 1990). Lastly, weed-based classification of crop processing stages, focussing on relevant physical properties of weed seeds separated off by winnowing, coarse sieving or fine sieving, or remaining with the grain product, was assessed using discriminant analysis, following a method developed by Jones (1984; 1987).

Only free-threshing cereals were grown in the study on Amorgos, and a comparable ethnobotanical model for crop processing stages of glume wheats has not been established to date. Since free-threshing cereals and glume wheats require different processing stages, and potentially storage modes (Hillman, 1984a), no direct comparison of Jones' (1990) free-threshing cereal model with glume wheat samples in the archaeobotanical assemblages could be made.

Table 5.1 Proportions of cereal grain and chaff and ratios of cereal grain to chaff in the four main crop processing stages based on Jones' modern ethnobotanical data (1990). *The figure of six-row barley grain was divided by three since barley at the three archaeological sites is predominantly or entirely the two-row form.

Crop processing stages	Percentage						Grain: rachis ratio		
	% Free-threshing wheat grain	% Free-threshing wheat rachis	% Two-row barley grain*	% Two-row barley rachis	% Free-threshing cereal grain	% Free-threshing cereal rachis	Free-threshing wheat grain: rachis	Two-row barley grain*: rachis	Free-threshing cereal grain: rachis
Winnowing by-product	3	13	6	79	19	81	1:4	1:13	1:4
	0	74	0	26	1	99	0:1220	1:63	1: 82
	1	45	2	51	7	93	1:47	1:23	1: 13
	7	88	0	5	8	92	1:12	1:26	1: 12
	9	87	0	4	9	91	1:10	1:26	1: 10
	2	52	1	45	5	95	1:24	1:54	1: 21
	7	56	0	36	9	91	1:8	1:75	1: 11
	10	52	6	33	24	76	1:5	1:6	1: 3
	1	68	0	31	1	99	1:85	0:228	1: 123
	2	7	2	88	9	91	1:3	1:40	1: 10
	4	56	2	38	9	91	1:15	1:20	1: 10
	5	58	5	32	19	81	1:11	1:6	1: 4
	2	70	0	28	3	97	1:39	1:95	1: 36
	5	60	2	34	10	90	1:12	1:21	1: 10
	2	21	2	76	6	94	1:13	1:50	1: 16
	1	84	1	14	4	96	1:80	1:17	1: 27
	4	52	1	43	7	93	1:14	1:32	1: 12
	5	31	4	60	16	84	1:6	1:15	1: 5
	1	27	6	66	16	84	1:19	1:12	1: 5
	0	54	0	46	1	99	1:231	1:390	1: 170
	0	5	1	93	4	96	1:14	1:67	1: 22
	3	62	4	31	13	87	1:23	1:8	1: 6
	1	25	1	73	4	96	1:35	1:61	1: 23
	3	62	1	34	7	93	1:23	1:25	1: 14
	6	31	6	57	21	79	1:5	1:10	1: 4
Coarse sieve by-product	7	12	25	56	55	45	1:2	1:2	1: 1
	11	58	3	28	20	80	1:5	1:8	1: 4
	19	31	15	35	49	51	1:2	1:2	1: 1
	2	90	0	9	2	98	1:59	0:800	1: 65
	35	64	0	1	36	64	1:2	1:5	1: 2
	8	54	1	38	10	90	1:7	1:46	1: 9
	14	58	3	25	22	78	1:4	1:8	1: 4
	5	60	4	30	16	84	1:12	1:7	1: 5
	6	70	1	23	9	91	1:11	1:27	1: 10
	4	13	5	78	18	82	1:3	1:15	1: 5
	12	25	5	59	24	76	1:2	1:12	1: 3
	18	59	2	21	23	77	1:3	1:11	1: 3
	15	48	3	34	24	76	1:3	1:10	1: 3

Crop processing stages	Percentage						Grain: rachis ratio		
	% Free-threshing wheat grain	% Free-threshing wheat rachis	% Two-row barley grain*	% Two-row barley rachis	% Free-threshing cereal grain	% Free-threshing cereal rachis	Free-threshing wheat grain: rachis	Two-row barley grain*: rachis	Free-threshing cereal grain: rachis
	36	53	2	9	40	60	1:1	1:5	1: 1
	17	72	3	8	24	76	1:4	1:3	1: 3
	19	34	10	38	40	60	1:2	1:4	1: 2
	1	40	2	58	6	94	1:79	1:30	1: 15
	16	57	2	25	20	80	1:4	1:15	1: 4
	0	0	6	94	15	85	1:1	1:17	1: 6
	23	49	3	25	30	70	1:2	1:9	1: 2
Fine sieve by-product	43	0	57	0	100	0	29:0	38:0	144:0
	39	42	14	5	63	37	1:1	3:1	2:1
	78	0	22	0	100	0	32:0	9:0	59:0
	99	0	1	0	100	0	179:0	1:0	182:0
	95	4	1	0	96	4	25:1	1:0	25:1
	84	0	16	0	100	0	96:0	19:0	152:0
	93	0	7	0	100	0	270:1	20:0	329:1
	94	0	6	0	100	0	27:0	2:0	32:0
	95	0	5	0	100	0	34:0	2:0	39:0
	31	0	68	1	100	0	34:0	73:1	254:1
	72	0	28	0	100	0	36:0	14:0	79:0
	71	8	19	1	93	7	9:1	13:1	13:1
	81	8	10	1	92	8	10:1	9:1	12:1
	86	0	14	0	100	0	99:0	16:0	99:0
	51	0	49	0	100	0	18:0	17:0	18:0
	91	2	7	0	98	2	42:1	19:0	52:1
	91	0	9	0	100	0	54:0	6:0	71:0
	24	0	43	32	83	17	3:0	1:1	5:1
	89	1	10	0	99	1	82:1	9:0	109:1
	100	0	0	0	100	0	103:0	0:0	104:0
	73	6	19	2	94	6	12:1	11:1	16:1
	75	0	21	4	97	3	35:0	5:1	32:1
	32	15	53	0	93	7	2:1	37:0	13:1
	86	2	12	0	99	1	56:1	24:0	80:1
	46	0	50	5	98	2	20:0	11:1	43:1
	52	17	20	10	80	20	3:1	2:1	4:1
	75	3	22	0	98	2	25:1	37:0	47:1
Cleaned product	18	0	81	1	100	0	1400:0	113:1	364:1
	76	0	24	0	100	0	3528:1	1089:1	3397:1
	46	0	54	0	100	0	6800:1	395:1	1452:1
	99	0	1	0	100	0	9999:1	1370:1	9464:1
	97	0	3	0	100	0	1084:1	95:1	875:1
	47	0	53	0	100	0	572:1	434:1	1010:1
	64	0	36	0	100	0	9070:1	1013:1	4045:1
	66	0	34	0	100	0	1072:1	1009:1	1759:1

Crop processing stages		Percentage						Grain: rachis ratio		
		% Free-threshing wheat grain	% Free-threshing wheat rachis	% Two-row barley grain*	% Two-row barley rachis	% Free-threshing cereal grain	% Free-threshing cereal rachis	Free-threshing wheat grain: rachis	Two-row barley grain*: rachis	Free-threshing cereal grain: rachis
		90	0	10	0	100	0	891:1	216:1	814:1
		1	0	99	0	100	0	8:1	238:1	616:1
		67	0	33	0	100	0	417:1	1305:1	899:1
		58	0	41	0	100	0	143:1	3283:1	433:1
		81	0	19	0	100	0	193:1	366:1	292:1
		48	0	52	0	100	0	193:1	827:1	650:1
		60	0	40	0	100	0	4250:0	1395:1	6310:1
		81	0	19	0	100	0	965:1	1033:1	1351:1
		79	0	21	0	100	0	420:1	1292:1	696:1
		16	2	82	1	99	1	10:1	145:1	119:1
		76	0	24	0	100	0	1006:1	1462:1	1613:1
		99	0	1	0	100	0	5147:1	157:0	5303:1
		65	0	35	0	100	0	531:1	1144:1	1111:1
		77	1	21	1	98	2	61:1	19:1	59:1
		20	1	79	1	100	0	33:1	125:1	207:1
		79	0	21	0	100	0	8143:1	4358:1	9787:1
		6	0	94	0	100	0	249:1	520:1	1414:1
		54	0	46	0	100	0	453:1	333:1	748:1
		71	0	28	0	100	0	534:1	241:1	623:1
Average	**Winnowing by-product**	**3**	**49**	**2**	**46**	**8**	**92**	**1:17**	**1:24**	**1:11**
	Coarse sieve by-product	**19**	**50**	**3**	**27**	**27**	**73**	**1:3**	**1:8**	**1:3**
	Fine sieve by-product	**80**	**3**	**17**	**1**	**97**	**3**	**26:1**	**23:1**	**34:1**
	Product	**74**	**0**	**26**	**0**	**100**	**0**	**822:1**	**430:1**	**1012:1**

With regard to assessment of dung-related material, it has been shown that wild taxa such as small sized legumes and other hard coated small seeds are derived from animal dung pellets in some southwest Asian archaeobotanical assemblages (Charles and Bogaard, 2001; Charles, 2007; Charles and Bogaard, 2010; Bogaard *et al.*, 2013). Wild species that are likely to have entered into archaeological sites via routes other than harvested crops and associated weeds are preferentially detected here for the examination of dung-derived material, based on four key criteria proposed by Charles (1998) and subsequent observations of seed survival through sheep digestion in experimental work (Valamoti and Charles, 2005; Wallace and Charles, 2013). The samples are

initially examined for the presence of intact dung pellets, and then the habitat, seasonality and overall 'dung index' of weed/wild plants are considered, including in the context of trends observable using correspondence analysis. Furthermore, archaeological samples are entered in discriminant analysis as a separate group in order to observe any divergence reflecting the sign of wild taxa other than crop weeds. This analysis is to distinguish archaeological samples from modern ethnobotanical samples from the traditional processing on Amorgos, to assess the possibility of dung-derived wild/weed seeds that diverge in their physical properties and combinations from the weed seeds expected at different crop processing stages. Lastly, the degree of mixing of different crops and plant parts associated with different crop processing stage(s) is examined. This can provide evidence of deliberate mixture and the potential usage of those samples.

5.1. Tell Mohammed 'Arab

5.1.1. Crop processing of single crop groups

5.1.1.1. Crop-based analysis

In section 4.1 it was shown that the Tell Mohammed 'Arab assemblage includes samples dominated by three major crop categories: barley, free-threshing wheat and glume wheat. Each archaeobotanical sample (classified into these groups) presumably represents a particular crop processing stage or mixture of stages. Since the processing of barley and free-threshing wheat shares more or less the same stages (Hillman, 1984a; Hillman, 1985; Jones, 1984), the classification of samples in these groups was conducted using the same approach. In contrast, the processing of glume wheat is somewhat different to that of free-threshing cereals and therefore samples in the glume wheat group were considered separately using a different approach (Hillman, 1984a; Hillman, 1984b). In the barley group, samples TM33 and TM49 were left out of this analysis since each contained numbers of crop items below 30.

Table 5.2 shows the classification of nine free-threshing wheat and two-row hulled barley samples by crop processing stage, based on proportions of cereal grain and rachis internodes and the ratio of cereal grain to rachis. This indicates four barley fine sieve by-product/product samples, three barley product samples, one barley fine sieve by-product and one free-threshing wheat winnowing/coarse sieve by-product.

Table 5.2 The classification of free-threshing wheat and two-row hulled barley crop group samples by crop processing stage based on proportions of cereal grain and rachis and ratios of cereal grain to rachis. Samples containing less than 30 crop items were excluded. W = winnowing by-product, C = coarse sieve by-product, F = fine sieve by-product and P = product. *Hand-collected. **The figure of two-row barley grain was multiplied by three.

Classification	Crop group	Percentage						Grain: rachis ratio			Sample
		% Two-row hulled barley grain	% Two-row hulled barley rachis	% Free-threshing wheat grain	% Free-threshing wheat internodes	% Free-threshing cereal grain**	% Free-threshing cereal chaff	Two-row hulled barley grain: rachis	Free-threshing wheat grain: rachis	Free-threshing cereal grain**: rachis	
W/C	Free-threshing wheat	2	6	7	85	13	87	1:2	1:13	1:7	TM37
F	Barley	54	45	0	2	78	22	1:1	0:2	3:1	TM48
F/P	Barley	100	0	0	0	100	0	36:0	0:0	36:0	TM16
F/P	Barley	99	1	0	0	99	1	66:1	0:0	66:1	TM53
F/P	Barley	100	0	0	0	100	0	52:0	0:0	52:0	TM7*
F/P	Barley	100	0	0	0	100	0	100:0	0:0	100:0	TM11*
P	Barley	100	0	0	0	100	0	192:0	0:0	192:0	TM56
P	Barley	100	0	0	0	100	0	394:1	0:0	1181:1	TM27
P	Barley	100	0	0	0	100	0	1458:1	0:4	1458:1	TM22+27

Amongst eight barley group samples, four were determined either as barley fine sieve by-product or product. Sample TM16 and 53 are composed almost entirely of grains, suggesting barley product material. They were, however, provisionally considered to belong to fine sieve by-product stage as well since the ratios of grain to rachis suggests fine sieve by-product stage when compared to Amorgos ratio data (Table 5.1). Samples TM11 and 7 were collected on site by hand and thus

sizeable charred remains were collected while any chaff and weed/wild seeds of smaller size were likely missed. Despite this limitation, the classification of both samples was considered as fine sieve by-product/product stages in terms of the ratio of grain to rachis, as in Table 5.1.

Three samples were identified as barley product. Grain of free-threshing wheat was not found in these samples. TM 27 and TM22+27 were much closer to the product stage in terms of the ratio compared to Jones model shown in Table 5.1, whereas the grain to rachis ratio was narrower in TM56 than in TM 27 and TM22+27.

In the ethnobotanical data shown in Table 5.1, the majority of barley fine sieve by-product samples and the average figures of barley fine sieve by-product are represented by the significantly higher percentage of barley grain than rachis. On the other hand, the grain to rachis ratio of TM48 barley material is one to one. Nevertheless, sample TM48 was classified as barley fine sieve by-product since it still shows plausibly the closest features to the Amorgos free-threshing cereal fine sieve by-product. Furthermore, two samples in the modern data contain a *c*. one to one ratio of free-threshing cereal grain to rachis.

TM37 is the only sample classified in the free-threshing wheat group at Tell Mohammed ʻArab. This resembles early processing stages, that is, winnowing/coarse sieve by-product, when the proportions of the rachis internodes and the grain to rachis ratio are considered.

Samples in the glume wheat group at Tell Mohammed ʻArab are rich in glume bases. In Table 5.3, it is obvious that glume bases always significantly outnumber glume wheat grains. Since glume wheat grain to glume base ratios are generally one to one or one to two in unprocessed glume wheat spikelets, the archaeobotanical ratios observed suggest material unlikely to reflect storage for human consumption. Glume wheat grain identified from Tell Mohammed ʻArab is, moreover, relatively small in size and no intact glume wheat spikelets were identified. It is, therefore, apparent that they are by-products derived from a late processing stage, after pounding/dehusking (Hillman, 1984a).

Table 5.3 The classification of glume wheat crop group samples by crop processing stage based on proportions of cereal grain and glume bases and ratios of cereal grain to glume bases. Samples containing less than 30 crop items were excluded. BP = by-product.

Classification	**Crop group**	**Percentage**						**Grain: rachis ratio**			**Sample**
		% Glume wheat grain	**% Glume wheat glume bases**	% Two-row hulled barley grain	% Two-row hulled barley rachis	% Free-threshing wheat grain	% Free-threshing wheat internodes	**Glume wheat grain: glume bases**	Two-row hulled barley grain: rachis	Free-threshing wheat grain: rachis	
BP	Glume wheat	18	70	8	0	5	0	1:4	15:0	9:0	TM29
BP	Glume wheat	8	67	25	0	0	0	1:8	24:0	0:0	TM51
BP	Glume wheat	11	61	22	1	4	1	1:6	25:1	5:1	TM44eIII
BP	Glume wheat	17	57	18	1	6	2	1:3	20:1	4:1	TM28
BP	Glume wheat	23	54	17	0	6	0	1:2	170:0	59:0	TM50

TM50 contains a slightly higher proportion of grain compared to the other four samples and the ratio of grain to glume bases is *c*. 1:2, which would be consistent with one-seeded glume wheat spikelet material. However, this scenario can be excluded since the glume wheat grain in this sample was mostly identified as from two-seeded spikelets. Sample TM50 is, nevertheless, also notable in that other cereal material consists of grain, i.e. two-row hulled barley grain and free-threshing wheat grain, without any rachis. All glume wheat group samples contained a certain quantity of barley grain, implying perhaps a deliberate admixture.

5.1.1.2. Crop- and weed-based analysis

In order to determine the crop processing status of barley and free-threshing wheat samples, ten barley group and one free-threshing wheat group samples out of total 27 samples were examined using the relative percentage of three plant components, i.e. grain, rachis and weed seeds, in comparison to Jones' (1990) ethnographic data from Amorgos (Figure 5.1a). In general, the

archaeobotanical samples are composed of mostly either grain or a combination of grain and weed seeds, with few rachis internodes.

Table 5.4 indicates the classification of crop processing stage based on Figure 5.1a. Five barley samples (TM7, TM11, TM27, TM22+27 and TM56) were concentrated at the top of the diagram, containing up to approximately 100 percent grain, suggesting that they derived from fine sieve product. Of these, two (TM7 and TM11) were recovered by hand on site, meaning that weed seeds and rachis internodes may be underrepresented. Nevertheless, these are more likely to reflect barley product in that lumps of barley grains were distinctively recognised for hand-collect. The other five samples are located the midway between the weed and grain vertices and resemble Amorgos fine sieve by-products. It is noticeable that one of these five, TM48, contains approximately 10 percent rachis implying mixing of some early stage by-product. Sample TM37, the only free-threshing wheat group sample, is dominated by a combination of weed seeds and rachis internodes, without any grain. It resembles by-products from Amorgos early processing stages, either winnowing by-product or coarse sieve by-product.

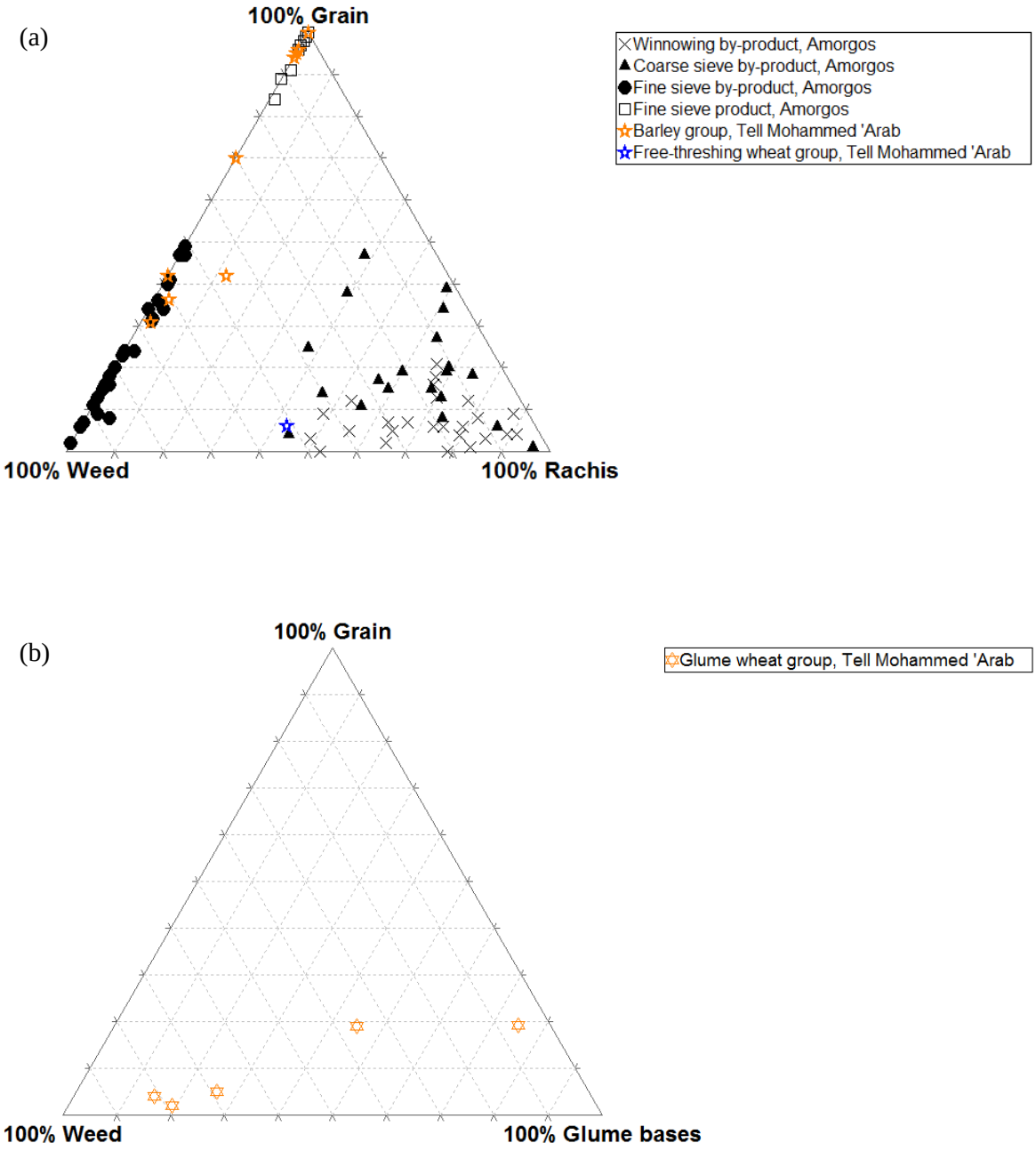


Figure 5.1 (a) Triangular plot of the 11 Tell Mohammed 'Arab barley and free-threshing wheat group samples based on the relative proportions of grain, rachis and weed in comparison to Jones' (1990) Amorgos data and (b) triangular plot of the five Tell Mohammed 'Arab glume wheat group samples based on the relative proportions of grain, glume bases and weed.

Figure 5.1b shows proportions of grain, glume bases and weed seeds in glume wheat samples, and Table 5.4 shows the classification. As mentioned in the previous section, Jones' (1990) model established from Amorgos is based on only free-threshing cereals and no comparable ethnographic model for glume wheat processing exists. Of the five glume wheat group samples (Figure 5.1b),

none resemble cleaned product samples. Two samples (TM50 and 29) are dominated by glume bases while the other three (TM28, 51 and 44eIII) are dominated by weed seeds; all resemble by-product material from a crop processing stage(s) following dehusking (Hillman, 1984b).

Table 5.4 The classification of 16 Tell Mohammed ‘Arab barley, free-threshing wheat and glume wheat group samples by crop processing stage based on the proportions of grain, chaff and weed seeds. *Hand-collected.

Classification	**Crop group**	**Sample**
Winnowing/coarse sieve by-product	Free-threshing wheat	TM37
Fine sieve by-product	Barley	TM53
Fine sieve by-product	Barley	TM33
Fine sieve by-product	Barley	TM48
Fine sieve by-product	Barley	TM49
Fine sieve by-product/product	Barley	TM16
Product	Barley	TM56
Product	Barley	TM27
Product	Barley	TM22+27
Product	Barley	TM11*
Product	Barley	TM7*
By-product	Glume wheat	TM28
By-product	Glume wheat	TM29
By-product	Glume wheat	TM44eIII
By-product	Glume wheat	TM50
By-product	Glume wheat	TM51

5.1.1.3. Weed-based analysis

The barley, free-threshing wheat and glume wheat samples were further compared with the Amorgos ethnobotanical samples on the basis of physical weed seed properties using discriminant analysis, following the method of Jones (1984; 1987). Samples containing ten or more weed seeds were included. Thus, two hand-collected samples (TM7 and 11) lacking weed seeds were omitted.

Figure 5.2a shows the discriminant analysis plot of nine Tell Mohammed ‘Arab free-threshing cereal samples against Jones’ (1984; 1987) ethnobotanical samples from four crop processing stages. The blue and orange data points represent the Tell Mohammed ‘Arab free-threshing wheat and barley samples, respectively.

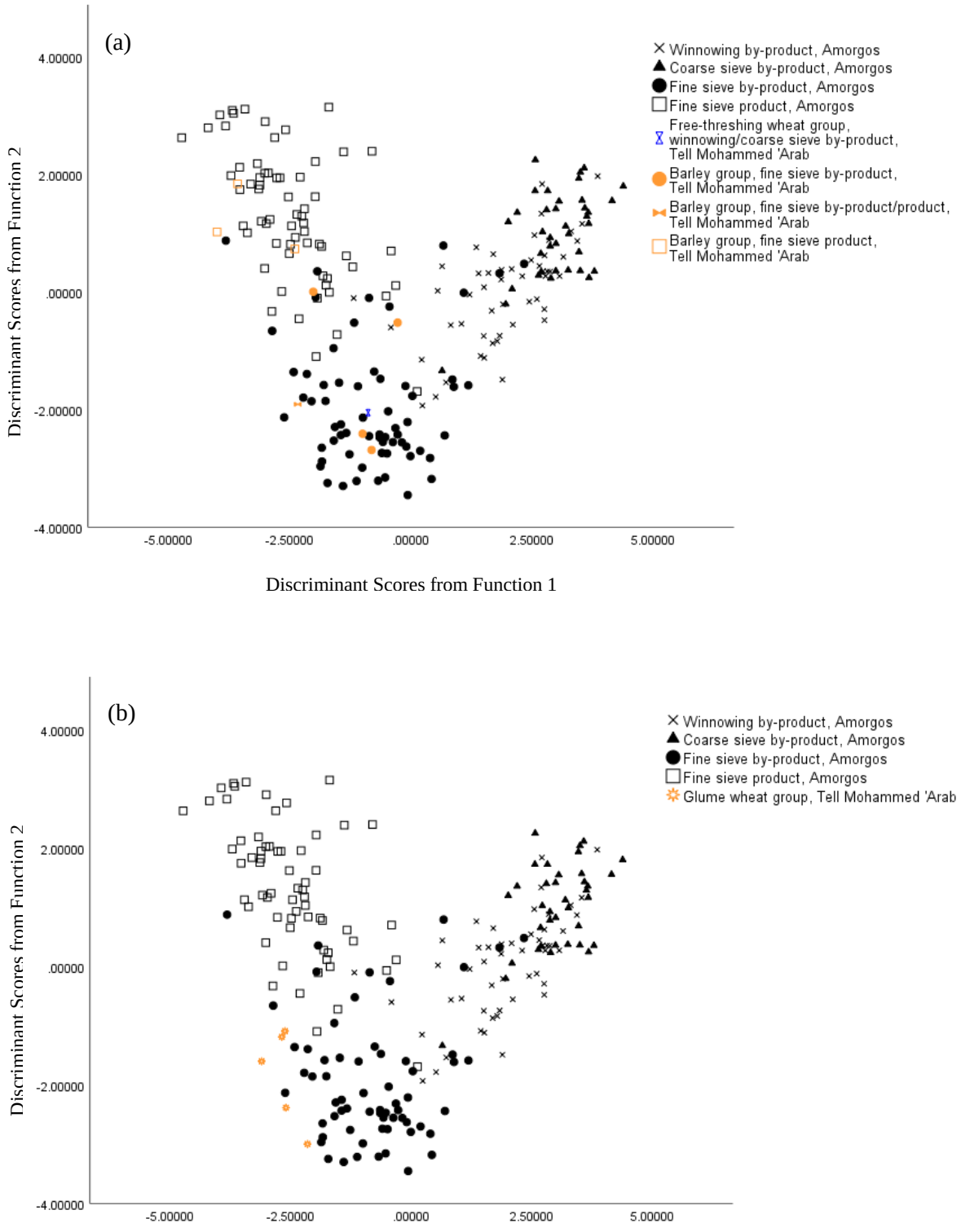


Figure 5.2 (a) Discriminant analysis plot of the nine Tell Mohammed 'Arab barley and free-threshing wheat group samples in comparison to Jones' (1984; 1987) Amorgos data and (b) Discriminant analysis plot of the five Tell Mohammed 'Arab glume wheat group samples in comparison to Jones' (1984; 1987) Amorgos data.

Table 5.5 summarises the results of the discriminant analysis together with the probabilities of each sample classification. It can be seen that the results of the weed-based discriminant analysis generally agree with those reported in previous sections. The majority of samples is classified into late crop processing stage categories. Specifically, three barley group samples (TM22+27, 27 and 56) were categorised as fine sieve product with high probabilities. The other three samples (TM49, 33 and 16) in this group were classified to fine sieve by-product, again high probabilities. However, the plant composition of TM16 is intermediate in all approaches, positioned between barley fine sieve by-product and product (Table 5.2, Figure 5.1a and Figure 5.2a). Similarly, two other barley group samples, TM48 and 53, which were both classified as fine sieve by-products in the previous two sections but were reclassified by the weed-based discriminant analysis as fine sieve product and winnowing by-product, respectively. The probability of TM48, grouped to fine sieve product in the result of discriminant analysis, is relatively low (0.883). Its second highest classification, is as fine sieve by-product. It is also notable that TM48 contains a quantity of *Prosopis farcta* (BHH) and SFH weed categories, suggesting the mixture of multiple sources of material (including burnt dung fuel material, i.e. *Prosopis farcta*) and potentially also multiple processing stages. This sample represents material accumulated in a fire installation context (hearth). The classification of TM53 as winnowing by-product by the weed-based discriminant function is associated with relatively low probability (0.789); its second highest classification was fine sieve by-product. This sample contains the highest number of *Bromus* seeds, classified as SFL, resulting in the identification of the sample as winnowing by-product. This sample also contains a high number of *Prosopis farcta*, suggesting a contribution of dung-derived material.

Table 5.5 The classification of barley, free-threshing wheat and glume wheat group samples by crop processing stage based on physical weed seed types.

Classification	***P*-value**	**Crop group**	**Sample**	**Second Highest Group**	
				Classification	***P*-value**
Winnowing by-product	0.789	Barley	TM53	Fine sieve by-product	0.191
Fine sieve by-product	0.999	Barley	TM49	Winnowing by-product	0.000
Fine sieve by-product	0.998	Barley	TM33	Winnowing by-product	0.002
Fine sieve by-product	0.979	Barley	TM16	Fine sieve product	0.021
Fine sieve by-product	0.963	Free-threshing wheat	TM37	Winnowing by-product	0.035
Fine sieve product	1.000	Barley	TM22+27	Fine sieve by-product	0.000
Fine sieve product	1.000	Barley	TM27	Fine sieve by-product	0.000
Fine sieve product	0.991	Barley	TM56	Fine sieve by-product	0.009
Fine sieve product	0.883	Barley	TM48	Fine sieve by-product	0.114
Fine sieve by-product	1.000	Glume wheat	TM51	Fine sieve product	0.000
Fine sieve by-product	0.994	Glume wheat	TM28	Fine sieve product	0.006
Fine sieve by-product	0.827	Glume wheat	TM29	Fine sieve product	0.173
Fine sieve by-product	0.723	Glume wheat	TM44eIII	Fine sieve product	0.276
Fine sieve by-product	0.712	Glume wheat	TM50	Fine sieve product	0.288

The single free-threshing wheat sample (TM 37) was classified as fine sieve by-product with relatively high probability (0.963) while its second highest classification was winnowing by-product with the probability of 0.035. This sample was previously grouped as winnowing and/or coarse sieve by-product stages in the ratio of grain and rachis and in the proportions of grain, rachis and weed analyses, which conflicts with the result of the discriminant analysis. This sample is represented by SFH seeds typical of fine-sieve by-products together with SHH types (*Medicago* and *Malva*) and an SFL taxon (*Bromus*). This composition suggests a mixture of early and late processing stages, which is plausible given the hearth context of this sample.

The classification of glume wheat samples by the weed-based discriminant function is consistent with the results of previous analyses. All five samples in this group were classified as the fine sieve by-product by the discriminant function (Figure 5.2b and Table 5.5).

5.1.1.4. Comparison of the results of different approaches

In Table 5.6, the classifications of Tell Mohammed ‘Arab samples by crop-based, crop- and weed-based and solely weed-based analyses are shown by crop group. The Tell Mohammed ‘Arab assemblage is mostly represented by barley fine sieve by-product and product samples. The glume wheat samples, dominated by glume bases, also represent late stage processing material. It is of note that the glume wheat material always coincides with a certain amount of barley grain. While this could reflect post-depositional missing, it could also represent a deliberate mixture for specific purposes such as fodder use.

Table 5.6 Summary of the final classification of Tell Mohammed ‘Arab samples by crop processing stage. W = winnowing by-product, C = coarse sieve by-product, F = fine sieve by-product, P = product and BP = by-product. *Hand-collected.

Classification				**Crop group**	**Sample**
Final	**Crop-based**	**Crop- + weed-based**	**Weed-based**		
Fine sieve by-product	N/A	F	F	Barley	TM33
Fine sieve by-product	N/A	F	F	Barley	TM49
Fine sieve by-product/product	F/P	P	N/A	Barley	TM7*
Fine sieve by-product/product	F/P	P	N/A	Barley	TM11*
Fine sieve product	F/P	F/P	F	Barley	TM16
Fine sieve product	P	P	P	Barley	TM56
Fine sieve product	P	P	P	Barley	TM27
Fine sieve product	P	P	P	Barley	TM22+27
Mixed stages	F	F	P	Barley	TM48
Mixed stages	F/P	F	W	Barley	TM53
By-product	BP	BP	F	Glume wheat	TM29
By-product	BP	BP	F	Glume wheat	TM50
By-product	BP	BP	F	Glume wheat	TM51
By-product	BP	BP	F	Glume wheat	TM28
By-product	BP	BP	F	Glume wheat	TM44eIII
Mixed stages	W/C	W/C	F	Free-threshing wheat	TM37

5.1.1.5. Correspondence analysis of crop processing stages and arable weeds

The composition of Tell Mohammed ‘Arab samples classified into crop processing stages was investigated further using correspondence analysis. This was carried out to explore associations

among wild/weed taxa and crop processing (by-)products (cf. Bogaard *et al.*, 2013). Figure 5.3a shows a correspondence analysis plot of 24 samples on the basis of 38 taxa, with samples coded by crop processing stage and crop group, along axis 1 (horizontal) and axis 2 (vertical). Only weed taxa present in 10 percent or more of samples and taxa unlikely to be dung-derived (i.e. scoring 1 in 'dung index', see section 5.1.2 and Table 5.8) were included; those more likely to be dung-derived (i.e. scoring 2 and 3) were excluded in order to increase the likelihood of isolating arable weeds as much as possible in relation to crop type and crop processing stage (see Table 5.8).

The correspondence analysis shows a clear separation between barley products, barley fine-sieve by-products and glume wheat by-products (Figure 5.3a). One of the barley product samples, TM16, is, however, located between the barley product cluster and the other processing groups, reflecting its intermediate composition seen also in the crop processing classification, i.e. fine sieve by-product/product (Table 5.6). Two mixed stage barley samples are situated near barley fine sieve by-products. Although they are mixed, their position suggests that they are still dominated by barley fine sieve by-product material. Glume wheat by-product samples tend to occur towards the positive ends of both axes in the upper right part of the plot. Mixed crop samples, situated toward the positive (right) end of axis 1, are broadly distributed along axis 2.

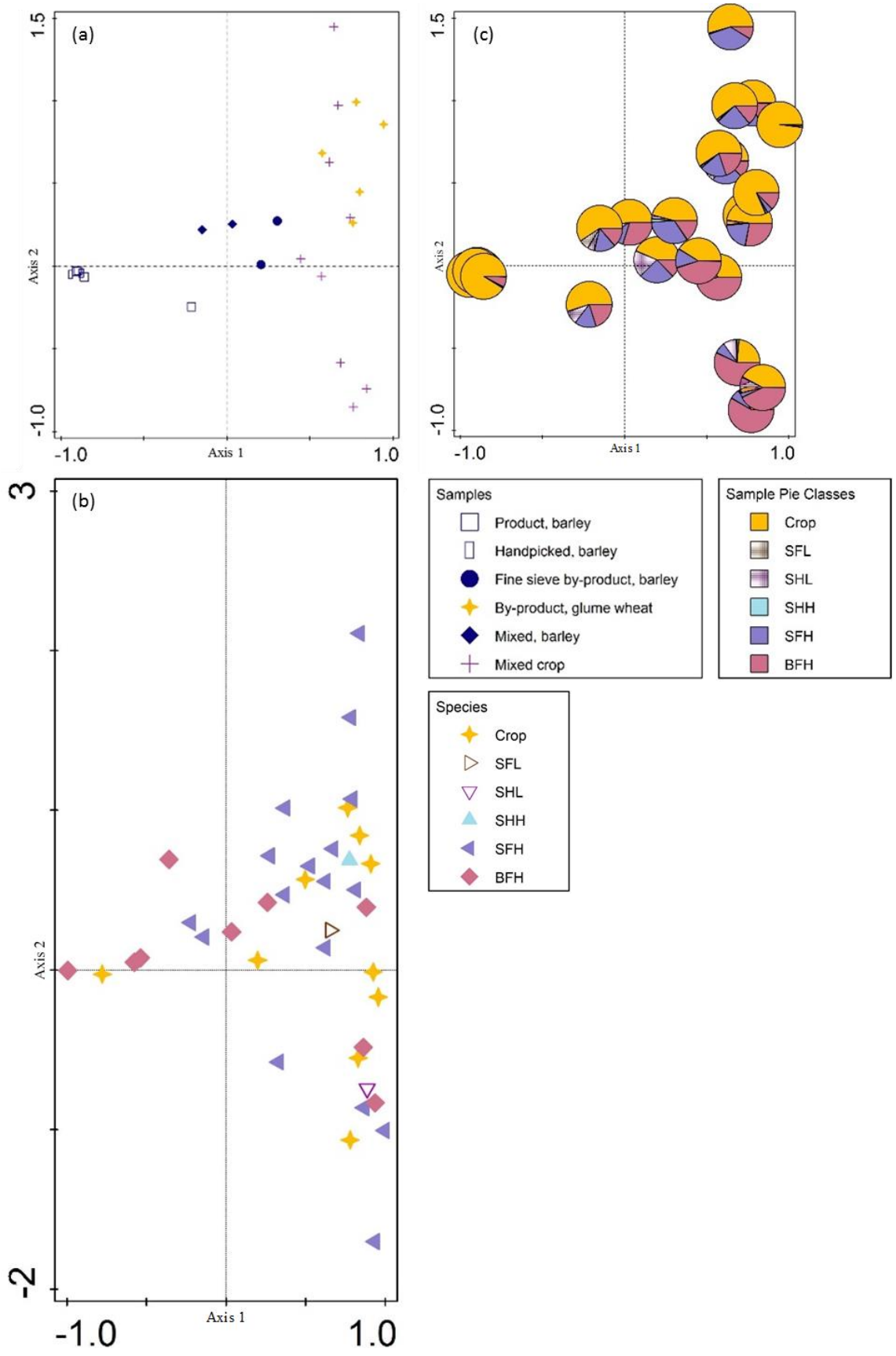


Figure 5.3 Correspondence analysis plot of 24 samples on the basis of 38 taxa (a) with samples coded by crop processing stage and crop group; (b) with taxa coded by weed characteristics (SFL: small-free-light, SHL: small-headed-light, SHH: small-headed-heavy, SFH: small-free-heavy and BFH: big-free-heavy); (c) with samples represented as pie charts illustrating proportions of crop and weed material.

Figure 5.3b shows that the great majority of species are of SFH type, followed by BFH, reflecting their significant relation with material from the dominant late processing stages (Table 3.4). Barley grain at the left end of axis 1 is associated with certain BFH taxa (*Bellevalia* sp., *Galium spurium* and *Vaccaria hispanica*). These species are thus closely associated with barley and its field growing conditions. The neutral positions of *Gypsophila* sp. and *Adonis* spp. (SFH) near the origin mean that they are widely distributed, and/or occur evenly in samples located at both ends of axis 1.

Samples in the upper right part of the plot, characterised by chaff of glume wheat and barley, are associated with a number of SFH taxa and a few of BFH type. It is also notable that *Aegilops* grain and chaff (BFH) occur in both barley product and mixed barley/crop samples. Their occurrence in mixed barley/crop samples can be interpreted as by-product material from hand sorting, mixed with other components (Charles and Bogaard, 2001; cf. van Zeist and Bakker-Heeres, 2014). Glume wheat glume bases are associated with a number of SFH taxa, though it is difficult to distinguish these from others occurring in mixed crop samples. Representation of samples as pie charts samples (Figure 5.3c) shows similarities among samples distributed along axis 2. Moreover, since there are only two barley by-product samples, potential distinctions between arable weed species in barley by-product and those in glume wheat by-product cannot be made. The relatively minor crops – free-threshing wheat and pulses – occur in samples towards the positive end of axis 1, mostly with SFH taxa. *Lolium rigidum*, one of the most abundant and ubiquitous species at Tell Mohammed ‘Arab, occurred especially in mixed crop processing samples.

5.1.2. Consideration of potentially dung-derived material

Four Tell Mohammed ‘Arab samples (i.e. TM2, 34, 47 and 50) out of 27 contain one or two whole sheep/goat dung pellets with some fragments derived from different context types (i.e. pit, ash and courtyard). Following Charles’ (1998) first criterion – the observation of plant material in the

matrix of fragmented dung pellets – the broken dung fragments were closely observed in detail, and whole pellets dissected. The identifiable dung material from Tell Mohamed ‘Arab, however, contained no visible seeds. Thus, while the presence of dung pellets suggests that some dung-derived material may be present in the samples, the low frequency of dung pellets and lack of direct evidence for what they contained means that it is necessary to rely on the other criteria.

Charles’ (1998) second criterion is to assess biological and ecological information on weed/wild taxa in order to ascertain the possibility that certain seed types were brought onto the site via dung rather than with harvested crops. Table 5.8 presents a summary of habitat, fruiting time and the likelihood of being dung-derived by scoring for the Tell Mohammed ‘Arab weed/wild taxa.

At Tell Mohammed ‘Arab, two taxa, *Bolboschoenus glaucus* and *Cyperus* sp., are associated with wetlands while the rest of them belong to dry habitats or to an intermediate dry/wet category. Figure 5.4a shows a correspondence analysis plot with samples coded by crop processing stage and crop group. All weed taxa present in over 10 percent were included in this analysis (Figure 5.4-5.5). It is apparent that potentially dung-related taxa are mainly associated with mixed samples. Use of these categories to code taxon data points in a correspondence analysis of 23 samples and 43 wild/weed taxa (Figure 5.4b and 5.4c) does not reveal clear patterning. It is, however, notable that in Figure 5.4b, which shows the four Tell Mohammed ‘Arab samples containing dung pellets/fragments with taxa, the samples also contain wetland taxa. While a wetland habitat association is not necessarily indicative of dung derivation, an association of wetland taxa and dung has been noted at other sites in semi-arid zones of western Asia, where animals preferentially graze wetland habitats in summer (cf. Bogaard *et al.*, 2013).

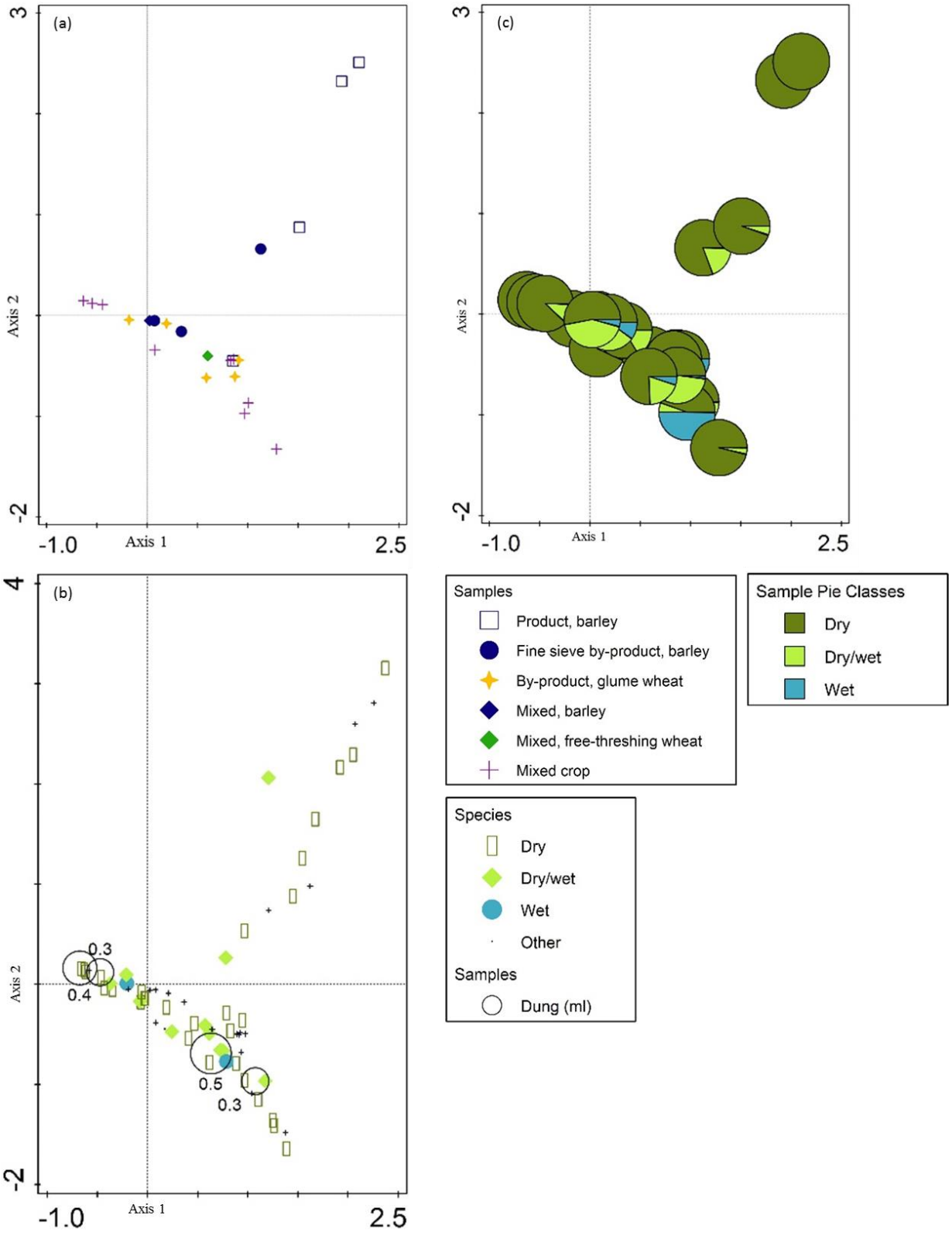


Figure 5.4 Correspondence analysis of 23 samples based on 43 wild/weed taxa showing (a) samples coded by crop processing stage and crop group; (b) dung (ml) containing samples, with taxa coded by habitat wetness; (c) samples represented as pie charts illustrating the proportions of habitat categories.

The fruiting/flowering time (i.e. seasonality) of weed/wild taxa in comparison with cereal harvesting time provides key evidence to distinguish between crop weeds and potentially dung-derived forage taxa. Table 5.7 shows the seasonality of species categorised by the flowering/fruiting periods, based chiefly on *Flora of Iraq* (Guest, 1966; Townsend and Guest, 1974; Townsend, Guest and Omar, 1980; Guest and Townsend, 1980; Guest and Townsend, 1985; Bor and Guest, 1968; Ghazanfar and Edmondson, 2013; Anjani, 2010) followed by '*Notes on plants and plant products with their colloquial names in Iraq*' (Guest, 1933) and *Flora of Turkey* (Davis, 1965-1988; Davis, Miller and Tan, 1988; Güner *et al.*, 2001). The region of Tell Mohammed 'Arab has been typically cultivated with winter cereals such as barley and wheat, sown in October/November and harvested in April to May (-June) (Schnepf, 2004). Today, barley is often harvested before the grain fully develops, for the purpose of fodder use (Hald, 2008) and barley is harvested slightly earlier than wheat (Soppe and Saleh, 2012, p. 9). Five taxa (*Chenopodium* sp., *Heliotropium* sp., *Bolboschoenus glaucus*, *Cyperus* sp. and *Prosopis farcta*) flower and/or fruit mostly or entirely after the harvest and are thus likely to be related to animal dung-derived. Of these *Prosopis farcta* is a typical fodder for cattle and sheep in Iraq, also known as an indicator of whether barley cultivation is productive in the fields (Hanelt *et al.*, 2001). Most taxa were classified as early flowering/fruiting, and were plausibly harvested in fruit as arable weeds. An intermediate class, which continue flowering/fruiting at least until July, were ambiguous since they could be crop weeds and/or dung-derived. Coding of the correspondence analysis plot with these three categories produced a discernible pattern in which late species cluster together with dung-containing samples from the negative end of axis 1 to the lower right of the plot (Figure 5.5a and b). The association of intermediate with late taxa implies that both groups may be dung-derived (Figure 5.5a).

Table 5.7 Seasonality of wild/weed taxa identified at Tell Mohammed 'Arab in relation to cereal harvesting time. Taxa occurring in more than 10 percent of samples were included. (): rarely occurs. E: early, I: intermediate and L: late.

Taxa	Months of flowering/fruiting												Class
	J	F	M	A	M	J	J	A	S	O	N	D	
Androsace maxima			X	X									E
Medicago radiata			X	X	(X)								E
Malva nicaeensis			X	X	(X)								E
Valerianella coronata			X	X	X								E
Medicago polymorpha			X	X	X								E
Medicago sp.			X	X	X								E
Malva sp.			X	X	X								E
Plantago sp.			X	X	X								E
Adonis spp.			X	X	X								E
Valerianella dentata type			X	X	X	(X)							E
Helianthemum sp.			X	X	X	(X)							E
Lepidium sativum			X	X	X	(X)	(X)						E
Phalaris sp.			X	X	X	(X)	(X)	(X)					E
Avena sp.			X	X	X	X							E
Bromus spp.			X	X	X	X							E
Rumex sp.			X	X	X	X							E
Centaurea sp.			X	X	X	X	X						E
Hordeum spontaneum			X	X	X	X	X						E
Lepidium draba			X	X	X	X	X	(X)					E
Bellevalia sp.			(X)	X	X	(X)							E
Coronilla scorpioides			(X)	X	X	(X)							E
Scorpiurus muricatus			(X)	X	X	(X)							E
Aegilops, glume bases			(X)	X	X	X							E
Trigonella astroites				X	X								E
Aegilops tauschii, glume bases				X	X								E
Bupleurum cf. *intermedium*				X	X								E
Cephalaria sp.				X	X	X							E
Silene dichotoma type				X	X	X							E
Vaccaria hispanica				X	X	X							E
Hordeum murinum type				X	X	X							E
Galium spurium				X	X	X							E
Ornithogalum sp.				X	X	X	(X)						E
Leguminosae, small seeded			X	X	X	X	X	X					I
Lolium rigidum				X	X	X	X						I
Ajuga/Teucrium sp.				X	X	X	X						I
Ziziphora sp.				X	X	X	X						I
Gypsophila sp.				X	X	X	X						I
Thymelaea passerine/mesopotamica				X	X	X	X	(X)					I
Taeniatherum caput-medusae					X	X							I
Triticum boeoticum					X	X							I
Bolboschoenus glaucus				(X)	X	X	X	X	(X)	(X)	(X)		L
Cyperus sp.				(X)	X	X	X	X	X	X	X		L
Chenopodium sp.					X	X	X	X					L
Heliotropium sp.					X	X	X	X	X	X			L
Prosopis farcta	X	X					X	X	X	X	X	X	L

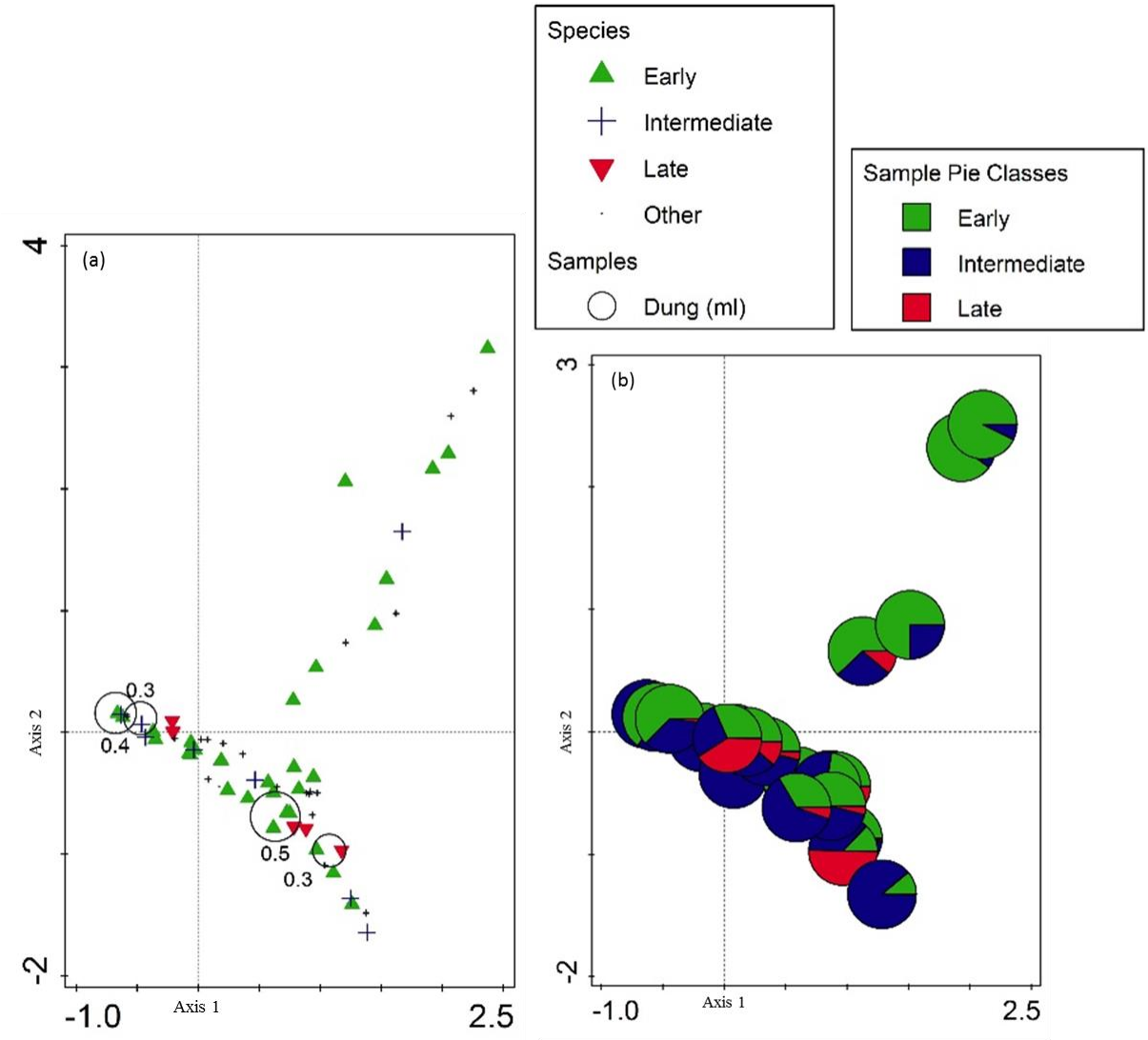


Figure 5.5 Correspondence analysis plot of 23 samples on the bases of 43 taxa showing (a) dung (ml) containing samples, with taxa coded by seasonality; (b) samples as pie charts illustrating the proportions of seasonality categories.

The likelihood of seeds deriving from animal dung was also explored by coding each taxon according to composite scores based on the criteria considered above. Table 5.8 summarises these scores on a scale of 1 to 3, the ones highly likely to be dung species obtaining the highest score of 3. Both crop and weed taxa were included in this analysis which present in 10 percent or more of samples. The taxa scored 3 are *Medicago* sp., small-seeded *Leguminosae*, *Bolboschoenus glaucus*, *Cyperus* sp. and *Prosopis farcta.* Figure 5.6b and c show a correspondence analysis of 25 samples and 62 species, which include crop categories, with taxa coded by dung scores and with samples represented as pie charts illustrating the proportions of scores, respectively.

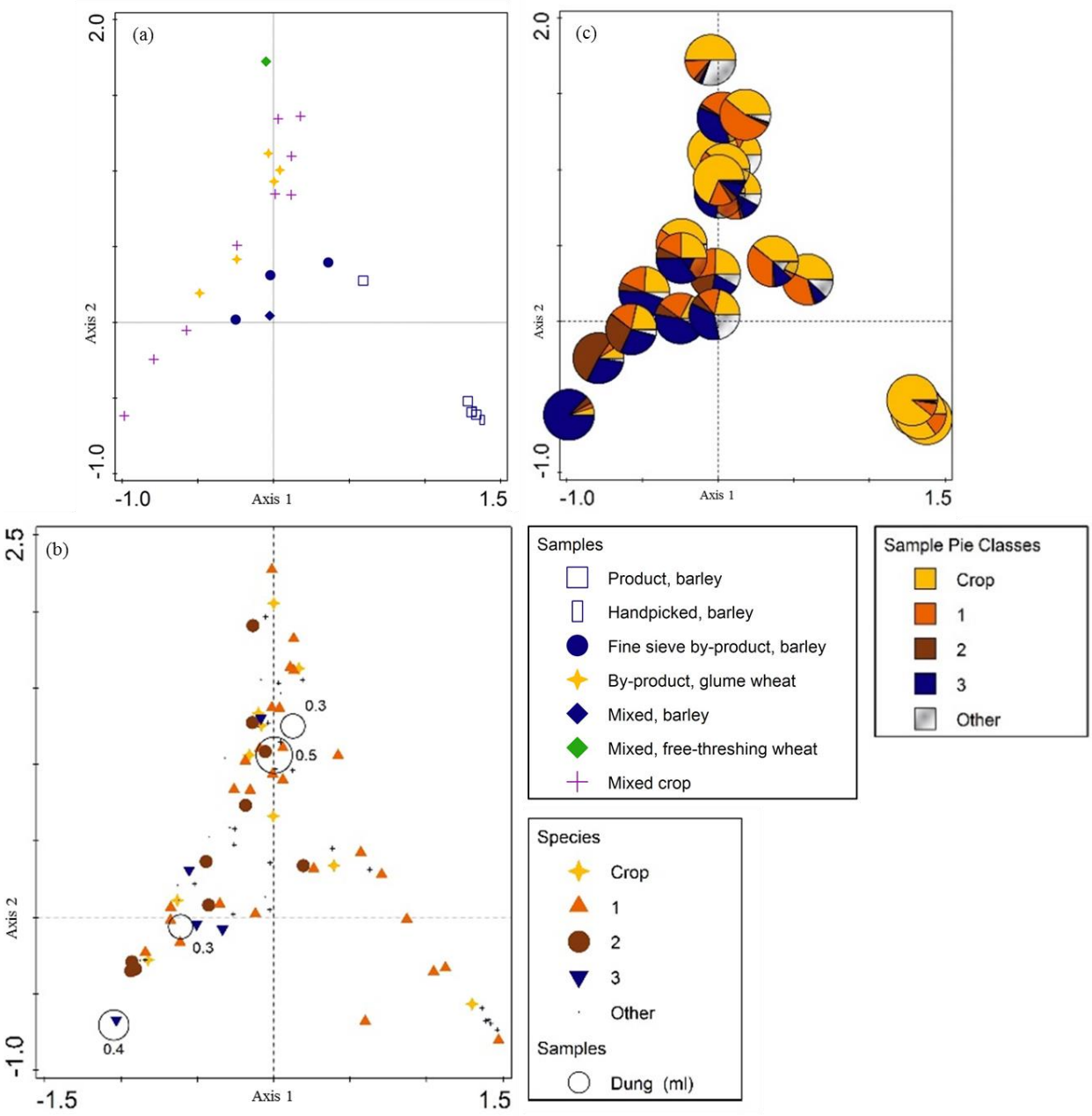


Figure 5.6 Correspondence analysis plot of 25 samples and 62 taxa showing (a) samples coded by crop processing stage and crop group; (b) dung (ml) containing samples, with taxa coded by dung score; (c) samples represented as pie charts illustrating the proportions of scores.

In Figure 5.6b, all taxa with scores of 3 are situated toward the negative end of axis 1, as are samples containing these taxa in Figure 5.6c. This pattern coincides with mixed samples in Figure 5.6a, indicating that it is mixed samples, particularly, that contain dung-related species. It is noticeable that all taxa with scores of 2, except *Coronilla scorpioides*, are associated with taxa scoring 3 (Figure 5.6b and c). This suggests that, at least some of the taxa with scores of 2 are

likely dung-derived. The fact that *Coronilla scorpioides* occurred only in samples represented as barley fine sieve by-product and barley product, never appearing in any mixed samples at Tell Mohammed ʻArab assemblage (Figure 5.6a), explains the reason for the exceptional position of *Coronilla scorpioides* towards the positive end of axis 1. The large number of species scored 1 were plausibly harvested with cereal material as arable weeds. These taxa are generally distributed (Figure 5.6a, b and c). Most of them are likely to originally stem from crop processing stages.

Table 5.8 summarises the classification of dung status based on these results. Overall, 3s (*Medicago* sp., *Leguminosae*, *Bolboschoenus glaucus*, *Cyperus* sp. and *Prosopis farcta*) seem to be dung-derived taxa. In particular, the hard-coatedness of *Bolboschoenus glaucus*, *Cyperus* sp. and *Prosopis farcta*, and small size of small-seeded *Leguminosae*, *Bolboschoenus glaucus* and *Cyperus* sp. support the likelihood of their dung derivation, since the hardness and small size of seeds enhance the survivability of seeds that passed through animal guts (Wallace and Charles, 2013). Nevertheless, caution is warranted in the interpretation of *Leguminosae* as purely dung-derived, since this represents an extensive family including several hundreds of species within Iraq including likely crop weeds. The taxa scored as 2s (*Medicago polymorpha*, *Medicago radiata*, *Scorpiurus muricatus*, *Malva* sp., *Rumex* sp., *Trigonella astroites*, *Ajuga/Teucrium* sp., *Ziziphora* sp. and *Heliotropium* sp.) appear to be closely related to dung-derived taxa. Of these, *Rumex* sp., *Ziziphora* sp., *Ajuga/Teucrium* sp. and *Heliotropium* sp. are hard-coated and *Trigonella astroites*, *Ajuga/Teucrium* sp., *Ziziphora* sp. and *Heliotropium* sp. are small in size, raising the possibility of dung-derived seeds.

Table 5.8 Summary of habitat, flowering/fruiting time and dung scores for wild/weed taxa in the Tell Mohammed 'Arab assemblage. Taxa occurring in more than 10 percent of samples were included.

Species	**Habitat**	**Seasonality**	**Dungness**
Androsace maxima	Dry	Early	1
Bellevalia sp.	Dry	Early	1
Valerianella coronata	Dry	Early	1
Valerianella dentata Type	Dry	Early	1
Helianthemum sp.	Dry	Early	1
Lepidium sativum	Dry	Early	1
Phalaris sp.	Wet/dry	Early	1
Plantago sp.	Wet/dry	Early	1
Adonis spp.	Dry	Early	1
Centaurea sp.	Dry	Early	1
Lepidium draba	Wet/dry	Early	1
Aegilops sp.	Dry	Early	1
Bromus spp.	Dry	Early	1
Aegilops (glume bases)	Dry	Early	1
Hordeum spontaneum	Dry	Early	1
Avena sp.	Dry	Early	1
Cephalaria sp.	Dry	Early	1
Vaccaria hispanica	Dry	Early	1
Silene dichotoma Type	Dry	Early	1
Hordeum murinum type	Dry	Early	1
Galium spurium	Dry	Early	1
Ornithogalum sp.	Dry	Early	1
Lolium rigidum	Dry	Intermediate	1
Gypsophila sp.	Dry	Intermediate	1
Thymelaea passerine/mesopotamica	Dry	Intermediate	1
Taeniatherum caput-medusae	Dry	Intermediate	1
Triticum boeoticum	Dry	Intermediate	1
Chenopodium sp.	Wet/dry	Late	1
Medicago radiata	Dry	Early	2
Coronilla scorpioides	Wet/dry	Early	2
Scorpiurus muricatus	Wet/dry	Early	2
Medicago polymorpha	Wet/dry	Early	2
Malva sp.	Dry	Early	2
Rumex sp.	Wet/dry	Early	2
Trigonella astroites	Dry	Early	2
Ajuga/Teucrium sp.	Dry	Intermediate	2
Ziziphora sp.	Dry	Intermediate	2
Heliotropium sp.	Dry	Late	2
Medicago sp.	Wet/dry	Early	3
Leguminosae, small seeded	Dry	Intermediate	3
Bolboschoenus glaucus	Wet	Late	3
Cyperus sp.	Wet	Late	3
Prosopis farcta	Wet/dry	Late	3

With regard to Charles' (1998) third criterion, Figure 5.7 illustrates the discriminant analysis plot of the 25 Tell Mohammed 'Arab samples entered as ungrouped (a) and as a separate group (b), in comparison to Jones' (1984; 1987) ethnobotanical processing groups. Hand-collected samples TM 7 and 11 were excluded. This pattern in Figure 5.7b remains more or less the same as in Figure 5.7a.

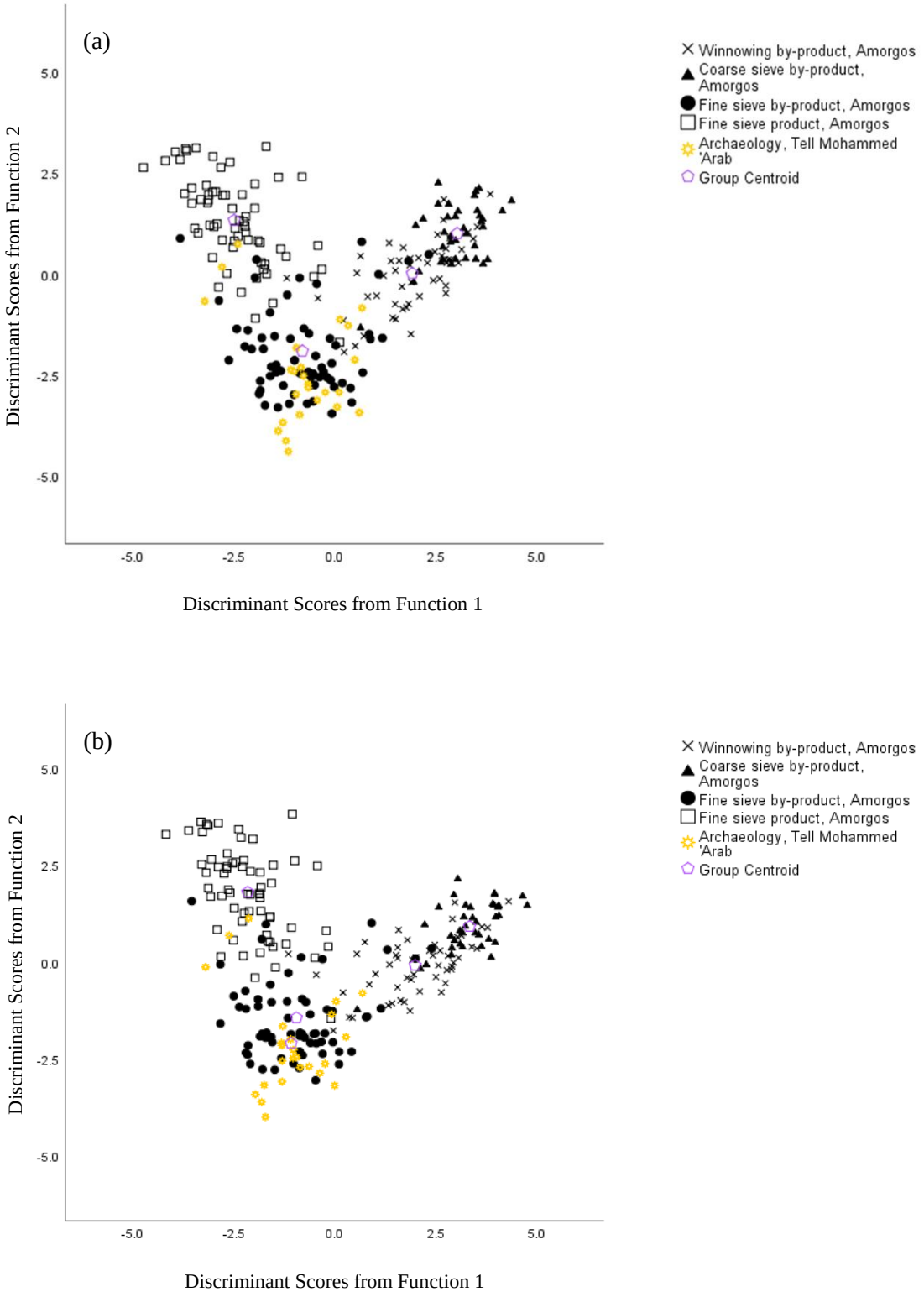


Figure 5.7 Discriminant analysis plot of the 25 Tell Mohammed ‘Arab samples that are (a) entered as ungrouped in the classification stage of the discriminant analysis and (b) entered as a separate group in the discrimination phase. Two hand-collected samples, TM7 and 11, were excluded.

Table 5.9 shows the classification of the 25 Tell Mohammed ‘Arab samples in these two discriminant analyses. In the five-group version, 21 samples were reclassified into the archaeological group instead of with the crop processing groups (Table 5.9). The fact that 84 percent of Tell Mohammed’ Arab samples were reclassified with their own group implies that dung-derived material reduced their resemblance to canonical crop processing stages. The reason there is no visible difference between Figure 5.7a and 5.7b, despite the results of the predicted group membership in Table 5.9b (i.e. 84 percent the five-group version), may have been triggered by the third/fourth axis, which is not shown in this study. However, the discriminant analysis plots with axis 3 and 4 revealed limited deviation between the two types of analysis.

Table 5.9 Summarised sample classifications based on two versions of the weed-based discriminant analysis, with (a) the archaeobotanical samples entered as ungrouped in the classification phase and (b) as a separate group in the discrimination phase.

Predicted Group Membership						
		Winnowing by-product	Coarse sieve by-product	Fine sieve by-product	Fine sieve product	Group 5
a	Count	2	0	20	3	N/A
	%	8.0	0.0	80.0	12.0	N/A
b	Count	1	0	0	3	21
	%	4.0	0.0	0.0	12.0	84.0

Overall, it appears that at least some of the Tell Mohammed ‘Arab samples contain wild taxa that are likely derived from the burning of animal dung, but at a modest level in quantitative terms.

With regard to Charles’ (1998) fourth criterion, at Tell Mohammed ‘Arab 11 samples were defined as belonging to the mixed crop group. Table 5.10 summaries the proportions of crop components and the ratio of grain to chaff in the Tell Mohammed ‘Arab mixed crop group samples. The proportions of key cultigens directly highlight that the 11 Tell Mohammed ‘Arab mixed crop samples are dominated by two-row hulled barley grain and glume wheat (both grain and glume bases), accounting for at least 74 percent up to fully 100 percent, though TM2 is an exception containing no chaff material. Conversely, free-threshing wheat and pulses are present consistently at low levels or absent. In terms of the ratio of grain to chaff expected in unprocessed cereals, 1:1

would be expected for two-row hulled barley. The ratio of barley grain in Tell Mohammed ‘Arab mixed group samples always exceeds that of rachis, seemingly resembling more or less cleaned product. As for (one-grained) einkorn and (two-grained) emmer, 1:2 and 1:1 are the expected ratios of grain to glume bases in unprocessed material, respectively. In this assemblage glume wheat grain was mostly of two-grained type, with one-grain glume wheat grain hardly identified (Appendix I) and therefore the application of 1:1 is more plausible for the Tell Mohammed ‘Arab samples. Table 5.10 indicates that glume wheat grain and glume bases approximate the expected unprocessed ratio for two-grained spikelets of 1:1. However, at Tell Mohammed ‘Arab, glume wheat glume bases are poorly preserved. This poor preservation of glume bases cannot be linked with animal digestion since any survival of chaff through small ruminant digestion is rare (Wallace and Charles, 2013).

Table 5.10 Proportions of crop components and the ratio of grain to chaff in the Tell Mohammed ‘Arab mixed crop group samples. *less than 30 items in total.

Crop group	Percentage								Grain: chaff ratio			Sample
	% Two-row hulled barley grain	% Two-row hulled barley rachis	% Free-threshing wheat grain	% Free-threshing wheat internodes	% Glume wheat grain	% Glume wheat glume bases	% Lentil	% Grass pea	Two-row hulled barley	Free-threshing wheat	Glume wheat	
Mixed crop	25	1	6	1	17	49	1	0	35:1	6:1	1:3	TM35
Mixed crop	22	7	9	1	19	38	2	2	3:1	11:1	1:2	TM36
Mixed crop	26	13	4	2	18	36	0	0	2:1	2:1	1:2	TM47
Mixed crop	25	0	5	0	39	30	0	1	69:1	27:0	1:1	TM43
Mixed crop	30	3	8	1	24	30	4	0	11:1	10:1	1:1	TM34
Mixed crop	38	6	0	3	28	25	0	0	6:1	0:1	1:1	TM3
Mixed crop	27	3	12	3	33	21	0	0	9:1	4:1	2:1	TM54
Mixed crop	43	0	21	5	19	12	0	0	18:0	5:0	2:1	TM42
Mixed crop	56	0	5	0	27	0	5	7	23:0	2:0	11:0	TM2
Mixed crop	50	0	0	0	0	50	0	0	6:0	0:0	0:6	TM41*
Mixed crop	52	10	0	0	24	14	0	0	6:1	0:0	2:1	TM30*

Overall, the admixture of two crop species and parts associated with different crop processing activities is clearly observable in the mixed crop group. Their co-occurrence in most mixed crop samples could reflect a deliberate mixture for a particular purpose such as animal fodder use or fuel, or possibly for dung cake preparation, if not daily mixing as routine discard.

5.2. Tell Atchana

5.2.1. Crop processing of single crop groups

5.2.1.1. Crop-based analysis

Two crop groups were identified in the Tell Atchana assemblage: free-threshing wheat and free-threshing cereal (section 4.2). The samples were classified into probable crop processing stages by examining proportions of cereal grain and rachis internodes and the ratio of cereal grain to rachis (Table 5.11), and by comparing this with the ethnobotanical data from Amorgos (Table 5.1). At Tell Atchana, free-threshing wheat grain is generally far more abundant than rachis in all of the samples, with ratios varying from just over 1:1 to 894:0. Moreover, ratios for free-threshing wheat indicate either a complete absence of rachis or very few rachis items in more than half of the samples. Two-row hulled barley material was also dominated by grain, although the range of grain to rachis ratios was narrower, from 0 and 65:1. The comparison to Amorgos data (Table 5.1) leads to the inference that all samples derive from late processing stages (Table 5.11). As to the free-threshing wheat group, one definite product sample, six intermediate fine sieve by-product/product samples and five fine sieve by-product samples were identified. Amongst the free threshing cereal group samples there were ten intermediate fine sieve by-product/product samples and six fine sieve by-product samples. Given the ratios of the two crop varieties in unprocessed ears, it can be inferred that the majority of samples consist of fine-sieve by-products and/or cleaned products.

Table 5.11 The classification of free-threshing wheat and free-threshing cereal crop group samples by crop processing stage based on proportions of cereal grain and rachis and ratios of cereal grain to rachis. Samples containing less than 30 crop items were excluded. F = fine sieve by-product and P = product. **The figure of two-row barley grain was multiplied by three.

Classification	Crop group	Percentage						Grain: rachis ratio			Sample
		% Free-threshing wheat grain	% Free-threshing wheat internodes	% Two-row hulled barley grain	% Two-row hulled barley rachis	% Free-threshing cereal grain**	% Free-threshing cereal chaff	Free-threshing wheat grain: rachis	Two-row hulled barley grain: rachis	Free-threshing cereal grain**: rachis	
F	Free-threshing wheat	67	33	0	0	67	33	2:1	0:0	2:1	TA2012.18
F	Free-threshing wheat	72	25	0	3	72	28	3:1	0:3	3:1	TA2012.25
F	Free-threshing wheat	66	20	2	12	70	30	3:1	1:6	2:1	TA2010.9
F	Free-threshing wheat	63	22	5	10	71	29	3:1	1:2	2:1	TA2010.10
F	Free-threshing wheat	53	24	3	20	58	42	2:1	1:7	1:1	TA2010.6
F	Free-threshing cereal	77	0	4	19	82	18	40:0	1:5	5:1	TA2010.3
F	Free-threshing cereal	74	9	15	1	92	8	8:1	12:1	11:1	TA2011.92
F	Free-threshing cereal	64	8	20	8	88	12	8:1	8:1	8:1	TA2012.15
F	Free-threshing cereal	69	11	16	4	88	12	6:1	6:1	8:1	TA2011.39
F	Free-threshing cereal	40	25	4	31	48	52	2:1	1:7	1:1	TA2010.14
F	Free-threshing cereal	41	32	4	23	49	51	1:1	1:5	1:1	TA2010.11
F/P	Free-threshing wheat	100	0	0	0	100	0	44:0	0:0	44:0	TA2012.4
F/P	Free-threshing wheat	97	0	3	0	100	0	37:0	1:0	38:0	TA2006.72
F/P	Free-threshing wheat	89	0	11	0	100	0	34:0	4:0	38:0	TA2011.45
F/P	Free-threshing wheat	100	0	0	0	100	0	33:0	0:0	33:0	TA2011.22
F/P	Free-threshing wheat	88	0	11	1	99	1	91:0	11:1	102:1	TA2011.314
F/P	Free-threshing wheat	96	0	4	0	100	0	22:0	1:0	23:0	TA2010.12
F/P	Free-threshing cereal	86	2	12	0	98	2	35:1	28:0	49:1	TA2011.91
F/P	Free-threshing cereal	91	0	6	3	97	3	58:0	2:1	35:1	TA2012.22
F/P	Free-threshing cereal	85	3	7	6	93	7	34:1	1:1	13:1	TA2010.4
F/P	Free-threshing cereal	88	3	5	5	93	7	35:1	1:1	14:1	TA2010.8
F/P	Free-threshing cereal	88	4	7	1	96	4	24:1	6:1	22:1	TA2011.30
F/P	Free-threshing cereal	80	0	12	8	94	6	20:0	2:1	15:1	TA2012.17
F/P	Free-threshing cereal	81	0	16	4	97	3	46:0	5:1	37:1	TA2011.320
F/P	Free-threshing cereal	63	0	38	0	100	0	35:0	21:0	98:0	TA2012.10
F/P	Free-threshing cereal	57	1	40	2	99	1	65:1	65:1	68:1	TA2011.32
F/P	Free-threshing cereal	52	1	47	0	99	1	47:1	43:0	176:1	TA2011.28
P	Free-threshing wheat	99	0	1	0	100	0	894:0	8:0	902:0	TA2011.332

5.2.1.2. Crop- and weed-based analysis

Fourteen free-threshing wheat group samples and 16 free-threshing cereal group samples were included in the crop- and weed-based crop processing analysis, so excluding one pure olive sample and 19 mixed crop group samples. Figure 5.8 shows that the Tell Atchana samples are dominated by grain and weed seeds while rachis internodes are absent in the majority of samples. Grain-rich samples (TA2011.332, 2011.32, 2012.10 and 2011.28) are highly likely to be fine sieve products. Samples distributed between the grain and weed vertices resemble fine sieve by-product, but some of these samples include an appreciable proportion of rachis, implying some mixing with early stage by-product. The location of TA2012.18 is rather equivocal, occurring in the middle of the triangle between the Amorgos coarse sieve by-product and fine sieve by-product groups, and this sample seems to represent mixed stages. However, the total number of crop items in this sample is small, with 34 (see Table 4.6). Free-threshing wheat group and free-threshing cereal group are not clearly distinguished in Figure 5.8, suggesting that barley could have been at least partially grown, harvested and processed with free-threshing wheat together from the same fields.

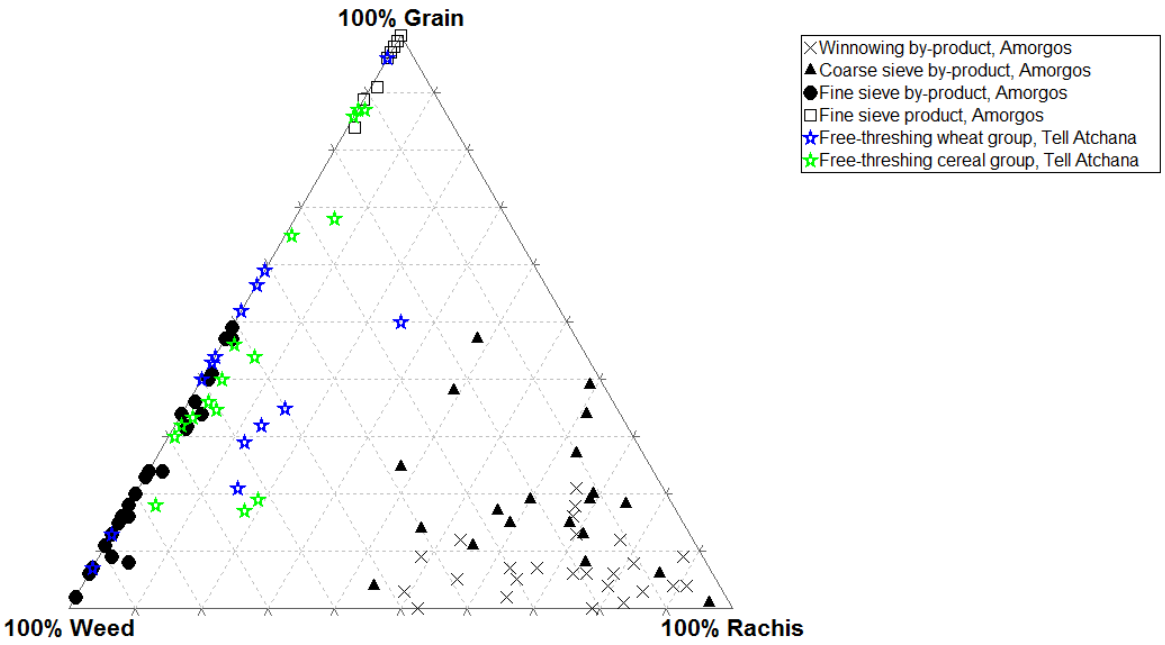


Figure 5.8 Triangular plot of the 30 Tell Atchana free-threshing wheat and free-threshing cereal group samples based on the relative proportions of grain, rachis and weed in comparison to Jones' (1990) Amorgos data.

Table 5.12 summarises the resulting classification by crop processing stage based on the proportions of grain, rachis and weed in the 30 Tell Atchana free-threshing wheat and free-threshing cereal group samples. This analysis identifies one product sample, 12 fine sieve by-product samples and one mixed stage sample in the free-threshing wheat group, and three product samples, two fine sieve by-product/product samples and 11 fine sieve by-product samples for the free-threshing cereal group. On the basis of this comparison, Tell Atchana samples tend to represent the late stages processing, as well as fine sieve by-product samples with an admixture of early stage by-product.

Table 5.12 The classification of 30 Tell Atchana free-threshing wheat and free-threshing cereal group samples by crop processing stage based on the proportions of grain, rachis and weed seeds.

Classification	Crop group	Sample
Fine sieve by-product	Free-threshing wheat	TA2006.72
Fine sieve by-product	Free-threshing wheat	TA2010.12
Fine sieve by-product	Free-threshing wheat	TA2011.22
Fine sieve by-product	Free-threshing wheat	TA2011.45
Fine sieve by-product	Free-threshing wheat	TA2011.314
Fine sieve by-product	Free-threshing wheat	TA2011.330
Fine sieve by-product	Free-threshing wheat	TA2012.4
Fine sieve by-product	Free-threshing wheat	TA2012.5
Fine sieve by-product?	Free-threshing wheat	TA2010.6
Fine sieve by-product?	Free-threshing wheat	TA2010.9
Fine sieve by-product?	Free-threshing wheat	TA2010.10
Fine sieve by-product?	Free-threshing wheat	TA2012.25
Fine sieve by-product	Free-threshing cereal	TA2010.3
Fine sieve by-product	Free-threshing cereal	TA2010.4
Fine sieve by-product	Free-threshing cereal	TA2010.8
Fine sieve by-product	Free-threshing cereal	TA2011.30
Fine sieve by-product	Free-threshing cereal	TA2011.39
Fine sieve by-product	Free-threshing cereal	TA2011.320
Fine sieve by-product	Free-threshing cereal	TA2012.15
Fine sieve by-product	Free-threshing cereal	TA2012.17
Fine sieve by-product	Free-threshing cereal	TA2012.22
Fine sieve by-product?	Free-threshing cereal	TA2010.11
Fine sieve by-product?	Free-threshing cereal	TA2010.14
Fine sieve by-product/product	Free-threshing cereal	TA2011.91
Fine sieve by-product/product	Free-threshing cereal	TA2011.92
Fine sieve product	Free-threshing wheat	TA2011.332
Fine sieve product	Free-threshing cereal	TA2011.28
Fine sieve product	Free-threshing cereal	TA2011.32
Fine sieve product	Free-threshing cereal	TA2012.10
Mixed stages	Free-threshing wheat	TA2012.18

5.2.1.3. Weed-based analysis

The resulting discriminant analysis plot of the 29 Tell Atchana free-threshing wheat and free-threshing cereal samples in comparison to Jones' (1984; 1987) Amorgos data is shown in Figure 5.9 and Table 5.13 lists the classification of samples along with the probability. TA2012.18 was excluded in this analysis for less than ten weed seeds. It was evident that the majority of Tell

Atchana samples were placed in or near the Amorgos fine sieve by-product or fine sieve product groups.

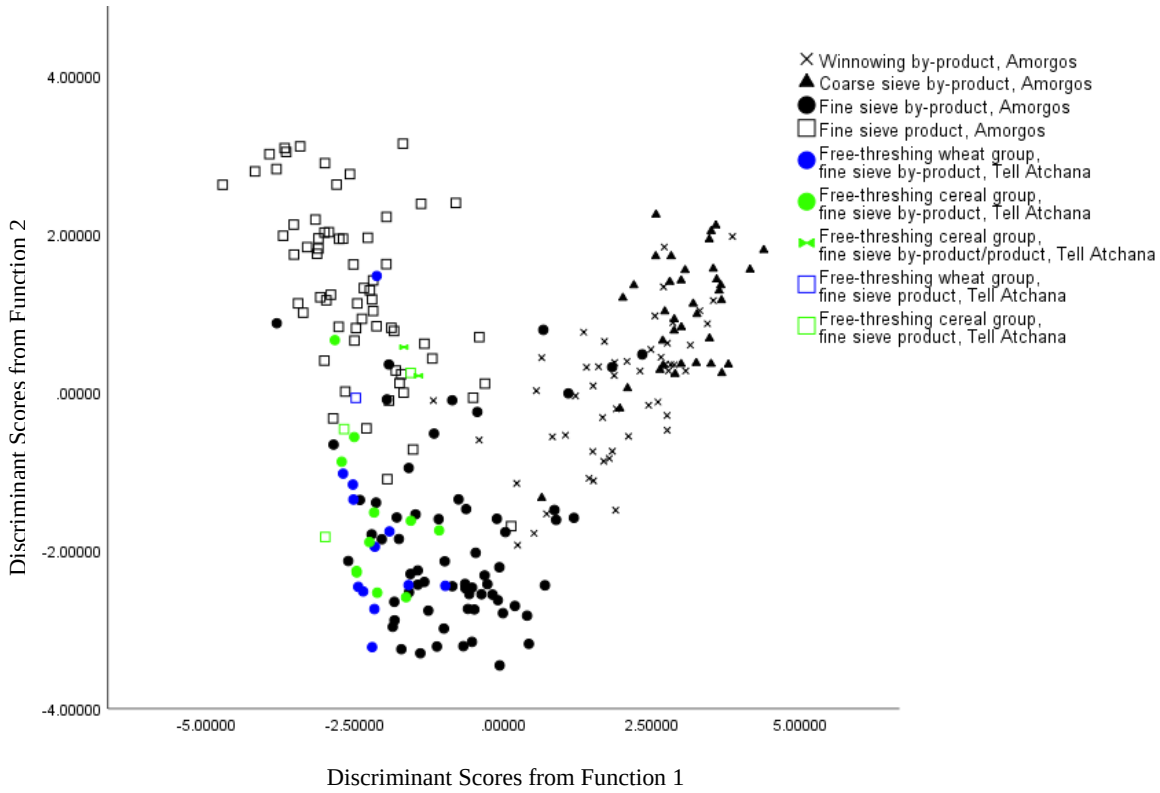


Figure 5.9 Discriminant analysis plot of the 29 Tell Atchana free-threshing wheat and free-threshing cereal group samples in comparison to Jones' (1984; 1987) Amorgos data.

This pattern is clearly consistent with the results of crop-based and crop- and weed-based analyses (above). The probabilities of the classifications were high in all samples except four (Table 5.13). Of the samples classified as fine sieve by-product, TA2011.22 and TA2011.314 had low probabilities and their second highest classification was fine sieve product (Table 5.13). In the previous two sections, these samples were classified as fine sieve by-product/product in crop-based crop processing analysis on account of being rich in grain and poor in rachis (Table 5.11), but they were classified as solely fine sieve by-product in crop- and weed-based analysis due to higher proportions of a weed component (Figure 5.8). Despite the low probabilities, both samples still seem to represent fine sieve by-product.

Table 5.13 The classification of free-threshing wheat and free-threshing cereal group samples by crop processing stage based on physical weed seed types.

Classification	***P*-value**	**Crop group**	**Sample**	**Second Highest Group**	
				Classification	***P*-value**
Fine sieve by-product	1.000	Free-threshing wheat	TA2011.330	Fine sieve product	0.000
Fine sieve by-product	0.999	Free-threshing wheat	TA2012.25	Fine sieve product	0.001
Fine sieve by-product	0.998	Free-threshing wheat	TA2010.6	Fine sieve product	0.001
Fine sieve by-product	0.998	Free-threshing wheat	TA2012.4	Winnowing by-product	0.002
Fine sieve by-product	0.996	Free-threshing wheat	TA2010.9	Fine sieve product	0.004
Fine sieve by-product	0.994	Free-threshing wheat	TA2010.10	Fine sieve product	0.006
Fine sieve by-product	0.985	Free-threshing wheat	TA2010.12	Fine sieve product	0.015
Fine sieve by-product	0.971	Free-threshing wheat	TA2012.5	Fine sieve product	0.026
Fine sieve by-product	0.856	Free-threshing wheat	TA2011.45	Fine sieve product	0.144
Fine sieve by-product	0.762	Free-threshing wheat	TA2011.22	Fine sieve product	0.238
Fine sieve by-product	0.607	Free-threshing wheat	TA2011.314	Fine sieve product	0.392
Fine sieve by-product	0.998	Free-threshing cereal	TA2010.14	Fine sieve product	0.001
Fine sieve by-product	0.997	Free-threshing cereal	TA2010.4	Fine sieve product	0.003
Fine sieve by-product	0.991	Free-threshing cereal	TA2010.11	Winnowing by-product	0.005
Fine sieve by-product	0.990	Free-threshing cereal	TA2012.22	Fine sieve product	0.010
Fine sieve by-product	0.989	Free-threshing cereal	TA2012.15	Fine sieve product	0.011
Fine sieve by-product	0.978	Free-threshing cereal	TA2012.17	Fine sieve product	0.021
Fine sieve by-product	0.959	Free-threshing cereal	TA2010.8	Fine sieve product	0.025
Fine sieve by-product	0.954	Free-threshing cereal	TA2010.3	Fine sieve product	0.045
Fine sieve by-product	0.922	Free-threshing cereal	TA2011.32	Fine sieve product	0.078
Fine sieve product	0.999	Free-threshing wheat	TA2006.72	Fine sieve by-product	0.001
Fine sieve product	0.904	Free-threshing wheat	TA2011.332	Fine sieve by-product	0.096
Fine sieve product	0.996	Free-threshing cereal	TA2011.39	Fine sieve by-product	0.004
Fine sieve product	0.958	Free-threshing cereal	TA2011.92	Fine sieve by-product	0.027
Fine sieve product	0.863	Free-threshing cereal	TA2012.10	Fine sieve by-product	0.129
Fine sieve product	0.818	Free-threshing cereal	TA2011.28	Fine sieve by-product	0.182
Fine sieve product	0.817	Free-threshing cereal	TA2011.91	Fine sieve by-product	0.167
Fine sieve product	0.736	Free-threshing cereal	TA2011.30	Fine sieve by-product	0.264
Fine sieve product	0.554	Free-threshing cereal	TA2011.320	Fine sieve by-product	0.446

On the other hand, the other two low probability samples, TA2011.30 and 2011.320 (0.74 and 0.55, respectively), were classified as fine sieve products and the next highest classification was as fine sieve by-product. They were again classified as fine sieve by-product/product stages in the crop-based crop processing analysis (Table 5.11). In the crop- and weed-based analysis both were classified as fine sieve by-products (Figure 5.8) since they contain significantly high percentages of weed. Together with the low probabilities, they are highly likely to contain fine sieve by-product material. The primary reason TA2011.30 and 2011.320 were identified as products in the discriminant analysis was the occurrence of *Lolium temulentum*. They could represent the mixing of fine sieve and hand sorting by-products.

5.2.1.4. Comparison of the results of different approaches

Table 5.14 summarises final classification of Tell Atchana samples by three approaches, and it is apparent that fine sieve by-products dominate the Tell Atchana assemblage. Except for one free-threshing wheat product sample and five free-threshing cereal product samples, the rest of the 24 Tell Atchana samples are associated with fine sieve by-products.

Table 5.14 Summary of the final classification of Tell Atchana samples by crop processing stage. FB = fine sieve by-product, P = product and M = mixed stages.

Classification				**Crop group**	**Sample**
Final	**Crop-based**	**Crop- + weed-based**	**Weed-based**		
Fine sieve by-product	FB/P	FB	P	Free-threshing wheat	TA2006.72
Fine sieve by-product	FB	FB	FB	Free-threshing wheat	TA2010.6
Fine sieve by-product	FB	FB	FB	Free-threshing wheat	TA2010.9
Fine sieve by-product	FB	FB	FB	Free-threshing wheat	TA2010.10
Fine sieve by-product	FB/P	FB	FB	Free-threshing wheat	TA2010.12
Fine sieve by-product	FB/P	FB	FB	Free-threshing wheat	TA2011.22
Fine sieve by-product	FB/P	FB	FB	Free-threshing wheat	TA2011.45
Fine sieve by-product	FB/P	FB	FB	Free-threshing wheat	TA2011.314
Fine sieve by-product	N/A	FB	FB	Free-threshing wheat	TA2011.330
Fine sieve by-product	FB/P	FB	FB	Free-threshing wheat	TA2012.4
Fine sieve by-product	N/A	FB	FB	Free-threshing wheat	TA2012.5
Fine sieve by-product	FB	M	N/A	Free-threshing wheat	TA2012.18
Fine sieve by-product	FB	FB	FB	Free-threshing wheat	TA2012.25
Fine sieve by-product	FB	FB	FB	Free-threshing cereal	TA2010.3
Fine sieve by-product	FB/P	FB	FB	Free-threshing cereal	TA2010.4
Fine sieve by-product	FB/P	FB	FB	Free-threshing cereal	TA2010.8
Fine sieve by-product	FB	FB	FB	Free-threshing cereal	TA2010.11
Fine sieve by-product	FB	FB	FB	Free-threshing cereal	TA2010.14
Fine sieve by-product	FB/P	FB	P	Free-threshing cereal	TA2011.30
Fine sieve by-product	FB	FB	P	Free-threshing cereal	TA2011.39
Fine sieve by-product	FB/P	FB	P	Free-threshing cereal	TA2011.320
Fine sieve by-product	FB	FB	FB	Free-threshing cereal	TA2012.15
Fine sieve by-product	FB/P	FB	FB	Free-threshing cereal	TA2012.17
Fine sieve by-product	FB/P	FB	FB	Free-threshing cereal	TA2012.22
Fine sieve product	P	P	P	Free-threshing wheat	TA2011.332
Fine sieve product	FB/P	P	P	Free-threshing cereal	TA2011.28
Fine sieve product	FB/P	P	FB	Free-threshing cereal	TA2011.32
Fine sieve product	FB/P	FB/P	P	Free-threshing cereal	TA2011.91
Fine sieve product	FB	FB/P	P	Free-threshing cereal	TA2011.92
Fine sieve product	FB/P	P	P	Free-threshing cereal	TA2012.10

5.2.1.5. Correspondence analysis of crop processing stages and arable weeds

Based on the final classification of crop processing stages and the six weed characteristics displayed in Table 5.14 and Table 3.4, Tell Atchana samples and species were entered into correspondence analysis in order to explore variation amongst samples and the influence of crop processing further. Taxa scoring 3 in dung index were left out in this analysis since they are unlikely to be crop weeds (see Table 5.16). Also mixed crop samples were excluded.

Figure 5.10a illustrates the correspondence analysis plot of 45 samples on the basis of 50 taxa, with samples coded by crop processing stages and crop groups. Weed species present in at least 6 percent of samples were used in this analysis. This clearly presents that both free-threshing wheat and cereal product samples are separated from those of fine sieve by-product samples, pulling out along the upper right end of the plot. It is intriguing that, among product samples, the free-threshing wheat product sample is distinguished from free-threshing cereal product samples, which occur near free-threshing wheat fine sieve by-product samples. Within by-product samples, a free-threshing wheat fine sieve by-product versus free-threshing cereal by-product separation can be observed: that is, more free-threshing wheat fine sieve by-product samples tend to be towards the product sector in the upper right whereas free-threshing cereal fine sieve by-product samples are radially distributed from the origin with more the samples occurring in the left hand of the plot. Meanwhile, mixed crop group tend to spread toward the bottom of the third axis.

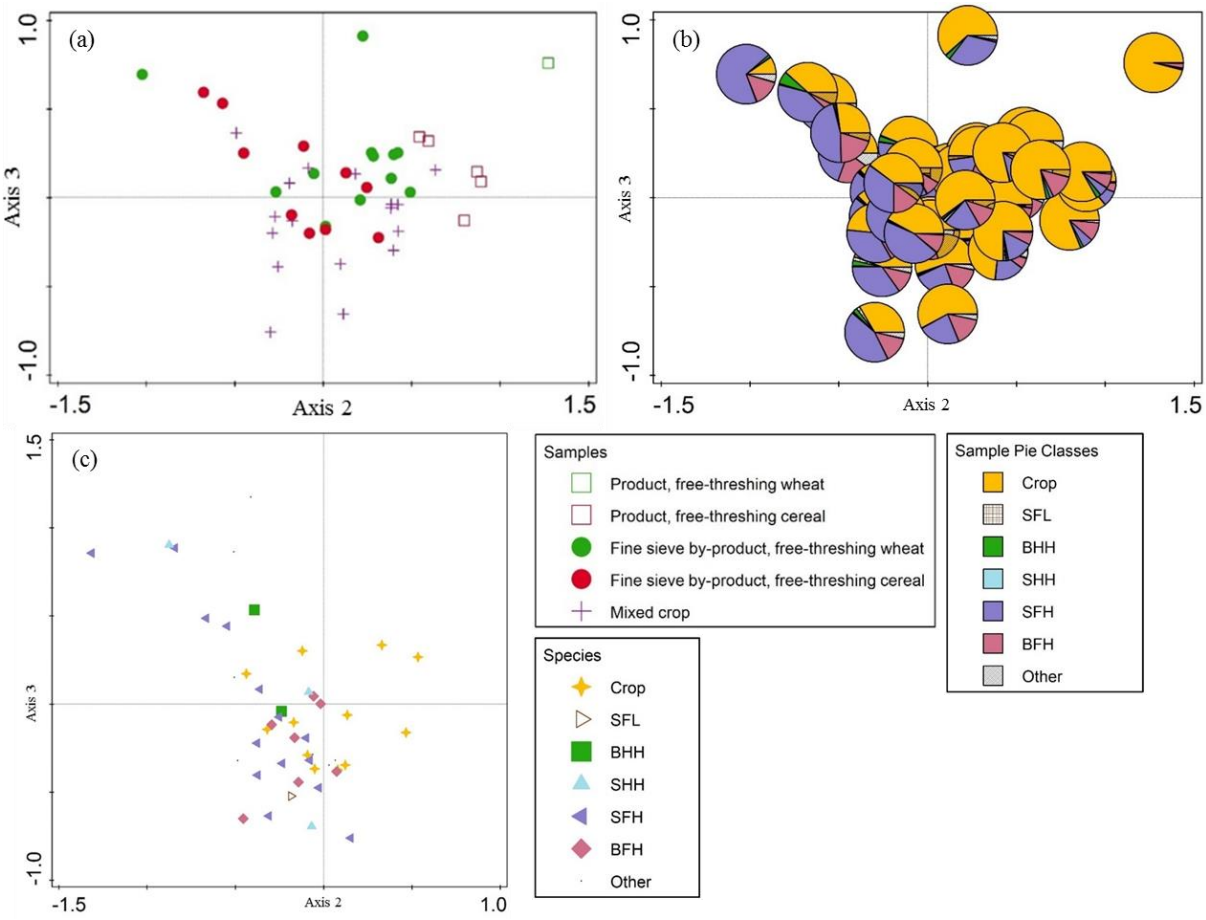


Figure 5.10 Correspondence analysis plot of 45 samples on the basis of 50 taxa (a) with samples coded by crop processing stage and crop group; (b) with taxa coded by weed characteristics (SFL: small-free-light, BHH: big-headed-heavy, SHH: small-headed-heavy, SFH: small-free-heavy and BFH: big-free-heavy); (c) with samples represented as pie charts illustrating proportions of crop and weed material.

In Figure 5.10, the plot of samples as pie-charts (Figure 5.10c) broadly illustrates the influence of crop processing stage on sample composition: crop-rich samples are distinguished top right from weed-rich samples bottom left. The weed-rich samples include fine sieve by-products and are especially rich in the expected SFH type (Figure 5.10b). BFH weeds are quite widely distributed but constitute the dominant weed type in some product samples, as expected.

5.2.2. Consideration of potentially dung-derived material

The Tell Atchana assemblage yielded a single dung pellet fragment without observable seeds (TA2011.25). Turning to the next criterion of Charles (1998), biological and ecological data were

used to determine the likelihood of wild taxa derived from animal dung. A summary of habitat and fruiting times, together with an overall score for the likelihood of dung derivation, is shown in Table 5.16. Correspondence analysis conducted in this section (Figure 5.11-5.13) used both crop and weed/wild species that present in 6 percent or more of samples.

The assessment of wild taxa in terms of their habitat wetness (dry, dry/wet and wet) gives rise to a single wetland taxon and a certain number of taxa occurring in both dry and wet habitats, while the majority of species were categorised as dry (Figure 5.11b). *Bolboschoenus glaucus* is the only species in the wet category (Table 5.16) and its location adjacent to the origin in Figure 5.11b provides little information related to dung origin. Furthermore, the proportions of this species are not distinctive (Figure 5.11c). Instead, seven dry/wetland taxa occur toward the negative end of axis 2 (Figure 5.11b). In Figure 5.11a, it can be seen that mixed crop samples, which are more likely to be associated with dung species, occur in lower right of the plot. This pattern seems to overlap partly with that of dry/wet taxa. Meanwhile, species from dry habitats tend to be distributed all over the plot except for the lower left section. A single dung-containing sample, which is one of the mixed crop group, is also relatively far away from both wetland and dry/wetland taxa in the upper right (Figure 5.11b and 5.11a).

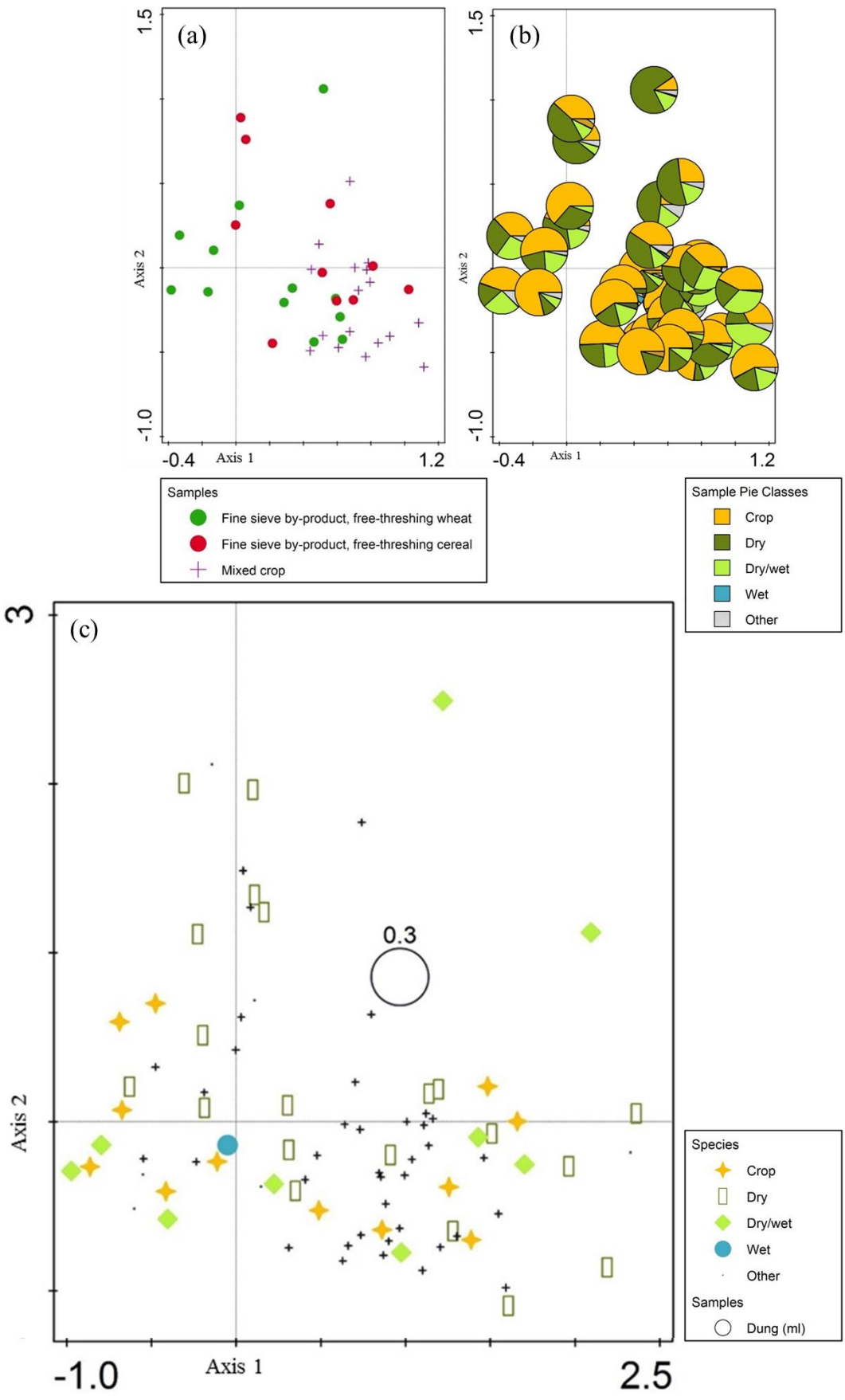


Figure 5.11 Correspondence analysis 39 samples based on 48 crop and wild/weed taxa showing (a) samples coded by crop processing stage and crop group; (b) dung (ml) containing samples, with taxa coded by habitat wetness; (c) samples represented as pie charts illustrating the proportions of habitat categories. Product samples were left out.

Table 5.15 presents the flowering/fruiting periods of wild/weed taxa from the Tell Atchana assemblage. The wheat harvest time in Hatay province, which includes Tell Atchana, is late May to late June today (Karabina, 2016) and thus the seasonality of taxa was considered in relation to a June harvest time. Although early flowering/fruiting taxa are dominant at Tell Atchana, as many as five taxa were grouped as late flowering/fruiting and seven species were categorised as intermediate (Table 5.15).

Table 5.15 Seasonality of wild/weed taxa identified at Tell Atchana in relation to cereal harvesting time. Taxa occurring in more than 10 percent of samples were included. (): rarely occurs. E: early, I: intermediate and L: late.

Taxa	**Months of flowering/fruiting**												**Class**
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	
Hippocrepis unisiliquosa/ciliata/multisiliqusa			X	X	X								E
Ranunculus arvensis			X	X	X	X							E
Galium spurium			X	X	X	X							E
Coronilla sp.			X	X	X	X							E
Echium angustifolium/parviflorum			X	X	X	X	X	X					E
Scorpiurus muricatus				X	X								E
Valerianella dentata				X	X	X							E
Vaccaria pyramidata				X	X	X							E
Silene sp.				X	X	X	X						E
Rumex sp.				X	X	X	X						E
Bupleurum intermedium				X	X	X	X						E
Bromus spp.				X	X	X	X	(X)					E
Plantago sp.				X	X	X	X	X					E
Thymelaea passerine/gussonei/mesopotamia				X	X	X	X	X	(X)				E
Phalaris aquatica					X	X							E
Valerianella coronata Type					X	X	X						E
Hordeum murinum type					X	X	X						E
Lolium temulentum					X	X	X						E
Medicago sp.				X	X	X	X	X	X				I
Anagallis arvensis				X	X	X	X	X	X				I
Sherardia arvensis				X	X	X	X	X	X				I
Leguminosae, small seeded				X	X	X	X	X	X				I
Chenopodium sp.					X	X	X	X					I
Cephalaria sp.					X	X	X	X					I
Anthemis cotula						X	X						I
Bolboschoenus glaucus					X	X	X	X	X				L
Centaurea sp.					X	X	X	X	X	X			L
Malva sylvestris/neglecta					X	X	X	X	X	X			L
Heliotropium sp.					(X)	X	X	X	X	X			L
Prosopis farcta	X	X					X	X	X	X	X	X	L

Figure 5.12a shows the species plot coded by seasonality. While the pattern is not strong intermediate and late species are mostly confined to the right of the plot along with the one sample that contains dung material. Samples classified as mixed crop group are likely to be related with these intermediate and late taxa (Figure 5.11a).

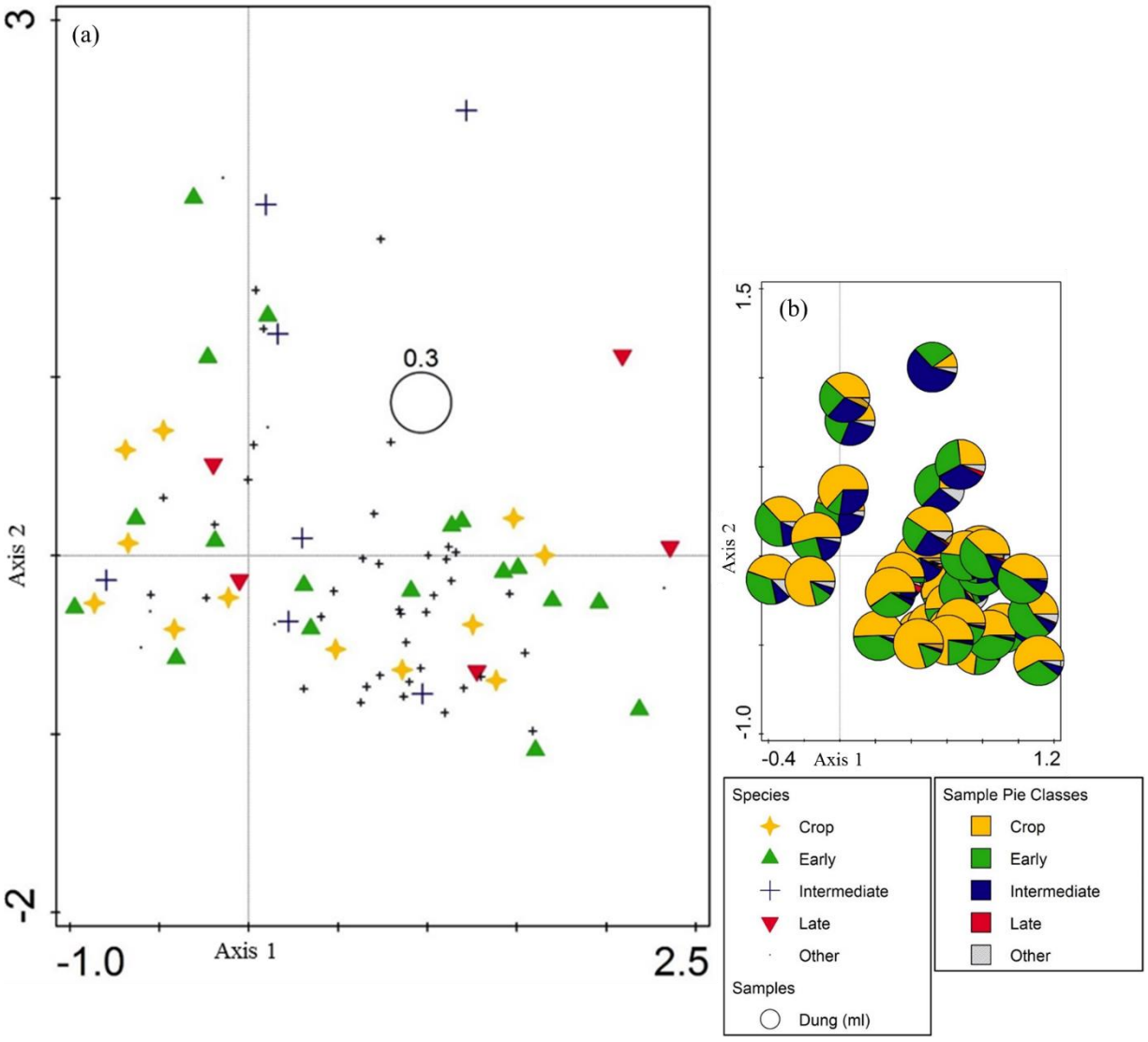


Figure 5.12 Correspondence analysis plot of 39 samples on the bases of 48 taxa showing (a) dung (ml) containing samples, with taxa coded by seasonality; (b) samples as pie charts illustrating the proportions of seasonality categories.

Tell Atchana weed/wild species were scored on a scale of 1 to 3 in order to investigate the likelihood of being dung-derived (Table 5.16) and entered into the correspondence analysis (Figure

5.13a and 5.13b). Those scores of 3 are scattered broadly in company with a dung containing sample in the right of the first axis (Figure 5.13a) and this also coincide with the mixed crop group in Figure 5.11a, probably implying dung-derived species. Class 2 species are distributed all over the plot (Figure 5.13a), however, its percentage is fairly lower in the left side than right in Figure 5.13b, and thus species scoring 2 may partially contain dung related taxa, associated with mixed crop samples.

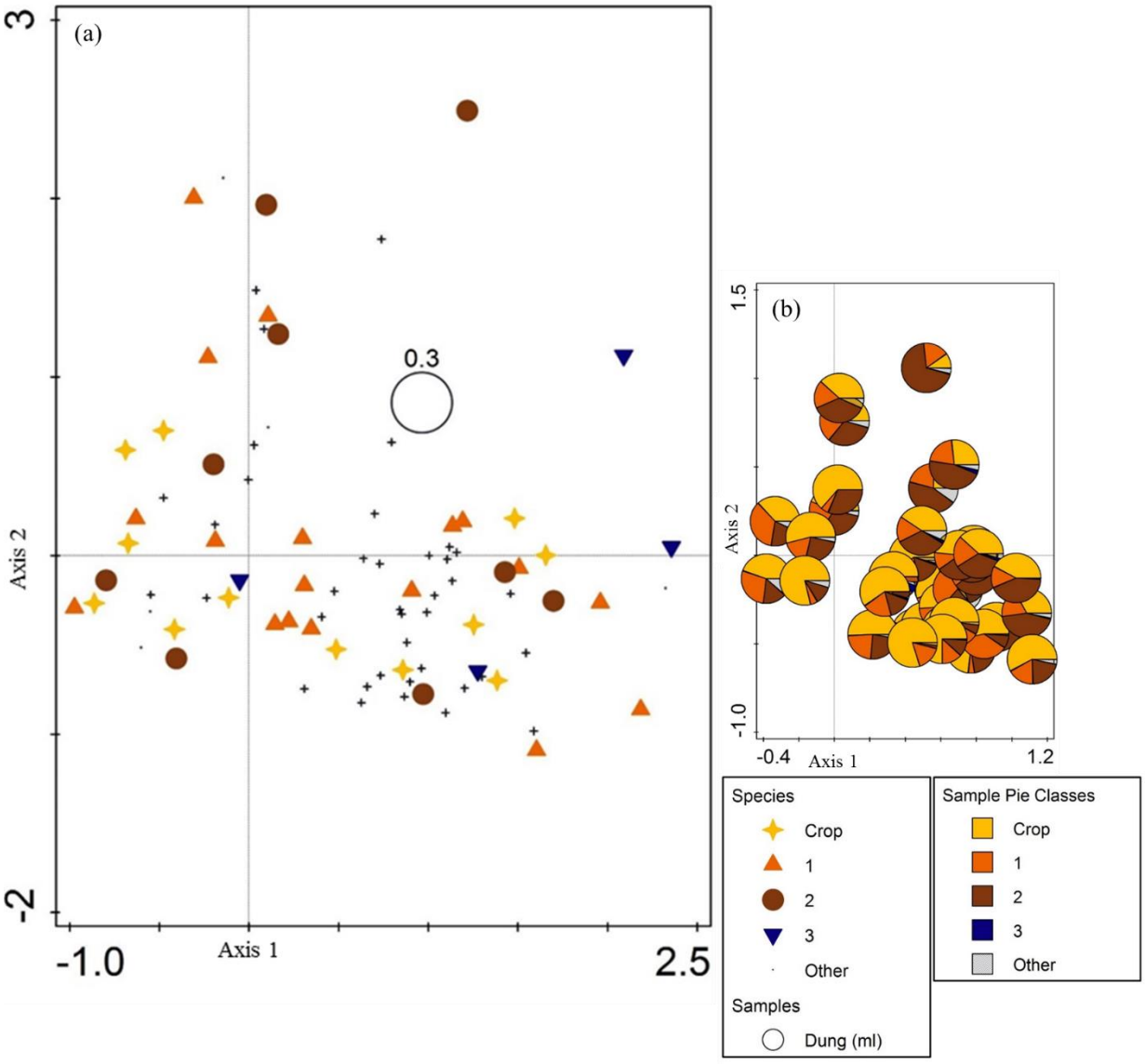


Figure 5.13 Correspondence analysis plot of 39 samples and 48 taxa showing (a) dung (ml) containing samples, with taxa coded by dung score; (b) samples represented as pie charts illustrating the proportions of scores.

Overall, the correspondence analyses of biological and ecological indicators from the Tell Atchana assemblage suggests that there are four possible dung species, namely *Heliotropium* sp., *Bolboschoenus glaucus*, *Prosopis farcta* and *Malva sylvestris/neglecta.*

Table 5.16 Summary of habitat, flowering/fruiting time and dung scores for wild/weed taxa in the Tell Atchana assemblage. Taxa occurring in more than 10 percent of samples were included.

Species	**Habitat**	**Seasonality**	**Dungness**
Hippocrepis unisiliquosa/ciliata/multisiliqusa	Dry	Early	1
Ranunculus arvensis	Dry	Early	1
Galium spurium	Dry	Early	1
Echium angustifolium/parviflorum	Dry	Early	1
Scorpiurus muricatus	Dry	Early	1
Valerianella dentata	Dry	Early	1
Vaccaria pyramidata	Dry	Early	1
Silene sp.	Dry	Early	1
Bupleurum intermedium	Dry	Early	1
Bromus spp.	Dry	Early	1
Thymelaea passerine/gussonei/mesopotamia	Dry	Early	1
Valerianella coronata Type	Dry	Early	1
Hordeum murinum type	Dry	Early	1
Lolium temulentum	Dry	Early	1
Coronilla sp.	Dry/wet	Early	1
Sherardia arvensis	Dry	Intermediate	1
Anagallis arvensis	Dry/wet	Intermediate	1
Rumex sp.	Dry/wet	Early	2
Plantago sp.	Dry/wet	Early	2
Phalaris aquatica	Dry/wet	Early	2
Leguminosae, small seeded	Dry	Intermediate	2
Anthemis cotula	Dry	Intermediate	2
Medicago sp.	Dry/wet	Intermediate	2
Chenopodium sp.	Dry/wet	Intermediate	2
Cephalaria sp.	Dry/wet	Intermediate	2
Centaurea sp.	Dry	Late	2
Heliotropium sp.	Dry	Late	3
Malva sylvestris/neglecta	Dry	Late	3
Prosopis farcta	Dry/wet	Late	3
Bolboschoenus glaucus	Wet	Late	3

Following of Charles' (1998) third criterion, 46 Tell Atchana samples were entered as a separate group and this was compared to Jones' (1990) ethnographic crop processing data. Four samples

(TA2006.96, 2010.1, 2012.18 and 2012.32) were excluded from this analysis since they contain less than ten wild/weed items. There were no distinctive differences between the archaeological samples and ethnographical data, and the vast majority of the Tell Atchana samples gathered near the Amorgos fine sieve by-product group or slightly the outer edge of it while a few samples tend to place in Amorgos fine sieve product group in both Figure 5.14a and b. Although 94 percent of Tell Atchana samples were reclassified with their own group (Table 5.17), the overall picture is that dung-related species played a minor role and that the influence of crop processing predominates in the Tell Atchana assemblage.

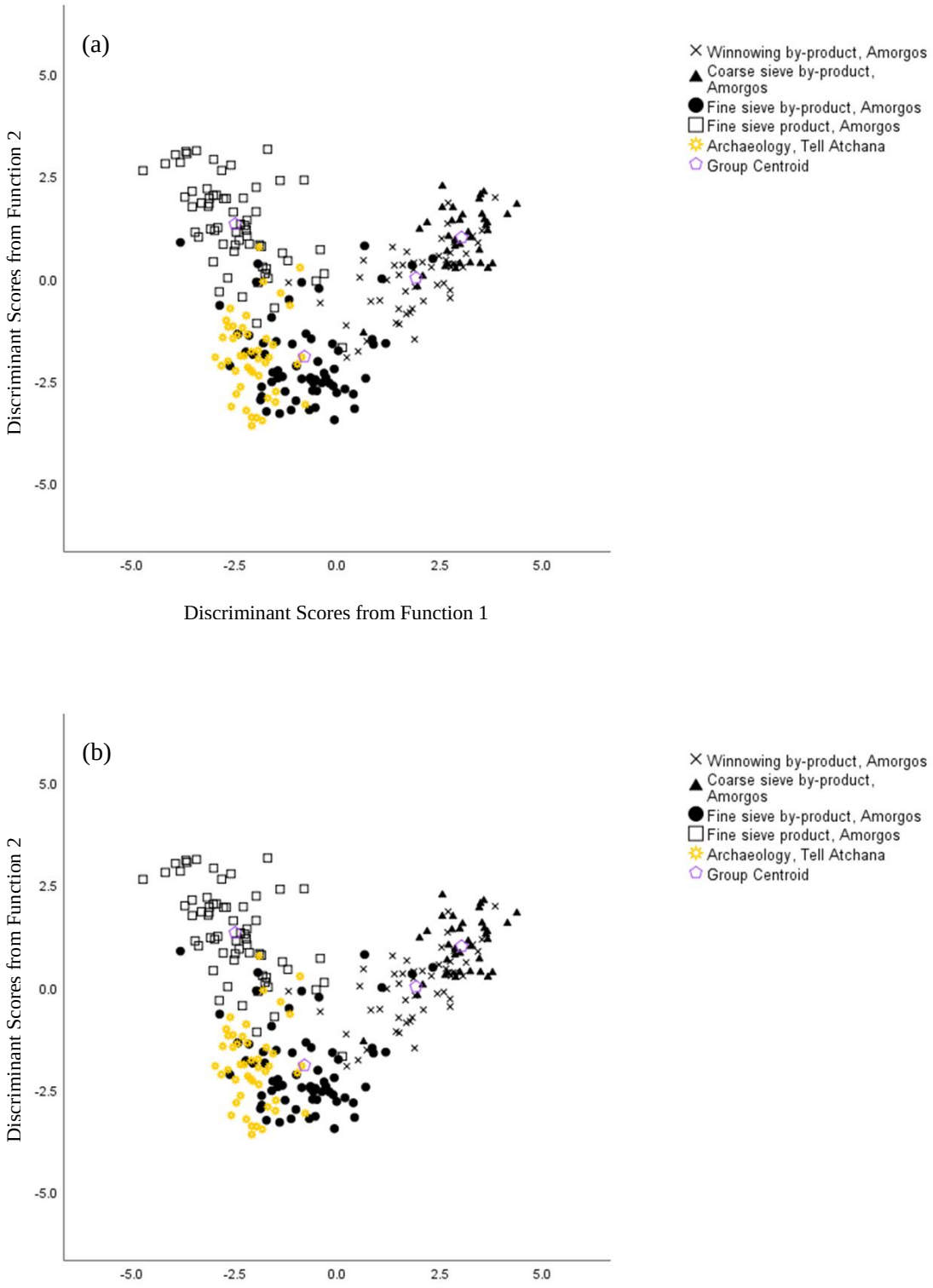


Figure 5.14 Discriminant analysis plot of the 46 Tell Atchana samples that are (a) entered as ungrouped in the classification stage of the discriminant analysis and (b) entered as a separate group in the discrimination phase.

Table 5.17 Summarised sample classifications based on two versions of the weed-based discriminant analysis, with (a) the archaeobotanical samples entered as ungrouped in the classification phase and (b) as a separate group in the discrimination phase.

Predicted Group Membership						
		Winnowing by-product	Coarse sieve by-product	Fine sieve by-product	Fine sieve product	Group 5
a	Count	0	0	41	5	N/A
	%	0.0	0.0	89.1	10.9	N/A
b	Count	0	0	2	1	43
	%	0.0	0.0	4.3	2.2	93.5

The fourth criterion of Charles (1998) is to investigate proportions of crop components and the ratio of grain to chaff with mixed samples. At Tell Atchana, free-threshing wheat grain is the dominant crop part, followed by bitter vetch (Table 5.18). The percentage of bitter vetch is over 20 percent in most samples and it reaches up to 60 percent.

Table 5.18 Proportions of crop components and the ratio of grain to chaff in the Tell Atchana mixed crop group samples. *less than 30 items in total.

Crop group	Percentage									Grain: chaff ratio			Sample
	% Free-threshing wheat grain	% Free-threshing wheat internodes	% Two-row hulled barley grain	% Two-row hulled barley rachis	% Glume wheat grain	% Glume wheat glume bases	% Lentil	% Bitter vetch	% Olive	Free-threshing wheat grain: rachis	Two-row hulled barley grain: rachis	Glume wheat grain: glume bases	
Mixed crop	53	4	9	1	2	1	5	24	1	15:1	7:1	3:1	TA2011.25
Mixed crop	35	15	9	7	6	13	7	8	0	2:1	1:1	1:2	TA2011.334
Mixed crop	45	2	16	2	0	0	2	32	0	20:1	7:1	0:0	TA2011.33
Mixed crop	52	0	12	2	10	0	12	13	0	27:0	6:1	5:0	TA2011.315
Mixed crop	50	7	7	0	0	0	7	29	0	7:1	1:0	0:0	TA2011.36*
Mixed crop	50	4	8	0	0	8	4	25	0	12:1	2:0	0:2	TA2012.26*
Mixed crop	60	0	0	0	0	3	3	35	0	24:0	0:0	0:1	TA2012.32
Mixed crop	45	4	8	1	1	2	2	37	0	12:1	11:1	1:3	TA2011.326
Mixed crop	52	0	0	4	0	0	13	30	0	12:0	0:1	0:0	TA2012.7*
Mixed crop	39	3	11	3	5	0	8	32	0	15:1	4:1	2:0	TA2011.322
Mixed crop	21	10	10	14	3	10	10	17	3	2:1	1:1	1:3	TA2012.14*
Mixed crop	50	0	0	0	21	0	0	29	0	7:0	0:0	3:0	TA2011.327*
Mixed crop	39	0	11	0	0	3	10	36	1	28:0	8:0	0:2	TA2011.93
Mixed crop	46	0	3	0	9	0	20	23	0	16:0	1:0	3:0	TA2011.29
Mixed crop	34	2	8	3	2	1	3	47	0	18:1	3:1	4:1	TA2011.41
Mixed crop	35	2	6	2	0	7	9	38	0	14:1	3:1	0:6	TA2012.11
Mixed crop	11	0	26	0	0	2	0	60	0	6:0	14:0	0:1	TA2012.35
Mixed crop	23	3	9	0	6	6	2	50	0	8:1	21:1	1:1	TA2011.331
Mixed crop	27	0	2	0	0	0	17	23	31	14:0	1:0	0:0	TA2010.1

Both free-threshing wheat and two-row hulled barley are dominated by grain across most samples (Table 5.18). Two exceptional samples, TA2011.334 and 2012.14, show free-threshing wheat grain to internode ratios of 2:1 and two-row barley grain to rachis ratios of 1:1, however, the ratio of chaff still exceeds that expected in an unprocessed spikelet (3:1 and 1:1, respectively). Moreover, TA2012.14 contains less than 30 crop items in total.

To sum up, the predominant mixed crop combination is that of free-threshing wheat grain and bitter vetch. Bitter vetch is known as not only famine food but also animal fodder and it cannot be

ruled out that a mixing of both crop types in the Tell Atchana assemblage is related to the preparation for animal consumption, in addition to the possibility of daily discard.

5.3. Tell Brak

5.3.1. Crop processing of single crop groups

5.3.1.1. Crop-based analysis

The Tell Brak samples were classified into two major groups in section 4.3.1, barley and free-threshing cereal, with only a few glume wheat items found across the assemblage (Figure 4.6). Table 5.19 shows the classification of 33 barley and free-threshing cereal group samples by crop processing stage based on proportions of cereal grain and rachis internodes and the ratio of cereal grain to rachis. All 33 samples meet the minimum number of 30 items and thus all of them were included in this examination.

Table 5.19 The classification of two-row hulled barley and free-threshing cereal crop group samples by crop processing stage based on proportions of cereal grain and rachis and ratios of cereal grain to rachis. Samples containing less than 30 crop items were excluded. W = winnowing by-product, C = coarse sieve by-product, F = fine sieve by-product and P = product. **The figure of two-row barley grain was multiplied by three.

Classification	Crop group	Percentage						Grain: rachis ratio			Sample
		% Two-row hulled barley grain	% Two-row hulled barley rachis	% Free-threshing wheat grain	% Free-threshing wheat internodes	% Free-threshing cereal grain**	% Free-threshing cereal chaff	Two-row hulled barley grain: rachis	Free-threshing wheat grain: rachis	Free-threshing cereal grain**: rachis	
W/C	Barley	12	80	2	6	30	70	1:7	1:3	1:2	TB11/26.19
C	Barley	38	58	2	2	65	35	1:2	1:1	2:1	TB07/10
C	Barley	36	59	2	4	64	36	1:2	1:2	2:1	TB07/69
C	Barley	35	65	1	0	62	38	1:2	1:0	2:1	TB07/54
C	Barley	32	66	1	0	60	40	1:2	4:0	1:1	TB07/89
C	Barley	28	64	3	4	56	44	1:2	1:1	1:1	TB11/26.18
C	Barley	26	68	2	4	53	47	1:3	1:2	1:1	TB07/60
C	Barley	21	64	10	5	52	48	1:3	2:1	1:1	TB11/27.22
C	Barley	24	63	3	10	51	49	1:3	1:3	1:1	TB07/61
C	Barley	21	64	6	9	48	52	1:3	1:2	1:1	TB11/28.23
C	Barley	19	75	1	5	42	58	1:4	1:4	1:1	TB11/26.17
C	Barley	18	77	3	2	42	58	1:4	2:1	1:1	TB11/26.20
C	Barley	17	79	5	0	41	59	1:5	4:0	1:1	TB07/70
C	Free-threshing cereal	13	65	11	11	39	61	1:5	1:1	1:2	TB07/84
C/F	Barley	41	56	2	0	69	31	1:1	1:0	2:1	TB07/21
C/F	Barley	45	49	3	3	73	27	1:1	1:1	3:1	TB07/76
C/F	Barley	41	46	5	8	70	30	1:1	1:2	2:1	TB07/92
F	Barley	72	24	4	0	90	10	3:1	22:0	9:1	TB07/82
F	Barley	67	29	4	0	88	12	2:1	3:0	7:1	TB07/52
F	Barley	63	23	14	0	90	10	3:1	37:0	9:1	TB06/149
F	Barley	63	36	0	1	84	16	2:1	0:1	5:1	TB06/150
F	Barley	59	33	6	2	84	16	2:1	3:1	5:1	TB06/132
F	Barley	58	35	4	4	82	18	2:1	1:1	5:1	TB06/148
F	Barley	54	35	6	6	81	19	2:1	1:1	4:1	TB06/70
F	Barley	55	38	3	3	80	20	1:1	1:1	4:1	TB07/68
F	Barley	48	39	6	7	77	23	1:1	1:1	3:1	TB07/77
F	Barley	47	45	8	0	77	23	1:1	3:0	3:1	TB11/26.16
F	Free-threshing cereal	47	33	20	0	83	17	1:1	9:0	5:1	TB11/13.5
F	Free-threshing cereal	50	19	29	1	90	10	3:1	21:1	9:1	TB11/16.2
F	Free-threshing cereal	40	33	24	4	80	20	1:1	7:1	4:1	TB07/67
F/P	Barley	82	18	0	0	93	7	5:1	0:0	14:1	TB11/14.3
F/P	Barley	78	6	16	0	98	2	12:1	15:0	40:1	TB06/124
F/P	Barley	62	11	23	5	93	7	6:1	5:1	13:1	TB06/5

There were 14 samples classified into the early processing stages. Of these, one sample (TB11/26.19) appears to be intermediate between winnowing by-product and coarse sieve by-product, while the other 13 samples clearly resemble coarse sieve by-products in terms of proportions and the grain to chaff ratio (Table 5.19).

Three further Tell Brak samples appear to be intermediate between coarse sieve by-product and fine sieve by-product (Table 5.19). A number of other Tell Brak samples were classified as fine sieve by-products. The ratios of grain to rachis in these samples range from 1:1 to 4:1. Finally, three barley samples are intermediate between fine sieve by-products and products (Table 5.19).

Overall, the crop-based crop processing analysis of the Tell Brak assemblage implies the coexistence of both early and late processing stages, i.e. coarse sieve by-products and fine sieve by-products.

5.3.1.2. Crop- and weed-based analysis

Since the entire Tell Brak assemblage represent free-threshing cereal types and glume wheat is minor, all 33 samples could be compared to the Amorgos data directly. Crop- and weed-based crop processing analysis with 29 barley group and four free-threshing cereal group samples reveals a complex picture in Figure 5.15. The Brak samples are distributed between the ethnobotanical groups, suggesting extensive mixing of different crop processing stages. Though there are several grain-dominated samples, none resemble cleaned product samples.

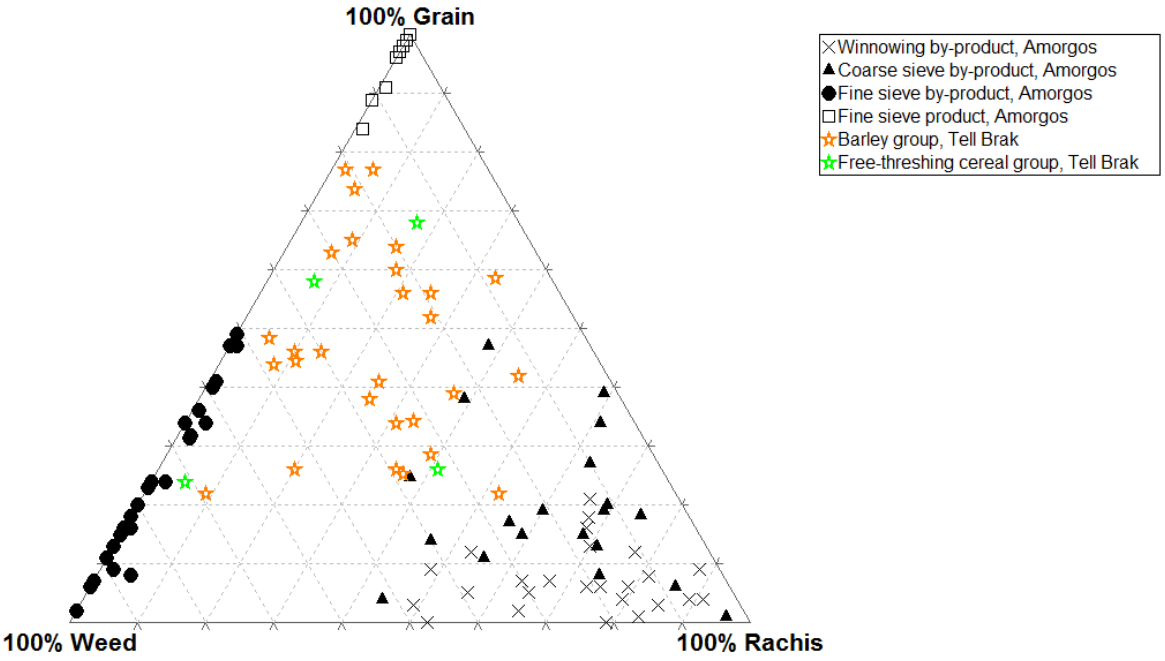


Figure 5.15 Triangular plot of the 33 Tell Brak barley and free-threshing cereal group samples based on the relative proportions of grain, rachis and weed in comparison to Jones' (1990) Amorgos data.

A number of Tell Brak samples contain a combination of grain and weed seeds with relatively a few rachis items, and so most closely resemble Amorgos fine sieve by-products. Amongst these, proportions of grain exceed 70 percent in three samples suggesting that they may represent barley product (Figure 5.15 and Table 5.20). A clear separation between barley group and free-threshing cereal group is not shown (Figure 5.15).

Table 5.20 The classification of 33 Tell Brak barley and free-threshing cereal group samples by crop processing stage based on the proportions of grain, rachis and weed seeds.

Classification	**Crop group**	**Sample**
Winnowing/coarse sieve by-product	Barley	TB07/70
Winnowing/coarse sieve by-product	Barley	TB11/26.17
Winnowing/coarse sieve by-product	Barley	TB11/26.19
Winnowing/coarse sieve by-product	Barley	TB11/26.20
Winnowing/coarse sieve by-product	Barley	TB11/27.22
Winnowing/coarse sieve by-product	Barley	TB11/28.23
Winnowing/coarse sieve by-product	Free-threshing cereal	TB07/84
Fine sieve by-product	Barley	TB06/70
Fine sieve by-product	Barley	TB06/132
Fine sieve by-product	Barley	TB06/148
Fine sieve by-product	Barley	TB06/149
Fine sieve by-product	Barley	TB06/150
Fine sieve by-product	Barley	TB07/52
Fine sieve by-product	Barley	TB07/77
Fine sieve by-product	Barley	TB07/82
Fine sieve by-product	Barley	TB07/92
Fine sieve by-product	Free-threshing cereal	TB11/13.5
Fine sieve by-product	Free-threshing cereal	TB11/16.2
Fine sieve by-product/product	Barley	TB06/5
Fine sieve by-product/product	Barley	TB06/124
Fine sieve by-product/product	Barley	TB11/14.3
Mixed stage?	Barley	TB07/10
Mixed stage?	Barley	TB07/21
Mixed stage?	Barley	TB07/54
Mixed stage?	Barley	TB07/60
Mixed stage?	Barley	TB07/61
Mixed stage?	Barley	TB07/68
Mixed stage?	Barley	TB07/69
Mixed stage?	Barley	TB07/76
Mixed stage?	Barley	TB07/89
Mixed stage?	Barley	TB11/26.16
Mixed stage?	Barley	TB11/26.18
Mixed stage?	Free-threshing cereal	TB07/67

Seven samples resemble coarse sieve by-products in composition or, less convincingly, winnowing by-product in comparison to Jones' model (1990). As for the rest of the samples, relatively high proportions of grain imply that they are not utterly derived from the early stage of processing but from the mixed components of early and late crop processing stages. Their intermediate position

between early and late processing stages in the diagram (Figure 5.15) indicates that proportions of grain are higher than expected in early processing stages while proportions of rachis are lower than is typical for early processing by-products. These 12 samples were therefore classified as barley and free-threshing cereal mixed stage samples (Table 5.20).

The classification of crop processing stage using the relative proportions of grain, weed and rachis results in seven early processing stage samples, 14 late processing stage samples and 12 mixed stage samples in the Tell Brak assemblage.

5.3.1.3. Weed-based analysis

Figure 5.16 and Table 5.21 show the results of discriminant analysis along with associated probabilities. One sample containing less than ten weed items was left out (TB11/27.22) in this analysis. The results indicate that Tell Brak samples are dominated by weed seeds that are related to fine sieve by-products. In Figure 5.16, it can be seen that certain Tell Brak samples that were classified as mixed stage and winnowing/coarse sieve by-product in the previous crop- and weed-based analysis are positioned on the edge of the Amorgos fine sieve by-product group, reflecting their intermediate position. As shown in Table 5.21, nevertheless, almost the entire Tell Brak dataset belongs to the fine sieve by-product group with high probabilities; only four samples classified as fine sieve by-product obtained low probabilities (TB06/149, 07/82, 07/89 and 11/26.18). Meanwhile, two other samples were classified as fine sieve products with high probabilities (TB07/92 and 11/26.18).

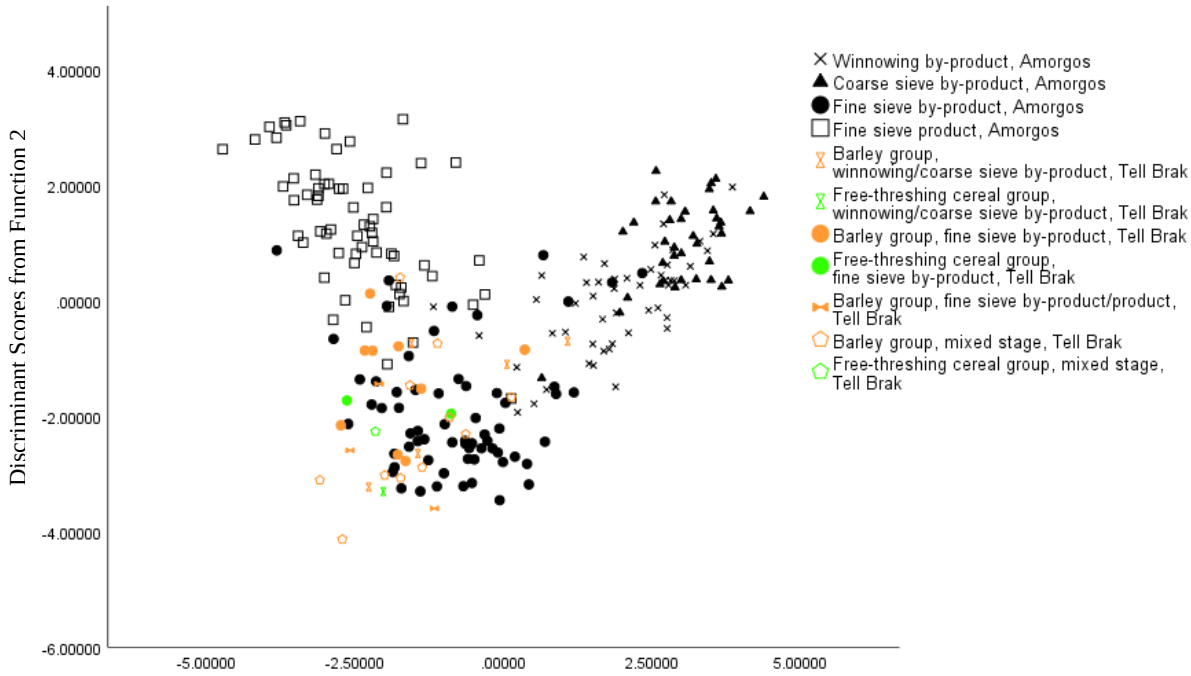


Figure 5.16 Discriminant analysis plot of the 32 Tell Brak barley and free-threshing cereal group samples in comparison to Jones' (1984; 1987) Amorgos data.

Table 5.21 The classification of barley and free-threshing cereal group samples by crop processing stage based on physical weed seed types.

Classification	***P*-value**	**Crop group**	**Sample**	**Second Highest Group**	
				Classification	***P*-value**
Fine sieve by-product	1.000	Barley	TB06/124	Winnowing by-product	0.000
Fine sieve by-product	1.000	Barley	TB07/10	Fine sieve product	0.000
Fine sieve by-product	1.000	Barley	TB07/76	Fine sieve product	0.000
Fine sieve by-product	1.000	Barley	TB11/26.17	Fine sieve product	0.000
Fine sieve by-product	1.000	Free-threshing cereal	TB07/84	Fine sieve product	0.000
Fine sieve by-product	0.999	Barley	TB06/148	Fine sieve product	0.001
Fine sieve by-product	0.999	Barley	TB07/60	Winnowing by-product	0.001
Fine sieve by-product	0.999	Barley	TB07/61	Winnowing by-product	0.001
Fine sieve by-product	0.999	Barley	TB07/70	Fine sieve product	0.000
Fine sieve by-product	0.999	Barley	TB07/77	Fine sieve product	0.001
Fine sieve by-product	0.997	Barley	TB06/5	Fine sieve product	0.003
Fine sieve by-product	0.997	Barley	TB07/69	Fine sieve product	0.003
Fine sieve by-product	0.996	Free-threshing cereal	TB07/67	Fine sieve product	0.004
Fine sieve by-product	0.995	Free-threshing cereal	TB11/13.5	Winnowing by-product	0.003
Fine sieve by-product	0.994	Barley	TB11/26.16	Winnowing by-product	0.006
Fine sieve by-product	0.987	Barley	TB06/150	Fine sieve product	0.012
Fine sieve by-product	0.981	Barley	TB07/21	Winnowing by-product	0.017
Fine sieve by-product	0.978	Barley	TB06/70	Fine sieve product	0.022
Fine sieve by-product	0.976	Barley	TB07/68	Fine sieve product	0.023
Fine sieve by-product	0.970	Barley	TB11/28.23	Winnowing by-product	0.022
Fine sieve by-product	0.945	Barley	TB07/54	Winnowing by-product	0.053
Fine sieve by-product	0.940	Free-threshing cereal	TB11/16.2	Fine sieve product	0.060
Fine sieve by-product	0.912	Barley	TB11/14.3	Fine sieve product	0.086
Fine sieve by-product	0.870	Barley	TB11/26.20	Fine sieve product	0.130
Fine sieve by-product	0.827	Barley	TB06/132	Winnowing by-product	0.152
Fine sieve by-product	0.812	Barley	TB07/52	Fine sieve product	0.187
Fine sieve by-product	0.786	Barley	TB07/89	Fine sieve product	0.133
Fine sieve by-product	0.698	Barley	TB06/149	Fine sieve product	0.302
Fine sieve by-product	0.535	Barley	TB07/82	Fine sieve product	0.460
Fine sieve by-product	0.395	Barley	TB11/26.19	Coarse sieve by-product	0.369
Fine sieve product	0.925	Barley	TB07/92	Fine sieve by-product	0.075
Fine sieve product	0.898	Barley	TB11/26.18	Fine sieve by-product	0.101

5.3.1.4. Comparison of the results of different approaches

The summary of the final classification of Tell Brak samples is shown in Table 5.22. Overall the Tell Brak samples present a complex mixed composition in terms of crop processing stages. Only ten samples that were classified as fine sieve by-product in the crop-based and crop- and weed-based analyses were consistent with their classification as fine sieve by-product in the weed-based

analysis. These samples were finally classified as fine sieve by-product (Table 5.22). The other three samples were classified into fine sieve product (TB06/5, 06/124 and 11/14.3). Although these gained an intermediate classification (fine sieve by-product/product) in the crop-only and crop- and weed-based work, the proportions of grain were high for fine sieve by-products. The remaining samples classified as fine sieve by-product based on weed characteristics were either early stages or mixed stages in the crop-based and crop- and weed-based analyses, and they are all finally classified as mixed stages (Table 5.22). The ambiguity of these samples and the result show no change when discriminant analysis was run without two potential dung-related species (*Prosopis farcta* and *Bolboschoenus glaucus*).

Table 5.22 Summary of the final classification of Tell Brak samples by crop processing stage. W = winnowing by-product, C = coarse sieve by-product, F = fine sieve by-product, P = product and M = Mixed stages.

Classification				**Crop group**	**Sample**
Final	**Crop-based**	**Crop- + weed-based**	**Weed-based**		
Fine sieve by-product	F	F	F	Barley	TB07/52
Fine sieve by-product	F	F	F	Barley	TB06/148
Fine sieve by-product	F	F	F	Barley	TB07/82
Fine sieve by-product	F	F	F	Barley	TB06/132
Fine sieve by-product	F	F	F	Barley	TB06/70
Fine sieve by-product	F	F	F	Barley	TB07/77
Fine sieve by-product	F	F	F	Barley	TB06/149
Fine sieve by-product	F	F	F	Barley	TB06/150
Fine sieve by-product	F	F	F	Free-threshing cereal	TB11/13.5
Fine sieve by-product	F	F	F	Free-threshing cereal	TB11/16.2
Fine sieve product	F/P	F/P	F	Barley	TB06/5
Fine sieve product	F/P	F/P	F	Barley	TB06/124
Fine sieve product	F/P	F/P	F	Barley	TB11/14.3
Mixed stages	W/C	W/C	F	Barley	TB11/26.19
Mixed stages	C	W/C	F	Barley	TB07/70
Mixed stages	C	W/C	F	Barley	TB11/26.17
Mixed stages	C	W/C	F	Barley	TB11/26.20
Mixed stages	C	W/C	F	Barley	TB11/28.23
Mixed stages	C	W/C	F	Free-threshing cereal	TB07/84
Mixed stages	C	M	F	Barley	TB07/10
Mixed stages	C	M	F	Barley	TB07/54
Mixed stages	C	M	F	Barley	TB07/60
Mixed stages	C	M	F	Barley	TB07/61
Mixed stages	C	M	F	Barley	TB07/69
Mixed stages	C	M	F	Barley	TB07/89
Mixed stages	F	M	F	Barley	TB07/68
Mixed stages	F	M	F	Barley	TB11/26.16
Mixed stages	F	M	F	Free-threshing cereal	TB07/67
Mixed stages	F/C	M	F	Barley	TB07/21
Mixed stages	F/C	M	F	Barley	TB07/76
Mixed stages	F/C	F	P	Barley	TB07/92
Mixed stages	C	M	P	Barley	TB11/26.18
Mixed stages	C	W/C	N/A	Barley	TB11/27.22

5.3.1.5. Correspondence analysis of crop processing stages and arable weeds

In order to explore relationships between weed taxa and crop processing stages, correspondence analysis was carried out and the sample plot is shown in Figure 5.17. All crop and weed taxa present in 10 percent or more of samples were included. Of these, one sample appeared as an outlier and was excluded (TB11/13.5). Taxa highly likely to be dung-derived (i.e. scoring 4 and 5 on the dung index) were also excluded in this analysis.

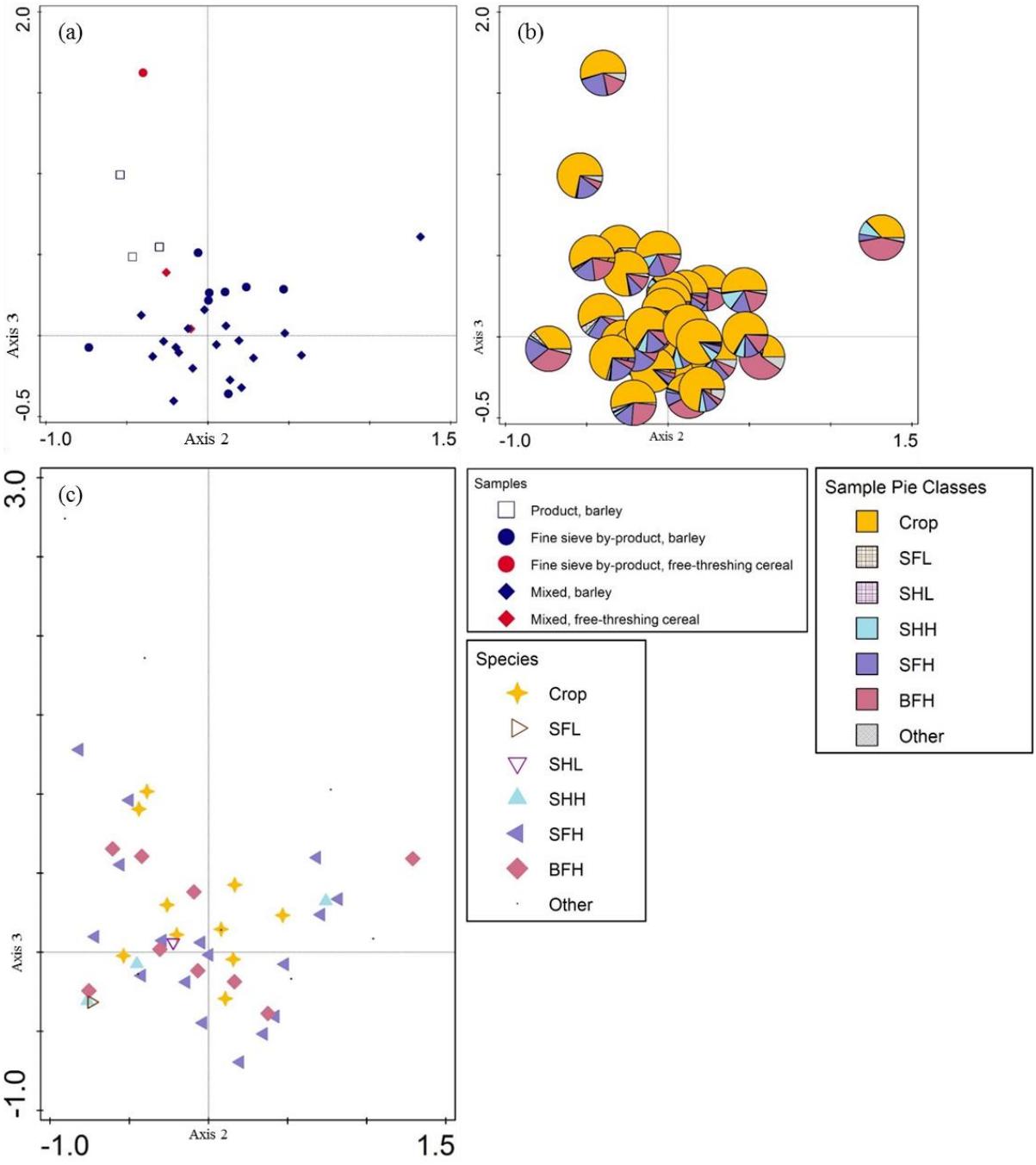


Figure 5.17 Correspondence analysis plot of 32 samples on the basis of 48 taxa (a) with samples coded by crop processing stage and crop group; (b) with taxa coded by weed characteristics (SFL: small-free-light, SHL: small-headed-light, SHH: small-headed-heavy, SFH: small-free-heavy and BFH: big-free-heavy); (c) with samples represented as pie charts illustrating proportions of crop and weed material.

In Figure 5.17a, a separation is observed between three barley product samples and the remaining samples. While the position of barley product samples is confined to the upper left of the plot, both fine sieve by-product and mixed samples cluster around the origin. Of these, most fine sieve by-

product samples are located towards the positive end of axis 3 whereas the vast majority of mixed stage samples occur below the negative end of axis 3, though there is considerable overlap.

The vast majority of Tell Brak crop weeds are of the SFH type, followed by BFH, and species belonging to the rest are rare when taxa with scores of 4 and 5 on the dung index scale are excluded in the correspondence analysis (Figure 5.17b and Table 3.4). Three BFH weed taxa characterise the barley product samples; these species are *Lolium rigidum, Hordeum spontaneum* and *Galium spurium* and strongly suggest they are typical arable weeds which were brought from barley fields to Tell Brak, particularly related to fine sieve product stage. Fine sieve by-product samples tend to be dominated by crop material rather than weeds in the sample composition whilst mixed samples contain mainly BFH and SFH seeds together with low proportions of other seeds categorised as SHH, SFL and Other (Figure 5.17a and 5.17c).

5.3.2. Consideration of potentially dung-derived material

Out of 33 samples, 21 contain animal dung pellets and/or dung fragments across the Tell Brak samples. Whole dung pellets were identified in three samples (TB07/10, 07/82 and 11/26.18). Of these, two (11/26.18 and 07/21) derive from fire installations, suggesting use of dung material for fuel. Seeds were not observable in the matrix of dung pellets. Samples classified as barley product were left out since those samples are not likely to contain dung-derived species.

According to Charles' (1998) ecological and biological approaches for the detection of dung-derived species, Figure 5.18a shows the correspondence analysis plot of samples coded by two crop processing stages and two crop groups. In this analysis (Figure 5.18-5.20), crop and weed/wild taxa containing at least 10 percent of samples were included. Fine sieve by-product samples are located towards the positive end of axis 3, particularly upper right, whereas mixed samples tend to be distributed around the origin. Figure 5.18b shows the correspondence analysis symbol plot of dung containing samples coded by the ecological condition of habitats. As clearly shown in the figure, the two species in the wet category and five species in the dry/wet category

occur towards the negative ends of axis 2 and 3. The wet taxa are *Bolboschoenus glaucus* and *Cyperus laevigatus/rotundus*, while the dry/wet taxa are *Medicago* sp., *Coronilla scorpioides*, *Aegilops tauschii* (glume bases), *Rumex* sp., *Lepidium draba* and *Prosopis farcta* (Table 5.24). Dung-containing samples are likewise located towards the negative ends of both axes, lower left (Figure 5.18b), implying also that wet and dry/wet categories are related to mixed samples (Figure 5.18a and 5.18b). In particular, the seeds of the two former species are hard-coated, with a high probability of survival through the ruminant gut and hence of dung-derivation. On the other hand, species classed as preferring dry habitats tend to be dispersed widely across the plot and may have a closer connection to barley fine sieve by-product (Figure 5.18a and 5.18b). Therefore, although the relative proportions of the weed/wild taxa classed as wet and dry/wet habitats occur at low levels compared to dry preferring taxa (Figure 5.18c), it is probable that Tell Brak samples contain dung-related taxa.

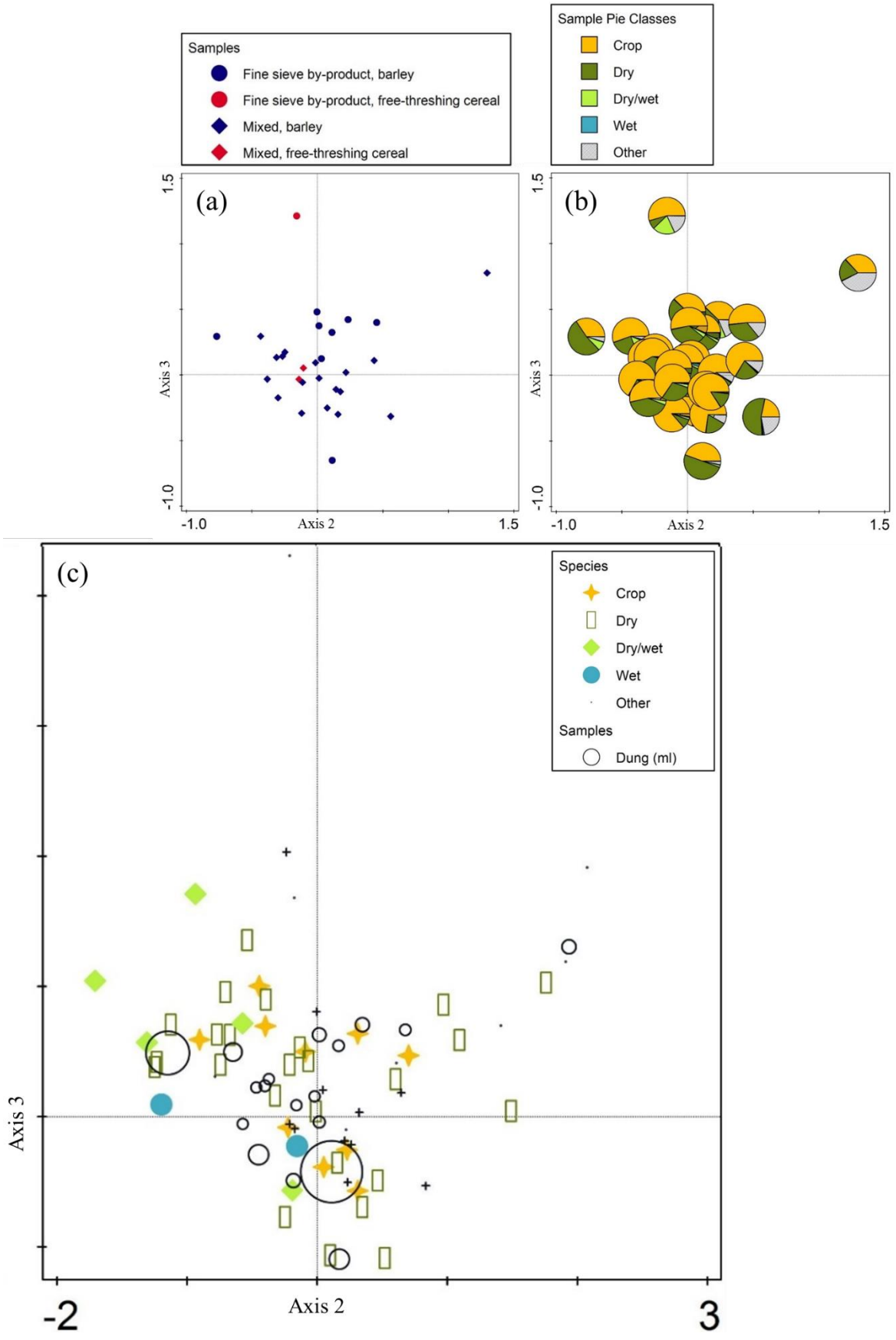


Figure 5.18 Correspondence analysis of 29 samples based on 50 crop and wild/weed taxa showing (a) samples coded by crop processing stage and crop group; (b) dung (ml) containing samples, with taxa coded by habitat wetness; (c) samples represented as pie charts illustrating the proportions of habitat categories. Product samples were left out.

Comparison of the seasonality of weed/wild taxa with crop harvesting time shows that the majority of species were classed as early flowering/fruiting, with three taxa as late (Table 5.23). The correspondence analysis plot coded by the seasonality categories in Figure 5.19a shows all three late taxa occur in the left of the axis 2, and four out of seven taxa that were categorised as intermediate were also located in the left side, which are *Gypsophila* spp., *Lolium rigidum*, *Taeniatherum caput-medusae* and small-seeded legumes. Of these, seeds of *Gypsophila* spp. and small-seeded legumes are small in size, perhaps suggesting a potential dung origin; however, the other two, *Lolium rigidum* and *Taeniatherum caput-medusae*, are relatively large in size and highly unlikely to survive ruminant digestion (Wallace and Charles, 2013). The other three taxa that occur towards the positive end of axis 2 are *Ziziphora* sp., *Teucrium/Ajuga* sp. and *Thymelaea passerina/mesopotamica*, all of which are small in size as well, though most of these species also can grow or invade crop fields. Figure 5.19b shows that late flowering/fruiting species occur rarely but are all associated with the negative end of axis 2.

Table 5.23 Seasonality of wild/weed taxa identified at Tell Brak in relation to cereal harvesting time. Taxa occurring in more than 10 percent of samples were included. (): rarely occurs. E: early, I: intermediate and L: late.

Taxa	Months of flowering/fruiting												Class
	J	F	M	A	M	J	J	A	S	O	N	D	
Malva parviflora			X	X									E
Androsace maxima			X	X									E
Valerianella coronata Type			X	X	X								E
Medicago sp.			X	X	X								E
Malva sp.			X	X	X								E
Hyoscyamus cf. *muticus*			X	X	X								E
Eremopyrum bonaepartis/distans			X	X	X	(X)							E
Fumaria parviflora Type			X	X	X	(X)							E
Coronilla scorpioides			(X)	X	X	(X)							E
Aegilops tauschii (glume bases)				X	X								E
Adonis aestivalis Type				X	X								E
Avena sp.			X	X	X	X							E
Bromus spp.			X	X	X	X							E
Rumex sp.			X	X	X	X							E
Centaurea sp.			X	X	X	X	X						E
Hordeum spontaneum			X	X	X	X	X						E
Lepidium draba			X	X	X	X	X	(X)					E
Aegilops sp. (glume bases)			(X)	X	X	X							E
Silene dichotoma Type				X	X	X							E
Vaccaria hispanica				X	X	X							E
Hordeum murinum type				X	X	X							E
Galium spurium				X	X	X							E
Ornithogalum sp.				X	X	X	(X)						E
Leguminosae, small seeded			X	X	X	X	X	X					I
Lolium rigidum				X	X	X	X						I
Teucrium/Ajuga sp.				X	X	X	X						I
Ziziphora sp.				X	X	X	X						I
Thymelaea passerina/mesopotamica				X	X	X	X	(X)					I
Gypsophila spp.				X	X	X	X	X					I
Taeniatherum caput-medusae					X	X							I
Bolboschoenus glaucus				(X)	X	X	X	X	(X)	(X)	(X)		L
Cyperus laevigatus/rotundus				(X)	X	X	X	X	X	X	X		L
Prosopis farcta	X	X					X	X	X	X	X	X	L

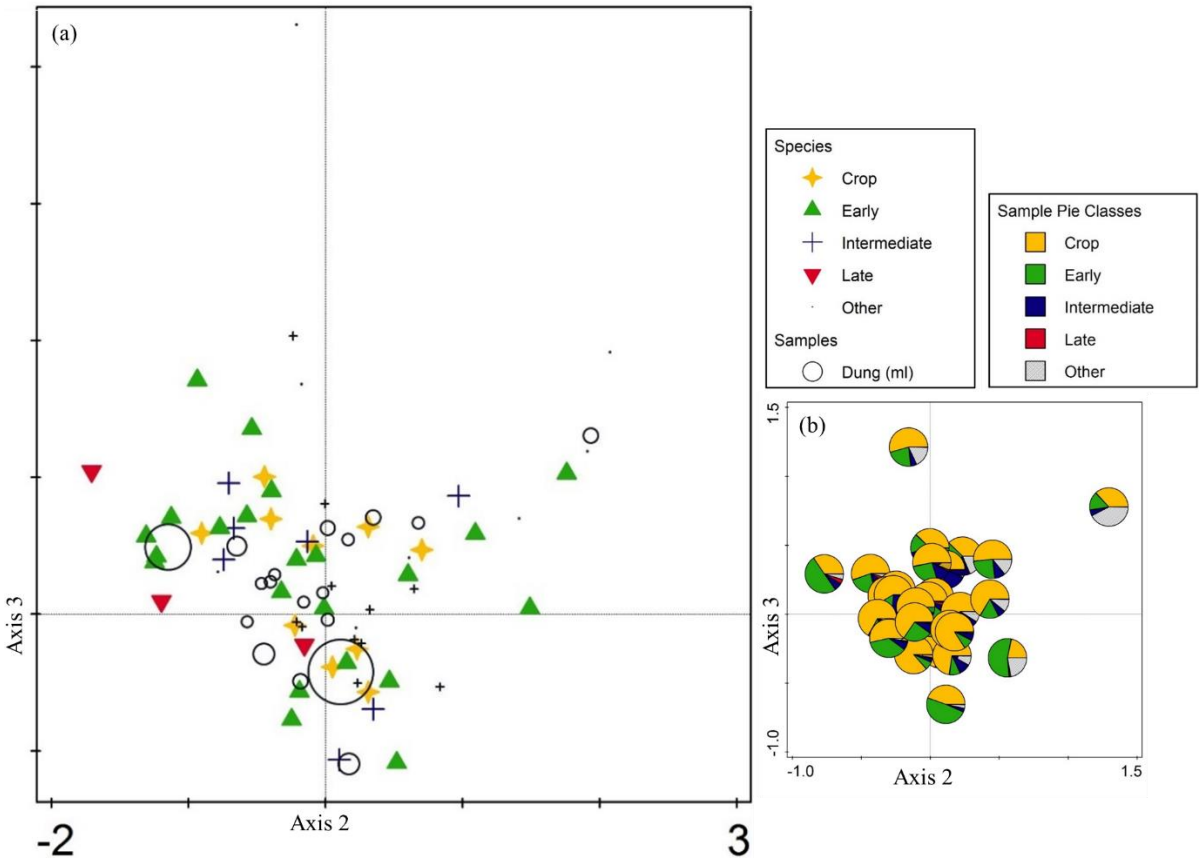


Figure 5.19 Correspondence analysis plot of 29 samples on the bases of 50 species (a) dung (ml) containing samples, with taxa coded by seasonality; (b) samples as pie charts illustrating the proportions of seasonality categories.

On the basis of the assessment of the habitat and seasonality of the Tell Brak weed/wild assemblage, the likelihood of taxa deriving from dung was examined. Species that are most likely to be derived from animal dung were scored 5 and those highly likely to be brought from crop fields with harvesting crop were scored 1. As a result, *Prosopis farcta* was the only species scoring 5 and *Bolboschoenus glaucus* and *Cyperus laevigatus/rotundus* followed with scores of 4 (Table 5.24). In Figure 5.20a, the species scoring 1 and 2 on the dung index are widely distributed over the plot whereas those scoring 5, 4 and several scoring 3 are confined to the negative end of axis 2, which are *Prosopis farcta*, *Bolboschoenus glaucus*, *Cyperus laevigatus/rotundus*, *Coronilla scorpioides*, *Medicago* sp., *Rumex* sp. and small-seeded legumes. These seeds are small in size and/or hard-coated, consistent with dung derivation.

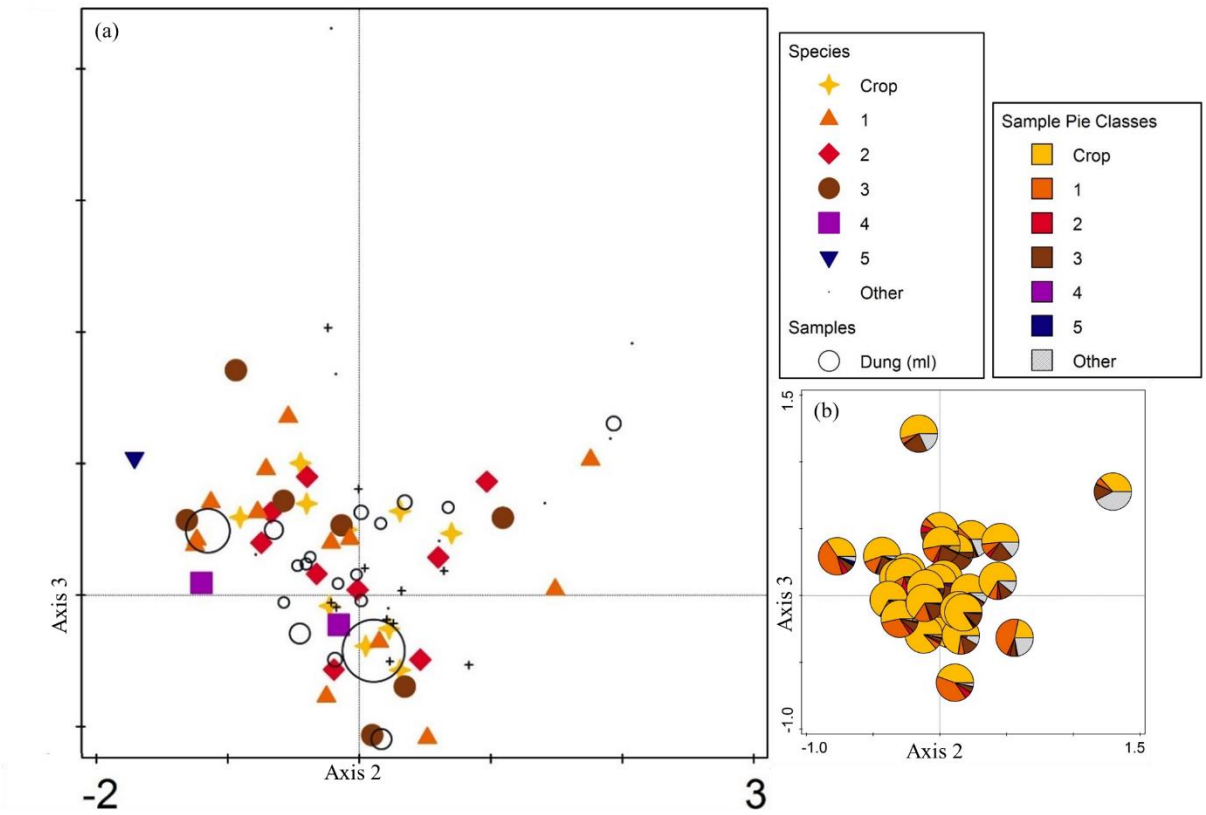


Figure 5.20 Correspondence analysis plot of 29 samples and 50 taxa showing (a) dung (ml) containing samples, with taxa coded by dung score; (b) samples represented as pie charts illustrating the proportions of scores.

Table 5.24 Summary of habitat, flowering/fruiting time and dung scores for wild/weed taxa in the Tell Brak assemblage. Taxa occurring in more than 10 percent of samples were included.

Species	**Habitat**	**Seasonality**	**Dungness**
Malva parviflora	Dry	Early	3
Androsace maxima	Dry	Early	2
Valerianella coronata Type	Dry	Early	1
Malva sp.	Dry	Early	3
Hyoscyamus cf. *muticus*	Dry	Early	2
Eremopyrum bonaepartis/distans	Dry	Early	2
Fumaria parviflora Type	Dry	Early	2
Adonis aestivalis Type	Dry	Early	1
Avena sp.	Dry	Early	1
Bromus spp.	Dry	Early	1
Centaurea sp.	Dry	Early	2
Hordeum spontaneum	Dry	Early	1
Aegilops sp. (glume bases)	Dry	Early	1
Silene dichotoma Type	Dry	Early	1
Vaccaria hispanica	Dry	Early	1
Hordeum murinum type	Dry	Early	1
Galium spurium	Dry	Early	1
Ornithogalum sp.	Dry	Early	1
Medicago sp.	Dry/wet	Early	3
Coronilla scorpioides	Dry/wet	Early	3
Aegilops tauschii (glume bases)	Dry/wet	Early	1
Rumex sp.	Dry/wet	Early	3
Lepidium draba (= *Cardaria draba*)	Dry/wet	Early	2
Leguminosae, small seeded	Dry	Intermediate	3
Lolium rigidum	Dry	Intermediate	1
Teucrium/Ajuga sp.	Dry	Intermediate	3
Ziziphora sp.	Dry	Intermediate	3
Thymelaea passerina/mesopotamica	Dry	Intermediate	2
Gypsophila spp.	Dry	Intermediate	2
Taeniatherum caput-medusae	Dry	Intermediate	2
Prosopis farcta	Dry/wet	Late	5
Bolboschoenus glaucus	Wet	Late	4
Cyperus laevigatus/rotundus	Wet	Late	4

Charles' (1998) third criterion is based on Jones' (1984; 1987) discriminant analysis based on physical weed seed types as a means of assessing how far samples conform to biases expected from crop processing, or how far they diverge from these expectations due for example to the pervasive effect of dung-derived material. To assess this, archaeological samples are entered at the classification phase and also as a separate group in the discrimination phase of the analysis (Figure

5.21a and b). TB11/27.22 was excluded since it contained less than ten weed/wild items. Although in the five-group analysis 56 percent of samples were classified in the separate Brak group (Table 5.25), comparison between the two graphs (without and with archaeological samples as a separate group) hardly shows a differentiation (Figure 5.21). The pattern of the two discriminant analysis plots in the Tell Brak assemblage seems to represent a mixture of residues from crop processing stages.

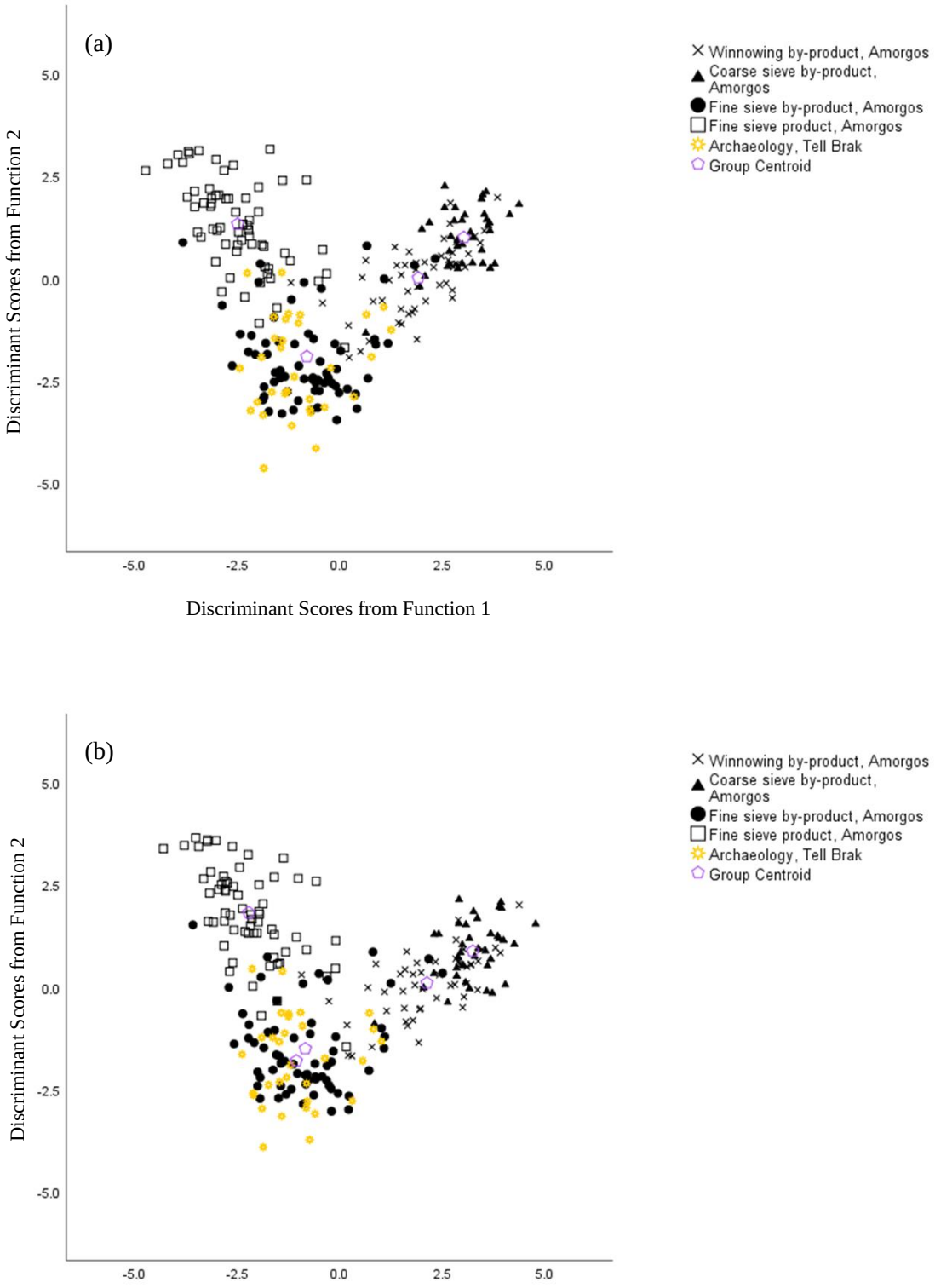


Figure 5.21 Discriminant analysis plot of the 32 Tell Brak samples that are (a) entered as ungrouped in the classification stage of the discriminant analysis and (b) entered as a separate group in the discrimination phase.

Table 5.25 Summarised sample classifications based on two versions of the weed-based discriminant analysis, with (a) the archaeobotanical samples entered as ungrouped in the classification phase and (b) as a separate group in the discrimination phase.

Predicted Group Membership						
		Winnowing by-product	Coarse sieve by-product	Fine sieve by-product	Fine sieve product	Group 5
a	Count	0	0	30	2	N/A
	%	0.0	0.0	93.8	6.3	N/A
b	Count	0	0	12	2	18
	%	0.0	0.0	37.5	6.3	56.3

At Tell Brak, none of the sample completely meets the condition of mixed crop group, using a 70 percent threshold, and all samples were grouped as either barley or free-threshing cereal rich (Table 4.12). The examination of mixture of different crop groups suggested by Charles (1998), thus, was not conducted for the Tell Brak assemblage.

In sum, the Tell Brak assemblage is dominated by weed seeds associated with various crop processing stages rather than dung-derived wild taxa. Nevertheless, it is evident that the samples do contain a small number of taxa that are likely dung-derived (e.g. small in size, hard-coated, preferring wet conditions, late flowering/fruiting).

Chapter 6. Exploring compositional variation in the archaeobotanical assemblages, including spatial patterning

The following chapter explores variation within the assemblages of the three sites using correspondence analysis. Samples were coded by period, area, context type and density in order to consider trends in sample composition. As for spatial patterning in the assemblages, pie charts were used to summarise archaeobotanical composition and plotted on relevant excavation plans, where available. Only species occurring in over 10 percent of samples were included from the Tell Mohammed ‘Arab and Tell Brak assemblage. As to Tell Atchana, taxa occurring in less than 6 percent of samples were excluded in order to secure more weed/wild categories. Codes for species plotted in the diagrams are explained in Table 6.1 and contextual information is described in Table 6.2.

Table 6.1 List of codes and taxa/types used in correspondence analysis for the three study site.

	Code	**Taxa/types**
Crop	BA_Gr	Two-row hulled barley grain
	BA_Ch	Two-row hulled barley rachis
	FW_Gr	Free-threshing wheat grain
	FW_Ch	Free-threshing wheat internodes
	GW_Gr	Glume wheat grain
	GW_Ch	Glume wheat glume bases
	AV_Gr	Oat grain
	AV_Ch	*Avena* cf. *sativa* floret base
	BITVT	Bitter vetch
	CHICK	Chickpea
	GRASP	Grass pea
	LENTI	Lentil
	PEA	Pea
	FLAX	Flax
	OLIVE	Olive
Weed/wilds	BELLE	*Bellevalia* sp.
	ORNIT	*Ornithogalum* sp.
	ECHIU	*Echium angustifolium/parviflorum*
	ECH/LIT	*Echium/Lithospermum* sp.
	HELIO	*Heliotropium* sp.
	CAPER	*Capparis spinosa*
	CEPHA	*Cephalaria* sp.
	VAL_C	*Valerianella coronata* (type)
	VAL_D	*Valerianella dentata* (type)
	GYPSO	*Gypsophila* sp.
	GYPSO	*Gypsophila* spp.
	SILEN	*Silene dichotoma* (type)
	SILEN	*Silene* sp.
	VAC_H	*Vaccaria hispanica*
	VAC_P	*Vaccaria pyramidata*
	CHENO	*Chenopodium* sp.
	HELIA	*Helianthemum* sp.
	ANT_C	*Anthemis cotula*
	CENTA	*Centaurea* sp.
	FCOMPO	Compositae type 5
	FCRUCI	Cruciferae indet.
	LEP_D	*Lepidium draba* (= *Cardaria draba*)
	LEP_S	*Lepidium sativum*
	BOLBO	*Bolboschoenus glaucus*
	FCYPER	Cyperaceae indet.
	CYPER	*Cyperus laevigatus/rotundus*
	COR_S	*Coronilla scorpioides*
	CORON	*Coronilla* sp.
	HIPPO	*Hippocrepis unisiliquosa/ciliata/multisiliqusa*
	LARLEG	Large legumes indet.

	Code	Taxa/types
	SMALEG	Leguminosae, small seeded
	MEDIC	*Medicago* sp.
	PRO_F	*Prosopis farcta*
	SCO_M	*Scorpiurus muricatus*
	AEG_Ch	*Aegilops* sp., glume bases
	AEG_Gr	*Aegilops* spp./sp., grain
	BROMU	*Bromus* spp.
	EREMO	*Eremopyrum bonaepartis/distans*
	GRASW	Grass weeds indet.
	HOR_S	*Hordeum spontaneum*
	HOR_W	*Hordeum murinum* type
	LOL_RSM	*Lolium rigidum* (<1mm)
	LOL_RLG	*Lolium rigidum* (>1mm)
	LOL_T	*Lolium temulentum*
	PHA_A	*Phalaris aquatica*
	PHALA	*Phalaris* sp.
	TAE_C	*Taeniatherum caput-medusae*
	TRI_B	*Triticum boeoticum*
	TEU/AJU	*Teucrium/Ajuga* sp.
	ZIZIP	*Ziziphora* sp.
	MALVA	*Malva* sp.
	MALVA	*Malva sylvestris/neglecta*
	FUM_P	*Fumaria parviflora* (type)
	PLANT	*Plantago* sp.
	RUMEX	*Rumex* sp.
	ANA_A	*Anagallis arvensis*
	AND_M	*Androsace maxima*
	ADONI	*Adonis aestivalis* (type)
	ADONI	*Adonis* spp.
	RAN_A	*Ranunculus arvensis*
	GALIU	*Galium* spp.
	GAL_S	*Galium spurium*
	SHE_A	*Sherardia arvensis*
	HYOSC	*Hyoscyamus* cf. *muticus*
	THYME	*Thymelaea passerine/gussonei/mesopotamia*
	THYME	*Thymelaea passerine/mesopotamica*
	BUP_I	*Bupleurum intermedium* (= *B. subovatum*)
	FUMBEL	Umbelliferae indet.
Fruit	FIG	*Ficus carica*
	GRAPE	*Vitis vinifera*

6.1. Tell Mohammed ‘Arab

Figures 6.1a and b show, respectively, correspondence analysis plots of species and of samples (represented as pie charts), based on a correspondence analysis of 25 samples and 62 taxa. Both plots are clearly divided into three groups: barley grain-rich samples lower right, glume wheat and free-threshing wheat samples top and weed/wild rich samples lower left.

Barley grain is situated at the positive (right) end of axis 1 along with several weed taxa such as *Bellevalia* sp., *Ornithogalum* sp., *Vaccaria hispanica* and *Galium spurium* in the species plot. Samples at this end of axis 1 are clearly dominated by barley grain, resembling barley product and relevant barley weeds.

Glume wheat grain, glume wheat glume bases and free-threshing wheat grain tend to co-occur towards the positive (top) end of the axis 2 (Figure 6.1a), and these types mainly appear to be related to glume wheat rich samples (Figure 6.1b), classified as glume wheat by-product in Chapter 5. Free-threshing wheat rachis internodes are also pulled out towards the top of the plot (Figure 6.1a). This relates to a single free-threshing wheat internode-rich sample identified in Chapter 5 as representing mixed free-threshing wheat stages (Figure 6.1). Barley rachis is a minor crop category in the Tell Mohammed ‘Arab samples, and occurs near the origin.

Meanwhile, the four pulse taxa are generally distributed. Of these, the location of grass pea is closer to barley grain-rich section whilst bitter vetch is adjacent to the cluster of glume wheat grain, glume wheat glume bases and free-threshing wheat grain. Lentil and chickpea tend to occur towards the weed/wild-rich group.

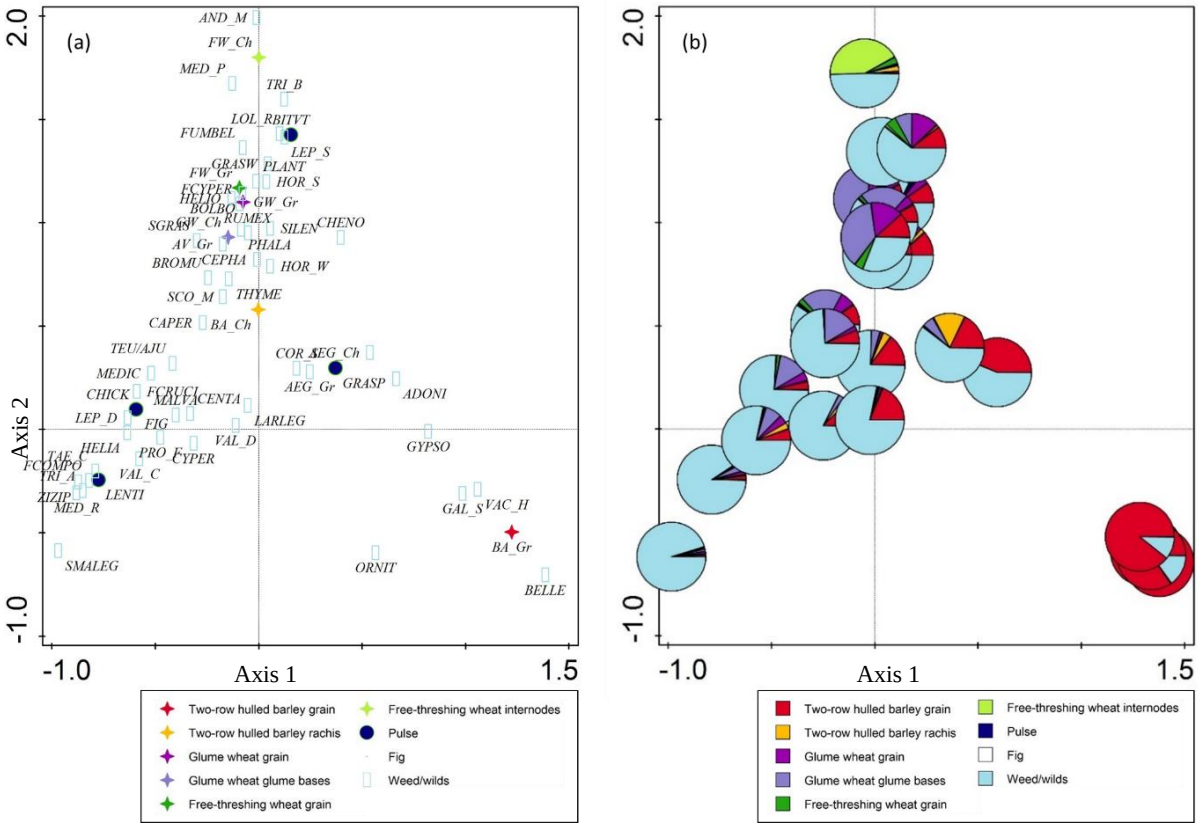


Figure 6.1 Correspondence analysis plots of (a) 62 taxa/types based on their occurrence in 25 samples and (b) 25 samples on the basis of 62 taxa/types, with samples represented as pie charts illustrating proportions of major taxa/types.

Figure 6.2 shows the plot of samples coded by three chronological periods at Tell Mohammed ʻArab. The samples are clearly separated according to the three periods in the plot. The Middle Assyrian samples tend to be dispersed towards the lower right of horizontal axis and are dominated by either barley, especially grain, or weed/wild taxa mixed with certain amount of barley material; accordingly, they were classified as barley product, barley fine sieve by-product and mixed barley in Chapter 5. One anomalous Middle Assyrian sample composed of mostly free-threshing wheat rachis internodes is located towards the top end of the plot and classified as mixed stage free-threshing wheat (Figure 6.2, 6.1b and 5.6a).

The majority of Ninevite V samples are widely distributed to the left of the plot whilst Late Uruk samples are concentrated towards the positive end of axis 2, overlapping with several Ninevite V ones (Figure 6.2). Both the Late Uruk and Ninevite V periods chiefly consist of a combination of glume wheat and weed/wild material (Figure 6.1b). However, it is notable that the Ninevite V

samples contain higher proportions of weed/wild taxa (and were mostly classified as mixed crop in Chapter 5) while the samples from the Late Uruk occupation contain more glume wheat by-product (Figure 6.1b, 6.2 and 5.6a).

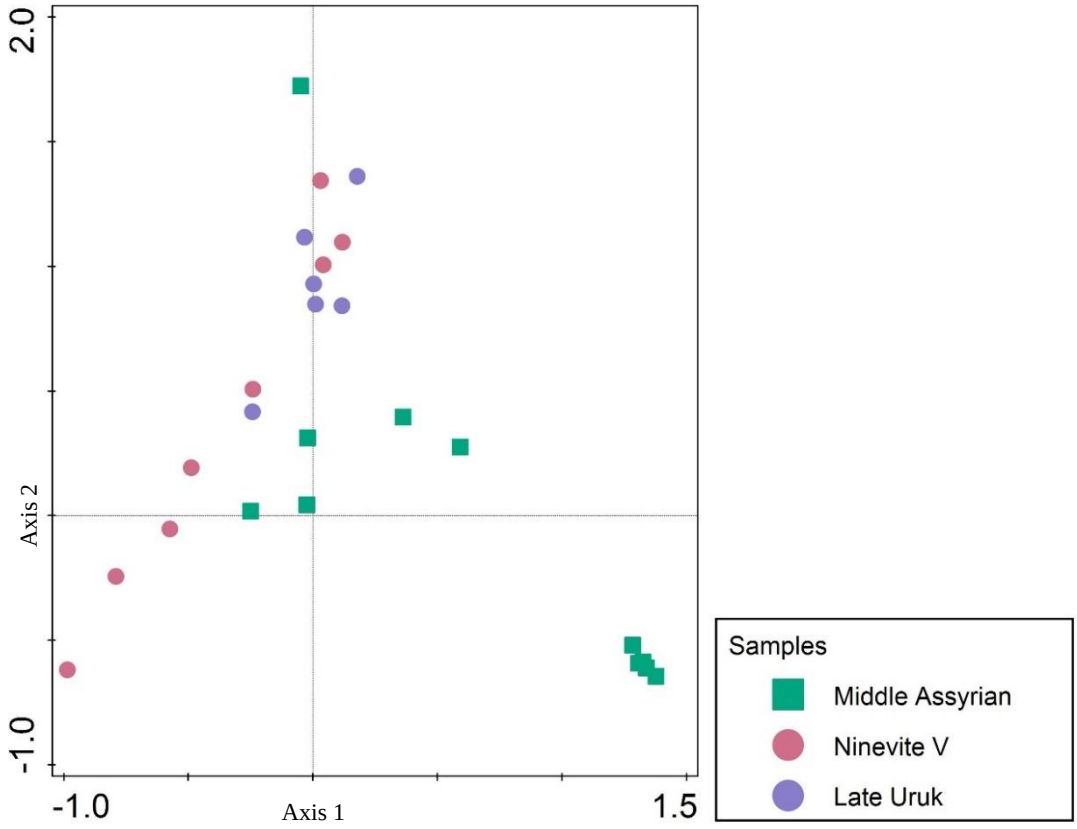


Figure 6.2 Correspondence analysis plot of 25 samples on the basis of 62 taxa/types with samples coded according to period.

In Figure 6.3, the Tell Mohammed ʻArab samples are coded by context types and it shows a weak contextual pattern, albeit based of a limited contextual information from this unpublished excavation. Two samples deriving from mudbricks occur lower right, away from other Middle Assyrian rich in barley grain (Figure 5.6a, Figure 6.3 and Figure 6.1b). Three Middle Assyrian samples taken from hearths (red triangle markers in Figure 6.3) tend to be rich in weed/wild material with a certain amount of either free-threshing rachis internode or barley, and were classified as mixed free-threshing wheat and barley fine sieve by-product, respectively. Meanwhile

the remaining samples derive from fills, a pit, a floor, rubbish and courtyards, and were samples identified as either mixed crop or glume wheat by-product stage in Chapter 5 (Figure 5.6a).

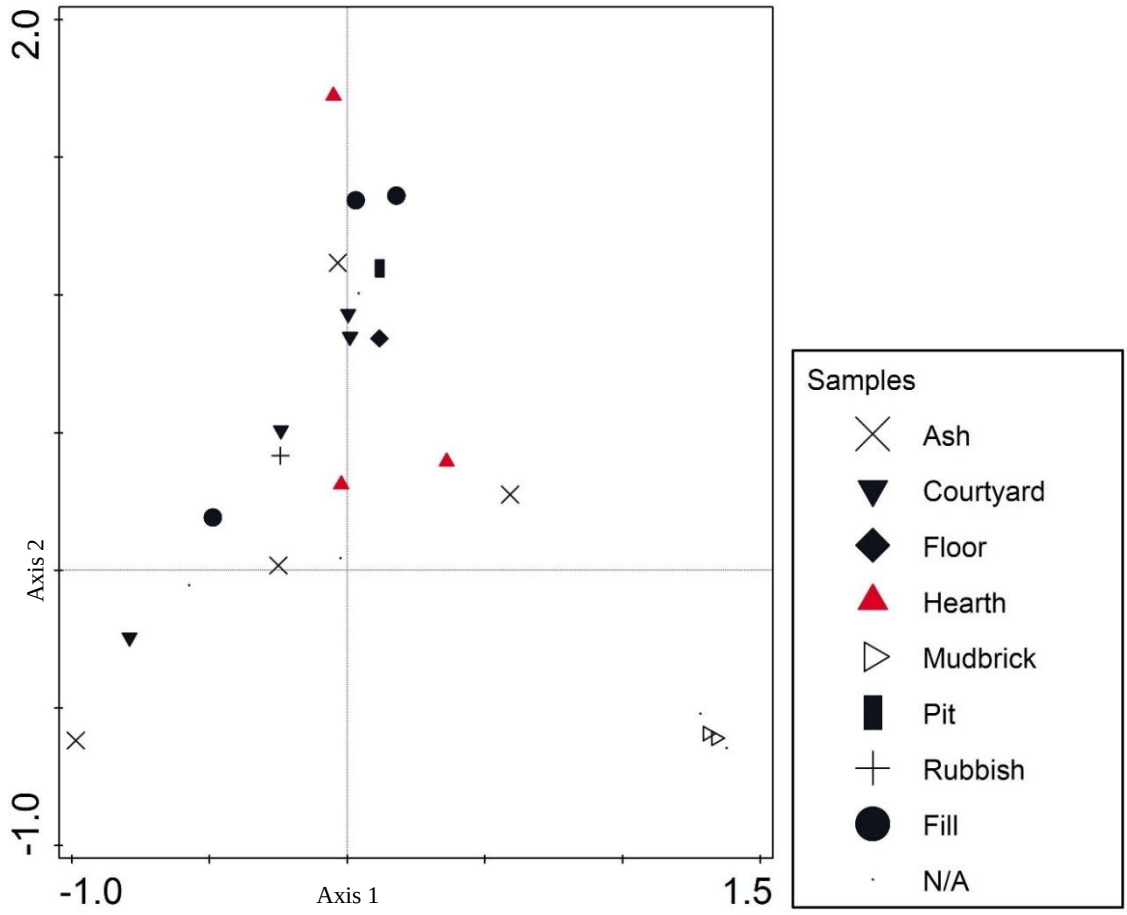


Figure 6.3 Correspondence analysis plot of 25 samples on the basis of 62 taxa/types with samples coded according to context types.

Despite the limited number of archaeological plans available for plotting sample pie charts, and the restricted range of context types, spatial patterning in plant composition was assessed for four available levels (i.e. level B, C, F and L) excavated in part of the main sounding by plotting samples on archaeological plans (Figure 6.4a, b, c and d). Level B, C and F derive from the Ninevite V period and level L from the Late Uruk period. The archaeological plans for the Middle Assyrian occupation were not available. All samples herein derive from courtyard layers associated with a building, except for TM28, which was collected from a burial pit/fill.

In level B, the major component of TM35 is weed/wild taxa with glume wheat glume bases, being classified as mixed crop in Chapter 5, and this was collected from courtyard layers associated with a building from the Ninevite V occupation (Figure 6.4a).

The level C sample, TM36, shares the same context, the same period and the same crop processing stage as TM35, i.e. courtyard layers from a Ninevite V period representing mixed crop stages, but this contained overwhelmingly weed/wild material, with a low proportion of crop material (Figure 6.4b).

Figure 6.4c illustrates the composition of TM28 plotted onto the plan for level F; this sample was identified as glume wheat by-product in Chapter 5 and is dominated by weed/wild taxa. Unlike the other samples, TM28 originates from the unique context of a grave cut/fill in the Ninevite V occupation.

Three samples plotted on the level L plan are shown in Figure 6.4d. They are all taken from courtyard layers associated with a building from the Late Uruk occupation. While two samples are weed/wild-dominated and classified as representing mixed crops/stages, it is clear that TM50 is mainly composed of glume wheat glume bases followed by glume wheat grain, barley grain and free-threshing wheat grain. It was classified as a glume wheat by-product in Chapter 5.

Plotting of samples as pie charts on the four level plans demonstrates limited patterning. The variation of the proportions of glume wheat glume bases is detected but not significant. None of these contexts relates to burning *in situ* and so represented re-deposited material.



Figure 6.4 Plans of the main sounding at Tell Mohammed ‘Arab from (a) Phase 2, Level B, (b) Level C, (c) Level F and (d) Level L with pie charts representing proportions of major taxa/types.

Tell Mohammed ‘Arab samples are coded by density in Figure 6.5, with some limited patterning (e.g. barley grain-rich samples resembling stored material are also relatively high in density) (Figure 5.6a).

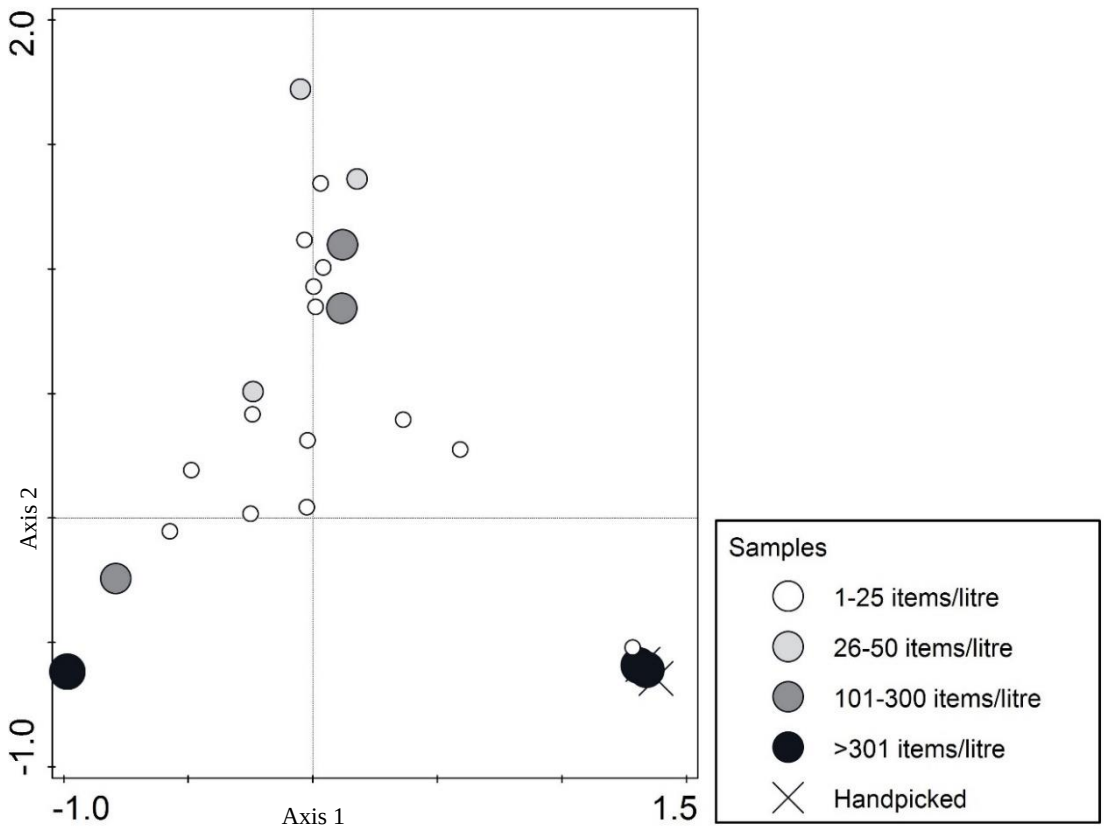


Figure 6.5 Correspondence analysis plot of 25 samples on the basis of 62 taxa/types with samples coded according to density.

To summarise, limited contextual data and the absence of archaeological plans from the Middle Assyrian period confine the assessment of patterning at Tell Mohammed ‘Arab. Nonetheless, the correspondence analysis of sample composition in accordance with periods and context types shows some clear trends and groupings. Three groups are observed: barley grain-dominant, glume wheat-dominant and weed/wild-dominant. The first has a strong association with the Middle Assyrian occupation, resembling the storage of barley product material, whilst the other two relate to the earlier periods, indicating glume wheat processing and/or mixed crop/processing signatures.

6.2. Tell Atchana

Tell Atchana samples were analysed using correspondence analyses in order to explore variation within the plant assemblage. Rare taxa occurring in less than 6 percent of samples were excluded

from the analysis. Sample containing less than 30 items (i.e. TA2011.330) was also left out. Further reduction of plant categories/samples was conducted where outliers appeared. This resulted in the elimination of five outlier samples and therefore 45 samples and 50 taxa were included in this subsequent analysis in order to display variation amongst remaining species and samples.

Figure 6.6a and b provide plots of species and samples. The former plot shows that the cereal chaff categories, towards the negative ends of both axes, are clearly distinguished from the remaining cereal grain and pulse types, towards the positive end of axis 1 and negative end of axis 2. Within the cereal grain and pulse types, the cereal grain categories tend to be more generally distributed. Free-threshing wheat grain is, however, slightly separated from the other cereal grains and weed/wild categories along the first axis. Bitter vetch and lentil are located upper right, adjacent to glume wheat grain.

The pattern shown in Figure 6.6a is reflected in the plot of sample pie charts (Figure 6.6b). In general, free-threshing wheat grain is the most abundant at the top end of axis 2 and declines towards the bottom whilst the percentage of weed/wild taxa rises towards the negative end of axis 2. The proportion of free-threshing wheat grain increases towards the positive (top) ends along both axes, at the expense of weed/wilds and other types. One sample at the top of axis 2 even shows almost pure free-threshing wheat grain composition. Toward the right end of axis 1, another group of samples is evident. This shows similar plant components to the first group (free-threshing wheat grain-rich) but is comprised of more weed/wild material and less free-threshing wheat grain and pulse types. By contrast, samples which are relatively rich in cereal chaff and poor in pulse are distributed towards the negative end of axis 1, especially lower left.

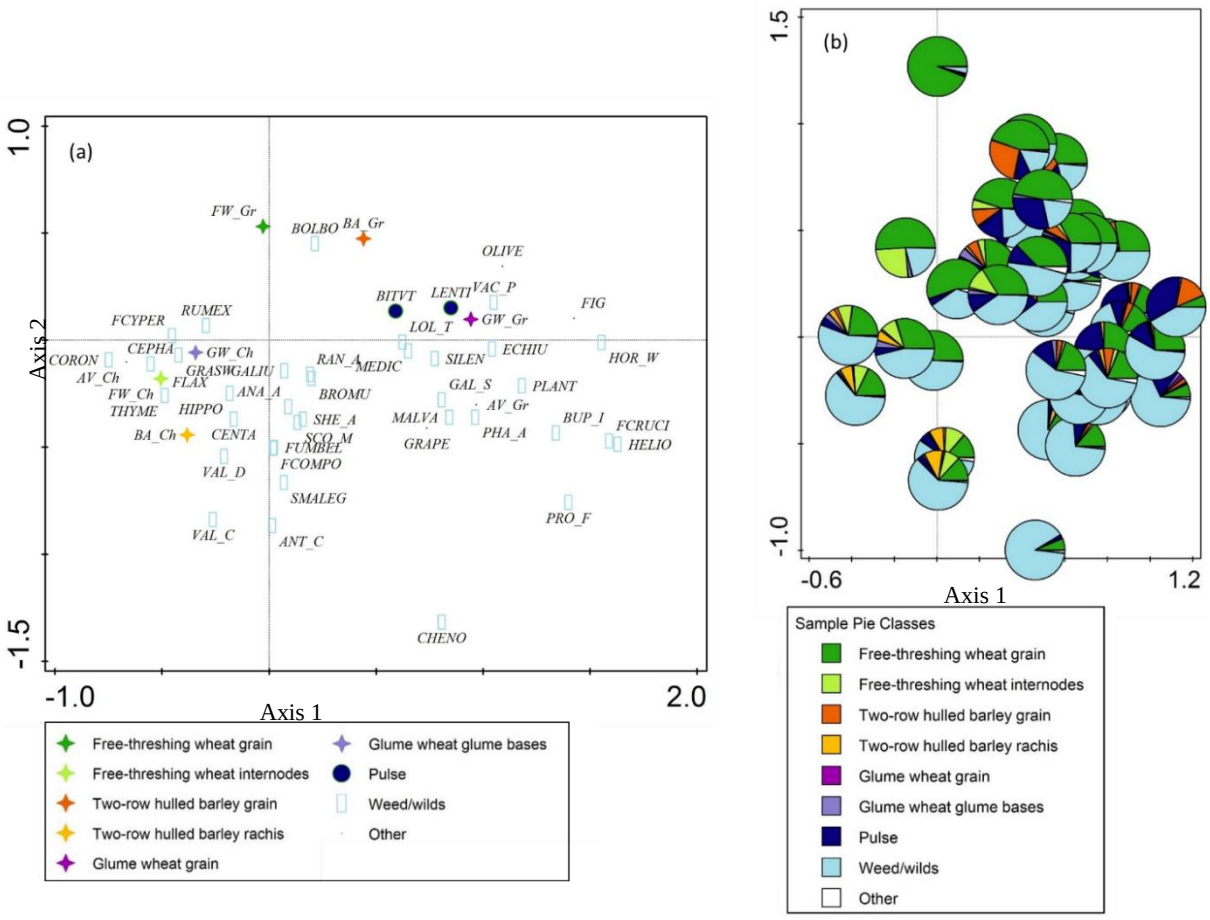


Figure 6.6 Correspondence analysis plots of (a) 50 taxa/types based on their occurrence in 45 samples and (b) 45 samples on the basis of 50 taxa/types, with samples represented as pie charts illustrating proportions of major taxa/types.

Figure 6.7 illustrates samples coded by Tell Atchana periods from 2 to 8 in order to explore chronological variation. The periods from 2 to 3 represents the Late Bronze II (ca. 1400-1300 BC), the periods from 4-6 represents the Late Bronze I (ca. 1600-1400 BC) and the periods from 7-8 represents the Middle Bronze II (ca. 1800-1600 BC). The plot demonstrates that the majority of samples from the Late Bronze I and II (period 2, 3, 3-4 and 6) spread out in the upper right part of the plot, which are linked chiefly to the high levels of free-threshing wheat grain and pulses with little cereal chaff (Figure 6.7 and 6.6). Within the Middle Bronze II (period 7 and 7-8), period 7 samples are clearly confined to the positive end of the axis 1, containing high proportions of weed/wild taxa with a relatively balanced proportion of free-threshing wheat grain and pulses (Figure 6.7 and 6.6b). On the other hand, period 7-8 samples are widely distributed, indicating that

the spectrum of the plant composition is variable, including the three plant composition groups discussed above for Figure 6.6b.

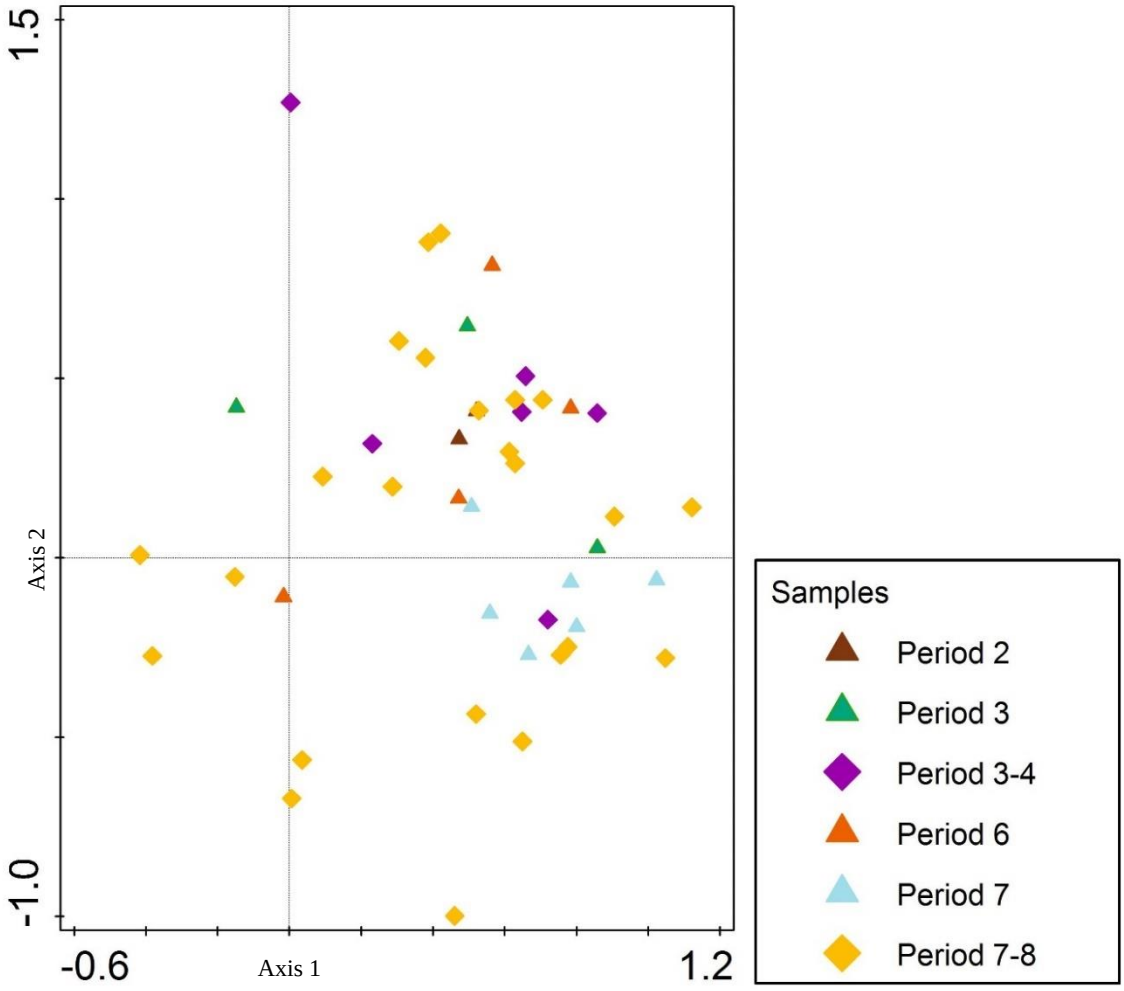


Figure 6.7 Correspondence analysis plot of 45 samples on the basis of 50 taxa/types with samples coded according to period.

Figure 6.8 shows the sample plot coded by Tell Atchana excavation area and square. As can be seen in Figure 6.7, the vast majority of Area 1 samples are obtained from the Middle Bronze Age and they are ubiquitous all over the plot. Samples from Area 3 are located lower right, being weed/wild-rich with a certain amount of free-threshing wheat grain and pulses. On the other hand,

Area 4 samples occur upper right and are strongly associated with cereal grain, especially free-threshing wheat grain.

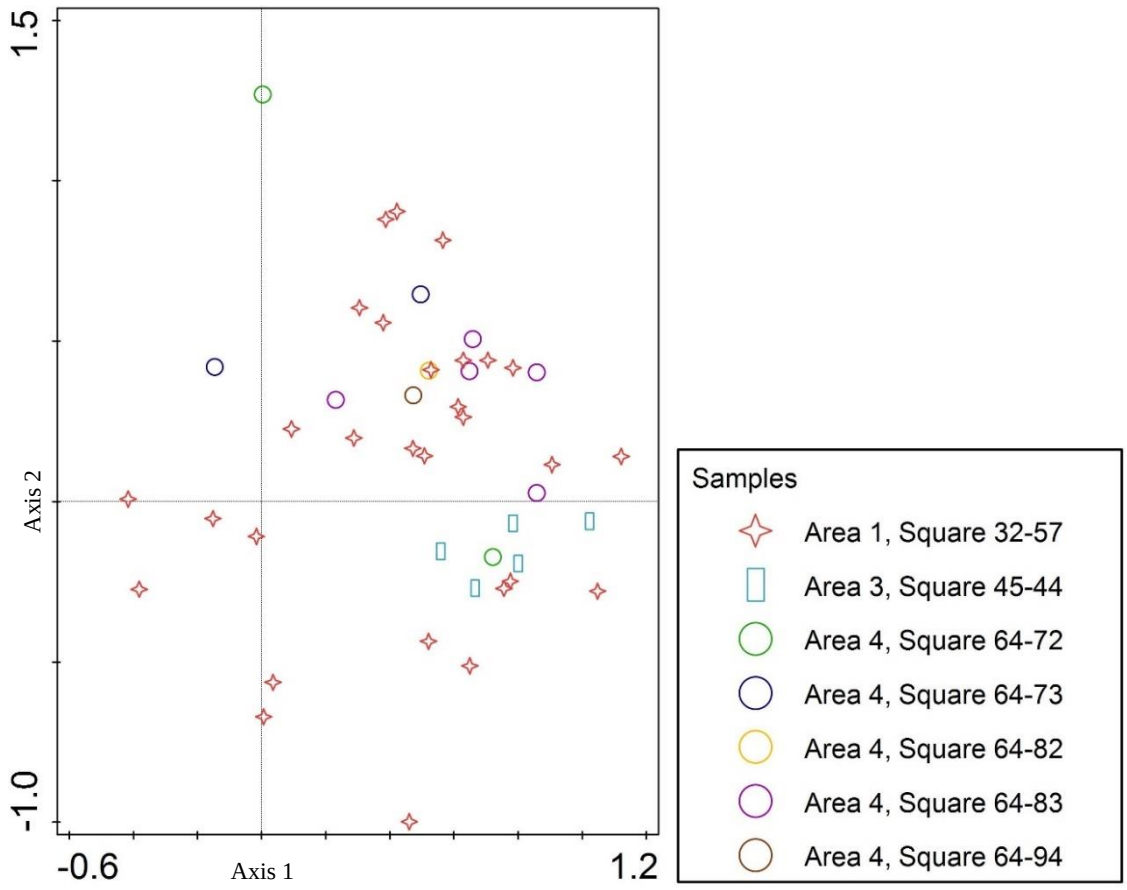


Figure 6.8 Correspondence analysis plot of 45 samples on the basis of 50 taxa/types with samples coded according to Area/Square.

Tell Atchana samples were coded by archaeological deposit type (Figure 6.9). The distribution of pit, ashy fill and fill samples tend to be towards the upper right of the plot. These samples can be characterised as rich in cereal grain and pulses, particularly free-threshing wheat grain and bitter vetch. The categories of fire installations (i.e. kiln and tandoor), floor and cemetery fill occur at the right end of the plot and contain high proportions of weed/wild taxa with free-threshing wheat grain and pulses. Conversely, samples from wood remains are located towards the negative ends of

both axes and are characterised by the combination of weed/wild material and relatively high proportions of cereal chaff.

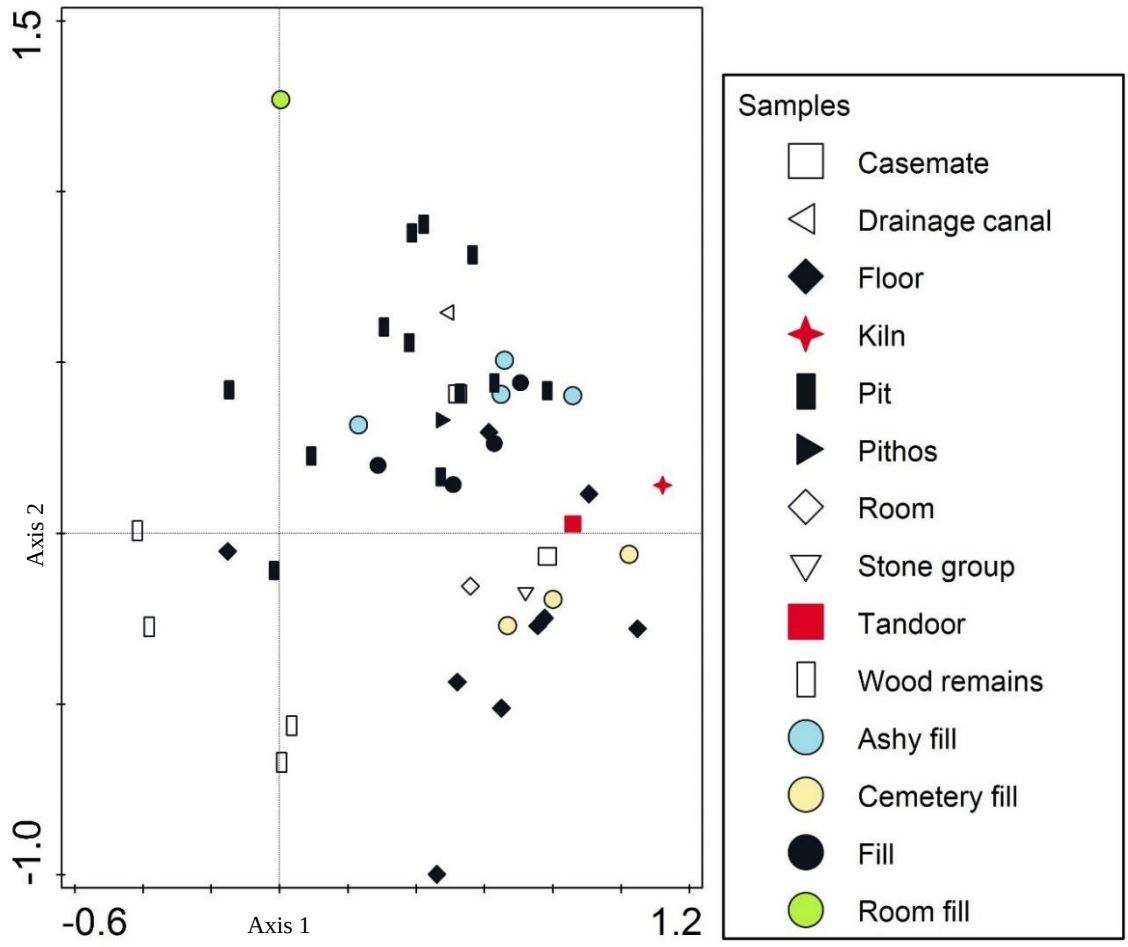


Figure 6.9 Correspondence analysis plot of 45 samples on the basis of 50 taxa/types with samples coded according to context types.

The following section displays the plant content of each excavation area in order to estimate archaeobotanical remains in relation to space, contextual types and periods. Samples taken from Area 1, 2, 3 and 4 were plotted onto plans as pie charts, where possible.

The majority of Tell Atchana plans available were provided for Area 1, Square 32.57 (Figure 6.10-6.11) which exposed part of a monumental apsidal building and potential sanctuary area (Yener, 2015a). Of these, Figure 6.10 shows a Late Bronze I sample plotted onto the plan, showing an

olive stone concentration originating from a burnt room fill from the Late Bronze I (period 5). A pure accumulation of olive stones/fragments adjacent to the ash pits from the indoor space (room) suggests that this was a deliberate accumulation related to by-products.

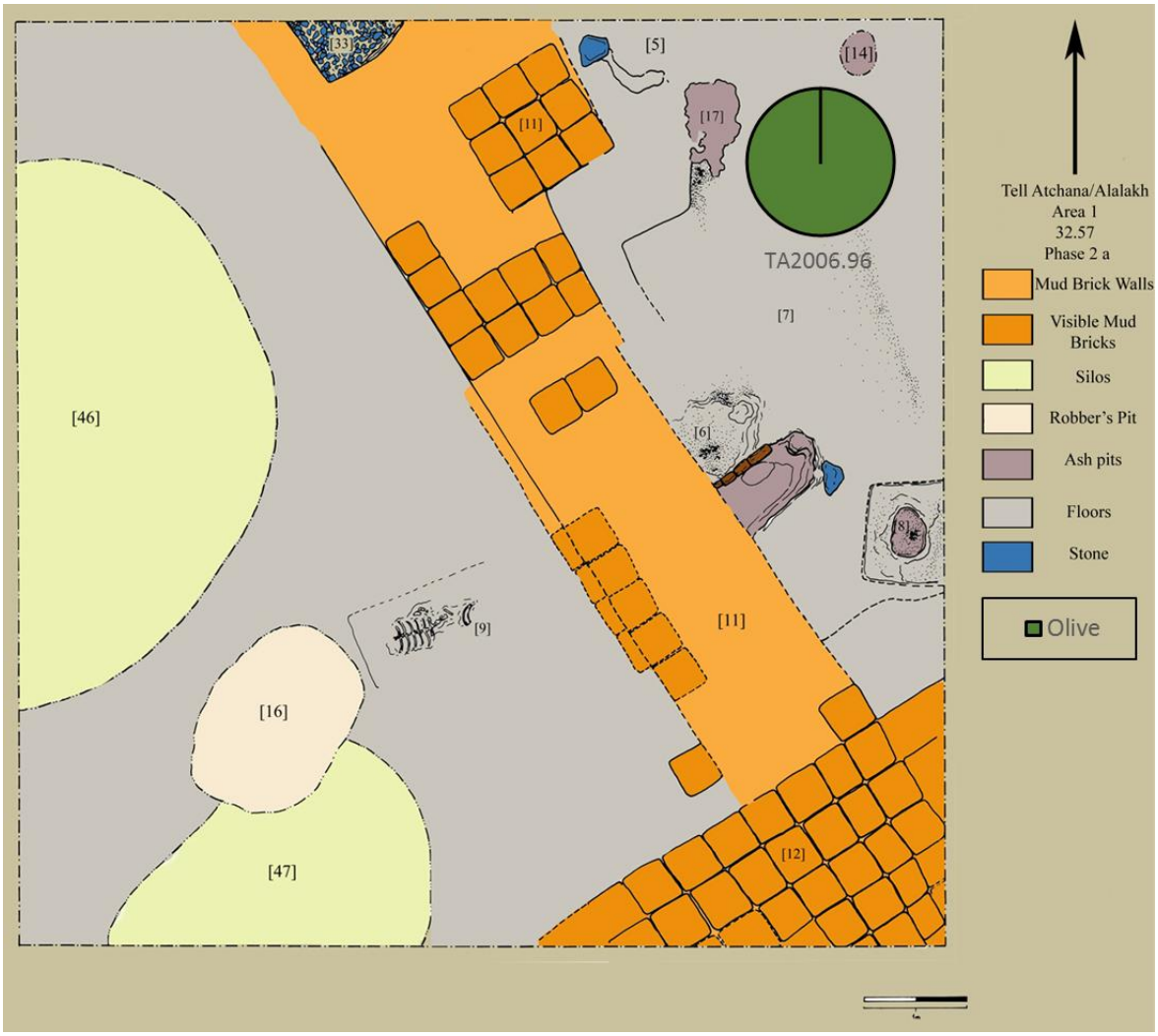


Figure 6.10 Plan of Area 1, Square 32.57 at Tell Atchana from Phase 2a with a pie chart representing a 100 percent pure olive accumulation.

Figures 6.11a, b, c and d plot samples onto four plans, for Phase 5b, 5c, 5d and 5f, respectively, in chronological order for Area 1, Square 32.57, within the Middle Bronze II (period 7-8). Samples in Phase 5b originate from a pit and floors (Figure 6.11a). TA2011.29 was sampled from a pit and represents mixed crop material with a high proportion of free-threshing wheat grain and bitter

vetch (Table 5.18). The remaining five samples within this phase were all derived from floor contexts. TA2010.3 and TA2010.9 were collected from the floor of room 178 in the north of the square and both were classified as free-threshing wheat fine sieve by-product, containing high level of weeds and chaff material. TA2011.22 was taken from a floor beside a pit and this consists of free-threshing wheat grain and bitter vetch. Meanwhile, the other floor samples, TA2010.12 and TA2010.1, originated outside the apsidal building. The former contains few crop items, while relatively high proportions of bitter vetch and olive stones were recovered from the latter sample.

Phase 5c samples are restricted to the south-west corner of the square, and were recovered from two pits (Figure 6.11b). Unlike other samples, it is interesting that the crop processing stages of these samples were identified to free-threshing cereal fine sieve product suggesting that these contexts might have played a role as storage pits for free-threshing wheat and barley grain. One exceptional sample, TA 2012.4, was identified as free-threshing wheat fine sieve by-product for a large proportion of weeds and a strong characteristic of fine sieve by-product-related weed species (Table 5.14). However, the fact that this sample is comprised of only free-threshing wheat grain and bitter vetch as crops, and that free-threshing wheat grain dominates it, implies that TA2012.4 could also represent stored product.

A single sample could be plotted onto each plan of Phase 5d and 5f (Figure 6.11c and d). The sample in the former plan (TA2011.41) derives from floor and represents mixed crop stages (Figure 6.11c). The Phase 5f sample (TA2012.25) was taken from a fill inside the apsidal structure. This sample is comprised of mainly free-threshing wheat grain and internodes, and was classified as free-threshing wheat fine sieve by-product (Figure 6.11d).

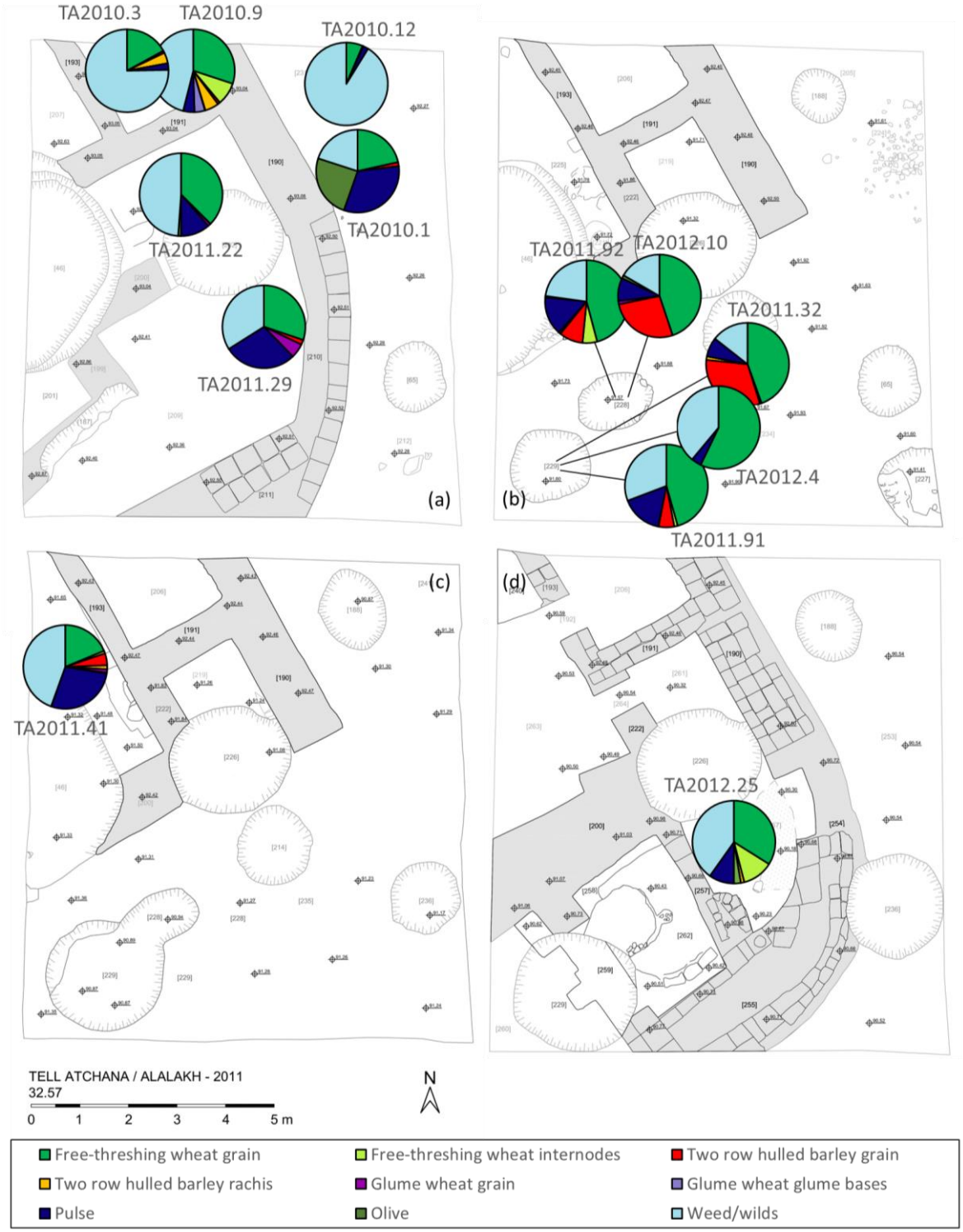


Figure 6.11 Plans of Area 1, Square 32.57 at Tell Atchana from (a) Phase 5b, (b) Phase 5c, (c) Phase 5d and (d) Phase 5f, with pie charts representing proportions of major taxa/types.

Only two samples, TA2011.327 and TA2011.330, were collected in a fire pit in Area 2, Square 44.86, both from phase 2 in the Late Bronze Age II (Figure 6.12). The former sample was

classified as mixed crop but the number of items was less than 30 (Table 4.7 and 5.18), whereas the latter one was classified as free-threshing wheat fine sieve by-product (Table 5.14). A minority of glume wheat grain and glume bases occurred in this sample. The plant remains in this sample might have been resulted from daily activity residues that accumulated and were burned in situ.

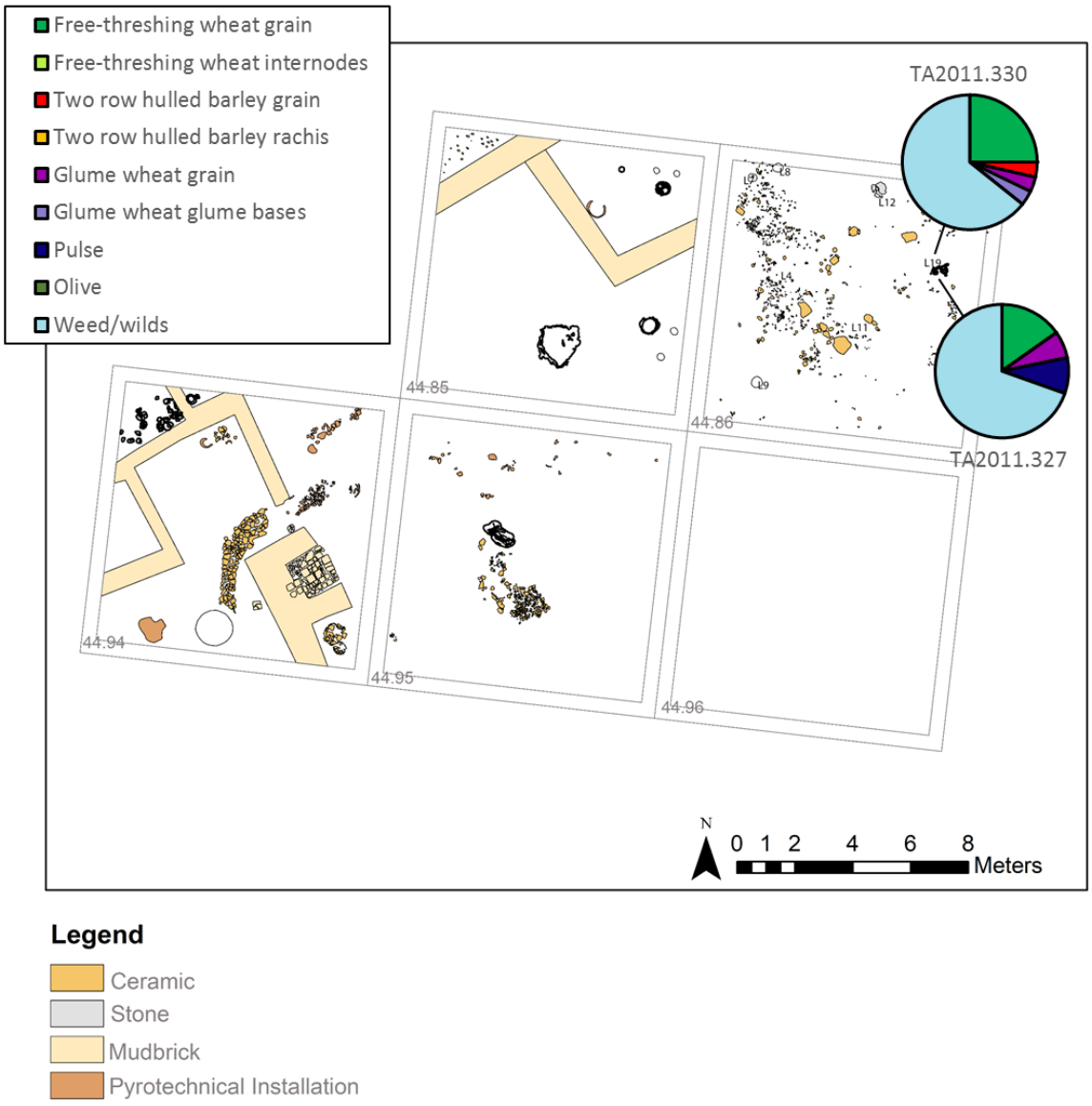


Figure 6.12 Plan of Area 2 at Tell Atchana from Phase 2 with pie charts representing proportions of major taxa/types.

Phase 5 in Area 3, Square 45.44 revealed a thick mudbrick fortification wall from the Middle Bronze II (Figure 6.13). Five samples were plotted on the plan, representing two context types. TA2012.14, TA2012.15, TA2012.17 and TA2012.22 originate outside the defensive structure, from a floor underlying cemetery fill. Of these, TA 2012.14 includes less than 30 items of mixed crops, whilst the other three were defined to the crop processing stage of free-threshing cereal fine sieve by-product (Table 5.14). Their key crop components are free-threshing wheat grain and bitter vetch, with high proportions of weed/wild taxa. On the other hand, TA2012.26 was collected inside the city wall from a room in the western corner of the trench. Its crop processing stage was defined as mixed crop but the number of items in this sample is less than 30, limiting further explanation.

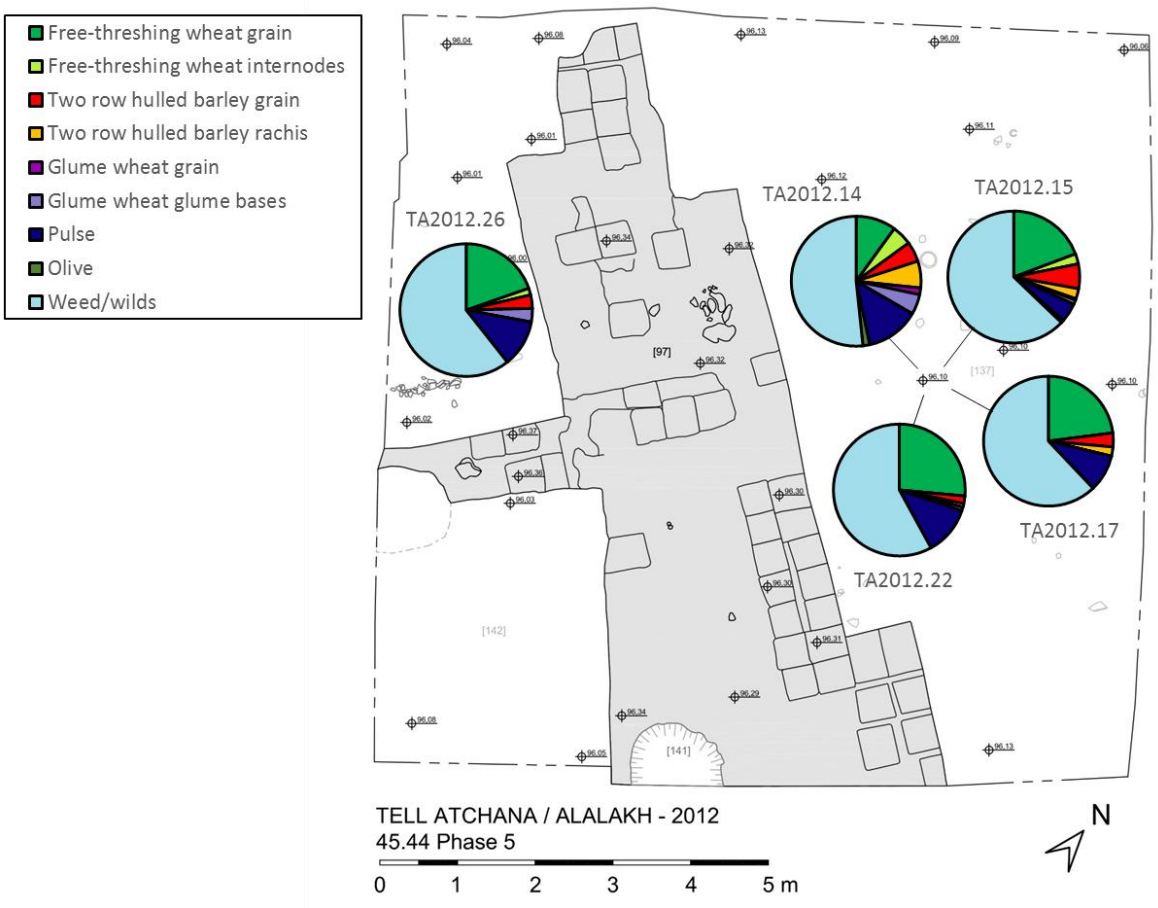


Figure 6.13 Plan of Area 3, Square 45.44 at Tell Atchana from Phase 5 with pie charts representing proportions of major taxa/types.

As for the plans of Area 4, Figure 6.14 shows TA2006.72 and TA2012.5 represented by pie charts illustrating archaeobotanical composition plotted onto the Area 4 plan in the Late Bronze II (Period 2). The former sample was collected from casemate 4 in building 2006-2, identified as free-threshing wheat fine sieve by-product (Table 5.14). The major reason why this sample was identified as fine sieve by-product was that it contains a large number of weed/wild items. However, this was classified as fine sieve by-product/product and product in the crop- and weed-based and weed-based crop processing analyses, respectively (Table 5.14) and thus could represent free-threshing wheat product mixed with other plant types through repeated use. Meanwhile, TA2012.5 also consists of weed/wild taxa, free threshing wheat grain and bitter vetch, and was classified as free-threshing wheat fine sieve by-product in both crop-based and crop- and weed-based analyses in Chapter 5 (Table 5.14). The context type of this sample, however, points to storage.

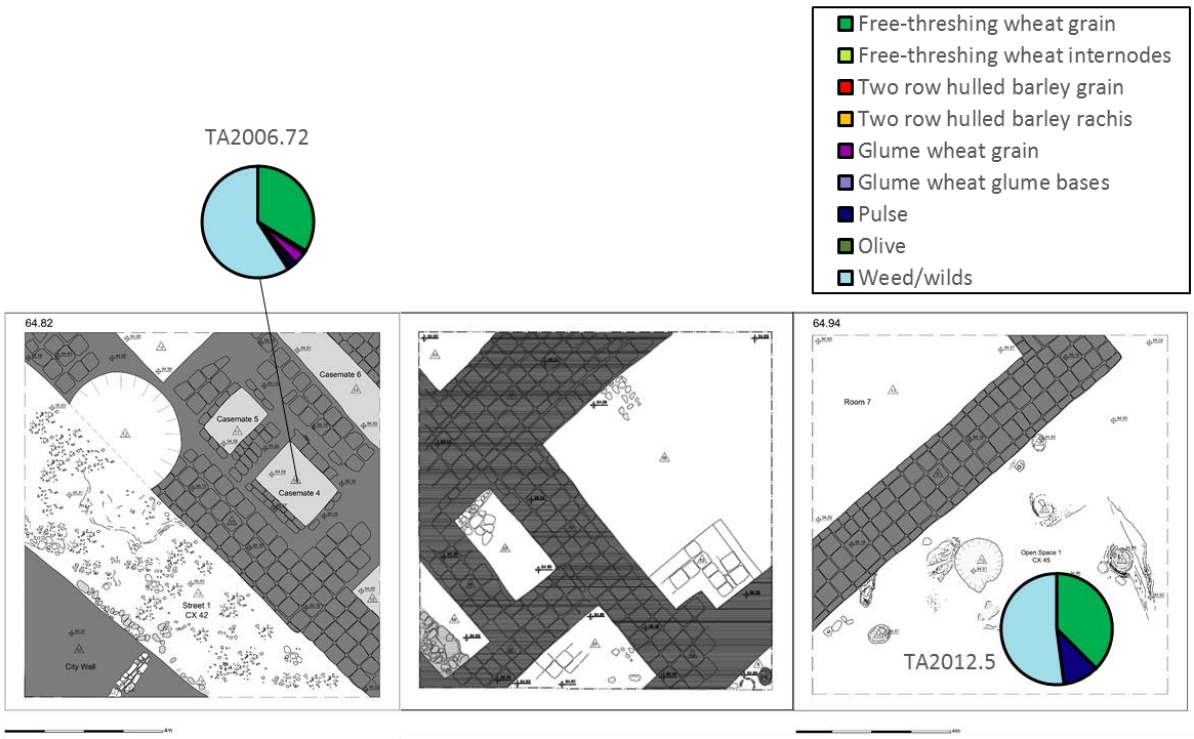


Figure 6.14 Plan of Area 4, Square 64.82 and 64.94 at Tell Atchana from Phase 2/2a with pie charts representing proportions of major taxa/types.

Figure 6.15 illustrates the plan for Phase 3, Area 4, exposed in six squares and representing the Late Bronze II sequence (period 3). The buildings within this phase are comprised of workshops and rooms equipped with hearths and storage areas (Yener and Akar, 2013). TA2012.18 was collected in a pit of Square 64.73, and contains a large quantity of free-threshing wheat grain and rachis internodes and was classified as free-threshing wheat by-product in Chapter 5. Perhaps the pit was used for refuse disposal.

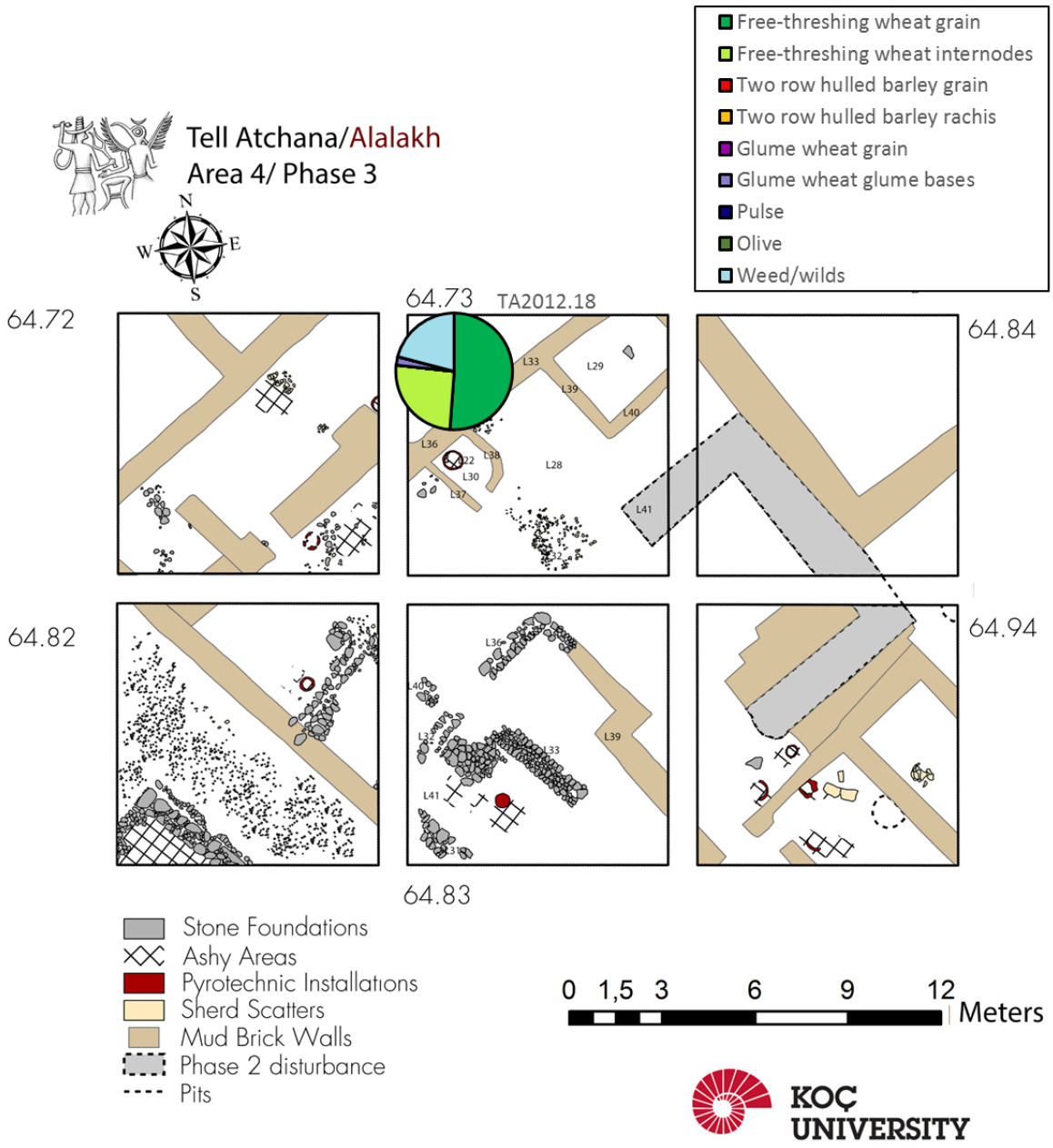


Figure 6.15 Plan of Area 4 at Tell Atchana from Phase 3b with a pie chart representing proportions of major taxa/types.

The plan of Area 4, Square 64.72 in Figure 6.16 shows TA2011.332, from a room fill of the Late Bronze I-II (Period 3-4). This sample represents a free-threshing wheat product stage (see Chapter 5) and its high density also implies that this context was a storage concentration. It is thus highly likely that the purpose of this room included the storage of free-threshing wheat grain as a product in the Late Bronze Age I-II.

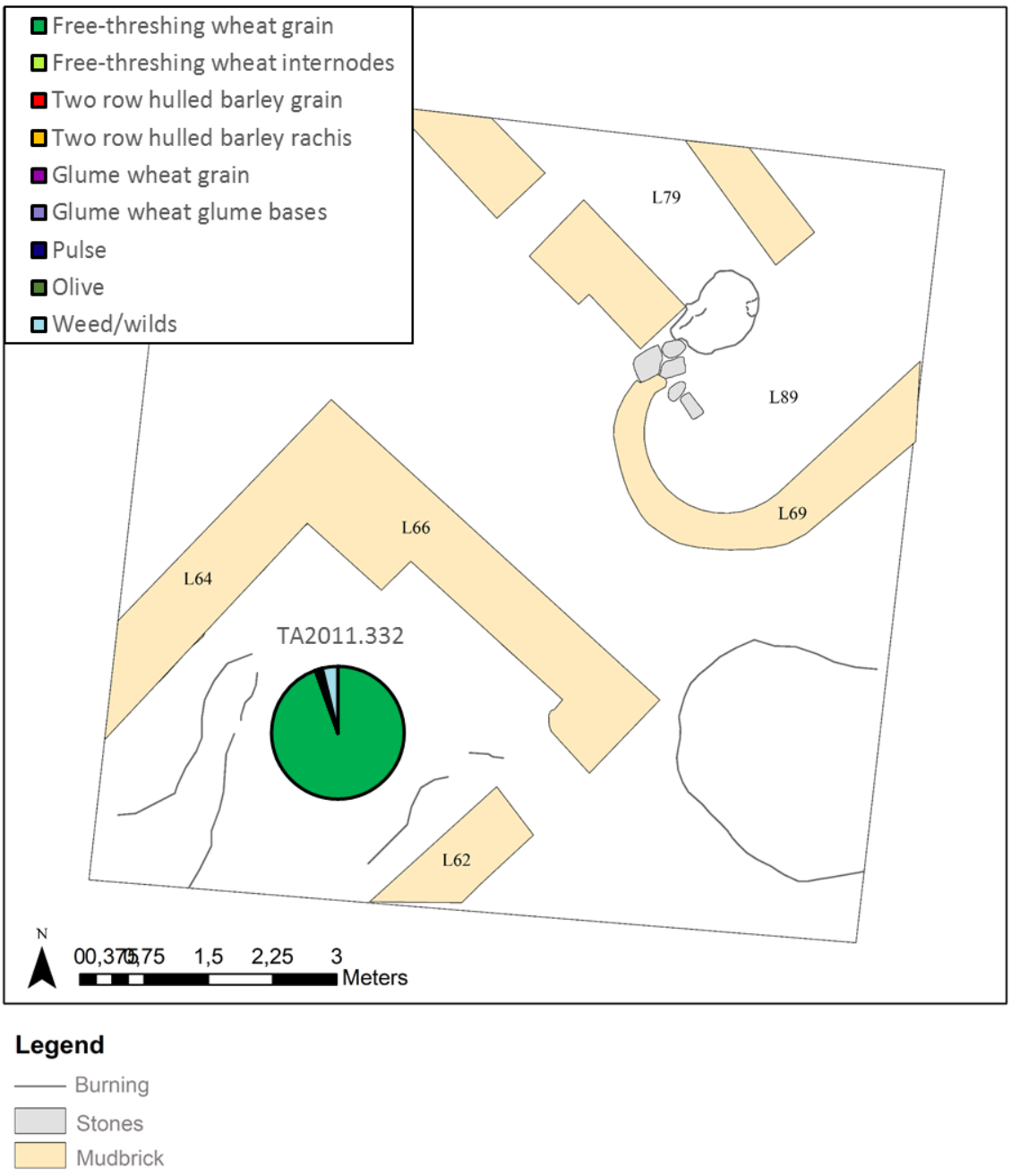


Figure 6.16 Plan of Area 4, Square 64.72 at Tell Atchana from Phase 4 with a pie chart representing proportions of major taxa/types.

Samples were coded according to the density of botanical items per litre sediment in Figure 6.17. It is clear that samples towards the left and lower left of the plot yielded the highest density of plant remains, the majority of which are dominated by a combination of weed/wild taxa and cereal chaff. These samples show a pattern in relation to Period 7-8 (Figure 6.7), Area 1, Square 32.57 (Figure 6.8), wood remain and floor contexts (Figure 6.9). The remaining samples tend to be lower in density as they spread out towards upper right.

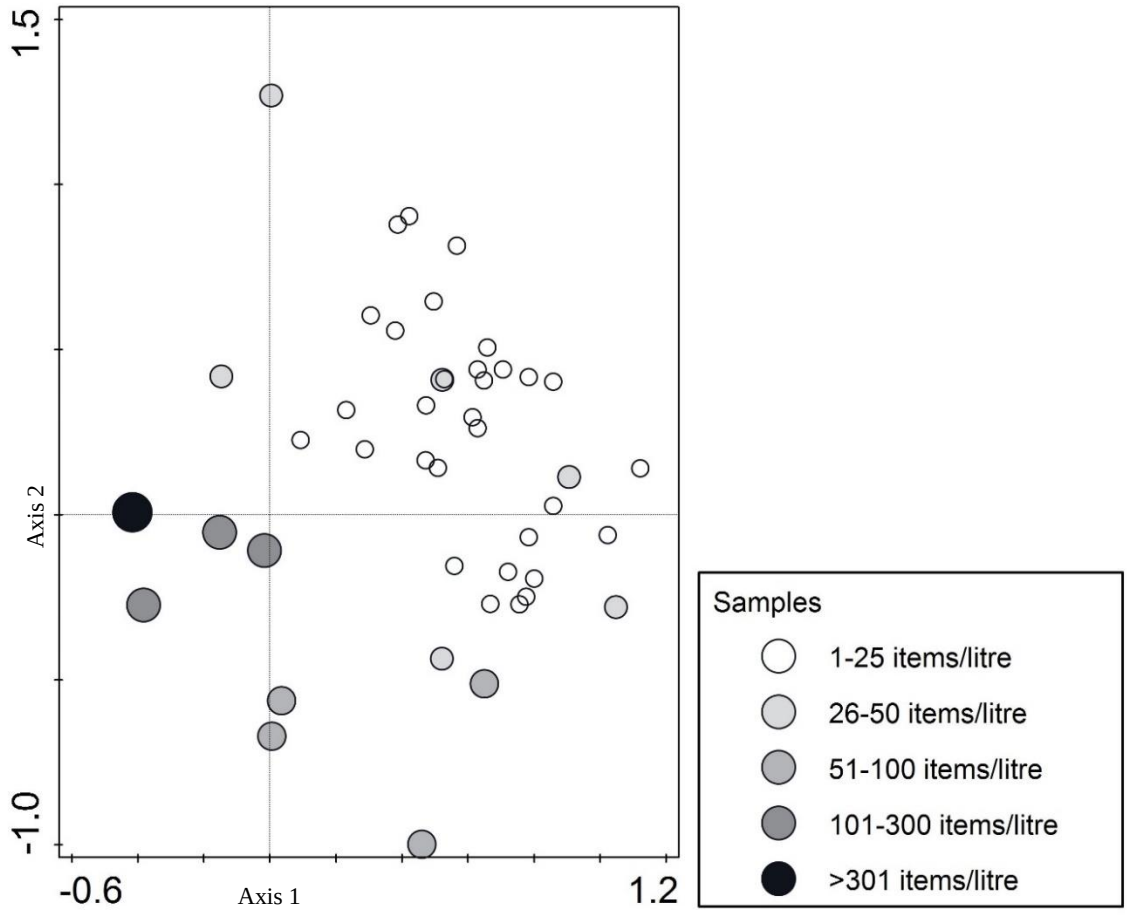


Figure 6.17 Correspondence analysis plot of 45 samples on the basis of 50 taxa/types with samples coded according to density.

In sum, correspondence analysis based on plant material reveals three groups. One sample group contains high proportions of free-threshing wheat grain and varying proportions of bitter vetch, and derives from the Late Bronze Age I-II, Area 1 and 4 and context types of pit and fill. A second

group shares similar crop components to the first but contains higher percentages of weed/wild taxa, with fairly balanced proportions of free-threshing wheat grain and pulses, and is associated with the Middle Bronze Age II, Area 1 and 3 and contexts of fire installations, floor and cemetery fill. A third sample group represents weed/wild taxa and cereal chaff and free-threshing wheat grain, deriving from wood remain contexts of the Middle Bronze Age II in Area 1, with high sample densities.

6.3. Tell Brak

Due to the lack of contextual information and the absence of excavation plans, the interpretation of the Tell Brak archaeobotanical assemblage and spatial patterning are limited. Thirty-two samples and 50 taxa/types from Tell Brak assemblage were included in correspondence analysis. TB11/13.5 contains as many as 149 *Coronilla scorpioides* seeds, rendering this sample an outlier which was left out subsequently. Only species occurring in more than 10 percent of the samples were included.

In Figure 6.18a and b, it is apparent that a large number of Tell Brak samples are dominated by barley grain and barley rachis. Proportions of barley grain and free-threshing wheat grain tend to be abundant towards the positive end of axis 3, at the expense of the rachis. Plant taxa/type categories and pie samples in both plots are clustered around the origin, showing that most Tell Brak samples share relatively similar crop compositions, typically a mixed character with a large quantity of barley grain and rachis. The majority of the samples were classified as mixed barley stages in Chapter 5, followed by barley fine sieve by-products (Figure 5.17a). While free-threshing wheat grain and glume wheat grain are situated upper left with the high proportion of free-threshing cereal grain in composition in Figure 6.18a and b, supported by the fact that three samples in this zone was classified as barley product (Figure 5.17a), glume wheat, free-threshing wheat and barley chaff are located near the origin, suggesting that the general distribution of these species in mixed barley samples (Figure 6.18). Among the three types of cereal chaff, free-

threshing wheat and barley rachis are situated lower right together, whereas glume wheat glume bases are slightly separated towards the left. Barley grain is situated near the cereal chaff categories, tending to co-occur in many samples. The four pulses were all located towards the upper part of the plot near the origin (Figure 6.18a).

Meanwhile, percentages of weed/wild taxa seem not to play a major role in composition (Figure 6.18b). Weed/wild taxa that are situated upper left are highly likely to be related to the grain of three cereals, particularly, barley grain, as three samples herein were classified as barley product; they are *Coronilla scorpioides*, *Hyoscyamus* cf. *muticus*, *Lolium rigidum*, *Hordeum spontaneum*, *Galium spurium*, *Gypsophila* sp. Those located in the lower and lower right of the plot are more likely to relate to cereal chaff, and to samples classified as mixed barley stages (Figure 6.18a).

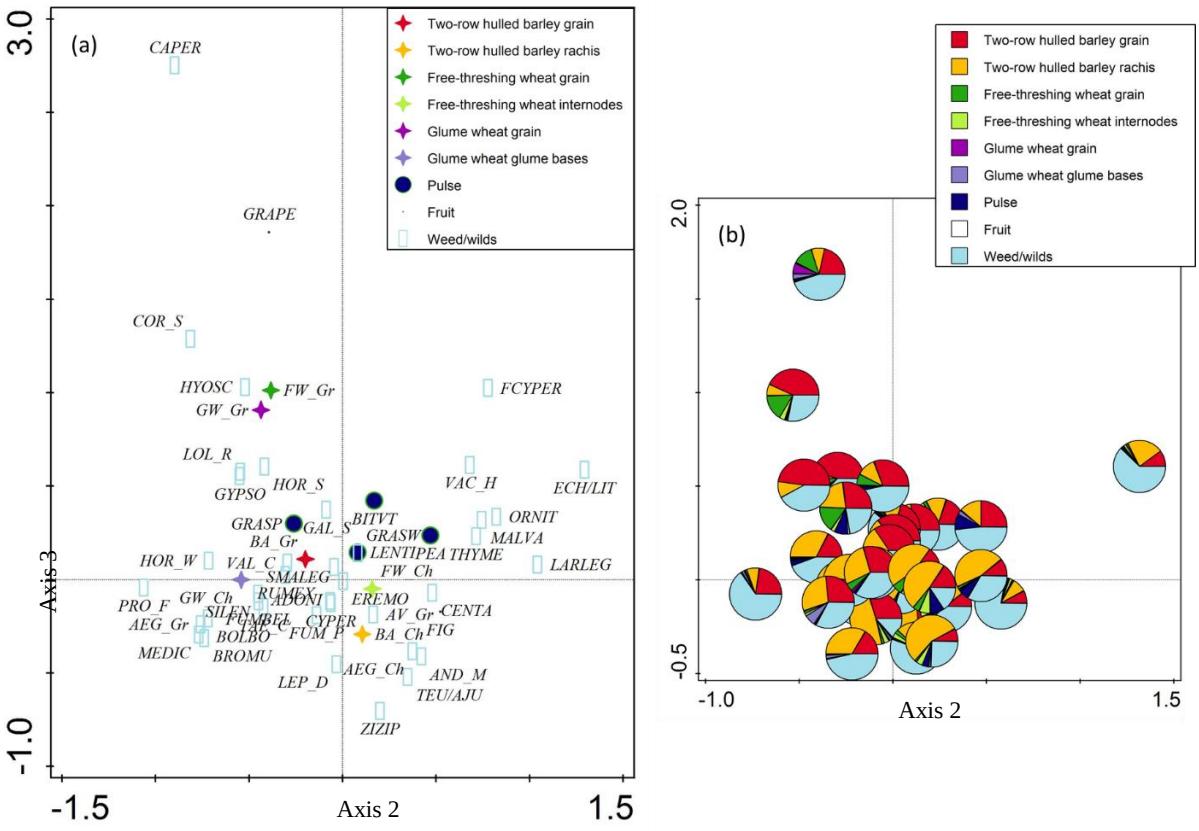


Figure 6.18 Correspondence analysis plots of (a) 50 taxa/types based on their occurrence in 32 samples and (b) 32 samples on the basis of 50 taxa/types, with samples represented as pie charts illustrating proportions of major taxa/types.

Figure 6.19 illustrates the correspondence analysis plot of samples coded by context type. Contextual information is not available yet for a number of Tell Brak samples, and no clear patterning is observed in relation to crop composition or processing.

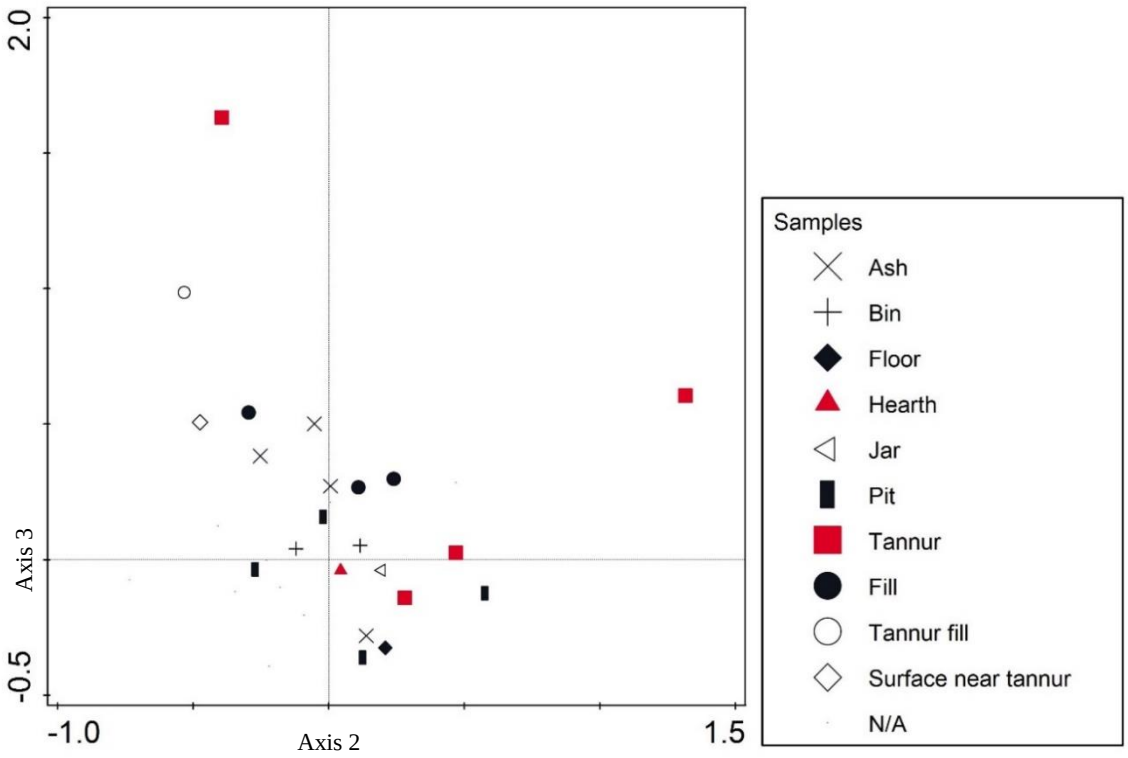


Figure 6.19 Correspondence analysis plot of 32 samples on the basis of 50 taxa/types with samples coded according to context types.

In Figure 6.20, the Tell Brak samples are coded according to sample density, showing that four denser samples occur lower left, and are dominated by weed/wild and cereal chaff material in addition to a certain proportion of barley grain. These were classified as mixed barley and barley fine sieve by-product samples (Figure 5.17a).

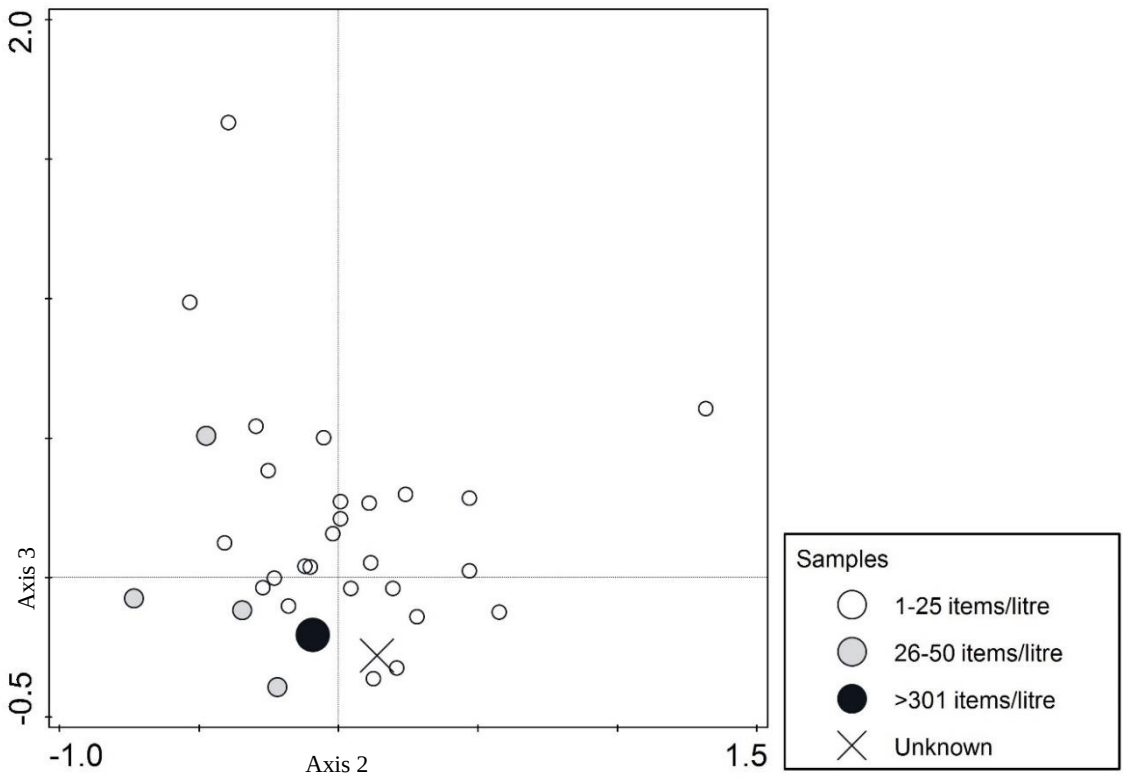


Figure 6.20 Correspondence analysis plot of 32 samples on the basis of 50 taxa/types with samples coded according to density.

With the limited information available for Tell Brak samples, context types and density reveal little clear patterning.

Table 6.2 Context description of Tell Mohammed ‘Arab, Tell Atchana and Tell Brak archaeobotanical samples provided by excavators.

Site	Sample	Context	Context description	Trench and Area/square/trench	Period
TM	TM16	Ashy	Spit, grey ashy	46P	Middle Assyrian
TM	TM33	Ashy	Black lens	45P	Middle Assyrian
TM	TM37	Hearth	Hearth	44R	Middle Assyrian
TM	TM48	Hearth	Fireplace in room	45Q	Middle Assyrian
TM	TM49	Hearth	Hearth	42P	Middle Assyrian
TM	TM22+27	Mudbrick	Mud brick/lumps with seed	44Q	Middle Assyrian
TM	TM27	Mudbrick	Mud brick/lumps with seed	44Q	Middle Assyrian
TM	TM7	N/A	N/A	44P	Middle Assyrian
TM	TM11	N/A	N/A	44P	Middle Assyrian
TM	TM30	N/A	Burnt area	45R	Middle Assyrian
TM	TM53	N/A	N/A	42P	Middle Assyrian
TM	TM56	N/A	N/A	45P	Middle Assyrian
TM	TM34	Ashy	Ashy sample	51V	Ninevite V
TM	TM28	Burial cut/fill	Grave cut/fill	50U	Ninevite V
TM	TM35	Courtyard	Courtyard layers associated with building	51T	Ninevite V
TM	TM36	Courtyard	Courtyard layers	50T	Ninevite V
TM	TM42	Fill	External fill?	50U	Ninevite V
TM	TM44eIII	Mixed	From a section cleaning. Possibility mixed	52V	Ninevite V
TM	TM47	N/A	N/A	52V	Ninevite V
TM	TM2	Pit	Pit with grey ash fill	50V	Ninevite V
TM	TM29	Ashy	Ashy layers	64X	Late Uruk
TM	TM41	Courtyard	Courtyard layers	51T	Late Uruk
TM	TM43	Courtyard	Courtyard layers associated with a building	50T	Late Uruk
TM	TM50	Courtyard	Courtyard layers associated with a building	50T	Late Uruk
TM	TM3	Floor	Grey orange floors by building	50V	Late Uruk
TM	TM54	Pit/burial fill	Rubbish above virgin soil. Pit/grave fill	50T	Late Uruk
TM	TM51	Rubbish	Rubbish above virgin soil	51U	Late Uruk

Site	Sample	Context	Context description	Trench and Area/square/trench	Period
TA	TA2006.072	Casemate	Casemate 4, Building 2006-2	4/64-82	LBA II
TA	TA2012.032	Drainage canal	Drainage canal	4/64-73	LBA II
TA	TA2011.327	Pit	Fire pit	2/44-86	LBA II
TA	TA2011.330	Pit	Fire pit	2/44-86	LBA II
TA	TA2012.018	Pit	Northwest corner pit	4/64-73	LBA II
TA	TA2012.005	Pithos	Pithos	4/64-94	LBA II
TA	TA2011.320	Tandoor	Tandoor Abutting 39	4/64-83	LBA II
TA	TA2011.039	Ashy fill	Ashy fill bounded by 31 and 32 stone foundations	4/64-83	LAB II-I
TA	TA2011.045	Ashy fill	Ashy fill bounded by 31 and 32 stone foundations	4/64-83	LAB II-I
TA	TA2011.314	Ashy fill	Ashy fill bounded by 31 and 32 stone foundations	4/64-83	LAB II-I
TA	TA2011.315	Ashy fill	Ashy fill bounded by 31 and 32 stone foundations	4/64-83	LAB II-I
TA	TA2011.332	Room fill	Room-fill area south of Locus 66 in SW of trench	4/64-72	LAB II-I
TA	TA2011.036	Stone group	Stone Group Adjacent to the East Baulk	4/64-72	LAB II-I
TA	TA2006.096	Room fill	Burnt room fill/burnt floor	1/32-57	LAB I
TA	TA2010.004	Pit	Pit on the SW corner of the trench	1/32-57	LAB I
TA	TA2011.028	Pit	Pit beneath 159, in the S-E corner of the trench	1/32-57	LAB I
TA	TA2011.033	Pit	Pit beneath 159, in the S-E corner of the trench	1/32-57	LAB I
TA	TA2011.093	Pit	Pit beneath 159, in the S-E corner of the trench	1/32-57	LAB I
TA	TA2012.007	Casemate	Casemate in Phase 5 fortification wall	3/45-44	MBA II
TA	TA2012.014	Cemetery fill	Floor at the bottom of cemetery fill	3/45-44	MBA II
TA	TA2012.015	Cemetery fill	Floor at the bottom of cemetery fill	3/45-44	MBA II
TA	TA2012.017	Cemetery fill	Floor at the bottom of cemetery fill	3/45-44	MBA II
TA	TA2012.022	Cemetery fill	Floor at the bottom of cemetery fill	3/45-44	MBA II
TA	TA2010.008	Fill	Fill on NE of the trench beneath 172	1/32-57	MBA II
TA	TA2011.030	Fill	Fill beneath 209, in the S-W area of the trench	1/32-57	MBA II
TA	TA2011.322	Fill	Fill beneath 233- 46 in the N-W corner of the trench	1/32-57	MBA II
TA	TA2012.025	Fill	Fill beneath fill 235 in the center of the trench	1/32-57	MBA II
TA	TA2010.012	Floor	Floor under 204 and 207, in the N-W area of the trench	1/32-57	MBA II

Site	Sample	Context	Context description	Trench and Area/square/trench	Period
TA	TA2011.025	Floor	Floor under 204 and 207, in the N-W area of the trench	1/32-57	MBA II
TA	TA2010.003	Floor	Floor beneath room 178	1/32-57	MBA II
TA	TA2010.009	Floor	Floor beneath room 178	1/32-57	MBA II
TA	TA2010.001	Floor	Floor beneath floor 208 on the E of the trench	1/32-57	MBA II
TA	TA2011.022	Floor	Floor under 204 and 207, in the N-W area of the trench	1/32-57	MBA II
TA	TA2011.041	Floor	Floor beneath 232	1/32-57	MBA II
TA	TA2012.011	Floor	Floor under floor 246 in the west of the trench	1/32-57	MBA II
TA	TA2011.331	Floor	Floor under fill 244 in the west of the trench.	1/32-57	MBA II
TA	TA2011.334	Floor	Floor under fill 244 in the west of the trench.	1/32-57	MBA II
TA	TA2012.035	Kiln	Soil mixed with pottery sherds as insulation between floors in kiln 262	1/32-57	MBA II
TA	TA2011.029	Pit	Pit beneath 209	1/32-57	MBA II
TA	TA2011.092	Pit	Pit beneath 223, layet out in N-E direction	1/32-57	MBA II
TA	TA2012.010	Pit	Pit beneath 223, layet out in N-E direction	1/32-57	MBA II
TA	TA2011.032	Pit	Pit beneath 223 in S-W corner of the trench	1/32-57	MBA II
TA	TA2011.091	Pit	Pit beneath 223 in S-W corner of the trench	1/32-57	MBA II
TA	TA2012.004	Pit	Pit beneath 223 in SW corner of the trench.	1/32-57	MBA II
TA	TA2011.326	Pit	Pit in the SW corner of the Silo	1/32-57	MBA II
TA	TA2012.026	Room	Room in the west corner of the trench.	3/45-44	MBA II
TA	TA2010.006	Wood remains	Wood remains in the room, 178	1/32-57	MBA II
TA	TA2010.010	Wood remains	Wood remains in the room, 178	1/32-57	MBA II
TA	TA2010.011	Wood remains	Wood remains in the room, 178	1/32-57	MBA II
TA	TA2010.014	Wood remains	Wood remains in the room, 178	1/32-57	MBA II
TB	TB06/148	Ashy	Ash deposit	HH/HHF	LBA
TB	TB06/149	Ashy	Ashy	HH/HHF	LBA
TB	TB07/10	Ashy	Ashy	HH/HHF	LBA
TB	TB07/67	Ashy	Ashy from basin	HH/HHF	LBA
TB	TB11/13.5	Ashy	Ashy street sealed by 754.2; near adult burial	HH/HHF	LBA
TB	TB11/26.16	Bin	Bin	HH/HHF	LBA

Site	Sample	Context	Context description	Trench and Area/square/trench	Period
TB	TB11/27.22	Bin	Bin; different layer from the other samples in this room (a bit later)	HH/HHF	LBA
TB	TB06/70	Fill	Fill from a large pit (?)	HH/HHE	LBA
TB	TB06/124	Fill	Fill from floor (?) layer	HH/HHF	LBA
TB	TB06/132	Fill	Fill from under sherd paving	HH/HHF	LBA
TB	TB11/26.19	Floor	Floor just next to 763.8; north east of tannur 763.8	HH/HHF	LBA
TB	TB07/21	Hearth	Fireplace	HH/HHF	LBA
TB	TB11/28.23	Jar	Jar	HH/HHF	LBA
TB	TB06/150	N/A	N/A	HH/HHF	LBA
TB	TB07/52	N/A	N/A	HH/HHF	LBA
TB	TB07/54	N/A	N/A	HH/HHF	LBA
TB	TB07/60	N/A	N/A	HH/HHF	LBA
TB	TB07/69	N/A	N/A	HH/HHF	LBA
TB	TB07/70	N/A	N/A	HH/HHF	LBA
TB	TB07/76	N/A	N/A	HH/HHF	LBA
TB	TB07/82	N/A	N/A	HH/HHF	LBA
TB	TB07/84	N/A	N/A	HH/HHF	LBA
TB	TB07/89	N/A	N/A	HH/HHF	LBA
TB	TB07/61	Pit	From pit	HH/HHF	LBA
TB	TB07/68	Pit	Pit	HH/HHF	LBA
TB	TB07/77	Pit	From pit	HH/HHF	LBA
TB	TB07/92	Pit	Pit	HH/HHF	LBA
TB	TB11/14.3	Tannur	Surface near tannur 758.2 (no ashy; normal reddish brown soil)	HH/HHF	LBA
TB	TB11/16.2	Tannur	Eastern tannur: earth sample from tannur L. 758.2	HH/HHF	LBA
TB	TB11/26.17	Tannur	Tannur	HH/HHF	LBA
TB	TB11/26.18	Tannur	Tannur	HH/HHF	LBA
TB	TB11/26.20	Tannur	2 tannurs close to each other; 763.6 is small	HH/HHF	LBA
TB	TB06/5	Tannur fill	Tannur fill	HH/HHE	LBA

Chapter 7. Crop husbandry

7.1. Traditional crop husbandry practices in the northern Fertile Crescent

Agriculture was a key means of economic production in the northern Fertile Crescent during the third and second millennia BC. This production was based on range of domesticated crops – including einkorn, emmer, barley, lentil, pea, chickpea, bitter vetch and flax – that had emerged in this region some six thousand years earlier (Hole, 2007). Expanding production of the staple crops in this region sustained episodes of urban human population growth (Wilkinson, 2003; Styring *et al.*, 2017). Traditionally autumn-sown cereals, wheat and barley, had long been dominant crops in the northern Fertile Crescent. In recent times the principal wheat types have been free-threshing varieties, with the glume wheats einkorn and emmer are rarely cultivated in restricted area and on a small scale (Bor and Guest, 1968; Davis, 1985; Charles, 1989). Wheat is typically grown for human consumption whereas barley is often considered more suitable as animal fodder, though it may become a human food in case of bad years or famine (Jones and Halstead, 1995; Kent and Evers, 2000; Hald, 2008). Pulses, such as lentil, grass pea and broad bean, and flax are also grown as traditional winter crops (Charles, 1989; Davis, 1967). The usage of flax has been to extract fibre and/or linseed oil (Davis, 1967). Olive has been a characteristic crop of the eastern Mediterranean zone, where Tell Atchana is situated, and this crop has also been cultivated recently farther inland in the vicinity of Tell Brak through to Tell Mohammed ʻArab as well under irrigation (personal observation). Grape and fig are also cultivated across the northern Fertile Crescent as indigenous species (Post, 1896; Baghasa, 2006) and these are well recorded along the eastern Mediterranean in the Bronze Age (Zohary, Hopf and Weiss, 2012).

In terms of natural environment conditions, the amount of precipitation is the biggest single factor in determining crop production in the northern Fertile Crescent. Nowadays all three sites receive over 250 mm of rain per year fulfilling the criteria of rain-fed agriculture. However, there are differences among them in terms of mean annual precipitation. Tell Atchana falls within the most reliable precipitation zone, recording more than 500 mm per year on average, followed by Tell

Mohammed ‘Arab, which receives approximately 450 mm annual rainfall. Tell Brak is located in a more marginal environment for rain-fed farming, receiving around 300 mm per annum (see Figure 2.17 in Chapter 2).

The distribution of precipitation through the year is also of considerable importance for crop management. Across the region, rainfall typically occurs from October/November through to May, including some snowfall in the winter months (see Chapter 2). During the October to May period winter crops were sown, grown and harvested under the rain-fed system. For the remaining period (June-October) today, when precipitation is low (Tell Atchana) or almost absent (Tell Mohammed ‘Arab and Tell Brak) and temperatures rise to extremely high levels, water-intensive summer crops and cash crops such as maize, cotton and vegetables are often grown using irrigation (Hole, 2007; Brooks, 2015; Karabina, 2016; FAO, 2017a; FAO, 2017b; FAO, 2018). The (winter) rainfall-dependent farming of northern Mesopotamia contrasts with that of main irrigated land of southern Mesopotamia, where winter and summer crops are grown (Charles, 1989; Jaradat, 2003).

In accordance with this correlation between rainfall and crop growing period, crops are sown in October, grown for the rainy winter months and eventually harvested between April and June in the site regions, i.e. Mosul in Iraq for Tell Mohammed ‘Arab, Hatay in Turkey for Tell Atchana and Al-Hassake in Syria for Tell Brak (Table 2.17). Barley is often harvested about one to three weeks earlier than wheat (Post and Dinsmore, 1932; Charles, 1990; Schnepf, 2004; Soppe and Saleh, 2012; Brooks, 2015; Karabina, 2016). It is notable that the three study sites have slightly different sowing and harvesting times to each other according to their environmental setting, especially precipitation (see Chapter 2 and 7).

Fallowing is conducted biennially in the Mediterranean rain-fed zone, mainly to control weed growth (Halstead and Jones, 1989; Halstead, 2014), and with rotation between winter crops (wheat and barley) and/or pulses (lentil, grass pea, bitter vetch, common vetch) for fodder, to recover soil fertility, secure the retention of moisture and prevent plagues and vermin (Hillman, 1984a; Schnepf, 2004; Halstead, 2014). In the Mediterranean region, it was observed that fallowing is not practiced on a regular basis in certain cases, for instance, for farmers who own little crop fields,

and those with large land also cannot fallow all their land due to the limited number of animals that can be mobilised for ploughing at the same sowing season (Halstead, 2014). Under the rain-fed farming system, inputs such as fertiliser, weeding and spraying pesticide are low (Schnepf, 2004). Traditionally, crop fields are ploughed by animals (i.e. donkeys, oxen or horses) prior to sowing in order to enhance soil fertility by loosening soil and uprooting winter weeds to prepare the seed bed (Charles, 1990). Harvesting of cereals, which normally grow up to *c*. 80 and 180 cm in height for barley and wheat, respectively, is practiced by hand through uprooting or by manual sickle harvesting and, once harvested, crops are fully dried in the field to be threshed (Guest, 1966; Bor and Guest, 1968; Townsend and Guest, 1974; Townsend, Guest and Omar, 1980; Guest and Townsend, 1980; Hillman, 1984a; Guest and Townsend, 1985; Anjani, 2010; Ghazanfar and Edmondson, 2013).

7.2. Tell Mohammed ʻArab

In order to reconstruct crop husbandry practices at Tell Mohammed ʻArab, samples in the mixed crop group were excluded, as were wild/weed species likely to be collected or dung-derived; taxa scored as 3 on the dung index scale (see section 5.1.2) were also automatically excluded. The Tell Mohammed ʻArab assemblage was dominated by barley material, and the barley crop group included fine sieve by-products and products according to the crop processing analysis (section 5.1.1.4). The glume wheat crop group consisted of five glume wheat by-product samples. The investigation of Tell Mohammed ʻArab crop husbandry practices was, therefore, based on the premise that arable weeds derive from these crop processing stages for barley and glume wheat.

7.2.1. Sowing and harvesting practices

7.2.1.1. Sowing and harvesting time

In order to identify crop sowing time(s), the onset and length of flowering period of crop weeds were examined as the proxy. The timing and duration of flowering has been verified as a robust

indicator of germination time in a study comparing modern autumn- and spring-sown crop weed flora (Bogaard *et al.*, 2001). This study defined three classes that can be used to identify sowing time in terms of weed flowering onset and length: 'short-flowering with early-intermediate onset' (1-3 months with January-June) for autumn-sown crops, and 'late-flowering' (1-5 months with July or later) and 'long-flowering' (>5 months with January-June) for spring sown crops (Bogaard *et al.*, 2001, p. 1175). These flowering onset/length classes provide an indication of relevant differences in germination timing and duration between weeds associated with autumn- versus spring-sown crops. Ploughing in advance of sowing has an impact on the occurrence of these seasonality classes. Weed species that germinate and flower early and for a short period can grow successfully with autumn-sown crops but are less successful in spring-sown crops because they are destroyed by ploughing in spring. Weeds germinating and flowering relatively late are likely to indicate spring sowing since they emerge after spring ploughing. Finally, weed species germinating and flowering for an extended period are able to recover from spring ploughing and hence tend to characterise that sowing regime (Bogaard *et al.*, 2001). It must be noted that these flowering classes were devised to work in central European temperate conditions and need adjustment for the different rainfall and temperature regimes in the study region.

Table 7.1 shows the classification of wild/weed species according to flowering onset and length for the Tell Mohammed 'Arab assemblage. As described below in detail, local harvest time was assumed to be April to May and thus, species flowering before April were grouped into early-intermediate, those flowering in April or May into intermediate, while flowering after June were classified as late. In total 11 taxa were classified as early-intermediate onset with short duration of flowering as an indicator of autumn sown crop relation. There were additionally seven species that are possible indicators of autumn sowing (classed as '(A)' in Table 7.1). These were defined by short length as explicit autumn sowing species but their flowering onset was intermediate rather than early-intermediate. In total these 18 taxa include typical arable weeds; of these, *Bellevalia* sp., *Vaccaria hispanica, Galium spurium* and *Adonis* spp. are exclusively found in barley product samples at Tell Mohammed 'Arab (see Chapter 5). Nineteen taxa were classified into the category

of medium flowering duration with intermediate onset and are expected to occur under either autumn- or spring-sowing regimes. A reasonable number of weeds indicating autumn sowing and the nearly absence of spring-sowing indicators suggest that barley and glume wheat crops were sown in the autumn at Tell Mohammed ‘Arab.

Table 7.1 Classification of sowing time based on weed flowering onset and length from Tell Mohammed ‘Arab assemblage. E = early, I = intermediate, L = late, Med = medium and A = autumn sown crop. Short = 1-3 months, Medium = 4-5 months and Long = more than 5 months.

Taxa	**Months of flowering**												**Onset**	**Length**	**Class**
	D	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**			
Sherardia arvensis				x	x								E-I	Short	A
Malva nicaeensis				x	x	(x)							E-I	Short	A
Adonis spp.				x	x	x							E-I	Short	A
Galium spurium				x	x	x							E-I	Short	A
Malva sp.				x	x	x							E-I	Short	A
Medicago polymorpha				x	x	x							E-I	Short	A
Plantago sp.				x	x	x							E-I	Short	A
Valerianella coronata				x	x	x							E-I	Short	A
Bellevalia sp.				(x)	x	x	(x)						E-I	Short	A
Coronilla scorpioides				(x)	x	x	(x)						E-I	Short	A
Scorpiurus muricatus				(x)	x	x	(x)						E-I	Short	A
Trigonella astroites					x	x							I	Short	(A)
Cephalaria sp.					x	x	x						I	Short	(A)
Hordeum murinum type					x	x	x						I	Short	(A)
Silene dichotoma Type					x	x	x						I	Short	(A)
Vaccaria hispanica					x	x	x						I	Short	(A)
Taeniatherum caput-medusae						x	x						I	Short	(A)
Triticum boeoticum						x	x						I	Short	(A)
Helianthemum sp.				x	x	x	(x)						E-I	Med	
Valerianella dentata Type				x	x	x	(x)						E-I	Med	
Phalaris sp.				x	x	x	(x)	(x)	(x)				E-I	Med	
Avena sp.				x	x	x	x						E-I	Med	
Bromus spp.				x	x	x	x						E-I	Med	
Rumex sp.				x	x	x	x						E-I	Med	
Lepidium sativum				x	x	x	(x)	(x)					E-I	Med	
Aegilops, glume bases				(x)	x	x	x						E-I	Med	
Aegilops sp.				(x)	x	x	x						E-I	Med	
Centaurea sp.				x	x	x	x	x					E-I	Med	
Hordeum spontaneum				x	x	x	x	x					E-I	Med	
Lepidium draba				x	x	x	x	x	(x)				E-I	Med	
Ornithogalum sp.					x	x	x	(x)					I	Med	
Ajuga/Teucrium sp.					x	x	x	x					I	Med	
Gypsophila sp.					x	x	x	x					I	Med	
Lolium rigidum					x	x	x	x					I	Med	
Ziziphora sp.					x	x	x	x					I	Med	
Thymelaea passerina/mesopotamica					x	x	x	x	(x)				I	Med	
Chenopodium sp.						x	x	x	x				I	Med	
Heliotropium sp.						x	x	x	x	x	x		I	Long	

Traditional crop harvest time for wheat and barley in northern Iraq is April to June. Barley is harvested a few weeks earlier than wheat, between April and May, whereas wheat is cut in May at the earliest through to June (Charles, 1990). Since the grain-rich barley group is dominant in the Tell Mohammed ʻArab assemblage, the harvest time was assumed to be from April to May. This was verified with the flowering/fruiting time of weeds (Jones, 1992; Charles, Jones and Hodgson, 1997; Bogaard *et al.*, 1999; Bogaard *et al.*, 2001; Bogaard, Jones and Charles, 2005). In Table 7.2, most taxa were classified as flowering and fruiting early, from April-May. They are highly likely to be brought with harvested crop material as autumn-sown crop weeds.

Table 7.2 Seasonality of weed taxa identified at Tell Mohammed ‘Arab in relation to harvesting time. (): rarely occurs. E: early, I: intermediate and L: late.

Taxa	Months of flowering/fruiting												Class
	J	F	M	A	M	J	J	A	S	O	N	D	
Sherardia arvensis			X	X									E
Malva nicaeensis			X	X	(X)								E
Adonis spp.			X	X	X								E
Malva sp.			X	X	X								E
Medicago polymorpha			X	X	X								E
Plantago sp.			X	X	X								E
Valerianella coronata			X	X	X								E
Helianthemum sp.			X	X	X	(X)							E
Valerianella dentata Type			X	X	X	(X)							E
Lepidium sativum			X	X	X	(X)	(X)						E
Phalaris sp.			X	X	X	(X)	(X)	(X)					E
Avena sp.			X	X	X	X							E
Bromus spp.			X	X	X	X							E
Rumex sp.			X	X	X	X							E
Centaurea sp.			X	X	X	X	X						E
Hordeum spontaneum			X	X	X	X	X						E
Lepidium draba			X	X	X	X	X	(X)					E
Bellevalia sp.			(X)	X	X	(X)							E
Coronilla scorpioides			(X)	X	X	(X)							E
Scorpiurus muricatus			(X)	X	X	(X)							E
Aegilops, glume bases			(X)	X	X	X							E
Aegilops sp.			(X)	X	X	X							E
Trigonella astroites				X	X								E
Galium spurium				X	X	X							E
Cephalaria sp.				X	X	X							E
Hordeum murinum type				X	X	X							E
Silene dichotoma Type				X	X	X							E
Vaccaria hispanica				X	X	X							E
Ornithogalum sp.				X	X	X	(X)						E
Ajuga/Teucrium sp.				X	X	X	X						I
Gypsophila sp.				X	X	X	X						I
Lolium rigidum				X	X	X	X						I
Ziziphora sp.				X	X	X	X						I
Thymelaea passerine/mesopotamica				X	X	X	X	(X)					I
Taeniatherum caput-medusae					X	X							I
Triticum boeoticum					X	X							I
Chenopodium sp.					X	X	X	X					L
Heliotropium sp.					X	X	X	X	X	X			L

7.2.1.2. Harvesting height and method

The heights of the weed taxa that grow in crop fields and are harvested with crops reflect crop harvesting height and this connection can provide a clue to harvesting methods. In ethnobotanical studies in Turkey Hillman (1984a) addresses probable harvesting methods for archaeology such as uprooting by hand or with a blunt sickle, reaping (low or high) with a sickle and hand-plucking of cereal ears.

The classification of the maximum weed stem height in the early and late periods from Tell Mohammed ‘Arab is shown in Table 7.3a and b, respectively. The former table presents the five glume wheat by-product samples (Table 7.3a) while the latter presents the four barley product and two barley by-product samples (Table 7.3b). The maximum height was divided into short (<35 cm), medium (36-80 cm) and tall (>80 cm) categories. It can be seen that medium species outnumber the other two with high occurrence and abundance in both tables. On the other hand, those categorised as short are relatively few in number and are represented by few items. Figure 7.1 illustrates the proportions of maximum weed stem height divided into short, medium and tall from the early and late periods of Tell Mohammed ‘Arab assemblage. As in the previous tables, the average values between the two periods show little difference although slightly more medium high species are observed in the Late Uruk and Ninevite V periods (Figure 7.1).

Table 7.3 (a) Classification of the maximum stem height for weed taxa in the Late Uruk and Ninevite V periods from Tell Mohammed ‘Arab glume wheat by-product samples.

(a) Taxa	**Maximum height (cm)**	**Class**	**No. sample**	**% sample**	**Total number of items**
Trigonella astroites	15 (-25)	Short	2	40	10
Scorpiurus muricatus	25 (-40)	Short	1	20	2
Malva nicaeensis	30 (-40)	Short	1	20	1
Helianthemum sp.	35	Short	4	80	16
Ziziphora sp.	35	Short	1	20	1
Short total			**4**	**80**	**30**
Sherardia arvensis	40	Medium	1	20	1
Malva sp.	40 (-60)	Medium	3	60	5
Silene dichotoma Type	45 (-70)	Medium	3	60	24
Thymelaea passerine/mesopotamica	45 (-75)	Medium	2	40	2
Taeniatherum caput-medusae	50	Medium	1	20	1
Heliotropium sp.	50	Medium	3	60	5
Hordeum murinum type	60	Medium	5	100	68
Aegilops sp.	60	Medium	4	80	35
Vaccaria hispanica	60	Medium	4	80	9
Aegilops sp.	60	Medium	2	40	40
Adonis spp.	60	Medium	2	40	3
Lepidium sativum	60	Medium	1	20	1
Lepidium draba	60	Medium	3	60	41
Medicago polymorpha	60	Medium	1	20	1
Hordeum spontaneum	70	Medium	1	20	5
Gypsophila sp.	70	Medium	1	20	2
Plantago sp.	70	Medium	1	20	1
Rumex sp.	70	Medium	5	100	111
Bellevalia sp.	70 (-80)	Medium	1	20	1
Lolium rigidum	80	Medium	5	100	328
Bromus spp.	80	Medium	2	40	2
Chenopodium sp.	80	Medium	1	20	1
Medium total			**5**	**100**	**687**
Avena sp.	100	Tall	2	40	9
Ajuga/Teucrium sp.	100	Tall	2	40	12
Galium spurium	100 (-160)	Tall	4	80	25
Cephalaria sp.	150	Tall	2	40	11
Triticum boeoticum	160	Tall	1	20	1
Phalaris sp.	180	Tall	4	80	130
Tall total			**4**	**80**	**188**

Table 7.3 (b) Classification of the maximum stem height for weed taxa in the Middle Assyrian period from Tell Mohammed ʻArab barley fine sieve by-product and product samples.

(b) Taxa	**Maximum height (cm)**	**Class**	**No. sample**	**% sample**	**Total number of items**
Ornithogalum sp.	5	Short	1	17	8
Trigonella astroites	15 (-25)	Short	1	17	1
Coronilla scorpioides	20 (-35)	Short	3	50	9
Valerianella coronata	25	Short	1	17	1
Valerianella dentata Type	25	Short	1	17	1
Scorpiurus muricatus	25 (-40)	Short	1	17	1
Helianthemum sp.	35	Short	1	17	2
Short total			**5**	**83**	**23**
Malva sp.	40 (-60)	Medium	1	17	8
Silene dichotoma Type	45 (-70)	Medium	2	33	3
Thymelaea passerine/mesopotamica	45 (-75)	Medium	1	17	1
Hordeum murinum type	60	Medium	5	83	25
Aegilops sp.	60	Medium	5	83	49
Vaccaria hispanica	60	Medium	2	33	101
Aegilops, glume bases	60	Medium	4	67	44
Adonis spp.	60	Medium	2	33	8
Lepidium sativum	60	Medium	1	17	3
Hordeum spontaneum	70	Medium	1	17	1
Gypsophila sp.	70	Medium	2	33	4
Rumex sp.	70	Medium	1	17	8
Bellevalia sp.	70 (-80)	Medium	4	67	426
Lolium rigidum	80	Medium	6	100	59
Chenopodium sp.	80	Medium	1	17	3
Medium total			**6**	**100**	**743**
Galium spurium	100 (-160)	Tall	6	100	288
Cephalaria sp.	150	Tall	1	17	3
Phalaris sp.	180	Tall	2	33	5
Tall total			**6**	**100**	**296**

The deficiency of short class taxa suggests that only a fraction was introduced through harvesting and hence that barley and glume wheat were not typically harvested low on the straw, close to the ground at Tell Mohammed ʻArab through the occupation periods. Bias stemming from crop processing stages, however, cannot be ruled out since four samples from the Middle Assyrian period were defined as barley product stages and had been thoroughly cleaned of weed seeds. In addition, the percentage of short stemmed taxa in two barley by-product samples (TM33 and TM49) from the Middle Assyrian is higher than that of the rest of four barley product samples, which might imply the possibility of the bias and the Middle Assyrian period people may have cut

barley straw lower than in earlier periods. Nevertheless, medium height taxa are still dominant showing more or less the same pattern in both barley and glume wheat groups across all samples in Figure 7.1.

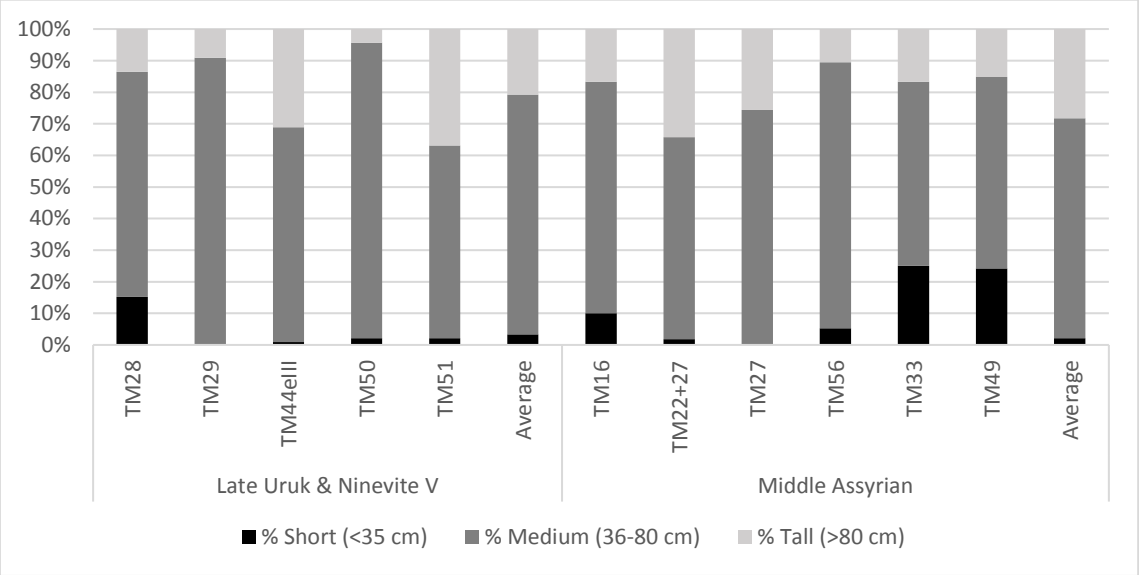


Figure 7.1 Bar chart displaying the proportions of maximum weed stem height divided into short, medium and tall from the Late Uruk and Ninevite V periods from Tell Mohammed ‘Arab glume wheat by-product samples and the Middle Assyrian period from Tell Mohammed ‘Arab barley fine sieve by-product and product samples.

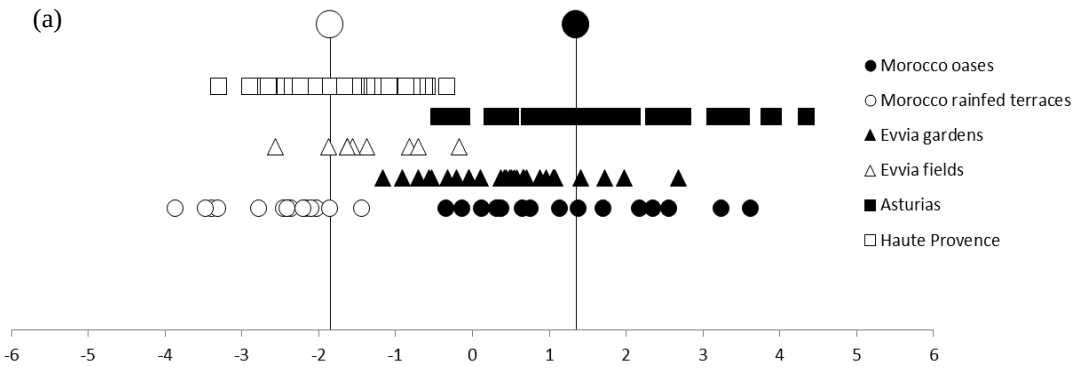
In addition to the occurrence of few low-growing species, the almost absence of basal cereal culm material compared to cereal culm nodes suggests that harvesting by uprooting was not typically practiced through the time at Tell Mohammed ‘Arab.

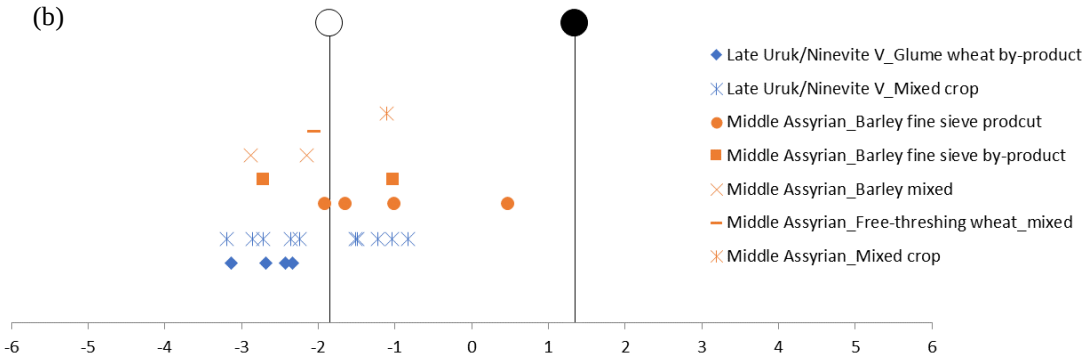
A prominent difference between the two periods and the two crop groups, i.e. barley and glume wheat, is not observable in terms of the height of cereal straw based on the weed maximum height evidence. Barley and glume wheat were likely to share a similar medium harvesting height with sickles in both the early and late periods.

7.2.2. Weed functional ecology

In order to investigate the management intensity of crop fields, a discriminant function separating present-day ‘traditional’ low and high input regimes was used to classify the Mohammed ‘Arab

samples. Inputs here refer to investment of labour per unit area in the form of manuring, weeding and (where relevant) watering. This discriminant analysis is based on modern weed survey data from field studies in Morocco, France, Spain and Greece (Charles, Jones and Hodgson, 1997; Jones *et al.*, 2000; Jones *et al.*, 2005; Bogaard *et al.*, 2016b; Bogaard *et al.*, 2018) on a presence/absence basis, so that the resulting function can be used to classify archaeobotanical samples based on presence/absence weed data. The discriminating variables in this analysis were canopy height and diameter, which reflect competitive ability, and specific leaf area and leaf area per node: thickness, which reflect growth rate; this set of variables correctly reclassified *c.* 94 percent of the modern fields as low versus high management intensity (Bogaard *et al.*, 2018). The discriminant function extracted from the modern study was used to classify samples from Tell Mohammed ʻArab (Figure 7.2a, b and c); that is, the archaeological samples were entered as ungrouped cases in the classification phase of the analysis. Here again, only potential arable weeds were included and samples with less than ten seeds of weeds identified more or less to species were excluded. The analysis was run twice, once with all taxa including *Bolboschoenus glaucus* and the other without *Bolboschoenus glaucus*, in order to detect the potential role and bias this species may produce.





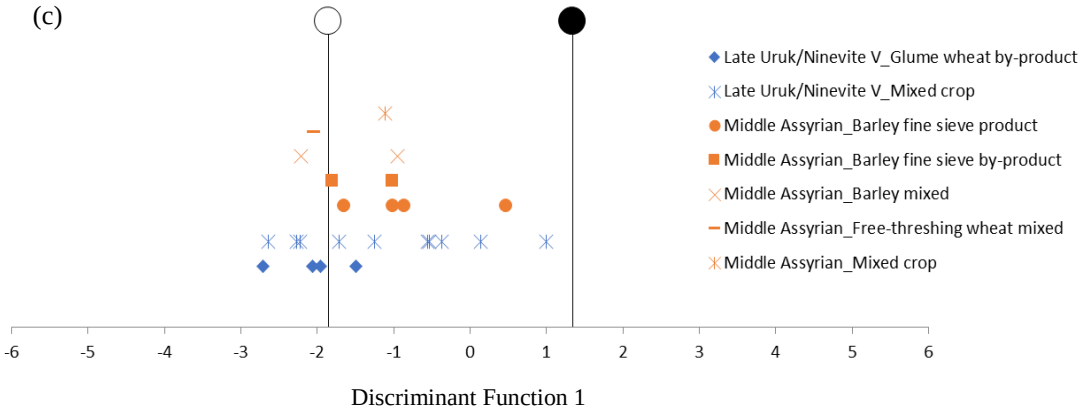


Figure 7.2 (a) The original discriminant function based on weed attribute scores showing the distribution of individual fields in the modern studies, and the results of the classification of the Tell Mohammed 'Arab samples (b) with all taxa and (c) without *Bolboschoenus glaucus*.

Figure 7.2a presents the original discriminant function of the modern fields showing the discrimination between low and high input groups. Figure 7.2b and c illustrate the results of the weed functional ecological analysis applied to the Tell Mohammed ‘Arab weed assemblage by crop processing stage and period, with and without *Bolboschoenus glaucus*. Table 7.4 presents a list of the Tell Mohammed ‘Arab samples included in the classification with their probabilities and discriminant scores.

Table 7.4 List of the Tell Mohammed ‘Arab samples used for the discriminant analysis and the classification of their intensity with the probabilities and discriminant scores.

Sample	**All taxa (including *Bolboschoenus glaucus*)**			**Taxa without *Bolboschoenus glaucus***		
	Class	**Probability**	**Discriminant scores**	**Class**	**Probability**	**Discriminant scores**
TM50	Low	0.408	-2.68	Low	0.831	-2.066
TM51	Low	0.562	-2.433	Low	0.922	-1.951
TM28	Low	0.631	-2.333	Low	0.719	-1.493
TM44eIII	Low	0.201	-3.131	Low	0.392	-2.708
TM54	Low	0.313	-2.861	Low	0.68	-2.266
TM43	Low	0.418	-1.042	High	0.229	0.145
TM41	Low	0.308	-0.834	High	0.727	0.999
TM2	Low	0.732	-1.51	Low	0.195	-0.556
TM3	Low	0.717	-1.491	Low	0.139	-0.374
TM34	Low	0.386	-2.719	Low	0.71	-2.224
TM35	Low	0.181	-3.191	Low	0.433	-2.637
TM36	Low	0.533	-1.229	Low	0.186	-0.531
TM42	Low	0.696	-2.243	Low	0.549	-1.253
TM47	Low	0.612	-2.359	Low	0.889	-1.713
TM16	High	0.379	0.467	High	0.381	0.47
TM22+27	Low	0.949	-1.917	Low	0.327	-0.872
TM27	Low	0.405	-1.02	Low	0.404	-1.018
TM56	Low	0.844	-1.656	Low	0.846	-1.658
TM33	Low	0.382	-2.727	Low	0.971	-1.816
TM49	Low	0.41	-1.028	Low	0.406	-1.022
TM48	Low	0.306	-2.877	Low	0.721	-2.21
TM53	Low	0.765	-2.152	Low	0.363	-0.944
TM37	Low	0.842	-2.052	Low	0.841	-2.054
TM30	Low	0.458	-1.111	Low	0.458	-1.11

It can be seen that samples are generally positioned towards the low intensity end of the function in both plots, with and without *Bolboschoenus glaucus*, with only a few samples towards high input group centroid (Figure 7.2a and b). In the version with all taxa, all samples except for one, TM16,

were classified into the low-intensity group with variable probabilities, and the other version excluding *Bolboschoenus glaucus* presents a similar pattern (Table 7.4). However, it is notable that there are differences in the discriminant scores depending on the inclusion and exclusion of *Bolboschoenus glaucus* to a certain degree. When this taxon was excluded, discriminant scores were higher in most samples and two more samples were classified with the high intensity group (Figure 7.2b and c and Table 7.4). This is not surprising since *B. glaucus* has relatively low values for the functional traits used as discriminating variables, especially specific leaf area.

If mixed samples are excluded, i.e. focussing only on samples representing unmixed processing stage, there is a slight different between Tell Mohammed ʻArab samples from the Late Uruk/Ninevite V and Middle Assyrian occupations. The glume wheat fine sieve by-product samples of the Late Uruk/Ninevite V have relatively low discriminant scores, indicating lower input, while the Middle Assyrian barley fine sieve product samples are associated with slightly higher discriminant scores, though there is overlap.

Overall, the discriminant analysis applied to the Tell Mohammed ʻArab weed assemblage indicates relatively low-input agriculture in both periods, with slightly wider variation in growing conditions during the earlier period. However, in comparison with the functional weed ecological spectrum of late third millennium BC (Early Bronze Age) Tell Brak – an urban settlement of *c.* 70 hectares – the weed discriminant scores of the Tell Mohammed ʻArab are *higher*, albeit within the low-input range (Oates, Oates and McDonald, 2001; Ur, Karsgaard and Oates, 2011; Bogaard *et al.*, 2018). This contrast may relate in part to the much smaller size of Tell Mohammed ʻArab, enabling more intensive land management. This topic is considered further in the discussion section 8.3 of following chapter.

7.2.3. Stable isotope analysis of charred crop remains

7.2.3.1. Carbon

Table 7.11 lists the Tell Mohammed ‘Arab samples used for stable carbon and nitrogen isotope analysis and Figure 7.3 shows the carbon discrimination ($\Delta^{13}C$) values of barley, glume wheat and free-threshing wheat divided by three periods from Tell Mohammed ‘Arab. In general, the vast majority of wheats fall into the well-watered zone, above 17 ‰ (green dashed line), while the $\Delta^{13}C$ values of barley vary ranging from poor through to well-watered when a 1.5 ‰ offset between wheat and barley thresholds is assumed (blue dashed line). A smaller 1 ‰ offset for barley would also illustrate more or less the same variable pattern as that of 1.5 ‰. Tell Mohammed ‘Arab barley was typically the two-row form. Modern two-row barley is associated with 1-1.5 ‰ higher stable carbon values than wheat grown under the same watering conditions (Wallace *et al.*, 2013) and thus, both 1 and 1.5 ‰ offsets for barley were considered in the statistical analysis below.

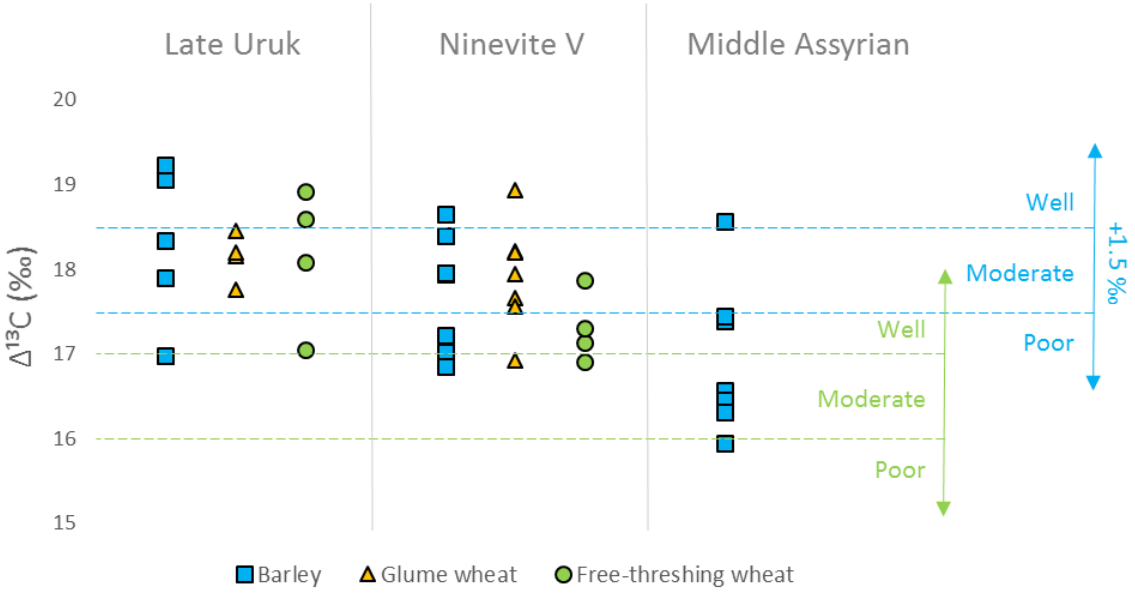


Figure 7.3 $\Delta^{13}C$ values of barley, glume wheat and free-threshing wheat divided by three periods from Tell Mohammed ‘Arab. Green and blue dashed lines indicate the categorisation of crop moisture conditions for wheat and barley, respectively, defined by Wallace *et al*. (2013). The blue dashed line for barley represents a 1.5 ‰ offset from wheat.

There were clear changes in barley $\Delta^{13}C$ values across the periods ($p = 0.015$ in Table 7.5). The Scheffe post hoc test confirms significant differences between the Late Uruk and Middle Assyrian periods, with a probability of 0.020 (Table 7.6 and Figure 7.3). In contrast, those for free-threshing wheat and glume wheat between the Late Uruk and Ninevite V were not significantly different, indicating no changes in water availability between those periods (Table 7.5).

Table 7.5 One-way analysis of variance with $\Delta^{13}C$ values for the comparison of major crop species across the periods. * = significant at the 0.05 level.

One-way ANOVA			
Species	Group	F	P
Barley $\Delta^{13}C$	Late Uruk, Ninevite V and Middle Assyrian	5.306	0.015*
Free-threshing wheat $\Delta^{13}C$	Late Uruk and Ninevite V	3.495	0.111
Glume wheat $\Delta^{13}C$	Late Uruk and Ninevite V	0.425	0.531

Table 7.6 Results of a Scheffe post hoc test on barley $\Delta^{13}C$ values for the multiple comparisons amongst each of three periods. * = significant at the 0.05 level.

Scheffe post hoc		
Period		P
Late Uruk	Ninevite V	0.497
	Middle Assyrian	0.020*
Ninevite V	Late Uruk	0.497
	Middle Assyrian	0.119
Middle Assyrian	Late Uruk	0.020*
	Ninevite V	0.119

The $\Delta^{13}C$ values of three crop species were compared within the Late Uruk and Ninevite V period (Table 7.7). In both periods, differences were not discovered in the results when no barley offset was applied.

Table 7.7 One-way analysis of variance with $\Delta^{13}C$ values, including barley offsets, for the comparison amongst the major crop species within the Late Uruk and Ninevite V, respectively. * = significant at the 0.05 level.

One-way ANOVA			
Period	Group	F	P
Late Uruk $\Delta^{13}C$, no offset	Barley, glume wheat and free-threshing wheat	0.064	0.938
Late Uruk $\Delta^{13}C$, 1 ‰ offset	Barley, glume wheat and free-threshing wheat	1.983	0.188
Late Uruk $\Delta^{13}C$, 1.5 ‰ offset	Barley, glume wheat and free-threshing wheat	5.008	0.031*
Ninevite V $\Delta^{13}C$, no offset	Barley, glume wheat and free-threshing wheat	1.327	0.293
Ninevite V $\Delta^{13}C$, 1 ‰ offset	Barley, glume wheat and free-threshing wheat	6.912	0.007*
Ninevite V $\Delta^{13}C$, 1.5 ‰ offset	Barley, glume wheat and free-threshing wheat	14.421	0.000*

The application of 1 ‰ offset to barley in the Late Uruk show no differences among species ($p = 0.188$). As for Ninevite V period, 1 ‰ offset to barley in $\Delta^{13}C$ values resulted in the significance of 0.007 in the probability among species. The post hoc test then presented significant differences between barley and glume wheat ($p = 0.007$). Overall, if the 1 ‰ offset is applied to barley $\Delta^{13}C$ values, it seems that the majority of all three crop samples from the Late Uruk represented well-watered conditions, without significant differences between crop types (Figure 7.4). On the other hand, the Ninevite V period samples with the same analysis indicates that barley was less well watered than wheats, showing simultaneously a wider range from poor to well-watered bands, while glume wheat and free-threshing wheat samples were moderately to well-watered (Figure 7.4).

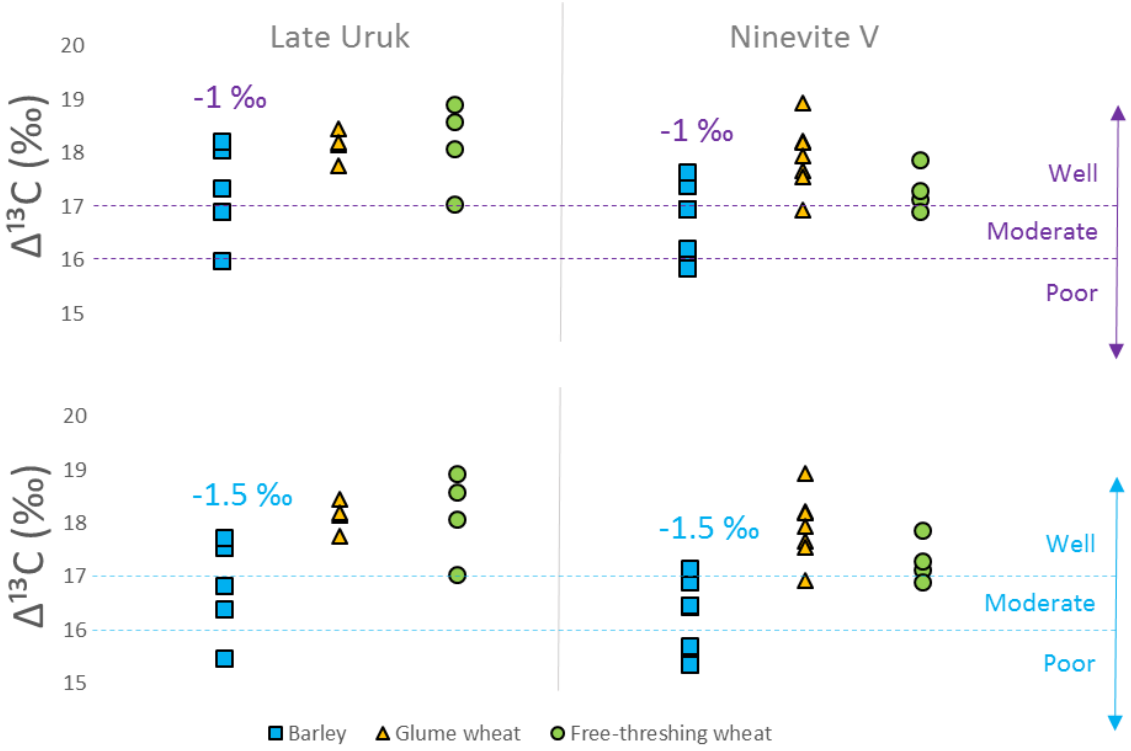


Figure 7.4 $\Delta^{13}C$ values of barley, glume wheat and free-threshing wheat with the application of 1 ‰ and 1.5 ‰ offsets to barley from the Late Uruk and Ninevite V periods from Tell Mohammed 'Arab. Dashed lines indicate the categorisation of crop moisture conditions defined by Wallace *et al*. (2013).

Application of a 1.5 ‰ offset to barley $\Delta^{13}C$ values affected the statistical results. The comparison between barley and wheats for the Late Uruk period reveals significant differences amongst the species (P = 0.031). Nevertheless, although free-threshing wheat and glume wheat $\Delta^{13}C$ values, which share the same mean $\Delta^{13}C$ values (18.16 and 18.14 ‰, respectively), appear to be higher than those of barley, these differences are insignificant between barley and wheats according to the Scheffe post hoc test (Table 7.8). These results suggest that Late Uruk barley samples was less well watered than glume wheat and free-threshing wheat (Figure 7.4). As for the later period, a 1.5 ‰ offset for barley shows significant differences between barley and wheats in both ANOVA and the post hoc tests (Table 7.7 and 7.8), and Figure 7.4 also clearly illustrates that barley is associated with poorer watering conditions than wheats.

Table 7.8 Results of a Scheffe post hoc test on Late Uruk barley 1.5 ‰ offset, Ninevite V barley 1 ‰ offset and Ninevite V barley 1.5 ‰ offset $\Delta^{13}C$ values for the multiple comparisons amongst each major crop species. * = significant at the 0.05 level.

Scheffe post hoc				
Species		Late Uruk $\Delta^{13}C$, 1.5 ‰ offset	Ninevite V $\Delta^{13}C$, 1 ‰ offset	Ninevite V $\Delta^{13}C$, 1.5 ‰ offset
		P	P	P
Barley	Glume wheat	0.068	0.007*	0.000*
	Free-threshing wheat	0.064	0.355	0.039*
Glume wheat	Barley	0.068	0.007*	0.000*
	Free-threshing wheat	0.999	0.298	0.298
Free-threshing wheat	Barley	0.064	0.355	0.039*
	Glume wheat	0.999	0.298	0.298

In summary, barley seems generally to have received moderate to high levels of water in the Late Uruk and Ninevite V periods, suggesting that the crop yields were not severely restricted by water supply. Compared to wheat, however, barley may have been grown in slightly drier conditions in the Late Uruk and Ninevite V periods, ranging from poor to well-watered conditions. Middle Assyrian barley was grown under poorly to moderately watered conditions and, compared to the earlier periods, its water status appears to have declined over time.

7.2.3.2. Nitrogen

Figure 7.5 displays the $\delta^{15}N$ values of barley, glume wheat and free-threshing wheat by periods from Tell Mohammed ʻArab. The stable nitrogen isotope ratios of all but a few samples were confined to the no or low manuring/middening boundary, ranging from 1 to 5 ‰ given local rainfall levels (Styring *et al.*, 2016; Styring *et al.*, 2017). The results of a one-way ANOVA show no significant differences amongst the three types of cereals through the time periods (Table 7.9 and 7.10). Intensive manuring is unlikely to have played an essential role in cereal production at Tell Mohammed ʻArab through these periods.

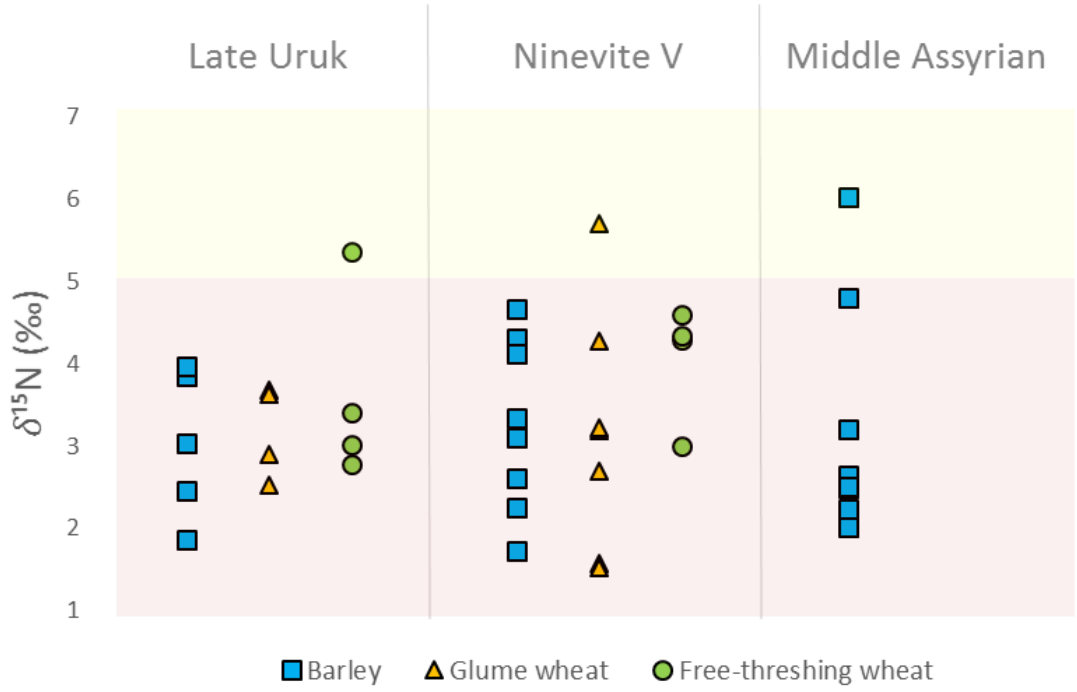


Figure 7.5 $\delta^{15}N$ values of barley, glume wheat and free-threshing wheat for three periods from Tell Mohammed 'Arab. Yellow shading indicates medium manuring and pink shading no/low manuring as defined by Styring *et al*. (2016), taking local rainfall levels and aridity effects into account to 'calibrate' manuring bands.

Table 7.9 One-way analysis of variance with $\delta^{15}N$ values for the comparison of major crop species amongst the periods.

One-way ANOVA			
Species	Group	F	P
Barley $\delta^{15}N$	Late Uruk, Ninevite V and Middle Assyrian	0.069	0.933
Free-threshing wheat $\delta^{15}N$	Late Uruk and Ninevite V	0.369	0.566
Glume wheat $\delta^{15}N$	Late Uruk and Ninevite V	0.000	0.984

Table 7.10 One-way analysis of variance with $\delta^{15}N$ values for the comparison amongst the major crop species within the periods.

One-way ANOVA			
Period	Group	F	P
Late Uruk $\delta^{15}N$	Barley, glume wheat and free-threshing wheat	0.516	0.612
Ninevite V $\delta^{15}N$	Barley, glume wheat and free-threshing wheat	0.808	0.463

Table 7.11 Stable carbon isotope and nitrogen isotope values of major crop samples from Tell Mohammed ‘Arab.

Taxa	Period	$\Delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	$\delta^{13}C$ (‰)	Lab ID	Sample
Barley	Late Uruk	17.9	1.9	-23.8	TM26	TM3
	Late Uruk	19.1	2.5	-24.9	TM32	TM29
	Late Uruk	18.3	3.9	-24.3	TM39	TM43
	Late Uruk	17.0	3.0	-22.9	TM34	TM50
	Late Uruk	19.2	4.0	-25.1	TM30	TM54
	Ninevite V	18.4	2.3	-24.3	TM38	TM2
	Ninevite V	17.0	3.1	-23.0	TM28	TM28
	Ninevite V	18.7	1.7	-24.5	TM24	TM34
	Ninevite V	18.0	2.6	-23.9	TM35	TM35
	Ninevite V	17.2	4.3	-23.2	TM23	TM36
	Ninevite V	18.0	4.1	-23.9	TM22	TM42
	Ninevite V	18.0	4.7	-23.9	TM01	TM44
	Ninevite V	16.9	3.3	-22.8	TM33	TM47
	Middle Assyrian	16.6	2.2	-22.7	TM29	TM7
	Middle Assyrian	16.3	2.7	-22.5	TM27	TM11
	Middle Assyrian	17.4	2.0	-23.5	TM40	TM16
	Middle Assyrian	16.5	2.5	-22.6	TM31	TM27
	Middle Assyrian	17.5	4.8	-23.5	TM36	TM48
	Middle Assyrian	18.6	6.0	-24.6	TM37	TM53
	Middle Assyrian	16.3	3.2	-22.4	TM03	TM56
	Middle Assyrian	15.9	2.5	-22.1	TM25	TM22+27
Glume wheat	Late Uruk	18.5	3.7	-24.4	TM15	TM29
	Late Uruk	18.2	2.5	-24.1	TM19	TM43
	Late Uruk	17.8	2.9	-23.7	TM18	TM50
	Late Uruk	18.2	3.6	-24.1	TM14	TM54
	Ninevite V	18.2	1.6	-24.1	TM06	TM2
	Ninevite V	18.2	3.2	-24.1	TM02	TM28
	Ninevite V	17.7	1.5	-23.6	TM21	TM34
	Ninevite V	17.9	2.7	-23.9	TM16	TM35
	Ninevite V	18.9	4.3	-24.8	TM13	TM36
	Ninevite V	17.6	3.2	-23.5	TM17	TM44
	Ninevite V	16.9	5.7	-22.9	TM20	TM47
Free-threshing wheat	Late Uruk	18.9	3.4	-24.8	TM08	TM29
	Late Uruk	18.1	3.0	-24.0	TM12	TM43
	Late Uruk	17.1	2.8	-23.0	TM11	TM50
	Late Uruk	18.6	5.4	-24.5	TM05	TM54
	Ninevite V	17.9	4.3	-23.8	TM09	TM34
	Ninevite V	17.1	3.0	-23.1	TM04	TM35
	Ninevite V	17.3	4.4	-23.2	TM07	TM36
	Ninevite V	16.9	4.6	-22.9	TM10	TM42

7.2.4. Combined summary of Tell Mohammed ‘Arab functional weed ecology and stable isotope analysis

This subsection considers on the findings of Tell Mohammed ‘Arab crop husbandry by comparing the functional weed ecology and the crop stable isotope results. Overall, comparison of the results in the functional weed ecological analysis and the crop stable isotope measurements shows satisfying agreement. The weed ecological results suggest relatively low-intensity cultivation, without practices such as systematic irrigation to ensure optimal water status or intensive manuring. The stable carbon and nitrogen isotope values of the cereal grain samples similarly point to variable watering conditions, ranging from dry to well-watered, and little to no manuring, respectively. On the other hand, the weed functional ecological results suggest slightly more fertile and/or disturbed growing conditions in the Middle Assyrian period than in the earlier periods, though the difference is slight and there is overlap. In terms of the stable carbon isotope results, cereal – especially barley – water status appears to have declined over time. Together, these results demonstrate the usefulness of weed ecological analysis for overall characterisation of cultivation intensity, and of stable isotope analysis for teasing apart differences among taxa as well as among factors contributing to fertility.

7.3. Tell Atchana

This section sets out the results of an investigation of crop husbandry practices at Tell Atchana. The Tell Atchana assemblage was overwhelmingly composed of free-threshing wheat. Arable weeds occurring in most samples are likely to reflect crop husbandry practices associated with this crop. Mixed crop samples and one pure olive sample were excluded, and thus only free-threshing wheat and free-threshing cereal by-product and product samples were considered. Species that are likely dung-derived such as *Prosopis farcta* and *Bolboschoenus glaucus* were excluded (see section 5.2.2).

7.3.1. Sowing and harvesting practices

7.3.1.1. Sowing and harvesting time

The sowing time of Tell Atchana free-threshing wheat was estimated using onset and length of flowering period for the Tell Atchana arable weed taxa (Bogaard *et al.*, 2001). As examined in the following paragraph and Table 7.13 below, harvesting time in the Tell Atchana region was presumed to be June, and based on this, flowering onset and length categories were adjusted. Species that begin to flower before June were defined as early-intermediate, those flowering in June as intermediate and those flowering after July as late. Table 7.12 lists species' classifications for flowering onset and duration. A total of 12 species was classified as indicative of autumn sowing and one species (*Anthemis cotula*) as potentially indicative since the onset classed as intermediate with short length; these are *Hippocrepis unisiliquosa/ciliata/multisiliqusa, Hymenocarpus circinnatus, Scorpiurus muricatus, Androsace maxima, Valerianella dentata, Vaccaria pyramidata, Pisum humile, Phalaris aquatica, Aegilops* sp., *Valerianella coronata* Type, *Hordeum murinum* type, *Lolium temulentum* and *Anthemis cotula.* There were no late- or long-flowering taxa likely to be associated with spring-sown crops.

Table 7.12 Classification of sowing time based on weed flowering onset and length from Tell Atchana assemblage. E = early, I = intermediate, L = late, Med = medium and A = autumn sown crop. Short = 1-3 months, Medium = 4-5 months and Long = more than 5 months.

Taxa	Months of flowering												Onset	Length	Class
	D	J	F	M	A	M	J	J	A	S	O	N			
Hippocrepis unisiliquosa/ciliata/multisiliqusa				x	x	x							E-I	Short	A
Hymenocarpus circinnatus				x	x	x							E-I	Short	A
Scorpiurus muricatus					x	x							E-I	Short	A
Androsace maxima					x	x							E-I	Short	A
Valerianella dentata					x	x	x						E-I	Short	A
Vaccaria pyramidata					x	x	x						E-I	Short	A
Pisum humile					x	x	(x)						E-I	Short	A
Phalaris aquatica						x	x						E-I	Short	A
Aegilops sp.						x	x						E-I	Short	A
Valerianella coronata Type						x	x	x					E-I	Short	A
Hordeum murinum type						x	x	x					E-I	Short	A
Lolium temulentum						x	x	x					E-I	Short	A
Anthemis cotula							x	x					I	Short	(A)
Ranunculus arvensis				x	x	x	x						E-I	Med	
Galium spurium				x	x	x	x						E-I	Med	
Coronilla sp.				x	x	x	x						E-I	Med	
Silene sp.					x	x	x	x					E-I	Med	
Rumex sp.					x	x	x	x					E-I	Med	
Bupleurum intermedium					x	x	x	x					E-I	Med	
Bromus spp.					x	x	x	x	(x)				E-I	Med	
Plantago sp.					x	x	x	x	x				E-I	Med	
Thymelaea passerina/gussonei/mesopotamia					x	x	x	x	x	(x)			E-I	Med	
Chenopodium sp.						x	x	x	x				E-I	Med	
Cephalaria sp.						x	x	x	x				E-I	Med	
Ornithogalum type 1						x	x	x	x				E-I	Med	
Hordeum spontaneum						x	x	(x)	(x)	(x)			E-I	Med	
Echium angustifolium/parviflorum				x	x	x	x	x	x				E-I	Long	
Medicago sp.					x	x	x	x	x	x			E-I	Long	
Anagallis arvensis					x	x	x	x	x	x			E-I	Long	
Sherardia arvensis					x	x	x	x	x	x			E-I	Long	
Ajuga/Teucrium sp.					x	x	x	x	x	x			E-I	Long	
Centaurea sp.						x	x	x	x	x	x		E-I	Long	

The harvest time for wheat in the Hatay province today is between late May and late June (Karabina, 2016). Table 7.13 shows the seasonality of weed taxa identified at Tell Atchana for harvesting time based on free-threshing wheat and free-threshing cereal product and fine sieve by-product samples. It can be seen that the great majority of species fruit by harvest time, implying that they were harvested in fruit with crop material.

Table 7.13 Seasonality of weed taxa identified at Tell Atchana in relation to harvesting time. (): rarely occurs. E: early, I: intermediate and L: late.

Taxa	Months of flowering/fruiting												Class
	J	F	M	A	M	J	J	A	S	O	N	D	
Hippocrepis unisiliquosa/ciliata/multisiliqusa			X	X	X								E
Hymenocarpus circinnatus			X	X	X								E
Scorpiurus muricatus				X	X								E
Androsace maxima				X	X								E
Pisum humile				X	X	(X)							E
Ranunculus arvensis			X	X	X	X							E
Galium spurium			X	X	X	X							E
Coronilla sp.			X	X	X	X							E
Valerianella dentata				X	X	X							E
Vaccaria pyramidata				X	X	X							E
Silene sp.				X	X	X	X						E
Rumex sp.				X	X	X	X						E
Bupleurum intermedium				X	X	X	X						E
Bromus spp.				X	X	X	X	(X)					E
Plantago sp.				X	X	X	X	X					E
Thymelaea passerina/gussonei/mesopotamia				X	X	X	X	X	(X)				E
Phalaris aquatica					X	X							E
Aegilops, glume bases					X	X							E
Valerianella coronata Type					X	X	X						E
Hordeum murinum type					X	X	X						E
Lolium temulentum					X	X	X						E
Echium angustifolium/parviflorum			X	X	X	X	X	X					I
Medicago sp.				X	X	X	X	X	X				I
Anagallis arvensis				X	X	X	X	X	X				I
Sherardia arvensis				X	X	X	X	X	X				I
Ajuga/Teucrium sp.				X	X	X	X	X	X				I
Hordeum spontaneum					X	X	(X)	(X)	(X)				I
Chenopodium sp.					X	X	X	X					I
Cephalaria sp.					X	X	X	X					I
Ornithogalum type 1					X	X	X	X					I
Anthemis cotula						X	X						I
Centaurea sp.					X	X	X	X	X	X			L

7.3.1.2. Harvesting height and method

The Tell Atchana weeds were classified into three categories, i.e. short (<35 cm), medium (36-80 cm) and tall (>80 cm), in accordance with their maximum heights in order to infer the harvesting height of cereals and harvesting methods. Potential crop weeds included 15 tall, 11 medium and six short taxa (Table 7.14). In particular, tall taxa are the most numerous and also occur in 100 percent of samples. Of the tall species, *Lolium temulentum* and *Phalaris aquatica* were dominant in terms of both the occurrence and abundance. Figure 7.6 shows again the high proportions of tall species (70 percent) in the Tell Atchana assemblage while short taxa take up only 6 percent on average.

Bias caused by genus-level identifications is not highly likely to affect the results since these occur in few samples (e.g. *Coronilla* sp.). The percentages of short taxa at Tell Atchana are low but the fact that these taxa occur in a number of samples (21) suggest that free-threshing cereals were sometimes cut close to the ground while the minimum height suggests medium-tall harvesting. Otherwise, it might have been cut from short to medium/high levels irregularly at one time. Ear-harvesting is unlikely given the widespread occurrence of short-medium taxa.

Table 7.14 Classification of the maximum stem height for weed taxa in Tell Atchana free-threshing wheat and cereal fine sieve by-product and product samples.

Taxa	**Maximum height (cm)**	**Class**	**No. sample**	**% sample**	**Total number of items**
Androsace maxima	15	Short	1	3	4
Valerianella dentata	25	Short	6	20	24
Valerianella coronata Type	25	Short	3	10	13
Scorpiurus muricatus	30	Short	19	63	371
Ranunculus arvensis	30	Short	7	23	25
Hymenocarpus circinnatus	35	Short	1	3	8
Short total			**21**	**70**	**445**
Sherardia arvensis	40	Medium	6	20	21
Hippocrepis unisiliquosa/ciliata/multisiliqusa	50	Medium	4	13	48
Anthemis cotula	55	Medium	6	20	25
Vaccaria pyramidata	60	Medium	4	13	9
Echium angustifolium/parviflorum	60	Medium	7	23	26
Aegilops sp.	70	Medium	1	3	1
Rumex sp.	70	Medium	22	73	857
Hordeum spontaneum	70	Medium	1	3	1
Medicago sp.	70	Medium	6	20	16
Thymelaea passerina/gussonei/mesopotamia	75	Medium	21	70	627
Anagallis arvensis	70 (-90)	Medium	7	23	61
Medium total			**27**	**90**	**1692**
Plantago sp.	90	Tall	13	43	63
Hordeum murinum type	100	Tall	4	13	9
Bupleurum intermedium	100	Tall	6	20	9
Bromus spp.	100	Tall	11	37	76
Ornithogalum type 1	100	Tall	1	3	27
Ajuga/Teucrium sp.	100	Tall	1	3	1
Lolium temulentum	110	Tall	29	97	1138
Phalaris aquatica	120	Tall	28	93	838
Silene sp.	130	Tall	3	10	7
Chenopodium sp.	150	Tall	2	7	5
Galium spurium	160	Tall	19	63	45
Pisum humile	200	Tall	1	3	1
Centaurea sp.	200	Tall	6	20	24
Coronilla sp.	250	Tall	16	53	2641
Cephalaria sp.	300	Tall	3	10	18
Tall total			**30**	**100**	**4902**

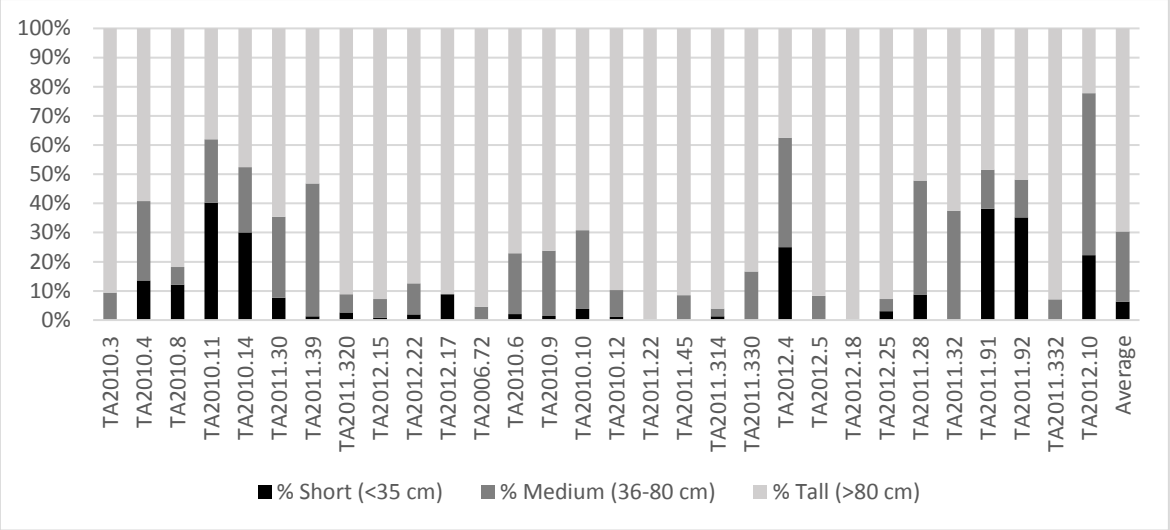


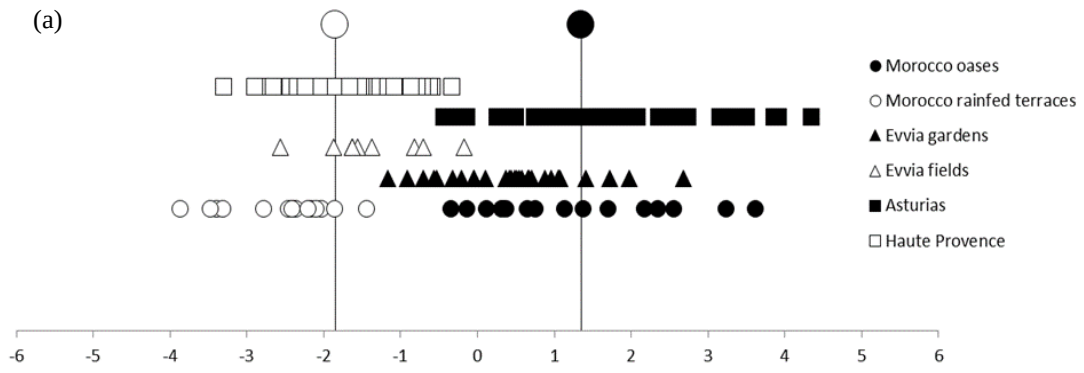
Figure 7.6 Bar chart displaying the proportions of maximum weed stem height divided into short, medium and tall from the Tell Atchana free-threshing wheat and cereal fine sieve by-product and product samples.

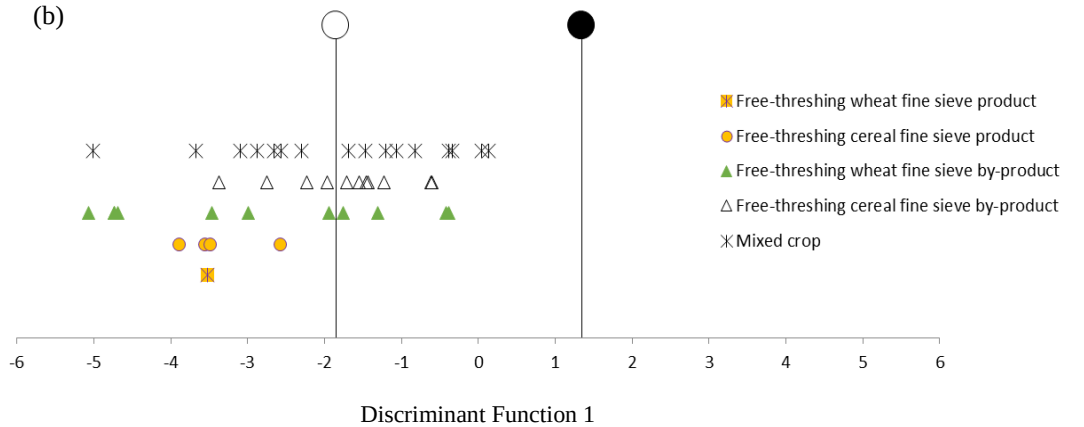
7.3.2. Weed functional ecology

The classification of Tell Atchana samples by discriminant function separating low- and high-intensity regimes indicates that the vast majority of samples resemble the low-input fields, with only two samples (i.e. TA2011.326 and TA2012.35) associated with the high-input group with low probabilities (Figure 7.7a, b and c and Table 7.15). There were no systematic differences between the inclusion and exclusion of *Bolboschoenus glaucus*, a potentially dung-derived taxon, in terms of the discriminant scores and the class probabilities (Figure b and c and Table 7.15). Also no obvious differences were observable amongst crop processing stages. Nevertheless, it can be noted that free-threshing wheat and cereal fine sieve by-product samples tend to possess a wider spectrum of discriminant scores compared to the product samples.

It is apparent that the Tell Atchana assemblage cereals tended to be grown under more extreme low-input conditions than the crops at Tell Mohammed ‘Arab (Figure 7.2). This contrast exists despite the fact that rainfall levels are higher in the Mediterranean zone of Tell Atchana, meaning that there would if anything be a climatic bias in the opposite direction. The Tell Atchana samples reflect agricultural production mobilised at a large urban centre of 22 hectares in extent (Yener, 2010). It is plausible, therefore, that the lower input growing conditions at Tell Atchana compared

with Tell Mohammed ‘Arab reflect the more extensive production regime needed to support the urban centre at Atchana.





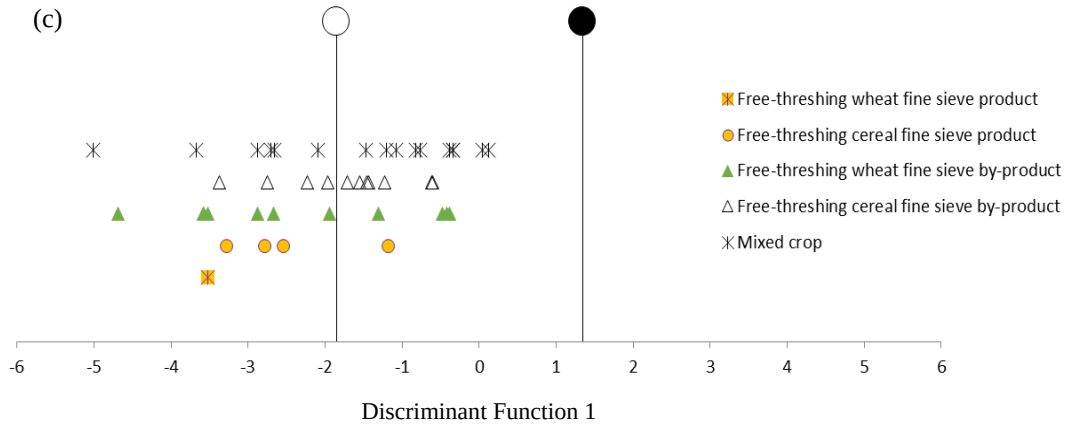


Figure 7.7 (a) The original discriminant function based on weed attribute scores showing the distribution of individual fields in the modern studies, and the results of the classification of the Tell Atchana samples (b) with all taxa and (c) without *Bolboschoenus glaucus*.

Table 7.15 List of the Tell Atchana samples used for the discriminant analysis and the classification of their intensity with the probabilities and discriminant scores.

Sample	**All taxa (including *Bolboschoenus glaucus*)**			**Taxa without *Bolboschoenus glaucus***		
	Class	**Probability**	**Discriminant scores**	**Class**	**Probability**	**Discriminant scores**
TA2011.332	Low	0.095	-3.52	Low	0.095	-3.52
TA2011.28	Low	0.089	-3.552	Low	0.353	-2.781
TA2011.32	Low	0.466	-2.582	Low	0.503	-1.183
TA2011.91	Low	0.041	-3.895	Low	0.152	-3.283
TA2011.92	Low	0.103	-3.484	Low	0.489	-2.545
TA2010.10	Low	0.257	-2.987	Low	0.418	-2.663
TA2010.12	Low	0.107	-3.463	Low	0.307	-2.874
TA2010.6	Low	0.15	-0.415	Low	0.15	-0.415
TA2010.9	Low	0.931	-1.939	Low	0.931	-1.939
TA2011.22	Low	0.001	-5.072	Low	0.095	-3.52
TA2012.25	Low	0.005	-4.684	Low	0.005	-4.684
TA2011.330	Low	0.928	-1.762	Low	0.169	-0.479
TA2006.72	Low	0.59	-1.313	Low	0.59	-1.313
TA2011.314	Low	0.143	-0.387	Low	0.143	-0.387
TA2011.45	Low	0.004	-4.729	Low	0.084	-3.58
TA2012.5	Low	0.004	-4.729	Low	0.084	-3.58
TA2010.11	Low	0.76	-1.548	Low	0.76	-1.548
TA2010.14	Low	0.532	-1.227	Low	0.532	-1.227
TA2010.3	Low	0.702	-2.235	Low	0.702	-2.235
TA2010.4	Low	0.211	-0.602	Low	0.211	-0.602
TA2010.8	Low	0.217	-0.617	Low	0.217	-0.617
TA2011.30	Low	0.368	-2.754	Low	0.368	-2.754
TA2012.15	Low	0.694	-1.459	Low	0.694	-1.459
TA2012.17	Low	0.128	-3.376	Low	0.128	-3.376
TA2012.22	Low	0.888	-1.712	Low	0.888	-1.712
TA2011.320	Low	0.678	-1.437	Low	0.678	-1.437
TA2011.39	Low	0.908	-1.968	Low	0.908	-1.968
TA2011.25	Low	0.212	-3.1	Low	0.392	-2.709
TA2011.322	Low	0.002	-5.012	Low	0.002	-5.012
TA2011.326	High	0.191	0.04	High	0.191	0.04
TA2011.33	Low	0.305	-2.878	Low	0.305	-2.878
TA2011.331	Low	0.477	-2.564	Low	0.808	-2.096
TA2011.334	Low	0.434	-1.071	Low	0.434	-1.071
TA2011.41	Low	0.302	-0.82	Low	0.302	-0.82
TA2011.93	Low	0.131	-0.343	Low	0.131	-0.343
TA2012.11	Low	0.142	-0.384	Low	0.142	-0.384
TA2012.35	High	0.223	0.129	High	0.223	0.129
TA2011.327	Low	0.871	-1.691	Low	0.276	-0.764
TA2012.14	Low	0.518	-1.207	Low	0.518	-1.207
TA2012.26	Low	0.653	-2.302	Low	0.131	-0.343
TA2012.7	Low	0.419	-2.661	Low	0.419	-2.661
TA2011.315	Low	0.068	-3.675	Low	0.068	-3.675
TA2011.36	Low	0.701	-1.469	Low	0.701	-1.469

7.4. Tell Brak

The Tell Brak assemblage is composed of two crop groups, namely, a barley group and free-threshing cereal group; mixed crop samples were absent. In the crop processing analysis, these two groups were defined further as barley product, barely/free-threshing cereal fine sieve by-product and barley/free-threshing cereal mixed stages (Table 5.22). The crop weed data assessed here are thus likely to be associated with barley rather than glume wheat or free-threshing wheat. Probable dung-derived species were excluded from the crop husbandry assessment (see section 5.3.2).

7.4.1. Sowing and harvesting practices

7.4.1.1. Sowing and harvesting time

The classification of weed taxa based on flowering onset and length is given in Table 7.16. As was the case for Tell Mohammed ʻArab, the harvest time for Tell Brak was estimated as April to May, and therefore early-intermediate onset was defined as flowering before April, while onset of flowering between April and May was classified as intermediate and after June as late. According to this classification, 13 species are likely associated with autumn-sown cereals, in addition to seven potential autumn sowing indicators. These latter ones designated as (A) in Table 7.16 were defined when species flowering length is short but the onset is intermediate. The majority of the 20 taxa defined as an autumn sowing indicators are known as typical arable weeds, although several of these were identified only to genus level (*Malva* sp. and *Medicago* sp.). Amongst the Tell Brak weed/wild flora that were not classed as autumn sowing indicators, a number are appear to be well-known crop weeds. However, their flowering duration was medium and so they are less conclusively associated with autumn sowing. Overall, the investigation of sowing time at Tell Brak weed flora detected only autumn sowing indicators.

Table 7.16 Classification of sowing time based on weed flowering onset and length from Tell Brak assemblage. E = early, I = intermediate, L = late, Med = medium and A = autumn sown crop. Short = 1-3 months, Medium = 4-5 months and Long = more than 5 months.

Taxa	Months of flowering												Onset	Length	Class
	D	J	F	M	A	M	J	J	A	S	O	N			
Malva parviflora				x	x								E-I	Short	A
Androsace maxima				x	x								E-I	Short	A
Valerianella coronata Type				x	x	x							E-I	Short	A
Medicago sp.				x	x	x							E-I	Short	A
Malva sp.				x	x	x							E-I	Short	A
Hyoscyamus cf. *muticus*				x	x	x							E-I	Short	A
Galium spurium				x	x	x							E-I	Short	A
Brassica sp.				x	x	x							E-I	Short	A
Glaucium sp.				x	x	x							E-I	Short	A
Eremopyrum bonaepartis/distans				x	x	x	(x)						E-I	Short	A
Fumaria parviflora Type				x	x	x	(x)						E-I	Short	A
Coronilla scorpioides				(x)	x	x	(x)						E-I	Short	A
Bellevalia sp.				(x)	x	x	(x)						E-I	Short	A
Adonis aestivalis Type					x	x							I	Short	(A)
Bupleurum intermedium					x	x							I	Short	(A)
Silene dichotoma Type					x	x	x						I	Short	(A)
Vaccaria hispanica					x	x	x						I	Short	(A)
Hordeum murinum type					x	x	x						I	Short	(A)
Ornithogalum sp.					x	x	x	(x)					I	Short	(A)
Taeniatherum caput-medusae						x	x						I	Short	(A)
Avena sp.				x	x	x	x						E-I	Med	
Bromus spp.				x	x	x	x						E-I	Med	
Papaver sp.				x	x	x	x						E-I	Med	
Hordeum spontaneum				x	x	x	x	x					E-I	Med	
Lepidium draba				x	x	x	x	x	(x)				E-I	Med	
Aegilops sp. (glume bases)				(x)	x	x	x						E-I	Med	
Aegilops spp./sp. (grain)				(x)	x	x	x						E-I	Med	
Lolium rigidum					x	x	x	x					I	Med	
Teucrium/Ajuga sp.					x	x	x	x					I	Med	
Gypsophila spp.					x	x	x	x					I	Med	
Thymelaea passerina/mesopotamica					x	x	x	x	(x)				I	Med	
Verbascum sp.					x	x	x	x	x	x	x		I	Long	

The wheat and barley harvesting times in the region of Tell Brak today are April and June (Brooks, 2015). In Table 7.17, the vast majority of the Tell Brak weeds was classified as early categories fruiting in April to May (-June), supporting autumn-sown and spring harvest free-threshing cereal.

Table 7.17 Seasonality of weed taxa identified at Tell Brak in relation to harvesting time. (): rarely occurs. E: early, I: intermediate and L: late.

Taxa	Months of flowering/fruiting												Class
	J	F	M	A	M	J	J	A	S	O	N	D	
Androsace maxima			x	x									E
Malva parviflora			x	x									E
Valerianella coronata Type			x	x	x								E
Medicago sp.			x	x	x								E
Malva sp.			x	x	x								E
Hyoscyamus cf. *muticus*			x	x	x								E
Brassica sp.			x	x	x								E
Glaucium sp.			x	x	x								E
Eremopyrum bonaepartis/distans			x	x	x	(x)							E
Fumaria parviflora Type			x	x	x	(x)							E
Avena sp.			x	x	x	x							E
Bromus spp.			x	x	x	x							E
Papaver sp.			x	x	x	x							E
Hordeum spontaneum			x	x	x	x	x						E
Lepidium draba			x	x	x	x	x	(x)					E
Coronilla scorpioides			(x)	x	x	(x)							E
Bellevalia sp.			(x)	x	x	(x)							E
Aegilops sp. (glume bases)			(x)	x	x	x							E
Aegilops spp./sp. (grain)			(x)	x	x	x							E
Adonis aestivalis Type				x	x								E
Bupleurum intermedium				x	x								E
Silene dichotoma Type				x	x	x							E
Vaccaria hispanica				x	x	x							E
Hordeum murinum type				x	x	x							E
Galium spurium				x	x	x							E
Ornithogalum sp.				x	x	x	(x)						E
Lolium rigidum				x	x	x	x						I
Teucrium/Ajuga sp.				x	x	x	x						I
Thymelaea passerina/mesopotamica				x	x	x	x	(x)					I
Gypsophila spp.				x	x	x	x	x					I
Verbascum sp.				x	x	x	x	x	x	x			I
Taeniatherum caput-medusae					x	x							I

7.4.1.2. Harvesting height and method

The classification of the Tell Brak weed taxa by maximum height identifies seven short, 17 medium and seven tall taxa (Table 7.18). It is clear that the majority of Tell Brak weed categories were dominated by medium height taxa across the samples but short taxa form a significant minority in all samples shown in Figure 7.8. Short taxa are more abundant than tall taxa due to two especially frequent short taxa (*Coronilla scorpioides* and *Eremopyrum bonaepartis/distans*). Overall, the estimated harvesting height of barley and/or free-threshing cereals at Tell Brak is likely to be low (*c.* 30-35 cm).

Table 7.18 Classification of the maximum stem height for weed taxa in Tell Brak barley and free-threshing cereal fine sieve by-product and product samples.

Taxa	**Maximum height (cm)**	**Class**	**No. sample**	**% sample**	**Total number of items**
Ornithogalum sp.	5	Short	3	23	4
Androsace maxima	15	Short	4	31	11
Coronilla scorpioides	20 (-35)	Short	12	92	317
Valerianella coronata Type	25	Short	3	23	4
Eremopyrum bonaepartis/distans	30	Short	11	85	136
Glaucium sp.	30	Short	1	8	1
Malva parviflora	35	Short	1	8	4
Short total			**13**	**100**	**477**
Malva sp.	40 (-60)	Medium	9	69	177
Silene dichotoma Type	45 (-70)	Medium	6	46	43
Thymelaea passerina/mesopotamica	45 (-75)	Medium	1	8	2
Taeniatherum caput-medusae	50	Medium	6	46	44
Fumaria parviflora Type	50 (-75)	Medium	4	31	9
Medicago sp.	60	Medium	1	8	4
Adonis aestivalis Type	60	Medium	4	31	16
Vaccaria hispanica	60	Medium	2	15	3
Lepidium draba	60	Medium	8	62	76
Aegilops spp./sp.	60	Medium	10	77	469
Hordeum murinum type	60	Medium	12	92	190
Papaver sp.	60	Medium	1	8	74
Gypsophila spp.	70	Medium	1	8	1
Hordeum spontaneum	70	Medium	8	62	32
Bellevalia sp.	70 (-80)	Medium	1	8	1
Bromus spp.	80	Medium	5	38	82
Lolium rigidum	80	Medium	10	77	92
Medium total			**13**	**100**	**1315**
Avena sp.	100	Tall	1	8	3
Teucrium/Ajuga sp.	100	Tall	3	23	4
Brassica sp.	100	Tall	1	8	3
Bupleurum intermedium	100	Tall	1	8	1
Galium spurium	100 (-160)	Tall	6	46	36
Hyoscyamus cf. *muticus*	150	Tall	2	15	5
Verbascum sp.	200	Tall	1	8	8
Tall total			**10**	**77**	**60**

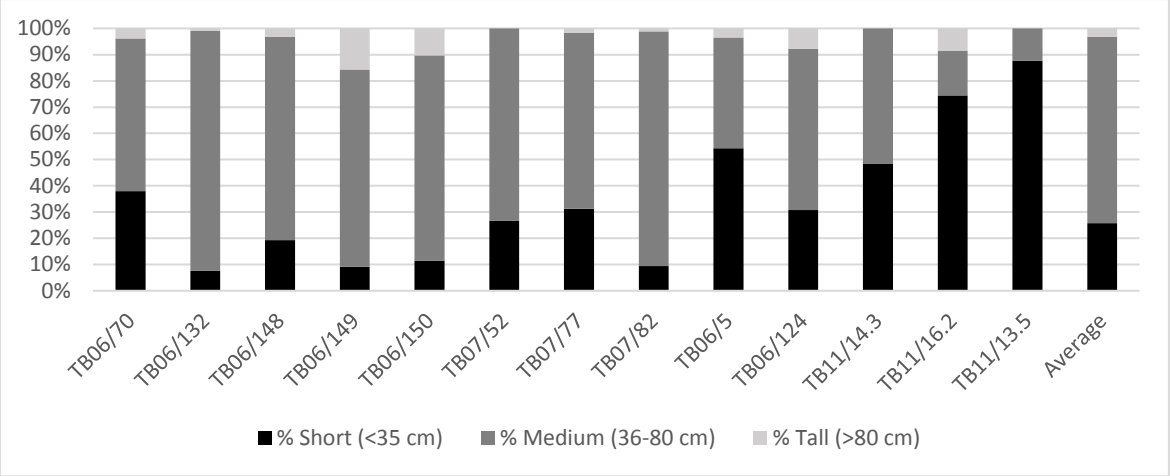
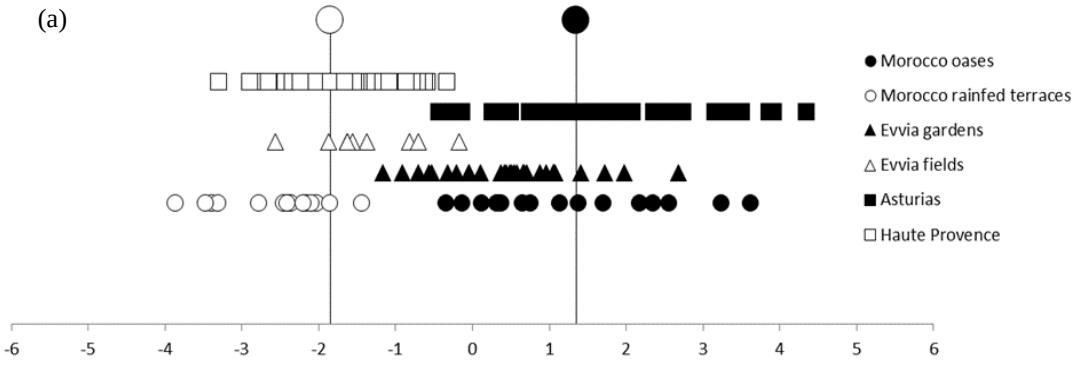
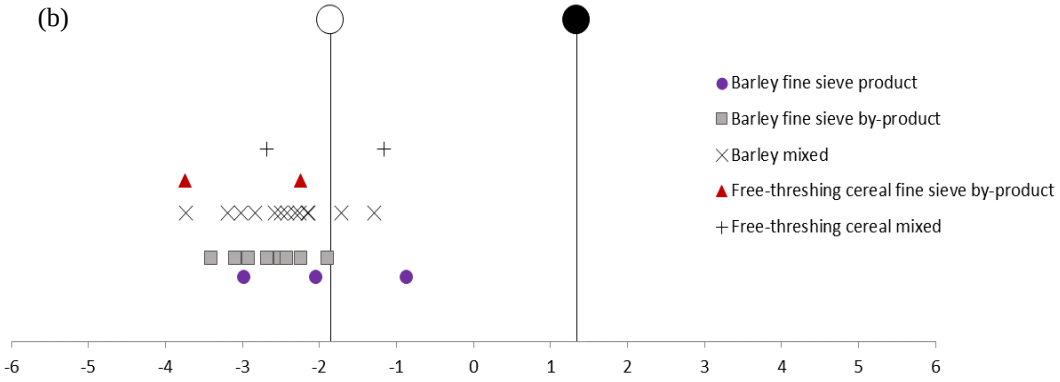


Figure 7.8 Bar chart displaying the proportions of maximum weed stem height divided into short, medium and tall from the Tell Brak barley and free-threshing cereal fine sieve by-product and product samples.

7.4.2. Weed functional ecology

The weed functional attributes of Tell Brak weed flora indicate low-intensity cultivation (Figure 7.9 and Table 7.19). There were no remarkable differences based on inclusion of *Bolboschoenus glaucus* in the discriminant analysis. Also there were no clear differences amongst crop processing stages. The entire Tell Brak group receives low discriminant scores (Table 7.19), implying generally poor growing conditions for barley/free-threshing cereals. Comparison with the results from Tell Mohammed ʻArab and Tell Atchana (see Figure 8.2a, b and c) shows that Brak scores tend to be lower than those at the small settlement of Mohammed ʻArab and less variable than those for Atchana. The implication is that Brak as an urban centre of 30 hectares during this second-millennium BC occupation (Ur, 2014) was associated with more extensive/lower input growing conditions than the small *c*. 2.4-hectare settlement of Mohammed ʻArab, on the one hand, and with more consistent (low-input) growing conditions than the urban centre of Atchana. This is discussed in further detail in Chapter 8.





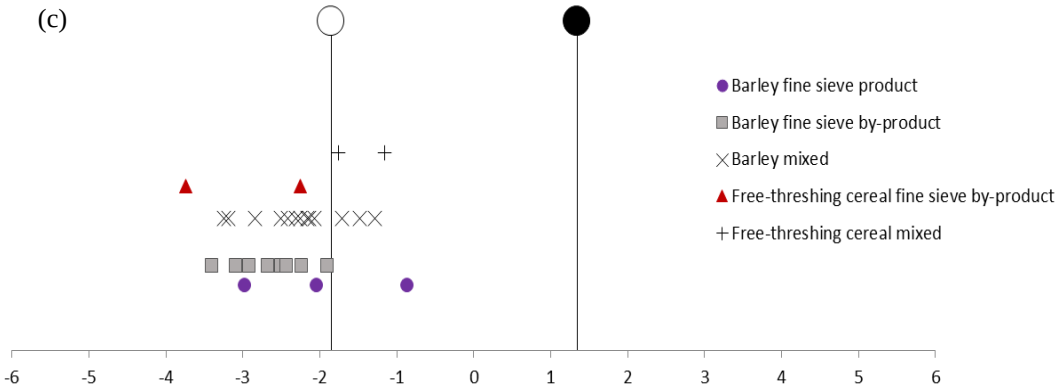


Figure 7.9 (a) The original discriminant function based on weed attribute scores showing the distribution of individual fields in the modern studies, and the results of the classification of the Tell Brak samples (b) with all taxa and (c) without *Bolboschoenus glaucus*.

Table 7.19 List of the Tell Brak samples used for the discriminant analysis and the classification of their intensity with the probabilities and discriminant scores.

Sample	All taxa (including *Bolboschoenus glaucus*)			Taxa without *Bolboschoenus glaucus*		
	Class	**Probability**	**Discriminant scores**	**Class**	**Probability**	**Discriminant scores**
TB06/124	Low	0.327	-0.873	Low	0.327	-0.873
TB06/5	Low	0.847	-2.046	Low	0.847	-2.046
TB11/14.3	Low	0.258	-2.984	Low	0.258	-2.984
TB06/132	Low	0.511	-2.51	Low	0.511	-2.51
TB06/148	Low	0.119	-3.41	Low	0.119	-3.41
TB06/149	Low	0.562	-2.433	Low	0.562	-2.433
TB06/150	Low	0.96	-1.903	Low	0.96	-1.903
TB06/70	Low	0.406	-2.683	Low	0.406	-2.683
TB07/52	Low	0.214	-3.094	Low	0.214	-3.094
TB07/77	Low	0.283	-2.927	Low	0.283	-2.927
TB07/82	Low	0.697	-2.242	Low	0.697	-2.242
TB07/10	Low	0.515	-2.504	Low	0.515	-2.504
TB07/54	Low	0.243	-3.02	Low	0.759	-2.16
TB07/60	Low	0.06	-3.735	Low	0.165	-3.242
TB07/61	Low	0.571	-2.419	Low	0.571	-2.419
TB07/68	Low	0.569	-1.283	Low	0.569	-1.283
TB07/69	Low	0.471	-2.574	Low	0.832	-2.065
TB07/70	Low	0.648	-2.309	Low	0.648	-2.309
TB07/76	Low	0.763	-2.154	Low	0.713	-1.484
TB07/89	Low	0.777	-2.136	Low	0.777	-2.136
TB07/92	Low	0.886	-1.709	Low	0.886	-1.709
TB11/26.17	Low	0.182	-3.188	Low	0.182	-3.188
TB11/26.18	Low	0.324	-2.838	Low	0.324	-2.838
TB11/26.20	Low	0.687	-2.255	Low	0.687	-2.255
TB11/13.5	Low	0.059	-3.742	Low	0.059	-3.742
TB11/16.2	Low	0.692	-2.249	Low	0.692	-2.249
TB07/67	Low	0.409	-2.678	Low	0.928	-1.762
TB07/84	Low	0.491	-1.163	Low	0.491	-1.163

Chapter 8. Discussion and conclusion

The results of the analysis of the archaeobotanical assemblages from Tell Mohammed ‘Arab, Tell Atchana and Tell Brak, and the consideration of contemporary society and environment in the northern Fertile Crescent described in the preceding chapters, have generated new insights pertaining to the research questions framed in Chapter 1. This final chapter accordingly reviews the major crop types, on-site agricultural activities and agricultural production strategies evidenced at the study sites, placing these findings in the context of research in the region, especially concerning the second millennium BC, when the assemblages studied here overlap chronologically.

8.1. Major crop types

The archaeobotanical assemblages analysed from Tell Mohammed ‘Arab, Tell Atchana and Tell Brak attest to the processing/use of five cereals, that is, barley, macaroni wheat, bread wheat, emmer wheat, einkorn wheat, three pulses, bitter vetch, lentil and grass pea, and two fruits, fig and grape. These are attested at all three of the sites, but with differential emphasis (Table 8.1). While the glume wheat and free-threshing wheat categories are represented by multiple taxa, the major barley type identified at the three sites is the hulled two-row form.

Certain crop taxa were only encountered in one or two of the site assemblages. The occurrence of ‘new type’ glume wheat is limited to Tell Mohammed ‘Arab and Tell Atchana; there is no firm evidence of this type at Tell Brak. Pea was found only at Tell Brak, and at fairly frequent levels, while chickpea was absent at Tell Atchana but was present at low levels at Tell Mohammed ‘Arab and Tell Brak in the Jazira region. Beyond cereals and pulses, a typical Mediterranean crop, olive, was evidenced at Tell Atchana. Flax was also well attested only at Tell Atchana. The presence of safflower was exclusively reported at Tell Mohammed ‘Arab and Tell Brak. Such a crop spectrum is also typical to a certain extent of other sites in the relevant periods in the northern Fertile Crescent (Table 8.2).

Table 8.1 Summary of crop composition at the three study sites in terms of ubiquity and total abundance of items.

Site	**Tell Mohammed 'Arab**		**Tell Mohammed 'Arab**		**Tell Atchana**		**Tell Brak**	
Region	Tigris		Tigris		Eastern Mediterranean		Khabur	
Date BC	3300-2500		1400-1100		1800-1200		1550-1300	
No. of sample	15		12		50		33	
	%	**Sum**	**%**	**Sum**	**%**	**Sum**	**%**	**Sum**
Cereal								
Two-row hulled barley	100	1370	**100**	**6687**	86	1569	**100**	**7632**
Glume wheat	**100**	**3401**	67	68	74	651	67	256
Free-threshing wheat	87	468	25	119	**98**	**8122**	97	650
Pulse								
Bitter vetch	7	4	8	1	94	1673	70	83
Lentil	33	27	8	1	78	208	45	42
Grass pea	40	17	17	7	8	5	21	13
Chickpea	13	13					3	1
Pea							55	108
Other								
Olive					32	129		
Flax					20	71		
Safflower	7	1	8	14			6	14

In addition to potential regional contrasts in terms of crop occurrence, it is clear that there are chronological differences as well in crop composition within the Tell Mohammed 'Arab assemblage. In early periods (the Late Uruk and Ninevite V), glume wheat material was more prevalent than two-row hulled barley, whereas the later period (Middle Assyrian) was dominated by storage concentrations of two-row hulled barley grain (Table 8.1).

8.1.1. The dominance of barley over glume wheat in the northern Fertile Crescent

Investigation of archaeobotanical assemblages indicates that, barley is, in general, the most common crop type, particularly, represented by a two-row hulled variety, during the Middle and Late Bronze Age based on previously published research (Table 8.2). There was a hint of the six-row form based on the identification of one rachis item at Tell Brak, as well as a few twisted grains, but their number was very low. Whether or not naked barley was present is unclear, with

few potential items at the three sites. Exceptionally, in case of the Tell Atchana samples, free-threshing wheat was distinctively by far the most common crop, though the work reported here nevertheless records a high frequency of two-row hulled barley.

During the Bronze Age, the significance of barley is obvious, and reliance on barley became even greater from around the onset of the Middle Bronze Age (van Zeist, 1994, p. 543; Riehl, 2010c). As can be seen in Table 8.2, it has been widely reported that hulled barley, especially the two-row form, dominates in the majority of other archaeological site assemblages across the northern Fertile Crescent through the Middle and Late Bronze Age. The results of the present research from the study sites clearly follow this broad chronological trend. The Late Bronze Age Tell Mohammed 'Arab and Brak assemblages are barley-dominated, whilst the Late Chalcolithic/Early Bronze Age Tell Mohammed 'Arab assemblage is dominated by glume wheat (Table 8.2). Ninevite V Tell Leilan crop remains are comparable to that in Tell Mohammed 'Arab. This massive site (*c*. 90 ha) is dominated by emmer, especially glume bases, followed by free-threshing cereal grain, which shows similar pattern to Tell Mohammed' Arab despite the great difference in site size (Wetterstrom, 2003). Moving back to the later period, there was no significant difference in the barley trend from the Middle to Late Bronze Age (Table 8.2). A rise of barley, overtaking glume wheat, during the Middle Bronze Age has been linked with, Early Bronze Age collapse in time after Early Bronze Age urbanisation (Riehl, 2010c). Records of the more demanding six-row form are far less common in the northern Fertile Crescent (Table 8.2).

Climate change may have exerted profound influence on not only agricultural systems but also socio-political organisation, particularly in conjunction with abrupt aridification in the Fertile Crescent. As manifested in previous palaeoclimate research, the 4.2 K yr BP dry event at the end of the Middle Bronze Age (see Chapter 2) has been identified by scholars as one prominent cause for the decline of urban societies, with reductions in site size and/or eventually abandonment of cities and towns in the region, also triggering the Akkadian empire's collapse in southern Mesopotamia (Cookson, Hill and Lawrence, 2019) (see Chapter 1, Figure 1.2). An increase in severe drought stress across inland northern Fertile Crescent would have threatened crop yields, especially of

wheat, which is a more demanding cereal than barley. Barley is far more tolerant of drought and salinity than any wheat species (Riehl and Bryson, 2007; Riehl, 2009). Ancient Sumerian texts describe that between 2350 and 2150 BC the production of wheat was reduced by 40 percent, while that of barley remained stable, due to soil salinization caused by intensified irrigation in southern Mesopotamia. In order to adapt to critically dry circumstances, therefore, the focus on barley cultivation could have been a breakthrough adaptive response, by minimising crop failures and securing a more stable food supply. Although past climatic proxy records suggest somewhat higher moisture levels during the Late Bronze Age compared to the Middle Bronze Age, in general, the increase was modest, and the focus on barley continued in northern Syria and Iraq.

Corresponding to the rise of barley in relation to the 4.2K drought episode, the results of stable carbon isotope analysis of charred cereal grain samples suggest that the water status of barley in the Fertile Crescent tended to decrease in the transition from the Early to the Middle Bronze Age, especially in the Khabur and at Qatna and Emar; the trend towards barley cultivation continued through to the Late Bronze Age, but with slightly better water status in Late Bronze Age than in the Middle Bronze Age (Riehl, Bryson and Pustovoytov, 2008; Riehl *et al.*, 2014). At Tell Mohammed ʻArab, the new stable carbon isotope data reported here indicate that the water status of barley was more favourable in the first half of the Early Bronze Age than in the Late Bronze Age II (see Chapter 7). This contrast could be related more to agricultural strategy than to overall climate; as Riehl (2014) has shown, barley stable carbon isotope values only tend to reflect climatic trends in relatively marginal (arid) parts of the region.

In addition to environmental factors, socio-political instability and political transitions may have affected agricultural systems in terms of barley preference. Early Bronze Age complex societies and urbanisation underwent considerably contraction or completely abandonment approximately between 2200 and 2000 BC in conjunction with climate change (Weiss, 1997; Akkermans and Schwartz, 2003; Ur, Karsgaard and Oates, 2011; Ur, 2015). After a number of cities and towns that used to play a role as urban centres shrank or collapsed, societies gradually recovered and began to regenerate during the Middle Bronze Age, and a number of small-scale regional polities controlled

extensive areas (Akkermans and Schwartz, 2003). Cuneiform archives from Mari mention that Tell Leilan was a local centre at this time, and it seems that the economy was heavily reliant on sheep/goat pastoralism (Luke, 1980; Buccellati, 1990; Akkermans and Schwartz, 2003; Hole, 2007). Hulled barley, including chaff material, is suitable as animal fodder, and as manifested in numerous archaeobotanical studies in this area, both the grain and chaff could have been provided to sheep/goat as fodder in one form or another. Even under unfavourable circumstances for wheat cultivation, barley-fed sheep/goats would have offered a complementary food source, and intake of meat and/or milk may have increased in importance in lean years.

During the Late Bronze Age, the northern Fertile Crescent entered upon an unprecedented imperial and international phase, and four empires – the Mitannian, Egyptian, Hittite and Assyrian – competed and interacted with each other politically and economically (Akkermans and Schwartz, 2003). On the one hand, vigorous warfare between the powers would have induced recursive socio-political unrest and disrupted agricultural operations, but on the other, under centralised administrative economic systems, crop production could have become even more important for garrison towns, military provisions, famine, emergency food supplies and animal feeding in order to maintain and support both individual households and political organisations. With the advantages of storage and fodder use, barley could have been fulfilled these elements most successfully. In particular, barley might have contributed to raising livestock as well as offering a human food in difficulties such as famine (cf. Halstead and Jones, 1989). With regard to fodder use, barley could be fed not only to livestock for (indirect) human food production and trade, but also to horses used with chariots in war. The light two-wheeled horse-drawn chariot was an innovation in warcraft at that time (Akkermans and Schwartz, 2003). At Tell Schech Hamad, a storage concentration of two-row hulled barley was discovered in a room in the Middle Assyrian palace; since it was only partially cleaned and contained a large quantity of weed seeds, it may have been destined for use as animal fodder, possibly for horses (van Zeist, 2015b), although potential human consumption cannot be ruled out (cf. Jones, 1998).

Table 8.2 Spectrum of crops attested in the northern Fertile Crescent through the second millennium BC, by period and geographical region, and with site size indicated. Crop ubiquities are indicated on a semi-quantitative scale, as follows: +: <25 %, ++: 25-49 %, +++: 50-74 %, ++++: 75-100 %. Umm el-Marra pulses are recorded on the basis of presence (p) based on the limited information available. Site names in bold are the three sites in the present study. Archaeobotanical samples which cover periods outside of the second millennium BC were excluded. References for each site are given in Table 1.1. Colour shading indicates subregions within northern Mesopotamia.

Site and size (small: 1-9/ medium: 10-39/ large: >40, *c.* ha)	**Region**	**Date BC**	**No. samples**	**Cereal**									**Pulse**						**Olive**	**Period**
				Two-row barley	**Six-row barley**	**Barley**	**Emmer**	**Einkorn**	**Glume wheat**	**Free-threshing wheat**	**Wheat**	**Cereal**	**Lentil**	**Bitter vetch**	**Grass pea**	**Bitter vetch/grass pea**	**Common pea**	**Chick pea**		
Tell Atchana (M, 22)	Eastern Mediterranean	1600-1200 (LBA I-II)	35			+	+			++	+		++	+		+				Late Bronze Age
Tell Atchana (M, 22)	Eastern Mediterranean	1600-1200 (LBA I-II)	248			+	+	+	+	+	+		+	+				+	++	
Tell Atchana (M, 22)	Eastern Mediterranean	1600-1300 (LBA I-II)	18	+					+	++ ++			+	+	+				+	
Umm el-Marra (M, 25)	NW Syria	1600-1200 (LBA I-II)	12	++ ++						+	+		p		p					
Tell Afis (M, 28)	NW Syria	1300-1200 (LBA II)	10		++		+			+	+		+		++				+	
Sabi Abyad (S, 4)	Balikh	1600-1200 (LBA I-II)	8	+		++ +				++										
Hadidi (M, 22)	Euphrates	1550-1400 (LBA I)	7	++ ++						+			+				+			
Emar (L, 70)	Euphrates	1600-1200 (LBA I-II)	15	++ +		++			+	+			+			+			+	
Tell Brak (M, 30)	Khabur	1550-1300 (LBA I-II)	33	++ ++					+	+			+	+	+		+			
Tell Schech Hamad (M, 15)	Khabur	1200 (LBA II)	10	++ ++							+				+		+			
Tell Schech Hamad (M, 15)	Khabur	1200 (LBA II)	3	++ ++																
Tell Bderi (S, 8)	Khabur	1300 (LBA II)	3		++ ++					+	+									
Tell Mohammed 'Arab (S, 2.4)	Tigris	1400-1100 (LBA II)	12	++ ++					+	+			+	+	+					

Site and size (small: 1-9/ medium: 10-39/ large: >40, *c.* ha)	**Region**	**Date BC**	**No. samples**	**Cereal**									**Pulse**						**Olive**	**Period**
				Two-row barley	**Six-row barley**	**Barley**	**Emmer**	**Einkorn**	**Glume wheat**	**Free-threshing wheat**	**Wheat**	**Cereal**	**Lentil**	**Bitter vetch**	**Grass pea**	**Bitter vetch/grass pea**	**Common pea**	**Chick pea**		
Tell Atchana (M, 22)	Eastern Mediterranean	1800-1600 (MBA II)	32	+					+	++ +			+	+	+				+	Middle Bronze Age
Umm el-Marra (M, 25)	NW Syria	2000-1600 (MBA I-II)	9	++ ++						+	+		p		p			p	p	
Ebla (L, 55)	NW Syria	2000-1900 (MBA I)	7	+	++		+	+		+	+		+	+					+	
Ebla (L, 55)	NW Syria	2000-1900 (MBA I)	78	+		+				++	+		+	+			+		+	
Hammam et-Turkman (M, 20)	Balikh	2000-1550 (MBA I-II)	13	++ ++			+		+	+			+	+						
Mezraa Höyük (S, 2.5)	Euphrates	2000-1500 (MBA I-II)	2	++ ++									+				+			
Hadidi (L, 55)	Euphrates	2000-1550 (MBA I-II)	10	++ +						+			+	+	+		+			
Emar (M, 37)	Euphrates	2000-1600 (MBA I-II)	3	+	+	++ +				+			+	+	+	+				
Tell Brak (M, 15-35)	Khabur	1800-1600 (MBA II)	33			++ ++	+	+	+	+	+		+	+	+	+	+			
Tell Arbid (M, 38)	Khabur	1900-1500 (MBA I-II)	18	++ +		+	+	+	+	+	+		+	+						
Tell Mozan (M, 30)	Khabur	2000-1800 (MBA I)	58	+		++ +	+	+	+	+	+		+	+			+	+		
Hirbermerdon (M, 10)	Tigris	2000-1800 (MBA I)	18			+	++	+	++	+	+		+	+						
Kenan Tepe (S, 6)	Tigris	2000-1800 (MBA I)	17									++ ++								
Tell Mohammed 'Arab (S, 2.4)	Tigris	3300-2500 (LC5-EJ0-I)	15	++					++ +	+			+		+	+		+		EBA

8.1.2. Free-threshing wheat

While barley increased in importance at a number of archaeological sites, at the expense of glume wheat across the inland northern Fertile Crescent region during the Bronze Age, free-threshing wheat was clearly the dominant cereal at eastern Mediterranean Tell Atchana. As can be seen in Table 8.2, free-threshing wheat was present at most sites through the Middle and Late Bronze Age, but as a minor crop, with the exception of Tell Atchana, Ebla and Tell Sabi Abyad. Tell Atchana and Ebla are located near the Mediterranean coast, where higher rainfall levels can support cultivation of free-threshing wheat (Caracuta and Fiorentino, 2015). By contrast, at Tell Mohammed 'Arab and Tell Brak, the precipitation would have been marginal for wheat cultivation, and a buffering system was essential in case of drought (Riehl, Bryson and Pustovoytov, 2008; Riehl *et al.*, 2014; Charles, Pessin and Hald, 2010). Middle Assyrian Tell Sabi Abyad is unique in that it is located on the Balikh river, well away from the Mediterranean coast, in a zone that receives only marginal levels of rainfall, *c*. 250 mm per annum; also, pure free-threshing wheat grain product material was found. It was suggested that this site was a garrison town to protect the Assyrian empire from the western powers (Akkermans and Rossmeisl, 1990; van Zeist, 1994; Akkermans and Schwartz, 2003), and the stored grain is therefore likely to have been brought from other sites rather than locally produced (van Zeist, 1994).

The decrease in glume wheat is recorded from eastern Turkey to the Levant during the Early Bronze Age, and glume wheat was a minor crop type by the second millennium BC (Miller, 1991; Nesbitt and Samuel, 1996). Instead, free-threshing wheat became an important crop in eastern Turkey (Nesbitt and Samuel, 1996). This replacement of glume wheat by free-threshing wheat in some regions during the Bronze Age could be more related to social complexity and urbanism than to environmental factors. At Tell Atchana, in a favourable geographical location in terms of water conditions during the Middle and Late Bronze Age, either type of wheat could have been produced. Free-threshing wheat production is advantageous in that yields tend to be high and processing costs are lower (Nesbitt and Samuel, 1996), saving labour and time, in contrast to glume wheat, which requires dehusking. A focus on free-threshing wheat may have been the best

strategy to cope with urbanisation and increasing population at Late Bronze Age Tell Atchana. A distinctive assortment of crops at Tell Atchana was comprised of free-threshing cereal plus bitter vetch, which co-occurred across the site assemblage analysed here. This combination is also attested at another site near the Mediterranean coast of Syria, at Middle Bronze I Ebla, in a storehouse (Fiorentino and Caracuta, 2010).

8.1.3. Bitter vetch

Bitter vetch occurs in numerous site assemblages across the northern Fertile Crescent, more so in the Middle than the Late Bronze Age (Table 8.2). Compared to Tell Mohammed ʻArab and Tell Brak, bitter vetch at Tell Atchana occurs at strikingly high levels, including outside of storage contexts. In recent times, lentil has been preferred for human consumption; the seed coat (testa) of bitter vetch contains toxins that must be removed by special preparation prior to food preparation, and is it often regarded as fodder, except under conditions of famine (Enneking *et al.*, 1995; Jones and Halstead, 1995). In order to eliminate the toxins, bitter vetch requires additional processing, that is, soaking and/or boiling until they lose their bitterness (Enneking and Miller, 2014).

An intriguing aspect of the Tell Atchana assemblage is the distinctive pairing of two crops, free-threshing wheat and bitter vetch, across almost all samples and all context types, including pure free-threshing wheat product material and storage contexts. Sharing an overlapping fruiting month with free-threshing cereals (June), this may suggest that bitter vetch acted as a weedy and/or supplementary crop, for fodder for example, in free-threshing cereal fields, surviving in wheat harvest and processing. Bitter vetch has been observed as a weed of cereals in the Wadi ibn Hamad, Kerak region, Jordan (Bogaard and Charles, personal observations, 1997). In Amorgos, Greece and Syria, bitter vetch has similarly been observed as a weed of cereals including free-threshing wheat (van Zeist, 1994; Jones and Halstead, 1995). It is not evidenced that this crop has been grown as a rotation crop in the previous year at Tell Atchana, however, bitter vetch is likely to be invasive rather than sown as a crop.

At Tell Mohammed ‘Arab bitter vetch is more likely to be one of the minor local field weed since the number of items and frequency are significantly low. Bitter vetch would have been preferred as animal fodder, if not for human consumption.

8.1.4. Olive

Olive was recovered in 16 samples at Tell Atchana. While olive mostly occurs at low levels, one sample (TA2006.96) was found to contain a pure deposit of olive stones, in the context of a burnt room fill/floor from the Late Bronze Age I. The fact that both whole pips and fragments (with many more fragments) were found together in this sample suggests that it represents either olive oil by-products, crushed by milling (i.e. *trapetum* type), although it cannot be ruled out that the sample contains a mixture of olive oil by-products and the remnants of olive fruit consumption (Margaritis and Jones, 2008). Such by-product material has been identified elsewhere as a fuel (Cartwright, 2002).

Olive oil production appears to have been an important part of agricultural and commercial activity in the eastern Mediterranean during the Bronze Age. Textual evidence indicates that olive production already played an important role at Ebla, Tell Yarmouth and Tell es-Sa’idiyeh in the eastern Mediterranean since the Early Bronze Age (Tubb, 1998; Salavert, 2008; Tengberg, 2012; Gaspa, Michel and Nosch, 2017), and this is supported by olive charcoal material found further inland at Emar on the Euphrates, in a sample from the Early Bronze Age (Deckers, 2005). At Ebla, olive stones were found in a domestic kitchen in the Middle Bronze Age I (Fiorentino and Caracuta, 2010). Given that olive was a typical crop within this region, it was plausibly cultivated at Tell Atchana. Actual cultivation (as opposed to import of olive fruits from elsewhere) is supported by anthracological research at Late Bronze Age Tell Atchana, in which a quantity of olive tree charcoal was identified (Deckers, 2010). Tell Atchana cuneiform texts of the Middle Bronze Age also record that olive was cultivated and that this site was a hub of olive production (Archi, 1991; Riehl, 2010a; Tengberg, 2012). As an authentic Mediterranean luxury, olive oil was

exported to inland Mesopotamia region during the Bronze Age (Tengberg, 2012), and Tell Atchana was one of the producer sites for olive oil export. The Mari tablet archive records that olive was cultivated in the Amuq plain and specifically at Alalakh (i.e. Tell Atchana) and that export of olive oil to Mari was significant, in one case amounting to delivery of 2000 litres of olive oil (Gaspa, Michel and Nosch, 2017). Nevertheless, both previous Tell Atchana archaeobotanical research (Riehl, 2010a) and the current study yielded limited evidence of olive stones in archaeobotanical samples. This may reflect processing of olive stones into fine pieces by milling for oil extraction, meaning that the by-product would not be widely identifiable. If this is the case, it would imply that there was a higher demand for oil than for the fruit itself for direct consumption.

The by-product resulting from olive oil extraction (i.e. residues from olive pressing) were used as fuel, occasionally mixed with dung, in the Near East (Tengberg, 2012, p. 189). However, in the current Tell Atchana assemblage olive material is not widely attested as a routinely used fuel.

8.1.5. Flax

The presence of flax suggests the possibility of fibre and oil use (Valamoti, 2011). At Tell Atchana, finds of this taxon were associated with wood remains in a room of the Middle Bronze Age II occupation, in a sample dominated by free-threshing cereal material classified as fine sieve by-product, and thus in a mixed context. Here, flax material was mostly represented by capsule fragments rather than seeds with well preservation. Flax seeds are therefore likely to have been grown at Tell Atchana rather than are imported from elsewhere, and moisture levels at Tell Atchana would have been favourable since flax requires high water availability (Riehl, 2010c). There was no evidence of seed pressing for oil production. This species may have been valued more for textile production than for oil at Tell Atchana, given a plentiful supply of olive oil. Especially if grown to obtain textile fibre, flax cultivation implies high water availability (Riehl and Bryson, 2007; Hald, 2008; Riehl, 2010c). It is plausible that the region around Tell Atchana offered suitable precipitation and land for flax growing.

8.2. Plant remains as evidence of human activities on site

Plant-related activities and circumstances of charring and deposition were investigated in Chapter 5, and are discussed further in this section. As a fundamental part of the subsistence economy during the Late Bronze Age in the study region, it is not surprising that the majority of charred plant remains reflected agricultural production, i.e. crop storage for specific purposes and often, to a certain extent, mixed forms of crop processing stages. In addition, there was evidence of fuel use based on not only agricultural by-products but also on dung and possibly collected material.

At all three sites there were relatively mixed and unmixed samples dominated by free-threshing cereal material, i.e. either barley- and/or free-threshing wheat-rich samples. The role of glume wheat was usually minimal. However, weed/wild contents occasionally occurred at much higher levels together with glume wheat material through the early occupation of Tell Mohammed ʻArab. In this early period the village settlement may have been a locale of more diverse plant-related activity than in the later occupation period of the Assyrian empire. The early samples therefore likely reflect more varied daily routines of individual households, unaffected by storage concentrations.

Except for the early period Tell Mohammed ʻArab samples, in the Late Bronze Age all of the sites contain product samples which can be considered to reflect storage practice. Barley products were found at both Tell Mohammed ʻArab and Tell Brak. Although the available contextual detail for the Middle Assyrian barley product samples is as yet limited, it is clear that, at least two are described as mudbrick/lumps with embedded seeds, suggesting *in situ* storage. Furthermore, the findspot is approximately 25 m from the thick and robust walled large Middle Assyrian main buildings on the summit of the tell, where luxury goods and cylinder seals were found (Roaf, 1984 and Figure 8.1 below). In addition, the remaining of four samples classified as either barley product or barley product/fine sieve by-product (hand-collected) were retrieved near the trench from which the other two barley product samples derive (Figure 8.1). Despite the lack of

archaeological information currently available, these samples are likely to be connected with the other two barley product samples. All of these pure barley product samples contain almost no other crop material and might have been associated with a large-scale grain installation linked with a powerful political institution.

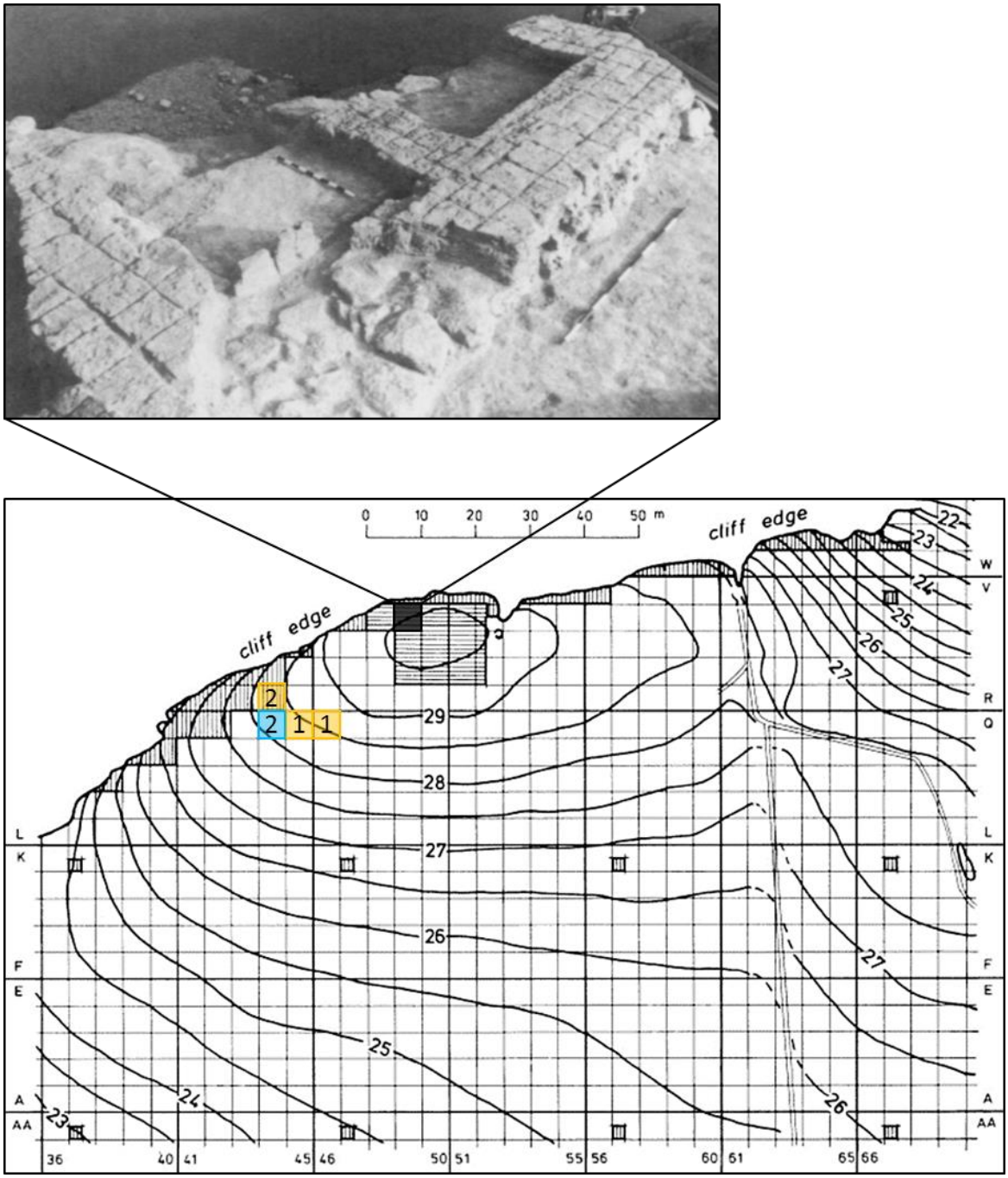


Figure 8.1 Tell Mohammed ‘Arab Middle Assyrian trenches where barley product samples were recovered in yellow and blue, with the number of sample taken (based on Roaf, 1984). Yellow shade: barley product samples. Blue shade: hand-collected barley product/fine sieve by-product samples. The photo above is the Middle Assyrian building (Roaf, 1984).

Compared to Tell Mohammed ‘Arab barley product samples, those from Tell Brak are more complex in terms of their composition and contextual origin. Sample TB11/14.3 taken from a surface near a tannur (oven) may represent a small amount of barley grains stored near a food preparation area, for immediate cooking, and accidentally charred by fire. Sample TB06/5, from

another tannur, can be interpreted in more or less the same vein. The tannur's fill plausibly reflects, at least in part, material from food preparation. The context description of TB06/124, fill from floor layer, is ambiguous. All three of the samples nevertheless contained more weed seeds than the Tell Mohammed 'Arab barley product samples and, moreover, small amounts of free-threshing wheat and pulses are additionally included in the Tell Brak samples. This 'less clean' product may suggest more diverse domestic-scale activities. The HHE and HHF trenches, where the Tell Brak samples were taken, revealed typical domestic architectures with multi-roomed houses, approximately 50 m away from the Mitanni palace and temple (McMahon *et al.*, 2007), and hence the barley product samples at Tell Brak may represent individual household use. Furthermore, the context of the barley grain samples is consistent with human consumption (food preparation).

The Tell Atchana assemblage included one free-threshing wheat and five free-threshing cereal product samples. The distinction between these two is not clear-cut. The former is from Area 4 in the Late Bronze Age while the latter is from Area 1 in the transition period from the Middle to Late Bronze Age. Intriguingly, the pure free-threshing wheat product sample was collected from room fill area enclosed by a mudbrick wall, and this strongly implies an organised storage facility for free-threshing wheat (Figure 6.16). Since this sample contained few barley grains or remains of the other crop species, it appears that how free-threshing wheat was stored separately with care. On the other hand, the five free-threshing cereal samples were found in two pits, from two and three different layers/loci within it. This pit may have been utilised to store free-threshing cereals (Figure 6.11b) since four of them were classified as product (Table 5.14), but there is a quantity of weed seeds and bitter vetch in these samples, too, alluding a possibility of animal fodder use.

Aside from the three study sites, grain products have previously been recovered from elaborate storage contexts at other Late Bronze Age sites in the northern Fertile Crescent (sites within Table 8.2 above). A room of the Middle Assyrian Palace exposed from Tell Schech Hamad (*c*. 15 ha) in Khabur was utilised as two-row barley storage, which was completely destroyed by fire *in situ* (van Zeist, 1994). This Middle Assyrian barley store might have shared the same function as the pure barley concentration in Tell Mohammed 'Arab. Another Late Bronze Age site, Tell Sabi Abyad,

with only approximately 4.1 hectares, on the Balikh river, yielded a huge amount of pure free-threshing cereals including two-row barley grain within the fortress structure (van Zeist, 1994).

Meanwhile, in the Ninevite V at Tell Mohammed ‘Arab, neither samples from storage-associated contexts nor those representative of crop product stages was uncovered, perhaps reflecting the small-scale of production and/or mobilisation and storage at this time (cf. van der Veen and Jones, 2006). To date, a number of small-scale Ninevite V settlements in the Jazira region, such as Kerma, Raqa’I, Atij, Kneidig, Hajji Ibrahim, Ziyadeh and Mashnaqa, Rad Shaqrah, Mulla Matar and Bderi, have revealed granary architectures for storage with substantial mudbricks, some of them filled with grain product (Akkermans and Schwartz, 2003; Ur, 2010). As for Tell Mohammed ‘Arab, in spite of a sign of administrative activity inferred from the discovery of clay cylinder and stamp seals and sealings, and its optimal location in the middle of the Jazira, with ease of access for interregional trade, the lack of large-scale storage facilities for grain and of archaeobotanical storage evidence suggest that the inhabitants of the settlement focussed on subsistence farming in the early occupation period rather than specialised surplus grain production to feed populations at other, urbanised sites.

To sum up, the implication is that Middle Assyrian Tell Mohammed ‘Arab barley product samples are more likely to represent a communal or larger scale storage feature whilst Mitannian Tell Brak product samples allude to domestic activity. The Late Bronze Tell Atchana pure free-threshing wheat sample from a storage structure is somewhat comparable to Late Bronze Tell Mohammed ‘Arab barley product samples.

A number of samples from the three sites were found to be comprised of fine sieve by-product material. The Tell Mohammed ‘Arab barley fine sieve by-product samples tend to be associated with fire installations, including one sample deriving from a hearth and another from an ashy black lens. Four Tell Brak barley and free-threshing cereal fine sieve by-product samples and one free-threshing cereal fine sieve by-product sample also originated from ashy deposits and/or tannur oven fill. This may imply that fine sieve by-product samples from both sites were mixed with other

fuel sources, and also that fine sieve by-product residues were an important component of fuel (e.g. kindling) in the region.

Glume wheat by-product samples from Tell Mohammed ʻArab in the early occupation periods plausibly represent routinely discarded residues from a mixture of domestic activities, including crop processing, animal fodder and dung and fuel use. One of these glume wheat by-product samples contained intact dung material, and this sample might relate to use of dung, with glume wheat chaff and other components added in a dung cake mixture (Anderson and Ertug-Yaras, 1998; Charles, 1998).

8.3. Agricultural strategies in the northern Fertile Crescent

Located within the northern Fertile Crescent, all of the three study sites likely practised cultivation of staple crops on the basis of rain-fed farming system. The selection of crop types was strategic, being strongly influenced by the environmental conditions. At Tell Mohammed ʻArab and Tell Brak, lying in the semi-arid climate zone with moderate and marginal precipitation, respectively, an increasing focus on barley cultivation, made sense as an adaptation to climate change including severe dryness from the end of the Early Bronze Age to the onset of the Middle Bronze Age, and typically dry conditions across the northern Fertile Crescent throughout the rest of the Bronze Age. Tell Atchana, however, was in a favourable climate zone, the Mediterranean coast, which tended to receive ample rainfall and moisture. This facilitated production of free-threshing wheat.

Agricultural communities in the northern Fertile Crescent grew their major crops by sowing in autumn and harvesting in spring, but there were subtle differences in seasonality in response to the crop type and the precipitation duration of each site region. Crop harvesting heights at each site show a certain variation. At Tell Mohammed ʻArab, crops were cut at medium height in both earlier and the Late Bronze Age periods, whilst those at Tell Brak were harvested at a low level in the Late Bronze Age. The height of Tell Atchana crops is likely to have varied, ranging from short to medium/tall in the Middle to Late Bronze Age. There is a possibility that straw stubble and

weeds left in the fields were grazed by animals outside of the cultivation season, but given that a low/no manuring indications (from crop stable nitrogen isotope values) at Tell Mohammed ʻArab, and indications of low-input cultivation from weed ecology at Tell Atchana and Tell Brak, the rate of animal dung application as a fertiliser is likely to have been low.

The reconstruction of ancient crop growing conditions and crop husbandry practices drawn from weed functional ecology and crop stable isotope results demonstrates that contemporary farmers endeavoured to promote agricultural output by increasing the unit of land under cultivation rather than by increasing the amount produced per area of land, inputs in terms of soil working or water and/or fertiliser. Within this broad consistent trend, it is intriguing that during the early period at Tell Mohammed ʻArab farmers pursued differential strategies for wheat and barley crops, as evidenced by their stable carbon isotope values. Moreover, there were relatively subtle contrasts amongst the three study sites in terms of land management practices, as evidenced by the functional weed ecology.

Tell Mohammed ʻArab crop fields were managed with relatively low cultivation intensity in both periods, including in their water and manuring status. During the Late Uruk and Ninevite V periods, however, there was a certain contrast in treatment between wheat and barley in terms of their water status. While both cereal types received little or no manuring, wheat was grown in fields where the availability of water was more favourable. Considering that Tell Mohammed ʻArab was lying on the bank of the Tigris, the field locations for wheat cultivation are likely to have been chosen carefully close to the river. The soil moisture of barley fields, however, varied to a certain extent, equating to poor through to moderate and well-watered conditions. In the Middle Assyrian period, Tell Mohammed ʻArab barley fields were drier than those of the earlier periods. The fact that this was the era of imperial control, encompassing warfare and trade, and that both cylinder seals and the impressions of Mitannian and Middle Assyrian styles were found at Tell Mohammed ʻArab might imply that agricultural production at this ancient village was managed by a centralised government body. In this temporal context, drier farming conditions plausibly reflected low-input techniques sponsored by central authorities of the Middle Assyrian empire.

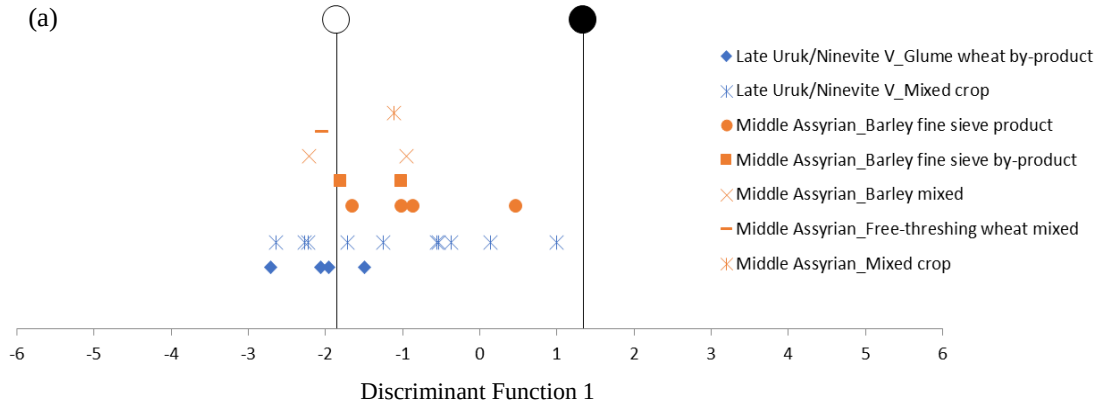
In Figure 8.2a, b and c, the discriminant function scores of all samples compared with modern low- and high-input regimes on the basis of weed functional trait values reveals clear contrasts in growing conditions among the three study sites. It is apparent that cultivation intensity as reflected in Figure 8.2 was associated with the size of each site and hence the radius of cultivation (Jones *et al.*, 1999; Bogaard, 2005; Jones, 2005; Bogaard *et al.*, 2018). While labour intensive inputs are relatively low at all three of the sites, there were subtle differences among the weed assemblages at each site. Tell Mohammed ʻArab, approximately 2.4 hectares in extent, was by far the smallest of the three settlements in size, while its discriminant scores were the highest. The implication is that Tell Mohammed ʻArab farming society managed their arable land rather more intensively than farmers at the urban centres of Tell Atchana and Tell Brak. The smaller extent and population of this ancient village would have required a less extensive agricultural regime compared to the full extent of cities like Tell Atchana and Tell Brak.

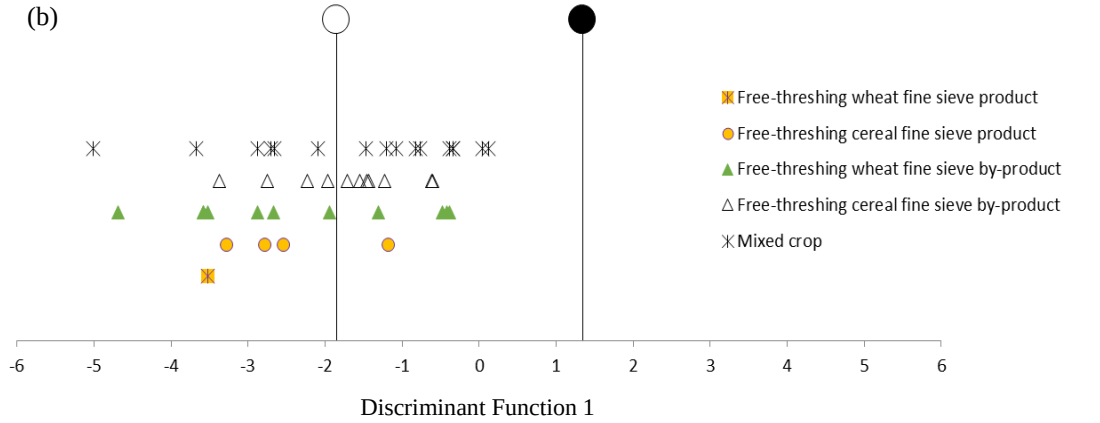
At Tell Atchana, a regional capital city of *c*. 22 hectares, free-threshing wheat was more extensively cultivated than Tell Mohammed ʻArab in general, accommodating a larger population under the imperial administration. Likewise, despite its considerable reduction in size in the second millennium BC, Mitannian Tell Brak still represented one of the largest cities in the region, with approximately 30 hectares (Ur, 2014). Nevertheless, weed ecological variability among the Tell Atchana samples in the discrimination function was substantially greater than that of Tell Brak (Figure 8.2b and c), and this suggests that Tell Atchana's focus on free-threshing wheat was associated with more variable cultivation intensity than Tell Brak's barley focussed production. This range of growing conditions might have stemmed partially from different crop husbandry techniques such as manuring, fallowing, rotation and soil work such as weeding and tillage amongst cereal plots within an overall low-input system. In environment terms, more flexibility in land management at Tell Atchana can be related to a more favourable climate, accommodating relatively high as well as low inputs. It also cannot be ruled out that Tell Atchana imported surplus crop production from other settlements to maintain the city's population, though there is no direct evidence for this. Displaying a narrower range of scores in Figure 8.2c, Tell Brak's barley

production appears to have been managed under a relatively homogeneous low-input system compared with Tell Atchana. The fact that barley was cultivated under similar growing conditions across the Tell Brak fields suggests a more coherent farming regime, encouraged by restricted environmental conditions.

It has previously been shown that Early Bronze Age Tell Brak cereals were managed at even lower agricultural intensities than the crop production represented by three site assemblages analysed here (Bogaard *et al.*, 2018). This again supports an intimate association between settlement and population size, on the one hand, and cultivation intensity, on the other; EBA Tell Brak was more than twice the size (at approximately 70 hectares) of the later Mitannian settlement of the second millennium BC (Oates, Oates and McDonald, 2001; Ur, Karsgaard and Oates, 2011).

Furthermore, the differences between Tell Atchana and Tell Brak must also reflect the different crop types associated with the weed assemblages entered into the discriminant analysis. Free-threshing wheat, which was the most important crop at Tell Atchana under the naturally more favourable rainfall conditions, could probably benefit more than two-row hulled barley from relatively intensive management (where that was feasible), contributing to variable management overall. Barley was the dominant crop in the Tell Brak assemblage. As mentioned above, this crop is highly drought tolerant and might have been consistently sown in drier land with less labour input compared to wheat species and the growing conditions of barley plots would have been poorer than wheat ones in general, contributing to the weed ecological difference between Figure 8.2b and c.





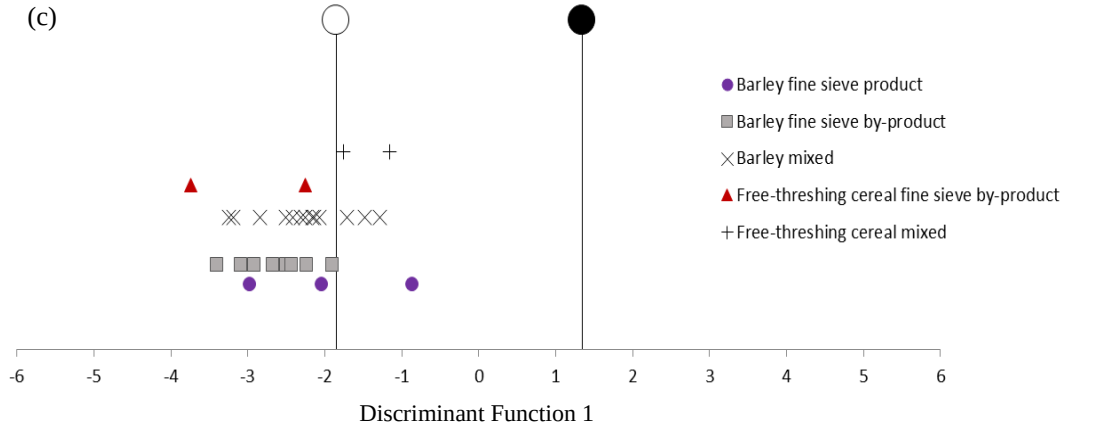


Figure 8.2 The discriminant function based on weed attribute scores showing the results of the classification of the (a) Tell Mohammed ʻArab, (b) Tell Atchana and (c) Tell Brak samples without *Bolboschoenus glaucus*.

8.4. Final remarks

The present research was designed to shed light on agricultural economies across the northern Fertile Crescent in especially the Late Bronze Age. Based on this integrated archaeobotanical analysis, the key finding to emerge is that the assemblages provide a certain diversity of cropping strategies and relatively extensive/low-intensity regimes, depending especially on environmental setting and settlement scale.

The investigation of crop processing has clarified dynamic on-site activities involving harvested and/or collected plant material. The significant finding in this context relates to crop storage practices, which reflect regional identities and socio-political circumstances. More specifically, there was, firstly, a marked discrepancy between the Assyrian and Mitanni zones in terms of the usage/purpose of crop product storage, ranging from large-scale communal concentrations to small-scale individual household stores. Secondly, with regard to the socio-political issues, Assyria's military campaigns are reflected in crop storage patterns. Meanwhile, within the Hittite empire, the clear focus at Tell Atchana on free-threshing wheat mirrors that of Assyrian barley storage in the northern Mesopotamia. At Tell Mohammed 'Arab the results also imply a considerable chronological shift in the type of crops being grown and/or stored on the site between the Late Chalcolithic and the Late Bronze Age.

The evidence from weed functional ecology and crop stable carbon and nitrogen isotope analysis supports the inferences that agricultural strategies in the northern Fertile Crescent varied among different between sites in accordance with climatic zonation, environmental setting, scale of urbanisation (represented by site size) and management style/governance of political entities. The former approach confirmed an existing theory of correlation between agricultural intensity and site scale (cf. Styring *et al.*, 2017; Bogaard *et al.*, 2018).

Notwithstanding the relatively weak generalisability from the early periods (the Late Uruk and Ninevite V) due to the limited scope of this research, this work offers valuable insights into agricultural practices across three different climatic zones of the northern Fertile Crescent during

the Bronze Age, a period which is relatively unknown in agricultural terms, despite its wider archaeological/proto-historical significance. More excavation and associated systematic recovery of charred plant remains across the northern Fertile Crescent, particularly in the Tigris and eastern Mediterranean regions, is required to expand our knowledge further, in addition to synthesis of archaeobotanical data from earlier periods. Meanwhile, to better understand the implications of the results, further research also needs to explore more closely the links between agricultural economies (particularly in terms of storage practices) and imperialism by the Mitannians, Assyrians and Hittites, in order to reveal similarities and differences in their approach. By assessing both crop spectra and weed ecology, this research has elucidated agricultural practice in greater detail than before. Together with consideration of environmental and societal variables, this study contributes to a comprehensive understanding of Late Bronze Age society and economy in the northern Fertile Crescent.

Appendix

Table I. Raw data for Tell Mohammed ‘Arab (1/3).

Sample code	**TM2**	**TM3**	**TM7**	**TM11**	**TM16**	**TM22+27**	**TM27**	**TM28**	**TM29**	**TM30**
Context	Pit	Floor	N/A	N/A	Ashy	Mudbrick	Mudbrick	Burial cut/fill	Ashy	N/A
Grid	50V	50V	44P	44P	46P	44Q	44Q	50U	64X	45R
Level	27	23	17	13	3	11	11	180	43	28
Phase	D	D	N/A	N/A	N/A	D	D	F	B	N/A
Period	Ninevite V	Late Uruk	Middle Assyrian	Middle Assyrian	Middle Assyrian	Middle Assyrian	Middle Assyrian	Ninevite V	Late Uruk	Middle Assyrian
Volume (litres)	1	1	N/A	N/A	50	4	4	20	12.5	52
Densities (items/litre)	234	103	N/A	N/A	2	856	929	24	17	12
CEREALS										
Hordeum vulgare - hulled straight grain	1	2	3	15	0	124	96	0	0	0
Hordeum vulgare - hulled cf. straight grain	0	0	4	27	0	392	288	0	0	0
Hordeum vulgare - hulled indet. grain	5	4	45	57	18	1948	1880	17	1	2
Hordeum vulgare - hulled cf. twisted grain	0	0	0	1	0	0	0	0	0	0
Hordeum vulgare - cf. naked indet grain	0	0	0	0	1	0	0	0	0	0
Hordeum vulgare indet. grain	17	6	0	0	14	452	884	3	14	9
Hordeum vulgare two-row rachis	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare cf. two-row rachis	0	1	0	0	0	0	0	1	0	0
Hordeum vulgare indet. rachis	0	1	0	0	0	2	8	0	0	2
Hordeum vulgare lemma bases	0	0	0	0	0	0	0	0	0	0
Triticum durum/aestivum grain	0	0	0	0	0	0	0	6	3	0
Triticum cf. *durum/aestivum* grain	0	0	0	0	0	0	0	0	5	0
Triticum aestivum rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum cf. *aestivum* rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum aestivum/durum (internodes)	0	0	0	0	0	4	0	0	0	0
Triticum durum rachis internodes	0	1	0	0	0	0	0	2	0	0
Triticum cf. *durum* rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum/(aestivum/durum) grain	3	0	0	0	0	0	0	1	1	0

Sample code	**TM2**	**TM3**	**TM7**	**TM11**	**TM16**	**TM22+27**	**TM27**	**TM28**	**TM29**	**TM30**
Triticum indet, grain	0	2	0	0	0	4	0	2	4	1
Cereal indet. Grain	3	1	0	0	3	0	0	0	0	1
Triticum monococcum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum grain (2-grained spikelet)	6	0	0	0	0	0	0	2	9	0
Triticum cf. *monococcum* grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	0	0	0	0	4	0	4	3	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	1	3	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	0	5	2
Triticum dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	4	9	0
Triticum cf. *dicoccum* grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	2	0	0	0	4	0	7	6	1
New type grain	0	1	0	0	0	0	0	0	0	0
cf. New type grain	0	0	0	0	0	0	0	0	0	0
Triticum monococcum (glume base)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* (glume bases)	0	0	0	0	0	0	0	0	6	0
Triticum monococcum (spikelet forks)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* spikelet forks	0	0	0	0	0	0	0	0	1	0
Triticum monococcum/dicoccum (glume bases)	0	0	0	0	0	0	0	8	27	0
Triticum cf. *monococcum/dicoccum* (glume bases)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	0	0	0	0	0	0	0	2	0	0
Triticum monococcum/dicoccum/spelta glume bases	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum/spelta spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum glume bases	0	1	0	0	0	0	0	36	20	3
Triticum spikelet forks	0	0	0	0	0	0	0	0	63	0
Triticum spikelet forks indet.	0	1	0	0	0	1	0	5	3	0
Triticum dicoccum glume bases	0	5	0	0	0	5	0	8	7	0

Sample code	**TM2**	**TM3**	**TM7**	**TM11**	**TM16**	**TM22+27**	**TM27**	**TM28**	**TM29**	**TM30**
Triticum cf. *dicoccum* glume bases	0	1	0	0	0	0	2	4	2	0
Triticum dicoccum spikelet forks	0	0	0	0	0	4	0	0	2	0
Triticum cf. *dicoccum* spikelet forks	0	0	0	0	0	0	0	1	3	0
Triticum dicoccum spikelet forks terminal	0	0	0	0	0	0	0	0	3	0
New type spikelet forks	0	0	0	0	0	0	0	0	0	0
cf. New type spikelet forks	0	0	0	0	0	0	0	0	0	0
Cereal indet. culm nodes	1	2	0	0	0	0	0	1	0	0
PULSES										
Cicer arietinum	0	0	0	0	0	0	0	0	0	0
Lens culinaris	1	0	0	0	0	0	0	0	0	0
Vicia ervilia	0	0	0	0	0	0	0	0	0	0
Vicia ervilia/Lathryus sativus	0	0	0	0	0	0	0	0	0	0
Lathryus sativus	2	0	3	0	0	4	0	0	0	0
Big legume indet.	2	0	0	0	0	0	0	0	0	0
CROP, OTHERS										
Carthamus tinctorious	0	0	0	0	0	0	0	0	0	0
Carthamus tinctorious/oxyacanthus	0	0	0	0	0	0	0	0	0	0
FRUITS/COLLECTED										
Ficus carica	0	0	0	0	0	0	0	0	0	0
Vitis vinifera	0	0	0	0	0	0	0	0	0	1
Capparis spinosa	0	0	0	0	0	0	0	0	0	0
cf. Capparis spinosa	0	0	0	0	0	0	0	3	1	0
WEED/WILD TAXA										
Aizoon hispanicum	0	0	0	0	0	0	0	0	0	0
Chenopodium sp.	1	0	0	0	3	0	0	0	0	0
Bellevalia sp.	0	0	0	0	1	172	248	0	0	0
Bellevalia/ornithogalum sp.	0	0	0	0	0	0	0	0	0	0

Sample code	TM2	TM3	TM7	TM11	TM16	TM22+27	TM27	TM28	TM29	TM30
Ornithogalum sp.	0	0	0	0	0	8	0	0	0	0
Centaurea sp.	0	0	0	0	0	0	0	0	0	0
Arnebia sp.	0	0	0	0	0	0	0	0	0	0
Heliotropium sp.	0	0	0	0	0	0	0	0	3	0
Cephalaria sp.	0	0	0	0	0	0	0	3	0	0
Valerianella coronata (type 1)	1	1	0	0	1	0	0	0	0	0
Valerianella dentata Type (type 2)	0	0	0	0	1	0	0	0	0	0
Caryophyllaceae type	0	0	0	0	0	0	0	0	0	0
Gypsophila sp.	0	0	0	0	0	1	3	0	0	0
Silene sp.	0	0	0	0	0	0	2	0	0	0
*Silene dichotoma t*ype (type 1)	0	0	0	0	0	0	0	0	0	0
Vaccaria hispanica	0	0	0	0	0	34	67	3	1	0
Helianthemum sp.	7	3	0	0	0	0	0	9	0	0
COMPOSITAE indet.	0	0	0	0	0	0	0	0	0	0
CRUCIFERAE indet.	0	0	0	0	0	0	0	0	0	0
Lepidium sp.	0	0	0	0	0	0	0	0	0	0
Lepidium sativum (type 1)	0	0	0	0	0	0	0	0	0	529
Lepidium draba (= *Cardaria draba*) (type 2)	0	0	0	0	0	0	0	28	0	0
CYPERACEAE indet.	0	0	0	0	1	0	0	10	0	0
Cyperus sp.	0	0	0	0	0	0	0	0	0	0
Bolboschoenus glaucus	1	3	0	0	0	4	0	11	1	0
Coronilla scorpioides	0	0	0	0	0	0	0	0	0	0
Large legumes indet.	0	0	0	0	0	16	0	6	0	29
LEGUMINOSAE, small seeded	12	9	0	0	6	29	14	188	1	1
Medicago sp. (type 2)	1	0	0	0	0	0	0	13	0	0
Medicago polymorpha (type 3)	0	0	0	0	0	0	0	0	0	0
Medicago radiata (type 1)	0	0	0	0	0	0	0	0	0	0
Prosopis farcta	0	0	0	0	0	0	0	1	0	0
Prosopis farcta (fragments)	0	0	0	0	0	0	0	0	0	0
Scorpiurus muricatus	0	0	0	0	0	0	0	0	0	0
Trigonella astroites	0	0	0	0	1	0	0	9	0	0
Aegilops sp.	12	8	0	0	1	16	28	5	0	2

Sample code	**TM2**	**TM3**	**TM7**	**TM11**	**TM16**	**TM22+27**	**TM27**	**TM28**	**TM29**	**TM30**
Aegilops (glume bases)	6	2	0	0	2	8	12	0	0	0
Aegilops (glume bases), type 1 (*A. tauschii*)	3	3	0	0	1	8	12	0	0	1
Avena sp., cult/wseed	0	0	0	0	0	0	0	5	0	1
Avena cf. sp., cult/wseed	0	0	0	0	0	0	0	0	0	0
Bromus sp.	3	0	0	0	0	0	0	0	0	4
Bromus type 1	0	0	0	0	0	0	0	0	0	0
Bromus type 2	1	0	0	0	0	0	0	0	0	1
Round grass indet.	0	0	0	0	0	0	2	0	0	0
Grass weeds indet.	28	8	0	0	8	0	0	0	0	8
Small GRAMINEAE indet.	8	0	0	0	0	0	0	4	0	0
Hordeum spontaneum	2	0	0	0	0	0	0	0	0	1
Hordeum cf. *spontaneum*	1	0	0	0	0	0	0	0	0	0
Hordeum murinum type	1	5	0	0	0	12	5	8	2	6
Lolium type 1 *(L. rigidum)*	0	0	0	0	0	0	0	0	0	0
Lolium type 2 *(L. rigidum)*	41	11	0	0	6	10	5	11	1	5
Lolium type 3	34	12	0	0	7	1	15	12	0	12
Lolium sp.	15	0	0	0	0	0	0	0	0	0
cf. *Lolium* sp.	0	0	0	0	0	0	3	0	0	0
Phalaris sp.	4	0	0	0	4	0	0	3	0	1
Taeniatherum caput-medusae	0	0	0	0	0	0	0	0	0	0
Triticum boeoticum	0	0	0	0	0	0	0	0	0	0
Ajuga/Teucrium sp.	0	0	0	0	0	0	0	0	0	0
Ziziphora sp.	0	0	0	0	0	0	0	0	0	0
Malva sp.	1	0	0	0	0	0	0	2	0	0
Malva nicaeensis	0	0	0	0	0	0	0	0	0	0
Plantago sp.	0	0	0	0	0	0	0	0	0	0
Rumex sp.	5	2	0	0	0	8	0	15	3	3
Androsace maxima	0	0	0	0	0	0	0	0	0	0
Adonis sp.	0	0	0	0	0	0	0	0	0	0
Adonis type 1	0	1	0	0	0	4	4	0	0	0
Adonis type 2	0	0	0	0	0	0	0	0	0	0
Galium sp.	0	0	0	0	1	23	6	2	0	1

Sample code	**TM2**	**TM3**	**TM7**	**TM11**	**TM16**	**TM22+27**	**TM27**	**TM28**	**TM29**	**TM30**
Galium type 1 *(G. spurium)*	0	0	0	0	0	4	0	0	0	0
Galium type 2 *(G. spurium)*	1	0	0	0	0	104	104	2	0	0
Galium type 3 *(G. spurium)*	0	0	0	0	0	8	24	0	0	0
Galium type 4 *(G. spurium)*	0	1	0	0	0	4	5	1	0	1
Sherardia arvensis	0	0	0	0	0	0	0	0	0	0
Verbascum sp.	0	0	0	0	0	0	0	0	0	0
Thymelaea passerine/mesopotamica	0	0	0	0	1	0	0	0	0	1
UMBELLIFERAE indet.	2	0	0	0	1	0	0	2	0	0
Bupleurum cf. *subovatum*	1	0	0	0	0	0	0	0	0	0
DUNG										
Dung (sheep/goat), pellets (ml)	0.3	0	0	0	0	0	0	0	0	0
Dung (sheep/goat), fragments (ml)	0	0	0	0	0	0	0	0	0	0

Table I. Raw data for Tell Mohammed ‘Arab (2/3).

Sample code	**TM33**	**TM34**	**TM35**	**TM36**	**TM37**	**TM41**	**TM42**	**TM43**	**TM44eIII**	**TM47**
Context	Ashy	Ashy	Courtyard	Courtyard	Hearth	Courtyard	Fill	Courtyard	Mixed	N/A
Grid	45P	51V	51T	50T	44R	51T	50U	50T	52V	52V
Level	12	123	115	143	4	160	208	177	111	112
Phase	K	B	B	C	N/A	L	K	L	N/A	N/A
Period	Middle Assyrian	Ninevite V	Ninevite V	Ninevite V	Middle Assyrian	Late Uruk	Ninevite V	Late Uruk	Ninevite V	Ninevite V
Volume (litres)	11	20	41	23.5	9	14	17	48	107	46
Densities (items/litre)	4	386	35	104	31	4	18	70	8	24
CEREALS										
Hordeum vulgare - hulled straight grain	0	4	2	6	0	0	2	12	0	4
Hordeum vulgare - hulled cf. straight grain	0	6	7	2	0	1	0	0	3	0
Hordeum vulgare - hulled indet. grain	1	55	56	21	1	2	10	66	38	33
Hordeum vulgare - hulled cf. twisted grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare - cf. naked indet grain	0	0	0	0	0	0	0	0	0	1
Hordeum vulgare indet. grain	4	44	76	22	2	3	6	60	35	24
Hordeum vulgare two-row rachis	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare cf. two-row rachis	0	0	0	1	1	0	0	0	0	0
Hordeum vulgare indet. rachis	1	10	4	14	6	0	0	2	3	32
Hordeum vulgare lemma bases	0	0	0	0	0	0	0	0	0	0
Triticum durum/aestivum grain	0	11	9	5	0	0	3	2	4	1
Triticum cf. *durum/aestivum* grain	0	8	15	6	4	0	3	10	6	2
Triticum aestivum rachis internodes	0	0	0	0	25	0	0	0	0	0
Triticum cf. *aestivum* rachis internodes	0	0	0	0	34	0	0	0	1	0
Triticum aestivum/durum (internodes)	0	2	2	2	46	0	2	0	0	4
Triticum durum rachis internodes	0	1	0	0	0	0	0	0	2	0
Triticum cf. *durum* rachis internodes	0	0	4	0	0	0	0	0	0	0
Triticum dicoccum/(aestivum/durum) grain	0	4	0	7	0	0	1	12	2	0
Triticum indet, grain	0	21	40	14	0	0	0	58	9	22

Sample code	TM33	TM34	TM35	TM36	TM37	TM41	TM42	TM43	TM44eIII	TM47
Cereal indet. Grain	0	14	3	5	4	0	4	6	0	4
Triticum monococcum grain (1- or 2-grained spikelet)	0	7	0	0	0	0	0	0	0	0
Triticum monococcum grain (1-grained spikelet)	0	0	0	0	0	0	0	2	0	2
Triticum monococcum grain (2-grained spikelet)	0	10	22	9	0	0	4	30	11	9
Triticum cf. *monococcum* grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	5	0	4	0	0	0	26	0	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	2	5
Triticum monococcum/dicoccum grain (1-grained spikelet)	0	0	0	0	0	0	0	0	2	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	21	15	3	0	0	2	74	4	0
Triticum dicoccum grain (1- or 2-grained spikelet)	0	1	0	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	9	13	6	0	0	0	6	11	0
Triticum cf. *dicoccum* grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	6	17	6	0	0	0	18	2	8
New type grain	0	1	0	0	0	0	0	0	0	0
cf. New type grain	0	1	0	0	0	0	0	0	0	0
Triticum monococcum (glume base)	0	0	0	0	0	0	0	8	0	0
Triticum cf. *monococcum* (glume bases)	0	0	3	0	0	0	0	0	7	0
Triticum monococcum (spikelet forks)	0	0	2	0	0	0	0	0	2	0
Triticum cf. *monococcum* spikelet forks	0	0	2	0	0	0	0	0	1	0
Triticum monococcum/dicoccum (glume bases)	0	6	120	6	0	0	0	22	119	33
Triticum cf. *monococcum/dicoccum* (glume bases)	0	0	27	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	0	23	29	2	0	1	0	8	19	5
Triticum monococcum/dicoccum/spelta glume bases	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum/spelta spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum glume bases	1	27	6	65	0	4	5	42	0	41
Triticum spikelet forks	0	6	68	0	0	0	0	70	15	0
Triticum spikelet forks indet.	0	18	10	2	0	0	0	4	14	4
Triticum dicoccum glume bases	0	3	0	6	0	0	0	8	1	0
Triticum cf. *dicoccum* glume bases	0	6	1	0	0	0	0	0	4	0

Sample code	**TM33**	**TM34**	**TM35**	**TM36**	**TM37**	**TM41**	**TM42**	**TM43**	**TM44eIII**	**TM47**
Triticum dicoccum spikelet forks	0	0	10	3	0	1	0	0	4	2
Triticum cf. *dicoccum* spikelet forks	0	1	3	0	0	0	0	4	10	0
Triticum dicoccum spikelet forks terminal	0	2	1	1	2	0	0	0	5	0
New type spikelet forks	0	4	0	0	0	0	0	0	2	0
cf. New type spikelet forks	0	14	0	1	0	0	0	0	4	2
Cereal indet. culm nodes	0	2	0	0	16	0	2	0	7	3
PULSES										
Cicer arietinum	0	3	3	0	0	0	0	0	0	0
Lens culinaris	0	11	1	2	0	0	0	0	0	0
Vicia ervilia	0	0	0	0	0	0	0	0	0	0
Vicia ervilia/Lathryus sativus	0	0	0	0	0	0	0	0	0	1
Lathryus sativus	0	0	0	2	0	0	0	2	0	0
Big legume indet.	0	7	8	4	0	0	0	2	2	0
CROP, OTHERS										
Carthamus tinctorious	0	0	0	0	0	0	0	0	0	0
Carthamus tinctorious/oxyacanthus	0	0	0	0	14	0	0	0	0	0
FRUITS/COLLECTED										
Ficus carica	0	3	4	1	0	0	0	0	0	0
Vitis vinifera	0	0	0	0	0	0	0	0	0	0
Capparis spinosa	0	0	0	0	0	0	0	0	3	4
cf. Capparis spinosa	0	0	6	2	0	0	0	0	0	7
WEED/WILD TAXA										
Aizoon hispanicum	0	0	0	0	0	0	0	2	0	0
Chenopodium sp.	0	0	0	0	0	0	0	0	1	0
Bellevalia sp.	0	3	0	3	0	2	0	2	1	2
Bellevalia/ornithogalum sp.	0	1	0	0	0	0	0	2	0	0
Ornithogalum sp.	0	0	0	5	0	0	0	16	0	0

Sample code	**TM33**	**TM34**	**TM35**	**TM36**	**TM37**	**TM41**	**TM42**	**TM43**	**TM44eIII**	**TM47**
Centaurea sp.	0	1	0	2	0	0	0	0	1	1
Arnebia sp.	0	0	0	0	0	0	0	0	0	0
Heliotropium sp.	0	1	0	0	0	0	0	0	1	0
Cephalaria sp.	0	0	0	0	0	0	0	0	8	0
Valerianella coronata (type 1)	0	5	0	0	0	0	0	0	0	0
Valerianella dentata Type (type 2)	0	0	0	1	0	0	0	0	0	0
Caryophyllaceae type	0	0	0	0	0	0	0	0	0	4
Gypsophila sp.	0	0	1	0	0	0	0	0	0	0
Silene sp.	0	0	1	1	0	0	0	0	0	0
*Silene dichotoma t*ype (type 1)	0	0	0	0	0	0	1	0	6	0
Vaccaria hispanica	0	1	2	3	0	0	0	4	1	1
Helianthemum sp.	0	69	60	28	0	0	0	0	2	92
COMPOSITAE indet.	0	0	0	10	0	0	0	0	0	4
CRUCIFERAE indet.	0	0	0	20	0	3	0	0	1	0
Lepidium sp.	0	0	0	0	0	0	0	0	0	4
Lepidium sativum (type 1)	0	0	0	0	0	0	0	0	0	0
Lepidium draba (= *Cardaria draba*) (type 2)	0	0	0	44	0	2	0	4	3	47
CYPERACEAE indet.	0	0	2	11	0	9	60	40	9	4
Cyperus sp.	0	0	0	1	0	0	0	0	0	0
Bolboschoenus glaucus	1	3	4	9	0	9	101	334	9	4
Coronilla scorpioides	2	0	0	0	0	0	0	0	0	0
Large legumes indet.	2	7	3	4	2	0	0	0	1	15
LEGUMINOSAE, small seeded	17	6684	325	563	2	5	3	198	52	273
Medicago sp. (type 2)	0	20	12	19	3	0	5	20	8	16
Medicago polymorpha (type 3)	0	0	0	0	2	0	0	0	0	0
Medicago radiata (type 1)	0	2	2	127	0	0	0	0	0	2
Prosopis farcta	0	0	2	131	0	0	0	4	8	12
Prosopis farcta (fragments)	0	0	0	0	0	0	1	0	0	0
Scorpiurus muricatus	1	0	4	0	0	0	0	0	0	0
Trigonella astroites	0	319	82	1142	4	0	2	2	1	299
Aegilops sp.	1	11	23	3	1	0	2	0	15	12
Aegilops (glume bases)	0	1	2	1	3	0	0	0	24	0

Sample code	**TM33**	**TM34**	**TM35**	**TM36**	**TM37**	**TM41**	**TM42**	**TM43**	**TM44eIII**	**TM47**
Aegilops (glume bases), type 1 (*A. tauschii*)	0	1	0	0	0	0	0	0	5	0
Avena sp., cult/wseed	0	0	1	0	0	0	0	0	0	0
Avena cf. sp., cult/wseed	0	1	0	0	0	0	0	0	4	0
Bromus sp.	0	12	6	0	6	0	1	2	1	1
Bromus type 1	0	0	0	0	0	0	0	0	0	1
Bromus type 2	0	0	0	0	2	0	0	2	0	2
Round grass indet.	0	2	0	0	0	0	0	0	0	0
Grass weeds indet.	1	14	38	7	22	0	3	32	57	6
Small GRAMINEAE indet.	0	3	4	5	11	4	0	0	0	4
Hordeum spontaneum	0	2	0	0	0	0	0	0	5	1
Hordeum cf. *spontaneum*	0	0	0	1	0	0	0	0	0	0
Hordeum murinum type	3	19	0	6	1	1	8	12	28	3
Lolium type 1 *(L. rigidum)*	0	0	2	0	0	0	0	0	0	0
Lolium type 2 *(L. rigidum)*	3	40	117	19	4	8	18	38	74	5
Lolium type 3	0	23	97	12	6	2	43	50	76	5
Lolium sp.	0	0	0	3	0	0	0	0	0	0
cf. *Lolium* sp.	0	0	2	0	0	0	9	0	5	0
Phalaris sp.	1	11	10	9	3	1	0	14	101	8
Taeniatherum caput-medusae	0	31	15	0	2	0	0	0	0	1
Triticum boeoticum	0	0	0	0	0	0	0	0	1	2
Ajuga/Teucrium sp.	0	2	4	2	0	0	0	2	0	4
Ziziphora sp.	0	6	0	0	1	0	0	0	0	0
Malva sp.	0	17	0	0	1	0	0	2	1	4
Malva nicaeensis	0	0	0	0	0	0	0	0	1	0
Plantago sp.	0	0	0	0	1	0	0	0	1	0
Rumex sp.	0	4	22	9	1	0	5	2034	24	6
Androsace maxima	0	0	0	0	1	0	1	0	0	0
Adonis sp.	0	0	0	0	0	0	0	0	0	0
Adonis type 1	0	0	2	0	1	0	0	0	0	0
Adonis type 2	0	0	0	0	0	0	0	0	0	0
Galium sp.	1	1	1	1	0	0	0	4	1	0
Galium type 1 *(G. spurium)*	0	0	0	0	0	0	0	0	0	0

Sample code	**TM33**	**TM34**	**TM35**	**TM36**	**TM37**	**TM41**	**TM42**	**TM43**	**TM44eIII**	**TM47**
Galium type 2 *(G. spurium)*	0	12	0	5	0	0	0	0	5	11
Galium type 3 *(G. spurium)*	0	0	0	0	0	0	0	0	0	0
Galium type 4 *(G. spurium)*	0	0	2	1	1	1	2	0	5	1
Sherardia arvensis	0	0	0	0	0	0	0	0	0	0
Verbascum sp.	0	3	0	0	0	0	0	0	0	0
Thymelaea passerine/mesopotamica	0	1	0	0	1	0	0	0	1	0
UMBELLIFERAE indet.	0	8	0	1	40	0	0	0	0	0
Bupleurum cf. *subovatum*	0	0	0	0	0	0	0	2	0	0
DUNG										
Dung (sheep/goat), pellets (ml)	0	0.3	0	0	0	0	0	0	0	0.2
Dung (sheep/goat), fragments (ml)	0	<0.1	0	0	0	0	0	0	0	<0.1

Table I. Raw data for Tell Mohammed ‘Arab (3/3).

Sample code	**TM48**	**TM49**	**TM50**	**TM51**	**TM53**	**TM54**	**TM56**
Context	Hearth	Hearth	Courtyard	Rubbish	N/A	Pit/burial fill	N/A
Grid	45Q	42P	50T	51U	42P	50T	45P
Level	30	19	178	204	21	183	23
Phase	N/A	N/A	L	M	N/A	K+M/M	N/A
Period	Middle Assyrian	Middle Assyrian	Late Uruk	Late Uruk	Middle Assyrian	Late Uruk	Middle Assyrian
Volume (litres)	16	9.5	90.5	57	61.5	132.5	11
Densities (items/litre)	24	8	16	7	6	28	20
CEREALS							
Hordeum vulgare - hulled straight grain	3	0	4	0	3	8	5
Hordeum vulgare - hulled cf. straight grain	3	0	4	1	4	20	7
Hordeum vulgare - hulled indet. grain	31	1	102	7	18	248	149
Hordeum vulgare - hulled cf. twisted grain	0	0	0	0	0	0	0
Hordeum vulgare - cf. naked indet grain	1	0	0	0	0	0	0
Hordeum vulgare indet. grain	29	10	60	16	41	116	31
Hordeum vulgare two-row rachis	0	0	0	0	0	0	0
Hordeum vulgare cf. two-row rachis	0	0	0	0	0	0	0
Hordeum vulgare indet. rachis	56	3	0	0	1	44	0
Hordeum vulgare lemma bases	0	0	0	0	0	0	2
Triticum durum/aestivum grain	0	0	8	0	0	68	0
Triticum cf. *durum/aestivum* grain	0	0	24	0	0	52	0
Triticum aestivum rachis internodes	1	0	0	0	0	8	0
Triticum cf. *aestivum* rachis internodes	0	0	0	0	0	0	0
Triticum aestivum/durum (internodes)	1	0	0	0	0	4	0
Triticum durum rachis internodes	0	0	0	0	0	34	0
Triticum cf. *durum* rachis internodes	0	0	0	0	0	0	0
Triticum dicoccum/(aestivum/durum) grain	0	0	20	0	0	32	0

Sample code	**TM48**	**TM49**	**TM50**	**TM51**	**TM53**	**TM54**	**TM56**
Triticum indet, grain	0	0	54	0	0	84	0
Cereal indet. Grain	0	0	24	3	3	36	0
Triticum monococcum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0
Triticum monococcum grain (1-grained spikelet)	0	0	0	0	0	24	0
Triticum monococcum grain (2-grained spikelet)	1	0	68	3	0	64	0
Triticum cf. *monococcum* grain (1-grained spikelet)	0	0	0	1	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	0	22	0	1	40	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	1	4	0	0	0	0
Triticum monococcum/dicoccum grain (1-grained spikelet)	0	0	0	0	0	12	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	1	0	0	1	0	48	0
Triticum dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	0	42	0	0	112	0
Triticum cf. *dicoccum* grain (1-grained spikelet)	0	0	4	0	0	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	0	26	0	0	84	0
New type grain	0	0	0	0	0	0	0
cf. New type grain	0	0	2	0	0	0	0
Triticum monococcum (glume base)	0	0	0	0	0	0	0
Triticum cf. *monococcum* (glume bases)	0	0	6	2	0	0	0
Triticum monococcum (spikelet forks)	0	0	0	0	0	0	0
Triticum cf. *monococcum* spikelet forks	0	0	14	0	0	4	0
Triticum monococcum/dicoccum (glume bases)	0	1	210	0	0	99	0
Triticum cf. *monococcum/dicoccum* (glume bases)	0	0	0	24	0	12	0
Triticum monococcum/dicoccum (spikelet forks)	0	1	64	0	0	14	0
Triticum monococcum/dicoccum/spelta glume bases	0	0	0	2	0	0	0
Triticum monococcum/dicoccum/spelta spikelet forks	0	0	0	0	0	1	0
Triticum glume bases	20	1	174	20	2	49	0
Triticum spikelet forks	0	0	0	0	0	0	0
Triticum spikelet forks indet.	0	0	12	4	0	0	0
Triticum dicoccum glume bases	0	0	22	0	1	25	0

Sample code	**TM48**	**TM49**	**TM50**	**TM51**	**TM53**	**TM54**	**TM56**
Triticum cf. *dicoccum* glume bases	0	0	20	10	0	65	0
Triticum dicoccum spikelet forks	0	0	10	0	0	30	0
Triticum cf. *dicoccum* spikelet forks	0	0	0	0	0	2	0
Triticum dicoccum spikelet forks terminal	0	0	4	2	0	1	0
New type spikelet forks	0	0	0	0	0	0	0
cf. New type spikelet forks	0	0	12	0	0	0	0
Cereal indet. culm nodes	5	1	2	2	1	5	0
PULSES							
Cicer arietinum	0	0	0	0	0	0	0
Lens culinaris	1	0	0	0	0	0	0
Vicia ervilia	0	0	0	0	1	0	0
Vicia ervilia/Lathryus sativus	0	0	0	0	0	8	0
Lathryus sativus	0	0	0	0	0	0	0
Big legume indet.	0	0	0	0	0	0	0
CROP, OTHERS							
Carthamus tinctorious	0	0	0	1	0	0	0
Carthamus tinctorious/oxyacanthus	0	0	0	0	0	0	0
FRUITS/COLLECTED							
Ficus carica	0	0	0	2	0	0	0
Vitis vinifera	0	0	0	0	0	0	0
Capparis spinosa	5	0	2	23	0	0	0
cf. Capparis spinosa	0	0	4	0	0	0	0
WEED/WILD TAXA							
Aizoon hispanicum	0	0	0	0	0	0	0
Chenopodium sp.	0	0	0	0	0	1	0
Bellevalia sp.	17	0	0	0	2	1	5
Bellevalia/ornithogalum sp.	0	0	0	0	0	0	0

Sample code	**TM48**	**TM49**	**TM50**	**TM51**	**TM53**	**TM54**	**TM56**
Ornithogalum sp.	0	0	0	0	0	0	0
Centaurea sp.	0	2	0	0	4	0	0
Arnebia sp.	0	0	0	0	0	0	0
Heliotropium sp.	0	0	0	1	0	2	0
Cephalaria sp.	3	3	0	0	0	0	0
Valerianella coronata (type 1)	0	0	0	0	0	0	0
Valerianella dentata Type (type 2)	0	0	0	0	0	0	0
Caryophyllaceae type	0	0	0	0	0	0	0
Gypsophila sp.	0	0	2	0	0	0	0
Silene sp.	0	1	12	2	0	0	0
*Silene dichotoma t*ype (type 1)	0	0	4	0	0	0	0
Vaccaria hispanica	16	0	4	0	0	12	0
Helianthemum sp.	0	2	4	1	7	1	0
COMPOSITAE indet.	0	0	0	0	0	0	0
CRUCIFERAE indet.	0	0	6	0	0	0	0
Lepidium sp.	0	0	4	1	0	5	0
Lepidium sativum (type 1)	0	3	0	0	0	6	0
Lepidium draba (= *Cardaria draba*) (type 2)	0	0	6	0	0	0	0
CYPERACEAE indet.	8	4	0	1	5	3	0
Cyperus sp.	0	0	0	0	2	0	0
Bolboschoenus glaucus	1	0	20	22	6	1	0
Coronilla scorpioides	4	6	0	0	0	0	1
Large legumes indet.	2	1	4	22	67	4	0
LEGUMINOSAE, small seeded	21	12	106	91	42	27	1
Medicago sp. (type 2)	2	0	4	14	0	2	0
Medicago polymorpha (type 3)	0	0	0	1	0	0	0
Medicago radiata (type 1)	0	0	0	0	0	0	0
Prosopis farcta	19	0	0	3	72	0	0
Prosopis farcta (fragments)	0	2	2	0	0	0	0
Scorpiurus muricatus	0	0	2	0	1	0	0
Trigonella astroites	0	0	0	0	0	9	0
Aegilops sp.	1	0	8	7	6	7	3

Sample code	**TM48**	**TM49**	**TM50**	**TM51**	**TM53**	**TM54**	**TM56**
Aegilops (glume bases)	11	0	0	10	1	0	0
Aegilops (glume bases), type 1 (*A. tauschii*)	6	0	0	1	0	0	1
Avena sp., cult/wseed	0	0	0	0	1	5	0
Avena cf. sp., cult/wseed	0	0	0	0	0	0	0
Bromus sp.	1	0	0	0	9	4	0
Bromus type 1	0	0	0	1	0	8	0
Bromus type 2	1	0	0	0	0	0	0
Round grass indet.	0	0	0	0	0	0	0
Grass weeds indet.	15	0	24	8	1	168	3
Small GRAMINEAE indet.	0	1	0	0	0	0	0
Hordeum spontaneum	0	0	0	0	0	13	0
Hordeum cf. *spontaneum*	0	0	0	0	0	0	1
Hordeum murinum type	17	3	22	8	3	50	2
Lolium type 1 *(L. rigidum)*	0	0	0	0	0	5	0
Lolium type 2 *(L. rigidum)*	6	1	72	0	4	1082	1
Lolium type 3	22	4	70	7	5	676	3
Lolium sp.	0	0	0	0	0	1	0
cf. *Lolium* sp.	0	0	0	0	2	6	0
Phalaris sp.	8	0	8	18	4	26	0
Taeniatherum caput-medusae	0	0	0	1	0	0	0
Triticum boeoticum	0	0	0	0	0	21	0
Ajuga/Teucrium sp.	0	0	2	10	1	0	0
Ziziphora sp.	0	0	0	1	0	0	0
Malva sp.	1	8	2	0	15	3	0
Malva nicaeensis	0	0	0	0	0	0	0
Plantago sp.	0	0	0	0	1	0	0
Rumex sp.	1	0	54	15	6	43	0
Androsace maxima	0	0	0	0	0	0	0
Adonis sp.	0	0	0	0	0	0	0
Adonis type 1	1	0	2	1	0	1	0
Adonis type 2	2	0	0	0	0	0	0
Galium sp.	14	1	0	5	2	5	0

Sample code	**TM48**	**TM49**	**TM50**	**TM51**	**TM53**	**TM54**	**TM56**
Galium type 1 *(G.spurium)*	0	0	0	0	0	0	0
Galium type 2 *(G.spurium)*	5	0	0	1	0	16	2
Galium type 3 *(G.spurium)*	0	0	2	0	0	7	0
Galium type 4 *(G.spurium)*	2	1	0	1	0	7	0
Sherardia arvensis	0	0	0	1	0	0	0
Verbascum sp.	0	0	0	0	0	0	0
Thymelaea passerine/mesopotamica	0	0	0	1	0	0	0
UMBELLIFERAE indet.	14	0	0	0	2	4	0
Bupleurum cf. *subovatum*	0	0	0	0	0	0	0
DUNG							
Dung (sheep/goat), pellets (ml)	0	0	0.4	0	0	0	0
Dung (sheep/goat), fragments (ml)	0	0	<0.1	0	0	0	0

Table II. Raw data for Tell Atchana (1/5).

Sample code	**TA2006.72**	**TA2006.96**	**TA2010.1**	**TA2010.3**	**TA2010.4**	**TA2010.6**	**TA2010.8**	**TA2010.9**	**TA2010.10**	**TA2010.11**
Period	Late Bronze Age II	Late Bronze I	Middle Bronze II	Middle Bronze II	Late Bronze I	Middle Bronze II	Middle Bronze II	Middle Bronze II	Middle Bronze II	Middle Bronze II
Context	Casemate	Room fill	Floor	Floor	Pit	Wood remains	Fill	Floor	Wood remains	Wood remains
Area	4	1	1	1	1	1	1	1	1	1
SQ	64-82	32-57	32-57	32-57	32-57	32-57	32-57	32-57	32-57	32-57
Locus	16	7	213	206	187	189	185	206	189	189
Lot	116	52	791	793	789	778	737	786	748	756
Local phase	2	2a	5b	5b	4	5b	5a,-b	5b	5b	5b
Phase	2	5	7-8	7-8	6	7-8	7	7-8	7-8	7-8
Period	LBA II	LAB I	MBA II	MBA II	LAB I	MBA II	MBA II	MBA II	MBA II	MBA II
Volume (litres)	4	<1	4	6	6	5	12	6	33	7
Densities (items/litre)	28	92	17	44	120	245	10	181	368	53
CEREALS										
Hordeum vulgare - hulled straight grain	0	0	1	0	0	0	1	2	0	0
Hordeum vulgare - hulled cf. straight grain	0	0	0	0	3	3	0	0	0	0
Hordeum vulgare - hulled indet. grain	1	0	0	2	5	3	0	0	12	4
Hordeum vulgare - hulled cf. twisted grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare - cf. naked indet grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare indet. grain	0	0	0	0	8	5	1	8	212	1
Hordeum vulgare - hulled two-row rachis	0	0	0	0	2	0	0	12	36	0
Hordeum vulgare - hulled cf. two-row rachis	0	0	0	2	1	40	0	0	0	5
Hordeum cf. naked two-row rachis	0	0	0	0	0	0	0	2	0	0
Hordeum vulgare rachis	0	0	0	8	10	42	2	42	376	22
Triticum aestivum/durum grain	15	0	3	5	64	53	14	66	540	16
Triticum cf. *aestivum/durum* grain	2	0	0	0	22	1	0	0	0	0
Triticum aestivum rachis internodes	0	0	0	0	0	0	0	4	36	0
Triticum cf. *aestivum* rachis internodes	0	0	0	0	0	0	0	0	0	0

Sample code	**TA2006.72**	**TA2006.96**	**TA2010.1**	**TA2010.3**	**TA2010.4**	**TA2010.6**	**TA2010.8**	**TA2010.9**	**TA2010.10**	**TA2010.11**
Triticum aestivum/durum internodes	0	0	0	0	4	72	0	52	688	25
Triticum durum rachis internodes	0	0	0	0	2	6	1	36	228	4
Triticum cf. *durum* rachis internodes	0	0	0	0	0	20	0	0	0	8
Triticum dicoccum/(aestivum/durum) grain	2	0	0	0	0	0	0	0	0	0
Triticum indet. grain	0	0	0	0	0	66	6	28	516	11
Triticum cf. *monococcum* grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	1	0	0	0	0	1	0	0	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	2	0	0	0	0	1	0	2	0	2
New type grain	0	0	0	0	0	0	0	0	16	0
cf. New type grain	1	0	0	0	0	0	0	0	4	1
Triticum dicoccum/new type grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain & spikelet fork	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (glume bases)	0	0	0	0	5	12	0	20	100	2
Triticum cf. *monococcum/dicoccum* (glume bases)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	0	0	0	0	0	0	0	0	64	0
Triticum spikelet forks	0	0	0	0	0	0	0	0	8	0
Triticum cf. *dicoccum* glume bases	0	0	0	0	0	0	0	2	0	0
Triticum dicoccum spikelet forks	0	0	0	0	8	0	0	20	120	0
Triticum cf. *dicoccum* spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks terminal	0	0	0	0	0	0	0	0	40	0
New type spikelet forks	0	0	0	0	0	0	0	0	0	0
cf. New type spikelet forks	0	0	0	0	0	0	0	0	0	0
cf. New type glume bases	0	0	0	0	1	0	0	0	8	0
Triticum dicoccum grain & spikelet fork	0	0	0	0	0	0	0	0	0	0
Cereal indet. grain	18	0	11	35	115	94	16	218	1596	20
Cereal indet. chaff	0	0	0	2	4	13	0	18	100	0

Sample code	**TA2006.72**	**TA2006.96**	**TA2010.1**	**TA2010.3**	**TA2010.4**	**TA2010.6**	**TA2010.8**	**TA2010.9**	**TA2010.10**	**TA2010.11**
Cereal indet. culm node	0	0	1	5	11	4	0	14	36	15
Cereal indet. culm root	0	0	0	0	1	1	0	0	0	0
Avena sp. cult/wseed	0	0	0	0	0	0	0	0	8	1
Avena cf. sp. cult/wseed	0	0	0	0	0	0	0	0	0	0
Avena cf. *sativa* floret base, cult	0	0	0	0	1	8	0	0	32	2
PULSES										
Lens culinaris	1	0	9	1	5	1	4	2	36	4
Vicia ervilia	1	0	4	1	22	9	5	36	392	12
Lathryus sativus	0	0	0	0	0	0	0	0	0	0
cf. *Lathryus sativus*	0	0	0	1	0	0	0	0	0	0
Pulse indet.	0	0	8	4	4	5	4	8	104	2
CROP, OTHERS										
Linum usitatissimum	0	0	0	0	0	1	0	0	0	1
Linum usitatissimum, bulb	0	0	0	0	4	0	0	0	40	2
Olea europaea	1	33	10	0	1	0	0	0	0	1
Olea sp., fragment	0	59	6	0	0	0	4	0	0	0
FRUITS/COLLECTED										
Vitis vinifera	5	0	0	0	0	1	0	0	0	1
Vitis vinifera, with skin	0	0	0	0	0	0	0	0	0	0
Ficus carica	0	0	1	0	0	0	0	2	0	0
Capparis spinosa	0	0	0	0	0	0	0	0	0	0
cf. *Capparis spinosa*	0	0	0	0	0	0	0	0	0	0
Capparis spinosa, bud	0	0	0	0	0	0	0	0	4	0
WEED/WILD TAXA										
Chenopodium sp.	0	0	0	0	0	0	0	0	0	0
Ornithogalum type 1	0	0	0	0	0	0	0	0	0	0
Heliotropium sp.	0	0	0	0	0	0	0	0	0	0

Sample code	**TA2006.72**	**TA2006.96**	**TA2010.1**	**TA2010.3**	**TA2010.4**	**TA2010.6**	**TA2010.8**	**TA2010.9**	**TA2010.10**	**TA2010.11**
Echium angustifolium/parviflorum	0	0	2	1	0	0	0	2	4	1
Cephalaria sp.	0	0	0	0	0	0	0	0	16	0
Valerianella coronata type (type 1)	0	0	0	0	3	0	0	0	4	0
Valerianella dentata (Type 2)	0	0	0	0	3	4	1	0	8	4
Silene sp.	0	0	0	0	0	0	0	0	0	2
Vaccaria pyramidata	0	0	0	0	0	0	0	0	4	0
Anthemis cotula (type 4)	0	0	0	4	2	4	1	6	0	0
Centaurea sp.	0	0	0	1	0	0	0	0	16	0
Compositae type 5	0	0	0	0	2	16	0	0	28	3
CRUCIFERAE indet.	0	0	0	0	0	0	0	0	0	0
CYPERACEAE	0	0	0	0	0	0	0	0	0	0
Bolboschoenus glaucus	0	0	0	0	0	0	0	0	16	0
Bolboschoenus glaucus, tuber	0	0	0	0	0	0	0	0	0	0
CYPERACEAE/POLYGONACEAE indet.	0	0	0	0	0	11	0	0	40	0
Astragalus/trigonella sp.	0	0	0	1	7	2	0	2	208	0
Coronilla sp.	0	0	0	1	72	250	4	118	2132	4
Hippocrepis unisiliquosa/ciliata/multisiliqusa	0	0	0	0	0	0	0	4	32	0
Medicago sp.	0	0	0	1	0	0	0	0	8	0
Medicago cf. *sheradii* (Type 1, with pod)	0	0	0	0	0	0	0	0	0	1
Hymenocarpus circinnatus, with pods	0	0	0	0	0	0	0	0	8	0
Trifolium/melilotus	0	0	3	58	151	169	9	162	728	91
Pisum humile	0	0	0	0	0	1	0	0	0	0
Prosopis farcta	0	0	0	0	0	0	0	0	0	0
Prosopis farcta, fragments	0	0	0	0	0	0	0	0	0	0
Scorpiurus muricatus	0	0	1	0	22	6	3	2	116	33
Aegilops sp.	0	0	0	0	0	0	0	0	0	0
Aegilops, glume bases	0	0	0	0	0	0	0	0	0	0
Bromus sp.	0	0	0	0	1	8	2	2	20	0
Bromus type 1	0	0	0	0	2	2	1	0	16	0
Bromus type 1.5	0	0	0	0	0	0	0	0	8	0
Bromus type 2	0	0	0	0	0	0	0	0	0	0
Grass weeds indet.	16	0	3	23	24	49	4	34	1232	12

Sample code	**TA2006.72**	**TA2006.96**	**TA2010.1**	**TA2010.3**	**TA2010.4**	**TA2010.6**	**TA2010.8**	**TA2010.9**	**TA2010.10**	**TA2010.11**
Hordeum spontaneum	0	0	0	1	0	0	0	0	0	0
Hordeum murinum type	0	0	0	0	0	0	0	0	0	0
Lolium temulentum (type 1)	27	0	1	32	12	44	3	16	144	14
Lolium type 2	0	0	0	0	0	0	0	0	0	0
Lolium sp.	15	0	0	14	7	35	2	10	188	0
Phalaris aquatica	0	0	1	38	27	43	11	54	228	14
Triticum boeoticum	0	0	0	0	0	0	0	0	0	0
Ajuga/Teucrium sp.	0	0	0	0	0	0	0	0	0	0
Malva sylvestris/neglecta	0	0	0	0	0	0	0	0	4	0
Plantago sp.	0	0	0	0	2	0	0	6	8	0
Rumex sp.	2	0	0	1	29	26	0	30	584	2
Androsace maxima	0	0	0	0	0	0	0	0	4	0
Anagallis arvensis (type 3)	0	0	0	0	2	12	0	4	40	0
Adonis sp.	0	0	0	0	0	0	0	0	0	0
Ranunculus arvensis	0	0	1	0	1	0	0	2	12	0
Rosaceae whole fruit indet.	0	0	0	0	0	0	0	0	0	0
Galium spp.	0	0	0	0	2	1	0	0	120	0
Galium spurium (type 1)	0	0	0	0	3	1	1	2	12	0
Galium spurium (type 2)	0	0	0	1	0	0	1	2	0	0
Sherardia arvensis	0	0	0	0	0	0	0	2	12	0
Thymelaea passerine/gussonei/mesopotamia	0	0	0	1	25	62	1	14	408	16
UMBERLLIFERAE indet.	0	0	0	0	0	8	1	0	8	0
Bupleurum intermedium (= B. subovatum) (type 1)	0	0	0	0	0	0	2	2	0	1
Bupleurum intermedium (= B. subovatum) (type 2)	0	0	0	0	0	0	0	0	0	0
type 0	0	0	0	0	0	0	0	0	0	0
type 1	0	0	0	0	0	0	0	0	0	0
type 2	0	0	0	0	0	0	0	0	0	0
type 99	0	0	0	0	0	0	0	0	0	0
DUNG										
Dung (sheep/goat), fragments (ml)	0	0	0	0	0	0	0	0	0	0
Mouse dung, pellets	0	0	0	2	0	0	0	0	0	0

Table II. Raw data for Tell Atchana (2/5).

Sample code	**TA2010.12**	**TA2010.14**	**TA2011.22**	**TA2011.25**	**TA2011.28**	**TA2011.29**	**TA2011.30**	**TA2011.32**	**TA2011.33**	**TA2011.36**
Period	Middle Bronze II	Middle Bronze II	Middle Bronze II	Middle Bronze II	Late Bronze I	Middle Bronze II	Middle Bronze II	Middle Bronze II	Late Bronze I	Late Bronze Age II-Late Bronze I
Context	Floor	Wood remains	Floor	Floor	Pit	Pit	Fill	Pit	Pit	Stone group
Area	1	1	1	1	1	1	1	1	1	4
SQ	32-57	32-57	32-57	32-57	32-57	32-57	32-57	32-57	32-57	64-72
Locus	188	189	216	188	227	214	223	229	227	58
Lot	744	756	802	818	822	821	820	825	826	233
Local phase	5b	5b	5b	5b	3d	5b	5b,c	5c	3d	4
Phase	7-8	7-8	7-8	7-8	6	7-8	7-8	7-8	6	3-4
Period	MBA II	MBA II	MBA II	MBA II	LAB I	MBA II	MBA II	MBA II	LAB I	LAB II - I
Volume (litres)	6	24.5	11	14	21	24.5	22	23.5	24.5	25
Densities (items/litre)	59	71	8	70	7	2	10	7	3	2
CEREALS										
Hordeum vulgare - hulled straight grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare - hulled cf. straight grain	0	2	0	4	0	0	0	3	0	0
Hordeum vulgare - hulled indet. grain	1	2	0	18	25	1	6	27	7	1
Hordeum vulgare - hulled cf. twisted grain	0	0	0	0	1	0	0	1	0	0
Hordeum vulgare - cf. naked indet grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare indet. grain	0	18	0	0	17	0	0	15	0	0
Hordeum vulgare - hulled two-row rachis	0	18	0	0	0	0	0	0	0	0
Hordeum vulgare - hulled cf. two-row rachis	0	4	0	0	0	0	0	1	0	0
Hordeum cf. naked two-row rachis	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare rachis	0	138	0	3	0	0	1	1	1	0
Triticum aestivum/durum grain	17	66	16	69	8	4	32	15	10	3
Triticum cf. *aestivum/durum* grain	0	0	0	0	0	0	0	0	0	0
Triticum aestivum rachis internodes	0	2	0	0	0	0	0	0	0	0

Sample code	**TA2010.12**	**TA2010.14**	**TA2011.22**	**TA2011.25**	**TA2011.28**	**TA2011.29**	**TA2011.30**	**TA2011.32**	**TA2011.33**	**TA2011.36**
Triticum cf. *aestivum* rachis internodes	0	8	0	0	0	0	0	0	0	0
Triticum aestivum/durum internodes	0	88	0	5	0	0	2	1	0	0
Triticum durum rachis internodes	0	32	0	0	1	0	1	0	1	1
Triticum cf. *durum* rachis internodes	0	0	0	4	0	0	0	0	0	0
Triticum dicoccum/(aestivum/durum) grain	0	0	0	0	0	0	0	0	0	0
Triticum indet. grain	5	40	0	4	7	0	0	2	0	4
Triticum cf. *monococcum* grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	0	1	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0	4	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
New type grain	0	4	0	1	0	0	0	0	0	0
cf. New type grain	0	0	0	1	1	0	1	0	0	0
Triticum dicoccum/new type grain (2-grained spikelet)	0	0	0	0	0	3	2	0	0	0
Triticum dicoccum grain & spikelet fork	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (glume bases)	0	6	0	0	0	0	0	0	0	0
Triticum cf. *monococcum/dicoccum* (glume bases)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	0	0	0	0	0	0	0	0	0	0
Triticum spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* glume bases	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* spikelet forks	0	0	0	2	0	0	0	0	0	0
Triticum dicoccum spikelet forks terminal	0	2	0	0	0	0	0	0	0	0
New type spikelet forks	0	4	0	0	0	0	0	0	0	0
cf. New type spikelet forks	0	4	0	0	0	0	2	0	0	0
cf. New type glume bases	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain & spikelet fork	0	0	0	0	0	0	0	0	0	0
Cereal indet. grain	0	100	17	58	32	12	39	48	10	0

Sample code	**TA2010.12**	**TA2010.14**	**TA2011.22**	**TA2011.25**	**TA2011.28**	**TA2011.29**	**TA2011.30**	**TA2011.32**	**TA2011.33**	**TA2011.36**
Cereal indet. chaff	0	36	0	0	0	0	0	0	0	0
Cereal indet. culm node	0	48	2	5	0	0	7	1	4	0
Cereal indet. culm root	0	0	0	0	0	0	0	0	0	0
Avena sp. cult/wseed	3	2	2	3	1	1	1	0	0	1
Avena cf. sp. cult/wseed	1	0	0	0	0	0	0	0	0	0
Avena cf. *sativa* floret base, cult	0	0	0	0	0	0	0	0	0	0
PULSES										
Lens culinaris	0	6	2	13	0	7	6	2	1	1
Vicia ervilia	5	42	4	26	10	5	8	4	2	4
Lathryus sativus	0	0	0	0	0	0	0	0	0	0
cf. *Lathryus sativus*	0	0	0	0	0	0	0	0	0	0
Pulse indet.	2	4	4	34	9	3	13	5	12	0
CROP, OTHERS										
Linum usitatissimum	0	0	0	0	0	0	0	0	0	1
Linum usitatissimum, bulb	0	10	0	0	0	0	0	0	0	0
Olea europaea	0	0	1	1	0	0	1	0	0	0
Olea sp., fragment	0	0	0	1	1	0	1	0	0	0
FRUITS/COLLECTED										
Vitis vinifera	2	8	1	6	0	0	0	0	0	1
Vitis vinifera, with skin	0	0	0	0	0	0	0	0	0	0
Ficus carica	0	0	0	1	0	0	2	0	0	0
Capparis spinosa	0	0	0	0	0	0	0	0	0	0
cf. *Capparis spinosa*	0	0	0	0	0	0	0	0	0	0
Capparis spinosa, bud	0	0	0	0	0	0	0	0	0	0
WEED/WILD TAXA										
Chenopodium sp.	0	4	0	2	0	0	0	0	0	0
Ornithogalum type 1	0	0	0	0	0	0	0	0	0	0

Sample code	**TA2010.12**	**TA2010.14**	**TA2011.22**	**TA2011.25**	**TA2011.28**	**TA2011.29**	**TA2011.30**	**TA2011.32**	**TA2011.33**	**TA2011.36**
Heliotropium sp.	0	0	0	0	0	0	0	0	0	0
Echium angustifolium/parviflorum	0	0	0	4	0	0	11	0	0	0
Cephalaria sp.	1	0	0	1	0	0	0	0	0	0
Valerianella coronata type (type 1)	0	6	0	0	0	0	0	0	0	0
Valerianella dentata (Type 2)	0	4	0	0	0	0	0	0	0	0
Silene sp.	0	0	0	0	0	0	0	0	0	0
Vaccaria pyramidata	0	0	0	1	1	0	0	0	0	0
Anthemis cotula (type 4)	0	8	0	0	0	0	0	0	0	0
Centaurea sp.	0	4	0	3	0	0	1	0	0	0
Compositae type 5	0	50	0	9	0	0	0	0	0	0
CRUCIFERAE indet.	0	0	0	0	0	0	0	0	0	0
CYPERACEAE	0	0	0	0	0	0	0	0	0	0
Bolboschoenus glaucus	2	0	1	1	1	1	0	1	0	0
Bolboschoenus glaucus, tuber	0	2	0	0	0	0	0	0	0	0
CYPERACEAE/POLYGONACEAE indet.	0	2	0	0	0	0	0	0	0	0
Astragalus/trigonella sp.	4	12	1	5	1	0	3	2	0	0
Coronilla sp.	4	36	0	3	0	0	0	0	0	0
Hippocrepis unisiliquosa/ciliata/multisiliqusa	4	0	0	8	0	0	0	0	0	0
Medicago sp.	0	0	0	0	0	0	2	0	0	0
Medicago cf. *sheradii* (Type 1, with pod)	0	0	0	0	0	0	0	0	0	0
Hymenocarpus circinnatus, with pods	0	0	0	0	0	0	0	0	0	0
Trifolium/melilotus	192	428	8	301	0	3	12	1	9	4
Pisum humile	0	0	0	0	0	0	0	0	0	0
Prosopis farcta	0	0	0	18	0	0	0	0	1	0
Prosopis farcta, fragments	0	0	0	5	0	0	0	0	0	0
Scorpiurus muricatus	1	110	0	4	2	1	5	0	5	1
Aegilops sp.	0	0	0	0	0	0	0	0	0	0
Aegilops, glume bases	0	0	0	0	0	0	0	0	0	0
Bromus sp.	0	0	0	2	0	0	1	0	0	0
Bromus type 1	0	4	0	1	0	0	0	0	0	0
Bromus type 1.5	0	0	0	0	0	0	0	0	0	0
Bromus type 2	0	0	0	0	0	0	0	0	0	0

Sample code	**TA2010.12**	**TA2010.14**	**TA2011.22**	**TA2011.25**	**TA2011.28**	**TA2011.29**	**TA2011.30**	**TA2011.32**	**TA2011.33**	**TA2011.36**
Grass weeds indet.	13	44	5	26	2	5	11	1	3	4
Hordeum spontaneum	0	0	0	0	0	0	0	0	0	0
Hordeum murinum type	0	0	0	1	0	0	0	0	0	1
Lolium temulentum (type 1)	37	34	15	132	2	4	17	2	3	10
Lolium type 2	0	0	0	0	0	0	0	0	0	0
Lolium sp.	3	10	6	17	4	0	2	1	0	0
Phalaris aquatica	35	94	4	101	5	0	19	6	2	7
Triticum boeoticum	0	0	0	0	0	0	0	0	0	0
Ajuga/Teucrium sp.	0	0	0	0	0	0	0	0	0	0
Malva sylvestris/neglecta	0	0	0	1	0	0	0	0	0	1
Plantago sp.	1	8	1	0	0	0	1	0	0	0
Rumex sp.	3	14	0	14	7	3	3	3	1	3
Androsace maxima	0	0	0	1	0	0	0	0	0	0
Anagallis arvensis (type 3)	0	0	0	3	0	0	0	0	0	0
Adonis sp.	0	0	0	0	0	0	0	0	1	0
Ranunculus arvensis	0	4	0	0	0	0	0	0	0	1
Rosaceae whole fruit indet.	0	0	0	0	0	0	0	1	0	0
Galium spp.	1	8	1	11	0	0	1	0	2	0
Galium spurium (type 1)	5	0	0	2	1	0	0	1	0	0
Galium spurium (type 2)	0	2	0	1	0	0	1	0	2	3
Sherardia arvensis	2	2	0	1	0	0	1	0	0	0
Thymelaea passerine/gussonei/mesopotamia	0	68	0	2	1	1	1	3	1	2
UMBERLLIFERAE indet.	0	8	0	0	0	0	1	0	0	0
Bupleurum intermedium (= B. subovatum) (type 1)	1	0	0	0	0	0	0	0	0	0
Bupleurum intermedium (= B. subovatum) (type 2)	0	0	0	0	0	0	0	0	0	0
type 0	3	0	1	1	0	0	1	0	0	0
type 1	0	0	0	0	0	0	0	0	0	0
type 2	0	0	0	0	0	0	0	0	0	0
type 99	0	0	0	0	0	0	0	0	0	0
DUNG										
Dung (sheep/goat), fragments (ml)	0	0	0	0.30	0	0	0	0	0	0

Sample code	TA2010.12	TA2010.14	TA2011.22	TA2011.25	TA2011.28	TA2011.29	TA2011.30	TA2011.32	TA2011.33	TA2011.36
Mouse dung, pellets	0	0	0	0	0	0	0	0	0	0

Table II. Raw data for Tell Atchana (3/5).

Sample code	**TA2011.39**	**TA2011.41**	**TA2011.45**	**TA2011.91**	**TA2011.92**	**TA2011.93**	**TA2011.314**	**TA2011.315**	**TA2011.320**	**TA2011.322**
Period	Late Bronze Age II-Late Bronze I	Middle Bronze II	Late Bronze Age II-Late Bronze I	Middle Bronze II	Middle Bronze II	Late Bronze I	Late Bronze Age II-Late Bronze I	Late Bronze Age II-Late Bronze I	Late Bronze Age II	Middle Bronze II
Context	Ashy fill	Floor	Ashy fill	Pit	Pit	Pit	Ashy fill	Ashy fill	Tandoor	Fill
Area	4	1	4	1	1	1	4	4	4	1
SQ	64-83	32-57	64-83	32-57	32-57	32-57	64-83	64-83	64-83	32-57
Locus	41	233	41	229	228	227	41	41	45	237
Lot	141	839	149	859	858	856	183	183	177	868
Local phase	4	5d	4	5c	5c	3d	4	4	3	5d-e
Phase	3-4	7-8	3-4	7-8	7-8	6	3-4	3-4	3	7-8
Period	LAB II - I	MBA II	LAB II - I	MBA II	MBA II	LAB I	LAB II - I	LAB II - I	LBA II	MBA II
Volume (litres)	52	24	22.5	61	53	25	24	12	15	22
Densities (items/litre)	15	39	4	8	8	4	9	9	18	3
CEREALS										
Hordeum vulgare - hulled straight grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare - hulled cf. straight grain	0	0	0	4	0	0	3	0	4	0
Hordeum vulgare - hulled indet. grain	18	32	4	19	33	8	2	6	4	4
Hordeum vulgare - hulled cf. twisted grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare - cf. naked indet grain	0	4	0	0	0	0	0	0	0	0
Hordeum vulgare indet. grain	26	5	0	5	3	0	6	0	1	0
Hordeum vulgare - hulled two-row rachis	0	5	0	0	0	0	0	0	0	0
Hordeum vulgare - hulled cf. two-row rachis	12	0	0	0	2	0	0	1	2	0
Hordeum cf. naked two-row rachis	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare rachis	0	8	0	0	1	0	1	0	0	1
Triticum aestivum/durum grain	92	97	13	63	68	12	33	17	17	6
Triticum cf. *aestivum/durum* grain	0	0	0	0	0	0	0	0	0	0
Triticum aestivum rachis internodes	4	0	0	0	1	0	0	0	0	0

Sample code	**TA2011.39**	**TA2011.41**	**TA2011.45**	**TA2011.91**	**TA2011.92**	**TA2011.93**	**TA2011.314**	**TA2011.315**	**TA2011.320**	**TA2011.322**
Triticum cf. *aestivum* rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum aestivum/durum internodes	6	9	0	4	7	0	0	0	0	1
Triticum durum rachis internodes	20	0	0	0	14	0	0	0	0	0
Triticum cf. *durum* rachis internodes	0	0	0	2	0	0	0	0	0	0
Triticum dicoccum/(aestivum/durum) grain	0	3	0	0	0	0	0	0	0	0
Triticum indet. grain	36	12	3	0	16	5	21	7	3	1
Triticum cf. *monococcum* grain (1-grained spikelet)	0	1	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	1	0	0	0	0	2	0	0	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	1
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	1	0	0	0	0	2	2	0	0
Triticum dicoccum grain (2-grained spikelet)	0	4	0	0	0	0	0	1	3	1
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	0	2	0	0	0	1	2	0	0
New type grain	0	5	0	0	0	0	0	0	0	0
cf. New type grain	2	0	0	1	0	0	3	0	0	0
Triticum dicoccum/new type grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain & spikelet fork	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (glume bases)	0	0	0	0	0	2	1	0	0	0
Triticum cf. *monococcum/dicoccum* (glume bases)	0	1	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	4	0	0	0	0	0	0	0	0	0
Triticum spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* glume bases	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks	24	2	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* spikelet forks	8	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks terminal	0	0	0	0	0	0	0	0	0	0
New type spikelet forks	0	0	0	0	0	0	0	0	0	0
cf. New type spikelet forks	0	0	0	0	0	0	0	0	0	0
cf. New type glume bases	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain & spikelet fork	0	0	0	0	0	0	0	0	0	0

Sample code	**TA2011.39**	**TA2011.41**	**TA2011.45**	**TA2011.91**	**TA2011.92**	**TA2011.93**	**TA2011.314**	**TA2011.315**	**TA2011.320**	**TA2011.322**
Cereal indet. grain	63	53	18	146	93	11	37	3	26	8
Cereal indet. chaff	4	0	0	0	1	0	0	0	0	0
Cereal indet. culm node	58	5	0	0	0	8	0	0	4	3
Cereal indet. culm root	0	0	0	0	0	0	0	0	0	0
Avena sp. cult/wseed	0	3	0	1	3	0	0	0	0	0
Avena cf. sp. cult/wseed	0	0	0	0	0	0	0	0	0	0
Avena cf. *sativa* floret base, cult	4	0	0	0	0	0	0	0	0	0
PULSES										
Lens culinaris	0	17	1	10	10	7	4	6	4	3
Vicia ervilia	42	92	2	32	26	13	12	5	10	7
Lathryus sativus	0	2	0	0	0	0	0	0	0	0
cf. *Lathryus sativus*	0	0	1	0	0	0	0	0	0	0
Pulse indet.	7	136	1	31	22	13	0	2	6	5
CROP, OTHERS										
Linum usitatissimum	0	0	0	1	2	0	0	0	0	0
Linum usitatissimum, bulb	0	0	0	6	0	0	0	0	0	0
Olea europaea	0	0	0	0	0	1	0	0	0	0
Olea sp., fragment	0	1	0	0	2	0	0	0	0	0
FRUITS/COLLECTED										
Vitis vinifera	0	0	0	0	0	0	0	0	0	0
Vitis vinifera, with skin	0	0	0	0	0	0	0	0	1	0
Ficus carica	2	0	0	1	0	0	0	0	20	0
Capparis spinosa	0	0	0	0	0	0	0	0	0	0
cf. *Capparis spinosa*	0	0	0	0	0	0	0	0	0	0
Capparis spinosa, bud	0	0	0	0	0	0	0	0	0	0
WEED/WILD TAXA										

Sample code	**TA2011.39**	**TA2011.41**	**TA2011.45**	**TA2011.91**	**TA2011.92**	**TA2011.93**	**TA2011.314**	**TA2011.315**	**TA2011.320**	**TA2011.322**
Chenopodium sp.	0	0	0	0	0	0	0	0	0	0
Ornithogalum type 1	0	0	0	0	0	0	0	0	0	0
Heliotropium sp.	0	0	0	0	0	0	0	0	0	0
Echium angustifolium/parviflorum	0	0	0	0	1	0	0	0	0	0
Cephalaria sp.	0	0	0	1	0	0	0	0	0	0
Valerianella coronata type (type 1)	0	0	0	0	0	0	0	0	0	0
Valerianella dentata (Type 2)	0	1	0	0	0	0	0	0	0	0
Silene sp.	0	0	0	1	0	0	0	0	0	0
Vaccaria pyramidata	0	0	0	2	0	0	2	1	0	0
Anthemis cotula (type 4)	0	0	0	0	0	0	0	0	0	0
Centaurea sp.	0	0	0	0	1	0	0	0	0	0
Compositae type 5	0	0	0	14	14	0	0	0	3	0
CRUCIFERAE indet.	0	1	0	0	0	0	0	0	0	0
CYPERACEAE	0	0	0	1	0	0	0	0	0	0
Bolboschoenus glaucus	0	0	1	7	4	0	0	0	0	0
Bolboschoenus glaucus, tuber	0	0	0	0	0	0	0	0	0	0
CYPERACEAE/POLYGONACEAE indet.	14	0	0	0	0	0	0	0	0	0
Astragalus/trigonella sp.	10	0	0	0	1	0	0	0	1	0
Coronilla sp.	0	5	0	1	0	0	0	0	1	0
Hippocrepis unisiliquosa/ciliata/multisiliqusa	8	0	0	0	0	0	0	0	0	0
Medicago sp.	0	1	0	2	0	0	0	0	0	0
Medicago cf. *sheradii* (Type 1, with pod)	2	0	0	0	0	0	0	0	0	0
Hymenocarpus circinnatus, with pods	0	0	0	0	0	0	0	0	0	0
Trifolium/melilotus	14	39	4	9	4	3	4	2	15	1
Pisum humile	0	0	0	0	0	0	0	0	0	0
Prosopis farcta	0	1	0	1	0	0	0	0	1	0
Prosopis farcta, fragments	0	0	0	0	1	0	0	0	0	0
Scorpiurus muricatus	0	6	0	37	19	0	0	0	2	3
Aegilops sp.	0	1	0	0	0	0	0	0	0	0
Aegilops, glume bases	0	0	0	0	0	0	0	0	0	0
Bromus sp.	0	1	0	0	1	0	0	0	0	0

Sample code	**TA2011.39**	**TA2011.41**	**TA2011.45**	**TA2011.91**	**TA2011.92**	**TA2011.93**	**TA2011.314**	**TA2011.315**	**TA2011.320**	**TA2011.322**
Bromus type 1	6	1	0	0	0	0	0	0	0	0
Bromus type 1.5	0	0	0	0	0	0	0	0	0	0
Bromus type 2	0	2	0	0	0	0	0	0	0	0
Grass weeds indet.	6	22	2	6	9	4	13	1	30	1
Hordeum spontaneum	0	1	0	0	0	0	0	0	0	0
Hordeum murinum type	2	5	0	0	0	0	1	0	2	0
Lolium temulentum (type 1)	88	86	17	20	15	2	43	30	47	6
Lolium type 2	0	3	0	0	0	0	1	0	0	0
Lolium sp.	44	28	4	13	5	0	6	3	17	0
Phalaris aquatica	24	142	11	9	5	13	20	5	33	2
Triticum boeoticum	0	2	0	0	0	0	0	0	0	0
Ajuga/Teucrium sp.	0	0	0	0	0	0	0	0	0	0
Malva sylvestris/neglecta	0	1	0	0	0	0	0	0	0	0
Plantago sp.	0	12	0	0	0	0	2	0	2	0
Rumex sp.	124	9	1	8	5	2	0	1	4	0
Androsace maxima	0	0	0	0	0	0	0	0	0	0
Anagallis arvensis (type 3)	0	1	0	0	0	0	0	0	0	0
Adonis sp.	0	0	0	0	0	0	0	0	0	0
Ranunculus arvensis	4	2	0	0	0	0	1	0	1	0
Rosaceae whole fruit indet.	0	0	0	0	0	0	0	0	0	0
Galium spp.	4	11	0	5	1	0	0	1	1	0
Galium spurium (type 1)	0	1	0	1	1	1	0	0	0	0
Galium spurium (type 2)	0	0	0	1	0	1	1	0	1	0
Sherardia arvensis	2	1	0	0	0	0	0	0	0	0
Thymelaea passerine/gussonei/mesopotamia	6	4	2	1	1	0	0	1	3	0
UMBERLLIFERAE indet.	0	5	0	0	0	0	0	0	0	0
Bupleurum intermedium (= B. subovatum) (type 1)	2	1	0	0	0	0	0	0	0	0
Bupleurum intermedium (= B. subovatum) (type 2)	0	0	0	0	0	0	0	0	0	0
type 0	0	0	0	1	0	0	0	0	0	0
type 1	0	0	0	0	0	0	0	0	0	0
type 2	0	0	0	1	0	0	0	0	0	0

Sample code	**TA2011.39**	**TA2011.41**	**TA2011.45**	**TA2011.91**	**TA2011.92**	**TA2011.93**	**TA2011.314**	**TA2011.315**	**TA2011.320**	**TA2011.322**
type 99	0	0	0	0	0	0	0	0	0	0
DUNG										
Dung (sheep/goat), fragments (ml)	0	0	0	0	0	0	0	0	0	0
Mouse dung, pellets	0	0	0	0	0	0	0	0	0	0

Table II. Raw data for Tell Atchana (4/5).

Sample code	**TA2011.326**	**TA2011.327**	**TA2011.330**	**TA2011.331**	**TA2011.332**	**TA2011.334**	**TA2012.4**	**TA2012.5**	**TA2012.7**	**TA2012.10**
Period	Middle Bronze II	Late Bronze Age II	Late Bronze Age II	Middle Bronze II	Late Bronze Age II-Late Bronze I	Middle Bronze II	Middle Bronze II	Late Bronze Age II	Middle Bronze II	Middle Bronze II
Context	Pit	Pit	Pit	Floor	Room fill	Floor	Pit	Pithos	Casemate	Pit
Area	1	2	2	1	4	1	1	4	3	1
SQ	32-57	44-86	44-86	32-57	64-72	32-57	32-57	64-94	45-44	32-57
Locus	239	19	19	246	63	246	229	17	101	228
Lot	879	94	86	896	330	904	921	63	623	925
Local phase	5e	2	2	5f	4	5f	5c	2a	5	5c
Phase	7-8	1-2	1-2	7-8	3-4	7-8	7-8	2	7	7-8
Period	MBA II	LBA II	LBA II	MBA II	LAB II - I	MBA II	MBA II	LBA II	MBA II	MBA II
Volume (litres)	15	15	33	25	34	19	17	26	40	11
Densities (items/litre)	12	6	2	35	28	18	5	2	1	7
CEREALS										
Hordeum vulgare - hulled straight grain	0	0	0	0	0	0	0	0	0	1
Hordeum vulgare - hulled cf. straight grain	1	0	0	2	2	3	0	0	0	1
Hordeum vulgare - hulled indet. grain	7	0	1	18	6	5	0	0	0	19
Hordeum vulgare - hulled cf. twisted grain	0	0	0	1	0	0	0	0	0	0
Hordeum vulgare - cf. naked indet grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare indet. grain	3	0	0	0	0	4	0	0	0	0
Hordeum vulgare - hulled two-row rachis	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare - hulled cf. two-row rachis	0	0	0	1	0	2	0	0	0	0
Hordeum cf. naked two-row rachis	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare rachis	1	0	0	0	0	8	0	0	1	0
Triticum aestivum/durum grain	19	2	0	17	126	17	21	13	6	10
Triticum cf. *aestivum/durum* grain	0	0	0	0	0	0	0	0	0	0
Triticum aestivum rachis internodes	0	0	0	0	0	1	0	0	0	0

Sample code	**TA2011.326**	**TA2011.327**	**TA2011.330**	**TA2011.331**	**TA2011.332**	**TA2011.334**	**TA2012.4**	**TA2012.5**	**TA2012.7**	**TA2012.10**
Triticum cf. *aestivum* rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum aestivum/durum internodes	3	0	0	1	0	13	0	0	0	0
Triticum durum rachis internodes	2	0	0	6	0	6	0	0	0	0
Triticum cf. *durum* rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum/(aestivum/durum) grain	0	0	0	0	0	0	0	0	0	0
Triticum indet. grain	2	2	4	5	130	0	0	0	0	0
Triticum cf. *monococcum* grain (1-grained spikelet)	0	0	0	2	0	0	0	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	1	0	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	2	1	6	0	2	0	0	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	0	0	0	0	2	0	0	0	0
New type grain	1	0	0	1	2	0	0	0	0	0
cf. New type grain	0	0	0	0	0	4	0	0	0	0
Triticum dicoccum/new type grain (2-grained spikelet)	0	0	0	5	0	0	0	0	0	1
Triticum dicoccum grain & spikelet fork	0	0	0	1	0	0	0	0	0	0
Triticum monococcum/dicoccum (glume bases)	0	0	1	2	0	7	0	0	0	0
Triticum cf. *monococcum/dicoccum* (glume bases)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	0	0	0	0	0	2	0	0	0	0
Triticum spikelet forks	0	0	0	2	0	2	0	0	0	0
Triticum cf. *dicoccum* glume bases	0	0	0	0	0	1	0	0	0	0
Triticum dicoccum spikelet forks	0	0	0	0	0	2	0	0	0	0
Triticum cf. *dicoccum* spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks terminal	1	0	0	1	0	0	0	0	0	0
New type spikelet forks	0	0	0	4	0	4	0	0	0	0
cf. New type spikelet forks	2	0	0	4	0	0	0	0	0	0
cf. New type glume bases	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain & spikelet fork	0	0	0	2	0	0	0	0	0	0

Sample code	**TA2011.326**	**TA2011.327**	**TA2011.330**	**TA2011.331**	**TA2011.332**	**TA2011.334**	**TA2012.4**	**TA2012.5**	**TA2012.7**	**TA2012.10**
Cereal indet. grain	37	3	3	35	638	31	23	5	6	25
Cereal indet. chaff	0	0	0	0	0	0	0	0	0	0
Cereal indet. culm node	7	0	0	67	0	9	4	2	0	0
Cereal indet. culm root	0	0	0	0	0	0	0	0	0	0
Avena sp. cult/wseed	1	0	0	8	0	0	0	0	0	0
Avena cf. sp. cult/wseed	0	0	0	0	0	0	0	0	0	0
Avena cf. *sativa* floret base, cult	0	0	0	0	0	0	0	0	0	0
PULSES										
Lens culinaris	3	0	0	6	0	9	1	0	3	1
Vicia ervilia	12	0	0	52	6	6	2	4	2	6
Lathryus sativus	0	0	0	0	0	0	0	0	0	0
cf. *Lathryus sativus*	0	0	0	0	0	0	0	0	0	0
Pulse indet.	36	4	0	70	0	5	0	1	5	0
CROP, OTHERS										
Linum usitatissimum	0	0	1	0	0	0	2	0	0	0
Linum usitatissimum, bulb	0	0	0	0	0	0	0	0	0	0
Olea europaea	0	0	0	0	0	0	0	0	0	1
Olea sp., fragment	0	0	0	0	0	0	0	0	0	0
FRUITS/COLLECTED										
Vitis vinifera	0	4	0	0	2	0	2	0	1	0
Vitis vinifera, with skin	0	0	0	0	0	0	0	0	0	0
Ficus carica	0	2	2	1	0	1	0	2	0	0
Capparis spinosa	0	0	0	0	0	0	0	0	1	0
cf. *Capparis spinosa*	0	1	0	0	0	0	0	0	0	0
Capparis spinosa, bud	0	0	0	0	0	0	0	0	0	0
WEED/WILD TAXA										

Sample code	**TA2011.326**	**TA2011.327**	**TA2011.330**	**TA2011.331**	**TA2011.332**	**TA2011.334**	**TA2012.4**	**TA2012.5**	**TA2012.7**	**TA2012.10**
Chenopodium sp.	0	0	0	1	0	0	0	0	0	0
Ornithogalum type 1	0	0	0	0	0	0	0	0	0	0
Heliotropium sp.	0	2	2	0	0	0	0	0	0	0
Echium angustifolium/parviflorum	0	0	0	1	0	1	0	0	0	0
Cephalaria sp.	0	0	0	0	0	0	0	0	0	0
Valerianella coronata type (type 1)	0	0	0	0	0	0	0	0	0	0
Valerianella dentata (Type 2)	1	0	0	0	0	0	0	0	0	0
Silene sp.	0	0	0	1	0	1	0	0	0	0
Vaccaria pyramidata	0	0	0	6	0	0	0	0	0	0
Anthemis cotula (type 4)	0	0	0	0	0	0	0	0	0	0
Centaurea sp.	0	0	1	1	0	0	0	0	0	0
Compositae type 5	0	0	0	0	0	0	0	0	0	0
CRUCIFERAE indet.	0	0	0	0	0	0	0	0	1	0
CYPERACEAE	0	0	0	0	0	0	0	0	0	0
Bolboschoenus glaucus	0	2	4	1	0	0	0	2	0	0
Bolboschoenus glaucus, tuber	0	0	0	0	0	0	0	0	0	0
CYPERACEAE/POLYGONACEAE indet.	0	0	0	0	0	0	0	0	0	0
Astragalus/trigonella sp.	0	0	0	5	0	1	2	0	0	1
Coronilla sp.	2	0	0	4	0	0	1	0	0	0
Hippocrepis unisiliquosa/ciliata/multisiliqusa	0	0	0	0	0	0	0	0	0	0
Medicago sp.	0	0	0	6	0	1	0	0	0	0
Medicago cf. *sheradii* (Type 1, with pod)	0	0	0	0	0	0	0	0	0	0
Hymenocarpus circinnatus, with pods	0	0	0	0	0	0	0	0	0	0
Trifolium/melilotus	4	3	3	19	4	21	19	6	9	2
Pisum humile	0	0	0	0	0	0	0	0	0	0
Prosopis farcta	0	0	0	0	0	0	0	0	0	0
Prosopis farcta, fragments	0	0	0	3	0	2	0	0	0	0
Scorpiurus muricatus	2	0	0	18	0	9	2	0	1	2
Aegilops sp.	0	0	0	0	0	0	0	0	0	0
Aegilops, glume bases	0	0	0	0	0	0	1	0	0	0
Bromus sp.	0	0	0	5	0	6	0	0	0	0

Sample code	**TA2011.326**	**TA2011.327**	**TA2011.330**	**TA2011.331**	**TA2011.332**	**TA2011.334**	**TA2012.4**	**TA2012.5**	**TA2012.7**	**TA2012.10**
Bromus type 1	3	0	0	9	0	0	0	1	0	0
Bromus type 1.5	0	0	0	1	0	0	0	0	0	0
Bromus type 2	0	0	0	0	0	0	0	0	0	0
Grass weeds indet.	1	0	0	25	2	8	0	3	2	1
Hordeum spontaneum	0	0	0	0	0	0	0	0	0	0
Hordeum murinum type	1	1	0	0	0	1	0	0	3	0
Lolium temulentum (type 1)	10	8	2	37	10	12	0	8	3	1
Lolium type 2	0	0	0	3	0	0	0	0	0	0
Lolium sp.	1	1	0	2	12	0	0	1	0	0
Phalaris aquatica	15	3	0	265	4	73	2	1	3	1
Triticum boeoticum	0	0	0	0	0	0	0	0	0	0
Ajuga/Teucrium sp.	0	0	1	1	0	0	0	0	0	0
Malva sylvestris/neglecta	0	3	1	3	0	0	0	0	0	0
Plantago sp.	0	0	0	0	0	9	0	0	1	0
Rumex sp.	0	0	0	33	2	5	1	0	1	5
Androsace maxima	0	0	0	0	0	0	0	0	0	0
Anagallis arvensis (type 3)	0	0	1	16	0	0	0	0	0	0
Adonis sp.	0	0	0	1	0	0	0	0	0	0
Ranunculus arvensis	0	0	0	1	0	0	0	0	0	0
Rosaceae whole fruit indet.	0	0	0	0	0	0	0	0	0	0
Galium spp.	0	1	0	19	0	5	0	0	0	0
Galium spurium (type 1)	0	1	0	9	0	1	0	0	0	0
Galium spurium (type 2)	1	0	1	0	0	0	0	0	0	0
Sherardia arvensis	0	0	0	3	0	0	0	0	0	0
Thymelaea passerine/gussonei/mesopotamia	2	0	0	9	0	2	1	1	0	0
UMBERLLIFERAE indet.	0	0	1	0	0	1	0	0	0	0
Bupleurum intermedium (= B. subovatum) (type 1)	0	1	0	1	0	3	0	0	0	0
Bupleurum intermedium (= B. subovatum) (type 2)	0	0	0	0	0	9	0	0	0	0
type 0	0	0	0	0	0	0	0	0	0	0
type 1	0	4	0	0	0	0	0	0	0	0
type 2	0	0	1	0	0	0	0	0	0	0

Sample code	**TA2011.326**	**TA2011.327**	**TA2011.330**	**TA2011.331**	**TA2011.332**	**TA2011.334**	**TA2012.4**	**TA2012.5**	**TA2012.7**	**TA2012.10**
type 99	0	18	43	0	0	0	0	0	0	0
DUNG										
Dung (sheep/goat), fragments (ml)	0	0	0	0	0	0	0	0	0	0
Mouse dung, pellets	0	0	0	0	0	0	0	0	0	0

Table II. Raw data for Tell Atchana (5/5).

Sample code	**TA2012.11**	**TA2012.14**	**TA2012.15**	**TA2012.17**	**TA2012.18**	**TA2012.22**	**TA2012.25**	**TA2012.26**	**TA2012.32**	**TA2012.35**
Period	Middle Bronze II	Middle Bronze II	Middle Bronze II	Middle Bronze II	Late Bronze Age II	Middle Bronze II	Middle Bronze II	Middle Bronze II	Late Bronze Age II	Middle Bronze II
Context	Floor	Cemetery fill	Cemetery fill	Cemetery fill	Pit	Cemetery fill	Fill	Room	Drainage canal	Kiln
Area	1	3	3	3	4	3	1	3	4	1
SQ	32-57	45-44	45-44	45-44	64-73	45-44	32-57	45-44	64-73	32-57
Locus	252	137	137	137	43	137	256	140	45	270
Lot	926	649	652	654	164	654	956	656	175	983
Local phase	5e	5	5	5	3b	5	5f-g	5	3	5f
Phase	7-8	7	7	7	3	7	7-8	7	3	7-8
Period	MBA II	MBA II	MBA II	MBA II	LBA II	MBA II	MBA II	MBA II	LBA II	MBA II
Volume (litres)	13	10	31	16	1.5	16	15	27	23	21
Densities (items/litre)	20	6	10	6	35	15	18	2	2	5
CEREALS										
Hordeum vulgare - hulled straight grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare - hulled cf. straight grain	2	0	1	1	0	0	0	0	0	0
Hordeum vulgare - hulled indet. grain	3	3	15	2	0	4	0	1	0	14
Hordeum vulgare - hulled cf. twisted grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare - cf. naked indet grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare indet. grain	0	0	1	0	0	0	0	1	0	0
Hordeum vulgare - hulled two-row rachis	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare - hulled cf. two-row rachis	0	1	0	0	0	0	0	0	0	0
Hordeum cf. naked two-row rachis	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare rachis	2	3	7	2	0	2	3	0	0	0
Triticum aestivum/durum grain	18	2	23	13	2	27	10	5	3	3
Triticum cf. *aestivum/durum* grain	0	0	0	0	0	0	0	0	0	0
Triticum aestivum rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum cf. *aestivum* rachis internodes	0	0	1	0	0	0	0	1	0	0

Sample code	**TA2012.11**	**TA2012.14**	**TA2012.15**	**TA2012.17**	**TA2012.18**	**TA2012.22**	**TA2012.25**	**TA2012.26**	**TA2012.32**	**TA2012.35**
Triticum aestivum/durum internodes	2	2	0	0	9	0	25	0	0	0
Triticum durum rachis internodes	0	0	3	0	2	0	2	0	0	0
Triticum cf. *durum* rachis internodes	0	1	3	0	0	0	0	0	0	0
Triticum dicoccum/(aestivum/durum) grain	0	0	0	0	0	0	0	0	0	0
Triticum indet. grain	3	1	8	2	0	23	4	2	2	0
Triticum cf. *monococcum* grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	1	1	0	0	0	0	0	0	0
New type grain	0	0	0	0	0	0	0	0	0	0
cf. New type grain	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum/new type grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain & spikelet fork	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (glume bases)	4	0	3	0	0	0	0	0	0	1
Triticum cf. *monococcum/dicoccum* (glume bases)	0	1	0	0	1	0	0	0	1	0
Triticum monococcum/dicoccum (spikelet forks)	2	0	0	0	0	0	6	0	0	0
Triticum spikelet forks	0	2	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* glume bases	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks	0	0	0	0	0	2	0	0	0	0
Triticum cf. *dicoccum* spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks terminal	0	0	0	0	0	0	0	0	0	0
New type spikelet forks	0	0	0	0	0	0	0	2	0	0
cf. New type spikelet forks	0	0	0	0	0	0	0	0	0	0
cf. New type glume bases	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain & spikelet fork	0	0	0	0	0	0	0	0	0	0
Cereal indet. grain	7	3	23	5	20	8	62	5	19	3
Cereal indet. chaff	0	1	1	0	5	0	1	0	0	0

Sample code	**TA2012.11**	**TA2012.14**	**TA2012.15**	**TA2012.17**	**TA2012.18**	**TA2012.22**	**TA2012.25**	**TA2012.26**	**TA2012.32**	**TA2012.35**
Cereal indet. culm node	1	0	6	0	2	0	7	2	0	1
Cereal indet. culm root	1	0	0	0	1	0	0	0	0	0
Avena sp. cult/wseed	0	0	4	0	0	1	0	0	0	0
Avena cf. sp. cult/wseed	0	0	0	0	0	0	0	0	0	0
Avena cf. *sativa* floret base, cult	0	0	0	0	0	0	0	0	0	0
PULSES										
Lens culinaris	7	3	3	2	0	5	0	1	1	0
Vicia ervilia	15	1	5	6	0	16	7	3	6	30
Lathryus sativus	0	0	0	0	0	0	0	0	0	0
cf. *Lathryus sativus*	0	0	0	0	0	0	1	0	0	0
Pulse indet.	16	4	5	0	0	5	15	3	8	2
CROP, OTHERS										
Linum usitatissimum	0	0	0	0	0	0	0	0	0	0
Linum usitatissimum, bulb	0	0	0	0	0	0	0	0	0	0
Olea europaea	0	1	0	0	0	0	0	0	0	0
Olea sp., fragment	0	0	2	0	0	0	0	0	0	0
FRUITS/COLLECTED										
Vitis vinifera	0	0	2	1	0	0	1	0	1	0
Vitis vinifera, with skin	0	0	0	0	0	0	0	0	0	0
Ficus carica	0	0	0	0	0	1	0	2	0	0
Capparis spinosa	0	0	0	0	0	0	0	0	0	0
cf. *Capparis spinosa*	0	0	0	0	0	0	0	0	0	0
Capparis spinosa, bud	0	0	0	0	0	0	0	0	0	0
WEED/WILD TAXA										
Chenopodium sp.	0	0	1	0	0	0	0	0	0	0
Ornithogalum type 1	0	0	0	0	0	0	27	0	0	0
Heliotropium sp.	0	0	1	16	0	0	0	0	0	0

Sample code	**TA2012.11**	**TA2012.14**	**TA2012.15**	**TA2012.17**	**TA2012.18**	**TA2012.22**	**TA2012.25**	**TA2012.26**	**TA2012.32**	**TA2012.35**
Echium angustifolium/parviflorum	0	0	0	0	0	6	0	0	0	0
Cephalaria sp.	0	0	0	0	0	0	0	0	0	0
Valerianella coronata type (type 1)	0	0	0	0	0	0	0	0	0	0
Valerianella dentata (Type 2)	0	0	0	0	0	0	0	0	0	0
Silene sp.	0	0	0	0	0	0	4	0	0	0
Vaccaria pyramidata	0	0	0	0	0	0	0	0	0	0
Anthemis cotula (type 4)	0	0	0	0	0	0	0	0	0	0
Centaurea sp.	0	0	0	0	0	0	0	0	0	0
Compositae type 5	0	0	1	0	0	0	0	0	0	0
CRUCIFERAE indet.	5	0	0	0	0	0	0	0	0	0
CYPERACEAE	0	0	1	0	0	0	0	0	0	0
Bolboschoenus glaucus	0	0	0	0	0	0	0	1	0	0
Bolboschoenus glaucus, tuber	0	0	0	0	0	0	0	0	0	0
CYPERACEAE/POLYGONACEAE indet.	0	0	1	0	0	0	0	0	0	0
Astragalus/trigonella sp.	10	0	0	0	0	0	0	0	0	0
Coronilla sp.	0	0	5	3	0	1	8	1	0	0
Hippocrepis unisiliquosa/ciliata/multisiliqusa	0	0	0	0	0	0	0	0	0	0
Medicago sp.	0	0	0	0	0	0	0	0	0	0
Medicago cf. *sheradii* (Type 1, with pod)	0	0	0	0	0	0	0	0	0	0
Hymenocarpus circinnatus, with pods	0	0	0	0	0	0	0	0	0	0
Trifolium/melilotus	32	8	32	2	2	19	7	14	1	4
Pisum humile	0	0	0	0	0	0	0	0	0	0
Prosopis farcta	0	0	0	0	0	0	2	0	0	0
Prosopis farcta, fragments	2	0	4	0	0	1	0	0	0	0
Scorpiurus muricatus	3	0	1	3	0	2	3	0	1	0
Aegilops sp.	0	0	0	0	0	0	0	0	0	0
Aegilops, glume bases	0	0	0	0	0	0	0	0	0	0
Bromus sp.	0	0	1	0	0	0	0	0	0	0
Bromus type 1	0	0	0	0	0	0	0	0	0	0
Bromus type 1.5	0	0	0	0	0	0	0	0	0	0
Bromus type 2	0	0	0	0	0	0	0	0	0	0
Grass weeds indet.	6	3	7	0	2	0	9	4	1	3

Sample code	**TA2012.11**	**TA2012.14**	**TA2012.15**	**TA2012.17**	**TA2012.18**	**TA2012.22**	**TA2012.25**	**TA2012.26**	**TA2012.32**	**TA2012.35**
Hordeum spontaneum	0	0	0	0	0	0	0	0	0	0
Hordeum murinum type	2	0	4	0	0	0	0	0	0	1
Lolium temulentum (type 1)	26	3	30	14	1	10	10	0	4	11
Lolium type 2	0	0	0	0	0	0	0	0	0	0
Lolium sp.	4	2	5	0	1	2	15	6	2	0
Phalaris aquatica	17	10	62	11	3	53	21	5	0	11
Triticum boeoticum	0	0	0	0	0	0	0	0	0	0
Ajuga/Teucrium sp.	0	0	0	0	0	0	0	0	0	0
Malva sylvestris/neglecta	0	0	1	0	0	0	0	0	0	0
Plantago sp.	2	2	3	2	0	22	5	1	0	4
Rumex sp.	9	1	2	0	0	0	1	0	0	0
Androsace maxima	0	0	0	0	0	0	0	0	0	0
Anagallis arvensis (type 3)	4	0	1	0	0	1	0	0	0	1
Adonis sp.	0	0	0	0	0	0	0	0	0	0
Ranunculus arvensis	3	0	0	0	0	0	0	0	0	0
Rosaceae whole fruit indet.	0	0	0	0	0	0	0	0	0	0
Galium spp.	3	0	2	1	0	3	0	1	1	1
Galium spurium (type 1)	1	0	3	1	0	2	0	0	0	0
Galium spurium (type 2)	0	1	0	0	0	0	0	2	0	0
Sherardia arvensis	0	1	0	0	0	0	0	0	0	0
Thymelaea passerine/gussonei/mesopotamia	0	0	5	0	0	4	3	0	0	0
UMBERLLIFERAE indet.	0	0	0	0	0	0	1	0	0	0
Bupleurum intermedium (= B. subovatum) (type 1)	5	0	1	0	0	0	0	0	0	2
Bupleurum intermedium (= B. subovatum) (type 2)	0	0	0	0	0	0	0	0	0	0
type 0	0	0	0	0	0	0	0	0	0	0
type 1	0	0	0	0	0	0	0	0	0	0
type 2	0	0	0	0	1	0	0	0	0	0
type 99	0	0	0	0	0	0	0	0	0	0
DUNG										
Dung (sheep/goat), fragments (ml)	0	0	0	0	0	0	0	0	0	0
Mouse dung, pellets	5	0	0	0	0	0	0	0	0	0

Table III. Raw data for Tell Brak (1/4).

Sample code	**TB06/5**	**TB06/70**	**TB06/124**	**TB06/132**	**TB06/148**	**TB06/149**	**TB06/150**	**TB07/10**	**TB07/21**	**TB07/52**
Context	Tannur fill	Fill	Fill	Fill	Ashy	Ashy	N/A	Ashy	Hearth	N/A
Area/trench	HHE	HHE	HHF	HHF	HHF	HHF	HHF	HHF	HHF	HHF
Locus	3.3	628	703.5(0)	703.45	703.46	703.34	703.33	706.4	706.9	708.4
Volume (litres)	50	25	68	28	32	145	69	N/A	5	38
Densities (items/litre)	15	24	3	10	5	4	6	N/A	14	4
CEREALS										
Hordeum vulgare - hulled straight grain	25	9	17	7	2	6	6	3	0	0
Hordeum vulgare - hulled cf. straight grain	0	19	0	0	0	8	0	2	0	0
Hordeum vulgare - hulled indet. grain	70	48	26	8	19	59	18	197	9	18
Hordeum vulgare - hulled cf. twisted grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare indet. grain	69	17	21	17	4	62	4	365	7	22
Hordeum vulgare - hulled two-row rachis	18	32	2	3	6	32	6	136	0	3
Hordeum vulgare - hulled cf. two-row rachis	3	0	2	0	0	6	0	0	0	0
Hordeum vulgare - hulled cf. six-row rachis	0	0	0					4	0	0
Hordeum vulgare rachis	25	37	2	24	12	24	38	1052	23	17
Hordeum vulgare lemma bases	0	0	0	0	0	0	0	0	0	0
Triticum durum/aestivum grain	35	2	9	1	0	15	0	17	2	2
Triticum cf. *durum/aestivum* grain	9	3	2	2	1	12	0	0	0	0
Triticum aestivum rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum cf. *aestivum* rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum aestivum/durum rachis internodes	20	4	0	2	2	0	1	24	0	0
Triticum durum rachis internodes	1	4	0	0	0	0	0	20	0	0
Triticum cf. *durum* rachis internodes	0	3	0	0	0	0	0	0	0	0
Triticum dicoccum/(aestivum/durum) grain	0	0	0	0	0	0	0	0	0	0
Triticum indet. grain	3	2	0	0	0	5	0	7	0	0
Cereal indet. grain	151	19	14	19	6	35	50	215	2	7

Sample code	**TB06/5**	**TB06/70**	**TB06/124**	**TB06/132**	**TB06/148**	**TB06/149**	**TB06/150**	**TB07/10**	**TB07/21**	**TB07/52**
Triticum monococcum grain (1-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum grain (2-grained spikelet)	1	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	2	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	1	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum/new type grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum spikelet forks	2	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* spikelet forks	0	0	0	0	0	0	8	0	0	0
Triticum monococcum/dicoccum (glume bases)	0	0	0	0	1	4	0	0	0	0
Triticum cf. *monococcum/dicoccum* (glume bases)	0	2	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum glume bases	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* glume bases	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks terminal	0	0	0	0	0	0	0	0	0	0
Cereal chaff indet.	0	2	0	0	0	3	0	0	0	0
Cereal indet. culm node (<2mm)	47	44	9	20	3	49	14	177	6	7
Cereal indet. culm root/base	32	10	0	0	0	8	0	56	0	6
PULSES										
Cicer arietinum	0	0	1	0	0	0	0	0	0	0
cf. *Lens culinaris*	0	3	0	0	0	0	0	0	0	0
Lens culinaris	0	0	5	0	0	2	0	6	0	2
Vicia ervilia	1	0	0	0	0	2	0	0	0	0
Lathryus sativus	0	0	0	0	1	0	0	0	0	0
Pisum sativum	0	0	0	0	0	0	2	0	0	0

Sample code	**TB06/5**	**TB06/70**	**TB06/124**	**TB06/132**	**TB06/148**	**TB06/149**	**TB06/150**	**TB07/10**	**TB07/21**	**TB07/52**
cf. *Pisum sativum*	1	0	0	0	0	2	0	0	0	0
Pulse indet.	4	1	0	6	1	11	29	6	1	1
CROP, OTHERS										
cf. *Linum* sp.	0	0	0	0	0	0	0	0	0	0
Carthamus tintorius	0	0	0	0	0	0	0	0	0	0
FRUITS/COLLECTED										
Ficus carica	0	0	0	0	1	0	0	8	0	0
Vitis vinifera	0	0	0	0	0	0	0	0	0	0
Capparis spinosa	1	0	0	0	0	0	0	0	0	0
cf. *Capparis spinosa*	4	0	0	0	0	0	0	0	0	0
Big fruit indet.	0	0	0	0	0	0	0	1	0	0
WEED/WILD TAXA										
CHENOPODIACEAE indet.	0	0	0	0	0	0	0	0	0	0
Bellevalia sp.	0	0	0	1	0	0	0	0	0	0
*Ornithogalum*sp.	1	1	0	0	0	0	2	0	0	0
Heliotropium sp.	0	0	0	0	0	0	0	0	0	0
Echium/Lithospermum sp.	7	72	0	5	7	14	36	133	0	6
*Valerianella coronata t*ype	0	1	0	0	0	0	0	0	0	0
Gypsophila type 1	1	0	0	0	0	0	0	0	0	0
Gypsophila type 2	0	0	0	0	0	0	0	0	0	0
Silene sp.	2	0	0	2	0	0	2	0	0	0
*Silene dichtoma t*ype	0	0	0	0	0	4	0	16	0	0
Vaccaria hispanica	1	0	0	0	0	0	0	0	0	0
Centaurea sp.	0	0	0	0	0	0	0	0	0	0
Brassica sp.	0	0	0	0	0	0	0	0	0	0
Lepidium sp.	0	14	4	4	1	8	0	173	0	0
Lepidium draba (= Cardaria draba)	0	0	0	0	0	0	0	16	0	0
CYPERACEAE indet.	0	1	4	0	1	0	0	0	0	0
Cyperus laevigatus/rotundus	0	0	0	0	0	4	0	0	0	0

Sample code	**TB06/5**	**TB06/70**	**TB06/124**	**TB06/132**	**TB06/148**	**TB06/149**	**TB06/150**	**TB07/10**	**TB07/21**	**TB07/52**
Bolboschoenus glaucus	0	0	0	0	0	0	0	0	0	0
Bolboschoenus glaucus, tuber	0	0	0	0	0	0	0	0	0	0
Coronilla scorpioides	53	7	2	1	3	8	0	0	0	1
Large legumes indet.	0	1	0	0	0	0	0	0	0	0
LEGUMINOSAE, small seeded	18	91	16	38	43	46	26	176	8	7
Medicago sp.	0	0	0	0	0	0	0	0	0	0
Onobrychis sp.	0	0	0	0	0	0	0	0	0	0
Prosopis farcta	2	0	0	0	0	1	0	0	0	1
Prosopis farcta (fragments)	0	6	1	0	0	2	0	0	0	0
Scorpiurus muricatus	0	0	0	0	0	0	0	0	0	0
Erodium sp.	0	0	0	0	0	0	0	0	0	0
Aegilops tauschii (grains)	0	0	0	0	0	0	0	0	0	0
Aegilops sp. (grains)	5	6	0	0	3	11	7	6	0	4
Aegilops tauschii (glume bases)	2	3	0	0	0	4	7	1	1	1
Aegilops tauschii/speltoides (glume bases)	0	0	0	0	0	0	0	0	0	0
Aegilops sp. (glume bases)	1	6	0	0	1	4	3	8	0	7
Avena sp., cult/wseed	0	3	0	0	0	0	0	0	0	0
cf. *Avena* sp., cult/wseed	0	0	0	0	0	0	0	0	0	0
Bromus sp.	0	0	0	0	0	0	2	0	0	0
Bromus type 1 (blunt)	0	0	0	0	0	0	0	4	0	0
Bromus tectorum type	0	3	0	0	0	0	0	16	0	0
Eremopyrum bonaepartis/distans	8	36	6	6	2	6	7	40	0	7
Grass weeds indet.	23	24	12	5	5	18	8	17	0	4
Hordeum spontaneum	0	4	0	2	0	8	0	4	0	1
Hordeum cf. *spontaneum*	1	0	0	0	0	0	0	0	0	0
Hordeum murinum type	19	17	6	2	3	4	6	1	1	5
Lolium rigidum	17	2	0	1	3	16	0	0	2	2
cf. *Lolium* sp.	0	0	0	0	0	0	0	0	0	0
Taeniatherum caput-medusae	0	5	2	0	5	2	2	24	0	0
Triticum boeoticum	0	0	0	0	0	0	0	0	0	0
Teucrium/Ajuga sp.	0	1	0	0	1	0	0	36	0	0
Ziziphora type 1	0	0	0	0	0	0	0	80	0	0

Sample code	**TB06/5**	**TB06/70**	**TB06/124**	**TB06/132**	**TB06/148**	**TB06/149**	**TB06/150**	**TB07/10**	**TB07/21**	**TB07/52**
Ziziphora type 2	0	0	0				0	0		
Malva sp.	3	19	4	22	9	58	38	61	5	10
Malva parviflora (with pod)	0	0	0	0	0	0	0	0	0	0
Fumaria parviflora type	0	1	0	0	0	0	2	0	0	0
Glaucium sp.	1	0	0	0	0	0	0	0	0	0
Papaver sp.	0	0	0	74	0	0	0	0	0	0
Rumex sp.	0	0	0	0	0	0	0	0	0	0
Androsace maxima	0	4	0	2	1	0	0	32	1	0
Adonis type 1	0	4	0	0	0	2	2	4	0	0
Adonis sp.	0	0	0	0	0	0	0	0	0	0
Galium sp.	0	1	2	1	0	18	0	2	0	0
Galium spurium	1	0	0	0	0	4	0	0	0	0
Galium cf. *tricornutum*	0	0	0	0	0	0	0	2	0	0
Verbascum sp.	0	0	0	0	0	0	8	0	0	0
Hyoscyamus cf. *muticus*	3	0	0	0	0	2	0	0	0	0
Thymelaea passerina/mesopotamica	0	0	0	0	0	2	0	0	0	0
UMBERLLIFERAE indet.	0	2	0	2	0	2	0	0	0	0
Bupleurum intermedium (= B. subovatum)	0	0	0	0	0	0	0	0	0	0
type 1	0	0	0	0	0	0	85	0	0	0
DUNG										
Dung (sheep/goat), pellets (ml)	0	0	0	0	0	0	0	5	0	0
Dung (sheep/goat), fragments (ml)	0.3	1.0	0.3	0.3	0.0	0.9	0.2	8.3	0.4	0.0
Dung (mouse)	0	0	0	0	0	1	0	4	0	0

Table III. Raw data for Tell Brak (2/4).

Sample code	**TB07/54**	**TB07/60**	**TB07/61**	**TB07/67**	**TB07/68**	**TB07/69**	**TB07/70**	**TB07/76**	**TB07/77**	**TB07/82**
Context	N/A	N/A	Pit	Ashy	Pit	N/A	N/A	N/A	Pit	N/A
Area/trench	HHF	HHF	HHF	HHF	HHF	HHF	HHF	HHF	HHF	HHF
Locus	709.5	709.12	709.4	708.11b	705.2	714.2	712.1	714.2	708.8	712.4
Volume (litres)	20	25	25	18	20	5	7	14	36	52
Densities (items/litre)	12	24	8	6	7	334	25	44	23	37
CEREALS										
Hordeum vulgare - hulled straight grain	0	0	0	0	0	14	0	1	1	7
Hordeum vulgare - hulled cf. straight grain	0	0	5	0	0	22	0	5	3	24
Hordeum vulgare - hulled indet. grain	21	32	15	10	12	89	8	83	29	195
Hordeum vulgare - hulled cf. twisted grain	0	0	0	0	0	1	0	0	0	0
Hordeum vulgare indet. grain	17	42	0	10	30	294	4	33	58	171
Hordeum vulgare - hulled two-row rachis	5	51	6	0	0	105	8	27	26	36
Hordeum vulgare - hulled cf. two-row rachis	0	0	6	0	0	141	0	0	0	52
Hordeum vulgare - hulled cf. six-row rachis										
Hordeum vulgare rachis	66	146	43	18	33	491	58	138	90	52
Hordeum vulgare lemma bases	0	0	0	0	0	1	0	0	0	0
Triticum durum/aestivum grain	1	3	3	11	0	10	2	4	10	16
Triticum cf. *durum/aestivum* grain	0	2	0	0	2	1	1	0	0	1
Triticum aestivum rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum cf. *aestivum* rachis internodes	0	0	0	0	0	8	0	0	0	0
Triticum aestivum/durum rachis internodes	0	11	9	1	3	34	0	6	20	0
Triticum durum rachis internodes	0	0	0	1	0	2	0	3	2	0
Triticum cf. *durum* rachis internodes	0	0	0	0	0	4	0	0	0	0
Triticum dicoccum/(aestivum/durum) grain	0	0	0	0	0	0	0	0	0	0
Triticum indet. grain	0	0	0	1	0	5	0	0	4	2
Cereal indet. grain	0	2	1	3	6	39	3	35	54	19

Sample code	**TB07/54**	**TB07/60**	**TB07/61**	**TB07/67**	**TB07/68**	**TB07/69**	**TB07/70**	**TB07/76**	**TB07/77**	**TB07/82**
Triticum monococcum grain (1-grained spikelet)	1	0	0	0	0	0	0	0	0	1
Triticum monococcum grain (2-grained spikelet)	0	0	0	0	0	1	0	0	0	1
Triticum cf. *monococcum* grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	4
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	0	0	0	0	1	0	0	0	2
Triticum dicoccum grain (1- or 2-grained spikelet)	1	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	0	0	0	0	1	0	0	0	1
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	0	1	0	0	2	0	0	0	0
Triticum dicoccum/new type grain (2-grained spikelet)	0	0	0	0	0	0	0	0	2	0
Triticum monococcum spikelet forks	0	2	0	0	0	0	0	0	0	8
Triticum cf. *monococcum* spikelet forks	0	0	0	0	0	2	0	0	0	0
Triticum monococcum/dicoccum (glume bases)	0	16	10	0	2	16	13	33	0	16
Triticum cf. *monococcum/dicoccum* (glume bases)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	2	10	2	0	0	2	0	2	0	0
Triticum dicoccum glume bases	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* glume bases	0	0	0	0	0	0	0	1	0	0
Triticum dicoccum spikelet forks	0	2	0	0	0	2	0	0	0	0
Triticum cf. *dicoccum* spikelet forks	0	0	0	0	0	0	0	2	0	0
Triticum dicoccum spikelet forks terminal	0	0	0	0	0	0	0	2	0	8
Cereal chaff indet.	0	0	0	0	0	0	0	0	0	0
Cereal indet. culm node (<2mm)	13	37	16	18	3	97	5	33	66	54
Cereal indet. culm root/base	4	6	13	2	0	60	3	7	62	23
PULSES										
Cicer arietinum	0	0	0	0	0	0	0	0	0	0
cf. *Lens culinaris*	0	0	0	1	0	0	0	0	0	0
Lens culinaris	0	0	1	0	0	5	0	4	0	0
Vicia ervilia	3	1	0	2	1	1	0	1	1	0
Lathryus sativus	0	0	0	0	0	2	0	0	0	0
Pisum sativum	1	0	0	0	0	2	1	0	0	0

Sample code	**TB07/54**	**TB07/60**	**TB07/61**	**TB07/67**	**TB07/68**	**TB07/69**	**TB07/70**	**TB07/76**	**TB07/77**	**TB07/82**
cf. *Pisum sativum*	0	1	2	0	0	2	0	0	1	0
Pulse indet.	3	7	3	4	4	3	0	2	2	6
CROP, OTHERS										
cf. *Linum* sp.	0	0	0	0	0	0	0	0	0	0
Carthamus tintorius	0	0	0	0	0	0	0	0	0	0
FRUITS/COLLECTED										
Ficus carica	0	0	0	0	0	0	0	0	0	4
Vitis vinifera	0	0	0	1	0	0	0	0	0	0
Capparis spinosa	0	0	0	0	0	0	0	0	0	0
cf. *Capparis spinosa*	0	0	0	0	0	0	0	0	0	0
Big fruit indet.	0	0	0	0	0	0	0	0	0	1
WEED/WILD TAXA										
CHENOPODIACEAE indet.	0	0	0	0	0	0	0	0	0	0
Bellevalia sp.	0	0	0	0	0	0	0	1	0	0
*Ornithogalum*sp.	0	0	0	0	0	0	0	0	0	0
Heliotropium sp.	0	0	0	0	0	0	0	0	0	0
Echium/Lithospermum sp.	0	4	0	0	2	0	0	2	1	16
*Valerianella coronata t*ype	0	0	0	1	0	0	0	2	2	0
Gypsophila type 1	0	0	0	0	0	0	0	0	0	0
Gypsophila type 2	0	2	0	0	0	0	0	0	0	0
Silene sp.	0	0	1	0	0	0	0	0	0	16
*Silene dichtoma t*ype	0	1	0	0	0	2	0	0	0	16
Vaccaria hispanica	0	0	0	0	0	0	0	0	0	0
Centaurea sp.	0	0	0	0	0	0	0	0	0	0
Brassica sp.	0	0	0	0	0	0	0	0	0	0
Lepidium sp.	0	9	1	4	0	9	0	12	10	24
Lepidium draba (= Cardaria draba)	0	4	0	0	2	4	0	1	2	8
CYPERACEAE indet.	0	0	0	0	0	0	0	0	0	0
Cyperus laevigatus/rotundus	0	0	0	0	4	11	4	2	0	8

Sample code	TB07/54	TB07/60	TB07/61	TB07/67	TB07/68	TB07/69	TB07/70	TB07/76	TB07/77	TB07/82
Bolboschoenus glaucus	4	4	0	1	0	1	0	26	0	0
Bolboschoenus glaucus, tuber	0	0	0	0	0	0	0	0	1	0
Coronilla scorpioides	16	10	5	0	2	17	2	8	2	44
Large legumes indet.	0	0	0	0	0	0	0	0	0	0
LEGUMINOSAE, small seeded	22	143	23	0	8	32	25	37	18	68
Medicago sp.	3	1	0	0	0	0	0	0	0	4
Onobrychis sp.	0	0	0	0	0	0	0	0	0	0
Prosopis farcta	0	3	0	0	0	0	0	0	1	59
Prosopis farcta (fragments)	5	3	0	0	0	0	0	0	1	0
Scorpiurus muricatus	0	0	0	0	0	0	0	0	0	0
Erodium sp.	0	0	0	0	0	0	0	0	0	0
Aegilops tauschii (grains)	0	0	0	0	0	0	0	0	0	0
Aegilops sp. (grains)	1	4	3	3	2	8	4	1	39	387
Aegilops tauschii (glume bases)	0	0	1	1	1	3	1	5	16	20
Aegilops tauschii/speltoides (glume bases)	0	0	0	0	0	0	0	0	0	1
Aegilops sp. (glume bases)	4	0	1	3	0	8	3	7	212	132
Avena sp., cult/wseed	0	0	0	0	0	9	0	0	0	0
cf. *Avena* sp., cult/wseed	0	0	0	0	0	0	0	0	0	0
Bromus sp.	0	2	0	0	1	0	0	0	0	0
Bromus type 1 (blunt)	1	3	1	0	0	1	0	1	0	0
Bromus tectorum type	9	4	4	0	0	8	0	11	4	72
Eremopyrum bonaepartis/distans	1	3	7	0	0	5	10	10	24	32
Grass weeds indet.	9	5	2	1	0	40	2	5	22	65
Hordeum spontaneum	0	0	0	0	0	1	0	0	0	2
Hordeum cf. *spontaneum*	0	0	0	0	0	0	0	0	0	10
Hordeum murinum type	8	9	7	1	3	12	1	11	6	120
Lolium rigidum	6	5	4	0	0	9	13	15	0	24
cf. *Lolium* sp.	0	0	0	1	0	0	0	0	0	0
Taeniatherum caput-medusae	0	2	0	1	0	3	0	6	0	28
Triticum boeoticum	0	0	0	0	0	1	0	0	0	0
Teucrium/Ajuga sp.	0	0	0	0	0	0	0	1	2	0
Ziziphora type 1	0	0	1	0	0	0	0	8	0	0

Sample code	**TB07/54**	**TB07/60**	**TB07/61**	**TB07/67**	**TB07/68**	**TB07/69**	**TB07/70**	**TB07/76**	**TB07/77**	**TB07/82**
Ziziphora type 2						1				
Malva sp.	2	6	0	1	13	2	1	0	10	0
Malva parviflora (with pod)	0	0	0	0	0	0	0	0	4	0
Fumaria parviflora type	1	0	0	0	0	3	0	0	2	4
Glaucium sp.	0	0	0	0	0	0	0	0	0	0
Papaver sp.	0	0	0	0	0	0	0	0	0	0
Rumex sp.	4	2	0	0	0	0	0	1	0	0
Androsace maxima	0	2	0	0	0	0	0	0	4	0
Adonis type 1	0	0	0	0	1	0	0	0	0	0
Adonis sp.	0	0	0	0	0	0	0	0	0	8
Galium sp.	0	0	0	0	4	4	0	0	0	2
Galium spurium	0	0	0	0	0	8	0	2	0	7
Galium cf. *tricornutum*	0	0	0	0	0	0	0	0	0	0
Verbascum sp.	0	0	0	0	0	0	0	0	0	0
Hyoscyamus cf. *muticus*	0	0	0	0	0	0	4	0	0	0
Thymelaea passerina/mesopotamica	0	0	0	0	0	0	0	0	0	0
UMBERLLIFERAE indet.	0	2	1	0	0	0	0	12	0	0
Bupleurum intermedium (= B. subovatum)	0	0	0	0	0	0	0	0	0	0
type 1	0	0	0	0	0	0	0	0	0	0
DUNG										
Dung (sheep/goat), pellets (ml)	0	0	0	0	0	0	0	0	0	2
Dung (sheep/goat), fragments (ml)	2.1	0.1	0.1	0.0	0.1	1.0	0.3	0.1	2.5	6.6
Dung (mouse)	0	0	0	0	0	1	0	0	0	0

Table III. Raw data for Tell Brak (3/4).

Sample code	**TB07/84**	**TB07/89**	**TB07/92**	**TB11/13.5**	**TB11/14.3**	**TB11/16.2**	**TB11/26.16**	**TB11/26.17**	**TB11/26.18**	**TB11/26.19**
Context	N/A	N/A	Pit	Ashy	Surface near Tannur	Tannur	Bin	Tannur	Tannur	Floor
Area/trench	HHF	HHF	HHF	HHF	HHF	HHF	HHF	HHF	HHF	HHF
Locus	708.10B	712.6	715.8	754.4	758.1	758.2	763.5	763.3	763.8	763.2
Volume (litres)	40	18	65	25	3	21	33.5	39	54.5	15
Densities (items/litre)	6	33	23	11	43	11	2	20	12	6
CEREALS										
Hordeum vulgare - hulled straight grain	0	14	1	1	0	0	3	7	2	0
Hordeum vulgare - hulled cf. straight grain	0	0	0	4	0	2	0	3	6	0
Hordeum vulgare - hulled indet. grain	8	39	45	13	34	13	14	54	42	3
Hordeum vulgare - hulled cf. twisted grain	0	0	0	0	0	0	0	0	0	0
Hordeum vulgare indet. grain	0	34	42	2	5	11	0	0	11	2
Hordeum vulgare - hulled two-row rachis	16	38	32	0	0	1	6	101	55	14
Hordeum vulgare - hulled cf. two-row rachis	0	0	16	3	8	0	4	20	27	2
Hordeum vulgare - hulled cf. six-row rachis										
Hordeum vulgare rachis	50	140	61	12	4	13	7	170	57	25
Hordeum vulgare lemma bases	0	0	0	0	0	0	0	0	0	0
Triticum durum/aestivum grain	5	4	5	1	0	5	0	4	2	1
Triticum cf. *durum/aestivum* grain	0	0	4	2	0	1	1	0	5	0
Triticum aestivum rachis internodes	0	0	4	0	0	0	0	2	0	0
Triticum cf. *aestivum* rachis internodes	0	0	0	0	0	0	0	0	0	0
Triticum aestivum/durum rachis internodes	11	0	16	0	0	1	0	13	0	2
Triticum durum rachis internodes	0	0	0	0	0	0	0	2	3	0
Triticum cf. *durum* rachis internodes	0	0	0	0	0	0	0	2	6	1
Triticum dicoccum/(aestivum/durum) grain	0	0	0	1	0	0	0	0	0	0
Triticum indet. grain	1	0	1	4	0	13	1	0	0	0
Cereal indet. grain	10	0	11	2	17	18	2	11	0	1

Sample code	**TB07/84**	**TB07/89**	**TB07/92**	**TB11/13.5**	**TB11/14.3**	**TB11/16.2**	**TB11/26.16**	**TB11/26.17**	**TB11/26.18**	**TB11/26.19**
Triticum monococcum grain (1-grained spikelet)	1	0	0	0	0	0	0	0	0	0
Triticum monococcum grain (2-grained spikelet)	0	0	4	0	0	0	0	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	0	4	0	0	0	0	0	0	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	2	0	1	0	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain (1- or 2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	0	0	0	0	2	0	0	0	0
Triticum dicoccum/new type grain (2-grained spikelet)	0	0	0	0	0	1	1	0	0	0
Triticum monococcum spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum cf. *monococcum* spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (glume bases)	8	9	0	0	0	3	0	0	0	0
Triticum cf. *monococcum/dicoccum* (glume bases)	0	0	0	0	0	0	0	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	4	2	0	0	0	0	0	2	2	0
Triticum dicoccum glume bases	0	0	0	0	0	1	0	0	0	0
Triticum cf. *dicoccum* glume bases	0	0	0	0	0	2	0	0	0	0
Triticum dicoccum spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum cf. *dicoccum* spikelet forks	0	0	0	0	0	0	0	0	0	0
Triticum dicoccum spikelet forks terminal	0	0	0	0	0	0	0	1	1	0
Cereal chaff indet.	0	0	0	0	0	0	3	4	0	0
Cereal indet. culm node (<2mm)	24	43	160	4	3	14	7	24	10	7
Cereal indet. culm root/base	14	5	66	0	1	2	0	1	5	0
PULSES										
Cicer arietinum	0	0	0	0	0	0	0	0	0	0
cf. *Lens culinaris*	0	0	2	0	0	1	0	1	0	2
Lens culinaris	0	0	3	2	0	0	0	0	0	1
Vicia ervilia	1	0	0	3	0	0	1	2	1	0
Lathryus sativus	0	0	0	0	0	1	0	0	0	0

Sample code	**TB07/84**	**TB07/89**	**TB07/92**	**TB11/13.5**	**TB11/14.3**	**TB11/16.2**	**TB11/26.16**	**TB11/26.17**	**TB11/26.18**	**TB11/26.19**
Pisum sativum	1	0	3							
cf. *Pisum sativum*	1	2	4	0	0	0	0	1	0	0
Pulse indet.	6	1	10	2	0	0	0	11	6	0
CROP, OTHERS										
cf. *Linum* sp.	0	0	0	0	0	0	0	1	0	0
Carthamus tintorius	0	0	0	0	1	13	0	0	0	0
FRUITS/COLLECTED										
Ficus carica	0	0	0	0	0	0	0	13	4	1
Vitis vinifera	0	0	0	1	0	1	0	0	0	0
Capparis spinosa	0	0	0	8	0	3	0	1	0	0
cf. *Capparis spinosa*	0	0	0	0	1	0	0	0	0	0
Big fruit indet.	0	0	0	0	0	0	0	0	0	0
WEED/WILD TAXA										
CHENOPODIACEAE indet.	0	0	0	0	0	1	0	1	0	0
Bellevalia sp.	0	0	0	0	0	0	0	0	0	0
*Ornithogalum*sp.	0	0	4	0	0	0	0	1	0	0
Heliotropium sp.	0	0	0	0	0	0	0	1	0	0
Echium/Lithospermum sp.	0	5	152	0	0	20	0	18	238	0
Valerianella coronata type	0	0	0	0	1	0	0	0	0	0
Gypsophila type 1	1	0	0	0	0	0	0	0	0	0
Gypsophila type 2	0	0	0	0	0	0	0	0	0	0
Silene sp.	0	2	0	1	0	0	1	5	3	1
Silene dichtoma type	0	0	0	0	0	0	0	0	0	0
Vaccaria hispanica	0	0	0	0	2	0	0	4	2	0
Centaurea sp.	1	0	0	0	0	0	0	1	0	0
Brassica sp.	0	0	0	0	0	3	0	0	0	0
Lepidium sp.	5	0	1	1	0	0	0	0	0	0
Lepidium draba (= Cardaria draba)	1	8	0	0	0	0	0	0	0	0
CYPERACEAE indet.	1	0	0	0	0	0	0	0	4	1

Sample code	TB07/84	TB07/89	TB07/92	TB11/13.5	TB11/14.3	TB11/16.2	TB11/26.16	TB11/26.17	TB11/26.18	TB11/26.19
Cyperus laevigatus/rotundus	0	0	12	0	0	0	0	2	0	0
Bolboschoenus glaucus	0	0	0	0	0	0	0	0	0	0
Bolboschoenus glaucus, tuber	0	0	0	0	0	0	0	0	0	0
Coronilla scorpioides	3	0	4	149	14	33	1	2	2	0
Large legumes indet.	0	0	1	0	0	0	0	14	4	0
LEGUMINOSAE, small seeded	15	24	3	22	1	3	3	53	22	6
Medicago sp.	1	4	0	0	0	0	0	0	0	0
Onobrychis sp.	0	0	0	0	0	0	0	0	0	1
Prosopis farcta	0	5	4	1	0	0	0	0	0	0
Prosopis farcta (fragments)	0	0	0	0	0	0	0	0	0	0
Scorpiurus muricatus	0	0	0	0	0	0	0	0	0	1
Erodium sp.	0	0	0	0	0	0	0	3	0	0
Aegilops tauschii (grains)	0	0	0	0	0	0	0	0	2	0
Aegilops sp. (grains)	0	59	100	1	6	0	1	7	3	1
Aegilops tauschii (glume bases)	1	8	15	0	3	0	0	0	1	0
Aegilops tauschii/speltoides (glume bases)	0	0	0	0	0	0	0	0	0	0
Aegilops sp. (glume bases)	3	52	419	1	10	0	4	10	17	2
Avena sp., cult/wseed	0	0	0	0	0	0	0	0	0	0
cf. *Avena* sp., cult/wseed	0	0	0	0	0	0	0	1	0	0
Bromus sp.	0	0	0	0	1	0	1	3	0	0
Bromus type 1 (blunt)	0	0	0	0	0	0	0	0	0	0
Bromus tectorum type	1	14	4	0	0	0	0	6	0	0
Eremopyrum bonaepartis/distans	2	12	25	0	0	2	1	16	0	0
Grass weeds indet.	8	4	116	9	3	6	1	15	7	4
Hordeum spontaneum	0	0	0	0	2	0	0	0	0	0
Hordeum cf. *spontaneum*	0	0	0	0	0	2	0	3	1	0
Hordeum murinum type	2	20	16	0	1	1	2	10	2	0
Lolium rigidum	5	4	0	18	4	4	0	5	4	0
cf. *Lolium* sp.	0	0	0	0	0	1	0	0	0	0
Taeniatherum caput-medusae	5	0	1	0	0	0	0	5	0	0
Triticum boeoticum	0	0	0	0	0	0	0	0	0	0
Teucrium/Ajuga sp.	0	6	0	0	0	0	2	3	3	1

Sample code	**TB07/84**	**TB07/89**	**TB07/92**	**TB11/13.5**	**TB11/14.3**	**TB11/16.2**	**TB11/26.16**	**TB11/26.17**	**TB11/26.18**	**TB11/26.19**
Ziziphora type 1	0	0	0	0	0	0	0	0	0	0
Ziziphora type 2								1		
Malva sp.	3	8	66	0	0	0	3	52	58	3
Malva parviflora (with pod)	0	0	0	0	0	0	0	0	0	0
Fumaria parviflora type	0	0	0	0	0	0	0	4	0	0
Glaucium sp.	0	0	0	0	0	0	0	0	0	0
Papaver sp.	0	0	0	0	0	0	0	0	0	0
Rumex sp.	2	2	0	0	0	0	1	0	1	0
Androsace maxima	0	0	0	0	0	0	0	8	2	0
Adonis type 1	0	4	0	0	0	0	0	1	0	0
Adonis sp.	0	0	4	0	0	0	0	3	0	0
Galium sp.	0	0	4	0	0	0	0	2	1	0
Galium spurium	1	0	5	0	0	0	0	0	0	0
Galium cf. *tricornutum*	0	0	0	0	0	0	0	0	0	0
Verbascum sp.	0	0	0	0	0	0	0	0	0	0
Hyoscyamus cf. *muticus*	0	0	0	0	0	0	0	1	0	0
Thymelaea passerina/mesopotamica	0	0	0	0	0	0	0	6	1	0
UMBERLLIFERAE indet.	0	4	0	0	0	0	0	0	0	0
Bupleurum intermedium (= B. subovatum)	0	0	0	0	0	1	0	0	0	0
type 1	0	0	0	0	0	0	0	0	0	0
DUNG										
Dung (sheep/goat), pellets (ml)	0	0	0	0	0	0	0	0	1	0
Dung (sheep/goat), fragments (ml)	0.1	2.6	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dung (mouse)	0	0	1	0	0	0	0	0	0	0

Table III. Raw data for Tell Brak (4/4).

Sample code	**TB11/26.20**	**TB11/27.22**	**TB11/28.23**
Context	Tannur	Bin	Jar
Area/trench	HHF	HHF	HHF
Locus	763.6&763.7 mixed	763.10	766.1
Volume (litres)	30	20	19
Densities (items/litre)	8	4	4
CEREALS			
Hordeum vulgare - hulled straight grain	0	0	0
Hordeum vulgare - hulled cf. straight grain	0	0	0
Hordeum vulgare - hulled indet. grain	22	9	7
Hordeum vulgare - hulled cf. twisted grain	0	0	0
Hordeum vulgare indet. grain	1	0	3
Hordeum vulgare - hulled two-row rachis	33	10	11
Hordeum vulgare - hulled cf. two-row rachis	4	0	0
Hordeum vulgare - hulled cf. six-row rachis			
Hordeum vulgare rachis	60	17	23
Hordeum vulgare lemma bases	0	0	0
Triticum durum/aestivum grain	3	1	0
Triticum cf. *durum/aestivum* grain	1	3	2
Triticum aestivum rachis internodes	0	0	0
Triticum cf. *aestivum* rachis internodes	0	0	0
Triticum aestivum/durum rachis internodes	2	2	4
Triticum durum rachis internodes	0	0	1
Triticum cf. *durum* rachis internodes	0	0	0
Triticum dicoccum/(aestivum/durum) grain	0	0	0
Triticum indet. grain	0	0	0
Cereal indet. grain	0	0	2

Sample code	**TB11/26.20**	**TB11/27.22**	**TB11/28.23**
Triticum monococcum grain (1-grained spikelet)	0	0	0
Triticum monococcum grain (2-grained spikelet)	0	0	0
Triticum cf. *monococcum* grain (2-grained spikelet)	0	0	0
Triticum monococcum/dicoccum grain (1- or 2-grained spikelet)	0	0	0
Triticum monococcum/dicoccum grain (2-grained spikelet)	0	0	0
Triticum dicoccum grain (1- or 2-grained spikelet)	0	0	0
Triticum dicoccum grain (2-grained spikelet)	0	0	0
Triticum cf. *dicoccum* grain (2-grained spikelet)	0	0	0
Triticum dicoccum/new type grain (2-grained spikelet)	0	0	0
Triticum monococcum spikelet forks	0	0	0
Triticum cf. *monococcum* spikelet forks	0	0	0
Triticum monococcum/dicoccum (glume bases)	0	0	0
Triticum cf. *monococcum/dicoccum* (glume bases)	0	0	0
Triticum monococcum/dicoccum (spikelet forks)	0	0	0
Triticum dicoccum glume bases	0	0	0
Triticum cf. *dicoccum* glume bases	0	0	0
Triticum dicoccum spikelet forks	0	0	0
Triticum cf. *dicoccum* spikelet forks	0	0	0
Triticum dicoccum spikelet forks terminal	0	0	0
Cereal chaff indet.	0	0	0
Cereal indet. culm node (<2mm)	8	5	4
Cereal indet. culm root/base	0	0	0
PULSES			
Cicer arietinum	0	0	0
cf. *Lens culinaris*	0	0	0
Lens culinaris	1	0	0
Vicia ervilia	2	0	3
Lathryus sativus	0	0	0
Pisum sativum	3		

Sample code	**TB11/26.20**	**TB11/27.22**	**TB11/28.23**
cf. *Pisum sativum*	3	0	0
Pulse indet.	5	3	3
CROP, OTHERS			
cf. *Linum* sp.	0	0	0
Carthamus tintorius	0	0	0
FRUITS/COLLECTED			
Ficus carica	0	0	0
Vitis vinifera	0	1	0
Capparis spinosa	0	0	0
cf. *Capparis spinosa*	0	0	0
Big fruit indet.	0	0	0
WEED/WILD TAXA			
CHENOPODIACEAE indet.	0	0	0
Bellevalia sp.	0	0	0
*Ornithogalum*sp.	1	0	0
Heliotropium sp.	0	0	0
Echium/Lithospermum sp.	22	0	0
*Valerianella coronata t*ype	0	0	0
Gypsophila type 1	0	0	0
Gypsophila type 2	0	0	0
Silene sp.	3	0	0
*Silene dichtoma t*ype	0	0	0
Vaccaria hispanica	3	0	0
Centaurea sp.	1	0	0
Brassica sp.	0	0	0
Lepidium sp.	0	0	0
Lepidium draba (= Cardaria draba)	0	0	0
CYPERACEAE indet.	0	1	0
Cyperus laevigatus/rotundus	0	0	0

Sample code	**TB11/26.20**	**TB11/27.22**	**TB11/28.23**
Bolboschoenus glaucus	0	0	0
Bolboschoenus glaucus, tuber	0	0	0
Coronilla scorpioides	1	0	0
Large legumes indet.	0	1	1
LEGUMINOSAE, small seeded	9	3	3
Medicago sp.	1	0	0
Onobrychis sp.	0	0	0
Prosopis farcta	0	0	0
Prosopis farcta (fragments)	0	0	0
Scorpiurus muricatus	0	0	0
Erodium sp.	0	0	0
Aegilops tauschii (grains)	0	0	0
Aegilops sp. (grains)	2	0	0
Aegilops tauschii (glume bases)	1	0	0
Aegilops tauschii/speltoides (glume bases)	0	0	0
Aegilops sp. (glume bases)	1	1	0
Avena sp., cult/wseed	2	0	0
cf. *Avena* sp., cult/wseed	0	0	0
Bromus sp.	0	0	0
Bromus type 1 (blunt)	0	0	0
Bromus tectorum type	0	0	0
Eremopyrum bonaepartis/distans	6	0	1
Grass weeds indet.	1	4	0
Hordeum spontaneum	0	0	0
Hordeum cf. *spontaneum*	0	0	0
Hordeum murinum type	0	0	0
Lolium rigidum	3	1	1
cf. *Lolium* sp.	0	0	0
Taeniatherum caput-medusae	0	0	0
Triticum boeoticum	0	0	0
Teucrium/Ajuga sp.	1	2	0
Ziziphora type 1	0	0	0

Sample code	**TB11/26.20**	**TB11/27.22**	**TB11/28.23**
Ziziphora type 2			
Malva sp.	11	1	5
Malva parviflora (with pod)	0	0	0
Fumaria parviflora type	0	0	0
Glaucium sp.	0	0	0
Papaver sp.	0	0	0
Rumex sp.	0	0	0
Androsace maxima	0	0	0
Adonis type 1	0	0	0
Adonis sp.	0	0	0
Galium sp.	1	0	0
Galium spurium	0	0	0
Galium cf. *tricornutum*	0	0	0
Verbascum sp.	0	0	0
Hyoscyamus cf. *muticus*	0	0	0
Thymelaea passerina/mesopotamica	0	0	0
UMBERLLIFERAE indet.	0	0	0
Bupleurum intermedium (= B. subovatum)	0	0	0
type 1	1	0	0
DUNG			
Dung (sheep/goat), pellets (ml)	0	0	0
Dung (sheep/goat), fragments (ml)	0.0	0.0	0.0
Dung (mouse)	0	0	0

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