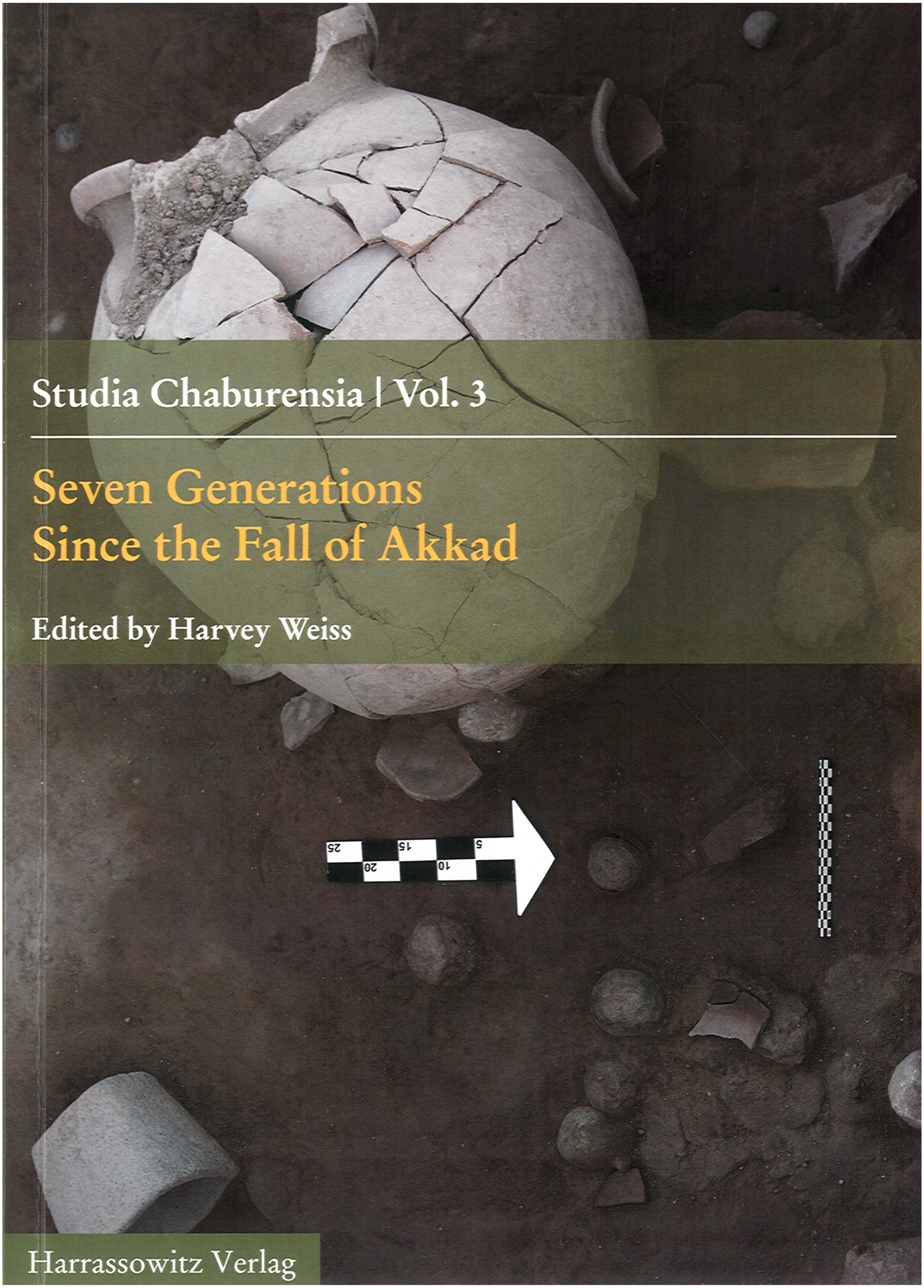

Studia Chaburensia | Vol. 3

Seven Generations Since the Fall of Akkad

Edited by Harvey Weiss

Harrassowitz Verlag

ALEXIA SMITH
Department of Anthropology, University of Connecticut

Akkadian and post-Akkadian Plant Use at Tell Leilan

Abstract
During the 2006 season at Tell Leilan, 245 archaeobotanical samples dating to the Akkadian and post-Akkadian occupation phases were collected from the large Administrative Building complex on the Acropolis Northwest. Employing data generated from these samples, this paper provides preliminary information on Akkadian cultivation and plant use at Leilan and documents the significant shift in plant remains evident during the brief post-Akkadian reoccupation of part of the Administrative Building. Akkadian cultivation focused on 2-row barley and free-threshing wheats. Large concentrations of *Aegilops* spp. were also recovered, together with smaller proportions of crop legumes, grape, and safflower. Numerous tannurs illustrate the intensive use of dung fuel and the production of bread decorated and flavored with poppy seed. A grain storage facility and room used for measuring grain highlight the importance of plant resources within the complex. The granary was used to store partially cleaned grain, some of which may have been intended as fodder. The post-Akkadian samples originate predominantly from dung and document the importance of pasture and possibly intentional foddering for livestock management.

Introduction

Over the past few decades, a large and diverse body of palaeoclimatic data has underscored the severity of an abrupt climatic shift that led to much cooler and drier conditions across Southwest Asia and beyond at the end of the third millennium B.C. (e.g., Cullen et al. 2000; Dalfes et al. 1997; Luterbacher et al. 2006; Staubwasser and Weiss 2006; Weiss, in press; Weiss 1997). Scholars have debated the impact that this shift had on the stability of the Akkadian Empire, and Tell Leilan has focused prominently within these debates (e.g., de Menocal 2001; Ristvet and Weiss 2005; Ristvet and Weiss 2000; Weiss 2000; Weiss and Bradley 2001; Weiss et al. 1993; Weiss et al. 2002). At present, it is unclear from archaeobotanical and zooarchaeological data exactly how this abrupt climatic shift differentially affected food production across the region. While cultural choices and an ability to modify the micro-environment remain important factors in determining cropping decisions, water availability was a major determinant affecting farmers' choices across Syria between the fourth and first millennia B.C., as it continues to be today (Kaniewski, van Campo, Weiss 2012; Ristvet and Weiss 2005; Smith and Munro 2009; Weiss, in press). Following the 4.2k BP climatic shift farmers would undoubtedly have been affected, with those in drier regions being impacted more harshly.

The Syrian Ministry of Agriculture currently defines five agro-ecological zones that are based primarily on rainfall patterns, underscoring the importance of available moisture to food production decision making in the region (Saliba 1997). In areas receiving more than

600 mm per annum, rain-fed crops are planted annually with success. As the amount of precipitation declines, cropping intensity decreases to one or two cropping seasons every three years, and emphasis shifts from wheat and summer crop production to barley or permanent grazing. In the drier regions, only grazing is possible. The environmental constraints that form these zones existed in the past also, although the boundaries between each zone would likely have differed from modern-day boundaries and, indeed, would have shifted through time in response to climate change (Kaniewski et al. 2012). Owing to the steep precipitation gradients that exist within Syria, occupants of site located within an area able to sustain annual wheat production could find themselves within a zone better suited to pasture and less secure cropping following a shift to increased aridity such as the one evident at the end of the third millennium.

In this paper, I consider how plant use differed at Tell Leilan between the Akkadian period (phase IIb) and the brief post-Akkadian reoccupation of the site (phase IIc), the latter of which corresponds with the cooler and more arid conditions. Before these differences are considered, plant use across the large Administrative Building on the Acropolis Northwest is discussed in order to provide a benchmark for comparison. More than 1000 m^2 of the complex were exposed in 2006 (Weiss et al., this volume: 163) providing a rare opportunity to examine spatial patterns of Akkadian plant use across the complex in detail. This study builds on earlier archaeobotanical analyses of Ninevite 5 and mid–late third millennium remains from Tell Leilan conducted by Wilma Wetterstrom and Dominique de Moulins respectively (de Moulins 2003; Weiss et al. 2002; Wetterstrom 2003), and also complements archaeobotanical work conducted at nearby Tell Brak and Tell Mozan (Charles and Bogaard 2001; Charles and Hald 2003; Charles et al. 2010; Colledge 2001; Colledge 2003; Emberling et al. 2001; Hald 2008; McMahon et al. 2007; Riehl 2000; Riehl 2010; Weiss et al. 2002).

Methods

During the 2006 season, 245 flotation samples were collected from across the Administrative Building complex. In total, 3227.25 liters of sediment were floated, yielding 6453.6 ml of charred plant remains. To date, this represents the largest body of Akkadian material recovered from a single building complex. A systematic sampling strategy was adopted, targeting all areas and most loci. Owing to the large scale of the excavation, it was not possible to sample every single locus. Multiple context types were sampled, including floors, kitchens, tannurs, streets, drains, roof collapse, debris dumps, pit fill, foundation trenches, vessel contents, and burials. The volume of each sample was measured to the nearest quarter of a liter prior to flotation. All of the sediment samples were floated by Fawas Musa using a modified Siraf-type flotation tank in the courtyard of the dig-house (Nesbitt 1995). The charred botanical remains (light fractions) were collected in 250-micron mesh and dried in the shade in order to minimize damage. All heavy fractions were carefully sorted in the field and the few plant remains that were recovered were added to the appropriate sample's light fraction. The light fractions were then transported to the Archaeobotany Laboratory at the University of Connecticut for analysis. All hand collected wood samples were sent to the University of Tübingen, where they have been examined by Katleen Deckers (Deckers and Pessin 2011).

Prior to sorting, the volume of all samples was measured in milliliters. Samples were then sieved using 4-, 2-, and 1-mm sieves and each fraction was weighed. Sieving in this manner eases the sorting process and provides a means for assessing differential preservation or fragmentation of charred remains between samples. All remains greater than 1 mm were separated in full and the remains identified using the reference collection in the Archaeobotany Laboratory which is rich in Near Eastern material. A range of flora, seed identification manuals, and archaeobotanical publications were used to assist with identifications and provide ecological and ethnobotanical information (e.g., Davis 1965-1985; Nesbitt 2006; van Zeist and Bakker-Heeres 1984 (1986); van Zeist and Bakker-Heeres 1985 (1986)). All remains smaller than 1 mm were fully scanned and any identifiable plant part was removed for identification.

Intact plant parts, such as whole seeds, achenes, and nutlets were counted as one, as were individual culm, and rachis fragments. Leguminous seeds that had both cotyledons intact were counted as one, even if a small part of a cotyledon was missing. Individual cotyledons were counted and the total count halved and rounded up to the next integer. Sizeable caryopsis fragments were organized into apical and embryo ends. The number of each was counted and the largest of the two numbers used as the seed count. Many small cereal fragments were recovered. Given the difficulty in quantifying these, the fragments were counted and divided by four to obtain a seed count. Awns were also present in some of the samples. They were too numerous and fragile to quantify with any degree of accuracy, so relative assessments of their abundance were made following the scheme frequently adopted by van Zeist (e.g., van Zeist 1993: 506, where certain remains are listed as present, common, or many).

Differences between the Akkadian and post-Akkadian samples were explored using correspondence analysis (CA) and partial canonical correspondence analysis (pCCA). Both the full dataset and crop only data were explored. Correspondence analysis has often been used successfully within archaeobotany (e.g., Charles and Bogaard 2001; Colledge et al. 2004; Jones et al. 2010; Riehl 2010; Smith and Munro 2009), since it is well suited to both presence/absence and abundance data where the number of species is high and many zero values exist within the dataset (ter Braak 1996: 1). Partial canonical correspondence analysis is less commonly used, but provides a powerful tool for assessing the existence and nature of temporal or spatial differences between groups of samples. The composition of an archaeobotanical sample can be affected by numerous variables including preservation conditions, the type of deposit, and the age of a sample. As with any ecological study, it is impossible to account for *all* of the variables, but it is possible to account for some. In this study, context type and sample age were considered to be important explanatory variables. Using pCCA, the variance within the dataset caused by context types was partialled out, allowing temporal differences between the Akkadian and post-Akkadian samples to be assessed more simply (ter Braak 1988). Unlike CA, pCCA allows for the statistical significance of null hypotheses to be tested via Monte Carlo permutation testing. Such testing provides a further tool for researchers to substantiate conclusions drawn from the data (Lepš and Šmilauer 2003:64-70; ter Braak and Šmilauer 2002).

Multivariate analyses were conducted using Canoco version 4.53 and attribute plots of the results were drawn using CanoDraw version 4.12. Since rare taxa and samples with small seed counts can often obscure real trends within a dataset, the data were cleaned by deleting tentative identifications, samples containing less than 45 specimens, and taxa occurring in less than 3 samples. Both abundance and presence-absence data were explored in order to assess whether patterning within the data was consistent between analyses. Raw counts of seeds and plant parts were transformed logarithmically to offset the skew commonly encountered in plant data (transformed count = ln [1.0 × raw count + 1.0]). The statistical significance of each pCCA test was assessed using a Monte Carlo permutation test, employing 999 permutations under the reduced model with blocks being defined by sample context designation.

Preliminary observations of Akkadian plant use across the Akkadian Administrative Building

In general, the charred plant remains retrieved in 2006 were well preserved with very few mineralized specimens. Of the 245 samples collected in 2006, the density of charred plant remains per liter of sediment varied from 0.08 to 57.44 ml/L, with a mean and mode of 5.88 ml/L and 3.50 ml/L respectively. A wide variety of context types were sampled: here attention is focused on the high concentration of tannurs exposed in the eastern portion of the complex, a dumping area, open spaces, a storage facility, food preparation area, and Room 12 located in close proximity to the tannurs (a plan of the excavated area is provided in Weiss et al., this volume: 163).

Tannurs

A dense series of tannurs was exposed on the eastern portion of the excavated area (listed as T1-T12, Weiss et al., this volume: 163). Such a dense concentration of tannurs is unusual, and points to intensive food preparation. Some of the tannurs displayed long-term use and reconstruction, and all were filled with sediment at the time of excavation. Three samples were collected from each tannur: one roughly from the top, one from the middle, and one from the bottom. Samples were also taken from the floors surrounding the tannurs to allow for spatial patterns to be examined. In tannurs 1-5, the heat within the oven had been so intense that most of the plant material was fully combusted, leaving dense concentrations of very fine ash and fairly dense concentrations of silicified plant material that resembled cereal culm (stem) fragments and awns. Preservation of macro-botanical remains in Tannurs 6, 10, 11, and 12 in Rooms 11 and 13, was much better suggesting that the heat was less extreme. Samples from the tannurs in these rooms yielded small amounts of lentils (*Lens culinaris*), the occasional pea, and large concentrations of two-row barley (*Hordeum vulgare* subsp. *distichum*) and free-threshing wheat (*Triticum durum/aestivum*) mixed with *Aegilops* spp. (goat grass). Examination of the *Aegilops* spikelet bases indicates the presence of *Aegilops speltoides, Aegilops tauschii,* and *Aegilops crassa.* Identification of the free-threshing wheat to the species level was made possible by the presence of rachis fragments (Zohary and Hopf 2000: 34) which demonstrate the presence of both *Triticum aestivum* (bread wheat) and *Triticum durum* (durum wheat), the latter of which is better able to tolerate dry conditions relative to bread wheat (Riehl 2009): rachis fragments of durum wheat are more numerous.

While remnants of the food or bread cooked in the tannurs are scarce (or are not readily identifiable), a number of samples are noteworthy, particularly those from Tannur 5. The plant assemblage from the middle of the tannur contained limited quantities of grain and weed seeds, suggesting that this sample represents post-depositional fill rather than the contents of the oven. These remains contrast sharply with the material recovered from the bottom of the tannur, where hundreds of *Papaver* sp. (poppy) seeds were retrieved. It is likely that poppy was added to the surface of bread to provide flavor and decoration, and that the seeds fell off during cooking becoming preserved at the base of the tannur. This find underscores the importance of collecting samples from multiple levels within a tannur, since it is not safe to assume that a sample taken from the top or the middle is representative of the whole.

A variety of weeds were also present in the tannurs including *Galium/Asperula* spp., *Bolboschoenus maritimus, Rumex* sp., and Cyperaceae, all of which are commonly encountered within dryland cereal fields. Many of the tannurs yielded dung fragments that contained inclusions of randomly oriented 2-row barley, wild barley, and assorted chaff fragments. The proportion of wood fragments in the tannur samples (and indeed in almost all of the samples from Leilan) is very low, so dung was undoubtedly the most intensively used fuel. Given the presence of cultivars, as well as crop weeds in the dung, it would seem that the livestock around Leilan were being intentionally foddered for at least part of the year.

Phytolith scatters

An intriguing, and related find to the tannurs came from all of the open areas within the complex (Areas 1-6, Weiss et al., this volume: 163). In addition to charred remains, the light fractions retrieved from sediments samples in these areas yielded a very fine, light yellowish brown substance that readily became airborne as the dried light fractions were being placed into containers. The substance was clearly visible with the naked eye and in some samples initially measured more than 10 ml in volume (although this volume lessened considerably upon settling). As the excavation proceeded, it quickly became apparent samples containing this material all originated from open areas dating to the terminal Akkadian period. The sampling strategy was modified slightly to track the distribution of this material and excavators carefully collected samples following a 1 × 1 grid from all open areas. The presence of the substance was confirmed in every open-air surface making it an excellent chronostratigraphic marker sealing the terminal Akkadian levels.

Jim Eckert from the Department of Geology and Geophysics at Yale University examined the chemical composition and structure of this material under a scanning electron microscope and identified it as a concentration of phytoliths. The thin layer of phytoliths was not visible in the field so the ability to observe it through flotation allowed for rapid feedback to excavators within a day or so. Given the high density of silicified material within the tannurs, it is likely that some phytoliths became airborne within the smoke and were then deposited in the open areas. While matting in open areas is theoretically possible, mats often leave clear markers within sediment and none were present.

Collecting phytoliths in this manner is not likely to be the most rigorous or accurate method for a formal study of phytolith remains, but this observation indicates that phytoliths *can* be collection via flotation. From a methodological point of view, this is significant, because the <1 mm fraction of many light fraction samples sitting in labs throughout the world likely contain phytoliths and may provide useful information in instances where excavations took place before the advent of micro-botanical analyses, or in situations where phytolith analyses would prove useful in addressing research questions and no conventional samples were collected. A micro-botanical study that compares the efficacy of phytolith retrieval from sediment samples collected via conventional means versus the <1 mm light fraction of floated sediment, would help determine how useful such samples could be.

Glacis and dump

In addition to open walkways or corridors, the glacis located on the western portion of the excavated area was also sampled (illustrated as the contoured area adjacent to Areas 1 and 2, Weiss et al., this volume: 163). The glacis descended steeply from the northern edge of the mound and yielded very few plant remains. While this may be expected, an unexpected dense concentration of organic debris was found further east in close proximity to the tannurs, just north of a large Akkadian period wall that was preserved to a height of 4m (just west of Rooms 15 and 16, Weiss et al., this volume: 163). The accumulation of organic debris was 1.6 m deep and the entire deposit was sampled using 20 cm strips. The sediment above the organic deposit was also sampled, but it yielded few plant remains. All of the samples from within the organic deposit were rich in charred plant remains and contained large amounts of two-row barley, free threshing wheats, *Aegilops,* and a range of dryland weeds along with limited amounts of legumes such as lentil, *Vicia* sp., and *Lathyrus* sp. The occasional grape and a limited number of *Prosopis farcta* seeds were also found here, the latter of which continues to provide useful fodder and be hand-picked and consumed by people across rural parts of Southwest Asia today. The clear similarities between samples from the tannurs and the organic accumulation indicate that waste from the tannurs was dumped over the wall along with other waste materials from the area.

Crop Storage

The intensive nature of food production within the Administrative complex would have necessitated substantial storage and grinding of grain. Evidence for both of these activities appears very close to the tannurs. A feature measuring roughly 3 × 3m constructed from mudbrick and lined with baked brick lay just northwest of Room 11 (Weiss et al., this volume: 163). This was identified in the field as a granary and samples from this feature were very rich in cereal remains, containing a mix of 2-row barley, a variety of wheat species including *Triticum dicoccum* (emmer) and free threshing wheats (*T. aestivum* and *T. durum*), and fairly small-sized *Aegilops* grains. Judging from the amount of chaff and weeds within the assemblage, the wheat and barley crops appear to have been threshed and winnowed prior to storage, but not fully cleaned by sieving or basket winnowing (Hillman 1984a; Hillman 1981; Hillman 1984b; Jones 1984). Weeds in the assemblage include an abundance of *Galium/Asperula* spp., and a fair amount of *Vaccaria pyramidata, Coronilla* sp., *Trigonella astroites, Bolboschoenus maritimus, Malva* spp., and *Teucrium/Ajuga* spp. Storage of such a mixed, relatively unclean assemblage of grain within an Administrative Building is intriguing. Ethnographic work conducted on the Greek island of Amorgos by Glynis Jones has shown that glume wheats (such as emmer) and free-threshing wheats (such as durum and bread wheat) are rarely grown together as maslin crops owing to the different steps required to process the crops post-harvest (Jones and Halstead 1995). Consequently, the store appears to represent crops harvested from multiple fields and may represent yields from different farmers. Owing to the mixed nature of the store, it is possible that the grain were intended for animal consumption, and this idea is definitely supported by the type of plant remains preserved within dung in the tannurs. Jones' (1998) work further demonstrates, however, that storage of food and fodder crops do not always differ significantly, so while a portion of the crop could have been intended for animals, the remainder could have been stored for human consumption. Sieving, basket winnowing, and hand-picking of material from this store could easily separate clean grain suitable for human consumption from the resultant by-products that could be fed to animals. If this were the case, then the social conditions that led to a minimal input of post-harvest labor prior to storage need to be considered. Could it be that this grain was collected from multiple local farmers by administrators at the palace as some form of taxation? If so, unless mandated otherwise, farmers would have had little incentive to process the grain fully. In order to test this idea further, it would be useful to examine storage practices within small contemporary households to determine whether differences in the level of post-harvest/pre-storage processing exist between the Administrative Building and individual households presumably occupied by farmers.

Food Preparation

Within the Administrative Building, food preparation and grinding of grain appears to have been concentrated in a small room in Area 5 (Weiss et al., this volume: 163). Excavations in this area revealed grinding stones, a number of vessels associated with food preparation, and a dense concentration of *Aegilops* spp. (including *Aegilops speltoides, Aegilops tauschii,* and *Aegilops crassa*). The intended function of this relatively pure concentration of *Aegilops* remains unclear. Archaeobotanists typically interpret the presence of *Aegilops* as a crop weed or fodder, depending upon the context within which they are found, and caches such as this are rare. Given that the grains in the cache are prime sized, roughly the same size as prime wheat or barley, it would be difficult to selectively remove them via sieving and hand picking would be necessary. Consequently, the cache may represent a hand-picked by-product removed from a stored crop. While this may explain *how* the cache came into existence, it does not explain what the cache would have been used for. The vast majority of the literature discussing *Aegilops* use refers to its qualities as a fodder or as an important genetic contributor for enhancing wheat varieties. Given the abundance of *Aegilops* within the complex, and the presence of almost pure caches, the idea that it was intentionally grown and used for human consumption needs to be explored more fully.

Room 12

Further evidence for the ways in which the stored crops were managed across the complex was provided by Room 12, located on the eastern edge of the excavated area (Weiss et al., this volume: 163). Within this room, excavators uncovered a large ceramic storage vessel, a number of smaller clay vessels, and a ground-basalt vessel in association with round clay balls and flattened clay balls representing tablet blanks. The ground-basalt vessel was able to hold exactly 2 liters of grain (the Akkadian equivalent of 2 SILA [*qu*]). Sadly, due to the absence of any sustained charring in this room, only limited amounts of plant remains were preserved and subsequently recovered, so it is not possible to discuss the nature of plant use within this room in any great detail. The artifact distribution strongly suggests that the room served an important function for distributing grain. The floor contained small frequencies of 2-row barley, free-threshing wheat, small *Aegilops* grains and several rather large lentil seeds, together with small numbers of weed seeds including, *Galium/Asperula* spp. and a range of small grasses. The archaeobotanical assemblage recovered from the post-depositional fill of the large storage vessel was roughly the same, so these remains may represent botanical background noise at the site rather than the actual contents of the room.

Differences between Akkadian and post-Akkadian samples

The brief post-Akkadian reoccupation was restricted to Rooms 15-17 in Square 44S16 (located in the northeastern portion of the area excavated in 2006; Weiss et al., this volume: 163). From these rooms, a total of 12 Akkadian and 9 post-Akkadian samples were collected in 2006. Four additional post-Akkadian samples collected during the 2002 field season were graciously provided by Dominique de Moulins for this study, resulting in a total of 13 post-Akkadian samples. The Akkadian samples were collected from a hearth, floors, a foundation trench, drain fill, pot fill, and inside occupational debris. The post-Akkadian context types were broadly similar with samples being collected from floors, ashy deposits, a tannur, the outside of a tannur, and foundation trenches. In total, 12,242 specimens were identified from these 25 samples: 2,779 dated to the Akkadian period and 9,443 dated to the post-Akkadian.

The mean density of charred remains per liter of sediment was 2.1 ml/L and 10.5 ml/L for Akkadian and post-Akkadian samples respectively with an overall mean of 6.1 ml/L. While this difference may seem sizeable, a t-test conducted on the data was not statistically significant owing to large variation in the density of charred remains within each time period. Such variation may be attributed to differential plant deposition and use and/or preservation and taphonomic factors. While the samples were largely collected from distinct archaeological contexts, the botanical signatures of the samples suggest that the plant remains are of mixed origin and do not represent primary remnants of stored crops or distinct activities. With the exception of two small post-Akkadian samples, all of the samples contain an admixture of chaff from free threshing and glume wheats suggesting that mixing of processing debris occurred. Many of the samples also contain dung. Similar mixing of chaff associated with dung has also been reported from Tell Brak (Charles and Bogaard 2001; Colledge 2003). No intact goat or sheep pellets were found within the samples, but fragments of dung were clearly identifiable (Charles 1998 provides guidelines for identifying dungs from archaeobotanical samples). The dung fragments varied in size, rendering the quantification of the remains somewhat subjective, but there is no doubt that the occurrence of dung was greater in the post-Akkadian samples where remains were both more ubiquitous and more numerous (52 fragments were recovered from 3 Akkadian samples versus 548 fragments from 8 post-Akkadian samples). The number of identifiable taxa per sample varies between samples, reflecting both the size and nature of the samples. In general the diversity of taxa is greatest in the post-Akkadian period with a mean of 43 taxa per sample (ranging from 21 to 61, for samples with 45 specimens and above). This compares with a mean of 31 taxa per sample for Akkadian samples (ranging from 14 to 59). This greater number of taxa during the post-Akkadian period can be explained by the enhanced diversity of non-cultivars within the dung, but may also relate to the larger size of the post-Akkadian assemblage.

Correspondence analysis was conducted on a cleaned dataset which consisted of 66 taxa and 11,443 specimens from 12 Akkadian and 10 post-Akkadian samples (the methods used to clean the data were outlined in the methods section). A summary of the cultivars within of these samples is provided in Table 1. Both abundance and presence-absence data were explored and since both analyses revealed similar patterning, only the results of the presence/absence data are presented here. CA analyses of the dataset demonstrates a clear and well-defined separation of Akkadian and post-Akkadian samples along the first, horizontal axis suggesting that change through time is the prime determinant of variation. Monte Carlo permutation testing of the pCCA analysis (which extracted variation caused by context type) indicates that the differences in plant remains between the Akkadian and post-Akkadian phases are statistically significant at the 5% level (p-value: 0.0330, F-ratio: 1.631). Analyses were repeated using crop only data, and a similar pattern was evident (Fig. 1).

Table 1: Summary of the cultivars retrieved from Akkadian (n = 12) and post-Akkadian (n = 10) samples from Square 44S16 (only samples containing more than 45 specimens are included).

	Akkadian			**Post-Akkadian**		
Volume of sediment floated (L)	143.75			81.75		
Total mass of light fraction (g)	37.97			49.98		
Mass of wood >1mm (g)	4.82			1.32		
% wood by weight	12.69			2.64		
Cultivars	**Total count**	**Prop (%)***	**Ubiquity (%)***	**Total count**	**Prop (%)**	**Ubiquity (%)**
Triticum monococcum L.	18	1.2	50	22	0.5	50
Triticum dicoccum Schübl	58	3.9	75	43	1.0	70
Triticum aestivum/durum	25	1.7	58	69	1.6	70
Triticum spp.	54	3.6	83	156	3.6	90
Hordeum vulgare subsp. *distichum* L.	198	13.3	100	295	6.7	100
Cereal indeterminate grain	565	38.0	100	551	12.6	90
Triticum spp. glume base	308	20.7	100	1281	29.3	90
Triticum durum L. rachis fr.	4	0.3	17	270	6.2	60
Triticum aestivum L. rachis fr.	0	0.0	0	126	2.9	40
Triticum aestivum/durum rachis fr.	16	1.1	58	699	16.0	90
Hordeum vulgare subsp. *distichum* rachis fr.	43	2.9	50	221	5.1	90
Cereal culm	117	7.9	75	505	11.5	100
Cereal indeterminate awn	0	0.0	0	some-many	-	100
Cereal indeterminate embryo	9	0.6	50	46	1.1	90
Cicer arietinum L.	2	0.1	17	1	0.02	10
Vicia spp.	1	0.1	8	1	0.02	10
Lens culinaris Medik.	43	2.9	83	15	0.3	60
Lathyrus spp.	5	0.3	25	1	0.02	10
Pisum sp.	3	0.2	17	2	0.1	10
Leguminosae indet.	14	0.9	58	11	0.3	40
Papaver spp.	0	0.0	0	53	1.2	10
Vitis vinifera L.	1	0.1	8	0	0.0	0
Vitis spp. pedicel	2	0.1	17	5	0.1	10
Carthamus tinctorius L.	0	0.0	0	4	0.1	30
Carthamus cf. *tinctorius* capitulum	0	0.0	0	3	0.1	20
Total	1486			4380		

* Prop = proportion, calculated as a percentage proportion of all cultivars; Ubiquity, calculated as a percentage of the number of samples within which each taxon is present for each time period.

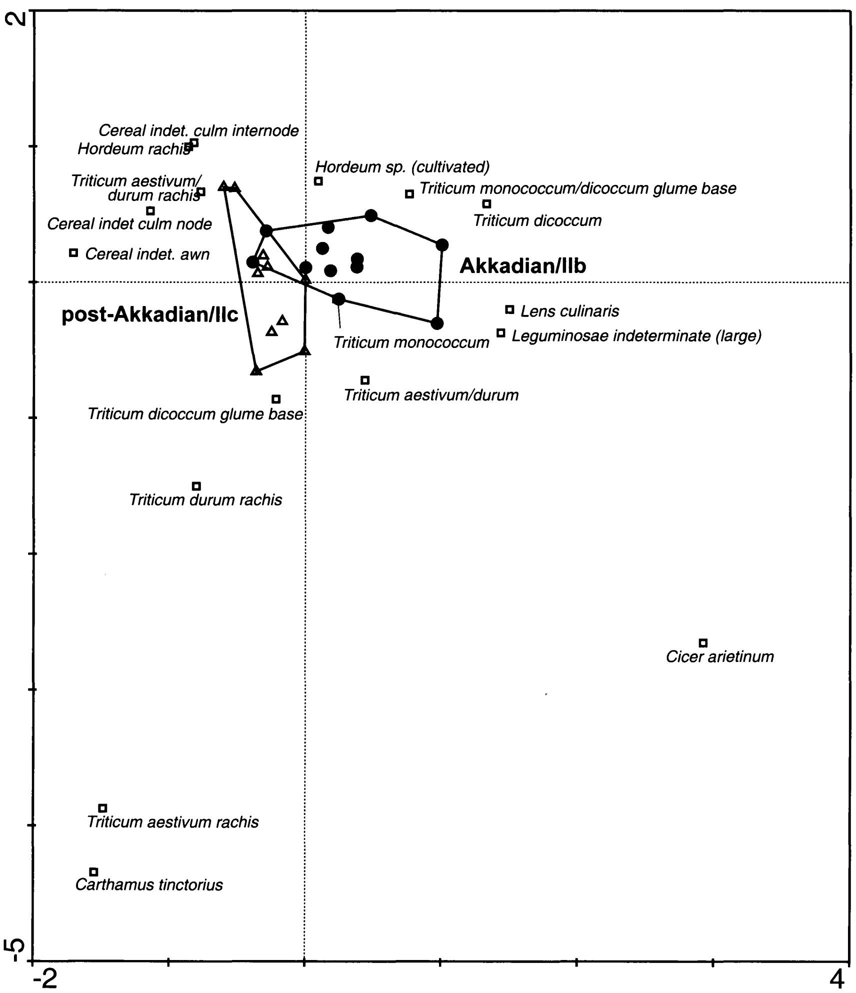

Fig. 1: Correspondence analysis biplot of presence/absence data for cultivars from Akkadian and post-Akkadian open triangle samples.

In general, the post-Akkadian samples tend to contain much higher proportions of cereal chaff, wild grasses, and weed/non-economic taxa; higher proportions of dung; and slightly fewer crop legumes (Fig. 2). While the mixed origin of the samples makes it difficult to discuss the agronomic methods used by farmers in any great detail, it is still possible to discuss the nature of cultivars present. In both periods, *Hordeum vulgare* subsp. *distichum* (2-row hulled barley) is the most ubiquitous and numerous cultivar, present in all of the samples. *Triticum aestivum/durum* is the second most ubiquitous and numerous cultivar followed by *T. dicoccum* (emmer) (Table 1). Minor occurrences of *T. monococcum* (einkorn) exist. As observed in the Akkadian samples from across the Administrative Building complex, *Triticum durum* rachis fragments tend to be more numerous than *T. aestivum* rachis fragments, and this pattern appears to be accentuated in the post-Akkadian samples where chaff if particularly abundant. It is possible that farmers adapted to the more arid conditions evident during

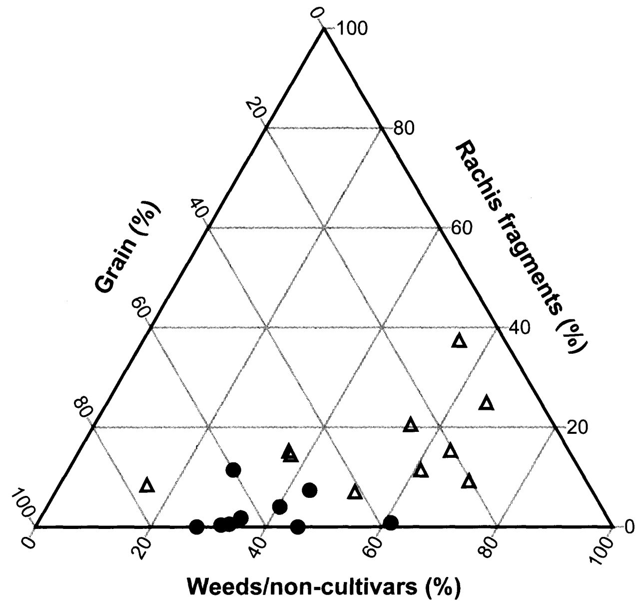

Fig. 2: Triangle plot illustrating relative proportions of grain, rachis fragments, and weeds/non-cultivars within the Akkadian (solid black circle) and post-Akkadian (open triangle) samples from 44S16.

the post-Akkadian occupation by focusing more heavily on more drought-tolerant crops, although it is clear that attempts were made to continue growing the crops preferred during the Akkadian period.

Large amounts of *Aegilops* grain and spikelet bases as well as *Triticum* and *Hordeum* chaff (including rachis fragments, glume bases, and culm fragments) appear in both time periods, but the presence of awns is restricted to the post-Akkadian samples. Only one sample from a tannur originally dated to the Akkadian period contained awns. It is highly likely that this sample represents reuse of abandoned Akkadian features by the post-Akkadian reoccupants and consequently, the sample was included alongside the other post-Akkadian samples for analytical purposes. The reason for the restricted occurrence of awns in post-Akkadian samples is not entirely clear. Differential preservation conditions between the two time periods is a possibility, but this seems doubtful given the marked increase of all chaff parts during the post-Akkadian. The presence of awns in dung-related samples could, therefore, represent a change in the scale at which cereals were processed and/or different uses of each crop-processing by-product, such that awns were incorporated into fodder during times of scarcity. The presence of chaff parts during the post-Akkadian period, combined with the increase in small wild grasses and other weed species, suggests that animals were allowed to graze pasture supplemented with crop processing debris for at least part of the year. That being said, the possibility that crop processing debris was added to the dung *after* it had been excreted in order to enhance its properties as a fuel cannot be entirely discounted. If this were the case, it begs the question of why people suddenly changed long-held practices for making dung fuel cakes. If dung cakes were suddenly made in a different manner, could this represent occupation of the tell by "outsiders" who had no habitation link with the tell during the Akkadian occupation?

Crop legumes present in both time periods include *Lens culinaris* (lentil), *Cicer* cf. *arietinum* (chickpea), *Pisum* sp. (pea), and *Lathyrus* sp. (grass pea). Lentil appeared in more than half of the samples, whereas occurrence of the other legumes is sporadic. Across the Near East, legumes often appear in lower concentrations than cereals; this systematic discrepancy is often thought to reflect differential preservation of cereals and legumes rather than human consumption patterns. While the relative proportion of legumes is less during the post-Akkadian period, they occur too infrequently to conclude that this is a real trend with any degree of certainty.

Isolated finds of other cultivars include *Vitis vinifera* (grape) which was represented by one pip and one pedicel in the Akkadian period and *Carthamus tinctorius* (safflower) which was represented by two achenes and possibly three capitula in the post-Akkadian period. Safflower was often grown in northern Syria and used as an oil and textile dye (McCorriston 1998). Poppy (*Papaver* sp.) seeds were also found. Since their occurrence is restricted to tannurs, it would appear that poppy continued to be added to bread during the post-Akkadian period, a practice that continues today.

Conclusions

The Akkadian plant remains from the Palace complex provide integrated and consistent evidence for cereal storage, cereal processing, intensive food preparation, and cooking in tannurs, as well as disposal of waste from the tannurs. In order of abundance, the most common cereals encountered are 2-row barley, *Aegilops* spp. (the use of which is still in question), and bread and durum wheat. Lesser amounts of lentil, chick pea, pea, and grass pea (*Lathyrus* sp.) were encountered along with isolated finds of grape and safflower. The presence of seeds identified within animal dung fragments recovered from tannurs indicates intentional foddering of animals with cereals and crop processing debris for at least part of the year. Crops were stored within the complex in a threshed and partially cleaned state and may have been used for both animal and human consumption.

Statistically significant differences exist between the Akkadian and post-Akkadian plant remains from Square 44S16. The samples are of mixed origin, which complicates interpretation, but several lines of evidence suggest that while people continued to grow the same crops during the post-Akkadian reoccupation, attempts were made to adapt to drier conditions. People may have used dung fuel more intensively reflecting a greater scarcity of wood, may have provisioned animals with lower quality fodder, and may have restructured the processing of plant remains to the household level.

Acknowledgments

I remain indebted to Harvey Weiss for inviting to me to be part of the Tell Leilan team and for asking me to participate in the 8ICAANE Workshop, "Seven Generations since the Fall of Akkad." I extend thanks to entire Leilan team, without whom this research would not have been possible. I am especially grateful to Fawaz Musa for his detailed attention to flotation and to Dominique de Moulins for providing four samples that she collected during the 2002 season at Tell Leilan. Many thanks are extended to Wilma Wetterstrom for her ongoing support. This archaeobotanical research was funded by a Wenner-Gren Foundation Post-Ph.D. Research grant, a University of Connecticut Faculty small grant, and National Science Foundation Faculty Early Career Award grant number 1054938.

Bibliography

Charles, M.

1998 Fodder from Dung: the Recognition and Interpretation of Dung-Derived Plant Material from Archaeological Sites. *Environmental Archaeology* 1: 111-122.

Charles, M. and A. Bogaard

2001 Third Millennium BC Charred Plant Remains from Tell Brak. In D. Oates, J. Oates, and H. McDonald (eds.), *Excavations at Tell Brak Vol. 2. Nagar in the Third Millennium BC.* Cambridge: McDonald Institute for Archaeological Research and the British School of Archaeology in Iraq.

Charles, M. and M.M. Hald

2003 Crop production and use at Tell Brak in the fourth millennium BC. *Iraq* 65: 26-32.

Charles, M., H. Pessin, and M.M. Hald

2010 Tolerating change at Late Chalcolithic Tell Brak: responses of an early urban society to an uncertain climate. *Environmental Archaeology* 15: 183-198.

Colledge, S.

2001 *Contextual Analysis of the Use of Space at Two Near Eastern Bronze Age Sites. Part 4: Final report on the Archaeobotanical Analyses* [Online]. Available: http://ads.ahds.ac.uk/catalogue/adsdata/arch-311-1/dissemination/pdf/scCont.pdf [Accessed 13 September 2012].

Colledge, S.

2003 Plants and People. In R. Matthews (ed.), *Excavations at Tell Brak. Vol. 4: Exploring an Upper Mesopotamian Regional Centre, 1994-1996.* Cambridge: McDonald Institute for Archaeological Research and the British School of Archaeology in Iraq.

Colledge, S., J. Conolly, and S. Shennan

2004 Archaeobotanical Evidence for the Spread of Farming in the Eastern Mediterranean. *Current Anthropology* 45: 35-58.

Cullen, H.M., P.B. Demenocal, S. Hemming, G. Hemming, F.H. Brown, T. Guilderson, and F. Sirocko

2000 Climate Change and the Collapse of the Akkadian Empire: Evidence from the Deep Sea. *Geology* 28: 379-382.

Dalfes, H. N., G. Kukla, and H. Weiss (eds.)

1997 *Third Millennium BC Climate Change and Old World Collapse. NATO ASI Series Vol. I 49.* Berlin: Springer-Verlag.

Davis, P. H.

1965-1985 *Flora of Turkey and the East Aegean Islands. Vol. 1-9.* Edinburgh: University of Edinburgh Press.

De Menocal, P. B.

2001 Cultural Responses to Climate Change during the late Holocene. *Science* 292: 667-673.

De Moulins, D.

2003 *City Gate: Archaeobotanical Analysis.* [Online]. Yale University Tell Leilan Project. Available: http://leilan.yale.edu/works/city_gate/archaeobotanical.html [Accessed 13 September 2012].

Deckers, K. and H. Pessin

2011 Vegetation Development in relation to Human Occupation and Climatic Change in the Middle Euphrates and Upper Jazirah (Syria/Turkey) during the Bronze Age. In K. Deckers (ed.), *Holocene Landscapes through Time in the Fertile Crescent. Subartu* 28. Turnhout: Brepols.

Emberling, G., H. McDonald, M. Charles, W.A.Green, M.M. Hald, J. Weber, and H.T. Wright

2001 Excavations at Tell Brak 2000: Preliminary Report. *Iraq* 63: 21-54.

Hald, M.M.

2008 Storage of crops during the fourth and third millennia B.C. at the settlement mound of Tell Brak, NE Syria. *Vegetation History and Archaeobotany* 17: 35-41.

Hillman, G.

1981 Reconstructing Crop Husbandry Practices from Charred Remains of Crops. In R. Mercer (ed.), *Farming Practice in British Prehistory.* Edinburgh: Edinburgh University Press.

1984a Interpretation of archaeological plant remains: The application of ethnographic models from Turkey. In W. Van Zeist and W.A. Casparie (eds.), *Plants and Ancient Man: Studies in Palaeoethnobotany.* Rotterdam: Balkema.

1984b Traditional Husbandry and Processing of Archaic Cereals in Recent Times: The Operations, Products, and Equipment which might feature in Sumerian Texts. *Bulletin on Sumerian Agriculture* 1: 114-152.

Jones, G.

1998 Distinguishing Food from Fodder in the Archaeobotanical Record. *Environmental Archaeology* 1: 95-98.

Jones, G., M. Charles, A. Bogaard, and J. Hodgson

2010 Crops and weeds: the role of weed functional ecology in the identification of crop husbandry methods. *Journal of Archaeological Science* 37: 70-77.

Jones, G. and P. Halstead

1995 Maslins, Mixtures and Monocrops: on the Interpretation of Archaeobotanical Crop Samples of Heterogeneous Composition. *Journal of Archaeological Science* 22: 103-114.

Jones, G.E.M.

1984 Interpretation of archaeological plant remains: Ethnographic models from Greece. In W. Van Zeist and W.A. Casparie (eds.), *Plants and Ancient Man: Studies in Palaeoethnobotany.* Rotterdam: Balkema.

Kaniewski, D., E. Van Campo, and H. Weiss

2012 Drought is a recurring challenge in the Middle East. *Proceedings of the National Academy of Sciences* 109: 3862-3867.

Luterbacher, J., E. Xoplaki, C. Casty, H. Wanner, A. Pauling, M. Küttel, T. Rutishauser, S. Bronnimann, E. Fischer, D. Fleitmann, F.J. González-Rouco, R. García-Herrera, M. Barriendos, F. Rodrigo, J.C. Gonzalez-Hidalgo, M.A. Saz, L. Gimeno, P. Ribera, M. Brunet, H. Paeth, N. Rimbu, T. Felis, J. Jacobeit, A. Dünkeloh, E. Zorita, J. Guiot, M. Türkes, M.J. Alcoforado, R. Trigo, D. Wheeler, S. Tett, M.E. Mann, R. Touchan, D.T. Shindell, S. Silenzi, P. Montagna, D. Camuffo, A. Mariotti, T. Nanni, M. Brunetti, M. Maugeri, C. Zerefos, S. De Zolt, P. Lionello, M.F. Nunes, V. Rath, H. Beltrami, E. Garnier, and E. Le Roy Ladurie

2006 Mediterranean Climate Variability Over The Last Centuries: A Review. In P. Lionello, P. Malanotte-Rizzoli, and R. Boscolo (eds.), *Mediterranean Climate*

Variability. Developments in Earth & Environmental Studies 4. Amsterdam: Elsevier.

McCorriston, J.

1998 Syrian Origins of Safflower Production: New Discoveries in the Agrarian Prehistory of the Habur Basin. In A. B. Damania, J. Valkoun, G. Willcox, and C. O. Qualset (eds.), *The Origins of Agriculture and Crop Domestication. The Harlan Symposium.* Aleppo: ICARDA.

McMahon, A., J. Oates, S. Al-Quntar, M. Charles, C. Colantoni, M. M. Hald, P. Karsgaard, L. Khalidi, A. Soltysiak, A. Stone, and J. Weber

2007 Excavations at Tell Brak 2006-2007. *Iraq* 69: 145-171.

Nesbitt, M.

1995 Recovery of Archaeological Plant Remains at Kaman-Kalehöyük. *Bulletin of the Middle Eastern Culture Center in Japan* 8: 115-130.

2006 *Identification Guide for Near Eastern Grass Seeds.* London: University College London, Institute of Archaeology.

Riehl, S.

2000 Erste Ergebnisse der archäobotanischen Untersuchungen in der zentralen Oberstadt von Tall Mozan/Urkeš im Rahmen der DOG-IIMAS-Kooperation. *Mitteilungen der Deutschen Orient-Gesellschaft zu Berlin* 132: 229-238.

2009 Archaeobotanical evidence for the interrelationship of agricultural decision-making and climate change in the ancient Near East. *Quaternary International* 197: 93-114.

2010 Plant Production in a Changing Environment: The Archaeobotanical Remains from Tell Mozan. In K. Deckers, M. Doll, P. Pfälzner, and S. Riehl (eds.), *Development of the Environment, Subsistence and Settlement of the City of Urkeš and its Region.* Wiesbaden: Harrassowitz Verlag.

Ristvet, L. and H. Weiss

2000 Imperial responses to environmental dynamics at late Third Millennium Tell Leilan. *Orient-Express* 4: 94-99.

2005 The Hābūr Region in the Late Third and Early Second Millennium B.C. In W. Orthmann (ed.), *The History and Archaeology of Syria. Vol. 1.* Saarbrucken: Saarbrucken Verlag.

Saliba, G. I.

1997 Managing Resources, its Socioeconomic and Environmental Consequences. *Journal of Developing Societies* 13: 158-167.

Smith, A. and N. D. Munro

2009 A Holistic Approach to Examining Ancient Agriculture: A Case Study from the Bronze and Iron Age Near East. *Current Anthropology* 50: 925-936.

Staubwasser, M. and H. Weiss

2006 Holocene Climate and Cultural Evolution in Late Prehistoric-Early Historic West Asia. *Quaternary Research* 66: 372-387.

Ter Braak, C. J. F.

1988 Partial Canonical Correspondence Analysis. In H. H. Bock (ed.), *Classification and Related Methods of Data Analysis.* Amsterdam: North-Holland.

1996 *Unimodal Models to Relate Species to Environment.* Wageningen, DLO-Agricultural Mathematics Group.

Van Zeist, W.
1993 Archaeobotanical Evidence of the Bronze Age Field-Weed Flora of Northern Syria. *Dissertaciones Botanicae* 196: 499-511.

Van Zeist, W. and J. A. H. Bakker-Heeres
1984 (1986) Archaeobotanical Studies in the Levant 2. Neolithic and Halaf Levels at Ras Shamra. *Palaeohistoria* 26: 151-170.
1985 (1986) Archaeobotanical Studies in the Levant 4. Bronze Age Sites on the North Syrian Euphrates. *Palaeohistoria* 27: 247-316.

Weiss, H.
1997 Late Third Millennium Abrupt Climate Change and Social Collapse in West Asia and Egypt. In H. N. Dalfes, G. Kukla, and H. Weiss (eds.), *Third Millennium BC Climate Change and Old World Collapse. NATO ASI Series Vol. I 49.* Berlin: Springer-Verlag.
2000 Beyond the Younger Dryas: Collapse as Adaptation to Abrupt Climate Change in Ancient West Asia and the Eastern Mediterranean. In G. Bawden and R. M. Reycraft (eds.), *Environmental Disaster and the Archaeology of Human Response. Anthropological Papers No. 7.* Albuquerque: Maxwell Museum of Anthropology, University of New Mexico.
in press Altered Trajectories: The Intermediate Bronze Age in Syria and Lebanon 2200-1900 BCE. In A. Killebrew and M. Steiner (eds.), *Oxford Handbook of the Archaeology of the Levant.* Oxford: Oxford University Press. Available at http://leilan.yale.edu/pubs/files/weiss_2010_altered_trajectories.pdf [Accessed 13 September 2012]

Weiss, H. and R. S. Bradley
2001 What Drives Societal Collapse? *Science* 291: 609-610.

Weiss, H., M.-A. Courty, W. Wetterstrom, F. Guichard, L. Senior, R. Meadow, and A. Curnow
1993 The Genesis and Collapses of Third Millennium North Mesopotamian Civilization. *Science* 261: 995-1004.

Weiss, H., F. Delillis, D. De Moulins, J. Eidem, T. Guilderson, U. Kasten, T. Larsen, L. Mori, L. Ristvet, E. Rova, and W. Wetterstrom
2002 Revising the contours of history at Tell Leilan. *Annales Archeologiques Arabes Syriennes* 45: 59-74.

Wetterstrom, W.
2003 Ninevite 5 Period Agriculture at Tell Leilan: Preliminary Results. In E. Rova and H. Weiss (eds.), *The Origins of Northern Mesopotamian Civilization: Ninevite 5 Chronology, Economy, Society.* Brussels: Brepols.

Zohary, D. and M. Hopf
2000 *Domestication of Plants in the Old World. The Origin and Spread of Cultivated Plants in West Asia, Europe and the Nile Valley.* Oxford: Oxford University Press.

For the past twenty years, the Khabur Plains of northeast Syria have been a testing ground for the Akkadian collapse c. 2200 BC and remnant post-Akkadian occupations. On May 2, 2012, a workshop for the presentation and discussion of the latest archaeological data was convened in Warsaw, at the 8th International Congress for the Archaeology of the Ancient Near East. The fifteen research papers from that conference present the analyses and perspectives from eight excavated sites, Arbid, Barri, Chagar Bazar, Brak, Mohammed Diyab, Leilan, Mozan, and Hamoukar, and two regional surveys. The new data include the Tell Leilan high-resolution radiocarbon chronology for the Akkadian collapse, an Akkadian palace built within the shell of a destroyed pre-Akkadian palace, The Unfinished Buildings at Tell Leilan and Tell Mohammed Diyab, the terminal occupations at Tell Brak, Chagar Bazar, Hamoukar, Arbid, Mohammed Diyab and Leilan, quantified regional settlement distributions across the Akkadian collapse, measured paleobotanical data for imperial Akkadian and remnant post-Akkadian agriculture, and documentation for the collapse of the imperial Akkadian administration.

9 783447 068239

www.harrassowitz-verlag.de