AGRICULTURE AND STORAGE PRACTICES IN AN EARLY IRON AGE HOUSEHOLD: ANALYSES OF PLANT MACRO REMAINS AT TELL ABU AL-KHARAZ, JORDAN VALLEY

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Abstract: *The discovery of exceptionally well-preserved plant macroremains in an early Iron Age (11th century BCE) compound in Tell Abu al-Kharaz, Jordan Valley, sheds light on agricultural and storage practices in the Southern Levant. The samples, which primarily were intended to serve as dating material, were collected in four different basement rooms of the compound. The analysed samples consisted of edible plants such as wheat, barley, chickpea, grass pea, flax, lentil, olive, pomegranate and common grape. In contrast to other Levantine sites, where free-threshing wheat dominates in the Iron Age, the dominant cereal crop at Tell Abu al-Kharaz was emmer wheat, which is more tolerant to drought and poor soils and less susceptible to diseases. It is also easier to store, because is more resistant to pests, yet requires more work to process than free-threshing wheats.*

The assemblage in one of the rooms represents prime grain in the final stages of crop processing for meal preparation, which is further supported by the presence of (bread) ovens (tawabin and tananir) as well as mortars and grinding implements in the compound. Judging by the storage capacity and the variety of botanical remains, it is suggested that the basement of the compound represents a private storage facility associated with domestic areas in the upper storey, rather than a communal storeroom.

Key words: *archaeobotany, early Iron Age, Jordan, agriculture, storage*

Introduction

Tell Abu al-Kharaz is a 12 ha mound in the central Jordan Valley (Fig. 1), 5 km east of the Jordan River and just north of the perennial Wadi al-Yabis (today Wadi ar-Rayyan). The central Jordan Valley has a semi-arid climate but is one of the more humid regions of Jordan with (at present) an average of 250–300 mm annual precipitation (Tarawneh and Kadioğlu 2003) allowing rain-fed agriculture. The highest amount of rainfall in the entire area of Jordan today, 600 mm, is measured near the upper reaches of the nearby Wadi al-Yabis (Mabry and Palumbo 1988, 275). Rainfall is concentrated in the winter months and the transitional periods, i.e. from October to April (Cordova 2007, 42, 45 with further references). The location of Tell Abu al-Kharaz is between the fertile Ghor – the Jordan Rift Valley – and the less fertile Irano-Turanian steppe zone to the east and south, which is a transitional region between the Mediterranean vegetation and climate zone and the desert (Cordova 2007, 102–104; Palmer 2013). The soils of the region around Tell Abu al-Kharaz are formed on basalt or limestone and are of the red Mediterranean "Terra Rossa" type (Waitzbaur and Petutschnig 2004, 122, fig. 18; Cordova 2007, 56–61; Lucke *et al*. 2013, fig. I.17).[3] These soils are the most fertile soils in Jordan due to their high clay content and the capacity to retain water for lengthy periods (Waitzbaur and Petutschnig 2004, 124; Lucke *et al*. 2013). The vegetation is characterized by a small number of trees, e. g. oak, pistachio, pine or juniper, and maquis or garrigue vegetation dominated by shrubs (Horowitz 1979, 31; Cordova 2007, 64–81; Palmer 2013). Initial observation of the land surrounding Tell Abu al-Kharaz before the start of the excavation in 1989 and before the entire area was farmed revealed traces of irrigation systems in the plain surrounding

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3 This term is known from old classification systems. Nowadays soil taxonomies of the United States Department of Agriculture (USDA) or the Food and Agriculture Organization (FAO) of the UNESCO are preferred. As these classification systems use different taxonomies and terminologies (see e. g. Cordova 2007, 60, table 2.7), the old and more widespread term in non-technical literature is used here.

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Fig. 1 Map of the Southern Levant with major Iron Age sites; sites referred to in Table 3 are emphasised (map by T. Bürge)

Fig. 2 Aerial photograph of Tell Abu al-Kharaz; early Iron Age compound in southern part (October 2014; photograph by P.M. Fischer and T. Bürge)

the tell.[4] We may assume that productive agriculture was mainly practiced with irrigation during the Bronze and Iron Ages, although rainfed agriculture may have been carried out during certain periods (see also Fischer 2013, 468). The untillable areas are used as grazing grounds for livestock, mainly caprines (Fischer and Holden 2008, 308).

The site (cf. Fig. 1) is located on the ancient trade route through the Jordan Rift Valley between the Sea of Galilee in the north (c. 35 km away) and the Dead Sea in the south (c. 70 km away). The eastern end of the road from the Jordan Valley to the Mediterranean (approximately 80 km away), through the Jezreel Valley, is just north of Tell Abu al-Kharaz. The favourable position of the site facilitated travel and trade from the site to various regions of the Eastern Mediterranean and vice versa throughout all settlement periods, i.e. from the Early Bronze Age IB (approximately 3200 BCE) to the Iron Age IIB/C, approximately the end of the 8th century BCE (Fischer 2006, 2008, 2013).

As has been suggested by Fischer (2013, 482) the main economic resources through all periods were agriculture and cattle breeding. Imported pottery and other objects hint at the great importance of trade with neighbouring and more remote regions, such as the Mediterranean, Egypt and the Central and Northern Levant.

A large and exceptionally well-preserved early Iron Age compound (c. 1100 to first half of the 11th century BCE; see below) at Tell Abu al-Kharaz (Fischer 2013; Fischer and Bürge 2013a, 2013b; Bürge in press) offers the possibility of a better understanding of agriculture, storage and the household in the Southern Levant during this period.

The early Iron Age compound

The earliest Iron Age occupation at Tell Abu al-Kharaz, Phase IX of the occupational sequence of the site, is mainly attested in Area 9 in the south-

[4] Personal information by P.M. Fischer, 14th September 2018.

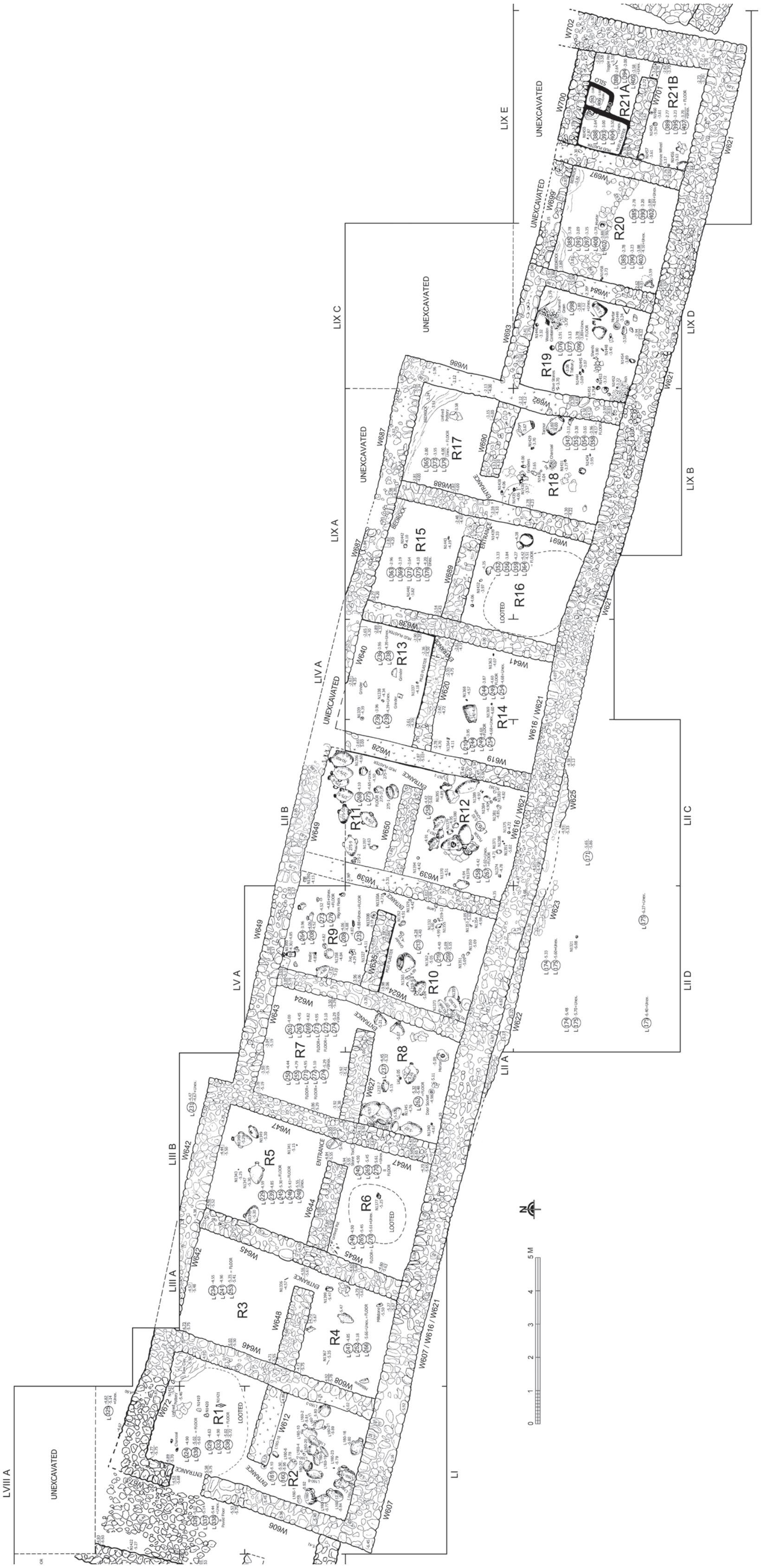

Fig. 3 Plan of the early Iron Age compound (drawing by M. al-Bataineh)

ern part of the tell (see the overview in Fig. 2), where a 46 m long and 8 m wide compound was excavated. It is built against the city wall and consists of 21 rooms of standardized sizes, approximately 3–3.5 m × 3.5–4 m (Fig. 3). They are arranged pairwise, with small doorways between the two rooms, one to the north and one to the south, of the same pair. The easternmost three rooms did not have an adjoining room to the north, as the bedrock in the northeast did not provide enough space. The contexts inside the compound were sealed by a roughly one metre thick layer of secondarily fired mudbricks and debris from the collapsed upper storey including stones, carbonised wood and ash.

The context of the finds clearly indicates that the building and its contents were exposed to fire. The stone walls, partly preserved to a height of 2 m, generally have no passages leading to the exterior.[5] Therefore, this structure is interpreted as a basement, which could be reached from above via ladders. The upper storey, presumably a living space, was built of mudbricks evidenced by the large amount of such bricks in the debris, which covered the basement. The rooms contained more than 200 complete or almost complete ceramic vessels, in addition to metal and bone objects, alabaster vessels and other stone objects, and textile production tools. Several clay ovens and a clay silo were also found in the basement of the compound, and remains of ovens could be identified amongst the debris from the upper storey. A large amount of carbonized organic remains were preserved in vessels or spread on the floors.[6] The large number of storage jars suggests that the structure was used for storage. However, other vessel types, especially cooking pots, but also kraters, jugs, juglets and bowls, which are most commonly connected to the preparation and consumption of food, are also well represented (Bürge 2017; in press).

In regards to relative chronology, the pottery from the compound is best placed in the Iron Age IB, with numerous parallels at related sites in the Southern Levant (see the more detailed discussions in Fischer and Bürge 2013a; 2013b; Bürge 2017, 302–306; in press). Radiocarbon analyses of a total of 44 Iron Age samples, of which 17 stem from short-lived Phase IX material of one single destruction event, indicate that the destruction of Phase IX occurred between 1193 and 1049 BCE with a probability of 95.4 % (2σ). If the probability is reduced to 68.2 % (1σ) the time span of the destruction can be narrowed to 1128–1055 BCE. If both 2σ and 1σ probabilities are taken into account, the destruction cannot be dated later than around 1050 BCE.

Material and methods

Most samples were collected when archaeobotanical material was visible to the naked eye and consisted of large plant fragments (over 2 mm). Soil samples (e. g. debris from a floor level, oven or pot content) contained microscopic plant remains, in addition to grain. The material was primarily thought to serve only as dating material, i.e. in those rooms where more material was visible to the naked eye more samples were collected.[7] In total, eleven soil samples were analysed.

In the laboratory, the sample volume was measured, and the samples were dry-sieved using a 0.5 mm mesh sieve. Two samples (K12/R19/4 and K10/R10/12) were wet-sieved using a 0.4 mm mesh sieve. Samples described as seeds were not sieved but directly sorted in dry condition. One sample, described as possible flour, was analysed to verify the presence of starch, which would indicate possible remains of cereals. A sub-sample was taken and 5 ml iodine was added. If the sample consisted of flour, the presence of starch would have caused the iodine to turn blue. However, the colour of iodine remained unchanged. Therefore, the sample was water-sieved.

All the material was sorted under a low-power stereomicroscope (6.5–40×). The macroscopic plant remains were picked from the sieved residues and identified from morphological characters. All macrofossil identifications were checked against the botanical literature (Jacomet 2006; Cappers *et al.* 2012) and compared with the modern reference collection of the Bioarchaeology Laboratory, Department of Archaeology, Silesian Museum.

5 Only the westernmost pair of rooms, Rooms 1 and 2, could be entered from the exterior via a doorway leading into Room 1.

6 All botanical remains discussed in the present article were retrieved inside vessels or spread on or just above floors (cf. Table 1). We are on safe ground in assuming that all of them come from the basement, thus excluding that they were spilled from above when the upper storey collapsed.

7 Archaeobotanical studies were not included in the project due to funding limitations. Therefore, the sampling was not conducted with a concern to archaebotanical methodology.

No.	Locus	Room	N	E	H	Volume (ml)	Location and information	Sample no.
1	354	18	–26.68	12.53	–3.83	only seeds	just above floor; sample consisted only of seeds (no remaining soil)	K12/R18/1
2	358	18	–	–	–	5	floor	K12/R18/2
3	396	19	–	–	–	5	below floor L377	K12/R19/3
4	377	19	–26.36	16.37	–3.69	440	floor	K12/R19/4
5	354	18	–26.41	13.81	–3.96	one seed	fill above floor	K12/R18/5
6	377	19	–26.23	15.02	–3.70	only seeds	floor	K12/R19/6
7	377	19	–	–	–	just charcoal	floor	K12/R19/8
8	377	19	–26.42	17.1	–3.71	960	floor	K12/R19/9
9	395	21B	29.08	22.06	–3.71	only seeds	fill above floor	K12/R21/10
10	394	21A	–	–	–3.33	only seeds	fill above floor	K12/R21/11
11	219	10	–	–	–	100	content of storage jar N1359 on floor of room	K10/R10/12

Table 1 Information on samples and their contexts. Coordinates (N, E, H) refer to the fixpoint on the summit of the tell, which has the coordinates N 200623.07, E 206196.54 according to the Palestine Grid System. The height is 116.00 m below mean sea level

Nomenclature follows Cappers *et al.* (2012) and Zohary *et al.* (2012). All samples offered material for archaeobotanical analysis;[8] all the material was charred. General information regarding material can be seen at Table 1 while the identified taxa are presented in Table 2.

Results

All samples delivered archaeobotanical material. Samples were collected from four rooms, and therefore it was decided to describe assemblages from the same location together as they were probably stored together and the possibility of mixing between separate rooms is rather low. Besides the botanical remains, a concise description of the contexts, in which these were found, will be provided.

Room 10

Room 10, which is 8.68 square metres in area (dimensions are 3.1 m × 2.8 m), contained a considerable number of vessels of many different types and several stone tools. Most vessels come from the floor of this basement room and include at least six storage jars, two kraters, two lamps, a cooking pot and a number of fineware vessels, such as pyxides, flasks, jugs and bowls.

One botanical sample from Room 10, the content of a storage jar, was analysed. Primarily, it was thought to consist of flour. After a closer examination it was decided to water-sieve the sample. In the residue there was a grain of indeterminate cereal (*Cerealia* indet.), small fragments of charcoal impossible to determinate, pieces of burned indeterminate bones and fish bones, and fragments described as organic slag. The fragments of organic matter of various sizes and shapes could represent parts of cooked food, bread or elements of the pulp of fruits.

Room 18

Room 18 is 9.28 square metres (dimensions 2.9 m × 3.2 m). The walls are still black from the conflagration. A large number of finds were preserved in this room, including jugs and juglets, some miniature vessels, a cooking pot and a lamp, polishing and grinding stones and flint blades. A clay oven of *tannur* type (see e. g. Mcquitty 1984; van der Steen 1991; Mulder-Hymans 2014) was found leaning against the eastern wall of the room. There was a high concentration of charcoal on the floor of the room. A curved wooden object, possibly a sickle, was found in the central part of the room. Other objects from the floor of the room include miniature and standard-sized bowls, a cooking pot and a cooking jug, a pyxis and a bowl of alabaster, a polishing stone and flint blades, and a spindle whorl.

Three samples from Room 18 were analysed. They contained wheat (*Triticum* sp.) and fragments of indeterminate cereal grains. The group of pulses included chickpea (*Cicer arietinum*), grass pea (*Lathyrus sativus*) and the small-seeded variety

[8] The article describes the results obtained from the preliminary examination of samples excluding charcoal analyses. The study of wood remains will be the subject of a separate paper.

ROOM	10	18			19						21B	21A
Sample no.	K10/R10/12	K12/R18/1	K12/R18/2	K12/R18/5	K12/R19/3	K12/R19/4	K12/R19/6	K12/R19/7	K12/R19/8	K12/R19/9	K12/R21/10	K12/R21/11
CEREALS												
two-rowed barley (*Hordeum distichum*)						1	2			65		
barley (*Hordeum* sp.)												
*rachis										1		
emmer wheat (*Triticum dicoccum*)						40	2			6021		
bread/macaroni wheat (*Triticum aestivum/ durum*)						16				781		
wheat (*Triticum* sp.)												
*grain			1			49	2			2144		
*spikelet fork										1		
cereals (*Cerealia* indet.)	1		3			xx				678;xx		
OTHER ECONOMIC PLANTS												
chickpea (*Cicer arietinum*)		2								6		
grass pea (*Lathyrus sativus*)		1										
flax (*Linum usitatissimum*)					1							
lentil (*Lens culinaris*)		6			3							
olive (*Olea europaea*)				1		10fr.	21;193fr.			2fr.		
pomegranate (*Punica granatum*)					14							
pomegranate? (cf. *Punica granatum*)										4fr.		
common grapevine (*Vitis vinifera*)												
*complete fruit											73	11
*fruit fragments											22	87
*pip			1			2						
grapevine (*Vitis* sp.)										5fr.		
common fig (*Ficus carica*)										8		
common vetch (*Vicia sativa*)							1					
RUDEAL AND SEGETAL PLANTS												
darnel (*Lolium temulentum*)										3		
cyperus (*Cyperus* sp.)										54		
brome grasses (*Bromus* sp.)										30		
fescue (*Festuca* sp.)										2		
plantains (*Plantago* sp.)										1		
sorrels (*Rumex* sp.)										11		
grasses family (Poaceae indet.)										167		
*straw										7fr.		
*awns										4fr.		
legume family (Fabaceae indet.)						2fr.				2fr.		
gourd family (Cucurbitaceae indet.)					3					1		
indeterminate			1							10;26fr.		
organic slag	x									13fr.		
CHARCOAL	x									x		
ring-porous								x	x			
diffuse-porous indet.								x	x			
shrub									x			
indet.								x	x			
bones & fishbones	x									16fr.		

Table 2 Taxa identified at Tell Abu al-Kharaz; x indicates presence, xx indicates presence of thousands of fragments

Fig. 4 Photograph of Room 19 during excavation with heaters/ovens and remains of wooden containers or installations; detail of charred grains in lower right corner (photograph by T. Bürge)

(microsperma group) of lentils (*Lens culinaris*). Grass pea, although considered animal and famine food for humans, is appreciated for its ability to grow in dry places and on poor soils. It requires boiling before eating, as it contains toxic substances (Zohary *et al*. 2012, 95). Whereas lentils and chickpeas, with a seed protein content of c. 2%, constitutes an important meat substitute in poor societies (Zohary *et al*. 2012, 87), they could also have been used as soil enriching plants and animal fodder.

In addition to the botanical remains mentioned above, an olive stone (*Olea europaea*), common grape (*Vitis vinifera*) pips and one indeterminate seed were uncovered in Room 18.

Room 19

Room 19 has an area of 8.96 square metres (dimensions 2.8 m × 3.2 m). The floor of Room 19 yielded a significant amount of charcoal, especially in the northern part, which might originate from carbonized wooden containers that once held cereal seeds, judging by the large amount found there (Fig. 4). Other finds from this room include several bowls, a lentoid flask, a frying pan (?), flint blades and spindle whorls. Below the beaten earth floor (L377), a flat surface, which was covered by pottery sherds, was exposed (L396). A juglet and a flint blade were found on this floor.

In total, six samples were collected from Room 19, which are the richest found in the compound. They contained various taxa including cereals, vegetables and fruit. Two of the samples consisted just of charcoal. In a sample from L396 (below the floor of the room) a seed of flax (*Linum usitatissimum*), lentils, pomegranate (*Punica granatum*) and indeterminate gourd family (Cucurbitaceae indet.) seeds were identified. Pomegranate, olive, common fig and date palm are among the oldest group of fruit trees around which horticulture evolved in the Mediterranean basin (Zohary *et al*. 2012, 121). Flax was a major source of fibre and oil in the Old World and evidence for its cultivation stretches as far back as the Neolithic (Zohary *et al*. 2012, 101).

The most interesting samples were collected on the floor of Room 19 (L377). The group of cereals was dominated by emmer wheat (*Triticum dicoccum*). It was accompanied, in significantly lower quantities, by grains of hulled two-rowed barley (*Hordeum distichum*) and free-threshing wheat. In the case of the free-threshing wheats, distinguishing between the two relevant species (*Triticum durum* and *Triticum aestivum*) on the basis of

Fig. 5 Charred fruit of common grape wine (*Vitis vinifera*) with preserved stalks and pips

grains alone is not possible, as they can only be separated on the basis of rachis internodes, which were absent from the studied assemblage. The residue also included indeterminate wheat grains (*Triticum* sp.) and thousands of damaged fragments of cereals.

This assemblage of crops was mixed with some additional taxa including a few seeds of chickpea, common fig (*Ficus carica*), common grape, common vetch (*Vicia sativa*), fragments of olive stones and pieces of what is likely to be pomegranate (cf. *Punica granatum*). The quantity and quality of the mixture indicate that those plants were accidentally included in the crop assemblage, most likely deposited during the destruction of the building. It is probable that the crops were primarily associated with the grains and seeds of segetal and ruderal plants brought from the field together with the harvest. They are represented by darnel (*Lolium temulentum*), cyperus (*Cyperus* sp.), brome grasses (*Bromus* sp.), fescue (*Festuca* sp.), plantain (*Plantago* sp.), sorrels (*Rumex* sp.) and representatives of the grass (Poaceae indet.), legume (Fabaceae indet.) and gourd families (Cucurbitaceae indet.).

Room 21

Room 21, the easternmost room of the compound, has a different layout when compared with all the other rooms: it is divided into a northern space (Room 21A) and a southern space (Room 21B) by a 0.5 m wide wall. The adjoining spaces are connected by a small doorway. Room 21A is 2.9 m × 1.4 m (4.06 square metres) and Room 21B 3.0 m × 1.5 m (4.50 square metres).

The main feature in Room 21A was a container of greenish-brown sun-dried clay. The container consists of two “chambers”, both roughly 0.1 m wide and 0.8 m high. The stone walls next to them also were covered with a layer of clay, as well as the bottom of the containers. The western “chamber” is the larger of the two and occupies the whole width of the room measuring 1.25 m × 1.0 m (inner dimensions). Its volume is approximately 1 m^3. The other “chamber” is built against the northwestern wall of the former and its surface is approximately 0.6 m × 0.55 m. It has a volume of 0.26 m^3. Room 21B was crowded with ceramic vessels and other finds, which include nine storage jars, a cooking pot, bowls, kraters and jugs, basalt weights and mortars.

	EARLY IRON AGE		IRON AGE										
	JORDAN								ISRAEL			SYRIA	
SITE	**Tell Abu al-Kharaz**	**Deir ‘Alla**	**Tell Abu al-Kharaz**	**Tall al-‘Umayri**	**Dhiban**	**Tall Hesban**	**Tall Jawa**	**Pella**	**Tell Qasile**	**Shiloh**	**Ashkelon**	**Ain Dara**	**Tell Mishrifeh**
REFERENCES		van Zeist and Heeres 1973, 22	Fischer and Holden 2008, 315–319	Ramsay and Mueller 2016, 17–18	Fatkin et al. 2011, 260	Gilliland 1986	Daviau 2002, 307	Willcox 1992, 255	Kislev and Hopf 1985	Kislev 1993; Liphschitz 1993	Weiss and Kislev 2004	Crawford 1999,120	Peña-Chocarro and Rottoli 2007, 141, table 18
CEREALS													
einkorn wheat (*Triticum monococcum*)													x
emmer wheat (*Triticum dicoccum*)	x	x		x					x		x		
bread/maccaroni wheat (*Triticum aestivum/durum*)	x	x		x	x	x		x		x	x	x	
einkorn/emmer wheat (*Triticum monococcum/dicoccum*)			x										x
wheat (*Triticum* sp.)	x		x	x	x	x	x						x
two-rowed barley (*Hordeum distichum*)	x	x	x	cf.x		x		x	x	x	x		
six-rowed barley (*Hordeum vulgare*)				x					x	x		x	x
barley (*Hordeum* sp.)					x	x	x						x
oat (*Avena* sp.)										x			
rye (*Secale* sp.)				x									
millet (*Panicum* sp.)				x									
LEGUMES													
chickpea (*Cicer arietinum*)	x	x		x			x	x			x		
alfalfa (*Medicago sativa*)								x					

pea (*Pisum sativum*)		x		x				x				x	
lentil (*Lens culinaris*)	x	x		x			x	x	x	x	x	x	
lentil (*Lens* sp.)						x							x
bitter vetch (*Vicia ervilia*)		x		x				x		x	x		x
broad bean (*Vicia faba*)							x		x	x			
common vetch (*Vicia sativa*)	x			x								x	
grass pea (*Lathyrus sativus*)	x			x									
wild/grass pea (*Lathyrus cicera/ sativus*)									x	x	x		
pea/vetch (*Lathyrus* sp./Vicia sp.)			x										x
OTHER ECONOMIC PLANTS													
common grape (*Vitis vinifera*)	x	x		x	x		x	x	x	x	x	x	x
common fig (*Ficus carica*)	x			x	x	x	x		cf.x	x	x	x	
sycamore fig (*Ficus sycomorus*)											x		
common flax (*Linum usitatissimum*)	x	x						x	x	x			
olive (*Olea europaea*)	x						x	x		x	x		x
date palm (*Phoenix dactylifera*)	x							x					
pomegranate (*Punica granatum*)								x			x	x	
terebinth (*Pistacia palaestina*)										x			
pistacia (*Pistacia* sp.)				x			x				x		
Palestine oak (*Quercus callipri-nos*)										x			
oak (*Quercus* sp.)											x		
almond (*Amygdalus communis*)											x		
almond (*Amygdalus* sp.)							x	x					
plum/cherry (*Prunus* sp.)									x				

Table 3 Taxa from selected (early) Iron Age sites of the Levant

In both parts of the room (21A and 21B) the remains of common grape were recovered in two forms: the whole fruits (Fig. 5) and pips attached to the fruit flesh.

Agriculture in the Iron Age Levant

Although many archaeobotanical studies[9] have been conducted at Levantine sites, many of them focus on different periods and/or environments than our study. Nevertheless, data from eleven Iron Age sites in modern Jordan, Israel and Syria were collected for comparison (Table 3).[10]

It should be remembered that each of these sites has its own method of sampling and processing of the material, which might have influenced the final results. Therefore, the table was constructed to provide information on the occurrence of taxa at the selected sites, in order to correlate the cultigens, and not to compare quantities.

In general, it seems that the agricultural practices of the inhabitants of Tell Abu al-Kharaz were similar to many of the contemporaneous communities in the surrounding regions. However, it became obvious during the collection of data that although emmer wheat was still present in the materials of other Iron Age sites, it is the bread/macaroni wheat which dominates the assemblages. In contrast, emmer outstands the remaining crop species at early Iron Age Tell Abu al-Kharaz. Moreover, it seems that there was a tendency to cultivate hulled wheat by the community of Tell Abu al-Kharaz already in the Early, Middle and Late Bronze Ages according to studies conducted by Holden (see Fischer and Holden 2008, 311–322).[11] The rich assemblage from the floor of Room 19 (L377) will be discussed in more detail.

The cultivation of emmer wheat at Tell Abu al-Kharaz

From the dominant group of wheat in the sample from Room 19, a subsample of 100 randomly chosen grains was measured. Three dimensions were taken (length, breadth and thickness) and indexes

	Length	Breadth	Thick-ness	index	
				L/B	T/B
Min	3.5	2.0	2.0	116.7	50.0
Max	6.0	4.0	3.5	225.0	120.0
Mean	5.1	3.2	2.6	157.5	81.6

Table 4 Dimensions of emmer wheat (in millimetres)

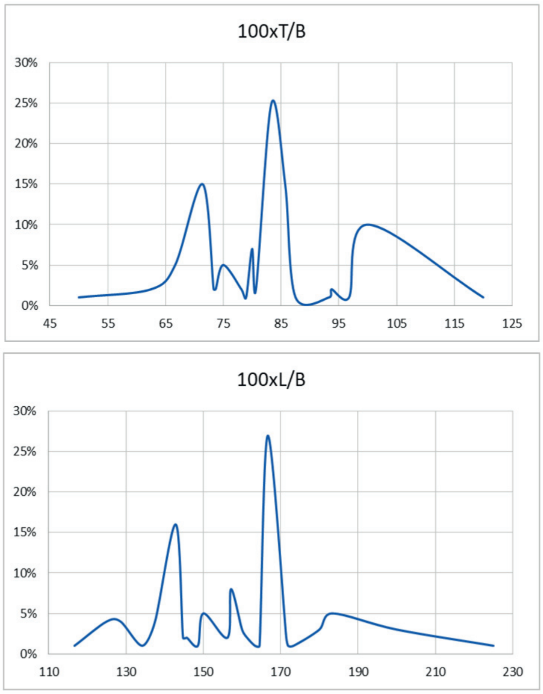

Fig. 6 Indexes for emmer wheat of Tell Abu al-Kharaz (L = length;B = breadth, T = thickness)

were calculated (Table 4; Fig. 6) in order to characterize the variability within the stored wheat crop and verify the identification. The measurements showed that the average length of grains was 5.1 mm, the breadth 3.2 mm and thickness 2.6 mm. Most of the L/B indexes are placed around 170 whereas T/B around 85. The ratios of L/B lower than 170 possibly indicate that the grains are bread/macaroni wheat, while the ratios above 170 turn the interpretation towards emmer wheat (Jacomet 2006). Nevertheless, it needs to be

9 Databases of archaeobotanical studies: https://www.sas.upenn.edu/~nmiller0/biblio.html (15.04.2018) and *Archaeobotanical Database of Eastern Mediterranean And Near Eastern Sites* (*ADEMNES*) (http://www.ademnes.de/database.php).

10 The table was constructed using data collected from available literature and *ADEMNES*.

11 The main focus of these studies was the Bronze Age botanical remains. Consequently, only very few samples from Iron Age contexts were analysed, which all come from Iron Age II layers (Personal information by P.M. Fischer, 14th September 2018). These will not be discussed in detail.

borne in mind that although the indexes are widely used by archaeobotanists (e.g. van Zeist 1970; Regnell 1994), they do not always provide a definitive taxa identification (Lityńska-Zając and Wasylikowa 2005, 219) due to the variability of grains from the same taxa and shrinkage that might occur during charring. Based on the indexes and identification under the microscope the grains were determined as emmer wheat.[12]

It is generally thought (van Zeist and Bakker-Heeres 1985; Riehl 2009, 103) that by the end of the Early Bronze Age, emmer wheat gave way to bread/macaroni wheat, which has been dominant since. However, emmer outnumbers the remaining crop species in the early Iron Age Tell Abu al-Kharaz material. One of the reasons could be its higher resistance to soil salinity. Based on the presence of weeds including plantain and sedges, we may assume that the fields of Tell Abu al-Kharaz were most probably irrigated, which might have increased the salinity of the soil.

The choice of cultivating emmer wheat could also have an economic basis. Emmer wheat has good drought tolerance as well as being able to grow in poor soils and resist fungal diseases if stored within the glumes (Riehl 2009, 98). If left in chaffs, it can therefore be stored for longer and survive in more humid environment (Hillman 1984), which may have been the case in the basement rooms, from where it was sampled.

Archaeobotanical (Riehl 2009) as well as physicochemical (Riehl *et al.* 2014) studies have shown that the transition between the Late Bronze and the Iron Age in the Levant, Mesopotamia and Northern Syria – in contrast to the Middle Bronze Age – is characterized by slightly less arid conditions and a momentary rise in precipitation throughout the entire Levant (Langgut *et al.* 2014, 16). Nonetheless, it must be noted that there were regional differences and the climate and precipitation were not the same all over the ancient Near East (Riehl and Shai 2015; Kaniewski *et al.* 2010). Additionally, in many regions of the Levant, the beginning of the Iron Age is known as a period of crisis: the collapse of Late Bronze Age societies, which are characterised by extensive trade networks and far-reaching cultural contacts throughout the Eastern Mediterranean – including Transjordan – and beyond, resulted, inter alia, in altered political and social conditions (see e.g. Ward and Joukowsky 1992; Oren 2000; Killebrew and Lehmann 2013; Fischer and Bürge 2017). It is possible that in uncertain times households became more self-sufficient and started creating surpluses (Venturi 2015, 92–93), and emmer wheat was a good choice for storage beyond a single season. Considering the evidence from Tell Abu al-Kharaz in the light of other Iron Age sites, it seems that ecological, cultural, economic and social factors played an important role in determining the varieties of crops chosen at various locations.

Different cereals have various requirements as regards soil and moisture. Barley, compared to wheat, is more resistant to drought and soil salinity. Therefore, growing more than one species of cereal, as was the case at Tell Abu al-Kharaz, could have been a farming strategy intended to minimize the risk of crop loss (Mueller-Bieniek *et al.* 2015, 673). Moreover, it seems to have been widely practiced across the ancient Near East.

Crop processing at Tell Abu al-Kharaz

In his ethnographic studies of traditional farming systems in Turkey, Hillman (1984) identified 30 various operations that are involved in preparing crops for consumption. After the crops are harvested, they are processed following a series of steps, which include threshing, several rounds of winnowing, and sieving with meshes of different sizes to remove contaminants. Each of the stages produces products and by-products, inter alia straw, chaff and weed seeds, all of which can be found in archaeobotanical assemblages of crops. Depending on the stage at which the crop is put into storage, samples of different compositions can result.

The material recovered from Room 19 appears to be the remains of a crop which had been well cleaned with only two remains of chaff (one spikelet fork of wheat and one rachis of barley) and very few small-seeded[13] weed contaminants, which

[12] Another method to verify the species of plants is geometric morphometric analysis (e.g. Ros *et al.* 2014; Bonhomme *et al.* 2017). However, it requires a series of high-resolution microscopic photographs, measurements and calculations, which at the time of conducting the archaeobotanical research of the Tell Abu al-Kharaz material could not be provided.

[13] For further information on this topic see Bogaard *et al.* 2005.

Fig. 7 Germinated grain of emmer wheat (*Triticum dicoccum*)

most probably were simply overlooked during hand sorting (Hillman 1984; Jones 1984). The ratio of weeds to grains was just 0,36 %.

The assemblage represents prime grain in the final stages of crop processing awaiting meal preparation. It is likely that the wheat was stored for some short time, i.e. a couple of days, in this cleaned condition. Moreover, it seems that some of the grains started germinating (Fig. 7) – most likely the result of the humid conditions in Room 19. This means that the grains were kept there for at least three to four days for germination to start. Therefore, the grains stored in Room 19 seem to have been kept for consumption rather than to be sown in the next season, although we should take into account the possibility that the grains germinated unintentionally.

It is probable that these grains were intended to be ground into gruel or further into flour and turned into bread. Tools and installations related to the production of bread, such as mortars and ovens (*tawabin* and *tananir*) were uncovered in the discussed compound. Although it has been suggested that *tawabin* and *tananir* were more commonly used for bread baking than for "stove-top" cooking (e. g. Ben-Shlomo 2011, 273; Badre 2011, 150), smaller scale installations, which were used just by one household, might have served both functions – baking and cooking. Although there is no direct archaeological evidence, this might also have been the case at early Iron Age Tell Abu al-Kharaz, as the diameters of the bodies of all cooking pots are large enough to be placed on the open rims of the preserved *tananir*. In addition, Badre (2011, 150) pointed out that *tananir* could have been used in a secondary stage, when the walls of the oven were collapsed but still preserved to a sufficient height.

Another matter that requires discussion is the composition of the crop assemblage: as mentioned above, the presence of vegetables and fruit most probably was accidental in the analysed assemblages (although these were probably stored in the same room), whereas the ruderal and segetal plants may have been brought from the field together with the harvest. However, glume wheats (such as emmer) and free-threshing wheats (such as durum and bread wheat) are rarely grown together as mixed crops owing to the different steps required to process the crops post-harvest. Consequently, they are harvested and stored separately, in order to avoid mixing of grains destined for next year's sowing. These wheats may have been mixed in the collapse of the early Iron Age compound, when the containers in which these were stored broke or were burned.

In addition, remains of hulled two-rowed barley were retrieved from the described assemblage. Barley can withstand drier conditions and poorer soils than wheat and is the main component in beer fermentation (Zohary *et al.* 2012). It was considered to be poor people food, nonetheless it was used to prepare bread and porridge (Zohary *et al.* 2012, 52). Furthermore, it was grown as fodder for large populations of livestock, when forage was minimal (Crawford 1999). If one continues in the vein of crops awaiting meal preparation, it is suggested that wheats and barley were stored next to each other and may have been mixed in the course of the collapse and conflagration of the building.

Conclusions

Although further archaeobotanical studies are essential, the following preliminary conclusions on the significance of cultivated plant species in the agriculture and economy of early Iron Age Tell Abu al-Kharaz can be drawn:

The analysed samples consisted of edible plants such as barley, wheat, chickpea, grass pea, flax, lentil, olive, pomegranate and common grape vine. The dominant crop species is wheat, and only 65 grains of barley have been found in all the samples. Although this proves that barley was present and most probably also cultivated in early Iron Age Tell Abu al-Kharaz, it may have been less common, or it was not preserved in the compound where the samples were collected, or stored elsewhere. The presence of a spikelet fork (although only one) indicates that the assemblage consisted of species of hulled wheats. It seems that emmer was more common on the site than bread/macaroni wheat. The evidence of germinated grains may point to the preference of the inhabitants of the compound to storage grains rather than flour, possibly due to the humid environment in the basement.

Grapes also played an important role for nutrition, perhaps for both humans and animals. They may also have been cultivated for wine production, but there is no direct evidence of it in the early Iron Age settlement of Tell Abu al-Kharaz. Other plants which were used for food or fodder include fig and pomegranate, but neither of them occurs plentiful in the sampled areas.

As regards cultivation, it is suggested that the crops with the greatest water requirements were harvested on the slopes of the tell or surrounding areas with better access to rainfalls. They may also have been irrigated. Emmer wheat, which has a lower water demand, may have been harvested elsewhere with a lower water supply. An additional proof for irrigation is the presence of sedges and plantain (Farahani *et al*. 2016, 43).

In summary, the rich material from the compound is a result of the excellent preservation conditions at the site and the fact that later settlers left the compound largely untouched. The question, whether the present compound with its cell-plan structure is to be interpreted as regular basements for several households or may have served as communal storeroom, will be discussed in a further study (Bürge in press). Judging by the calculated minimum storage capacity of the whole compound of 2173 litres, which includes all ceramic storage vessels and the clay silo in Room 21A, it seems more likely that the building, and especially its basement (which has an area of 182.5m^2), reflects a domestic storage facility. Based on the area of the building and an evaluation of the find assemblages, at least three to four households, or roughly 30 to 40 persons may have lived in the compound (Bürge in press)[14]. This is also supported by the fact that the botanical evidence represents a wide variety of crops and other edible plants.

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[14] It is difficult to assess the exact storage needs of one household, especially if the number of persons per household is unknown. Calculations carried out by Nowicki (1999, 156, table 2), which are mainly based on ethnographic studies, suggest that around 1000 litres of cereals, 300 litres of pulses and 300 litres of olive oil have been stored through the year to support a family of five persons. Although these figures refer to a Late Minoan IIIC settlement on Crete, we may assume that a similar amount would have been stored at early Iron Age Tell Abu al-Kharaz.

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