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A day in the life of an Ubaid household: archaeobotanical investigations at Kenan Tepe, south-eastern Turkey

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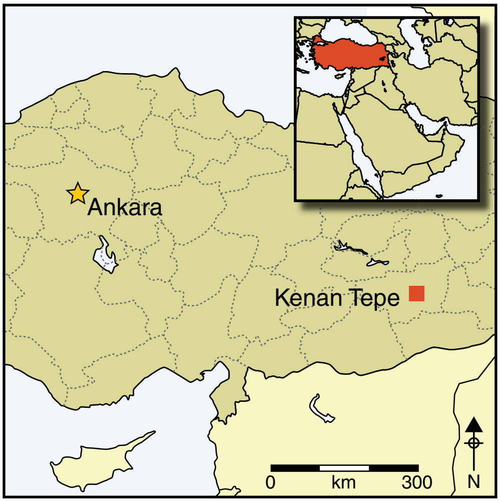

The Ubaid period in south-west Asia constitutes a key period of social and political change anticipating the emergence of complex societies in the following millennium. Well-preserved archaeobotanical assemblages have enormous potential to document these changes at both the site and individual household levels. The conflagration that consumed Structure 4 at the Ubaid settlement of Kenan Tepe in south-eastern Turkey provides a case study through the analysis of almost 70 000 charred macrobotanical remains. The results suggest that labour may have been pooled between households to process emmer wheat to spikelet stage after harvesting. Final processing was conducted on the roof of the house by members of the individual household as need arose. The pooling of resources may reflect the intensification of production and the emergence of elites during the Ubaid period in this region.

Keywords: Turkey, Kenan Tepe, Ubaid period, fifth–fourth millennia BC, archaeobotany, agriculture

Introduction

The Ubaid period in south-west Asia (7300–6100 BP) was a time of rapid political, economic and social change. The production of larger amounts of agricultural produce and privatisation of crop surpluses are thought to have accompanied increased social complexity (Huot 1989; Algaze 2001; Stein 2010) but, to date, the nature of Ubaid agricultural production has not been thoroughly assessed using archaeobotanical evidence, and publications reporting plant remains from Ubaid period sites are scarce. Critical assessment of any relationship between intensified agricultural production and social change cannot be achieved until more archaeobotanical data from Ubaid period (and earlier) sites

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across Mesopotamia are available. This paper presents the contents of 30 archaeobotanical samples retrieved from an Ubaid house structure at Kenan Tepe. The house burned down in a catastrophic fire which resulted in excellent preservation of charred plant remains across the structure. The excellent preservation combined with spatial patterning of plant remains allow us to discuss crop storage, crop processing, household economy and the social and economic organisation of labour at the site. Currently, this assemblage represents the largest published corpus of Ubaid plant remains examined from a single site and, as such, contributes towards a much needed regional dataset.

Ubaid Structure 4: the burnt house

Under the direction of Bradley Parker, excavations at Kenan Tepe, a 4.5 hectare, multi-period tell located on the banks of the Tigris River in the Diyarbakır Province of south-eastern Anatolia, took place between 2000 and 2008 as part of the Upper Tigris Archaeological Research Project (UTARP). Excavations revealed occupations dating to the Ubaid, Late Chalcolithic, Early and Middle Bronze Ages and Iron Age (Figures 1 and 2; Parker *et al.* 2009 and other Parker *et al.* papers cited therein). The Ubaid remains were restricted to the eastern side of the main mound and have been divided into four stratigraphic phases, all dating to between 6700 and 6400 BP (a breakdown of phasing is provided by Parker *et al.* 2008: 4). Structure 4, examined here, dates to Phase 3, placing it within the Ubaid 3/4 transition, a time that witnessed an Ubaid expansion throughout northern Mesopotamia.

Excavations of Structure 4 revealed 15 rooms of a domestic tripartite house, the western portion of which was not preserved (Figure 3). The fire that destroyed the structure was concentrated within the core of the house (Rooms 1 to 4), resulting in excellent preservation of dense quantities of plant remains in this area (Parker *et al.* 2009: 90–91; Graham 2011). 14 samples were examined from the core (Table 1). During the conflagration, the roof of Room 1 collapsed. Within Room 1, distinct layers of roof collapse and room collapse lay atop the floor. The roof collapse layer contained very large amounts of well-preserved, charred cereals, some of which were spilling out of a partially preserved reed basket (Parker *pers. comm.* 2010). Unfired clay tubs and basins were also intermixed within the roof collapse (Parker *et al.* 2009), indicating that the roof served as a workspace containing multiple activity areas. From the thickness of collapse deposits in other rooms, Parker concluded that the roof workspace did not extend beyond Room 1.

Outside the core, the fire was less intense, resulting in sub-optimal preservation conditions. Unfortunately, samples were not collected from Rooms 8, 9, 11 and 15. Individual samples taken from Rooms 6, 7, 10, 12, 14 and Outside Surface 2 yielded no charred remains at all. Sizeable concentrations of plant remains were recovered from Outside Surfaces 1 and 3, providing information on the nature of plant-related activities conducted around the house (Table 1; Figure 3).

Crop processing and plant use

The 30 samples associated with Structure 4 yielded 68 794 specimens from 22 genera. The assemblage was dominated by *Triticum dicoccum* (emmer) and *Hordeum vulgare* subsp.

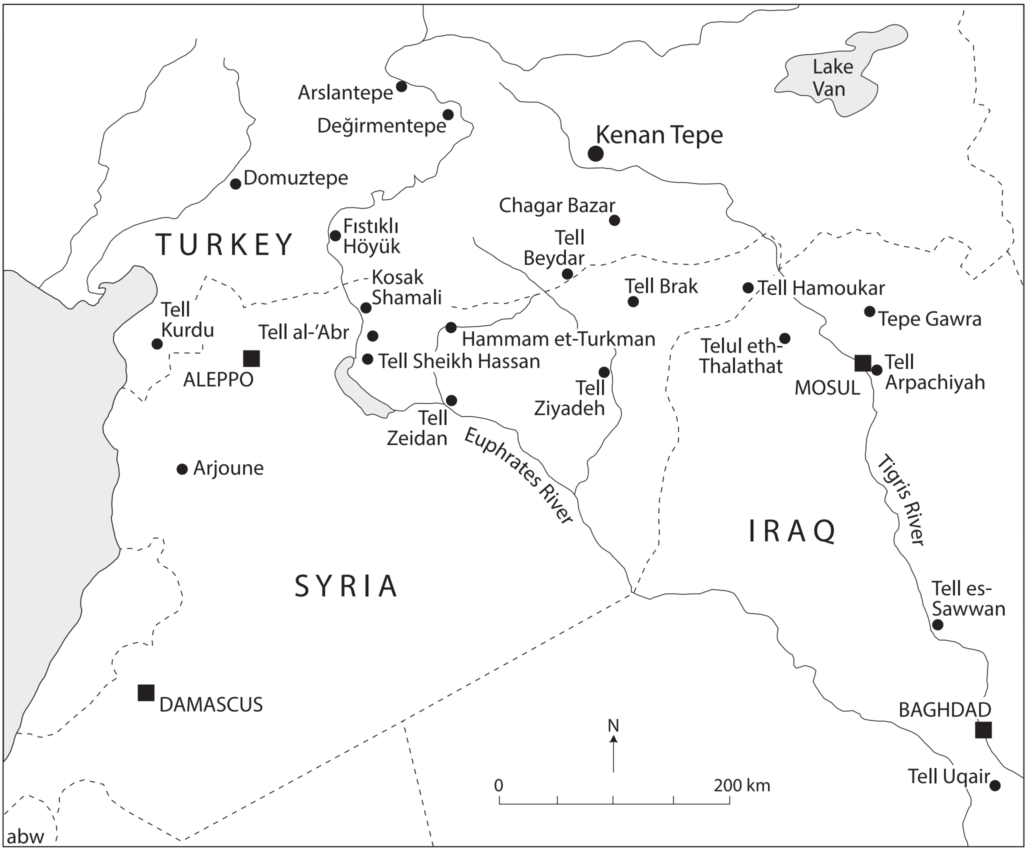

Figure 1. Map of important Ubaid period sites highlighting the location of Kenan Tepe (adapted from Carter & Philip 2010: viii–ix).

distichum (two-row hulled barley) (Tables 1 and 2). Small amounts of einkorn were also present, likely collected incidentally with the emmer crop. Large quantities of damaged or distorted grain were identified as *Triticum* and since no free-threshing wheat species were recovered, it is reasonable to assume that these remains represent glume wheat, most likely emmer. Lesser amounts of *Linum usitatissimum* (flax), *Lens culinaris* (lentil) and *Pisum sativum* (pea) were also present. Despite the modest proportions of legumes within the assemblage, sizeable caches of lentil and pea were recovered from the room collapse within Room 1, suggesting their importance to household diet (Table 1). Non-economic or weed taxa were very poorly represented. Their relative paucity is notable, and results from the way in which the crops were processed prior to storage.

Ethnographic studies have demonstrated that the major steps associated with crop processing have "a consistent and readily discernible effect on the composition of crop products and by-products" (Hillman 1984a: 39), allowing suppositions regarding crop processing stages to be made from archaeobotanical samples. While inferences can often be complicated by post-depositional mixing, the catastrophic fire within Structure 4 at Kenan

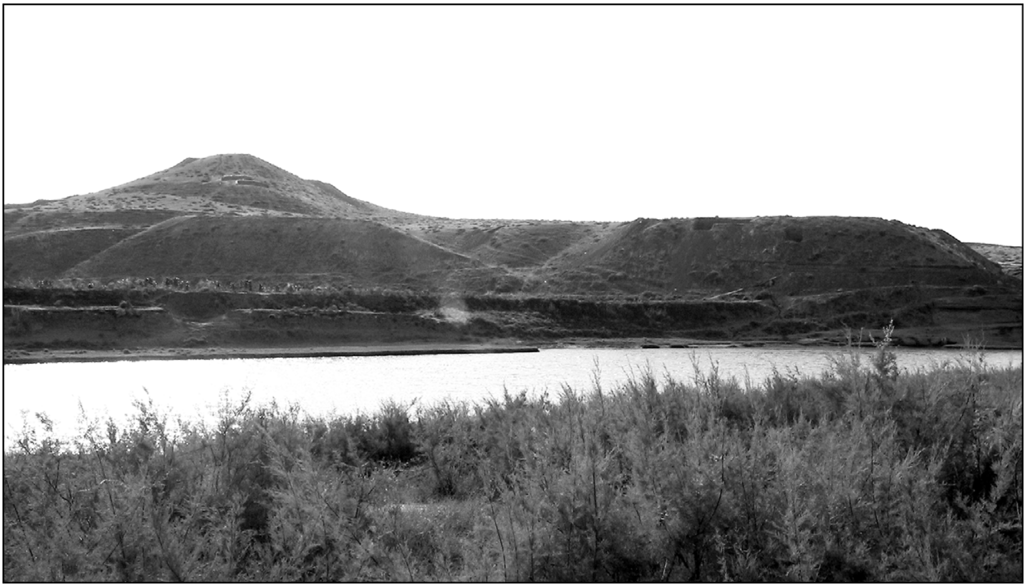

Figure 2. View of Kenan Tepe and the Tigris River taken from the south-east (image courtesy of UTARP).

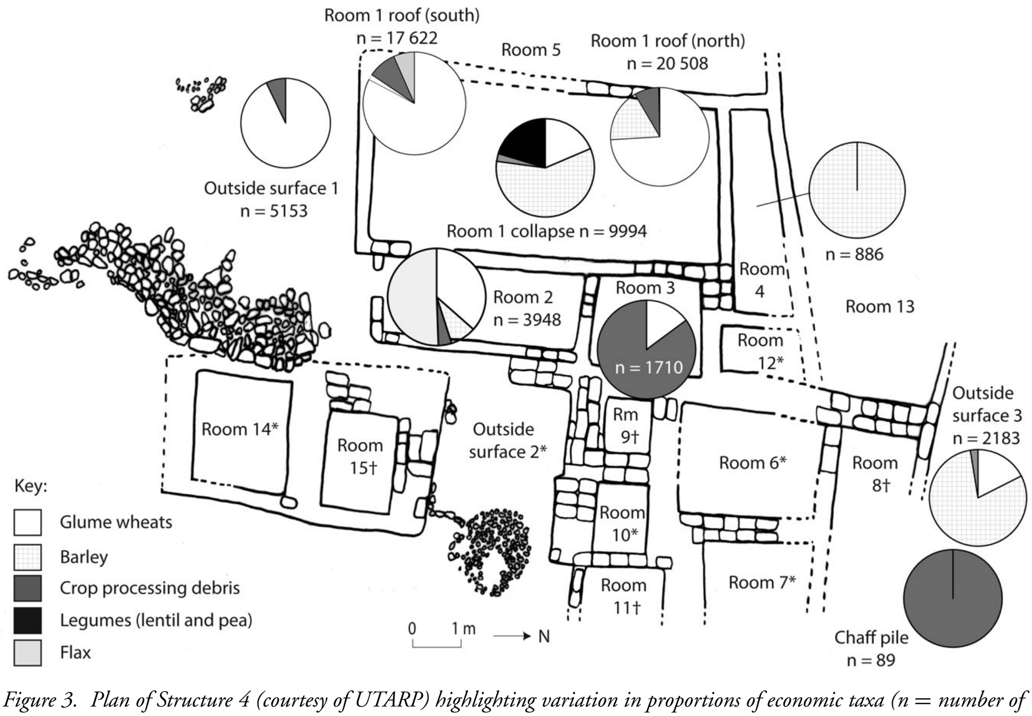

*Figure 3. Plan of Structure 4 (courtesy of UTARP) highlighting variation in proportions of economic taxa (n = number of specimens for economic taxa only). Specimens within each illustrated category were totalled; categories with <50 specimens were omitted to enhance clarity of the diagram. Omitted specimens are not included in the counts listed here. * = samples yielded no charred plant remains; † = room not sampled.*

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Table 1. Contents of archaeobotanical samples yielding charred remains.

	Room 1 (N roof)	Room 1 (S roof)	Room 1 (collapse)	Room 1 (floor)	Room 2	Room 3	Room 4	OS1*	OS3	Chaff pile
Number of samples	2	2	3	3	1	1	2	3	8	5
Mass of light fraction (g)	393.2	455.3	257	89	253	85	38	177	122	51
Volume of sediment floated (L)	20	10	22.5	23.5	2.5	8.5	3.5	7.25	36.5	23
Density of charred remains (g/l)	19.7	45.5	11.4	3.8	101.2	10.0	10.8	24.4	3.4	2.2
Wood (ml)	3.1	2.1	3.3	0.2	0.1	2.3	0.5	3.9	0.6	0.4
Charred animal dung (ml)	18.1	0.8	23.8	–	60.0	125.0	–	–	9.1	0.1
Hordeum vulgare L. subsp. *distichum*	3588	294	5852	5	337	254	886	23	1744	3
Triticum monococcum L.	234	14	38	–	24	7	–	5	12	–
Triticum dicoccum Schübl.	10 513	8077	1341	–	816	35	12	2260	242	1
Triticum sp.	4442	6494	478	17	625	202	7	2725	141	4
Triticum sp. tail grains	–	–	–	–	–	24	–	–	8	1
Triticum rachis fragments	42	55	3	1	2	325	–	4	–	1
Triticum glume bases **	1459	1500	188	2	248	1447	28	237	74	144
Cereal indet.	1653	713	937	21	426	143	133	526	91	6
Cereal culm internode	8	2	12	–	–	20	–	2	4	–
Cereal culm node	7	–	6	–	–	1	1	1	–	–
Cereal embryo	130	23	19	–	–	13	4	157	26	–
Lens culinaris Medik.	84	10	2029	3	–	27	7	7	–	1
Pisum sativum L.	1	–	444	–	–	1	–	–	–	–
Vicia/Lathyrus spp.	10	5	32	–	–	5	2	–	–	–
Medium legume indet.	4	–	10	–	–	20	–	–	–	–
Linum usitatissimum L.	2	1163	1	–	1996	1	–	–	1	–
Non-economic taxa	83	23	54	1	3	99	5	21	5	3
Number of specimens	22 261	18 373	11 444	50	4477	2624	1085	5968	2348	164

* OS = Outside surface

** Intact spikelet forks counted as two glume bases

Tepe preserved a narrow range of processing steps *in situ,* making it possible to reconstruct a sequence of activities that took place during a short period of time.

Much has been written about the processing stages of free-threshing cereals but, unfortunately, comparatively little has been written about glume wheats (but see Hillman 1981, 1984a & b; Charles 1984; Nesbitt & Samuel 1996; D'Andrea & Haile 2002). It is well understood that harvested emmer needs to be threshed, winnowed and sieved with a coarse mesh in order to extract the spikelets, but the processes associated with spikelet dehusking

Table 2. The ubiquity and proportions of taxa recovered from within and around Structure 4.

Taxon	Common name	Total count	Ubiquity (%) (30 samples)	Proportion (%) N = 68 794
Cereal indet.	–	4649	80	6.76
Triticum sp.	Wheat	15 135	63	22.00
Triticum monococcum	Einkorn	334	30	0.49
Triticum dicoccum	Emmer	23 297	50	33.86
Hordeum vulgare L. *subsp. distichum*	Two-row hulled barley	12 986	63	18.88
Culm fragments	Stems	64	23	0.07
Rachis fragments	–	433	33	0.55
Glume bases	–	5327	70	7.74
Lens culinaris	Lentil	2168	33	3.15
Vicia/Lathyrus spp.	Vetch	54	23	0.13
Pisum sativum	Pea	446	17	0.65
Linum usitatissimum	Flax	3164	20	4.60
Non-economic taxa	–	297	50	0.43

that separate the grain from the surrounding chaff are less clear. The use of parching is often cited within the archaeobotanical literature but, as Nesbitt and Samuel (1996) assert, ethnographic studies highlight the frequent use of other highly effective methods. In many countries where non-mechanised emmer processing has been observed, spikelets are sometimes sun-dried and then pounded with wooden pestles or mallets within a mortar; stone implements are less commonly used since they can damage the grains (Harlan 1967; D'Andrea & Haile 2002). Through this process, grains become detached from glumes, lemmas and spikelet forks, the latter of which often break into two glume bases (Hillman 1981: fig. 4). Separation of the freed grain from the spikelet chaff and any accompanying weeds can then be achieved by secondary basket winnowing and sieving with sequentially smaller sieve meshes. Open spaces, such as courtyards or roofs, provide opportune locations for this type of processing.

Several lines of evidence suggest that the inhabitants of Structure 4 stored emmer as well-cleaned spikelets. First, Rooms 9, 10, 14 and 15 were all interpreted by the excavators as storage structures. Unfortunately, no charred remains were recovered from these features, but impressions of intact spikelets are clearly visible in the sediment of Room 9 (Figure 4). Second, all of the emmer grain and by-products recovered from across the structure correspond with processing stages that extract pure grain caches from spikelets. Plant parts (e.g. culm or stem fragments) and small light weeds that tend to be removed during earlier processing stages, such as winnowing or coarse sieving, were rarely encountered in association with the structure (Table 1; Hillman 1984a: fig. 3, steps 1–7). Triangle plots of the data illustrating the relative proportions of cereal grains, chaff and non-economic taxa clearly demonstrate the paucity of non-economic taxa across the structure (Figure 5). Despite their scarcity, the species present are informative. Based on ethnographic studies of non-mechanised processing of free-threshing wheats, Jones (1984) observed that the size, headedness (the tendency of seeds to remain in large heads during threshing), and aerodynamic properties of seeds affected the processing stage at which different species

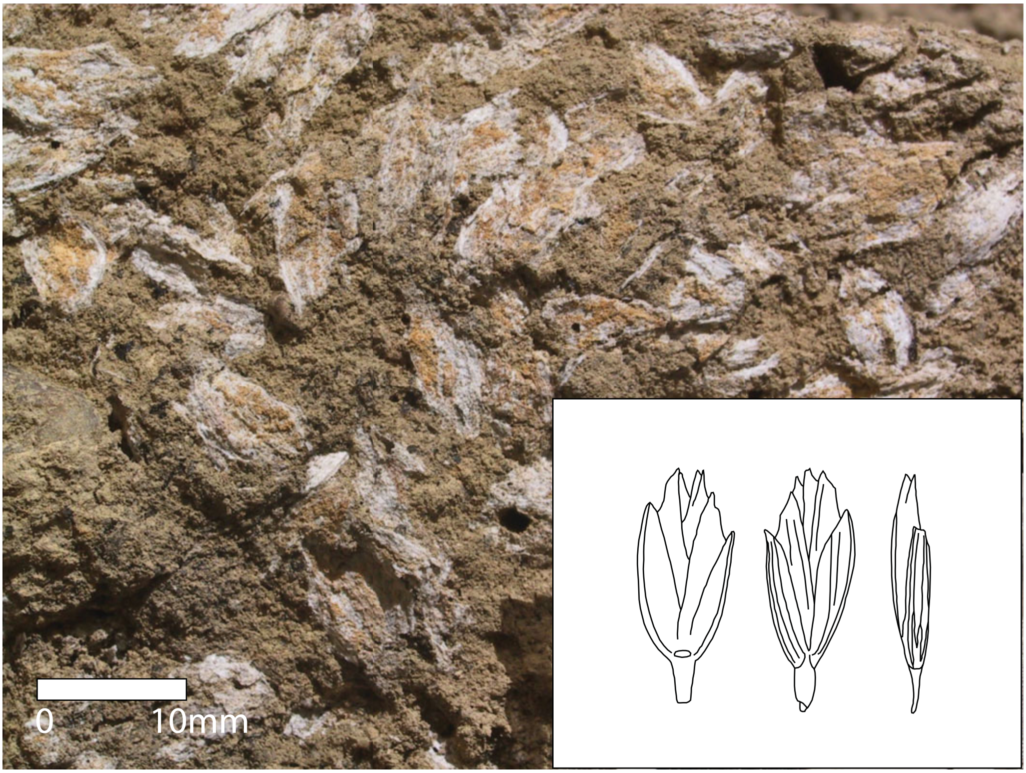

Figure 4. Photograph of spikelet impressions on cell floor from Room 9 (image courtesy of UTARP). Inset illustrates an emmer spikelet in ventral, dorsal and lateral view from left to right (adapted from Charles 1984: 18). Modern spikelets average 15mm in length.

were selectively removed. The vast majority of weed seeds recovered from the structure were small, free and heavy, indicative of fine-sieving by-products (Table 3). Ethnographic evidence suggests that threshing, winnowing and coarse sieving typically take place away from the settlement, so the absence of these steps in the archaeobotanical record is not too surprising. A single cache of chaff was recovered from Outside Surface 3 and the significance of this is discussed later.

It is reasonable to assume that people gathered basket loads of emmer spikelets from the storage structures and moved to the roof of Room 1 to process them as needed. Emmer spikelets usually contain two grains and two glume bases (the latter of which are the only chaff parts that routinely survive charring). As spikelets are processed, one would expect the grain:glume ratio to increase within the 'product' portion (and decrease within the by-product) with each progressive stage used to separate pure grain from by-products. Preservation issues complicate the simple application of ratios, however, since glume bases do not preserve as readily as grain (Boardman & Jones 1990). Stevens (2003: 68) reports a 2:1 ratio of grains to glume bases from the lining of a storage pit that was used to store intact spikelets at Danebury in England, where reduced atmospheric conditions resulted in optimal preservation of intact spikelets. A different sample from inside the same pit yielded

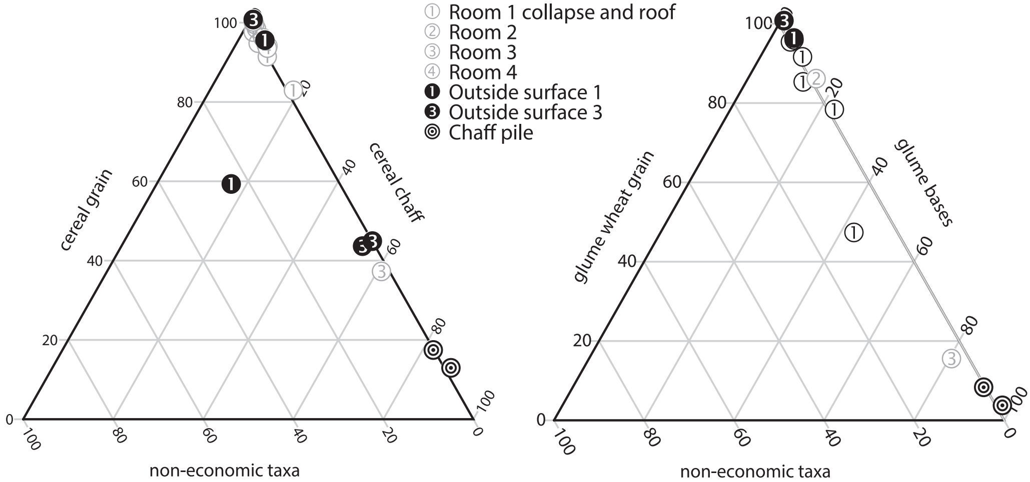

Figure 5. Triangle plot illustrating relative proportions of cereals and chaff (left) and glume wheats and glume bases (right) to non-economic taxa (only samples with ⩾50 specimens included).

a ratio of 10:1, so large disparities are possible. Nonetheless, the context and data from the roof of Structure 4 imply that people were in the process of removing grain from emmer spikelets on the roof when the house burned down. At the southern end of the roof, a large concentration of emmer grain within a reed basket yielded a grain to glume ratio of 405:1, indicating that it had been very well cleaned. Elsewhere on the roof, samples yielded grain to glume ratios of 3.1:1, 3.5:1 and 10.5:1, indicating that these remains represent either intact spikelets awaiting processing or spikelets that had been pounded but not sieved. Once cleaned, the grain was likely taken inside the structure for immediate use or short-term storage.

Room 4 appears to have served an important storage function. Excavators uncovered a medium-sized fired-clay vessel embedded in the floor and a mud-brick bin built into one of the walls (Parker *et al.* 2009: 88–89). The bin contained 886 two-row barley grains that were minimally contaminated with emmer grains, small amounts of chaff and the occasional weed seed (Table 1). Samples collected from the room collapse within Room 1 contained sizeable concentrations of two-row barley, emmer, lentil and pea (Figure 3). Sediment collected from the floor itself yielded very few charred plant remains, a common phenomenon in many houses across south-west Asia given the hardened, packed nature of the floors.

Finds on the floor of Room 1 include shell, various lithic tools, loom weights and spindle whorls, suggesting that textile production was an important activity within the household (Parker *et al.* 2009: 89, 130–32). Whether the fabric was produced strictly for household use or as a trade item is not clear, but since spindle whorls are relatively widespread at Ubaid sites (e.g. Sudo 2010), cloth production likely formed a routine component of household economies. It is unclear at present whether linen and/or woollen textiles were produced at Kenan Tepe, but linen production at a minimum seems likely. Concentrations of flax seeds were recovered from the roof of Room 1 and Room 2; while no flax fibres were recovered, the concentrations of seeds indicate that the inhabitants of Kenan Tepe had access to them. The seeds may have been kept to produce oil. There is no archaeological

Table 3. List of weeds recovered from Structure 4 and associated size, headedness and aerodynamic properties (derived from Jones 1984: 40; Van der Veen 1992; Hald 2008: 63).

	Weed seed category		
Weed species	Size	Headedness	Aerodynamic properties
cf. *Neslia* sp.	small	free	heavy
Vaccaria pyramidata Medik.	small	free	heavy
Silene sp.	small	headed	heavy
Polygonum sp.	small	free	heavy
Rumex sp.	small	free	heavy
Malva sp.	small	headed	heavy
Astragalus sp.	small	free	heavy
Trigonella sp.	small	free	heavy
Medicago sp.	small	free	heavy
Scorpiurus sp.	small	free	heavy
Valerianella sp.	small	free	heavy
Centaurea sp.	small	free	heavy
Adonis sp.	small	free	heavy
Galium/Asperula spp.	small	free	heavy
Bolboschoenus sp.	small	free	heavy
Teucrium sp.	small	free	heavy
Hordeum sp. (wild)	no data available (mimic crop?)	no data available (mimic crop?)	no data available (mimic crop?)
Hordeum/Lolium sp.	no data available (mimic crop?)	no data available (mimic crop?)	no data available (mimic crop?)

evidence for pressing at Kenan Tepe, but extraction on a small scale is certainly possible (Parker *et al.* 2009).

All of the samples associated with the core of the structure yielded grain-rich material indicative of late-stage processing, with the exception of one sample from Room 3 that may suggest small-scale storage of dung fuel. The sample contained 125ml of fragmented dung (identified using the criteria outlined in Charles 1998) intermixed with dense concentrations of cereal processing debris, two-row barley grains and a variety of wild taxa (Figure 5). The presence of grain within securely identified dung suggests that animals were foddered with barley and possibly crop-processing debris, although the latter can be added to dung fuel cakes to enhance their consistency. Similar assemblages were found at Abu Salabikh, where Charles (1998) also reported the use of fodder. Given that the season of dung-cake manufacture is not known, it is impossible to assert whether foddering at Kenan Tepe was practiced seasonally or continually.

Three areas outside of the structure were sampled (Figure 3). Samples from Outside Surface 2 were completely sterile, but dense concentrations of charred remains were recovered from Outside Surfaces 1 and 3 (Figure 3). Material recovered from Outside Surface 1 represents an almost pure cache of emmer minimally contaminated with two-row barley, einkorn and lentil (Table 1). This assemblage is very similar in proportion to that recovered from the northern side of the roof. Given that Outside Surface 1 abuts the northern edge of Room 1, it would appear that the remains from the ground represent spill as the house collapsed (Figure 3). Of the eight samples collected from Outside Surface 3, five contained fewer than five specimens, deeming them sterile. Two contained small amounts of cereal grains and processing debris. The eighth sample, however, contained a large cache of two-row barley grains contaminated with emmer and small amounts of dung (Table 1). This cache lay just west of an area identified by excavators as a 'chaff pile', where a concentration of white material, probably phytoliths, was encountered along with long, straw-like impressions in the sediment beneath the outward collapse of the wall from Room 1. The chaff pile yielded a small charred assemblage that contained mostly glume bases. Given that barley was present in high concentrations within the dung-rich sample recovered from Room 3, the barley-dominated grain cache from Outside Surface 3 alongside the chaff pile could represent fodder (Figure 5). While partially speculative, if this cache was indeed intended to be used as fodder, the grains had been well cleaned. As Jones (1998) notes, ethnographic evidence demonstrates that the boundary between food intended for human consumption and fodder is flexible, and in times of abundance, cleaned grains can be fed to animals.

Household economy: social implications

Given the catastrophic nature of the destruction of Structure 4, it is likely that the later-stage crop processing activities represented within the household spanned a day or two, although such actions were likely repeated frequently and, as such, represent typical events within daily life. Emmer, barley, lentil, pea and flax were all important contributors to the household economy. While consideration of the crops present is essential to any study of economy, archaeobotanical data have enormous potential to address much broader sets of social questions. As Palmer and Van der Veen (2002: 195) argue, the deposition of archaeobotanical remains within their archaeological contexts is both socially and culturally defined. Attempting to explore these social and cultural factors is particularly relevant during the Ubaid period, when increased social complexity is often associated with more intensive (or possibly extensive) methods of food production. The production of food surplus has frequently been linked with feasting, which would have served to build and maintain social networks and bonds (Pollock 2003). At present, there is no firm evidence for animal-based feasting at Kenan Tepe during the Ubaid period, but strengthening social bonds (potentially through food sharing) would have been important within small households, such as Structure 4, or in areas of low population density, where the availability of labour during the harvesting season may have posed a constraint on the extent to which crops could be harvested and processed before they were placed in storage.

Multiple factors affect the ways in which crops are stored. Hillman (1984a: 8) argued that in modern Turkey environment is an important determinant, whereby glume wheats tend to be stored in the spikelet in wetter areas and as fully processed grain in drier regions. Archaeobotanical data from Structure 4 at Kenan Tepe and elsewhere in south-west Asia (including fourth-millennium Kuruçay in western Anatolia and Tell Brak in Syria) do not corroborate this observation in antiquity, and demonstrate that glume wheats were stored in spikelet form also in dry areas (Nesbitt & Samuel 1996; Hald & Charles 2008). Storing grain in the spikelet imparts protection against insect pests, which would have been important in maintaining crop quality and quantity (Nesbitt & Samuel 1996: 51), but social considerations are also significant. As Stevens (2003: 72) states, storage represents an interim phase between harvesting and the daily processing of crops for consumption, so the form in which crops were stored reflects both the social organisation and availability of post-harvest, pre-storage labour.

A number of researchers have devised models linking relative proportions of grain, chaff and weeds to social aspects of Iron Age cereal production and use in the British Isles (Hillman 1984a; Jones 1985; Campbell 2000; Stevens 2003; Van der Veen & Jones 2006), and some of these models may have enormous potential for south-west Asia. Their direct applicability is limited here given that the models refer to plant remains preserved via different conditions than those evident in Structure 4, but some comments can be offered. According to Stevens (2003: fig. 7), small-scale household organisation of labour is linked with storage of unclean crops in sheaves or in partially threshed form, whereas larger-scale communal organisation of labour is associated with storage of semi-clean spikelets, as evident in Structure 4. If crop storage at Structure 4 does indeed signify communal organisation of labour, then the precise way in which this communal labour was organised is of great importance in understanding processes of social change. At the more egalitarian end of the spectrum, one can imagine several families voluntarily pooling labour to process grain more efficiently for their mutual benefit; with a shift to a chiefdom society, provision of labour may have been socially enforced through reciprocal obligation or some other means. At present, there is no way to distinguish between these two alternatives using plant data. Differing storage practices between households at both the intra- and inter-site level could, however, provide a marker for emerging elites, given their enhanced control over resources and labour, thereby providing an additional tool for examining social complexity. Since little evidence for storage of cereals on the sheaf exists in south-west Asia, it may be more useful to consider differences in storage of partially sieved versus un-sieved spikelets as a partial proxy for labour. While organisation of human labour is an important factor affecting the form of stored crops, the level of privatisation of resources, the availability of animal labour, weather conditions and the costs involved in transporting and storing unprocessed crops cannot be ignored (Halstead & Jones 1989). In this sense the size, nature and location of storage facilities reflects a household's socio-economic status as well as their expectations regarding projected crop yield and ability to pool labour.

Little can be said regarding agricultural intensification at Kenan Tepe during Phase 3 for several reasons. First, only late stages of crop-processing are evident in the remains from Structure 4. Since it is not fair to assume that the full range of crop weeds is represented, inferences regarding the methods used to grow crops are severely complicated. Furthermore, no pre-Ubaid plant data are available from the site, rendering temporal comparison of agronomic methods impossible. As the body of archaeobotanical data for the region grows, further comment will be possible. Van der Veen and Jones (2006) argue that regional patterns in grain-rich versus chaff-rich samples can be used to assess the scale of cereal production in Iron Age Britain. If their argument holds true within south-west Asia, the publication of archaeobotanical data from other Ubaid period and Halaf sites would enable the timing, nature and scale of agricultural intensification to be examined. With such a dataset, archaeobotany could be used to examine more rigorously the nature and scale of crop production and the organisation of labour, and to explore the link between food production and changing social organisation, thereby adding an exciting dimension to discussions of emerging social complexity.

Conclusions

This study provides detailed evidence of Ubaid plant use within a northern Mesopotamian household. The inhabitants of Ubaid Structure 4 used emmer wheat, barley, lentil, pea and flax. Cereal caches, crop processing debris and weed assemblages from the structure indicate late-stage cereal processing that suggests that emmer was stored in cleaned spikelet form and further processed on the roof of the house as needed. Dung fuel recovered from the structure indicates that animals were foddered with a mix of barley and legumes for at least part of the year. The data presented here illustrate that this small Ubaid homestead formed part of a community where labour may have been pooled for post-harvest, pre-storage cereal processing. Archaeobotany has enormous potential to contribute to discussions of changing social complexity, and this is best accomplished at the regional level.

Acknowledgements

We are indebted to all members of the Kenan Tepe excavation team and UTARP for providing us with samples and sharing contextual information and insights; special thanks are owed to Bradley Parker, Catherine Foster and Jason Kennedy. We thank Al B. Wesolowsky Graphics for preparing Figure 1, and Natalie Munro, Austin Hill and two reviewers for their comments on drafts of this paper. Their insights helped tremendously and are much appreciated. We also thank Mike Charles for permission to reproduce the inset in Figure 4. This research was funded by National Science Foundation Dissertation Improvement Grant number 09341 and the Curtiss T. and Mary G. Brennan Foundation.

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Received: 22 May 2012; Accepted: 21 August 2012; Revised: 6 December 2012