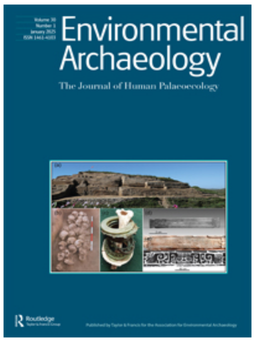

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Archaeobotany at Tel Bet Yerah (Khirbet el-Kerak): Aspects of Food Production in Early Urban and Diasporic Early Transcaucasian Communities of the Levant

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ABSTRACT
Archaeobotanical material from excavations at Tel Bet Yerah (Khirbet el-Kerak) provides insight into Early Bronze Age urbanisation in the Southern Levant and differences in food choices between Levantine and diasporic Early Transcaucasian communities. In the pre-urban period of the Early Bronze 1B (3350-3100 BC), comparative analysis of cereals and crop processing by-products indicates that food production was managed by individual households in a village type economy. The site dramatically changed in the Early Bronze II urbanisation period (3100–2850 BC). Household food production appeared stable throughout, however, there is evidence for beginnings of centralised storage of agricultural resources in the urban period at Tel Bet Yerah. During the Early Bronze III (2850–2500 BC), the site's urban organisation collapsed and migrant settlers bearing Khirbet Kerak Ware occupied abandoned sections of the site alongside local inhabitants. Comparison of crops and weed flora identifies that the two groups potentially cultivated and processed some of their crops separately and that the crop choices of the Khirbet Kerak Ware community maintained connections to northern Early Transcaucasian Culture culinary traditions.

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Early Bronze Age; Near East; urbanisation; Kura-Araxes; agriculture; identity

Recent decades have seen a proliferation of studies on Levantine Early Bronze Age (EBA) charred seed assemblages that provide evidence of the consolidation of a Mediterranean economy – grain, olive, grape – accompanying the transition from a village to an urbanising society (Borojevic 2006; Falconer and Fall 2006; Frumin et al. 2021; Fuller and Stevens 2019; McCreedy 2003; Riehl 2004; Salavert 2008; Simchoni and Kislev 2012; Simchoni, Kislev, and Melamed 2007; White, Chesson, and Schaub 2014; White, McCreedy, and Toro 2020). Also, recent archaeobotanical studies of Kura-Araxes, or Early Trancaucasion Communities (ETC) – of which the 'Khirbet Kerak Ware' (KKW) producers/users of the northern Jordan Valley are the southernmost expression – have established the core recurrent features of this agropastoral lifestyle, which reached its broadest extent in the first half of the third millennium (Decaix et al. 2019; Hovsepyan 2015; Longford 2015). Our study of Tel Bet Yerah (TBY) complements these, as it is the first to emerge from a systematic programme of sampling, targeting several important transitions and interactions in a site that exhibits both a stratigraphic sequence that extends from EB IB village to early EB III urbanising stages and interaction between coeval local-tradition and KKW-using communities. Although preliminary in nature, our study provides important insights into the management of agricultural products, labour organisation and group identity at TBY over the Early Bronze Age.

Archaeological Setting

Tel Bet Yerah, also known as Khirbet el-Kerak (32.718° N; 35.572° E), is located at the head of the Kinrot valley; about 30 hectares in size, it lies on top of a low mound between the southwestern shore of the Sea of Galilee (Lake Kinneret) and the ancient channel of the Jordan River (Figure 1). The site was first excavated in 1933, and in every decade since then by numerous excavators (Greenberg and Paz 2006). In 2003, excavations were renewed by Tel Aviv University in the northern part of the mound, adjacent to areas previously excavated.

The excavations have shown that the settlement began as a scattered village, ca 3600 BCE (EB IA)

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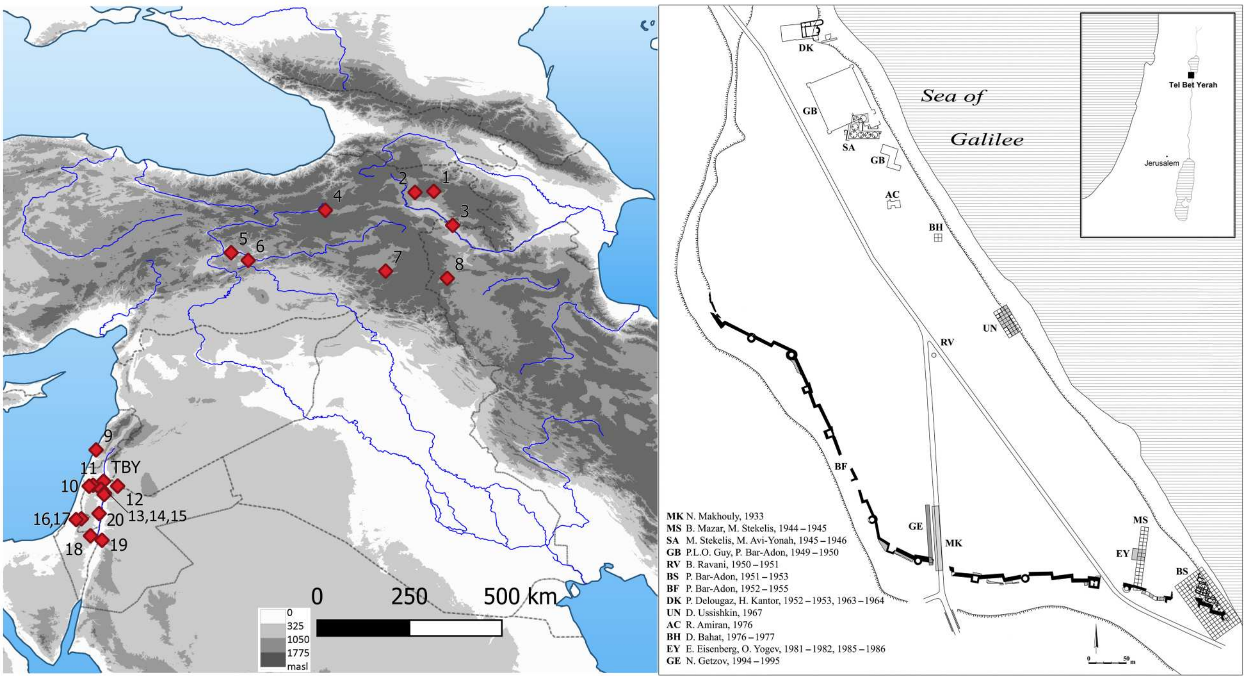

Figure 1. Location map and plan of Tel Bet Yerah. **A**. Location of Tel Bet Yerah (TBY) and other sites mentioned in the text: 1. Aparan, 2. Tsaghkasar, 3. Maxta, 4. Sos Höyük, 5. Aşvan, 6. Tepecik, 7. Dilkaya, 8. Haftavan, 9. Sidon, 10. Megiddo, 11. Afula, 12. Zeraqōn, 13. Tell Beth Shean, 14. Tell Abu Al-Kharaz, 15. Tell el Handaquq, 16. Tell eṣ-Ṣâfī, 17. Tell Yarmouth, 18. Arad, 19. Numayra, 20. Jericho. **B**. Plan of Tel Bet Yerah and of the 2003–2015 excavations (Dov Porotsky and R. Greenberg; Tel Bet Yerah Archaeological Project).

growing to its maximum size during the EB IB (ca. 3200 BCE), and eventually forming a walled city in EB II (ca. 3100–2850 BCE), characterised by rectangular houses defined by a network of orthogonal paved streets with three construction phases (Paz and Greenberg 2016) (See Table 1 for chronology; Regev et al. 2019). The early EB III settlement (c. 2850–2700 BCE) inherited this basic layout, while introducing monumental architecture, such as the massive, unfinished 'Circles Building' (Greenberg et al. 2012, 97; Greenberg et al. 2017). In this period a new ceramic culture, the Khirbet Kerak Ware (KKW), was introduced to the site by people bearing a distinct cultural and technological package (Greenberg 2021; Iserlis 2009; Paz 2009) that is widely seen as the southern extension of ETC, originating in the Kura-Araxes basin (Greenberg, Iserlis, and Shimelmitz 2014; Ishoev and Greenberg 2019). Its bearers settled in houses that had been abandoned at the end of EB II and in the foundations of the Circles Building, alongside local residents (Greenberg et al. 2017).

An unpublished study of phytoliths from a small number of contexts excavated in 2003 and 2007 suggested significant dominance of wheat over barley in all phases. It also appeared to demonstrate the presence of greater proportions of wild plants, at least for the late EB II, and a change in the plants commonly used in the Circles Building upon the arrival of the presumed ETC migrants (Tan n.d.; Greenberg et al. 2017). A study of charred plant material from the 1982–1986 excavations, primarily from EB IB contexts, indicated the potential of a more systematic programme of retrieval (Liphschitz 2014), and identified remains of olive, wheat and legumes, as well as arboreal vegetation similar to that of the present day.

A central aim of the renewed excavations of 2003–2015, which centred on the Circles Building and its environs, was the retrieval of data relating to human

Table 1. Tel Bet Yerah chronology (Regev et al. 2012, 2019).

Tel bet yerah period	General period (S. Levant)	Main finds	Ceramic culture	Approximate calendric date	Contemporary cultures
A	EB IA	Refuse pits	Gray Burnished Ware	3600–3350	Middle Uruk
B	EB IB	House compounds and refuse pits	Grain-wash ware	3350–3100	Late Uruk, Egyptian predynastic
C	EB II	First planned fortified settlement	South Levantine Metallic Ware	3100–2850	Egypt Dynasty I; Amuq G
D	EB III	Crisis and rebuilding; arrival of 'Khirbet Kerak people'	Local tradition and Khirbet Kerak ceramics	2850–2500	Egypt Dynasties 2–4
E	EB III final	Urban decline	'Terminal EB'	2500–2400	Egypt Dynasty 5; rise of Ebla

interaction with the environment – an element almost entirely lacking in earlier research at the site. This new data, representing the cumulative evidence of everyday life, offers insight into the dynamics of social change, urbanisation and cultural interaction and transmission.

Environmental Setting

Tel Bet Yerah is situated on laminar marl that was deposited by Lake Lisan. To the south, the Kinrot valley is practically an alluvial fan, covered by calcareous rendzina soil eroded from the nearby hills. About 2 km to the east and north, basalt rocks are covered by heavy brown basaltic soil, and further inland alluvial vertisols with both chalky and basaltic origins spread over the lower Galilee (Ravikovitch 1969).

A pollen core from the northern section of Lake Kinneret, 11.5 km NNE of TBY, has enabled reconstruction of the Bronze Age environment (Langgut, Finkelstein, and Litt 2013, 2015, 2016; Schiebel and Litt 2018). Surrounding Lake Kinneret, pollen evidence reveals that there was a Mediterranean maquis of deciduous oak (*Quercus ithaburensis*-type) and pistachio (*Pistacia* spp.) with an understorey of herbs and shrubs. The abundance of Mediterranean arboreal pollen in the Lake Kinneret core together with the Soreq Cave δ^{13} Carbon isotope record indicates that the region was very humid at the beginning of the EBA (Bar-Matthews and Ayalon 2011; Langgut, Adams, and Finkelstein 2016). Although there was a slight decrease in the Mediterranean forest cover and humidity over time, the area remained relatively wet climatically throughout the EBA occupation at TBY (Langgut, Adams, and Finkelstein 2016). At the beginning of the EBA the high proportion of *Olea* pollen in the core indicates there were extensive olive groves across the Kinneret catchment zone; by EB III, however, the proportion of olive pollen dramatically declined (Langgut, Finkelstein, and Litt 2013; Schiebel and Litt 2018). This decline is a regional trend attested in both the Lake Hula and Birkat Ram cores (Neumann et al. 2007; van Zeist, Baruch, and Bottema 2009).

Today, the lake area is characterised by a Mediterranean climate, with average annual precipitation of around 400 mm. Surrounding the Kinneret, the hillslopes of the Galilee Mountains to the west and Golan to the east are largely deforested, but disturbed remnants of the characteristic Mediterranean deciduous *Quercus ithaburensis* maquis remain with dwarf shrub and herb understorey (Zohary 1973). The upper Jordan valley, from the southern shore of the Kinneret, is dominated by Irano-Turanian steppe vegetation characterised by *Ziziphus lotus, Artemisia* and Chenopodiaceae (Zohary 1973). On the eastern coast of the Kinneret, *Ziziphus spina-christi* covers the lower Golan slopes, while the higher chalky cliffs are characterised by semi-steppe shrubland and even desert vegetation, such as *Retama raetam*, *Salsola vermiculata* and *Sarcopoterium spinosum* (Zohary 1973). To the west, on the slopes of the lower Galilee, patches of natural vegetation include savanna vegetation dominated by *Ziziphus spina-christi*, and open garigue of *Ziziphus lotus* and *Anagyris foetida* with a large component of annual herbs (Ramon 2002, 61–75).

On the banks of the lake, beaches that undergo repetitive flooding and drying are occupied largely by reeds of several *Cyperus* species and *Typha domingensis*. Microhabitats with more predictable water regimes, such as streams and springs that flow into the lake, host various hydrophilic species. These include, among others, *Vitex pseudo-negundo, Arundo donax, Cyperus laevigatus*, *Juncus maritimus*, *Nerium oleander* and *Rubus sanguineus. Tamarix* trees inhabit the banks of the Jordan river and recently some have colonised the lake shores as well, due to the persistent low water level (Zohary and Gaslith 2014). Currently, most of the Kinrot valley is cultivated.

Methods

Excavations in 2003–2012 focused on a few undisturbed contexts within the monumental EB III Circles Building (largely excavated in 1945-1946) and on its immediate surroundings. These included, to the west, a domestic complex (Area SA-S), continuous in plan with the Early Bronze II, and therefore, understood to represent mostly the activities of an indigenous population, and to the north, an area of open-air or domestic activities, including possible food preparation and refuse discard in a large, open plaza (Areas SA-M and GB-H) (Figure 2). In this phase, the 'Circles Building' itself underwent a substantial reorientation from public to domestic use, in the wake of what has been termed 'squatter occupation' by KKW producers/users, assumed to be recent migrants to the site (Greenberg et al. 2017).

This study describes items retrieved from 107 samples, including about 1300 litres of sediment sampled and subjected to bucket flotation in 2009, 2010 and 2012 and additional material retrieved by dry sieving in these and the 2003 season together with a single sample retrieved by flotation in the 1982 season. The majority of samples analysed, 61, were taken from the EB III KKW-rich contexts, mainly from middens and surfaces in the plaza, which are radiocarbon dated to the earlier part of the period, c. 2850–2700 BCE (Regev et al. 2019). A few samples, retrieved in 2003 and 2009, come from soundings in previously unexcavated portions of the Circles Building and were reported in Greenberg et al. (2017). Material dating to EB II comes from floors and a pit dated to the later part of the period

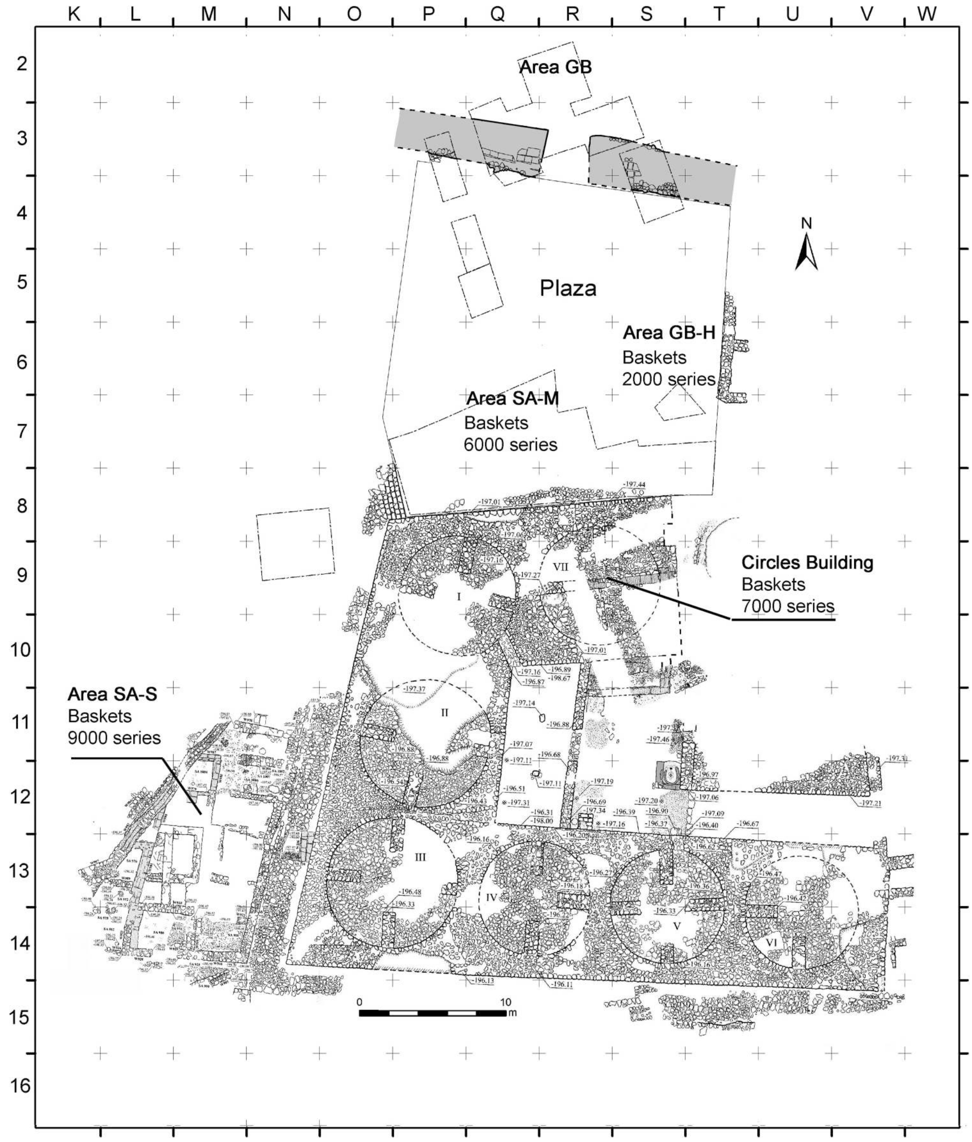

Figure 2. General plan of the 2003–2010 excavation areas at Tel Bet Yerah indication trench and basket locations (Courtesy of the Tel Bet Yerah Archaeological Project).

(c. 2900 BCE) (Regev et al. 2019), while the EB I seeds were retrieved primarily from flotation of sediments in a large pit excavated in the southern part of the mound in 1982 (Area EY, Locus 487) (Eisenberg and Greenberg 2006, 343) and by dry sieving from scattered floors.

Archaeobotanical identifications were made using a low-power binocular stereomicroscope with reference to modern samples from the Gordon Hillman comparative collection at University College London and the seed reference collection at the University of Sheffield, *Flora Palaestina* (Feinbrun-Dothan 1978, 1986; Zohary 1966, 1972) and seed atlases (Cappers, Neef, and Bekker 2009; Jones, Taylor, and Ash 2004; Neef, Cappers, and Bekker 2012; Nesbitt 2006). Material from the first four seasons was identified by Berger supervised by Fuller, while Longford analysed samples from the 2012 season.

All identified plant remains of each sample were recorded as either complete or fragmentary specimens. The Minimum Number of Individuals (MNI) was calculated by summing up the whole seeds and fragments as initially recorded. For identified cereal grains, MNI was based on whole grain and fragment counts with at least a quarter of a complete grain with embryo. For poorly damaged cereal indeterminate grains, MNI was calculated by the total weight of cereal fragments in a sample divided by the average weight of barley and wheat grains from TBY for each period following Miller (1990). For olive stones and grape pips, fragments of a quarter or larger were counted as such, but the smaller fragments were all assumed to be of average size of an eighth to provide an approximate indication of olive and grape quantities.

Comparison of the dry sieved and flotation samples from TBY demonstrates a clear recovery bias towards larger charred remains, particularly grain, in the dry sieved samples. Only samples recovered by flotation were included in statistical analyses. For analysis, indeterminate cereal grains in each sample were divided between barley, glume wheat or naked wheat based on the proportions of the identified grains. Patterns in the crop assemblage were investigated using correspondence analysis of contexts with more than 40 crop items. Correspondence analysis is an ordination technique that plots samples along axes according to compositional variables; the distance between samples relates to their compositional similarity. Canoco for Windows 5 was used to perform the correspondence analysis and create the plots (Ter Braak and Šmilauer 2012). Crop processing analysis follows Jones (1987) ethnographic study of cereal processing in Amorgos, Greece, where weed seeds are grouped according to their size, headedness and aerodynamic properties; crop processing stages and by-products can be separated through discriminant analysis. The TBY weed seeds were classified based on Jones (1987), Charles and Bogaard (2001, 312), Hald (2008, 63), and Filipovic (2014, 80–81) and the classification of weed seeds is recorded in Supplement 1. Only contexts with more than 10 charred wild/weedy seeds, excluding potentially intrusive mineralised *Echium angustifolium* seeds, were included in the discriminant analysis, conducted in SPSS 26 (IBM 2019).

Results

A total of 5487 charred plant remains representing 43 taxa were identified in the TBY assemblage. The assemblage is summarised by period in Table 1, and Supplement 1 provides the assemblage data table. Images of common taxa are provided in Figures 3 and 4. Cereals were the most common crop element at TBY (n = 3502) especially glume wheat chaff. Glume wheats, einkorn (*Triticum monococcum*) and emmer (*T. dicoccum*), were the main cereals. Although emmer grain and chaff are more common, the amount of indeterminate grain and glume wheat chaff in the assemblage however, makes it difficult to determine which of the two was the primary crop throughout the Early Bronze Age. Grains of both one-grained and two-grained einkorn were identified in the assemblage. Identification criteria for these two forms of einkorn follow Kreuz and Boenke (2002). The presence of two-grained einkorn is of note, as this is one of the youngest finds of two-grained einkorn in the region. This form of einkorn appears to be a distinct domestication from typical one-grained einkorn (*Triticum monococcum sensu stricto*) (Fuller, Willcox, and Allaby 2012; Willcox, Fornite, and Herveux 2008). Both einkorn types spread into Neolithic Europe, but the two-grained form is unknown after the Bronze Age (ca. 1200 BC) (Kohler-Schneider 2003). In the Near East it persisted in parts of the Anatolia and the Southern Levant; with reports from other EBA sites such as Arad and Tell Abu al-Kharaz (Fischer and Holden 2008; Hopf 1978).

Frequent small amounts of free threshing naked wheat grains (*T. aestivum/durum* type) were present in most KKW contexts of the EB III and absent from all other contexts except the EB IB pit which contained two naked wheat grains. Whether the free-threshing wheat was hexaploid or tetraploid is unknown because no wheat rachis internodes were recovered. Naked and hulled barley grains were present throughout the assemblage. Based on their symmetry and the lack of any identifiable asymmetric grains, these grains may be two-row barley (*Hordeum* cf. *distichum*), which is supported by the identification of a two-row barley rachis internode in the EB IB pit. The amount of indeterminate cereal grain in some samples, however, hinders confident identification of the barley species at TBY.

Pulses were present in all periods at TBY as minor crop elements. Across the assemblage, lentil (*Lens culinaris*) was the most common pulse followed by pea (*Pisum sativum*), bitter vetch (*Vicia ervilia*) and grass pea (*Lathyrus sativus*). Olive (*Olea europaea*) stones and grape (*Vitis vinifera*) pips and pedicels were recovered from all periods, although most grape remains were found in the EB IB. Fig (*Ficus carica*) seeds were only present in EB III. Fragments of plum type (*cf. Prunus* sp.) fruit stones and almond (*Amygdalus* cf. *communis*) shells were found in small quantities in EB II and III contexts.

Seeds from 29 different wild plant taxa constituted 20–35% of the plant remains found in each period. Most wild plant taxa are potential weeds of cultivated fields or colonisers of waste ground (Feinbrun-Dothan 1978, 1986; Zohary 1966, 1972). *Lolium temulentum* (Darnel) was the most ubiquitous wild seed in the assemblage, although a high concentration of *L. persicum* was found in the EB IB pit [EY 487]. Other identified taxa include *Amaranthus* sp., *Astragalus* sp., *Galium* cf. *tricornutum*, *Gypsophila* cf. *arabica*, *Phalaris* cf. *minor*, *Portulaca oleracea*, *Scrophularia* sp., and *Scorpiurus muricatis* . In the EB III, *Echium angustifolium* was the most abundant wild plant taxon, however these seeds are mineralised and do not bear signs of charring and possibly represent intrusive material. Such seeds are potentially deposited when *E. angustifolium* plants invaded the area after the site's abandonment (*cf.* Borojevic 2011; *contra* Pustovoytov, Riehl, and Mittmann 2004).

Exploring General Trends in Sample Composition

Correspondence analysis of contexts which contain more than 30 crop items reveals a distinct pattern based on the presence of naked wheat grain in the EB III KKW contexts, and the differing proportions

Figure 3. Photographs of representative specimens for crop taxa. Images taken with a Leica M205C microscope and DFC450 camera. a. *Triticum monococcum* 2-grained type (EB I, b4230); b. *T. monococcum* 1-grained type (EB II, b9648); c. *T. dicoccum* (EB II b9514); d. *T. aestivum/durum* (EB III b6331); e. *Hordeum* sp. Hulled straight grain (EB II b9648); f. *T. monococcum* splikelet fork (EB I, b4230); g. *T. dicoccum* spikelet fork (EB II b9665); h. *H. disticum* rachis internode showing the top and abaxial views (EB I b4230); i. *Pisum sativum* (EB I b4230); j. *Vitis vinifera* (EB I b4230); k. *Olea europaea* (EB I b4230). All scale bars are 1 mm, separate scales for a–e, f–h, i–j and k.

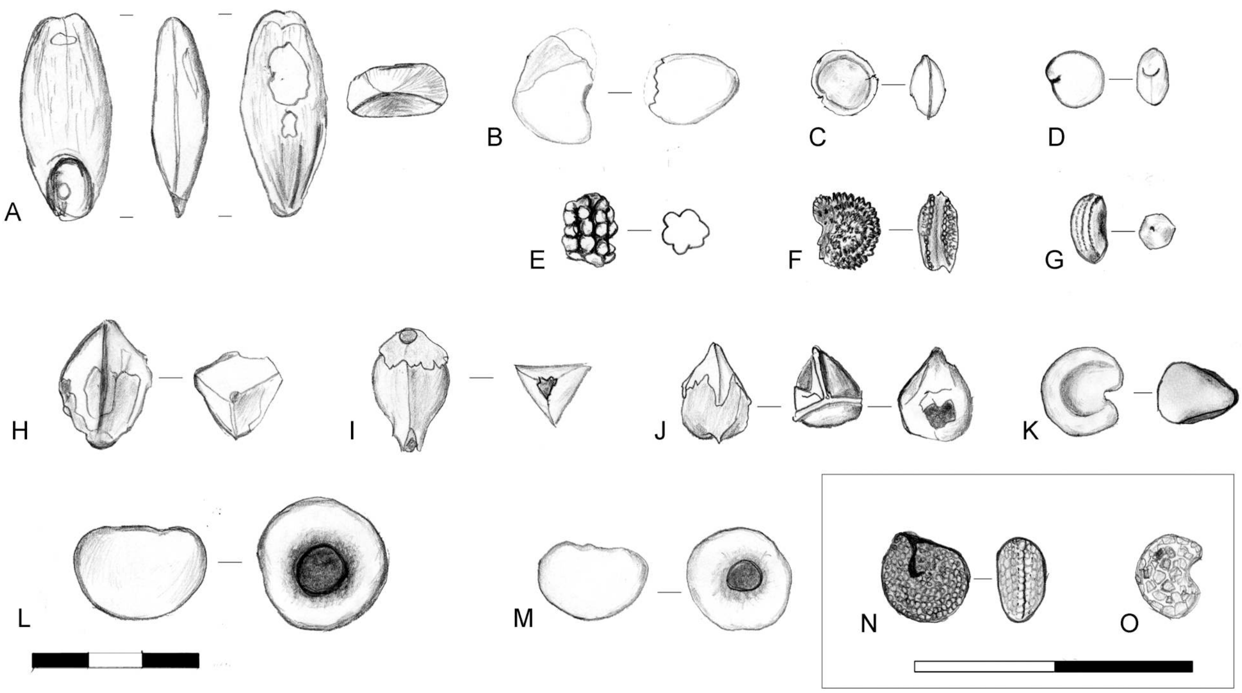

Figure 4. Drawings of representative specimens for selected taxa. A. *Lolium temulentum* (SA1607 b6327); B. *Scorpiurus muricatus* (SA1650 b6372); C. *Amaranthus* sp. (SA1651 b6375); D. *Chenopodium* album (SA1651 b6375); E. *Scrophularia sp.* (SA953 b9482); F. *Gypsophila* cf. *arabica* (SA953 b9482; G. Apiaceae mericarp type (SA953 b9482); H, I, J.. Polygonaceae nutlets (SA992 b9476, SA1638 b6331, SA953 b9482); K. *Malva sp.* (SA953 b9482); L. *Galium sp.* (SA953 b9482); M. *Galium sp.* (SA992 b9476); N. *Portulaca oleracea* (SA1651 b6373) O. *Papaver* sp. (SA986 b9457). All original drawings by Alice Berger. Scales in mm, separate scales for A-M and N-O.

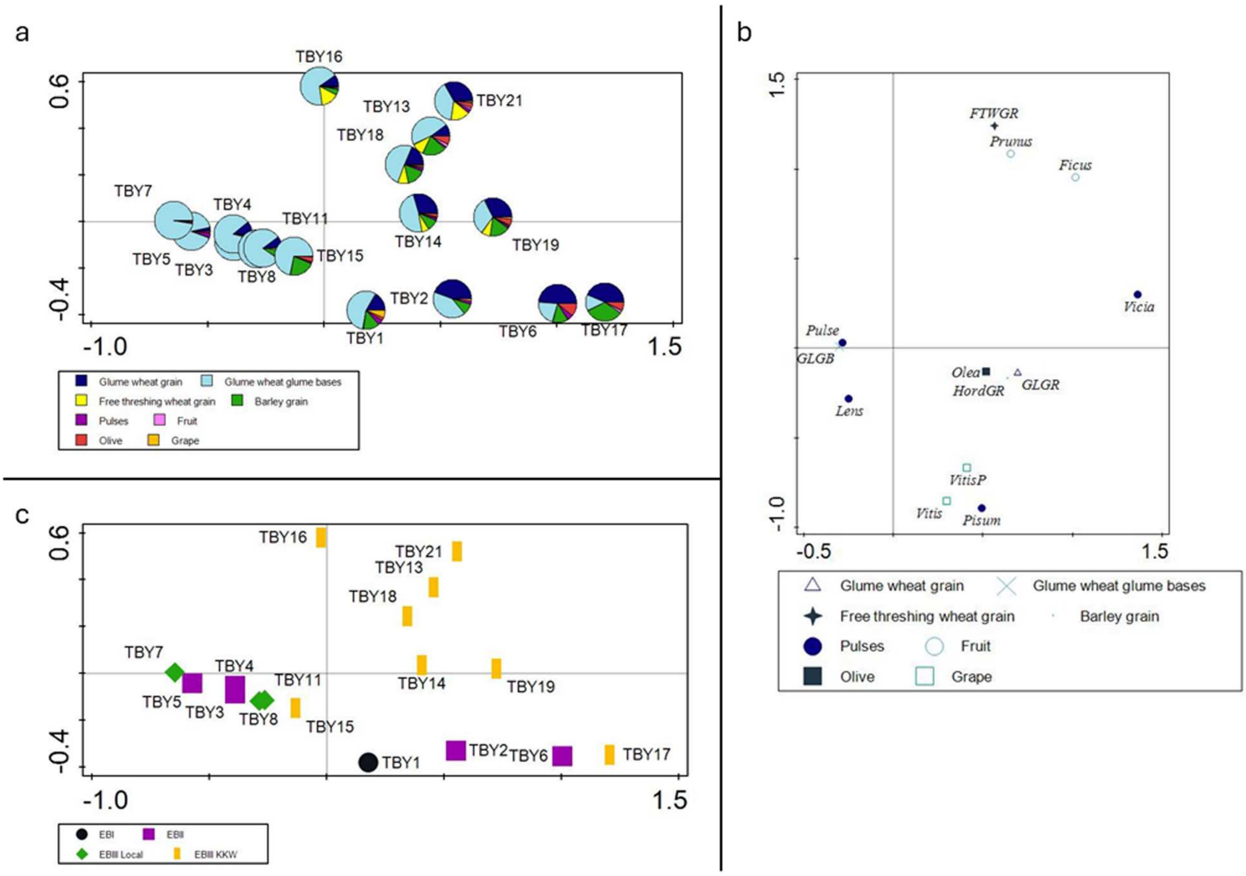

Figure 5. Correspondence analysis of crop remains from Tel Bet Yerah of sample groups with more than 40 crop items. (A) plot of sample groups with sample points represented as pie charts showing the proportions of different crop items. (B) plot of species. Species codes: GLGR: Glume wheat grain, GLGB: Glume wheat glume bases, HordGR: 2-row barley grain, FTWGR: Free threshing wheat grain, Lens: Lentil, Pisum: Pea, Vicia: Vetch, Pulse: Indeterminate pulse, Olea: Olive stone, Vitis: Grape pip, VitisP: Grape pedicel, Amyg: Almond, Prunus: Indeterminate Prunus stone, Ficus: Fig seed. (C) plot of sample groups with sample points coded by archeological period.

of grain to chaff across the assemblage. In Figure 5a,b, the first axis separates contexts rich in grains, and fruits, towards the positive (right) end of the axis, from contexts rich in glume wheat chaff which plot negatively (left) on the axis. On the second axis, contexts with free threshing wheat and fig plot positively (top) away from contexts rich in glume wheat grain, barley grain and grape which plot slightly negatively (bottom) on the axis. When coded by period (Figure 5c) the majority of KKW EB III contexts (TBY 13, 14, 16, 18, 19, 21) differ from the other TBY contexts and plot towards the positive ends of both axis in the upper right quadrant because of their free threshing wheat grain content. All Local EB III as well as three EB II contexts (TBY 3,4 5) and one KKW EB III (TBY 15), plot towards the negative end of the first axis because they contain a high proportion of glume wheat chaff. The remaining EB II contexts (TBY 2, 6), one KKW EB III (TBY 17) and the EB IB pit plot positively on the first axis due to their higher proportion of fruits and grain to cereal chaff. The two axes separate the TBY contexts relating to two interpretive themes, the first axis differentiates the contexts based on economic activity and the second axis distinguishes contexts according to cultural identity.

Crop processing produces archaeologically recognisable products and by-products (Hillman 1984a; Jones 1984). The lack of straw culm nodes and paucity of barley or free threshing wheat rachis internodes throughout the TBY assemblage suggest that the early stages of cereal processing, threshing and winnowing, probably occurred off-site and that glume wheats, barley and free threshing wheat were brought onto site in a similar semi-cleaned state. Based on Jones' (1987) ethnographic model of weed seed characteristics (big:small/light:heavy/headed:free) relating to crop processing stages, the weed seeds from all TBY contexts fit the crop processing model as either the products (EB II TBY 2 and TBY 6) or by-products (EB IB, EB II TBY 3-5, EB III) of final fine sieving (Figure 6). As a proportion of cereal content, most TBY samples have more than 70% glume wheat (grain and chaff) content (Figure 5a). Glume wheats are commonly stored either as semi-cleaned spikelets or dehusked grain where decisions on storage form are affected by the scale of production/consumption (van der Veen and Jones 2007), availability of

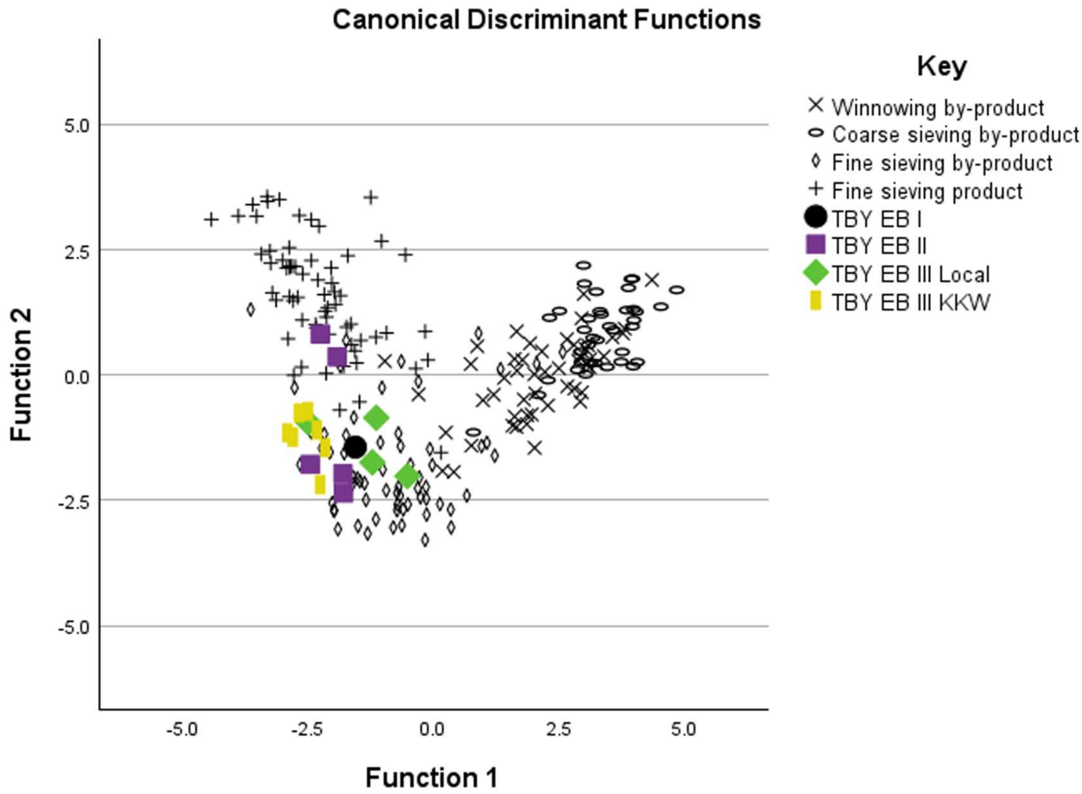

Figure 6. Discriminant analysis of weed seed characteristics related to crop processing comparing the TBY material to the ethnographically studied stages of crop processing on the island of Amorgos. See Supplement 1 for classification of weed seeds by physical characteristics related to crop processing stages (Jones 1987).

labour (Fuller, Stevens, and McClatchie 2014; Stevens 2003), and/or summer rainfall conditions (Hillman 1984b).

With no evidence of widespread burning uncovered during excavation, the assemblage probably represents incidental deposition of accidently charred material related to crop consumption and processing, contemporary with the stratigraphic layer in which it was found (Regev et al. 2019). Although eight silicified sheep/goat faecal pellets were found in EB II and EB III contexts, no traces of amorphous dung remains were identified in the TBY material. Moreover, none of the TBY contexts conform to Charles' (1998) criteria for identifying archaeological dung fuel burning. Finally, the ubiquity of *Lolium temulentum,* a toxic plant to both humans and animals (Feinbrun-Dothan 1986; Dörfler et al. 2011, 114) in all phases makes it unlikely that these wild seeds were consumed by livestock and, therefore, a high proportion of wild plant seeds probably entered the assemblage as crop contaminants.

Discussion

In the EB IB pre-urban period, both the high proportion of glume wheat chaff and weeds to grains in pit EY 487 and the physical traits of the crop weeds (Figure 6) indicates that the charred plant remains represent crop processing waste from final stage fine sieving (Supplement Table 1). It is likely that cereals were stored as semi-processed spikelets and that final dehusking and cleaning of the grain occurred regularly at a focused, household level. As other archaeological evidence indicates that at this time the settlement was a large village (Greenberg and Paz 2014; Paz 2012), it seems that these finds are consistent with an economy of independent households or small groups, processing their agricultural products only to a limited extant at harvest, with most crop cleaning carried out piecemeal throughout the year.

The EB II data show continuity of economic practices. These samples from EB II houses in the northern part of TBY are characterised by the remnants of household food preparation with both crop processing products and by-products. The EB II at TBY is a period of clear social re-organisation from the EB IB village community to a well-planned fortified town. EB II TBY inhabitants built their houses along on a preconceived street grid, constructed 8 m thick mudbrick city fortifications and centralised ceramic production (Greenberg and Iserlis 2014; Greenberg and Paz 2014). Volumetric analysis of charcoal and fish remains (Lernau et al. 2021; Mor 2022) points to periodic cleaning of floors and streets and concentration of refuse in pits in late EB II. These features indicate that TBY was a well-ordered community with communal management of resources and waste. By the late EB II the absence of storage installations or storage cellars in individual houses (Greenberg and Paz 2014) suggests that grain storage and distribution had become centrally or communally managed across the site, however the archaeobotanical assemblage indicates that throughout the EB II, households were still engaged in final dehusking and processing of grain. Further analysis of more material from the later (2012-2015) seasons will help to determine how the urban developments affected agricultural production and distribution at TBY.

It is thought that during the EB II, horticultural secondary products like olive oil and hardwood resins were exported to Egypt from the northern Jordan valley, by way of urbanising centres like TBY (Genz 2003; Greenberg and Iserlis 2020). The Lake Kinneret pollen core indicates substantial olive groves in the region around TBY during the early EBA (Langgut, Finkelstein, and Litt 2013, 2016; note that the chronological range assigned to EB I in these publications overlaps with our EB II). Ceramic petrography and geochemical provenancing has demonstrated that jugs deposited in First Dynasty tombs at Abydos in Egypt were manufactured in an EB II potter's workshop at TBY, as well as workshops located farther north (Iserlis, Steiniger, and Greenberg 2019). Although it is not known with certainty what these jugs contained, residue studies suggested that they contained vegetal oils (Serpico and White 1996), most likely olive oil from the Kinneret region. Moreover, Esse (1991, 123–125) identified a possible olive oil extraction unit in the University of Chicago excavations (in 1963-1964) at Bet Yerah. However, while grape and olives were present in low numbers in all periods in the recent excavations (Table 2 and Supplementary Table I), the preliminary archaeobotanical results do not provide evidence for olive oil or wine production at TBY in the areas excavated.

While late EB II household architecture suggests communal (or centralised) storage of crops, no structural evidence for public granaries have been uncovereed at TBY in this period. Dating to the beginning of the EB III however, the Circles Building, although never completed, has been interpreted as a potential monumental public grain store (Greenberg et al. 2017; Mazar 2001). Continuing economic centralisation in the EB II may have motivated the initial construction of a large central granary, the Circles Building, in the early EB III period (Greenberg et al. 2017). Although construction of the Circles Building was halted prior to the creation of its mudbrick superstructure, considerable effort, calculated as requiring between 5000 and 11,800 work days, was expended to demolish existing EB II houses and build the raised monumental stone platform containing the foundations of seven round silos, 7–9 m diameter (Greenberg et al. 2017). Archaeobotanical material from the Circles Building, mostly incidental secondary fills in

Table 2. Summary of crop and economic taxa counts for each phase with the EB III separated into local and KKW contexts. Counts are for grain/seeds unless stated otherwise.

	Early bronze IB	Early bronze II	Early bronze III (Local)	Early bronze III (KKW)
Number of samples	7	18	21	61
Cereals				
Triticum monococcum	22	6	1	1
Triticum monococcum (2-grained)	2	15	1	8
Triticum dicoccum	17	37	2	3
Glume wheat indeterminate	15	76	4	22
Free threshing wheat	2	0	0	15
Triticum spp.	7	21	13	49
Hordeum sp. (straight, naked)	22	16	12	31
Hordeum sp. (straight, hulled)	30	33	1	10
Cereal indeterminate	84	66	61	532
T. monococcum (glume base)	71	7	2	0
T. dicoccum (glume base)	40	512	2	0
T. monococcum/ dicoccum (glume base)	236	483	407	890
Hordeum distichum (rachis internode)	1	0	0	0
Hordeum sp. (rachis internode)	3	0	0	0
Cereal culm node	0	1	0	0
Pulses	0	0	0	0
Lens culinaris	14	57	9	16
Pisum sativum	13	0	1	3
Vicia ervilia	0	2	0	2
Lathyrus sativus	0	0	1	2
Large pulse indet.	0	5	3	4
Fruits	0	0	0	0
Vitis venifera	34	7	6	7
Vitis venifera pedicel	10	1	1	4
Olea europaea	17	29	13	51
Ficus carica	0	0	1	8
Amygdalus	0	0	0	2
cf. *Prunus*	0	0	1	10
Fruit stone indet.	0	3	1	2

Circle VII, is scarce, but consistent with the crops in other EB III contexts (Supplementary Table 1). The Circles Building – its planning, construction, and its dereliction – remains an architectural embodiment of the potential scale, and decline, of the grain-producing economy at TBY. This fluctuation in grain production at TBY is reflected in the Kinneret pollen core by a gradual increase then dramatic drop in Cerealia-type pollen over the EB II-III period (Langgut et al. 2015).

Archaeobotanical material from local EB III houses to the west of the Circles Building, indicates consistency of the household grain economy based on glume wheats and barley with the EB II (Figure 5 and Supplementary Table 1). The continued accumulation of final stage crop waste (Figure 6) shows local EBIII inhabitants maintained household processing of threshed glume wheat spikelets and barley grain (Fuller and Stevens 2009; Fuller, Stevens, and McClatchie 2014; Stevens 2003; van der Veen and Jones 2007). Across TBY signs of an EB III administrative crisis, such as waste accumulating on previous cleaned streets, the repurposing of public areas, blockage of the southeastern gateway and the city walls falling into disrepair (Greenberg et al. 2012), mirror the abandonment of the Circles Building and point to a cessation of collective labour projects.

South Levant Early Bronze Age Economies

The urban trajectory at TBY coincides with similar changes at other large settlements in the Southern Levant. In the Southern Levant during the EBA, there was a shift from village communities in the EB I to large walled settlements in the EB II-III. Whether these fortified towns represent fully urban centres like those of Mesopotamia or a separate social expression is still debated (Chesson 2015; Chesson and Philip 2003; Esse 1991; Greenberg 2002; Greenberg 2019; Paz 2012; Paz and Greenberg 2016; Philip 2001; Savage, Falconer, and Harrison 2007). However, their planned streets, fortifications, traded commodities, and limited indications of social stratification are suggestive of a local Levantine form of urbanisation (Paz 2012; Paz and Greenberg 2016; Greenberg 2019, 131–132).

Across the Southern Levant, architectural and ceramic evidence demonstrates there was a shift from private domestic storage of crop resources using pithoi in the EB IB to centralised consolidation and management of economic products in large public buildings by the EB II (Faust and Golani 2008; Golani and Yannai 2016). Tel Beth Shean provides an early example where pithoi of pulses and caches of grain and flax were found stored in a large EB IB multi-pillared public building (building MA) (Mazar, Rotem, and Weinblatt 2012, 41–53; Simchoni and Kislev 2012, 424–425). This building may have been especially dedicated to food storage and processing, as many pithoi and large grinding installations, probably used for milling grain, were found in the hall which lacked cooking facilities. At Tell Abu Al-Kharaz, great quantities of dehusked emmer/einkorn grains were found stored in multiple pithoi in at least one EB IB and two EB II buildings (Fischer and Holden 2008, 319–321; Fischer 2014). At Arad, which had a pattern of rapid urban rebuilding similar to TBY in the EB II (Regev et al. 2017; 2019), over 10,000 barley grains were found in one early EB II house (Amiran and Ilan 1996, 86; Regev et al. 2017, 167), and several pure stores containing thousands of charred barley grains were found in houses and administrative buildings of the later EB II (Hopf 1978, 64, 66). At Jericho, silos containing thousands of dehusked and cleaned glume wheat and barley grains have been attributed to EB II (Hopf 1983, 595; Bruins and van der Plicht 2001; Regev et al. 2012).

At all these sites, particularly EB II Arad, Jericho and Tell Abu al-Kharaz, the purity of these stores, usually one crop per vessel or silo; the low ratios of chaff and weeds showing grains were stored dehusked and cleaned; and their scale, regarded as too large for household consumption, suggest that these are neighbourhood or centrally administered crop stores. The extent of labour required for processing the huge quantities of dehusked grain, co-ordinating its storage and distribution implies community planning and organisation, which could have been co-ordinated by the leading households at each site. Whether these grain stores were supplied by tithes on household surpluses or by increased yields through large-scale cooperative or elite planned farming projects (Greenberg 2019, 101; *cf.* Bogaard 2017), these centralised stores suggest increased agricultural productivity during the EB II. These economic developments were all part of the EB II urban restructuring in the Southern Levant. At TBY, the lack of EB II household storage installations together with the conception of the Circles Building in the EB III, may indicate a nascent but short-lived urban economy at TBY in parallel to large-scale agricultural developments at other Levantine sites.

In the EB II to EB III transition many sites were abandoned in the Southern Levant. Settlement aggregated into large newly fortified sites and EB III economies shifted from collective to unequal distribution of agricultural resources at sites. Large EB III palatial economies, like at Zeraqōn, Tell Yarmuth and Megiddo, appear to have been designed to serve only the leading families, consolidating agricultural products for elite consumption and status through commensal feasting (Greenberg 2019). The Zeraqōn and Yarmuth palatial complexes contained extensive storage facilities with numerous pithoi and jars for hoarding crops, olive oil and wine, while individual households maintained their own food supplies (de Miroschedji 1999, 11; Genz 2003, 2010; Salavert 2008). Zeraqōn also shows a clear internal status difference, the upper town preserved evidence for more elite foods like emmer and grape, whereas in the lower town hulled barley, although not dominant, was more ubiquitous (Riehl 2004, 112–116). Alternatively smaller sites, like Numayra and Bab edh-Dhra’, lack evidence for non-domestic resource accumulation (Chesson and Goodale 2014; White, McCreedy, and Toro 2020). Excavations at Numayra instead reveal extensive private storage and management of agricultural foodstuffs which may have led to increasing inequalities between households (Chesson and Goodale 2014; White, McCreedy, and Toro 2020). Despite evidence for social differentiation at Zeraqōn and Tell Yarmuth, upper town assemblages at both sites contain the final discard of habitual glume wheat dehusking (Riehl 2004, 112; Salavert 2008: S57), similar to EB III TBY. This suggests that the organised bulk cereal processing, which emerged during the EB II urbanisation of the Southern Levant, may not have persisted into the EB III period even at sites with large palatial economies.

On the Northern Levantine coast, however, large urban sites were thriving. At Sidon approximately 160 kg of charred 2-row barley grains, potentially more than 1 million grains, were discovered in a large EB III storage room, providing evidence of a booming urban economy (de Moulins 2009, 15; Doumet-Serhal 2013, 99). This coincides with the breakdown of the urban systems in the Southern Levant and a decline in trade with Egypt as maritime trade routes developed between Egypt and the Northern Levant in the EB III (Genz 2003; Greenberg and Iserlis 2020; Sowada 2009).

Identity

As crisis destabilised the early EB III town, migrants bearing KKW material culture settled in empty EB II houses and around the abandoned Circles Building alongside local inhabitants. The KKW settlers, interpreted as a diasporic ETC community, differ from their local neighbours with their distinctive red-black ceramics, method of pottery production, architecture, use of space and cooking practices (Greenberg 2021; Greenberg et al. 2012; 2014; Greenberg and Goren 2009; Iserlis 2009; Ishoev and Greenberg 2019; Paz 2009). The archaeobotanical record reveals that the KKW and local groups also contrasted in their agricultural practices and diet.

KKW contexts on and north of the Circles Building comprised mainly domestic refuse, processed animal bones, hearth ashes and industrial waste. The plant remains are similarly a mix of kitchen refuse: spoiled charred grain and final processing by-products (glume wheat chaff and weed seeds from fine sieving) (Figures 5 and 6). Just as in local EB III contexts, this pattern of discard suggests household storage and regular processing of already threshed and winnowed cereals. Interestingly, KKW deposits in the plaza, unlike local houses, bear traces of plaster-lined bins (Greenberg, Iserlis, and Shimelmitz 2014, 188–190) which could have stored glume wheat spikelets and semi-cleaned free threshing cereal grains. While the weed assemblages of local and KKW groups are both representative of late stage fine sieving by-products (Figure 6), there are slight differences in the wild seed assemblages between the two groups. Compared to local contexts, *Amaranthus* sp., *Chenopodium album*, *Gypsophila* cf. *arabica*, and *Scrophularia* sp. are scarcer or absent in KKW contexts which may suggest that the two groups were not integrated into one economic system. While these differences may relate to taphonomic or sampling differences, the scarcity of wild/weedy taxa like more aridity tolerant *Gypsophila* cf. *arabica* in KKW contexts may indicate that each community potentially used different areas of the Kinrot Valley and the hillslopes surrounding TBY or employed different crop cultivation and processing strategies. Indeed, analysis of KKW animal figures from TBY, primarily horned cattle with attachments for yokes or harnesses, as well as bone pathologies observed in cattle from plaza contexts indicates that KKW occupants may have employed cattle as traction animals, possibly occupying a specialised niche in local agricultural production (Berger 2018; Bladt Knudsen and Greenberg 2020; Maurer and Greenberg 2022). Further analysis of the wild/weedy seed assemblage of these and samples excavated in 2012–15 seasons is needed to explore potential differences in crop husbandry between local and KKW farmers.

The KKW settlers also consumed a different crop: free threshing wheat. The lack of free threshing wheat chaff in these samples, potentially due to off-site winnowing, makes it difficult to determine whether grain was imported or cultivated at TBY. Nevertheless, although never the dominant cereal, free threshing wheat grains are present in 60% of KKW context groups, together with glume wheat and barley; this prominence of naked wheat distinguishes the KKW samples from other archaeobotanical material from the site (Figure 5). A few naked wheat grains are also found in the EB IB pit (EY487) but are absent from EB II and indigenous EB III samples. Free threshing wheat was apparently re-introduced to the site by the KKW settlers, potentially suggesting that the consumption of free threshing wheat was culturally significant. Similarly, the absence of free threshing wheat grains from contemporary local contexts at TBY may indicate an avoidance or unawareness of naked wheat by the local community, or that access to free threshing wheat was restricted and controlled by KKW households. In Anatolia and the Caucasus, ETC sites show a distinct preference for hexaploid free threshing wheat and, at some sites, such as Sos Höyük, Aşvan, Tepecik, Dilkaya, Aparan, Maxta, Tsaghkasar and Haftavan, it is the main wheat type cultivated by ETC communities (Hovsepyan 2015; Longford 2015). While glume wheats remain the dominant crops at TBY, the presence of free threshing wheat grains in samples from KKW contexts may indicate a lingering culinary connection to the traditional crops of the ETC homeland.

In the EBA of the Southern Levant, naked wheats are rare but not unknown. Agriculture across the region is either barley – or glume wheat-dominated, primarily two-rowed barley and emmer, when taxa are identified to species. In the EB I, scarce finds of free threshing wheat grains were made at Afula (Melamed 1996, 69), Tell el Handaquq (Donaldson and Mabry 1996, 142–143) and Tell Abu al Kharaz (Fischer and Holden 2006, 311) and in the EB II at Arad (Hopf 1978, 68). At Jericho, thousands of free threshing wheat grains were reported from the NDV Silo (Hopf 1983, 595) dated either to EB I (Nigro et al. 2019) or EB II (Bruins and van der Plicht 2001; Regev et al. 2012). At nearby Tel Beth Shean a large quantity of free threshing *T. parvicoccum* grains (a Levantine tetraploid free threshing wheat variety) were found in EB IB contexts (Simchoni, Kislev, and Melamed 2007, 703) and a few grains in EB III KKW and local contexts (Simchoni and Kislev 2012, 425). Small quantities of free threshing wheat grains were also identified at EB III Zeraqōn (Veermeersch et al. 2021) and *T. parvicoccum* grains and chaff at Tell eṣ-Ṣâfī (Frumin et al. 2021). In the EB III southern Levant, free threshing wheat is rare, however, at all of the sites, where free threshing wheat has been recorded KKW, connections have been identified. Both TBY and Tel Beth Shean have evidence for KKW occupation (Iserlis, Greenberb, and Goren 2012, 326–327); KKW ceramics were being locally produced at Tell eṣ-Ṣâfī (Shai et al. 2014: 30–32) and they were found in the upper town at Zeraqōn (Genz 2002, 30, 44).

Free threshing wheats, as their name implies, are easier to process than glume wheats. Hexaploid free threshing wheats in particular are softer in texture and richer in gluten, which make them more suited to baking, breadmaking, gruels and porridges (Delcour et al. 2010). Perhaps the presence of free threshing wheat grains in limited but persistent quantities at TBY indicates that the crop was required as an ingredient in particular KKW dishes. Indeed, the KKW cooking assemblage (large local wholemouth cooking pots with KKW lids), portable hearths (andirons) and serving dishes (decorated KKW kraters with individual eating bowls) indicate that KKW cuisine inclined towards ‘wet foods’, like soups, stews and gruels (Ishoev and Greenberg 2019; Paz 2009), which may have included glutinous free threshing wheat grains. Moreover, the lack of grinding stones in KKW contexts may further demonstrate that KKW ingredients required pounded grain for porridges and gruels rather than milled flour for breads (Greenberg 2021). These culinary practices differ from the broad flat platters of the local TBY EB III ceramic repertoire (Paz 2009) which may have been more suited to communal feasting on ‘drier’ roasted meats and fish (Bunimovitz and Greenberg 2004; Ishoev and Greenberg 2019; Paz 2012). This drier cuisine of roasted meats can be suggested to link to breads, also baked in dry conditions, that were core to a long-term culinary tradition (baking and roasting) associated with the Neolithic Near East (Fuller and Gonzalez Carretero 2018; Fuller and Rowlands 2011). The KKW material represents a distinct, intrusive culinary tradition.

Archaeozoological analysis of TBY EB III material similarly shows a higher proportion of cattle and sheep bones in the KKW occupied plaza than local assemblages, which may imply a variation in diets (Berger 2018; Maurer and Greenberg 2022). As food, in terms of ingredients, preparation and consumption, is deeply reflective of cultural identity (Emberling 1997; Fuller and Rowlands 2011; Gumerman 1997; Stein 2012; Twiss 2012), the maintenance of a distinctive cuisine with potential links to northern ETC culinary traditions emphasises the different origins of the local and KKW inhabitants of TBY.

Conclusion

This preliminary study on the TBY archaeobotanical assemblage illuminates two pivotal issues in the EBA of the Southern Levant: urbanisation and the arrival of KKW-producing communities. Archaeobotanical data from TBY show continuity of small-scale household grain processing throughout the EB period. This appeared to remain stable as TBY changed from an EB IB village to a well-planned fortified town in the EB II, before undergoing urban collapse in the EB III. As TBY developed its urban economy, it is uncertain whether agricultural production and provisioning was managed by individual households or communally. The construction of the Circles Building in the early EB III however, suggests an intention to centralise grain storage and distribution at the site, suggesting that management of agricultural resources was integral to the urban restructuring of Levantine society in the EB II.

After the EB III urban decline, new KKW settlers at TBY maintained separate agricultural practices from local inhabitants, apparently cultivating and processing their crops separately and potentially growing free threshing wheat. KKW use of free threshing wheat may be suggestive of a culinary link to ETC communities of Anatolia and the Caucasus. The persistence of distinct KKW foodways may have enabled the preservation and communication of a recognisable KKW cultural identity, distinguishable from the local neighbouring populations at TBY.

Further archaeobotanical analysis of the TBY assemblage will continue to investigate the effect of urbanisation and its collapse on the agricultural economy at the site as well as examine the crop husbandry and foodways of local and KKW communities at TBY.

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