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High-Resolution Spatial Analysis of Archaeobotanical Remains from a Kitchen Context in Imperial Late Antique (ca. A.D. 600) Dhiban, Jordan

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ABSTRACT

Archaeological plant remains are key data in the identification of the material consequences of imperial interventions in past local lifeways. In this paper, the spatial and stratigraphic analysis of plant remains preserved in a hypothesized kitchen context from the archaeological site of Dhiban, Jordan, is presented in detail. This context is dated to ca. A.D. 570–640 based on 16 AMS dates, a time when the Dhiban community was part of and located at the eastern edge of the Byzantine empire. Analysis of over 130 point-provenienced flotation samples reveals a local emphasis on the agricultural production of wheat, peas, and grape, in spite of the challenges of water management in a semi-arid landscape. Comparison with other nearby and contemporaneous sites indicates that while all grew a similar suite of crops, their frequencies vary, possibly indicating a community of agricultural practice specializing in different foodstuffs or crops.

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Introduction

The archaeological investigation of how imperial interventions affected local lifeways in the past relies on a wide array of different analytic methods and perspectives, as each line of evidence represents the physical outcome of a multi-faceted sociocultural process (Sinopoli 2001). For that reason, archaeological research on premodern empires has examined settlements located far from primary imperial centers of elite or economic influence to broaden the investigation of how, why, and if imperial networks affected the lifeways of incorporated communities (Lightfoot and Martinez 1995; Stein 2002). Analysis of a growing corpus of data collected on Inka (Peru) and Hittite (Turkey) period archaeological sites, for example, has highlighted how roadways and spheres of influence contingent on environment and local politics structured the economic and social connections between formerly disconnected communities that were brought together by the affordances of (attempted) centralized political control by imperial elites (Glatz 2009; Garrido 2016; Zori, Brant, and Rodríguez 2017).

While the circulation of ceramics and prestige architecture such as monumental structures have played a primary role in identifying the development of these socio-economic networks, plant remains systematically collected from archaeological sites provide another key source of data. Economically important domesticated plants (i.e., crops) and, in particular, domesticated grasses (wheat, maize, rice, etc.) formed the foundation of the agricultural economies that maintained the inhabitants of nearly every premodern imperial polity worldwide. In addition, these same cultigens held cultural and political, and therefore symbolic, value, often serving as metaphors for the state itself as depicted in art and iconography (Hastorf 2009). A considerable amount of human labor in imperial polities was oriented toward

agricultural production, both at the scale of a household, however defined, or of the state. Detectable changes in local agricultural lifeways that revolved around the seasonally cyclical growth of desired plants, even at the scale of a household or single room, provide insight into the timing and extent of the impacts of imperial networks on these communities (Hastorf 1990; D'Altroy and Hastorf 2002).

For example, the period of Byzantine political intervention in the eastern Mediterranean, occurring approximately from the reign of Constantine I ca. A.D. 325 until the Umayyad conquest of the area in A.D. 642, has been argued to have ushered in a period of sustained agricultural intensification and a florescence of village settlement in an area that encompasses contemporary Israel, Jordan, Lebanon, Palestine, and western Syria (Watson 2008). While a number of inorganic archaeological proxies, discussed below, have been used to identify how and why this florescence in settlement occurred, organic remains as recovered through archaeobotanical or zooarchaeological methods figure less visibly in historical syntheses of regional economies during this period (cf. Decker 2009).

Moreover, when archaeological plant remains are collected, the resolution of collection and presentation of data is typically at the site level or time period (but see Pető et al. 2015; Forste 2021). Lost in this less granular resolution of collection are the ways in which archaeological plant remains provide quantitative data about site formation processes, cultural practices of deposition, or spatial variability in archaeological plant density that might suggest storage, processing, or consumption. While time-consuming, the point-provenience of samples in a bulk collection strategy provides another line of evidence regarding why (carbonized) archaeological plant remains are present in the places in which they are found (van der Veen 2007). In turn, greater

precision in the identification of depositional practices (i.e., crop processing, rubbish disposal, etc.) provides a link between archaeological plant remains and the socio-natural circumstances that led to their inclusion and preservation in the archaeological record (Fuller and Stevens 2009). When these insights are coupled with high-resolution radiometric dating and other forms of archaeological evidence, and when compared to contemporaneous data from nearby settlements, it is possible to identify the extent to which agricultural practices were affected, or not, by the incorporation of local communities into imperial networks.

In this paper, the results of the analysis of 131 archaeological sediment samples from an archaeological site in central Jordan (Dhiban, Madaba Governate) are presented in detail. These samples were collected from an exceptional taphonomic context located in the southeastern corner of the site ("Field S") preserved by the collapse of a room engulfed by a fire. Numerous archaeological plant remains recovered through flotation provide direct physical evidence of the specific crops that were grown and consumed, which include free-threshing wheat, peas, grapes, lentils, and figs. Sixteen AMS radiocarbon dates on the plant remains themselves indicate that this context represents a snapshot of at least one season of the agricultural economy in the late 6th/early 7th century A.D. Spatial analyses of the plant remains and artifacts from the same samples (grinding stones, ceramics, etc.) suggest that these remains are an in situ food-preparation assemblage inside of what was likely a kitchen or larder.

It is argued below that some of the ceramic storage vessels may have contained wine based on the specific parts of the grape plant recovered from the same sampled locations. Comparison of the archaeobotanical assemblage of Field S at Dhiban to those from nearby and contemporaneous archaeological sites reveal a common production of specific cultigens (wheat, pea, and grape) across much of the southern Levant at this time, which is alluded to in historical documents. The similarity of this crop inventory across communities may represent networks of practice in which agricultural techniques and knowledge were shared. However, differences in the ubiquities of specific cultigens at some sites, such as barley (e.g., between Lejjun and Dhiban), may point to intentional specialization, functional needs, and community exchange.

Papyrological evidence discussed below suggests that the Byzantine state did not directly intervene in the agricultural production schemes of the villages of the Late Antique southern Levant. These archaeobotanical data therefore suggest that the economic connectedness of the Byzantine empire facilitated, but did not dictate, economic exchange and crop production at Dhiban. Moreover, any less granular level of spatial resolution would not permit the identification of these plant remains as deriving from a likely food-preparation space and, by extension, the activities that occurred within it. Therefore, this study highlights the importance of using these high-resolution methods when logistically and financially feasible.

Historical Background

The beginning of the political existence of the Byzantine empire is typically dated to ca. A.D. 325 in the eastern Mediterranean with the ascension of the emperor Constantine

I. At its height, the empire stretched across the majority of the eastern Mediterranean but contracted considerably in size after a series of wars with the Umayyad Caliphate beginning in A.D. 641. The capital city of the Byzantine empire was Constantinople (Istanbul), but several other large cities were nearly as important with respect to political governance and economic production, especially Alexandria (al-Iskandariyah) in Egypt and Antioch (Antakya) on the eastern Mediterranean littoral. The area that is now the Hashemite Kingdom of Jordan, at varying times part of the Byzantine provinces of Arabia and Palaestina Salutaris/Tertia, remained its southeastern-most frontier throughout this time. Regional imperial officials recruited both local clients and appointed regional functionaries to monitor and protect this area through a system of military encampments and fortresses along the western edge of the Eastern Desert (Parker 1987, 2006; Kennedy 2004).

A diverse array of archaeological proxies indicates an increase in economic exchange and settlement density in the southern Levant at this time (Kingsley and Decker 2001; Chavarria and Lewit 2004), although some researchers have argued that this increased economic production and exchange should be dated just prior to the end of Byzantine political hegemony in the region ca. A.D. 640 (Bar-Oz et al. 2019; Fuks et al. 2020). The data for the latter are visible in the expansion and density of non-urban and urban settlements (Hirschfeld 1997; Bar 2004); the number of new constructions of buildings, specifically churches (Di Segni 1999); the circulation of ceramic vessels such as amphorae (Pieri 2012) and number of shipwrecks with diverse-origin cargo (Parker 1992); and, the number and density of agricultural installations, such as olive and wine presses (Frankel 1997).

One hypothesis for this increase in proxies of exchange is that the demands of large urban centers such as Constantinople and Alexandria spurred rural communities to supply foodstuffs to non-producing urban dwellers (Morrison and Sodini 2002). The extent to which this rural-to-urban food redistribution was overseen by the Byzantine state (in the form of the taxation system known as the *annona civica*) is still debated, although it is clear that Byzantine political elites did occasionally oversee transfers of grain from state-owned storage structures to buffer against crop loss, drought, and starvation (Laiou and Morrisson 2007, 31–33).

In addition, local recruits into the Byzantine army were stationed around the southeastern borders of the Levant in response to major recurring military conflicts with the bordering Sasanian Persian empire and buffering Arab client states such as the Nasrids (Sauer et al. 2017). These soldiers required food to be provisioned by local communities (Rubin 1996, 63–67), and there is papyrological evidence that actively commissioned soldiers were engaged in small-scale agriculture (Fiema 2007). The payment of this food to the military as tax via the *annona militaris* has thus been argued to be a mechanism which promoted intensified agriculture at this time, as local communities increased crop production to supply foodstuffs to nearby barracks (Kingsley and Decker 2001, 5–9).

Finally, in A.D. 380, Christianity became the sole official religion of the Byzantine empire through an edict of the emperor Theodosius. Although formal adoption of Christianity occurred at different rates in different regions for diverse individuals and communities, the church as an institution, and the clergy especially, gained considerable power

as a consequence of their fusion with the bureaucratic apparatus of the state (Brown 2012). The prestige of the church was likely elevated among the communities of the southern Levant in the 5th–6th centuries A.D. particularly because the area had been the one in which Christianity originated (Morrison and Sodini 2002, 182). Numerous pilgrimages were organized, and the entire area received its designation as the “Holy Land” (Wolf 1964). A corollary of this prestige has been argued to have been financial gain: papyri from villages and cities indicate that by the 6th century A.D., ecclesiastic institutions owned vast tracts of land in the Levantine provinces (Ashkenazi and Aviam 2017). Quantitative analysis by Di Segni (1999) of the number of inscriptions that mention dates of foundations on churches from Jordan and Syria shows a burst of ecclesiastic building construction in the period of A.D. 530–640, but not thereafter.

Taken together, the arguments for increased agricultural production and more extensive economic connections among the communities of the Late Antique southern Levant furnish the opportunity to identify such socio-economic transformations at specific archaeological sites in the region through the recovery of the outcomes of these initiatives: the plant remains themselves.

The Archaeological Site and Environmental Context of Tall Dhiban

Excavations (2009–2023) at the archaeological site of Dhiban (Lat/Long: 31° 30′ 6.97″ N, 35° 46′ 35.33″ E, Figure 1A) in the Hashemite Kingdom of Jordan provide evidence of how one such community was involved in the negotiation of these socio-economic changes through local strategies of agricultural production.

The archaeological site of Dhiban consists of a 12.5–15 ha mound, or *tall*, that is located on a plateau bearing the same name. The plateau is hemmed by two deep escarpments of Cretaceous origin that have water perennially available at their bottoms, known as wadis: the Wadi al-Mujib to the south and the Wadi al-Wala to the north. These wadis were historically recharged by precipitation that falls between the months of November and March, although contemporary dams, reservoirs, and wells have dramatically changed the direction, speed, and intensity of water flow. Precipitation data collected by the Water Authority of Jordan from 1960 until 1990 indicates that the mean annual precipitation of Dhiban is 256.56 mm/yr, with considerable inter-annual variability (El-Naqa 1993).

The climate of this area is characterized as mainly hot summer-Mediterranean (Csa) and arid (Bwh), according to the Köppen classification (Peel, Finlayson, and McMahon 2007). The plateau and site itself are at the intersection of a Mediterranean and Irano-Turanian bioclimate (Cordova et al. 2005, 30), with plant taxa characteristic of Mediterranean, Irano-Turanian, and even Sudanian floristic provinces (Soto-Berelov, Fall, and Falconer 2012).

Early excavations were conducted at Dhiban in the 1950s by W. Morton, D. Reed, A.D. Tushingham, and F. Winnett (Winnett and Reed 1964; Tushingham 1972; Morton 1989), while recent excavations have been undertaken by Katherine Adelsberger, Danielle Steen Fatkin, Melissa Kutner, Benjamin Porter, and Bruce Routledge between 2004 and 2023 under the mantle of the Dhiban Excavation and

Development Project (DEDP). These excavations have produced evidence that communities have repeatedly resettled the mound for nearly 5000 years, from ca. 3000 B.C. through the present. This is visible in monumental walls, architecture, inorganic objects, and biological remains (Porter et al. 2005, 2010, 2012; Routledge et al. 2013).

The site has been divided into four primary areas of excavations referred to as “Fields:” 1) W, 2) L-West, 3) L-East, and 4) S. Field S is located in the southeastern corner of the tall (Figure 1B). Surface surveys in 2009 and 2010, followed by initial excavations in 2012, led to a preliminary dating of this area to ca. A.D. 500–750 based on diagnostic ceramic evidence. Further excavations within a 10 × 10 m area were then conducted in 2013, 2017, and 2019. All of the data presented in this study derive from Field S.

Phasing and chronology of Field S

A combination of stratigraphy, architecture, radiocarbon dates, and the absence of particular diagnostic pottery points to two broad spans of use of the structures recovered in the 10 × 10 m excavation area of Field S: the period up to and including a catastrophic collapse of these structures (“collapse phase”) and all reuse and reinhabitation that occurred afterward in this same area (the “post-collapse phase”). While the phase of collapse predated the phase of reuse above it, the available radiocarbon evidence, discussed below, suggests that the difference in time between the two phases is likely measurable in decades, if not years, sometime around A.D. 600.

The post-collapse phase begins approximately 25 cm below the surface and comprises what appears to be a reuse and, in certain places, reconstruction of earlier existing architecture. The deposits of this phase are mostly composed of undifferentiated accumulations of sediment (fill), although there were some cooking installations and pits.

The older collapse phase beneath it consists of at least two identifiable rooms. For ease of readability in this report, these rooms and/or areas, whose architectural limits became clearer by the end of 2013 and were finalized in 2017, are numbered one through four. The westernmost of these rooms (Room 1) was supported by four arch springers (Figure 2A:1). The deposits found in its center contained large, flat, limestone paving stones more than 1 m in length (Figure 2A:2) that constituted either an upper floor or a roof. In addition, there were burn marks on the limestone room walls (Figure 2B), large quantities of charcoal in adjacent deposits, burned small vessels, and numerous reconstructible vessels of various sizes (Figure 2C). This evidence points to a conflagration and then collapse (or vice-versa) of this room, sealing all of its contents within it, albeit in a fragmentary state.

Calibration of 16 AMS ¹⁴C dates of short-lived (annual) archaeological plant remains reveals that 10 out of the 16 date to a 2σ probability interval of CAL A.D. 560–645. It is likely that 12 dates in total date to this range, but larger error ranges from two samples (#13 and 14) do not permit direct chronological comparison in temporal distributions. These samples were chosen from deposits at different depths and across all excavation units (Figure 3A, C).

The radiocarbon data indicate that four dates are major temporal outliers. Room 4 (Unit AX55) contained a drain comprised of two rows of stone ca. 30 cm apart ending in a reused basalt mill-stone outlet (Figure 2A:3). The drain



Figure 1. A) The geographic region surrounding the archaeological site of Dhiban, with site location marked. B) The archaeological site of Dhiban. Excavation units (5 × 5 m) are outlined in white, and adjacent labels name each excavation area. The topographic lines are at an interval of 15 m.

appears to have been blocked not too long after its construction. Two radiocarbon dates from within and adjacent to the drain (#12 and 46) produce the same date range: ca. CAL A.D. 430–550, even though they are separated vertically by 50 cm. In addition, the fills of this room consistently contain pale painted pottery; this pale painted ware is not present inside the adjacent and arched larger room (Room 1). The depositional processes that led to the infill of this drain feature must have involved the movement of older organic material.

Unfortunately, this does not clarify its function. As a result, the data from Room 4 are presented separately in subsequent tables, as its chronological association with surrounding deposits cannot be verified. Nevertheless, in some spatial visualizations, samples from Room 4 are associated with the phase of major collapse based on the stratigraphic position of samples alone.

The remaining two anomalous dates (#41 and 43) date to the later Abbasid/Fatimid/Crusader periods. They both



Figure 2. The collapsed room in Field S in 2013. Unit boundaries have been superimposed on their approximate locations as dashed black lines (photo credit: John E. Webley). The dashed white lines indicate hypothesized arch locations on each set of springers. The numbers indicate 1) arch springers, 2) fallen paving stones, and 3) a drain-like feature. Breakout boxes illustrate B) extensive ash and burning visible on architecture (AX55/AW54) and C) large quantities of pottery, especially storage vessels, recovered from the southern portion of Unit AW54 between A:2 and A:1.

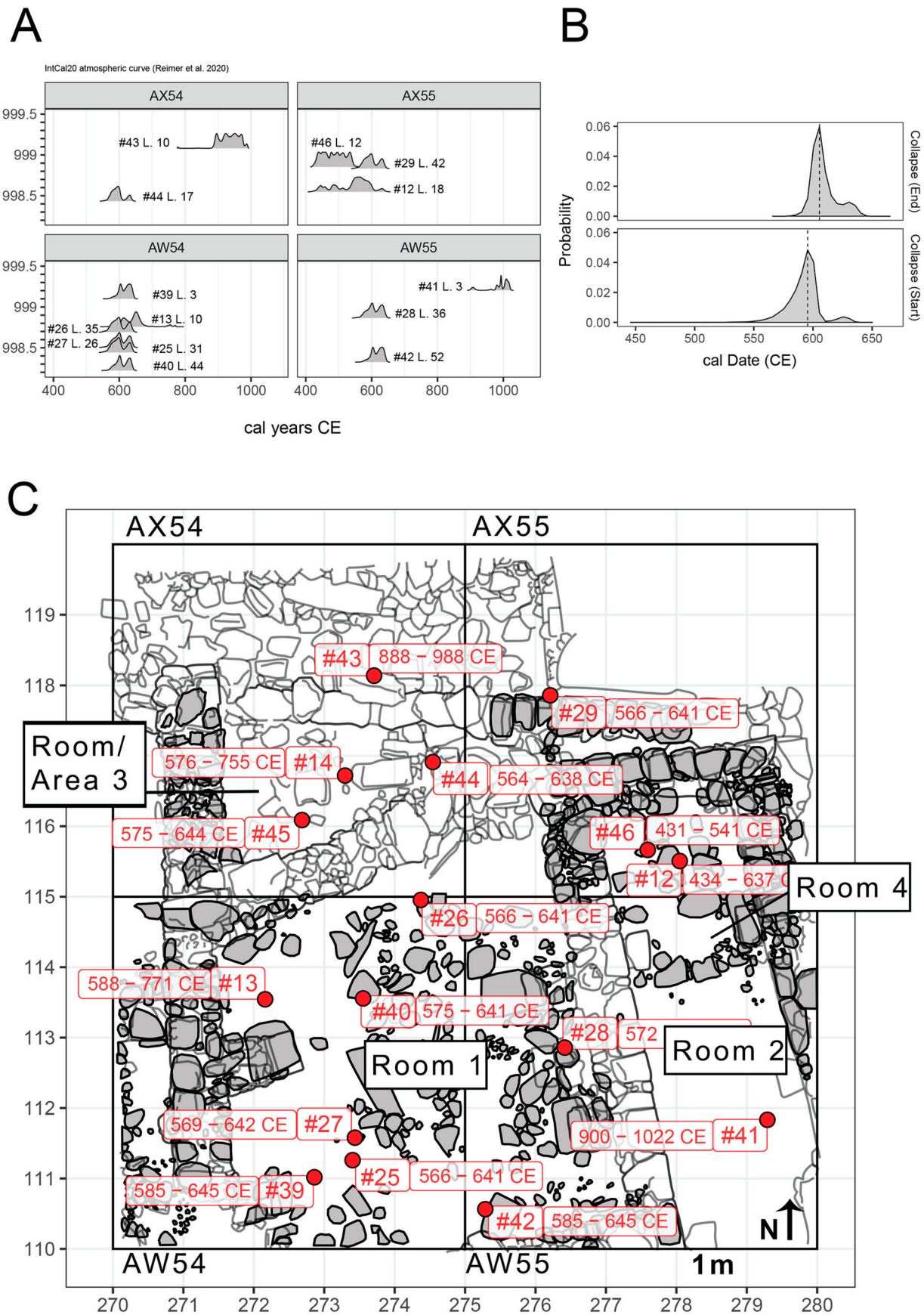


Figure 3. A) Calibrated radiocarbon probability distributions arranged according to their depth (y-axis) and by excavation unit. B) Bayesian modeled start and end date boundaries for the collapse context (see Supplemental Material 1). C) Spatial locations of calibrated dates within both phases of architecture (post-collapse: gray, collapse: unfilled lines), with rooms or areas highlighted and labeled.

derive from the uppermost deposits of their respective units (see Figure 3A), within 10–20 cm of topsoil. They are also located at the furthest northern and southeastern areas of

these excavation units, respectively (see Figure 3C). These late dates are likely due to disturbance of these deposits during or after the time period to which these plant remains

date (Porter et al. 2007). In contrast, the dates from collapse period deposits in Room 1, three of which were found interspersed among fragmented storage vessels (#25, 26, and 28) and one embedded within a more compact deposit (#27), are all stratigraphically contemporaneous and date to the same exact range, CAL A.D. 550–640 (2 σ , Table 1).

A Bayesian model of all of the non-outlier radiocarbon dates (Ramsey [2009]; using OxCal 4.4; see Supplemental Material 1 for code) from Room 1 ($n = 8$) illustrates that the modeled boundaries of the collapse event are centered on a starting date around A.D. 590 and an end date of A.D. 630 (Figure 3B). This date range serves as the terminus ante quem for the material below it. The two modeled dates from the upper deposits of Room 1, which belong stratigraphically to the post-collapse phases, fall within a 1 σ range of CAL A.D. 600–640 (#13 and 39). They contrast with dates below them that are consistently within a modeled 1 σ interval of CAL A.D. 575–635.

Given this date interval, it is unlikely that the Umayyad conquests of ca. A.D. 640 are the reason for the room's destruction. Instead, the modeled date of the collapse of the structures in the early 7th century A.D. correlates with archaeological and epigraphic evidence for earthquakes in the region (Rucker and Niemi 2010), as well as the destruction of contemporaneous sites (En-Gedi) on the western shore of the Dead Sea. The destruction of these sites near the Dead Sea remains unexplained, however. Researchers have attributed evidence of destruction to attacks by so-called nomads or social and political tension (Hirschfeld 2005). In addition, the Sasanian Persian campaign through the Levant in the early 6th century A.D. is a further possibility, considering that Sasanian armies successfully captured Jerusalem in A.D. 614 and held it until A.D. 630 (Foss 2003). At present, earthquake damage has not been identified in the Field S structures at Dhiban, nor is there yet any indication of violence (e.g., arrowheads, human skeletons, etc.) in the collapse of these structures.

Even still, Field S is an exceptional context, as the collapse and burning of these rooms, especially Room 1, preserved a snapshot of agricultural production and daily life in the 6th–7th centuries A.D. As a result, its archaeobotanical data illustrates the ways in which the Dhiban community negotiated with larger Byzantine imperial networks in the Late Antique southern Levant during this moment of efflorescence of village life.

Paleoclimate and paleoenvironment

Unlike the archaeological proxies of economic intensification, there is substantial debate regarding climatic conditions in the southern Levant between the 5th and 7th centuries A.D., and systematic reviews of current paleoclimatic evidence are available (e.g., Fuks et al. 2017). In brief, palynological (Neumann et al. 2007) and limnological (Enzel et al. 2003) research conducted at sites near the Dead Sea (and within the Sea itself), alongside analyses of stable inorganic isotopes of $\delta^{18}\text{O}$ in cave speleothems to the west (Bar-Matthews, Ayalon, and Kaufman 1997), have been argued to indicate increased precipitation, runoff flooding, and humidity at this time. The confluence of these climate proxies has led researchers to dub this period as the “Late Antique Little Ice Age” (Büntgen et al. 2011, 2016), as inferred temperatures reached some of the lowest for this area during the

Holocene. Olive and grape pollen have featured prominently in this debate, as they are tied to anthropogenic landscape changes in the form of agriculture, and several pollen cores collected around the Dead Sea note an increase in the frequency of the pollen of both plants, especially from the 4th–7th century A.D. (Neumann et al. 2007, 2010).

Furthermore, there has been a large amount of archaeological, paleoecological, and paleoclimatic research within the Negev Desert region, as it receives very little precipitation (< 100 mm/yr), and yet archaeobotanical evidence collected from several sites reveals local production of cereals, grape (for wine), and fig up to the mid-6th century A.D. (Ramsay and Tepper 2010; Ramsay et al. 2016; Ramsay 2017). Archaeological evidence of wine presses dating to the 5th and early 6th centuries A.D. likewise indicate major community investment in an agricultural industry that was dependent on a quantity of water that did not exist without irrigation or floodwater runoff capture (Rosen 2007). Stable inorganic isotopic evidence ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{18}\text{O}$) from ovicaprid remains from Shivta and Nessana are argued to show little evidence of a major climatic change in this region, however, as ruminant grazing as well as human herd management strategies persisted both before and after these periods (Vai Glover et al. 2020). The archaeobotanical evidence also indicates that the cessation of sustained wine production began up to a century before any major proposed aridification events in the late 6th and early-to-mid 7th century A.D. (Bar-Oz et al. 2019). In short, Fuks and colleagues (2020) conclude that “current evidence does not support major long-term climate change in the Negev over the Byzantine–Umayyad period.”

It is therefore likely that temperature and precipitation conditions around Dhiban in the 6th/7th centuries A.D. would have been similar to those encountered today, although with a slightly greater amount of precipitation and less aridity. The Dhiban community still grappled with agricultural production in a semi-arid climate in which rainfall alone could not be entirely relied upon, but one in which water irrigation infrastructure was necessary.

Methodology

Archaeobotanical field sampling

All of the deposits encountered in Field S, as well as the entire archaeological site of Dhiban, were sampled for archaeological plant remains (Farahani 2018). A blanket sampling strategy was employed in that every identified context was sampled (d'Alpoim Guedes and Spengler 2014). At least one bulk sample was collected from each context. Each bulk sample was one individual collection of sediment from a discrete, physically bounded space. When possible, multiple non-contiguous bulk samples were collected per unique, identifiable archaeological deposit (Lennstrom and Hastorf 1992). Archaeological features such as pits and tabuns, if identified as such, were collected in their entirety. These features were sampled at 10 cm intervals, and each subdivision was processed separately. Deposits identified as surfaces were divided into 1 × 1 m grids. No archaeological remains were removed from the sediment matrix during sampling, including faunal remains, ceramic, shell, and other organic and inorganic material. All samples were point-provenienced using a total station. Samples were

Table 1. Uncalibrated and calibrated radiocarbon dates collected from archaeological plant remains in Field S deposits up to the 2017 season. Calibrated dates are based on the IntCal20 curve and were calibrated in R using the rcarbon package. For modeled dates, see Supplemental Material 1.

Project #	Lab #	Unit	Locus	SG	Dated Remain	Uncal B.P.	Error (+/-)	d ¹³ C	Calendar Range 2s	Calendar Range 1s
41	UCIAMS-244882	AW55	3	20	Hordeum vulgare	1065	15		A.D. 900–1022	A.D. 979–1019
43	UCIAMS-244884	AX54	10		Triticum sp.	1125	15		A.D. 888–988	A.D. 893–974
13	AA100555	AW54	10	8	Vitis vinifera	1391	39	-25.3	A.D. 588–771	A.D. 607–664
14	AA100556	AX54	6		Hordeum	1404	39	-24.8	A.D. 576–755	A.D. 606–658
39	UCIAMS-244880	AW54	3	18, 19, 23, 24	Triticum sp.	1455	15		A.D. 585–645	A.D. 600–640
42	UCIAMS-244883	AW55	52	21, 22	Triticum aestivum	1455	15		A.D. 585–645	A.D. 600–640
45	UCIAMS-244886	AX54	40		Triticum aestivum	1460	20		A.D. 575–644	A.D. 595–640
28	UCIAMS-157798	AW55	36		Hordeum vulgare	1465	20	-23.7	A.D. 572–643	A.D. 588–639
40	UCIAMS-244881	AW54	44	4, 9	Pisum sativum	1465	15		A.D. 575–641	A.D. 590–638
27	UCIAMS-157797	AW54	26	19	Triticum cf. dicoccum	1470	20	-20	A.D. 569–642	A.D. 580–637
25	UCIAMS-157795	AW54	31		Pisum cf. sativum	1475	20	-23	A.D. 566–641	A.D. 575–635
26	UCIAMS-157796	AW54	35	5	Vitis vinifera	1475	20	-20.6	A.D. 566–641	A.D. 575–635
29	UCIAMS-157799	AX55	42	11	Triticum dicoccum	1475	20	-20.4	A.D. 566–641	A.D. 575–635
44	UCIAMS-244885	AX54	17	15	Triticum aestivum	1480	15		A.D. 564–638	A.D. 573–603
12	AA100554	AX55	18	18, 19, 23, 24	Triticum sp.	1524	38	-22.1	A.D. 434–637	A.D. 443–600
46	UCIAMS-244887	AX55	12	23	Vitis vinifera	1585	15		A.D. 431–541	A.D. 435–537

processed using a mechanized flotation device based on the Siraf model (Williams 1973). An additional ca. 50 g of sediment was also collected from each deposit for microbotanical analysis, which has not yet been conducted.

The results of sample collection between 2009 and 2017 yielded 304 samples in Field S (1189.5 L total of sediment, mean = 7 L). Samples collected up to and including the 2017 excavation season are presented below. However, only a subset ($n = 9$) of the 2017 samples whose coordinate data could be confirmed through independent field records are utilized. The entirety of each dried light fraction sample was passed through a series of US Standard geologic meshes > 2 mm, > 1 mm, and > 0.5 mm in size. All archaeological plant remains were separated, identified, and quantified using a stereo-microscope to the most specific taxonomic level possible, e.g., to species, genus, or family, in each mesh size up to 0.5 mm. In addition, all of the heavy fraction for each of these samples was processed, which is the material that did not float, and which was captured in a 1 mm mesh. The dried heavy fraction was passed through a set of sieves > 25 mm, > 12.5 mm, > 8 mm, > 4 mm, and > 2 mm in size. All of the analyzed results of heavy fraction sorting are incorporated into this study. Identifications of archaeobotanical specimens were based on modern comparative collections in addition to numerous online and physical resources (e.g., Neef et al. 2012).

Spatial and statistical analyses

Spatial analysis of the archaeological plant remains utilizes the Getis-Ord G_i^* statistic, which locates a point or feature within a defined radius and calculates the spatial clustering of high or low attribute values, in this case the density of plant remains (#/L) (Ord and Getis 1995). The output is a G_i^* statistic based on a distance-weighted version of a z-score across all samples within a reference area (Bivand,

Pebesma, and Gomez-Rubio 2013; Bivand and Wong 2018). Samples with higher G_i^* values, i.e., higher z-scores, will tend to share greater density values with nearby samples. A permutation method was chosen, re-simulating the data 499 times, and the search space around each sample was set to 1 m. In order to reduce the probability of committing a Type I error, research shows that for a sample size of 45 or over, a critical value (α) over 3.0175 must be used (Ord and Getis 1995). Analyses were conducted in R > v.4.2.0 using the *spdep* package.

Results

The collapse assemblage constituted 59 individual samples that equaled 353 L of sediment across 25 unique loci (see Table 2 for a breakdown by room). These samples produced 5890 archaeological plant remains (excluding wood charcoal), of which 1102 were identified as disseminules of agricultural crops (19% of the total) (see Supplemental Material 1). There was a high level of fragmentation, as there were 2224 fragments identifiable to some crop (38% of all remains) and 1580 unidentifiable fragments (27% of all remains). The large number of identifiable and unidentifiable fragments (65% of all remains) is likely due to the destructive processes that led to the collapse and conflagration of the room(s).

Within the collapse deposits, the most numerous identified whole plant remains of agricultural origin were free-threshing wheat caryopses (= grains, see Table 2), most likely of bread or macaroni wheat (*Triticum aestivum* L./*durum* L.) based on the evidence of the preserved rachis nodes and diagnostic caryopsis morphology. The next most abundant remains were grape pips (*Vitis* cf. *vinifera* L.) and pea (*Pisum sativum* L.) seeds, and then fig (*Ficus carica* L.) achenes. In addition, barley (*Hordeum vulgare*) caryopses were identified, both of the (hulled) two (*Hordeum vulgare*

Table 2. The count, proportion, and ubiquity of major classes of archaeobotanical remains recovered in Field S by Room/Area.

		Room 1 N = 40, Volume (L) = 253.5			Room 2 N = 6, Volume (L) = 29			Room 3 N = 7, Volume (L) = 37.5			Room 4 N = 12, Volume (L) = 91.5			Extramural N = 6, Volume (L) = 33			
Common Name	Taxon	Ct	% Ct	Ubiq	Ct	% Ct	Ubiq	Ct	% Ct	Ubiq	Ct	% Ct	Ubiq	Ct	% Ct	Ubiq	Total
Cereals																	
Barley	Hordeum vulgare	16	0.02	0.32	-	-	-	2	0.03	0.29	28	0.22	0.58	3	0.08	0.5	49
Cereal (Unidentified)	Indeterminate cereal	27	0.03	0.28	-	-	-	6	0.09	0.57	7	0.05	0.42	1	0.03	0.17	41
Wheat (Bread)	Triticum aestivum	-	-	-	-	-	-	1	0.01	0.14	-	-	-	-	-	-	1
Wheat (Bread/ Macaroni)	Triticum aestivum / durum	91	0.09	0.25	-	-	-	21	0.3	0.71	2	0.02	0.17	9	0.24	0.5	123
Wheat (Emmer)	Triticum dicoccum	23	0.02	0.15	-	-	-	3	0.04	0.29	2	0.02	0.17	4	0.11	0.33	32
Wheat (indet)	Triticum sp.	283	0.29	0.45	-	-	-	9	0.13	0.43	8	0.06	0.33	-	-	-	300
Legumes																	
Grass pea	Lathyrus sativa	-	-	-	-	-	-	-	-	-	1	0.01	0.08	-	-	-	1
Lentil	Lens culinaris	15	0.02	0.2	-	-	-	3	0.04	0.29	11	0.09	0.42	2	0.05	0.33	31
Common Pea	Pisum sativum	184	0.19	0.35	-	-	-	-	-	-	-	-	-	-	-	-	184
Bitter vetch	Vicia ervilia	7	0.01	0.12	-	-	-	-	-	-	2	0.02	0.17	-	-	-	9
Fava bean	Vicia faba	8	0.01	0.12	-	-	-	-	-	-	-	-	-	-	-	-	8
Vetch	Vicia sp.	3	-	0.05	1	0.12	0.17	2	0.03	0.29	4	0.03	0.25	-	-	-	10
Fruits																	
Fig	Ficus carica	143	0.15	0.8	6	0.75	0.33	16	0.23	0.86	17	0.13	0.67	12	0.32	0.83	194
Olive	Olea sp.	2	-	0.05	-	-	-	-	-	-	-	-	-	-	-	-	2
Grape	Vitis vinifera	184	0.19	0.68	1	0.12	0.17	6	0.09	0.43	47	0.36	0.75	6	0.16	0.5	244
Christ's Thorn Berry	Ziziphus spina-christi	-	-	-	-	-	-	1	0.01	0.14	-	-	-	-	-	-	1
Vegetables																	
Fennel	Foeniculum vulgare	-	-	-	-	-	-	-	-	-	-	-	-	1	0.03	0.17	1
Total		986			8			70			129			38			1231

ssp. distichon) and six (*Hordeum vulgare* *ssp. vulgare*) row varieties, although barley grains were neither abundant ($n = 16$) nor ubiquitous ($\%_{ubiq} = 0.32$). There were also emmer wheat (*Triticum dicoccum*) grains interspersed throughout these samples, although their low count and ubiquity ($n = 23$, $\%_{ubiq} = 0.15$) suggests that they were a trace crop (i.e., likely residually present in fields), rather than a major object of cereal production.

Lentils (*Lens culinaris* L.) were the most abundant legume, followed by at least two different varieties of vetch interspersed with other crop seeds, including bitter vetch (*Vicia ervilia* Willd) and broad bean (*Vicia faba*). Many of the pea remains were found either halved or fragmented and yet still identifiable due to surface morphology and diagnostic features such as the presence of the hilum. The preservation of many whole pea remains allowed for estimation of the number of peas from identifiable fragments based on weight. An ordinary least squares regression model was created based on random resampling with replacement of available pea weights (see Supplemental Material 1). This method estimated an additional 278–338 peas across six loci, and with this estimate, peas would be the numerically most abundant recovered plant remain (451–511 seeds total).

Finally, while grape pips were the second (or third, if the pea estimates are factored in) most abundant whole crop remain type recovered, there were also other elements of the grape plant present, as well. Grape pedicels, the parts of the stem that attach directly to the grape fruit, as well as pressed grape fruit (mesocarp) and skins, some of which contained embedded grape pips, were found in 28% (pedicels) and 16% (mesocarp) of all samples.

Other infrequently occurring crop or potentially consumable plant remains included two whole olive (*Olea europaea* L.) pits, a Christ's Thorn Berry seed (*Ziziphus spina-christi*), and a fennel (*Foeniculum vulgare*) schizocarp. The latter two derive from the top of a wall separating Rooms 1 and 3 and from within Room 3, respectively, and therefore may have moved downward from the uppermost deposits.

A larder for wheat, peas, and grapes?

Calculation of the Getis-Ord G_i^* statistic on the densities (#/L) of grape, pea, and wheat remains shows that there are two separate “hot spots”—one statistically significant cluster of samples that contained a dense concentration of wheat grains and pea seeds in the southern half of Room 1 and another cluster of samples that contained grape pips in the southwestern portion of the same room (Figure 4). These two clusters of samples contained the greatest densities of remains for each of these taxa and were also spatially proximate in three-dimensional coordinate space.

The stratigraphic position of these samples likewise demonstrates that the densest concentrations of wheat and pea were found just below and amid the collapsed limestone paving stones in Room 1 (Figure 5). Grape remains are predominately found in samples from Room 1 in upper (post-collapse) and lower (collapse) deposits, suggesting that their use (and likely production/harvesting) continued after these rooms collapsed and were re-organized. Peas, in contrast, are virtually absent from almost all of the samples in the upper (post-collapse) deposits. Instead of a termination of production of peas by the Dhiban community after the collapse of these rooms, the presence of pea in the lower collapse deposits, and their absence above, is likely explainable by the exceptional taphonomic circumstances of the conflagration that preserved them nearly in situ in Room 1.

Moreover, the spatial distributions of the archaeological plant remains and artifacts recovered from the same samples suggest that Room 1 served a purpose akin to a larder in the moments just before its catastrophic collapse: a place where food was kept, handled, and prepared for its final (consumptive) use. While several lines of evidence point to this specific interpretation, until further excavation of this area securely identifies the functional connection of this structure to others at the site, the identification of this space as a larder or a kitchen remains a hypothesis.

First, the G_i^* values of the densities of ceramic vessel remains (g/L) are the most highly correlated to those of

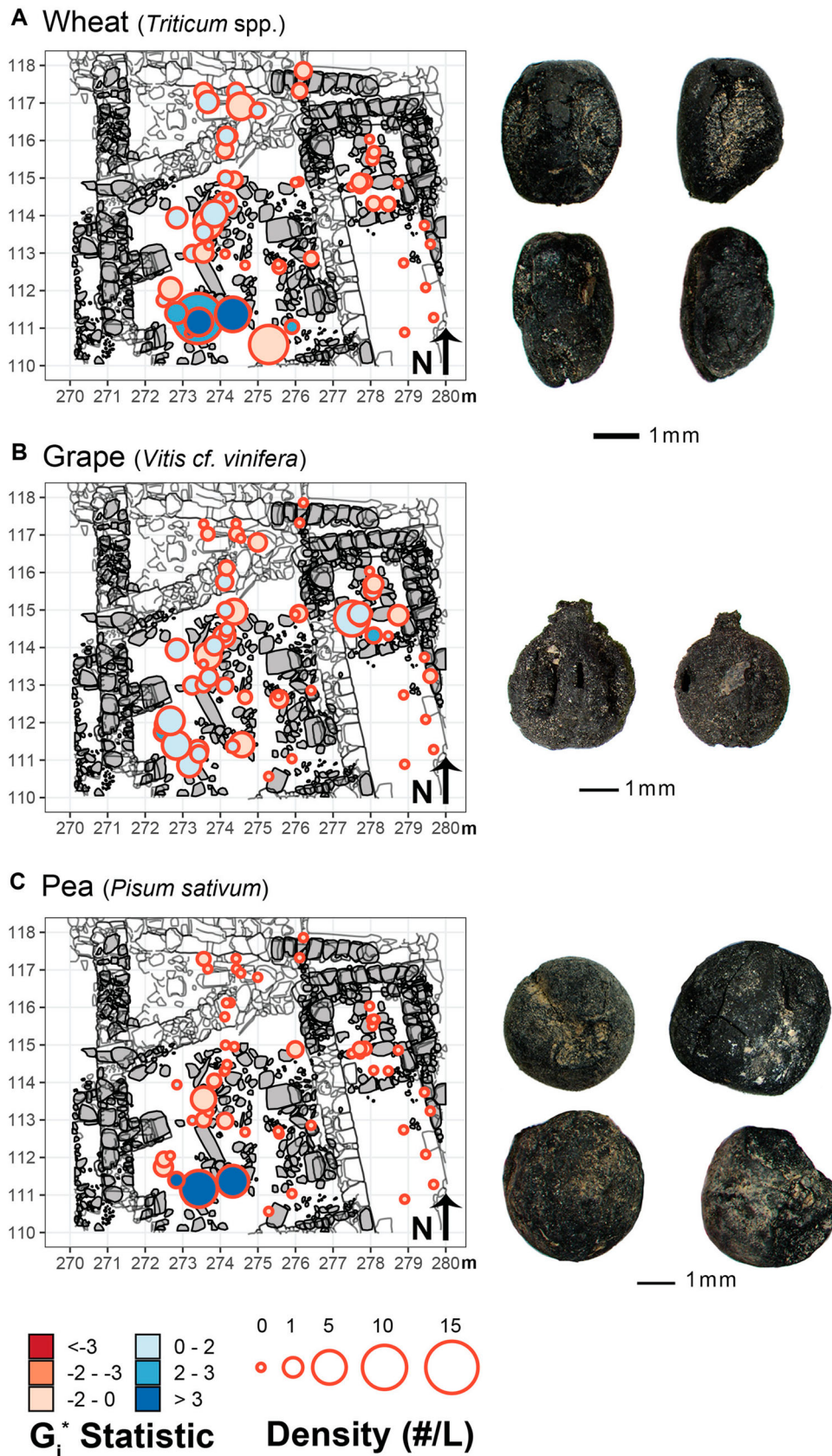


Figure 4. The spatial distribution of the densities of crop remains (grains, seeds, etc. per L) recovered in each flotation sample. Each point represents a bulk flotation sample, and its size is proportional to the density of remains. Color symbolizes the G_i^* statistic. Representative photos of specimens of each type of crop remain are located to the right of each plot.

wheat and pea (#/L) in Room 1 ($r_{pea} = 0.81$, 95% CI = 0.70–0.88; $r_{wheat} = 0.70$, 95% CI = 0.54–0.81; Figure 6A). That is, the densest clusters of samples containing ceramic remains were often the densest clusters of wheat grains and pea seeds. Two adjacent samples in the south of Room 1 have the highest G_i^*

values for the densities of ceramic and crop remains—this is likely because the wheat grains and pea seeds were stored in at least two or more separate, spatially proximate vessels. Based on the ceramic evidence, both were likely storage jars—neither were amphorae meant for transport (e.g.,

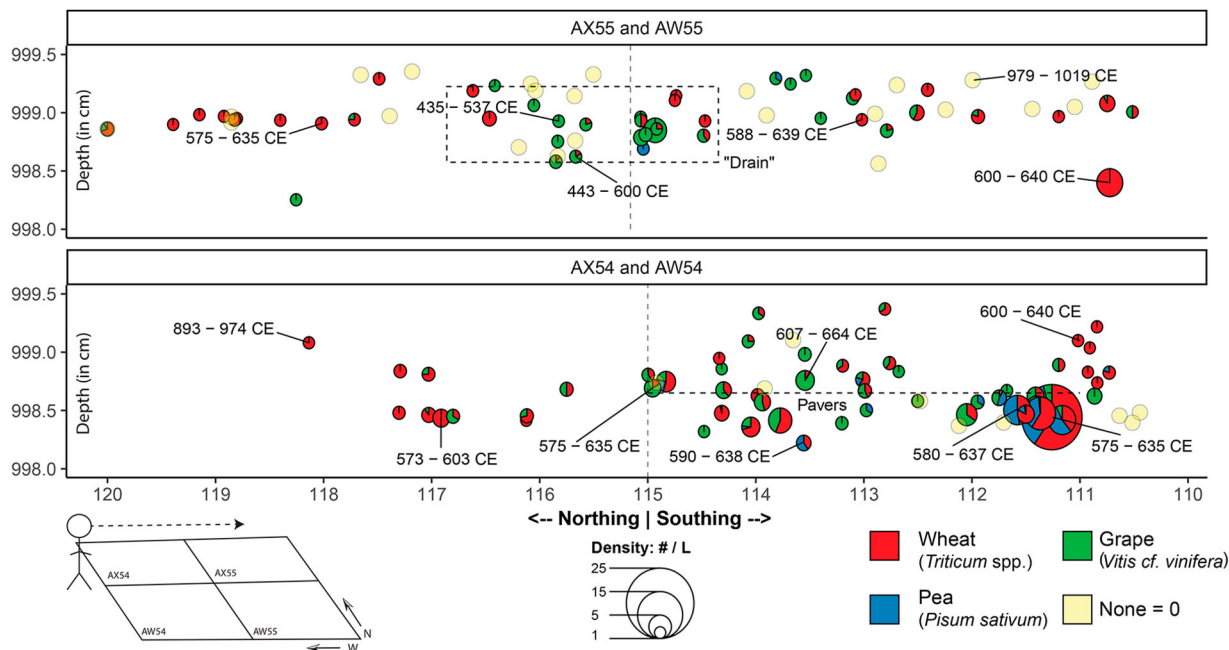


Figure 5. The vertical location of each bulk flotation sample, where the y-axis represents depth (in cm), and the x-axis represents northing and southing values (in m). The figure in the bottom-left indicates the direction of view across excavation units. Point sizes are proportional to the combined density of wheat, pea, and grape remains. Points are colored according to the relative percentage of each taxon they contain. The none category indicates none of the three remains was present. All radiocarbon dates are calibrated to 1σ .

Magness 1993, 227–230). Therefore, these vessels likely held these grains and seeds at the point of transformation into cuisine, as associated samples consisted of more than 94% of crop remains.

In addition, these dense samples were within 0.5 m of a half-preserved basalt quern and an intact small serving juglet (Figure 6B:1, 2). Two m to the north, there was a “cooking pot” (cf. Tushingham 1972, fig. 9, 6–10), a pouring vessel, large numbers of metal nails, and a large carbonized larva possibly of the Calyptratae, a subsection of the order Diptera that includes house flies (Figure 6B:4–6).¹ The presence of a large larva in the same deposits as these cooking vessels and grape fruit remains suggests that it was undisturbed for a long enough time to reach a late stage in its growth cycle. Preliminary analysis of the ceramic remains indicate that there were ten pithoi, or very large storage vessels (e.g., Sauer and Herr 2012, fig. 3.63.2-4; Tushingham 1972, fig. 12, 47–57), in this room, in addition to bowls and plates (e.g., Sauer and Herr 2012, figs 3.22.7, 3.71.9, 3.90.3-4), further supporting the interpretation that these vessels were kept in and part of an area of active food storage and processing. Analysis of the faunal remains by Dr. Hannah Lau mirrors the spatial distribution of crop density, in that the deposits within Room 1 contain the greatest concentration of fish (ichthyofaunal) remains, as well as those of domesticated animals such as sheep, goat, chicken, and pig. Therefore, both plants and animals likely destined for consumption were handled in the same area.

Wine at Late Antique Dhiban?

Margaritis and Jones (2006) have argued that the presence of different parts of the domesticated grape plant—pips, pedicels, and fruits—found within ceramic vessels may indicate wine storage or its presence. By comparing ethnoarchaeological research on wine-making techniques in contemporary rural Greece with the results of the experimental charring of grape

mesocarps and pips, Margaritis and Jones argued that if all of these remains are found together in association with whole or fragmented pithoi, “they can represent wine dregs of any kind of wine stored in the vessel” (Margaritis and Jones 2006, 798). The authors indicate that remains found in this state might indicate white wine specifically (Margaritis and Jones 2006, 799). In fact, Flavius Cresconius Corippus, a poet of the 6th century A.D., praised the wine of Byzantine Palestine for its “very fair snow white color” (*alba colore nivis blandoque levissima*, In *Laudem Iustini Augusti Minoris* 3.85–97).

It is likely that some of the samples from Room 1 derive from the remains (dregs) of wine. Specifically, the deposits in the southwest of Room 1 contained 1) the most grape pips, 2) pressed grape mesocarps with seeds still embedded, and 3) very long pedicels (Figure 7). The deposit directly underneath these samples contained a dense concentration of ceramic remains (59 g/L, symbolized in light green in the 1×1 m grid of Figure 6A), among which preliminary analysis has identified jars.

It is possible, however, that these grape remains represent raisins or whole grapes, since it is not always possible to morphologically distinguish archaeological raisins, grapes, and the dregs of wine. For example, at Bronze Age Tell es-Sa‘idieh in the Jordan Valley, researchers argued that carbonized grape remains preserved in a similar larger context were whole grapes, and not raisins, based on SEM analyses of surface morphology (Cartwright 2003). Similarly, Margaritis and Jones (2006, 800) remark that raisins and whole grapes are identified in archaeological contexts as “embedded whole fruits, occasionally with attached or loose pedicels.”

While this description fits a dense concentration of grape pips and fruit fragments found in the north of Room 1, where they are found alongside cooking and serving vessels (Figure 7), no whole grapes were found, despite the excellent conditions of preservation. In contrast, the samples in the southwest of Room 1 do not contain a high density of

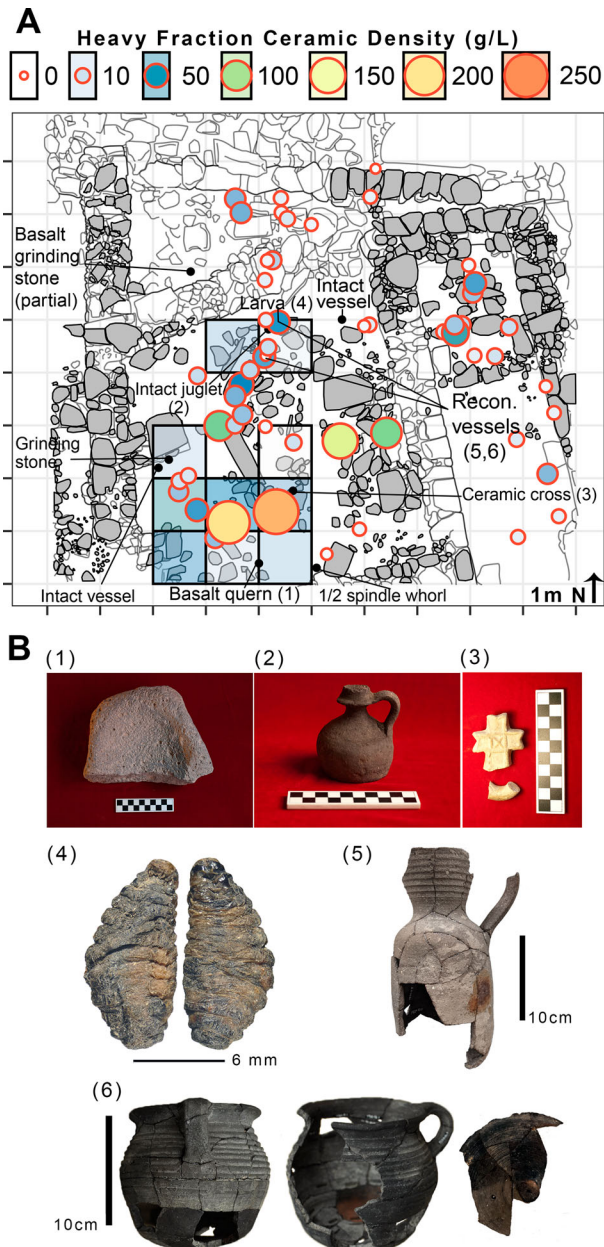


Figure 6. A) Density of ceramic remains (g/L) recovered in the heavy fraction of flotation samples. The size of points and color (including the 1×1 m grids) indicates the density of remains. B) Images of objects include 1) a basalt quern, 2) an entire juglet recovered in situ, 3) a ceramic cross, 4) an as-yet-identified carbonized larva, and 5) and 6) are reconstructed pouring and cooking vessel, respectively (assembled at UCLA by Francisca Bravo, Cassandra Dadat, and Kaitlyn Ireland under the supervision of Vanessa Muros). The locations of these items are indicated on the map by their associated number.

pips, contain long pedicels, and are also more correlated with ceramic remains. It is therefore more likely that the remains in the north of Room 1 (i.e., those found in the same area as the larva and the cooking pots) are grapes (or raisins) meant for consumption, while those from the southwestern corner of the room could represent wine. Further analysis of the ceramic vessels from these contexts will help distinguish between these possibilities.

Specialization and localization in Late Antique Dhiban and the greater Dead Sea communities

At a much larger scale, the presence of wheat, peas, and grape in association with ceramic vessels used for storage, cooking, and serving all point to a broader agricultural strategy

focused on the production of these crops. The near-contemporaneous Nessana and Petra papyri provide supporting evidence that wheat and grape were grown broadly in the region at this time. These papyri are a unique source of information, as they highlight the minutiae of agricultural life recorded by members of the communities of Nessana (in the Negev) and Petra (near Wadi Musa), both approximately 150 km to the south of Dhiban. Nessana Papyrus 82, for example, explicitly mentions the triple-cropping of wheat-legume-grape, describing how wheat (*sitos*) and a legume (*arakos*) were alternated in adjacent plots (Kraemer 2015).

Moreover, Nessana Papyrus 39, dated to the mid-6th century A.D., lists several nearby cities (*poleis*) of the Negev west of the Dead Sea from whom taxes are collected by imperial authorities in fractions and “carats,” or fractions, of *solidii*, which were gold coins used in this period as a tradeable item with a semi-stable value fixed to their level of fineness and weight (Morrison and Sodini 2002, 218; Kraemer 2015, 120–121;). While these are taxes “in coin,” illustrating the importance of the Byzantine imperial monetary economy in the southern Levant (Walmsley 1999), Nessana Papyrus 40, dated to the early 7th century A.D., indicates that wheat could often be used as a form of salary (*tropheia*) for work performed. Nessana Papyrus 80 also records that wheat alone was used as a donative to the local church. Wheat served not only a functional role as food for the Late Antique communities of the southern Levant but could also be used as salary, a donative, and a taxed commodity.

Therefore, how and why the communities around the Dead Sea and broader southern Levant chose to engage in specific schemes of agricultural production appears to be a product of imperial demand and local specialization. The triple-cropping strategy identified in the archaeological plant remains recovered at Dhiban and recorded in papyri from the Negev may indicate that there were regional knowledge networks about agricultural production among the Dead Sea Late Antique communities that were specifically oriented to the environmental challenges of plant growth in a semi-arid landscape but also respondent to the social realities of taxation and payments of salary.

There are two key indicators of this specialization. The first is olive, which is rare among the analyzed samples in the collapse deposits of Field S at Dhiban. Only two samples yielded an entire *Olea* pit, while fragments were interspersed in very low densities (< 0.05 g in four samples). The rarity of olive at Dhiban suggests that olive was not grown in the vicinity of the site, was present as processed oil alone, or that the fruits of this crop are to be found in other areas of the site. Another possibility is seasonality: as olive trees were typically harvested in the ancient Mediterranean between November and December (Foxhall 2007, 6–9), the contents of this kitchen might represent the harvest of wheat and pea only, which often occurs between the months of April and June (Palmer 1998, 150).

Still, the presence of olive remains at other contemporaneous sites in the region that report archaeobotanical data illustrate the unique situation of this specific context at Dhiban. Olive is present in 41% of samples at Hisban, 20% of the samples from Khirbet Faris, 20% of the samples at Pella, and it constitutes 34% of the identified domesticated remains (not samples) from a pool and garden context at Petra

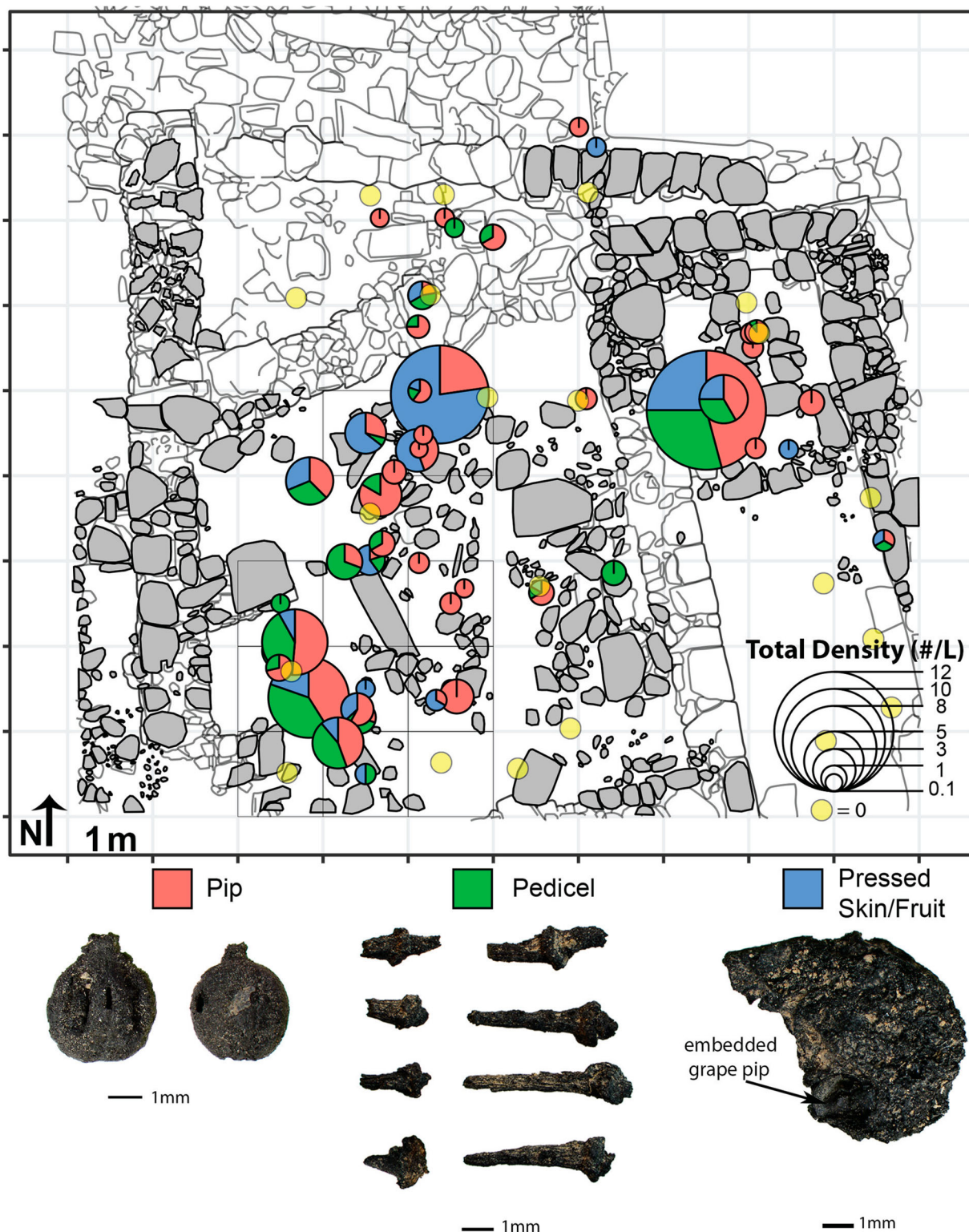


Figure 7. The distribution of all grape remains recovered in flotation samples from the collapse deposits, in which point size is proportional to the total density of grape pips, pedicels, and pressed skins. The interior colors represent the relative percentage of each recovered item, and images of representative archaeological remains are located beneath the legend.

(Figure 8, Table 3). Moreover, olive pits have been recovered at sites in the arid Negev, such as Elusa (Bar-Oz et al. 2019), and an olive press at Shivta suggests larger scale oil production there (Fuks et al. 2016). Given that the unique taphonomic circumstances of the collapse context in Field S at Dhiban seem to have preserved most of the archaeological plant remains, if olive were consumed or stored whole, there is little evidence of it in this area, which is all the more surprising considering the remains of cooking and food preparation activities in this space.

In contrast, the collapse contexts of the Field S structures at Dhiban have one of the highest ubiquities of grape pips (58% of samples) of any contemporaneous site, apart from the wine producing centers of Nessana and Shivta. It could be argued that differences in crop frequencies between settlements are due to the archaeological contexts that have been excavated. For instance, thus far at Dhiban, only one Byzantine/Late Antique period structure-complex (Field S) has been sampled for archaeobotanical and faunal remains. Nevertheless, differences in excavation contexts alone cannot

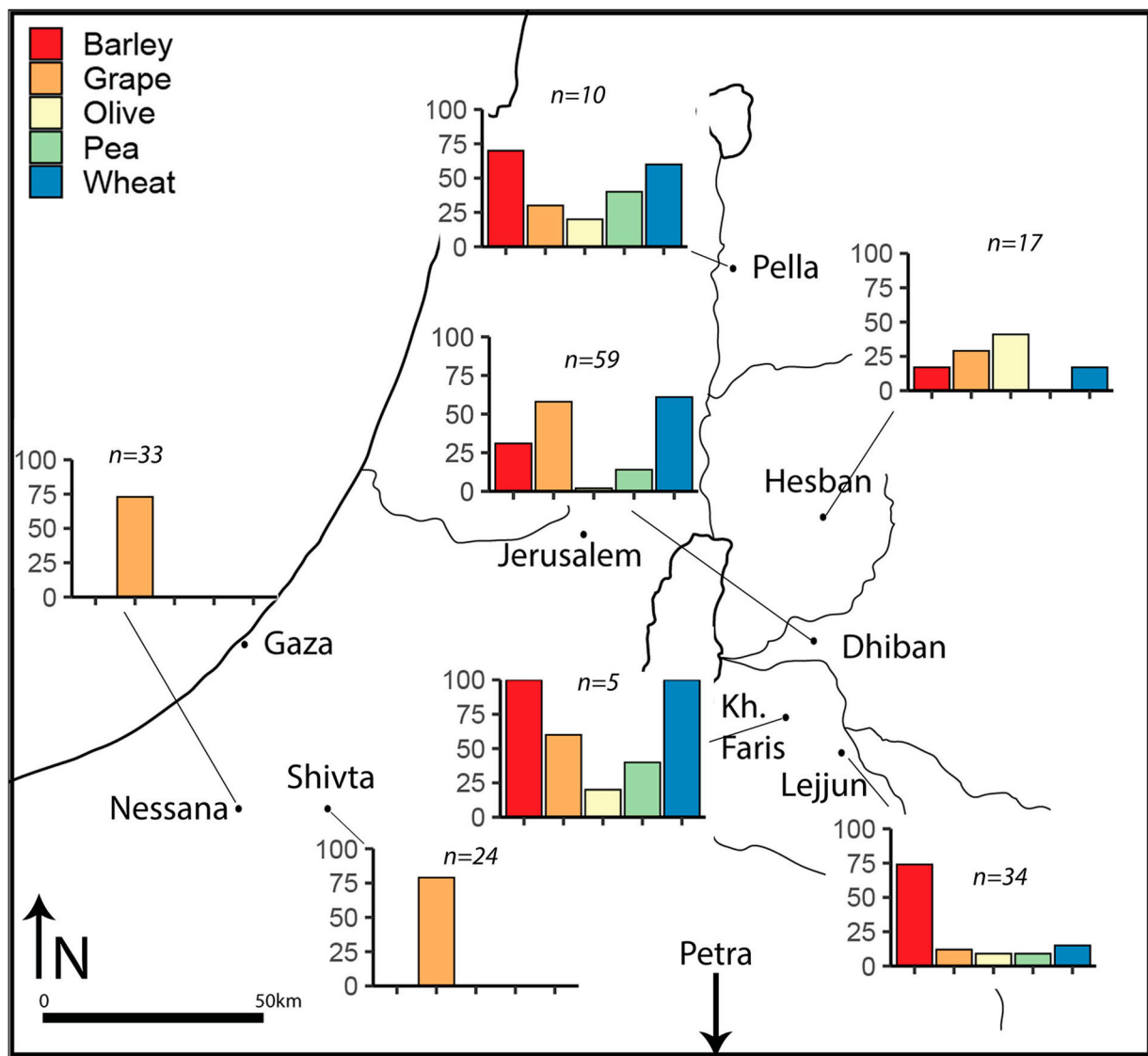


Figure 8. The ubiquity, or proportional presence across samples, of selected crop remains from sites near Dhiban that date approximately between A.D. 500 and 700 where such data are available. The number of analyzed samples is located with each plot.

account for the presence and absence of major crops across these sites. Despite the greater amount of sediment processed in Field S at Dhiban, neither dates (*Phoenix dactylifera*) nor peach pits (*Prunus persica*) have been found, and yet they are present at nearby Lejjun and Khirbet Faris, despite the smaller number of analyzed samples.

Instead, the greater relative frequency of some crops, such as wheat and grape at Dhiban, barley at Lejjun, and olive at Hisban, appear connected to the interdependence of the (tax) desires of imperial elites and trade between and among these communities based on their specific local environmental opportunities and challenges. Here, “elite” refers to imperial agents such as the governors of provinces and on-the-ground local functionaries drawn from a mixed Greek and Arabic (and to a lesser degree, Aramaic) speaking population (as seen in the names of the sons of Eulais in Nessana Papyrus 31, including one Victor and Khalaf Allah). While certain plants, such as wheat, were an important domesticate for millennia in this region, the Nessana papyri nonetheless illustrate how they gained considerable legal, economic, and political potency under the Byzantine imperial state in the Late Antique period.

To this end, Eusebius, in his *Onomasticon*, noted that Dhiban was a very large village stationed in a remote area (*epi tēs erēmīou*) in the 4th century A.D. Even in the early 8th century A.D., church mosaics, including at Umm al-Rasas, 8 km southeast of Dhiban, do not include it among the registers of important cities (*poleis*) in the Late Antique period (Bowersock 2006). Rather, Dhiban was most likely a village, or a *komē*. As Kraemer (2015, 123) argues from the evidence of the Nessana papyri, one group under taxation in these villages (*komai*) were the *suntelstai*, or “the association of citizens responsible for seeing that tax quotas were met,” whether in coin or in wheat valued by weight. The organization of these tax efforts seems to have had little direct state intervention, as inscriptions in the Negev cite officials known as *vicarii*, who were “prominent on the local level but did not hold high-ranking positions in the imperial administration” (Rubin 1996, 62).

A *komē* like Dhiban would have likely paid taxes as wheat organized by their own local *suntelstai*. Apart from the very-dense samples of wheat from Room 1 that were likely from specific, destroyed storage vessels, wheat is the most ubiquitous crop remain across the collapse context of Field S, attesting to its importance. Indeed, comparison of the

Table 3. Contemporaneous sites in the southern Levant ca. 6th/7th century A.D. that have reported relevant archaeobotanical data. A '+' indicates the presence of that archaeobotanical remain category. Sites are arranged according to their direct linear distance in kilometers from Dhiban.

Site	Reference	N	Wheat	Wheat Rachis	Barley	Barley Rachis	Lentil	Vetch/Pea	Date	Grape	Olive	Fig
Dhiban		45	+	+	+	+	+	+		+	+	+
Khirbet Faris	Hoppé 1999	5	+	+	+		+	+		+	+	+
Lejjun	Crawford 2006	34	+	+	+	+	+	+	+	+	+	+
Hesban	Gilliland 1986	17	+		+		+	+		+	+	
Pella	Willcox 1992	10	+	+	+	+	+	+	+	+	+	+
Bir	Ramsay and Smith 2013	5	+	+	+	+	+	+	+			+
Madhkur												
Shivta	Ramsay and Tepper 2010; Fuks et al. 2016; Fuks et al. 2020	24	+	+	+			+	+	+	+	+
Nessana	Fuks et al. 2020	33	+		+					+		
Petra	Ramsay and Bedal 2015	13			+			+		+	+	
Humayma	Perry et al. 2013	10	+	+	+	+	+	+	+	+		+

archaeobotanical data from Field S to later periods of inhabitation at the same site illustrates the temporal specificity of the importance of specific crops. During the Middle Islamic II period (ca. A.D. 1260–1450), when Dhiban was part of the Mamluk empire, archaeobotanical data show a much lower ubiquity of grape and a greater abundance of barley, in near parity with wheat, likely due to a shifted emphasis on sheep-goat husbandry (Farahani 2018).

More contemporary sites reveal a similar trend. At al-Lejjun, a contemporary military barracks 20 km to the south-east of Dhiban, nearly 75% of the analyzed samples contain barley, interpreted as likely animal fodder. Wheat caryopses were not abundant, but a higher ubiquity of wheat rachises suggests that the stationed soldiers and affiliated villagers were also harvesting it. As Crawford (2006, 459) notes, however, “it is not clear ... whether all of these items were produced locally.” One possibility is that a *komē* such as Dhiban, with clear evidence of sustained wheat production, was one such exporter of wheat to nearby communities.

The abundance of grape pips (seeds), pedicels, and exo/mesocarps (skins/fruits) in Field S at Dhiban likewise suggest that the community produced these crops for more than intra-community consumption. Regional and long-distance exchange in wine and grape in the Late Antique southern Levant is well documented through the circulation of specific types of amphorae and serving vessels (Kingsley 2001; da Costa 2007) and is depicted in mosaics from the region: one from Kissufim, now in Israel, shows a named individual (*Orbikon*) leading a camel that bears likely wine-holding amphorae, as the driver conspicuously holds a bunch of grapes in his right hand (Fuks et al. 2020). This trade was supported by networks of caravanserais across the region used by travelers, merchants, and religious pilgrims (Kingsley and Decker 2001).

Wine, apart from its ritual significance in church rites, was also a major object of ecclesiastic production for trade and exchange (Mayerson 1985). The structure complex containing Room 1 in Field S at Dhiban is 80 m to the west and north of a contemporaneous church documented by Tushingham and colleagues in the 1950s A.D. (Tushingham 1972, 63–68). The excavators dated the structure to the late 6th century A.D. based on a Justinian coin found underneath the church pavement, indicating that it could be dated “no earlier” than his reign. While no wine presses have been found at Dhiban, a small 6 × 6 cm ceramic cross found in Room 1 (Figure 6B:3) suggests that agricultural productive efforts related to grape could have contributed to larger ecclesiastic functions relating to food or at least may have been traded across inter-community exchange networks.

Again, inscriptional and architectural evidence shows that there was a dense concentration of churches in settlements around Dhiban, such as at Hisban, Umm al-Rasas, and Mount Nebo (Di Segni 1999), which were vital conduits in pilgrimage and ecclesiastic-economic networks.

Finally, further morphometric research will determine to what extent these grapes were of domesticated or wild varieties. Morphometric research has shown that morphological differentiation between wild and domesticated archaeological grape remains by shape is possible using statistical techniques such as elliptical Fourier analysis (Terral et al. 2010; Bouby et al. 2013). An archaeobotanical analysis of a Roman-period wine press in Portugal using such methods found that nearly 60% of archaeological grape seeds were likely of wild origin, suggesting that wine was made even with wild grapes (Coradeschi et al. 2023). Therefore, it is possible that some of the grape pips recovered at Field S are of wild origin but were nonetheless harvested for processing, consumption, and trade.

Conclusion

Paleoethnobotanical evidence illustrates that the inhabitants of Dhiban were fully integrated into regional agricultural networks and adapted to the local socio-economic realities of the 6th and 7th centuries A.D. through the production of specific crops and not others. The recovery of grapes, wheat, and peas, but not olive or date, provides a unique window into how the Dhiban community negotiated its role within the larger Byzantine empire: through the production of agricultural goods, such as wheat, of great value to imperial political functionaries, through possible participation in exchange networks with grapes, but also through attention to local environmental conditions by growing nitrogen-fixing peas. What the differential distribution of these crops between contemporaneous sites illustrates are the ways in which plants played a key role in the relationships of southern Levantine communities of Late Antiquity to each other, to the Byzantine imperial state, and to their local environment. To what extent these agricultural practices correlate with climatically favorable conditions for agriculture, especially after the mid-6th century A.D., remains debated (Neumann et al. 2010; Rambeau 2010; Izdebski et al. 2016; Fuks et al. 2017).

Papyrological evidence from the Negev and archaeological evidence from Dhiban suggest that the Byzantine state did not directly intervene into the lifeways of the local community but instead facilitated the conditions for emergent

communities of agricultural practice and specialization in the southern Levant through the mechanisms of taxation, supply of food to the army, and religious sponsorship. The kitchen context of Field S at Dhiban is therefore a microcosm of this broader economic and environmental world—the crops found within it exist only because they were embedded in larger socio-economic practices and productive strategies. The archaeobotanical data recovered at Dhiban suggest that its community participated in these socio-economic networks in intentional ways—not necessarily because of any deliberate imperial mandate but in response to local opportunities while grappling with a less predictable water supply. The Dhiban community, therefore, was far from a passive reactant, as it seems to have actively negotiated its place within a broader mosaic of cities and villages.

Finally, while time and labor intensive, the point-provenience of each of these individual archaeobotanical samples is a key driver of insight into the spatial association of plants, artifacts, and architecture used to answer the question of non-local imperial invention that would have been lost with less granular methods. Presentation of these data as an entire time period dis-embedded from its spatial context would miss the ways in which these plants were heterogeneously distributed across the site. Much more information is revealed concerning the daily, lived practices of the community, including how they stored food, where, and in what ways. Use of these methods therefore improves the ability of archaeologists to identify changes in lifeways locally and regionally in moments of imperial socio-political reconfiguration. Paleoethnobotany can provide data when epigraphic, historical, or other forms of available written language evidence might be scarce or otherwise absent.

Endnote

1. Preliminary identification by Dr. Martin Hauser, Senior Insect Biosystematist, California Department of Food and Agriculture.

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The authors report there are no competing interests to declare.

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