Archaeobotanical and Geospatial Analyses of Bronze Age Plant Remains from Kaymakçı, Western Turkey

By

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A Thesis Submitted to the Graduate School of Social Sciences and Humanities in Partial Fulfillment of the Requirements for the Degree of Master of Arts

In

Archaeology and History of Art

Koç University

January 2019

Koc University

Graduate School of Social Sciences and Humanities

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To my parents, mentors, and friends. Thank you for everything.

Abstract (ENG)

Archaeobotanical analysis at Kaymakçı, a 2nd millennium BCE site in the Marmara Lake Basin of western Anatolia, adds valuable information regarding agricultural practices and foodways to this understudied region. To understand better archaeobotanical data from Kaymakçı, I present a review of the available literature regarding archaeobotanical research of western Anatolia during the Bronze Age. A total of six archaeological sites, including Kaymakçı, are reviewed and their respective data are separated into three different periods: Early Bronze Age, Middle Bronze Age, and Late Bronze Age. The different sites share many of the same cultivars to varying degrees across the different time periods. These cultivars include barley (*Hordeum vulgare*), wheat (*Tritcum aestivum, Triticum turgidum* ssp.*durum*, *Triticum turgidum* ssp. *dicoccum*, and *Triticum monococcum*), bitter vetch (*Vicia ervilia*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), fig (*Ficus carica*), grape (*Vitis vinifera*), and olive (*Olea europa*), among other crop taxa. This review of archaeobotanical research in the region, thus provides a wider, regional context to view Kaymakçı's archaeobotancial dataset, which is presented in two articles (Roosevelt et al. 2018; Shin et al. in review). Due to copyright regulations, only the abstracts of the two articles are included in this study, yet both form the primary work for my MA thesis. This review of agricultural practices in the context of archaeobotanical research provides an overview of the primary questions currently being asked of for our understanding of Late Bronze Age Anatolia.

Özet

Batı Anadolu’nun Marmara Gölü Havzası’nda milattan önce 2. bin yıllık bir yeri olan Kaymakçı’da yapılan arkeobotanik analiz, tartıştığı bu bölgeye tarımsal uygulamalar ve yiyecek yolları hakkında değerli bilgiler katmaktadır. Kaymakçı'dan daha iyi arkeobotanik verileri anlamak için, Tunç Çağı boyunca batı Anadolu'nun arkeobotanik araştırmalarına ilişkin mevcut literatürle ilgili bir derleme sunuyorum. Kaymakçı da dahil olmak üzere toplam altı arkeolojik alan incelenmiş ve ilgili veriler üç farklı döneme ayrılmıştır: Erken Tunç Çağı, Orta Tunç Çağı ve Geç Tunç Çağı. Farklı bölgeler, farklı zaman dilimlerinde aynı çeşitlerin çoğunu değişen derecelerde paylaşır. Bu çeşitler arpa (Hordeum vulgare), buğday (Tritcum aestivum, Triticum turgidum ssp.durum, Triticum turgidum ssp. Dicoccum ve Triticum monococcum), burçak (Vicia ervilia), nohut (Cicer arietinum) incir (Ficus carica), üzüm (Vitis vinifera) ve zeytin (Olea europa), diğer mahsul türleri arasındadır. Bölgedeki arkeobotanik araştırmaların bu incelemesi, Kaymakçı’nın iki makalede sunulan arkeobotanyal veri setini görüntülemek için daha geniş ve bölgesel bir bağlam sunmaktadır (Roosevelt ve ark. 2018; Shin ve ark.). Telif hakkı düzenlemeleri nedeniyle, bu iki makalenin sadece özetleri bu çalışmaya dahil edilmiştir, ancak ikisi de yüksek lisans tezim için birincil çalışmayı oluşturmaktadır. Arkeobotanik araştırma bağlamında yapılan tarımsal uygulamaların bu incelemesi, Geç Tunç Çağındaki Anadolu'yu anlamamız için halen sorulan temel sorulara genel bir bakış sunmaktadır.

Acknowledgements

This research is the result of collaboration and support of many people. I would like to thank the General Directorate of Cultural Heritage and Museums of Turkey's Ministry of Culture and Tourism, as well as, the annual representatives that were part of the excavation from year to year. This research could not have been possible without the various funding institutions: the National Endowment for the Humanities, National Science Foundation, Boston University, and Koç Univeristy. I am also grateful to the participants of the Kaymakçı Archaeological Project (KAP) whose efforts were crucial for the collection of the botanical samples that made this study possible. In particular, I would like to thank the Director of KAP, Professor Christopher H. Roosevelt at Koç University whose permission to work on the botanical remains made this study possible. I would like to further thank Associate Professor Christina Luke at Koç University, who as my thesis advisor, was instrumental throughout the whole thesis writing process and whose support I am truly grateful for. I am additionally grateful to Assistant Professor John M. Marston at Boston University who first sparked my interest in archaeobotany and taught me with patience and passion. His continuous guidance and support throughout the years will always be remembered.

I would personally like to thank the volunteers in the field and the lab who helped in the collection and analysis of the botanical samples presented in this thesis: Rojda Aslan, Şule Erken, Ece Erlat, Kathleen Forste, Anna Graham, Kristina Jarošová, Emily Johnson, Moyra Richards, Noah Roosevelt, Lucia Šušková, Cassandra Tomkin, and any others who aided in this process, but are not mentioned here. I would also like to thank the Şener family for their role in facilitating this research.

Lastly, I would like to thank my family and friends for supporting me throughout my academic career.

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List of Abbreviations

KAP: Kaymakçı Archaeological Project
EBA: Early Bronze Age
MBA: Middle Bronze Age
LBA: Late Bronze Age
B.C.E: Before Current Era
C.E.: Current Era
l.: liter
g.: gram
GIS: Geographic Information Systems
EA: Excavation Area
MH: Middle Helladic
LH: Late Helladic

1. Introduction

Understanding the complex relationship between people, their environment, and their food resources has been the major focus of my research throughout both my undergraduate and graduate careers. Though it mainly focuses on plant food resources, archaeobotany remains a great avenue to explore how people managed these resources and changed their environment in the process of agriculture. The seemingly unremarkable objects like seeds reveal so much more than what people were consuming. When systematically collected and analyzed, the seeds found in botanical samples may provide insights about ancient environmental conditions, agricultural decision-making procedures, how people used different spaces across a site, as well as, the social perception of the different cultivated plant species. Five years of field and lab experiences in Turkey have led me to understand more profoundly that the relationship between ancient peoples and their environments is multifaceted and complex.

Archaeobotanical analysis includes the study of macrobotanical remains such as carbonized seeds, plant parts, and charred wood, as well as, microbotanical remains such as phytoliths, starch grains, and pollen grains. Though charred wood has been included in the body of material under study, its use in my research is limited to the collection of charred wood fragments to calculate charred density values. Species identification of charred wood fragments were not conducted and are beyond the scope of my research. Therefore, the major body of material included in my archaeobotanical investigations at Kaymakçı, a Bronze Age (BA) citadel site, is carbonized crop seeds and, to a lesser extent, the carbonized weed seeds in the site's archaeobotanical assemblage.

Deeper quantitative analyses were focused mainly on the site's crop seeds. To delve further into agricultural practices, geospatial analyses were conducted. This approach allowed me to map seed locations to identify specific activity areas within the site's excavation areas. The results of these analyses culminated in two articles, the abstracts of which are included here. The first article presents the preliminary interpretations of the archaeobotanical analyses. In this paper, my work is contextualized within the broader scope of Kaymakçı's community. In turn, this work allowed me to develop a much closer investigation of archaeobotanical analyses and incorporate geospatial analyses of seed locations. These topics are the focus of the second article.

In the sections that follow, I provide an overview of the current state of archaeobotanical research in western Anatolia during the BA. Next, I provide a detailed description of Kaymakçı. I then move to summarize the research goals and approaches that provided the framework for my investigations, as well as, a short description of archaeobotany at Kaymakçı. I then include the abstracts and references for the two articles. Finally, I provide conclusive remarks and future research plans. In Appendix I, to give the reader a visual perspective of my work, I include the figures from the second article. Appendix II includes the tables from the second article, and Appendix III provides seed images as the benchmark for future work.

2. Kaymakçı

Kaymakçı is located in the Marmara Lake Basin in Turkey's Manisa province and is part of a larger network of citadels that surround the lake basin (Roosevelt and Luke 2017). As one of 6 contemporary citadels, Kaymakçı is the largest with an area of 8.6 ha (Roosevelt and Luke 2017). The citadel's prominent ridge-top location, proximity to the Gediz and Bakırçay rivers, and large size make it among the best candidates for the capital of the Seha River Land (Roosevelt and Luke 2017). As this historiography would suggest, and archaeological data confirm, the site was most heavily occupied during the Middle to Late Bronze Age (MBA-LBA). The local MBA dates range from 2000-1700/1650 B.C.E with local LBA dates ranging from 1700/1650-1200 B.C.E. (Roosevelt et al. 2018). The Seha River Land and its political ties to the Hittites (Bryce 2005; Roosevelt and Luke 2017) make it an important political entity in western Anatolia during the BA. Subsequently, archaeobotanical research at Kaymakçı has the potential to provide important information on the role that agricultural production may have played in the political geography of the region.

Sediment samples for archaeobotanical analysis at Kaymakçı were collected from all seasons of excavation (2014, 2015, 2016, and 2018). Only the samples from the 2014, 2015, and 2016 excavation seasons are included in my master's research as the samples from the most recent excavation season are part of ongoing analysis and will be included in future work. Samples were collected from all appropriate contexts from seven excavation areas (81.551, 93.545, 95.555, 97.541, 98.531, 99.526, and 108.522/109.523). Each excavation area (EA) is denoted by a coordinate pair identifying the EA's longitudinal and latitudinal coordinates (Roosevelt et al. 2015). The results of archaeobotanical analysis at Kaymakçı reveal the incorporation of risk-management mechanisms in the agricultural decision-making process of the site's inhabitants. The markers of agricultural risk-management (see ch. 5) observed at the citadel site are also seen at other contemporary western Anatolian sites, such as Troy and therefore, the data places Kaymakçı within a wider context of western Anatolian risk-management systems.

3. Archaeobotanical Research in Western Anatolia during the Bronze Age

To interpret Kaymakçı's archaeobotanical data within a wider regional context, it is important to understand the agricultural practices of the region as a whole; however, relatively little is known about the agricultural practices of western Anatolia during the Bronze Age due to a lack of systematic archaeobotanical research in the region. Additionally, the lack of archaeobotanical research makes it difficult to understand if any trends seen at one site are particular to that specific area or to western Anatolia. Therefore, making apt comparisons between sites becomes difficult because of the dearth of archaeobotanical data available.

The Bronze Age (BA) is a particularly interesting time for understanding the evolution of agricultural practices in not only Anatolia, but also the Near East and the Aegean. Early Bronze

Age (EBA) sites offer data for how crop selection may have changed after the Neolithic or Chalcolithic (depending on the region), as well as, how the scale of agriculture may have changed with the introduction of new technologies that appear during the Middle and Late Bronze Ages, and certainly come to define the Iron Age (see Table 1 for dates). Changes in climate shifts (now very much accepted) contribute further to the rise and fall of different political entities in the region, which in turn had an impact on agricultural practices and economies (Drake 2012; Kaniewski et al. 2013; Knapp and Manning 2016).

It is through this type of historical investigation along with detailed archaeobotanical work that we can ask more questions related to foodways, as well as, shifts in agricultural trends over time.[1] In turn, we are in the position to understand which agricultural practices may have been specific to regions within western Anatolia. Agricultural practices of interest include, but are not limited to, crop selection and crop-management strategies. In a brief case-study to demonstrate not only the paucity of research, but also the great opportunities for future work, I examine the archaeobotanical analyses and results of six sites all ranging from the EBA to the Late Bronze Age (LBA): Bakla Tepe, Liman Tepe, Troy, Yenibademli Höyük, Beycesultan[2], and Kaymakçı. These sites are extremely important precisely because there is accessible[3] literature on archaeobotanical analyses. The archaeobotanical results from each site are separated according to chronological period: EBA, MBA, and LBA.

[1] For this portion of my work, I thank Professor Çiğdem Maner. It was in her graduate seminar that fostered this work.

[2] Though Beycesultan is geographically located in western central Anatolia, the site's archaeobotanical data are included in this discussion of western Anatolia due to the site's connections to the western Anatolian region as evidenced in the cultural artifacts recovered from the site (see Mac Sweeney 2010).

[3] EBA archaeobotanical data from Küllüoba are available; however, they are not included in this study due to lack of access to the book (Çizer 2015) containing the information.

3.1 Early Bronze Age

Sites that have phases belonging to the EBA are Bakla Tepe, Liman Tepe, Troy, and Yenibademli Höyük. Plant remains from Bakla Tepe were recovered during the 1996 excavation under the direction of Hayat Erkanal and Armağan Erkanal and were analyzed by Emel Oybak and Cahit Doğan (2008). Bakla Tepe is located in the Izmir region approximately 40 km inland from the coast of the Izmir Bay. The plant remains from the EBA (c. 3000 BCE) are minimal. There are six samples from Bakla Tepe (Oybak and Doğan 2008). The low number of samples and unclarified sampling method from the site prevent any results from being representative of agricultural practices during the EBA; even so, this data is useful for some insight into big trends. The six samples from Bakla Tepe show a reliance on cereals over pulses with emmer (*Triticum turgidum* ssp. *dicoccum*) as the dominant wheat, followed by einkorn (*Triticum monococcum*), and then by barley (*Hordeum vulgare*) (Table 2). Pulses are represented only by lentil (*Lens culinaris*) and indeterminate pulses that could not be identified to the genus (Oybak and Doğan 2008) (Table 2).

Liman Tepe has expansive EBA exposure. It is located on the southern coast of the Izmir Bay approximately 40 km northwest of Bakla Tepe. The site was also excavated by Hayat Erkanal and Armağan Erkanal starting from 1992. Archaeobotanical interpretations from Liman Tepe derive from 10 samples with a total volume of 4,523 liters of soil floated that were excavated in 2000-2002 (Dönmez 2006). All the samples come from three houses. From these Liman Tepe households, at least 11 major crop taxa are present: einkorn, emmer, free-threshing wheat (*Triticum aestivum* or *T. turgidum* ssp. *durum*), wheat indeterminate (*Triticum sp.*), barley, lentil, bitter vetch (*Vicia ervilia*), grass pea (*Lathyrus sativus*), garden pea (*Pisum sativum*), fig (*Ficus carica*), and grape (*Vitis vinifera*). Emmer and einkorn are both the dominant cereal cultivars followed by barley and then free-threshing wheat. Among the pulses, lentil is the preferred crop with bitter vetch as the next most abundant pulse. The other pulses are present only in small amounts. Grape and fig also occur consistently within the samples. Grape is only slightly higher in count than fig, and thus without a greater sample size, we cannot presume that there would have been more intensive cultivation of grape over fig (Table 2) (Dönmez 2006).

The EBA samples from Liman Tepe are largely similar to samples from Bakla Tepe in that both assemblages share many of the same taxa. Emmer and einkorn are the major cultivated cereals at both sites. Unlike at Bakla Tepe, bitter vetch is also present in significant amounts from the Liman Tepe samples. Interestingly, free-threshing wheat is also present at Liman Tepe, which is not seen in the EBA samples either from Troy or Yenibademli Höyük (Dönmez 2006).

EBA samples from Troy (c. 2900 BCE), which are from Troy phases I and II, have better resolution in terms of representativeness and information available, due to a larger number of samples and a larger seed count (Riehl 1999: 27-45). Troy is located on the Biga Peninsula and was occupied from slightly before the BA to the Byzantine period. Archaeobotanical analyses from the site focus mainly on the BA phases of occupation with minimal analyses of pre-BA and post-BA samples. Statistical analyses were performed on the data from 19 EBA samples, which produced a total species count of 69. The total number of samples from EBA phases were greater than 19; however, only 19 were selected based on several criteria the author had chosen (Riehl 1999: 21). Similar to Bakla Tepe, emmer wheat was the dominant cereal and crop at Troy, while pulses such as bitter vetch and lentil did not make up a large part of the crop assemblage in this period. Grape, fig, and olive, to a lesser extent, were also cultivated at the site. With only eight out of 16 possible crop species represented in this phase’s crop-seed assemblage, species diversity is low (Riehl 1999). Low species diversity, according to Riehl, indicates a certain amount of crop specialization (see below). Additionally, there were no significant changes between samples from Troy I and II indicating little change in crop selection or other agricultural strategies at the site during the EBA.

Another northwestern Anatolian site, Yenibademli Höyük is located on Gökçeada, which is an island situated off the coast of the Biga peninsula. The site was most heavily occupied in the EBA with some LBA remains showing minimal occupation in the later periods of the BA. The mound is about 18 m high with area dimensions of 130 m along the north-east axis and 1200 m along the east-west axis of the mound. Finds from the site indicate connections to other Aegean sites, particularly Troy (Dönmez 2005). There are 56 archaeobotanical samples with about 1200 liters of soil floated. Based on both ubiquity and absolute count, the botanical assemblage is mostly dominated by pulses, but cereals and fruits are also represented in the botanical samples. The author mentions a total of 10 taxa: bitter vetch, fava (*Vicia faba*), grass pea (*Lathyrus sativum*), Spanish vetchling (*Lathyrus clymenum*), garden pea (*Pisum sativum*), lentil, clover (*Trifolium* sp.), einkorn wheat, emmer wheat, and barley (Table 2). Carbonized seed remains are mainly from storage contexts, but still present interesting results on agricultural practices.

Several of the unbroken pithoi were mixtures of different species, which may indicate planting maslins (Dönmez 2005). Maslins, planting multiple crops in the same agricultural field, are well-attested ethnographically in the Aegean (Jones and Halstead 1995). The maslins found at Yenibademli Höyük are fava bean and barley (Pithos 2), bitter vetch and hulled wheats (Pithos 4), and barley and wheat (Pithos 1). While a barley and wheat maslin is a common mixture seen in several Aegean sites (Jones and Halstead 1995), as well as at Troy, the other mixtures seen at Yenibademli Höyük are uncommon. The pithoi all derive from one house (Dönmez 2005), so it is not yet possible to say if this was a common way to store plant foods or if it can inform on agricultural practices of the site as a whole. Nevertheless, the finds from these pithoi are an important find for archaeobotanical research in the region.

3.2 Middle Bronze Age

Data from Troy give us the strongest picture from the Middle Bronze Age, and to date, this dataset remains the benchmark for MBA agricultural practices. Excavations from Liman Tepe and Beycesultan do have excavated levels dating to the MBA, yet owing to changes in practices, archaeobotanical data is not yet available. For this reason, I concentrate here on the dataset from Troy.

Statistical analyses from Troy derive from a total of 27 samples with a total species count of 71, which includes both crop and weed species. Data from the citadel site show that, among other crops seen from the EBA, flax (*Linum usitatissimum*), camelina or gold-of-pleasure (*Camelina sativa*), and garden pea increased in importance over time. What is more, while olive and fig production decrease, grape cultivation appears to increase. In the MBA, the number of cultivated species increases from eight to 13 out of 16 possible crop cultivars (Riehl 1999). Therefore, there is increased species diversity in the MBA compared to the EBA. Riehl notes that the type of flax produced at the site were low-growing, thus indicating that flax was most likely cultivated for oil-production and not for producing linen. This result fits well with decreased cultivation of olive as flax-seed oil may have replaced olive oil (Riehl 1999: 46).

Among the cereals, emmer wheat continues to be an important wheat variety followed by both einkorn and barley (Riehl 1999: 155). However, in the MBA free threshing wheat sees increased cultivation and is ubiquitous throughout the samples. Yet, Riehl notes that based on absolute count free-threshing wheat was still not an important crop compared to the other cultivars being grown at the site. Garden pea is the dominant pulse; however, bitter vetch and lentil cultivation also see an increase in the MBA compared to the EBA (Riehl 1999: 156). Increased grape cultivation also indicates that the crop gained importance perhaps for its ability to make different products such as syrups, wine, or leaves – all important components in the Mediterranean diet (Miller 2009).

3.3 Late Bronze Age

Archaeobotanical data from the LBA come from Beycesultan, Kaymakçı, and Troy. Archaeobotanical results from Beycesultan are not as representative as those results from Troy and Kaymakçı, yet the archaeobotanical data from Beycesultan remains valuable. The samples analyzed from Beycesultan (Helbaek 1961) are all from storage contexts, thus, we must adjust our interpretations accordingly. For example, this lens gives us evidence only of the types of plants that were able to be stored in vessels, which may exclude other crops that possibly would not have been stored in this manner such as fruits; yet the studied plant remains still provide important insight into the major cultivated crops at the site.

Archaeobotanical data from Beycesultan come from 7 samples, which are the contents from pithoi or other type of ceramic storage vessels (Helbaek 1961). There are at least 8 crop taxa present in the samples analyzed by Helbaek that were cultivated: bitter vetch, lentil, einkorn, emmer, bread wheat, club wheat, hulled barley, and naked barley. Other cultivars such as mustard and grape are present, but in negligible amounts with a count of only one seed each per taxa. Helbaek's excellent work for the early 1960s does provide a plant list with seed amounts, yet in trying to derive absolute counts for each taxon there are some limitations. For some taxa the author provides counts, yet in other instances when the count exceeds a certain number, which is not clarified, the seed amount is simply marked with an "x" which denotes ccm or ml (Table 2). This type of documentation was chosen most probably to save time during the analysis of what were most likely homogenous samples making it understandable not to count the exact number of seeds per sample.

The absence of absolute counts makes it difficult to determine if cereals are more abundant than pulses, or which species of pulses and cereals are the preferred species in their respective categories. However, Helbaek does record the average seed or grain size of each taxa, which reveals the growing conditions of the crops. With the exception of emmer, cereal grain sizes are large and reach maximum sizes for their respective species. The large grain size demonstrates optimal growing conditions, thus signifying that the agricultural strategies of the inhabitants at Beycesultan were successful and/or that climate conditions were ideal (Helbaek 1961). Within the cereals, Helbaek (1961) mentions that there is a predominance of wheat over barley. For the pulses, the author notes that the sizes of the pulses are generally smaller than seen in examples from Mesopotamia, though the author does not believe the small size is necessarily due to growing conditions (Helbaek 1961).

LBA phases at Troy show significant changes from MBA phases at the citadel site with the introduction of chickpea (*Cicer arietinum*) and millet (*Panicum miliaceum*). There is only a slight decrease in species diversity for the LBA phases with 10 species in Troy VI, 11 species in Troy VIIa, and 12 species in Troy VIIb. Though species diversity doesn't decrease significantly, the author notes that there is a specialization of a few of the species. Flax is also no longer cultivated in the LBA, which indicates an abandonment of flaxseed oil production. Olive cultivation increases in this period though does not reach the same production levels seen in the EBA (Riehl 1999: 84). Unlike Kaymakçı (see Roosevelt et al. 2018; Shin et al. in review), at Troy there is a significant decrease of free-threshing wheat with an initial increase in barley production in Troy VI. Botanical trends fluctuate throughout the LBA phases at Troy (Riehl 1999). Troy VIIa again sees an increase in emmer, as well as, in einkorn. Chickpea becomes a significant crop in this phase and most likely became an important source of protein for the site's inhabitants. Barley production again increases in Troy VIIb with chickpea no longer a staple crop.

3.4 Discussion

Though there are only a few sites with archaeobotanical data available from the EBA, based on data from Bakla Tepe, Liman Tepe, and Troy cereals seem to be the more important crop over pulses. At Yenibademli Höyük, the opposite seems to be true, where pulses are dominant. This pattern may reflect the conditions of mainland compared to island conditions. Yet, within the cereals cultivated at all the different sites it seems that emmer is the most heavily cultivated cereal followed by einkorn and barley. Emmer wheat was cultivated throughout the Neolithic and into the EBA as evidenced by the archaeobotanical data from western Anatolian sites. Emmer is a hardy, drought resistant cereal that can tolerate different types of soil (Hunshal et al. 1990; Sairam et al. 2001), which makes sense as to the intense cultivation of this cereal for the EBA. If stored within glumes, emmer is also more resistant to fungal diseases again attesting to its reliability as a crop (Riehl 2009). Einkorn and free-threshing wheat require more water and more specific soil conditions (Oleinikova 1976). Free-threshing wheat is also not very tolerant to flooding, and therefore requires more exact growing conditions than emmer or barley. Barley is even more drought tolerant than emmer, as well as, more tolerant of soil salinity and alkalinity (Choi and Min 1982).

Many of the founder crops (Zohary et al. 2012) from the Neolithic are still being cultivated at these EBA sites. Considering its botanical properties, emmer would have been easier to cultivate than other wheat varieties such as einkorn or free-threshing wheat. Though free-threshing wheat is more nutritious and higher-yielding, emmer wheat was known in the Neolithic and knowledge of how best to cultivate the plant must have already been known.

With the pulses, we see a reliance on lentil as the major cultivated pulse during the EBA from all EBA sites, except at Troy where pulses don’t seem to be an important component of the diet in general. Lentil is high in protein (about 25%) and is moderately tolerant of stress regarding water levels and soil conditions (Riehl 2009). The cultivation of bitter vetch in the

EBA is also interesting, as the pulse is toxic to humans in its raw form (Miller and Enneking 2012). Bitter vetch is also a highly drought-tolerant crop and highly tolerant of different soil conditions making it a robust crop. Despite its high protein content (20-27%), and its stress tolerance, the toxicity of the pulse may contribute to its secondary position as a subsistence crop (for humans) to lentil.

Additionally, fig and grape are the only fruits that are cultivated throughout the different sites. The cereals, pulses, and fruits cultivated by the EBA sites' inhabitants seem to indicate that crop preferences and crop selection did not vary too much from the Neolithic/Chalcolithic or differ too much despite the distance between the northern sites of Troy and Yenibademli Höyük with the central western sites of Bakla Tepe and Liman Tepe.

The lack of changes in crop selection also seem to indicate indirectly that agricultural practices did not change significantly in the EBA. Species diversity seems to be low, as not many supplementary wild species, such as nuts and berries, are recorded in the archaeobotanical assemblages from any of the sites examined for the EBA. It is difficult to determine what low or high species diversity can indicate for sites other than Troy and Yenibademli Höyük because of the small sample sizes. The low species diversity noted at Troy is an indication to Riehl (1999) that the site's inhabitants are practicing crop specialization strategies, which suggests a more centralized agricultural economy. Specific crops, such as emmer wheat, are more intensively cultivated which suggests a stratified society where a ruling class or elite wielded significant control over the selection of cultivated crops.

This interpretation of elite power over agricultural production is corroborated by the archaeological finds from the site. Low species diversity may also suggest that there is little risk in focusing on the cultivation of a few crops, which may mean crop failure was not a significant issue (Marston 2011). Conversely, high species diversity can indicate risk-buffering strategies that would protect from massive crop failure ensuring that if disease or other risks to crop health affects one crop, the other crops would still produce enough to ensure that famine does not occur (Marston 2011). The high species diversity of crops with varied environmental requirements noted by Dönmez (2006) at Yenibademli Höyük indicates to me that the inhabitants of this island site diversified their crops to mitigate risk. The risks that the inhabitants attempted to avoid are linked to possible crop failure (Dönmez 2006). However, high species diversity may also indicate a less stratified society, which would fit well with the interpretations of the arrangement of the buildings excavated at the mound site (Dönmez 2006). Though only attested at Yenibademli Höyük, the crop mixtures seen in the pithoi from the site may also indicate that planting maslins were part of the agricultural practices of the site's inhabitants. Pulses enrich soil with their nitrogen-fixing capabilities and thus may have been advantageous for the farmers at the site to pair different pulses and cereals together in the same agricultural field.

In sum, agricultural practices at the known EBA sites with archaeobotanical data in western Anatolia indicate that emmer wheat and lentil were important crops in people's diets, that crop selection did not change much from earlier periods, and that stratification of a society likely influences the diversity of species being grown at the site.

Due to Troy being the single site with samples analyzed from the MBA, it is difficult to determine if the changes seen at Troy are representative for broad-scale, contemporary patterns in the greater region of western Anatolia and beyond. To be sure, the reasons behind the sudden change in agricultural strategy from crop specialization to a more diversified crop assemblage, as well as, the sudden spike in flax production are unclear. Riehl (1999) mentions no significant environmental fluctuations that may have prompted such change in strategy. The author mentions that Korfmann, Troy's director, saw the architectural changes of the MBA as an indication of a migration of a group of people who were more "Anatolian" in culture (Riehl 1999). This new group may have brought new agricultural practices with them, such as the emphasis of flax production and the cultivation of more pulses (perhaps for protein). Similarly, these people seem to have abandoned olive and fig cultivation. Regardless of these shifts, the types of cereals cultivated did not change much from the EBA. Free-threshing wheat began to be grown in this period, but was still not intensely cultivated at the site, despite its high calorie content.

In comparison to the MBA, the LBA is not much better represented regarding the number of sites available for study; however, the sampling method of at least Kaymakçı and Troy can ensure that the data from these sites are representative of agricultural practices and crop preferences of these sites. Interpretations from Beycesultan are preliminary as only special storage contexts were sampled. The counts derived from these storage contexts do not necessarily represent preferences, but simply how many seeds were left in the vessel at the time of carbonization. With such few samples from the site, it is also hard to use ubiquity to determine preferences. One useful measure is perhaps average grain size, which can be linked to the intensity of cultivation of a certain taxon. The large grain sizes of the cereals at Beycesultan signify that this group of crop plants were important to the diet (Helbaek 1961). Whereas, the generally smaller size of the pulses possibly indicates that at Beycesultan pulses were not a major part of the inhabitant's diet.

Further north at Troy, agricultural practices varied throughout the BA. Though both occupation phases show different crop preferences, I note that Troy VI and VIIa are likely to be agriculturally prosperous periods. Here elites likely controlled the agricultural economy. There is a focused cultivation of multiple cereal taxa throughout the phases particularly barley and among the pulses, bitter vetch is the most abundant. Considering the prosperity of Troy VI and VIIa, these two crops may have been used for fodder, which would indicate that there was already enough to feed the human inhabitants, and thus could devote precious labor and territory to the keeping of animals. Agricultural production may have been high enough to spare these crops for animals managed by the citadel. The increased cultivation of wheats in addition to barley seen in

Troy VIIa also seem to confirm the allocation of barley and bitter vetch for animal fodder. Troy VIIb shows a decrease in wheat varieties and bitter vetch which may indicate that the increased barley seen in this period may have been the focus of the agricultural economy and that this less preferable crop was grown to ensure enough food for the citadel's human inhabitants.

4. Research at Kaymakçı

The opportunity to add to the research presented in the previous section became available with excavations at Kaymakçı. The major research goals during my master's program were to expand the site's archaeobotanical dataset and to understand further the foodways, as well as, the agricultural practices of Kaymakçı's inhabitants.

Archaeobotanical analyses during my undergraduate career had already produced data from 80 samples. During the year after the end of my undergraduate program and during my masters, I completed the analysis of 248 additional archaeobotanical samples from the site. Thus, a total of 5 years of archaeobotanical analysis resulted in 328 botanical samples analyzed producing a large dataset with a total taxa count of 52 (11 crop taxa and 41 wild taxa; Table 3). The first two semesters of my master's program were dedicated to sample analysis with the latter half of the program dedicated to writing one article (Shin et al. in review) that is the core of my work for my Masters.

To delve further into agricultural strategies, spatial locations of the assemblage's crop seeds were mapped to identify any spatial patterning of the different seed species across the site and within specific excavation areas.

After quantitative and spatial analyses, which included simple statistics such as ubiquity (the proportion of samples within which a taxon is present), simple ratios, and density calculations, resulting in GIS-based density maps (Appendix 1), there were some initial indicators of the possibility of a risk-management strategy. The archaeobotanical data was further reviewed to determine how many archaeological markers of risk management, as outlined in Marston (2011), were present in the dataset. These results form the basis for my conclusions, again as presented in the article (Shin et al. in review). Below I summarize the major findings.

5. Archaeobotany at Kaymakçı

The occupational phases from Kaymakçı date to the MBA and the LBA, yet most samples from the citadel come from LBA contexts with 328 samples analyzed. Samples were taken from all contexts, and therefore, the data from these samples are representative of general agricultural practices of the site. The crops with the highest ubiquity values in the assemblage are barley, bitter vetch, and grape. Other major crops in the assemblage, are free threshing wheat, einkorn, emmer, chickpea, grass pea, lentil, and common vetch (*Vicia sativa*), and fig. Based on count, weight, and ubiquity there is a clear preference for barley over all other wheat varieties and bitter vetch over other pulse taxa (Appendix 2). Generally, there is a preference for barley and bitter vetch which are drought-tolerant taxa that could signify a need for cultivating these plants. Though there is a strong preference for barley and bitter vetch, free-threshing wheat and chickpea are the next most abundant cereal and pulse, respectively (Appendix 2). Additionally, there is a total absence of olive remains, which indicates that this was not an important agricultural product for the site's inhabitants as it is at other sites, specifically Troy. Alternatively, olive oil (rather than olives per se) may have been acquired through trade.

Preliminary diachronic analyses from the site also show some differences between the chronological phases at the site (see Appendix 1). There is a higher diversity of species in the earlier phases. All 11 crop species present in the assemblage are represented in the LB 1 phase of the site. The LB 2 phase of the site sees a slight reduction in species diversity with 9 species. There is also an increase in free-threshing wheat and chickpea with a decrease in the other wheat varieties and pulses. I interpret these changes as a strong indication that there was a move towards crop specialization in the LB 2 phase of Kaymakçı. Potential reasons for crop specialization are numerous and variable, yet the consistent production of barley, bitter vetch, and increased production of free-threshing wheat and chickpea may be because these crops were successful and efficient. Additionally, there is a high co-presence of barley and bitter vetch, as well as, with free-threshing wheat and chickpea, which may indicate the cereal-pulse pairs were grown together in the same field as a maslin.

At Kaymakçı, the heavy reliance on barley and bitter vetch indicates a preference for drought-tolerant plants over other less stress-tolerant cereals and pulses (i.e. emmer and einkorn or lentil and garden pea). There is also a higher ratio of pulses to cereals. Additionally, the LB 1 phases of the site show increased species diversity which steadily decreases into the late LB 2 phase of occupation. The initial species diversity and reliance on drought-tolerant plants indicate agricultural practices that attempt to mitigate risk such as crop failure due to plant disease and/or a lack of water. At this moment, the change to a more specialized crop selection cannot be linked to changes in administration or social organization; however, the change in species diversity do suggest that there was some motivation to make changes to the agricultural strategy at the citadel site.

Interestingly, crop specialization did not target other hardier crop plants, but focused on the cultivation of highly nutritious, yet less stress-tolerant crops such as free-threshing wheat and chickpea. This pattern suggests that despite a risk-management strategy against drier conditions, there was still an effort to grow preferred consumables (free-threshing wheat and chickpea), as barley and bitter vetch are less preferable for human consumption and was commonly used for animal fodder (Riehl 1999). Additionally, the most abundant and ubiquitous crop in the entire assemblage is bitter vetch, which is toxic in its raw form and requires several steps of preparation (leeching) to be ready for human consumption. Here we can draw some tangential data from later textual sources. For example, evidence from Hippocrates states that bitter vetch became a larger part of the Greek diet during a famine and that those who incorporated the pulse into their diet experienced health problems (Hippocrates 6.130). With this extra information, we might suggest that the intensive cultivation of bitter vetch seen at Kaymakçı may indicate that this pulse was cultivated not only for its protein, but perhaps for its other botanical properties such as its stress-tolerant nature; this is considering that other pulses like lentil have an almost equal amount of protein content and are easier to prepare for human consumption.

In summary, at Kaymakçı, we see a risk-management strategy that targeted the more intensive cultivation of pulses over cereals. The incorporation of risk-management mechanisms at Kaymakçı were most likely to ensure enough food for all of the site's inhabitants, humans and animals alike. The current interpretations of the Kaymakçı dataset are treated in full in the following two papers. Owing to copyright considerations, I include only the titles, abstracts and references for the essays.

6. Archaeological Work at Kaymakçı

Title:

"Exploring space, economy, and interregional interaction at a second-millennium BCE citadel in central western Anatolia: 2014–2017 research at Kaymakçı"

Abstract:

Current understandings of the archaeology of second-millennium B.C.E. central western Anatolia are enriched by ongoing research at Kaymakçı, located in the Marmara Lake basin of the middle Gediz River valley in western Turkey. Discovered during regional survey in 2001, the site offers a critical node of exploration for understanding a previ-ously unexamined period in a well-traversed geography thought to be the core of the Late Bronze Age Seha River Land known from Hittite texts. Here we present results from the first three seasons of excavation on the citadel of Kaymakçı plus a study season (2014– 2017), introducing the site's chronology, historical and regional context, and significance through presentation of excavation areas as well as material and subsistence economies. With reference to such evidence, we discuss the site's development, organization, and interregional interactions, demonstrating its place in local and regional networks that connected Aegean and central Anatolian spheres of interest.

Reference:

Roosevelt CH, Luke C, Ünlüsoy S, Çakırlar C, Marston JM, O'Grady CR, Pavúk P, Pieniazek M, Mokrisová J, Scott C, Shin N, Slim F (2018) Exploring space, economy, and interregional interaction at a second-millennium BCE citadel in central western Anatolia: 2014–2017 research at Kaymakçı. *American Journal of Archaeology* 122(4): 645–88.

7. Risk-management strategies at Kaymakçı

Title:

"Applying archaeobotanical and geospatial analysis to identify patterns of plant use and risk-management strategies at Bronze Age Kaymakçı, Western Anatolia."[4]

Abstract:

Archaeobotanical analysis at Kaymakçı, a 2nd millennium BCE site in western Turkey, helps shed light on ancient food and agricultural practices as well as environmental change in this understudied region. Using geospatial analyses of archaeobotanical remains we identify risk- management mechanisms practiced at Kaymakçı, including both diversification and intensification strategies. These include a reliance on drought-tolerant species, use of a large variety of cultivars in early phases of occupation, and the construction of numerous structures inferred to be grain storage silos. Geospatial analysis of the distributional patterns of the site's crop taxa illuminates the distribution strategies of certain crop plants over others, which complement more traditional risk-management mechanisms seen at the site. Preliminary diachronic analysis shows how agricultural practices changed over time from a more diverse assemblage of crop plants to the focused cultivation of fewer crops which include barley (Hordeum vulgare), free-threshing wheat (Triticum aestivum or T. turgidum ssp. durum), bitter vetch (Vicia ervilia), and chickpea (Cicer arietinum). Possible changes in environmental conditions and the citadel's political alliances most likely led to the adoption of risk-management strategies in crop selection and cultivation at Kaymakçı. Therefore, archaeobotanical analyses at the citadel provide valuable new information about local and regional agricultural practices regarding which crops were cultivated at the site and how the citadel's inhabitants managed their plant food resources.

Reference:

Shin N, Luke C, Marston JM, Roosevelt CH, Riehl S (in review) Applying archaeobotanical and geospatial analysis to identify patterns of plant use and risk-management strategies at Bronze Age Kaymakçı, Western Anatolia. *Vegetation History and Archaeobotany.*

[4] *The title and abstract are subject to change as this submission moves through the peer-reviewed process and sees eventual publication, which at this time is aimed for *Vegetation History and Archaeobotany*, where the essay is currently under review. Should this become unsuitable, then, it will be revised and submitted to another venue. I have included the figures and tables in Appendix I to give the reader an overview of the visual aspects of this work.

8. Conclusion and Future research

In reviewing the literature for archaeobotanical research in Anatolia currently present for the BA, it becomes clear that there is great opportunity to expand our current knowledge of western Anatolian agricultural practices. As new data becomes available for the sites discussed, as well as, for additional sites, our interpretations of key archaeological markers of agricultural diversification and intensification that indicate risk-management mechanisms can be further tested and refined. Among the most exciting aspects of future work is the important level of detail that will be added by including geospatial analyses of seed locations with precise contextual information.

As analysis of the botanical samples from Kaymakçı continues, the dataset will continue to grow and it will be important to reassess previous arguments of risk-management. While not presented in this master's thesis, the potential for stable carbon isotope analyses to add to our understandings of the BA (and other periods) in western Anatolia is immense. Stable carbon isotope analysis can be used to determine the water-stress levels of selected crop species from different phases of occupation, which would reveal the growing conditions of the different crops grown at the site, as well as, how these conditions changed over time. Labor investment analyses of the various crop plants would further help to understand the difficulties or ease of cultivating certain plants and how these aspects may have affected crop selection. Furthermore, deeper analysis of the weed species present in the site's seed assemblage could provide the putative locations of agricultural fields. As there is a lack of archaeobotanical research in western Anatolia, current research from Kaymakçı has already contributed new information and serves as a valuable reference site for future archaeobotanical research at other sites in the region. As sample analysis is ongoing, archaeobotanical data from Kaymakçı will continue to inform on agricultural practices and bring greater understanding to this understudied region of how ancient people interacted with and manipulated their environment to produce sufficient sustenance for their various needs.

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[5] The references here are specific to this summary of the work. For the comprehensive analysis, please see Roosevelt et al. 2018, and Shin et al., in review.

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Tables

Table 1. Chronological phases of the Bronze and Iron Ages in Anatolia and corresponding dates as written in Sagona and Zimanksy (2009).

Chronological phase	Date Range
Early Bronze Age	3000-2000 BCE
Middle Bronze Age	2000-1650 BCE
Late Bronze Age	1650-1200 BCE
Iron Age	1200-550 BCE

Table 2. Absolute counts of major crop taxa from EBA sites: Bakla Tepe, Liman Tepe, and Yenibademli Höyük, not including Troy.

Taxa	Bakla Tepe	Liman Tepe	Yenibademli Höyük
Cereals			
Einkorn (*Triticum monococcum*)	13	98	2981
Emmer (*Triticum turgidum ssp. dicoccum*)	28	204	47 million (M)
Free-threshing wheat (*Triticum aestivum/durum*)	0	31	0
Barley (*Hordeum vulgare*)	2	110	354 M
Pulses			
Bitter vetch (*Vicia ervilia*)	0	34	37 M
Fava (*Vicia faba*)	0	0	1560 M
Grass pea (*Lathyrus sativus*)	0	12	1484
Spanish vetchling (*Lathyrus clymenum*)	0	0	39 M
Garden pea (*Pisum sativum*)	0	2	95 M
Lentil (*Lens culinaris*)	4	70	15
Fruits			
Fig (*Ficus carica*)	1	30	0
Grape (*Vitis vinifera*)	1	37	15
Total number of samples	**6**	**14**	**56**

Table 3. Absolute counts of major crop taxa from LBA sites: Beycesultan and Kaymakçı, not including Troy.

Taxa	**Beycesultan**	**Kaymakçı**
Cereals		
Einkorn (*Triticum monococcum*)	x	11
Emmer (*Triticum turgidum ssp. dicoccum*)	51	4
Free-threshing wheat (*Triticum aestivum/durum*)	190 x	30
Barley (*Hordeum vulgare*)	x	128
Pulses		
Bitter vetch (*Vicia ervilia*)	xx	381
Fava (*Vicia faba*)	0	0
Grass pea (*Lathyrus sativus*)	0	2
Spanish vetchling (*Lathyrus clymenum*)	0	0
Garden pea (*Pisum sativum*)	0	0
Lentil (*Lens culinaris*)	x	7.5
Fruits		
Fig (*Ficus carica*)	0	5
Grape (*Vitis vinifera*)	1	57
Total number of samples	**7**	**328**

Table 4. Full list of seed taxa found at Kaymakçı to date.

Taxa List		
Crop Taxa	**Wild Taxa**	
Hordeum vulgare	Amaranthus	Trifolium/Melilotus
Triticum aestivum/durum	Chenopodium	Ziziphora
Triticum monococcum	Bifora radians	Malva
Triticum turgidum sbsp. dicoccum	Torilis	Fumaria densiflora
Cicer arietinum	Onopordum	Papaver
Lathyrus	Heliotropium	Aegilops
Lens culinaris	Lithospermum	Bromus
Vicia ervilia	Brassica	Lolium
Vicia sativa	Neslia	Hordeum
Ficus carica	Capparis	Phalaris
Vitis vinifera	Cerastium	Phleum
	Gypsophila	Taeniatherum caput-medusae
	Silene	Polygonum
	Stellaria	Rumex
	Chenopodium	Adonis
	Suaeda	Galium
	Carex	Hyoscyamus
	Eleocharis	Thymelaea
	Scirpus	
	Astragalus	
	Medicago	

Appendices

Appendix I.

Here I provide the visual materials for Kaymakçı as presented in Shin et al., in review. I include the figures as well as the tables. These will form the basis for the final publication.

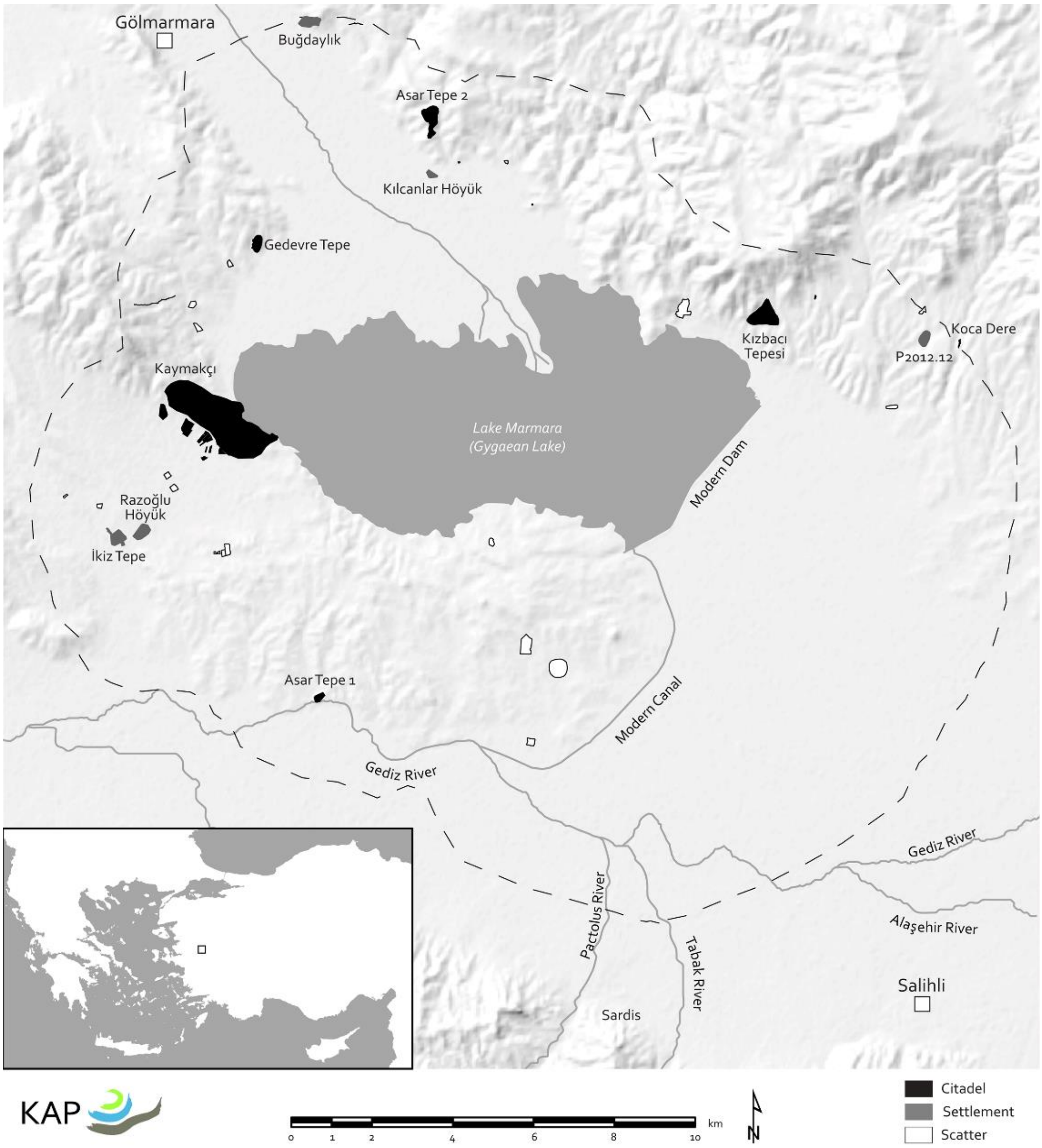


Figure 1. Map of Kaymakçı region, with contemporary sites identified through systematic survey noted.

Figure 2. Aerial image of citadel with excavation areas labeled.

Figure 3. Siraf-style flotation machine used by Kaymakçı Archaeological Project.

Figure 4a. Density maps of pulses from excavation area 97.541.

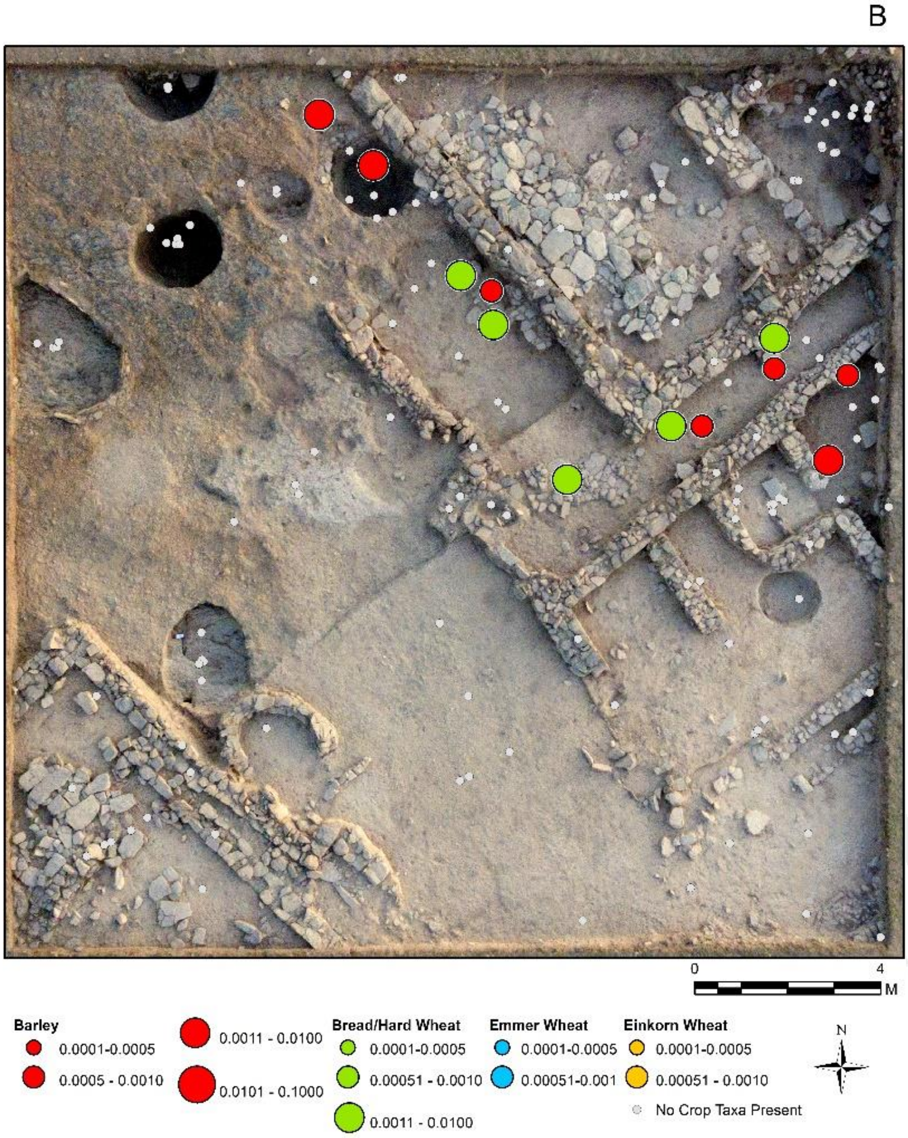


Figure 4b. Density maps of cereals from excavation area 97.541.

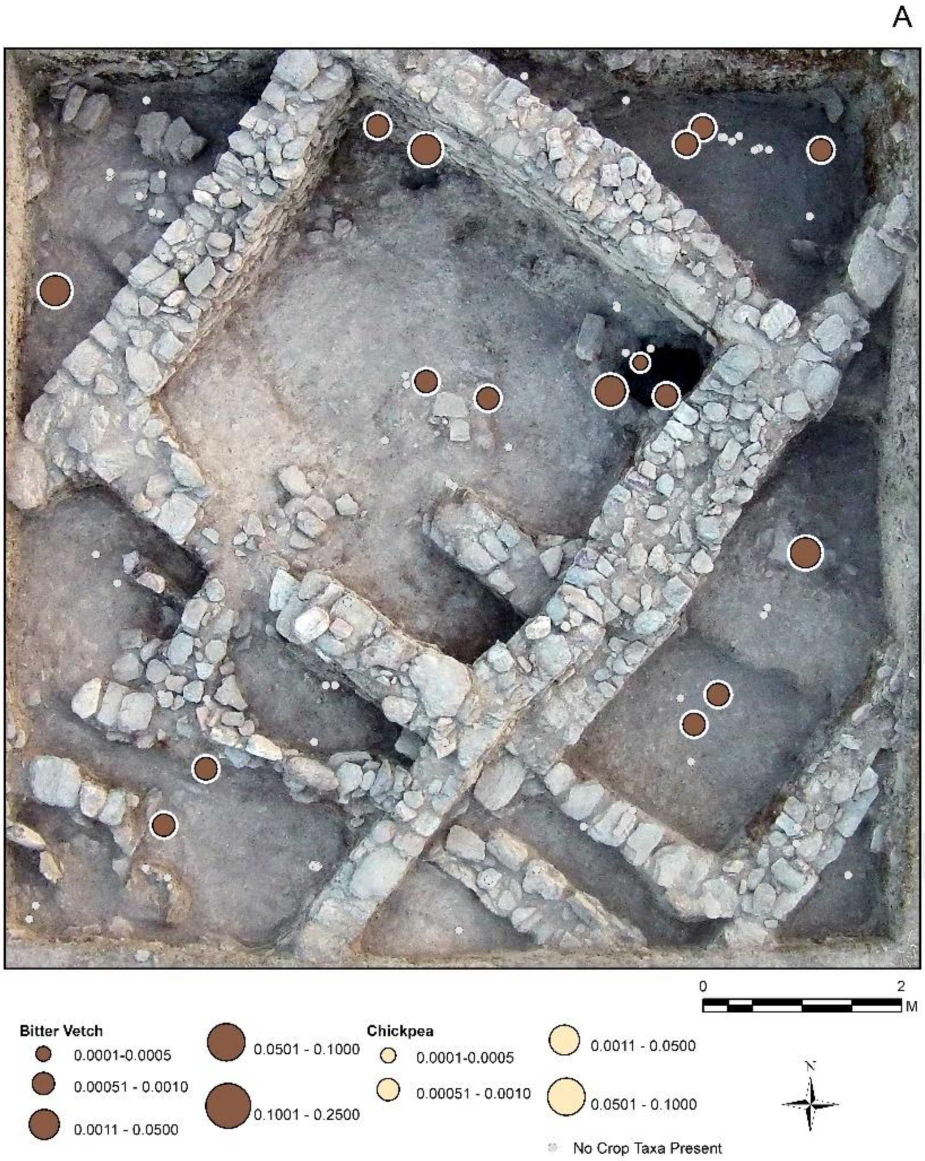


Figure 5a. Density maps of pulses from excavation area 98.531.

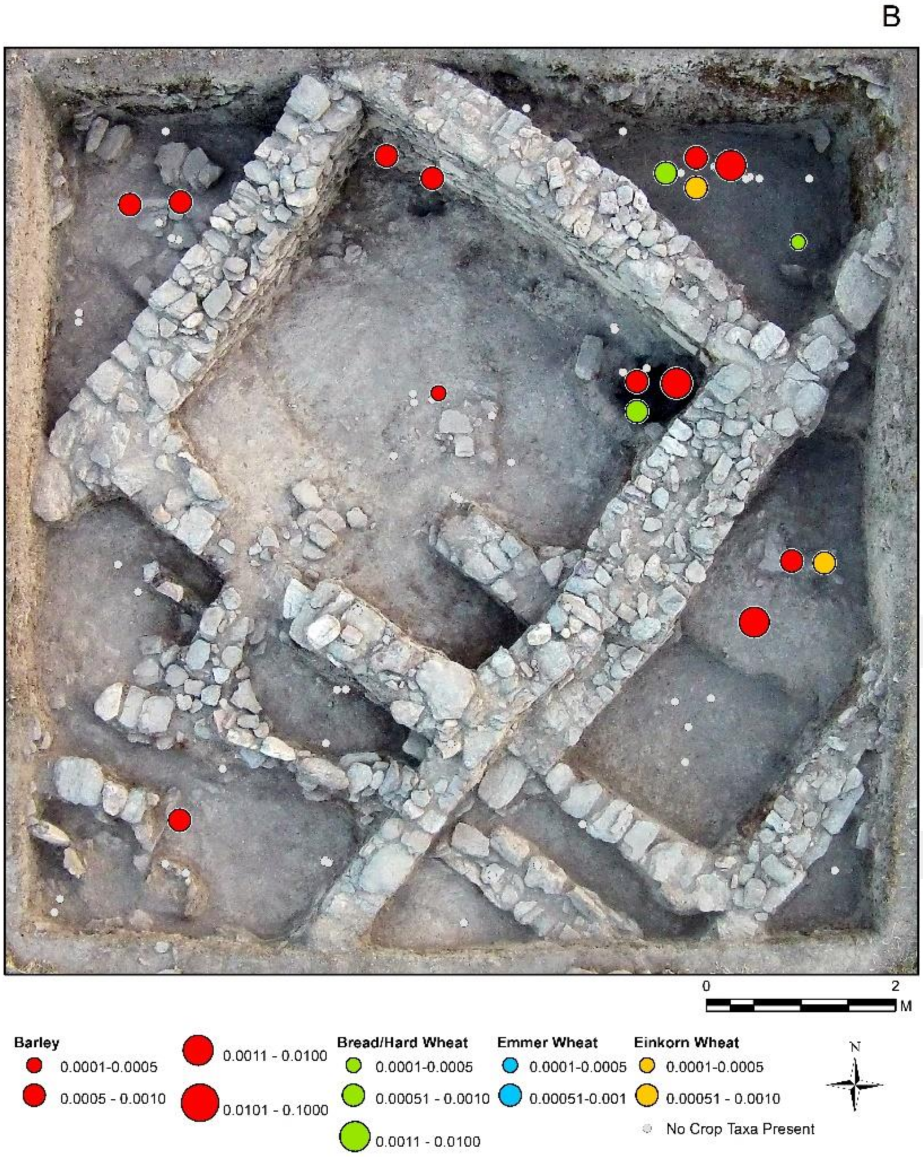


Figure 5b. Density maps of cereals from excavation area 98.531.

Figure 6a. Density maps of pulses from excavation area 99.526.

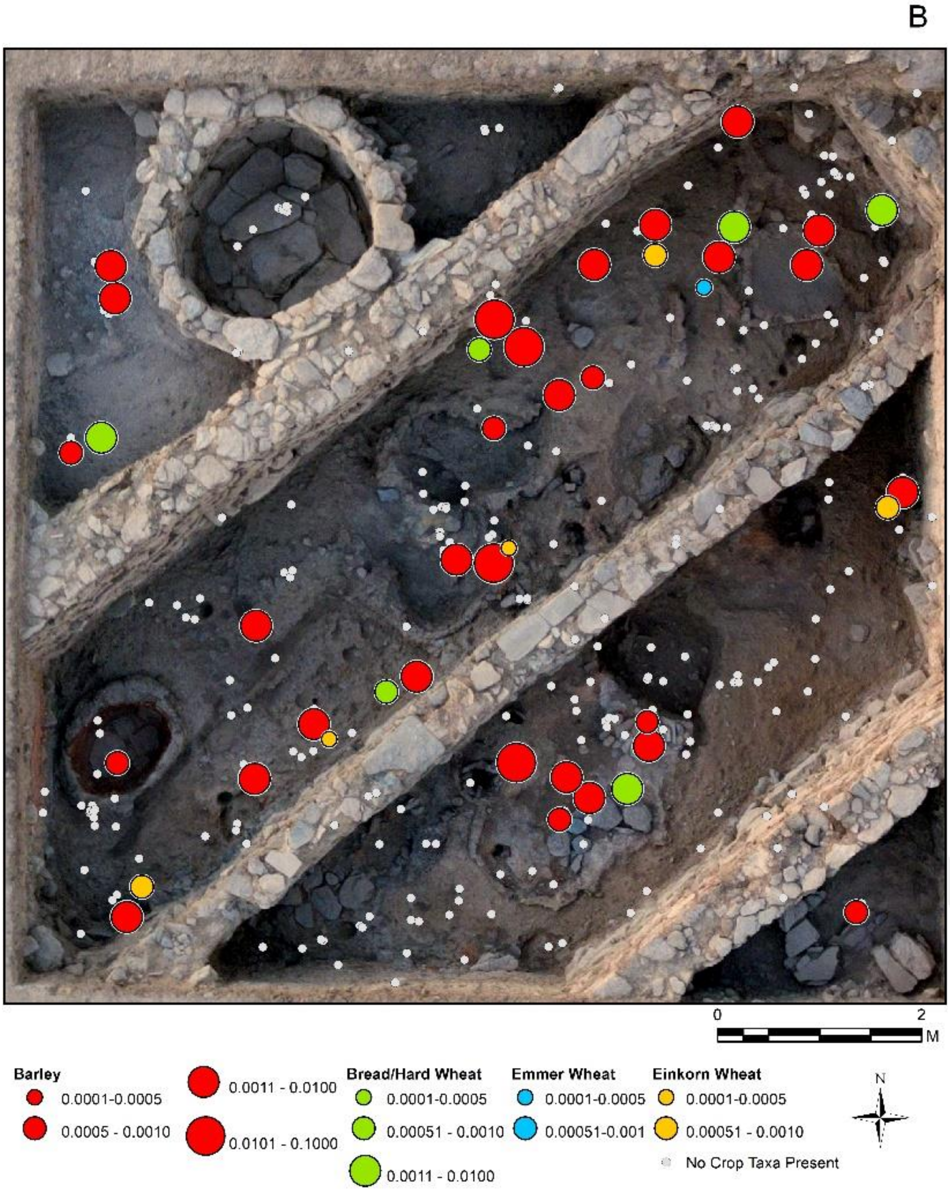


Figure 6b. Density maps of cereals from excavation area 99.526.

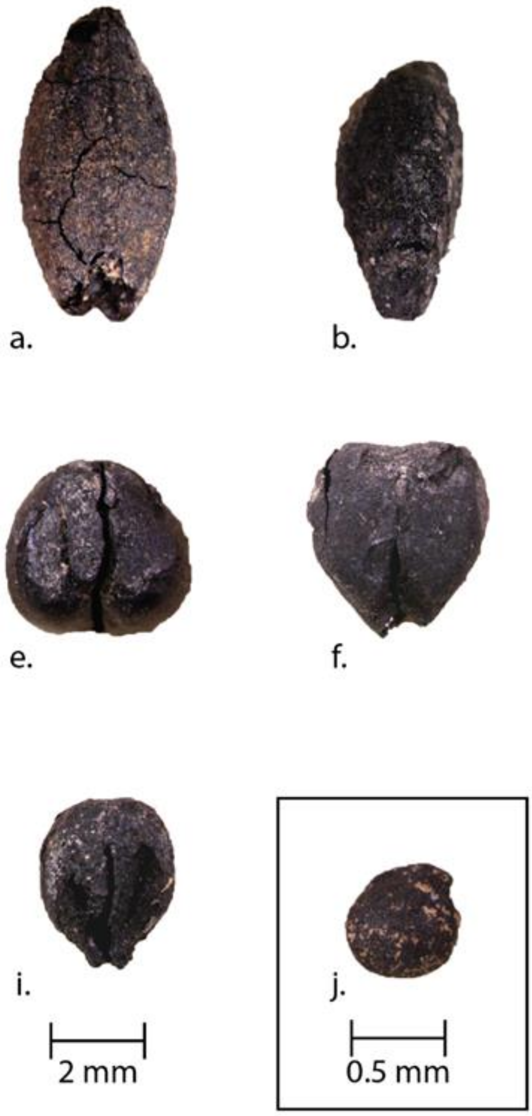


Figure 7. Major crop seeds at Kaymakçı. (a) Barley (*Hordeum vulgare*), (b) einkorn wheat (*Triticum monococcum*), (c) emmer wheat (*Triticum turgidum* ssp. *dicoccum*), (d) free-threshing wheat (*Triticum aestivum* or *T. turgidum* ssp. *durum*), (e) bitter vetch (*Vicia ervilia*), (f) chickpea (*Cicer arietinum*), (g) common vetch (*Vicia sativa*), (h) lentil (*Lens culinaris*), (i) grape (*Vitis vinifera*), (j) fig (*Ficus carica*).

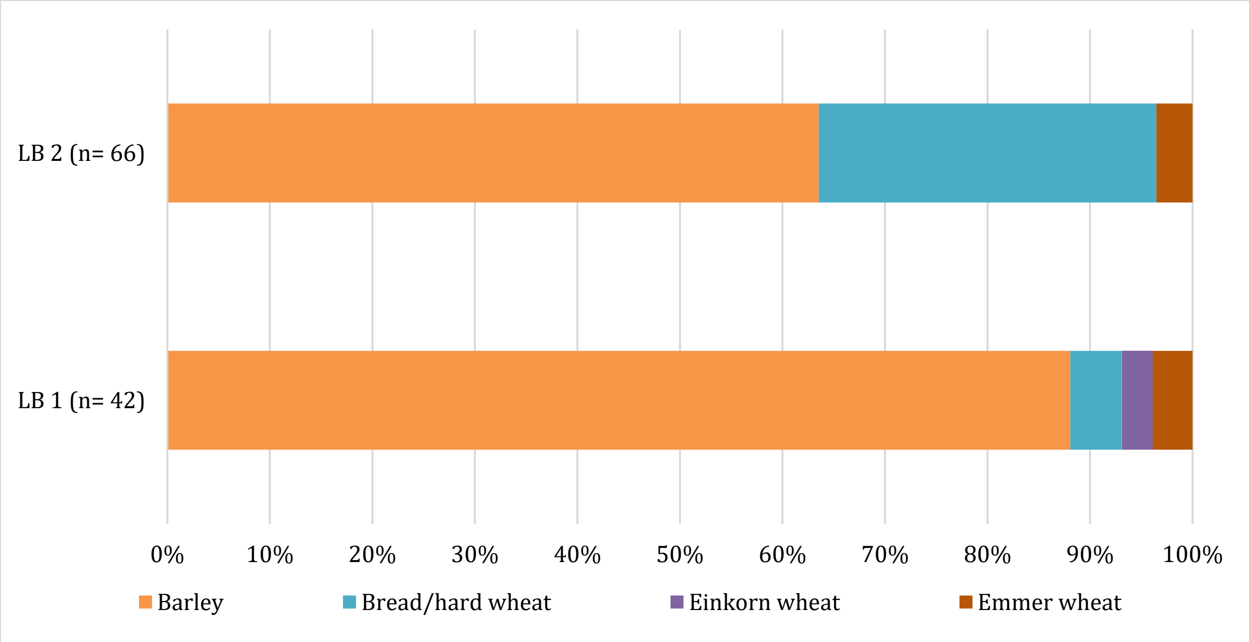


Figure 8. Relative percentages of cereals by weight over time in area 99.526 of the southern terrace.

Appendix II.

Table 1. Cultivated seeds counts, weight, and summary sample metrics by excavation area.

Taxon	All areas		Fortification system		Inner citadel		Southern terrace	
	Count	Weight (g)	Count	Weight (g)	Count	Weight (g)	Count	Weight (g)
Cereals								
Barley (*Hordeum vulgare*)	128	1.391	0	0.002	26	0.225	102	1.164
Bread/hard wheat (*Triticum aestivum/durum*)	30	0.364	1	0.014	17	0.251	12	0.099
Einkorn wheat (*Triticum monococcum*)	11	0.058	1	0.002	5	0.019	5	0.037
Emmer wheat (*Triticum turgidum* sbsp. *dicoccum*)	4	0.057	0	0.000	0	0.006	4	0.051
Wheat indeterminate (*Triticum* sp.)	13	0.178	0	0.003	5	0.079	8	0.096
Cereal indeterminate	71	4.338	0	0.017	21	1.224	50	3.097
Pulses								
Chickpea (*Cicer arietinum*)	50	1.947	0	0.000	45.5	1.740	4.5	0.207
Grass pea (*Lathyrus* sp.)	2	0.023	0	0.000	1	0.017	1	0.006
Lentil (*Lens culinaris*)	7.5	0.092	0	0.000	2.5	0.036	5	0.056
Bitter vetch (*Vicia ervilia*)	381	5.465	3	0.026	35	0.330	343	5.109
Common vetch (*Vicia sativa*)	2.5	0.019	0	0.000	0	0.000	2.5	0.019
Pulse indeterminate	14.5	1.440	0.5	0.014	5	0.411	9	1.015
Fruits								
Fig (*Ficus carica*)	5	0.003	0	0.000	1	0.002	4	0.001
Grape (*Vitis vinifera*)	57	0.582	4.0	0.026	16	0.148	37	0.408
Number of samples	328		38		161		129	
Total soil volume	2760		320		1388		1052	
Total cultivated seed count	776.5		9.5		180		587	
Total cultivated seed weight (g)	15.957		0.104		4.488		11.365	
Total wild seed count	821		42		213		566	
Total wood charcoal weight >2mm (g)	42.742		10.017		10.870		21.855	
Mean charred density of charred material >2 mm (g/l)	0.019		0.032		0.010		0.028	

Table 2. Ubiquity of cultivated taxa of all areas combined and per section of the citadel.

Taxon	All areas	Fortification system	Inner citadel	Southern terrace
	Ubiquity	Ubiquity	Ubiquity	Ubiquity
Cereals				
Barley (*Hordeum vulgare*)	0.207	0.026	0.161	0.318
Bread/hard wheat (*Triticum aestivum/durum*)	0.070	0.026	0.068	0.085
Einkorn wheat (*Triticum monococcum*)	0.040	0.026	0.025	0.062
Emmer wheat (*Triticum turgidum* sbsp. *dicoccum*)	0.018	0.000	0.006	0.039
Wheat indeterminate (*Triticum* sp.)	0.082	0.026	0.062	0.124
Cereal (any, including indeterminate)	0.591	0.211	0.615	0.540
Pulses				
Chickpea (*Cicer arietinum*)	0.091	0.000	0.124	0.078
Grass pea (*Lathyrus* sp.)	0.012	0.000	0.012	0.016
Lentil (*Lens culinaris*)	0.030	0.000	0.019	0.054
Bitter vetch (*Vicia ervilia*)	0.216	0.053	0.199	0.287
Common vetch (*Vicia sativa*)	0.006	0.000	0.000	0.016
Pulse (any, including indeterminate)	0.418	0.158	0.429	0.385
Fruits				
Fig (*Ficus carica*)	0.015	0.000	0.006	0.031
Grape (*Vitis vinifera*)	0.314	0.105	0.304	0.388
Charcoal >2mm	0.573	0.447	0.497	0.705
Number of samples	**328**	**38**	**161**	**129**

Table 3. Summary ratios of Kaymakçı's assemblage including (left) and excluding outliers (right). Values are calculated from site totals (see Table 1); outliers are samples 99.526.497.3 and 99.526.572.2.

Ratios (incl. outliers)	**Values (g/g)**	**Values (#/#)**		**Ratios (excl. outliers)**	**Values (g/g)**	**Values (#/#)**
Pulse:cereal	1.407	1.780		Pulse:cereal	0.831	0.937
Barley:wheat	2.117	2.207		Barley:wheat	1.261	1.589
Bitter vetch:chickpea	2.807	7.620		Bitter vetch:chickpea	0.731	2.495
Wild seed:crop seed (#/g), (#/#)	51.451	1.057		Wild seed:crop seed (#/g), (#/#)	75.816	1.661
Crop seed:charcoal (g/g), (#/g)	0.373	18.167		Crop seed:charcoal (g/g), (#/g)	0.260	11.863
Wild seed:charcoal (#/g)		19.208		Wild seed:charcoal (#/g)		19.703

Table 4. Cultivated seed counts and weights by phase in areas 97.541 of the inner citadel and 99.526 of the southern terrace, compared with corresponding chronological phases at Troy (counts derived from unpublished data supplied by Riehl). Kaymakçı LB1 corresponds to Early/Middle Troy VI; Kaymakçı LB2 is contemporary with Late Troy VI; Troy VIIa dates later than phased archaeobotanical remains from Kaymakçı.

Taxon	**Kaymakçı LB 1**		**Kaymakçı LB 2**		**Early and Middle Troy VI**	**Late Troy VI**	**Troy VIIa**
	Count	**Weight (g)**	**Count**	**Weight (g)**	**Count**	**Count**	**Count**
Cereals							
Barley (*Hordeum vulgare*)	92	1.086	17	0.133	797	57	1,581
Bread/hard wheat (*Triticum aestivum/durum*)	7	0.062	16	0.259	0	14	14
Einkorn wheat (*Triticum monococcum*)	5	0.037	2	0.011	95	43	43
Emmer wheat (*Triticum turgidum* sbsp. *dicoccum*)	3	0.048	1	0.003	151	58	65
Pulses							
Chickpea (*Cicer arietinum*)	3.5	0.198	46	1.732	16	*0	1
Grass pea (*Lathyrus* sp.)	0.5	0.198	0.5	0.024	0	0	0
Lentil (*Lens culinaris*)	4.5	0.049	0	0	0	0	2
Bitter vetch (*Vicia ervilia*)	325	4.898	26	0.276	281	543	12
Common vetch (*Vicia sativa*)	2.5	0.019	0	0	0	0	0
Fruits							
Fig (*Ficus carica*)	3	0.001	2	0.002	5	34	12
Grape (*Vitis vinifera*)	30	0.332	14	0.157	11	10	15
Number of samples	**42**		**127**		**6**	**6**	**10**

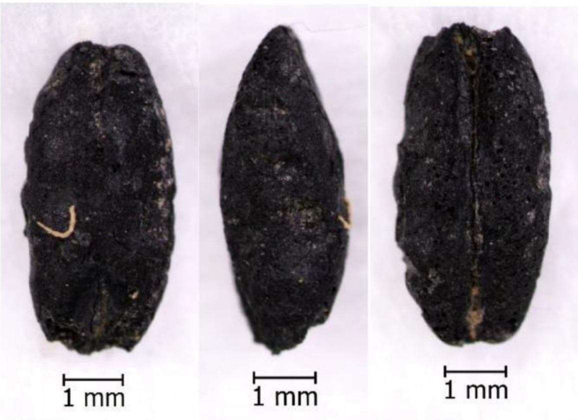
*Actual chickpea count is 15,102, but these come from a burned storage context so were removed from the table for better comparability with samples from Kaymakçı, where to date no seeds from primary storage contexts have been identified.

Table 5. Counts of cultivated taxa from Kaymakçı compared with those of contemporary levels at sites in Greece and Anatolia. Note that some of these contexts include burned crop stores (e.g., Kastanas).

Taxa	**Kaymakçı**	**Troy VI-VIIa (Unpublished data, Riehl)**	**Citadel of Midea (Shay et al. 1998)**	**Dimitra (Renfrew 1997)**	**Kastanas (Kroll 1983)**	**Tiryns (Kroll 1982)**	**Gordion (Miller 2010: 57, App. F2) [only weights reported, in g]**
Cereals							
Barley (*Hordeum vulgare*)	128	2435	1,288	55	1,187	658	7.90
Bread/hard wheat (*Triticum aestivum/turgidum* ssp. *durum*)	30	28	15	1	73	16	5.36
Einkorn wheat (*Triticum monococcum*)	11	181	0	153	652	1,358	0.17
Emmer wheat (*Triticum turgidum* ssp. *dicoccum*)	4	181	2	9	10,751	11	0
Pulses							
Chickpea (*Cicer arietinum*)	50	17	70	0	0	0	0
Grass pea (*Lathyrus* sp.)	2	0	763	0	39	19	0
Lentil (*Lens culinaris*)	7.5	2	92	1	128	57	0.06
Bitter vetch (*Vicia ervilia*)	381	836	439	126	246,978	1,573	1.02
Fruits							
Fig (*Ficus carica*)	5	51	101	0	14	4,394	0
Grape (*Vitis vinifera*)	57	36	2	8	582	165	0.02
Cereal to pulse ratio	0.39	3.30	0.96	1.72	0.05	1.24	12.44
Barley to wheat ratio	2.84	6.24	75.76	0.34	0.10	0.48	1.43
Total number of samples	**328**	**22**	**204**	**4**	**N/A**	**111**	**32**

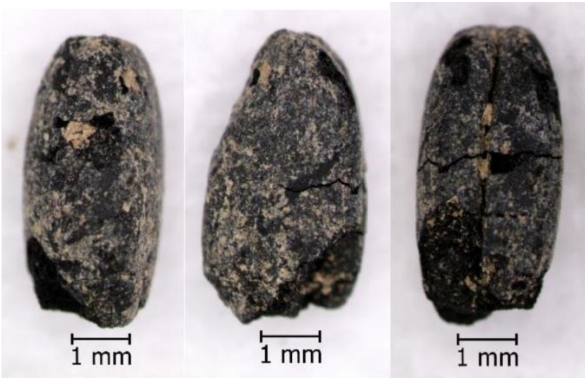
Appendix III.
Images of taxa mentioned in article, Shin et al. (in review).

Cereals



Barley (*Hordeum vulgare*)

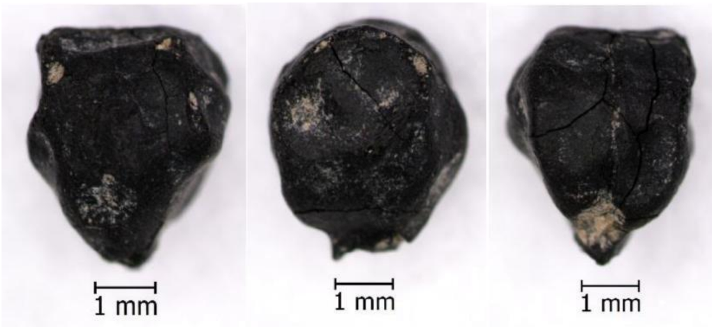
Free-threshing wheat (*Triticum aestivum* or *T. turgidum* ssp. *durum*)



Emmer wheat (*Triticum turgidum* ssp. *dicoccum)*

Einkorn wheat (*Triticum monococcum)*

Pulses



Chickpea (*Cicer arietinum*)

Grass pea (*Lathyrus* sp.)

Lentil (*Lens culinaris*)

Bitter vetch (*Vicia ervilia*)

Common vetch (*Vicia sativa*)

Fruits

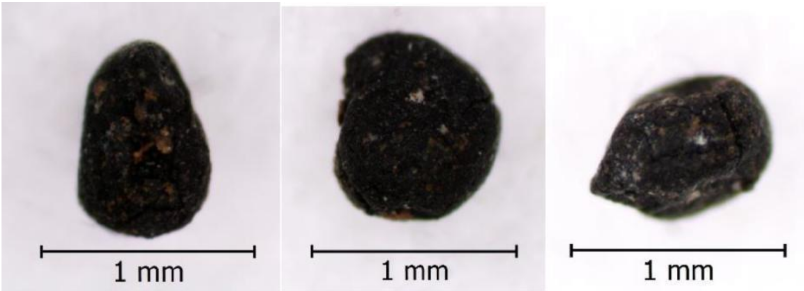
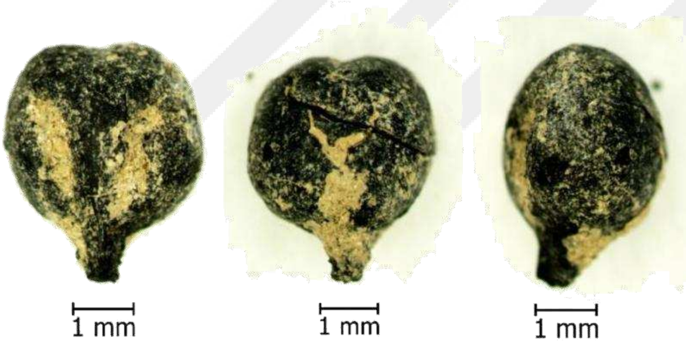
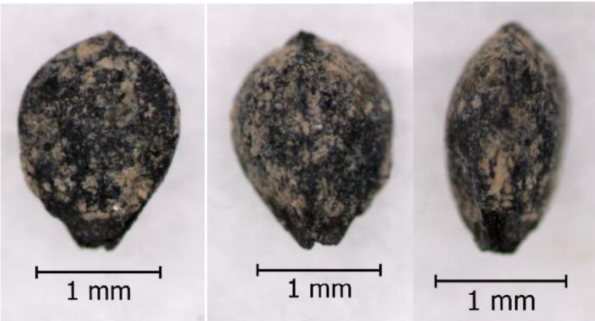


Fig (*Ficus carica*)



Grape (*Vitis vinifera*)

Wild Seeds



Bulrush (*Scirpus*)