AN APPRAISAL OF ARCHAEOBOTANICAL DATA, AGRICULTURAL DYNAMICS AND THE HITTITES' IMPERIAL TRANSFORMATION IN BRONZE AGE CENTRAL ANATOLIA

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ABSTRACT

AN APPRAISAL OF ARCHAEOBOTANICAL DATA, AGRICULTURAL DYNAMICS AND THE HITTITES' IMPERIAL TRANSFORMATION IN BRONZE AGE CENTRAL ANATOLIA

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Archaeobotany is a discipline that allows us to understand people's interactions with their environment and agricultural practices in the past as well as past vegetation. In this context, archaeobotanical data has an important potential in determining the social and cultural relations of past societies and their interactions with other cultural material elements. Within the scope of this thesis, the transformation of the Hittites from a local kingdom to a regional superpower, also called an empire, was examined with the archaebotanical macro remains obtained from the important Hittite settlements of Hattusha, Kalehöyük, Çadırhöyük, Kuşaklı and Ortaköy. Within the scope of the study, the changes in the product preferences, production diversity, sowing periods and tillage densities in agricultural activities over time were statistically analyzed, and similarities, differences and significant patterns in agricultural practices were evaluated in the context of centralization.

Keywords: empire, Hittite, archaeobotany, agriculture, Bronze Age

ÖZ

TUNÇ ÇAĞI İÇ ANADOLU'SUNDA ARKEAOBOTANİK VERİLER, TARIM DİNAMİKLERİ VE HİTİTLERİN İMPARATORLUK DÖNÜŞÜMÜNE İLİŞKİN BİR DEĞERLENDİRME

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Arkeobotanik, insanların geçmişte çevreleriyle olan etkileşimlerini, tarımsal uygulamalarını ve geçmiş bitki örtüsünü anlamamızı sağlayan bir disiplindir. Arkeobotanik veriler bu bağlamda, insanların sosyal, kültürel ve diğer maddi kültür öğeleriyle olan ilişkilerini belirlemede önemli bir potansiyele sahiptir. Bu tez çalışması kapsamında, önemli Hitit yerleşimleri olan Hattuşaş, Kalehöyük, Çadırhöyük, Kuşaklı ve Ortaköy'den elde edilen arkeobotanik makro veriler kullanılarak Hititlerin yerel bir krallıktan, imparatorluk olarak da adlandırılan bölgesel bir süper güce dönüşümü incelenmiştir. Çalışma kapsamında Hititlerin; ürün tercihleri, üretim çeşitlikleri, ürün ekim dönemleri ve tarımsal faaliyetlerindeki yoğunlukların zaman içerisinde değişimleri istatistiksel olarak analiz edilmiş, tarımsal uygulamalarda görülen benzerlikler, farklılıklar ve anlamlı örüntüler merkezileşme bağlamında değerlendirilmiştir.

Anahtar Kelimeler: imparatorluk, Hitit, arkeobotanik, tarım, Tunç Çağı

To my Family

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CHAPTER 1

INTRODUCTION

1.1. Rationale

Reconstruction of past vegetations, understanding of the agricultural practices of past societies and their interactions with the environment are the main goals of archaeobotany. It also has the potential to reveal past social, cultural relations (Palmer & Van der Veen, 2002) or political strategies. In this context, this thesis study focuses on how socio-political transformation of the Hittite State may have altered agricultural practices in order to support their imperial borders, political and religious authorities, army, artisans, bureaucrats and populated cities, through archaeobotanical data. These investigations are important to find out the wider context where centralization locates and to specify the agricultural agents of this socio-political transformation period. Trigger (1996) stated that the interpretation of concepts such as past social issues from archaeological concrete data is still a controversial issue (Trigger, 1996). In this regard, it is seen that the overwhelming majority of the studies on the Hittites' empire process in the literature focus on textual sources, ceramics, seals, and monumental structures that can be more easily reconciled with the concept of empire. Therefore, specifically how far this sociopolitical transformation of Hittites has been influenced by economic factors particularly from the agricultural point of view has been not yet fully uncovered. Within the scope of this study, an attempt will be made to build a bridge between the archaeobotany and Hittite imperial process as an abstract concept.

The Hittite economy was mainly based on agriculture and animal husbandry (Bryce, 2002). This can also be observed through the written sources, large food silos and other archaeological remains that reconciled to agricultural production. However, both documentary sources and archaeological remains are in the status of secondary data and notably do not provide enough information about the husbandry strategies of Hittites. For this reason, it is more likely to fully understand past agricultural practices by using archaeobotanical data, which are direct remnants of agriculture and can be considered as primary data sources.

Thus, the rationale of the thesis is to pursue the imperial transformation of Hittites through the similarities, differences and significative patterns of analysis results of the archaeobotanical macro remains in order to fully understand their agricultural policies first-hand. The studied period is between Middle Bronze Age (hereafter MBA) to the Late Bronze Age (hereafter LBA). The study traces the imperial process by focusing on five settlements located in the Kızılırmak Basin; Şapinuva (Ortaköy), Sarissa (Kuşaklı), Boğazköy (Hattusha), Kaman-Kalehöyük and Çadırhöyük.

1.2. Objectives

A total of 207.491 plant remains with 147.518 carbonized grains, 9.632 carbonized legume seeds, 21.485 chaff, internodes and other cereal parts, 27.877 carbonized weed seeds were analyzed in the scope of this thesis study in total. It is aimed to bring out thoroughly all the points defined in the below listed research questions in order to understand the imperial process in the Hittite core region.

In this study, univariate and multivariate analysis were applied on the existing archaeobotanical data to examine the transformation of the variations on agricultural strategies over time. More specifically, the analyzes are applied to weed ecology to trace the change in husbandry practices and seasonality and to cereal and legumes for the crop diversification and crop preferences. In this way, it is hoped to develop an insight of how the imperial process takes place from agricultural point of view city to the state level particularly in the Kızılırmak Basin. The central question of the thesis concerns how Hittites modified their agricultural practices to meet the demands of their newly formed socio-political situation that is their "Empire". The need to support larger populations at cities as well as a big "state" machine that is based on non-food producing individuals including political and religious authorities, armies, artisans and bureaucrats requires an increase in food production. Trade also requires agricultural surplus. In this regard, the practices are examined that could be put forward to increase agricultural surplus and it was seen that this aim can be met in two ways: Extensification and/or intensification. Extensification can be achieved by several ways such as expanding the borders through wars, setting up new settlements or clearing land from wild flora to create new agricultural fields. Intensification signifies the most intensive use of existing lands to produce higher yields. The thesis study specifically focuses on observing the intensification endeavors in agriculture practices. In this regard, the following research questions are established to well conclude the imperial transformation from the MBA to Empire of the 14th century BC Central Anatolia:

1) How have the crop-choices changed over time?
2) Is there an observable change in tillage density?
3) Is there an observable change in sowing periods?
4) Is there an observable change in crop diversity?
5) and finally, is there any intensification effort in agriculture that indicates strong centralization?

In order to address above listed questions, weed ecology will be analyzed alongside economic plants. Weeds are generally considered as undesirable plants. However, the taxa of economic crops even from storage pits or hearth context generally include weed seeds brought in unintentionally collected during harvest together with the crops. On the other hand, some weeds are sometimes deliberately collected as economic plants. The weed seeds, their types and concentrations can be used to understand various indicators. Tillage density, sowing periods of crops, crop diversity and crop preferences listed in point-bullets (2), (3), (4) and (5) are the most important ones in the thesis. Apart from these, features such as herding strategies (Rosenzweig & Marston, 2018) or soil characteristics can also be predicted by weed ecology. It is aimed to elaborate the above listed research questions in the subsequent chapters.

1.3. The Organization of the Thesis

The thesis includes eight sections. The first chapter, *the Introduction*, explains the rationale and objective of the thesis including the research questions. It also gives brief information about the organization of the thesis and summarized the key points of the work. The second chapter, *Imperialism in the context of Hittites*, of the thesis goes into detail about the empire notion and elaborate its requirements and provides information about the history of Hittite Empire. The third chapter, *the land of Hatti*, details main geographical and climatic features of the region and provide information about the settlements studied under this thesis study. It will end by giving information about the main plants recovered from the studied settlements.

The fourth chapter of the thesis, *Methodology*, includes the limitations, data sources and statistical methods. This chapter describes the methods applied during the selection, arrangement, analysis and interpretation of the data. The fifth chapter, *Archaeobotanical Samples*, is devoted to sample details of the existed data. The sixth chapter, *Results*, of the work includes the results of the statistical analyses applied to the existing data set. The seventh chapter, *Discussion*, is the interpretation of the analysis results according to the research questions and the imperial process of Hittites. The eight and last chapter is conclusion which includes summary of all what has been mentioned and done in the thesis.

CHAPTER 2

IMPERIALISM IN THE CONTEXT OF HITTITES

2.1.Introduction

This section will concentrate on the empire concept and elaborate it considering the prominent definitions in the literature. Main features of empires are examined as a first step. Next, the theoretical relationship between the role of states in the past and agricultural production is discussed. Lastly in this chapter, the history of the Hittites is mentioned briefly by underscoring the key turning points of their chronology.

2.2.The Empire Concept

2.2.1. Main Characteristics of Empires

Language is a living, developing and changing phenomenon and it is affected by social factors (İstanbul Üniversitesi, n.d.), interrelations with other societies as well as external agents such as geography, climate and environment thus it can take different forms over time (Everett, Blasi, & Roberts, 2015). This change can be observed in many different ways. The words that form the backbone of a language, along with grammar, are open to these changes, just like the language itself. These changes can manifest themselves as morphological as well as sole meaning alterations (Penn Arts & Sciences D. of Linguistics, n.d.). The word *empire* similarly has undergone various semantic and morphological changes and developments in the course of time. The homeland of the word is Rome and it is originated from the word *imperium*. Originally, it was a Latin word and means "to rule" in its most simple form (Renfro & Alessio, 2020). Likewise, the word emperor, derived from the root of the verb "to rule", *imperare*, was used to describe the successful generals during the Republic period of

Rome. However, it has similarly undergone a semantic change over time and has become an adjective describing the rulers of their imperial structure (Lieven, 2000).

Carle Schmitt mentioned in his work *Der Begriff des Politischen* (1932) that abstract concepts, such as political ones, are always connected to a real phenomenon in real life and they will be meaningless when the real phenomenon disappears. According to this definition, the concept of empire may have disappeared with Rome and new empire concepts should be produced for the other “empires”. A view that supports this view also comes from Kosseleck (2006) who stated that each concept should be evaluated in its own period (Koselleck, 2006). Similarly, in his book Empire, Alejandro Colas (2007) suggested that definitions can change not only with time and place, but also with the political, social and cultural differences (Colas, 2007). As a matter of fact, although he lived in the Roman period, Tacitus in his famous work *the Germany and the Agricola,* defined the Roman Empire as theft, plunder and massacre (Fontana, 1993). Thus, it is expected that there are many different empire definitions in the literature reflecting this various point of views. Some of the important ones are listed below.

According to Britannica, as a generic description of empires: “*empire, major political unit in which the metropolis, or single sovereign authority, exercises control over territory of great extent or a number of territories or peoples through formal annexations or various forms of informal domination.”*

This general definition slightly elaborated by John A. Hall (2011) in his review essay on ancient and modern empires where an ideal empire associated with a strong center that controls other states. It is also emphasized by him that the ruled societies must be separately connected to the governing center and do not have direct relation with each other (Hall, 2011).

According to the Doyle’s (1986) definition in his book Empire, imperialism is simply defined as the domination exercised by one state over other states or political structures, formally or informally (Doyle, 1986). It is important that the word “domination” is placed in the center of his concept.

On the other hand, some sources have analyzed empires in different typologies. In "*Empires in World History: Power and the Politics of Difference*" by Jane Burbank and Frederick Cooper (2010), empires are separated into different types, such as sea, land and agricultural (Jane & Cooper, 2010). Similarly, some publications in the literature make distinct separations between the past and modern empires (Hall, 2011). So, it is important to open a window to the definitions of ancient empires in this regard.

Sinopoli (1995), who has worked on ancient empires, defines empires as states that have territorially large areas with integrated systems who exert controls on other societies (Sinopoli, 1995). In his study on Hittite imperialism, Karacic (2014) accepted the empire concept as the power difference between two non-equal countries (Karacic, 2014).

According to the view of Streets-Salter and Getz (2016), empires have to be heterogeneous structures, and should be defined as the political structures that controlled other states and societies under its rule without fully integrating or assimilating them. This view emphasizes that if a state assimilates their subordinate communities in line with their ideologies, that state will lose its imperial identity (Streets-Salter & Getz, 2016). So, a new concept, homogeneity, is appeared in this definition as the features of empires.

The number of definitions can be increased, but in the light of the available data and the main definitions, we can come to some conclusions about the basic elements of empires. The far most important feature of empires is seen as a strong centralization which enable to exert control on other states or societies as formally or informally. Exerting domination to these dependent states and societies in or beyond the borders can be considered as *sine qua non* for these strong capitals. In his work "*The Rise and Fall of the Hittite Empire in the Light of Dendroarchaeological Research*" Andreas Müller-Karpe (2009) stated that the centralism and effective bureaucracy were very important factors in the rise of the Hittite Empire (Müller-Karpe, 2009). Apart from the strong centrality, having a heterogeneous structure and large lands, albeit relatively, emerges other distinctive features especially for historical empires. Thanks to the above explanations what is not an empire is also defined implicitly. So, it can be concluded that kingdoms or non-empire states are a type of states that control more limited area and predominantly their dominations do not exceed their own borders. Besides, they should not have strong centers as empires have. Another fundamental difference between empires and non-empires is evaluated in the aspect of homogeneity. It is suggested that fully assimilation of peoples led states to lose their imperial identity.

Therefore, while analyzing the variations in the husbandry changes, it is also expected to be able to observe the increased centralism on the samples studied. In addition, the hegemonic sphere of influence exceeding the borders of the empires should be among the phenomena that are expected to be observed in time through the archaeobotanical data. However, the lack of documents showing the administrative and/or imperial policies of the Hittites emerges as a compelling factor (Postgate, 2007). Besides, the existing textual sources mostly belong to the Hittite core region (Glatz, 2009). At this stage, it is debatable to what extent increasing centralization or borders of the hegemony can be traced through the material culture or archaeobotanical remains. Important studies in this field claim that strong centralization brings a state-controlled standardization especially on material culture such as ceramics. For example, the standardization of the ceramic vases found in Kinethöyük has been interpreted as the existence of an economic policy carried out by the state (Gates M., 2001). Mass-production and concentrating on certain number of goods and standardization in production stages are also attributed with the existence of imperial policies in the literature (Gates M. , 2001). However, notably in some studies, it is underlined that the said imperial policies and influences are hardly observed outside their core hegemonic area (Postgate, 2007). Thus, it was decided that the scope of this study will be limited within the Hittite core region. Main objectives of the study are to trace these possible patterns that imperial practices can create on agricultural production with a special focus on Kızılırmak Basin. In this sense, the relationship between centralization and agriculture will be examined in the next section.

2.2.2. Centralization and Agriculture

The economy of Hittites is based on agricultural production (Bryce, 2002). The continuity and increase of agricultural production were therefore directly related to the survival of their imperial system (Rosenzweiga & Marston, 2018). Therefore, it is important to answer how the Hittites increased their agricultural surplus production in this sense.

Agricultural production strategy is generally based on two basic elements for meeting the needs of a growing state, as intensification and extensification. Intensification is explained as the production increase per unit area through increasing the inputs and/or using advanced soil use practices such as irrigation, crop rotation or manuring (Food and Agriculture Organization of the United Nations, 2004). Extensification, on the other hand, is defined by Van der Veen (2005) as increasing the output per capita by increasing the total unit area of the arable lands (Van der Veen, 2005).

Extensification can be carried out on a personal or state scale by factors such as wars, newly established cities or the conversion of forest areas to agricultural fields. Thus, elite or state-level intervention to extensification is envisaged especially in huge increases in agricultural lands (Styring et al., 2017). However, there are different views in the literature about what exactly are the reasons and agents of agricultural intensification. The leading name of these studies was Ester Boserup (1965) who explained the agricultural intensification with a political economic point of view in her study "*The Conditions of Agricultural Growth*". The main argument was that population pressure pushes people to innovate and to find solutions in order to increase productivity in agriculture (Boserup, 1965). The view of Boserup was extended by others adding other variables to the theory as market demand, environmental changes and centralization (Thurston & Fisher, 2007). Among these variables which we intend to focus within the scope of our study is centralization. However, in the literature, there are many controversial views about the link between centralization and agricultural intensification as well.

One group of scholars suggest that intensification in agriculture is the result of the pressure of the state rather than the individual initiatives of the farmers. According to this view, since concentration in agriculture requires a high level of workforce, technology and organization, it can only be possible with the planning, cooperation and management capability of a centralized structure with a top-down approach where direct intervention of the state is essential (Thurston & Fisher, 2007). Moreover, again as a supportive view, as per *Law of Least Effort*, it is claimed that the farmers generally are not tending to produce more surplus than they need, so again elite intervention is distinctly needed to increase the production according to this theory (Erickson 2006). On the other hand, another group of scholars, who have more human-centric view, claim that the increase in agricultural production can be achieved at individual, local or regional levels and do not necessarily need a central intervention. They argued that societies that did not have a complex hierarchical structure or state organization could also construct notable structures and produce surplus (Erickson, 2006). Mabry and Cleveland (1996) suggested that indigenous local systems are more sustainable and efficient especially in long-term comparing with state supported industrialized farming (Mabry & Cleveland, 1996). Thus, direct relation between intensification and centralization is a debated issue.

Erickson (2006) argued that it is not entirely possible for the top of the hierarchy to follow agricultural activities and stated that the state can only have some influence on intensification. It is stated that there were possibly countries that strictly controlled agricultural production in the past, but only few of them might have followed a strategy of intensification (Erickson, 2006). However, it is known from the documentary sources that state-controlled strict production policies were implemented by Bronze Age civilizations in the past. Assyria can be given as a good example in this sense their influence on industrial products such as textile or ceramics. Similarly, the standardization of ceramics examples especially in the Hittite core region can also be interpreted as the strong influence of the centralization on production (Postgate, 2007). Strong centralization can be observed in other ways besides standardization. Mass-production and more specialized production are other noteworthy traces of state control production (Gates M., 2001). Again, the dam structures and large food warehouses, which we encounter more in the Hittite core region particularly in

Hattusha and Sarissa, can be considered valuable in terms of showing that the state had an infrastructure policy that includes the food system.

Müller-Karpe (2009) bases the Hittite imperialism mainly on three pillars as advanced water structures, large food storages and strong centralization. Only in the Sarissa region more than six dams have been discovered (Müller-Karpe, 2009). Similarly, in Kalehöyük, the underground silos seen in the Hittite period are much larger than the previous period silo's (Fairbairn & Omura, 2005) which can be considered as the policies of the Hattusha to strive with unfavorable seasons as well as to increase their agricultural production and provide more control on surplus. However, it has been noted that this standardization generally has decreased in archaeological remains, especially in ceramic production, in areas outside the direct control area of the Hittite center (Postgate, 2007). For this reason, the evaluation of analogous patterns in the context of centralization within the scope of this thesis is limited to the Kızılırmak basin.

Written sources are also valuable in delineating the boundaries of state control in production. For example, the Middle Assyrian documentary sources are important as they show how the industrial production was tightly controlled by the Assyrian State (Postgate, 2007). As an opinion that goes a little further on this, it is suggested that it is not certainly possible to prove the role of centralization on agriculture without the presence of written sources (Styring et al., 2017). In this sense, it is possible to come across textual evidences focusing on economic issues in the Hittite archive, although their number is relatively low and overwhelmingly provide information from the Hittite core region (Glatz, 2009). Documentary sources such as, political texts, laws and administrative and/or diplomatic correspondences contain explicit or implicit information about the policies and actions of the Hittite state on agricultural production. In some of these sources, it was recorded that war captives, called as *NAM.RA*, assigned as farmers to farmlands in order to ensure agricultural sustainability (Alagöz, 1966). Supportively, the edict of Telipinu provides us a lot of implicit information about the agricultural policies of the central system.

In KUB (*Keilschrifturkunden aus Boğazköy*) XXXI 57 I, it is written that "*The administrator of the city of Kaštama from Palace, gives the seeds of barley and wheat. they sow, they reap, they put in the barn*" (Ünar, 2018). This text emphasizes that the seeds were given directly by the local administrators authorized by the palace. It can be evaluated as one of the most important proofs showing the direct influence of the central authority on agricultural production.

Another text that shows the direct influence of Hittite Palace is again found in Telipinu Edicts where the king expressed that *"(I) made the king (them) real farmer(I). I took their guns from their shoulders. I gave them the plows*". Another section in the Telipinu Edict includes the following statement: *"Then I increased the crops. Let the farmers sow those fields (and) the land and seal the crops! Those villagers should not cheat at the end of the harvest! ... "*(Kuhrt, 2007: Alp, 2011: Reyhan, 2017: Ünar, 2018). This passage can be interpreted as the central influence on increasing of agricultural production.

Another passage from the Telipinu edict is important showing the strict control of the central authority on food storages: *"Whosoever becomes king after me in the future, seal the crops (crop barns) with their names!"* (Kuhrt, 2007: Alp, 2011: Reyhan, 2017: Ünar, 2018).

Apart from these, it is seen that agricultural issues were also mentioned in the private correspondences and orders of the Hittite kings. In one of these, a Hittite king ordered to a castle commander about the returning of the seeds taken by the field workers after their work has finished (Alp, 2011: Reyhan, 2017: Ünar, 2018). This text can be considered as a proof that Hittites Palace tried to establish control mechanism even on seeds and defined standardized practices. It is known that food production was also standardized by Hittites as other production items such ceramics or textiles (Gates, 2001). There are several parts about the centralization of bread making in many places in the Hittite texts (Nesbitt, 1993).

These documentary evidences, the number of which we can increase even more, show philologically that the Hittite state was very closely interested in the continuity of their agricultural system. In this context, it can be concluded that the Hittites were in a regulatory and supervisory position on agricultural production and food storage and it is possible that the Hittites had standardized and/or specialized policies on agricultural production which could be observed in their core region. In brief, while bottom-up human-centered view or other environmental factors are not totally ignored on agricultural intensification, it is aimed to analyze the archaeobotanical data on by concentrating more on centralization and to interpret the results from this perspective.

2.3.Brief History of Hittites

2.3.1. Ethnicity of the Central Anatolia

The Hittites, who ruled between 1650 BC till around 1200 BC, established one of the most important and powerful empires of the Bronze Age in Central Anatolia (Sagona & Zimansky, 2009). Its borders, starting from the area which is also called as the Land of Hatti, at contemporary Central Anatolia, extended to the Aegean Sea and Northern Syria (Bryce, 2002). They had a civilization that was advanced in military, political, artistic and cultural terms which could be compared with other contemporary powers such as Egypt, Babylon and Assyria (Sagona & Zimansky, 2009).

Considering the views discussed in the previous section that one of the major elements of being empire is defined as heterogeneity, as a first step, we have to commence to concentrate on the ethnic composition of the Central Anatolia in a chronological order. In order to understand the ethnic structure of the Hittites, it is essential to go back to the previous, Pre-Hittite, periods. When we go back to the Early Bronze Age, there is no definite and clear information about the dominant character of the existing communities in the region. However, the strongest estimates are that the area was inhabited by a group of non-Indo-European origins called the Hatti. However, it is thought that groups of Indo-European origin were also found in the Mid-Kızılırmak region in the same period, based on the remains such as burial techniques and grave objects (Bryce, 2005).

In the Middle Bronze Age, the most dominant element that we encounter was the Assyrian Trade Colonies (Klengel, 1998). For this period, it can be reached documentary sources which may help determining the ethnic composition of the region. Most of the personal names written on the tablets found in the city of Kanesh, where was the center of trade colonies in Anatolia, were identified as Indo-European origin. However, since the ethnic character of the population in other Central Anatolian settlements is not known exactly, it is not possible to give precise information about the ethnic structure in this region. Nevertheless, it is envisaged that just before the emergence of Hittites, the ethnic identity of Central Anatolia were a mixture of Hatti, Hurrian and Indo-Europeans (Bryce, 2005). The official language of the Hittites was from the Indo-European family. However, when expressing themselves, the Hittite kings emphasized that they were from the Hatti people, and they did not refer to any other ethnic element (Bryce, 2005). This shows that the elements in the core region have a somewhat strictly interconnected and perhaps had a homogenous structure.

However, the state had to merge with the conquered and neighboring societies throughout their history. It is possible to see the effects of these societies in religious and cultural life. The gods and goddesses of these societies were added to the Hittite Pantheon, so that the Hittites were called “the country of a thousand gods” (Bryce, 2002). The cultural traces of other societies can also be seen in the open-air temple of Yazılıkaya where Hurrian deities were depicted (Bryce, 2002).

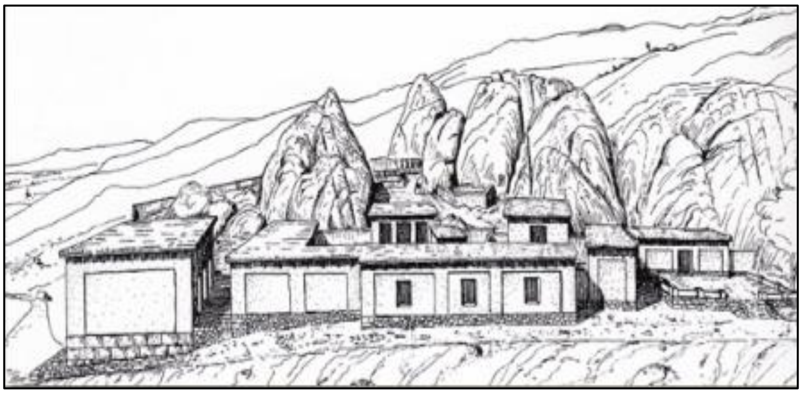

Figure 1 Yazılıkaya Open Sanctuary (source: Ankara Üniversitesi)

Mitanni-Hurri elements also show themselves in royal personal names. The son of the I. Şuppliliuama who was assigned to Carchemish had two personal names as *Piyassili* and *Sarri-Kushuh,* where it is known that Kushuh is a Hurrian origin God name. Similarly, Puduhepa, which is considered as one of the most important queens of the Hittite history, had a Hurrian name (Bryce, 2005). Therefore, it can be said that the Hittites might have shown both homogeneous and heterogeneous characteristics.

2.3.2. Establishment and Expansion Phase of Hittites

Generally accepted establishment date of the Hittites in the literature is 1650 BC. In the time between the MBA and this date, we see the dominance of Assyrian Trade colonies in Anatolia where the sovereignty was shared between the fragmented kingdoms in the region (Klengel, 1998).

The first king of the Hittite state was *Hattuşili I*. However, it is thought that the roots of Hittite Dynasty went back at least two generations before him. *Telipinu* Edict, which is one of the sources containing the oldest information about Hittite history, is important because it contains detailed information about the foundation of the Kingdom and the founder *Labarna* (Bryce, 2005).

In a part of the *Telipinu* Edict, it is stated that "*the land of Hatti was small"*. This might be the oldest information which mentioned the size of the state. Thus, it can be considered this as the base-line of Hittite enlargement. The edict then mentions *Labarna*'s conquests and captures of regions such as *Landa*, *Zallara*, and *Parsuhanta.* This is how the expansion of the Hittites began. When the places conquered by *Labarna* and the historical evidence are compared, it is suggested that the king mentioned as *Labarna* must be *Hattuşili I,* and the aforementioned title used by all kings instead of *Labarna* being a personal name (Bryce, 2005). However, the crucial point here is that the kingdom grew systematically and followed a policy of expansion.

Even during the *Hattuşili I.* period, raids began to northern Syria and the city of *Tell Atchana*, which was in an important location in this region, was plundered. As a result of these raids, although a definite result or an absolute domination could not be achieved, the roadmap for the expansion of the state began to emerge. *Murşili*, the successor of *Hattuşili I.*, continued this policy of his father and continued his Syrian raids. Having captured *Aleppo* with the defeat of the *Yamhad Kingdom*, the Hittites went further south and plundered the city of *Babylon*, but did not establish a permanent dominance there (Genz & Mielke, 2011).

Hittites, who made a quick entrance to the stage of history with these two powerful kings, later entered a turbulent period full of throne disputes. This period of confusion and stagnation continued until the reign of King *Telipinu* until 1525 BC (Genz & Mielke, 2011). During this period, the power of the state and the size of the land were lost. The borders were drawn back up to the Kızılırmak basin (Klengel, 1998) and Northern Syria was captured by *Mitanni*. *Telipinu* enacted a long-established and influential set of laws pertaining to probate, taxation, logistics and state administration. After establishing internal stability, *Telipinu* resumed the conquests. This period, which started with *Telipinu* and lasted for about 150 years, was also called the Middle Kingdom Period overwhelmingly by Hittite researchers (Klengel, 1998).
The state, which managed to survive with the Telipinu laws, weakened again in the early 14^{th} century BC due to the *Mitanni* raids in the south, *Kashka* in the north and *Arzawa* in the west and shrank down to the Kızılırmak basin again. This downfall ended with the period of *I. Şuppliliuama* (Klengel, 1998).

2.3.3. Imperial Age of the Hittites

The enthronement of *Şuppliliuama I.* is generally accepted as the beginning of the imperial period, which is the milestone within the scope of the thesis. The fact that the Hittites reached a cross-border power beyond expanding their lands and strengthening the central authority can be shown as the most important factor in the transition of the Hittites to the empire in this period. The full control and authority imposed on vassal states started with the reign of *I. Şuppliliuama* (Bryce, 2005). This can also be accepted as a sign of strong centralization.

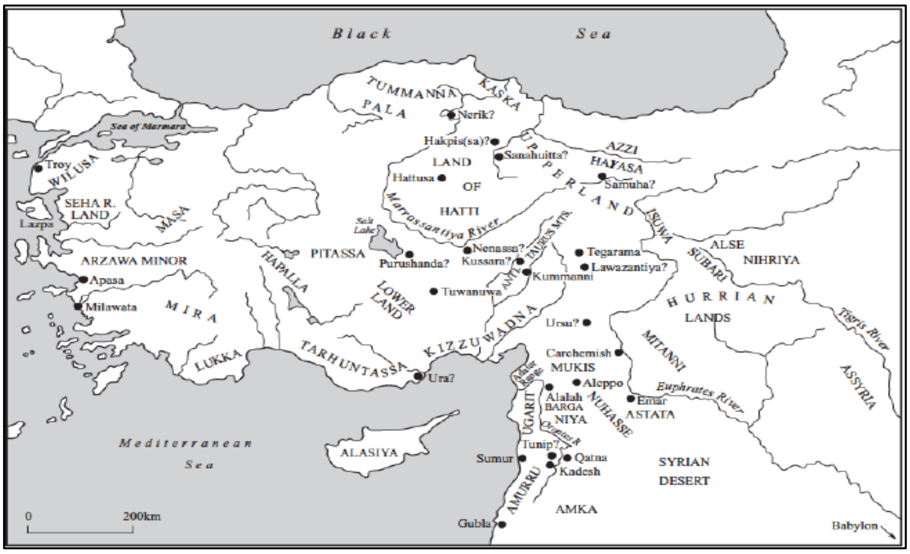

Figure 2 The Land of Hatti and main Hittite settlements (source: Bryce, 2002)

It can be said that the conquest strategy of the state did not change during the imperial period and Syria was again very important. Struggles with great powers such as *Mitanni* and *Egypt* continued in this region, and the lost lands were recaptured and efforts were made to establish sovereignty in Central Syria (Klengel, 1998).

2.3.4. Collapse of the Empire

After *I. Şuppliliuama* until its collapse, the state made its influence to be felt in Anatolia and Northern Syria and managed to become one of the most important powers of this period. In 1200 BC, it was destroyed in the period of *II. Şuppliliuama* after a series of as yet unexplained events and turmoil, such as the invasion of sea people (Bryce, 2002). Although there are various opinions about the collapse of empires, it is known that collapses can be due to different reasons such as economic and geopolitical (Arbesman, 2011). Thus, it can be thought that there was more than one reason for the collapse of the Hittites.

There is no doubt that the Hittites were a respected state in the history. The high level it reached in terms of technology and literature, for example, signing the *Treaty of Kadesh* which is the first written peace agreement in history and building water structures with methods close to today's techniques are the traces of the high civilization they reached.

CHAPTER 3

THE LAND OF HATTI

3.1. General

Within the scope of this section, the general characteristics of the Kızılırmak Basin including its geography and climate are mentioned. Next, the settlements within the scope of the study are mentioned considering their geography, climate, general features and excavation history. The chapter's final section deals with the important crops and weed ecology analyzed under the scope of the thesis.

3.1.1. Imperial Domain

The Hittites had a territory of sovereignty stretching from the Aegean Sea in the west to the Euphrates River in the east and to the middle of Syria. These lands were generally divided into four regions. These are; Kızılırmak basin where Hattusha is located, regions outside the center but directly subordinate to the center, vassal kingdoms and viceregal states (Bryce, 2002). However, within the scope of this thesis, the Kızılırmak basin, which was the core region of the empire and also called as "*the Land of Hatti*" (Bryce, 2005), was concentrated on.

3.1.2. Geographical Features of the Kızılırmak Basin

Kızılırmak, the longest river in Turkey, constitutes the basin which corresponds to approximately 11 percent of the Turkey's lands, covers a total of 18 provinces, including the provinces where some of the most important centers of the Hittites are located (See **Figure-3**). Boğazköy (*Hattusha*), Kaman-Kalehöyük, Kuşaklı (*Sarissa*), Çadırhöyük are located in Kızılırmak Basin whereas Ortaköy (*Şapinuva*) is located in the immediate border area of the Kızılırmak and Yeşilırmak Basins but considered in Yeşilırmak Basin.

The Kızılırmak River that had been called *Maraššantiya* by the Hittites and *Halys* in antiquity (Bryce, 2002), has a basin that is mostly located in the *Central Anatolian Plateau*, which is bordered by the *Taurus Mountains* in the south and the *North Anatolian Mountains* in the north, and it is divided into various sized plains inward by many mountain ranges. The average elevation of the region is around 1250 meters.

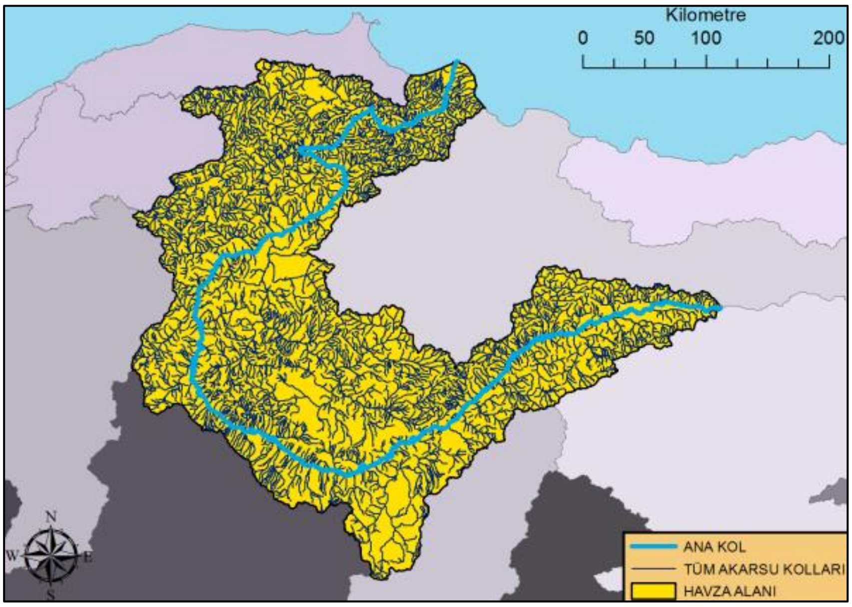

Figure 3 Kızılırmak Basin (source: www.tarımorman.gov.tr)

Especially the inner parts of the basin, which is the Hittite homeland, mainly consists of high plateaus. Even though it is irrigated by Kızılırmak, the plateau is one of the regions of Turkey that receives the least amount of precipitation. The annual rainfall average of the basin is generally below 500 mm (Bryce, 2002).

3.1.3. Main Hittite Settlements

This section gives brief information about the main Hittite settlements which also studied in the scope of this thesis. The history of the sites as well as its climate, vegetation and geography will be covered briefly. Besides, archaeobotanical studies carried out in the regions will be mentioned.

3.1.3.1.Boğazköy (Hattusha)

3.1.3.1.1. Description and History of the Site

Hattusha was the capital city and the imperial center of the Hittites. It is located 87 km south of the Çorum, within the borders of Boğazköy district. It covered 167.7 ha area and considered among the largest settlements in Bronze Age (Sagona & Zimansky, 2018). Hattusha was also the religious and administrative center of the Empire. The city included temple structures, royal palace, administrative buildings and public storages. According to Müller-Karpe (2009) more than 30 temples were built at the city and most of them were located at upper city (Müller-Karpe, 2009). *Yazılıkaya*, where the important gods and goddesses of the country are carved in relief on the rock in rows is located in the vicinity of Hattusha.

The history of the city begun in the Early Bronze Age. In the Middle Bronze Age, the city was one of the destinations of Assyrian Colonist and had a *karum* where had been formerly located in the Great Temple area. In the Middle Bronze age and Old Kingdom Periods, the city spread to the northern slopes. Then, in the imperial period, it enlarged to the south slopes with many public and temple structures (Sagona & Zimansky, 2018). The site is on the UNESCO World Heritage List.

Figure 4 The Lion Gate in Hattusha (source: https://www.kulturportali.gov.tr)

The ancient city was surrounded approximately by 6,5 km wall with hundreds of defense towers. There were also five gate structures on these walls. **Figure-4** shows one of these gates that called as the Lion's Gate which locates in the south-west of the city. Great temple is the largest temple in the city dated to the 13th century BC. It is dedicated to the storm god of Hatti and the sun god of the city of *Arinna*. The basic part of the building was made of large limestone blocks and the upper part was made of mud brick, although it could not be preserved. *Büyükkale* is another important location of the city that was used as palace complex. Between the great temple and *Büyükkale*, three were several slope houses which could be used for administrative purposes. The city also included 28 small temples in the upper city (UNESCO, 2022).

3.1.3.1.2. Geography, Climate and Vegetation of the Site

The average altitude of the city is 1200 m above sea level. Climatologically, the region is dominated by continental climate and receives an average of 450 mm of precipitation per year (Diffey et al. 2020). The share of forests in vegetation is high. According to the pollen analysis, it is seen that the vegetation of the Boğazköy region was heavily forested in the 2nd millennium BC (Genz & Mielke, 2011). The *İbikçam Forest* is located on the south side of the city is thought as the last remaining parts of this forest cover (UNESCO, 2022).

3.1.3.1.3. Excavation History and Archaeobotanical Studies at the Site

The area had been first discovered by the French explorer Charles Texier in 1834. Initial excavations in the city were made in 1893 by Ernest Chantre. However, systematic excavations in Hattusha started in 1906. Excavations have been going on under the leadership of Deutsches Archaeologies Institute (Hereafter DAI) for more than 100 years since 1907. Excavations are carried out today under the direction of Andreas Schachner.

Most important discovery in the field of archaeobotany in the region is the large hermetic storage areas found in *Büyükkale*. The Silo complex had been first discovered in 1960 excavations. However, later in 1998-2000 campaign, large quantity of charred cereals was found by the team of Jürgen Seeher in 1999 which are dated to 16th century BC. (Diffey at al. 2020). Other studies about the archaeobotanical remains from Hattusha was published by Hopf in 1992 and by Schachner in 2012. The crop remains in these studies belong to 14th, 13th and 17th BC respectively. The last study, which analyzed samples from the Karum and Old Hittite layers and also compared another period of sociopolitical transformation, is unique.

3.1.3.2.Ortaköy (Şapinuva)

3.1.3.2.1. Description and History of the Site

The settlement, which is approximately 60 km away from the city center of Çorum, is within the Ortaköy district today. Although the archaeological findings of the city are coming mostly from the 14th and 13th centuries BC, its name was mentioned in the written texts that belong to the 15th century BC. Therefore, it can be thought that the city was first inhabited during the Old/Middle Kingdom periods (Steadman & McMahon, 2011). It is thought that Hittites did not settle to the existing villages in the valley instead, they terraced and leveled the land on the plateau and established the city (Süel & Süel, 2011).

Figure 5 Şapinuva (source: https://www.kulturportali.gov.tr)

More than 4000 cuneiform tablets obtained from the settlement in the archaeological excavations. In the light of these tablets, it is understood that the city was an important administrative center and royal affairs were carried out from here from time to time (Süel & Süel, 2011). It is known that *III. Tuthaliya*, *I. Şuppliliuama*, *II. Murşili* resided in the city (Süel M., 2008). The region was also an important military and religious center. Palace structures, temples, administrative areas, food warehouses and ritual areas are amongst the monumental buildings that have been discovered through archaeological excavations. The *Ağılönü* region, where archaeobotanical data were obtained, is thought to be an important religious center (Oybak Dönmez, 2019). This structure is considered as one of the most important monumental and religious works built in Anatolia in the early ages (Süel & Süel, 2011).

3.1.3.2.2. Geography, Climate and Vegetation of the Site

The settlement is located on a low plateau drained by the *Özdere*, *Aşdagul* and *Göçet* streams, which are the tributaries of the *Çekerek* River. The valley of *Çekerek* River stretched to *Göynücek, Zile, Amasya, Alaca* and on the way to Hattusha, thus the city has a strategic location as well as its agricultural potential (Gülersoy & Gülersoy, 2016). In this way the region has been heavily inhabited since ancient times. Apart from Şapinuva, there are other ancient settlements in the region such as *Yuğ Höyük* and *Tülüce Höyü*k. Ortaköy region is located in a transition zone between steppe and forest zones. This made its climate milder than the continental climate. Average annual rainfall is slightly above 400 mm. The average temperature is 10.8 °C annually, 0.8 °C in January and 20.4 °C in August. With its cereal growing potential and forest existence especially juniper, larch and oak, is thought to make the region suitable for settlement (Gülersoy & Gülersoy, 2016).

3.1.3.2.3. Excavation History and Archaeobotanical Studies at the Site

The first survey work in the settlement area was carried out in 1988. The archeological excavations at site have been carried out in the direction of Prof. Dr. Aygül Süel and the late Prof. Dr. Mustafa Süel between 1990-2020. Since 2021, the excavations have been doing under the direction of Dr. Önder İpek. The plant remains uncovered in Şapinuva belong to approximately 1400 BC, from the beginning of the imperial period.

3.1.3.3.Kuşaklı (Sarissa)

3.1.3.3.1. Description and History of the Site

Sarissa was a Hittite settlement in north-eastern Anatolia, within the borders of present-day Sivas. It has been excavated since 1993 by Andreas Müller Karpe (Müller-Karpe, 1998). Archaeological findings from Sarissa take the history of the city back to the 16th century (Steadman & McMahon, 2011). The temple building, which dates back to 1525 BC, is the largest religious structure of the Hittite period with a dimension of 75 meters width. This structure strengthens the argument that the city was an important religious center. In addition, it is thought that the city was not developed or grew over time, rather it was designed and established in a planned way (Müller-Karpe, 1998).

3.1.3.3.2. Geography, Climate and Vegetation of the Site

Sarissa is located at the highest altitude of all other Hittite settlements in Anatolia, with an altitude of 1650 meters (Müller-Karpe, 2009). **Figure-6** shows the cross-sectional view of the city location from east-west and south-north directions with 20 and 25 km distance respectively. It is seen in the **Figure-6** that the entire region has very high altitudes. Continental climate is dominant in the region where annual amount of precipitation is around 380 mm. This amount of precipitation is quite low and is considered to be risky for sustainable agricultural activities (Schachner A. , 2022). The summers of Kuşaklı region are dry and the winters are long when frost is a major problem. However, the climate is thought to be more favorable for agriculture in LBA than today. Dendroclimatological analysis results support the pollen records which was taken from the from *Suppitassu* lake locates near Kuşaklı which suggests that the region was much rainier and warmer in the Late Bronze Age than today. It is also explaining how a place with very high altitude was chosen by Hittites to establish a settlement possibly having significant population. Step type plants dominates the vegetation of the region at the present time and forests are scarce. However, according to the pollen studies, the area predominantly covered by pine trees in third and early second millennia BC (Müller-Karpe, 2009). Later periods oak and cultivated plants are observed together with a dramatic decrease in pine pollens (Dörfler, Neef, & Pasternak, 2000: Müller-Karpe, 2007).

Figure 6 Cross sectional view of the Sarissa region. East-West (top) and North-South (below) directions.

3.1.3.3.3. Excavation History and Archaeobotanical Studies at the Site

Archaeological excavations in Sarissa started in 1992 and continue today under the direction of A. Müller-Karpe. The studies in the field of archaeobotany were published by Pasternak in 1998 and 2000 and Dörfler 2011.

3.1.3.4.Kaman-Kalehöyük

3.1.3.4.1. Description and History of the Site

Kaman-Kalehöyük is a multi-period mound located 3 km east of Kaman district of Kırşehir. Ottoman, Byzantium, Iron Age, Late and Middle Bronze and Early Bronze ages are the detected periods in the settlement (Omura, 2015). The height of the mound and its diameter are 16 m and 280 m respectively, (see **Figure-7)**. It was a destination on Assyrian Trade route and preserved its importance in the Old Hittite Period. Although the occupation levels include mainly domestic structures with mud-brick and timber, the architecture shows difference in Hittite Period layers where large stone buildings were found albeit limited number comparing with Hattusha and Kuşaklı. The food storages used to store agricultural products are important architectural elements in the settlement (Fairbairn & Omura, 2005) especially in terms of the archaeobotanical studies. Two different city walls were identified, one on the lower city and one on the hill. The height of the walls on the hill is over 7 m. In addition, the walls, which are suggested to be in two rows in the lower city, were built in a technique similar to those in Boğazköy (Omura, 2010). The large silos found in the Old Hittite Layer is thought to be a collection point of the surplus in the immidiate vicinity (Fairbairn & Omura, 2005).

Figure 7 Kaman-Kalehöyük (source: https://www.kulturportali.gov.tr)

3.1.3.4.2. Geography, Climate and Vegetation of the Site

The altitude of the mound is 1070 meter above the sea level. Vegetation is almost devoid of forest cover natural & human related reasons and the dominant natural vegetation is anthropogenic steppe. Continental climate dominates the region and the annual rainfall amount is 350 mm (Nesbitt, 1993). *Kılıçözü* and *Kızılırmak* are the most important rivers in the region.

3.1.3.4.3. Excavation History and Archaeobotanical Studies at the Site

Archaeological excavations in the settlement began on 31 May 1986, and continue under the chairmanship of Dr. Sachihiko Omura. Archaeological layers of Hittite and Asyrian periods mostly include domestic structures, thus the city is thought to be more agricultural oriented (Fairbairn & Omura, 2005). Publications on archaeobotanical studies in the city focus on Assyrian and Old Hittite periods. The samples were collected mainly from heart and pit fills (Fairbairn, 2006).

3.1.3.5.Çadırhöyük

3.1.3.5.1. Description and History of the Site

Çadırhöyük is located 2 km south of the *Peyniryemez* village in the district of *Sorgun*, Yozgat. The settlement is located at a junction of *Eğrisu* and *Kanak Su* Rivers both located in *Gelingilli* Dam Basin today (Von Baeyer, Smith, & Steadman, 2021). The Höyük is roughly 220 m of diameter and 32 m in height (see **Figure-8)**. It is thought that the habitation in Çadırhöyük lasted from 5200 BC to the Islamic Periods (Ross, Steadman, McMahon, Adcock, & Cannon, 2019). Through archaeological excavations, layers from Chalcolithic, Early Bronze, Middle Bronze, Hittite, Phrygian, Hellenistic, Rome and Byzantium have been identified. The city is also thought to be the city *Zippalanda* that mentioned in Hittite Texts (Gorny, 2006: Smith, 2007).

Figure 8 Çadırhöyük (source: https://www.kulturportali.gov.tr)

3.1.3.5.2. Geography, Climate and Vegetation of the Site

The region is located in the *Bozok Plateau* and mostly flat and has continental climate with hot and dry summers and cold winters. Steppe is the characteristic vegetation of the region. The *Eğri* River is the prominent water source of the landscape. The mound is located just near the *Eğri* River which is thought to be the most important water source of the city in ancient times (Chernoff & Harnischfeger, 1996). The average precipitation is changed between 370-425 mm (Smith, 2007) and the altitude of the mound is 1020 m. The soil type in the region is loamy which is suitable for agriculture. However, the modern analysis shows that the organic matter in the soil amount is around 1 percent which is well below the defined lower-limits 3 % - 4 %. The nitrogen amount in the soil of the Çadırhöyük region is also below the lower-limits (T.C. Tarım ve Orman Bakanlığı, 2022). However, the region is heavily cultivated today and agriculture is the main economic activity with the contribution of chemical fertilizers as well as legume rotations (Smith, 2007).

3.1.3.5.3. Excavation History and Archaeobotanical Studies at the Site

The site was first discovered by Van der Osteen in 1926. However, the first studies in the field started with the surface surveys in 1993. Archaeological excavations were initiated by the University of Chicago in 1999 under the direction of Robert Gorny. Archaeobotanical studies in the field have also progressed in coordination with archaeological studies (Smith, 2007). The archaeobotanical data used in this study were taken from the article "*Plant Use at Çadır Höyük, Central Anatolia*" by Alexia Smith, which also benefited from the previous archaeobotanical studies of Chernoff and Harnischfeger 1996 "*Preliminary Report on the Botanical Remains from the 1994 Season of Çadırhöyük*" (Chernoff & Harnischfeger, 1996).

3.2. Main Agricultural Crops in the Land of Hatti

The two most important data sources about the plants consumed by the Hittites are cuneiform tablets and plant micro/macro remains. It is known from the documentary evidences that the Hittites used a large number of crops. Most important crops in their economy were cereals predominantly. Legumes take the second place after cereals with their rich nutritional content (Zohary & Hopf, 1973). Grape (*Vitis vinifera*), which is the most common fruit species in the examined samples, was among the important fruit species of the Hittite period Anatolia (Nesbitt, 1995). Additionally, wild plants often were used for the purposes of food or medicine (Genz & Mielke, 2011).

3.2.1. Wheat

Wheat was grown abundantly by the Hittites (Genz & Mielke, 2011). Archaeobotanical findings in Hittite settlements show that einkorn (*Triticum monococcum*), emmer (*Triticum dicoccum*), and bread wheat (*Triticum aestivum*) were the most abundant wheat species (Genz & Mielke, 2011).

Triticum monococcum (einkorn wheat)*:* Einkorn wheat is one of the first domesticated and dominant species until Early Bronze Age in Anatolia (Nesbitt, 1995). Morphologically it is a hulled wheat, that is, its grain is enclosed by glumes. So, it is more resistant to cold, diseases and insects than the free-threshing wheat is (Matsuoka, 2011). In the samples examined in this thesis, einkorn is generally less common than other wheat types.

Triticum dicoccum (Emmer Wheat): Emmer wheat is one of the two oldest domesticated species along with the einkorn. It is known that emmer wheat has been cultivated as far back as 10,000 years ago (Matsuoka, 2011). It was one of the widely used types of wheat in the ancient world as well as in Hittite times (Nesbitt, 1995). Emmer wheat is known to be one of the dominant species in Anatolia before Early Bronze Age (Nesbitt, 1995: Matsuoka, 2011). Characteristic features of emmer can be defined as its adaptation ability to bad soils and unfavorable climatic conditions where other wheat species cannot grow (Konvalina , Capouchová , & Stehno , 2012). Accordingly, emmer wheat is quite resistant to fungal diseases, drought and extreme temperatures (Zaharieva, Ayana, Al Hakimi, Misra, & Monneveux, 2010). Its domestic and wild species are hulled and it is necessary to exert more effort to reach the grain than the durum or bread wheat (Matsuoka, 2011). Emmer wheat is the dominant hulled-wheat in the scope this study.

Triticum aestivum (Bread Wheat): It is morphologically free-threshing and easy to process due to their non-hulled grains and soft glumes. However, both its adaptability and endurance are less than the emmer and einkorn wheat. When it is compared with durum wheat, its protein content is lower, but the starch content is higher than durum. It is more difficult to grind in the mill, but the flour obtained is very fine. Thus, it is more suitable for bread production (Matsuoka, 2011).

Triticum durum (Durum Wheat): Durum wheat is rich in protein, mineral and vitamin content. It is extensively used for production of variety of end products such as pasta, bread and bulgur (Elias, 1995). One of the most important differences between bread and durum wheat is cold tolerance. Although bread wheat can grow cold places such as Russia and Norway (Mastrangelo & Cattivelli, 2021), summer months are more suitable for sowing durum wheat (Elias, 1995).

Triticum monococcum, *Triticum dicoccum* and *Triticum aestivum/durum* are the most commonly found wheat species in the settlements examined in the scope of the thesis. Free-threshing wheat (*Triticum aestivum/durum*) dominates most of the samples that are analyzed in this thesis work.

3.2.2. Barley

As one of the oldest crops in the ancient world, barley was also a favorite cereal of the Bronze Age Anatolia due to its drought resistance, production stability and relatively cold resistance (Nesbitt, 1995) as well as its resistance to alkaline, salty soils, drought and summer frosts (United States Department of Agriculture, 1979). Accordingly, it is considered as the most densely cultivated plant in Hittite realm (Nesbitt, 1995). Barley can tolarete high temperatures for regions where humidity is low such as the Central Anatolia region. However, as a winter crop it is less productive than wheat (United States Department of Agriculture, 1979).

It was used as for variety of purposes in the past as brewing, animal fodder and human consumption. Moreover, it was also recorded in the written texts that barley was used for a tool for exchange in Hittites and wages of workers (Oybak Dönmez, 2019) also used in religious rituals, medicine purposes in other ancient civilizations (Newman & Newman, 2006). *Both Hordeum vulgare* and *Hordeum distichum* are found in high abundance in the studied settlements.

3.2.3. Legumes

Legumes were important food sources together with cereals in the ancient world (Zohary & Hopf, 1973). They have high amount of protein in their content. In addition to being used as food, they can enrich the soil by allowing the free nitrogen in the air to pass into the soil and increase the yield. Therefore, it is preferred as a second product due to its high nutritional value and enriching the soil in terms of nitrogen (Liu, Wu, Baddeley, & Watson, 2011). Thus, the presence of legumes can be evaluated as the evidence of rotational planting or variances in subsistence strategies (Wolff, Westbrook, & DiTommaso, 2022).

Vicia Faba L.: Vicia Faba is a plant in legume family and has very high content of protein. It can enrich the soil by allowing the free nitrogen in the air to pass into the soil as the other members in the legume family. *Vicia Faba* is a temperate-climate plant (Kirk, 2004). For this reason, summer-sowing is appropriate in geographies such as Central Anatolia, where winters are harsh. It is found with high abundance especially in the 16^{th} BC Hittite samples.

Cicer Arietinum (Chickpea): It is one of the oldest crops in the ancient world. It has been cultivated in Anatolia since the 8^{th} millennium BC (Nesbitt, 1995). Chickpea has an important place in human nutrition thanks to 20-25% protein, 40-60% carbohydrates, fat, phosphorus and calcium in its grains. It is a drought-resistant, annual, summer legume plant that can fix the free nitrogen of the air in the root nodules. Being the most resistant to drought and heat after lentils, chickpea is one of the most important plants of semi-arid and is among the most important products for the Central Anatolia region (Babaoğlu, 2022).

Pisum Sativum (Pea): Peas are a very important type of food for human nutrition with significant amounts of protein, carbohydrates, phosphorus, potassium and vitamin A in it. As like the other legume family members, Pea roots can keep the free nitrogen of the air (Dahl, Foster, & Tyler, 2012). However, in successive sowing serious decrease in yield can be seen. Peas can withstand low temperatures close to freezing and can grow very well in cool and humid conditions, but hot and dry weathers are not suitable for its development. Soil preference is well-drained clay loam soils. The most suitable sowing time in the Central Anatolia region is spring (Demirci & Ünver, 2005).

Vicia Ervillia (Bitter Vetch): Bitter vetch seeds were found during excavations at many Neolithic settlements in Anatolia. Furthermore, it is thought to have been extensively cultivated in the Bronze Age (Zohary and Hopf, 1973). It can be grown in very dry areas where other cultural plants cannot be economically cultivated (Başaran, Acar, Önal Aşçı, Mut, & Ayan, 2007). This plant, which is used as animal feed today and in the Roman period, is thought to be consumed as food in times of famine but the exact function of this plant in the Bronze Age is not exactly known (Zohary & Hopf, 1973). This plant was frequently encountered in the samples within the scope of the study.

Lens Culinaris (Lentil): Lentils have been an important source of nutrients and protein since 8000 BC in Anatolia (Nesbitt, 1995). It is thought to be as old as the cultivation of wheat and barley (Zohary and Hopf, 1973). Today, Yozgat, Çorum, Kırşehir, Ankara and Konya, which are considered to be the homeland of the Hittites, are the prominent cities of the green lentils production in Turkey. Green lentils are harvested in summer period in the Central Anatolia (Erbaş Köse, Bozoğlu, & Mut, 2017). Lentil seeds are well represented especially in the Old Hittite Period Hattusha.

Lathyrus Sativus (Grass pea): *L. Sativus* can grow naturally in almost every region of Turkey. It is also found in the coastal and inner parts of the Central Black Sea Region of Turkey where the borders of Hittites stretched. It can be grown in very dry areas where other agricultural plants cannot be economically cultivated. By this feature, it is considered as an important option for crop rotation for dry regions (Başaran, Acar, Önal Aşçı, Mut, & Ayan, 2007).

3.2.4. Fruits

Olive (*Olea europaea*), grape (*Vitis vinifera*) and fig (*Ficus carica*) are important fruit species whose remains started to appear in the Early Bronze Age Anatolia (Nesbitt, 1995). In the scope of this study, Grapes (*Vitis vinifera*) seeds were recovered from the samples with a very-low relative abundance.

3.2.5. Weeds

Weeds are generally known as undesirable species. However, indeed, they are important archaeobotanical findings and can give lots of information about past flora, soil use techniques and even the agricultural organizations like labor (Wolff, Westbrook, & DiTommaso, 2022). In this respect, certain weeds can also be considered as an important indicator of intensive land use (Schachner, 2012).

A total of 27.829 weed seeds have been identified from Hattusha, Kuşaklı and Şapinuva. Weed seeds from Çadırhöyük and Kalehöyük were recorded by abundance and presence/absence scales respectively. The 16th century BC Hattusha samples, as one of the biggest archaeobotanical findings in Anatolia, includes high amount of weed seeds. Among other samples, weed species were meticulously recorded in Kaman and especially in Sarissa. *Galium triconutum Dandy, Polygonum aviculare L., Ranunculus arvensis L., Vaccaria pyramidata Medik., Bifora radians M. Bieb., Chenopodium* and *Lolium sp.* are prominent weed taxa found in high ubiquities and abundance in the scope of this thesis.

CHAPTER 4

METHODOLOGY

4.1.Data Sources

Archaeobotanical data is the primary source used in this work where only published sources were used. Archaeological and historical sources have been preferred as secondary data sources to support the proposed ideas occasionally. Assyrian and Hittite Texts are the most important written sources that shed light on the Middle and Late Bronze Age of Anatolia. While Assyrian texts focus more on trade-related topics, Hittite texts cover a wider area such as laws, rituals, edicts, and offer more content on agricultural topics (Fairbairn et al., 2019).

Archaeobotanical macro remains which are cereal grains & non-grain sections, pulses and weeds are the main input of this study where published archaeobotanical reports of five Hittite settlements Hattusha, Ortaköy, Kuşaklı, Çadırhöyük and Kalehöyük were used for. The availability of archaeobotanical quantitative/qualitative data in these publications is the primary reason of selecting the above listed sites apart from their administrative, geographic, politic and historical importance. The study is limited with the time ranges of MBA and LBA.

4.2.Limitations

One of the most important difficulty of the study is the shortage of the published data sources that have a methodology suitable for understanding the mechanisms behind imperial formations of Hittites particularly from the agricultural point of view. Although there are growing numbers of recent studies in agricultural practices of LBA sites in Central Anatolia in the literature (Marston et al., 2021), the number of studies that are analyzing the formation of ancient empires in the context of Hittites is not high. Furthermore, the ancient sources do not include any term related with empire or imperialism which were later conceptualized by historians (Fitzpatrick-McKinley, 2015). The second and main difficulty in thesis, on the other hand, is the paucity of archaeobotanical data. There is not a complete set of published data which covers the all-occupational periods of settlements even the administrative centers such as Hattusha and Şapinuva. This situation prevents the full follow-up of the imperial process over time. The fact that some of the available data cover a very wide chronological range (more than 500 years span) is also a reflection of the difficulties of relative and precise dating methods in archaeology in determining dates with a clear and high-resolution precision. All these difficulties make it hard to follow the socio-politic continuity over time and to make a comparison of the different stages of the agricultural evolution.

Another important limitation encountered during the study is the contextual differences of the archaeobotanical samples which prevents making holistic interpretations. Due to the paucity of available data, data taken from various contexts such as public storages, gatehouses, temple or domestic structures had to be evaluated together occasionally. Similarly, N. Miller (2010) conducted a survey to increase the effectiveness of archaeobotanical reports. The results of the survey are important in terms of showing the deficiencies in the contextual information of the published archaeobotanical reports (Miller, 2010). Another difficulty encountered during the study of archaeobotanical data is the methodological differences particularly in recording and publishing of samples. While some data are given numerically, some others were published according to relative abundance scales without any conversion coefficient. This kind of data are converted to numerical values with coefficients[1] defined in this work for carrying out statistical analysis. These converted data are specifically indicated with a "C" mark as prefix or suffix in the analysis results.

[1] In the present study, especially in Kaman sample, a five-level abundance scale, *very abundant, abundant, occasionally, rare, very low* was used. The scale in question was digitized as multiples of five; very low (5^1), rare (5^2), occasions (5^3), abundant (5^4), very abundant (5^5) =3125.

Nevertheless, as new studies and analyzes are obtained, the structure and changes of the Hittite agriculture will be better understood. In this study, it is aimed to compare and interpret the available published data in the best possible way. It is therefore hoped that the results of this thesis will bring our knowledge a step forward and will benefit further studies for Anatolian archaeology.

4.3.Analysis of Data

In this study, univariate and multivariate statistical analysis were applied to analyze the existing data. While the main tool in univariate analysis was Microsoft Excel, R Language was used for Correspondence Analysis (hereinafter CA) as a multivariate method. Besides, ubiquity and the relative abundance of taxa (hereafter RA) were applied to assemblages which allows to us to understand the botanical taxa distribution local and regional level and makes it possible to compare different settlements.

4.3.1. Ubiquity and Relative Abundance

The ubiquity of crops and weeds were calculated using below formula (Diehl, 2017):

$$U_{taxon} = \frac{N_{taxon}}{N_{total\ in\ zone}},$$

Where,

U_{taxon} = the ubiquity of the plant,

N_{taxon} = the number of samples one taxon is found,

$N_{total\ in\ zone}$ = the total number of samples

The RA was calculated by dividing the number of finds of one taxon by the total number of finds in the whole assemblage and multiplied by 100.

These methods aim to measure how common or rare the plant in the assemblage is. Both have advantages and disadvantages. The ubiquity is a more general measure that shows how often a plant is found. Nevertheless, it does not tell anything about the quantity of the plant and therefore the importance of its use. If it is found one grain of wheat or one thousand grains in one sample both situations are equal for the ubiquity estimation. Turning to the relative abundance, here it is faced with the problem that the number of seeds or grains differ from plant to plant. For example, an apple will have a few seeds but a fig will have hundreds. In addition, storage facilities can potentially have thousands of seeds of stored crops which can exaggerate the importance of the particular crops to be found. For these reasons multiple methods are used to evaluate better the archaeobotanical assemblages in this thesis study.

4.3.2. Similarity/Diversity Analysis

A diversity index is a mathematical measure of species diversity in a given community. Ecological diversity indices are used to the different datasets to evaluate the degree of plant diversity in archaeobotanical taxa of different periods. These indices consider richness and evenness calculating the diversity of samples (Magurran, 2004).

In this work, Simpsons Index of Diversity (Yalçın, 2019) is used to measure the diversity. All calculations were made using Microsoft Excel®.

4.3.2.1.Simpson Index

The Simpson Index (D) is used to measure the probability that two unit randomly selected from a sample are different species. It is a measure of diversity that consider richness and evenness. The greater value means the greater diversity (Yalçın, 2019).

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

where,

D = Simpson Index,

n_i = the number of plants in the i^{th} taxa,

N= the total number of plants of all taxa

4.3.3. Multivariate Analysis

By multivariate statistical methods, it is possible to analyze large data sets at the same time. In this way, large data sets are reduced to a single graph to a low-dimensional space (generally two-dimensional). Excessive data are purified and by this way more precise and clear results can be obtained. Multivariate analysis can reveal significant differences and relationships between data sets (Smith, 2014).

4.3.3.1.Correspondence Analysis

CA has been become the most preferred multivariate analysis method in archaeobotany in recent years (Smith, 2014). The main aim of CA is to visualize rows and columns of a data table in a lower-dimensional space (Blasius, Lebaron, Le Roux , & Schmitz, 2019). It is possible to work with large datasets containing numerous zero values (Smith, 2014). R programming language is used for making the Correspondence Analysis in this work.

CHAPTER 5

ARCHAEOBOTANICAL SAMPLES

5.1.The Content, Context and Date of the Samples

In this chapter the archaeobotanical data taken from published reports of Hattusha, Ortaköy, Kuşaklı, Çadırhöyük, and Kalehöyük are presented. The archaeobotanical sources used for these sites were mentioned briefly in the previous chapters. In this section, the dominant plant remains will be noted according to their abundancy and then a short evaluation about the taxa will be provided. Besides, this chapter will also present the plant remains with a chronological order by indicating their contexts.

5.1.1. Archaeobotanical Data of Hattusha

In this thesis study, archaeobotanical data of Hattusha were obtained from three different data sources. These publications are the "*Plant Remains from Boğazköy*" by Maria Hopf in 1992, "*the supplementary report*" of the underground silo remains published by Charlotte Diffey, Reinder Neef, Jürgen Seeher and Amy Bogaard. The final publication is "*Die Ausgrabungen in Boğazköy-Hattusha 2011*" by Andreas Schachner.

The oldest period within the scope of the study in particular for Hattusha belong to the 17^{th} century BC Karum period. It is followed by the Old Hittite Period again dated to 17^{th} century BC both published by A. Schachner (2012). These two samples are thought to belong to domestic context. Another Hittite example from the Old Kingdom period examined within the scope of the study is dated to the 16^{th} century BC published by Charlotte Diffey et al., (2020). The context of this sample is state-level underground silo. The latest period within the scope of the study belongs to the 14th/ 13th BC (Imperial period) published by M. Hopf (1992).

The Pre-Hittite, Karum Age, sample contains few einkorn (*Triticum monococcum*) and bread wheat (*Triticum aestivum*) remains. More than half of the remains are unidentified cereals. Among the defined cereals; barley (*Hordeum sp.)* and emmer, (*Triticum dicoccum*) predominate. Sample is rich in terms of weed and legume content. *Lens culinaris* and *Vicia ervillia* are the most abundant legumes. *Lithospermum, Asteraceae* and *Carex* seeds were relatively more frequent among weeds.

The 17th century BC Hittite Age sample were quite similar to the preceding period. Emmer wheat (*Triticum dicoccum*) and barley (*Hordeum vulgare)* were still frequent. Bread wheat (*Triticum aestivum*) and einkorn wheat (*Triticum monococcum*) remains are scarce. It is notable that *Lens culinaris* is the prominent legume in the sample. Weed seed numbers are still abundant as previous period. *Galium, Chenopodium, Lithospermum* are abundant weed species.

The 16th century BC underground silo context includes more than four tones of charred archaeobotanical material from five separate chambers numbered 12, 28, 29, 30, 32, **Figure-9**. The published results obtained from the analysis of a 50 kg sample taken from these rooms are used in this study. The remains are thought to belong to the early 16th century BC Old Kingdom period (Diffey et al., 2020). This period likely corresponds to *I. Murşili* (1620-1590) or *I. Hantili* (1590-1560) reigns. According to the Telipinu edict, this period is the beginning of a period in which the Hittite state also began to decline and struggled with misfortune and disasters. The burning of this silo may also be one of the events that marked the period. The samples are listed in **Table-1** in detail.

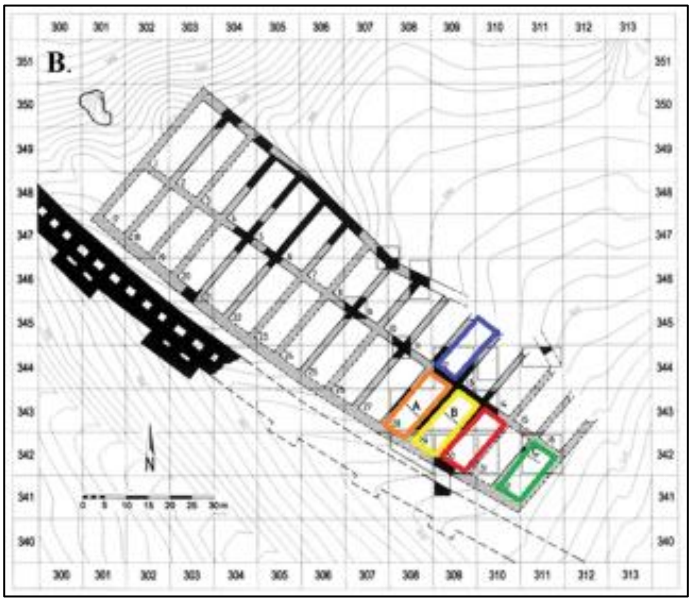

Figure 9 The underground silo complex and chambers from Hattusha (source: Diffrey, Neef, Seeher, & Bogaard, 2020)

The sample obtained from Chamber-12 contains 17.922 remains in total. It is rich in *Hordeum vulgare* and *Triticum dicoccum* grains. There are very few *Hordeum vulgare var. Nudum L.* and *Triticum monococcum* grains in the sample. Free-threshing wheats are almost absent. Remains of *Vicia faba L. var. minuta* is the most prominent legume. The sample is rich in terms of weed seeds. *Buglossoides arvensis L.*, *Boreava aptera*, *cf. Bunias/Boreava sp.*, *Cruciferae*, *Buglossoides tenuiflorum L. fil*, *Bunias orientalis L.*, *Buglossoides sp.*, *cf. Lamium sp.*, *cf. Ziziphora sp*. are prominent weeds in the sample.

The sample size of Chamber-28 is the smallest among all chambers with 1.366 total remains. The sample is dominated by *Hordeum vulgare* grains. *Triticum dicoccum* Schübl. follow the barley. *Triticum monococcum* is completely absent in the sample. There are very few free-threshing wheat grains. *Vicia faba L. var minuta* is the only legume while there are no fruit seeds. Weed concentration in the sample is quite low. The sample obtained from Chamber-29 contains 12.270 remains in total. The cereal composition of this chamber is quite alike with Chamber-12**.** *Hordeum vulgare L.* grains dominate the sample and *Triticum dicoccum* grains follows it. *Triticum monococcum* and *Triticum aestivum/durum* are almost absent in the sample. *Vicia faba L. var minuta* is again the leading legume as other samples. Prominent weed species are; *Bifora radians M. Bieb.*, *Avena cf. sterilis L*., *Polygonum aviculare L.*, *Ranunculus arvensis L.*, *Galium triconutum Dandy*, *Galium spurium L.*

The sample obtained from Chamber-30 is the largest among all chambers with 89.707 remains in total. It is dominated with *Hordeum vulgare* and *Triticum dicoccum* Schübl grains. *Triticum monococcum* presence in this sample is relatively more than the other chambers. *Triticum aestivum* grains are rather rare. *Galium triconutum Dandy*. dominates the weed taxa. *Bifora radians* M. Bieb., *Ranunculus arvensis L*. are other abundant weed species in the sample.

The sample taken from Chamber-32 contains 40.014 remains in total. *Hordeum vulgare* and *Triticum dicoccum* grains dominate the taxa. *Triticum monococcum* and *Triticum aestivum/durum* are almost absent. *Vicia faba L*. var *minuta* is again the most abundant legume by far. *Vaccaria pyramidata Medik*., *Polygonum aviculare L*., *Ranunculus arvensis L., Galium tricornutum Dandy* are the prominent weed species in terms of seed number.

Table 1 Plant remains from Hattusha samples

Table: Plant Remains from Hattusha									
Dates		*BC 17th*	*BC 17th*	*BC 16th*	*BC 16th*	*BC 16th*	*BC 16th*	*BC 16th*	*BC 14/13th*
Period		*Karum Age*	*Old Hittite*	*Old Hittite*	*Old Hittite*	*Old Hittite*	*Old Hittite*	*Old Hittite*	*Empire Hittite*
Location		*Lower City*	*Lower City*	*Büyükkale*	*Büyükkale*	*Büyükkale*	*Büyükkale*	*Büyükkale*	*Lower City*
Context		*Domestic*	*Domestic*	*Silo*	*Silo*	*Silo*	*Silo*	*Silo*	-
Sample		-	-	*12*	*28*	*29*	*30*	*32*	-
Published by		*J.Seeher*	*J.Seeher*	*J.Seeher*	*J.Seeher*	*J.Seeher*	*J.Seeher*	*J.Seeher*	*M.Hopf*
Publication Date		*2009-2011*	*2009-2011*	*1999*	*1999*	*1999*	*1999*	*1999*	*1992*
Cereals									
Triticum monococcum	einkorn wheat	7	6	14	0	164	4390	118	-
T. monococcum, Spelzbase	einkorn wheat	2	0	13	2	52	3553	6	-
Triticum dicoccum	emmer wheat	39	52	2507	196	2029	12685	10514	10
T. dicoccum, Spelzbase	emmer wheat	8	5	1061	128	452	9744	2521	-
Triticum aestivum	free-threshing wheat	14	12	-	-	-	-	-	-
Hordeum vulgare	barley	47	57	7498	941	7720	43801	14205	5
H. vulgare, Spindelglied	barley	1	3	109	5	5	409	14	-
Hordeum distichum/vulgare grain	barley	-	-	-	-	-	-	-	80
Triticum aestivum/durum	free-threshing wheat	-	-	22	16	21	13	5	40
Triticum aestivum/durum, rachis	free-threshing wheat	-	-	1	-	2	115	7	-
Hordeum vulgare var. Nudum L.	barley	-	-	2	-	2	21	1	-
Cerealia indet.	cereal indet.	141	136	2	3	1	10	-	-
Legumes									
Lathyrus sativus/cicera	Grass Pea	-	-	8	-	1	3	1	-
Lathyrus sativus	Grass Pea	4	6	-	-	-	-	-	-
Lens culinaris	Lentil	16	68	1	-	10	44	-	-
Vicia Ervilia	Bitter vetch	16	13	-	-	-	-	-	-
Vicia Ervilia wild	Bitter vetch	-	-	29	-	13	59	351	-
Pisum Sativum	Pea	1	5	-	-	-	-	-	-
Vicia faba L. var minuta	Broad beans	1	3	2699	6	187	851	5155	-
Weeds		120	111	3774	69	1596	14312	7113	2

14 /13th century BC Empire Period sample contains 135 remains in total. *Hordeum distichum/vulgare* grains dominate the assemblage. Free-threshing wheat grains are also abundant. There are a small number of *Triticum dicoccum* grains. The sample is

very poor in terms of weed and legume presence. cf. *Lathyrus cicero* L and *cf. Avena sativa ssp. sterilis* are represented with one seed each.

Table 2 Weed remains from Hattusha samples

Table-Some Weeds of Hattusha From Beginning to Empire Age				
Dates	*BC 17th*	*BC 17th*	*BC 16th*	*BC 14/13th*
Period	*Karum Age*	*Old Hittite*	*Old Hittite*	*Empire Hittite*
Location	*Lower City*	*Lower City*	*Büyükkale*	*Lower City*
Context	*Domestic*	*Domestic*	*Silo*	-
Published by	*J.Seeher*	*J.Seeher*	*J.Seeher*	*M.Hopf*
Publication Date	*2009-2011*	*2009-2011*	*1999*	*1992*
Ajuga	0	1	-	-
Alyssum sp.	-	-	50	-
Asteraceae	10	-	-	-
Avena cf. sterilis L.	-	-	397	1
Bifora radians M. Bieb.	-	-	2516	-
Boreava aptera Boiss. & Heldr.	-	-	165	-
Brassicaceae	-	2	-	-
Bromus	1	3	-	-
Buglossoides arvensis L.	-	-	294	-
Buglossoides tenuiflorum L. fil.	-	-	93	-
Bunias orientalis L.	-	-	60	-
Bupleurum sp.	-	-	303	-
Carex sp.	16	4	7	-
Caryophyllaceae	3	1	-	-
Caucalis platycarpos	-	-	341	-
Centaurea sp.	-	-	103	-
Cephalaria syriaca L. Schrad.	-	-	244	-
cf. Bunias/Boreava sp.	-	-	147	-
cf. Stachys sp.	-	-	91	-
cf. Vicia sp.	-	-	184	-
Chenopodium	5	11	-	-
Chenopodium album L.	-	-	27	-
Conringia orientalis L.	-	-	108	-
Cruciata laevipes Opiz.	-	-	253	-
Cuscuta	0	2	-	-
Galium parisiense L.	8	10	-	-
Galium spurium L.	-	-	698	-
Galium triconutum Dandy.	-	-	12001	-
Lithospermum	20	22	-	-
Lolium sp.	1	3	-	-
Lolium persicum Boiss. & Hohen.	-	-	565	-
Medicago sp.	3	1	35	-
Neslia paniculata L.	-	-	150	-
Papaver	3	1	-	-
Polygonaceae	8	15	10	-
Polygonum aviculare L.	-	-	2068	-
Plantago	3	1	-	-
Ranunculus arvensis L.	-	-	1900	-
Rumex sp.	4	2	-	-
Teucrium sp.	1	0	11	-
Thymelaea cf. passerina L.	3	0	11	-
Turgenia latifolia	-	-	634	-
Vaccaria pyramidata Medik.	-	-	1883	-
Veronica hederifolia L.	-	-	160	-

5.1.2. Archaeobotanical Data of Çadırhöyük

The only data source of Çadırhöyük is taken from the publication of "*Plant Use at Çadırhöyük in Central Anatolia*" by Alexia Smith that is published in the Journal *Anatolica* in 2007.

According to the source document, there are five layers that includes archaeobotanical remains belong to the Hittite Period. These layers are numbered as 11, 12, 13, 14, and 15. However, only one of these layers (layer 13) has been definitively dated to a certain period. Therefore, the available data do not allow us to follow-up changes in agricultural practices in a wide chronological sequence. In addition, archaeobotanical data were recorded according to the only absent/present methodology. Therefore, it is not possible to make any quantitative calculations even by assigning coefficient. All layers have various contexts such as floor, pit, pot, hearth, oven and burial (Smith, 2007).

The sample obtained from Layer-11 consist of pot contents. The species in this sample are indeterminate cereal, *Triticum sp.*, *Hordeum sp*., cereal culm nodes, rachis fragments, indeterminate small legumes, *Buglossoides* sp., and *Silene* type, indet., small grasses and *Galium* sp. The sample obtained from Layer-12 consist of pit content. The species in this sample are indeterminate cereal, *Triticum monococcum*, *Triticum dicoccum*, *Triticum aestivum*, *Hordeum sp.*, *Hordeum vulgare,* spikelet forks, rachis fragments, *Lens culinaris medic*, *Vicia ervillia* (L.) wild, *Buglossoides arvense johnston* and *Echium vulgare*, *Carex* sp., *Erodium* sp., *Stipa* sp., *Galium* sp.

Layer-13 is the only one that can be dated to a certain period. The sample taken from Layer-13 has the context of hearth and dated to Old Hittite Period. The species in this sample are indeterminate cereal, *Triticum monococcum*, *Triticum dicoccum*, *Triticum aestivum*, *Hordeum* sp., *Hordeum vulgare*, *Hordeum vulgare distichum* type, indeterminate *Leguminosae*, *Lens culinaris* medic, *Pisum* sp., and *Vicia ervillia* (L.) wild, *Buglossoides* sp. and *Echium vulgare* (L.), cf. *Scirpus* sp., *Erodium* sp., *Bromus* sp., *Phalaris* type, indet. small grasses, *Polygonum* sp. The sample includes large wood particles relatively to seeds.

The sample obtained from Layer-14 has domestic floor context. The species in this sample are *Triticum aestivum, Hordeum* sp., *Hordeum vulgare, Lens culinaris medic, Vicia ervillia* (L.) wild. No weed seeds are observed in the sample.

The last sample in the report belongs to Layer-15 consist oven content. The species in this sample are indeterminate cereal, *Triticum monococcum, Triticum dicoccum, Triticum aestivum, Hordeum sp., Hordeum vulgare distichum* type, cereal culm nodes, cereal culm bases, spikelet forks, rachis fragments, *Lens culinaris medic, Vicia ervillia* (L.) wild, *Buglossoides arvense johnston, Buglossoides* sp. and *Echium vulgare* (L.) cf. *Anchusa* sp. indet. composite, indet. small grasses, cf. *Hypericum* sp., *Ajuga* sp., cf. *Teucrium* sp., *Papaver* sp. and *Gallium* sp.

In general, seed numbers are not provided in the source document. In addition to this, there is only one exact period in the original study which makes impossible to conduct a diachronic analysis.

5.1.3. Archaeobotanical Data of Şapinuva (Ortaköy)

The only data source of Ortaköy is the article "*Hitit Kenti Şapinuva'da (Ortaköy-Çorum) Arkeobotanik Buluntular*" published by Emel Oybak Dönmez (2019).

The archaeobotanical remains were obtained from two underground pits in *Ağılönü mevkii*. The finds were recovered from the storage pits next to two imperial buildings. It is thought that one of these pits was used for storage where stored plants were used for food and/or ritual purposes. The context of the second pit is also thought to be ritual purposes (Oybak Dönmez, 2019). The samples are dated to around 1400 BC. In the first pit, free-threshing wheats *Triticum aestivum/durum* grains dominate most of the assemblage. Due to the reason no rachis and spikelet are present in the sample, it could not be determined whether the remains belonged to bread wheat or durum wheat. There are also little *Hordeum vulgare* grains and *Galium aparine* seeds in the sample. Second pit includes some charred olive (*Olea europaea L.*) seeds and Oak tree (*Quercus L.*) remains.

In General, the first pit in Şapinuva is overwhelmingly dominated by *Triticum aestivum/durum* grains. The number of other taxa is very low so they might be considered as contaminant. There is no chaff or spikelet in the samples which may indicate that the crops were fine processed to a clean state and sufficient labor for this work was available (Oybak Dönmez, 2019). There are very few remains found in the second sample. The samples are dated to 1400 BC. It almost coincides with the transition between the kingdom and imperial periods of Hittites.

5.1.4. Archaeobotanical Data of Sarissa (Kuşaklı)

In this thesis study, archaeobotanical data of Sarissa was obtained from three different data sources. These are; Pasternak, R. (1998). "*Übersicht über die Ergebnisse der archäobotanischen Arbeiten in Kuşaklı 1994 - 1997 und ein Interpretationsansatz zu den Befunden*" Mitteilungen der Deutschen Orient-Gesellschaft zu Berlin 130: 160 - 170; 171–174. Pasternak, R. (2000). "*Archäobotanische Arbeiten 1999: Die Bearbeitung eines Massenfundes von Gersten im Nordflügel des Gebäudes C.*" Mitteilungen der Deutschen Orient-Gesellschaft zu Berlin 132: 348 – 351, and Segschneider, M. (1995) „*Pflanzliche Großreste. Untersuchungen in Kuşaklı 1992 – 94*". A. Müller-Karpe. 127: *27 - 30.* The organized data was obtained from the online database called *ADEMNES* which is developed by Tubingen University and DFG (*Deutsche Forschungsgemeinschaft*).

The oldest period within the scope of this study in particular for Sarissa belong to the Old Hittite Period. It is followed by Middle Hittite Period. In this thesis study, three different empire period samples will be analyzed which are 14/13th BC with no definite area, 14/13th BC from a gate area and 14/13th BC from a temple area.

The sample belong to Old Hittite period are dominated by *Hordeum vulgare* grains. Free-threshing wheat grains are abundant in the sample. On the other hand, very little *Triticum dicoccum* and *Triticum monococcum* grains are present. High amount of unidentified cereal, *Poaceae* and *Fabaceae* remains are present. The sample is rich in terms of weed seeds, but pulses and fruits are almost absent.

Middle Hittite sample is dominated by *Hordeum distichum* grains by far. *Triticum* species are almost absent. No remains of *Hordeum vulgare* and *Triticum monococcum* are present in this sample. Legume and fruit seeds were almost absent. *Convolvulus arvensis* (L.) and *Polygonum sp*. are prominent weeds in the sample.

Empire Period is represented by three different samples. First group has no specified context. The dominant species in this layer was *Triticum dicoccum* grains by far. *Triticum monococcum* was relatively more frequent than in previous layers. *Hordeum distichum* remains were almost absent in contrast to the Middle Hittite period samples. Pulses are relatively high in number. Although the number of weeds is higher than previous periods, it is still low in rate. *Chenopodium sp*. is the prominent weed. *Lolium sp.* seeds are also abundant in the sample. *Cyperaceae indet., Polygonaceae and Rumex crispus* are other weeds found high presence in the sample.

Second sample of Empire Period belong to a gatehouse area. The sample is dominated by free-threshing wheat grains by far. Hulled wheat grains are relatively scarce and no remains of legumes is present. It is notable that *Triticum spelta* grains, albeit low in number, are only present in this sample. Weed concentration is high. *Lolium* sp., *Lolium temulentum* and *Rumex sp*. seeds are abundant. *Onopordum acanthium L., Polygonum aviculare L., Bromus sp.* are other prominent weed taxa.

Third sample group that belong to the Empire Period is coming from a temple area. Free-threshing wheat grains dominate the sample. There are few *Hordeum vulgare* grains. Hulled wheat is almost entirely absent. There is very little *Lens culinaris medic.* unlike other periods but its ratio is negligible. Even though the number of weeds is higher than in previous periods, it is low in rate. *Chenopodium sp., Trifolium sp.,* and *Silene type* are prominent weeds.

Table 3 Plant remains from Kuşaklı (Sarissa) samples

Table: Plant Remains from Kuşaklı (Sarissa)					
Sample No	*1*	*2*	*3*	*4*	*5*
Context	-	-	-	*Gate*	*Temple*
Date	-	-	*BC 14/13th cen.*	*BC 14/13th cen.*	*BC 14/13th cen.*
Period	*Old Hittite*	*Middle Hittite*	*Empire Hittite*	*Empire Hittite*	*Empire Hittite*
CEREALS					
Cereal indeterminate (grains)	52	-	380	26	67
Poaceae indet.	12	4	38	18	134
Hordeum distichum/vulgare (rachis)	-	-	-	3	2
Hordeum vulgare vulgare grain (hulled)	34	-	101	18	687
Hordeum distichum grain (hulled)	-	5120	1	-	97
Free threshing wheat hexaploid (rachis)	-	-	21	98	20
Triticum dicoccum (grains)	8	1	11244	11	14
Triticum dicoccum (glume bases)	2	-	30	7	2
Free threshing wheat hexaploid (grains)	18	4	134	43	20046
Triticum monococcum (glume bases)	6	-	723	4	10
Triticum monococcum (grains) (1/2g)	6	-	127	5	19
Triticum spelta grains (glume basis)	-	-	-	4	-
Triticum spelta grains	-	-	-	4	-
Indeterminata	2	-	2	6	-
PULSES	-	-	-	-	-
Fabaceae sat. indet.	8	-	16	-	6
Fabaceae indet.			1		
Lens culinaris Medik.	1	-	12	-	19
Pisum sativum	-	-	-	-	
Vicia type	1	-	4	-	1
Vicia ervilia	5	5	2	-	2
Pulses indet.	-	-	-	-	-
FRUIT					
Vitis vinifera L. (pips)	-	1	2	-	5
WEEDS	59	82	304	68	404

In general, in Sarissa samples; the Old Hittite period context includes a large number of weeds taxa which is nearly as high as cereal grains in number. The context may be dung or trash deposits. Middle Hittite sample is dominated by *Hordeum distichum* by far while very few weed and chaff remains. It might be fine processed storage sample. The Empire Period sample from unknown context includes a very high quantity of emmer wheat grains. In the Gate context, cereal and weed seed numbers are quite close to each other which may be evaluated again as dung deposit. In the Empire Period sample obtained from temple area, free-threshing wheat grains dominate the assemblage where the ratio of weed and other taxa are low so it can be evaluated as a well cleaned food store.

Table 4 Weed remains from Kuşaklı (Sarissa) samples

	Periods				
	Old	*Middle*	*Emp (NC)*	*Emp (GC)*	*Emp(TC)*
Adonis sp.	-	-	-	-	2
Aegilops sp. glume bases (spikelet bases)	-	-	5	1	-
Agrostemma sp.	-	-	6	-	-
Ajuga chamaepitys (L.) Schreber	-	-	-	-	1
Allium sp.	1	-	-	-	-
Apiaceae indeterminate	-	-	10	-	-
Artemisia sp. L.	5	-	-	-	1
Asteraceae indet.	4	-	8	2	2
Brassicaceae indet.	-	-	2	-	46
Bromus arvensis type	2	-	10	1	5
Bromus sp.	1	-	6	4	2
Bupleurum sp. L.	-	-	1	-	1
Caryophyllaceae indet.	5	1	4	1	12
Centaurea type	-	1	5	-	-
Chenopodium ficifolium Sm.	-	-	1	-	-
Chenopodium sp.	6	-	59	-	74
Chenopodium album L.	-	-	-	1	-
Convolvulus arvensis L.	-	10	1	-	1
Crataegus sp. L.	-	-	-	-	1
Cuscuta sp. L.	1	-	-	-	1
Cyperaceae indet.	2	-	28	-	13
Daucus type	-	-	-	-	8
Galium sp.	-	5	-	-	-
Glaucium corniculatum (L.) Rud.	-	-	-	-	2
Juncus sp.	-	-	1	-	-
Lamiaceae indet.	-	-	2	2	2
Lathyrus sativus L.	-	-	5	-	-
Liliaceae indeterminate	-	-	1	-	1
Linum usitatissimum L.	-	-	1	-	-
Lithospermum L. sp.	-	-	1	-	3
Lolium sp.	3	-	33	16	6
Lolium temulentum L.	-	-	4	12	1
Neslia sp.	-	-	-	-	1
Onopordum acanthium L.	-	-	-	1	-
Papaveraceae indeterminate	-	-	2	-	1
Pistacia atlantica Desf.	-	-	-	-	1
Polygonum sp.	-	65	-	-	-
Polygonum aviculare L.	2	-	1	4	8
Polygonum convolvulus L.	-	-	5	-	20
Polygonaceae indet.	4	-	25	6	31
Rosa sp. L.	-	-	1	-	-
Rosaceae indeterminate	1	-		1	2
Rubiaceae indeterminate	7	-	12	2	48
Rumex acetosella L.	-	-	4	-	-
Rumex acetosa	-	-	1	-	-
Rumex crispus L.	6	-	20	12	-
Rumex sp.	-	-	5	2	28
Scilla sp.	-	-	14	-	-
Setaria italica (L.) P. Beauv.	-	-	-	-	3
Sherardia sp.	1	-	-	-	-
Silene type	2	-	6	-	43
Stipa sp. awn	-	-	-	-	1
Solanaceae indeterminate	-	-	1	-	-
Teucrium sp.	1	-	1	-	-
Trifolium type	5	-	11	-	28
Vaccaria sp.	-	-	1	-	4

5.1.5. Archaeobotanical Data of Kaman-Kalehöyük

In this thesis study, archaeobotanical data of Kaman-Kalehöyük was obtained from four different data sources. Initial source is published by Nesbitt, M. (1993), "*Ancient crop husbandry at Kaman-Kalehöyük: 1991 archaeobotanical report"* The archaeobotanical data in this study are belong to MBA/Assyrian period (1930-1730 BC), and Assyrian/Old Hittite (1700 BC) transitional periods.

Second data source used in the study is the article "*Archaeological Identification and Significance of ESAG (Agricultural Storage Pits) at Kaman-Kalehöyük Central Anatolia*" published by A. Fairbairn and S. Omura in 2005. This article concentrated on the storage pits in the mound. In this article, it was pinpointed that there are generally two types of storage pits in the mound. The first group are small-scale in size which are thought to be more suitable for domestic use dated to Pre-Hittite Period. The second group pits, on the other hand, are far bigger in terms of size comparing with the first group, thus it is thought that those bigger pits were built by the Hittite State possibly to control the production in the region (Fairbairn & Omura, 2005). It can be said for the samples in that publication that *Triticum aestivum, Hordeum vulgare* are most dominant crops. *Triticum monococcum* grains are also abundant.

Third and fourth data sources are based on the publications of preliminary reports of archaeobotanical studies carried out at excavation seasons at Kalehöyük and published at yearly basis. Preliminary reports of the years 2003 and 2005 are used in this thesis work. In 2003 report, there are three different contexts, two of them belong to Assyrian Colonial Period and one to Old Hittite Period. The sample numbers are 58 R150, 14 R151, 21 R 345 respectively. The 58 R150 sample has two different flotation specimens, named as S044 and S045, both are recovered from Room-150. **Table-5** shows the plant remains of Kaman-Kalehöyük. S044 was recovered from burnt comb as domestic context where *Triticum monococcum/dicoccum* grains are the far most dominant species with high abundance. There are little *Triticum aestivum or durum* grains. *Galium tricornutum type* is the only recognized weed seed. Cereal parts other than grain dominates the sample with very high abundance. S045 was recovered as room fill with domestic context. There, *Triticum aestivum or durum* grains are more abundant than *Triticum monococcum* grains. Cereal parts other than grain dominate the sample with very high abundance. *Galium tricornutum type* and *Umbelliferae* are two recognized weed species in this sample. It is also notable that sample S045 includes cloth/threads remains. All of these remains are thought to be used either as food or fodder purposes due their high chaff content (Fairbairn, 2004). The sample S046 is recovered from another room, Room-151 whose concentration is completely different from Room-150. The 14 R151 layer is room fill with domestic context. There are almost no non-grain cereal parts. *Triticum monococcum* is the most dominant species in the taxa with very high abundance. *Triticum aestivum* or *durum* and *Hordeum vulgare* grains are not common comparing with einkorn wheat. *Cephalaria sp.* is the only recognized weed in the taxa and has very low abundance. 21 R345 layer in a burnt house have been dated to Old Hittite period. There are low quantities of *Hordeum vulgare, Triticum aestivum* or *durum* grains and *Vicia ervillia* seeds. Vesicular materials are predominantly abundant. *Linum usitatissimum, Galium type, Gramineae* (small types) (occasional), *Salsola* type, *Thymelea sp.* are present.

In the Archaeobotany at Kaman-Kalehöyük 2005 report published by Andrew S. Fairbairn, 13 different samples were reported from hearth areas. The data presented in the report shows the relative abundance of the found remains. 4 of 13 samples belong to Old Hittite period.

Sample-1, Context P2886: The sample size is 36 liters. *Triticum aestivum / Triticum durum grains and Arnebia/Lithospermum* seeds are noted as frequent. *Hordeum vulgare* grains, *Triticum monococcum* grains, *Triticum monococcum* spikelet forks, *Vicia ervillia* seeds and *Gramineae* (small types) seeds are noted as occasional. *Ziziphora, Lolium, Gramineae* (large types), *Galium tricornutum type* are other plants found but they are rare. Sample-2, Context H260: Sample size is 2 liters. *Chenopodium/Atriplex sp*. seeds and *Vitis* sp. seeds are noted as occasional. *Triticum aestivum / Triticum durum* grains, *Potentilla* seeds, *Vicia ervillia* seeds, *Gramineae* (small types) seeds are noted as rare. Sample-3, Context H269: Sample size is 0,5 liters. There are rare indeterminate cereals and indeterminate wild taxa in this context. Only recognizable species is *Gramineae* (small types) seeds with rare abundance. The presence of only free-threshing wheat and *Chenopodium* seeds suggest that the fields were well-irrigated. Sample-4, Context H274: Sample size is 6 liters. *Cruciferae* and *Gramineae* (small types) seeds are frequent in the sample. *Triticum aestivum / Triticum durum* grains, *Triticum monococcum/dicoccum* spikelet forks are found as occasional and *Hordeum vulgare* grains, *Gramineae* (large types), *Chenopodium/Atriplex sp*, *Arnebia/Lithuspermum* seeds, *Thymelea sp.* are other species found as rare.

Table 5 Plant remains from Kaman-Kalehöyük samples

Table - Plant Remains in Kaman-Kalehöyük						
	Sample	*7*	*11*	*5*	*22*	*28*
	Period	*Asyr./Hittite*	*Asyr./Hittite*	*Assyrian C.*	*Assyrian C.*	*Assyrian C.*
	Date	*BC 1700*	*BC 1700*	*BC1930-1730*	*BC1930-1730*	*BC1930-1730*
	Context	*Section*	*Pit*	*-*	*Pit*	*Ashes*
CEREALS						
Cereal (culm nodes)		20	44	-	46	11
Barley (grain)		44	-	34	74	17
Barley (internodes)		6	1	-	10	-
Triticum aestivum (grains)		106	349	78	336	461
Triticum aestivum (internodes)		32	1796	9	147	80
Triticum dicoccum/monococcum (grains)		7	-	11	11	24
Triticum dicoccum (spikelet forks)		9	1	3	21	5
Triticum monococcum (spikelet forks)		14	2	3	31	169
PULSES (seeds)		11	-	2	6	3
FRUITS (seeds)		-	1	1	1	1
WEEDS (seeds)		171	11	132	103	97

In General, Kaman samples mainly cover the transition period between Karum and Hittite periods. Therefore, the dataset is very valuable as it covers a period when another socio-political change occurred. However, due to the abundance taxonomy, it is not possible to exert a comprehensive quantitative analysis on the data. The quantitative analysis was applied only a limited number of data which some of them were converted to numeric values with assigned coefficients.

Regarding the contexts; in MBA samples, in Room-150, weed seeds are quite low in number. However, the cereal fragments are quite frequent. In Room-151 on the other hand, cereal fragments are absent. Similarly, there is almost no weed seeds. It might be inferred that the crops were fine processed probably making them ready for food consumption. *Triticum monococcum* grains are very abundant. It is notable that this sample is one of the rare examples where einkorn is more common than other wheat species. In the *58 R150*, *14 R151*, *21 R345* contexts, *Galium tricornutum type* and *Umbelliferae* and *Cephalaria sp.* were the only recognized weed species.

CHAPTER 6

RESULTS

6.1. Introduction

This section is aiming to see the variations in agricultural practices (crop diversification, tillage density, crop preferences, seasonality) by applying relative abundance, divergence, absence/presence and correspondence analysis to cereals, legumes and weed ecology. The analysis results will be presented in this section both at settlement as well as regional level which will provide the means to see the variations in the same location over time with a diachronic order as well as to follow the similar patterns in the Land of Hatti.

6.2. Site Based Analysis

6.2.1. Çadırhöyük Sample Results

Çadırhöyük samples include only one certainly dated period which is Old Hittite. Thus, it is not possible to follow how agricultural practices changed over time in Çadırhöyük. In addition, numerical analysis could not be applied to the Çadırhöyük samples, since no numerical value or abundance information was provided in the original source documents.

In general, it is understood from the sample distribution that hulled and free-threshing wheats are both found together with barley. *Vicia ervillia* (L.) wild, *Buglossoides* sp. and *Echium vulgare* L., cf. *Scirpus* sp., *Erodium* sp., *Bromus* sp., *Phalaris* type, indet small grasses, *Polygonum* sp. are the prominent legume and weeds in the sample. It is known that this plant is used as animal fodder today as it was in the Roman period

(Zohary & Hopf, 1973). Possibly, Bitter Vetch might be used for fodder purposes in Hittite Çadırhöyük. *Echium vulgare L.*, is a toxic plant but the presence of *Phalaris sp.* is attributed to animal grazing (Riehl, 2010: Stirn, 2013). Considering that the weed ecology and the sample context is hearth, it can be inferred that animal dung was used as fuel.

6.2.2. Hattusha Sample Results

Hattusha and Sarissa are the only places in the scope of this thesis work where we can follow the transformation from Assyrian Age to Empire period diachronically. However, the contextual differences prevent us to make holistic interpretations. RA values of the cereal, legume and weed ecology of the Hattusha samples are shown in **Table-6**. Total seed numbers in Hattusha samples are 144.195. This number includes; 107.547 cereal grains (including 293 indeterminate), 9.551 legumes seeds and 27.097 weed seeds. In the **Table-6**, the RA of the species is calculated considering their sub-groups as cereals, legumes and weeds. Indeterminate cereal grains in the samples were not included in the RA calculations.

6.2.2.1. Cereals

Figure-10 shows the cereal composition of samples according to the periods. Represented by a relative abundance of over 40 percent in all periods, barley was definitely the dominant crop among all grains. Particularly, the Old Hittite samples dated to 16th BC, the RA of barley grains reached to 70 percent (except Chamber-32) in cereal group. Hulled wheats stand out the second dominant cereal group while there are almost no free-threshing wheats in the 16th BC chambers. The dominance of barley and hulled wheats in these samples can be linked with the advantageous morphologic features of these cereals in terms of long-term storage. Considering that the context of the 16th century BC samples was obtained from an underground silo, it is highly possible choosing of more durable cereals by the Hittites for long-term storage purposes and hulled wheats are much more durable to decay and infestation than the free-threshing wheats thanks to their glumes (Nesbitt, 1995).

Table 6 Plant remains and RA values from Hattusha samples

	Dates	BC 17th	BC 17th	BC 16th	BC 16th	BC 16th	BC 16th	BC 16th	BC 14/13th
	Period	Karum Age	Old Hittite	Old Hittite	Old Hittite	Old Hittite	Old Hittite	Old Hittite	Empire Hittite
	Context	Domestic	Domestic	Silo	Silo	Silo	Silo	Silo	-
	ChamberNo	-	-	12	28	29	30	32	-
Hulled	NISP	46	58	2521	196	2193	17075	10632	10
Wheat	RA	43%	46%	25%	17%	22%	28%	43%	7%
Free-Thresing	NISP	14	12	22	16	21	13	5	40
Wheat	RA	13%	9%	0,22%	1,39%	0,21%	0,02%	0,02%	30%
Hulled	NISP	47	57	7498	941	7720	43801	14205	85
Barley	RA	44%	45%	75%	82%	78%	72%	57%	63%
Naked	NISP	0	0	2	0	2	21	1	0
Barley	RA	0,00%	0,00%	0,02%	0,00%	0,02%	0,03%	0,00%	0,00%
Total Cereal	NISP	248	263	10045	1156	9937	60920	24843	135
inc. İndet	RA	61,08%	56,08%	60,67%	93,91%	84,61%	79,96%	66,31%	98,54%
Lathyrus	NISP	0	0	8	0	1	3	1	0
sativus/cicera	RA	0%	0%	0%	0%	0%	0%	0%	0%
Lathyrus	NISP	4	6	0	0	0	0	0	0
sativus	RA	11%	6%	0%	0%	0%	0%	0%	0%
Lens culinaris	NISP	16	68	1	0	10	44	0	0
	RA	42%	72%	0%	0%	5%	5%	0%	0%
Vicia Ervilia	NISP	16	13	0	0	0	0	0	0
	RA	42%	14%	0%	0%	0%	0%	0%	0%
Vicia Ervilia	NISP	0	0	29	0	13	59	351	0
wild	RA	0%	0%	1%	0%	6%	6%	6%	0%
Pisum Sativum	NISP	1	5	0	0	0	0	0	0
	RA	3%	5%	0%	0%	0%	0%	0%	0%
Vicia faba L.	NISP	1	3	2699	6	187	851	5155	0
var minuta	RA	3%	3%	99%	100%	89%	89%	94%	0%
Total Legumes	NISP	38	95	2737	6	211	957	5507	0
Total Taxa	RA	9%	20%	17%	0%	2%	1%	15%	0%
Weeds	NISP	120	111	3774	69	1596	14312	7113	2
Total Taxa	RA	30%	24%	23%	6%	14%	19%	19%	1%
Total	NISP	**406**	**469**	**16556**	**1231**	**11744**	**76189**	**37463**	**137**
	RA	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Despite this, it is clearly seen in the **Figure-10** that the hulled-wheat presence has decreased over time. Moreover, according to **Figure-10** it can be concluded that *Triticum monococcum* amounts were decreased continuously in time and disappeared in the Empire Period. This may be linked with the growing conditions of the einkorn wheat. Riehl (2012) underlined that one of the most plausible reason of disappearing of einkorn wheat in the ancient world as its lower productivity and relatively high-water requirements (Riehl, 2012).

Although the amount of hulled wheat species shows steadily decrease in time, it can be said that the *Triticum dicoccum* maintained its importance still in the Empire period with 7% RA while *Triticum monococcum* totally disappeared. The presence of the emmer wheat is attributed with small-scaled and intensive cultivation (van der Veen, 1992). Thus, a shift from small scale to large scale agriculture can be proposed for Hattusha over time. It is noteworthy that free-threshing wheats are the most abundant cereal among all wheat types in the imperial era. In general, the decline of hulled wheat can be reasoned with economic conditions, cultural changes (Stirn, 2013) and/or population increase and/or central efforts who aimed to focus on more-productive crops. Accordingly, the increase in free-threshing wheats can also be attributed to contextual differences or favorable environmental conditions. Furthermore, it can be linked with increased irrigation and manuring endeavors of Hittites since the free-threshing wheats are considered as more "source demanding" crops and they need more water or high-quality soils than hulled-wheats (Behre & Jacomet, 1991).

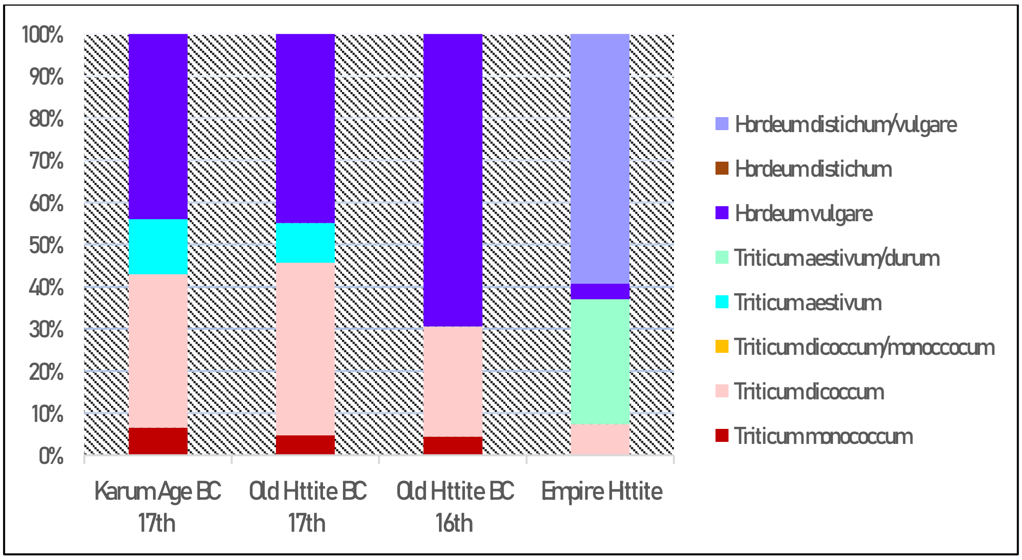

Figure 10 Bar chart of the proportional representation of cereals from Hattusha samples

The fact that the samples taken from Karum and 17th century BC Hittite layers are dated relatively close to each other may be the reason that the taxa did not show an apparent difference despite the change of the political structure. However, it is seen in the long run that hulled wheat was almost replaced by the free-threshing wheat. High hulled wheat concentration of the underground silo samples found in the 16th BC samples is considered as long-term storage requirement and thought that it does not disrupt the general trend.

6.2.2.2. Legumes

In Hattusha, legumes are represented nearly in all periods except imperial one. However, in the 16th century BC samples, legume content in Chamber 28, 29 and 30 can be evaluated as contaminant since the RA of the legumes ranges between 0-2% (**see Table-6**). Though, the overwhelming presence of *Vicia faba* in all 16th century BC samples, including those with very low RA, is immediately apparent. Thus, according to data presented in the **Table-6**, it can be concluded that this crop was cultivated intensively in the 16th century BC Hattusha comparing with the previous periods. Moreover, it can also be evaluated as that this legume was used as rotational and secondary product by the Hittite farmers. The dominance of the *Vicia Faba* can also be explained as the small-scale arable farming in salt-marsh fields which could be mainly exercised near the creeks (Behre & Jacomet, 1991). The presence of emmer wheat supports the small-scale farming (van der Veen M. , 1992). Broad bean (*Vicia faba* L.) is known as a moderately salt tolerant species (Tunçtürk, Tunçtürk, Oral, & Baran, 2020). Thus, it can be thought that the samples might came from the Kızılırmak shores or its branches or irrigated fields. Philologically it is known that the ancient name of the river, *Halys*, means salt water. Furthermore, the modern analysis show that Kızılırmak is a river having very serious salinity content. Similarly, the branches of Kızılırmak in the vicinity of Hattusha; *Delice* and *Acıçay* rivers have very high salinity content (Alagöz, 1966). However, it should be note that apart from the landscape, climate, irrigation and soil properties can also cause salination in the soil (Atasoy & Geçen, 2014).

As another important legume species, *Vicia ervillia* wild seeds are also found in low abundancy especially in 16th century BC samples in which they can be evaluated as contaminant. On the other hand, it is quite abundant in Karum Age sample but there is a sharp decrease in the 17th century BC Hittite layers in a relatively short period of time. *Vicia ervillia* is considered as a famine food and consumed today mainly as animal fodder but the exact function of this plant in the Bronze Age is not well known (Zohary & Hopf, 1973). However, Petkova et al. (2020) suggest that bitter vetch seeds have nutritional content and thus can be considered a good food source (Petkova et al., 2020). *Lathyrus Sativus* is only found in Hattusha samples in the whole study. *L. Sativus* is generally used for fodder purposes presently and is thought to be preferred for human consumption only again in poverty or famine conditions (Zohary & Hopf, 1973). The relative abundances of *L. Sativus* are 11 % and 6 % in Karum and 17th century BC Hittite periods respectively. Then, it almost disappeared in later periods. The high RA in Karum period may be assessed as drought or political instabilities which affected the agricultural practices as well as cultural choices. However, it is clear that the legumes which is seen as famine foods became almost obsolete in the region under Hittite reign.

Lens Culinaris is the most important legume in Central Anatolia today. However, it was almost absent in the 16th BC and imperial period samples while it was recorded as abundant in 17th BC Old Hittite samples. Lentils have high nutritional value and ability to enrich the soil in terms of nitrogen. Although it is a very productive product for the Central Anatolia region in economic terms, the fact that no lentil remains were found can be explained as that the underground state silo was meant for the storage of only cereals or the lentils might have not been preferred as rotational crop. Instead, *Vicia faba* presence is observed heavily in all chambers of underground silo, although the remains from different chambers are thought to be collected different regions of Hattusha hinterland according to the isotope and weed ecology results (Diffrey, Neef, Seeher, & Bogaard, 2020). **Figure-11** shows the *Vicia faba* against all other legumes recorded in all five chambers belong to 16th BC.

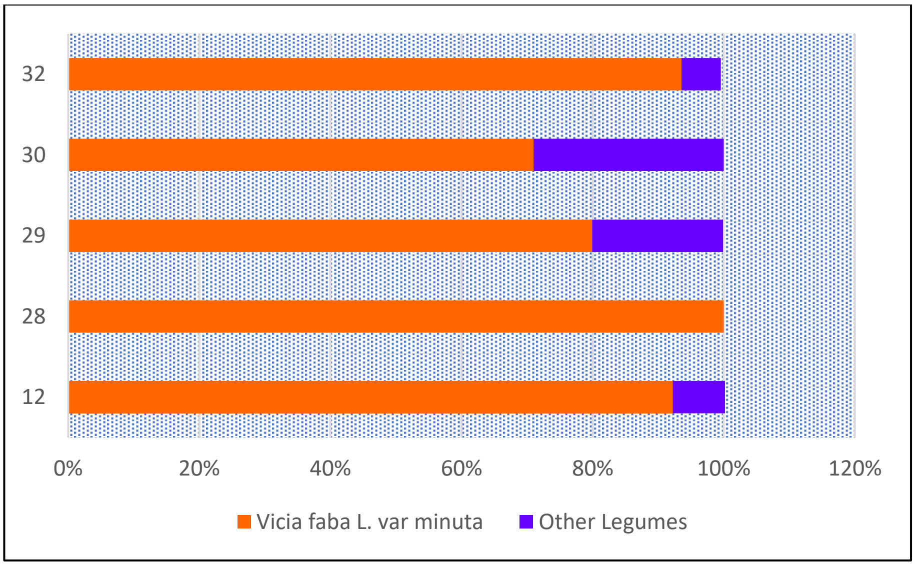

Figure 11 RA of *Vicia faba* against other legumes from 16th BC Hattusha samples

This plant may have been especially preferred by the Hittites due to its nitrogen-fixing capacity. The ability to bind the free nitrogen in the air to the soil is 19 kg/da in bean and 12 kg/da in lentils (Ankara Üniversitesi, 2022). Therefore, broad beans can enrich the soil by more than 50% compared to lentils. Furthermore, *Vicia faba* is also considered as moderate salt tolerant plant. These results show that the Hittites may have used legumes to enrich the soil and tried to select the highest performing legumes for their soil. However, these results cannot be supported by data from other sites and more data is needed for more reliable interpretations.

6.2.2.3. Weeds

In Hattusha, weed seeds are represented in relatively significant quantities nearly in all samples except the imperial one. In the Karum Age samples, the most ubiquitous wild plants are *Lithuspermum*, *Carex* sp., *Asteraceae*, *Galium parisiense* L. and *Chenopodium*. In the 17th century BC Hittite phase, the most ubiquitous wild plants are *Lithospermum*, *Polygonaceae*, *Chenopodium*, *Galium parisiense* L. and *Carex* sp. In the 16th century BC Hittite samples, *Galium triconutum Dandy* dominates the weed taxa with 45% RA. *Bifora radians M. Bieb*., *Polygonum aviculare* L., *Ranunculus arvensis* L. and *Vaccaria pyramidata Medik*. are other prominent weeds. There are very few data for the Empire period in terms of the wild taxa. *Avena cf. sterilis L*. is the only weed species recorded in the source document.

Table-7 shows the RA of all weed taxa recorded of Hattusha samples. According to the **Table-7**, the underground silo samples contain weed seeds at an average of 20 percent RA nearly in all chambers. Considering that these chambers were used for long term-storage, it is suggested that farming areas were not weeded or crops were not processed in detail before storage (Diffey, Bogaard, & Neef, 2017). Specifically, as one of the most common weeds in Hattusha samples*;* *Chenopodium* and *Galium* are suggested to have higher chances to appear in the archaeobotanical record than other weeds due to their small size and protective coated seed surviving from digestion (Matuzeviciute, Mir-Makhamad, & Tabaldiev, 2021). Besides, *Chenopodium* is also considered as an indicator of nitrogen-rich, moist and well-manured soils and garden-type agriculture (Çizer, 2006). *Carex* taxa also is suggested to grow in open and wet environments (Hiebert et al., 2003: Matuzeviciute et al., 2021) and it is an off-site weed, meaning that it grows out or in the margins of the crop fields (Van Zeist, 2003). Thus, well-irrigated, garden-type and manured agriculture practices can be suggested in the vicinity of Hattusha for Karum and 17^{th} BC periods. Accordingly, the decrease in *Carex* and *Chenopodium* seeds in later periods can be attributed to the shift from small to large scale cultivation.

Table 7 RA of the prominent weed taxa from Hattusha samples

Time Period	BC 17th Karum	BC 17th Old Hittite	BC 16th Old Hittite	BC 14/13th Empire
Ajuga	0%	1%	0%	0%
Asteraceae	11%	0%	0%	0%
Avena cf. sterilis L.	0%	0%	2%	100%
Bifora radians M. Bieb.	0%	0%	10%	0%
Boreava aptera Boiss. & Heldr.	0%	0%	1%	0%
Brassicaceae	0%	3%	0%	0%
Bromus	1%	4%	0%	0%
Buglossoides arvensis L.	0%	0%	1%	0%
Bupleurum sp.	0%	0%	1%	0%
Carex sp.	18%	5%	0%	0%
Caryophyllaceae	3%	1%	0%	0%
Caucalis platycarpos	0%	0%	1%	0%
Cephalaria syriaca L. Schrad.	0%	0%	1%	0%
Chenopodium	6%	14%	0%	0%
Cuscuta	0%	3%	0%	0%
Galium parisiense L.	9%	13%	0%	0%
Galium spurium L.	0%	0%	3%	0%
Galium triconutum Dandy.	0%	0%	46%	0%
Lithospermum	22%	28%	0%	0%
Lolium sp.	1%	4%	0%	0%
Lolium persicum Boiss.&Hohen.	0%	0%	2%	0%
Papaver	3%	1%	0%	0%
Polygonaceae	9%	19%	0%	0%
Polygonum aviculare L.	0%	0%	8%	0%
Plantago	3%	1%	0%	0%
Ranunculus arvensis L.	0%	0%	7%	0%
Rumex sp.	4%	3%	0%	0%
Teucrium sp.	1%	0%	0%	0%
Thymelaea cf. passerina L.	3%	0%	0%	0%
Turgenia latifolia	0%	0%	2%	0%
Vaccaria pyramidata Medik.	0%	0%	7%	0%
Veronica hederifolia L.	0%	0%	1%	0%

Convolvulus arvensis L., Plantago major L, Plantago spp., Rumex spp. and Carex sp., are perennial weeds. *Polygonaceae* (Brandbyge, 1993), *Lithospermum* (United States Department of Agriculture, 2022), which is represented RA over 20 percent in both Karum and 17th BC Hittite samples, and *Bromus* family has both annual and perennial species.

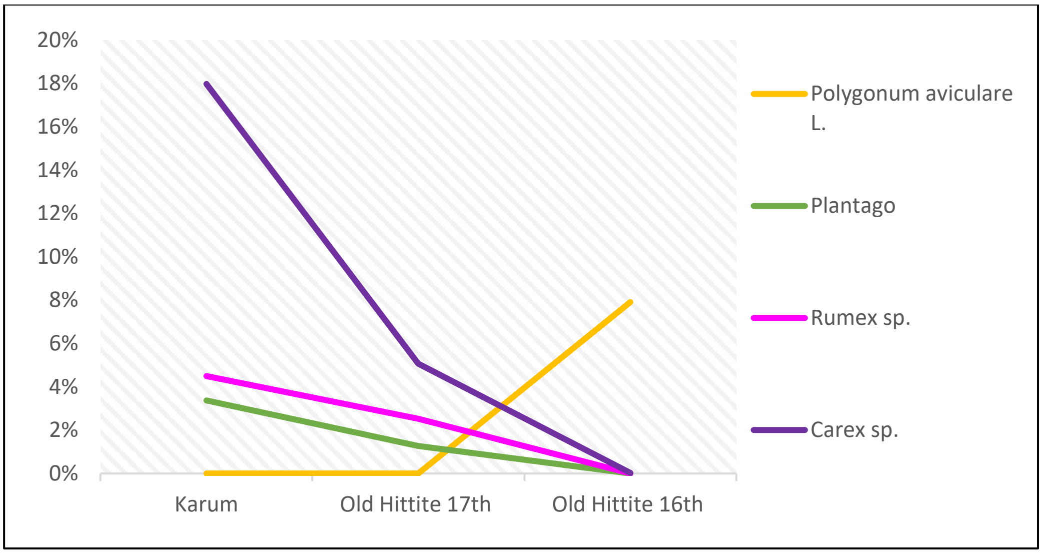

Figure 12 Line chart of the changes in perennial weed ecology from Hattusha samples

Table-7 indicates the RA of prominent perennial and annual weed species in the Hattusha samples. As it is seen in **Figure-12**, the perennial weeds were consideribly reduced under the reign of Hittites and almost vanished in the 16th century BC samples. **Figure-13** also shows the perennial and annual weed compositions of the Hattusha samples. In **Figure-13**, it can be clearly seen that the perennial weed concentration is above 50 percent in Karum age and in 17th BC Hittite samples it is lower than 10 percent. The empire period is represented by only one weed seed therefore more data are needed to make exact interpretation for empire period. However, a trend of more than one century may show considerable increase in tillage density under Hittite reign. It is suggested that herbaceous habitat is replaced by more woody species in soils that are not cultivated and left empty for a long time (Behre & Jacomet, 1991). Thus, dominance of annual weeds and under-representation of the perennials especially in 16th century BC Hattusha suggest increase in intensive tillage.

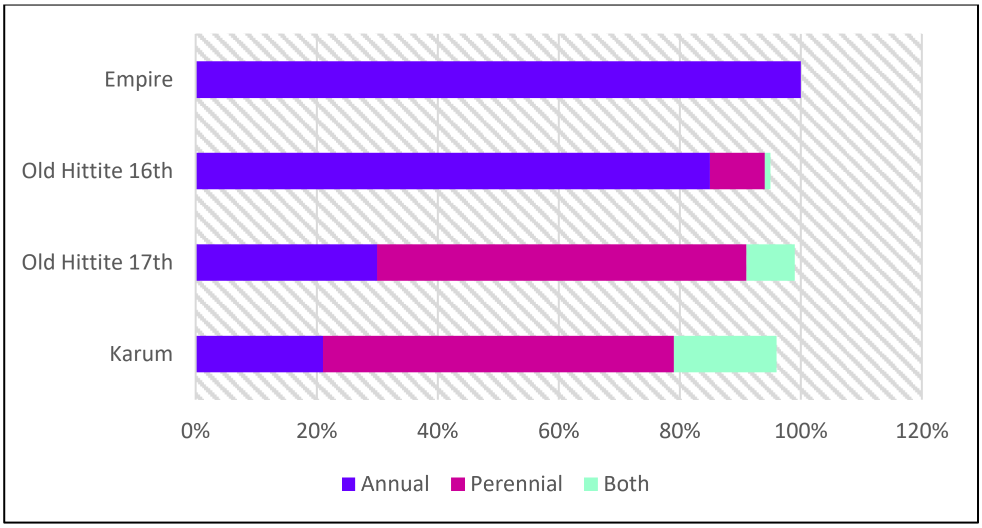

Figure 13 Bar chart of RA of perennial and annual weed groups from Hattusha samples

Galium triconutum Dandy in *Rubiaceae* family is also an important plant in modern weed studies. In their study *Determination of the Weed Species, Density and Frequency in Wheat Fields in Bingöl Province*, Esim and Çoruh (2021) show that this plant grows in wheat cultivation areas with a density much higher than other wild species. Similar results were obtained in the studies conducted wheat fields of Tokat and Van. (Topçu Esim & Çoruh, 2021). Thus, it would not be wrong to conclude that there was an intensive wheat cultivation in the 16th century BC Old Hittite period comparing with previous periods.

Weed ecology can also be used as indicator of soil fertility. Küster (1991) classified the weeds into two main categories as an indicator of soil fertility (Küster, 1991). Weeds including the group of *Chenopodiatea* classified as high fertility weeds with small scale garden-type farming (Jones, 1992), while *Secalietae* weeds attributed to cereals growing in less irrigated and low-fertile soils (Jones, Bogaard, Halstead, Charles, & Smith, 1999). *Chenopodiaceae* and *Polygonaceae* are analyzed under *Chenopodiatea* group (Küster, 1991; Lucas, 2012). Thus, rise in *Secalietae* type weeds is evaluated as intensification in agriculture (Riehl, 1999; Jones, 1992; Çizer 2006). In Hattusha, the RA of *Chenopodium* species in Karum and 17th century BC Hittite samples were 6% and 14% respectively that decreased to almost zero in 16th century

BC samples. This variations in weed ecology can be evaluated as the shift from well-manured, irrigated agriculture to more intense cereal cultivation.

Modern agricultural studies suggest that *Bifora radians Bieb*., *Galium tricornutum Dandy*., *Sinapis arvensis L* in Central Anatolia and *Agrostemma githago L*, *Ranunculus arvensis L*., *Galium tricornutum Dandy*., *Polygonum aviculare L*., *Chenopodium album L*., *Convolvulus arvensis L*., *Adonis spp*., *Bifora radians Bieb* and *Sinapis arvensis L*. in Central Black Sea region were recorded as the most dominant species along with wheat cultivation (Sırrı, 2019). Comparing modern and past weed ecology may not reflect the actual conditions in the past, but can provide insight into past practices. The changes of these weeds in the Hittite geography over time are given in the **Figure-14**. It is quite striking that modern weed ecology shows a sharp increase in time. This situation might be interpreted as intense wheat cultivation possibly in the vicinity of Hattusha in less-fertile and less-irrigated soils which also correlate with the decrease in *Chenopodiaceae* group and perennials in 16th BC Old Hittite samples.

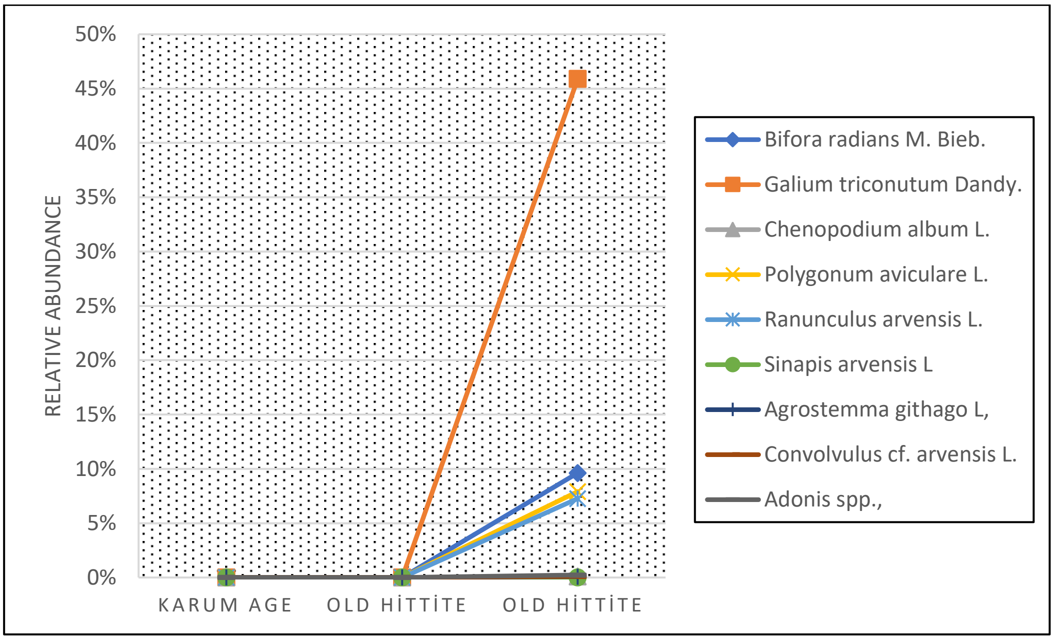

Figure 14 Line chart of prominent modern wheat field weed ecology from Hattusha samples

6.2.3. Kaman- Kalehöyük Samples

Kaman samples include Assyrian, Assyrian/Hittite and Old Hittite period samples. It is possible to observe the "*Hittitization*" in the region to some extent but it is not possible to trace its imperial process due to the absence of imperial samples. Twelve samples, seven of them recorded according to their abundance, were analyzed in this section. The samples recorded according to abundance scale were multiplied with a constant coefficient in order to include them in the numerical analysis. They are marked with a "C" prefix in the **Figure-15**. Total identified seed/grain/rachis numbers that are published quantitatively in Kaman samples are 4.552. This number includes only cereal parts. In the original data sources, no specific legume name was given. Weeds were also recorded according to the abundance scale in the source documents.

6.2.3.1. Cereals

The cereal composition of Kaman-Kalehöyük samples is shown in **Figure-15.** *Triticum aestivum* is the most dominant cereal almost in all samples except two ones which are dominated by *Triticum monococcum.*

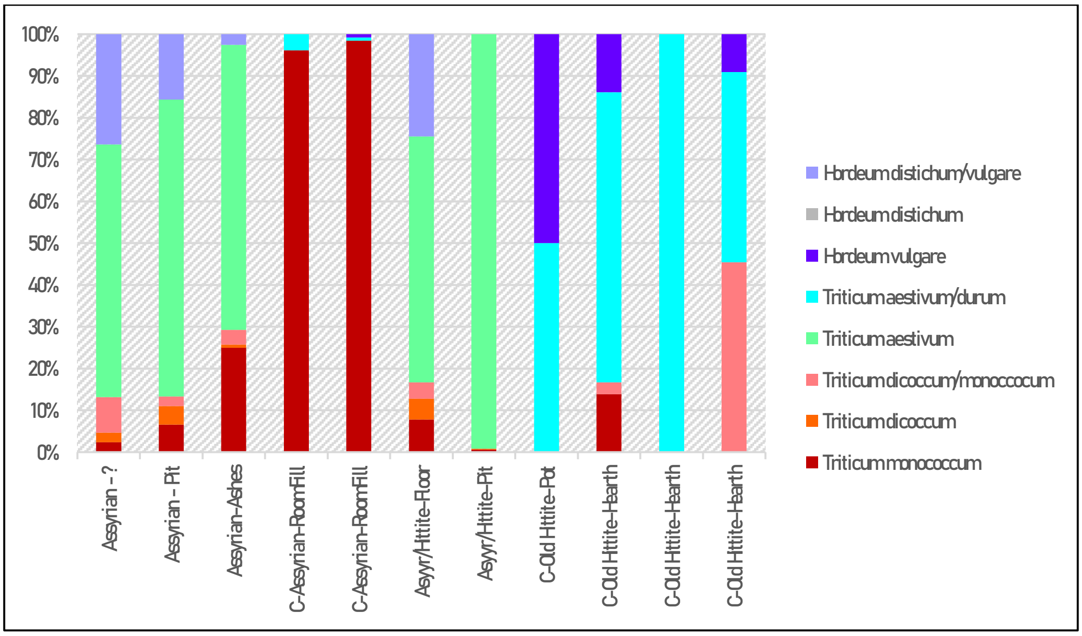

Figure 15 Bar chart of RA of cereals from Kaman-Kalehöyük samples

Most noticeable change in the **Figure-15** is the decrease in the share of hulled wheat in cereal production which is replaced by free-threshing wheats and barley in time. However, the absence of archaeobotanical remains from the imperial period at Kalehöyük does not allow us to make a further and complete evaluation about how the imperial transformation is traced through archaeobotanical data. However, the proportional increase in free-threshing wheat, which is a more productive type, is evident over time.

The **Figure-16** shows the CA results of cereals grouped into three categories as hulled-wheat, free-threshing wheat and barley from Kaman-Kalehöyük. The dominance of free-threshing wheats is obvious. It can also be concluded that hulled wheat dominance is almost over after Assyrian Period. Accordingly, barley generally was not a preferred crop by Pre-Hittite inhabitants according to the **Figure-16** results.

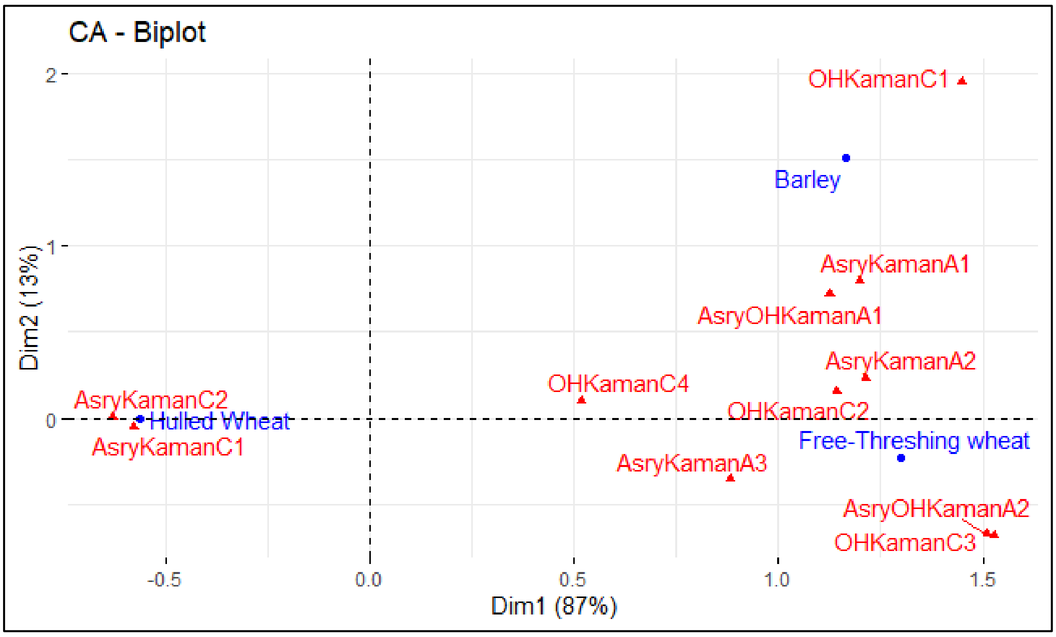

Figure 16 CA of cereals from Kaman-Kalehöyük samples. Suffix "C" indicates that the sample recorded according to abundance scale

Table-8 shows the grain against non-grain parts in samples. **Table-8** can provide an important insight about the context of the taxa. Non-grain parts and weed taxa dominates all assemblages in Kaman samples. According to the Nesbitt (1993), this kind of a composition is only possible when the deposits include dungs and the low-representation of barley can be the result of using cattle dung instead of horse dung (Nesbitt, 1993). The share of cereal grains is decreased in Assyrian-Hittite transition period. Considering that the sample is dung, these results can represent the shift in fodder compositions under Hittite control. These results can also be interpreted as lesser cleaning of cereals in Hittite period.

Table 8 RA of grain and non-grain remains from Kaman-Kalehöyük samples

Period	Assyrian/Old Hittite	Assyrian/Old Hittite	Assyrian	Assyrian	Assyrian
Cereal Grains	37%	16%	45%	53%	58%
Non-Grain Cereal Parts and Weeds (Culm nodes, internodes, spikelet forks, pulses, weeds)	63%	84%	55%	47%	42%

6.2.3.2 Legumes and Weeds

The RA of legumes in all periods in Kaman-Kalehöyük samples are below < 1 percent thus, legume presence can be considered as contaminant. The only specified legume is Bitter vetch with a low abundance. Therefore, more data is needed to understand exactly the legume cultivation strategy in the region. On the other hand, the samples are providing more info in terms of weed taxa.

Cephalaria sp. is observed only in Assyrian Period samples. It is known as a natural plant in wheat fields. *Cephalaria syriaca spp.* is used in flour and bread making and the existence of this weed may be linked with wheat cultivation (Başar, Karaoğlu, & Boz, 2016). *Lolium sp.* is an indicator of fine-sieving (Çizer, 2006). *Galium tricornutum* type is observed both in Hittite and Assyrian periods with albeit low abundancy can be an indicator of wheat cultivation (Topçu Esim & Çoruh, 2021).

In the 17th century BC Old Hittite samples, *Potentilla* sp. seeds are recorded as rare abundance. *Potentilla L.*, *Potentilla recta L.* and *Potentilla reptans L.* are accepted as weeds of the Kaman flora today. Among them, *Potentilla reptans L.*'s natural habitat is defined as lakesides (Bahar & Güneş Özkan, 2021). Similarly, *Salsola type* that found in Old Hittite samples can also be considered as marine water plant indicator

(Çizer, 2006). *Tuz* (Salt) *Lake* and *Seyfe Lake* in the region are salty lakes. In addition, the Kızılırmak river contains a high amount of salt (Alagöz, 1966). Therefore, it can be claimed that agriculture was done around these water resources in the past or irrigation was practiced by Hittite farmers.

6.2.4. Sarissa Samples

Sarissa is the second place in the scope of this study where there are archaeobotanical data from Old Hittite to Empire periods. Thus, Sarissa offers precious information for understanding the relation between the imperial process and agricultural strategy. **Table-9** indicates RA values for cereal, legume and weed remains. Total seed numbers in Sarissa samples are 40.423. This number includes; 39.415 cereal grains (including 8 indeterminate grains and non-grain parts), 83 legumes, 8 fruit and 917 weed seeds.

6.2.4.1. Cereals

Triticum aestivum and *Triticum dicoccum* are seen as the dominant cereals in the Empire period samples according to the **Figure-17**. *Hordeum vulgare* grains are quite low comparing with wheat species especially in the late-period layers. However, the dominant species in each period differ considerably and contextual differences are immediately apparent. The context of the samples holds a very critical role in the interpretations of archaeobotanical data. However, the sample composition can also be a tool to understand the context of the samples reciprocally (Hillman, 1984; Smith, 2007). In the scope of Sarissa, the crop composition of the samples taken from Old Hittite and Empire gate (GC hereafter) samples are quite similar except for the presence of *Triticum spelta* and *Triticum aestivum*. Compared with the previous periods, it may be said that there was an increase in the crop range and agricultural productivity particularly in the imperial period. It is also important that *Triticum spelta* remains are only present in empire period Sarissa sample among all samples in the study. Besides, the presence of spelta was suggested by van der Veen (1992) as increasing of less intense and large-scale production (van der Veen, 1992). Therefore, it can be concluded that in the empire period Sarissa both intensification and extensification might be practiced.

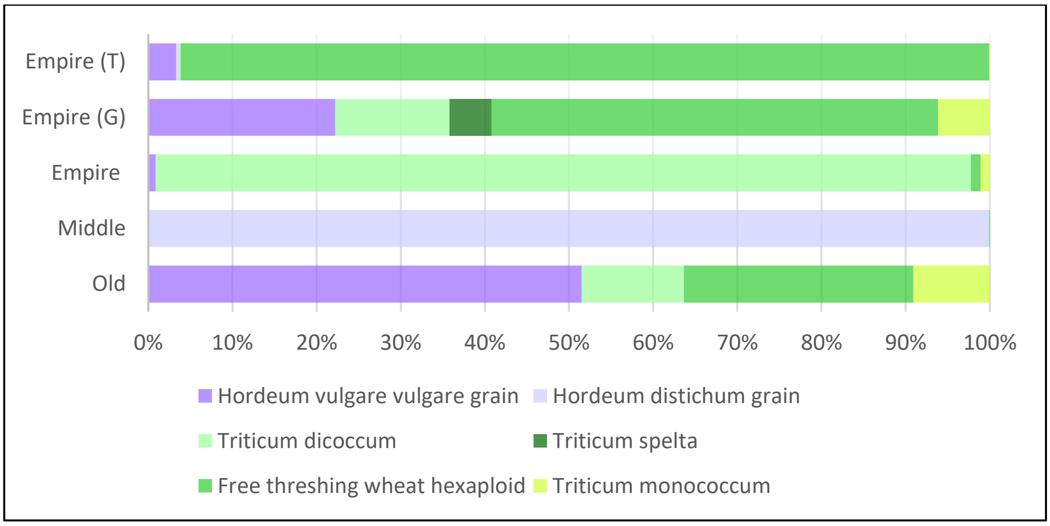

Figure 17 Bar chart of the RA of cereals from Kuşaklı (Sarissa) samples

6.2.4.2. Legumes

The Sarissa samples are very poor in terms of legume content. Except for the Old Hittite sample which has indeterminate *Fabaceae* (4% RA) and *Vicia ervillia* seeds (2% RA), the legume presence is below 1% RA in the other samples. Thus, they can be inferred as sample contaminant. Supportively, the relative abundance of weed seeds in the Middle Hittite, Empire no context (NC hereafter) and Empire temple context (TC hereafter) layers does not exceed 2%. This shows that the main crop is being tried to be purified from undesired plants. Therefore, more data is needed to understand legume cultivation in Sarissa.

Table 9 RA of plant remains from Kuşaklı (Sarissa) samples

	Periods				
	Old	*Middle*	*Emp (NC)*	*Emp (GC)*	*Emp(TC)*
CEREALS					
Cereal indeterminate (grains)	24%	-	3%	8%	0%
Poaceae indet.	6%	0%	0%	6%	1%
Hordeum distichum/vulgare (rachis)	-	-	-	1%	0%
Hordeum vulgare vulgare grain (hulled)	16%	-	1%	6%	3%
Hordeum distichum grain (hulled)	-	98%	0%	-	0%
Free threshing wheat hexaploid (rachis)	-	-	0%	31%	0%
Triticum dicoccum (grains)	4%	0%	86%	3%	0%
Triticum dicoccum (glume bases)	1%	-	0%	2%	0%
Free threshing wheat hexaploid (grains)	8%	0%	1%	14%	93%
Triticum monococcum (glume bases)	3%	-	6%	1%	0%
Triticum monococcum (grains) (1/2g)	3%	-	1%	2%	0%
Triticum spelta grains (glume basis)	-	-	-	1%	-
Triticum spelta grains	-	-	-	1%	-
Indeterminata	1%	-	0%	2%	-
PULSES	-	-	-	-	-
Fabaceae sat. indet.	4%	-	0%	-	0%
Fabaceae indet.	0%	0%	0%	0%	0%
Lens culinaris Medik.	0%	-	0%	-	0%
Pisum sativum	-	-	-	-	0%
Vicia type	0%	-	0%	-	0%
Vicia ervilia	2%	0%	0%	-	0%
Pulses indet.	-	-	-	-	-
FRUIT	0%	0%	0%	0%	0%
Vitis vinifera L. (pips)	-	0%	0%	-	0%
WEEDS	28%	2%	2%	22%	2%

6.2.4.3. Weeds

For Sarissa, weed seeds are represented in all samples. The prominent weed taxa are shown in **Table-10.** Soil compaction is the phenomenon in which the volume of soil decreases due to the reduction of air in it. This situation restricts the expansion of the roots of the plants into the soil. Thus, it is an important factor affecting the agricultural productivity (Nawaz, Bourrié, & Trolard, 2013). *Polygonum* sp. (Sweetser, 2021), *Plantago* sp., *Convolvulus arvensis* and *Rumex crispus* are the weed species that can be observed usually in the compacted soils (Sandborn, 2016). Soil compaction can result from natural or human related factors (DeJong-Hughes, Moncrief, Voorhees, & Swan, 2001). Mechanical forces on soil such as tillaging and grazing especially after the harvest can cause compaction of the soil (Aksakal E. , 2004).

Table 10 RA of weed ecology from Kuşaklı (Sarissa) samples

	Periods				
	Old	*Middle*	*Emp (NC)*	*Emp (GC)*	*Emp(TC)*
Agrostemma sp.	0%	0%	2%	0%	0%
Allium sp.	2%	0%	0%	0%	0%
Artemisia sp. L.	8%	0%	0%	0%	0%
Asteraceae indet.	7%	0%	3%	3%	0%
Brassicaceae indet.	0%	0%	1%	0%	11%
Caryophyllaceae indet.	8%	1%	1%	1%	3%
Centaurea type	0%	1%	2%	0%	0%
Chenopodium sp.	10%	0%	19%	0%	18%
Chenopodium album L.	0%	0%	0%	1%	0%
Convolvulus arvensis L.	0%	12%	0%	0%	0%
Cuscuta sp. L.	2%	0%	0%	0%	0%
Galium sp.	0%	6%	0%	0%	0%
Lathyrus sativus L.	0%	0%	2%	0%	0%
Lolium sp.	5%	0%	11%	24%	1%
Lolium temulentum L.	0%	0%	1%	18%	0%
Onopordum acanthium L.	0%	0%	0%	1%	0%
Papaveraceae indeterminate	0%	0%	1%	0%	0%
Polygonum sp.	0%	79%	0%	0%	0%
Polygonum aviculare L.	3%	0%	0%	6%	2%
Polygonum convolvulus L.	0%	0%	2%	0%	5%
Polygonaceae indet.	7%	0%	8%	9%	8%
Rubiaceae indeterminate	12%	0%	4%	3%	12%
Rumex crispus L.	10%	0%	7%	18%	0%
Rumex sp.	0%	0%	2%	3%	7%
Scilla sp.	0%	0%	5%	0%	0%
Setaria italica (L.) P. Beauv.	0%	0%	0%	0%	1%
Sherardia sp.	2%	0%	0%	0%	0%
Silene type	3%	0%	2%	0%	11%
Teucrium sp.	2%	0%	0%	0%	0%
Trifolium type	8%	0%	4%	0%	7%
Vaccaria sp.	0%	0%	0%	0%	1%

Other leading reasons of soil compaction are natural forces. Drying of soil or excessive precipitation may cause soil compaction. Tillage of wet soils can also lead to serious compaction in the soil (Munkholm & Schjønning, 2004). **Table-10** shows the RA of prominent weed seeds in Sarissa. It is striking that *Convolvulus arvensis* and *Polygonum* sp. constitute over 90 percent of the Middle Hittite Period weed assemblages as it is shown in **Table-10** while the total amount of weed seeds are almost 2 percent as indicated in **Table-9**. The low percentage of weed seeds and high amount of *Hordeum disticchum* may exhibit barley cultivation with rigorous cleaning.

Thus, the weed ecology is highly possible to come from the agricultural land whose soils were compacted. Since compaction prevented oxygen and water inflow and root penetration (Aksakal, 2004), it can be concluded that agriculture was relatively less productive in the Middle Hittite Period. On the other hand, comparing with a modern application, tillage applications in wet soils in spring is considered as one of the main reasons of soil compaction in agricultural lands of Denmark (Munkholm & Schjønning, 2004). Therefore, soil disturbance in spring seasons might be proposed for Middle Hittite Sarissa fields combining with the results shown in **Figure-27** where flowering time of the Middle Hittite Period sample suggests winter and summer sowing. However, the high altitude of Sarissa is open to discussion in terms of growing two crops per year. The ethnobotanical study carried out by Laurent (2015) in the Tibetan region suggest that two yields could be obtained per year in the past at heights that could be considered as extreme (Laurent, 2015). However, it is also possible that the plant remains suggested summer sowing were mixed to the sample as contaminant. Thus, more data are needed for more reliable interpretations.

Perennial and biennial weed variation in Sarrisa suggest that tillage intensity has been increased through the Empire period except the Empire gate sample. This sample contains high amount of *Rumex crispus* seeds (18% RA) that is quite striking. This perennial weed can be an indicator of low-intense tillage or long-termed fallowed areas. *Onopordum acanthium L.* is found in the sample, as a biennial plant may be an indicator of non-disturbed areas. Nesbitt (1993) suggested that in the assemblages where the weed and crop remains amounts are close to each other the probability of being animal dung is high (Nesbitt, 1993). Depending on the presence of *Onopordum acanthum L.*, a biennial plant, with *Rumex crispus* as perennial also strengthens the hypothesis that the sample in question came from animal dung of grazing animals in a grassland or previously cultivated fields but remaining at that particular time fallow and used for animal pasture. This claim is also supported by the Correspondences Analysis (CA) which was performed on weed taxa. The analysis was performed by removing the Middle Hittite period sample in order to purify the analysis results. According to the result shown in **Figure-18,** Empire (GC) sample varies significantly from other samples. *Lolium temulentum L., Onopordum acanthum L.*, *Rumex Crispus*

L. and *Chenopodium album L.* stand out as plant residues that contributes the most to this difference. It is important to see that the Old Hittite, Empire (NC) and Empire (TC) samples are clustering at the center of the graph that means the weed compositions of them do not much differ from each other. The main cause of the variance of Empire (GC) are the perennial weeds. Based on Hillman's (1984) suggestion that plant composition can help determine the context of the samples (Hillman, 1984), it would not be wrong to say from this table that the Empire (GC) sample comes from an area that is not heavily tillaged. This also supports Nesbitt's (1993) dung theory.

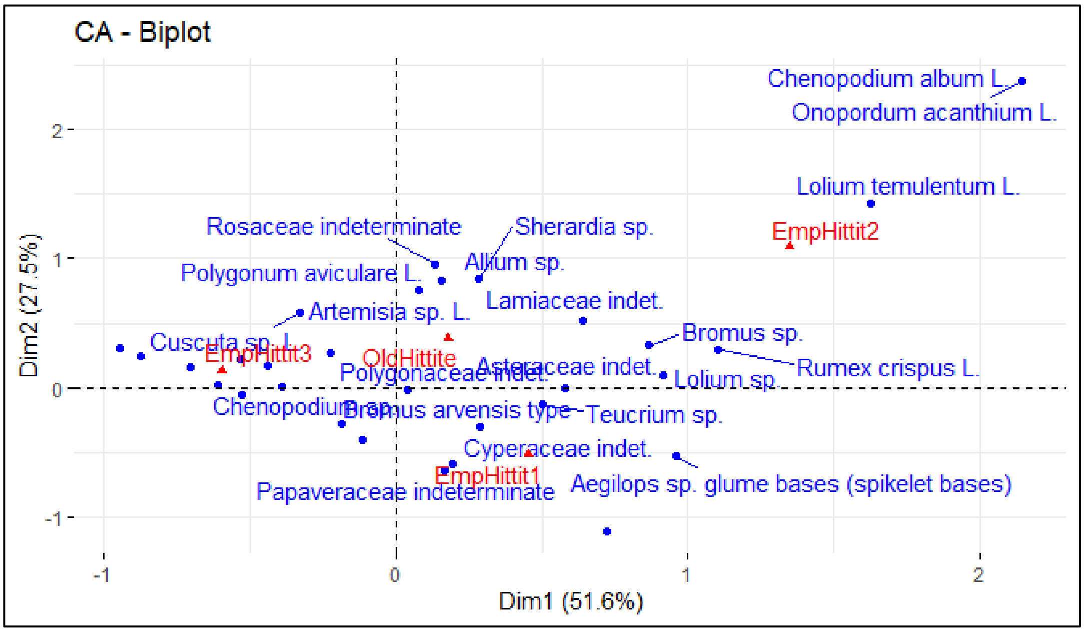

Figure 18 CA of weed ecology from Kuşaklı (Sarissa) samples. Empire (1), Empire (2) and Empire (3) samples correspond to Empire (NC), Empire (GC) and Empire (TC) respectively.

Although represented with very few amounts, foxtail millet *(Setaria italica L.)* may be an important indicator of change in crop choices and diversification in production possibly through the impact of the central authority. In the light of archaeobotanical data, it was thought that this plant was first grown in large quantities for food purposes in Anatolia during the Iron Age. The fact that this plant was recorded for the first time in the Empire (TC) samples and even though it was found in very small amount, because it was in the context of a temple it is argued that it was used for food. This can be interpreted as an increase in the crop range in the Hittite Sarissa in this period (Nesbitt & Summers, 1988).

Weed concentrations can also be a good indicator to show the intensity of the cultivation practices. Weed families such as *Cyperaceae* (University of Hawaii, 2022), and *Chenopodiaceae* are used in archaeobotanical studies to interpret the quality and humidity of the cultivated soils as mentioned above (Küster, 1991). *Chenopodiaceae* seeds are generally attributed to well-manured, small scaled garden type cultivation (Çizer, 2006) while *Cyperaceae* family can be an indicator of satured or wet soils (University of Hawaii, 2022). The RA of *Chenopodium* seeds in the Old, Empire (NC) and Empire (TC) samples are 10 percent, 19 percent and 18 percent respectively while Middle and Empire (GC) samples do not include seeds of this weed groups. If we accept the suggestion that the Middle Hittite samples obtained from a less-fertile compacted soil, the low abundance of *Chenopodium* as a sign of fertility is consistent. The RA of perennial weed ecology, especially in Old Hittite, Empire (NC) and Empire (GC) periods can be an indicator of low-density tillage or long-term fallow. However, perennial weeds are almost absent in the Empire (TC) sample. Therefore, the data can be interpreted as well manured and irrigated agriculture possibly practiced in the vicinity of the city with different intensities especially in the imperial period.

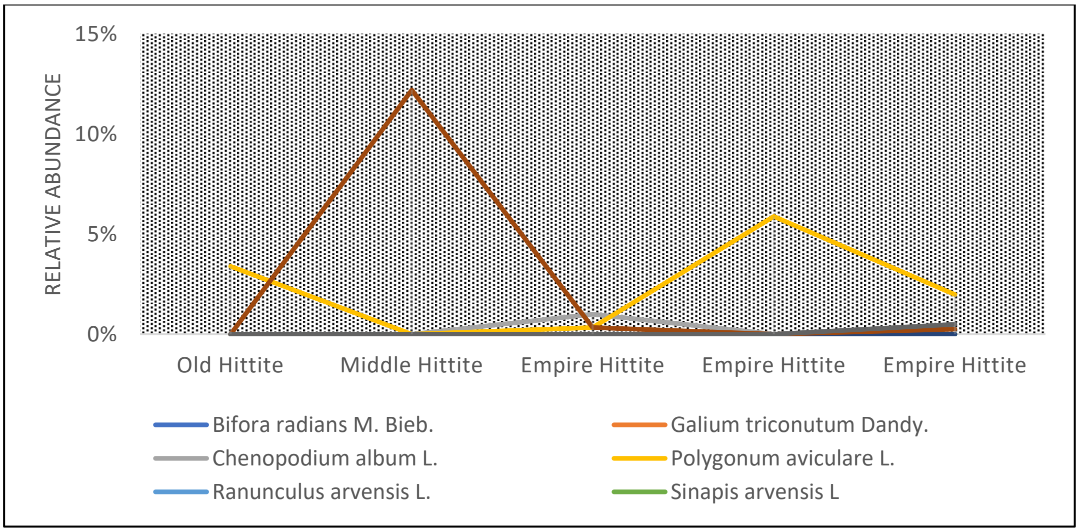

Figure 19 Line chart of the RA of modern wheat field weed ecology from Kuşaklı (Sarissa) samples

The trend of modern cereal fields weeds in Sarissa samples is shown in **Figure-19**. It is unlikely that exactly the same results will be observed, as the climate, vegetation, species and climatic conditions will not be the same as before. However, it is aimed to obtain only an insight by making comparisons with modern and past weed ecologies. According to the **Figure-19**, modern cereal field weeds do not show prevalence in any period in the Sarissa except the *Convolvulus Arvensis* found in Middle Hittite samples. The presence of *Rumex sp.* can be attributed to dry conditions (Çizer, 2006). Empire samples have higher relative abundance of *Rumex sp.* may be explained as the changed and dried climatic conditions until the end of millennia. Another prominent weed taxon is *Cuscuta sp. L.* This plant belongs to the class of parasitic plants and can considerably reduce the agricultural efficiency (Kaya, Nemli, & Demir, 2018). The fact that this plant has not been seen except for the Old Hittite period may indicate that the Hittites were successful in struggling against parasitic grasses in empire age. However, more data is needed for exact interpretations.

6.2.5. Şapinuva Samples

The Empire sample of Şapinuva similarly was dominated by only one taxon, *Triticum aestivum*. The context of this sample is thought to be a short-term food storage for imperial temple (Oybak Dönmez, 2019). This taxon is considered as important for showing the importance of free-threshing wheat in Empire Period Hittite.

The samples are lack of legumes remains. As weed taxa, *Galium Aparine* is the only recorded species in the source document. This weed is quite prevalent and can be found in different habitats such as meadows, prairies, woodlands, abandoned fields, disturbed areas and cultivated fields (Gucker, 2005). Therefore, there is no sufficient data to make more comprehensive interpretations.

6.3.Combined & Comparative Analysis

6.3.1. Combined Analysis for Cereals

In this section it is aimed to see the region-based variations in subsistence strategies with a holistic approach by comparing the different settlements. **Figure-20** shows the RA of grains of main cereal group as sample and settlement basis. The overwhelmingly dominance of *Triticum aestivum* stand out nearly in all samples. However, the presence of free-threshing wheat becomes more evident in the imperial era. Barley is seen as a sign of Hittite presence. Intense barley cultivation of Hittites may come from environmental restrictions, durability of barley to aridity or an increase in livestock activities. Hulled wheat, on the other hand, can be said to be a relatively more important product for the Assyrian period. Except one sample in Sarissa, the hulled wheat ratios decline steadily to the empire period.

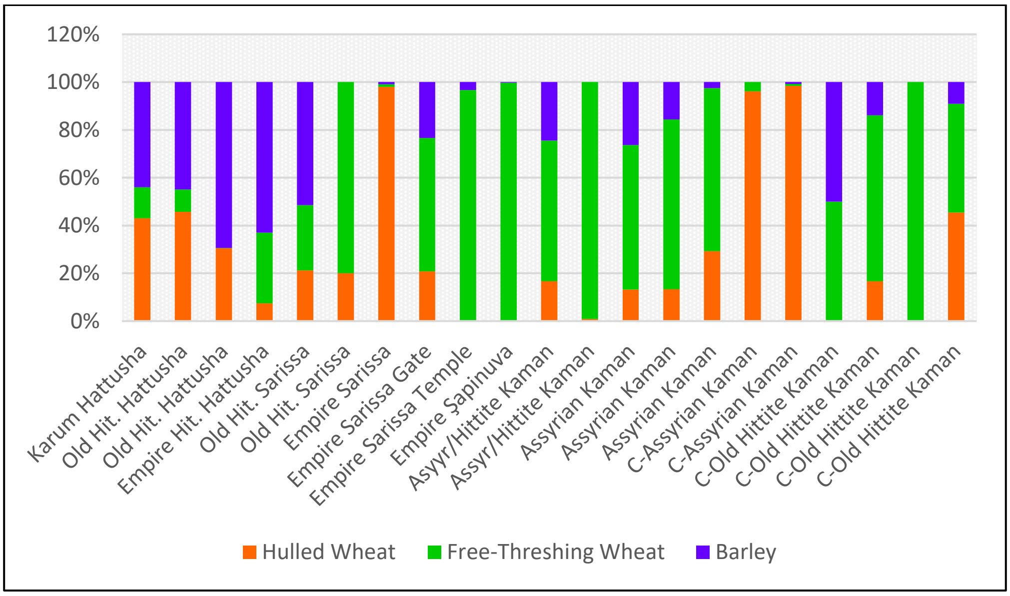

Figure 20 Bar chart of the RA of main cereal groups from Hattusha, Sarissa, Şapinuva and Kalehöyük samples. The prefix "C" indicates that the original sample is recorded according to abundance scale and converted to numeric values with coefficients

Figure-21 shows the chronologic trend of the free-threshing wheats in the studied settlements between 20th BC – 13th BC. The dominance of free-threshing wheats in Karum and Empire period samples are apparent. However, there is a sharp decrease especially in Old and Middle Hittite periods when the relative abundance of the free-threshing wheats does not exceed the 24 percent. The results in this table may be the preference of the Hittites, natural causes or long-term storage concerns (e.g., high hulled-wheat presence in underground silo in Hattusha). Nevertheless, there is a distinct patterning in terms of the free-threshing wheat ratio in different socio-politic periods. It is seen that Middle and Old Hittite periods were specifically concentrated on hulled-wheat and barley. In this sense, the next analysis in the thesis will be to analyze the product diversity in the mentioned periods.

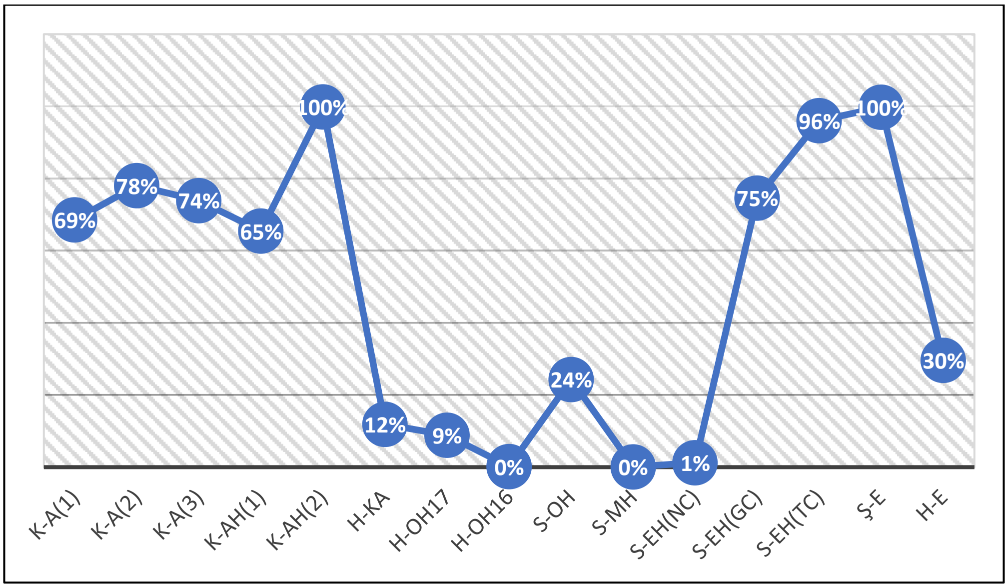

Figure 21 Line-chart of the RA change of free threshing wheats from Kalehöyük, Hattusha and Sarissa samples

Simpson index was used to observe the diversification of cereal production in Hittite Land. According to the **Figure-22**, four of the six lowest index numbers belong to Empire Hittite period and the lowest index comes from Middle Hittite Sarissa where the overwhelming majority of the sample is *Hordeum distichum*. Contrary, Assyrian Period samples, either Hattusha or Kalehöyük, have the largest indexes. These results can be interpreted as indications that the Hittites specialized in the production or storage of certain products, as in the Middle Hittite example. Agricultural specialization can simply be defined as use of the resources for producing a limited number of crops (David J. Abson, 2019). Applying appropriate farming methods is essential for economic and environmental sustainability as well as productivity

(Czyżewski & Smędzik-Ambroży, 2015). Production of certain ceramic groups by Hittites is interpreted as a sign of imperial influence (Gates M. , 2001). Therefore, specialization in agriculture is one of the important issues that are still discussed today and could be an indicator of imperial process. It is expected that agricultural specialization will create specialized production skills and increase productivity by reducing the learning curve. On the other hand, it is stated in the literature that specialized production reduces resilience (de Roest, Ferrari, & Knickel, 2018) and does not make a significant difference in terms of efficiency (Czyżewski & Smędzik-Ambroży, 2015).

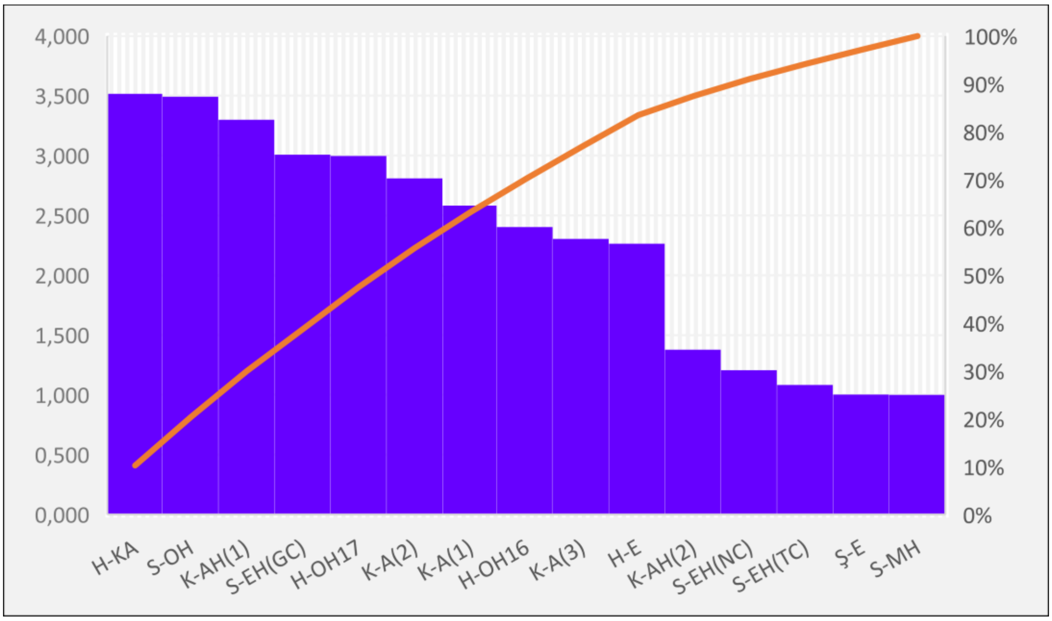

Figure 22 Bar-chart of the Simpson Reciprocal Index results from Hattusha, Kalehöyük and Sarissa samples

Another important point in this regard is that specialization in agriculture can provide us with information about field sizes. In their study on European agriculture, de Roest, Ferrari and Knickel (2018) stated that large farms do more specialized agriculture, while small ones focus on general and diverse production. The data we have about the size of the agricultural lands of the Hittite period is important in this respect. Alp (1949) suggested that the NAM.RA people/slaves were either assigned to large fields or allocated land to cultivate. On the other hand, Schachner (2012) suggested that the fields were big enough only for a family in the Central Anatolia in the 2nd millennia BC (Schachner, 2012). However, the practices such as the large water structures, underground warehouses are considered as significant imperial efforts of Hittites to increase the agricultural production (Müller-Karpe, 2007). Furthermore, the presence of spelta in Sarissa and decrease of emmer wheat especially in Hattusha can be evaluated as large-scale production (van der Veen M. , 1992). In the Hittite tablets, it has been recorded that the number of NAM.RA increased the household size (Schachner, 2012). This additional workforce may had made possible to manage larger fields than before, and as a possible result of our archaeobotanical analysis results, specialized agriculture might have been applied in these enlarged lands.

In **Figure-23**, Correspondence Analysis (CA) was performed for twenty-six (26) different samples taken from the settlements in the scope of this work except Çadırhöyük. Correspondence Analysis is a useful method that converts large tables of data into a two-dimensional space to provide a clearer picture. It is aimed to create a region and chronology based holistic view by analyzing all samples. There are five main time period groups as Assyrian, Assyrian/Hittite, Old Hittite, Middle Hittite, and Empire Hittite in the scope of the studied samples. Sarissa sample from the Middle Hittite Period is discarded in order to focus on details of other settlements. This sample contained overwhelmingly *Hordeum distichum* which is totally unique taxon it led to clustering of all other samples in one side. This was apparently a bias in the results and did not allow for evaluation of the rest of the samples.

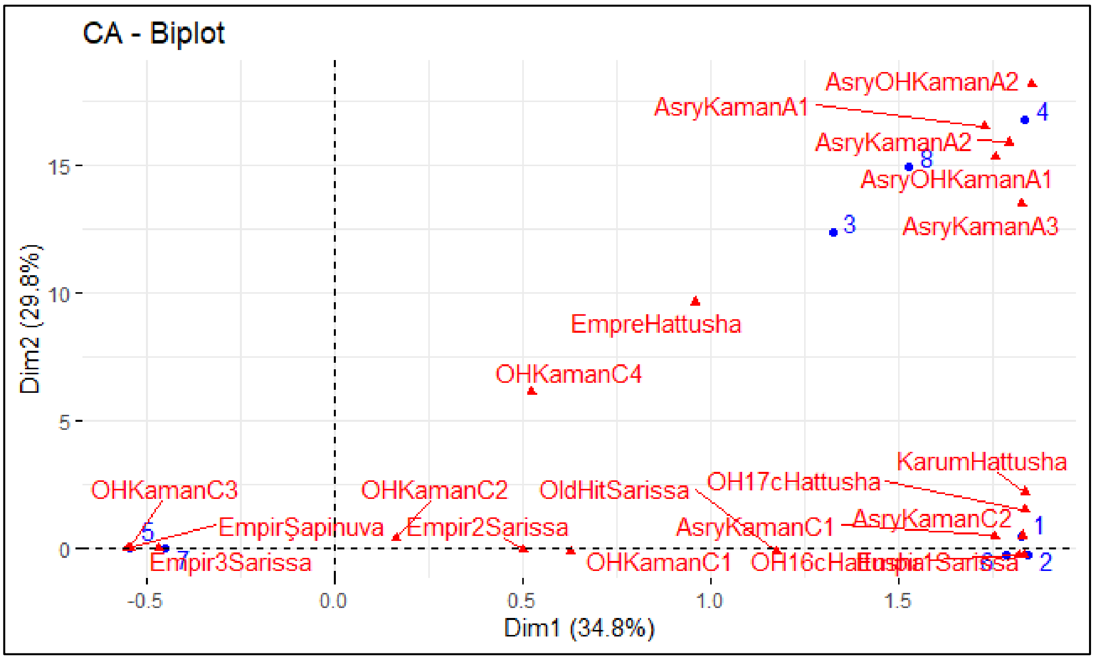

Figure 23 CA of the main cereals from Kalehöyük, Hattusha and Sarissa samples. The numbers correspond to specific cereal species. *1) Triticum monococcum 2) Triticum dicoccum 3) Triticum dicoccum/monococcum 4) Triticum aestivum 5) Triticum aestivum/durum 6) Hordeum vulgare 7) Hordeum distichum 8) Hordeum distichum/vulgare*. The suffix "C" indicates that the sample is recorded according to the abundance scale in the original document.

The CA results in **Figure-23** suggest both chronological and regional patterning. Assyrian Kaman-Kalehöyük samples are clustered distinctly far right-top. Accordingly, an increase in barley abundance is seen as the key feature of Hittite reign. Free-threshing wheats are abundant in empire period Hittite samples. In **Figure-24**, the results of the CA applied same samples by grouping them under three main cereal groups as hulled, free-threshing and barley are presented. Free-Threshing wheat dominance is highlighted more obviously. Hulled-wheat are not represented much comparing with other two groups. The shift from hulled wheat and barley to free-threshing wheat in Hattusha is compatible with RA results.

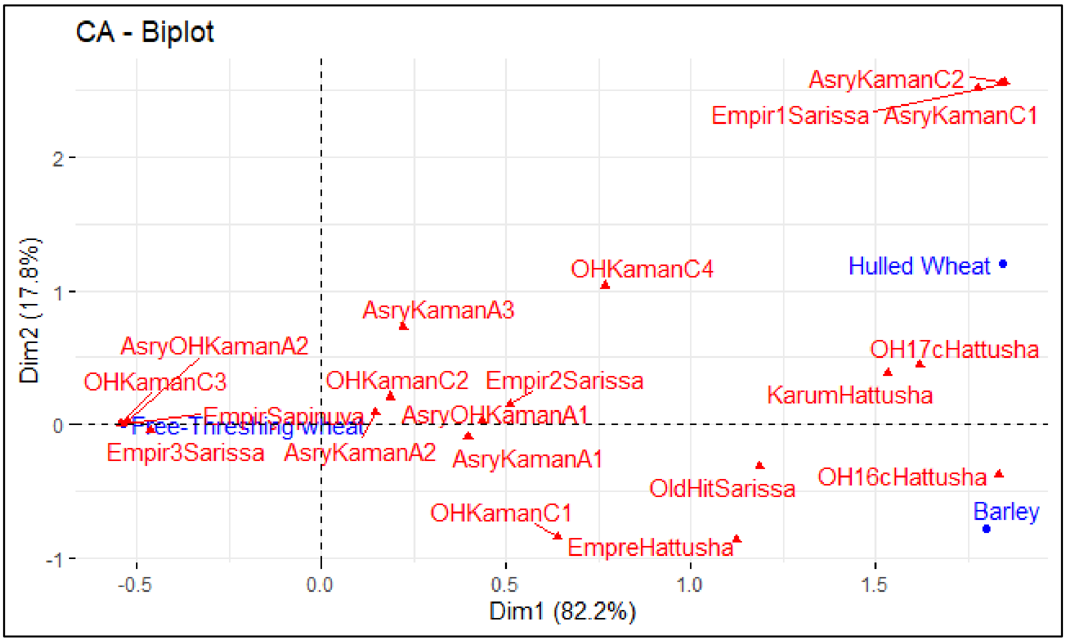

Figure 24 CA of the main cereal groups from Hattusha, Kalehöyük and Sarissa samples. Suffix "C" indicates samples recorded as abundance scale in the original study. Empire1Sarissa-Empire (NC), Empire2Sarissa-Empire (GC), Empire3Sarissa-Empire (TC)

For Sarissa, the preferences are seen as shifted from barley to wheat in time. Except some large administrative Hittite structures, the general settlement type of Kaman-Kalehöyük is thought to be domestic (Fairbairn & Omura, 2005) in which it can be clearly seen that the main cultivated crop is overwhelmingly free-threshing wheats. Hulled wheats are dominant in only two Assyrian period samples. The dominance of free-threshing wheats in the Kalehöyük samples can be explained by favorable landscape and climate features of the region, intensification efforts and/or domestic preferences. For Hattusha samples, the increasing trend of the free-threshing wheats towards empire period is obvious. However, in the state control silos the free-threshing wheat amounts are almost absent and the CA results in **Figure-24** show that 16th BC Hattusha samples differs considerable from other samples. Here, the central authority might force farmers to produce more stable, durable and less risky crops in the vicinity of Hattusha in order to ensure sustainability of the empire or the central authority specifically stored only the durable cereals without intervening to farmers' choices of cultivation. In any case, deliberate distinction in crop choice is obvious in the state control silos.

There is no doubt that the CA results represents contextual clustering rather than chronological. The results of the diversity analysis also yielded very similar results. While in state-controlled silos and pits generally one dominant species represents the samples, in the domestic samples the diversity is higher. As the number of archaeobotanical studies increases, samples from different periods and regions with similar contexts will be analyzed within themselves. This will surely produce much healthier and more reliable results. However, with the constrained data set, at least the importance of contextual differences in archaeobotanical studies and the effect on data types could be observed in this thesis study.

6.3.2. Comparative Analysis for Certain Weed Taxa

In **Figure-25**, CA was performed in order to trace the patterning of weed taxa in different settlements and time periods. The analysis is applied only for Hattusha and Sarissa due to the absence in quantitative information of other settlements. Three main clustering regions stand out in **Figure-25**. The CA results presented in **Figure-25** show a regional distinction for Sarissa, while the distinction for Hattusa is specific to agricultural intensity and context. The Hattusha's 16th BC sample mainly represents intense arable weed taxa. Karum and 17th BC Hittite samples are located at the other side of the graph and distinctly diverged from other samples. The weed ecology of these two samples represents well-manured and irrigated soils. Sarissa samples are clustered in the upper right part of the graph. Sarissa's weed ecology represents a well-fertilized, garden-type cultivation. It differs from the Hattusha samples especially by its perennials, which are a sign of low tillage. More specifically, *Chenopodium*, *Cyperaceae*, *Trifolium* and *Polygonaceae* in Empire (NC) and Empire (TC) samples suggest well-manured, nitrogen-rich, moist soils with garden-type agriculture possibly near the city. The perennials such as *Teucrium* and *Rumex acetosella L*. may suggest low-intense tillage or fallowing in this regard. These results also correlate with the presence of spelta which is considered as a sign of less tillaged large scale agriculture. In this regard, extensification in agriculture in empire period Sarissa could be suggested according to the existed data set and results.

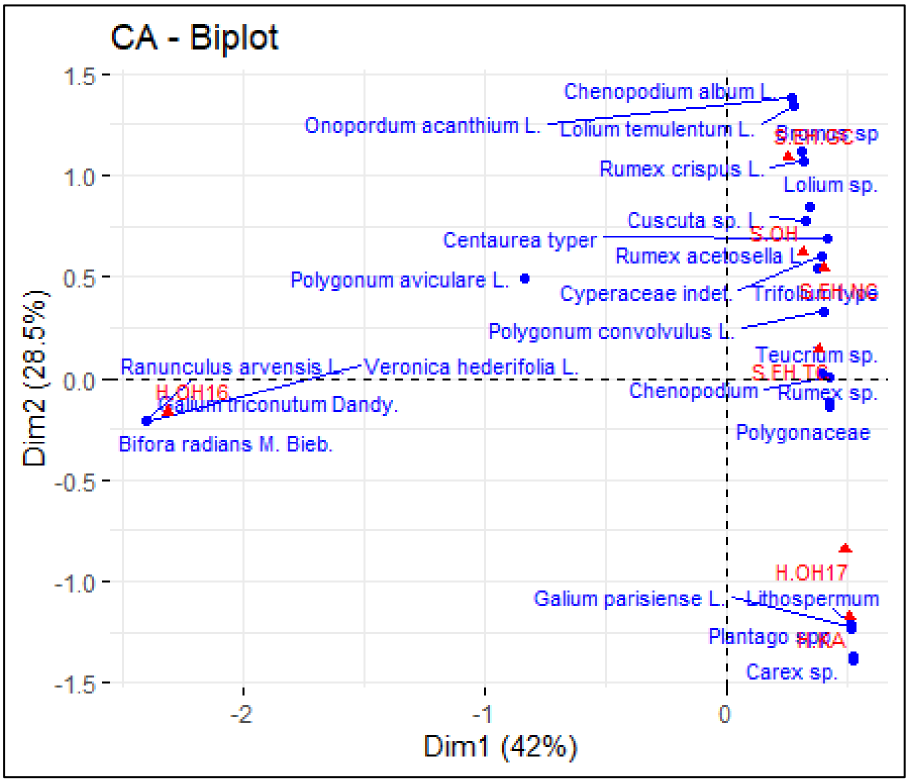

Figure 25 CA of the selected weed species (listed in Table 10) from Hattusha and Sarissa samples

Certain weed groups or species having specific features and ecological preferences are used as indicator species in archaeobotanical interpretations. The coexistence of weed groups with certain common characteristics strengthens the archaeobotanical interpretations (Jones, 2002). Plant species grown only in extreme conditions can also provide clearer data for understanding husbandry practices. In this sense, **Table-11** contains weed data that can be found in certain environmental conditions and that can provide important inferences about husbandry practices in this sense.

Table 11 Prominent weed species their main features in the study (AHDB, n.d.)

		Weed	*Soil Properties*				
Species	*Family*	*Type*	*Compacted*	*Fertile*	*Moist*	*Non-Fertile*	*Salt*
Agrostemma Githago	*Caryophyllales*	*Annual*					
Ambrosia spp.	*Asteraceae*	*Annual*				+	
Attriplex patula	*Amaranthaceae*	*Annual*			+		
Avena sp	*Gramineae*	*Both*				+	
Bifora radians M. Bieb.	*Apiaceae*	*Annual*					
Bromus sp	*Gramineae*	*Both*				+	
Carex sp.	*Cyperaceae*	*Perennial*			+		
Centaurea type	*Asteraceae*	*Both*		+			
Chenopodium	*Chenopodiaceae*	*Both*		+			
Chenopodium album L.	*Chenopodiaceae*	*Annual*		+	+		
Cirsium arvense	*Asteraceae*	*Perennial*		+			
Convolvulus arvensis L.	*Convolvulaceae*	*Perennial*	+				
Cuscuta sp. L.	*Convolvulaceae*	*Annual*				+	
Cyperaceae indet.	*Cyperaceae*	*Both*			+		
Galium aparine	*Rubiaceae*	*Annual*		+	+		
Galium parisiense L.	*Rubiaceae*	*Annual*					
Galium tricornutum Dand	*Rubiaceae*	*Annual*				+	
Gramineae indet.	*Gramineae*	*Both*				+	
Lithospermum	*Boraginaceae*	*Both*					
Lolium perenne	*Gramineae*	*Perennial*				+	
Lolium sp.	*Gramineae*	*Perennial*				+	
Lolium temulentum L.	*Gramineae*	*Annual*				+	
Onopordum acanthium L.	Asteraceae	*Biennal*					
Phalaris sp	*Gramineae*	*Both*				+	
Pisum sativum	*Leguminosae*	*Annual*		+	+		
Plantago spp.	*Plantaginaceae*	*Both*	+			+	
Polygonaceae	*Polygonaceae*	*Both*		+			
Polygonum aviculare L.	*Polygonaceae*	*Annual*		+	-		
Polygonum convolvulus L	*Polygonaceae*	*Annual*				+	
Polygonum sp.	*Polygonaceae*	*Both*	+				
Ranunculus arvensis L.	*Ranunculaceae*	*Both*					
Ranunculus repens	*Ranunculaceae*	*Perennial*			+		
Rumex acetosella L.	*Polygonaceae*	*Perennial*		+			
Rumex crispus L.	*Polygonaceae*	*Perennial*	+	+			
Rumex sp.	*Polygonaceae*	*Both*					
Salsola sp	*Chenopodiaceae*	*both/perennial*			+		+
Scirpus spp.	*Cyperaceae*	*Perennial*			+		
Senecio vulgaris	*Asteraceae*	*Both*		+			
Setaria sp.	*Gramineae*	*Both*				+	
Sinapis arvensis	*Brassicaceae*	*Annual*		+	+		
Teucrium sp.	*Lamiaceae*	*Perennial*					
Trifolium repens	*Leguminosae*	*Perennial*		+			
Trifolium type	*Leguminosae*	*Both*		+			
Veronica hederifolia L.	*Plantaginaceae*	*Annual*					

Weed flora can also give information about the sowing and harvesting timeline of economic plants. Thus, the seasonality of sowing times in Hittite settlements can be inferred by this way. Seasonality can provide us valuable information about the productivity of the agricultural activities. For cereals, sowing can be done two times in year. However, the most suitable season of cereal sowing is autumn for the dryland conditions (Ozturk, Çağlar, & Bulut, 2006) such as Central Anatolia region. Harvesting time for Central Anatolia region is summer months.

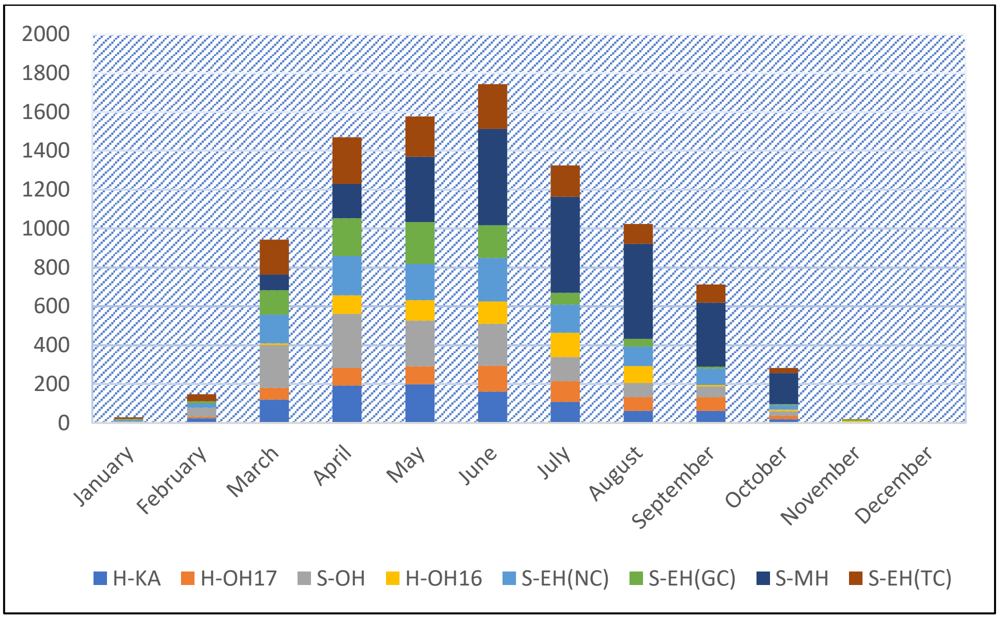

Figure 26 Bar chart of the flowering time of the weed ecology from Sarissa and Hattusha samples

Figure-26 shows the flowering time of the prominent weed taxa listed in **Table-11** for Hattusha and Sarissa (AHDB, n.d., Lucas, 2012). The results suggest that winter sowing was practiced both in Hattusha and Sarissa throughout the life-span of the empire. However, the Middle Hittite sample for Sarissa has distinctive pattern. **Figure-27** and **Figure-28** indicate the flowering time of weed species for Sarissa and Hattusha in order to observe the city-based patterns more detail.

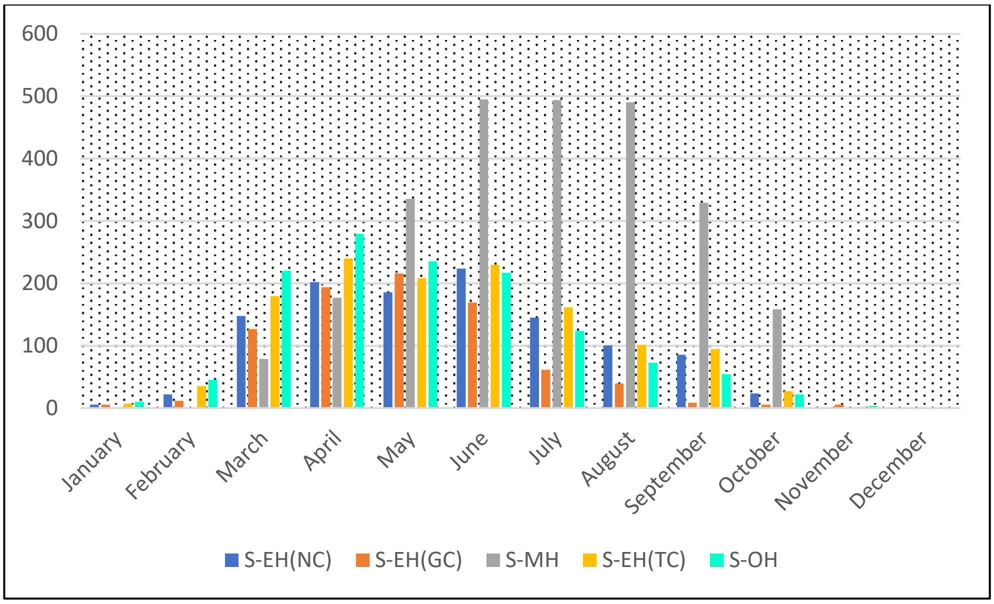

Figure 27 Bar chart of the flowering time of weed ecology from Sarissa samples

According to the results in **Figure-27**, seasonality does not show much alteration due to time in Sarissa. Dominant flowering time of weed species are April, May and June which suggest winter sowing. It can only be said that flowering slightly shifted from May to June in Empire Period. On the other hand, Middle Hittite samples suggest both winter and summer sowing for *Hordeum disticchum*. However, it should be noted that both **Figure-26**, **Figure-27** and **Figure-28** are prepared based on the probability. Weeds given in the archaeobotanical reports with only family information without specific taxa name, are calculated considering average flowering time of all species under that family indicated in **Figure-29**. Therefore, when the species names are revealed more precisely in future archaebotanical studies, more precise results will undoubtedly be obtained. On the other hand, the probability of both summer and winter harvests for barley in Sarissa is quite high according to the present data set.

Figure-28 indicates flowering time of the weed taxa from Hattusha. The chronological change in the flowering time is more obvious in **Figure-28**. The flowering time in Karum Period shows a sharp differentiation from the subsequent period. However, both periods indicate winter sowing crops (Bogaard et al., 2001: Lucas, 2012). Very small number of autumn flowered weeds might be explained as contaminant. Although they could not be included to the analysis due to the scarcity of both quantitative and identifiable data, Çadırhöyük and Kaman weed taxa shows similar patterns and suggest winter sowing.

According to the results shown in **Figure-28**, the flowering time of the weed taxa in Hattusha shifted from April-May to June-July similar to Sarissa samples. It can be suggested that this change in time is not large enough to argue for a different than winter sowing time. Nevertheless, it may indicate that agricultural lands were expanded from the plains only to include further areas up to highlands which could have been colder places hence the weeds were flowering slightly later that can be an indicator of extensification in agriculture. **In Figure-28**, it is seen that the flowering shifts over time after a sharp decrease in 17th BC. Therefore, another claim can be that the climate was warmer in Karum age when the flowering time was earlier for about one or two months back. This results also consistent with the pollen analysis in Sarissa (Müller-Karpe, 2009) and plant isotope analysis in the Hattusha region (Schachner A. , 2022) that suggest milder and more humid environment in the beginning of second millennia. As new information becomes available, more precise judgments will be made.

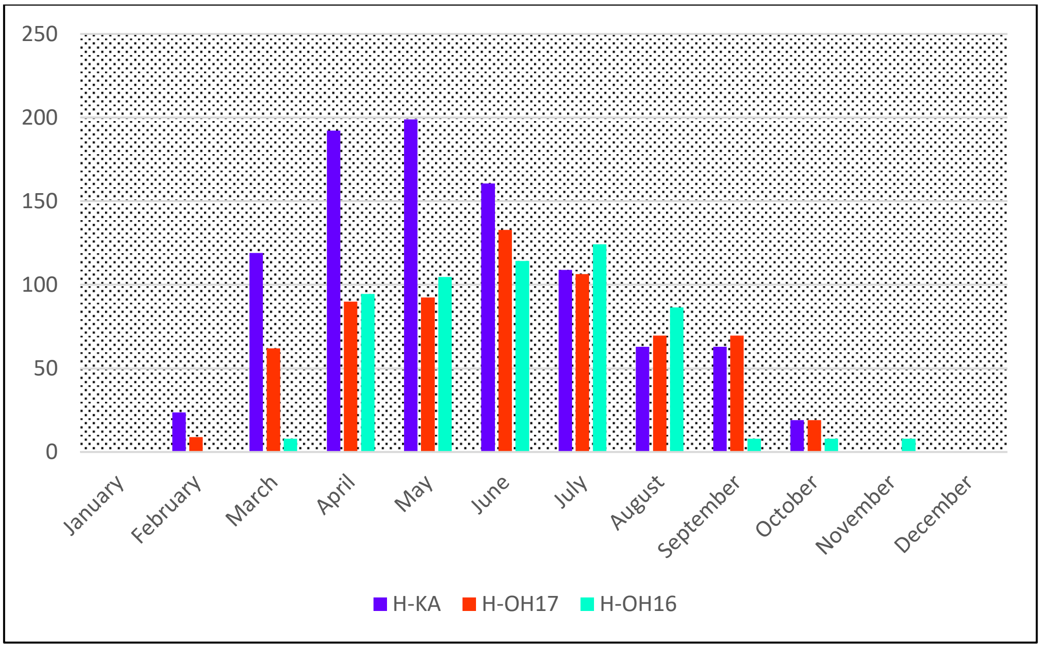

Figure 28 Bar chart of the flowering time of weed ecology from Hattusha samples

Figure-29 shows the density of the flowering time of selected weed taxa used in the analysis. It shows the distribution of flowering species by month within the plant family. The more species there are in that month, the more weight is given in the calculations.

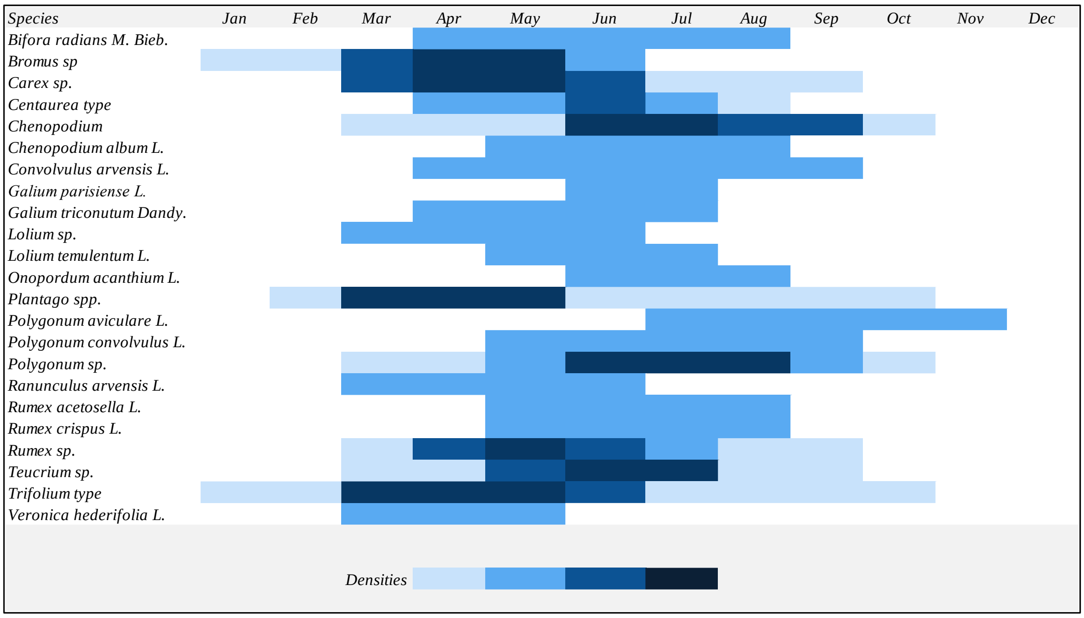

Figure 29 Density map of the flowering period of the selected weed ecology (sources: AHDB, n.d.; Lucas, 2012)

CHAPTER 7

DISCUSSION

7.1. General

In General, the archaeobotanical assemblages of all sites examined in the scope of this study consist of 207.491 plant remains with 147.518 carbonized grains, 9.632 carbonized legume seeds, 21.485 chaff, internodes and other cereal parts, 27.877 carbonized weed seeds in total. The unidentifiable cereal remains (grain, seed, cereal parts) constitutes approximately 10% of total number. In this study, cereals, legumes and weed ecology are used to understand the variations in the crop diversity, crop preferences, tillage strategies and seasonality as well as to trace the role of central authority in the socio-politic transformation of Hittites from kingdom to empire. By using these agents, it is specifically concentrated on revealing evidence for any diversification, similarity or meaningful pattern and crop pairs that could boost agricultural production or support the role of the centralization on surplus increase. The ultimate aim of thesis is to understand the intensification efforts in the farming strategies and to what extend the influence of the central authority may exerted in the imperial process.

7.2. Diachronic Changes in Crop Diversifications

Crop diversification has been a widely used technique from the time of early farmers to reduce the risks of crop failure and to guarantee the sustainability and resilience of the food system (Marston J. M., 2011). It is an effective solution against product losses that may occur due to a possible frost, disease, drought or other reasons (Styring et al., 2017). At the same time, it is an effective way to increase the resilience of the agricultural systems (de Roest, Ferrari, & Knickel, 2018). Main cereal species in the investigated sites are *Triticum aestivum*, *Triticum aestivum/durum*, *Triticum dicoccum* and *Triticum monococcum* forming the wheat group and *Hordeum vulgare* and *Hordeum distichum* as the barley group. Especially the large hermetic underground silos of Hattusha contain huge number of barley grains possibly for food and fodder purposes as well as seed source for drought years (Diffrey, Neef, Seeher, & Bogaard, 2020). Barley could always have been preferred due to its drought resistance. It is known that it has been grown at very high altitudes such as Sarissa since ancient times (Laurent, 2015). Considering that the agriculture in Central Anatolia is rain fed (Schachner, 2012), the importance of barley is well understood. *Triticum spelta* grains and rachis fragments found in Sarissa can be considered as a very important sign of increasing efforts of the product range and/or expansion of the agricultural fields. Foxtail millet (*Setaria italica* L.) found in Sarissa, similar to spelta, might be an important indicator of increasing crop range possibly by the influence of imperial body considering the religious and administrative position of the Sarissa city where crop diversification could directly be managed by central authority. However, the diversity analysis results show that especially in the imperial period there was a considerable decrease in the crop diversification. The vast majority of the imperial period samples and Middle Hittite period Sarissa sample have the lowest diversity indexes. This result may originate from contextual differences and/or environmental changes. However, specialization in agriculture with relatively large fields under the control of central authority might also be suggested. As it is discussed in the previous chapters that mass production, standardization and specialization are suggested as the main indicators of imperial influence on production (Gates M., 2001). It may be possible to intensify production by concentrating on certain product types and specializing in them with the political involvement. This result is also parallel with the previous archaeobotanical studies which suggested that certain crop species concentrated in hilltop settlements (Styring et al., 2017) and the relation between agricultural land expansion and the presence of *Triticum spelta* (van der Veen M. , 1992).

7.3. Diachronic Changes in Crop Preferences

It can be inferred from the analysis results that the crop preferences show an obvious shift from hulled to free-threshing wheat from Karum to Empire period over time nearly in all settlements. In this regard, a standardization is observed in the Hittite core region in terms of increase in the free-threshing wheat prevalence. Free-threshing wheats have higher productivity and required less labor input to be processed because the grains of free-threshing wheat fall free from the glumes. Thus, free-threshing wheats have the potential to increase the output by decreasing the input which can be suggested as a strong sign of intensification in agricultural production. However, free-threshing wheats are considered as demanding crops thus, their water and soil requirements are higher than other wheat species (Behre & Jacomet, 1991). Therefore, it could be suggested that irrigation and/or fertilization facilities may have been increased especially towards the imperial period. Schachner (2022) suggested that the surplus increase is mainly possible with extensification in pre-Industrial periods except some manuring and small-scale irrigation activities. However, there is fact that excessive irrigation could lead salinization of soil in the long-term and this may lead Hittites to cultivate barley, meadow and/or pasture plants to reduce salt in the soil (Atasoy & Geçen, 2014). Salination is considered as a very serious problem for agricultural sustainability (Jacobsen & Adams, 1958).

In the 16th BC Hattusha samples, it is observed that barley was the prominent crop together with *Vicia faba* as legume possibly as a second product. Barley is known for its drought resistance as well as its ability to grown in salty soils (Atasoy & Geçen, 2014). Furthermore, it can reduce the salt content of the soil by absorbing it. Therefore, Hittites might be cultivated barley to reduce salt content of their fields. Jacobsen and Adams (1981) stated that salinization is an important factor that determine the crop choices (Jacobsen & Adams, 1958). However, barley is a demanding crop and require rich soil contents. *Vicia faba* on the other hand, is a legume that can be found near salty marshes (Behre & Jacomet, 1991) and it is one of the most effective legumes in terms of nitrogen binding. Thus, a model could be constructed for barley presence with high amounts. In this model, Hittite center might perform intense irrigated agriculture comparing with the previous periods. However, these intensive agricultural efforts caused salination in the soil and they directed to cultivate barley as a salt absorber and to provide efficiency enrich the soils with the most suitable legumes. The existence of barley and *Vicia faba*, therefore, are seen a very good combination especially for the salinized soils which have been irrigated either by wells and/or very salty rivers such as Kızılırmak and Delice River. Thus, crop rotation or intensive irrigation practices may be suggested for Hittite periods. Nevertheless, the increase in barley amounts can also be attributed with the intensification in animal husbandry as well as unfavorable climatic conditions that lead to drought. Since it is known that barley is more tolerant to drought and sharp climatic changes than the wheat species (McCorriston & Weisberg, 2002).

The decreasing amount of hulled wheat in the samples can also be evaluated as directing to more efficient products and increasing the scale of farming. The presence of hulled wheats can also be evaluated as indicator of low population density and thus a lower level of social complexity (Lucas, 2012) and small-scale agriculture specifically for emmer (van der Veen, 1992). The productivity of hulled wheats might not have been sufficient to produce surplus to feed a populous empire. On the other hand, it should be remembered that emmer and einkorn and barley are suitable for long-term storage due to their morphologic structures (Nesbitt, 1995). Also, the glumes protect the grain from fungi infestations and for this, these hulled cereals are preferred in the wet climate of Black Sea even today (Nesbitt, 1995). Besides, einkorn is a crop that intake less organic matter from the soil. Thus, it is known that in Roman times it was used in the crop rotation cycles (White, 1970). The presence of the emmer is also evaluated as intense but small-scale agriculture (van der Veen, 1992). Therefore, it is possible that Hittites increased the scale of their agriculture practices and exercised crop rotations, the plant remians support this view notably in Hattusha.

7.4. Diachronic Changes in Husbandry Practices

Soil preparation has a great influence on productivity. Applications such as fallowing, weeding, tillage, erosion prevention and water retention are the main husbandry strategies used to increase yield. In this sense weed ecology in archaeobotanical samples is considered a good indicator to learn the past husbandry practices. Analysis results suggest a distinct decrease in perennial weed taxa towards imperial period while the number of annual weeds increase. These results generally are interpreted as high-intense tillage and/or decrease in fallowing durations (Styring et al., 2017: Jones, 2002) and possibly the cultivation of same fields (Jones, 2002). Thus, intensive tillage can be suggested notably under the Hittite rule. The decreasing trend of emmer wheat also supports the increase of agricultural fields. Emmer wheat is an indicator of small-scale agriculture, whereas the presence of spelta is evaluated as an increase in the scale of production with less intensification (van der Veen, 1992). In the light of the data we have, it can be concluded that large scale production and extensification has been started over time, especially in Sarissa and Hattusha.

Fallow is another important practice that can increase the fertility of fields especially the regions having fewer or instable annual precipitation (Demiralay, 1981). In order to increase the water holding capacity of the soil and prevent soil erosion fields are occasionally left fallow with stubble in modern agricultural fields (Dursun, 2017). However, fallow pasture applied in these fallow areas can cause soil compaction. Weeds that indicate compacted soils is mostly found in Middle Hittite Sarissa. However, the empire period samples in Sarissa include weed remains that suggest well-manured, garden type cultivation. On the other hand, the presence of spelta remains represent low intense large-scale agriculture (van der Veen M. , 1992). The high perennial concentration in empire Sarissa sample support less tillaged fields. Besides, in Hattusha samples, no weed ecology is seen as an indicator of intensive soil compaction. The interpretations that can be made for the Middle Hittite period Sarissa sample are the possibility that the lands could be left fallow with stubble and grazing practiced on these fields or intense cultivation was performed possibly in wet soils particularly in spring season for summer sowing. The flowering months of the weed taxa suggest both winter and summer sowing according to the analysis results. However, the compaction might occur due to other environmental factors. Therefore, more data is needed for more reliable interpretations.

Crop rotation is another important application for ensuring productivity. Sowing of the same cereal in consecutive years cause cereal disease and lead to serious yield loss. Legumes are generally preferred in crop rotation with cereals (Bağcı et al., 2010). In the studied samples, no legumes were found to a large extent except the 16th century BC samples where *Vicia faba* dominates some of the chambers with approximately 20 percent RA. Here, considering that the remains of the chambers were collected from distinct regions, it can be suggested that cereal and legume cultivation might be performed in the same field regions either same time or diachronically (Diffrey, Neef, Seeher, & Bogaard, 2020). Nevertheless, it can also be suggested either full or partial crop rotation may have been applied in some regions where a big field might be divided into smaller sections in order to grow different crops. **Figure-30** shows the scheme of partial crop rotation.

Figure 30 Representation of partial crop rotation (source: T.C. Milli Eğitim Bakanlığı,2016)

7.5. Diachronic Changes in Sowing Periods

The analysis results show no major alterations in seasonality of economic crops considering the flowering time of the weed taxa found in the analyzed samples. The cereal sowing period was winter in Hittite realm considering Çadırhöyük, Hattusha, Kaman and Sarissa samples. The result is consistent with accepted applications which suggest winter sowing is much more productive than summer sowing especially in the dry regions (Tülübaş & Kara, 2019). The only example that can be shown as an exception is the Middle Hittite period sample which includes weed taxa flowering in the September-October period with a high ratio. It can be claimed that summer and winter barley cultivation could be applied in Middle Hittite Sarissa as mentioned in the previous sections.

7.6. Regional Comparisons and Centralization

It is thought that the analysis results presented in this thesis work provides important insight about the past agricultural strategies of the Hittites. Considering the overall region, it can generally be suggested that there is a shift from hulled to free-threshing wheat over time. On the other hand, region-based CA results show us contextual representations rather than chronological. Storages and house contexts are tended to cluster distinctly. It was one of the important outputs of the study.

To observe the sustainability efforts of central authority can be accepted as the other important output of the thesis work. Van der Veen & Jones (2006) in their study in England pointed out that pits storing cereals in hillforts were considered as the proof of large-scale production and consumption and such might also be the case for Sarissa and Hattusha (van der Veen & Jones, 2006). It would not be wrong to interpret these big public structures as one of the Hittites' agricultural surplus controls. The underground silo at Hattusha can be seen as evidence of the Hittites' long-term food supply policy (Schachner, 2012). It is known that some of the farmers in Anatolia still store their products in pits which can save cereals over hundred years. In this respect, it can be said that the Hittite state made efforts to ensure sustainability in agriculture and concentrate on durable cereals. The historical trend of cereals shown in **Figure-21**, it is seen that majority of the Old /Middle Hittite Period samples are represented by hulled cereals and especially barley, whereas the Assyrian and Imperial Hittite Periods are mainly represented by free-threshing wheat. The differences could be contextual such as public and domestic usage. Similarly, the high barley concentration can be attributed with the intensification in animal husbandry, or arid seasons (McCorriston & Weisberg, 2002). The high barley concentration can also be attributed to soil salinization, which was seen as a problem so great that it could cause the fall of ancient civilizations (Jacobsen & Adams, 1958). Thus, the increased ratio of barley content in the samples belong to different settlements might be interpreted as the standardized policy of Hittites on special crops. Standardization and specialization on certain products are interpreted as the indicators of the imperial policies of Hittites on the intensification in production (Gates M. , 2001)

The intense barley production together with high amount of *Vicia faba* in 16th century BC Hattusha layers might suggest the full or partial crop rotation which is applied by dividing the field into pieces. This result can also be evaluated as the effort of the Hittites to make optimum use of their land. Excessive cultivation or irrigation might cause salination of agricultural fields. Barley is a plant that is salt tolerant and has the ability to reduce the salt content in the soil. *Vicia faba* is also a product that can grow around salty waters and enrich the soil with about 50 percent more nitrogen than lentils. Thus, it can be interpreted as the coexistence of this plant duo as a possible crop rotation combination. Considering that these plant remains were recovered from a state controlled underground silo, it can be suggested that the production practices are at least within the knowledge of the central administration. Again, according to the analysis results, it is observed that einkorn wheat disappeared over time. We can also interpret the disappearance of this product, which has low productivity and high-water requirements, as an effort for getting more product from per-unit area and using resources more efficiently (Riehl, 2012). Another interpretation can be done in terms of the scale of the agricultural practices. The presence of emmer is evaluated as the small-scaled and intense subsistence strategy whereas the abundance of spelta is attributed with less intense large-scale farming (van der Veen, 1992). Thus, the decrease in emmer concentration and presence of spelta specifically for Sarissa could be evaluated as shift to less intense but large-scale agriculture in the empire period. The increasing number of perennials in the empire period samples support the decrease in soil disturbance levels.

Weed taxa also provides valuable information about the intensity of cereal cultivation. The presence of modern wheat field weeds in the ancient samples may indicate an intense cereal cultivation in the Hittite empire. The decrease in perennial weeds and increase in wheat field weed taxa in the Empire Period can be considered as a strong proof of increasing agricultural intensity e.g. tillage and/or weeding or shorten the fallowing durations and/or applying successive crop rotations. Flowering time of the weed taxa also suggest the sowing time of the cereals. The results are compatible with modern practices. It is very important to see this result with archaeobotanical data as well. The analysis results of weed taxa also suggest both well manured and irrigated garden type cultivation as well as intense cereal cultivation in different regions of empire and in the close periods. It can be proposed that various agricultural practices were applied in the region.

Another noteworthy result of the analysis is to observe a considerable decrease in crop divergence especially in Empire Hittite samples. This result can be evaluated as specialization in production that managed by the central authority. However, the decrease in crop diversity can also be linked with environmental factors. Unfavorable climatic conditions may have made it necessary to turn to certain products.

CHAPTER 8

CONCLUSION

The results of the archaeobotanical analysis of the prominent Central Anatolia settlements located in the Hittite core region present an important insight on subsistence strategies and possible central interventions of Hittites in their socio-political transformation to empire. In this sense, it was initially focused on the concept of empire. After examining the empires in general terms, the possible effects of strong centralism which is the most prominent feature of historical empires, was searched for. It is understood from the prominent imperial studies on Hittites that mass production, standardization in production and specialization in some senses are considered as the possible indicators of imperial influence on production. Thus, while investigating the effect of the central authority, it is specifically tried to focus on intensification activities in agriculture. In this respect, crop preferences, crop diversity, seasonality and tillage densities over time were analyzed in order to trace any sign of specialization, standardization as well as similarities, differentiations and meaningful patterning on the changed data in time. Archaeobotanical samples obtained from five main Hittite settlements located in the core region were analyzed both individually and regionally in this respect.

The results of the archaeobotanical analysis of the existing data set show that there is an obvious shift from hulled to free-threshing wheat over time. Another important result of the study is the intense barley production especially under Hittite reign in the analyzed settlements. Free-threshing wheat is more resource demanding than emmer and einkorn wheat in terms of soil and water requirements. However, the advantage of bread wheat is that it is easy to process because it has no glume and its productivity is high. Similarly, although barley is highly resistant to drought, it is a plant with high soil requirements and absorbs more organic matter from the soil. Thus, the observable increase of these two resource demanding crops in the Hittite period led to analyze the agricultural practices of the Hittites in more detail.

Fallowing, crop rotation, seasonality, tillage intensity, crop diversification in this sense, were the variables that it is primarily focused on. The fact that the existed data is chronologically discontinuous and few in number caused to prevent of making definite judgments. If the number of samples had been larger and chronologically complete, no doubt that the results of the analysis could have produced more precise results. However, it has obtained some results thought to be significant.

1. The presence of high amounts of *Vicia faba* and barley in the 16th century BC Hattusa levels may suggest complete or partial crop rotation. This result can be evaluated as efforts to intensify in agriculture. The high barley content, especially in Hittite samples, can also be evaluated as a concentration in animal husbandry, the presence of dry seasons or salinization in agricultural soils. Salinization is often caused by intensive cultivation, particularly improper irrigation of farmland and/or landscape features. Therefore, intensive irrigation can be suggested as a sign of agricultural intensification during the Hittite period.

2. Weed ecology analysis results suggest that cereals were generally sowed in winter in all settlements and this situation have not changed much over time. Results suggesting both summer and winter cultivation were obtained only in the Middle Hittite Sarissa sample. The reasons such as the focus of the sample on a single product, the meticulous removal of weeds, and the fact that it has an administrative context may show the influence of the central authority in this practice.

3. The increase in the edible crop species in Sarissa samples in time could be accepted as the increasing of crop range. *Triticum spelta* and *Setaria italica* were only seen in the imperial Sarissa samples. Considering that Sarissa was an administrative center of the empire, it is possible that the cultivation of these crops could be attributed to the imperial intervention. The presence of spelta

may also show large-scale farming and expansion of the agricultural fields in the imperial period.

4. The large food stores found in the Hittite layers of Hattusha, Sarissa and Kaman can be interpreted as the effort of the Hittite Center to control the food supply. In particular, large quantities of barley and hulled wheat recovered from the large underground hermetic silo in Hattusha show that certain products were especially preferred for long-term food or seed storage and that there could be a long-term policy in that area.

5. Decrease in the crop heterogeneity in the samples toward to the imperial period could be evaluated as the specialization in the agricultural production. Specialization in agriculture may also be evidence of farming on larger areas. Therefore, specialization can also be an indicator of expanding farmland and imperial influence.

6. The increase of modern wheat field weeds such as *Galium triconutum Dandy, Bifora radians M. Bieb., Polygonum aviculare L., Ranunculus arvensis L.* over time can be evaluated as an increasing intensification of wheat cultivation.

7. Decreasing in the perennial weed taxa especially in Hattusha samples through time is an important indicator of intense-tillage and/or less-fallowing. In this regard, it can be suggested that tillage density was increased towards the imperial age in Hattusha.

In summary, the crop preferences under Hittite reign shows a shift to more productive crops. More intensive cultivation and preferences of crop species suitable to the landscape are other significant results of the Hittite period different from previous periods. The archaeobotanical data found generally focus on certain product types may be interpreted as the State's specialization in production. In this context, the results of the analysis of the archabotanical data support the intensification and expansion of agriculture in a way that will meet the increasing needs of the Hittites during the transition to the empire. Besides, the fact that the majority of the archaeobotanical data was recovered from the state-controlled silos can be regarded as an archaeological reflection of the state's role in agricultural production. Further researches in this field can focus on more in empire period Hattusha layers as well as smaller rural settlements to trace the influence of central authority in detail. Furthermore, as it can be seen from the analysis results in this thesis work, the contextual information of the samples is very important for the interpretation of the archaeobotanical data. For this reason, it will be very useful for future studies to address context information in detail particularly in the new archaeobotanical publications. In the same way, numerical representation of the plant remains will enable more statistical analyzes to be made on the data and to reach new results.

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APPENDICES

A. TURKISH SUMMARY / TÜRKÇE ÖZET

Tarih sahnesinde MÖ 1650 yılında çıkan Hititler, Orta Anadolu'da Tunç Çağı'nın en önemli ve güçlü ve büyük imparatorluklarından birini kurmuşlardır. Hitit ülkesinin sınırları, Hatti Ülkesi olarak da anılan ve kabaca Kızılırmak havzasına karşılık gelen çekirdek bölgeden başlayarak, zaman içerisinde batıda Ege Denizi, doğuda Fırat Nehrinin ilerisi ve güneyde de Kuzey Suriye'ye kadar genişlemiştir. Hititler aynı zamanda Mısır, Babil ve Asur gibi diğer çağdaş güçlerle askeri, siyasi, edebi, sanatsal ve kültürel açıdan karşılaştırılabilecek gelişmiş bir medeniyete sahip olmuşlardır. Hitit kronolojisi literatürde genel olarak Eski, Orta ve İmparatorluk dönemi olmak üzere üç genel kısma ayrılmaktadır. Bunlardan özellikle sınırlarını ve etki alanını önemli ölçüde arttırdığı MÖ 14. Yüzyılın ortaları, Hititlerin imparatorluk çağının başlangıcı olarak kabul edilir. Genişleyen sınırlar, artan nüfus, büyüyen bir bürokrasi ve ordu gibi olguları da beraberinde getirdiği düşünülen bu dönem için tarımsal üretim artışının bir zorunluluk olduğu düşünülmektedir. Bununla birlikte Anadolu gibi yağmur suyuna bağımlı, sıklıkla kuraklıkların yaşandığı ve özellikle endüstri öncesi dönemlerde oldukça kırılgan bir yapıya sahip olduğu bilinen bir tarım sisteminin Hitit'leri güçlü bir imparatorluğa nasıl taşıdığı sorunsalı literatürde üzerinde durulan konulardandır. Nitekim artan ihtiyaçların karşılanabilmesi için, gıda ithalatının yanında önemli ölçüde bir tarımsal artışın da olması gerektiği düşünülmektedir. Bu anlamda Andreas Schachner özellikle Hititler gibi endüstri devrimi öncesi toplumlarda tarımsal ürün artışının büyük çoğunlukla tarım topraklarının genişletilmesi yoluyla elde edilebileceğini öne sürmüştür. Bu bağlamda, Şapinuva ve Sarissa gibi Hititler tarafından planlı olarak kurulan yerleşimler ve tarıma açılan yeni arazilerin varlığı, polen kayıtları ile gözlemlenen orman bitki örtüsünün yerini tahıl vejetasyonun alması ve işbu tez çalışması kapsamında elde edilen analiz sonuçları, Hititlerin belirtildiği gibi tarım arazilerini genişletmek suretiyle tarımsal üretimlerini arttırmaya çalıştıklarına işaret etmektedir. Bununla birlikte tarımsal üretimi arttırmanın bir diğer yolu ise birim alandan daha çok ürün elde etmek olarak da tarif edilen tarımsal yoğunlaşma faaliyetleridir. Günümüzde de tarımsal arazilerin ölçeğini arttırmada yaşanan sıkıntılar nedeniyle daha çok birim alandan elde edilen ürünlerin miktarını arttırmaya odaklanılmıştır. Verimliliğin arttırılması olarak da bahsedebileceğimiz bu uygulamaların geçmiş dönemlerde nasıl uygulandığını anlamaya dair elimizdeki en önemli araçlar yazılı kaynaklar ve arkeobotanik verilerdir. Bununla birlikte yazılı kaynakların tarım sistemleri ile ilgili teknik konulara pek fazla girmiyor oluşu, söz konusu sistemlerin arkeobotanik verilerin analizi yoluyla yorumlanması zaruri kılmaktadır. Söz konusu tez çalışması kapsamında da Hititlerin küçük bir krallıktan bölgesel bir süper güce dönüştüğü imparatorluk yapısına geçiş sürecinin bilhassa tarımsal yoğunlaştırma açısından analiz edilmesi amaçlanmıştır. Söz konusu analizler arkeobotanik makro veriler kullanılarak gerçekleştirilmiştir.

Arkeobotanik, geçmiş bitki örtüsünün yanı sıra insanların geçmiş tarımsal uygulamaları ile çevreleriyle etkileşimlerini anlamamızı sağlayan bir disiplindir. Bu bağlamda arkeobotanik veriler, geçmiş toplumların sosyal ve kültürel ilişkilerinin ve diğer kültürel malzeme unsurlarıyla olan etkileşimlerinin belirlenmesinde önemli bir potansiyele sahiptir. Söz konusu tez çalışmasında bu potansiyel Hititlerin zaman içinde geçirdiği sosyopolitik dönüşümü anlamak ve değerlendirmek için kullanılmaya çalışılmıştır. Ancak arkeolojik somut veriler ile geçmişteki sosyal konu gibi kavramların yorumlanması, üzerinde birbirinden farklı çeşitli görüşlerin yer aldığı tartışmalı bir konudur. Bu bağlamda literatürde Hititlerin imparatorluk sürecini konu alan çalışmaların ezici çoğunluğunun imparatorluk kavramıyla daha kolay bağdaştırılabilecek yazılı kaynaklar, seramik, mühür ve anıtsal yapılar üzerinde yoğunlaştığı görülmektedir. Bu nedenle Hititlerin sosyopolitik dönüşümünün tarım özelinde ekonomik faktörlerden ne ölçüde etkilendiği henüz tam olarak ortaya çıkarılmamıştır. Bu çalışma kapsamında soyut bir kavram olarak tarif edebileceğimiz imparatorluk süreci kavramı ile arkeobotanik somut veriler arasında bir köprü kurulmaya çalışılmıştır.

Hitit ekonomisinin ağırlıklı olarak tarım ve hayvancılığa dayalı olduğu bilinmektedir. Tarımın Hititler açısından önemi ayrıca, tarımsal üretimle ilgili konuları içeren kanunları vb. içeren yazılı kaynakların varlığı ile Orta Tunç çağı ve daha öncesine tarihlenen yerleşimlerde özellikle Hitit dönemi ile birlikte gözlemlenmeye başlayan büyük ölçekli gıda siloları ile görülebilmektedir. Ancak hem yazılı metinler hem de arkeolojik kalıntılar ikincil statüde kabul edilebilecek nitelikte veri kaynaklarıdır. Tez kapsamındaki ana hedeflerden biri de tarımsal stratejilerdeki değişimleri birincil veri kaynakları olarak sayılabilecek ekonomik ve yabani ot kalıntılarının incelenmesi yoluyla elde etmektir.

Bu bağlamda, Hititlerin kuruluş dönemi ve birkaç yüzyıl daha öncesinden, Hititlerin imparatorluk sürecinin sonlandığı özellikle MÖ 14. yüzyıla kadar olan dönem içerisinde gerçekleşen tarımsal stratejilerin değişikliklerinin analiz edilmesi amaçlanmıştır. Araştırma periyodunun Orta Tunç Çağına kadar uzatılması değişimlerin daha geniş bir perspektiften izlenmesi amacıyla tercih edilmiştir. Bununla birlikte bağlamdan uzaklaşmamak için Erken Tunç Çağı örnekleri kapsama dahil edilmemiştir. Söz konusu süreç içerisinde arkeobotanik veriler kullanılarak ağırlıklı olarak, ürün tercihlerindeki değişimler, üretimde çeşitlilik, tahıl ekim dönemleri ve tarımsal uygulamalardaki yoğunlukların değişimlerinin incelenmesi üzerinde durulmuştur. Analiz sonuçları neticesinde elde edilen benzerlik, farklılık ve anlamlı örüntüler, merkezi otoritenin bu süreçteki tarımsal stratejiler üzerindeki olası etkileri de göz önüne alınarak yorumlanmıştır. Çalışmanın bütüncül bir bakış açısıyla gerçekleştirilmesi hedeflenmiştir. Bu sebeple yerleşim bazlı analiz ve değerlendirmelerin yanında bölgesel bazda karşılaştırma ve analizler de gerçekleştirilmiştir. Bu kapsamda, Hititlerin başkenti olan Hattuşaş, yine idari, askeri ve dini öneme sahip kentler olan Şapinuva ve Sarissa ile bu idari merkezlere yakın konumlarda yer alan Çadırhöyük ve Kaman-Kalehöyük, tez çalışması kapsamında yer alan yerleşimlerdir. Çalışmasının kapsamı Orta Anadolu bölgesi, daha spesifik olarak Kızılırmak Havzası olarak seçilmiştir. Çalışmanın bu bölge ile sınırlandırılması veri setine sahip Hitit yerleşim sayısının azlığının yanı sıra imparatorluğun idari merkezlerinin yer aldığı ve imparatorluk politikalarının daha çok hissedildiği kabul edilen bir bölge olmasıdır.

İmparatorluk kavramı literatürde birbirinden farklı birçok tanımlama ile karşımıza çıkmaktadır. İlk kez Roma döneminde ortaya çıkan kavram yönetmek anlamına gelen imprare kökünden türemiştir. Söz konusu kavram, özellikle modern dönem tarihçileri tarafından geçmişte var olmuş birçok büyük ve güçlü devlet için de kullanılmaya başlanmıştır. Bununla birlikte, tarihteki her devletin kendine ait özelliklerinin ve farklılıklarının olması, birbirinden farklı tarihsel dönem ve coğrafyalarda yer almaları, tarihteki tüm devletleri kapsayabilen tek bir tanım türetilmesini engellemiştir. Bu konu üzerinde Robert Gorny her bir imparatorluğun kendi içinde eşsiz olduğunu belirtmektedir. Dolayısıyla imparatorluklar literatürde farklı kategoriler altında tanımlanmaya çalışılmıştır. Bu kategorilerden öne çıkan bazıları; imparatorlukları deniz, kara ve tarım olarak gruplarken bir başka gruplama ise imparatorlukların modern ve antik olarak ayrılması suretiyle yapılmıştır. Literatürdeki tanımlama ve kategorilerin çokluğu her ne kadar genel bir tanıma ulaşmayı zorlaştırsa da tanımlamalar arasında önemli ortak noktalar da bulunmaktadır. Bu itibarla, imparatorluk kavramı ile ilgili öne çıkan ve literatürdeki tanımlamaların çoğu tarafından ortak olarak nitelenen en önemli özellik güçlü merkeziyetçilik olarak göze çarpmaktadır. Güçlü merkeziyetçiliğin mümkün kıldığı sınırların ötesine hükmedebilme kabiliyeti ise yine imparatorlukların ortak özelliklerinden olarak öne çıkmaktadır. Toprak büyüklüğü, heterojen yapı gibi unsurlar da yine antik imparatorluklar için literatürde öne çıkarılan diğer önemli unsurlardır. Bununla birlikte güçlü merkezi yapının tarımsal üretim üzerindeki izlerinin nasıl izleneceği çalışma kapsamında üzerinde durulan bir diğer konu olmuştur. Güçlü merkeziyetçiliğin tarımda yoğunlaştırma faaliyetleri ile ilişkilendirilip ilişkilendirilmemesi de yine literatürde üzerinde anlaşmaya varılamayan konulardandır. Bu konudaki görüşlerden biri tarımda yoğunlaşmanın, çiftçilerin bireysel inisiyatiflerinden ziyade devletin baskısının sonucu olabileceğini öne sürmektedir. Bu görüşe göre, tarımda yoğunlaşma yüksek düzeyde iş gücü, teknoloji ve organizasyon gerektirdiğinden, devletin doğrudan müdahalesinin gerekli olduğu yukarıdan aşağıya doğru bir yaklaşımla ve merkezi bir yapının planlama, iş birliği ve yönetim kabiliyeti ile mümkün olabileceğini belirtmektedir. Ayrıca, yine destekleyici bir görüş olarak, en az çaba yasasına göre, çiftçilerin genellikle ihtiyaç duyduklarından daha fazla ürün üretme eğiliminde olmadıkları, artı ürün için seçkinlerin müdahalesine ihtiyaç duyulduğu iddia edilmektedir. Öte yandan, konu üzerindeki bir diğer hâkim görüş ise tarımsal üretimdeki artışın bireysel veyahut yerel düzeyde sağlanabileceği ve merkezi bir müdahaleye ihtiyaç olmadığı yönündedir. Karmaşık bir hiyerarşik yapıya veya devlet organizasyonuna sahip olmayan toplumların da dikkate değer yapılar inşa edip artı üretebildikleri ve yerel sistemlerin, özellikle uzun vadede, devlet destekli sanayileşmiş çiftçiliğe kıyasla daha sürdürülebilir ve verimli olduğu belirtilmektedir. Konu hakkında kesin bir fikir birliği olmamakla birlikte, tez çalışmanın bir diğer zorlayıcı noktası, üretim artışında merkezi otoritenin bir etkisi olsa bile bunu yazılı kaynakların varlığı olmadan ispat edilemeyeceği konusundaki literatürde yer alan görüşlerdir. Bununla birlikte güçlü merkezi yapının, Hititler özelinde yapılan çalışmalar neticesinde; üretimde ve ürünlerde standartlaşma, seri üretim, belirli ürünlerin üretimine odaklanma şeklinde kendini gösterdiği daha önceki çalışmalarda gösterilmeye çalışılmıştır. Bu bağlamda analiz sonuçları benzerlik, farklılık ve anlamlı örüntüler üzerine yoğunlaşırken aynı zamanda üretimde standartlaşmış bir politika ya da belirli ürünlere yönelim olup olmadığı gibi imparatorluğun üretim üzerindeki daha somut ve kanıtlanabilir etkileri olarak kabul edilebilecek unsurlar da yine analiz sonuçları sonunda değerlendirilmiştir.

Çalışma kapsamında Hitit ana bölgesinde yer alan beş yerleşim yerinden elde edilen arkeobotanik makro veriler analiz edilmiştir. Veri seti olarak sadece yayımlanmış kaynaklar kullanılmıştır. Söz konusu veriler üzerine göreceli bolluk, uyumluluk ve benzerlik/çeşitlilik analizleri uygulanmıştır. Çalışma kapsamında tahıl, baklagiller ve yabani ot türleri analiz kapsamında yer almıştır. Bunlardan tahıl ve baklagiller özellikle ürün çeşitliliği ve ürün tercihlerindeki değişimleri izlemek için kullanılırken, toprak işleme yoğunluğu ve ekim dönemlerini anlamak için ise yabani ot tohumları incelenmiştir. Yabani ot tohumları tarım alanları açısından genellikle istenmeyen ve verimi düşüren bitkiler olarak görülmektedir. Bununla birlikte arkeobotanik açısından bakıldığında, geçmiş flora, ürün tercihleri, üretim yoğunluğu gibi değişkenleri açıklamada oldukça önemli göstergeler olarak kabul edilirler. Arkeobotanik verilerin yorumlanmasında daha çok uç ekolojik tercihlere sahip türler indikatör türler olarak kullanılmaktadır. Belirli ortak özelliklere sahip yabancı ot gruplarının bir arada bulunması ise yapılan yorumları güçlendirmektedir.

Analiz sonuçlarının doğru yorumlanmasında araştırılan bölgenin iklim ve coğrafyası ile araştırılan bitkilerin karakteristik özelliklerinin bilinmesi de önem arz etmektedir. Türkiye topraklarının yaklaşık yüzde 11'ine karşılık gelen bir alanı kaplayan Kızılırmak Havzası, çalışma kapsamında incelenen Hitit yerleşimleri de dahil olmak üzere toplam 18 ili kapsamaktadır. Antik çağda Hititler ve Halys tarafından Maraššantiya olarak adlandırılan Kızılırmak Nehri güneyde Toros Dağları ve kuzeyde Kuzey Anadolu Dağları ile sınırlanan Orta Anadolu Platosunda yer almaktadır. Bölgenin ortalama yükseltisi 1250 metre civarındadır ve yıllık ortalama yağış 500 mm mertebesindedir. Tahıl ve baklagiller bölgede yetiştirilen en önemli tarım ürünlerindendir. Hitit ekonomisindeki en önemli mahsuller de ağırlıklı olarak tahıllardı. Bakliyatlar zengin besin içerikleri ile tahıllardan sonra ikinci sırada yer almaktaydı. Tahıllar arasında ilk sırayı arpa ve buğday almaktaydı. Buğday, Hititler tarafından bol miktarda yetiştiriliyordu. Hitit yerleşimlerindeki arkeobotanik buluntular, siyez (Triticum monococcum), emmer (Triticum dicoccum) ve ekmeklik buğdayın (Triticum aestivum) en bol bulunan buğday türleri olduğunu göstermektedir. Siyez buğdayı, Anadolu'da Erken Tunç Çağı'na kadar ilk evcilleştirilen ve baskın türlerden biridir. Morfolojik olarak taneleri kavuzlarla çevrilidir. Bu nedenle soğuğa, hastalıklara ve böceklere karşı serbest harman buğdayına göre daha dayanıklıdır. Emmer buğdayı, siyez buğdayı ile birlikte en eski evcilleştirilmiş iki türden biridir. Ekiminin 10.000 yıl öncesine kadar gittiği bilinmektedir. Hititler döneminde olduğu gibi antik dünyada da yaygın olarak kullanılan buğday türlerinden biriydi. Emmerin karakteristik özellikleri, diğer buğday türlerinin yetişemediği kötü topraklara ve elverişsiz iklim koşullarına uyum sağlama yeteneği olarak tanımlanabilir. Ek olarak buğday hastalıklarına, kuraklığa ve aşırı sıcaklıklara da oldukça dayanıklıdır. Ekmeklik buğday ise morfolojik olarak serbest harman grubunda olup, kabuksuz taneleri ve yumuşak kavuzları sayesinde işlenmesi kolaydır. Ancak hem değişen iklim koşullarına uyum yeteneği hem de dayanıklılığı emmer ve siyez buğdayından daha azdır. Ekmeklik buğdaydan elde edilen un çok incedir. Bu nedenle ekmek üretimi için daha uygundur. Antik dünyanın en eski mahsullerinden biri olan arpa ise kuraklığa, alkali ve tuzlu topraklara dayanıklılığı, üretim kararlılığı ve iklim dalgalanmalarına karşı daha stabil oluşu gibi nedenlerle Tunç Çağı Anadolu'sunda çokça tercih edilen bir tahıl olmuştur. Hitit ülkesinde en yoğun yetiştirilen bitki olarak kabul edilmektedir. Arpa, İç Anadolu bölgesi gibi nemin düşük olduğu bölgelerde yüksek sıcaklıklara dayanabilmektedir. Ancak kışlık bir ürün olarak buğdaydan daha az verimlidir. Bununla birlikte yıllık yağış oranı oldukça düşük ve düzensiz olan Orta Anadolu Bölgesi için oldukça önemli bir türdür. Baklagiller antik dünyada tahıllarla birlikte diğer önemli besin kaynaklarıydı. Baklagillerin içeriğinde yüksek miktarlarda protein bulunmaktadır. Toprağı azot yönünden zenginleştirebilmeleri nedeniyle genellikle dönüşümlü ekimde tercih edilmektedirler. Dolayısıyla baklagillerin varlığı, dönüşümlü ekimin veya geçim stratejilerindeki farklılıkların kanıtı olarak değerlendirilebilir. Bakla, nohut, bezelye, nohut, fiğ ve mercimek. Çalışma kapsamında en çok karşılaşılan Hitit dönemi baklagilleri olarak öne çıkmaktadırlar.

Analizler bölgesel ve yerleşim bazında daha detay olarak da tahıl, baklagiller ve yabani ot ekolojisi özelinde gerçekleştirilmiştir. Çalışma kapsamında elde edilen en önemli sonuçların bazıları Hitit başkenti Hattuşaş'tan elde edilmiştir. Anadolu'da bulunan en büyük arkeobotanik kalıntı olarak kabul edilen ve MÖ 16. Yüzyıla tarihlendirilen, devlet kontrolüne ait olduğu düşünülen yer altı silosundan elde edilen bitki kalıntıları Hititlerin tarımsal stratejilerini anlama konusunda önemli veriler sunmaktadır. Yine Karum ve Hitit kuruluş dönemine tarihlendirilen bitki kalıntıları, Hitit kuruluş dönemine ait önemli veriler sunmakta olup bir başka sosyopolitik dönemin anlaşılmasına ışık tutmaktadır. Kuruluş, Eski Krallık dönemlerinin yanı sıra imparatorluk dönemine ait veriler de sunan Hattuşaş böylece çalışma kapsamında imparatorluk sürecinin izlenmesine olanak sağlayan Sarissa ile birlikte iki yerleşimden biri olarak öne çıkmaktadır. Hattuşaş'tan elde edilen verilerin analiz sonuçları, kabuklu buğdaylardan, serbest harman buğdaylara doğru bir değişim yaşandığını göstermektedir. Bu durum verimliliği düşük olan buğday türlerinden daha verimli türlere bir geçiş olarak yorumlanmakta ve tarımda yoğunlaşmanın olası bir işareti olarak görülmektedir. Bununla birlikte yer altı silosundan elde edilen kalıntıların ise göreceli bolluk olarak en çok arpa ve kabuklu buğdaylarca temsil edildiği görülmüştür. Uzun süreli gıda, yem ya da tohum depolanması için kullanıldığı düşünülen bu yer altı silosunun, bozulma, çürüme ya da böcek istilası gibi etmenlere daha dayanıklı olarak kabul edilen kabuklu buğday ve arpa türlerinin özellikle tercih edilmiş olduğu, çok düşük serbest harman buğday varlığı ile görülebilmektedir. Söz konusu tercihler ve deponun devlet kontrolünde olması Hitit Devletinin uzun süreli tarım politikalarına sahip olduğunu göstermesi açısından önemlidir. Yine yer altı silosundan elde edilen örnekler kapsamında elde edilen bir diğer önemli sonuç da bakla bitkisinin, MÖ 16. Yüzyıla ait tüm örneklerde, diğer baklagillere kıyasla çok daha fazla bolluklarda bulunmasıdır. Bu durum baklanın göreceli tuz dayanımı ve toprağa azot bağlama kapasitesinin mercimek gibi bazı baklagillerden daha yüksek oluşuna bağlanabilir. Ek olarak baklanın yoğun arpa varlığıyla birlikte bulunması topraktaki tuzluluk sorununa karşı yapılan bir ürün dönüşümünü işaret edebilir. Bölgede yer alan Kızılırmak ve Delice çayı gibi su kaynaklarının yüksek tuzluluk oranına sahip olduğu bilinmektedir. Bunun yanı sıra aşırı toprak işleme ve sulama faaliyetlerinin de toprakta tuzlanmaya yol açtığı bilinmektedir. Tuzlanma tarihteki birçok önemli devletin ortadan kalkmasına sebep olacak kadar önemli bir sorundur ve günümüzde de güncelliğini korumaktadır. Bu kapsamda, arpanın varlığı, artan sulama faaliyetleri, bir diğer ifadeyle de tarımda yoğunlaşma çabalarıyla açıklanabilir. Arpa ve baklanın bu doğrultuda birbirinden farklı yerlerden alınan birçok numunede yüksek oranlarda bulunması ise sistematik ve standart olarak gerçekleştirilen bir ürün tercihi ve ekim rotasyonuna işaret edebilir. Bu nedenle MÖ 16. Yüzyıl Hattuşaş örnekleri tarımda yoğunlaşma ve merkezi otoritenin etkisi ile ilgili güçlü veriler sunmaktadır. Bununla birlikte yüksek arpa konsantrasyonunun; arpanın kuraklığa ve iklim değişimlerine dayanımı ya da hayvan yemi ile de ilişkili olabileceği göz ardı edilmemelidir. Verimi düşük kabuklu buğday türlerinin zaman içinde azalımı, düşük ölçekli yoğun tarımdan büyük ölçekli ancak daha az yoğun tarıma işaret ettiğine dair literatürde çalışmalar bulunmaktadır. Kabuklu buğdayların azalışının bu çerçeveden yorumlanması yeni ya da atıl tarım arazilerinin ekonomiye kazandırıldığı şeklinde yorumlanabilir. Hattuşaş’tan elde edilen yabani ot kalıntılarının analiz sonuçları, tahıl ve baklagiller üzerine yapılan analiz sonuçlarını destekler niteliktedir. Karum döneminden imparatorluk dönemine doğru azalış gösteren iki ya da çok yıllık bitkilerin yerini zaman içerisinde tek yıllık otsu bitkilerin aldığı görülmüştür. Söz konusu durum genellikle toprak işleme faaliyetlerinde artış olarak kabul edilmektedir. Bu kapsamda, işlenmeyen ve boş bırakılan toprakların habitatının zaman içerisinde odunsu bitkilere doğru yöneldiği bilinmektedir. Dolayısıyla, sonuçlar imparatorluk dönemine doğru tarımsal faaliyetlerde bir artış olduğu şeklinde yorumlanabilir. Benzer sonuçlar iyi gübrelenmiş, sulanmış, genellikle küçük ölçekli bahçe tipi tarımı işaret eden *Chenopodiatea* ve *Polygonaceae* türlerinin Karum döneminden itibaren azalış göstermeye başladığını buna karşın günümüzde Hitit coğrafyasında yoğun buğday tarımı yapılan yerlerde sıklıkla rastlanılan *Bifora radians Bieb., Galium tricornutum Dandy., Sinapis arvensis L, Agrostemma githago L, Ranunculus arvensis L., Polygonum aviculare L., Chenopodium album L., Convolvulus arvensis L., Adonis spp.*, yabani ot türlerinin imparatorluk dönemine doğru önemli bir artış sergilediği görülmüştür. Bu sonuçlar da Hititlerin tarımsal üretimlerinde zaman içerisinde yoğunlaşmaya doğru gidilmiş olabileceğini göstermesi açısından önemlidir.

Sarissa örnekleri ise farklı bağlamsal koşulları yansıtmaktadır. Bununla birlikte, Sarissa örneklerinin analiz sonuçları farklı dönemlerde hem yoğunlaşma hem de tarımsal arazilerin genişletilmesi yoluyla üretim artışı sağlandığına dair kanıtlar sunmaktadır. İmparatorluk dönemi tabakalarında tespit edilen *Triticum spelta*'nın varlığı literatürde, tarım arazilerinin arttırılması ve tarım yoğunluğunun düşürülmesi şeklinde yorumlanmaktadır. Bununla birlikte yine imparatorluk dönemi tabakalarından elde edilen yüksek emmer buğday içeren örnekler ise yüksek ve düşük yoğunluklu tarımın benzer dönemlerde uygulandığına işaret edebilir. Yine imparatorluk dönemi tabakalarında spelta kalıntıları ile birlikte tespit edilen örneklerdeki *Rumex crispus, Onopordum acanthium L*., gibi çok yıllık türlerin göreceli bolluğundaki artış bu örneklemin elde edildiği bölgedeki düşük yoğunluklu tarımı desteklemektedir. Yine modern buğday tarlası yabani ot kalıntılarının imparatorluk döneminden elde edilen tüm örneklerde önemli bir artış göstermemesi farklı tarım stratejilerinin uygulandığına işaret etmektedir. Bununla birlikte, Sarissa Orta Krallık dönemine tarihlendirilen örnekler tarımsal yoğunlaşma ile ilgili önemli ipuçları sunmaktadır. Yüzde 98 oranında arpa konsantrasyonuna sahip bu örneklemde, diğer bitki kalıntılarının oranı yüzde 2'nin altındadır. Ürünlerin titizlikte temizlendiğini gösteren bu sonuçlar ayrıca literatürde devlet etkisini işaret eden unsurlardan kabul edilen üretimde belirli ürünlere odaklanıldığı şeklinde de yorumlanabilir. Yine analiz sonuçlarından mevcut yabani ot konsantrasyonun yüzde 90 mertebesinde sıkışış topraklarda yetişen türlerin oluşturduğu görülmüştür. Toprakta sıkışma doğal nedenlerle oluşabileceği gibi hayvan otlatma, yoğun ve özelikle de ıslak toprağın işlenmesi ile ortaya çıkabilmektedir. Ekim dönemi analizinden elde edilen sonuçlar da Orta Krallık Dönemine ait olan bu örnekte yazlık ve kışlık ekim yapıldığına dair kanıtlar sunmaktadır. Dolayısıyla sonuçlar yoğun toprak işleme şeklinde yorumlanabilir.

Kalehöyük örneklerinde elde edilen en önemli sonuçlar serbest harman buğdaylarının tüm dönemlerdeki ezici çoğunluğu ve Hitit dönemi ile birlikte göreceli olarak artan arpa yoğunluğu olarak not edilmiştir. Bununla birlikte örneklerdeki kabuklu buğday konsantrasyonunun Hitit dönemine doğru azalış göstermesi daha büyük ölçekli tarıma, daha verimli türlerin yetiştirilmesi, kuraklık ya da tuzlanmaya karşı daha dayanıklı türlerin seçimi şeklinde yorumlanabilir. Bununla birlikte Kaman-Kalehöyük örneklerinin imparatorluk dönemi örnekleri içermemesi, imparatorluk dönüşümünün yorumlanmasını sınırlandırmıştır. Çadırhöyük ve Şapinuva'dan elde edilen örnekler de sadece birer dönemi kapsadığı için sürecin takibini yapmayı imkânsız kılmıştır. Söz konusu örneklerdeki yabani ot tohumlarının kayıtlarının azlığı ya da nümerik olarak yapılmaması da yine aynı şekilde tarım stratejileri üzerine analiz gerçekleştirilememesine neden olmuştur. Bununla birlikte eldeki verilerle, Kaman-Kalehöyük, Çadırhöyük ve Şapinuva'da kışlık tarım yapıldığı görülmektedir. Bu durum Orta Anadolu gibi yıllık yağışı yetersiz olan coğrafyalar için beklenen bir sonuçtur ve geçmişteki uygulamaların modern uygulamalarla karşılaştırmasını yapması açısından önemlidir.

Mevsimsellik analizi sonuçları, Sarissa'dan alınan Orta Hitit Dönemi örneği dışındaki tüm örneklerde kışlık tarıma işaret ederken, söz konusu örneğe ait sonuçlar hem kışlık hem de yazlık tarımın yapıldığını önermektedir. Bununla birlikte Sarissa gibi 1650 metre yükseklikte kurulmuş ve karasal etkilerin fazlasıyla hissedildiği bir coğrafyada yılda iki ürün alınıp alınamayacağı önemli bir husus olarak karşımıza çıkmaktadır. Bu anlamda yabani otların sonradan örneğe bulaşmış olması ya da geçmişte polen ve ağaç halkası analizlerinin önerdiği gibi bölgede bugünkünden daha yumuşak bir iklime sahip olması ihtimal dahilindedir. Bununla birlikte Tibet'te geçmişte aşırı kabul edilebilecek yüksekliklerde yazlık ve kışlık tarımın uygulanabildiği bilinmektedir. Bununla birlikte, söz konusu uygulamanın tüm çalışma kapsamında sadece tek bir örnekte görülmüş olması nedeniyle daha fazla örneğin analiz edilmesiyle daha net sonuçlara varılacağı düşünülmektedir. Mevsimsellik analizi sonucu elde edilen bir diğer önemli sonuçta yabani otların çiçeklenme döneminin, Karum döneminden imparatorluk dönemine doğru geçen süre içerisinde yaklaşık iki ay kadar ileriye kaymış olmasıdır. Bu sonuçlar, iklimsel bir soğumaya işaret edebileceği gibi yeni ve daha yüksekte yer alan arazilerin tarım arazisi olarak kullanılmaya başlanması şeklinde de yorumlanabilir. Bölgesel bazda gerçekleştirilen bir diğer analiz de ürün çeşitliliğindeki değişimi gözlemlemek üzere tüm yerleşimlere ait tahıl kalıntıları üzerine uygulanmıştır. Analiz sonuçları imparatorluk dönemine doğru ürün çeşitliliğinde düşüş olduğunu göstermektedir. Evsel bağlama ait olduğu düşünülen örnekler ile Asur Dönemine ait örnekler ise yüksek ürün çeşitliliğini gösteren yüksek indekslere sahiptir. Söz konusu sonuçlar, imparatorluk döneminde, yine imparatorluğun etkisiyle belirli ürünlerin üretimi üzerine yoğunlaşma olduğu şeklinde yorumlanabilir.

Sonuç olarak, Hattuşaş, Şapinuva, Sarissa, Kaman-Kalehöyük ve Çadırhöyük'ten elde edilen verilerin analiz sonuçlarına göre tüm bölgede serbest harman buğday yoğunluğunda bir artış gözlemlenmiştir. Bu durum imparatorluğun ana bölgesinde bir standartlaşmaya gidildiği şeklinde yorumlanabileceği gibi daha verimli ürünlere bir yönelim şeklinde de değerlendirilebilir. Serbest harman buğdaylarının suya ve organik maddeye daha çok ihtiyaç duyması bu anlamda sulama ve gübreleme faaliyetlerinde süreç içerisinde yaşanan gelişmelere işaret edilebilir ve tarımda yoğunlaşma şeklinde yorumlanabilir. Mevsimsellik analizleri, Hititli çiftçilerin günümüzdeki uygulamalara benzer şekilde, arazi ve iklime en uygun olan ekim dönemlerini tercih ettiklerini göstermesi açısından önemlidir. Analiz sonuçlarından elde edilen, tarımda özelleşme, ürün rotasyonu ve yoğun toprak işleme yine imparatorluk dönemine doğru artış görülen ve tarımsal üretimin artışına işaret eden göstergelerdir. Benzer şekilde kabuklu buğdayların özellikle de emmer buğdayının azalışı ve spelta gibi buğday türlerinin varlığı yoğunlaşma yanında tarımsal arazilerde genişleme yaşandığını göstermesi açısından önemlidir. Sonuçlar ayrıca merkezi otoritenin üretim artışındaki rolünü destekler niteliktedir. Çalışma kapsamında elde edilen bir diğer önemli sonuç, verilerin bağlam bilgisinin arkeobotanik verilerin yorumlanmasındaki önemini göstermesi olmuştur. Uyumluluk analizleri sonuçlarının zamansaldan ziyade çoğunlukla bağlamsal nitelikte sonuçlar verdiği görülmüştür. Bu alandaki yeni yapılacak çalışmaların bu anlamda verilerin bağlam bilgisini detaylı olarak sunması oldukça önemlidir. Yine benzer şekilde yeni çalışmalardaki verilerin nümerik olarak yayınlanması veri setleri üzerine yeni analizler yapılmasını ve Hititlerin imparatorluk süreci ile ilgili yeni sonuçlara ulaşılmasını sağlayacaktır.

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