



An estate at Zincirli? Land use and resource exploitation at the Middle Bronze Age monumental building Complex DD in Zincirli, Gaziantep Province of Turkey

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Abstract

Near Eastern monumental buildings once hosted institutions with a variety of economic and environmental footprints. In this article examining a Middle Bronze Age II (seventeenth century BC) building complex at Zincirli, Turkey, we integrate bioarchaeological remains with ceramic and artifactual evidence to evaluate whether this building was a specialized node in a broader network and centralized economy. Combining seed/fruit/chaff analysis with charcoal, phytolith, diatom, and spherulite investigations and zooarchaeology allows for a more holistic identification of the building's environmental and economic catchments. The pronounced presence of conifer, probably related to the building's architecture, suggests an elite function of the complex. A broad range of activities took place within the complex, such as the preparation, storage, and consumption of different food and drink products, alongside craft activities. There is evidence for centralized storage of diverse crops and production of wine and textiles. The building seems to have functioned as a kind of estate, possessing access to large areas of land. The bioarchaeological remains evidence the exploitation of the varied environments surrounding the site, where economically valuable resources were locally available and exploited, such as cedar, pine, grapes, and large hunting game. Complex DD provides evidence of wetland exploitation, agropastoral production, wood procurement, and hunting in the semi-steppe batha environments of the Islahiye plain and the woodland forests of the Amanus.

Keywords Middle Bronze Age · Archaeobotany · Seed and fruit analysis · Anthracology · Phytoliths · Zooarchaeology · Diatoms · Dung spherulites · Northern Levant · Amanus · Turkey · Carpology

Introduction

Monumental buildings in the Near East interpreted as palaces, temples, and fortresses with administrative, ceremonial, and/or military functions¹ are usually considered the archaeological signature of large socio-political institutions with significant economic power. The study of these institutional economies, and in particular their land and resource catchments, is generally underdeveloped, as excavations have traditionally focused on the retrieval of precious artifacts and texts. Recent archaeobotanical and zooarchaeological

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¹ There are other possible functions that typically are not considered and can only be detected by applying archaeological sciences (e.g., Shahack-Gross et al. 2005; Marom et al. 2014). For example, the Phoenician monumental building at Tell Dor was found to have been used as a stable through a combination of micromorphology and phytolith analysis (Shahack-Gross et al. 2005).

studies, however, demonstrate the potential of these types of data for gaining better understanding of the function of such buildings and reveal interesting variability in the economic organization of related institutions (e.g., Marom et al. 2014; Weiss et al. 2019; Nicoli et al. 2022). For example, zooarchaeological study of monumental buildings from Middle Bronze Age (ca. 2000–1600 BC) Hazor and Tel Kabri, Israel, suggested economies based on, respectively, specialization and diversification of animal resources (Marom et al. 2014; Yasur-Landau et al. 2015). These studies mostly focus on either archaeobotany or zooarchaeology, while integrative studies are rarer (exceptions are, e.g., Vermeersch et al. 2021; Marston et al. 2021), especially in the study of large institutions of complex societies.

In this article, we demonstrate the utility of integrative archaeobiological investigations in the analysis of institutional economies by applying this approach to a Middle Bronze Age II (MB II) monumental building complex, Complex DD, at Zincirli Höyük (seventeenth century BC) in the Gaziantep Province of Turkey. This building's contents were well-preserved by the fierce conflagration that ended its use-life. Artifacts and ceramics from Complex DD indicate that administration of goods, textile production, and possibly the preparation of wine for transport flasks were carried out there, all suggesting a specialized economy oriented to the long-distance trade networks attested during this period (Morgan and Richardson 2020; Morgan and Soldi 2021). Study and comparison of multiple bioarchaeological datasets (including seed/fruit/chaff remains, charcoals, phytoliths, diatoms, and faunal remains) inform us of the scale, intensity, and diversity of the land-use and resource-exploitation practices supporting this complex in a pivotal but understudied region. Not only does the region around modern Zincirli lie at the intersection of important historical trade routes, but it is additionally recognized today for its extraordinary biodiversity (Morgan and Richardson 2020; Eken et al. 2016). This gives insight into whether Complex DD was a specialized trade-oriented center being provisioned through a centralized network or instead exhibited greater economic self-sufficiency benefitting from diversified subsistence practices. Bioarchaeological datasets form an important counterbalance to evidence from architecture, ceramics, and artifacts that enables a more holistic reconstruction of the economic basis of the related institution in comparison to contemporary MBA centers.

Middle Bronze Age Zincirli: site and setting

The site of Zincirli sits in a zone of geographic transition and biodiversity in the narrow Islahiye valley, at the foot of the Amanus Mountains (modern Nur Dağları) (Fig. 1). According to ancient texts, the Amanus Mountains were

considered an important timber source in the ancient Near East (Kunihom 1997). The site guards the important Bahçe (Arslanlı Bel) Pass, also called the Amanian Gates, at the intersection of Cilicia, Central Anatolia and Northern Syria. Travelers of the past could reach Central Anatolia from Syria by following the Islahiye valley northwards, passing directly through the Zincirli hinterlands (Matessi 2021).

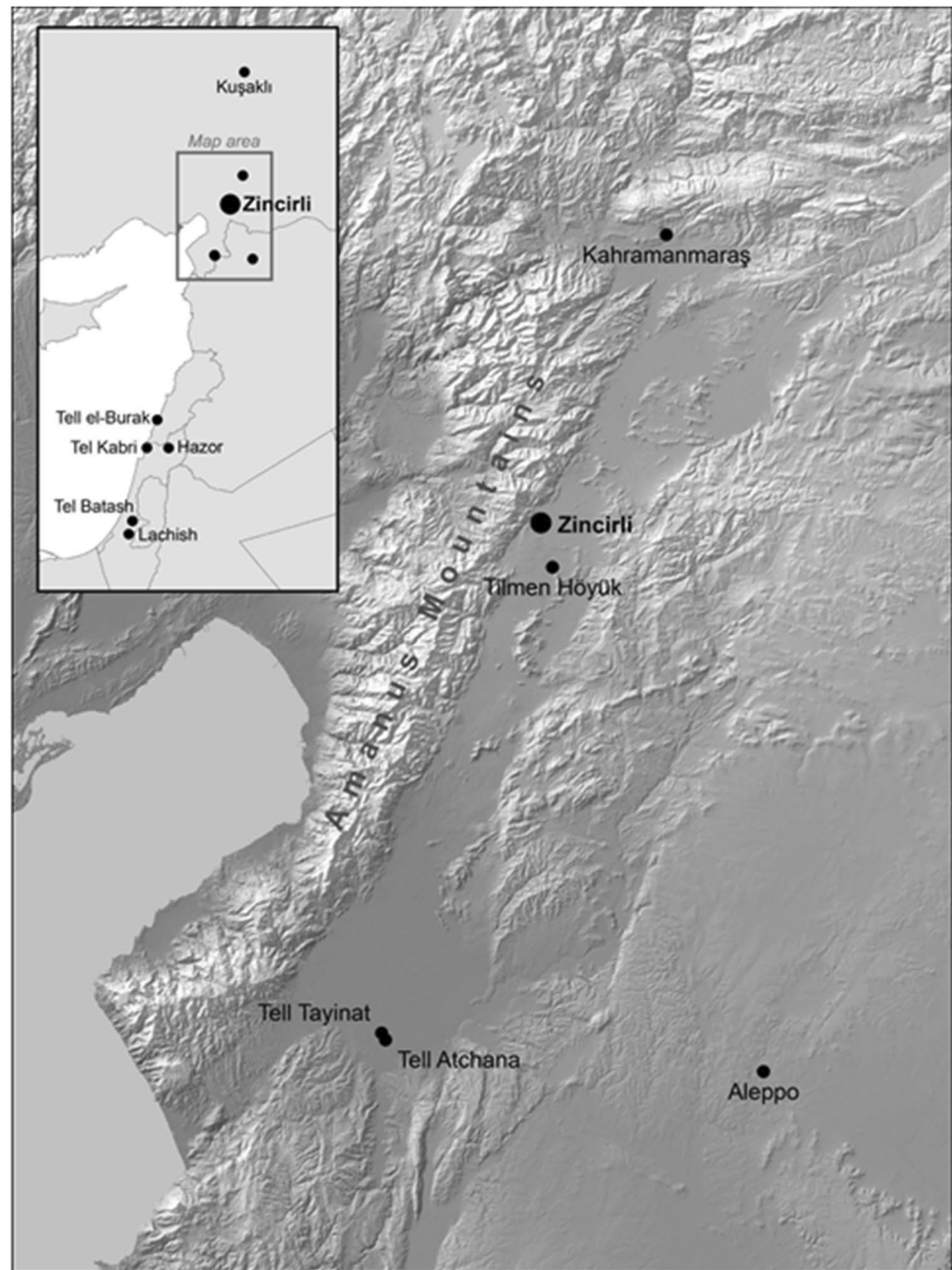
Zincirli is best known as a large Iron Age city of ca. 39 ha, resettled on an Early Bronze Age mound, but new investigations have found that the upper citadel was also occupied in the MBA. We currently estimate the extent of the MBA occupation at ca. 2 ha., a notable reduction in settlement size when compared to the Early Bronze Age occupation that covered the entirety of the upper mound and a sizeable area to the south (Herrmann and Schloen 2021). The regional capital in the MBA was likely Tilmen Höyük (probably ancient Zalb/war), which lies 8 km to the south (Duru 2003; Marchetti 2011). So far, Complex DD is the only intensively investigated MBA II context at Zincirli, constructed adjacent to the ruins of a massive building, “Hilani I,” currently understood to be a temple of MBA I or EBA construction (Herrmann and Schloen 2021). The institutional nature of Complex DD architecture and finds suggest that despite its small size, Zincirli may have been a secondary center in the kingdom of Zalb/war.

The here-studied monumental building Complex DD consists of two blocks of rooms, named Buildings DD/I and DD/II. These are separated from each other by a narrow, paved street (Street 200) (Fig. 2). Similarities in material culture suggest that the two buildings belonged to the same institution. Building DD/I, which architecturally resembles a service building, yielded evidence for food preparation, while building DD/II, which appears to be a fortification with wide walls and a linear plan, provides material culture that suggests an administrative function (Morgan and Soldi 2021).

Three rooms of building DD/I have been fully excavated: DD1, DD2, and DD3. Room DD1, substantially disturbed by later activity, contained a large storage jar filled with bitter vetch (*Vicia ervilia*). In DD2, the ceramic assemblage included vessels for storage, cooking, and service, as well as a pressing/grinding installation; in DD3, perforated jars and jar stands along one wall indicate the manipulation of liquids, possibly wine, as suggested by a concentration of grape remains, discussed below (Morgan and Soldi 2021). Despite the artefactual indications of food preparation in DD2 and DD3, no hearths or ovens have been found in the complex; the southwest edge of building DD/I had eroded away, however.

Building DD/II, on the other side of Street 200, consists of room DD4, tower DD5/DD6/DD7, room DD10, and room DD13 (excavated in 2021 and not included in Fig. 2 or these analyses). The official nature of the building is suggested by the presence of in situ door-sealings, along with other

Fig. 1 Map that shows the location of Zincirli and the sites mentioned in the text

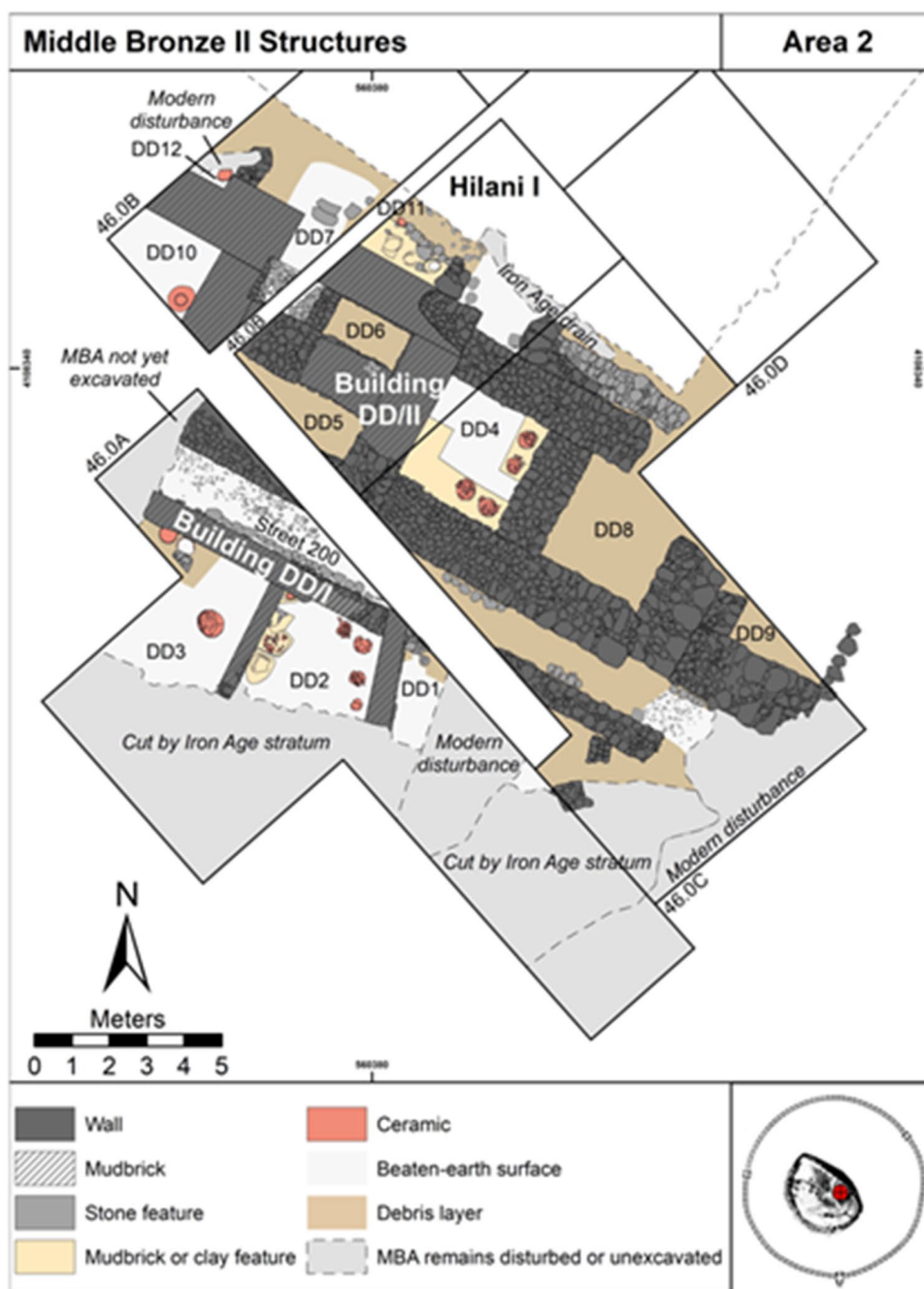


seal-impressed materials throughout the building. DD4 contained storage vessels on benches, DD5/DD6/DD7 a stairway; rooms DD10 and DD13 contained a varied assemblage of at least 51 complete vessels, among them at least five globular “pilgrim flasks,” jugs of several sizes for pouring, and goblets for drinking, in painted and fine wares. Two bronze daggers and a cache of beads also came from room DD10.

The globular “pilgrim flasks” found throughout Complex DD are identified as wine-transport containers of a type found from the Middle Euphrates to Central Anatolia. The bichrome-painted variety of these flasks that seems to be local to Zincirli has been found as an imported good in

central Anatolia, suggesting a specific trade link between these areas (Morgan and Richardson 2020; Morgan and Soldi 2021). In addition, throughout Complex DD and its environs, the team discovered loom weights, bronze needles, bone pins, and spatulas, suggesting that textile production also played some role in the institutional activity at MBA Zincirli. This craft, along with the production of wine, may have integrated MBA Zincirli into the interregional trade in luxury commodities of wine and woolen textiles attested in texts from Kültepe (Turkey) and Mari (Syria) (Morgan and Richardson 2020; Morgan and Soldi 2021; Poolman and Morgan in *press*). The site’s

Fig. 2 Plan of the Middle Bronze Age II remains at Zincirli



position guarding the “Amanian Gates” to Cilicia and timber sources in the mountains may have made it a valuable way-station for long-distance trade, as well as an attractive target for conquest. The complex was destroyed by an intense conflagration in the late seventeenth century BC, probably in the campaigns of the Hittite king Hattušili I against north Syria (Herrmann and Schloen 2021; Herrmann et al. 2023). This destruction, the centuries after which Zincirli was only ephemerally occupied, left the contents of the rooms largely intact, if often smashed and

heavily burnt, and facilitated particularly good preservation of botanical remains.

Geographical and biological setting

Present-day climate, flora and fauna of this region, as well as the landscape’s evolution, can help us understand patterns of resource exploitation and land use related to Complex DD.

Due to its location near the Mediterranean Sea, Zincirli experiences a typical Mediterranean climate, with most

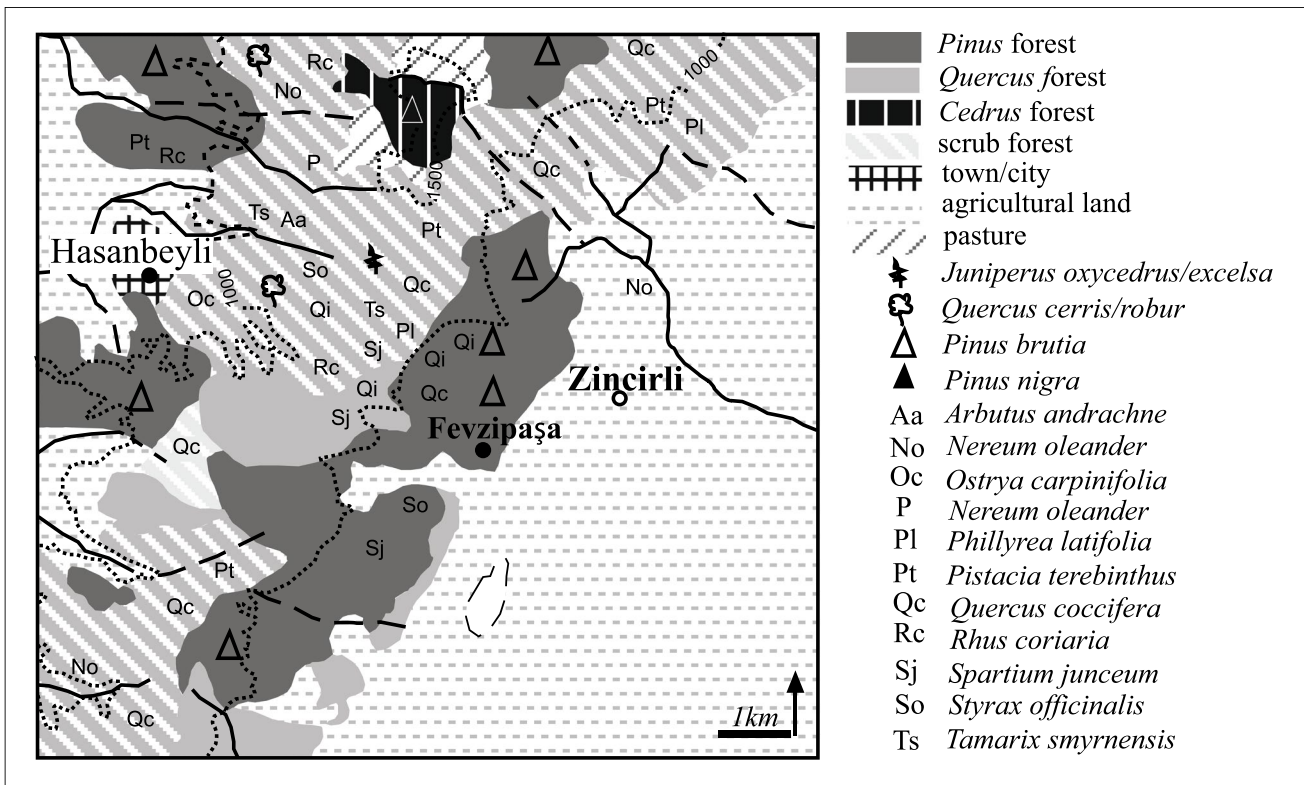


Fig. 3 Present day vegetation map of the Zincirli region (after Aytaç and Semenderoğlu 2011)

of the annual precipitation falling in winter, while summers are almost completely dry. Rainfall within the wider region is not evenly distributed and is strongly influenced by the local topography. The Amanus Mountains intercept a part of the precipitation and humidity on their western face, causing their eastern side, where Zincirli lies, to be drier. In numbers, annual rainfall varies over a short distance, between 1200 mm in the Orontes Delta to about 500 mm further inland (Akman 1973), with Zincirli receiving approximately 900 mm (Pisa et al. 2013). Winter temperatures vary in the region, depending on the elevation and distance from the Mediterranean, with Zincirli being exposed to colder winters compared to milder coastal sites (Akman 1973).

Situated thus at the intersection of different climatic zones, Zincirli has access to a diverse array of vegetation and fauna. It is located along the Anatolian Diagonal, a major biogeographical barrier that runs from northeast to southwest Anatolia and over the Amanus (Gür 2016). For this reason, the Amanus exhibit an exceptionally high level of biodiversity (Blondel et al. 2010: 128, Zohary 1973: 34). Remarkably, the western side of the Amanus includes Euro-Siberian elements in its vegetation, such as broadleaved forest consisting of *Fagus orientalis*, *Alnus*, *Acer*, *Castanea*, *Carpinus*, *Cornus mas*, *Corylus avellana*, and *Buxus sempervirens*. This is due to suitable habitat factors, such as fog

and orographic rain on this side of the mountains (Byfield et al. 2010; Atalay et al. 2014). This type of vegetation is located more than 30 km SW of Zincirli as the crow flies.

A clear elevation zonation is present in the vegetation of the Amanus (see summary in Kehl 1998), with, from low to high elevations, the following vegetation dominating: maquis between 0 and 400/750 m (m.a.s.l.), *Pinus brutia* forest with maquis undergrowth between 0 and 500/1100 m (m.a.s.l.), *Carpinus orientalis-Quercus cerris* forest between 500 and 1500/1750 m (m.a.s.l.), *Pinus nigra* forest between 1100 and 2000 m (m.a.s.l.), *Fagus orientalis* forest between 500/1000 and 2000 m (m.a.s.l.), and *Abies cilicica-Cedrus libani* at the highest locations between 1600/1900 and 2100 m (m.a.s.l.). Only a few spots within the Amanus are above the tree line (Kehl 1998). Within a 5 km radius of Zincirli, there remains today mainly *Pinus* forest with maquis undergrowth, maquis, *Quercus* forest and, on the highest grounds, *Abies* and *Cedrus* forest (Aytaç and Semenderoğlu 2011) (Fig. 3). Although the region appears well-forested today, Kehl (1998) nonetheless indicates that anthropogenic impact on the vegetation has been strong, and that the actual vegetation differs accordingly from the potential vegetation.

The Islahiye Valley is today a key faunal biodiversity area in Turkey (Eken et al. 2016). As recently as a century ago, the Amanus and Kurt Dağ ranges, as well as the Islahiye Basin,

were all home to diverse populations of fauna (Masseti 2004, 2009). The Amanus were known for their historical roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*), and fallow deer (*Dama dama mesopotamica*) populations (Chapman and Chapman 1980; Masseti 2000). Fallow deer populations have remained present in nearby mountain ranges until the modern day (Chapman and Chapman 1980). Studies of nearby regions further provide evidence for a wide array of wild mammalian, aquatic, and avian fauna (Kinzelbach 1987; Coğal et al. 2016; Kabiatar 2017). These include artiodactyla like gazelle (*Gazella gazella*) and boar (*Sus scrofa*), as well as carnivores including brown bear (*Ursus arctos*), grey wolf (*Canis lupus*), striped hyena (*Hyaena hyaena*), red fox (*Vulpes vulpes*), and wild cat (*Felis silvestris*, *Felis chaus*) (Coğal et al. 2016; Kabiatar 2017). It is likely that the relatively recent reduction in biodiversity has been a result of progressive deforestation and hunting pressure (Harrison and Bates 1991).

In addition to the impact of the Amanus ecosystem, the Islahiye valley has been subject to a long history of anthropogenic modification, as agricultural, pastoral, and clearing activities have shaped the vegetation. Today, most of the flat ground in the Islahiye plain near Zincirli is used for farming (Fig. 3). About half of the ground surface is used for dryland farming and irrigation provides water to the other half. Pasture occurs mainly on the uneven grounds and rocky outcrops that are less suitable for agriculture (Özüpekçe 2018). Away from the fields, the remaining vegetation consists of herbaceous species, patches with indicators for overgrazing (e.g., *Alhagi mannifera*), and other areas where perennial woody taxa occur, like “*Paliurus spina-christi*, *Crataegus aronia* var. *aronia*, *Styrax officinalis*, *Prunus spinosa*, *Jasminum fruticans*, *Ulmus minor*” (Pisa et al. 2013, 8). Some scrubland is present in the area, mainly consisting of *Quercus coccifera*, but also including *Styrax officinalis*, *Quercus brantii*, and *Rosa arvensis* (Pisa et al. 2013). The archaeologists working at Zincirli in the late nineteenth century noted oak forests covering the large basalt plateau between and to the south of Zincirli and Islahiye (see Fig. 4; Euting 1889–1890: 58–59, map on 170). Waterways and water bodies are also present with associated hydrophilous vegetation that includes *Salix*, *Phragmites australis*, *Cyperus longus*, and *Cyperus serotinus* (Pisa et al. 2013).

Prior to its draining, Lake Amuq, 80 km south of Zincirli, was historically a site of regional economic significance, as it was a seasonal resting place for migrating Palearctic bird species (Çalışkan 2008). Marshes related to the lake also played an important part of the former landscape (Eger 2011). Nineteenth century administrative records indicate that these marshes around the Amuq Lake were used as fisheries (Efe 2016). Its modern importance notwithstanding, it has been argued that the lake was much smaller or even non-existent in the 3rd millennium BC (Wilkinson 1997, 1999; Wilkinson et al. 2001; Casana and Wilkinson 2005).

A sediment core suggests its presence during the Middle Bronze Age (ca. 2000–1600 BC), however (Eger 2011; El Ouahabi et al. 2017). The lake seems to have expanded during the mid to late 1st millennium AD (Casana and Wilkinson 2005), possibly due to significant hillslope erosion in combination with the sedimentation of rivers and canals that once drained into the lake (Gerritsen et al. 2008). So far, geomorphological changes have not been investigated in detail in the Islahiye Valley; it is currently unknown how far the swamps reached into the valley during the MBA or how the river developed through time.

Taphonomy, materials, and methods

A combination of methods was applied to investigate former land use and resource exploitation and infer productive activities at Complex DD at Zincirli. Seeds and fruits, charcoals, phytoliths, diatoms, dung spherulites, and animal bones were recovered and analyzed from the MBA destruction layer. The buildings were destroyed by a conflagration event, which marked the end of their use. The destruction layer therefore comprises primary contexts and remains of a collapsed roof. The absence of ovens/hearths², but also the institutional character of the complex, makes it unlikely that secondary refuse was located inside these buildings during their MBA occupation, nor is it suggested by the below results. It is possible that a few tertiary botanical and phytolith material remains were introduced from decaying mudbrick which collapsed into the room, unburned, after the conflagration. The mudbrick preservation was varied throughout the complex, from very good to some disintegration. Care was taken to separate floor and in situ materials from the overlying mudbrick collapse and the latter is excluded from the analyzed samples. Furthermore, as can be expected, zooarchaeological remains are very scanty inside the buildings. They come primarily from outdoor contexts including a street and two outdoor workspaces (DD11 and DD12 on Fig. 2), although faunal materials recovered from the occupational debris from indoor contexts were also included. These bones are likely the result of primary deposits, discarded there after their initial consumption or utilization in and around Complex DD.

During excavations at Zincirli, field archaeologists undertook intensive bioarchaeological sampling with careful spatial control. Finds in all material culture categories were associated with the smallest observational unit, the pail (a subdivision of the locus, which represents a distinct archaeological event). Stratigraphic and locational data for each pail was immediately and systematically recorded in

² Again, these may have been in the eroded part of the building

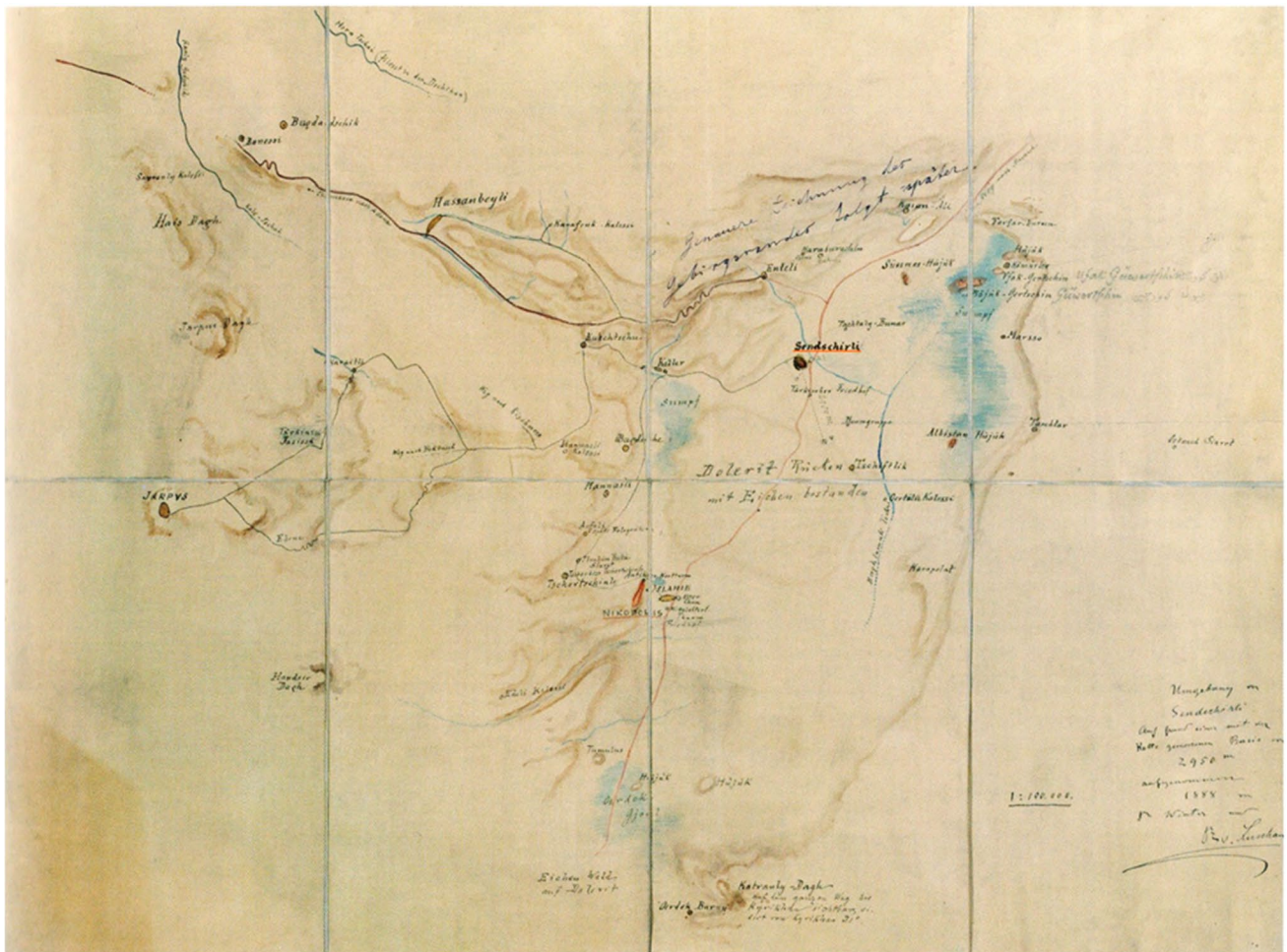


Abb. 6 Umgebungskarte von Sindschirli, Karton (8 Teile) auf Leinen gezogen; Aufnahme von F. Winter und F. v. Luschan 1888.

Fig. 4 Sketch-map of the region of Zincirli (here Sindschirli) showing the location of oak forests (Eichen) and marshes (Sumpf) (published in Wartke 2005: Abb. 6)

the relational database OCHRE while still in the field. The relational structure of this database provides a cross-referenced system for classifying and connecting the separate data points on various spatial and temporal scales (Schloen and Schloen 2012). This has allowed specialists to retrieve detailed context descriptions for samples, objects, and features unearthed during the excavation. Though minor variations in the sampling protocols for certain specialist analyses have meant that comparative study of specific features was not always possible, it has not prevented our gaining significant insights into the organization and use of the investigated building complex.

Seeds and fruits

Systematic recovery of archaeobotanical samples has been conducted since the MBA horizon in area 2 was first discovered in 2015. Excavators collected 199 samples in total

during three seasons between 2015 and 2018. The volume of the sediment samples ranged between 500 g to 32 l, depending on the respective archaeological feature/object excavated. Flotation was carried out using an Ankara-type flotation machine (French 1971). A 1-mm plastic mesh was maneuvered on the first tank to pour the sediment down. Buoyant plant materials were collected into cloth rather than sieves. Samples which were smaller than 2 l were dry-sieved with 1 mm and 0.20-mm sieves. In addition, the heavy residues were sorted in the field allowing for the recovery of very small bioarchaeological remains (micro-faunal finds) and material culture (diagnostic pottery sherds, small finds, metal slugs).

For the current study, 105 archaeobotanical samples were analyzed from building DD/I. After amalgamation of multiple sampled units, the total number of samples was reduced to 67. In sum, 41,427 plant macro-remains were identified under 132 analytical categories, but most of these

remains ($n=38,671$) were recovered from an in situ bitter vetch deposit in room DD1. The comparative collections in the Laboratory of Archaeobotany at the University of Tübingen and relevant archaeobotanical publications were used for the identifications of charred botanical remains (e.g., Berggren 1969, 1981; van Zeist and Bakker-Heeres 1984a, 1984b, 1985; Anderberg 1994; Nesbitt 2006; Bojnanský and Fargavsová 2007).

Find density and ubiquity scores were calculated to express the frequencies and the rate of deposition of plant taxa across the excavated units. Taxon proportions were not used in most analyses, as area 2's destruction layers, from which we gathered our samples, constitute primary depositional contexts. The calculation of proportional representation of taxa is usually employed to reconstruct complicated taphonomic histories of secondary and tertiary depositional contexts, quite different from those represented here. Because the plant remains were not evenly distributed across the three rooms, their proportional values among the respective groupings (e.g., crops, weeds) could cause erroneous conclusions. This type of quantification has only been used for the in situ bitter vetch deposit to deliver the proportions of diverse plant groups (e.g., weeds, crops). Ecological information on individual taxa was collected from the Flora of Turkey (Davis 1968–1985) to specify their flowering times and possible seed setting periods. For the plant taxa that were only identified to the genus level, the flowering periods of all species of that genus from the region (square C6 in the Flora of Turkey classification) were amalgamated to reconcile the discrepancies in identification.

Charcoals

The MBA charcoal fragments were studied to understand wood resource exploitation. We reconstruct former vegetation from charcoals at archaeological sites assuming the “Principle of Least Effort”, i.e., that wood was from the direct surroundings of the site in approximate proportion to its natural occurrence (Shackleton and Prins 1992). Long-term deposits, like middens and fills, are generally considered the best contexts from which to reconstruct the local environment (Asouti and Austin 2005), but most MBA Zincirli charcoals do not derive from such contexts, since no hearths, ovens, or rubbish dumps were found in this area. Our woody remains likely derive from the roof that burned and collapsed during the building's destruction, as well as from furniture and wooden objects, allowing us to still gain environmental information, as well as insight into the exploitation of woody resources.

Charcoals larger than 1 mm were retrieved from the same flotation samples as the seeds and fruits (see “Seeds and fruits” section for details on the sampling) and identified. The charcoal reference collection from the University of Tübingen was consulted as well as identification literature,

such as Fahn et al. (1986), Gale and Cutler (2000), Schweingruber (1990), and Crivellaro and Schweingruber (2013).

In total, 36 wood charcoal samples were identified, consisting of 3326 fragments. Some of the conifer specimens could not be identified in greater detail because the fragments were too small, or they showed compression features. Similarly, some Dicotyledons could not be identified to greater resolution, because the fragments were too small. Results are reported as fragment percentages here as the charcoal content of the individual samples is similar (see SI 5).

Phytoliths, diatoms, and spherulites

A microfossil pilot study was undertaken on 19 samples from 9 different loci from the MBA Complex DD/I (Table 1). These can be assigned to rooms DD1, DD2, and DD3, as well as an outside area (see Fig. 2). The samples derive from sediments collected for macrobotanical study but were separated prior to flotation and investigated at the Phytolith Laboratory of the Physical Geography, Freie Universität Berlin.

Phytoliths, the inorganic particles of plant cells, were examined to gain microbotanical information complementary to macrobotanical analysis, especially regarding plant parts that do not preserve well in macro-records (see, e.g., Piperno 2006, Bates et al. 2017). They are abundant in grasses and provide clues about plant families, plant parts and, overall botanical abundance in archaeological contexts, even if exact taxonomic determination cannot be achieved (Ryan 2014). However, identification reliability increases when used in combination with macrobotanical analysis and this improved knowledge can then be extended to other contexts. Of particular interest to our research are plant species that provide clues to exploited environmental zones, like, for example, remnants of reeds that would indicate a humid environment.

The preparation of the phytolith samples followed the method described in Katz et al. (2010). The phytoliths were separated from approximately 0.04 g of sediment by heavy liquid subtraction. Phytolith counts and statistical analysis were performed according to Albert et al. (1999) using the ICPS nomenclature (Madella et al. 2005). The counts of phytoliths for 1 g of sediment, the percent of phytoliths from the grass and dicotyledonous plant families and weathered morphotypes (WM), and the percent preservation of phytoliths as multicellular (MC) and single celled morphotypes in each sample were calculated.

Diatoms, the glass cell wall remains of algae, can provide a range of information on the water bodies they were living in (Battarbee 1988) as they are very sensitive to environmental changes and can provide information regarding salinity, pH of the water, nutrient, temperature, and saprobity

Table 1 Samples for phytoliths, diatoms, and dung spherulites analyzed with their context information

Phyto- liths Lab ID	Sample ID(1)	Sample ID(2)	Locus	Context type	Room
Zi 01	P17-46.0A#142	R17-46.0A#91	L17-2052	Mixed burnt destruction and occupational debris in room DD3	DD3
Zi 02	P17-46.0A#117	R17-46.0A#62			
Zi 03	P17-46.0A#120	R17-46.0A#68			
Zi 08	P17-46.0A#120	R17-46.0A#73			
Zi 09	P17-46.0A#122	R17-46.0A#71			
Zi 10	P17-46.0A#132	R17-46.0A#78			
Zi 11	P17-46.0A#132	R17-46.0A#82			
Zi 12	P17-46.0A#146	R17-46.0A#97			
Zi 16	P17-46.0A#142	R17-46.0A#92			
Zi 04	P17-46.0A#91	R17-46.0A#39	L17-2053		
Zi 06	P17-46.0A#157	R17-46.0A#113	L17-2083	Occupational debris just above surface in room DD3	
Zi 13	P17-46.0A#138	R17-46.0A#86	L17-2078	Occupational debris above floor in in W half of room DD3 with charcoal and phytoliths	
Zi 05	P17-46.0A#103	R17-46.0A#56	L17-2004	Destruction/collapse debris on top of jar stand installation (for wine?), room DD3	
Zi 07	P17-46.0A#101	R17-46.0A#51			
Zi 15	P15-46.0#51	R15-115	L15-2009	Intensely burnt destruction debris surrounding storage jars on bench lining walls of room DD2	DD2
Zi 19	P15-46.0A#67	R15-230			
Zi 14	P15-46.0#192	R15-633	L15-2026	Mixed burnt destruction and occupational debris in room DD1, just above floor level	DD1
Zi 17	P15-46.0#63	R15-234	L15-2013	Mudbrick detritus, collapsed superstructure of wall L15-2017 in room DD1	
Zi 18	P17-46.0B#60	R17-46.0B#62	L17-2063	Mixed destruction and occupational debris around outdoor food processing installations (the highly burnt, “millennial pink feature”)	Outdoor

(Ognjanova-Rumenova 2008: 291). No off-site samples could be used for comparison, so the results presented here cannot replace a comprehensive study of diatoms. However, they can deliver insight into the types of diatoms present in the settlement, which may yield evidence for water use, quality, and sources, and for humidity. The preliminary analysis of diatoms was included during the phytolith counting in the respective slides. Identifications were based on photographs, which were compared with images from the PhytCore Platform (<https://phytcore.org>).

A preliminary study of dung spherulites was additionally undertaken. Spherulites are microparticles formed in the intestines of ruminants and are deposited into sediment via dung (for an overview see Canti 1997). Analysis of dung spherulites can provide information on the presence of animals at the site, hygiene conditions, the use of dung, and many other issues (for dung spherulites in archaeological contexts and their interpretation, see Portillo et al. 2014, Albert et al. 2008, and Smith et al. 2019).

Spherulite samples were prepared and counted according to Canti (1997). Approximately 0.001 g of sediment was weighed and fixed on slides with Entellan, Neu (Merck). Counting was performed under an Olympus BH-2 optical microscope with polarized light. The evaluation was carried

out according to Portillo et al. (2010), whereby the number of spherulites per 1 g sediment was calculated. The results presented here are preliminary and give a first insight into the distribution within the samples. A more detailed discussion of the data will follow in future publications.

The overall microfossil results of the individual samples were summarized according to context type in the respective rooms. An average value for each context is used for the interpretation of the results.

Faunal material

Faunal material from MBA contexts in and around buildings DD/I and DD/II were hand-collected during excavations, which likely biases the samples discussed here toward larger specimens (Payne 1972). However, previous systematic wet sieving of locations on both the high and low mound provided an extremely small number of microfaunal remains, suggesting that they likely degraded in the site’s soil, which appears inhospitable to bone preservation. After washing, bones were identified to skeletal element and, when possible, the closest possible taxonomic resolution according to established morphological criteria, especially when identifying species of caprines and cervids (Lister 1996; Zeder

and Lapham 2010). Evidence of epiphyseal fusion, tooth wear, pathology, and any other anomalies was recorded, although these will not be the focus of the discussion below. For the purposes of this study, all remains from primary depositional contexts associated with Complex DD were pooled for collective analysis. While the faunal collection is relatively small, the remains and the animal taxa that they represent provide evidence of the exploitation of different geographical and environmental landscapes surrounding MBA Zincirli.

Results

Seeds and fruits

The find density of the overall assemblage is 46 seeds per 1 l of sediment, although this figure decreases to 3 seeds if the stored bitter vetch deposit in room DD1 is omitted. The densities of seeds also differ among the rooms. Room DD1 demonstrates the highest find density, with 939 singular remains per liter of sediment, again related to the presence of the bitter vetch concentration here. When the two bitter vetch samples are omitted, the values drop to 12 remains per liter of sediment in this context. Room DD2 and room DD3, on the other hand, contain 5 and 2 seeds and fruits per liter of sediment, respectively. The comparably higher density in DD2 is a by-product of concentrated finds of barley and lentil spread around the floor of the room.

Cereals and pulses comprise the largest crop category in absolute counts. The cereals include barley (*Hordeum vulgare*) and bread/hard wheat (*Triticum aestivum/durum*), with ubiquity scores of 28% and 13%, respectively (Table 2). Glume wheats, like emmer or einkorn grains (*Triticum monococcum/dicoccum*), appear less often ($n=2$) but are better represented by their glume bases ($n=11$).

The pulses represent a more diverse category than cereals, including several potential crop species such as lentil (*Lens culinaris*), bitter vetch (*Vicia ervilia*), chickpea (*Cicer arietinum*), garden pea (*Pisum sativum*), common vetch (*Vicia cf. sativa*), and grass pea (*Lathyrus sativus*). Lentil ($n=688$) and bitter vetch ($n=38,097$) have higher ubiquity scores than cereals appearing in 37% and 15% of all samples, respectively (Table 2). These two taxa also appear in different spatial contexts. Lentil appears in every room but with higher ubiquities in DD3 (60%). It was also found in small concentrations in DD2, totaling to the bulk of lentil finds with 621 counts. Bitter vetch, on the other hand, is largely concentrated in DD1 in a storage vessel with 38,085 counts in total but appears only sporadically in other rooms. Other pulses appear less frequently. Common vetch ($n=2$) only appears within the bitter vetch deposit in DD1. Grass pea

($n=1$) only occurs in DD3. Chickpea ($n=3$) and garden pea ($n=2$) were encountered in very low ubiquities (3% of the entire dataset for both).

Grape (*Vitis vinifera*) remains are present as several fully developed and rudimentary pips, as well as skins and stalks. When only fully developed pips are considered, grape pips represent the second most ubiquitous crop (28%) in the entire dataset after lentils (Table 2). The morphology of one grape pip resembles wild forms with a more globular outline and conspicuously shorter stalk, so this was classified as *Vitis* sp. Grape skins were distributed in certain archaeological contexts, hinting at specialized activities like pressing and/or mixing of grape juice. Olive (*Olea europaea*), on the other hand, has a lower ubiquity of 13% and mainly appears in DD2 and DD3. Fig (*Ficus carica*) has a very low ubiquity in the dataset (4%) and the remains are restricted to DD1 (40%) and, to a much lesser extent, DD2 (3%) (Table 2).

The most prominent plant taxa in the wild plant assemblage are ryegrass (*Lolium*) and aggregate clovers (*Melilotus/Trifolium*). Ryegrass has an overall ubiquity of 46%, but this figure reaches 68% in DD3. Aggregate clovers are the most ubiquitous plant taxon in the assemblage with 57% of all samples, which rises to 84% in DD3. Among the remaining wild plants, only a few occur in ubiquities over 10% in our entire dataset. These include hedge parsley (*Torilis arvensis/japonica*), cress (*Lepidium* type), wild poppy (*Papaver*), canary grass (*Phalaris*), dock (*Rumex*), and indeterminate macro-remains from the bedstraw family (Rubiaceae). The remaining taxa, which have less than 10% ubiquity, show varying occurrences across the excavated area (SI 1).

The distribution of seeds and fruits shows the following pattern by room:

The sample composition of the stored bitter vetch in DD1 is substantially different from other samples elsewhere in building DD/I. First, the proportion of insect-damaged seeds to undamaged seeds is 3%. When the whole assemblage is considered, the proportion of weedy plants in this deposit is low (2%). All non-crop categories (e.g., insect-damaged bitter vetch seeds, larvae, weeds) in this deposit have a proportion of 4%. Some weedy taxa (e.g., *Galium aparine/spurium*, *Asperula*, *Ranunculus cf. arvensis*) appear in higher quantities than others. Moreover, it should be noted that several taxa are only present in room DD1 (e.g., *Vicia lathyroides*, *Buglossoides arvensis*, *Sherardia arvensis*, *Fumaria*). Finally, there is a strong seasonal signal in these deposits for the winter-spring time frame in terms of flowering/fruiting times (SI 2).

In DD2, a total of 1261 seed/fruit remains were classified. Lentils form half of this assemblage ($n=621$). Similarly, another sample includes concentrated finds with several complete and fragmented remains of barley. Another two taxa with high counts are aggregate clovers ($n=61$)

Table 2 Summary of major seed/fruit taxa according to proportions and ubiquity

	Counts			Ubiquity scores			Percentages					
	Total counts	DD1	DD2	DD3	Whole assem-blage	DD1	DD2	DD3	Whole assem-blage	DD1	DD2	DD3
Main field crops												
<i>Hordeum vulgare</i>	44		24	20	28.36	0.00	21.62	44.00	0.11	0.00	3.12	5.56
<i>Triticum aestivum/durum</i>	19	1		18	13.43	20.00	0.00	32.00	0.05	0.00	0.00	4.76
<i>Lens culinaris</i>	688	42	622	24	37.31	40.00	21.62	60.00	1.66	0.11	80.78	6.61
<i>Vicia ervilia</i>	37158	37150	1	7	14.93	60.00	2.70	24.00	89.70	97.29	0.13	1.85
<i>Vicia ervilia</i> (insect eaten)	939	935	4	4	5.97	40.00	0.00	8.00	2.27	2.45	0.00	1.06
Arboricultural crops												
<i>Vitis vinifera</i> (pips)	33	10	14	13	28.36	60.00	18.92	40.00	0.08	0.03	1.82	3.44
<i>Olea europaea</i>	11	4	3	8	13.43	0.00	8.11	24.00	0.03	0.00	0.39	2.12
<i>Ficus carica</i>	5	4	1		4.48	40.00	2.70	0.00	0.01	0.01	0.13	0.00
Potential field crops												
<i>Triticum sp.</i>	6			6	7.46	0.00	0.00	20.00	0.01	0.00	0.00	1.59
<i>Triticum monococcum/dicoccum</i> (grain)	2		2		2.99	0.00	5.41	0.00	0.00	0.00	0.26	0.00
<i>Pisum sativum</i>	2	1		1	2.99	20.00	0.00	4.00	0.00	0.00	0.00	0.26
<i>Vicia cf. sativa</i>	2	2			1.49	20.00	0.00	0.00	0.00	0.01	0.00	0.00
<i>Vicia/Lathyrus</i>	11	5	1	5	11.94	40.00	2.70	20.00	0.03	0.01	0.13	1.32
cf. <i>Cicer arietinum</i>	3			3	2.99	0.00	0.00	8.00	0.01	0.00	0.00	0.79
<i>Lathyrus sativus</i>	1			1	1.49	0.00	0.00	4.00	0.00	0.00	0.00	0.26
Rachis internodes and grape pedicels												
<i>Hordeum vulgare</i> (rachis internodes)	6		1	7	8.96	0.00	2.70	28.00	0.01	0.00	0.13	1.85
<i>Triticum durum</i> (spikelet bases)	1			1	1.49	0.00	0.00	4.00	0.00	0.00	0.00	0.26
<i>Triticum monococcum/dicoccum</i> , (spikelet bases)	2		1	1	2.99	0.00	2.70	4.00	0.00	0.00	0.13	0.26
<i>Triticum monococcum/dicoccum</i> (glumes)	9		1	8	11.94	0.00	2.70	28.00	0.02	0.00	0.13	2.12
<i>Vitis vinifera</i> (pedicels)	2	1	1		2.99	20.00	2.70	0.00	0.00	0.00	0.13	0.00
Weeds												
<i>Trifolium/Melilotus</i>	250	16	61	173	56.72	60.00	37.84	84.00	0.60	0.04	7.92	45.77
<i>Lolium sp.</i>	130	18	37	76	46.27	60.00	29.73	68.00	0.31	0.05	4.81	20.11

and indeterminate remains ($n=184$). The ubiquity scores of plant taxa remain low in DD2. The three most ubiquitous categories are lentils (22%), cultivated barley (22%), and aggregate clovers (38%). Grape also appears at 16% ubiquity in DD2. Notably, the distribution of the archaeobotanical finds is strongly linked to varied archaeological features. For instance, several ceramic containers uncovered in this room are devoid of seeds or fruits. In contrast, two archaeological features (L17-2007 and L17-2061), likely related to the dilution and pressing/mixing of liquids, are rich in wild plant taxa. Importantly, the composition of the wild plant assemblage in these two features is distinctively different from other samples recovered. Several taxa which are strongly linked to freshwater environments appear here (e.g., Charophytes, *Alopecurus aequalis/geniculatus*, *Phalaris arundinacea*, *Polypogon maritimus/monspeliensis*, *Typha*, *Potamogeton*) with a strong seasonality towards late summer-early autumn seed setting (SI 3).

In DD3, a total of 1420 seed and fruit remains were identified. This room is full of crops, wild plants, and chaff remains with a greater degree of diversity, comprising 99 individual taxa. Fragmented large and medium-sized grasses make up the most represented category with a total count of 406, while indeterminate remains reach a count of 309. There are no concentrated finds of any crop species comparable to the other rooms. Among the crop species, lentil is ubiquitous with 60% (despite a count of only 24), as are bitter vetch (24%), barley (44%), and free-threshing wheat (32%). Only one spikelet base of free-threshing wheat has been found in the entire dataset. This object can be unequivocally identified as a tetraploid wheat species. In addition, one possible six-rowed barley caryopsis has also been recovered in this room. No further information could be gathered from rachis internodes of barley due to their poor preservation. Additionally, in DD3, numerous over-burned amorphous organic remains were found, with a ubiquity score of 48%. They appear to be concentrated in loci L17-2052 and L17-2053. Another singular deposit in DD3 (L17-2083) contains over-burned and fragmented cereal remains. Because of carbonization, it is not possible to securely identify these finds, but they can be tentatively classed as barley and/or free-threshing wheat. Ryegrass ($n=76$) and aggregate clovers ($n=173$) are ubiquitously represented in the DD3 assemblage with higher scores (68% and 84% respectively). Furthermore, the wild plant assemblage contains several rare taxa that only appear in DD3, such as *Artemisia*, *Cichorium*, *Hieracium*, *Trigonella monspeliaca*, *Silene*, *Cyperus*, *Coronilla*, *Medicago*, and many others (SI). Moreover, the plant taxa show distinct seasonal differences in terms of flowering/seed setting time frames. Two groups of wild plants can be identified. First are those with their flowering/seed setting period concentrated in spring and early summer (May–June). This group comprises several species including those with

known weedy habits like *Vaccaria hispanica* and *Scorpiurus muricatus*. The second group contains those taxa with seed setting habit in late summer-early autumn, related to freshwater environments, such as *Typha*, *Cyperus*, *Phalaris arundinacea*, and *Eragrostis minor/pilosa*, as well as more open vegetation elements such as *Hieracium*, *Torilis arvensis/japonica*, *Artemisia*, and *Cichorium* (SI 4).

This preliminary investigation of seed and fruit remains, although currently limited to building DD/I only, demonstrates that a wide range of ecological zones was represented in the productive activities of the complex. These activities were apparently varied, but included food preparation, wine production, and storage of cereals and pulses. We can thus begin to reconstruct a political economy characterized by the ability to mobilize and allocate resources from a broad area, converting them into specific products for trade and prestige networks and/or for feasting occasions. This is perhaps particularly suggested by the evidence for storage of crop species in DD1 and DD2 (as well as in other parts of Complex DD not covered in this article), which may have been in support of personnel involved in the wine or textile production indicated by artefactual analysis (see also “Faunal material” section, below).³ According to Sinopoli (1994, p. 165), the intensity of institutional involvement in productive processes varies according to “administrative structure, distance to accumulation points (the imperial capital or centers), the distribution of centralized institutions (centers, garrisons, or outposts), and the economic and symbolic significance of specific products.” Most probably, it was the latter aspect, the production of economically and symbolically important organic consumables, that was the main reason for the institutional involvement at Zincirli.

Charcoals

The charcoal fragments from the MBA are overall remarkably small, so a rather large proportion could not be precisely identified (e.g., Dicotyledon or conifer) (Fig. 5).

Notwithstanding these challenges, the charcoal samples from MBA Zincirli are exceptionally rich in taxa compared to many northern Mesopotamian sites (e.g., Deckers and Pessin 2010), which typically provide refuse dump remains where higher taxonomic diversity is expected (Asouti and Austin 2005). A minimum of 22 taxa have been identified among Zincirli’s MBA charcoal fragments (SI 5). Conifers that could not be identified with greater precision dominate the fragments at 34% and may represent different conifer taxa. Of the identifiable conifer remains, four taxa have been positively identified within MBA layers from Zincirli

³ These results could not be included in the manuscript, since only part of the material has been analyzed and access to the samples for analysis has not been possible for reasons beyond our control.

Fig. 5 Charcoal fragment proportions for the MBAII at Zincirli. All taxa listed within the figure are present (even if not well visible on the graph)

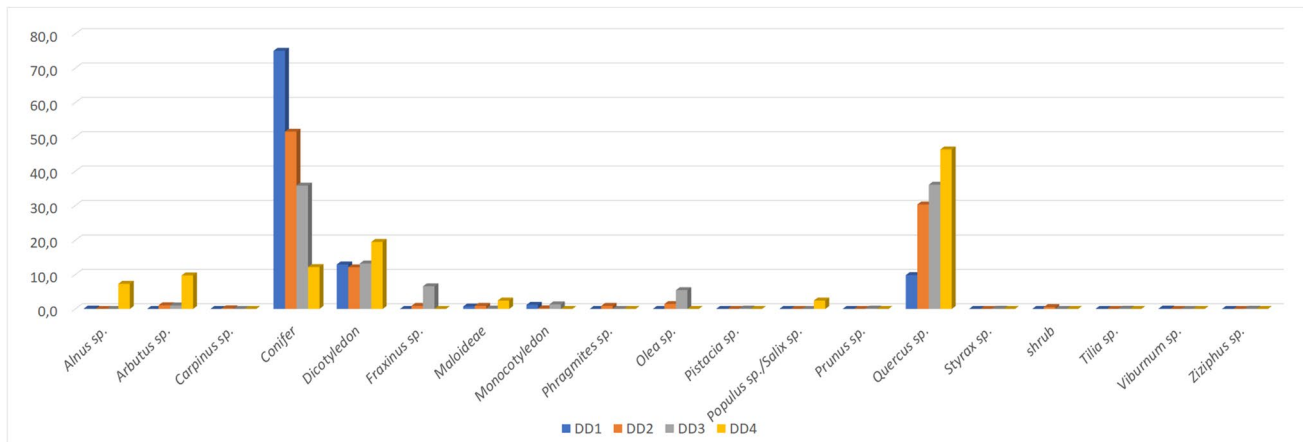
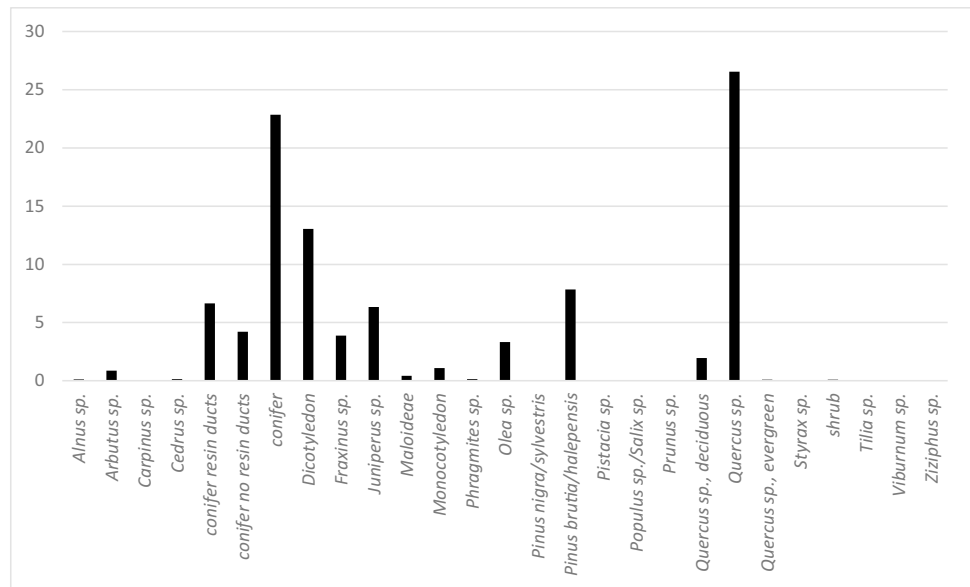


Fig. 6 Charcoal fragment percentage proportions according to room for Complex DD at Zincirli

(Fig. 5). Resin ducts were observed in some of the conifer fragments that could not be exactly identified, which narrows the possible taxa to *Pinus* sp., *Picea* sp., or *Larix* sp., with *Pinus* sp. most likely as it has been positively identified elsewhere on site.

The group with the second greatest proportional value in MBA levels is *Quercus* sp. (29%). A few fragments could be identified as deciduous oak, while proportionally less fragments were evergreen (Fig. 5).

The third largest woody taxon group proportionally represented are Dicotyledons (13%), which likely represent diverse taxa, but could not be identified into greater detail because the fragments were too small. *Pinus brutia/halepensis* was represented in 8% of the fragments, while *Juniperus* sp. comprised 6%, *Fraxinus* sp. 4%, and *Olea europaea* 3% (Fig. 5).

All other taxa, like *Alnus* sp., *Arbutus* sp., *Carpinus* sp., *Cedrus* sp., *Maloideae*, *Monocotyledon*, *Phragmites* sp., *Olea europaea*, *Pinus nigra/sylvestris*, *Pistacia* sp., *Populus* sp./*Salix* sp., *Prunus* sp., *Styrax* sp., *Tilia* sp., *Viburnum* sp., and *Ziziphus* sp., occur in minor proportions (Fig. 5).

Although there is a somewhat similar presence of taxa within the different rooms, the major difference is the proportion of conifers versus oak. For example, room DD1 has more conifers than does room DD4, whereas the latter has a higher relative proportion of *Quercus* sp. (Fig. 6). In DD3, there is a slightly higher proportion of *Olea* sp. and *Fraxinus* sp. Of note in DD2 is a small proportion of *Phragmites* sp.

Figure 7 depicts the identified charcoal taxa from Zincirli according to their typical habitat in this region (following Zohary 1973; Kehl 1998; Crivellaro and Schweingruber

Fig. 7 Taxa that are present in MBA Zincirli with an indication of their typical habitat in this region (according to Zohary 1973; Kehl 1998; Crivellaro and Schweingruber (2013); Atalay et al. 2014). Indication of their abundance according to size of the dot

	<i>Alnus (glutinosa)</i>	<i>Carpinus (orientalis)</i>	<i>Tilia (argentea)</i>	<i>Cedrus (libani)</i>	<i>Pinus nigra</i>	Comifer	<i>Quercus</i> (8 species)	<i>Quercus deciduous</i> (4 species)	<i>Juniperus (oxycedrus)</i>	<i>Quercus evergreen (coccifera)</i>	<i>Fraxinus (ornus)</i>	<i>Arbutus (andrachne)</i>	<i>Pinus brutia</i>	<i>Pistacia (terebinthus)</i>	<i>Styrax (officinalis)</i>	<i>Viburnum (tinus/opulus)</i>	<i>Ziziphus (lotus)</i>	<i>Olea europaea</i>	<i>Prunus sp.</i>	<i>Phragmites (australis)</i>	<i>Populus/Salix</i>	
Water bodies																						
Cultivated																						
Plain							•	•														
Mid-elevation							•	•	•													
High-elevation							•	•	•													
Eu-Siberian elements	•	•	•																			

Table 3 Amount of phytoliths in the samples according to their location

Room/area	Context type	Phytoliths 1g sedi- ment
DD3	Mixed burnt destruction/occupational debris	955660
	Occupational debris	944400
	Destruction/collapse debris	849503
DD2	Burnt destruction debris	868450
DD1	Mixed burnt destruction/occupational debris	1203360
	Mudbrick detritus	1339902
Outdoor area	Mixed destruction/occupational debris	116786

2013; Atalay et al. 2014). Figure 7 indicates an abundance of different woody taxa represented in the MBA archaeological record, attesting to the wide variety of surrounding environments exploited for their woody resources.

Phytoliths, diatoms, and spherulites

Phytoliths

Results of ongoing microbotanical analysis are summarized here. The detailed data set will be presented in future work, in conjunction with macrobotanical analyses.

The absolute amount of phytoliths in the samples from Zincirli is generally high, especially from room DD1; outdoor areas generally had very small amounts of phytoliths (Table 3). Recovered phytoliths can be identified as monocotyledonous (grasses) or dicotyledonous (woody plants) depending on their form (see Albert and Weiner 2001 for details). Grasses generally produce more phytoliths than do woody plants, so it is not surprising that the majority of phytoliths listed here belong to grasses (Piperno 2006). Within the grasses, stem/leaf and inflorescences can be distinguished, as can wood/bark and leaves among

dicotyledonous plants. However, grass short cells occur in the whole grass plant, so they are not characteristic of distinct plant parts.

In general, there is a high proportion of inflorescences in the samples from Zincirli (Fig. 8), especially in DD1, whereas a certain proportion of woody plants derives from room DD2 and DD3. Within the woody plants, the wood/bark is almost always present at a significantly higher level than leaves, which are present at a low level. Comparison of the inflorescence phytoliths at Zincirli shows a clear majority of C3 plants as compared to C4 plants, with the latter comprising ca. 90% of the overall sample.

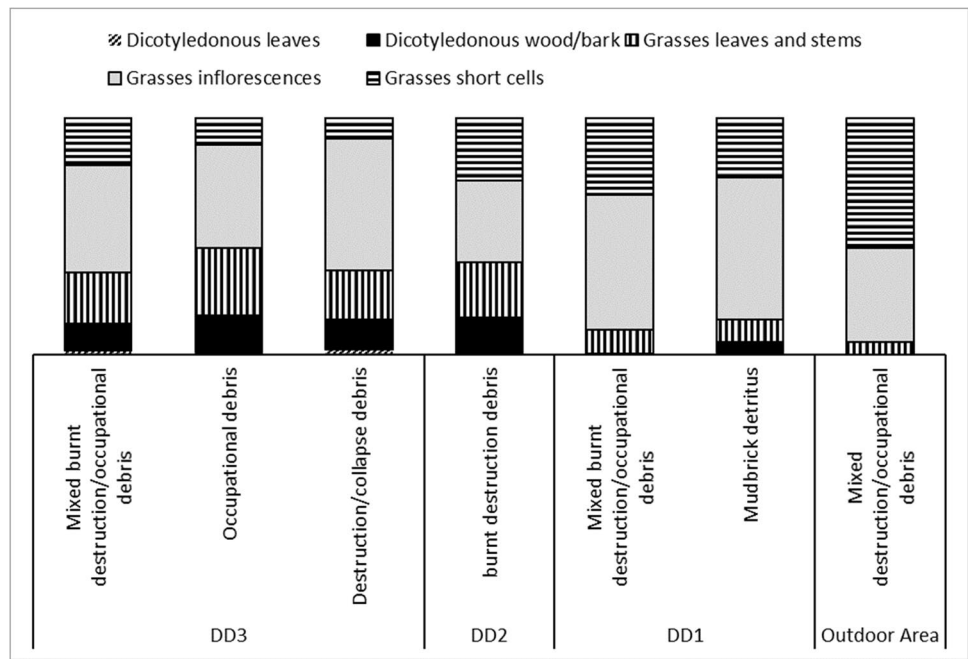
Although phytoliths are generally very difficult to reliably identify to taxonomic resolution, some of the Zincirli phytoliths could be precisely determined. Among these, cultivated cereals wheat and barley were present (with a higher occurrence of barley). Other plant families/species include *Phragmites* (reed) (Fig. 9a) (see Portillo et al. 2010 Fig. 67), Fagaceae (beech family) (Fig. 9b), Cyperaceae (sour grass family) (Fig. 9c, d), *Quercus* (oak, possibly *coccifera/calliprinos*, i.e., kermes oak/common oak) (see Albert et al. 1999, Fig. 7e) (Fig. 9e), and Panicoideae (sweet grass subfamily). In Table 4, their distribution in the different rooms is shown.

Hence, the phytolith remains indicate the presence of plant foods like barley and wheat in Complex DD. Phytoliths from several different plant remains could additionally be identified.

Diatoms

Nine of the investigated samples included diatoms (see also Table 4 summarized), some of which could be identified vis a vis comparison to Al-Handal and Abdullah (2010). From a total of 26 diatoms, the following taxa could be identified: cf. *Amphora veneta* (Fig. 10a), cf. *Nitzschia* (n=9) (Fig. 10b), cf. *Epithemia* (n=7) (Fig. 10c), cf. *Synedra komm* (n=4), and cf. *Rhoicosphenia* (n=3).

Fig. 8 Phytoliths from grasses compared to woody plants from Complex DDI and its surroundings



According to the descriptions of the identified diatoms (e.g., in Bathurst et al. 2010, Solak et al. 2019), all species appear to occur in flowing and stagnant waters, with the most abundant species identified also present in brackish waters.

There are several ways that these diatoms might have entered our MBA archaeological record, for example as part of the mudbricks that perhaps were retrieved in the alluvial plain or in water brought to the site. However, as

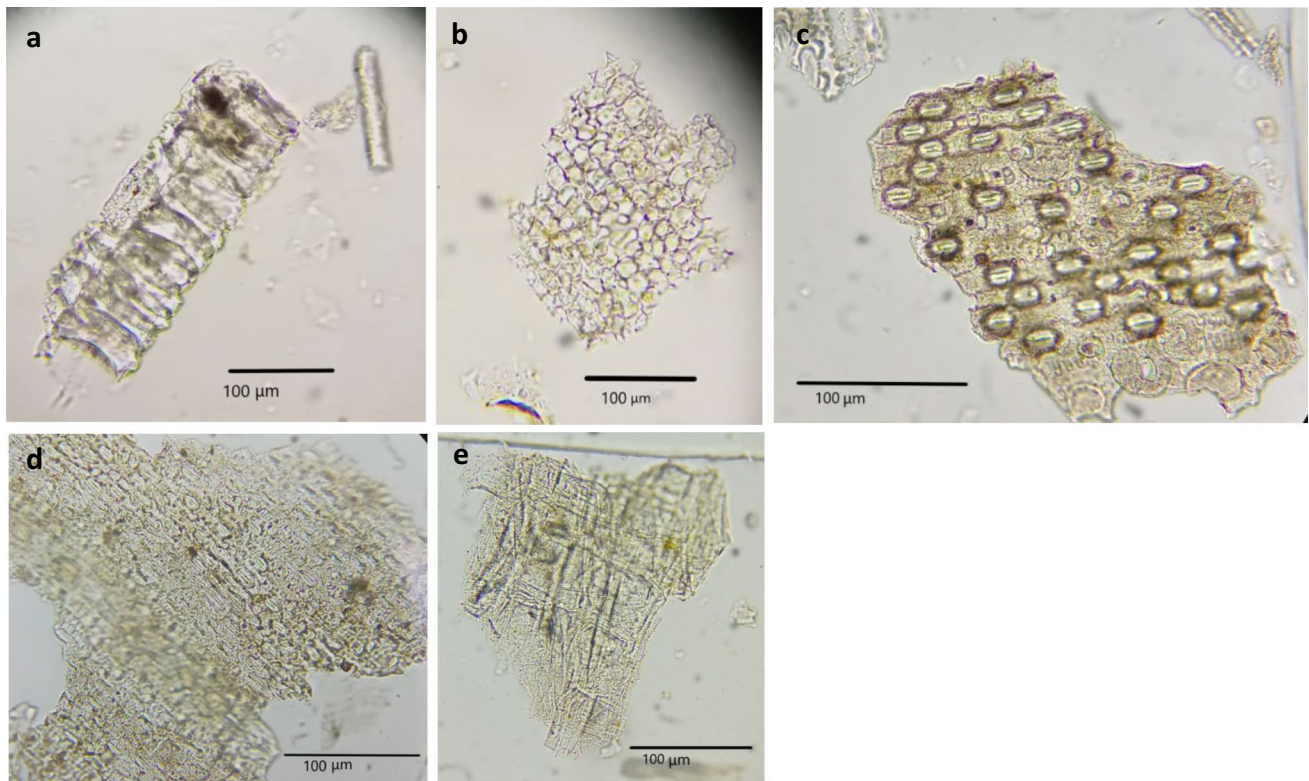
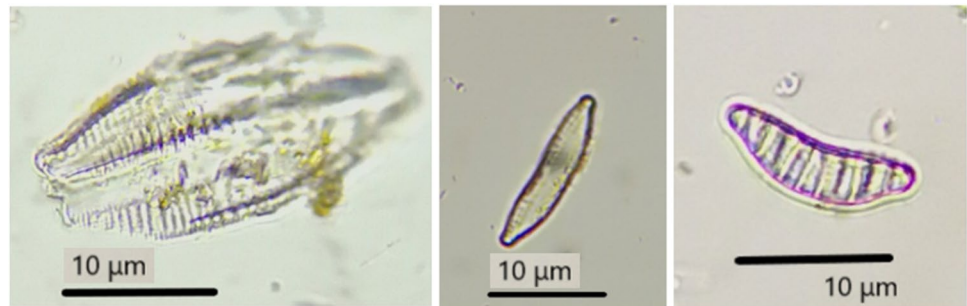


Fig. 9 Selected images from a SSK bulliform, b honeycomb multicell, c and d multicells with stomata, and e irregular multicell

Table 4 Summary of the presence of phytoliths, diatoms, and dung spherulites in their respective contexts (gen. = in general)

Room/area	Context type	Fagaceae		Poaceae				Poales		Diatoms	Dung spherulites	
		Fagaceae (gen.)	Quercus Wood/bark	Fagaceae (gen.)	Quercus Wood/bark	Poaceae (gen.)	Triticum monococcum and/or aestivum/durum	Hordeum vulgare	Phragmites			Panicoidae
DD3	Mixed burnt destruction/occupational debris	x	x	x	x	x	x	x	x	x	x	Very few
		x	x	x	x	x						Very few
DD2	Burnt destruction debris			x	x	x						Very few
												Very few
DD1	Mixed burnt destruction/occupational debris											Very few
												Very few
Outdoor area	Mixed destruction/occupational debris											Very few
												Few

Fig. 10 Selected images from diatoms. **a** *cf. Amphora veneta*, **b** *cf. Nitzschia*, **c** *cf. Epithemia*



mentioned before, mudbricks were generally not sampled, aside from the one purposely sampled mudbrick.

Dung spherulites

Dung spherulites generally occurred in very low numbers in MBA contexts with only the sample from the outdoor area providing a slightly higher number (Table 4). While this generally indicates the presence of herbivorous animals or at least their dung in the settlement, the DD/I complex appears to have been generally kept clean and away from dung-related activities, such as animal husbandry or the use of dung as a secondary product such as heating fuel. This is also suggested by the absence of fire installations in the archaeological record. Additionally, dung seems not to have been used in the architecture, e.g., as an admixture in the mudbricks or plaster.

Faunal material

Table 5 summarizes the NISP for identifiable faunal taxa groups from MBA contexts in Complex DD. Faunal remains from MBA levels of Zincirli Höyük derive from surfaces, drains, streets, and other secure activity contexts from the period under investigation. For the purposes of this study, all MBA faunal remains from these contexts were pooled, although future analyses will further investigate the contextual nature of these remains. These animal remains were likely the product of both consumption and craft-production activities (discussed further below). Several faunal remains showed evidence of significant burning (~70 specimens burned in total, ca. 18% of the total assemblage), perhaps as the result of conflagration or, in some cases, on-the-bone roasting. Cut marks ($n=25$), largely grouped on bovid remains, were likely the product of slaughter and cooking processes.

A diverse array of faunal taxa was recovered. These include at least 11 identified mammalian species that represent most of the assemblage ($NISP=335$), while a handful of avian, herptile, and aquatic species were also recovered. A majority of remains belonged specifically to domestic fauna, primarily sheep (*Ovis aries*), goat

(*Capra hircus*), and cattle (*Bos taurus*). In the cases of both caprines and cattle, individuals seem to have been kept into adulthood (Poolman and Morgan in press). Other domestic fauna present include pigs (*Sus scrofa*), equid remains likely horse (*Equus equus*), donkey (*Equus asinus*), or potentially onager (*Equus hemionus*), as well as domesticated dogs (*Canis familiaris*). Finally, a small but significant handful of remains belong to wild species including gazelle (*Gazella gazella*), red and fallow deer, hare (*Lepus sp.*), foxes (*Vulpes sp.*), herptiles, birds, and even crustacea. The relatively small size of the faunal sample derived from MBA contexts in and around Complex DDI/II will only allow for a cursory consideration of environmental implications of the recovered species. The faunal remains from Complex DD document the procurement species from a variety of ecozones, betraying a somewhat diversified subsistence economy regarding animal exploitation.

Table 5 Results of the faunal remains from Complex DD at Zincirli

Taxonomic name	Animal	<i>N</i>	%NISP
<i>Caprines</i>	Sheep/goat	202	52%
<i>Ovis aries</i>	Sheep	26	7%
<i>Capra hircus</i>	Goat	16	4%
<i>Bos taurus</i>	Cattle	84	22%
<i>Sus scrofa</i>	Pig	22	6%
<i>Equus spp.</i>	Equid	2	1%
<i>Canis familiaris</i>	Dog	3	1%
<i>Gazella gazella</i>	Gazelle	4	1%
Cervid	Deer	15	4%
<i>Cervus elaphus</i>	Red deer	1	<1%
<i>Dama dama sp.</i>	Fallow deer	1	<1%
<i>Vulpes sp.</i>	Fox	1	<1%
<i>Lepus sp.</i>	Hare	2	1%
<i>Testudines</i>	Tortoise/turtle	12	3%
<i>Aves spp.</i>	Aves	11	3%
<i>Mollusca</i>	Shell	30	8%
<i>Crustacea</i>	Crab	1	<1%
	Total NISP	389	100%

Discussion

Exploitation of a diversity of environments associated with the MBA monumental building complex at Zincirli

While the samples derived only from Complex DD and its associated surroundings, an unusually large variety of exploited environments are recognizable in our analysis (Medail and Quezel 1997; Cuttelod et al. 2009). This suggests that users of the monumental building complex possessed access to a diversity of environments around the site of Zincirli.

Wetland exploitation

The Amuq wetland landscape has changed considerably since ancient times, but the presence of wetland faunal and floral species within Complex DD at Zincirli is significant. When identifiable to species, avian remains at the site are represented by the wetland bird species *Fulica atra*, or the common Eurasian coot. Coots tend to prefer larger, open bodies of water and travel seasonally through Turkey during their annual Palearctic migrations (Porter and Aspinall 2010). The presence of this bird attests to the probable importance of bird hunting around large, regional bodies of water (Çalışkan 2008). A single crab claw was recovered from L17-2070, probably belonging to the genus *Potamon* that is widespread throughout freshwaters of Anatolia (Kinzelbach 1987; Jesse et al. 2011; Harlıoğlu et al. 2018). Aquatic shells discovered at the building derive from both freshwater and saltwater sources.

The exploitation of wetlands is also attested in the occurrence of several terrestrial and submerged plant species including terrestrial green algae (Charophytes), crustaceans like ostracods (indicative of standing to slow-flowing water), and several burned mollusks in the plant samples. A small proportion of the charcoal fragments from Zincirli also indicates the use of wetlands for wood/reed procurement, like, e.g., *Phragmites* and *Populus/Salix* (Fig. 7).

Surprisingly, while Cyperaceae and *Phragmites* phytoliths have been identified, seeds from the Cyperaceae family (e.g., *Scirpus maritimus*) do not appear often in the assemblage, which is unusual considering the durable nature of their hard-shelled nutlets. Two submerged elements of wetland plants were found, more precisely Charophytes and *Potamogeton*, which indicate the exploitation of permanent water bodies, since the seeds/oogonia of these genera germinate at the muddy bottom (Akman et al. 2011). Moreover, several wetland taxa from the

building complex at Zincirli are not typical weeds infesting the dry-farmed or irrigated fields. Their seed setting period (and oogonium formation for Charophytes) covers late summer and early autumn. The summer/autumn time window indicates that these plants derived from more persistent aquatic ecosystems such as small lakes, ponds, and/or slow-flowing rivers but probably not temporary marshes that dry up in increasing summertime temperatures. Analogous local ecological conditions appear today in the vicinity of Tilmen Höyük in the Islahiye Plain, which supports a rich array of faunal and floral species including hygrophilous plant communities dominated by *Phragmites australis* (Pisa et al. 2013, 2020).

While it is not possible to determine the exact kind of wetland environment that was used by denizens of the monumental building complex, there are strong indications that nearby wetlands, including both marshes and deeper water bodies, were, in fact, exploited.

Agropastoral production and wood procurement in the Islahiye plain and flanks of the Amanus

In addition to the exploitation of wetlands, there is evidence for agricultural production related to the MBA monumental building complex that likely took place in the Islahiye valley. It was dependent upon several crop species typical to the Near East. The plant evidence suggests that important crop plants for dietary practices were cereals (barley and bread/durum wheat) and pulses (bitter vetch and lentil). Although today cultivation also takes place on the hilly flanks and uplands of the Amanus, e.g., near Hasanbeyli, it is likely that these areas were forested during the Bronze Ages (cf. Casana and Wilkinson 2005). Therefore, the present crops (except perhaps for bitter vetch, see below) were probably cultivated in the Islahiye plain, since this is the only level area where the edaphic and water conditions are favorable. Other pulses and cereals occur too infrequently in the assemblage to assess their importance for the local economy. For instance, common vetch and grass pea are two crop species that often behave as weeds among other crops, and this is likely the case for our sample.

In addition to the in situ bitter vetch finds (discussed below), some other crop finds (barley and free-threshing wheat) were cleaned completely of impurities and were clearly at the final stage of crop processing, hand sorting, when deposited in their primary contexts. The last remaining contaminants in these otherwise “clean” crop concentrations are rye-grass seeds, a segetal plant typical to Cilicia (Sollee et al. 2020; Hynd 1997; Bending and Colledge 2007; Harding 2019), the Levant, and Northern Mesopotamia (Riehl 2010b) that mimics wheat and barley cultivars in size and growing habit (Sollee et al. 2020; Hynd 1997; Bending and Colledge 2007; Harding 2019). The most ubiquitous taxon

in the assemblage, aggregate clover (*Melilotus/Trifolium*), on the other hand, includes a heterogeneous group of plants becoming part of every plant association (Zohary 1973). Although specific archaeobotanical identifications are hampered by close morphological resemblances to carpological finds (cf. Butler 1996), Turkey is particularly rich in *Trifolium* with more than 100 species (Zohary 1973; Maier et al. 1990) suggesting that the seeds found in the Zincirli assemblage most probably belong to this genus. Most concentrated crop finds at Zincirli are devoid of aggregate clovers, except for the bitter vetch deposit, where they appear in comparably low quantities. This suggests that small seeded leguminous plants like clovers were eliminated in earlier stages of crop processing during coarse sieving in the arable fields. The weedy status and taphonomic significance of this taxon cannot be clearly ascertained from these contexts.

One of the most ecologically significant findings among Mediterranean therophytes at the MBA monumental building complex in Zincirli is the occurrence of *Diplotaxis eruroides*-type, which forms a dominant element among segetals thriving in heavy alluvial, fine-grained soils today (Zohary 1973). Surprisingly, the summer elements of the same plant association, typically dominated by *Prosopis farcta*, are absent at Zincirli. In contrast, *P. farcta* was abundant at EBA Tell Tayinat (Karakaya 2020) and LBA Alalakh (Riehl 2010a; Stirn 2013) in the Lower Orontes Basin. Ruminants eat fresh leaves in early spring and the fleshy pods of this plant in late summer (Charles 1998); the seeds were also used in human consumption in South America (Capparelli and Lema 2011). The absence of this species in Complex DD at Zincirli could demonstrate a lack of summer cultivation of alluvial soils (or the presence of summer fallow), and/or relate to the lack of dung burning. It seems likely that the fields associated with the complex were left fallow during the summer, an observation also reflected in the lack of warm season crops among the seed remains. Fallowing for half a year, one or multiple years are a widely practiced strategy to restore soil moisture and nutrient content in ancient farming (cf. Wilkinson 1994; Halstead 1987).

Some segetals or ruderals found within the building complex, like, e.g., *Vaccaria hispanica*, *Bromus*, *Phalaris*, and *Anthemis cotula*, likely entered the building through harvesting, since they typically grow in arable fields and anthropogenic habitats.

Most of the zooarchaeological sample consists of sheep and goat specimens, reflecting a reliance on caprine species related with the building complex. These species may have been herded in the Islahiye Plain to the southeast of the site and seasonally moved to the hills of the Amanus during the summer months, as has been observed in modern practices of transhumance (BNI 1919; Özüpekçe 2018). The predominance of sheep (relative to goat) is likely reflective of a relatively temperate environment,

without significant tendencies towards extreme heat (Redding 1984; Lancaster and Lancaster 1991). Pigs similarly do well in these temperate environments, benefitting either from intrinsic penning or extrinsic grazing, and in this case, they likely provided supplementary meat to the staple food sources provided by sheep, goat, and cattle (Grigson 2007). This picture of domestic livestock is broadly consistent with patterns of livestock management seen across many Near Eastern Bronze Age sites.

Olive, represented by stones and charcoal, and grape, represented by pips and skins, may also have been cultivated in the valley or, perhaps, on the slopes of the nearby mountains as is often the case in the Mediterranean region (Loumou and Giourgia 2003). *Ficus*, which was only represented by seeds, may have been cultivated in the valley, but also grows naturally in areas up to 950 m in the Amanus region (Kehl 1998).

Regarding grape vine, Zincirli is located within the natural distribution zone of the wild variety, *Vitis sylvestris* (Zohary and Hopf 2000; Riehl 2014), as well as another vine species from the *Vitaceae* family, *Ampelopsis orientalis* (Wagenitz 1962). In the Mediterranean vegetation belt, wild grape vines occur in the relatively cooler, mesic environments, although scattered populations are found along the stream sides in more xeric environments (Zohary et al. 2012). It is assumed that grape domestication took place well before the MBA (e.g., Zohary and Spiegel-Roy 1975; Arroyo-García et al. 2006; Miller 2008; Myles et al. 2011; Fuller and Stevens 2019; Pagnoux et al. 2021). The presence of rudimentary, miniature pips at Zincirli suggests that they were from domesticated grapevine stocks (Kroll 1999). Rudimentary pips are indeed widespread regionally (Miller and White 2018; Karakaya 2020) and material culture evidence for viticulture occurs in the forms of ETC goblets in the Lower Orontes Valley (Batiuk 2013) and globular flasks in the Northern Levant (Morgan and Richardson 2020). It is highly likely that the communities here also specialized in cultivating domesticated grapestocks. The lack of *Vitis* wood in the building complex does not imply that it was not cultivated locally: it may be due to the absence of ovens, hearths or dumps and the fact that *Vitis* wood is not the preferable wood for architecture and furniture. The local production of globular flasks that probably served for storing and transporting wine, along with contemporary texts referring to a special sweet, expensive wine from the nearby region of Mamma, suggest that Zincirli may have been a wine production center in the MBA (Morgan and Richardson 2020).

At ca. 3%, the proportion of olive charcoal is somewhat low compared to EBA sites with strong indications for intensive olive cultivation in the Levant, which have olive proportions of ca. 60–80% (Deckers et al. 2021). This may, however, also be related to the fact that no typical fuel (waste) was investigated.

Fig seems to have played less of a role in the monumental building complex at Zincirli, as demonstrated by few car-pological findings and the absence of its charcoals. Fig was already domesticated by the MBA in the Near East (Kislev et al. 2006). However, it cannot be excluded that wild figs may have been used, since Zincirli is in the distribution of wild fig (Zohary and Hopf 2000). Wild fig is an element of the Mediterranean maquis and garrigue formations. Although their primary habitats are rock crevices, gorges, and stream sides, the feral forms usually occupy man-made habitats such as terrace walls, wells, collapsed cisterns, and cave entrances (Zohary and Hopf 2000).

Some crops found within the complex were likely cultivated on somewhat higher grounds, e.g., on the hilly flanks of the Amanus. The sample composition of stored bitter vetch finds in room DD1 (as well as another bitter vetch deposit in DD10 which is not reported here but identical in sample composition) is unique in demonstrating what the weed flora of bitter vetch fields and seasonality may have been in the MBA. The proportion of weedy plants and the lack of bitter vetch pods in this deposit indicate that the harvested bitter vetch was threshed before it was deposited in the archaeological site. Two types of adaptive strategy are visible in the archaeobotanical record. First, most of the weedy plants have roundish forms resembling bitter vetch. The size mimicry is a well-known adaptive strategy for weedy taxa that evade post-harvest filters to include their propagules in the seed crop. Secondly, the weedy plants whose disseminules had hooked surface structures seem to have been selected prominently. Although the habitat preferences of plants can change through time and it is highly varied for most species (e.g., *Rumex*), a number of taxa in this assemblage thrive on the rocky calcareous and limestone slopes and rock crevices (e.g., *Buglossoides arvensis*, *Vicia cf. sativa*, *Heliotropium*, *Plantago*, *Fumaria*) and as undergrowth in *Pinus brutia* forests (e.g., *Vicia lathyroides*) or in openings in forested areas (*Sherardia arvensis*) according to the habitat information in the Flora of Turkey (Davis 1968–1985). This suggests that the bitter vetch fields may have been located closer to the Amanus Mountains, specifically on the hilly flanks of Amanus, with possibly thinner and less desirable soil cover in degraded forest areas.

Besides agropastoral activities, some wood procurement may also have taken place in the plain. It is not always possible to differentiate between an origin from the plain or mid-elevation, since not all taxa exclusively belong to one zone (Fig. 7). *Arbutus* and *Ziziphus* are taxa that exclusively indicate a location in the plain, however. Other taxa, like evergreen *Quercus* (also identified among the phytoliths), *Fraxinus*, *Pinus brutia*, *Pistacia*, and *Viburnum*, could have grown either within the plain or at mid-elevation. Finally, for some of the charcoals, especially those that could not be exactly identified but also others, like e.g., *Quercus* sp.,

conifer, and *Pinus nigra*, the possible source area is even less well defined: they can occur in different elevations, such as the plain, mid-, and high elevations.

Hunting and wood exploitation related with woodland and forests

Higher elevations in the Amanus were also exploited by the users of the building complex, likely for wood procurement. For example, the attested *Juniperus* typically occurs in mid- and high elevations in the Amanus; *Cedrus* typically grows in mid-elevations in this region (Fig. 7). Figure 3 makes visible the present-day location of *Cedrus* within the 5 km radius of Zincirli.

A very small proportion of the wood charcoal from Zincirli may have derived from a further distance from the site, i.e., those taxa that represent Euro-Siberian elements like *Alnus*, *Carpinus*, and *Tilia*. These likely had a source within the Amanus, but probably on its western side.

The faunal remains also indicate a utilization of the Amanus forest. Among large-bodied game animals, specimens from red and fallow deer are represented, as is what seems to be a single large boar specimen. Red deer is represented not only by a single shed antler but also two phalanges, suggesting not only the collection of antlers shed in the wintertime but also the hunting of these species as well (Lister 1996). Red deer are largely forest-dwelling species and likely thrived in pine forests of the Amanus to the north of Zincirli during the MBA (Geist 1998). The presence of the shed antler suggests that red deer, a migratory species, was indeed present in the region during the winter months, where they may have readily browsed upon *Pinus spp.* to supplement their winter diet (Straus 1981).

Hunting took place in the region surrounding Zincirli and made significant contributions to the MBA assemblage. Remains at Zincirli of *Dama dama mesopotamica*, a species that persisted in its native form among the coastal wooded mountains and plains of southeastern Anatolia throughout the Holocene (Chapman and Chapman 1975, 1997), indicate the use of scrub landscapes between 100 and 900 m above sea level. These animals feed on maquis species like *Quercus coccifera*, *Phillyrea media*, *Arbutus unedo*, and *Pistacia spp.* (Swift and Holloway 1967; Chapman and Chapman 1980). The presence of multiple deer species at MBA Zincirli attests to the utilization of pine forests, as well as perhaps the mixed woodlands represented in the Amanus mountains.

Omnivorous and generalist species, like wild boar and foxes, were likely regular inhabitants not only of the Amanus forests but also of the semi-wooded spaces directly around Zincirli. The nocturnal wild boar prefers forests and bushes during daylight hours but will often venture into available open grasslands and farmlands in the evenings to feed on agricultural crops (İnci et al. 2013). The Eurasian red fox is also widely distributed through a large variety of habitat

types throughout modern Anatolia (Ambarlı et al. 2016). Their presence at Zincirli might suggest their hunting for meat (in the case of wild boar) or skins (in the case of foxes), further implying that denizens of MBA Zincirli had ready access to these forested environments.

Exploitation of semi-steppe batha environments

Besides hunting of species typical of woody environments, some of the faunal remains from MBA Zincirli are indicative for more arid, steppe-like environs. Mountain gazelle is attested, a species which regularly inhabit arid steppe-like habitats in the Northern Levant. Wild hares (*Lepus* sp.) are also present among the Zincirli MBA remains. These animals are known to also inhabit dry, open woods and scrublands in the Islahiye and Hatay regions both in modern day and in the past (Lösch et al. 2006; Coğal and Sözen 2017). Both carapace fragments as well as long bones attributable to *Testudo graeca* are attested at the site. These small aridity-adapted reptiles can be found between sea level and approximately 2700 m (m.a.s.l.), most often on dry steppes and scrub-covered hillsides, although they also appear in anthropogenic environments like vineyards and gardens (Başoğlu and Baran 1977; Ayaz and Çiçek 2010).

Phytolith analysis indicates that there was a clear majority of inflorescence phytoliths from C3 plants compared to C4 plants at MBA Zincirli, which suggests a rather semi-batha environment instead of steppe in the neighborhood of the site (Twiss 1992).

Function of monumental building Complex DD

The presence of a large proportion of conifer wood in Complex DD, perhaps within its architecture, may indicate that the complex was a high-ranked building. It should be noted that the apparent lack of conifers in the phytolith assemblage is probably because they are difficult to identify (Rovner 1971; Xiao-Hong 2016). In the Near East, the use of conifer wood, especially *Cedrus*, but also *Pinus*, is most often associated with temples and palaces, rather than domestic contexts (Deckers 2011). For example, *Cedrus* was used in the palace of Qatna and the monumental building of Tell el-Burak, both of which date to the MBA (Deckers 2011, 2019); *Pinus* and *Cedrus* both were used in the MBA palace from Lachish (unpublished data Deckers), while *Abies* was identified from a possible MBA temple in Tilmen Höyük (Macchioni and Lazzeri 2013). Palaces and temples of both earlier and later periods often included in their construction coniferous wood that had been imported from a further distance (e.g., *Pinus* in the EBA palace B from Bi'a, *Pinus* in the EBA palace from Tell Mozan). In contrast, locally available wood was used for domestic architecture (Feisel 2000; Deckers 2010). Unlike many regions of the Near East,

Zincirli had ready access to a variety of conifers, so it can be questioned whether the use of conifer at Zincirli was exclusively for the higher ranked. For example, in nearby, Tilmen Höyük conifers were also used in domestic architecture (Macchioni and Lazzeri 2013). Notwithstanding this domestic use of conifers, there are several other indications that Complex DD was a high-ranked building, and the inclusion of a large proportion of conifer supports this association.

The analysis of the upper-structure mudbrick detritus indicates that it did not include dung, but instead a temper of grasses. This grassy temper consisted of parts of inflorescences as well as leaves, perhaps straw and chaff, which is the most common temper in the ancient Near East and not reserved for official structures (Oates 1990; Homsher 2012). These kinds of bricks would have been made after the harvest in the dry season. Additionally, some bark or wood remains appear to have been included in the temper. However, since it is only a very small proportion of the temper overall, it was likely added unintentionally. Wood temper was likely used as a second-choice temper, if straw and chaff were not available (Homsher 2012).

While some of the charcoals may have belonged to the roof, others may have been part of doors, furniture and utensils that became charred in the MBA conflagration. Unfortunately, we cannot determine the precise origin of the identified wood charcoal. Notwithstanding this difficulty, an exceptionally wide variety of wood taxa were found in Complex DD, which may reflect its elite use and access to a variety of ecological niches. It may also reflect the overall setting of the site, since recent work on Iron Age samples from the site indicates a similarly high diversity of woody taxa used (Deckers unpublished data). As mentioned above, no oven contexts were found within the complex thus far, so the charcoals are unlikely to represent the remains of fuel, which more often display such taxonomic variety (Asouti and Austin 2005). Notably, although comparatively few, there are also phytoliths of leaves from dicotyledonous plants (especially in DD3), so possibly not all the wood was part of worked carpentry.

The botanical and faunal remains attest to the preparation, storage, and consumption of different kinds of food, as well as to craft activities, especially textile production. Although, as stated above, installations for cooking were not identified in our study area, there is evidence for other kinds of food processing. Within building DD/I, two archaeological features presumed to be related to liquid manipulation were excavated. In room DD2, installation L17-2061 consisted of a grinding stone set on an elevated bench alongside a plastered bin or basin with drainage channel. The associated flotation samples contained grape pips and skin finds and many wetland plant taxa. Grape was the only crop plant in this context. Concentrated grape remains were also identified in room DD3 in association with two jar stands, two

medium-sized jars with pre-firing perforations at the base, and a shallow basin inset into the floor of the room. Room DD3 has been only recently fully excavated, and interpretive explanation is still pending further analyses. Nonetheless, we hypothesize that these features may have served for pressing or mixing additives and/or for dilution of wine. The scale of these features is small compared to, e.g., the recently excavated Phoenician wine press at Tell el-Burak, located at the outskirts of the settlement (Orsingher et al. 2020). Nonetheless, Zincirli may have been an important regional wine supplier, given its favorable local climate and its strategic position in the trade networks connecting the Eastern Mediterranean Basin to Mesopotamia and Central Anatolia (Morgan and Richardson 2020). Zincirli sits at the hinterland of the forested landscape of the Amanus Mountains, so the rich floristic diversity of the region might have provided a large variety of herbal ingredients to be mixed during wine production, analogous to what has been discovered in the organic residue from pottery at MBA Tel Kabri in the Southern Levant (Koh et al. 2014).

There is evidence for seed storage in room DD1, with bitter vetch deposited in a storage jar. Although today it is mostly grown as a fodder plant, it was part of the food founder crops in the Near East (Zohary and Hopf 2000). The increased focus on bitter vetch in the 2nd millennium BC in the Levant may relate to horse warfare and chariot riding, used as fodder for horses (Miller and Enneking 2014). When unprocessed, it is toxic to horses just as it is for humans; however, ruminants like cattle, goat, and sheep can tolerate it if their consumption of it does not exceed 25% of the total diet (Miller and Enneking 2014). Processing the crop removes toxins by leaching these in the water and then pounding the seeds to remove the seed coat (Valamoti et al. 2011). This process changes the morphology of the grain, leaving several split cotyledons with a concave shallow depression at the inner part of the cotyledon (Valamoti et al. 2011). None of the bitter vetch samples at Zincirli show evidence for this kind of processing so far (cf. Sarpaki 1992). Bitter vetch is traditionally considered a low value crop in Greece, used as food only in case of hunger or starvation due to its toxicity (Halstead 2015). Notwithstanding the traditional Aegean association with low value food, bitter vetch and another toxic vetch (*Lathyrus sativus/cicera*) have been found in some temples and elite residences, e.g., in a Hittite temple of Kuşaklı (cf. Pasternak 1998, though rather few bitter vetch), a Neo-Assyrian temple of Tell Tayinat (Karakaya 2020), and in other cultic contexts at Tel Burna in Lebanon (Orendi et al. 2017) and Tel Batash in Israel (Mahler-Slasky and Kislev 2010). We can only speculate as to its intended function at the MBA monumental complex at Zincirli. Besides its use as food and fodder, it has also been reported as an additive to wine (Smith 2005). Textual sources from ancient Egypt suggest a large variety of possible uses of bitter vetch in the past,

including medicinal help, performing magical spells, and as a dye (Ismail 2019). Traditional farmers in the Aegean region of modern Turkey even developed a folk play that addresses the neurological effect of bitter vetch (Cizer 2015).

Besides the storage of bitter vetch, a high proportion of grass inflorescence phytoliths was found in DD1, likely relating to grain storage. No charred cereal concentration has been found to date, but half of the room was not preserved due to later pitting and trenching. Charred cereal concentrations were found associated with food processing installations outside building DD/II (labeled DD11 in Fig. 2). The phytolith data from around these installations further indicate the presence of ground cereal products by their proportion of WM to MC phytoliths.

The faunal remains from Complex DD are mainly a byproduct of food consumption and craft activities. The consumption of mature caprines as mutton indicates that they were likely raised for wool production, and the high proportion of caprine lower limbs suggests that the consumers in Complex DD had more direct access to these herds, rather than having procured them from an external source or market. This indicates that it not only had access to the meat of these animals but was also directly involved with wool and textile production, as also suggested by the presence of loom weights, bone pins, spatulas, and bronze needles (Poolman and Morgan in press). The lack of dung spherulites within the complex shows that the animals were kept away from these buildings during their lifetimes.

In addition to the preparation, storage, consumption, and craft activities that occurred within the direct confines of the complex, archaeobiological remains also hint at a diverse array of activities that took place in different locales of Zincirli's surroundings during different periods of the year. There is evidence for year-round environmental exploitation, with, e.g., May/June crop harvesting as indicated by the weeds, olive harvesting in autumn, possibly late summer harvesting of grapes, and use of wetland environments in summer/early autumn. Moreover, there are indications for the winter hunting of deer, antler collection, and year-round livestock keeping.

This diverse utilization of the local landscape surrounding the MBA elite building resembles that attested at the elite building at Kabri in Israel, which also utilized a wide variety of faunal taxa from its surrounding environs (Marom et al. 2014). This diversified strategy contrasts with archaeobiological findings from other palatial centers in the Near East, particularly those with specialized production strategies like, e.g., caprine specialization at Hazor, or mono-crop specialization at elite sites in Southern Mesopotamia (Marom et al. 2014; Marston et al. 2021).

This complex may have functioned as a kind of estate within a centralized institution and, in any case, possessed access to the resources from an extensive area of land. The rich environmental landscape in Zincirli's surroundings

allowed for this diverse provisioning strategy, which in turn mitigated against risk.

Conclusion

The archaeobiological remains from the monumental building Complex DD at Zincirli indicate the year-round environmental exploitation within a wide and rich variety of environments in the surroundings of the site. There is evidence for the exploitation of wetlands, agropastoral production and wood procurement in the Islahiye plain and flanks of the Amanus, hunting and wood exploitation in woodlands and forests, and use of semi-steppe batha environments by those who once utilized Complex DD. Most of these environments lie within 5 to 10 km radius, and only a small minority of the wood was possibly acquired some 30 km away, within the Euro-Siberian vegetation zone. Hence, this institution seems to have been embedded in its immediate environs, a rich habitat where highly valued elite resources were locally available and exploited (e.g., cedar, pine, grape, and large hunting game). This environment contrasts with the modern regional environment, especially in the presence of woodlands and marshes, and along with their associated fauna. Today, much of the oak woodland has disappeared from the valley as well as Lake Amuq and associated marshes.

A broad range of activities took place within Complex DD, including the preparation, storage, and consumption of different foods and liquids. Additionally, craft activities, especially textile production, took place within the complex while it also served as the site for the centralized storage of a diversity of crops grown around the site. The diverse ecological exploitation strategy revealed at MBA Zincirli is notable in the context of monumental buildings in the Near East, where there seems to be a divergence in the economic strategies employed by centralized institutions. The evidence does not indicate a specialized economy, but instead suggests that MBA Zincirli may have been able to engage with interregional trade through the simultaneous exploitation of localized environments and the specialized production of valuable goods like wool, wine, and, perhaps, wood. Unfortunately, our results cannot yet be directly compared to similar MBA institutions, as few have comprehensively published their faunal and botanical datasets. However, the potential for this type of multidisciplinary analysis remains immense and future studies of this type could greatly elucidate relationships between localized exploitation and interregional exchange, and thereby the environmental situatedness of ancient Near Eastern economies.

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Declarations

Dr. Jason Herrmann, who is a co-author of the manuscript, is associate editor of the journal.

Human and animal rights This research did not involve living human participants and/or animals.

Conflict of interest The authors declare no competing interests.

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