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Subsistence economy and land use strategies in the Burdur province (SW Anatolia) from prehistory to the Byzantine period

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ABSTRACT

A reconstruction of the ancient subsistence economy and land use strategies is presented here for the province of Burdur, more specifically the area south and southeast of Lake Burdur, in southwestern Turkey. This review is based on the results from archaeozoological (including bone collagen carbon and nitrogen stable isotope analyses) and archaeobotanical analyses available from seven sites, dated to distinct time periods ranging from the Neolithic to the Middle Byzantine period. The data (both published and unpublished) are compiled with information available on settlement development and dynamics, in the study area. Results show changing agrarian and animal husbandry practices for a period of more than 8000 years, ranging between self-sustaining economies to specialised husbandry practices and an intensive agricultural exploitation of the landscape, in relation to human settlement activities.

1. Introduction

With the onset of the Neolithic, human societies emerged in which the exploitation of cereals and animal husbandry provided the staple subsistence resource. This inevitably resulted into a modification of the natural environment (Goudie, 2013: 11–20). These early subsistence economies led to the rise of sedentary life, the ability of producing food surpluses and an increase of population densities (Colledge et al., 2005). In the subsequent periods, the further development of economic subsistence strategies, that were depending on cultural, biotic and abiotic backgrounds, caused considerable impact on the landscape (Dearing et al., 2006; Goudie, 2013; Walsh, 2014). Studies of ancient subsistence strategies are therefore of great importance for understanding the organisation of agricultural production – including the cultivation of crops and the raising of animals – through time and its link to land use intensity, technological developments and social complexity. Providing direct evidence on the scale and nature of early plant and animal cultivation is not only relevant for archaeological research, but also for other disciplines like paleoecology, geomorphology and land use reconstructions and modelling. Also, it can be of great importance for simulations of pre-industrial land use (Kaplan et al., 2011).

Human impact on the environment, related with the beginnings and development of agrarian subsistence, took place in Anatolia as early as the 9th millennium BC (Asouti and Fairbairn, 2010; Düring, 2011: 16–17). Human communities underwent thorough changes during prehistory, starting from the Neolithic (8500–6100 B C), continuing through the Chalcolithic (6100–3000 B C) and followed by the development of urban communities and more complex societies in the Early Bronze Age (3000–2000 B C) (Sagona and Zimansky, 2009; Düring, 2011). The Lake District (SW Anatolia) – including the Burdur region – plays a major role in the discussions on diffusion and/or migration processes from the Near East into Europe during Neolithic times (Thissen, 2010; Brami and Heyd, 2011; Düring, 2011). Also in later periods, the Burdur region continued to play a pivotal role, because of its location along one of the major north-south routes through this mountainous area as

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well as being connected to routes leading west, in combination with the presence of a vast area of fertile land (Mitchell, 1993; Talloen, in press). During the Roman Imperial period the archaeological site of Sagalassos became a large urban center that fulfilled a central role in the wider region (Waelkens, 2011; Waelkens et al., 2011).

Archaeological research in the Burdur province (SW Anatolia) documents the rise and continuous change of settlements from the Neolithic (7th millennium BC onwards) up to the Byzantine times (11th/13th century AD) (e.g. Vanhaverbeke and Waelkens, 2003; Kaptijn et al., 2012, 2013; Vandam et al., 2013; Vandam, 2014, 2015; Vandam et al., in prep.). Furthermore, there is an increasing number of environmental and bioarchaeological studies available for this region. Archaeobotanical reports from this area (Helbaek, 1970; Nesbitt, 1996; Martinoli and Nesbitt, 2003) provide information on the crops grown in the Late Neolithic and Chalcolithic periods. Studies on faunal assemblages have been published by Westley (1970), Deniz and Şentuna (1988), De Cupere (2001), De Cupere and Duru (2003) and De Cupere et al. (2008). Several palynological and paleoecological studies (Bottema and Woldring, 1984; Eastwood et al., 1998; Vermoere et al., 2002; Vermoere, 2004; Kaniewski et al., 2007; for a more recent review see; Bakker et al., 2012) focussed on the development of land use and the human impact on vegetation, as well as on past climatic changes. Complementary information on the exploitation of animals within this region was obtained through geochemical evidence (Vanhaverbeke et al., 2011a). Human diet and animal husbandry practices in the Classical/Hellenistic (400–200 B C), Roman Imperial (25BC–450 AD) and Byzantine (450–1200 AD) periods were reconstructed through bulk collagen stable isotope analyses (Fuller et al., 2012).

The environmental archaeological studies, available for the Burdur region, can, if combined, be highly informative on past subsistence practices in the region, but are until now not sufficiently explored. Therefore, the objective of this contribution is to compile and, as far as possible, to integrate all available information – both published and unpublished – from archaeozoological and archaeobotanical research, together with relevant archaeological evidence, in order to provide a diachronic (and where possible spatial) reconstruction of subsistence and land use strategies in the study area from prehistory into the Byzantine period. This article seeks to elucidate the interaction between human society, subsistence economies and the environmental setting.

2. Physical setting and description of the study area

The area for which the data will be presented in this paper is located within the province of Burdur (SW Turkey), ~100 km north of the Turkish Mediterranean coast, and covers a surface of approximately 1200 km^2 (Fig. 1). The study area is part of the Lake District and characterised by the presence of mountains, intermountain basins and the large saline Lake Burdur within the Burdur basin. The highest peaks in the study area range between 2000 m (Beşparmak) and 2275 m (Akdağ). The intermountain valleys (like those of Ağlasun, Hisarköy, Çanaklı, and Çeltikçi-Bağsaray) are generally filled with clay sediments (Dusar et al., 2012). The valley of Ağlasun is located at a height of approximately 1100 m. More to the south, the plain near Bucak is situated at an altitude of about 750–800 m a.s.l. To the southwest of the Burdur lake (about 850 m a.s.l.), the Burdur plain can be found, between the modern villages of Düğer and Kuruçay; its altitude rises in accordance to the distance from the lake up to 950 m a.s.l. To the east and southeast of Lake Burdur, a large zone of marl deposits occurs, the so-called 'Badlands of Burdur'.

The climate in this region is considered to have an Oro-Mediterranean character, with typically dry hot summers and long wet winters (Paulissen et al., 1993). From July until September the area is submitted to arid conditions, whereas the other months are quite humid. Temperatures frequently drop below freezing point during the winter months and most of the precipitation falls in January and December, primarily in the form of snow.

The natural vegetation in the study area belongs to the Oro-Mediterranean zone, mainly characterised by forests of *Pinus brutia*, *P. nigra* and deciduous trees such as *Quercus cerris* (Zohary, 1973). However, the vegetation consists nowadays of a mixture of Mediterranean forests and woodlands, mainly composed of *Pinus nigra*, *Juniperus excelsa* and *J. oxycedrus*, and to a lesser degree *Quercus coccifera* (Bakker, 2012, p. 9). Today the most fertile areas are virtually all under cultivation, while intensive grazing pressure has taken place on the lower slopes, around the agricultural fields, and resulted in maquis or quite open anthropogenic steppe with, among other species, *Q. coccifera*, *J. oxycedrus*, *Artemisia herba/alba* and *Astragalus* (Kaniewski et al., 2007).

3. Material and methods

As already mentioned in the introduction, the data of principally two disciplines will be used to make inferences on the subsistence and land use strategies within the study area through time. These are archaeozoology and archaeobotany. The chronological frame addressed in this paper ranges from the Neolithic to the Byzantine periods. It was tried to gather as much information as possible from these two disciplines for the different periods. Data of own research was used, as well as published data by other researchers. Materials from the following sites have been considered: Düzen Tepe, Hacılar, Hacılar Büyük Höyük (here after called Hacılar BH), Höyücek, Kuruçay, Sagalassos and Bademağacı. The site of Bademağacı is located at about 50 km south of our study area; nevertheless its data were also included, as it is situated within an environment which is very similar to the one discussed here. By including the data of this site, it is possible to make inferences about the Neolithic in the wider region of Burdur.

Faunal and macrobotanical assemblages are widely recognised to be a valuable source of information on past human activities and they are often used to reconstruct the human diet or, more generally, subsistence in the past (Jacomet and Kreuz, 1999; Reitz and Wing, 1999). Plant remains can indeed document the presence of locally cultivated crops, weeds, imported plants or plants collected in the wild, and provide information on the agricultural developments, vegetation and land use (Jacomet and Kreuz, 1999). Due to the soil conditions in the study area, only charred plant remains are preserved (with charring being most often the result of daily settlement activities).

Faunal remains document the importance of hunting versus herding, the composition of livestock and the exploitation of animals (Davis, 1987; Reitz and Wing, 1999). The contribution or importance of each animal species or group is considered to be reflected by the number of their respective remains (Reitz and Wing, 1999). In this paper the quantification of the faunal remains is based on the Number of Identified Specimens (NISP), which represents the total number of identified elements of each species or taxonomic group. Worked bones or antler fragments are not included, since artisanal activity implies selection and possible concentration (e.g. De Cupere, 2001) and could, therefore, lead to false conclusions about the importance of a certain species in the

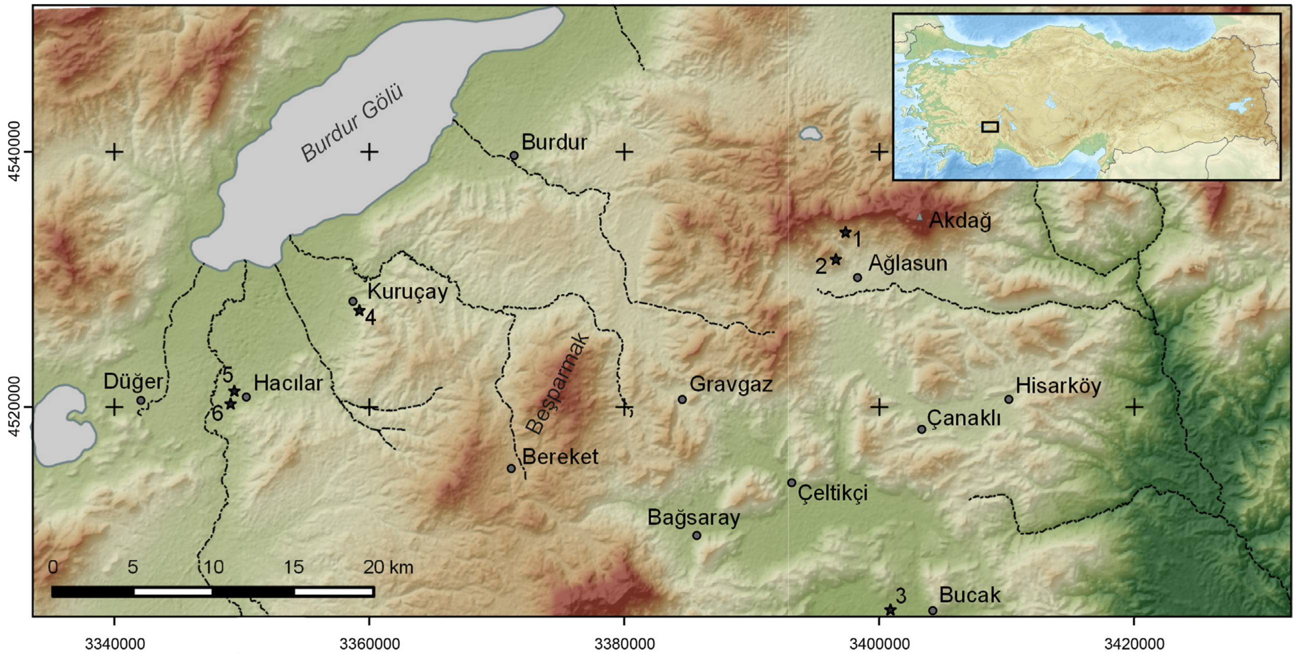

Fig. 1. Map of the study area, with indication of the present-day localities (dots) and archaeological sites (stars; 1: Sagalassos, 2: Düzen Tepe; 3: Höyücek; 4: Kuruçay Höyük; 5: Hacılar; 6: Hacılar BH) mentioned in the text.

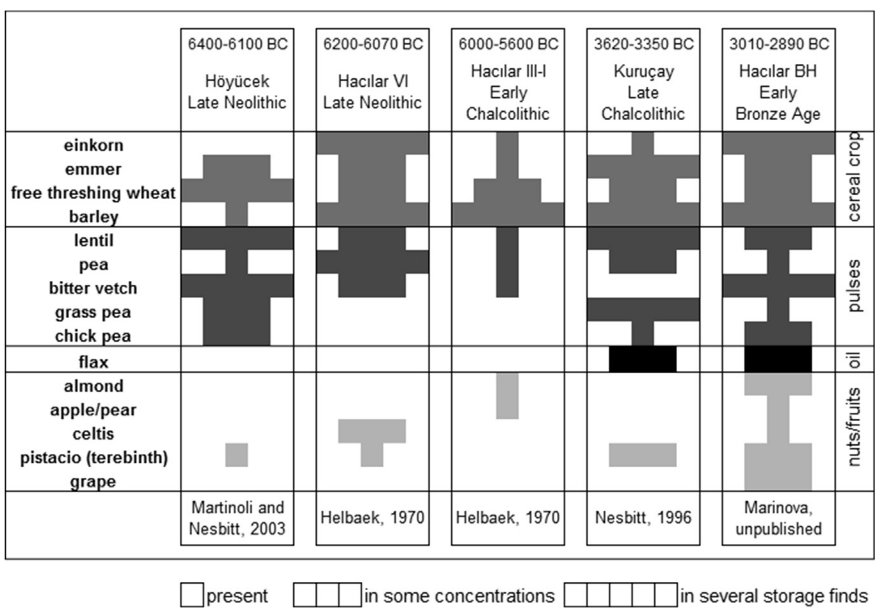

Fig. 2. Archaeobotanical evidence on the Neolithic to Early Bronze Age plant subsistence in the study area.

subsistence. Similarly, remains of intrusive animals and carcasses have not been considered.

An overview of the available archaeobotanical and archaeozoological data is given in Table 1 and summarises the major traits of the considered assemblages, in order to evaluate the comparability of the different datasets. Regarding the archaeobotanical data, we have considered in this paper samples that were obtained through flotation (i.e. at the sites of Hacılar BH, Düzen Tepe and Sagalassos), as well as plant remains that were hand-collected in the excavation trench from visible concentrations, usually from storage facilities (i.e. at the site of Höyücek, Hacılar and Kuruçay). The archaeobotanical assemblages from concentrations evidently are not as representative for the whole range of plants used at a site as the flotation samples are, but they can be used to prove the cultivation or use of certain plants at the sites where they are found (Jacomet and Kreuz, 1999). As most of the archaeobotanical data from the prehistoric sites are semi-quantitative, they are represented on an abundance scale (Fig. 2); the fully-quantified data from the other sites (Düzen Tepe and Sagalassos) are given as percentages of the main ecological and economic groups (Fig. 3).

In the case of the archaeozoological assemblages, all sites have yielded data on hand-collected faunal remains; at Düzen Tepe and Sagalassos material has in addition also been retrieved through sieving. In order to guarantee the comparability between data from

Table 1
Overview of the sites from which data have been used in this paper (AZ: archaeozoology; AB: archaeobotany).

Site	Site description	Reference to AZ/AB data	Collection method	Sample size: number of bones/number of AB samples
Bademağacı	Mound; Neolithic levels which are covered by quite large Early Bronze Age settlement	AZ De Cupere et al. 2008; De Cupere et al., in press a AB	Hand	More than 12,000 bones
Höyücek	Small mound; site consisting of 2 rectangular rooms, separated by some smaller storage areas; dated to the Neolithic	AZ De Cupere and Duru, 2003 AB Martinoli and Nesbitt, 2003	Hand Hand	626 bones 11 samples
Kuruçay	Impressive fortification wall with a pair of semi-circular towers, surrounding small village; dated from the Neolithic to the Early Bronze Age	AZ Deniz and Şentuna, 1988 AB Nesbitt, 1996	Hand Hand	Approx. 1500 bones; data on Neolithic material missing; identification not always reliable 25 samples
Hacılar	Mound; uninterrupted settlement with 9 phases, dated from the Neolithic to the end of the Chalcolithic	AZ Westley, 1970 AB Helbaek, 1970	Hand Hand	Numbers not always given 9 samples
Hacılar BH	Mound; large-sized settlement, surrounded by fortification wall; mainly dated to EBA I and EBA II	AZ De Cupere, unpublished data AB Marinova, unpublished data	Hand Hand/Flotation	Approx. 3000 bones 12 / 6 samples
Düzen Tepe	Large, fortified village site, on hill; dated to Classical/Hellenistic period (500–200 B C)	AZ De Cupere et al., in press b; unpublished data AB Fuller et al., 2012; Marinova, unpublished data	Hand/Sieved Flotation	About 36,000 bones 36 samples
Sagalassos	Urban site, on hill slope, with large territory; mainly inhabited during Roman-Early Byzantine period	AZ De Cupere, 2001; unpublished data Fuller et al., 2012 AB Fuller et al., 2012; Marinova, unpublished data	Hand/Sieved Flotation	Very large collection of animal bones 96 samples

the different sites, only hand-collected remains have been considered and will be discussed in this paper. The publication on the faunal remains from Hacılar (Westley, 1970) is based on a very small amount of animal remains and exact numbers are not always given; they should be interpreted with care. The faunal report on Kuruçay (Deniz and Şentuna, 1988) mentions the identified faunal remains according to phase, but the list of the Neolithic material is lacking. In addition, most of the identifications do not go beyond the 'small/large ruminant'-level. Therefore, these data are of limited use. The archaeozoological data of the sites are presented in Figs. 4 and 5. Bone collagen stable isotope analysis ($\delta^{13}C$, $\delta^{15}N$) has been carried out on animal remains from Düzen Tepe and Sagalassos assemblages and documents changes in livestock feeding strategies from the Classical-Hellenistic to the Middle Byzantine periods (Fuller et al., 2012); results of this study will also be included in this paper. For the moment there are no archaeobotanical or archaeozoological data on the study area for the Middle and Late Chalcolithic, Late Bronze Age and Iron Age.

In addition to the archaeobotanical and archaeozoological data, results of previously published palaeoecological studies within the region are considered in this paper. A review on the palynological and other palaeoecological studies in the region has already been published by Bakker et al. (2012) and will be used here.

The subsistence data will be discussed in view of the settlement pattern in the region through time; a summary of this is presented in Fig. 6. The knowledge on the settlement patterns in the study area is based on two types of survey, i.e. intensive and non-intensive or extensive survey. During the early years of the Sagalassos Project, the entire territory was investigated by non-intensive survey (Waelkens et al., 1997, 2000; Vanhaverbeke and Waelkens, 2003), followed by a series of intensive surveys, first in the direct vicinity of the city (1999–2006) (Vanhaverbeke et al., 2007), later in more remote valleys of the territory, i.e. around Bereket (2008) and Bağsaray (2009) (Vanhaverbeke et al., 2011b; Kaptijn et al., 2013) and in the Burdur Plain (2010–2012) (Kaptijn et al., 2012; Vandam et al., 2013; Vandam, 2014).

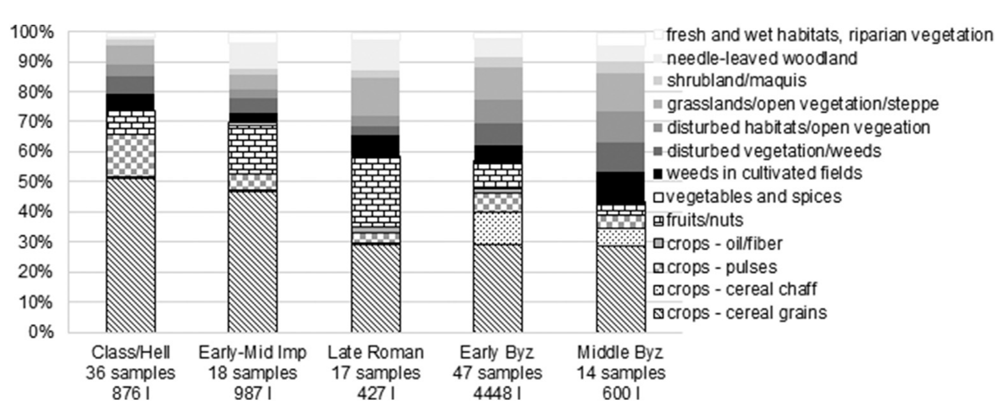

Fig. 3. Archaeobotanical evidence on the plant subsistence at Düzen Tepe and Sagalassos (Classical/Hellenistic to Middle Byzantine).

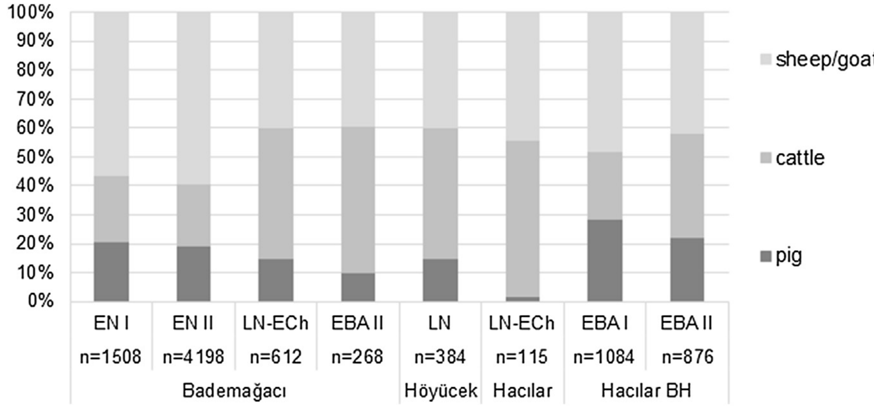

Fig. 4. Composition of the livestock in the prehistoric faunal assemblages (Neolithic to Early Bronze Age). Numbers (n) indicate NISP's.

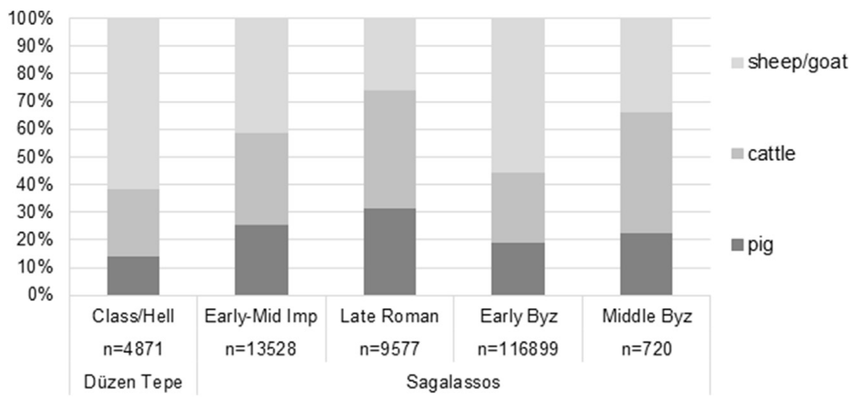

Fig. 5. Composition of the livestock in the faunal assemblages of Düzen Tepe and Sagalassos (Classical/Hellenistic to Middle Byzantine). Numbers (n) indicate NISP's.

4. Diachronic synthesis of data

4.1. Neolithic and Early Chalcolithic period (7000–5500 B C)

Indications of human activity preceding 6500 B C in the Burdur province are scant. The possibly aceramic phase excavated at Hacılar (Mellaart, 1970, pp. 3–7) remains controversial (Duru, 1989). The earliest levels of Bademağacı (EN I levels) could indicate that the Neolithic way of life had probably already been established before 6500 B C, as seen most clearly at Ulucak Höyük (Level VI; Çilingiroglu et al., 2012, p. 141). However, the limited amount of finds and absolute dates of these levels make it difficult to assess their possible pre-6500 B C date. The first conclusive evidence of human occupation derives from the Late Neolithic (6500–6100 B C). The known Late Neolithic settlements appear to be similar in character, consisting of small/medium-sized villages (1–2ha), with no evidence for smaller, contemporarily, dispersed farms or hamlets yet identified (Vandam, 2014; Vandam, accepted). These Neolithic villages were spread throughout different intermountain plain areas of the Burdur region (French, 2012, maps 11.16–11.17) and located in favorable places in close proximity to water sources and fertile land (Vandam, accepted). A similar settlement pattern can be reconstructed for the Early Chalcolithic (6100–5500 B C) but now, in addition, smaller isolated nuclei of habitation, probably farmsteads or hamlets, seem to have been present in the landscape (Kaptijn et al., 2012; Vandam, accepted).

The emergence of Neolithic cultures involved the introduction and establishment of domestic flocks (comprised of sheep/goat, cattle and pigs) with the first settlers (De Cupere et al., 2008). For the early levels at Bademağacı, a great reliance on sheep and goat is observed, while pig and cattle are much less important. Given the slaughter data, it has been argued that the small livestock – with sheep outnumbering goats – at this site were (at least partially) exploited for their milk; the presence of dairy fat was also attested through residue analysis carried out on ceramic sherds (De Cupere et al., 2008; De Cupere et al., in press a). The evidence for milk production, together with their predominance in faunal assemblages, underlines the importance of sheep/goats, and especially of sheep (De Cupere et al., in press a). Data on slaughter ages suggest that herding strategies for cattle were directed towards meat production (De Cupere et al., 2008). During the Late Neolithic-Early Chalcolithic, both at Bademağacı and Höyücek there is a strong increased importance of cattle, which can be linked to an intensification of beef production or, as indicated by the kill-off pattern, a preference towards milk exploitation (De Cupere et al., 2008). In addition to the domesticates, remains of wild animals were also found in the faunal assemblages. Their share represents the importance of hunting versus herding and breeding through time. Among the hunted species are mainly deer, including all three species native to this region, namely red deer (*Cervus elaphus*), fallow deer (*Dama dama*) and roe deer (*Capreolus capreolus*). Occasionally, other large mammals such as wild boar (*Sus scrofa*), bezoar goat (*Capra aegagrus*), mouflon (*Ovis orientalis*) and brown bear (*Ursus arctos*) were counted. Remains of small wild mammals that contributed to the subsistence, including hare (*Lepus europaeus*), and birds, are scant in the hand-collected faunal assemblages. Altogether, the Neolithic assemblages of Bademağacı show quite small numbers of wild remains (up to 5%).

No stable isotope data are available for this period in the geographical area considered. However, the faunal assemblages of

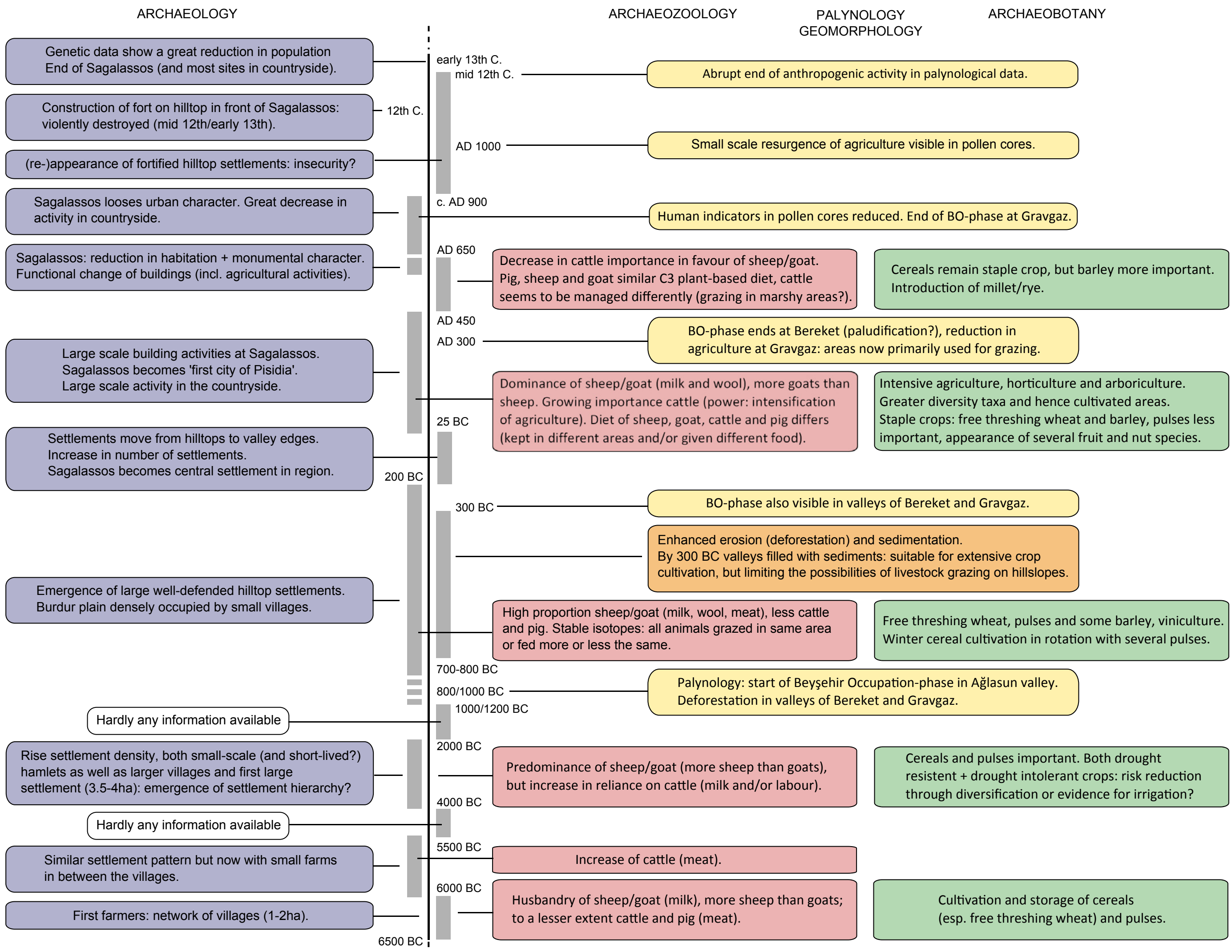

Fig. 6. Synthesis of the bioarchaeological and archaeological data, presented through time (Time scale is not linear).

several sites from southcentral (Çatalhöyük: 7500–6000 cal BC) and south-eastern (Çayönü Tepesi, 9th–7th mil. cal BC) Anatolia and northern Syria (Tell Sabi Abyad, 6800–5800 cal BC) have been subjected to bone collagen carbon and nitrogen stable isotope analysis (Pearson et al., 2007, 2013, 2015; van Der Plicht et al., 2012). Most data concern sheep/goat, while cattle and pig are less documented. Depending on the site and period considered, the proportion of C_4 plants varies greatly in the diet of domestic animals: from absent or anecdotic (as is generally the case for pigs) to a likely steady amount (e.g. for sheep/goats from Çatalhöyük and the earliest level of Tell Sabi Abyad). Changes in the management of sheep/goats through time are observed, including a shift in the environments exploited. A specific management strategy is suggested for cattle at Çayönü Tepesi (where cattle stand out with very high $\delta^{15}N$ values compared to pigs, sheep/goats and humans), while a diversity in cattle management is proposed for Çatalhöyük. A diachronic shift in the environments exploited as grazing areas is also noticed at the latter site. Pig values testify to a rather herbivorous diet, indicating extensive herding rather than a permanent presence within the villages. In short, it appears that already during the Neolithic, different herd management strategies had developed according to the site and/or the period considered. This may reflect different processes: specialisation, adaptation to available resources and/or to a changing environment. Similar processes might have taken place in our study area.

The prehistoric plant economy was based on a variety of cereal crops (barley, free threshing and hulled wheat) and pulses (pea, lentil, bitter vetch, grass pea, chick pea). The importance of pulses corresponds with the observations made for crop assemblages from the Aegean and Central Anatolia, dated from the Neolithic up to the Early Bronze Age (Asouti and Fairbairn, 2002; Riehl, 2014). However, the assemblages presented here were, with the exception of some samples from Early Bronze Age Hacılar BH, collected from accidentally burnt storages. Therefore, they are not representative for the whole range of plants used and the abundance of each plant group (i.e. cereals, pulses, oil crops, etc.) does not necessarily reflect its relative importance. Nevertheless, the presence of storage facilities with the remains of pulse crops show that they were already available (Fig. 2). Free threshing wheat also played a significant role in the subsistence, again similar to tendencies that have been observed at Neolithic sites in central and eastern Anatolia (Riehl, 2014). Free threshing wheat is less drought stress tolerant than barley and hulled wheat, and requires more care (Nesbitt and Samuel, 1996). It is usually grown separate from hulled wheat, implying different cultivation plots and reliance on a diversity of crops.

4.2. Middle and Late Chalcolithic and Early Bronze Age (5500–2000 B C)

For the Middle Chalcolithic and the beginning of the Late Chalcolithic (i.e. the period between 5500 and 3500 BC) no remains of human activity have yet been found in the study region (Kaptijn et al., 2012; Vandam et al., 2013; Vandam, 2015). Palynological and sedimentological data also point towards a low anthropogenic impact and pronounced dry conditions (Bakker et al., 2012). From 3500 BC onwards a rise in site numbers in the Burdur region and SW Turkey in general can be noticed (French, 2012, maps 11.16–11.17). The Burdur plain is characterized by a high number of sites, which were mainly small-scale, flat and probably short-lived, and co-existed with larger villages, like Kuruçay Höyük (Vandam, 2014; Vandam et al., in prep). The appearance of Hacılar BH (Umurtak and Duru, 2012, 2013) in the Early Bronze Age I (3000–2600 BC) is the first indication for the emergence of a more complex society. This settlement, which is currently being excavated and seems to be radial in shape like Bademağacı, is particularly large and may even, for the first time in the settlement history of the Burdur Plain, have surpassed the size of a village. To what extent its presence in the landscape implied site hierarchy is currently unknown. During the Early Bronze Age II (2600–2400 BC), a further rise in number of sites can be noticed, alongside the appearance of cemeteries and formal burials in the landscape (Vandam et al., 2013). In contrast with other regions in Western Anatolia, there is currently no evidence to assume that large complex sites with lower and upper settlements such as Liman Tepe or Troy occurred in the study region (Vandam, 2014). Only very few sites, dating to the following Early Bronze Age III (2400–2000 BC), have been identified and this might illustrate a shift towards settlement nucleation.

Sheep/goats are the most abundant at the site of Hacılar BH, but from EBA I to EBA II an increasing reliance on cattle is noted; cattle is predominant in the EBA II-levels of the site of Bademağacı (Fig. 4). Both sheep/goats and cattle were kept well into maturity during the Early Bronze Age at both sites; this change in slaughter age, especially of cattle, suggests a herd management adjusted to a different economy compared to the Late Neolithic/Early Chalcolithic, most probably a multi-purpose use (principally including milk, fleece, labour and meat) of these domesticates (De Cupere, unpublished data). In general, the composition of livestock is depends on environmental and political/social conditions. Cattle were important in economic, symbolic and ritual practices during the Bronze Age and a general correlation between cattle and site status has been observed: economically they were highly valued for their secondary products, including power. They were used as beasts as burden, as shown in depictions and Late Bronze Age texts (Arbuckle, 2014). The high proportion of cattle in the subsistence at Hacılar BH can most probably be linked to the size of the site. Although the presence of mainly old/senile individuals points towards the possible use of cattle as draught animals, no pathological deformations that can be related to hard labour have been observed by us in the faunal assemblages of Hacılar BH, nor from the EBA-level at Bademağacı. The intensity of their use as beasts of burden was either too low to induce pathologies on their bones or cattle were mainly kept for their other secondary products in this region. No isotope data pertaining to animal husbandry are available for the Chalcolithic/Early Bronze Age in the geographical area considered, and in the wider geographical frame of Anatolia, faunal stable isotope analyses are too scarce to be usable. Compared to the Neolithic period, larger numbers (between 5 and 10%) of wild mammal remains are observed for the Early Bronze Age. Considering the possible meat yield of these wild mammals (which exceed in almost all cases these of sheep and goat), they represent a non-negligible component of the subsistence economy.

The diversity of cereal crops known from the Neolithic period continues during the Chalcolithic and Early Bronze Age period; pulses also continue to be an important element of the diet. But, in contrast to the Neolithic period, they now mostly represent drought resistant species, such as bitter vetch (*Vicia ervilia*) and grass pea (*Lathyrus sativus/cicera*). Further, oil/fibre crops (*Linum usitatissimum*) are found for the first time within the region, in storage facilities at Kuruçay (Late Chalcolithic) and Hacılar BH (Early Bronze Age). The presence of this plant species is also an indication for fields with drought intolerant crops. These two elements point towards the existence of an agricultural system with disparate cultivated areas. This may be considered an attempt to spread the risk of crop failure. Another possibility would be that certain plots were irrigated. Such practices have been suggested for the Late Chalcolithic and Early Bronze Age (3000–2000 BC) pastoral community village of Arslantepe (south-eastern Turkey) (Masi et al., 2014). The growth conditions of barley and emmer have been investigated at this site through isotope analysis and their $\Delta^{13}C$ (the carbon isotope discrimination; see e.g. Araus et al., 1999) variation patterns indicated that the barley fields were most likely not irrigated (Riehl, 2008; Masi et al., 2014). Emmer, on the contrary, might have benefited from anthropogenic water input or its cultivation was relocated to water-rich areas (from which barley would have been excluded) during the period 3000–2750 BC (Masi et al., 2014).

Wild plant resources also continuously played a role in the subsistence within the study area. At Hacılar BH, the presence of concentrations of Brassicaceae (cf. *Descurainia*), almonds (*Amygdalus*/*Prunus*), terebinths (*Pistacia* sp.) and other wild food plants shows a continuity of Neolithic traditions (as for example observed at Çatalhöyuk, see Filipovich, 2014; Fairbairn et al., 2006). The numerous grape finds, found in all flotation samples of Hacılar BH, may reflect the increasing importance of this fruit in the plant economy of the region. Parallels are known from nearly contemporary sites in East Anatolia and West Asia (Miller, 2008).

4.3. Archaic, Classical and Hellenistic times (750–25 B C)

In both the research area and the wider region only few settlement remains have been identified from the Middle and Late Bronze Age (2000–1650/1650–1200 BC) and the Early Iron Age (1200–750 BC). This scarcity of remains makes it impossible to develop a reliable reconstruction of human subsistence during these periods. In the Archaic period (750–500 BC) sites appear that are located on top of mountains and display elaborate fortification walls. Additionally, several, apparently agricultural, villages were recently discovered in the Burdur plain, located at close intervals (i.e. ~1 km) on river banks (Kaptijn et al., 2012). Contemporaneous with the reappearance of visible human presence around c. 1000–800 BC, pollen cores in the Ağlasun valley show an increase in human indicators. This is considered to be the start of the so-called Beyşehir Occupation Phase in this area (Vermoere, 2004). In another valley, at Gravgaz, a distinct period of human induced deforestation occurred starting at more or less the same time, i.e. c. 800 B C (Vermoere et al., 2002). Geomorphological research has identified a peak in slope erosion and corresponding valley sedimentation with a starting date around 800/700 B C (Dusar et al., 2012). Furthermore, geomorphologic modelling at Gravgaz has shown that climate played only a negligible role in this erosion, and that human impact, i.e. deforestation, was the dominant factor (Dusar, 2011). The reappearance of significant – visible in the archaeological record – human presence in the region during the Archaic period had clearly a large impact on the natural environment.

In the Classical period the settlement pattern remained more or less the same with most sites continuing or new ones being founded on similar locations. One of the newly founded sites is Düzen

Tepe. This site fits all the characteristics typical for Archaic/Classical sites; it is located on a steep mountain, has a substantial fortification wall and is of considerable size. Excavations have shown that it was a large densely settled village, occupied between the 5th and the 2nd century BC, that incorporated craft production (Braekmans, 2010; Vanhaverbeke et al., 2010; Vyncke, 2013). At the site of Sagalassos, located on a neighbouring slope, activity also appears during this period. Although the character of Classical Sagalassos is not entirely clear yet, it was at this time most probably smaller than Düzen Tepe (Waelkens et al., 2011; Poblome et al., 2014).

The Hellenistic period (333–25 B C) marks a change in the settlement pattern. Instead of large fortified hilltop settlements, new sites are now located in or on the edge of valleys. This location can be (partially) explained by the slope erosion that had been ongoing since c. 800/700 B C. It is estimated that by c. 300 B C limestone slopes had lost most of their sediment and were almost completely bare (Dusar, 2011). This not only made crop cultivation impossible, but also severely limited grazing in the higher areas. However, the valleys, where the eroded sediment had been deposited, now contained large areas of fertile soil highly suited for crop cultivation. The Hellenistic villagers in the valley were intensively farming the valley plains. At two other pollen core locations the Beyşehir Occupation Phase is now also visible, i.e. Gravgaz from 400 to 260 B C onwards and Bereket from 280 B C onwards (Bakker et al., 2012). During the Hellenistic period Sagalassos had outgrown Düzen Tepe that ceased to exist towards the end of this period. Instead, Sagalassos became the political center of the region and part of the study area turned into the territory of this town.

The faunal assemblage of Düzen Tepe (500–200 B C) shows a low proportion of cattle and pigs, and a high proportion of sheep/goat (Fig. 5), goats being as numerous as sheep (De Cupere et al., in press b). According to their slaughtering pattern, sheep and goats were mainly raised for their milk and wool, and ultimately meat (De Cupere et al., in press b). Stable isotope analysis of cattle, sheep, goat and pig bone collagen provided mean δ^{13}C and δ^{15}N values close to each other, which indicates that all these species were allowed to graze in the same area or were fed a nearly identical diet (Fuller et al., 2012). Altogether it is suggested that, regarding animal management, the inhabitants of Düzen Tepe had developed a small-scale rural self-sustaining economy, with a herd management based on sheep and goats. In addition, the share of wild mammals at Düzen Tepe is very low and does not even exceed 1% (De Cupere et al. in press b), indicating that hunting played a minor role in the food economy.

The archaeobotanical evidence from Düzen Tepe indicates that the main cereal crops are free threshing wheat and to a lesser extent barley, accompanied by a quite high variety of pulses, including lentil, bitter vetch and chick pea (Fig. 3). Pulses are nearly as important as they were in the prehistoric period and comprise, based on the number of identified remains in the flotation samples, approximately 20–25% of the crop plants. Considering the numerous finds of grape (including pips, skins and stalks), viniculture was part of the agricultural economy in the region. Almost no further evidence for the cultivation of fruits/nuts was found at the site. Hulled wheat (einkorn and emmer), typical for the Aegean (Riehl and Nesbitt, 2003), is completely absent. The composition of the main crops corresponds well to what is generally observed in the eastern Mediterranean. The identified weeds point towards winter cereal cultivation. Considering the high proportion and diversity of the pulse crops, these were probably grown in rotation with the cereals in order to increase soil fertility.

4.4. Early–Middle Roman Imperial and Late Roman period (25 B C – AD 450)

The growth of Sagalassos continued in the Early and Middle Roman Imperial (25 BC–AD 100/AD 100–300) and Late Roman periods (AD 300–450). By the end of the 2nd century AD Sagalassos could boast of a theatre, a huge bath complex, several monumental fountains and it was allowed to call itself 'the first city of Pisidia' (Waelkens et al., 2011). The prosperity of Sagalassos is mirrored in the countryside where the number of villages, hamlets and villas has grown exponentially.

At Sagalassos, the Roman Imperial period is characterised by a dominance of sheep/goat (Fig. 5) – goats are now more important than sheep – which were slaughtered at an old age, showing again that they were primarily raised for their milk and wool (De Cupere, 2001, p. 87, p. 140: Fig. 100). However, the proportion of cattle increases during the Early and Middle Roman Imperial and Late Roman periods (Fig. 5). Almost exclusively old cattle were slaughtered at this site (De Cupere, 2001, pp. 93–94) and pathological deformations that could be related to the use of these animals for heavy work, such as ploughing arable land and transport, were observed (De Cupere et al., 2000; De Cupere, 2001, pp. 105–116). The increase of cattle remains, together with their old slaughter age and pathological deformations, can also be interpreted as a possible reflection of the intensification of agriculture in the territory of the site – as more cattle were needed to work on the land (see also De Cupere, 2001). Possibly these strong animals were also brought into action for other purposes, e.g. transport of goods (Corremans et al., 2012). So, cattle were not only exploited for their meat, but also for their power. This stands largely in contrast with the prehistoric sites, and even with Düzen Tepe (De Cupere et al., in press b), where no or very few labour-related pathologies were found. Further, from the Early and Middle Roman Imperial periods onwards, stable isotope analysis also clearly indicates that species differ from each other both by their δ^{13}C and δ^{15}N values – in sharp contrast to the Classical/Hellenistic period. Cattle and sheep show a slight increase in their δ^{13}C mean values (though not statistically significant), which suggests an increased contribution of C_4 plants to their diet and change in the feeding strategy of these species, potentially kept in the same areas or fed a similar diet (Fuller et al., 2012). Pigs had a mainly C_3 terrestrial signature and a ^{15}N-enriched diet that likely included human food refuse. Goats stand out by their low δ^{13}C and δ^{15}N mean values, which indicate a rather different management compared to the other species, likely including keeping, herding or grazing in other areas (possibly along the mountainsides; Fuller et al., 2012). Hunting continues to play a minor role in the subsistence: as a whole, the share of wild mammals in the faunal assemblages of Sagalassos is very low and hardly ever exceeds 1% (De Cupere, 2001; De Cupere, unpublished data).

The archaeobotanical assemblages from the cultural layers of Sagalasssos show that the staple crops are free threshing wheat and barley (Fig. 3). Pulses become less important but a variety of fruit/nut species have now appeared on the species list. Indeed, pollen cores and counter-weights from olive or wine presses (found in several valleys throughout the countryside) also suggest that the inhabitants were practicing intensive agriculture including arboriculture (Vermoere et al., 2003; Vermoere, 2004; Kaniewski et al., 2007). Based on the wild weeds that are found together with the cereals – (such as *Agrostemma githago*, *Anthemis cotula*, *A. pseudocotula*, *Bupleurum* cf. *rotundifolium*, *Bromus* cf. *arvensis*, *Galium* cf. *spurium*, *Lolium* cf. *temulentum*, *Ranunculus arvensis*, *Sherardia arvensis*, *Vaccaria* cf. *pyramidata*, *Vicia hirsuta/tetrasperma*) – it is assumed that the cereals were intensively cultivated as winter crops. Most of these weeds point towards good soil quality and moisture availability. Among the fruits and nuts, it appeared that most of these were grown locally (i.e. *Amygdalus* sp., *Ficus carica*, *Juglans regia*, *Malus/Pyrus*, *Punica granatum*, *Prunus* sp., *Vitis vinifera*); some species (including *Corylus* sp., *Pinus pinea*), however, could – considering their ecological requirements – not be cultivated locally but were imported. There is also diverse evidence of

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vegetables, aromatic herbs and spices (like *Anethum graveolens*, *Apium graveolens*, *Coriandrum sativum*, *Cucumis melo*, *Cuminum cyminum*, *Satureja hortensis*, *Trigonella phoenum-graecum*), most of which, although already present in earlier periods in the Eastern Mediterranean, became a typical element of the diet and agriculture during the Roman period. The introduction and establishment of extensive arboriculture and horticulture, each with their species and specific requirements, indicate that there also must have been an increasing diversity of cultivated areas.

4.5. Early Byzantine times (450–700 AD), Byzantine Dark Ages (700–850 AD) and the Middle Byzantine period (850–1200 AD)

Habitation intensity was still high during the second half of the Late Roman (AD 300–450) and the Early Byzantine periods (AD 450–700). In certain valleys intensive crop cultivation and arboriculture disappeared or greatly decreased and grazing grew in importance during this period (Bakker et al., 2013). However, the settlement pattern continued seemingly unchanged (Kaptijn et al., 2013), indicating that this change of landscape use is likely the reflection of new economic choices rather than a decrease in human control/pressure. At Sagalassos, a reduction in the monumental character of habitation becomes visible in the late 6th century (Jacobs, 2015). The archaeobotanical assemblages show that cereals remain the staple crop in the Early Byzantine period, although barley is now more important than wheat (Fig. 3). Rye and millet are introduced into the area and, considering the ecological requirements of certain weeds and wild growing plants and their presence in the archaeobotanical record, there is increasing evidence of the use of nitrogen rich, disturbed habitats (Fuller et al., 2012). In addition, remains of crop processing by-products are found at the site, which were nearly absent during Roman Imperial/Late Roman times. This could be considered as an indicator for the incorporation of agricultural practices in the urban center of Sagalassos in the Early Byzantine times. It is also during the course of the Early Byzantine period that the public latrine of the Imperial Baths was repurposed as a production site of ruminant dung-based manure (Baeten et al., 2012). Flocks of sheep and goats became more important again during the Early Byzantine period (Fig. 5) and continued to be slaughtered at an old age. Just as in Roman Imperial and Late Roman times, goats were more common than sheep (De Cupere, 2001, p. 140: Fig. 100). As for the collagen stable isotope analysis, pigs, sheep and goats display similar lower $\delta^{13}C$ values in accordance with a mainly C_3 terrestrial signature, while cattle stand out with a slightly, but statistically significant, higher $\delta^{13}C$ mean value, indicating that at least some of them had access to C_4 plants. Both pigs and cattle are characterized by $\delta^{15}N$ mean values significantly higher than those of sheep and goats. The ^{15}N-enriched collagen of pigs can be explained by their omnivorous diet. Cattle most likely benefited from a different management, implying a greater contribution of C_4 plants to their diet and their feeding on ^{15}N-enriched pastures or food resources (Fuller et al., 2012).

A likely possibility for the greater contribution of C_4 plants to the diet of cattle could be mixed grasslands, particularly as trampling and increased grazing pressure further the development of C_4 plants (Čarni and Mucina, 1998; Wang, 2002). Plant remains characteristic of such disturbed vegetation (e.g. *Setaria* spp. and *Portulaca oleracea* for C_4 plants, *Polygonum aviculare*, *Lolium perenne* and *Plantago* spp. for C_3 plants; Čarni and Mucina, 1998) have been identified within the Early Byzantine botanical assemblages (Marinova, unpublished data). This could perhaps be related to the change from intensive crop cultivation to grazing, observed in some valleys. Alternatively, the marshy areas of the territory could have been exploited, as already proposed by Fuller et al. (2012). The gathering of fodder in wetlands has been attested in Central Anatolia (Ertuğ-Yaraş, 1997). Remains of C_4 plants that are typical of wet habitats (such as *Carex* sp., *Eleocharis* sp. or *Salsola* sp.) have been identified in the botanical assemblages (Marinova, unpublished data) and palynological data show increased moisture availability during the Early Byzantine period with marshes and wetlands potentially expanding in certain valleys (Bakker et al., 2013). Both alternatives could have resulted in higher $\delta^{15}N$ collagen values; in the first case as a result of adjunction of cattle manure to the prairie – increasing the $\delta^{15}N$ of the plants (e.g. Bol et al., 2005); in the second case linked to the fact that moisture can locally increases $\delta^{15}N$ plant values (Handley et al., 1999).

In the first half of the 7th century, an earthquake destroyed large parts of the city. Habitation in the city continued, but on a reduced scale (Poblome, 2014). From the middle of the 7th century onwards, a reduction in the intensity of habitation is also visible in the rest of the territory. Only a small portion of the settlements continued into the Byzantine Dark Ages (AD 650–850/900), mostly the larger Roman villages, suggesting a certain level of continuity. The exact reason for this change in social organization is unknown, but follows wider contemporary trends and patterns in Asia Minor. Palynologically, all intensive crop cultivation seems to have ended and an even increased importance of animal husbandry is suggested (Bakker et al., 2013). The end of the so-called Beyşehir Occupation Phase, signalled by a sharp decrease in anthropogenic indicator species, is recorded at several places in the territory of Sagalassos, though the timing differs from location to location (Gravgaz: between AD 600 and 700; Ağlasun: ca. AD 1000 AD; Bereket: around ca. AD 300 AD; Bakker et al., 2012).

Most of the Byzantine Dark Age sites continued into the Middle Byzantine period (ca. AD 850/900–1200), but now several fortified sites, located on steep mountain tops have also been identified. Most, but not all, are reoccupied sites from the Archaic/Classical period. These locations suggest a concern for security, i.e. these locations are often poorly accessible and far removed from both potential agricultural fields and perennial water sources. During this period, palynology shows a limited resurgence of crop cultivation (Bakker et al., 2013) and at Sagalassos evidence of occupation has been attested at several locations in the ancient city (Waelkens, 2005, 2006, 2009). Only small archaeozoological assemblages are available for the Middle Byzantine period and these data should therefore be interpreted with care. Nevertheless, from the bone collagen stable isotope analysis (Fuller et al., 2012), only slight differences in domestic animals' diet compared to the earlier phase can be inferred. The most noticeable one is that sheep seem characterized by isotope values that are closer to cattle than to goat values (more alike Roman Imperial and Late Roman than Early Byzantine periods), suggesting they were kept with cattle rather than with goat, although this observation is based on a few remains of specimens only. In the valley below Sagalassos, a large village is now present, located close to the agricultural fields (Vionis, 2009). During the 12th century AD, a fort was constructed at Alexander's Hill, a steep hill in front of Sagalassos, but this was violently destroyed somewhere between the middle of the 12th and early 13th century AD (Vionis et al., 2010). All habitation at Sagalassos ended at this time or shortly after. The village in the valley below continued, however, and Selçuk influence has been found in the nearby village of Ağlasun (Vanhaverbeke et al., 2005). Like other sites in the region, Sagalassos and its territory was part of the Selçuk empire in the early 13th century AD.

5. Discussion

Wild fauna included mainly the remains of cervids. When going more into detail and analysing the proportions of the various deer species at the prehistoric sites, it appears that roe deer has only been identified at the sites of Bademağacı and Höyücek. Preliminary research shows that it is absent at the site of Hacılar BH. In addition, at the latter site red deer is much more prominent than fallow deer, this in contrast with the situation at Bademağacı and Höyücek, where fallow deer is more common than red deer. Roe deer is mentioned only once at Hacılar (involving an antler fragment with pedicle) within level IX (Late Neolithic) (Westley, 1970). At Kuruçay, all antler fragments have been labelled as roe deer and this identification might be questioned since no other deer species have been listed, not among the antler remains, nor among the post-cranial elements (Deniz and Şentuna, 1988). Remains of roe deer are also completely missing and fallow deer is underrepresented at Classical/Hellenistic Düzen Tepe (De Cupere et al., in press b). At Roman – Early Byzantine Sagalassos, remains of roe and fallow deer are occasionally found, while red deer occurs a little more frequently in the faunal assemblages.

The total absence of roe deer and the dominance of red deer, in the Burdur plain (at Hacılar BH) during the Early Bronze Age (and most probably also during the Neolithic) is very striking, especially when compared to the situation in the southern part of our study area where roe deer is well represented and fallow deer is more abundant than red deer. Ecological requirements of the three cervid species are overlapping, since all three preferably live in landscapes where forests alternate with open areas (Broekhuizen et al., 1992). Red deer and roe deer occur both in low- and highlands (Van Den Brink, 1978). Before its introduction and distribution into Europe, the main population of fallow deer lived in western and southern Anatolia, where they must have been common on the coastal wooded plains and in the lower elevations of the mountains (Kumerloeve, 1975; Uerpmann, 1987, p. 57; Masseti and Vernesi, 2015, Fig. 2.1). At Çatalhöyük, a predominance of red deer over fallow deer is reported and also roe deer is only occasionally recorded (Russell and Martin, 2005, p. 43: Table 2.5), which is very similar to the situation at Hacılar BH, Düzen Tepe and Sagalassos. One can assume that people targeted the available wild fauna. Therefore, it is very likely that the sites in the northern part of our study region fall outside the natural distribution range of fallow deer (and also roe deer) and that people had access to different game depending on the zone within the study area.

Sheep and goats are among the major components of the faunal assemblages throughout all periods considered in this contribution. It is interesting to note that the ratio sheep:goat varies through time: from the Neolithic to the Early Bronze period sheep outnumber goats; both species are present in about equal numbers during the Classical/Hellenistic period, and from Roman Imperial times onwards goat becomes the most abundant. This might be related to the different areas preferentially inhabited and the exploitation of the land during the various periods, combined with the feeding habits of sheep and goats. Sheep are preferentially grazers while goats are more likely to be herded and browse on mountain slopes. The prehistoric sites were located in the valleys; accordingly, people were more likely to keep sheep considering the vicinity of the pastures. At the hilltop settlement of Düzen Tepe (Classical/Hellenistic), stable isotope analysis show that all domesticates (sheep, goat, cattle and pig) had access to similar fodder (Fuller et al., 2012). Under such conditions both sheep and goats can be kept, which might explain the increase of goat compared to the Early Bronze Age. Following the evolution of soil erosion, which started in the Archaic period and culminated in Hellenistic times, villages were built on the edge of the valleys (Dusar, 2011). The intensification of land exploitation – from the Roman Imperial period onwards – put as much as possible of the landscape into cultivation, including the lower slopes (Vanhaverbeke and Waelkens, 2003, 306). Due to the expansion of arable land and the increase of cattle herds, there was less place for sheep herds in the valleys and people were more inclined to keep goats on the mountain slopes: even though the upper slopes were severely eroded, they remained suitable for goat herding.

Archaeozoological data are used to indicate the exploitation of domestic animals. Next to meat, milk, wool and power, another by-product of these animals to be considered is manure. Although archaeozoological data do not allow to establish the use of manure, the collection of human and animal manure has been attested at Early Byzantine Sagalassos through faecal biomarker analysis (Baeten et al., 2012). In archaeological survey manuring of fields with animal and habitation refuse has often been attested in the eastern Mediterranean and Near East through the presence of large haloes or 'carpets' of worn pottery sherds (Wilkinson, 1982; Bintliff et al., 2007; Kaptijn, 2009). In the intensively surveyed Burdur Plain such ceramic evidence was absent. On the contrary, the sites, from all periods, stood out because of their sharp boundaries between site and off-site (also corroborated by geophysical evidence). Away from sites, the off-site scatter was almost non-existent (Vandam, 2014, p. 82). However, it is very unlikely that the inhabitants of Sagalassos did not use the collected manure. Instead, manure of Sagalassos was most probably applied as a fertiliser on fields more in the immediate vicinity of the town.

Geochemical analyses of trace elements (Pb and Cu) in archaeological bone from goat, cattle and pig of Sagalassos have been used to reconstruct land use changes in the vicinity of the town, a heavily polluted zone (Vanhaverbeke et al., 2011a). It was shown that the distance from where animals were obtained, stands in relation to the urban-rural integration of the town and its territory. When the relation between Sagalassos and the countryside was at its closest, during the Late Roman period, the animals consumed in town originated from beyond the immediate vicinity. During the Early–Middle Roman Imperial and Early Byzantine periods the city was primarily exploiting the area close-by, as shown by the higher levels of trace elements in the animal bone.

Increasing social complexity through time is also reflected by the archaeobotanical remains. Although no quantative data from the Neolithic/Early Chalcolithic period could be used, the numerous grape finds at Hacılar BH can be an indication for grape cultivation during the Early Bronze Age, a crop which requires long term investment of labour and certainly more than annual corps. In its turn, this can be interpreted as a sign for specialisation in subsistence strategies. At Classical/Hellenistic Düzen Tepe, viniculture certainly took place, while pulses and cereal crops were probably grown in rotation. Clear archaeobotanical indications for a more complex society come from the city of Sagalassos where the records point to a plant subsistence system involving not only specialisation (including annual crops, arboriculture, vegetables and spices), but also consumption of imported food (such as date palm and stone pine), which therefore could have had a luxury character.

Botanical records show that during the Neolithic up to the Early Bronze Age the main strategy to reduce risk included the diversification of crops grown: the population relied on three to four different cereal crops and on up to four pulse crops. Some of these crops, such as emmer, were more productive, while others, such as barley, einkorn, bitter vetch, were more resistant to drought or unfavourable conditions. During the Hellenistic and Roman periods, the staple cereal crops included only two species: free threshing wheat and barley. But, considering at the same time the presence of plant taxa which were interpreted as weeds (cf. supra), this might be an indication for the intensification of growing these staple crops. The overall crop diversity increases significantly during the Roman and Byzantine periods and is related to a more sophisticated agricultural system including not only annual staple crops, but also fruit trees and vegetables. Millet, a summer crop that was introduced in the area during the Byzantine period (Fig. 3), provided another back-up in case of failure of the other cereals grown.

Until now, the prehistoric sites from within the study area have yielded mainly botanical remains from concentrations, flotation samples being available only for Hacılar BH. The absence of flotation samples makes it difficult to estimate the presence and proportion of both the cultivated and the wild plant resources in the archaeobotanical record. As a consequence, the ratio wild/cultivated in the plant material cannot be established. Therefore, more archaeobotanical studies including material obtained through flotation are necessary. It would allow achieving a better quantification of the archaeobotanical record and, as a result, to get a more detailed and correct insight on the agricultural production and importance of the different crops, weeds and used wild vegetation. In addition to the archaeobotanical remains, data from wood-charcoal analyses could complement the reconstruction of land use and wood land use directly from the sites and period of occupation (Martinoli, 2009). Similarly, faunal remains from sieved samples are missing from the prehistoric sites. It is well possible that small mammals, such as hare, and wild birds played a more pronounced role in subsistence than has been estimated from the hand-collected material. Also, for now, archaeozoological and archaeobotanical data are available from only 1–2 sites for each period. Increasing the number of sites, distributed over the study area, would result in more reliable conclusions.

In this paper results from the carbon and nitrogen stable isotope analysis of bulk bone collagen are presented. This type of analysis provides $\delta^{13}C$ and $\delta^{15}N$ values which are linked to the animal's diet stable isotope composition (Peterson and Fry, 1987), averaged over several years of its life (Klepinger, 1984; Hedges et al., 2007). Ongoing research on the combined interpretation of $\delta^{18}O$ and $\delta^{13}C$ variation sequences measured in tooth enamel may allow to investigate diet at the seasonal scale (see e.g. Balasse et al., 2013; Chase et al., 2014; Dufour et al., 2014), and over the lifespan corresponding to the time period necessary for the sampled enamel layer to be fully mineralized (from a few months to several years depending on the tooth and the species considered (e.g. Balasse, 2002; Hoppe et al., 2004; Zazzo et al., 2005, 2010). Such a methodological approach is being undertaken on domestic animals from Early Byzantine Sagalassos (Frémondeau et al., in prep. a, in prep. b) and could document more in detail the breeding and herding of the domesticates.

6. Conclusion

This contribution has brought together data from archaeozoological and archaeobotanical research from sites in the Burdur province (SW Turkey), dated from the Neolithic to the Middle Byzantine periods. The combination of these data with evidence on palynology, paleoecology and settlement dynamics in the study area allows to better understand the development of the subsistence economy and land use strategies for a period of more than 8000 years.

During the Neolithic and Early Chalcolithic period, inhabitants of small/medium sized villages, located in the more favourable fertile areas, were relying on a subsistence economy, mainly based on hulled and free threshing wheat, barley and pulses, and, to a lesser extent, wild plants, complemented with the products of caprine herds. In the subsequent periods (Late Chalcolithic and Early Bronze Age), the increase in number of sites (including Kuruçay) and the emergence of a more complex society (Hacılar BH) induced a shift in livestock composition. Cattle became more important; the increase of cattle remains at the site of Hacılar BH can most probably be linked to the size of the site. The plant economy relied largely on hulled wheat and barley, as well as mainly drought resistant pulses and some wild food plants; archaeobotanical finds show the increasing importance of grape. In addition, there is also evidence suggesting the existence of disparate cultivated areas, with drought resistant and drought intolerant crops, or irrigation. Meat was partially provided through hunting in the prehistoric periods, with the available game being different depending on the zone within the study area.

No archaeological or bioarchaeological data are available for the Middle and Late Bronze Age and the (Early) Iron Age. Human presence is archaeologically documented again between 1000 and 800 BC and at that time, pollen cores and geomorphological research also show an increase in the effects of human activity. Sites were founded on hill tops, a tradition that continued into the Classical period. At Classical/Hellenistic Düzen Tepe, all livestock had access to similar food resources and animal management was focussed on sheep/goat. Staple crops included free threshing wheat, barley and pulses; the latter continued to play a significant role in the diet since prehistoric times. In addition, there is archaeobotanical evidence for the development of viniculture in the study area. Altogether, bioarchaeological data point towards a rural self-sustaining economy. Due to human induced soil erosion, good grazing and crop cultivation areas became increasingly limited to the valleys.

Sagalassos, which was probably founded by the end of the fifth century BC, continued to grow and became a large prosperous town during the Early and Middle Roman Imperial period. The inhabitants were relying on intensive agriculture (winter cereal crops), using an increasing diversity of cultivated areas, including fertile and moist soils. The diet was diversified with a variety of fruits and nuts; vegetables and spices were added. Cattle became more important, probably as a result of their role as beasts of burden for agrarian and other purposes. Collagen stable isotope analysis shows a specialisation in herd management strategies, with the various species having (mostly) different food resources. During the Early Byzantine period, intensive crop cultivation and arboriculture disappeared in certain valleys and was completely abandoned at the end of this period. Archaeobotanical evidence points towards the increasing ruralisation of Sagalassos. This is also reflected in the regained importance of herds of sheep and goats. Collagen stable isotope analysis shows the access of cattle to C_4 plants, implying a different management than that of goats and sheep.

Several questions on the diachronic development and spatial variation of the subsistence strategies applied in the study area still remain. Ongoing and future bioarchaeological research will help to gain an even more detailed and comprehensive picture of past human economy and land use in the Burdur region and their dependence on cultural and environmental change.

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References

Araus, J.L., Febrero, A., Catala, M., Molist, M., Voltas, J., Romagosa, I., 1999. Crop water availability in early agriculture : evidence from carbon isotope discrimination of seeds from a tenth millennium BP site on the Euphrates. Global Change Biology 5, 201–212.

Arbuckle, B.S., 2014. The rise of cattle cultures in Bronze Age Anatolia. Journal of Eastern Mediterranean Archaeology and Heritage Studies 2, 277–297.

Asouti, E., Fairbairn, A., 2002. Subsistence economy in Central Anatolia during the Neolithic – the archaeobotanical evidence. In: Thissen, L., Gerard, F. (Eds.), The Neolithic of Central Anatolia. Internal Developments and External Relations during the 9th – 6th Millennia Cal. BC. Ege Yayınları, Istanbul, pp. 181–192.

Asouti, E., Fairbairn, A., 2010. Farmers, gatherers or horticulturalists? Reconstructing landscapes of practice in the early Neolithic. In: Finlayson, B., G.Warren (Eds.), Landscapes in Transition: Understanding Hunter-gatherer and Farming Landscapes in the Early Holocene of Europe and the Levant, pp. 161–172. Levant Supplementary Series 8. Oxford: Oxbow.

Baeten, J., Marinova, E., De Laet, V., Degryse, P., De Vos, D., Waelkens, M., 2012. Faecal biomarker and archaeobotanical analyses of sediments from a public latrine shed new light on ruralisation in Sagalassos, Turkey. Journal of Archaeological Science 39, 1143–1159.

Bakker, J., 2012. Late Holocene Vegetation Dynamics in a Mountainous Environment in the Territory of Sagalassos, Southwest Turkey. Ph.D. thesis. University of Leuven, Belgium.

Bakker, J., Paulissen, E., Kaniewski, D., De Laet, V., Verstraeten, G., Waelkens, M., 2012. Man, vegetation and climate during the Holocene in the territory of Sagalassos, Western Taurus mountains, SW Turkey. Vegetation History and Archaeobotany 21, 249–266.

Bakker, J., Paulissen, E., Kaniewski, D., De Laet, V., Verstraeten, G., Waelkens, M., 2013. Climate, people, fire and the city of Sagalassos: new insights into post-Beyşehir occupation phase vegetation dynamics in the Near East. Climate of the Past 9, 57–87.

Balasse, M., 2002. Reconstructing dietary and environmental history from enamel isotopic analysis: time resolution of intra-tooth sequential sampling. International Journal of Osteoarchaeology 12, 155–165.

Balasse, M., Bălăşescu, A., Janzen, A., Ughetto-Monfrin, J., Mirea, P., Andreescu, R., 2013. Early herding at Măgura-Boldul lui Moş Ivănuş (early sixth millennium bc, Romania): environments and seasonality from stable isotope analysis. European Journal of Archaeology 16 (2), 221–246.

Bintliff, J., Howard, P., Snodgrass, A., 2007. Testing the Hinterland. The Work of the Boeotia Survey (1989-1991) in the Southern Approaches of the City of Thespiai. McDonald Institute for Archaeological Research, Cambridge.

Bol, R., Eriksen, J., Smith, P., Garnett, M.H., Colemnan, K., Christensen, B.T., 2005. The natural abundance of 13C, 15N, 34S and 14C in archived (1923-2000) plant and soil samples from the Askov long-term experiments on animal manure and mineral fertilizer. Rapid Communications in Mass Spectrometry 19, 3216–3226.

Bottema, S., Woldring, H., 1984. Late Quaternary vegetation and climate of southwestern Turkey. Part II. Palaeohistoria 26, 123–149.

Braekmans, D., 2010. The Archaic, Classical and Hellenistic Ceramics in the Later Territory of Sagalassos and Düzen Tepe : the Petrographic and Geochemical Evidence. Ph.D. thesis. University of Leuven, Belgium.

Brami, M., Heyd, V., 2011. The origins of Europe's first farmers: the role of Hacılar and Western Anatolia, fifty years on. Praehistorische Zeitschrift 86, 165–206.

Broekhuizen, S., Hoekstra, B., Van Laar, V., Smeenk, C., Thissen, J.B.M., 1992. Atlas van de Nederlandse zoogdieren. Stichting Uitgeverij van de Koninklijke Nederlandse Natuurhistorische Vereniging, Utrecht.

Čarni, A., Mucina, L., 1998. Vegetation of trampled soil dominated by C4 plants in Europe. Journal of Vegetation Science 9, 45–56.

Chase, B., Meiggs, D., Ajithprasad, P., Slater, P.A., 2014. Pastoral land-use of the Indus civilisation in Gujarat: faunal analyses and biogenic isotopes at Bagasra. Journal of Archaeological Science 50, 1–15.

Çilingiroglu, A., Çevik, Ö., Çilingiroglu, C., 2012. Ulucak Höyük. Towards understanding the early farming communities of Middle West Anatolia: the contribution of Ulucak. In: Özdogan, M., Basgelen, N., Kuniholm, P. (Eds.), The Neolithic in Turkey: Western Anatolia. Archaeology & Arts Publications, Istanbul, pp. 139–175.

Colledge, S., Conolly, J., Shennan, S., 2005. The Evolution of early Neolithic farming from SWAsian origins to NW European limits. European Journal of Archaeology 8 (2), 137–156.

Corremans, M., Degryse, P., Wielgosz, D., Waelkens, M., 2012. The import and the use of white marble and coloured stone for wall and floor revetment at Sagalassos. In: Gutierrez Garcia, A., Lapuente, P., Roda, I. (Eds.), Interdisciplinary Studies on Ancient Stone. Proceedings of the IX ASMOSIA Conference (Tarragona 2009). Documenta 23. Institut Catala d'Arqueologica Classica, Tarragona, pp. 38–51.

Davis, S.J.M., 1987. The Archaeology of Animals. B.T. Batsford Ltd, London.

Dearing, J.A., Battarbee, R.W., Dikau, R., Larocque, I., Oldfield, F., 2006. Human–environment interactions: towards synthesis and simulation. Regional Environmental Change 6 (1–2), 115–123.

De Cupere, B., 2001. Animals at Ancient Sagalassos. Evidence of the Faunal Remains [Studies in Eastern Mediterranean Archaeology 4]. Brepols, Turnhout.

De Cupere, B., Duru, R., 2003. Faunal remains from Neolithic Höyücek (SW-Turkey) and the presence of early domestic cattle in Anatolia. Paléorient 29, 107–120.

De Cupere, B., Lentacker, A., Van Neer, W., Waelkens, M., Verslype, L., 2000. Osteological evidence for the draught exploitation of cattle: first applications of a new methodology. International Journal of Osteoarchaeology 10, 254–267.

De Cupere, B., Duru, R., Umurtak, G., 2008. Animal husbandry at the Early Neolithic to Early Bronze Age site of Bademağacı (Antalya province, SW Turkey): evidence from the faunal remains. In: Vila, E., Gourichon, L., Choyke, A.M., Buitenhuis, H. (Eds.), Archaeozoology of the Near East VIII. Tome II. Maison de l'Orient et de la Méditerranée, 49. TMO, Lyon, pp. 367–405.

De Cupere, B., Baeten, J., De Vos, D. Milk production at Bademağacı (SW Turkey) during the Early Neolithic. In: Duru, R., Umurtak, G. (Eds.), Archaeozoological Data and Residue Analysis Combined (Bademağacı), (in press a).

De Cupere, B., Van Neer, W., Vyncke, K., Vanhaverbeke, H., 2015b. Animal exploitation during the Classical/Hellenistic period at Tepe Düzen (SW Turkey) : preliminary results. In: Mashkour, M., Beech, M., Choyke, A.M., Buitenhuis, H. (Eds.), Archaeozoology of the Near East IX. Oxbow Books, Oxford (in press b).

Deniz, E., Şentuna, C., 1988. Kuruçay Höyük Kazısı arkeobiyolojik materyalinin tüm değerlendirilmesi. In: IV. Arkeometri Sonuçları Toplantısı, Ankara 23-27 Mayis 1988. Kültür ve Turizm Bakanlığı Dösimm Basimevi, Ankara, pp. 169–185.

Dufour, E., Goepfert, N., Léon, B.G., Chauchat, C., Jordan, R.F., Sanchez, S.V., 2014. Pastoralism in Northern Peru during Pre-Hispanic times: insights from the Mochica Period (100-800 AD) based on stable isotopic analysis of domestic camelids. Plos One 9 (1), e87559. http://dx.doi.org/10.1371/journal.pone.0087559.

Düring, B.S., 2011. The Prehistory of Asia Minor. From Complex Hunter–gatherers to Early Urban Societies. Cambridge University Press, Cambridge.

Duru, R., 1989. Were the earliest cultures at Hacılar really aceramic? In: Emre, K., Mellink, M., Hrounda, B., Özgüç, N. (Eds.), Anatolia and the Ancient Near East: Studies in Honor of Tahsın Özgüç. Türk Tarih Kurumu Basımevi, Ankara, pp. 99–106.

Dusar, B., 2011. Late Holocene Sediment Dynamics in a Mediterranean Mountain Environment. Ph.D. thesis. University of Leuven, Belgium.

Dusar, B., Verstraeten, G., D'Haen, K., Bakker, J., Kaptijn, E., Waelkens, M., 2012. Sensitivity of the eastern Mediterranean geomorphic system towards environmental change during the Late Holocene: a chronological perspective. Journal of Quaternary Science 27, 371–382.

Eastwood, W., Roberts, N., Lamb, H., 1998. Palaeoecological and archaeological evidence for human occupance in southwest Turkey: the Beyşehir occupation phase. Anatolian Studies 48, 69–86.

Ertuğ-Yaraş, F., 1997. An Ethnoarchaeological Study of Subsistence and Plant Gathering in Central Anatolia. Ph.D. thesis. Washington University, USA.

Fairbairn, A., Martinoli, D., Butler, A., Hillman, G., 2006. Wild plant seed storage at Neolithic Çatalhöyük East, Turkey. Vegetation History and Archaeobotany 16, 467–479.

Filipovich, D., 2014. Early Farming in Central Anatolia. In: BAR International Series 2667. Archaeopress, Oxford.

Frémondeau, D., De Cupere, B., Evin, A., Balasse, M., Van Neer, W.,2015a in prep a. Pig husbandry practices inferred from teeth: a synthesis of data from kill-off patterns, micro-wear, linear enamel hypoplasia, Geometric Morphometrics and light stable isotope analyses (δ^{18}O, δ^{13}C, δ^{15}N).

Frémondeau, D., De Cupere, B., Balasse, M., Van Neer, W., 2015b, in prep b. Caprines and cattle herd management at Sagalassos (SW Turkey) during the Early Byzantine period inferred from sequential stable isotope analyses (δ^{18}O, δ^{13}C) in teeth.

French, D.H., 2012. Pre-Hellenistic pottery of the Seki-Çaltılar. In: Coulton, J.J. (Ed.), The Balboura Survey and Settlement in Highland Southwest Anatolia, II [British Institute at Ankara Monographs 43]. British Institute at Ankara, Ankara, pp. 1–30.

Fuller, T.B., De Cupere, B., Marinova, E., Van Neer, W., Waelkens, M., Richards, M.P., 2012. Isotopic reconstruction of human diet and animal husbandry practices during the Classical-Hellenistic, Imperial, and Byzantine periods at Sagalassos, Turkey. American Journal of Physical Anthropology 149, 157–171.

Goudie, A., 2013. The Human Impact on the Natural Environment, seventh ed. Wiley-Blackwell, West-Sussex.

Handley, L.L., Austin, A.T., Robinson, D., Scrimgeour, C.M., Raven, J.A., Heaton, T.H.E., Schmidt, S., Stewart, G.R., 1999. The ^{15}N natural abundance (δ^{15}N) of ecosystem samples reflects measures of water availability. Australian Journal of Plant Physiology 26, 185–199.

Hedges,, R.E.M., Clement,, J.G., Thomas,, D.L., O'Connell,, T.C., 2007. Collagen turnover in the adult femoral mid-shaft: modelled from anthropogenic radiocarbon tracer measurements. American Journal of Physical Anthropology 133, 808–816.

Helbaek, H., 1970. The plant husbandry of Hacılar a study of cultivation and domestication. In: Mellaart, J. (Ed.), Excavations at Hacılar, vol. 1. The British Institute of Archaeology at Ankara, Edinburgh, pp. 189–244.

Hoppe, K.A., Stover, S.M., Pascoe, J.R., Amundson, R., 2004. Tooth enamel biomineralization in extant horses: implications for isotopic microsampling. Palaeogeography, Palaeoclimatology, Palaeoecology 206, 355–365.

Jacobs, I., 2015. From Early Byzantium to the Middle Ages at Sagalassos. In: Gnasso, A., Intagliata, E.E., MacMaster, T.J., Morris, B.N. (Eds.), The Long Seventh Century. Continuity and Discontinuity in an Age of Transition Peter Lang, Oxford, pp. 163–198.

Jacomet, S., Kreuz, A., 1999. Archäobotanik. Eugen Ulmer Verlag, Stuttgart.

Kaniewski, D., Paulissen, E., De Laet, V., Dossche, K., Waelkens, M., 2007. A high-resolution Late Holocene landscape ecological history inferred from an intramontane basin in the Western Taurus Mountains, Turkey. Quaternary Science Reviews 26, 2201–2218.

Kaplan, J.O., Krumhardt, K.M., Ellis, E.C., Ruddiman, W.F., Lemmen, C., Goldewijk, K.K., 2011. Holocene carbon emissions as a result of anthropogenic land cover change. The Holocene 21, 775–791.

Kaptijn, E., 2009. Life on the Watershed. Reconstructing Subsistence in a Steppe Using Archaeological Survey: a Diachronic Perspective on Habitation in the Jordan Valley. Sidestone Press, Leiden.

Kaptijn, E., Vandam, R., Poblome, J., Waelkens, M., 2012. Inhabiting the plain of Burdur. Results from the 2010 and 2011 Sagalassos Project Survey. News of Archaeology from Anatolia's Mediterrean Areas 10, 142–147.

Kaptijn, E., Poblome, J., Vanhaverbeke, H., Bakker, J., Waelkens, M., 2013. Societal changes in the Bereket valley in the Hellenistic, Roman and Early Byzantine periods. Results from the Sagalassos territorial archaeological survey 2008 (SW Turkey). Anatolian Studies 63, 75–95.
Klepinger, L.L., 1984. Nutritional assessment from bone. Annual Review of Anthropology 13, 75–96.
Kumerloeve, H., 1975. Die Säugetiere (Mammalia) der Türkei. Veröffentlichungen der Zoologischen Staatssammlung. München 18, 69–158.
Martinoli, D., 2009. Reconstruction of local woodland vegetation and use of firewood at two Epipalaeolithic cave sites in southwest Anatolia (Turkey). In: Fairbairn, A., Weiss, E. (Eds.), From Foragers to Farmers Festschrift Gordon Hillman. Oxbow Monographs, Oxford, pp. 161–170.
Martinoli, D., Nesbitt, M., 2003. Plant stores at pottery Neolithic Höyücek, southwest Turkey. Anatolian Studies 53, 17–32.
Masseti, M., Vernesi, C., 2015. Historic zoology of the European fallow deer, Dama dama dama: evidence from biogeography, archaeology and genetics. In: Baker, K., Carden, R., Madgwick, R. (Eds.), Deer and People. Windgather Press, pp. 13–22.
Masi, A., Sadori, L., Balossi Restelli, F., Baneschi, I., Zanchetta, G., 2014. Stable carbon isotope analysis as a crop management indicator at Arslantepe (Malatya, Turkey) during the Late Chalcolithic and Early Bronze Age. Vegetation History and Archaeobotany 23, 751–760.
Mellaart, J., 1970. Excavations at Hacılar. Edinburgh University Press, Edinburgh.
Miller, N., 2008. Sweeter than wine? The use of the grape in early western Asia. Antiquity 82, 937–946.
Mitchell, S., 1993. Anatolia. Land, Men, and Gods in Asia Minor. In: The Celts and the Impact of Roman Rule, vol. I. Clarendon Press, Oxford.
Nesbitt, M., 1996. Chalcolithic crops from Kuruçay Höyük: an interim report. In: Duru, R. (Ed.), Kuruçay Höyük II. Türk Tarih Kurumu, Ankara, pp. 89–93, 134-137.
Nesbitt, M., Samuel, D., 1996. From staple crop to extinction? the archaeology and history of the hulled wheats. In: Padulosi, S., Hammer, K., Heller, J. (Eds.), Hulled Wheats. Proceedings of the First International Workshop on Hulled Wheats, Promoting the Conservation and Use of Underutilized and Neglected Crops 4. International Plant Genetic Resources Institute, Rome, pp. 41–100.
Paulissen, E., Poesen, J., Govers, G., De Ploey, J., 1993. The physical environment at Sagalassos (Western Taurus, Turkey). A reconnaissance survey. In: Waelkens, M., Poblome, J. (Eds.), Sagalassos II. Report on the Third Excavation Campaign of 1992 [Acta Archaeologica Lovaniensia Monographiae 6]. Leuven University Press, Leuven, pp. 229–247.
Pearson, J.A., Buitenhuis, H., Hedges, R.E.M., Martin, L., Russell, N., Twiss, K.C., 2007. New light on early caprine herding strategies from isotope analysis: a case study from Neolithic Anatolia. Journal of Archaeological Science 34, 2170–2179.
Pearson, J.A., Grove, M., Özbek, M., Hongo, H., 2013. Food and social complexity at Çayönü Tepesi, southeastern Anatolia: stable isotope evidence of differentiation in diet according to burial practice and sex in the early Neolithic. Journal of Anthropological Archaeology 32, 180–189.
Pearson, J.A., Bogaard, A., Charles, M., Hillson, S.W., Larsen, C.S., Russell, N., Twiss, K., 2015. Stable carbon and nitrogen isotope analysis at Neolithic Çatalhöyük: evidence for human and animal diet and their relationship to households. Journal of Archaeological Science 57, 69–79.
Peterson, B.J., Fry, B., 1987. Stable isotopes in ecosystem studies. Annual Review Of Ecology And Systematics 18, 293–320.
Poblome, J., 2014. Shifting societal complexity in Byzantine Asia minor and dark age pottery. In: Poulou-Papadimitriou, N., Nodarou, E., Kilikoglou, V. (Eds.), LRCW 4 Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry. The Mediterranean: a Market without Frontiers. Archaeopress, Oxford, pp. 623–642.
Poblome, J., Braekmans, D., Waelkens, M., Firat, N., Vanhaverbeke, H., Martens, F., Kaptijn, E., Vyncke, K., Willet, R., Degryse, P., 2014. How did Sagalassos come to be? A ceramological survey. In: Tekocak, M. (Ed.), Studies in Honour of K. Levent Zoroğlu. Suna & Inan Kiraç Research Institute on Mediterranean Civilizations, Antalya, pp. 527–540.
Reitz, E.J., Wing, E.S., 1999. Zooarchaeology. Cambridge University Press, Cambridge.
Riehl, S., 2008. Climate and agriculture in the ancient Near East: a synthesis of the archaeobotanical and stable carbon isotope evidence. Vegetation History and Archaeobotany 17 (Suppl. 1), S43–S51.
Riehl, S., 2014. Changes in crop production in Anatolia from the Neolithic until the end of the Early Bronze Age. In: Wawruschka, C. (Ed.), Prehistoric Economics of Anatolia. Subsistence Practices and Exchange. Leidorf Verlag, Rahden/Westf, pp. 59–72.
Riehl, S., Nesbitt, M., 2003. Crops and cultivation in the Iron Age near east: change or continuity. In: Fischer, B., Genz, H., Jean, E., Köroğlu, K. (Eds.), Identifying Changes: the Transition from Bronze to Iron Ages in Anatolia and its Neighbouring Regions. Türk Eskiçağ Bilimleri Enstitüsü, Istanbul, pp. 301–312.
Russell, N., Martin, L., 2005. Çatalhöyük mammal remains. In: Hodder, I. (Ed.), Inhabiting Çatalhöyük, Reports from the 1995-99 Seasons, pp. 33–98. McDonald Institute for Archaeological Research, Cambridge; British Institute of Archaeology at Ankara, London.
Sagona, A., Zimansky, P., 2009. Ancient Turkey. Routledge, New York.
Talloen, P., 2015. The road to salvation. Travel and the sacred along the imperial road in Pisidia. In: Vandeput, L. (Ed.), Pathways of Communication. Roads and Routes in Anatolia from Prehistory to Seljuk Times. Cambridge University Press, Cambridge (in press).
Thissen, L., 2010. The Neolithic–Chalcolithic sequence in the SW Anatolian lakes region. Documenta Praehistorica 37, 269–282.
Uerpmann, H.-P., 1987. The Ancient Distribution of Ungulate Mammals I the Middle East. Dr. Ludwig Reichert Verlag, Wiesbaden. Beihefte zum Tübinger Atlas des Vorderen Orients, Reihe A Nr. 27.
Umurtak, G., Duru, R., 2012. Excavations at Hacılar Büyük Höyük, 2011. News of Archaeology from Anatolia's Mediterranean Areas 10, 21–26.
Umurtak, G., Duru, R., 2013. Yeniden Hacılar. Hacılar Büyük Höyük Kazıları 2011-2012. Journal of Archeaology and Art 142, 1–22.
Van Den Brink, F.H., 1978. Zoogdierengids. Elsevier, Amstedam/Brussel.
van Der Plicht, J., Akkermans, P.M.M.G., Buitenhuis, H., Kaneda, A., Nieuwenhuyse, O., Russell, A., 2012. Tell Sabi Abyad, Syria: an interpretation of stable isotope values of faunal bone collagen. Radiocarbon 54, 281–289.
Vandam, R., 2014. Everybody Needs Good Neighbours. Exploring Late Prehistoric Settlement Strategies and Socio-economic Behaviour in the Burdur Plain, SW Turkey. Ph.D. thesis. University of Leuven, Belgium.
Vandam, R., 2015. The Burdur plain survey project, SW Turkey. In search of the Middle Chalcolithic (5500-4200 BC). In: Steadman, S.R., McMahon, G. (Eds.), The Archaeology of Anatolia: Recent Discoveries (2011-2014), vol I. Cambridge Scholar Press, Cambridge, pp. 282–301.
Vandam, R. (accepted) Exploring the Late Neolithic (6500–6100 BC) cultural landscape of Hacılar and the Burdur Region, SW Turkey, in: Marciniak, A. (Ed.), Social and Economic Changes in the Second Half of the 7th Millennium in the Near East, Lockwood Press, Atlanta.
Vandam, R., Kaptijn, E., Poblome, J., Waelkens, M., 2013. The 2012 archaeological survey of the Sagalassos archaeological survey project. News of Archaeology from Anatolia's Mediterranean Areas 11, 230–233.
Vandam, R., Music, B., Medaric, I., 2015. Contextualizing Kuruçay Höyük. Reconstructing the Late Chalcolithic Cultural Landscape (4200-3100 BC) in the Burdur Plain, Southwest Turkey in prep.
Vanhaverbeke, H., Waelkens, M., 2003. The Chora of Sagalassos. The Evolution of the Settlement Pattern from Prehistoric until Recent Times [Studies in Eastern Mediterranean Archaeology 5]. Brepols, Turnhout.
Vanhaverbeke, H., Başağaç, Ö., Paul, K., Waelkens, M., 2005. A Selçuk hamam at Ağlasun, Burdur province, Turkey. Turcica. Revue d'Études Turques 37, 309–336.
Vanhaverbeke, H., Martens, F., Waelkens, M., 2007. Another view on late antiquity: Sagalassos (SW Anatolia), its Suburbium and its countryside in late antiquity. Proceedings of the British Academy 141, 611–648.
Vanhaverbeke, H., Waelkens, M., Vyncke, K., De Laet, V., Aydal, S., Mušič, B., De Cupere, B., Poblome, J., Braekmans, D., Degryse, P., Marinova, E., Verstraeten, G., Van Neer, W., Šlapšak, B., Medarič, I., Ekinci, H., Erbay, M., 2010. 'Pisidian' culture? The Classical-Hellenistic site at Düzen Tepe near Sagalassus (southwest Turkey). Anatolian Studies 60, 105–128.
Vanhaverbeke, H., Degryse, P., De Cupere, B., Van Neer, W., Waelkens, W., Muchez, Ph, 2011a. Urban-rural integration at ancient Sagalassos (SW Turkey). Archaeological, archaeozoological and geochemical evidence. Archaeofauna 20, 73–83.
Vanhaverbeke, H., Waelkens, M., Jacobs, I., Lefere, M., Kaptijn, E., Poblome, J., 2011b. The 2008 and 2009 survey season in territory of Sagalassos. In: Toy, A.N., Keskin, C. (Eds.), XXVIII. Araştırma Sonuçları Toplantısı, Istanbul, 24-28 May 2010. Kültür ve Turizm Bakanlığı Dösimm Basimevi, Ankara, pp. 139–153.
Vermoere, M., 2004. Holocene Vegetation History in the Territory of Sagalassos (Southwest Turkey): a Palynological Approach [Studies in Eastern Mediterranean Archaeology 6]. Brepols, Turnhout.
Vermoere, M., Van Thuyne, T., Six, S., Vanhecke, L., Waelkens, M., Paulissen, E., Smets, E., 2002. Late Holocene local vegetation dynamics in the marsh of Gravgaz (southwest Turkey). Journal of Paleolimnology 27, 429–451.
Vermoere, M., Vanhecke, L., Waelkens, M., Smets, E., 2003. Modern and ancient olive stands near Sagalassos (south-west Turkey) and reconstruction of the ancient agricultural landscape in two valleys. Global Ecology & Biogeography 12, 217–235.
Vionis, A.K., 2009. Medieval and Post-Medieval Ceramic Study 2009: Surface Survey Pottery from Akyamaç. Web report Sagalassos Porject 2009. http://www.sagalassos.be/en/node/1121.
Vionis, A.K., Poblome, J., De Cupere, B., Waelkens, M., 2010. A middle-Late Byzantine pottery assemblage from Sagalassos. Typo-chronology and sociocultural interpretation. Hesperia 79, 423–464.
Vyncke, K., 2013. Düzen Tepe: the Potential of Contextual Analysis and Functional Space Analysis by Means of an Interdisciplinary Archaeological and Archaeometric Research at a Classical/Hellenistic Site. Ph.D. thesis. University of Leuven, Belgium.
Waelkens, M., 2005. Report on the 2003 excavation and restoration campaign at Sagalassos. In: Olşen, K., Dönmez, H., Özme, A. (Eds.), XXVI. Kazı Sonuçları Toplantısı, Konya 24-28 Mayıs 2004. Kültür ve Turizm Bakanlığı Dösimm Basimevi, Ankara, pp. 421–443.
Waelkens, M., 2006. Report on the 2004 excavation and restoration campaign at Sagalassos. In: Olşen, K., Dönmez, H., Özme, A. (Eds.), XXVII. Kazı Sonuçları Toplantısı, Antalya 30 Mayıs – 3 Haziran 2005. Kültür ve Turizm Bakanlığı Dösimm Basimevi, Ankara, pp. 271–286.
Waelkens, M., 2009. Report on the 2006 and 2007 excavation and restoration activities at Tepe Düzen and at Sagalssos. In: Dönmez, H., Özme, A. (Eds.), XXX. Kazı Sonuçları Toplantısı, 26-30 Mayıs 2008, Ankara. Kültür ve Turizm Bakanlığı Dösimm Basimevi, Ankara, pp. 427–456.

Waelkens, M., 2011. Sagalassos. Erste Stadt Pisidiens, Freund und Bundgenosse der Römer. Antike Welt: Zeitschrift für Archäologie und Kulturgeschichte 3, 62–71.
Waelkens, M., Paulissen, E., Vanhaverbeke, H., Ilhame, Ö., De Cupere, B., Ekinci, H.A., Vermeersch, P.M., Poblome, J., Degeest, R., 1997. The 1994 and 1995 surveys in the territory of Sagalassos. In: Waelkens, M., Poblome, J. (Eds.), Sagalassos IV. Report on the Survey and Excavation Campaigns of 1994 and 1995. Leuven University Press, Leuven, pp. 11–102.
Waelkens, M., Paulissen, E., Vanhaverbeke, H., Reyniers, J., poblome, J., Degeest, R., Viaene, W., Deckers, J., De Cupere, B., Van Neer, W., Ekinci, H.A., Erbay, M.O., 2000. The 1996 and 1997 surveys in the territory of Sagalassos. In: Waelkens, M., Loots, L. (Eds.), Sagalassos V. Report on the Survey and Excavation Campaigns of 1996 and 1997. Leuven University Press, Leuven, pp. 17–216.
Waelkens, M., Poblome, J., De Rynck, P., 2011. Sagalassos. City of Dreams. Openbaar Kunstbezit Vlaanderen, Gent.
Walsh, K., 2014. The Archaeology of Mediterranean Landscapes. Human-environment Interaction from the Neolithic to the Roman Period. Cambridge University Press, Cambridge.
Wang, R.Z., 2002. Photosynthetic pathway types of forage species along grazing gradient from the Songnen grassland, Northeastern China. Photosyntetica 40, 57–61.
Westley, B., 1970. The mammalian fauna. In: Mellaart, J. (Ed.), Excavations at Hacılar. Edinburgh University Press, Edinburgh, pp. 245–247.
Wilkinson, T.J., 1982. The definition of ancient manured zones by means of extensive sherd-sampling techniques. Journal of Field Archaeology 9, 323–333.
Zazzo, A., Balasse, M., Patterson, W.P., 2005. High-resolution $\delta^{13}C$ intratooth profiles in bovine enamel: Implications for mineralization pattern and isotopic attenuation. Geochimica et Cosmochimica Acta 69, 3631–3642.
Zazzo, A., Balasse, M., Passey, B.H., Moloney, A.P., Monahan, F.J., Schmidt, O., 2010. The isotope record of short- and long-term dietary changes in sheep tooth enamel: implications for quantitative reconstruction of palaeodiets. Geochimica et Cosmochimica Acta 74, 3571–3586.
Zohary, M., 1973. Geobotanical Foundations of the Middle East. Gustav Fischer Verlag, Stuttgart.

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