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Published in:
Journal of Archaeological Science: Reports

DOI:
10.1016/j.jasrep.2021.103164

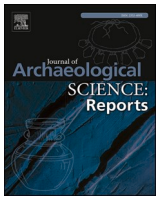
Publication date:
2021

Journal of Archaeological Science: Reports 39 (2021) 103164

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep



Animal husbandry in Classical and Hellenistic Thessaly (Central Greece): A zooarchaeological perspective from Almiros

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ARTICLE INFO

Keywords:
Classical
Hellenistic
Greece
Historical zooarchaeology
Animal mobility
Animal husbandry
Scale of economy

ABSTRACT

Scholars have been arguing about the nature and scale of Greco-Roman economy in mainland Greece for over fifty years. In this study we investigate the faunal assemblages of Magoula Plataniotiki and New Halos, two neighbouring Classical and Hellenistic towns in Almiros (Thessaly, Greece) to scrutinize how the animal economy functioned in central Greece between fourth and third century BCE, using traditional zooarchaeology. The results indicate an apparently stable subsistence economy, primarily based on caprine production, in addition to cattle, pig, and equid breeding. The establishment of New Halos brought about minor changes to the traditional herding and provisioning system; husbandry strategies remained apparently stable, whereas the contribution of game to the diet increased. The intensification of environmental exploitation, due to demographic nucleation in the plain, might have triggered such changes. The surprising underrepresentation of pig in New Halos suggests pork consumption on a non-household level. Zooarchaeological studies from various contemporary sites in Greece show similar patterns suggestive of small-scale subsistence economy. Geopolitical and environmental factors and tradition might have halted the integration of the Almiros markets into the larger market of the Hellenistic world. This study proposes an economic model where small-scale animal and plant husbandry practiced side by side that fits the agro-pastoral model of the ancient Greek economy suggested by Halstead and Hodkinson among others.

1. Introduction

In 1973, Finley followed Bücher's (1901) "minimalistic/primitivistic" model, and suggested that most urban centers in Antiquity aimed for self-sufficiency by practicing small-scale agriculture, while only luxury products were distributed in the larger market. The lack of technological innovation and division of labour prevented economic growth, and the vast majority of the population remained poor (Finley, 1973, pp. 17–34). However, recent scholarship has found numerous problems in this model. It has been argued that Finley conflated evidence from a wide variety of places and time periods neglecting the archaeological and documentary sources (Andreau, 2002; Reger, 2007; Archibald et al., 2011; Bresson, 2016). Contra to Finley's economic stability, recent scholars have suggested that large-scale political instability, warfare, migration, and the foundation of new urban centers and markets (Gehrke, 2010) affected the economic growth of the Hellenistic markets both positively and negatively (Chaniotis, 2011, pp. 123–128).

For over a century of research on ancient Greek economy (e.g., Bücher, 1901; Finley, 1973; Scheidel and Von Reden, 2002; Morris, 2004; Bresson, 2016), animal husbandry and production received hardly any attention in the general debate. The study of animal husbandry focuses on the rural Greek mainland, and it is, with some exceptions (e.g., MacKinnon, 2014; Margaritis, 2015; Dibble, 2017), mainly based on problematic texts (Nevett, 1995; Pomeroy, 1997; Nardo, 2000). Scholars debate whether specialized transhumance or an integrated animal and plant husbandry was the predominant economic activity of the rural population in ancient Greece. According to the specialized transhumance model, entire or parts of families were engaged with long or shorter distance movements to maximize their flocks' production targeting market consumption (e.g., Georgoudi, 1974; Skydsgaard, 1988; Reinders & Prummel, 1998; Cardete, 2019). According to the mixed agrofarming model, families cultivated small plots of land and owned small mixed herds for subsistence (e.g., Halstead, 1987; Hodkinson, 1988). Criticizing such a dichotomy, some scholars have proposed the existence of both models within a society or even a family (e.g., Alcock et al., 1994; Forbes, 1995; Howe, 2008).

In this paper, we contribute to the understanding of the nature of pastoralism in rural Classical and Hellenistic Greece by examining the

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https://doi.org/10.1016/j.jasrep.2021.103164
Received 30 April 2021; Received in revised form 3 August 2021; Accepted 15 August 2021
Available online 28 August 2021

mammal remains from Magoula Plataniotiki (ca. 4th century-3rd century BCE) and New Halos (ca. 302–265 BCE) in southern Thessaly, Greece. The well-documented and rich archaeological record of these sites offers an unprecedented opportunity to examine how sociopolitical changes affected animal-related economic activities in these neighbouring towns in Thessaly.

Thessaly had a predominant role in the political developments of the late fourth to early third century BCE, as the border between the expanding Macedonian Empire and the city-states of southern Greece (Graninger, 2010). As such, the recurring question is whether the political and military changes in this period affected the local economy.

This paper contributes to the discussion of local economic activities in Thessaly (Reinders and Prummel, 1998; Reinders and Prummel, 2003; Haagsma, 2010) and investigates the degree of integration of these local economies into the broader Hellenistic world by examining new evidence. Recent excavations at Magoula Plataniotiki suggest that the site was still inhabited in the third century BCE (pers. communication with excavation directors); thus, a zooarchaeological comparison between New Halos and Magoula Plataniotiki enables an investigation of the impact of the new, relatively larger town (New Halos) on the local herding system.

To understand the animal production targets, the scale of animal production, and the integration of the Classical and Hellenistic Almiros economy with other contemporary regional economies, we attempt to answer the following questions:

a) What are the differences and similarities in animal management between Magoula Plataniotiki and New Halos?
b) Did meat producers provide both towns with the same quality of meat, or was each town provided with different qualities?
c) Did the founding of New Halos change the traditional animal husbandry of the region?
d) Were Magoula Plataniotiki or New Halos herders specialized in certain animal products? If so, on what scale?
e) How similar was the management of Almiros herds to other regions in Greece?

To answer these questions, we examine the available faunal assemblages of Magoula Plataniotiki and New Halos in their broader historical and archaeological context.

Thessaly, famous in antiquity for its grain production (Chamoux, 2003) and horse breeding (Prummel, 2003; Haagsma, 2010), experienced extended instability from the second half of the fourth century BCE onwards (Westlake, 1969). After a short period of relative independence in the first half of the fourth century BCE, thanks to the Thessalian League, Thessaly was successively conquered by the Macedonians, the Aetolian League, and the Romans. Almiros plain was even more unstable, because it accommodated the only passage from North to South, and vice versa. The general insecurity had an impact on the landscape as in this period fortified sites (e.g. New Halos) and smaller forts appear in the region (Cantarelli, 2000, pp. 129) – it cannot be addressed here whether this was the result of local initiatives or an organized programme by expanding Macedonians; either way, this process must have had an impact on the local economies.

Disputes among cities concerning grazing rights in Thessaly (*IG* IX 2 522; *SEG* 13.391; GHW03078; *SEG* 45.588; *AE* 1917, pp. 15–18, n. 308) suggest that herding played a significant role in the local economies, causing conflicts among cities. Thanks to the Pagasetic Gulf`s good anchorages (Reinders and Prummel, 2003, pp. 17–19), Thessalian grain was exported to other regions of Macedonia and, later, to the Roman Empire (Xen. *Hell.*, 5.4–56; Philostr. *VS* 2.27; Segre, 1934; Garnsey et al., 1984; Helly, 2008).

2. The sites

Both towns are located in the southern border of Thessaly, between two small plains of moderate fertility (Floras and Sgouras, 2004): Almiros and Sourpi, and between the Othrys Mountain and the western coast of the Pagasetic Gulf (Fig. 1). Pollen diagrams from both Othrys and the plains indicate that deforestation and grazing occurred during the Hellenistic period (Bottema, 1988, figure between pages 226 and 227; Woldring, 2003, Fig. 4.4, pp. 162–163).

2.1. Magoula Plataniotiki

Ongoing excavations and geophysical surveys have revealed that Magoula Plataniotiki was a densely populated town with clear architectonical plan, inhabited from the sixth to the first half of the third century BCE (Sarris, 2015). The town was built on a beach ridge (Reinders, 1988 Table 16, pp. 43); its extent is tentatively estimated to 10 ha and it may have been inhabited by around 2000 people (Reinders et al., 2014, pp. 15). Surface surveys revealed pottery dated back to the Bronze Age until the Byzantine period (Agnousiotis et al., 2018). Geological analysis has shown that the marshland surrounding the settlement hindered the town's territorial expansion, and it was not suitable for extensive arable farming (Floras and Sgouras, 2004), which limited the opportunities for growth. Textual sources refer to Magoula Plataniotiki as Halos, and they suggest that it was one of the few ports of Achaia Phthiotis, the southern subregion of Thessaly (Dijkstra et al., 2017). Its importance diminished around 346 BCE, when the Macedonian army destroyed it and gave it to the neighbouring town of Pharsalos. Although textual evidence mentions Halos long after 346 BCE, it is unclear to which town it refers (Dijkstra et al., 2017).

Very little is known about the Archaic-period (6th century BCE) occupation, because excavations have thus far reached only the Classical (5thcentury- 323 BCE) and Hellenistic (323- first half of the 3rd century BCE). More than two hundred loom weights have been recovered (pers. communication with excavation directors), suggesting that part of the population was engaged with textile production. No luxury items and no indications for a luxurious lifestyle have been found so far. Due to the early stage of the excavations, no further evidence concerning the economic activities of Magoula Plataniotiki is available. The archaeobotanical and archaeomalacological evidence has not yet been systematically studied. The results of the zooarchaeological analysis are presented in Section 7.

2.2. New Halos

Around 300 BCE, New Halos was founded, two kilometers southwest of Magoula Plataniotiki between Othrys Mountain and Sourpi marsh (Fig. 2), possibly by a Macedonian nobleman and claimant to the throne, Demetrios Poliorketes, after his battle against the Macedonian King

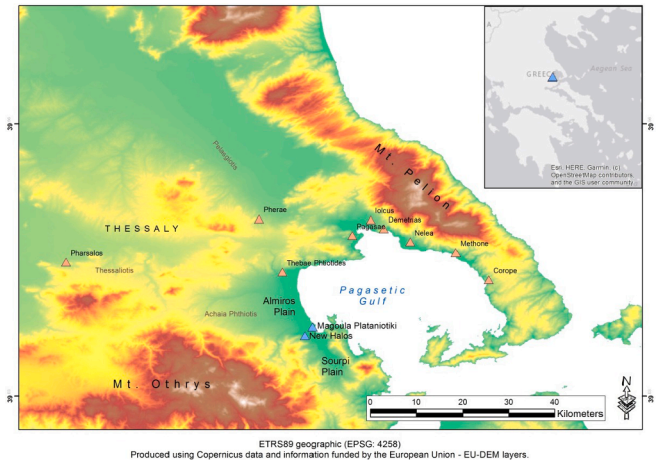

Fig. 1. Location of Magoula Plataniotiki and New Halos.

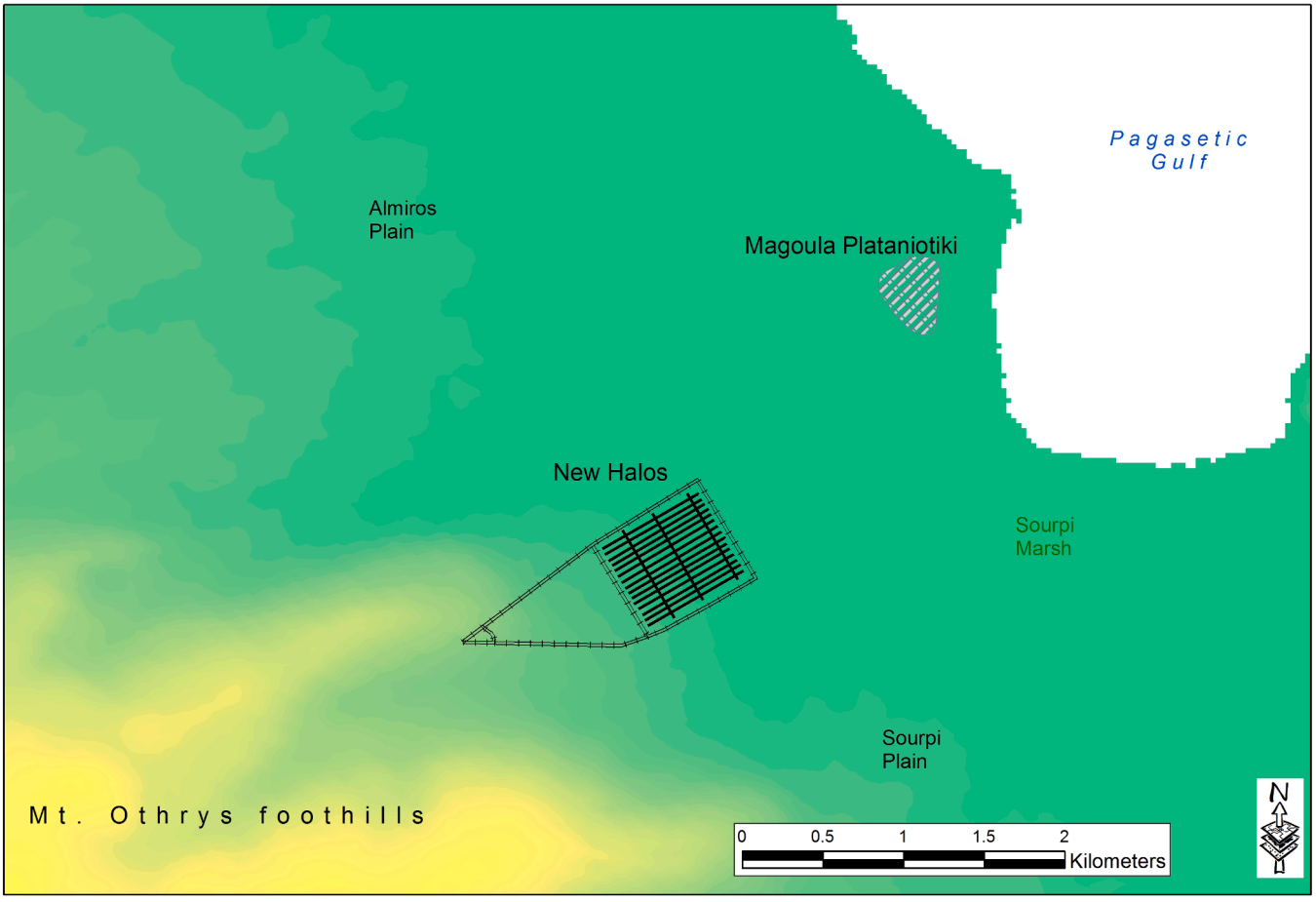

Fig. 2. Map of Magoula Plataniotiki, New Halos, and their immediate environment. The grid area in New Halos represents the lower residential town and the triangle represents the upper town.

Kassandros (Reinders, 1988, pp. 169–170). The site was built strategically, on a narrow passage that connects northern with southern Greece, and it was fortified, though scholars have not yet determined a military function for New Halos (Haagsma, 2010, pp. 77–118). After a short period of occupation, the town was destroyed in 265 BCE, probably by an earthquake (Reinders, 2003, pp. 239–240). The forty hectares of New Halos encompassed two sectors: the lower residential town, where the agora was probably situated (Fig. 2), and the "upper town", with public buildings and visual control over the Almiros and Sourpi plains and the Pagasetic Gulf, (i.e., over both land and sea routes). This was the largest and most crowded town in Almiros, with an estimated 9000 inhabitants (Reinders, 1988). Although the whole site was abandoned, the southeast gate of the town was converted into a farm house and was inhabited until at least 220 BCE (Reinders et al., 2014, pp. 22).

Coinage and pottery suggest interregional contact mostly oriented southward (i.e., Euboea and Lokris (Reinders, 2003, pp. 240–241). But the absence of luxury items (Reinders, 2003, pp. 244), evidence for local textile production (Burnier & Hijmans, 2003, pp. 122; Prummel, 2003, pp. 216), plant and animal husbandry (Hijmans, 2003, pp. 124–126) imply a modest economy.

Finally, archaeological surface surveys have revealed approximately eleven farmsteads scattered across the Almiros and Sourpi plains and a complex of small, fortified sites on the Othrys foothills, which comprised the *chora* (rural hinterland) of "Halos". Most of these long-occupied sites (Archaic/Classical-Hellenistic period) had visual intra-site contact and controlled the mountain passages and the plains (Haagsma et al., 1993; Reinders et al., 2000; Stissi, 2012; Efstathiou, 2014; Stissi et al., 2015).

3. Previous research on New Halos economy

In 1998, Reinders and Prummel proposed that New Halos herders practiced short-distance transhumance between the plains and Othrys Mountain, based on zooarchaeological, archaeobotanical, ethnoarchaeological, and literary evidence. The densely populated region, they argued, had formed a market where local producers could sell their products. The favourable environmental conditions allowed pastoralists to move their caprine and cattle herds onto Othrys during summer, as the plains were too dry to provide water and pasture. Yearly access to water and pasture is significant for milk production; mortality profiles suggested animal rearing for milk, and Reinders and Prummel connected seasonal movements with the production of good quality milk for market consumption. Caprines, cattle, equids, and pigs were exploited for their meat and other secondary products, while cattle may also have been used as traction animals (Prummel, 2003, p. 216). However, the available zooarchaeological data were too limited to provide concrete evidence for the scale of the animal husbandry and transhumance.

Haagsma suggested an economic model, according to which every economic activity aimed to secure the grain supply (2010, pp. 171–232). More specifically, New Halos residents practiced both arable farming and animal husbandry for subsistence on a small scale. However, the limited arable land (max 3500 ha according to Haagsma's estimation based on surface surveys (2010, pp. 256)) could not produce enough

grain to feed a large population. Consequently, large-scale milk production, made possible by short-distance transhumance, allowed the town to generate profit Reinders and Prummel (1998). Thanks to this profit, New Halos could be supplied with grain from the grain producers of the large Thessalian plains. Therefore, specialization, if any existed, would have aimed for subsistence, rather than profit and economic development (Haagsma, 2010, pp. 258). However, Haagsma's arguments on the scale of plant production relied on calculations of storage capacity, rather than on concrete archaeobotanical evidence.

4. Materials and methods

This study focuses on the faunal remains unearthed during systematic excavations of Magoula Plataniotiki Trenches 1, 2, 3, 4, 5, and 6 (Fig. 3). Dry sieving produced a few small identifiable bone fragments. The architectural remains of Trench 1 and 2 belong to the Classical and Hellenistic layers. Trench 3 contains a Classical monumental wall and a neighbouring building of the Hellenistic period (Stissi et al., 2018). The remains of two houses and a possible road junction in Trench 4 belong to the last phase of occupation (3rd century BCE). The construction of a more recent hut destroyed the architectural remains of the Hellenistic horizon in Trench 5. In contrast, Trench 6 contains a well-defined, large Classical building along with other architectural remains. The relationship of the architectural remains among trenches and the details of the stratigraphy of the site have yet to be determined, because the excavation is still in progress. Consequently, and to counter the small sample size, the present study follows a broad chronological (Classical-Hellenistic period) rather than contextual comparison.

Prummel analyzed the faunal remains from eight houses at New Halos (2003, pp. 175–223); results from six of those have been published (Reinders and Prummel, 2003), and the faunal materials from two recently excavated houses await publication (Reinders, 2008; Dijkstra et al., 2012). The zooarchaeological assemblages were collected by hand; a few wet-sieved contexts produced nothing more than tiny unidentifiable bone fragments (Prummel, 2003, pp. 182). Since the faunal remains from Magoula Plataniotiki and New Halos were recorded following different protocols, New Halos data were re-quantified for consistency.

To cast light on the anthropogenic and non-anthropogenic impact on the formation of faunal assemblages, we recorded the erosion marks and the fragmentation degree. In order to study erosion, we considered plant etches, weathering marks, encrustations, metal stains, burning and gnawing. In order to study fragmentation, we grouped faunal remains into the following categories: complete, fresh breaks and old breaks.

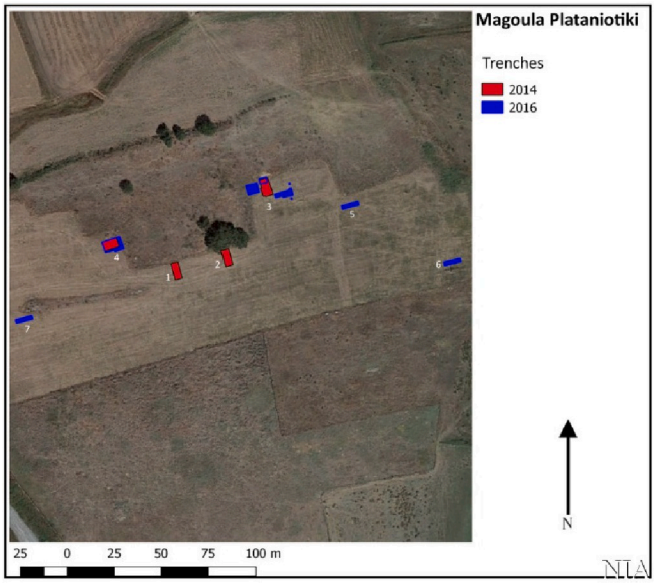

Fig. 3. Location of trenches in Magoula Plataniotiki. Excavations in Trenches 4 and 6 are in progress (photosource. https://chronique.efa.gr/?kroute=report&id=6173).

Halstead suggested that faunal assemblages with relative taxonomic evenness characterize a mixed non-specialized agropastoral economy, whereas the clear dominance of one species may imply large-scale, specialized production (Halstead, 1996). To reconstruct herd composition and understand the scale of production, we estimated the taxonomic frequency based on the Number of Identified Specimens (NISP) (Davis, 1987). We recorded and counted each specimen that included a Diagnostic Zone (DZ) (Watson, 1979). To compare evenly taxa with different number of skeletal remains, we normalized the numbers of metapodials and phalanges accordingly (for the detailed methodology, see supplementary, Table A4). To roughly measure the contribution of different meat types to the diet in Almiros, we used the relative proportion of bone weight (Çakırlar and Marston, 2019).

The distinction between sheep and goat, when possible, followed Zeder and Lapham (2010) for post-cranial elements and Payne, (1985) and Halstead et al. (2002) for teeth. The differentiation between red deer and cattle followed Prummel (1988), while the distinction between dog, fox, cat, and badger followed Johnson (2015). Horse, donkey and mule remains are classified as "equids".

To assess meat provisioning, we estimated the main domesticates' anatomical frequency, based on the %Minimum Animal Units (%MAU) (Binford, 1984; Lyman, 1994) (for the detailed list of the recorded anatomical units, see supplementary, Table A1). Sheep and goats were grouped as "caprines", while skeletal elements were grouped into anatomical regions following Arbuckle (2006, Table 3.8, pp. 153) (supplementary, Table A7).

Legge et al. (1991) proposed that the representation of all age classes implies that the animals were herded year-round nearby the site, whereas the absence of young age classes hints at seasonal movements; meanwhile, the recovery of foetal/neonatal animal bones implies that livestock was bred in the immediate vicinity of the site (Halstead, 1996). To explore the target of animal production, the degree of specialization, and the mobility of the herds, we reconstructed the mortality profiles of caprines, pigs, and cattle using mandibular teeth and bone epiphyses: Payne (1973, 1987) and Zeder (2006) for sheep and goat; Lemoine et al. (2014) and Zeder et al. (2015) for pigs; and Grant (1982), Legge (1992), and Reitz & Wing (2008, pp. 72) for cattle. When caprine teeth were attributed to multiple age groups, they were proportionally assigned to avoid exaggeration, following Payne (1973). The mid-shaft post-cranial elements with spongy texture (Prummel, 1987) were grouped as "perinatal" and "juvenile".

To examine sex-based culling strategies, whenever possible, we assigned sex to determinate herd composition and husbandry practices following Boessneck et al. (1964) and Schmid (1972). We identified pathologies in cattle remains to trace certain types of exploitation (e.g., cattle power), following Bartosiewicz et al. (1997). We measured the bones and teeth in order to identify size changes, different breeds, and estimate the sex composition of the adult population following von den Driesch (1976). We adjusted the Log Size Index (LSI) technique to increase the sample size and examine whether the demographic changes of the Hellenistic period forced Almiros herders to change the feeding strategies of their flocks or to introduce new breeds to cover growing demand (Meadow, 1999). We compared the taxonomic frequencies in Magoula Plataniotiki and New Halos with those from several domestic sites throughout Greece to evaluate the role of different animals in husbandry practices at Almiros in broader context. Finally, we applied chi-squared statistical tests for species composition and body-part distribution and ANOVA statistical test for measurements to examine whether the observed differences in frequencies are significant.

We identified 270 specimens (including six bird bones and ten fish bones) from Classical Magoula Plataniotiki and 250 specimens (including one tortoise bone, fourteen bird bones and one fish bone)

from Hellenistic Magoula Plataniotiki layers. We included 181 specimens from New Halos in the present study.

5. Results

One third of the Magoula Plataniotiki faunal remains show significant taphonomic deterioration (supplementary, Table A2). Erosion is more evident in the New Halos faunal material; according to Prummel (2003, pp. 182–189), "60.7% of the vertebrate remains could not be identified" due to poor preservation. Furthermore, only approximately 20% of the Magoula Plataniotiki remains from both periods was recovered complete; old and fresh breaks are frequent in both assemblages (supplementary, Table A3). Given the high degree of erosion and fragmentation, small-sized animals and skeletal remains and young individuals especially in New Halos might be underrepresented in the faunal assemblage (Dibble and Fallu, 2020).

Domesticate remains (90–97%) predominate in both sites, while wild fauna represents <10 (supplementary, Table A4). The slight increase in the proportion of wild fauna from the Classical to the Hellenistic Magoula Plataniotiki is statistically significant ($p = 0.024$). The present study focuses on the main domesticates: caprines (sheep (*Ovis aries*), goat (*Capra hircus*), sheep/goat), cattle (*Bos taurus*), pig (*Sus domesticus*), and equids (*Equus caballus/Equus asinus*).

Caprines are by far the most frequent animals among the domesticates in both sites, with sheep outnumbering goats (Fig. 4). Statistical analysis shows that the fluctuations in sheep and goat ratios between sites ($p = 0.3$) and periods ($p = 0.5$) are insignificant. Pigs are the second most frequent taxa in Classical Magoula Plataniotiki, but pigs at New Halos are by comparison underrepresented at New Halos. In Hellenistic Magoula Plataniotiki pig and cattle are equally represented; no significant differences in cattle frequency are noted between Magoula Plataniotiki and New Halos. Equids occur very infrequently in both sites and periods. Statistical analysis indicates that changes in the abundance of animals between Classical and Hellenistic Magoula Plataniotiki are insignificant ($p = 0.2$), whereas the differences between Hellenistic Magoula Plataniotiki and New Halos are significant ($p < 0.001$).

The estimation of bone weight of the main domesticates provides slightly different information, compared to the estimation of species frequency (Fig. 5). By bone weight, the proportion of cattle outnumbers the proportion of the other domesticates in both sites and periods. The proportion of caprine and pig bone weight remains stable from the Classical to Hellenistic Magoula Plataniotiki, and pig remains contribute very little to the total weight at New Halos. All changes in the proportions of animals weight between Classical and Hellenistc Magoula Plataniotiki, as well as between Hellenistic Magoula Plataniotiki and New Halos, are significant: ($p < 0.001$) and ($p < 0.001$) respectively.

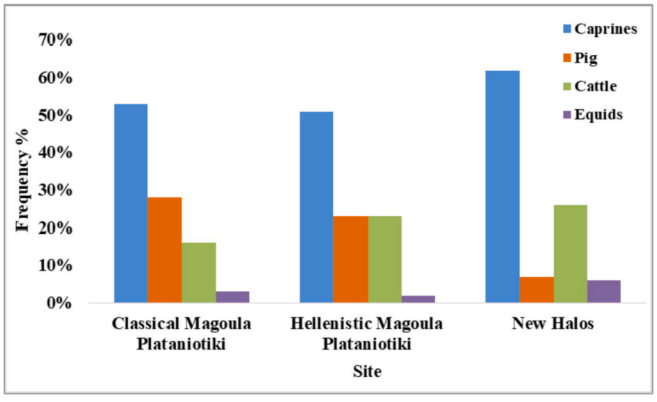

Fig. 4. Comparison of main domesticates' frequencies between Magoula Plataniotiki and New Halos (DZ = Classical Magoula Plataniotiki. 239.5; Hellenistic Magoula Plataniotiki. 207; New Halos. 159; Ratio goat:sheep = Classical Magoula Plataniotiki. 1:2.7, Hellenistic Magoula Plataniotiki. 1:1.9, New Halos: 1:3.3). For the raw data, see supplementary, Table A5.

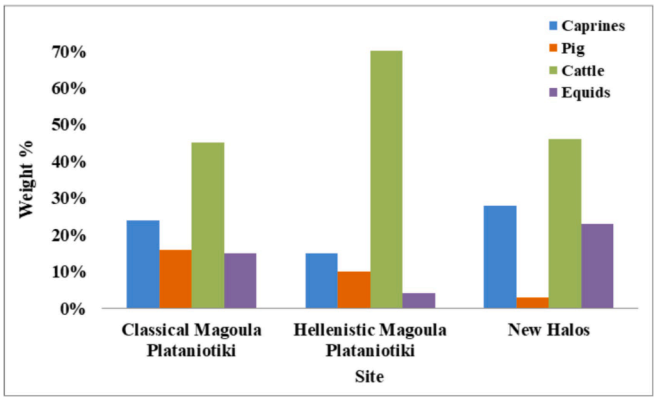

Fig. 5. Bone weight proportions of animal bones from Classical and Hellenistic Magoula Plataniotiki and New Halos. Teeth are exlcuded. For the raw data, see supplementary, Table A6.

All anatomical regions of caprines are represented in the faunal assemblage of both sites (Fig. 6). Hindlimbs seem to be more abundant in New Halos compared to the contemporary layers of Magoula Plataniotiki. However, statistical analysis indicates that, overall, there is no significant difference in body part distribution between sites ($p = 0.7$) and periods ($p = 0.5$).

Similarly to caprines, all anatomical regions of pigs are represented in both sites and through time (Fig. 7). Limb elements occur more frequently, compared to lower extremities and the trunk. There are no significant differences between pig body part distributions of Classical and Hellenistic Magoula Plataniotiki ($p = 0.7$).

Similar frequencies can be observed in cattle remains, as Fig. 8 illustrates. Skeletal elements from all the anatomical regions were identified and recorded. Hindlimbs are more frequent in the Hellenistic compared to the Classical period. Nevertheless, statistical analysis shows that overall, the differences in skeletal frequencies among sites ($p = 0.6$) and periods ($p = 0.8$) are not significant.

Figs. 9 and 10 compare the age-at-death of caprines in Magoula Plataniotiki through time and Classical Magoula Plataniotiki and New Halos respectively, based on dental data. Regarding Classical Magoula Plataniotiki, some individuals (40%) were slaughtered before reaching their first year of age. A second group of individuals was slaughtered after their second year of age, while no individual survived after six

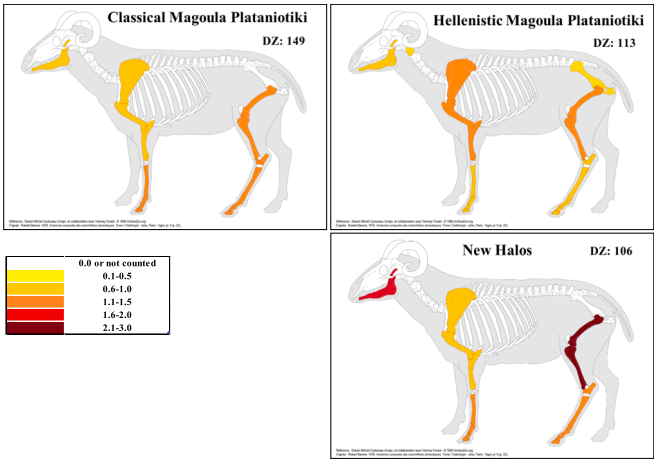

Fig. 6. Body part distribution in caprines. The figures depict the anatomical frequency based on %MAU. The 15 burnt astragali from New Halos that are related to ritual activity according to Prummel (2003) are excluded. For the raw data, see supplementary, Table A8.

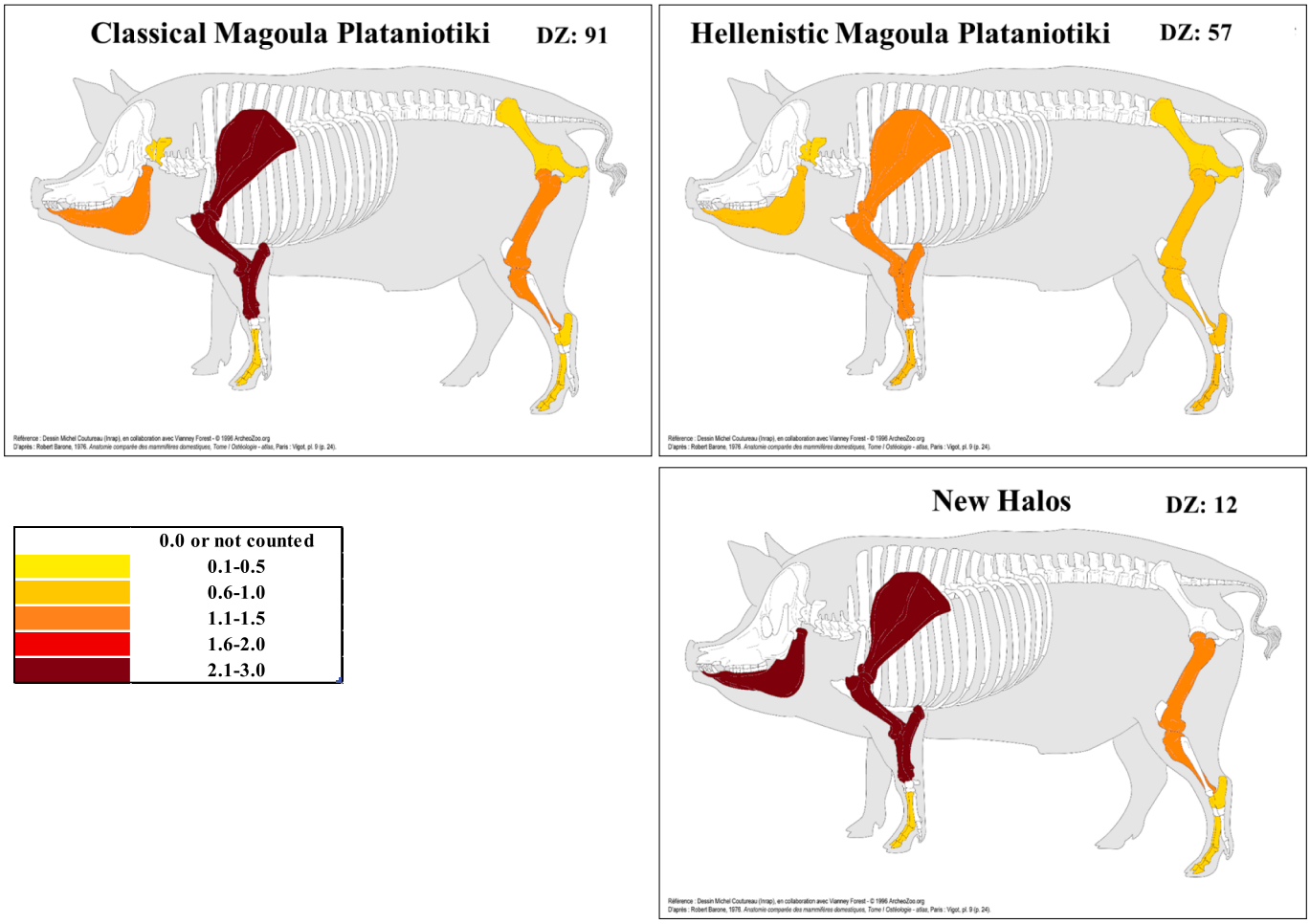

Fig. 7. Body part distribution in pigs. The figures depict the anatomical frequency based on %MAU. For the raw data, see supplementary, Table A9.

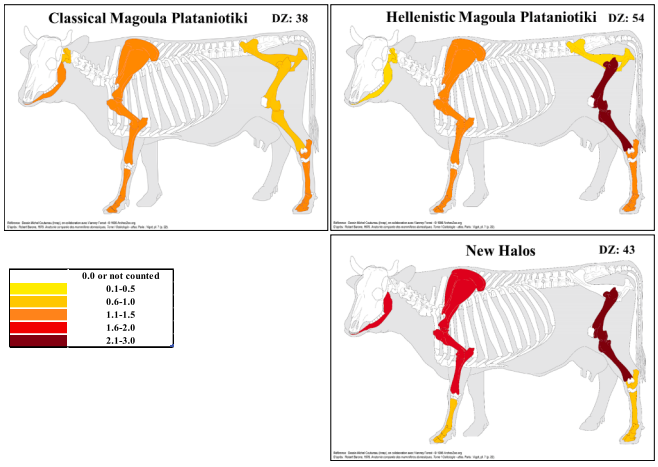

Fig. 8. Body part distribution in cattle. The figures depict the anatomical frequency based on %MAU. For the raw data, see supplementary, Table A10.

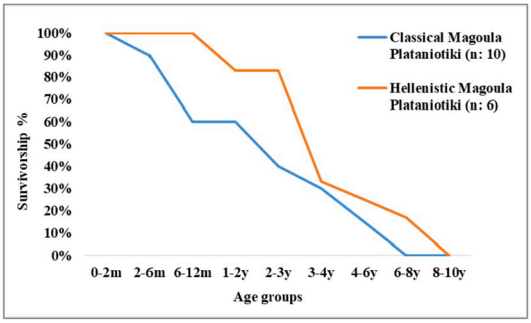

Fig. 9. Survivorship curves of Magoula Plataniotiki caprines based on tooth wear (n = Classical. 10, Hellenistic: 6). For the raw data, see supplementary, Table A11

years of age. At Hellenistic Magoula Plataniotiki, slaughter began after the first year of age, while one individual was slaughtered at more than 8 years old. The apparent delay in slaughtering compared to Classical Magoula Plataniotiki is most likely due to the sample size. All of the New Halos caprines were kept alive for their first year of life. After that period, they were gradually decreased in number. No individual lived beyond the age of eight years. The mortality profiles of Hellenistic Magoula Plataniotiki and New Halos caprines seems to be similar.

Comparable trends to the teeth ageing data emerge from postcranial elements. More specifically, the frequencies of fused and unfused elements remain stable from the Classical through the Hellenistic period in Magoula Plataniotiki (Fig. 11), while Hellenistic Magoula Plataniotiki and New Halos mortality profiles are also similar. A limited number of individuals died perinatally (Classical Magoula Plataniotiki: n = 6, Hellenistic Magoula Plataniotiki: n = 3 New Halos: n = 3).

The small sample size precludes creating a tooth mortality profile for pigs; five individuals from the Classical and three from the Hellenistic Magoula Plataniotiki, and two from New Halos died very young. Fusion

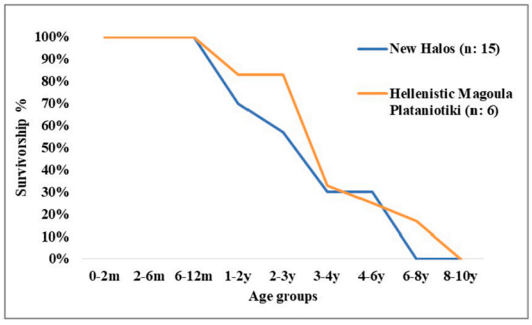

Fig. 10. Survivorship curves of Hellenistic Magoula Plataniotiki and New Halos caprines based on tooth wear (n = Hellenistic MP: 6, New Halos. 15). For the raw data, see supplementary, Table A11.

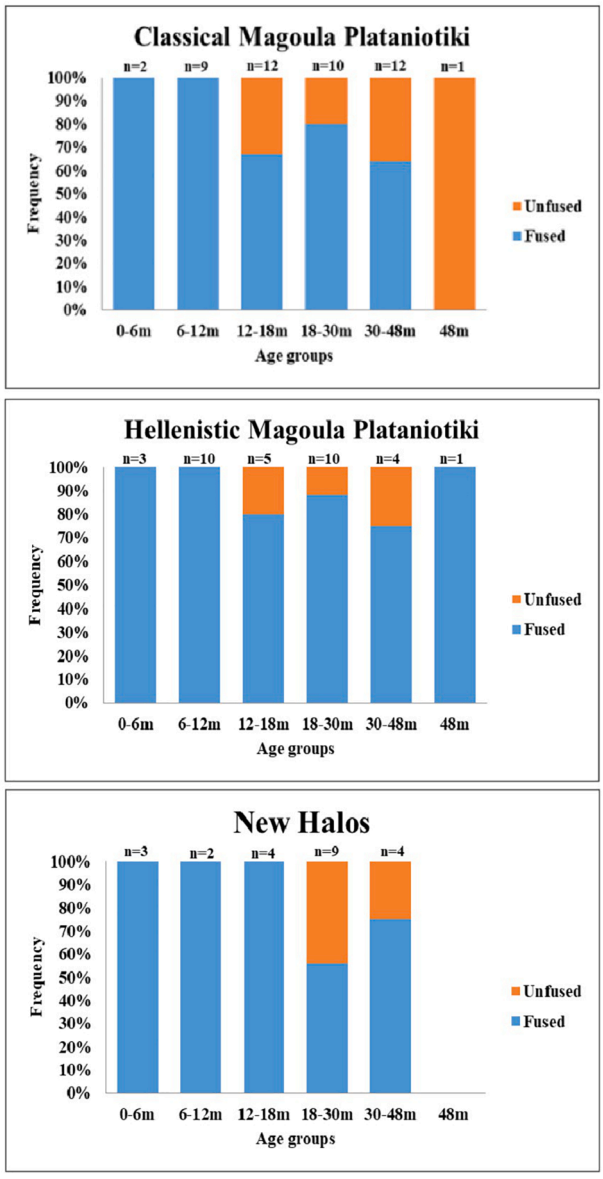

Fig. 11. Mortality profiles of caprines based on epiphyseal fusion. n = Classical Magoula Plataniotiki:46, Hellenistic Magoula Plataniotiki:33 and New Halos:22. For the raw data, see supplementary, Table A12.

data indicate continuity of all pigs at Magoula Plataniotiki being slaughtered before reaching their third year of age (Fig. 12). Some individuals died either just before or after birth (Classical Magoula Plataniotiki: n = 10, Hellenistic Magoula Plataniotiki: n = 6, New Halos: n = 1).

The number of cattle teeth is not sufficient for the construction of mortality profiles. In the Classical Magoula Plataniotiki, we found two adult individuals: one was three to six years old and the other was older than ten years; in the Hellenistic Magoula Plataniotiki, one individual was eighteen to thirty months old. In New Halos, we found two individuals up to three years old and two individuals between six and ten years old. The stage of bone fusion indicates that the majority of cattle in Classical Magoula Plataniotiki were kept alive at least until their third year of age (Fig. 13). However, some individuals were slaughtered either as yearlings or at an advanced age. In Hellenistic Magoula Plataniotiki and New Halos, cattle were culled at various periods of their lives.

Regarding sexing data, all five pelves found in Magoula Plataniotiki (both Classical and Hellenistic) belong to female caprines, while male and female pigs occur in similar numbers during the Classical and Hellenistic Magoula Plataniotiki periods. Finally, in New Halos one goat horncore has been characterized as female by Prummel. Pathologies in Magoula Plataniotiki caprines and cattle are infrequent at both sites, and when found, they occur in the lower extremities (metapodials and phalanges); lipping on phalanges proximal articulation and exostosis on proximal and distal halves of phalanges and metapodials are the most pathological traces observed in Magoula Plataniotiki faunal material (supplementary, Table A15); no pathological traces were identified among the New Halos faunal remains.

The slight increase in size of sheep from the Classical to the Hellenistic Magoula Plataniotiki (Fig. 14) is significant ($p = 0.002$). Hellenistic Magoula Plataniotiki and New Halos sheep differ in size as well ($p = 0.030$); however, the one small-sized specimen that stands out among measurements in New Halos (−0,17) is an astragalus, an element that is difficult to age. Therefore, it is also possible that this specimen belongs to a young individual and it might have lowered the mean value of New Halos sheep (−0,03). Regarding cattle (Fig. 15), no significant changes in size over time at Magoula Plataniotiki are noticed. However, the size range widens in the Hellenistic Magoula Plataniotiki, and more measurements occur at the extremities of the graph (e.g., −0,22, +0,10). In contrast, New Halos measurements fall into a narrower range. Overall, these changes are statistically insignificant (Classical vs Hellenistic Magoula Plataniotiki: $p = 0.9$; Hellenistic Magoula Plataniotiki vs New Halos: $p = 0.9$). Pig and goat measurements are too few to produce any evidence for size change and are thus not analyzed here.

6. Discussion

Comparing the animal management in Hellenistic Magoula Plataniotiki and New Halos, it becomes evident that residents consumed primarily stock-raised animals, supplementing their diet with game (supplementary, Table A4). During the Hellenistic period, archaeobotanical evidence implies more extensive exploitation of the natural environment, which might have resulted in the slightly higher proportion of game in the meat diet.

The animal husbandry was based on caprine exploitation with a larger focus on sheep production. In addition to caprines, pigs and cattle provided the towns with their primary and secondary products. Inscriptions suggest that the cult of Demeter, goddess of fertility and protector of agriculture (Papachatzis, 1985), was popular in ancient Thessaly (Mili, 2015, pp. 120–123; Nikolaou, 2015) and, archaeological evidence attests to the cult of Demeter in New Halos (Reinders, 1988; Reinders et al., 2014, pp. 38–39). As zooarchaeological data indicate that pig was the most common sacrificed animal in sanctuaries related to Demeter (Jarman, 1973; Bookidis et al., 1999; Dibble, 2017, pp. 292) and the frequency of pig remains in New Halos is low, pork consumption in a communal rather than domestic level is possible. Limited equid

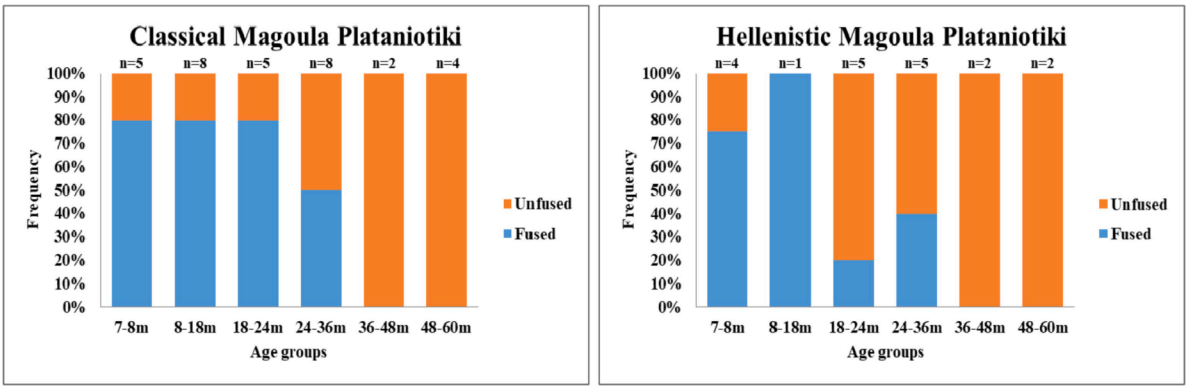

Fig. 12. Mortality profiles of pigs based on epiphyseal fusion. n = Classical Magoula Plataniotiki:34, Hellenistic Magoula Plataniotiki:19. For the raw data, see supplementary, Table A13.

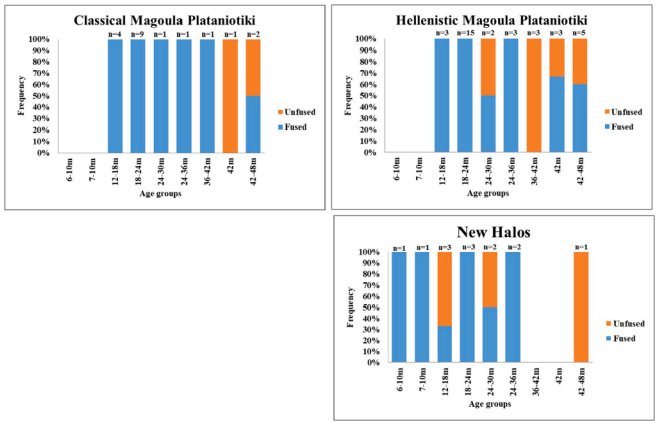

Fig. 13. Mortality profiles of cattle based on epiphyseal fusion. n = Classical Magoula Plataniotiki:19, Hellenistic Magoula Plataniotiki:34 and New Halos:13. For the raw data, see supplementary, Table A14.

rearing, or discard of the dead population outside Magoula Plataniotiki and New Halos, might have resulted in a low frequency of equid remains in both towns.

In terms of meat weight, beef was more important than lamb and pork in both towns. Although cattle rearing is more expensive compared to that of other domesticates, beef can feed dozens of people, as they are larger animals compared to caprines or pigs. Equid meat was not regularly consumed at Magoula Plataniotiki, as there are no signs of carcass processing and equid remains occur in low frequencies. In contrast, butchered bones at New Halos do suggest equid meat consumption (Prummel, 2003, pp. 215).

Survivorship curves indicate that Magoula Plataniotiki caprines were reared in a mixed strategy. Most of the animals were raised for meat and slaughtered before their fourth year of age, when they would have reached the maximum body size; older individuals were probably exploited for dairy, wool and fleece production or breeding. Although sexing data from Magoula Plataniotiki are limited, the predominance of females among caprines killed as adults, combined with the individuals killed at perinatal ages, suggests that at least some animals were exploited for dairy production (Payne, 1973). Similarly, New Halos caprines were reared for their meat, for breeding, and for their secondary products. The presence of perinatal remains in both cities suggests that at least part of the flock was bred close to the site and the lack of teeth from young individuals is possibly due to the small sample size.

Cattle mortality profiles do not provide any clear pattern. Individuals slaughtered at a young age were exploited for their meat, whereas the adults were potentially used for reproduction and secondary products. Pathologies such as lipping and exostosis suggest that some individuals

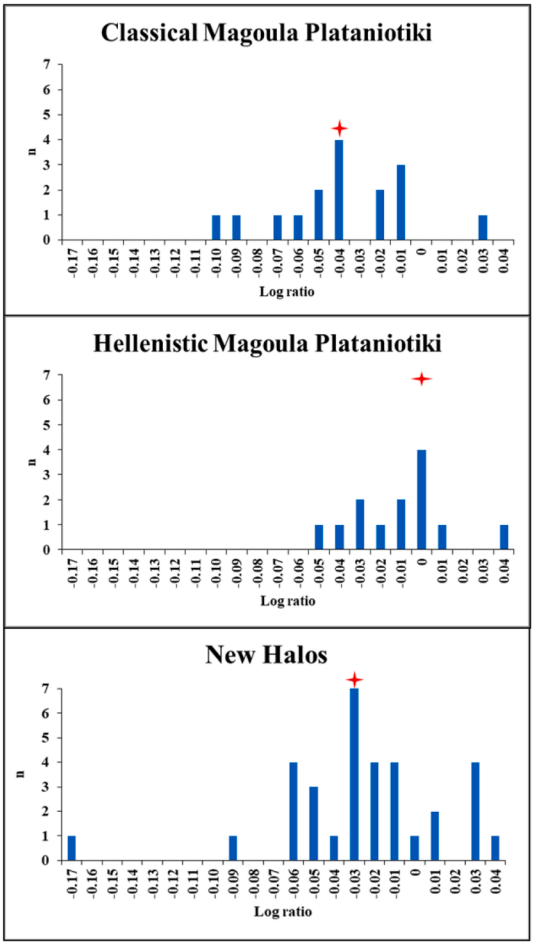

Fig. 14. Comparison of sheep measurements Classical Magoula Plataniotiki (n. 16), Hellenistic Magoula Plataniotiki (n:13), and New Halos (n:33). The mean is indicated by the red star. For the raw data and the statistical test, see supplementary Tables A16 and A17. The standard measurements used for the calculation of the log size index follow Uerpmann and Uerpmann (1994).

might have been used for traction (Gaastra et al., 2018). Finally, pig ageing data from both cities point towards meat production; individuals that survived longer than three years of age were most likely kept for breeding. The little sexing data cannot provide any further information regarding pig management.

Despite the small sample size, we noticed a slight increase of sheep size in Magoula Plataniotiki through time. Moreover, there are hints in

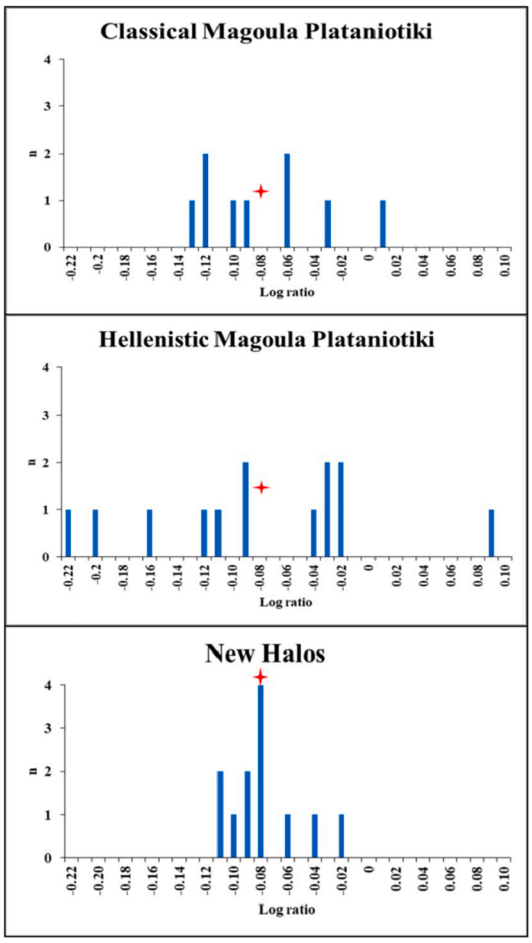

Fig. 15. Comparison of cattle measurements Classical Magoula Plataniotiki (n: 9), Hellenistic Magoula Plataniotiki (n:13), and New Halos (n:12). The mean is indicated by the red star. For the raw data and the statistical test, see supplementary Tables A18 and A19. The standard measurements used for the calculation of the log size index follow Degerbol and Fredskild (1970).

the data that suggest that Hellenistic Magoula Plataniotiki sheep were slightly larger than New Halos. Regarding Hellenistic Magoula Plataniotiki cattle, greater variation in size complicates the interpretation; the smaller individuals might be either cows or small breeds, whereas the largest animal might be either a bull or a large breed. Overall, Magoula Plataniotiki and New Halos cattle were of similar size.

In sum, zooarchaeological analysis demonstrated both differences and similarities in animal management between the two towns. Statistical analysis suggested that some differences might be significant (e.g., more extensive exploitation of pig in Magoula Plataniotiki, larger sheep in New Halos) and some others might be the result of random chance (e.g., more sheep than goat in New Halos). However, the small sample size sets limitations to the straightforward interpretation of the zooarchaeological data; a larger dataset might shed more light into the potential differences in animal husbandry of the region.

New Halos and Magoula Plataniotiki residents possibly received the same quality of meat, as well (Zeder, 1991). Both towns were provided with similar meat portions, with a slight preference for hind limb meat. Furthermore, both had access to meat of both good quality (meaty higher limbs and young animals) and lower quality (non-meaty lower limbs and older animals). Nonetheless, Magoula Plataniotiki received much more beef than lamb and goat compared to New Halos. As cattle are expensive animals, because of their high demand for food and water, not all herders could afford cattle raising. Given the absence of an archaeologically visible elite, beef production and distribution might have been coordinated by the local and religious authorities.

Zooarchaeological evidence of Magoula Plataniotiki reveals that the founding of New Halos altered slightly the traditional animal husbandry of the region. Animal production and exploitation depended primarily on caprines and less on pigs and cattle in all phases at Magoula Plataniotiki, whereas cattle meat became more important during the Hellenistic period. Body part distribution does not provide any evidence for changes in the system of provisioning through time. The residents received both meaty and non-meaty parcels of beef, pork, lamb, and goat. As the contextual resolution is low, this study avoids investigating whether different households received different quality of meat.

Magoula Plataniotiki caprines were reared in a mixed strategy, as survivorship curves indicate, in both periods. The majority of the animals were slaughtered at a young age for meat; the rest were probably exploited for breeding, milking, and wool and fleece production. Caprine epiphyseal fusion data further support continuity in animal management through time. Biometrical analysis shows that caprines became slightly larger in the Hellenistic period, implying an improvement in the nutrition strategy.

Regarding cattle and pig, the ageing data are too limited to provide evidence for the evolution of animal management through time. Pathological traces in extremities suggest that cattle may have been exploited for traction. The few measurements from Magoula Plataniotiki show that although the overall size did not change through time, size varied more among Hellenistic than Classical cattle. Such variation might be the result of the introduction of new breeds, castration, better nutrition, or a combination of these.

Zooarchaeological evidence might suggest small-scale, non-specialized animal rearing during the Classical and Hellenistic period in the Almiros Plain. Specialization requires the intensive exploitation of a few animal species, with the aim of maximizing production. In both Magoula Plataniotiki and New Halos, there was no evidence to suggest intensive exploitation, as the predominance of caprines is not so vast. Additionally, mortality profiles imply a mixed strategy, in which caprines and cattle provided meat, milk, wool/fleece, hides, and power.

Caprine flocks and cattle herds might have been reared in the plain and Othrys foothills throughout the year, as all age groups are present in the faunal assemblage. Remains of unborn and infant individuals indicate that herds spent, at least, their first year of age close to the sites. The marshy environment provided relatively rich pasture, disfavouring large-scale, intensive agriculture. It is unclear whether the grassland expansion at the expense of forests in Almiros, also evident in pollen diagrams throughout Greece (Weiberg et al., 2019, Figs. 6 and 7, pp. 751–752), was caused by the need for pastureland or by mining and timber use in house and ship construction. The farmhouses scattered across the plain, whose precise function is not clear yet, may have been used for farming activities. Given the small-scale production, we may further assume that an individual or a household practiced animal and plant husbandry side by side, according to the "mixed agrofarming model" (e.g., Halstead, 1987; Hodkinson, 1988). However, the scale of plant cultivation remains unknown, due to limited archaeobotanical work at the sites.

The apparent lack of diachronic changes in the faunal assemblages indicate that traditional animal husbandry proved resilient to the political instability and continuous conflicts in Thessaly in the Hellenistic era; the marginal physical and geopolitical environment of Almiros plain may have maintained the economic status quo. The volume of animal products, according to the zooarchaeological evidence, covered the households' needs. Surplus, if there were any, could have been sold to local or neighbouring markets. The Almiros market either did not have the means or did not have the intention to integrate with the larger Hellenistic markets. Neither the zooarchaeological nor archaeological data suggest any significant economic growth.

Growing zooarchaeological research within Classical archaeology (MacKinnon, 2007) allows us to investigate Magoula Plataniotiki and New Halos animal husbandry practices in the broader context of the

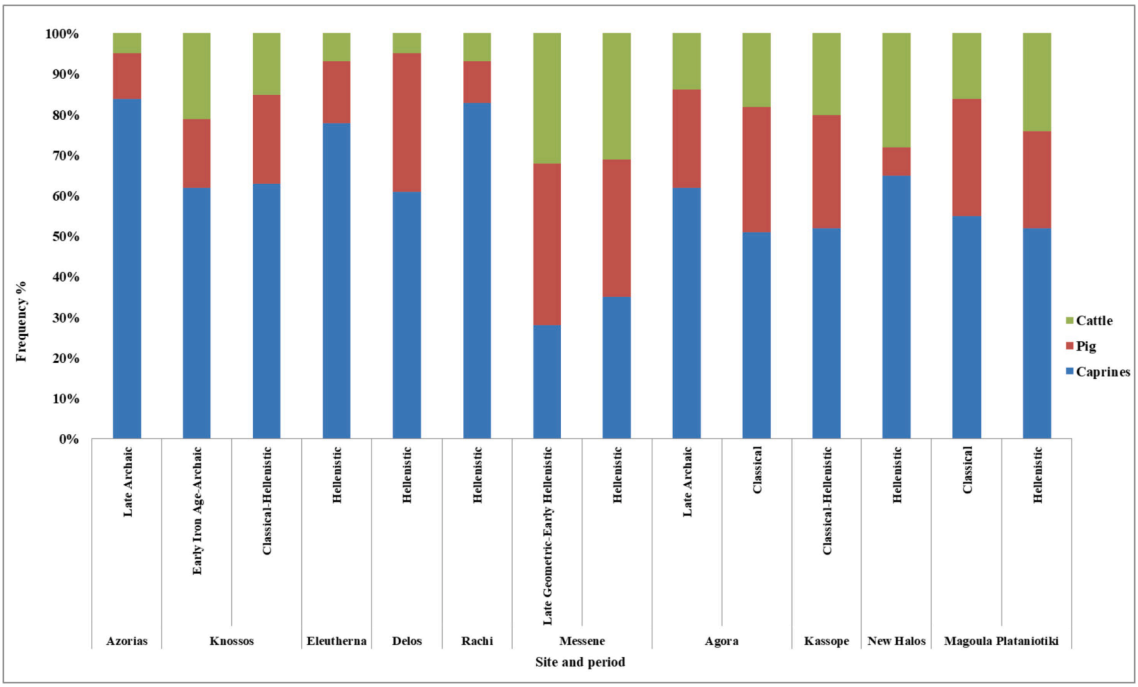

Fig. 16. Frequency of the major domestic taxa represented at EIA through Hellenistic period sites in the Greek world based on NISP and MinAU. As not all studies separated sheep from goats, we grouped them together under "caprines". Azorias (NISP. 7434) from Dibble 2021, Supplementary Materials, Table A7, Knossos (EIA-archaic = MinAU. 288, Classical-Hellenistic = MinAU: 458) from Dibble, 2012, table 6.1, Eleutherna (NISP: 286) from Vila, 1994, Table 1, Delos (NISP: not available) from Leguilloux, 2003, Fig. 27.2, Rachi (NISP: 102) from Reese, 1993, Messene (Late Geometric-Early Hellenistic = NISP: 1285, Hellenistic = NISP: 5344) from Nobis, 2001, Table 4, Athenian Agora (Late Archaic = MinAU: 919, Classical = MinAU: 2017) from Dibble, 2017, Tables 5.7 and 5.8, Kassope (NISP: 7463) from Friedl, 1984, New Halos (DZ: 150) from Fig. 4, Magoula Plataniotiki (Classical = DZ: 232.5, Hellenistic = DZ: 202) from Fig. 4.

ancient Greek world.

Fig. 16 illustrates the relative abundance of the main domesticates at various settlement sites spanning the 8th to the 2nd century BCE in Greece. Despite various recording and quantification methods applied to the zooarchaeological assemblages, it seems that, similar to Almiros, the animal husbandry of these sites relied primarily on caprine production. Sheep and goats had a predominant position among livestock in ancient Greece (Georgoudi, 1974; Cherry, 1988) as they are more easily adaptable animals than cattle, and more productive than pigs. This is confirmed by the clear predominance of caprines at sites in a dry environment (e.g., Azorias and Eleutherna), when compared to sites in wetter areas (e.g., Kassope, New Halos and Magoula Plataniotiki). In contrast, the water-rich Messenian plain could sustain larger herds of pig and cattle, as it is attested by the high proportion of cattle and pig remains in Messene's zooarchaeological assemblage. Nonetheless, Messene archaeofaunal material comes from both domestic and communal contexts and might not be completely representative of the local domestic economies.

Dibble looking at the zooarchaeological and archaeobotanical evidence and various forms of material culture, argued for a relative heterogeneity in animal and plant husbandry strategies among settlements in the Early Iron Age until the Classical period (2017, pp. 251–296). Fig. 16 reveals that this heterogeneity persists into the Hellenistic period as well, as the proportions of the main taxa vary among sites. Moreover, Dibble mentioned that animals were slaughtered at various ages, from very young to old, suggesting no specialization. Although some of the sites presented in Fig. 16 provide vague ageing data, it is evident that animals were slaughtered at all life stages, providing a range of products. Contrary to this pattern are the ageing data from Eleutherna (Vila, 1994) and Rachi (Reese, 1993). In the former, there is an intensive slaughter of caprines of 3–4 years old and, in the later, of caprines of 1–2 years old; both suggest specialized meat production. However, because the zooarchaeological data from Eleutherna come from a single household and the ones from Rachi come from a well, we cannot generalize for the whole site.

Margaritis (2015) examined the taxonomic frequency and abundance of plant and animal remains in two Hellenistic farmhouses in northern Greece. The results showed that one farmhouse, with abundant grape seeds, significant storage facilities, and scarce faunal remains, accommodated specialized viticulture for market consumption; the second farmhouse, with relatively uniform plant and animal taxonomic composition, accommodated mixed agrofarming for domestic consumption. Recently, a multi-site archaeobotanical study showed that polyculture was practiced across Greece in the first millennium BCE suggesting the importance of smallholders practicing extensive farming (Douché et al., 2021). Bishop and her colleagues (2020) revealed a complex system of animal management in Hellenistic Kastro Kallithea in Thessaly. Isotopes analysis in caprines teeth showed that some individuals spent most of their time near the site, whereas some others moved seasonally in non-local geologies before being slaughtered.

Political and historical factors may have restricted specialized animal production and distribution. Long-distance movement of large flocks requires political unity and an administrative center to determine the transhumance routes and coordinate the whole process (Whittaker, 1988). For example, Linear B tablets attest to the mobilisation of thousands of sheep under the administration of the Mycenaean palaces (Halstead, 1998). Such large flocks were exploited for their meat, for large-scale banquets, and for their secondary products. More recently, in 13th–19th century Spain, the state sponsored an organization called Mesta that produced merino wool for national and international markets (Braudel, 1949, pp. 91–93). Mesta owned millions of sheep and practiced long distance transhumance across Spain to maximize production, organized by the political institution of the Spanish Empire.

In contrast, continuous rivalry among the Classical city-states and the Hellenistic kingdoms undermined political unity. For instance, Chaniotis (1999), looking at the historical and archaeological evidence, noted that, although Crete is an island, the various city states did not unite before the Roman invasion in the first century BCE. Consequently,

he argued that transhumant pastoralism was very limited during the Classical and Hellenistic period, as animal rearing targeted subsistence; zooarchaeological evidence further supports this argument (see Fig. 16 and Dibble, 2017, pp. 251–295). The Almiros region experienced similar political instability, as Macedonians and Aetolians among other powers attempted to control the region (Graninger, 2010). Continuous conflicts among the cities as attested by the ancient sources disfavoured long-distance transhumance, which requires collaboration between land holders and cities. Therefore, only short-distance movements in the *chora* of Halos (Almiros and Sourpi plains and Othrys Mountain) might have been feasible at that time. The large-scale animal mobility in antiquity as documented in textual sources (e.g., Jason of Pherae and Delphoi sanctuary) involves sacrificial slaughter (Howe, 2008, pp. 5) and it is beyond the scope of this paper.

In sum, zooarchaeological evidence from various urban sites and environments suggests that regional variations in livestock management did occur across the Greek mainland. However, most of the animal production was caprine-based and it seems that it did not target large surplus production; environmental restrictions and the political fragmentation, amongst other things, might have disfavoured long-distance movement of animals and extensive production. Almiros evidence fits this model, as animal husbandry seems to have targeted subsistence, but we need more archaeological data to support that agrofarming was the predominant economic activity in Almiros plain.

7. Conclusions

The heated debate among historians and archaeologists about the scale of animal husbandry in the ancient Greek world is primarily text-based. This study is the first dedicated to the diachronic comparison of two towns in Almiros region. It presents new data on the impact of environmental and socio-political factors on livestock management and the scale of the animal husbandry.

Examining the faunal remains from Magoula Plataniotiki and New Halos in their broader archaeological and historical context, we first compared the husbandry strategies and meat provisioning of Magoula Plataniotiki and New Halos in the Hellenistic period. The results primarily showed mainly similarities in animal management, with some differences in meat provisioning and animal size between these towns. We also examined whether the foundation of New Halos affected the traditional animal-related economy in the region. Again, the overall similarities, but also limited variation observed between the zooarchaeological record of Classical and Hellenistic Magoula Plataniotiki imply an overall continuity, although some possible changes in animal husbandry through time may be attributed to the demographic changes in Almiros. Additionally, we explored the scale of production and livestock mobility to understand whether animal rearing targeted self-sufficiency or market consumption. The lack of predominance of any species or age group seems to suggest small-scale local production, possibly for subsistence. At last, we compared Magoula Plataniotiki and New Halos taxonomic frequencies with those from other domestic sites throughout Greece to evaluate the broader context for the role of different animals in husbandry practices at Almiros. This analysis suggested that most of the local animal-related economies were based on caprine production, while the environment significantly affected herd composition.

The evidence thus far available from Almiros suggests a modest economy lacking specialization in animal products. It seems that the economic growth, if it took place, of the large Hellenistic markets did not affect the regional economy of Almiros. Yet, further zooarchaeological work is necessary in order to better understand the scale of animal management, the degree of animal mobility, and the production goals in the region. The current excavations in Magoula Plataniotiki will increase the archaeofaunal sample size, assisting us in strengthening (or revising) our arguments about the Almiros economy. Moreover, current archaeobotanical study may shed further light on the scale of agricultural production, which is closely related to animal husbandry. Finally, the ongoing isotopic analysis (C, O, Sr) can provide direct evidence for herd diet and mobility.

CRediT authorship contribution statement

Dimitris Filioglou: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Software, Visualization, Writing - original draft. **Wietske Prummel:** Investigation, Resources, Validation. **Canan Çakirlar:** Conceptualization, Project administration, Data curation, Resources, Software, Supervision, Validation, Writing - review & editing.

Acknowledgements

This study was financially supported by the Groningen Institute of Archaeology, Faculty of Arts, University of Groningen. For lab equipment and reference collection, we owe special thanks to the Zooarchaeological Laboratory of the GIA, the Wiener Lab of the American School of Classical Studies at Athens (ASCSA), the "Apotheke" of Neos Platanos village, and Dr. Vasiliki Tzevelekidi. For permissions, we offer sincere thanks to the Netherlands Institute at Athens (NIA), the Ephorate of Antiquities of Magnesia, and the Greek Ministry of Culture and Sports. For general assistance with the bureaucratic work, special thanks to Dr. Vaso Rondiri, archaeologist in the Ephorate of Antiquities of Magnesia and director of Magoula Plataniotiki excavations. For the contextual information, specific thanks to Prof. Dr. Vladimir Stissi (University of Amsterdam), Prof. Dr. Yannis Lolos (University of Thessaly) and Dr. Tamara Dijkstra (University of Groningen). For general support and guidance on the manuscript, we thank Prof. Dr. Sofia Voutsaki (University of Groningen). For the proofreading of the article, sincere thanks to Kathryn Weber-Boer. For the map illustrations, hearty thanks to Alexandra Katevaini.

Funding resources

This work was supported by the Groningen Institute of Archaeology of the University of Groningen (project number: 150114104)

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2021.103164.

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