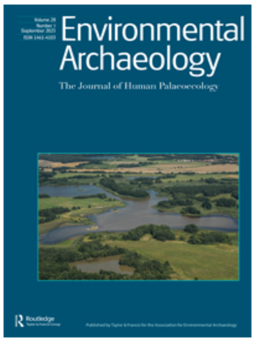

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Exploring Dietary Differentiation in the Roman Province of Macedonia: Isotopic Evidence from Pontokomi-Vrysi and Nea Kerdylia-Strovolos

Chryssa Vergidou[a,b], Georgia Karamitrou-Mentessidi[c], Penelope Malama[d], Konstantinos Darakis[e], Michael W. Dee[f], Sofia Voutsaki[b], Efthymia Nikita[a] and Petra Vaiglova[g]

[a]Science and Technology in Archaeology and Culture Research Centre, The Cyprus Institute, Nicosia, Cyprus; [b]Groningen Institute of Archaeology, University of Groningen, Groningen, The Netherlands; [c]Ephorate of Antiquities of Kozani, Archaeological Museum of Aiani, Aiani, Kozani, Greece; [d]Ephorate of Antiquities of Kavala-Thasos, Kavala, Greece; [e]Ephorate of Antiquities of Xanthi, Archaeological Museum of Abdera, Abdera, Greece; [f]Faculty of Science and Engineering, Energy Academy Europe, University of Groningen – Centre for Isotope Research, Groningen, The Netherlands; [g]Griffith Centre for Social and Cultural Research, Australian Research Centre for Human Evolution, Griffith University, Southport, Australia

ABSTRACT

This paper used stable isotope analysis (δ^{13}C and δ^{15}N) to examine whether intra- and inter-site sex and age differences existed within two distinct communities of Roman Macedonia in relation to the dietary preferences of their inhabitants. It also explored the degree of influence that the micro-ecology characterising the sub-region each community used to reside and the social status of these individuals had in determining the observed dietary profiles. The results showed no sex and age intra-community differences, but did reveal important inter-site differences. Together these observed patterns have implications regarding the way archaeologists and more specifically bioarchaeologists still examine social groups in relation to food; oversimplified divisions on inequalities in the household domain need to be reconsidered, or at least justified. They also show the potential bioarchaeology holds to enlighten aspects of the social history of the 'common' people residing in the provinces. It lastly argues for the potential of science-based approaches to the study of food to provide supplementary information regarding past dietary preferences that can be used as a proxy to detect variable degrees of incorporation into the globalising networks of the Roman world and argues for a closer collaboration between bioarchaeology and current theoretical discussions on Romanization.

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Introduction

Food and the ostentatious display surrounding dining at the Macedonian symposia have been studied extensively, largely confirming the obvious, namely the difference between members of the elite and the lower socio-economic classes (e.g. Carney 2015; 2007; Mari 2018; Sawada 2010; Vokotopoulou 2001; Zimi 2011). However, many more complex dimensions to food and social inequality (and/or equality) existed than this simplistic division, touching upon all groups of people during classical antiquity at varying degrees (Garnsey 1999). Unfortunately, available information on the consumption patterns of the 'common' people of ancient Macedonia and their internal subdivisions is scarce due to the few, fragmentary, and often biased textual sources referring to Macedonia (Rhodes 2010). In particular, textual information on Roman Macedonian dietary preferences and/or differences between men, women, and children of the lower and the middle classes and also between slaves and freedmen, is extremely limited (e.g. Petsas et al. 2000; Sverkos 2000; Tataki 1988).

Human skeletal remains could fill that gap by providing information about the diet of the 'common' people, and by revealing patterns of social unity or differentiation among its members (e.g. Kron 2019) that cannot be approached by means of other archaeological data (e.g. textual record, Rhodes 2010). For Roman times assemblages in Greece, recent bioarchaeological studies, albeit limited, have begun to reveal interesting dietary patterns (e.g. Bourbou 2005; Bourbou et al. 2011; Dotsika and Michael 2018; Ganiatsou et al. 2022; McConnan Borstad, Garvie-Lok, and Katsonopoulou 2018; Moles et al. 2022; Nikita et al. 2019; Vergidou et al. 2022; 2021).

Drawing upon the results of previously published papers on the Pontokomi-Vrysi (POV) Roman times (1st–4th c. AD) semi-mountainous community in Western Macedonia (Greece) (Figure 1) (Vergidou et al. 2022; 2021), this paper sets out to test whether the absence of distinct sex-related differences observed in the oral and skeletal health profile of the POV skeletal assemblage (which likely represented 'commoners') can also be detected in the dietary profile

CONTACT Vergidou Chryssa chryssavergidou@hotmail.com Science and Technology in Archaeology and Culture Research Centre, The Cyprus Institute, 20 Konstantinou Kavafi Street, 2121 Aglantzia, Nicosia, Cyprus

Figure 1. Location of the sites under investigation.

of this community with stable isotope analysis (δ^{13}C and δ^{15}N). For comparative purposes, it also examines the dietary patterns between the sex and age groups of another Roman era skeletal assemblage belonging to the Nea Kerdylia-Strovolos (NKS) coastal community also of 'commoners' in Eastern Macedonia (Greece) (Malama, Christopoulou, and Darakis 2002; Malama and Darakis 2003) (Figure 1). This comparative analysis allows us to test the hypothesis that the diet of different age and sex groups in the household domain was similarly undifferentiated. This hypothesis is also partly based on prior stable isotope research in Roman era assemblages from modern-day Greece. So far, there are only two such studies: Dotsika and Michael (2018) found no dietary differentiation between males and females for the Roman city of Edessa in Central Macedonia, while Moles et al. (2022) found minor differences between sexes for the Roman city of Knossos in Crete. Beyond intra-site sex and age differences, this paper seeks to investigate the existence of dietary similarities or differences at an inter-site level (POV vs NKS), assuming that NKS, which occupied a strategic location, had a more diversified diet compared to the rather isolated semi-mountainous POV. The human isotope data are interpreted using local faunal isotope data and under the light of each region's micro-ecology (i.e. physical environment, availability of resources and networks of connectivity, as well as the status of each community in the settlement hierarchy; for the definition of micro-ecology see Horden and Purcell 2002, 80) and social status of its inhabitants, the assumption being that any dietary patterns detected can be largely determined by the synergistic relationship of these two parameters.

Finally, it will be argued that these bioarchaeological observations on diet can provide supplementary information on past consumption patterns that can be used by studies using food as a proxy to identify the variable degrees to which these groups were incorporated into the globalising networks of the Roman world. Contrary to the Romanization debate premises that attempt to deconstruct past monolithic and top-down approaches for understanding the Roman world by 'deliberately' marginalising the importance of those in power (Versluys 2014), the theory of globalisation seeks to study networks of connectivity that can differentiate but also bind different groups of people with each other (Pieterse 2009; Pitts and Versluys 2014). In light of the theoretical framework of the latter, it is expected for the distinctive micro-ecological and social identity of the people of POV and NKS to be reflected in the consumption preferences of their populations. At the same time, it is expected for both communities to share common characteristics, including dietary patterns. Food, however, is inherently social and highly connected to power (Bourdieu 1984), and for this reason it is expected, within the constantly globalising and highly hierarchical Roman world, for entangled networks of local and wider food systems to act upon the two communities, sometimes differentiating and other times connecting their dietary preferences, thereby influencing the balance between their intra- and inter- power structures. In this context, individuals or groups within the POV and NKS communities were able to continuously balance between different identities that were 'appropriate for different social, cultural or even life-stage contexts' (Hodos 2014, 30). However, a full discussion of how food and diet can be used to test the relevance of the globalisation theory conceptual tools in bioarchaeology and archaeology in general lies beyond the scope of this study. Nonetheless, it can be argued that the findings of this paper could lay grounds for a greater synergy between science-based archaeology and current theoretical trends in Roman history and traditional archaeology and advocate the need for further studies, which take these variables into account, to be undertaken.

Background

Information on the socio-political history and organisation of Roman Macedonia is scarce and often biased. References in the ancient literature are confined mostly to the historical works of the Roman Livy and the Greek Polybius, while Diodorus, Appian, and Cassius Dio provide only limited information for the region and always in relation to the general context of the Roman Empire (Eckstein 2010; Vanderspoel 2010). The same holds for the epigraphic record; it is not only sparse and biased, reflecting the worldview of certain social groups, but it has also not been efficiently gathered by scholars in a single corpus (Hatzopoulos 1993; 1996; Rhodes 2010). The sparse and contradicting information has resulted in fierce scholarly debates (especially regarding the nature of Macedonia's socio-political organisation) even for the Imperial times where available evidence is less obscure (Hammond 2000; Hatzopoulos 1996; Kalléris 1988; Nigdelis and Souris 1997; Papazoglou 1988). In addition, while references to the 'common' people do exist in these ancient sources, when compared to the patriarchal and elite-based prevailing realities of the Graeco-Roman world, these groups remain largely under-represented.

Despite biases, it can be said that historically Macedonia held a lesser position within the framework of the imperial administrative structure (Evangelidis 2022). However, its particular ecological and geopolitical setting, the events that marked its political history and economy (e.g. early contact and often conflicts with Rome, periods of upheaval because of invaders from the north or periods of peace, civil wars, economic decline or prosperity, riots against the Roman or local authorities), its relatively low level of urbanisation, and its multi-cultural society played their own role in the formation of an idiosyncratic micro-ecological character within which its inhabitants interacted (Evangelidis 2022; Gruen 1982; Hammond and Walbank 1995; Kallet-Marx 1996; Vanderspoel 2010). Unquestionably, the Romans did change the socio-cultural and civic landscape of the province with the imposition of certain administrative rules, the creation of colonies (i.e. Pella, Dion, Kassandreia, and Philippi), the construction of Via Egnatia, and the mass transportation of Roman and Italian immigrants to the province (Gruen 1982; Lolos 2007). This brought to the province important changes in terms of connectivity, population composition of the cities and the villages (the komai) and inter- and intra-community power relations between the various groups of its inhabitants. However, the character of these changes was never catholic or static; as in any conqueror-conquered relationship, disruption and continuity for the province went hand in hand. At the same time, any change had to compete with well-established pre-Roman influences; the pre-existing Macedonian ones dating back to the kings, and the classical Greek ones (Hatzopoulos 1996; Papazoglou 1988; Tataki 1988). As such, the power relations between various groups (political, ethnic/cultural, religious, and social) were not always in an equilibrium, rather in a constant flux with individuals participating in a highly hierarchical system that had at the two extremes the bestowed Roman citizenship and slavery, respectively.

Contextualising both the POV and the NKS communities within the wider socio-political setting described above of Roman Macedonia is a daunting task. In the absence of large-scale excavations and systematic contextual analyses of mortuary practices in ancient Macedonia, assigning the two communities studied in this paper into social status categories presents severe challenges. However, on the basis of our general knowledge on funerary customs in the Graeco-Roman world (Dimakis and Dijkstra 2020) and Macedonia in particular (e.g. see Kottaridou 1997; Malama 2002; Vrahionidou 2017), it will be argued below that the majority of the burials in both communities under study must have belonged to the 'common' people of each population. In terms of micro-ecology, however, it will also be argued that they displayed different characteristics. It will be seen that both the regions that the two examined skeletal assemblages were found were characterised by advantageous but distinct natural resources available for exploitation that could provide nutritious food and secure survival (Karamitrou-Mentessidi and Moschakis 2006; Lazarides 1972). Similarly, the two sub-regions differed in their degree of connectivity with other parts of the province and the Roman world, in general. Lastly, information on their civic status can only be postulated, as no settlement was found associated with the cemeteries. It can be suggested, however, that the POV community was smaller than that at NKS. The former has been associated by the excavator with an extended nearby settlement (Karamitrou-Mentessidi 2002; 2001), whereas NKS has been related to a town once located at the foot of Mount Kerdylion (Malama, Christopoulou, and Darakis 2002; Malama and Darakis 2003).

Pontokomi-Vrysi

Pontokomi is a semi-mountainous village located at the eastern foothills of the mountain range of Askion at an altitude of 710 m and at the fringes of the Eordaea basin. Rescue excavations at the nearby site of Vrysi uncovered 101 graves dating from the 1st to the 4th c. CE (Karamitrou-Mentessidi 2002; 2001). Most graves belonged to single inhumations in poorly furnished pit graves, dug into the natural bedrock or into the earth, often destroying the walls of earlier buildings. Few graves contained more interments (nine graves contained two, and two graves three skeletons). Four poorly furnished and two unfurnished tile-covered graves deviated from this pattern, along with one richly furnished built cist and one unfurnished rectangular cist. The grave goods comprised primarily of pottery vases, followed by glass and bronze vases, jewelry, agricultural tools, brooches, and some coins.

It is postulated that the Eordaea basin, the region where the cemetery was found, corresponds to a territory that in Roman times was part of Upper Macedonia (*Ἄνω Μακεδονία*, Ano Makedonia), the westernmost administrative district of *Provincia Macedonia* (Papazoglou 1988). Hammond (1989) describes ancient Eordaea as a strategically important area since it constitutes the only passage from Upper Macedonia to the Emathia plain where an important road network existed (west–east, north–south) due to its basin-plateau terrain morphology (Karamitrou-Mentessidi and Moschakis 2006). Later on, the Romans planned the route of Via Egnatia crossing a significant part of its territory even though it is found quite far to the north and away from the examined site of POV.

Eordaea is distinct from adjacent regions because of its mountainous terrain, the high average altitude and plateaus, the plethora of lakes and streams, continental climate, and the long distance from the sea that characterises it (Karamitrou-Mentessidi and Moschakis 2006). Despite the relatively high altitude and its continental climate, the basin is considered to be relatively fertile, primarily favouring the cultivation of cereals and other dryland grain crops, even though the cultivation of the typical Mediterranean crops such as olives and grape vines has been attested in the region already from antiquity (e.g. see Karamitrou-Mentessidi 2014). Forests cover the northern part of the mountainous range to which Askion belongs, while the south is rocky, eroded and bare, but suitable for livestock farming and herding. Similarly, the presence of streams that flow into the region’s four lakes (Vegoritida, Petres, Cheimaditida, and Zazari) favours fishing (Tsotsos 2011).

Nea Kerdylia-Strovolos

Strovolos is a seaside settlement at the western part of the Strymonic gulf, approximately 15 kilometers to the northeast of the village of Amphipolis and seven kilometers to the west from the village of Nea Kerdylia. Rescue excavations to the north of Strovolos brought to light 246 graves, dated from the end of the 1st to the end of the 4th – beginning of the 5th c. CE (Malama, Christopoulou, and Darakis 2002; Malama and Darakis 2003). Most were hewn graves, followed by stone-lined pit graves, while a tile-covered grave, two cist graves, and a clay larnax were also found. Both inhumation and cremation were practiced, with the latter being less frequent. Single and double interments were found, as were burials with multiple individuals. Most graves contained grave-goods, but many had been looted. Among pottery vessels, cups, and oinochoai (wine jugs) predominated, followed by pinakia (plates). Among glass vessels, perfume containers prevailed. No bronze vessels were found and the presence of jewelry was limited, mostly found in the graves of women and children. The presence of oil lamps in several graves is also attested and so is the presence of ‘treasures’ of bronze coins.

In Roman times, the region where the cemetery was found belonged to the easternmost administrative district of *Provincia Macedonia* (Gruen 1982). The site was in a strategic location: the navigable Strymon River, Amphipolis, the major urban centre of the region, Eion, the Amphipolis harbour at the mouth of the river, as well as Via Egnatia, the great Roman road artery, created a hub of connectivity and commerce (Lazarides 1972; Lolos 2007). Therefore, the region attracted groups of people of different cultural and social backgrounds (inscriptions attest to the strong presence of Roman and Italian immigrants) engaging in a variety of enterprises (e.g. financial, commercial etc.) (Lolos 2007).

The natural environment of the area was also particularly favourable. The wild fauna and flora of the area was rich and the land was suitable for cultivation of a variety of crops, including wheat, olives, figs, and grape vines. Rich pastures were suitable for herding and livestock keeping, especially cattle, goats and horses, while rich sources for fishing were available at lake Kerkini, the Strymon River, and the coastal area near the mouth of the river and near Eion. The climate was not very different from that of today: temperate, humid, and characterised by cold winters, while the altitude did not exceed 400 masl (Lazarides 1972).

Materials and Methods

66 and 58 individuals were selected for analysis from POV and NKS, respectively. A description of the age-at-death and sex estimation methods adopted can be found in Vergidou et al. (2021; 2022). When possible, femora were chosen as the target skeletal element, as their isotopic values reflect the average composition of long-term dietary inputs in human diets. In the absence of femoral elements, tibial or humeral shafts (Tanasi et al. 2017), or proximal hand phalanges were sampled instead (Kaupová et al. 2018; Mion et al. 2019). An effort has been made to avoid sites where pathological lesions occurred. Five to eight grams of bone were obtained from each sampled element.

Because contemporary faunal samples necessary to build an interpretative isotopic baseline were not available from either study site, faunal samples were sought from nearby domestic contexts dated to the Roman times. The sampling strategy aimed to obtain at least three faunal specimens per key trophic level, and at least three specimens of the wild fauna. Despite extensive efforts, samples were only available from the area surrounding Mavropigi (MRP), a village 5.5 kilometers to the northwest of POV (Figure 1). In total, 29 samples were collected from the sites of Varkaris (MVA), Dasos (MDS), Ampelotopos (MAM), and Kouri (MKR). No carnivores were available for analysis.

To gain insights on micro-ecology and the degree to which different animal feeding and management practices may affect the observed human dietary patterns, the animal isotope values from the current study were compared against published faunal data for other Greek sites. Two studies were deemed most appropriate for comparison: the spatially proximal site of Sourtara (SRT) in Western Macedonia dating to the 6th–7th c. CE (Bourbou et al. 2011), and the temporally proximal site of Corinth (CRN) in Northern Peloponnese dating to the Roman times (McConnan Borstad, Garvie-Lok, and Katsonopoulou 2018) (Table 6). All human POV and NKS values and the MRP animal values were additionally compared to the faunal and plant values provided by Bourbou et al. (2011) and the fish values provided by Vika and Theodoropoulou (2012). Although these two studies represent assemblages that are temporally distant from the Macedonian samples under investigation, they are the only available comparative data from the region.

Chemical pretreatment and combustion for all 153 human and animal samples was conducted at the Centre for Isotope Research (CIO) of the University of Groningen in the Netherlands. The pretreatment and collagen extraction procedure followed a modified Longin protocol (Longin 1971) the details of which are outlined in Dee et al. (2020). In brief, samples of 0,5 grams were first demineralised in an HCl (4% w/vol) solution (replenished several times over 24 hrs), and then treated with NaOH (1% w/vol) to remove humic acids. A final HCl (4% w/vol) treatment took place to eliminate any CO_2 absorbed during the base phase. For each step a triplicate rinse in deionised and decarbonised water ensued. Samples were finally denatured to gelatin in deionised and decarbonised water (pH 3, 80̊C, 18 hrs) and dried.

Following pretreatment, the crystallised collagen product of each sample was weighed into aliquots of 5-6 mg. In-house quality control procedures reject samples that yield less than 0.5% collagen and so three samples from POV were removed.

Combustion was performed using an Elemental Analyser (Elementar Vario Isotope Cube™) connected to an Isotope Ratio Mass Spectrometer (IRMS, IsoPrime 100™). The C:N ratio was primarily assessed for the quality of collagen preservation. A C:N range of 2.9–3.6 is often cited as acceptable for collagen purity (DeNiro 1985). The CIO facility, however, prefers to use the more conservative interval of 3.1–3.3 (Dee et al. 2020; Guiry and Szpak 2021), and to reject samples falling outside 2.9–3.5. Each pretreatment batch included a secondary standard, with known isotope ratios, and a random duplicate. The IRMS allowed the following 1σ precisions to be determined: $\delta^{13}C = 0.15‰$ and $\delta^{15}N = 0.3‰$.

The CIO stable isotope ratios are substantiated by a range of international references and in-house controls. Stable carbon isotope compositions were calibrated relative to VPDB using in-house standards *oxalic acid* (−17.64 ± 0.03) and *caffeine* (−37.98 ± 0.04). Stable nitrogen isotope compositions were calibrated relative to AIR using in-house standards *caffeine* (−6.61 ± 0.02) and *enriched caffeine* (+18.80 ± 0.05). Measurement uncertainty was monitored using in-house standards *collagen* (−19.68 ± 0.05) and *enriched caffeine* (+0.65 ± 0.07) for δ^{13}C and using *collagen* (+9.87 ± 0.05) for δ^{15}N. Using the methods described in Szpak, Metcalfe, and Macdonald (2017), precision ($u(Rw)$) was determined to be ± 0.13 for δ^{13}C and 0.23 for δ^{15}N on the basis of repeated measurements of calibration standards, check standards, and sample replicates. Accuracy or systematic error ($u(bias)$) was determined to be ± 0.13 for δ^{13}C and 0.06 for δ^{15}N on the basis of the difference between the observed and known δ values of the check standards and the long-term standard deviations of these check standards. Using the equations presented in Szpak, Metcalfe, and Macdonald (2017), the total analytical uncertainty was estimated to be ± 0.19 for δ^{13}C and ± 0.24 for δ^{15}N.

It total, 139 samples produced acceptable yields and elemental values (POV: 59 samples; NKS: 56 samples; MRP: 24 samples) (Tables 1, 2, and 5). The detection of any meaningful differences between and within the animal and human groups under study employed summary statistics (range and mean values), scatter plots, plotted point mean estimates and associated 95% confidence intervals, and, finally, independent samples t-tests (Vaiglova et al. 2022). Statistical analysis was conducted in the R software package (version 4.2.2).

Results

Human Stable Isotope (δ^{13}C, δ^{15}N) Variation by Sex and Age

The humans from POV exhibit a δ^{13}C value range of 2.3‰ (−20.0‰ to −17.7‰) with a mean of −18.8 ± 0.4‰, and a δ^{15}N value range of 3.2‰ (7.1‰ to 10.3‰) with a mean of 9.3 ± 0.5‰ (Tables 1 and 3). No particular differences were observed between the values of males and females, or between adults and nonadults (Figure 2(a)), an observation also confirmed by t-tests (p-value > 0.05, Table 4) and means and associated 95% CI (Figure 3(a,b)).

The NKS human δ^{13}C values display a range of 0.8‰ (−19.8‰ to −19.0‰) and a mean of −19.4 ± 0.2‰, while the δ^{15}N values have a range of 2.4‰ (7.4‰ to 9.8‰) and a mean of 8.5 ± 0.5‰ (Tables 2 and 3). No difference is seen between males and females (Figure 2(b)), as also supported by a t-test (p-value > 0.05) (Table 4). Inspection of the mean values and associated CI shows slightly elevated δ^{13}C values for males and overlapping δ^{15}N values for both sexes (Tables 3 and 4; Figure 4(a,b)).

Contrary to the undifferentiated intra-site patterns presented above, inter-site comparisons for pooled sexes and separately for males and females revealed clear differences in both the δ^{13}C and δ^{15}N values with all POV ones being higher than the NKS ones (Table 4; Figure 2(a,d) and Figure 5(a,b)).

Human Stable Isotope (δ^{13}C, δ^{15}N) Variation by Site

The terrestrial faunal samples from MRP show a δ^{13}C range of −4.2‰ (δ^{13}C: −21.0‰ to −16.8‰) with a mean of −19.2 ± 1.1‰ and a δ^{15}N range of 5.1‰ (δ^{15}N: 3.4‰ to 8.5‰) with a mean of 6.1 ± 1.5‰ (Tables 5 and 7). Comparison of the mean human (9.3‰, Table 3) to the mean faunal δ^{15}N value (6.1‰, Table 7) suggests the consumption of terrestrial animal products and/or by-products by the POV humans (Figure 6(a)). This largely corresponds to the isotope fauna reconstructed scheme provided by Bourbou et al. (2011) to infer the diet of Byzantine populations (6th–15th c. AD) (Figure 6(b)). Bourbou et al. (2011) present fish values that largely correspond to those provided by Vika and Theodoropoulou (2012), but several fish values from the latter study (mostly freshwater and euryhaline ones) overlap with the POV human values (Figure 6(b)). This complicates the interpretation of fish remains in the current assemblage, and suggests that fish items did not form the primary component of the protein portion of POV human diets.

In the absence of site-specific faunal isotope data, the NKS values are discussed against the humans from POV, the terrestrial fauna from MRP, and the reconstructed baseline dietary faunal scheme provided by Bourbou et al. (2011) and the fish values provided by Vika and Theodoropoulou (2012), acknowledging the limitations of such a comparison (Figure 7). The lower NKS values overlap with the higher values of the MRP faunal assemblage, displaying a trophic level difference of 1.2‰. This number falls within the expected trophic level range of 2-6‰ (Schoeninger and DeNiro 1984) but it is almost twice lower than the respective from POV. Plotted NKS values against the Bourbou et al. (2011) faunal isotope scheme and the Vika and Theodoropoulou (2012) fish values show the same pattern as the one observed for the POV assemblage (Figure 7).

Animal Feeding and Management Practices: Faunal Isotopic Variation by Site and Trophic Level

Two samples in the MRP faunal assemblage, a rabbit (MVA_12) with a value of −21.0‰, and a cow (MDS_3) with a value of −16.8‰, stand outside two standard deviations from the mean and are herein treated as outliers (Table 5, Figure 8). When plotted, four additional outliers become visible: a deer (MKR_2, −17.7‰), and three sheep/goats (MAM_4, −17.2‰, MAM_1, −18.0‰, and MKR_7, −18.2‰) (Table 5, Figure 8). No outliers were found for the δ^{15}N values.

Herbivores (domestic and wild) exhibit a wider range and dispersion in δ^{13}C and δ^{15}N values compared to omnivores (Table 7, Figure 8). However, their mean values and associated 95% CI indicate overlapping values for the two trophic levels (Table 7, Figure 9(a,b)).

Among MRP herbivores, the cattle and sheep/goats, partly due to their larger number, display the widest range and dispersion (Table 7, Figure 8). Within the omnivore category, pig values overlap with the higher values of some of the herbivores (two cattle, two sheep/goats, and all horses/donkeys), while dog values cover a broader range with the lower ones overlapping

Table 1. $\delta^{13}C$ and $\delta^{15}N$ values of humans from Pontokomi-Vrysi. (Key: POV_GrX = Pontokomi-Vrysi_GraveX; M = male; F = female; I = indeterminate; NA = nonadult; YA = young adult; MA = middle-aged adult; OA = old adult; A = adult; adol. = adolescent).

CIO Database Entry	Sample ID	Sex	Age	Bone element	Collagen Yield %	C%	N%	C:N	$\delta^{13}C$ (±0.15)	$\delta^{15}N$ (±0.30)
73859	POV_Gr4	M	YA	femur	3.7	43.5	16.0	3.17	−19.2	8.8
73860	POV_Gr5	NA	adol.	hand phalanx	8.2	47.9	16.0	3.48	−18.9	9.2
73862	POV_Gr8	F	YA	hand phalanx	8.4	45.2	16.6	3.18	−18.4	10.3
73864	POV_Gr11a	F	MA	femur	10.1	43.2	15.6	3.23	−19.0	10.3
73865	POV_Gr11b	M	OA	femur	6.7	43.3	15.2	3.33	−18.9	9.4
73867	POV_Gr13	F	A	femur	4.9	47.3	15.8	3.50	−19.0	9.1
73869	POV_Gr15a	F	YA	femur	4.5	41.9	15.5	3.16	−18.8	9.9
73872	POV_Gr19a	M	MA	femur	4.9	41.2	15.2	3.17	−18.6	8.9
73873	POV_Gr19b	NA	adol.	hand phalanx	3.6	40.8	15.0	3.17	−19.2	9.8
73874	POV_Gr20	M	YA	hand phalanx	5.9	37.8	14.0	3.16	−19.3	9.4
73878	POV_Gr26	M	YA	femur	5	29.3	10.9	3.14	−19.3	9.2
73882	POV_Gr30	F	MA	femur	10.2	39.5	14.3	3.22	−18.7	9.4
73884	POV_Gr34	F	YA	femur	3.7	33.3	12.2	3.18	−19.6	9.2
73887	POV_Gr38a	M	MA	femur	5.2	31.7	11.8	3.12	−19.4	8.8
73888	POV_Gr38b	M	OA	femur	5.7	40.1	14.7	3.19	−19.0	9.2
73891	POV_Gr43	M	OA	femur	6	38.8	14.2	3.20	−18.8	10.3
73893	POV_Gr45	F	MA	femur	9.7	42.4	14.7	3.37	−18.5	9.2
73894	POV_Gr46	F	MA	hand phalanx	6.8	38.0	14.0	3.16	−19.0	9.8
73895	POV_Gr47	M	A	femur	17.7	37.2	13.6	3.19	−18.8	9.9
73986	POV_Gr48a	F	MA	femur	6.5	39.5	14.5	3.18	−19.0	8.7
73898	POV_Gr49	M	OA	femur	10.6	36.1	13.4	3.15	−18.9	9.6
73901	POV_Gr52	NA	adol.	femur	8.3	37.9	13.9	3.17	−18.6	8.9
73902	POV_Gr53	NA	adol.	femur	6.1	392	13.8	3.32	−19.0	10.2
73904	POV_Gr55	M	YA	femur	7.2	38.4	14.2	3.16	−19.0	9.3
73906	POV_Gr57	F	A	femur	5.7	35.4	13.2	3.14	−19.3	9.5
73909	POV_Gr59	I	MA	tibia	3.1	38.4	14.2	3.15	−18.9	9.3
73911	POV_Gr61	M	A	femur	19.7	36.7	13.5	3.18	−18.7	9.8
73912	POV_Gr63	M	A	humerus	4.4	41.4	14.5	3.33	−18.3	10.2
73913	POV_Gr64a	F	OA	femur	6.9	42.3	15.4	3.19	−18.1	9.2
73915	POV_Gr65	M	MA	femur	3.7	32.1	11.8	3.18	−17.7	9.3
73916	POV_Gr66	I	A	femur	4.3	41.2	15.0	3.20	−18.3	8.3
73917	POV_Gr67	F	YA	femur	10.2	40.6	14.7	3.21	−18.4	8.9
73919	POV_Gr69	F	MA	femur	5.1	39.7	14.6	3.18	−18.5	9.7
73920	POV_Gr70	F	YA	femur	10.7	35.7	12.8	3.25	−19.1	9.2
73922	POV_Gr72	F	YA	femur	7.1	41.5	15.1	3.22	−19.2	7.1
73924	POV_Gr74	F	MA	femur	7.3	38.5	14.2	3.20	−18.2	8.9
73925	POV_Gr75	F	YA	hand phalanx	4.1	38.1	14.1	3.15	−18.6	9.4
73926	POV_Gr76	F	YA	femur	3.4	29.9	11.2	3.13	−19.5	9.1
73927	POV_Gr77	F	OA	femur	9.4	38.5	14.2	3.16	−18.6	9.0
73929	POV_Gr80	F	OA	femur	3.4	39.5	14.3	3.22	−18.8	9.4
73930	POV_Gr82	M	OA	femur	4.5	39.3	14.4	3.19	−18.5	9.8
73933	POV_Gr86	M	MA	femur	4.3	38.9	14.2	3.19	−18.5	9.4
73934	POV_Gr87	F	OA	femur	4.5	34.7	12.8	3.16	−18.8	9.7
73936	POV_Gr88b	NA	adol.	femur	3.7	40.8	15.0	3.17	−18.9	9.1
73938	POV_Gr91	M	MA	femur	3.5	41.3	15.2	3.17	−18.7	8.9
73940	POV_Gr93	NA	adol.	femur	3.3	39.2	14.6	3.13	−19.0	8.9
73942	POV_Gr95	F	YA	femur	6.4	39.4	14.6	3.15	−18.8	10.0
73943	POV_Gr96	F	A	hand phalanx	4.7	41.6	15.3	3.17	−18.5	9.2
73944	POV_Gr97	M	MA	femur	3.7	38.8	14.3	3.16	−19.1	9.7
73945	POV_Gr98	M	MA	femur	13.2	39.0	14.4	3.16	−18.6	9.8
73946	POV_Gr99	M	MA	femur	3.5	41.5	15.2	3.18	−18.6	9.2
73949	POV_Gr102	F	OA	femur	3.3	35.1	13.5	3.04	−20.0	9.2
73951	POV_Gr105	M	MA	femur	3.7	39.1	14.4	3.17	−19.1	8.8
73953	POV_Gr107	M	OA	femur	4.3	37.8	13.8	3.19	−18.8	9.6
73954	POV_Gr108	F	OA	femur	21.4	40.7	15.0	3.17	−18.4	10.1
74955	POV_Gr109	M	YA	femur	11.0	38.2	14.1	3.16	−19.0	9.5
73956	POV_Gr111	M	YA	femur	3.4	37.9	14.1	3.13	−19.4	8.7
73958	POV_Gr113	NA	adol.	femur	7.5	42.8	15.0	3.32	−18.8	9.8
73959	POV_Gr114	F	YA	femur	4.4	37.9	14.1	3.14	−19.5	9.1

with the middle faunal values and the higher ones reaching the lower values of the human range (Table 7, Figure 8). Parametric tests showed no difference in the $\delta^{13}C$ and $\delta^{15}N$ values among different animals of the same trophic level (p-value always > 0.05, Table 8), as also attested by plots of the mean values and associated 95% CIs (Figure 9(a,b)).

Inter-site comparisons could only be made between the MRP and the CRN faunal assemblages. A t-test identified differences between the $\delta^{13}C$ values of the total samples (Table 8). When the dispersion of the values along with their mean and associated CI are taken into consideration, the following patterns between the three faunal assemblages emerge: lower $\delta^{13}C$ and $\delta^{15}N$ mean values for the CRN samples, roughly similar $\delta^{13}C$ range for all assemblages, and much greater dispersal and range of $\delta^{15}N$ values for CRN than in the other assemblages (Table 7, Figures 10 and 11(a,b)).

Divided by trophic level, both the MRP herbivores and omnivores exhibit overall higher $\delta^{13}C$ and $\delta^{15}N$ values compared to CRN, a pattern more pronounced

Table 2. δ^{13}C and δ^{15}N values of humans from Nea Kerdylia-Strovolos. (Key: NKS*X* = Nea Kerdylia-Strovolos (*X* = Grave number); M = male; PM = probably male; F = female; PF = probably female; I = indeterminate; YA = young adult; MA = middle-aged adult; OA = old adult; A = adult).

CIO Database Entry	Sample ID	Sex	Age	Bone element	Collagen Yield %	%C	%N	C:N	δ^{13}C (±0.15)	δ^{15}N (±0.30)
78890	NKS45	I	A	femur	10.0	33.2	12.3	3.15	−19.7	8.5
78922	NKS46a	M	YA/MA	femur	14.1	36.7	13.6	3.16	−19.5	8.7
78883	NKS47a	I	A	femur	11.6	35.0	12.8	3.19	−19.3	8.2
78884	NKS47b	I	A	femur	4.6	41.2	15.1	3.18	−19.1	9.7
78895	NKS48	F	MA	femur	7.1	40.9	14.7	3.24	−19.8	8.4
78940	NKS56a	M	MA	femur	15.7	22.0	8.2	3.13	−19.2	8.9
78923	NKS56b	PF	YA	femur	13.1	35.0	13.0	3.15	−19.4	8.1
78881	NKS59	F	MA	femur	125.2	35.1	12.9	3.18	−19.7	8.0
78913	NKS60a	M	YA/MA	femur	7.6	26.2	9.7	3.16	−19.5	8.7
78926	NKS62	I	A	femur	17.5	35.6	13.0	3.19	−19.3	7.7
78917	NKS63	F	MA/OA	femur	6.3	33.9	12.5	3.16	−19.6	7.9
78903	NKS69	M	YA	femur	3.0	41.0	14.9	3.21	−19.6	8.5
78906	NKS70	PF	A	femur	7.1	36.2	13.1	3.23	−19.4	8.6
78924	NKS76a	PF	YA	femur	11.2	37.0	13.5	3.19	−19.0	8.5
78925	NKS78b	I	A	femur	14.3	41.0	15.0	3.19	−19.5	8.6
78927	NKS79a	M	MA	femur	19.7	37.4	13.7	3.18	−19.5	8.1
78931	NKS91a	F	YA	hand phalanx	15.1	38.2	14.1	3.16	−19.8	8.1
78915	NKS93	F	YA/MA	hand phalanx	12.7	41.3	15.0	3.20	−19.6	8.4
78896	NKS94a	F	YA/MA	hand phalanx	2.7	40.8	14.8	3.21	−19.8	8.7
78897	NKS94b	PF	A	femur	3.1	24.7	9.0	3.19	−19.7	8.9
78934	NKS98a	PM	MA/OA	femur	17.8	33.4	12.4	3.14	−19.5	9.4
78886	NKS101a	PM	YA	femur	20.9	34.1	12.5	3.19	−19.6	8.2
78887	NKS101b	M	YA	femur	13.7	30.8	11.4	3.15	−19.8	8.0
78916	NKS102	M	MA	femur	8.0	31.5	11.6	3.17	−19.4	8.3
78938	NKS103	I	A	femur	9.1	36.6	13.3	3.21	−19.1	8.9
78910	NKS114a	M	YA/MA	femur	17.6	35.8	13.2	3.17	−19.3	7.8
78911	NKS114b	PM	MA	femur	7.2	35.1	12.9	3.17	−19.4	8.3
78904	NKS118	F	YA/MA	femur	16.8	36.9	13.5	3.18	−19.4	7.6
78907	NKS120	F	YA	femur	15.7	36.7	13.4	3.19	−19.4	9.3
78899	NKS135	F	YA/MA	femur	17.8	32.6	11.9	3.20	−19.7	8.3
78879	NKS137	PF	MA/OA	hand phalanx	16.9	38.1	14.0	3.17	−19.8	8.8
78888	NKS139a	PM	A	femur	4.1	39.9	14.4	3.23	−19.4	9.2
78889	NKS139b	PF	A	femur	5.8	41.1	15.0	3.19	−19.3	9.1
78939	NKS142	I	A	femur	4.4	34.5	12.7	3.18	−19.2	8.4
78900	NKS144	F	MA	femur	11.6	33.5	12.2	3.21	−19.4	9.1
78912	NKS151a	F	YA	femur	16.0	36.7	13.6	3.16	−19.6	8.4
78919	NKS152a	PM	A	femur	8.0	28.1	10.3	3.19	−19.3	8.5
78920	NKS152b	I	A	femur	12.5	20.4	7.4	3.20	−19.5	8.6
78876	NKS155a	M	MA	femur	14.7	35.9	13.2	3.17	−19.3	8.3
78941	NKS155b	PM	A	femur	0.6	40.9	15.0	3.17	−19.3	8.2
78878	NKS156	I	A	femur	9.2	39.2	14.2	3.22	−19.1	8.0
78914	NKS157	F	YA	femur	13.9	35.5	13.0	3.18	−19.3	7.4
78918	NKS160	F	MA	femur	15.2	37.1	13.5	3.21	−19.0	9.8
78892	NKS162a	M	MA/OA	femur	9.8	29.4	10.8	3.18	−19.0	8.8
78891	NKS162b	PM	YA/MA	hand phalanx	8.8	41.1	15.2	3.16	−19.1	9.2
78942	NKS164	PF	A	femur	12.8	33.4	12.3	3.18	−19.7	7.9
78943	NKS165	PM	A	femur	8.4	34.4	12.5	3.21	−19.3	8.9
78944	NKS166b	F	YA	hand phalanx	7.0	41.0	14.9	3.22	−19.5	7.4
78933	NKS169	PF	A	femur	8.2	24.1	8.9	3.15	−19.7	7.9
78893	NKS172	I	A	femur	6.7	40.0	14.4	3.23	−19.3	8.7
78905	NKS173	M	MA	femur	17.4	36.5	13.3	3.19	−19.6	8.5
78901	NKS182a	M	MA	femur	8.5	31.5	11.6	3.17	−19.4	7.5
78928	NKS184	PF	A	femur	1.2	39.1	14.4	3.18	−19.2	8.2
78898	NKS185	F	A	femur	10.9	13.8	5.1	3.18	−19.3	9.0
78946	NKS198	M	MA	femur	24.7	36.6	13.3	3.21	−19.5	8.3
78902	NKS211	F	YA/MA	femur	13.2	36.3	13.2	3.22	−19.4	9.0

for δ^{15}N (Tables 5–7, Figure 11(a,b)). Additional interesting patterns observed on the scatter plot of the values (Figure 10) are as follows: (a) excluding the two outliers (cow: δ^{13}C, −17.9‰ and pig: δ^{15}N, 0.8‰, Table 5), a two-group clustering within the herbivores of CRN distinguishing between cattle and pigs, on the one hand, and sheep/goats, on the other; (b) a remarkable distribution of δ^{15}N values for the omnivores of CRN; and finally, (c) similar dog δ^{13}C values among all three assemblages. Parametric tests showed differences in the δ^{13}C and δ^{15}N values between the MRP and CRN herbivores, between the CRN herbivores and omnivores, and between the CRN omnivore dogs and pigs (Table 8).

Discussion

Diet in the Pontokomi-Vrysi (POV) Community

The δ^{13}C and δ^{15}N values of the POV assemblage show that the same dietary profile characterised the whole community, irrespective of age and sex. Adult individuals display a greater range of isotopic values compared to adolescents, potentially suggesting a

Table 3. Summary of δ^{13}C and δ^{15}N mean and range values of the human assemblages mentioned in the paper.

	Site	Sex and/or Age Group	Range	Mean & S.D.
δ^{13}C values	POV	total sample	2.3‰ (−20.0‰ to −17.7‰)	−18.8 ± 0.4‰
		males	1.8‰ (−19.4‰ to −17.7‰)	−18.8 ± 0.4‰
		females	1.9‰ (−20.0‰ to −18.1‰)	−18.9 ± 0.5‰
		adults	2.3‰ (−20.0‰ to −17.7‰)	−18.8 ± 0.4‰
		nonadults	0.6‰ (−19.2‰ to −18.6‰)	−18.9 ± 0.2‰
	NKS	total sample	0.8‰ (−19.8‰ to −19.0‰)	−19.4 ± 0.2‰
		males	0.8‰ (−19.8‰ to −19.0‰)	−19.4 ± 0.2‰
		females	0.8‰ (−19.8‰ to −19.0‰)	−19.5 ± 0.2‰
δ^{15}N values	POV	total sample	3.2‰ (7.1‰ to 10.3‰)	9.3 ± 0.5‰
		males	1.6‰ (8.7‰ to 10.3‰)	9.4 ± 0.4‰
		females	3.1‰ (7.1‰ to 10.3‰)	9.3 ± 0.6‰
		adults	2.3‰ (7.2‰ to 10.3‰)	9.3 ± 0.6‰
		nonadults	1.3‰ (8.9‰ to 10.2‰)	9.4 ± 0.5‰
	NKS	total sample	2.4‰ (7.4‰ to 9.8‰)	8.5 ± 0.5‰
		males	2.0‰ (7.5‰ to 9.4‰)	8.5 ± 0.5‰
		females	2.0‰ (7.4‰ to 9.8‰)	8.4 ± 0.6‰

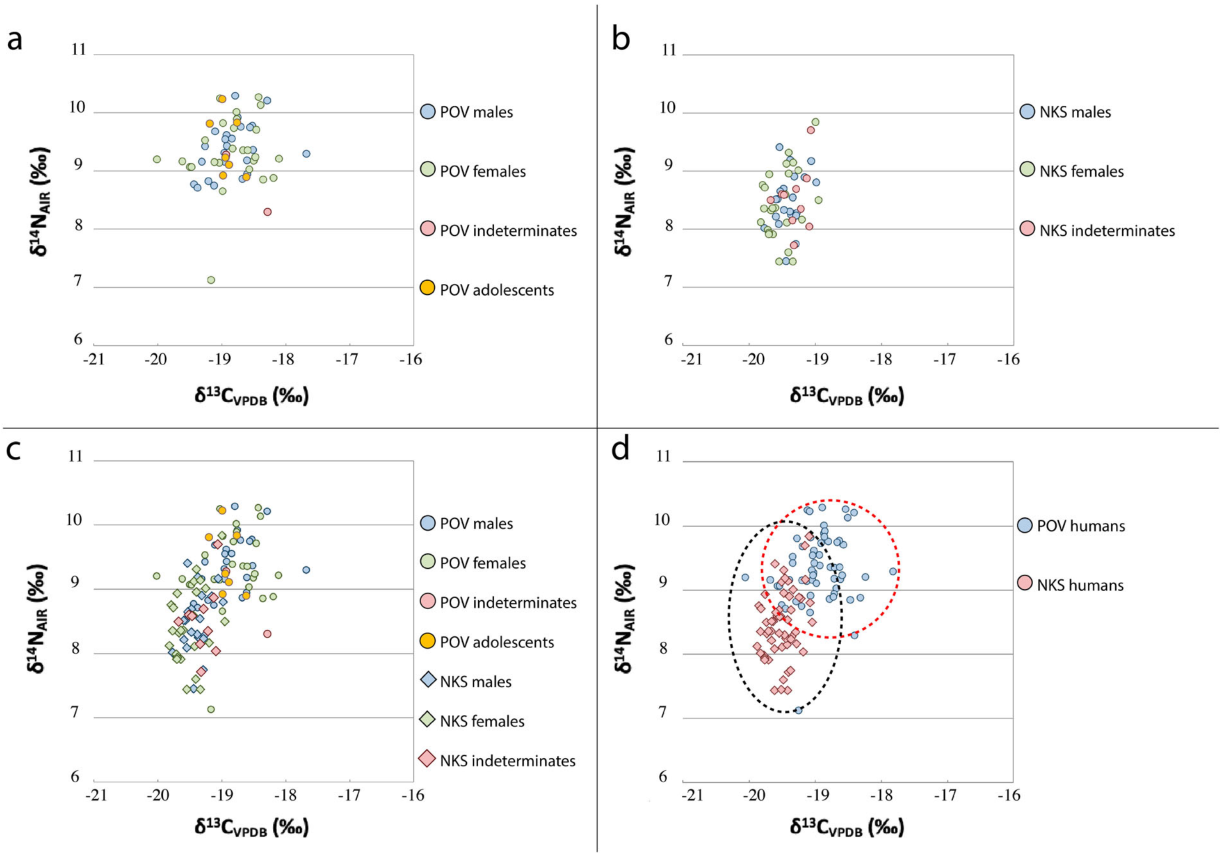

Figure 2. δ^{13}C and δ^{15}N values of human samples from POV and NKS: (a) POV samples identified by sex and age; (b) NKS samples identified by sex; (c) all samples identified by site, sex, and age; (b) all samples grouped by site.

more varied diet with increasing age, a result also found in the study of Dotsika and Michael (2018) between the adults and juveniles of the Roman city of Edessa. Given the small sample size for the POV adolescents, however, this is a tentative comparison and more research is needed before definitive conclusions can be made concerning the region's character of adult – juvenile dietary consumption patterns. The δ^{13}C and δ^{15}N values also show that both the POV humans and the MRP animals residing in this region had primarily C_3 plant-based diets (composed of either non-leguminous or leguminous plant foods) (Richards and van Klinken 1997; Schoeninger and DeNiro 1984). It is, also, evident that the POV human collagen has slightly higher δ^{13}C values compared to the MRP fauna, suggesting that both humans and terrestrial animals obtained a significant amount of their dietary protein from plant resources. Although the higher δ^{15}N values of POV humans (compared to MRP animals) suggests the consumption of animal sources (such as meat or by-products including eggs, and milk), high δ^{15}N values could equally be the result

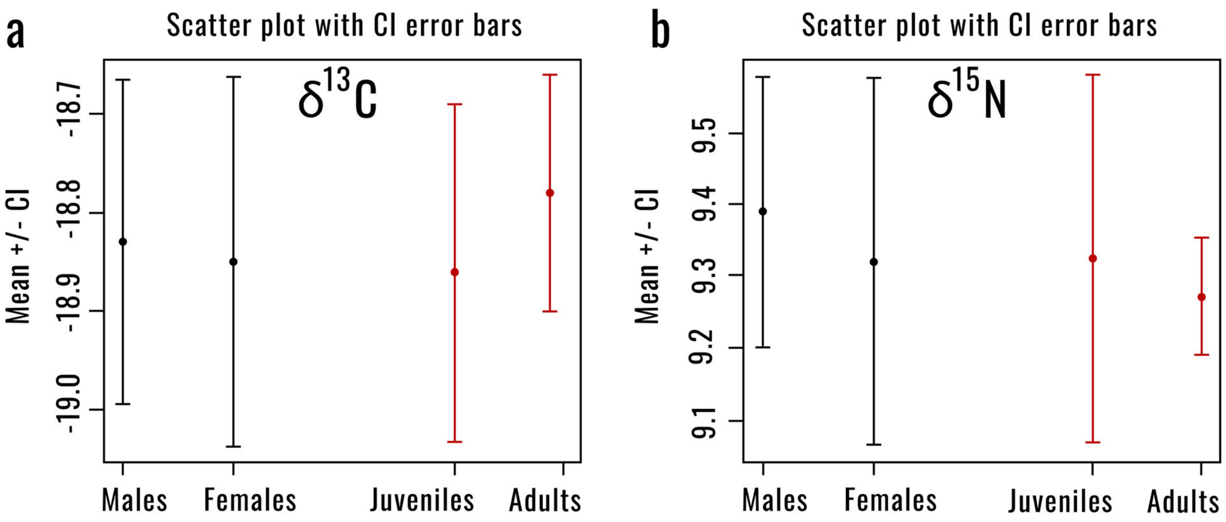

Figure 3. (a) POV δ^{13}C values by sex (in black) and POV δ^{13}C values by age (in red); (b) POV δ^{15}N values by sex (in black) and POV δ^{15}N values by age (in red).

Table 4. Intra- and inter-site statistically significant differences by total population and sex (key: POV = Pontokomi-Vrysi; NKS = Nea Kerdylia-Strovolos).

Comparison between		Element	*p*-value
POV	males vs females	δ^{13}C	n.s.
		δ^{15}N	n.s.
	adults vs nonadults	δ^{13}C	n.s.
		δ^{15}N	n.s.
NKS	males vs females	δ^{13}C	n.s.
		δ^{15}N	n.s.
POV vs NKS	total population	δ^{13}C	Mann-Whitney U = 309; *p*-value < 0.0001
		δ^{15}N	Mann-Whitney U = 379.5; *p*-value < 0.0001
	males	δ^{13}C	t = 5.637; *p*-value < 0.0001
		δ^{15}N	t = 7.056; *p*-value < 0.0001
	females	δ^{13}C	t = 6.551; *p*-value < 0.0001
		δ^{15}N	Mann-Whitney U = 80.5; *p*-value < 0.0001

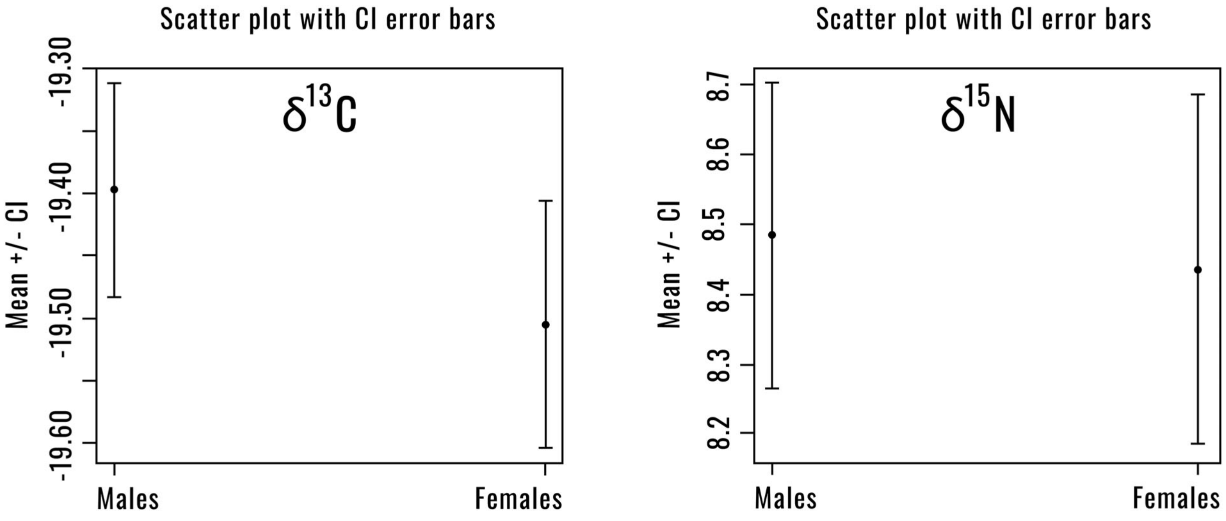

Figure 4. NKS males vs. females (left: δ^{13}C; right: δ^{15}N).

of consumption of manured crops (such as cereal crops) (Bogaard et al. 2007; Szpak et al. 2014).

Assessing the micro-ecology of the region brings further nuance to the dietary profile of the studied individuals from POV. In Western (ancient Upper Macedonia) and South-Western Macedonia, the semi-mountainous environment and the climatic conditions have favoured agro-pastoral activities including cereal cultivation (Tsotsos 2011) and pastoralism (non-nomadic or transhumant) (Chang and Tourtellote 1993; Ntassiou and Doukas 2019; Wace and Thompson 1914). The data obtained in this study is

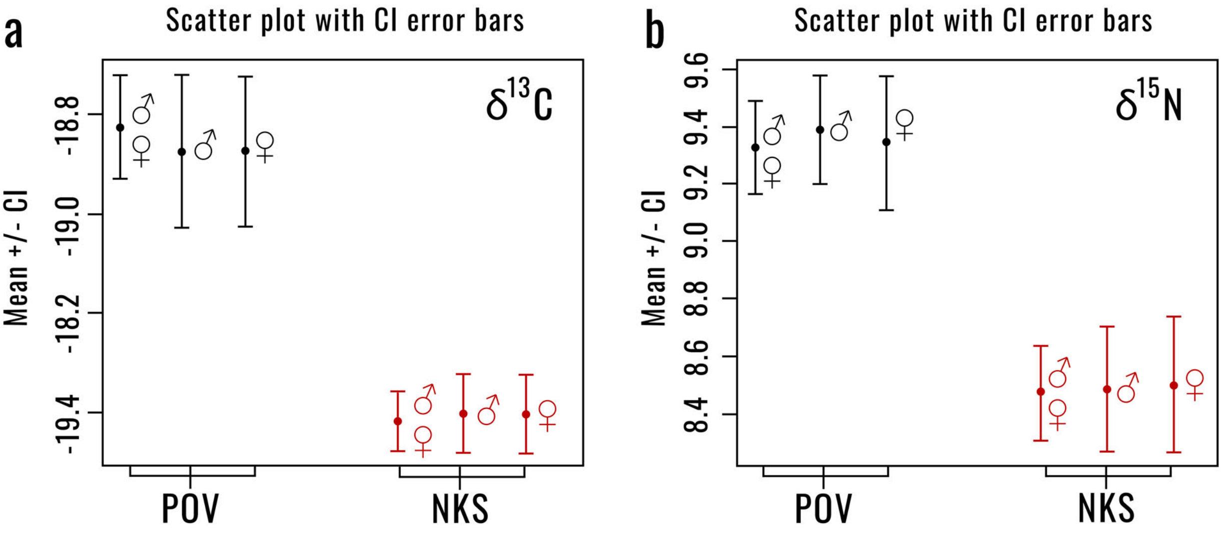

Figure 5. (a) POV (in black) vs. NKS (in red) δ^{13}C values by total sample and sex; (b) POV (in black) vs. NKS (in red) δ^{15}N values by total sample and sex.

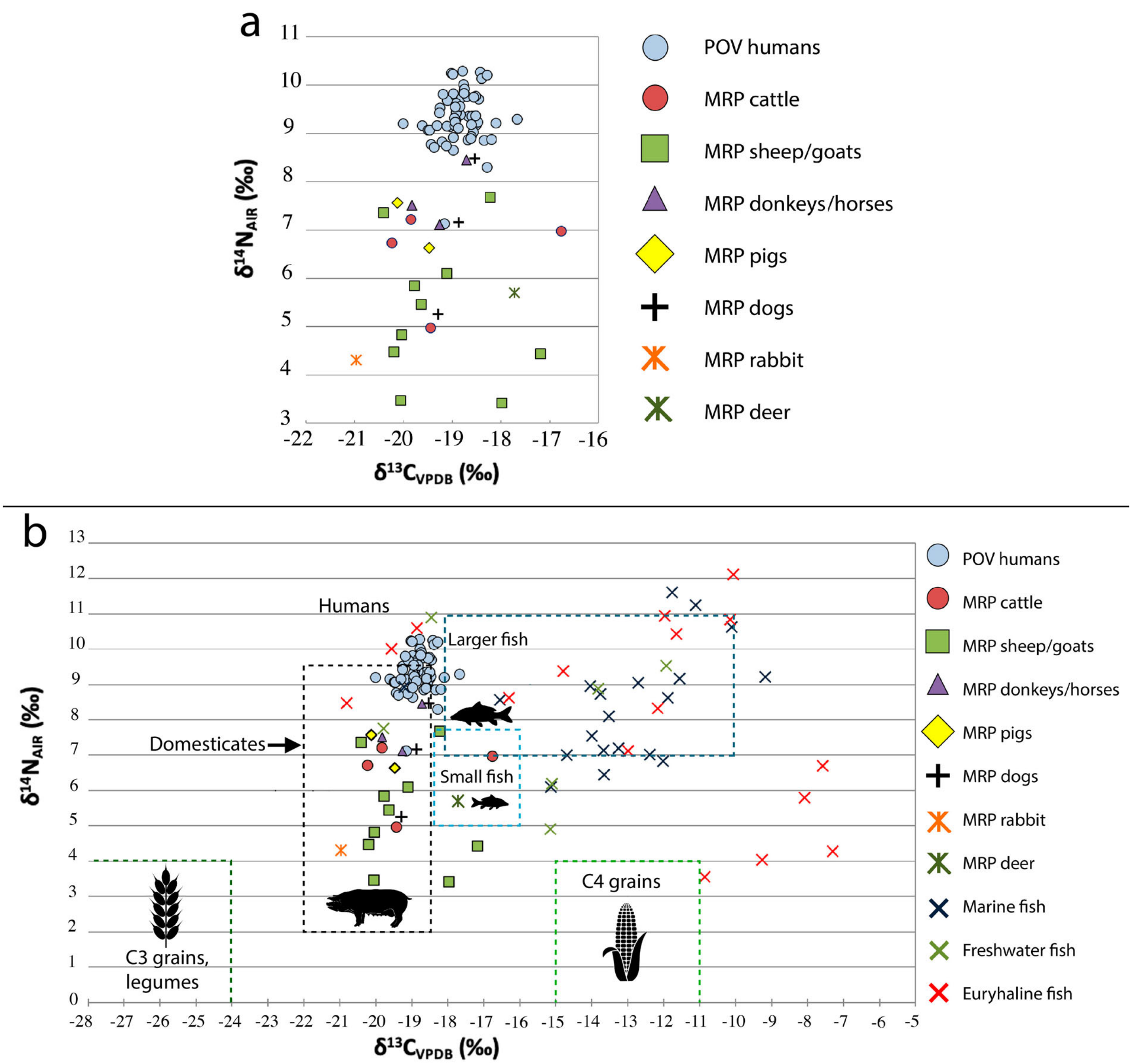

Figure 6. δ^{13}C and δ^{15}N values of human samples from POV plotted against (a) the faunal samples from MRP and (b) the faunal samples from MRP and the reconstructed baseline faunal dietary scheme provided by Bourbou et al. (2011) (within dashed black rectangles) and fish values provided by Vika and Theodoropoulou (2012).

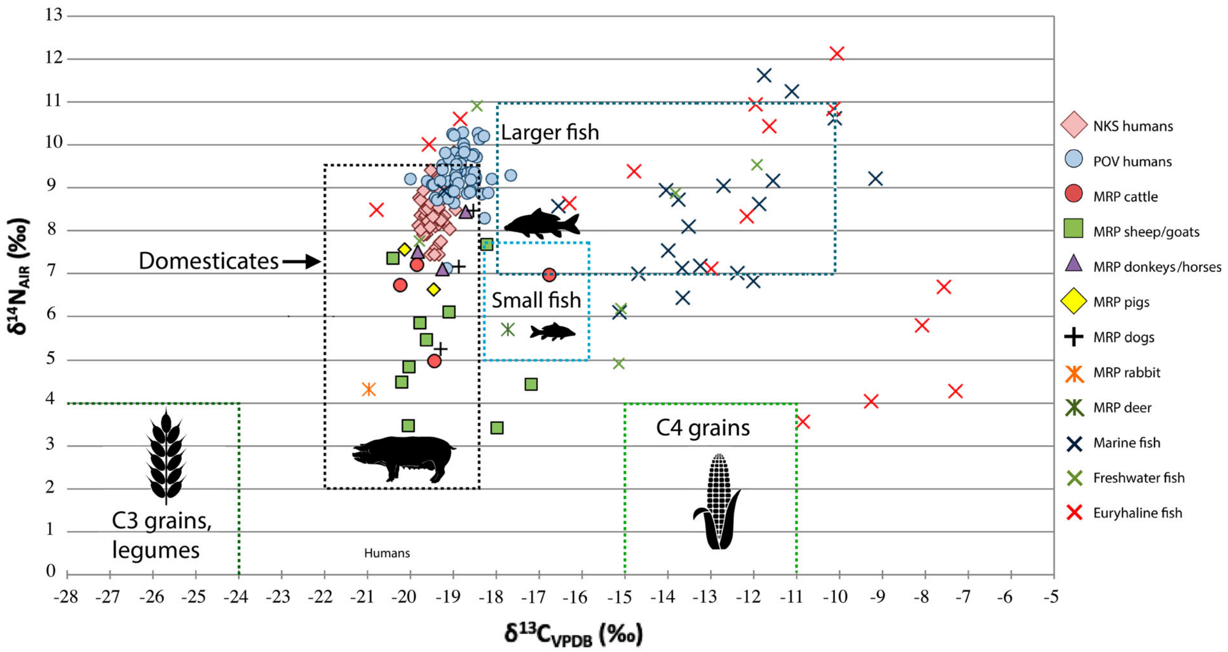

Figure 7. δ^{13}C and δ^{15}N values of human samples from NKS plotted against the human samples from POV, the faunal samples from MRP and the reconstructed baseline faunal dietary scheme provided by Bourbou et al. (2011) (within dashed black rectangles) and fish values provided by Vika and Theodoropoulou (2012).

Table 5. Faunal δ^{13}C and δ^{15}N values measured in this study. (Key: MVA = Mavropigi Varkaris site; MDS = Mavropigi Dasos site; MAM = Mavropigi Ampelotopos site; MKR = Mavropigi Kouri site).

CIO Database Entry	Sample ID	Species	Trophic level	Bone element	Collagen Yield %	%C	%N	C:N	δ^{13}C (±0.15)	δ^{15}N (±0.30)
73960	MVA_1	pig	omnivore	3rd metacarpal	6.8	40.3	14.5	3.24	−19.5	6.6
73961	MVA_2	goat	herbivore	tibia	22.2	40.0	14.5	3.22	−20.1	3.5
73962	MVA_3	cow	herbivore	humerus	10.5	31.8	11.5	3.21	−19.8	7.2
73963	MVA_4	dog	omnivore	radius	6.8	39.0	14.2	3.21	−19.3	5.3
73964	MVA_5	cow	herbivore	metatarsal	5.8	33.0	12.0	3.21	−20.2	6.7
73965	MVA_6	sheep/ goat	herbivore	radius	8.7	39.5	14.4	3.20	−19.6	5.5
73966	MVA_7	sheep	herbivore	tibia	6.6	30.7	11.0	3.24	−19.8	5.9
73967	MVA_8	dog	omnivore	tibia	9.3	40.6	14.9	3.19	−18.5	8.5
73968	MVA_9	sheep/ goat	herbivore	radius	9.8	31.0	11.0	3.29	−20.4	7.4
73969	MVA_10	horse	herbivore	radius	2.9	31.4	11.5	3.19	−18.7	8.5
73970	MVA_11	horse	herbivore	metacarpal	15.5	33.5	12.3	3.18	−19.8	7.5
73971	MVA_12	rabbit	herbivore	radius	96	39.6	14.2	3.25	−21.0	4.3
73972	MVA_13	horse	herbivore	long bone	13.9	34.6	12.5	3.24	−19.3	7.1
73973	MDS_1	sheep/ goat	herbivore	radius/ulna	11.4	34.1	12.6	3.16	−20.2	4.5
73975	MDS_3	cow	herbivore	metacarpal	7.5	19.7	7.4	3.10	−16.8	7.0
73976	MAM_1	sheep/ goat	herbivore	metatarsal	4.8	39.4	14.3	3.22	−18.0	3.4
73979	MAM_4	goat	herbivore	tibia	9.6	31.7	11.6	3.17	−17.2	4.4
73980	MAM_5	dog	omnivore	5th metacarpal	2.8	40.4	14.7	3.21	−18.9	7.2
73981	MKR_1	pig	omnivore	radius	13.1	33.4	12.1	3.23	−20.1	7.6
73982	MKR_2	deer	herbivore	1st foot (?) phalanx	1.4	38.3	14.0	3.20	−17.7	5.7
73984	MKR_4	sheep/ goat	herbivore	ulna	3.3	36.7	13.3	3.23	−20.0	4.8
73985	MKR_5	cow	herbivore	1st phalanx	1.7	39.5	14.4	3.20	−19.4	5.0
73987	MKR_7	sheep/ goat	herbivore	long bone	16.2	39.0	14.1	3.22	−18.2	7.7
73988	MKR_8	sheep/ goat	herbivore	long bone	2.7	40.1	14.6	3.21	−19.1	6.1

Disclaimer: Pigs are opportunistic feeders displaying a broad ecological niche within the anthropic system (Halstead and Isaakidou 2011)-. For this reason, assigning them to the omnivore trophic category is particularly controversial. In this study, their characterisation as omnivores was based on their obtained isotopic values.

consistent with the suggestion that such a mixed farming agro-pastoral system formed the basis of the local economy. The wide variability in the δ^{13}C values of the cows, sheep, and goats may be the result of grazing across large areas that exhibit subtle plant isotopic variability. Although small in number, horses/

Table 6. Comparative faunal δ^{13}C and δ^{15}N values from SRT (from Bourbou et al. 2011) and CRN (from McConnan Borstad, Garvie-Lok, and Katsonopoulou 2018) used in this study to help interpret the measured individuals.

Site	Date	Species	Collagen yield%	%C	%N	C:N	δ^{13}C	δ^{15}N
SRT	6th-7th c. AD	dog	2.8	34.9	12.2	3.3	−18.7	8.4
SRT	6th-7th c. AD	goat	9.1	40.0	14.6	3.2	−20.7	2.6
CRN	Roman	sheep/goat	–	–	–	–	−19.9	3.0
CRN	Roman	sheep/goat	–	–	–	–	−19.6	3.1
CRN	Roman	sheep/goat	–	–	–	–	−20.0	3.1
CRN	Roman	sheep/goat	–	–	–	–	−20.2	3.8
CRN	Roman	sheep/goat	–	–	–	–	−20.3	4.6
CRN	Roman	cow	–	–	–	–	−21.5	3.6
CRN	Roman	cow	–	–	–	–	−21.4	4.1
CRN	Roman	cow	–	–	–	–	−21.5	2.7
CRN	Roman	cow	–	–	–	–	−17.9	5.3
CRN	Roman	dog	–	–	–	–	−19.2	8.5
CRN	Roman	dog	–	–	–	–	−19.5	10.3
CRN	Roman	dog	–	–	–	–	−19.6	8.8
CRN	Roman	dog	–	–	–	–	−18.9	8.4
CRN	Roman	pig	–	–	–	–	−21.6	4.6
CRN	Roman	pig	–	–	–	–	−21.6	6.1
CRN	Roman	pig	–	–	–	–	−20.7	0.8
CRN	Roman	pig	–	–	–	–	−21.4	3.2

Table 7. Summary of measured δ^{13}C and δ^{15}N values of faunal samples from MRP compared to published δ^{13}C and δ^{15}N values of faunal samples from SRT (from Bourbou et al. 2011) and CRN (from McConnan Borstad, Garvie-Lok, and Katsonopoulou 2018).

	Site	Trophic level	Range	Mean
δ^{13}C values	MRP	all samples	4.2‰ (−21.0‰ to −16.8‰)	−19.2 ± 1.1‰
		herbivores	4.2‰ (−21.0‰ to −16.8‰)	−19.2 ± 1.2‰
		omnivores	1.6‰ (−20.1‰ to −18.5‰)	−19.3 ± 0.6‰
	SRT	all samples	2.0‰ (−20.7‰ to −18.7‰)	−19.7 ± 1.4‰
		herbivores	−20.7‰ ($n = 1$)	
		omnivores	−18.7‰ ($n = 1$)	
	CRN	all samples	3.7‰ (−21.6‰ to −17.9‰)	−20.3 ± 1.1‰
		herbivores	3.6‰ (−21.5‰ to −17.9‰)	−20.3 ± 1.2‰
		omnivores	2.7‰ (−21.6‰ to −18.9‰)	−20.3 ± 1.1‰
δ^{15}N values	MRP	all samples	5.1‰ (3.4‰ to 8.5‰)	6.1 ± 1.5‰
		herbivores	5.1‰ (3.4‰ to 8.5‰)	5.9 ± 1.5‰
		omnivores	3.2‰ (5.3‰ to 8.5‰)	7.0 ± 1.2‰
	SRT	all samples	5.8‰ (2.6‰ to 8.4‰)	5.5 ± 4.1‰
		herbivore	2.6‰ ($n = 1$)	
		omnivore	8.4‰ ($n = 1$)	
	CRN	all samples	9.5‰ (0.8‰ to 10.3‰)	4.9 ± 2.6‰
		herbivores	2.6‰ (2.7‰ to 5.3‰)	3.7 ± 0.8‰
		omnivores	9.5‰ (0.8‰ to 10.3‰)	6.3 ± 3.3‰

Table 8. Fauna statistically significant differences between intra- and inter-site comparisons (Key: n.s. = not significant).

Comparison between		Element	p-value < 0,05
MRP	Herbivores (both domesticated and wild) vs omnivores	δ^{13}C and δ^{15}N	n.s.
	In between domesticated herbivore categories (cows, sheep/goats, and horses/donkeys)	δ^{13}C and δ^{15}N	n.s.
	In between omnivore categories (pigs and dogs)	δ^{13}C and δ^{15}N	n.s.
CRN	Herbivores vs omnivores	δ^{13}C	n.s.
		δ^{15}N	$t = 2.350$, p-value = 0.033
	In between herbivore categories	δ^{13}C	n.s.
		δ^{15}N	n.s.
	In between omnivore categories	δ^{13}C	t = 7.620, p-value = 0.0002
		δ^{15}N	t = 4.401, p-value = 0.005
MRP vs. CRN	Total sample	δ^{13}C	t = 2.133, p-value = 0.039
		δ^{15}N	n.s.
	Herbivores	δ^{13}C	t = 2.202, p-value = 0.037
	Herbivores	δ^{15}N	t = 4.076, p-value = 0.0003
	Omnivores	δ^{13}C and δ^{15}N	n.s.

donkeys, pigs, dogs, and perhaps some cattle seem to have enjoyed a more restricted diet, potentially kept as livestock close to the household. The overlap between horse and pig values supports similar feeding strategies for these animals. In contrast, for only one of the dogs, the consumption of animal protein can be fully supported; it might be the case that meat was considered too valuable to be shared.

Additional trends in the subsistence patterns of the POV people can be extracted when animal values from the broader region are taken into consideration. Dietary variation can be notably inferred from the animal

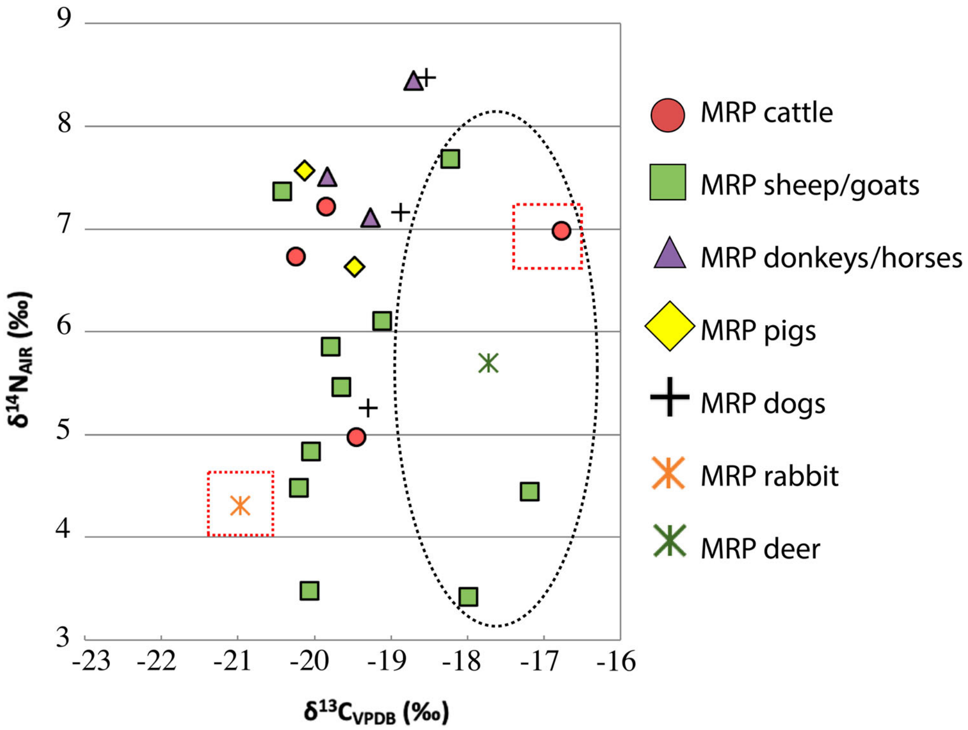

Figure 8. δ^{13}C and δ^{15}N values of faunal samples from MRP. Two standard deviation outliers are shown within red dashed rectangles. Outliers standing out in the plot shown within black circle.

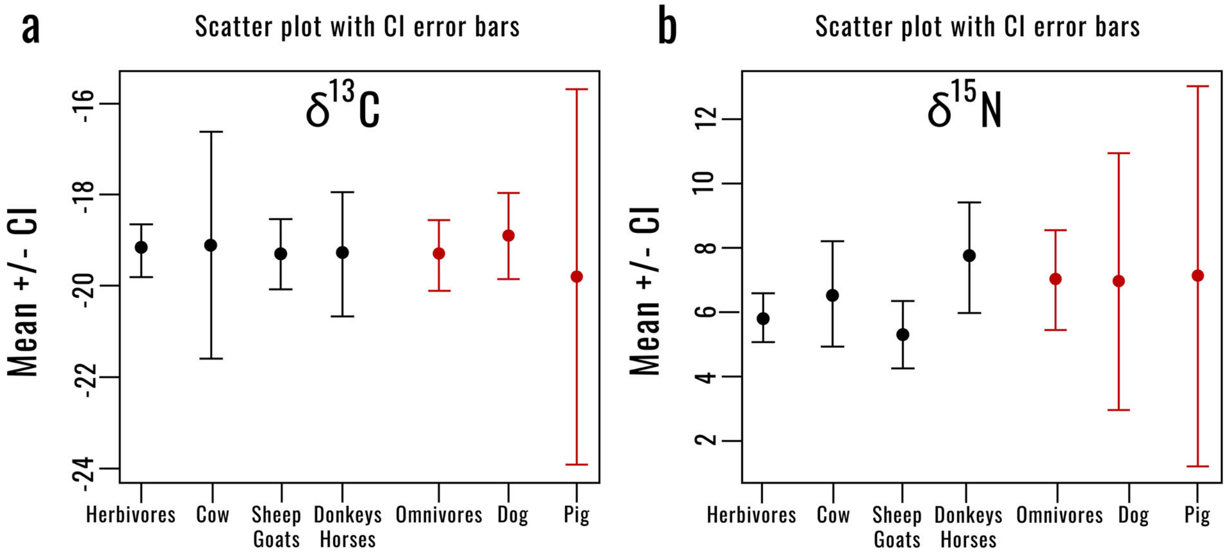

Figure 9. (a) MRP fauna δ^{13}C values by trophic level category and species; (b) MRP fauna δ^{15}N values by trophic level category and species (Herbivores in black; Omnivores in red).

outliers revealing a number of individual feeding behaviours most likely resulting either from varying physiological adaptations or from the existence of distinct ecologic niches in the region that the rest of the animals in the sample visited less frequently. For example, the wild rabbit's low δ^{13}C values suggest that browsing for this animal probably took place in a habitat where C_3 plants were growing in wetter soils (Wallace et al. 2013), and C_4 plants were either not preferred or did not grow. It may be the case, however, that the 'canopy effect' resulted in the δ^{13}C depletion for the plants consumed by this rabbit (Bonafini et al. 2013). However, since this is the only animal displaying δ^{13}C values lower than the rest of the faunal samples, this conclusion remains very tentative.

The slightly elevated δ^{13}C values of the rest of the outliers (1 cow, 1 deer, 3 sheep/goats) show that small quantities of C_4 plants were also consumed by some animals in addition to the primary C_3 plant input in their diet. Unfortunately, no studies have been conducted in Roman times animal assemblages from Greece to juxtapose this pattern and explain the 'preferential' consumption of C_3 plants by these animals. A number of zooarchaeological

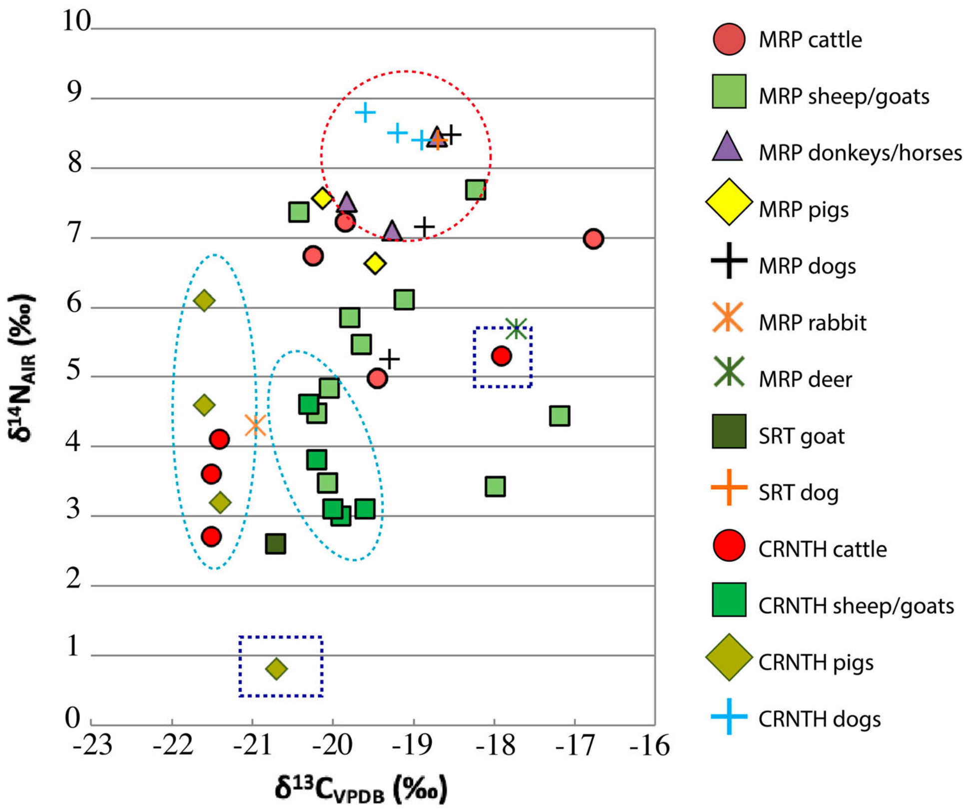

Figure 10. δ^{13}C and δ^{15}N values of faunal samples from MRP animals plotted against respective comparative animal values from SRT (Bourbou et al. 2011) and CRN (McConnan Borstad, Garvie-Lok, and Katsonopoulou 2018).

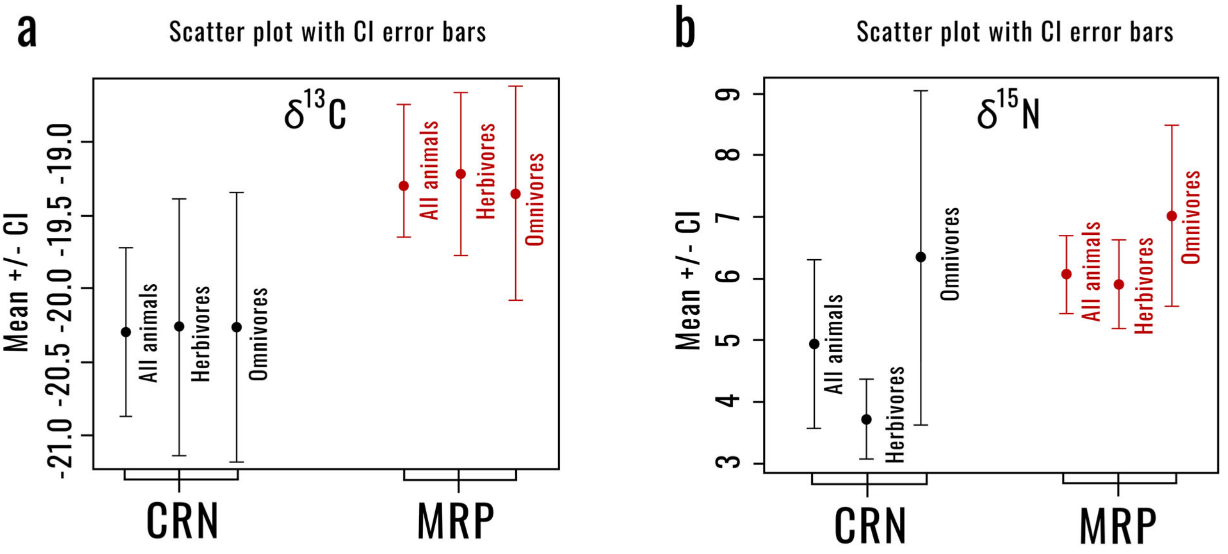

Figure 11. (a) CRN fauna vs. MRP fauna δ^{13}C values by total sample and trophic level category; (b) CRN fauna vs. MRP fauna δ^{15}N values by total sample and trophic level category (CRN in black; MRP in red).

studies, however, conducted in prehistoric northern Greece (Nitsch et al. 2017; Triantaphyllou 2015; Vaiglova et al. 2018) and Hellenistic Thessaly (Filioglou et al. forthcoming) confirm this pattern, showing that C_3 plants formed the prime component in the diet of each region's animals with only some individual cases consuming C_4 plants. The reason for this particular inclusion of C_4 plants in the diet of animals is still inconclusive. It has been supported that in the Classical period in the Mediterranean C_4 plants were used as fodder due to their lower nutritional and economic value, or as an emergency crop in times of crisis for both animals and humans (Garnsey 1989). For a region like Roman Upper Macedonia, which was severely afflicted by crises and war conflicts (Vanderspoel 2010), the use of millet would be an optimal subsistence strategy, though the time-limited contribution of C_4 plants as emergency crops in the diet of humans would be untraceable in the isotopic signal. Whatever the reason was, their use as basic staples should not surprise us, and prominent Roman writers like Pliny the Elder (*Naturalis Historiae* XVIII, 83-84) and Columella (*De Re Rustica*, 2.9.19) provide information concerning the consumption of millet, the only domesticated C_4 plant known in Greece prior to the Ottoman era, by humans (Nikita et al. 2019). However, plotting the POV values against the Bourbou et al. (2011) data suggests that it is unlikely that the humans of POV consumed C_4 plants. This is not the case, however, for some of the animals of the faunal assemblage. The fact that these outliers belong to both terrestrial domesticated and wild herbivores suggests that small quantities of consumed C_4 plants likely originated in the wild as some of the domesticated animals probably grazed in flocks, often reaching the ecological niche of the wild animals. The alternative case, that the elevated δ^{13}C values of these animals reflect grazing in pastures with increased salinity, can be rejected, primarily because of the low δ^{15}N values, and secondarily because of the very same geographic location and the climate characterising Western Macedonia; its great distance from the sea, and because mainland salt-affected soils occur mostly in arid and semi-arid environments (Shahid, Zaman, and Heng 2018), a fact coming in stark opposition with the wetter climatic conditions characterising the region.

When plotting the values against the data by Vika and Theodoropoulou (2012), some, albeit inconclusive, evidence for the consumption of aquatic foodstuffs emerges. While far from the coast, the Eordaea basin is crossed by streams ending up into swamps and lakes (Tsotsos 2011). We would expect humans to exploit these resources and consume freshwater fish. However, fish living in different habitats within freshwater lakes exhibit varying δ^{13}C values due to the numerous sources of carbon available in these ecosystems, but also elevated δ^{15}N values compared to terrestrial mammals, including humans. The study also of Vika and Theodoropoulou (2012), showed that fish isotope values in the North Aegean exhibit variability, and there are often overlapping ranges between fish from freshwater, euryhaline and marine habitats. Therefore, their detection is difficult and many researchers tentatively attribute suspiciously enriched δ^{15}N values to their consumption (Richards and Hedges 1999; Schoeninger and DeNiro 1984). The overlap in the isotope values between fish in these three habitats with those of the humans in POV suggests that if freshwater fish were consumed, they would only make a small contribution to their diet.

In summary, the diet of the POV community was characterised by the consumption of animals (and animal secondary products) consuming C_3 plants, supplemented by the direct consumption of C_3 plants, like cereals, legumes and fruit trees. This dietary profile corresponds to the micro-ecology of the region and characterises all members of the community irrespective of age and sex. The uniformity of the community is also attested in the skeletal and dental palaeopathological data for the site, supporting a population with less strictly defined age and gender-based roles when it comes to consumption and more differentiated when it comes to labour (Vergidou et al. 2021; 2022). This dietary uniformity is also reflected in the mortuary record, where all members of the community were buried in the same way. The lack of a comprehensive contextual study of mortuary and settlement evidence does not allow us to discern whether we are dealing with an undifferentiated population or a funerary ideology denying social differences. Nonetheless, the POV community likely represented an Upper Macedonian semi-mountainous agrarian community, with the majority of its inhabitants being commoners practicing animal husbandry (mainly transhumance pastoralism) and small-scale farming (Lomax et al. 1977).

Diet in the Nea Kerdylia-Strovolos (NKS) Community

The δ^{13}C and δ^{15}N values of the NKS assemblage showed no sex- and age-related dietary differences despite the slightly elevated δ^{13}C values for the male group. The same values support a terrestrial C_3 plant-based diet for the whole community. However, both the lower δ^{15}N values compared to the POV ones and comparison to the mean MRP faunal δ^{15}N value (6.1‰, Table 7) show that meat and other animal products contributed less to the protein content in the diet than protein coming from the direct consumption of C_3 plants and, more specifically, of grain legumes (Bogaard et al. 2007; Szpak et al. 2014). At the same time, the significantly smaller range of δ^{13}C values compared to the more dispersed from POV (0.8% vs. 2.3‰, Table 7) suggests that either the range of consumed C_3 plants was quite limited, or that people were consuming different plants with the same isotopic values.

No indication for the direct or indirect consumption of C_4 plant foodstuffs or foodstuffs of aquatic origin is clearly attested. The latter observation is also supported when plotting the data against the Bourbou et al. (2011) and Vika and Theodoropoulou (2012) studies. This is remarkable considering the affluent aquatic sources characterising the region (Lazarides 1972). At this point, one should consider the suggestions made regarding the limitations of bulk isotope analysis to determine the consumption of proteins of aquatic origin, particularly for the Mediterranean region. More specifically, it has been suggested that for a diet low in both terrestrial and aquatic protein, this method may not be able to detect the consumption of aquatic protein if this represents less than 20-30% of the total protein consumed (Hedges 2004; Webb et al. 2017). This was clearly shown in the stable isotope values of amino acids from bone collagen extracted from 17 adult skeletons from the coastal town of Herculaeneum in Italy (Soncin et al. 2021) when compared to previously extracted values of bulk isotope analysis from the same individuals (i.e. Martyn et al. 2018). These results showed not only the significant consumption of both marine and terrestrial foods, but also the tendency of bulk isotope data to underestimate the marine protein component of diet. Therefore, concluding that aquatic foodstuffs were excluded from the diet of the NKS community would be an exaggeration; instead, it can be argued that possible limitations in the bulk SIA method produced these erroneous results and that most probably fish had some, even small, contribution to the diet of these people.

In summary, the absence of male-female differences in the diet of this community probably reflects the absence of gender-based hierarchies concerning food. The same pattern is reflected in the mortuary record as all members of the community received similar post-mortem treatment. Any further interpretation requires a comprehensive contextual and bioarchaeological analysis against site-relevant historical data. As seen, the consumption profile of the NKS community was dominated primarily by terrestrial C_3 plants like cereals and grain legumes, but also those thriving in the region, like olive trees, figs, and vines, supplemented by the consumption of a limited range of animal foodstuffs (i.e. meat, eggs, milk, etc.). The agro-pastoral economic profile supported by these data is consistent with both the environmental and archaeological inference we have for the region (Lazarides 1972). It seems, therefore, that farming was the primary subsistence activity for this population, with the supplementary practice of animal husbandry and pastoralism. The small range of available foodstuffs agrees with the low status of the population who do not seem to have benefitted from the proximity to Amphipolis and Via Egnatia. What is also striking is the absence of fish consumption in the isotopic record for a site so close to a variety of aquatic resources and to major routes of commerce and communication (i.e. Via Egnatia). However, the complete exclusion of fish from the diet cannot be proven by the current data and, unless other cultural and economic explanatory factors can be considered, fish consumption must have been too restricted to be reflected in the isotopic signal of bulk SIA.

Inter-site Comparisons in Diet with Inferences on Demography, Subsistence Activities, and Micro-ecology

As shown, all members of the POV and NKS assemblages shared similar dietary patterns irrespective of their age and/or sex. This was also attested in the contemporaneous Roman city of Edessa in western Macedonia, Greece, where, similarly, no male-female or age group dietary differences were found in the isotopic values (Dotsika and Michael 2018). Our results also showed that both examined communities relied for their subsistence on a mixed strategy characterised primarily by the consumption of domestic C_3 plants and animals. This scenario agrees with research showing that most communities in classical (irrespective of their position in the settlement hierarchy of their region) practiced agriculture as the basis of their economy with the majority of their inhabitants being pastoralists and smallholding landowners (Alcock 2012; Amouretti 1999; Garnsey 1999; Kolb and Müller-Luckner 2004; Osborne 1987; Thommen 2012). The C_3 plant-based diet is also supported by archaeobotanical studies showing that C_3 plants were the prime component in the diet of the people of classical Macedonia and other parts of Greece (e.g. Douché, Tsirtsi, and Margaritis 2021; Margariti 2015). It is further supported by stable isotope studies conducted in the Roman city of Edessa in Western Macedonia (Dotsika and Michael 2018), the Byzantine rural community of Sourtara (6^{th}-7^{th} c. AD) also in western Macedonia (Bourbou et al. 2011), the Roman the city of Helike in northern Peloponnese (McConnan Borstad, Garvie-Lok, and Katsonopoulou 2018) and the Roman city of Knossos in Crete (Moles et al. 2022), where C_3 plants formed the basic component in the diet of the populations. As far as the consumption of C_4 plants and aquatic resources is concerned, the data of the current study have proven to be inconclusive, reflecting possibly the small and, thus, untraceable contribution of these resources in the diet of the examined groups. Interestingly, our results agree with those from the Roman city of Helike but contradict those from the two Macedonian sites, Roman Edessa and byzantine Sourtara where the consumption of C_4 plants and aquatic resources is attested, though not in large quantities. Note that wild C_4 plants occur in Greece today, but they constitute a minority restricted in certain arid ecosystems (Collins and Jones 1986; Pyankov et al. 2010). Any interpretations based on these dietary similarities and differences can only be tentative unless more isotopic studies from Roman Macedonia and other regions in Greece become available. It can be said, however, that no unique dietary pattern can be attested thus questioning the use of the generic terms Roman or Mediterranean.

In the same pace and besides similarities, a clear differentiation between the dietary profiles of the POV and the NKS communities is detected. In the absence of animal data from NKS, this difference cannot be fully interpreted. Nonetheless, it can be suggested that the source of protein consumed by the two communities was different, possibly owing to region-specific environmental parameters affecting the physiological and biochemical processes of the respective floras (e.g. seasonality, climate, water and altitude gradients, soil salinity levels, etc., see Marshall, Brooks, and Lajtha 2007) and, as a consequence, the isotopic signal of the plants consumed by animals and humans. It may be the case, however, that these dietary inter-community differences reflect certain anthropogenic disturbances (e.g. manuring intensity, forest harvest, etc.), but also the implementation of different intensification levels in the subsistence strategies practiced within the agro-pastoral economic spectrum (e.g. pastoralism vs crop cultivation), influenced, in their turn, by the interplay of each region's distinct micro-ecological features (i.e. position of each site in the settlement hierarchy and connectivity). Without a thorough analysis of the mortuary data and of related settlement data, any interpretation on the reasons behind this difference is tentative. It can be postulated, however, that food acquisition and consumption between the two communities of Roman Macedonia differed because it was dependent not only upon the local ecology, and less upon the civic status of each settlement (although, for reasons that have been already explained, such information cannot be confidently extracted). The physical distance of each community from major nodes of connectivity and communication where food trade between the cities and villages of the province was taking place is another potentially important factor.

The Importance of Micro-ecology to Human Diet: Comparisons Between the Animal Trophic Ecology of MRP and Other Roman Sites

The comparison of the MRP and CRN faunal assemblages supports the significance of micro-ecology in promoting different animal feeding and management strategies and shows the importance of extracting site-relevant plant and animal isotope data to reconstruct past human dietary profiles. The diet of all faunal assemblages comprised primarily of C_3 plants but, as supported by the different δ^{13}C and δ^{15}N values between MRP and CRN, of different species, or of the same species with different isotopic signals due to each region's environmental or anthropogenic influences. For example, the lower δ^{15}N values in the CRN sample may support the use of leguminous plants as crops, fodder, and/or forage as particular animal feeding strategies, while extensive manuring could be responsible for the higher δ^{15}N values observed in the MRP sample (Bogaard et al. 2007). Because of the small sample size, dietary information for the SRT animals cannot be obtained; however, SRT's micro-ecological features support strategies similar to the MRP ones.

As discussed, in the MRP sample all animals consumed C_3 plant-based foodstuffs, while outlying animals most probably consumed small quantities of C_4 plants. Although tentative due to the small samples, the overlap between the pig and horse values on the one hand and the lower values of the POV human range on the other hand suggests that these animals may have been kept close to the household, whereas cows, sheep, and goats were herded in flocks over longer distances. In the CRN sample dogs had a carnivorous diet, consuming meat and its byproducts, and/or the human waste coming from the same herbivore dietary input. The gap in the dog and pig δ^{15}N values, the clustering of pig and cow values, and the clustering of sheep and goat values support the suggestion that these animals had a different diet, resulting from their differential treatment by humans. Certainly, one would expect for the people in one of the most important colonies in Roman Greece to implement animal management practices that serve more efficiently the demands of the population compared to the people inhabiting the agrarian and semi-mountainous area surrounding MRP. While the community as a whole may have been more closely entangled with Roman markets, not all social groups may have benefitted from this. This nuance provides a bridge to the next section.

Concluding Remarks

This study used dietary data obtained through stable isotope analysis (δ^{13}C and δ^{15}N) in order to examine whether intra- and inter-site sex and age inequalities existed within two distinct communities of Roman Macedonia. It also explored the degree of influence the social structure and micro-ecology had in determining the observed dietary profiles in each community. Results showed no sex and age intra-community differences, but did reveal important inter-site differences. These findings suggest that the strong emphasis on age- or gender-based food hierarchies and inequalities in the household domain and in other spheres of life always need to be contextualised. These results also have significant implications regarding the need to move beyond the use of oversimplified divisions between the various communities of people residing in the Roman Empire; no clear-cut distinction of them can be made, nor can they be regarded identical in the way they positioned themselves in the world. While an extensive discussion on Romanization lies beyond the scope of this short article, this study does contribute to the debate concerning its conceptual premises as it suggests that bioarchaeology can provide valuable supplementary information regarding past consumption patterns that can be used as a proxy to detect variable degrees of incorporation into the globalising networks of the Roman Empire. Indeed, one could argue that both communities, despite their different dietary profiles, experienced the effects of an entangled food system, whereby food choices and strategies were dictated by shared identities and emerging power relations and divisions. In other words, this study argues that, if the Romanization debate is to be moved forward, a closer collaboration between bioarchaeology and current theoretical discussions needs to be developed.

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Disclosure Statement

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Notes on contributors

Chryssa Vergidou received her bachelor degree in History, Archaeology and the History of Art at the Aristotle University of Thessaloniki (AUTH), and her MSc in Human Osteology and Funerary Archaeology from Leiden University, The Netherlands in 2016. She is currently a joint PhD candidate at the Groningen Institute of Archaeology (GIA) and The Science and Technology in Archaeology and Culture Research Center (STARC) of The Cyprus Institute. In parallel with her academic steps, she worked as a professional archaeologist in excavations and projects carried out by Greece's Ministry of Culture. At the same time, she has been involved in survey projects and systematic excavations carried out by Cambridge and Groningen Universities. Finally, she worked professionally as a bioarchaeologist at the Ephorate of Antiquities in Kozani, Greece.

Georgia Karamitrou-Mentessidi studied archaeology at the Aristotle University of Thessaloniki and continued her post graduate studies at the Scuola Nazionale di Archaeologia in Rome with a scholarship from the Italian Institute. She has a doctorate in Archaeology from the Aristotle University in Thessaloniki. Dr. Karamitrou served both as the director of the Aiani excavations and later on from 2004 until 2011 as the director of the 4th Ephorate of Antiquities based in Aiani, where she implemented a persistent program to rescue and protect the heritage of the Kozani and Grevena Prefectures. As the excavator of Aiani, she made the ancient city and the necropolis open to visitors, she conducted a plethora pioneering educational programs and events, and laid the foundations for the realization and establishment of the Archaeological Museum of Aiani. She is the author of numerous articles and books concerning Upper Macedonia, which gave a new dimension to the history of the region. Since 2010, she has established the scientific meeting for the Archaeological Project in Upper Macedonia (AEAM), of which three volumes of proceedings have been published under her supervision, and the fourth is on the way.

Penelope Malama studied Classical Archeology and History in Graz, Austria where in 1988 she wrote her thesis on “The Late Classical and Hellenistic Tomb Grave-goods from Mesorachi Serres”. She started her career as a professional archaeologist in 1989 and, since then, she has served in many prominent positions within the Ephorates of Antiquities in Kavala and Serres, Greece. She has also carried out excavations in several archaeological sites in the Prefectures of Serres, Kavala, Thassos, and Drama. Among them, her position as head archaeologist for the site of Amphipolis stands out, as well as the rescue excavations she conducted during the construction of the Egnatia Road in the Prefecture of Serres (1999-2002). As part of this project, she published in 2008 the book “The Roman Cemetery in Nea Kerdylia Serres”, funded by the Egnatia Road SA, while at the same time, she excavated a large part of the eastern cemetery of the ancient city of Amphipolis, publishing the results of the Classical, Hellenistic and Roman times pottery and burial customs. She is also involved in the publications for the Ancient Gymnasium of Amphipolis, the Sanctuary of the Virgin in Kavala, and ancient Galipsos. She has participated in many conferences, both in Greece and abroad.

Konstantinos Darakis is a graduate of the department of Archeology and Art History of the University of Ioannina, Greece and holds a master's degree in “*Protection, Conservation and Restoration of Architectural Monumets.*” Aristotle University of Thessaloniki, Greece. He works in Northern Greece on excavations and research for the Greek Ministry of Culture. He has participated in scientific archaeological conferences and has written articles in Greek and international scientific archaeological journals. His main research interests are ancient Greek art, religion, topography and burial customs.

Michael W. Dee is Associate Professor of Isotope Chronology at the Centre for Isotope Research (CIO), Faculty of Science and Engineering, University of Groningen, the

Netherlands. He is also the head of the CIO's radiocarbon dating laboratory, the longest-running facility of its type in the world. Michael's background is in chemistry, but he began to specialise in radiocarbon dating during his DPhil (2006-2010) at the University of Oxford. His thesis focused on the application of Bayesian modelling to radiocarbon data, and was the basis for a *Science* paper in 2010. Michael then undertook a post-doctoral research position at Oxford (2010–2013) and a Research Fellowship in the same institution (2013–2016). During this time, he was also awarded a Junior Research Fellowship at St Edmund Hall. In 2016, Michael was the recipient of an ERC Starter Grant (€1.5 m), for a project on the potential of past solar storms for exact-year radiocarbon dating. The grant has produced, amongst others, a publication in *PNAS* and another in *Nature*. In 2021, Michael was awarded an ERC Consolidator Grant (€2.0 m) to continue his work on solar activity, radiocarbon production events and exact-year dating.

Sofia Voutsaki is Professor of Greek Archaeology at the Groningen Institute of Archaeology and Director of the Graduate Programme Archaeology. Her research interests include Aegean prehistory, Classical archaeology, mortuary studies, bioarchaeology, archaeological theory and the relevance of the past in the present. She has recently completed the excavation of the early Mycenaean North Cemetery and the urban survey at the recently discovered Mycenaean palatial centre at Ayios Vasileios, Laconia and is now preparing the final publications with an international team of specialists. She also directs the Halos Landscape Project in the Classical - Hellenistic site of Halos in Thessaly. She has co-edited six volumes on topics ranging from Aegean prehistory to bioarchaeology and the history of archaeology, and is the author of several peer-reviewed articles.

Efthymia Nikita is Assistant Professor in Bioarchaeology at the Science and Technology in Archaeology and Culture Research Center (STARC) of The Cyprus Institute. She studies human skeletal remains across the Mediterranean from prehistoric to post-Medieval contexts, shedding light on health and disease, diet, activity, demography and other important aspects of life in the past. She earned a BA in Archaeology from the Aristotle University of Thessaloniki and a PhD in Biological Anthropology from the University of Cambridge. Prior to her appointment at STARC, she held post-doctoral posts at the British School at Athens and the American School of Classical Studies at Athens, as well as a Marie Skłodowska-Curie fellowship at the University of Sheffield. Her research has resulted in over 80 articles and book chapters, including the textbook 'Osteoarchaeology: A Guide to the Macroscopic Study of Human Skeletal Remains' (Elsevier 2017). She is currently co-Editor-in-Chief for the second edition of the *Encyclopedia of Archaeology* (Elsevier), as well as Associate Editor for the *Journal of Archaeological Science* and *Archaeological and Anthropological Sciences*. She was recently awarded a Dan David prize for her contribution to the study of the past.

Petra Vaiglova is a Postdoctoral Researcher at the Australian Research Centre for Human Evolution and the Griffith Centre for Social and Cultural Research. In her work, she utilizes biomolecular techniques to seek answers to how people adapted to ancient environments, from development of early farming techniques in the Neolithic, through construction of large desert towns in the provinces of the Byzantine Empire, to the adoption of non-native domesticates in Bronze Age China. Vaiglova's specializes in development of new applications of isotopic analyses (carbon, nitrogen, oxygen, strontium, sulphur) in archaeology and on teaching courses in archaeological science.

ORCID

Vergidou Chryssa http://orcid.org/0000-0001-5281-7619

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