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THE SKELETAL REMAINS FROM THE LATE MYCENAEAN KASTROULI-DESFINA (GREECE): NEW ANTHROPOLOGICAL ANALYSIS AND PALAEODIETARY RECONSTRUCTION

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ABSTRACT

This paper presents the first preliminary isotopic data of skeletal (animal and human) remains recovered from Tomb A at the Mycenaean archaeological site of Kastrouli (Phocis) during the excavation periods from 2016 to 2021. The study also reports the results of the osteological analysis (minimum number of individuals, sex and age-at-death estimation) of several prenatal and adult bone fragments which were found commingled with animal remains in Tomb B, and Buildings 1 and 2.

The majority of the animal remains were identified as domesticated species, i.e. *Ovis aries*, *Capra hircus*, *Bos taurus* and *Sus scrofa domesticus*. Other animal species present were *Alectoris*, *Lepus*, and a few different species of gastropod shells (*Cerithium*, *Tarantinaea lignaria*, *Patella sp.*). Isotopic analysis ($\delta^{13}C$, $\delta^{15}N$) of 12 humans and four animals with good quality collagen indicates a mixed diet incorporating significant amounts of domestic animal protein, plants (some potential evidence for C_4), and possibly some marine contribution, all of which are archaeologically documented.

KEYWORDS: diet, prenatal, sheep, femur, skeletal, isotope, protein, freshwater, marine, C3-C4 plants, δ13C, δ15N, domesticated

1. INTRODUCTION

The three excavation periods during 2016-2021 at the Mycenaean site of Kastrouli, Phokis have revealed interesting finds regarding ceramic fabric, figurines, metals, plethora of human and animal bones, and architectural remains. The site has been looted in the past decades and excavated on a very limited scale by the Archaeological Service. It is located on the top of a rocky hill and delimited by a fortification wall, probably constructed in two phases, the earliest of which is Mycenaean. A hybrid rock-cut and built chamber tomb, excavated at the westernmost part of the fortified area, contained an undisturbed commingled burial of at least fifteen individuals (Fig.1) (Sideris et al., 2017; Levy et al., 2018).

Stirrup jars are the predominant ceramic form, while other tiny discoveries include bits of gold foil, steatite beads, and figurines of Phi and Psi types. The tomb was originally used during a time between LH IIIA 2 and LH IIIC Early or Advanced. There exists certain indications that the tomb was utilised again throughout the Middle Geometric Period (Sideris et al., 2017; Liritzis et al., 2016, Liritzis 2022; Lazaridis et al., 2022).

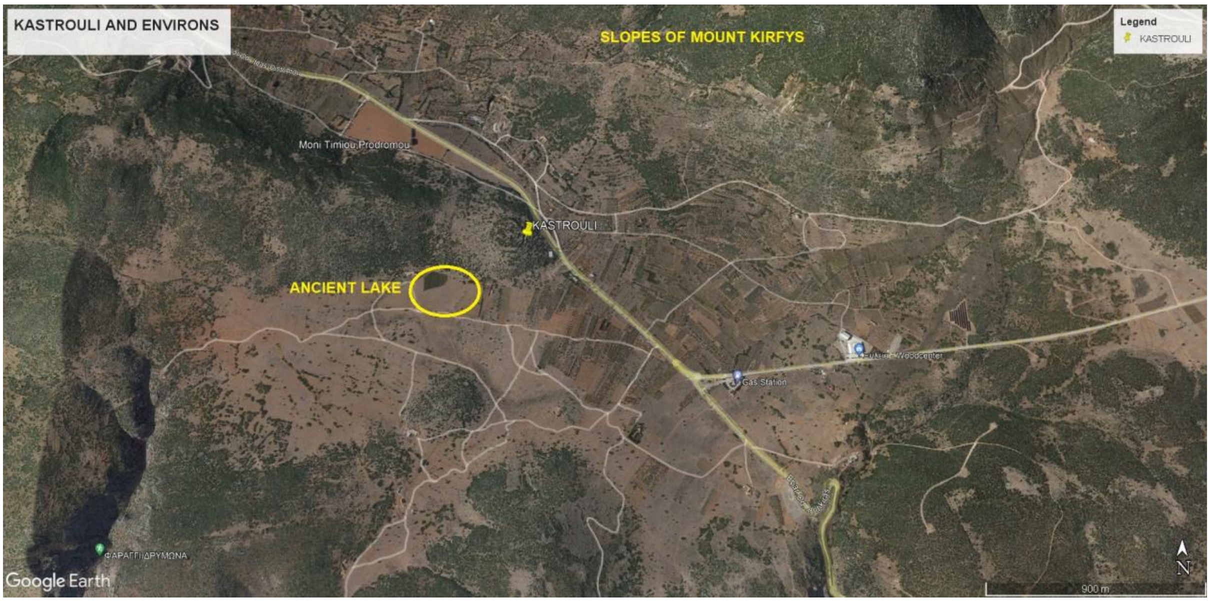

Figure 1. Kastrouli settlement and environment.

The discovery of the commingled grave in an undisturbed context starts to shed new light on the nature of the smaller Late Helladic III settlements on the outskirts of the larger Mycenaean "mega sites," such as Mycenae, Pylos, Thebes, Orchomenos, Sparta and others, despite the fact that Tombs A and B were disturbed in antiquity and by more recent tomb robbers. This small settlement may have had a more sophisticated economic function in the Mycenaean Phokis than previously thought, as evidenced by the presence of imported pottery vessels and particularly gold foil that likely embellished aristocratic clothing worn by the people of Kastrouli (Knodell, 2021).

While in unearthing Kastrouli the prompt and primary goal of our research team was how Kastrouli (LH IIIA 2 to at least the early LH IIIC) fits into the collapse of the palatial system and the survival and transformation of the non-palatial periphery in the Late Bronze Age civilization of Greece, the diet and bone diversification explored may shed light to this question. Until now, the regions of Phokis and Western Locris were regarded as being on the outside of the Mycenaean Palatial civilization. But the important tholos tomb recently found near Amphissa (Petrochilos, 2014), along with the ongoing discovery of a network of smaller Mycenaean fortified settlements and forts in the southern and eastern Phokis, may soon offer enough evidence for a reassessment of this periphery and its unique significance for the continuum between LBA and EIA on the Greek mainland (Livieratou 2015 and 2020).

The skeletal material in the Tombs A and B had severely degraded, and the majority of the bones were too fractured to provide any meaningful information (Chovalopoulou et al., 2017; Kontopoulos et al., 2019). However, some well-preserved femora and several teeth were recovered, allowing for MNI estimations for this mixed burial (Sideris et al., 2017; Levy et al., 2018). We estimated fifteen adults in Tomb A and one in Tomb B, plus two subadults, an infant, and a foetus. The long bones of the adults were not intact, which does not allow stature estimation since the formulas utilize maximum lengths. The same setting yielded skeletal remains of domesticated animals, and from the objects discovered, Tomb A dates to the Mycenaean/Late Helladic period, while Tomb B dates possibly to later archaic times according to the ^{14}C dates of the young man recovered from the tomb (Lazaridis et al., 2022; Polymeris et al., 2023).

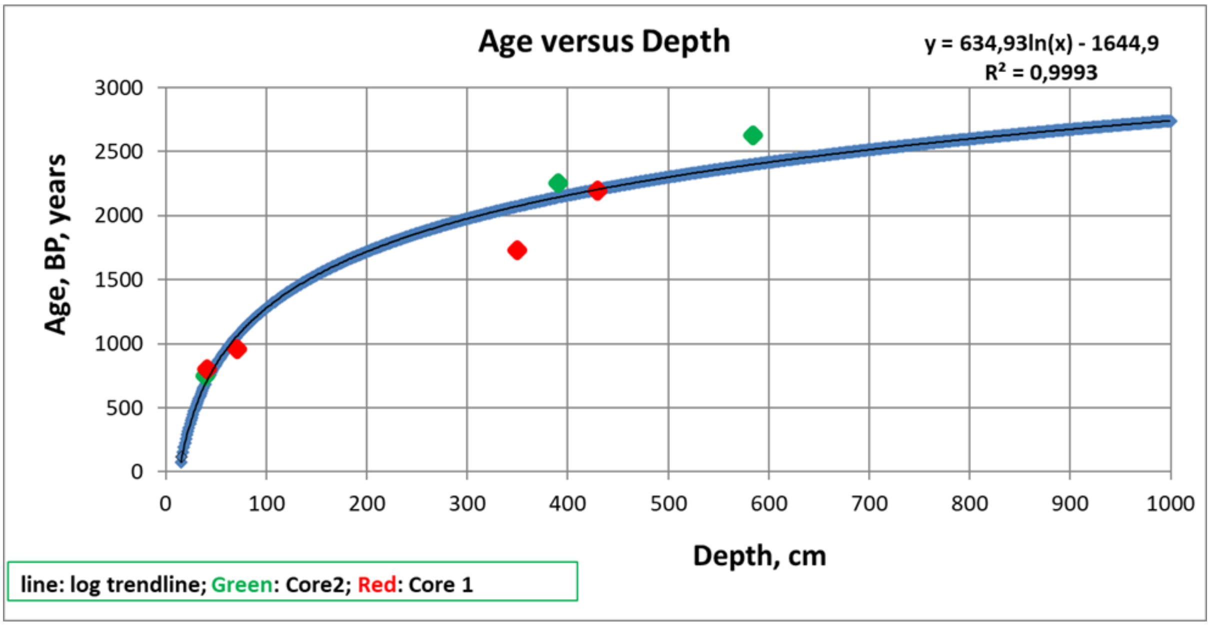

Figure 2. The exponential trend of sedimentation rate of depth versus age of two boreholes, dated by OSL. Upper right the exponential equation (based on Liritzis et al., 2022 and Polymeris et al., 2024, in press).

The Kastrouli Project has been investigated by a multi-scientific interdisciplinary approach (Liritzis 2021). Archaeometric, bioarchaeological and anthropological analysis has been combined, and provided a more integrated picture of this ancient settlement with its environs. A recent methodological approach to investigate the possible marsh/lake in the territory of the Kastrouli archaeological site (Late Mycenaean to later Roman and Byzantine times) has been the subject of a robust complementary work. The use of the digital elevation model (DEM) with GIS, electrical resistivity tomography (ERT) traverses, and two borehole cores with luminescence dating of the plain defined a limestone basin (length of 100 m and a depth of around 40–50 m), as well as the boundaries of an ancient lake. Optical luminescence dating (OSL) of sediment cores, and the presence of two natural sinkholes with apparent engineered hydraulic works to drainage, have documented the existence of an ancient lake which at the time of Late Mycenaean Kastrouli could have a depth of around 12m, but eventually converted to marsh (Fig. 2). This finding may also imply interaction with settlers in aspects of freshwater diet (Liritzis et al., 2022).

There has been little anthropological research done in the Phokis area. The first results of the anthropological and biochemical examinations of the skeletal (human and animal) remains found in the Kastrouli archaeological site have been previously reported in Chovalopoulou et al., 2017 and Kontopoulos et al. 2019. The excavation's initial findings are reported in Sideris et al., 2017, and subsequent excavations were reported in Levy et al., 2018; Sideris & Liritzis, 2018; Sideris 2022; Chovalopoulou et al., 2022. The information that could be extracted from the macroscopic examination of the skeletal remains at the Kastrouli site was severely limited due to the poor preservation of the discovered skeletal material (Bertsatos & Chovalopoulou, 2017). The environmental conditions in Kastrouli (Kontopoulos et al., 2019) seem comparable to those in other eastern Mediterranean regions (like Cyprus), which are distinguished by calcareous soils and exhibit a wide range of climate fluctuations from dry and hot to wet and cold. Further, the type of soil, wetness, deep ploughing, exposure to sunshine, plant roots, and the activities of different rodents and insects may all have contributed to variations in bone preservation.

The aim of this study is, therefore, to report on the new skeletal finds from Tomb B, and Buildings 1 and 2, and provide a reconstruction of past dietary habits of the individuals from Tomb A using the carbon and nitrogen isotopic composition of bone collagen.

2. MATERIALS AND METHODS

Several bones of various animals have been unearthed from the three excavation loci. Among the animal remains, few snake vertebrae and a few different species of gastropod shells (snails) have also been recovered. With respect to the domesticated animals, bones and/or teeth belonging to *Bos taurus* (domesticated cow), *Sus scrofa domesticus* (domesticated pig), and *Ovis aries/Capra hircus* (domesticated sheep/goat) were identified. In addition to the inherent difficulty to distinguish between the latter (sheep/goat), the recovered bones were poorly preserved and fragmented to allow for a more precise identification. From Tomb B, prenatal bones and the skeletal remains of a disarticulated young adult were found. The prenatal bones must be regarded with caution concerning their provenance, since prenatals from miscarriages were usually buried inside the houses, and we have in the immediate vicinity of the Tomb B (less than 2 m eastwards) the not yet fully excavated Building 3 (Sideris 2022). The first stage of the osteological analysis is presented in Chovalopoulou et al. (2017), while in the present study reports on the human and animal bones shown in Table A1 (Appendix).

2.1. Anthropological analysis

The anthropological analysis consists of three sections: the determination of the minimum number of individuals (MNI), the sex and age-at-death estimation of the individuals. Furthermore, a macroscopic examination of bones for pathologies was conducted.

Minimum number of individuals (MNI)

The determination of the minimum number of individuals relied on the following procedure. We sorted the identified bones by side and skeletal element and then assigned the highest frequency as MNI. Subadults, children, and newborns all had distinct MNI records.

Sex determination

Regarding adult individuals, sex determination was based on standard osteological methods, such as robusticity and cranial and pelvic morphology (Buikstra and Ubelaker, 1994).

Age-at-death estimation

For adults, age-at-death estimation relied on ectocranial suture closure (Meindl and Lovejoy, 1985) and skeletal degenerative changes (White and Folkens, 2005). In contrast, for juveniles, age-at-death estimation was based on the lengths of the long bone diaphysis (Scheuer and Black, 2000).

2.2. Stable isotope analysis

Collagen was extracted from 17 adult human (15 right femora and 2 petrous bones) and 4 animal samples from Tomb A (Table 2; see Chovalopoulou et al., 2017 for osteological analysis) using a modified (Longin, 1971) method with an additional Ezee filter step (Ramsey et al., 2004). The exterior surfaces of cortical bone samples were mechanically cleaned using a scalpel. Bone chunks of 300-500 mg were demineralized in 8 ml 0.6 M HCl at 4°C. Samples were agitated twice daily, and acid solution was changed every two days. When demineralisation was completed, samples were rinsed three times with distilled water. Gelatinization was carried out by adding 8 mL pH 3 HCl and samples were placed in hot blocks at 80° C for 48h. The gelatinised collagen was filtered using Ezee filters, frozen and freeze dried for 48 hours. The extracted collagen was analysed in duplicate using a Sercon 20-22 mass spectrometer coupled to a Sercon GSL elemental analyzer at the University of York (BioArCh). Data was normalised using a two-point linear correction using repeated measurements of international standard reference materials as calibration standards within each analytical run. These were IAEA 600 $\delta^{13}C_{raw}$ = -27.66 ±0.03 ‰, $\delta^{13}C_{true}$ = -27.77 ±0.043 ‰, $\delta^{15}N_{raw}$ = 0.90 ±0.06 ‰, $\delta^{15}N_{true}$ = 1 ±0.2 ‰; IAEA N2 $\delta^{15}N_{raw}$ = 20.4 ±0.19 ‰, $\delta^{15}N_{true}$ = 20.3 ±0.2 ‰; IA Cane, $\delta^{13}C_{raw}$ = -11.72 ±0.01 ‰; $\delta^{13}C_{true}$ = -11.64 ±0.03 ‰. Sample uncertainty for individual samples are calculated separately for both $\delta^{15}N$ and $\delta^{13}C$ using the Kragten spreadsheet model (Kragten 1994) as outlined in the Good Practice Guide for Isotope Ratio Mass Spectrometry (Dunn and Carter 2018, https://www.forensic-isotopes.org/gpg.html) by combining uncertainties in the values of the reported error associated with the published true value of the international standards, the measured error (precision) values of the international standards in the run, the precision error from the measurement of the two sample replicates. These are expressed as one standard deviation. The maximum uncertainty for all samples across all runs was <0.06‰ for $\delta^{13}C$ and <0.25‰ for $\delta^{15}N$.

Twelve human femoral and four animal samples with C/N ratio 2.9-3.6, more than 1 wt. % collagen, more than 4.5 wt. % C, and more than 1 wt. % N (DeNiro, 1985; Ambrose, 1990; Iacumin et al., 1998; Van Klinken, 1999) have been used for the paleodietary reconstruction. The samples KAS1, KAS7, KAS15 did not pass all the quality control criteria, while the two petrous bones are reported but not included in the study since they may belong to any of the 15 individuals.

3. RESULTS AND DISCUSSION

3.1. Anthropological study

This work is the follow-up to the anthropological study of the skeletal (animal and human) remains recovered from the Kastrouli archaeological site. The unearthed skeletal material was poorly preserved, probably due to the environmental conditions in

Greece. In fact the pH of the sediment in the settlement (based on the potensiometric method at 20°C and ratio sediment-to-H_2O=1/2) were 7.65, 7.70, 7.76, that is a slightly alkaline environment. Therefore, there were severe limitations on the information that could be retrieved from the macroscopic analysis of the skeletal remains. However, several sufficiently preserved prenatal bones along with identifiable bone fragments of an adult skeleton allowed for MNI estimates for the burials (Table 1). Additionally, several bones of various animals have been unearthed commingled with the dispersed human skeletal remains in the heavily disturbed Tomb B, in contrast to the undisturbed commingled burial of the Tomb A, which contained exclusively human bones. A number of samples, both animal and human, were prepared and retained for further analyses. Table A1 (Appendix) presents the total number of identified bones per excavated section (Buildings 1 and 2, Tomb B).

Table 1. Summary of individual counts for MNI calculation.

Bone examined	Individual count	Tomb / Room number	Bag	Age estimation	Sex estimation
Right humerus	2	Building 1	A14(5)	Prenatal	N/A
Long bones, Ribs and Ischial bone fragments	1	Buildings 2a and 2b	DK2022, P.B.14	Prenatal	N/A
Right femur	1	Tomb B	B1	Prenatal	N/A
Right hemimandible / Frontal bone	1	Tomb B	B6 / B8	Adult	Male

Table 1 summarises all skeletal remains considered in the MNI calculation and age, as well as sex estimation. According to the findings at least 4 prenatal (Figures 3, 4 and 5) and one male individual have been identified. Unfortunately, no adult age-characteristic bone fragments were identified. Therefore, no age estimation was possible for the male individual (Figure 6). Additionally, no conclusions can be drawn regarding the health status of the adult individual due to the poor condition of the bones. Finally, concerning the animal skeletal remains, among those that were identified as domesticated animals (Figures 7, 8 and 9), long bones of *Alectoris*, several *Lepus* (hare) bones and few different species of gastropod shells (snails) have also been recovered.

Figure 4. Posterior view of a human right humerus (prenatal) recovered from Buildings 2a and 2b.

Figure 3. Posterior view of two right and one left human humeri (prenatal) recovered from Building 1 (scale: 1 cm).

Figure 5. Posterior view of a human right femur (prenatal) recovered from Tomb B (scale: 5 mm).

Figure 6. Skull fragments of a human male individual recovered from Tomb B (scale: 5 cm).

Figure 7. Posterior view of a maxilla fragment with tooth (Ovis aries/ Capra hircus).

Figure 8. Lateral view of a phalanx (Bos taurus).

Figure 9. Plantar view of a talus (Bos taurus).

3.2. Palaeodiet

The average $\delta^{13}C$ and $\delta^{15}N$ values of the 12 human individuals that yielded good quality collagen are -19.14±0.51‰ (1 SD; range: -17.51‰ to -19.34‰) and 9.11±1.02‰ (1 SD; range: 8.15‰ to 10.02‰), respectively (Table 2). Only three specimens (KAS1, KAS7, KAS15) have been excluded from further analysis due to high C/N values (>3.6). The mean $\delta^{13}C$ of the four animal samples that are used as a baseline is -21.17±1.54‰ (1 SD; range: -20.06‰ to -23.44‰), while the mean $\delta^{15}N$ value is 5.85±1.27‰ (1 SD; range: 3.98‰ to 6.67‰) (Table 2). When KAS29 is excluded due to its unusual for the region carbon isotope signal, the mean $\delta^{13}C$ of the three animals (KAS22, KAS23, KAS28) is -20.41±0.34‰ (1 SD), and the mean $\delta^{15}N$ value is 5.60±1.43‰ (1 SD).

The animal $\delta^{13}C$ and $\delta^{15}N$ signals are all consistent with a C_3 terrestrial diet and no C_4 input. The difference observed in the ovicaprid $\delta^{13}C$ signatures (KAS28 vs KAS29) can be related to the consumption of plants with different crop management (e.g. wet/dry conditions), as carbon isotope signals reflect the water status of the plant (Wallace et al., 2013, 2015). A consumption of freshwater plants could also be a less likely explanation, as seen in turtles from the Late Helladic (1450-1150 BC) Aghia Triada with similar to KAS29 mean $\delta^{13}C$ (-23.2‰) and $\delta^{15}N$ (6‰) signals (Petroutsa et al., 2009; Petroutsa and Manolis, 2010), but this would also require further investigation. Regarding the difference seen in the nitrogen values between KAS22/23/29 and KAS28, this could be related to browsing/grazing in different areas that could have distinct soil N properties, feeding/grazing/browsing in manured fields, or due to differences between browsers and grazers (Honch et al., 2006; Petroutsa and Manolis, 2010; Vaiglova et al., 2014).

Table 2. Stable isotope data of the human and animal bones from Tomb A. Specimens in bold red letters with C/N>3.6.

Sample	Skeletal element	Species	% Col.	% C	% N	C/N	δ13C	δ15N
KAS22	Phalanx	Cattle	5.28	41.54	14.80	3.27	-20.74	6.15
KAS23	L. Humerus (D)	Pig	7.70	37.75	13.63	3.23	-20.43	6.67
KAS28	Phalanx	Ovis/Capra	13.23	34.44	12.36	3.25	-20.06	3.98
KAS29	Long Bone	Ovis/Capra	10.23	28.91	10.36	3.26	-23.44	6.62
KAS1	R. Femur (P)	Human	2.57	4.95	1.56	**3.70**	-20.02	6.30
KAS2	R. Femur (P)	Human	6.68	42.97	15.46	3.24	-19.28	9.13
KAS3	R. Femur (P)	Human	2.26	41.44	14.80	3.27	-19.10	8.16
KAS4	R. Femur (P)	Human	7.14	40.03	14.62	3.19	-19.07	8.15
KAS5	R. Femur (P)	Human	5.48	33.72	12.19	3.23	-19.17	9.39
KAS6	R. Femur (P)	Human	5.79	40.30	14.28	3.29	-19.13	9.75
KAS7	R. Femur (P)	Human	0.92	34.15	9.99	**3.99**	-19.69	9.88
KAS8	R. Femur (P)	Human	11.29	39.45	14.36	3.21	-19.34	8.49
KAS9	R. Femur (P)	Human	12.07	46.13	16.78	3.21	-18.99	8.86
KAS10	R. Femur (P)	Human	9.68	37.71	13.70	3.21	-18.95	10.02
KAS11	R. Femur (P)	Human	2.86	30.06	10.44	3.36	-19.26	9.75
KAS12	R. Femur (P)	Human	8.14	39.89	14.49	3.21	-17.51	9.99
KAS13	R. Femur (P)	Human	11.00	42.57	15.46	3.21	-18.93	8.96
KAS14	R. Femur (P)	Human	6.59	37.76	13.63	3.23	-19.08	8.18
KAS15	R. Femur (P)	Human	0.86	40.30	12.95	**3.63**	-19.59	10.27
KAS16	L. Petrous	Human	10.47	31.49	11.13	3.30	-19.23	9.74
KAS17	R. Petrous	Human	10.62	42.67	15.07	3.30	-18.95	9.92

The human mean δ^{13}C value (-19.14±0.51‰, 1 SD) shows an increase of approximately 2‰ compared to the animal mean δ^{13}C signal, while the mean δ^{15}N (9.11±1.02‰, 1 SD) is c. 3.3‰ higher than the mean animal values (Fig.10). Using the most commonly applied 1-2‰ $\Delta^{13}C_{collagen\text{-}diet}$ and 3-5‰ $\Delta^{15}N_{collagen\text{-}diet}$ offsets (Bocherens and Drucker 2003; Minagawa and Wada 1984; Schoeninger and DeNiro 1984) to translate bone collagen isotope values into diet, individuals in Kastrouli generally exhibit isotopic signatures indicative of diets relying heavily on animal protein (meat/milk products).

Some individuals in Kastrouli (e.g. KAS10 and KAS12) have isotope signals indicating a possible additional incorporation of aquatic food in their diet (Fig.10). Such a mixed diet is corroborated in Kastrouli by archaeological and geoarchaeological evidence from a) the presence of marine species (e.g. *Cerithium sp., Tarantinaea lignaria, Patella sp. Pinna sp.*) amongst the unearthed finds due the close proximity to the coastal area, and b) the location of an ancient lake of an estimated depth around 12 metres, which since those times has been transformed into an arable field, from hydraulic works and the transfer and deposition of sediments.

The detection of low amounts of marine (or freshwater) protein at an individual's level using bone collagen stable isotope analysis is challenging (Guiry 2019; Vika and Theodoropoulou, 2012). Marine and freshwater fish in Greece demonstrate variable δ^{13}C and δ^{15}N isotopic signals that often overlap (Vika and Theodoropoulou, 2012). The carbon isotope values can range from -10.11‰ to -19.21‰ for marine fish, and between -11.93‰ and -20.80‰ for freshwater fish, whereas the range for marine fish δ^{15}N values is 6.10‰ to 11.61‰, and 4.91‰ to 10.90‰ for freshwater fish (Vika and Theodoropoulou, 2012). Although individuals in the Aegean with an almost complete reliance on freshwater food could exhibit isotopic values similar to KAS10 and KAS12 (Vika and Theodoropoulou, 2012), a diet with freshwater food as a staple seems unlikely here. Therefore, a terrestrial C_3 based diet with significant consumption of animal products (predominantly dairy products) and a possible frequent incorporation of marine (and/or freshwater) protein seems a more likely scenario for KAS12 (and possibly KAS10).

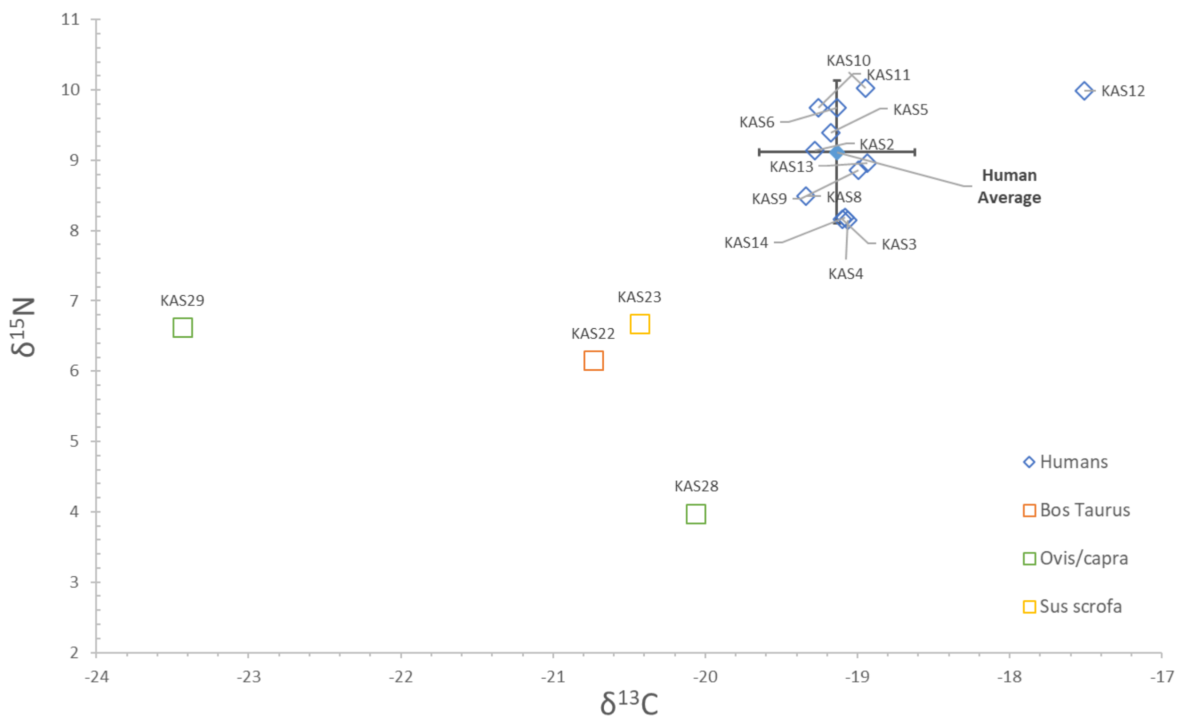

Figure 10. Human and animal carbon and nitrogen isotopic signatures (error bars ±1σ).

On the other hand, KAS3/4/8/14 with mean $\delta^{13}C$ -19.15‰ and $\delta^{15}N$ c. 8.25‰ (Fig.10), had probably a predominantly C_3 terrestrial diet with an important consumption of animal products but a rather limited or no exploitation of aquatic resources. Individuals with similar $\delta^{13}C$ to this group, but with increased $\delta^{15}N$, would have a diet richer in animal protein, although some contribution of marine food cannot be excluded. It is also noteworthy that a non-adult individual recovered from Tomb B, and radiocarbon dated to 775-542 cal. BC, shows similar dietary habits with the latter group as seen from the $\delta^{13}C$: -19.00‰ and $\delta^{15}N$: 10.06‰ values (Lazaridis et al. 2022); an indication that eating habits remained largely unchanged in Kastrouli in later periods.

The use of a larger offset of c. 6‰ for $\Delta^{15}N_{collagen-diet}$ (O'Connell et al. 2012), however, would indicate that the average consumption of animal products would be much lower in Kastrouli, with limited or no consumption of marine protein. In such a scenario, a significant consumption of C_4 foods such as millet would explain the more positive $\delta^{13}C$ values (Papathanasiou and Richards, 2015; Triantaphyllou, 2015).

Past studies have reported a predominantly C_3 based diet with significant consumption of animal protein and insignificant (<10%) consumption of marine/freshwater resources in Late Bronze Age Greece (Damiata and Southon, 2023; Petroutsa et al., 2009; Petroutsa and Manolis, 2010; Iezzi, 2015; Papathanasiou, 2015; Papathanasiou and Richards, 2015; Papathanasiou et al., 2020; Tritsaroli et al., 2023). Stable isotope data from other late Helladic (1325-1100 BC) individuals from central Greece, however, differ from those of Kastrouli individuals. The coastal sites from east Lokris show lower mean $\delta^{13}C$ (-19.9±1.2‰, 1 SD) and $\delta^{15}N$ (8.5±1.2‰, 1 SD) values compared to Kastrouli, whereas inland sites exhibit similar average $\delta^{13}C$ signals (-18.8±1.4‰, 1 SD; possible C4 consumption) but much lower $\delta^{15}N$ (7.6±1.4‰, 1 SD) values (Iezzi, 2015). Only the isotopic signatures of the individuals from the coastal site of Almyri ($\delta^{13}C$ = c.-19.2±0.2‰ and $\delta^{15}N$ = c.9.3±0.3‰, 1 SD) display similar isotopic signatures to those of Kastrouli (Petroutsa and Manolis, 2010). Consumption of animal protein in significant amounts coincides with periods of economic and cultural growth and prosperity such as the Mycenaean civilization (for a summary of isotope data in Greek prehistory see Papathanasiou and Richards, 2015), with significant consumption of marine protein reported only for some elite individuals from Grave Circle A ($\delta^{13}C$ = c.-18.6±0.5‰ and $\delta^{15}N$ = c.10.5±1.1‰, 1 SD) and Grave Circle B in Mycenae ($\delta^{13}C$ = c.-19.4±0.6‰ and $\delta^{15}N$ = c.8.6±1.9‰, 1 SD) (Richards and Hedges, 2008).

CONCLUSION

The anthropological study of the Kastrouli skeletal remains has provided new data on the human remains of individuals (prenatal to adult) recovered from building floors and tombs. Skeletal remains of domesticated animals (cow, pig, sheep/goat) were also identified. Isotopic data provides evidence of diet heavily relying on C_3 terrestrial animal protein (meat/milk products), and in some cases, isotope signals may reflect an additional incorporation of marine protein (and/or freshwater).

AUTHORS CONTRIBUTION

Conceptualization: I.L.; **Project administration**: I.L.; **Investigation**: I.L., I.K. (palaeodiet), M.C. (osteoarchaeology); **Resources**: I.L., A.S., I.K. (palaeodiet), M.V.T. (palaeodiet), M.A. (palaeodiet); **Data curation**: I.L., I.K. (palaeodiet), M.C. (osteoarchaeology); **Writing—original draft preparation**: I.L., I.K. (palaeodiet), M.C. (osteoarchaeology).; **Writing—review and editing**: I.L., I.K., M.C., A.S., M.V.T., M.A.; **Visualisation**: I.L., I.K., M.C.; **Supervision**: I.L., A.S.; **Funding acquisition**: I.L., I.K. (palaeodiet), M.A. (palaeodiet). All authors have read and agreed to the published version of the manuscript.

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APPENDIX

Table A1: Description of the skeletal remains excavated, recovered and cleaned from Kastrouli over the period 2018-2022.

Building 1				
Bag Tag	**Findings**		**Description**	**Sex and Age Estimation**
Bag A1	1	Human Right ulna	Proximal metaphysis	Prenatal
	1	Human Radius	Proximal metaphysis	Prenatal
	1	Human Right hemimandible		Prenatal
	3	Bovidae (Sheep or Goat) teeth		
	1	Bovidae (Sheep or Goat) humerus	Distal portion	
	1	Probably bird phalanx		
		Unidentified long bone, rib, vertebra and other fragments		
Bag A2	2	Cerithium		
	1	Gastropod shell core other than Cerithium		
	3	Bovidae (Sheep or Goat) phalanges		
	1	Bovidae (Sheep or Goat) tooth		
		Unidentified long bone, rib, vertebra and other fragments		
Bag A3	1	Cerithium		
Bag A4	1	Sus canine		
Bag A5	1	Micromammal femur		
		Unidentified long bone, rib, vertebra and other fragments		
Bag A6	1	Bovidae (Sheep or Goat) left glenoid fossa		
	4	Bovidae (Sheep or Goat) teeth		
		Unidentified long bone, rib, vertebra and other fragments		
Bag A7	3	Bovidae (Sheep or Goat) teeth		
	1	Bovidae (Sheep or Goat) phalanx		
	1	Sus terminal phalanx		
		Unidentified long bone, rib, vertebra and other fragments		
Bag A8	1	Tarantinaea lignaria		
Bag A9	2	Unidentified fragments		
Bag A10	1	Unidentified fragment		
Bag A11	1	Sus right hemimandible (2 fragments)		Young
Bag A12		Unidentified long bone, rib, vertebra and other fragments		
Bag A13		Metals		
Bag A14 (1)	1	Patella sp		

Bag A14 (2)		Unidentified animal bone fragments		
Bag A14 (3)	1	Unidentified fragment		
Bag A14 (4)	2	Bovidae (Sheep or Goat) phalanges		
	1	Bovidae (Sheep or Goat) tooth		
		Unidentified long bone, rib, vertebra and other fragments		
Bag A14 (5)	2	Human Right humeri	Distal metaphysis	Prenatals (one of them is approximately 38 weeks old)
	1	Human Left humerus	Distal metaphysis	Prenatal (approximately 38 weeks old)
	1	Human Left ulna	Proximal metaphysis	Prenatal
	1	Human Right ulna	Proximal metaphysis	Prenatal
	1	Human Radius	Proximal metaphysis	Prenatal
	4	Human Vertebral processes		Prenatal
	1	Bovidae (Sheep or Goat) tooth		
		Unidentified long bone, rib, vertebra and other fragments		
Bag A14 (6)	1	Patella sp		
	1	Bos taurus tooth		
	1	Bos taurus phalanx		
		Unidentified long bone, rib, vertebra and other fragments		
Bag A14 (7)	1	Bovidae (Sheep or Goat) tooth		
	1	Sus tooth		
	1	Animal mandible or maxilla	Fragment	
		Unidentified long bone, rib, vertebra and other fragments		
Bag A14 (8)	1	Bovidae (Sheep or Goat) tooth		
		Unidentified long bone, rib, vertebra and other fragments		
Bag A14 (9)	1	Human Left femur	Proximal metaphysis	Prenatal
	1	Human Left tibia	Proximal metaphysis	Prenatal
	4	Human Long bones		Prenatal
		Unidentified long bone, rib, vertebra and other fragments		
Bag A.1 (1)	1	Unidentified fragment		
Bag A.1 (2)	1	Unidentified fragment		
Bag A.1 (3)	2	Unidentified fragments		
Bag A.1 (4)	2	Unidentified fragments		
Bag A.1 (5)	1	Bovidae (Sheep or Goat) tooth		
Bag A.1 (6)	1	Bovidae (Sheep or Goat) radius	Proximal portion	
Bag A.1 (7)	3	Unidentified fragments		

Bag A.1 (8)	1	Sus metatarsal		Young
Bag A.1 (9)		Unidentified fragments		
Bag A.1 (10)	1	Bovidae (Sheep or Goat) tooth		
	1	Rib fragment		
	2	Unidentified fragments		
Bag A.1 (11)	3	Unidentified fragments		
Bag A.1 (12)	3	Unidentified fragments		
Bag A.1 (13)		Unidentified long bone and other fragments		
Bag A.2 (1)	1	Cerithium		
Bag A.2 (2)	3	Unidentified fragments		
Bag A.2 (3)	1	Unidentified fragment		
Bag A.2 (4)	6	Unidentified fragments		
Bag A.2 (5)	1	Bovidae (Sheep or Goat) tooth		
	1	Unidentified fragment		
Bag A.2 (6)	1	Bovidae (Sheep or Goat) tooth		
	1	Bos taurus tooth (2 roots are loose)		
		Unidentified long bone and other fragments		
Bag A.2 (7)	1	Cerithium		
	2	Sus teeth		
	1	Probably hare humerus		
	1	Animal vertebra		
		Unidentified long bone and other fragments		
Buildings 2a and 2b				
Bag Tag	**Findings**		**Description**	**Sex and Age Estimation**
Bag B1 (1)	1	Animal phalanx		
	4	Unidentified fragments		
Bag B1 (2)	2	Unidentified fragments		
Bag B1 (3)	1	Unidentified fragment		
Bag B1 (4)	2	Unidentified fragments		
Bag B1 (5)	1	Bovidae (Sheep or Goat) tooth		
		Unidentified long bone and other fragments		
Bag B1 (6)	1	Unidentified fragment		
Bag B1 (7)	1	Sus tooth		
	5	Unidentified fragments		
Bag B1 (8)	1	Rib fragment		
Bag B1 (9)		Unidentified long bone and other fragments		
Bag B1 (10)	1	Probably Bos taurus phalanx		
	1	Bovidae (Sheep or Goat) tooth		

		Unidentified long bone and other fragments	
Bag B1 (11)	2	Bos taurus teeth	
	1	Long bone fragment	
Bag B1 (12)	1	Bovidae (Sheep or Goat) humerus	Distal epiphysis
	2	Unidentified fragments	
Bag B1 (13)	1	Animal vertebral endplate and body	
		Unidentified long bone and other fragments	
Bag B1 (14)	1	Bovidae (Sheep or Goat) tooth	
	6	Animal tooth fragments	
	1	Unidentified fragment	
Bag B1 (15)	1	Bovidae (Sheep or Goat) tooth	
	1	Bos taurus tooth	
		Unidentified long bone and other fragments	
Bag B1 (16)	1	Bos taurus tooth	
		Unidentified long bone and other fragments	
Bag B2 (1)	4	Unidentified fragments	
Bag B2 (2)	2	Unidentified fragments	
Bag B2 (3)	2	Unidentified fragments	
Bag B2 (4)	2	Unidentified fragments	
Bag B2 (5)	3	Unidentified fragments	
Bag B2 (6)	1	Bovidae (Sheep or Goat) incisor	
	3	Unidentified fragments	
Bag B2 (7)	1	Bovidae (Sheep or Goat) talus	
	1	Bovidae (Sheep or Goat) tooth	
	6	Unidentified fragments	
Bag B2 (8)	5	Unidentified fragments	
Bag B2 (9)	1	Unidentified fragment	
Bag B2 (10)	1	Hare femur	Proximal portion
	1	Unidentified fragment	
Bag B2 (11)	1	Bovidae (Sheep or Goat) calcaneus	
	1	Bovidae (Sheep or Goat) phalanx	
	1	Bovidae (Sheep or Goat) tooth	
	5	Unidentified fragments	
Bag B2 (12)	4	Bovidae (Sheep or Goat) teeth	
	3	Unidentified fragments	
DK2022, P.B.3B	1	Animal Maxilla Fragment With Tooth (Ovis aries or Capra hircus)	
	1	Animal (Probably) Maxilla Fragment (Ovis aries or Capra hircus)	
	2	Animal Long Bone Fragments	
	2	Unidentified Animal Bone Fragments	

DK2022, P.B.6C	2	Animal Long Bone Fragments		
DK2022, P.B.4B, JLF	1	Animal Long Bone Fragment		
	1	Animal Vertebra (Ovis aries or Capra hircus)		
	1	Animal Phalanx (Bos taurus)		
	1	Animal Talus (Bos taurus)		
	≈50	Unidentified Animal Bone Fragments		
DK2022, P.B.13B, JLF	1	Animal Tooth (Ovis aries or Capra hircus)		
	1	Animal Tooth (Ovis aries or Capra hircus)		
	1	Animal Tooth (Ovis aries or Capra hircus)		
	1	Animal Tooth (Ovis aries or Capra hircus)		
	12	Animal Long Bone Fragments		
DK2022, P.B.47	1	Horn fragment (Ovis aries or Capra hircus)		
DK2022, P.B.I, JLF	1	Animal Tooth (Ovis aries or Capra hircus)		
DK2022, P.B.I D	1	Animal Long Bone Fragment		
	1	Unidentified Animal Bone Fragment		
DK2022, P.B.7, JLF	1	Animal Long Bone Fragment		
DK2022, P.B.5C, JLF	1	Animal Long Bone Fragment		
DK2022, P.B.14	1	Human Right Humerus	Diaphysis And Distal Epiphysis	Prenatal
	1	Human Radius	Proximal Epiphysis And Diaphysis	Prenatal
	4	Human Rib Fragments		Prenatal
	1	Human Right Femur	Proximal Epiphysis And metaphysis	Prenatal
	1	Human Right And Left Ischial Bone Fragment		Prenatal
	Enclosed Bag			
		Human Long Bone Fragments		Prenatal
		Unidentified Human Bone Fragments		Prenatal
		Unidentified Bone Fragments		
	1	Animal Tooth (Ovis aries or Capra hircus)		

Building 2b

Bag Tag	Findings		Description	Sex and Age Estimation
Bag C (1)	1	Spondylus		
Bag C (2)	1	Animal tooth fragment		
		Unidentified long bone and other fragments		
Bag C2 (1)	1	Animal proximal phalanx		
Bag C2 (2)	1	Bovidae (Sheep or Goat) talus		
	4	Unidentified fragments		
Bag C2 (3)	1	Spondylus		
Bag C2 (4)	1	Probably Bos taurus humerus	Distal portion	
	6	Unidentified fragments		
Bag C2 (5)	1	Bovidae (Sheep or Goat) tooth		
Bag C2 (6)	2	Unidentified fragments		
Bag C2 (7)	1	Animal tooth		
	2	Unidentified fragments		
Bag C2 (8)	2	Unidentified fragments		
Bag C2 (9)	3	Unidentified fragments		
Bag C2 (10)	1	Unidentified fragment		
Bag C2 (11)	3	Unidentified fragments		
Bag C2 (12)	1	Unidentified fragment		
Bag C2 (13)	5	Unidentified fragments		
Bag C2 (14)	2	Unidentified fragments		
Bag C2 (15)	1	Unidentified fragment		
Bag C2 (16)	3	Unidentified fragments		
Bag C2 (17)	6	Unidentified fragments		
Bag C2 (18)	6	Unidentified fragments		
Bag C2 (19)	1	Bovidae (Sheep or Goat) tooth		
	5	Unidentified fragments		
Bag C2 (20)	7	Unidentified fragments		
Bag C2 (21)	1	Bovidae (Sheep or Goat) tooth		
	5	Unidentified fragments		
BagC2 (22)	1	Bovidae (Sheep or Goat) radius		
Bag C2 (23)	1	Tooth fragment		
	9	Unidentified fragments		
Bag C3 (1)	1	Unidentified fragment		
Bag C3 (2)	1	Long bone fragment		
Bag C3 (3)	1	Bovidae (Sheep or Goat) tooth		
Bag C3 (4)	1	Unidentified fragment		
Bag C3 (5)	1	Unidentified fragment		
Bag C3 (6)	1	Unidentified fragment		
	3	Materials of unknown nature		
Bag C3 (7)	1	Unidentified fragment		

Bag C3 (8)	1	Bos taurus phalanx		
	1	Unidentified fragment		
Tomb B				
Bag Tag	**Findings**		**Description**	**Sex and Age Estimation**
Bag B1	1	Human Left talus		
	1	Human Left calcaneus		
	7	Human Phalanges		
	1	Human Left 1st metatarsal		
	1	Human Cervical vertebra		
	2	Human Thoracic vertebrae		
	1	Human Right radius	Proximal portion	
	1	Human Right hemimandible	Mandibular condyle	
	1	Human Left Os Coxa	Acetabular fossa	
	1	Human Left scapula	Glenoid fossa	
	1	Human Right femur	Proximal metaphysis	Prenatal
	1	Hare mandible with mandibular teeth		
	1	Bovidae (Sheep or Goat) tooth		
	1	Alectoris humerus	Proximal portion	
	1	Probably hare calcaneus		
	1	Probably hare long bone		
	1	Bovidae (Sheep or Goat) calcaneus		
		Unidentified long bone, rib, vertebra and other fragments		
Bag B2	1	Sus tooth		
		Unidentified long bone, rib and other fragments		
Bag B3	1	Human Right talus		
	1	Human incisor		
	1	Human Right Os Coxa	Acetabular fossa	
	1	Human Right 4th metatarsal		
	1	Probably hare calcaneus		
	1	Probably hare metapodial		
	1	Alectoris humerus		
	1	Alectoris femur	Proximal portion	
	1	Bovidae (Sheep or Goat) radius	Proximal portion	
	1	Bovidae (Sheep or Goat) tooth		
		Unidentified long bone, rib and other fragments		
Bag B4	1	Human incisor		
	1	Bovidae (Sheep or Goat) incisor		
		Unidentified long bone, rib and other fragments		
Bag B5	1	Human incisor		

	2	Human Parietal bones	Fragments	
	1	Human Thoracic vertebra		
	1	Bovidae (Sheep or Goat) tooth		
	1	Wolf or Dog maxilla	Fragment	
	1	Hare tibia	Distal portion	
	1	Hare humerus		
	1	Hare calcaneus		
	1	Hare Os Coxa		
	1	Hare radius		
	2	Hare metapodials		
	1	Hare long bone		
		Unidentified long bone, rib and other fragments		
Bag B6	1	Human Left Os Coxa	Part of the iliac spine	
	1	Human Right hemimandible with mandibular teeth (2 incisors / 1 canine / 1st premolar root / 3 molars)		Male
	1	Human Left hemimandible	Mandibular condyle	
	1	Human Left radius	Proximal portion	
	1	Human Left femur	Proximal epiphysis	
	1	Human Right tibia	Proximal epiphysis	
	1	Human Phalanx		
	1	Human Fibula	Diaphysis	
	1	Alectoris femur	Proximal portion	
	3	Unidentified long bone and other fragments		
Bag B7	2	Human Premolars		
	1	Human Coracoid process		
	1	Human Thoracic vertebra		
	1	Human Right ulna	Proximal epiphysis	
	1	Human Right humerus	Distal portion	
	1	Human Right hamate		
	1	Human Right cuboid		
	1	Human Left 4th metacarpal		
	2	Bovidae (Sheep or Goat) teeth		
		Unidentified long bone, rib and other fragments		
Bag B8	1	Human Right calcaneus		
	2	Human Premolars		
	3	Human Phalanges		
	1	Human Cervical vertebra		
	1	Human Frontal bone		Male
	1	Human Left Os Coxa	Part of the ilium	
	1	Human Left Radius	Distal epiphysis	
	1	Human Left 2nd metatarsal		

	1	Alectoris femur	Proximal portion	
	1	Alectoris coracoid bone		
		Unidentified long bone, rib and other fragments		
Bag B9	1	Probably Calf tooth		
Bag B10	1	Human Right femur	Proximal portion	
Bag B11	7	Human Phalanges		
	1	Human Femoral head		
	1	Human Right Scapula	Glenoid fossa	
	1	Human Left humerus	Diaphysis	
	1	Human Right humerus	Distal epiphysis	
	1	Human Left tibia	Diaphysis	
	1	Human Left hemimandible with the 1st and 2nd molars	Fragment	
	3	Human molars		
	2	Human canines		
	3	Human premolars		
	2	Human incisors		
	4	Human unidentified teeth		
	2	Bovidae (Sheep or Goat) teeth		
	1	Bos taurus tooth		
	1	Alectoris ulna	Distal portion	
		Unidentified long bone, rib, vertebra and other fragments		
Bag B12	2	Hare mandibles with mandibular teeth		
	1	Hare Os Coxa		
	1	Hare Os Coxa		Minor
	1	Bovidae (Sheep or Goat) tooth		
	1	Micromammal incisor		
	1	Alectoris femur	Distal portion	
	1	Alectoris humerus	Distal portion	
	1	Wolf or Dog maxilla atlas		
	2	Probably Hare ulnas		
	1	Bos taurus phalanx		
		Unidentified long bone, rib and other fragments		
	2	Ceramics		