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The animal remains from Calle Almendralejo nr. 41 (Mérida, Spain): A contribution to our understanding of animal husbandry in the capital of Roman Lusitania

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ABSTRACT

The study of zooarchaeological collections from Mérida is still rare, lacking above all information on the Romans diet and animal management. Here we present the description of the fauna found in a dump next to the northern part of the Roman wall, which also includes some contexts of ritual nature, dated to the 1st century AD until the beginning of 5th century AD. The osteological remains of animals have shown that most of them come from food waste and worked bones. We can see that there is a temporal evolution in the use of that space and in the species used, with smaller animals being preferred in the first phase and cattle being more abundant in the 4th century. Some improvement indicators were also identified, as would be expected for a provincial capital, such as *Emerita Augusta*. Also, ritual burials of numerous dogs as well as a skeleton of the oldest specimen in Iberia of Egyptian mongoose, camel and an edible dormouse, constitute interesting discoveries in this assemblage, demonstrating that this is an exceptional sample.

1. Introduction

This article presents a study of the animal remains from a series of contexts – formally - a dump located in the northern suburbs of the roman capital of Lusitania – *Emerita Augusta*, today named Mérida (Fig. 1).

The city of Mérida is located on the banks of the Guadiana River, in western Spain and less than 100 km from the border with Portugal. Its name derives from the Colonia Augusta Emerita, founded by order of Augustus around 25 B.C., named as such because it was a destination for retired soldiers - "emeritus" (plural "emeriti") - from the so-called Cantabrian Wars (29–19 B.C.). About ten years later, it became the capital of the Ulterior Lusitania Province, the westernmost known world. With the major administrative reform of Emperor Diocletian in 285, Lusitania became part of the Diocese of Hispaniarum, a new political-administrative entity encompassing the ancient provinces of the Iberian Peninsula and African Mauritania Tingitana. At the head of this vast territory was a high imperial official, the vicarius Hispaniarum, whose residence was established in Emerita (Arce, 2002), somewhat becoming the capital of the "Hispanias" diocese. The decline of the Roman Empire - at least its western part - throughout the 5th century, also marked the end of this city's political power, although it had already suffered various military assaults by barbarian peoples within the context of the so-called Great Migrations (Heras, 2018). Among these were the Suebi, who for a decade - from 439 to 448 - established their court or center of power - "sedes regia" - in Mérida, leveraging its primary role in the imperial administrative organization (Heras and Olmedo, 2015).

From an urban planning standpoint, Augusta Emerita was designed as a walled city, with a street layout following a grid pattern, equipped with the necessary amenities for a complete urban life (paved roads, sewage system, aqueducts, baths, large squares, and entertainment buildings such as the theatre, amphitheatre, and circus). The fortified area featured monumental gates at the ends of the main streets - the decumanus maximus and the kardo maximus - and smaller gates along its perimeter. Roads diverged in all directions from these gates, and along their routes, funerary monuments and simple burials were built, encircling the entire city.

Excavations in the "Corralón de los Blanes" or Calle Almendralejo No. 41 revealed part of the northern suburban area of the Roman city,

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displaying an interesting topographical evolution and a robust archaeological sequence, alternating between funerary, cultic, and industrial uses with urban waste dumps (Heras et al., 2011). Eleven meters of stratigraphy summarize almost ten centuries, from the 1st to the 10th AD, allowing an understanding of the development of this peripheral zone from the very origins of the Colony and the urban layout beyond the walls.

In this area, a few meters from one of these Roman gates, two monumental mausoleums up to 4 m in height were erected at the beginning of the 1st century. These were completely buried by urban debris within just 30 or 40 years of their construction. Upon their remains, in the 2nd century, new graves were once again excavated which, after a few years, were once more buried under several meters of domestic and construction sediments, interspersed with successive layers of inhumation graves. Only by the end of the 4th century does this alternation of dump-burials seem to pause for a few decades, to give rise to a complex of religious, domestic, and industrial buildings on levelled landfill strata, helping to regularize the topographical disparities of this city area (Heras et al., 2017).

Ultimately, the real protagonist of these excavations is the dump, which spans almost five centuries, alternating with other uses of space - mainly funerary - sealing and preserving constructions and burials. Above all, it serves as a testament to life within the city, reflecting changes in architectural tastes, the evolution of utensils, and the consumption habits of its inhabitants.

The bone assemblage presented in this dump comprised 1728 animal bones and teeth and 52 mollusk shells. Some were clearly food remains, while others are the debris resulting from bone working. Others represent animal ritual practices. These remains are therefore a unique and complex group of different zooarchaeological contexts that we shall attempt to interpret. The use of this space at Almendralejo street in Roman times can be told, in part, through these bones and the animals they represent.

Augusta Emerita was a newly founded city by the military in its efforts to expand the Roman empire. A great number of people lived in this region and so supplying such a big city with sufficient food must have been something of a challenge.

The authors have also conducted studies on remains from Casa de Mitreo, an important Roman *Villa* also located in Mérida. Excavations at this site have yielded faunal materials from various sections of the house, notably a *taberna* (workshop) containing abundant worked bones (Bustamante and Detry, 2019; Detry and Bustamante, 2024). Bustamante et al. (2021) also described a specific context at Calle Almendralejo, examining the ritual setting within a quadrangular building that had inside human remains alongside with approximately 36 dogs.

Undoubtedly Mérida must have received several innovations directly from the center of the Roman empire such as new husbandry techniques and perhaps even new livestock. Indeed, we have evidence for the introduction of exotic species such as a camel and an egyptian mongoose (Detry et al., 2018; Bustamante and Detry, 2019). We can also suggest that new cattle husbandry techniques introduced into Mérida resulted in an increase in size of this animal – perhaps reflecting a conscious improvement of cattle (Detry et al., 2022). In other Roman provinces of the Iberian Peninsula, animal improvement is limited to Roman cities with no indigenous occupation. Put another way, animal improvement appears mainly in newly founded Roman cities (Fernandez-Rodríguez, 2003; Colominas, 2013; Nieto-Espinet et al., 2021; Detry et al., 2022). This probably means that Roman engineers came and applied the same economic plan to supply these cities.

The primary objective of this article is to provide a comprehensive description of the faunal remains discovered at Calle Almendralejo and to interpret their significance. This includes elucidating the role of animals in the diet of the local population, comprehending the management of domesticated animals, assessing the significance of hunting practices, and even exploring potential relationships with pets.

2. Archaeological context

The sample presented comes from a large plot located in what was the ancient city of *Augusta Emerita*, capital of the Lusitania province. The interest of the site is defined by the following aspects.

a) Location: the intervened site had 5000 m2 and, although it is currently in the heart of the city, it was located in Roman times in what was the northern suburb of the city (Figs. 1 and 2). This space has been subject to the abrupt orography of the land with a wide fall between what is the provincial forum of the city - which flanks it on the north side- and the course of the Barraecas (Albarregas) river - on the southern limit. This unevenness has allowed a slow and powerful clogging with a stratigraphy that reaches, in some points, up to 12 m (see the profile in Fig. 3).
b) Chronology: its privileged location has allowed its uninterrupted use from the founding moments of the city (25 BC) to the present, which helps to trace a clear diachronic evolution of the place. The levels that provided animal remains date from the 1st to the 5th century AD
c) Functionality: the clogging dynamics of the entire space has developed from the engulfment of some chronological facies by others, which has ended up generating the elevation of the footing floor. The space has combined the function of a great necropolis marked out with monumental buildings between the Augustan period and the

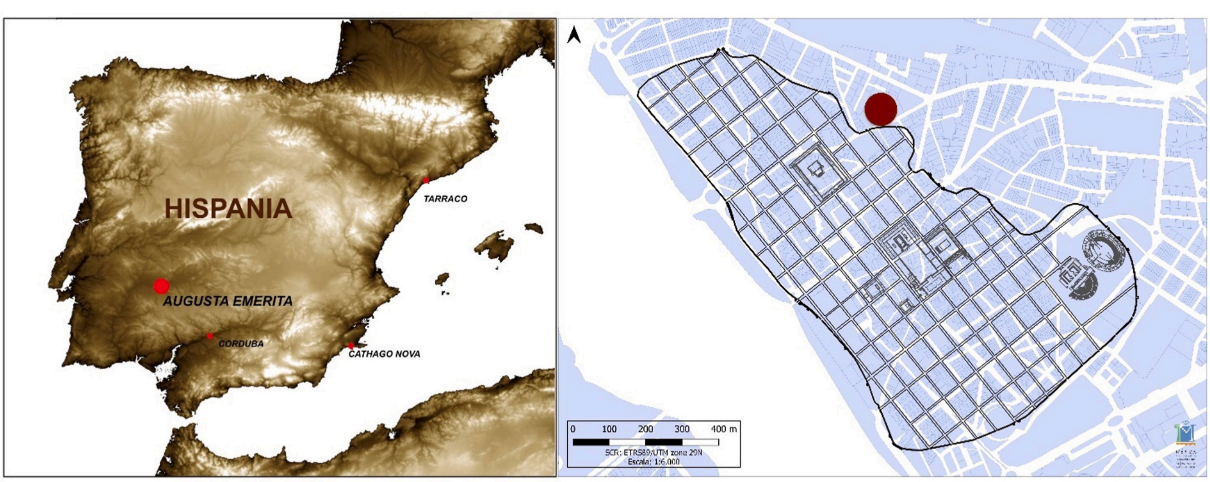


Fig. 1. – On the left location of Emerita Augusta (today's Mérida) in the Iberian Peninsula. On the right location of the site in the city of Mérida with the Roman plan of the city in dark.

Fig. 2. - Aerial photography of the excavations at Calle Almendralejo (Corralón de los Blanes) in Mérida. Photo by J. Rueda (Consorcio de la Ciudad Monumental de Mérida).

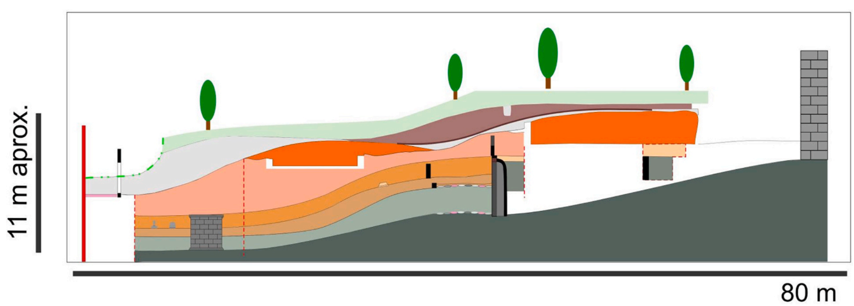


Fig. 3. - Schematic profile of the excavations at Corralón de los Blanes, the site on Calle Almendralejo No. 41 in Mérida.

reign of Nero; a large dumping ground for the debris from the city from the Neronian period to the 3rd century AD; the definition of late artisan spaces - case of a pistrinum/bakery -, as well as a cult space dedicated to the Magna Mater – taurobolium.

This combination makes the site the ideal one to evaluate any archaeological evidence in a diachronic and functional key. In fact, in the specific case of faunal resources, the majority come from the facies associated with the landfill. However, its proximity to the heart of the city makes it difficult to identify or relate to specific discharges.

These contexts were excavated between 2005 and 2007 and the strata attained a height of 5 m and ranged in date from the 1st century AD to the 5th century AD, moment that focuses our study (Heras and Olmedo, 2010; Heras et al., 2011, 2013). In addition, ritual contexts were also found such as a 5th century temple at the top of these layers (Heras et al., 2013) and a monument formed by a small tower with four human cremations, two human skeletons, some 36 dogs and one Egyptian mongoose dating to the year 60 AD (Heras and Olmedo, 2010; Detry et al., 2018; Bustamante et al., 2021).

This excavation produced a great amount of archaeological remains including construction materials, ceramics, metal, paintings, animal bones, human burials, and Roman structures. The sigillata have been thoroughly studied by Bustamante-Álvarez which provided a good chronological frame for the contexts (Bustamante, 2013). Due to the extensive excavation area and the construction context of a new park, the archaeological works had to be expedited, and no sieving was conducted.

3. Methodology

The animal remains were recovered during an emergency excavation directed by F.J. Heras on behalf of the Mérida consortium during 2005, 2006 and 2007 in advance of the construction of a park. The remains are stored at the Mérida consortium facilities and were studied with the help of Detry's private reference collection. Some were brought to Lisbon for identification using the reference collection of the Laboratory of Archaeosciences in Lisbon (Laboratório de Arqueociências – Direcção Geral do Património Cultural, Portugal).

Regarding the methodology used for recording bones and teeth aligns with the approach outlined by Davis (1992, 2012), a methodology that uses diagnostic zones, as suggested by Watson (1979). This methodology, referred to as "Parts of the Skeletons Always Counted" (POSAC), involves specific criteria for registering bones and teeth.

- Long bones: Distal parts are recorded when they are present more than 50%. Alternatively, when at least the medial half of the

articulation or metaphysis is present, allowing observation of the fusion state of the epiphysis.
- Short bones like the astragalus: Counted when more than half is present, and for the calcaneum, the articulation's presence is considered.
- Teeth and mandibles: At least one tooth needs to be present in more than 50% to be counted.
- Phalanges: Only the first and third are counted. The first is registered when the proximal articulation is present, while the third is counted if the articulation exists.
- Vertebrae, ribs, and cranium: These are not included in the count due to the difficulty in identifying them to the species level.

While this method, which is more restrictive, might be better suited for larger assemblages like the one from Mérida, it might not be as appropriate when seeking a more comprehensive understanding of taphonomic processes. As our primary aim, at this stage, was to gain an overview of the primary species within this specific subject, this method offers us a comprehensive insight into this subject.

The use of the POSAC method enabled us to determine the Number of Identified Specimens (NISP), which inherently serves as a Minimum Number of Elements. This facilitated quick identification of the Minimum Number of Individuals (MNI) for each species. To calculate the MNI, the NISP for each bone was divided by the bone's frequency within the skeleton. Additionally, the state of fusion was also used when determining the MNI. We described the NISP by anatomical parts, including state of fusion in the Supplementary materials 1.

In our efforts to distinguish between sheep and goat bones, we applied the criteria established by Boessneck (1970), Zeder and Pilaar (2010), and Zeder and Lapham (2010). However, based on our observations, we found consistent and reliable differences primarily in the decidual teeth, humerus, astragalus, calcaneum, and metapodials.

To differentiate between domesticates like pigs and wild boars, we initially relied on osteometry. However, findings indicated that measurements from these two suids are notably similar in the Iberian Peninsula, as highlighted by Albarella et al. (2005). Consequently, we identified all suids as *Sus* sp. Subsequently, we utilized odontometrics, specifically measurements of the inferior third molar, to further discern the presence of the wild form (following Davis, 2006).

Regarding bovines, we inferred that *Bos primigenius* had become extinct in the Iberian Peninsula. According to Castaños (1991), its disappearance occurred during the Bronze Age, while Detry et al. (2021) suggest its extinction sometime in the Iron Age. Consequently, all bovine remains were classified as *Bos taurus*.

Age-at-death information was obtained via the state of fusion of long-bone epiphyses and, for teeth, via their state of eruption and wear – Payne (1987) for caprines and Grant (1982) for pigs and cattle.

Selected bones were measured using a digital caliper (Mitutoyo) following the suggested measurements of Von de Driesch (1976) and Davis (1996) for metapodials. The measurements taken have been provided in the supplementary materials 2 for reference.

To standardize measurements across various bones to a uniform scale, we employed the Logarithmic Scale Index (LSI) method, as outlined by Simpson et al. (1960). This approach is valuable for harmonizing measurements from diverse bones into a singular scale, allowing for better comparison between samples and helping the interpretation of size variations.

The formula applied was d = Log (X) — Log (Standard), where d represents the value depicted in the graph, and X denotes the measurement obtained from the bone. In this analysis, a skeleton from the reference collection at the Laboratory of Archaeosciences (DGPC) in Lisbon served as the standard for comparison.

A thorough taphonomic analysis has not been done in this paper, as this aspect of the research is currently being pursued in greater depth by other researchers. In our observations, we recorded limited indications found on the identified bones, particularly signs of burning. Regarding incisions, we categorized them into cutmarks if they exhibited fine lines, chop marks when indicative of being produced by a cleaver or axe and identified sawn marks. However, our analysis did not encompass other types of fractures. In instances where alterations made by animal were evident, we primarily differentiated between marks made by rodents and carnivores. Notably, during excavation, archaeologists had previously separated worked bones, including bone needles, and this also needs a more thorough analysis.

Mollusks were registered when the hinge was present in bivalves and the opening of the shell in the case of gastropods. For taxonomic identification we used the atlas from Macedo (1996).

4. Results and discussion

A total of 141 molluscs and 1728 vertebrate remains were recorded. They are particularly well preserved with most showing few signs of corrosion. Many are also complete and quite a few had been worked to produce bone utensils.

4.1. Mollusca

Unlike the vertebrate remains, molluscs are not very abundant. This is hardly surprising given that Mérida is 250 km away from the coast. The Guadiana River crosses the city and was probably an important route for transporting goods and people. Some shells could have come from the southern Iberian coast – a distance that would have required several days' journey. These long distances from the coast must have made it difficult to keep molluscs in an edible state.

From a total of 141 shells found, 115 belonged to *Ostrea edulis* (Table 1), the round oyster, native to the Iberian Peninsula. According to Castaños and Escribano (2010) it is possible to pack oysters in wicker baskets thus maintaining them in good conditions for 7 days. In cold weather live oysters can survive up to 12 days. These same authors report several Roman sites in the interior of northern Spain where oysters where also relatively abundant, an aspect that seems very typical of the Roman period.

In fact, the Romans are known to have appreciated oysters and to cultivate them in *vivaria* and *ostrearia*. Pliny the Elder described how the first cultivation of oysters was attributed to Sergius Orata, a man of great wealth who led a life of luxury and who was a contemporary of L. Crassus (Pliny the Elder Book IX, Chapter 79, Gunther, 1897). The presence of this marine species in Mérida so far from the coast demonstrates the high status of this food. It was no doubt worth the effort to bring this species to some banquet of a person of importance.

In general oysters are more common in estuaries where they tolerate shallow water for several days - enough to be transported by land or water to Mérida. In today's Algarve coast, eg. at Castro Marim, vast areas are used for aquaculture and so it is likely that the same happened in Roman times.

The other few remaining bivalves belong to *Acanthocardia* sp., *Pecten maximus*, *Arctica islandica* and *Glycymeris* sp. All of these are characterized by having robust and beautiful shells that could have served as containers for liquids products as well as other uses. *Glycymeris* sp. could not have been collected alive since it lives on the sea bottom at depths of some 100 m. In Roman times boats capable of making such a collection did not exist. Normally these specimens are collected as dead valves on the beach and kept for other uses.

One *Murex* sp. and four *Stramonita haemastoma* were found, both were also appreciated since pre-roman times for their purple pigments used for dying fabrics (Marín-Aguilera and Gleba, 2019). The small number of these species does not serve as evidence for the use of these animals for this purpose. Nor would it be feasible since it is necessary to process it immediately after it has been collected. In this sense, the capital of Lusitania did have a well-developed dyeing industry thanks to the use of Kermes Vermilio or cochineal, for which we have a manufacturing complex also located in the vicinity of this place

Table 1
– Number of Identified Specimens (NISP) of the invertebrate taxa identified along the several chronologies at Calle Almendralejo (Mérida, Spain).

	1st Century						2nd Century		4th Century		5th Century
	Initial	Middle	50–60 ADd	80–90 AD	80–100 AD	Final (Trajan)	Initial	Middle	2nd Half	4th Quarter	
Gastropoda											
Stramonita haemastoma		1							3		
Murex sp.				1							
Bivalvia		1									1
Glycymperys sp.		1		2							
Artica islandica				2			1		3		
Ostrea edulis		10	29	18	1	11	1	1	23	19	2
Pecten maximus				2	1	1				1	1
Acanthocardia sp.				2							
Cf. *Unio* sp.	2										

(Bustamante et al., 2018).

A couple of specimens of freshwater molluscs were also identified which we were unable to identify taxonomicaly.

Most shell remains derive from 1st century AD levels (85 elements), unlike the vertebrate remains that are more common in the 4th century AD. Although the second larger group comes from the 4th century (49 elements), and very few remains (four shells) from the 5th century AD and three shells in the 2nd cent AD (Table 1).

Fish remains were very scarce and were not studied.

4.2. Mammalia

Mammals constitute most of the vertebrates, with 97% of the fragments registered at Calle Almendralejo dump site, with a total of 1560 bones and teeth (Tables 2 and 3).

41% of the remains come from one context dated to the second half of the 4th century AD (see Fig. 4). This indicates that this dump site was particularly active during that period.

The other time where we have more remains is in the 1st century AD, just after the foundation of the city. The stratigraphic unit with more remains from this time is dated to the year 80–90 AD, constituting 21% of the sample (Fig. 4).

If we gather the remains exposed in Fig. 4 by century, we see that in the 1st and 4th centuries the dump was equally used to dispose animal remains. The reduced number of remains during the 2nd and 3rd centuries may be indicative of a lower level of activity at this location, possibly linked to the management of waste. The accumulation of a vast amount of domestic refuse produces bad smell and problems of contamination that can affect important water sources.

Of the species present the most frequent throughout the sequence at Calle Almendralejo are cattle (*Bos taurus*), sheep (*Ovis aries*), goat (*Capra hircus*), pig (*Sus scrofa domesticus*), and red deer (*Cervus elaphus*) (Table 1 and Fig. 5). Some of the suid remains may have belonged to the wild boar (*Sus scrofa*) which is very difficult to distinguish from the domestic form in Iberia via its bone and teeth (Albarella et al., 2005). Cattle, sheep, goat and pig are also the most common in Roman sites from Lusitania (Detry et al., 2022).

A strong presence of domestic animals shows, what we would expect for a city of this size, whose inhabitants depended on domesticated livestock and plants.

There are however some differences through time in the prevalence of these three taxa - cattle, suids and caprines (sheep/goat). In 1st century AD contexts, there is a prevalence of suid followed by caprines and cattle in third place. In the decade of 80–90 AD there was a small change with sheep and goat gaining more importance (see Table 2). Later in 4th century the most frequent remains, were from cattle (Fig. 5).

4.2.1. Artiodactyla

4.2.1.1. Bos taurus (cattle). Cattle is the most frequent animal in the 4th century layers with 54% of the total vertebrates (NISP) and remained the dominant animal in the remaining periods. This indicates a change of strategy in the management of the animals with respect to their supply of meat at Mérida.

The investment in larger animals like cattle, could indicate the need to feed more people, it can also indicate an increase in the use of this animal for secondary products such as milk and power for transporting people, goods and agricultural machinery.

Very few deciduous teeth were found and only in the levels of the 1st century. The percentage of third molars, the last tooth to erupt in the mandible, is very high in the 5th cent., reaching around 37% of the total of teeth, and in the 4th century around 8%, higher than in preceding times (see supplementary materials 1 for the details on number of teeth). This probably demonstrates an increasingly intense exploitation of this animal in later times for secondary uses other than meat.

Fig. 6 illustrates the distribution of tooth wear across various stages, revealing a prevalence of older animals in the 4th century. These animals exhibit greater tooth wear, with a notable absence of deciduous or unworn teeth. In contrast, during the 1st century, there is a higher number younger animals, likely slaughtered for their meat. The shift towards older animals in the 4th century suggests a probable utilization for their strength in tasks such as transport and work in the fields.

Fig. 7 illustrates the percentage of unfused bones among various species, revealing a slight decrease in unfused bones in cattle. This trend is consistent with findings from the tooth wear analysis, reinforcing the idea towards the presence of older animals during the later period.

The abundance of metapodials especially in the Late Roman levels may have another explanation. We noted many that were sawn perpendicular to their diaphysis and near the epiphysis (Fig. 8).

In Fig. 9, the distribution of skeletal components is depicted, focusing on levels where cattle bones are more abundant. The graphic illustrates both the overall distribution and the prevalence of sawn bones. The data reveals that metapodials are most prevalent during the mid-1st century and the latter half of the 4th century.

In the late decades of the 1st century, there is a higher percentage of calcanea, though the adjacent astragalus does not show a similar increase (refer to Fig. 10 and Supplementary Materials 1). In the contexts of the 1st century (middle) and the second half of the 4th century, it is noteworthy that a significant portion of metapodials exhibit evidence of sawing in their diaphysis. Even when excluding these sawn bones, a substantial quantity of metapodials remains).

An interesting observation is that in the decade of 80–90 AD, femurs and tibias exhibit a higher frequency of sawing, while in the 3rd century, there is a notable increase in the sawing of radius and femurs.

This assemblage might have been, perhaps in part, derived from craftsmens' refuse.

The metapodials with their characteristic, length and robustness, are ideally suited for the production of bone needles - useful for sewing or to put the hair in place. At Casa de Mitreo (also in Mérida, Spain) several of these bone utensils were also found associated with sawn long bones (Bustamante and Detry, 2019; Detry and Bustamante, 2024), in this case the authors concluded it was a place to produce bone tools, no doubt a

Table 2
- Number of Identified Specimens (NISP) of the vertebrate taxa identified along the several chronologies at Calle Almendralejo (Mérida, Spain).

	1st Century	Transition 1st/2nd Cent.										2nd Century		3rd Century	4th Century			5th Century	
	Initial	Middle	2nd Half	50–60 AD	70–80 AD	80–90 AD	80–100 AD	Final (Trajan)	Final		1st/2nd Cent.	Initial	Middle	Final	2nd Half	3rd Quarter	Middle 3rd Quarter	Initial	All
MAMMALIA																			
Bos taurus	0	38	2	9	4	46	6	7	7	6	6	5	4	67	374	6	8	15	19
Ovis/Capra	1	26	1	7	0	168	0	5	0	0	0	25	0	0	140	0	0	15	5
Ovis aries	0	1	0	0	0	4	0	0	0	0	0	0	0	1	3	0	0	0	0
Capra hircus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
Sus sp.	2	94	2	1	0	101	2	9	6	5	0	25	2	1	48	1	0	2	1
Cervus elaphus	2	21	6	1	2	23	4	2	4	8	2	24	1	32	60	2	3	0	2
Dama dama	0	0	0	0	0	3	0	0	0	1	0	0	0	1	2	0	0	0	0
Capreolus capreolus	0	1	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0	0	0
Equus sp.	0	0	0	0	0	0	0	1	0	1	0	0	8	5	34	1	1	1	1
Oryctolagus cuniculus	5	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepus sp.	0	0	0	0	0	5	0	0	3	0	0	0	0	0	0	0	0	0	0
Canis familiaris	0	2	10	0	0	6	0	1	7	1	0	5	0	1	20	0	2	1	1
Felis catus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0
AVES																			
Galiformes	0	1	0	0	0	14	0	0	1	1	0	0	0	0	2	0	0	0	1
Gallus domesticus	1	1	1	9	0	1	0	2	0	0	0	0	0	1	1	0	0	0	0
Alectoris rufa	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	12	186	22	27	6	381	12	26.5	28	25	8	84	15	109	700	10	14	34	30

Table 3
– Minimum Number of Individuals (NMI) of the vertebrate taxa identified along the several chronologies at Calle Almendralejo (Mérida, Spain).

	1st Century										Transition 1st/2nd Cent.	2nd Century		3rd Century	4th Century			5th Century	
	Initial	Middle	2nd Half	50–60 AD	70–80 AD	80–90 AD	80–100 AD	Final (Trajan)	Final		1st/2nd Cent.	Initial	Middle	Final	2nd Half	3rd Quarter	Middle 3rd Quarter	Initial	All
MAMMALIA																			
Bos taurus	0	4	1	1	1	8	1	1	1	1	1	1	1	11	24	2	2	2	1
Ovis/Capra	1	3	1	1	0	16	0	0	0	0	0	3	0	1	14	0	0	2	1
Sus sp.	1	6	1	1	0	5	1	2	1	1	0	2	1	1	3	1	0	1	1
Cervus elaphus	1	3	2	1	1	4	1	2	1	2	1	4	1	9	5	1	1	0	1
Dama dama	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	0
Capreolus capreolus	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Equus sp.	0	0	0	0	0	0	0	1	0	1	0	0	1	1	3	1	1	1	1
Oryctolagus cuniculus	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepus sp.	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Canis familiaris	0	1	1	0	0	1	0	1	2	1	0	1	0	1	3	0	1	1	1
Felis catus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
AVES																			
Gallus domesticus	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
Alectoris rufa	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	4	20	6	4	2	40	3	7	6	8	2	11	4	26	55	5	5	7	7

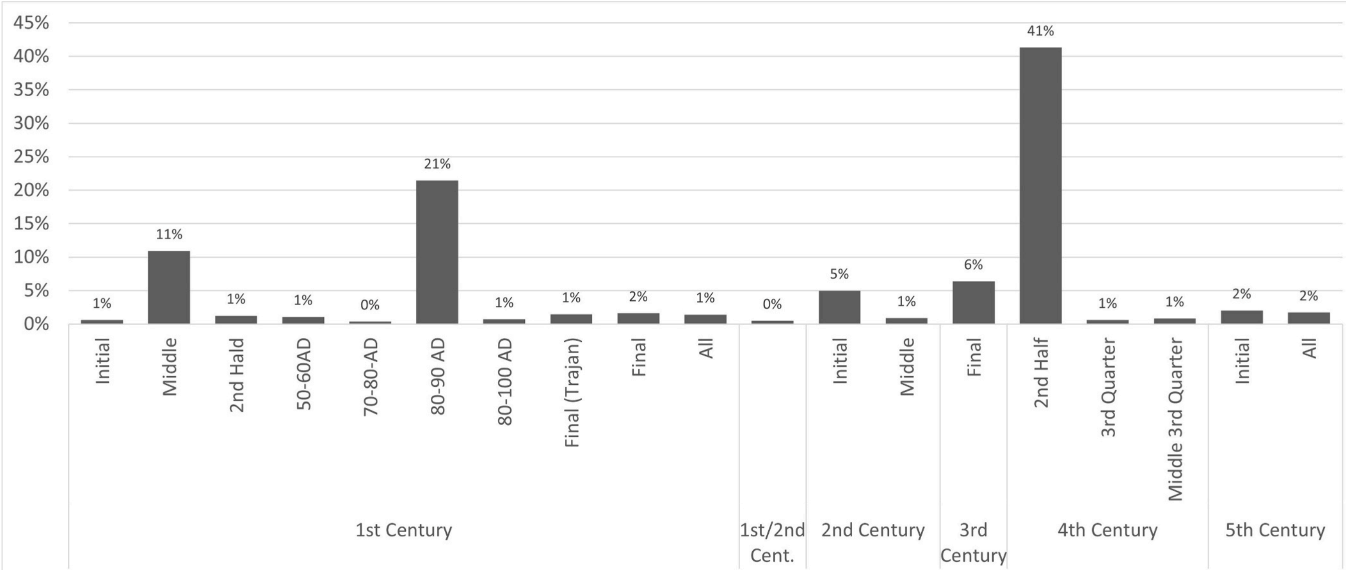


Fig. 4. – Percentage of animal remains by chronological phase at Calle Almendralejo No. 41 (Mérida).

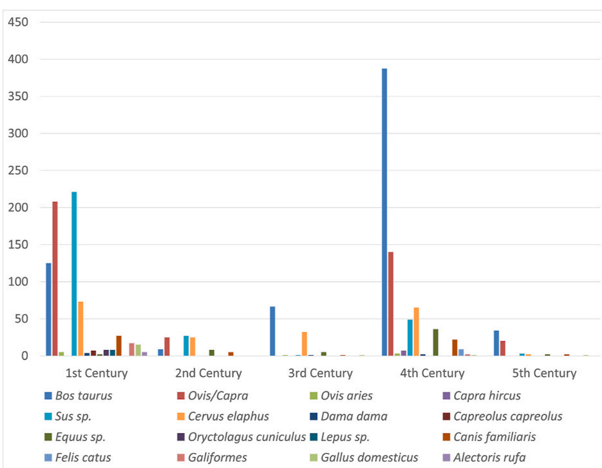


Fig. 5. – Number of Identified specimens by species and by century from the assemblage recovered at Calle Almendralejo No. 41 (Mérida).

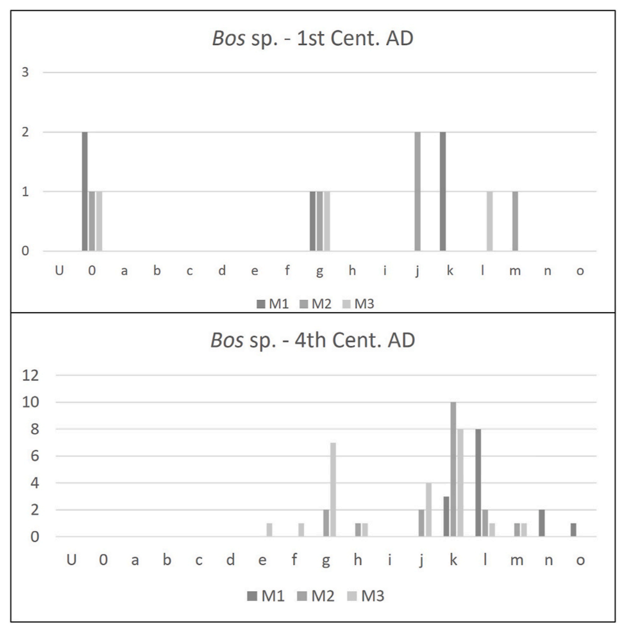


Fig. 6. – Distribution of number of lower teeth wear stages defined by Grant (1982) for *Bos* in two different periods from Calle Almendralejo (Mérida, Spain).

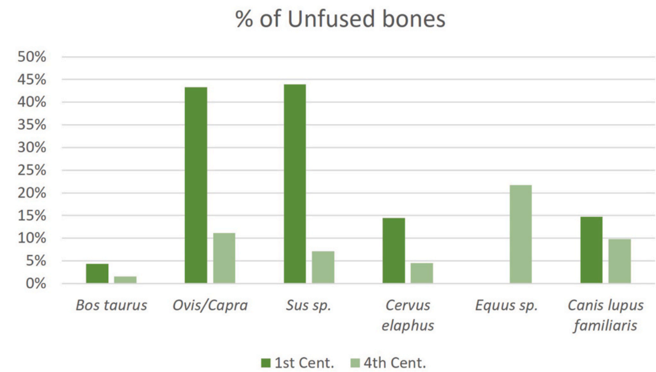
common and useful activity in late Roman Mérida.

These probably evidence the production of bone tools such as hair needles, bone plaques for jewelry, etc. In late Roman times there are more worked bones - metapodials were preferred. In the remains recovered in the excavations we can see all the parts of the "chaine opperatoire" (Fig. 10).

The high number of sawn metapodials and consequently higher number of bone needles in the late occupation of Calle Almendralejo could suggest the higher production of luxury items – perhaps a reflection of the wealth of this town during this time. A more detailed work will be published on these remains.

Fig. 5 shows a series of stacked histograms of measurements of distal metacarpals from several sites in Roman Lusitania. Note that the Roman cattle from Santarem were smaller than those from modern 15th century Beja. Detry et al., (2022) suggest that cities that had been occupied in pre-Roman times like Santarem had smaller cattle. Davis (2008), Davis et al., (2012), 2013, 2018) showed that cattle in Portugal were improved by the 15th century, as is confirmed at Beja. The measurements of the bones from late Roman Mérida and Ammaia, however, are larger than those from Santarém. Mérida, in the 1st and 2nd century, does not show significant differences from Santarém. We can also observe a certain spread of measurements forming two groups, since we know that metapodials can express sexual dimorphism we may assume that the smaller bones belonged to females and the larger ones to males. The separation is clearer when the greatest length of the metapodials is also considered (Davis et al., 2012, 2013, 2018), but at Mérida there were very few complete metapodials.

In the late Roman levels of Calle Almendralejo in Mérida, there is a distinct observation regarding the metacarpals. Unlike the other sets, which exhibit a bimodal distribution in measurements and indicate sexual dimorphism, the metacarpals present a unimodal distribution. We propose a hypothesis that in the late Roman levels, metapodials were intentionally chosen for a specific size, possibly with the intention of utilizing them for the production of bone utensils, since it coincides with the levels with higher number of sawn metapodials.



	1st Cent.				4th Cent.			
	F	UM	Total	%	F	UM	Total	%
B. taurus	133	6	139	4%	313	5	318	2%
Ovis/Capra	17	13	30	43%	32	4	36	11%
Sus sp.	60	47	107	44%	13	1	14	7%
C. elaphus	77	13	90	14%	63	3	66	5%
Equus sp.	7		7	0%	18	5	23	22%
C. l. familiaris	439	76	515	15%	46	5	51	10%

Fig. 7. – Percentage of unfused bones (i.e.; from immature animals) of the main species found at Calle Almendralejo (Mérida, Spain) and table with basic numbers. F – Fused, UM – Unfused Metaphysis.

Another interesting aspect that can be observed in Fig. 11 is that although aurochs may well have become extinct in the Iberian Peninsula before the Roman period, there are some large *Bos* bones of a size compatible with this wild animal (see also Supplementary Materials 2). According to Detry et al. (2022) no aurochs were found in Roman Iberia until now.

In the Chalcolithic the aurochs was relatively frequent (Driesch and Boessneck, 1976; Cardoso and Detry, 2001/2002; Detry et al., 2020; Valente and Carvalho, 2014). In the Bronze age their remains were very scarce presumably indicating they were already on their way to extinction (Castaños, 1991), with very few reports of aurochs in the Iberian Peninsula during the Iron Age (Cardoso, 1993; Detry et al., 2021b).

In fact, the absence of aurochs remains in the zooarchaeological record may not indicate the absence of this species in nature. A few wild herds may have continued to exist in isolated areas that served as refugia.

At any rate the vestigial presence of larger animals in this assemblage shows that even if they belonged to the wild form, this animal was rarely hunted and possibly only used for ritual purposes. Cattle on the other hand was certainly the species of choice to feed the people of Mérida in late Roman times.

4.2.1.2. Caprinae: Ovis aries (sheep) and Capra hircus (goat). Caprines are the most frequent taxa in the decade of 80–90 AD. If we look closer at the different periods these animals seem to be consistently the second most frequent in the second half of the 4th century and beginning of the 5th century. The proportion of sheep and goat varies in the course of time, especially in the levels with fewer bones (Tables 2 and 3).

In terms of body-part representation cattle and caprines differ. For caprines teeth are much more abundant (see supplementary materials 1). This may reflect a collection bias during excavation. Soil was not sieved at Mérida and so the various bones of the larger cattle are more likely to have been recovered. It is possible that teeth preserve better but this does not apply to the other species. In Fig. 12 we calculated the Minimum Number of Individuals (MNI) for the head, posterior and anterior member. The graphic demonstrates that during the 1st century (80–90 AD) and the latter part of the 4th century, the MNI is notably higher for the head. These specific levels were chosen for quantification due to their higher frequency and consequential significant data.

In the 4th century, 48% of the sheep and goat horns (totalling 58) exhibited signs of being sawn or chopped. Similarly, during the latter part of the 1st century, three out of six horns observed showed evidence of being sawn. These findings underscore a potential trend in deliberate modification or processing of horns during these periods.

Horns whose external part is keratin - often used to make cups, combs, and knife handles of various sorts. Keratin unfortunately does not generally preserve so only the underlying bone horn core and the

Fig. 8. – Sawn metapodials recovered from the stratigraphic unit [1600] at Calle Almendralejo (Mérida, Spain) and dated of the second half of the 4th century.

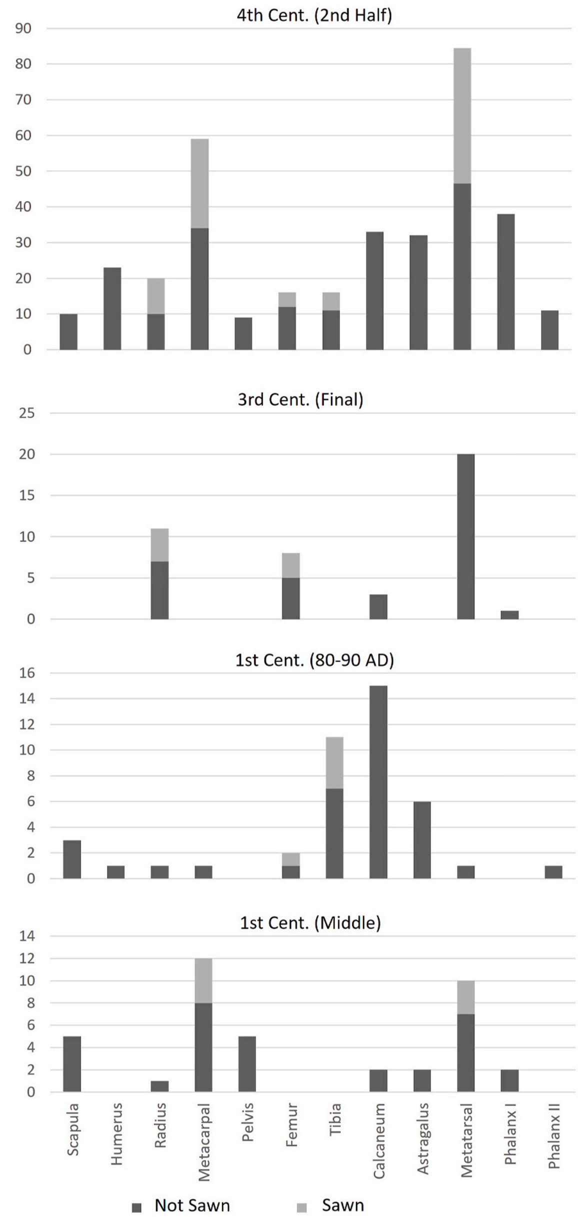


Fig. 9. – Number of identified specimens by parts of the skeletons for *Bos taurus*, including both sawn and unsawn specimens.

skull bones testify the use of this material. The animals were probably used for meat and secondary products and after slaughtering their heads sent to craftsmen who would then dump the refuse in this part of Mérida. Any remaining parts of the skeleton would have been deposited elsewhere.

The few caprine bones that could be identified to species level proved to be sheep. Horns are frequent in the 4th century and most (89%) were sheep. It is probable that sheep being more adapted to grazing the extensive planes around Mérida were preferred.

Fig. 13 shows the distribution of the mandibles by age classes. Note a slight difference between the 1st and the 4th century. Caprines were slaughtered at an older age in the 4th century - perhaps they were used more often for their secondary products such as milk and wool. In the 1st century there are two peaks, one around one to two years old, the best time to slaughter these animals for their meat since they have attained the maximum weight, and the meat is still tender. And a later peak around 3–4 years where animals were left to live a little bit longer to extract more resources.

Fig. 10. – "Chaine operatoire" of bone needles obtained from the diaphysis of cattle metapodials. Photo from Javier Heras.

Fig. 7 illustrates an important reduction in the occurrence of unfused bones from sheep and goat in the 4th century. The lower count of young animals in the 4th century contradicts the trends observed in teeth wear data. Also, some 13–18% of the teeth were deciduous throughout (see table S1.12 in Supplementary materials 1). The age profile does not seem to have changed drastically in the course of time. The animals deposited at the northern part of the city were probably used mainly for food and horn, with milk and wool being perhaps of subsidiary importance. It is although interesting the presence in the surroundings of some officinae lanificariae that tell us about how some of the vestiges could come from these artisan textile facilities dedicated to the processing of wool (Bustamante, 2018 or Bustamante and Picado, 2018).

4.2.1.3. Sus scrofa (wild boar) and Sus scrofa domesticus (pig). The suids were more common in the beginning of the 1st century AD – soon after the city was established (Fig. 5).

The suids are identified as *Sus* sp. As distinction between the wild boar and its domesticated descendant, the pig, is difficult. The wild boar still exists in the Iberian Peninsula and certainly existed in Roman times. It is omnivorous and very well adapted to the dry Mediterranean climate and with the scarcity of predators today it has become something of a plague that requires control. It was undoubtedly common in the forests around Roman Mérida.

The pig was probably domesticated in southwest Asia (Ottoni et al., 2013). Van Asch et al. (2012) show that in Iberia the pig suffered considerable genetic introgression from local wild boar. In their study of ancient DNA, Frantz et al. (2019) also found that the European pig admixed with European Wild Boar.

Differentiating pig from wild boar bones and teeth is mainly done through osteometry. The wild form is larger than the domestic form but there is some overlap which is even greater in the Iberian Peninsula (Albarella et al., 2005).

When we compare the measurements of the suids from Mérida with those of pigs from Launceston Medieval Castle in England (see Fig. 6, Albarella and Davis, 1996) and extant wild boar from Israel (measurements kindly provided by Umberto Albarella), we see that most of the Mérida *Sus* remains belonged to domestic pigs, with a few wild boars in later periods (Fig. 14).

Pigs are very well adapted and survive easily on human food scraps. The pig's high reproductive rate and easy transport also helps to make this species a preferred choice when there is the need to move around and provide food to a large amount of people.

Pigs do not produce secondary products and their primary function would be to provide meat and fat.

Pigs seem to be very frequent in the 1st and 2nd centuries and declined substantially in the 3rd, 4th and 5th century. Soon after the

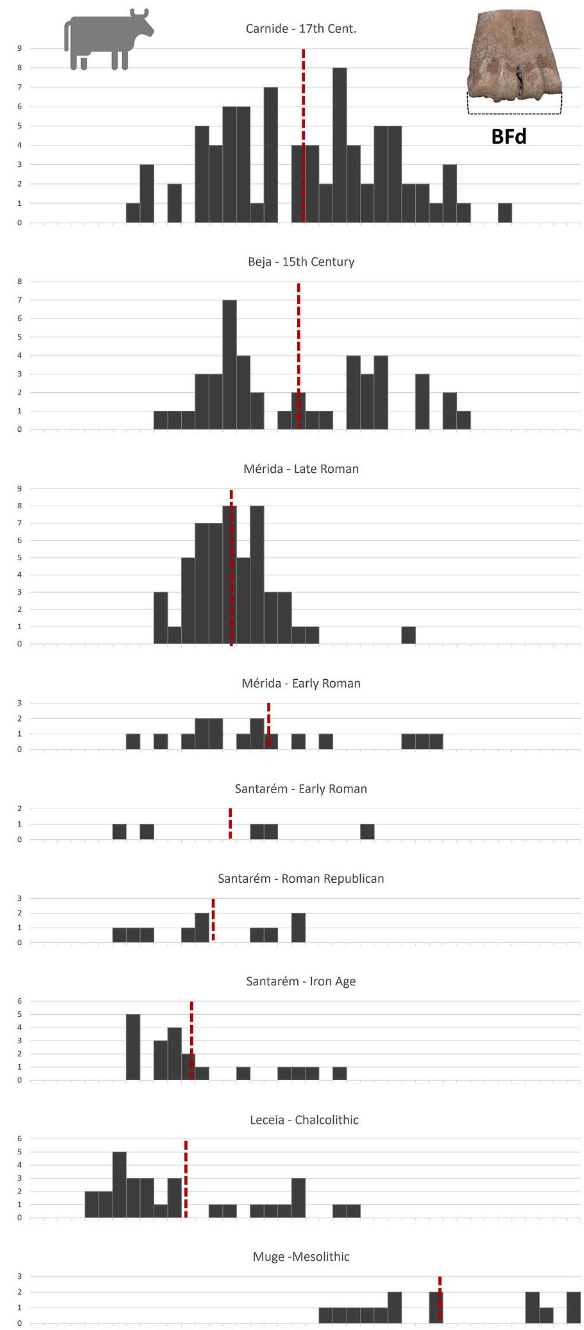


Fig. 11. - Stacked Histograms of measurements from *Bos taurus* metacarpals. Measurements from Muge are in Detry (2007), from Leceia (Cardoso&Detry, 2001/2002), from Santarém in Davis (2006), from Beja in Davis et al. (2012), from Carnide in Detry et al. (2021). The red line shows the average.

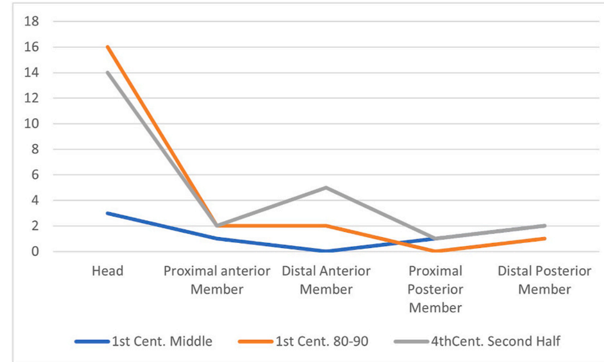


Fig. 12. – Number of Identified Specimens by main parts of the skeleton. We included in the head the mandibles; proximal anterior member – scapula and humerus; distal anterior member – Radius and metacarpal; proximal posterior member – pelvis and femur; distal posterior member – tibia, metatarsal, astragalus and calcanea.

Fig. 13. – Distribution of the wear stages of mandibles of sheep and goat wear stages of Payne (1973, 1987) in two periods in Calle Almendralejo (Mérida, Spain). 'A' being the youngest and 'H' the oldest.

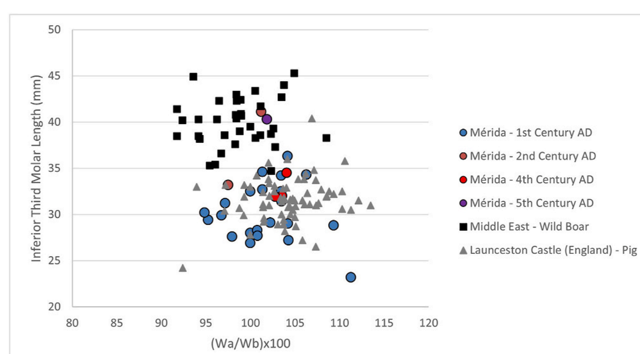


Fig. 14. – Measurements of third molars of *Sus* sp., length versus width of the first pillar (Wa) and second pillar (Wb). The measurements from Launceston castle are from Davis and Albarella (1996) and from the Middle East kindly given by U. Albarella.

foundation of Mérida, the pig was the second most abundant species and even the most abundant in the 1st century, but rare at the end of 1st century during Trajan's rule. This might indicate a less permanent occupation of the city in the beginning of the Era, which obviously changed during the construction of the city.

Big game hunting is obviously very important, and Romans are known for their love of big game. This may well explain the hunting of wild boars. In fact, the abundance of red deer bones shows that hunting was regular, and the surrounding forests would certainly have included numerous wild boar and deer.

In Fig. 15, the distribution of teeth wear stages in the 1st and 4th centuries is depicted. It is evident that during the 1st century, there exists a cluster of molars exhibiting higher wear stages (l, m, n), indicative of older animals. This cluster seems to be absent in the later phase.

It is during the 1st century, specifically in the decade of 80–90 AD, that we observe the presence of decidual teeth (supplementary materials 1, table S1.6). The clustering of both younger and older animals, which is relatively infrequent in the remaining periods, likely becomes more apparent when the overall assemblage is larger. Or given that pigs are not utilized for secondary products, the retention of older animals until

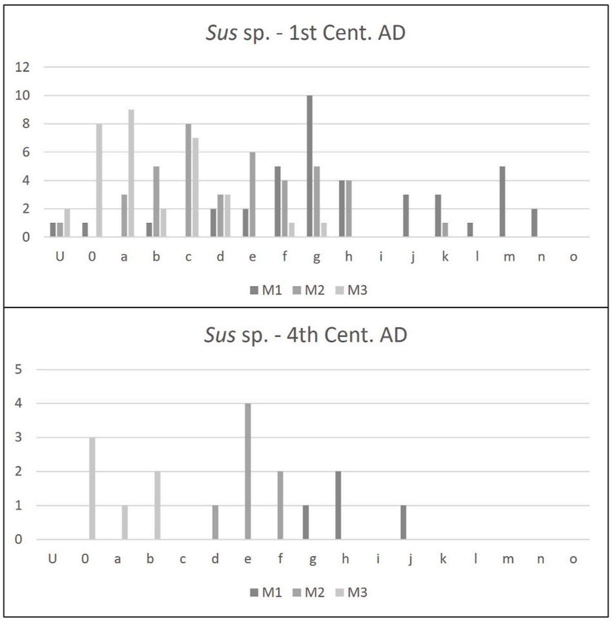


Fig. 15. – Distribution of number of lower teeth wear stages defined by Grant (1982) for *Sus* in two different periods from Calle Almendralejo (Mérida, Spain).

later suggests their purpose for breeding or older hunted wild boars. The occurrence of very young animals may signify occasional consumption of piglets or a peak in newborn mortality.

Also, in Fig. 7 we can observe that, similarly to sheep and goat, the percentage of unfused bones is more elevated in the 1st century. This pattern potentially strengthens the hypothesis that they were predominantly consuming younger animals in the earlier chronologies. However, it is crucial to acknowledge that the overall assemblage is considerably smaller in the 4th century.

We can hypothesize that the animals we see in the 1st cent. belong to a close production centre and where all the cohort is represented, and in a later phase we only see the animals that are traded and of high dietary value.

4.2.1.4. Cervidae - Cervus elaphus (red deer), Dama dama (fallow deer) and Capreolus capreolus (roe deer). The discovery of significant quantities of red deer remains at Calle Almendralejo indicates the potential importance of big game hunting, with proportions ranging from 55% to 0% when compared exclusively to cattle, suids, and caprines (see Fig. 16). Higher percentages seem to be associated with levels featuring smaller sample sizes, except for the fifth century, which lacked any remnants of this species. Assemblages with higher red deer percentages the proportion is approximately 10%, such as the middle of the 1st century, the decade of 80–90 AD, and the latter half of the 4th century.

Notably, levels dating to the end of the 3rd century stand out, displaying a distinctive characteristic with around 30% of red deer bones out of a total of 100 NISP. This may represent a specific moment marked by a heightened preference for this species. Nevertheless, red deer remains consistently appear throughout the sequence, suggesting that big game hunting was an enduring activity over time at Calle Almendralejo.

In Fig. 17, it is evident that both Republican and early Roman Empire sites in Lusitânia exhibit a similar proportion of red deer remains compared to the assemblages found in Mérida. However, in later Roman assemblages, there is a decrease in red deer numbers around Lisbon (e.g., NARC – Valenzuela, 2014, Odrinhas – Davis and Gonçalves, 2017; Tróia – Nabais, 2014), with higher numbers noted in interior sites like Quinta das Longas (Cardoso et al., 2005) and Mesas do Castelinho (Valenzuela and Fabião, 2012). This shift possibly indicates areas where the ideal habitats for red deer were more prevalent during that period.

In the representations of animals on Terra sigillata ceramics from Hispania Bustamante and Detry (2022) noted that the most represented herbivore is the male red deer, often with large antlers. The depictions of animals on ceramics exhibits mainly animals of particular interest to the Romans, and probably with mythical significance. Animals that were the main source of food are largely underrepresented (Bustamante and Detry, 2022).

Red deer hunting is sometimes associated with settlements that were probably only occupied briefly, such as military camps (eg. Monte dos Castelinhos, Santos et al., 2018), aristocracy (eg. Monte Molião, Detry and Arruda, 2013) or environmental reasons (abundant forests). In Lisbon, in the beginning of the Roman occupation we find red deer bones even inside the Roman walls (Santos et al., 2020). This large cervid was probably very common especially in forests in the interior of Lusitania and around larger towns such as Lisbon and Mérida. As is the case today

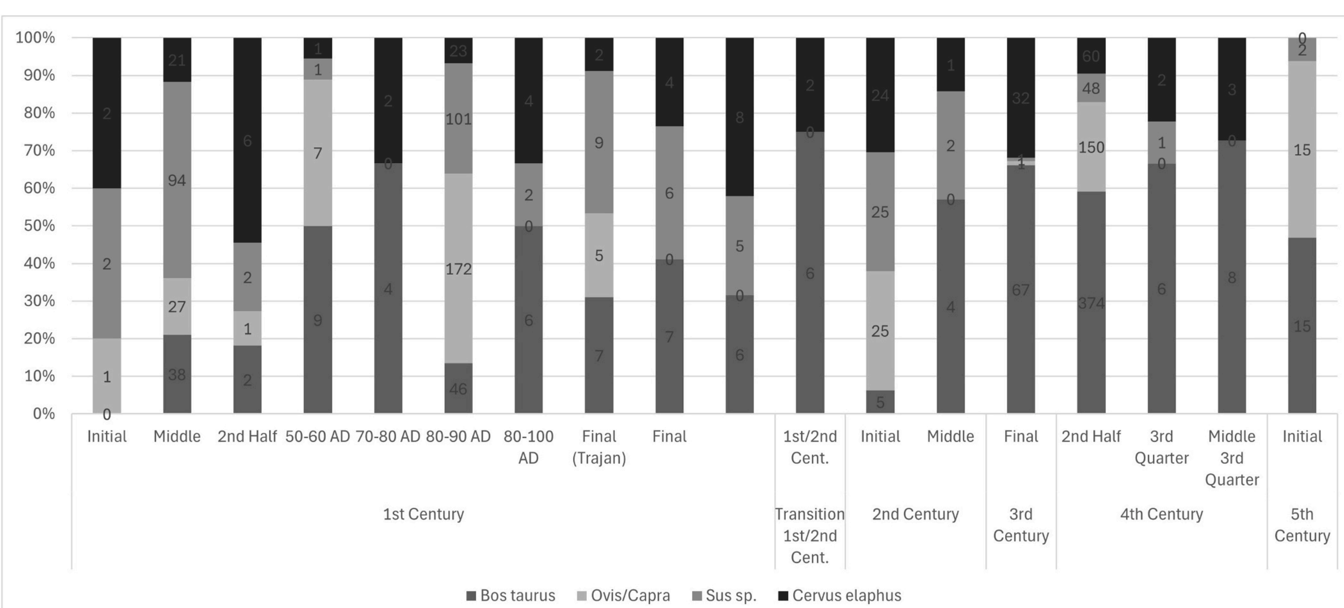


Fig. 16. – Percentages of the main artiodactyl species found in Calle Almendralejo (Mérida, Spain) along the different levels with emphasis on the red deer (*C. elaphus*).

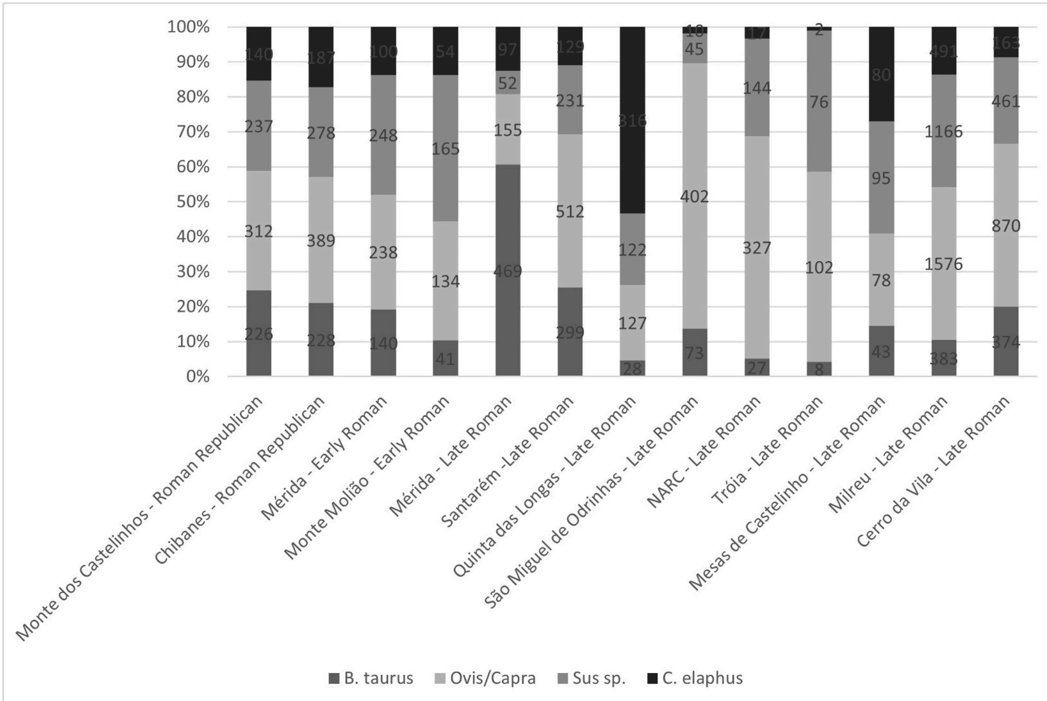


Fig. 17. – Percentage of remains of the main mammal species (bovines, suids, sheep, goat and red deer) in different archaeological sites in Lusitania in different phases of the Roman period.

the male antlers would serve as interesting trophies to the Roman aristocrats and military and possibly also have medical uses (Miller and Sykes, 2016).

Only four bones and three teeth of roe deer were found - all from 1st century AD levels.

The Roe deer is a small animal about the size of a sheep. It is scarce

Fig. 18. – Camelid distal radius. Photo José Paulo Ruas.

today and only present in mountainous and protected areas in northern Iberia, probably where there is less pressure from humans. It has been hunted in Iberia at least since the late Pleistocene (Davis, 2002) and during the Mesolithic (Detry, 2007). It is elusive and prefers bushy areas where it can hide, making it more difficult than other cervids to hunt.

The fallow deer was also rare - a mere seven bones, four in the 1st cent., one in the 3rd cent, and two in the following century were found. This medium-sized cervid, smaller than the red deer yet larger than the roe deer, became extinct in the Iberian Peninsula and most of Europe by the late Pleistocene (Cardoso, 1993; Masseti et al., 1996, 2008). It is believed to have faced extinction during that period. There is the indication that this species was reintroduced in Lusitania by the Romans (Davis and Mackinon, 2009). Similar introductions and probable management of these animals by the Romans occurred in various parts of the Roman Empire, including Britain (Sykes et al., 2011, 2013), Mallorca (Spain - Valenzuela et al., 2016), Sicily (Italy - Baker et al., 2024), and Belgium (Pigière et al., 2020).

Consequently, *Dama dama* experienced a significant expansion during the establishment of the Roman Empire due to its intentional introduction, potentially linked to its religious significance, such as its association with the goddess Diana (Baker et al., 2023). Its presence in the Calle Almendralejo assemblage suggests that its existence in Mérida was also valued.

4.2.1.5. Camelus sp. The distal end of a camelid radius was identified (Fig. 18). It is not possible to determine whether it belonged to *Camelus bactrianus* or *Camelus dromedarius*. The most probable is the dromedary (one humped, or Arabian camel) that exists in north Africa, the Bactrian camel is more common in Asia.

The diaphysis of the bone had been sawn transversally in the same way that cattle bones had been transformed. This bone is longer than those of large bovids with a flat anterior face making it ideal for making large plaques to produce worked objects.

The camel is known from several Roman sites in Spain but there is no evidence for the consumption of camel meat during the Roman occupation of Iberia (Morales-Muniz et al., 1995).

Camels played a significant role in Roman society, being extensively employed for the transportation of goods in daily routines and military expeditions, as well as for their milk yield (Pigière and Henrotay (2012), Morales-Muniz et al., 1995; Pigière and Henrotay (2012); Tomczyk, 2016; de Grossi Mazzorin and Minniti, 2019; Habinger et al., 2020).

The existence of camelids in the northern Roman provinces has been documented by Pigière and Henrotay (2012), while their presence in the northeastern Roman Empire is summarized by Tomczyk (2016) and in Central Europe and Italy by Albarella et al. (1993). Additionally, de Grossi Mazzorin & Minniti (2019) shed light on a late Roman camel sawn metapodial discovered in Rome, attributed to worked bone waste. Pigière and Henrotay (2012) as well describe the discovery of two tibias exhibiting identical processing treatment in a Vicus - Neu (Arlon, Belgium), dating to the late 3rd century to the 4th century.

Morales-Muniz et al. (1995) identifies four sites exhibiting evidence of camelids during Roman times in Iberia: Conimbriga (Condeixa-a-Nova, Portugal – Cardoso, 1993), Cartago (Múrcia, Spain), Complutum, and El Val (Alcalá de Henares, Spain). Further reference is made to a femur discovered in Mértola (Portugal, Davis & Moreno, 2007). Additionally, two more sites in Mérida (Spain) emerge: one detailed in this article located at Calle Almendralejo (end of the 4th cent.), and another at Casa de Mitreo (2nd-3rd Cent. - Bustamante and Detry, 2019). Notably, the camel bones found in Mérida were both sawn, resembling the manner of cattle bone processing. The only similar cases seem to arise from late Roman contexts in both Rome and Belgium. This hints at a possible dissemination of this specific bone processing technique within the Roman Empire during a later period of the Roman occupation.

4.2.2. Perissodactyla - equidae

53 equid bones and teeth were identified. Most (36 fragments) are dated to the second half of the 4th century. Equid bones and teeth are generally difficult to identify to species level (i.e., horse or donkey). One terminal phalanx was larger and with a rounded and open form typical of horses has suggested by Davis (2002). One mandible could be identified as horse since the molars had the interior fold in "U" shape and could be then classified following the criteria of Davis (1980, 2006).

The presence of equids may reflect the use of these animals for transport and/or working the fields or even for military purposes.

4.2.3. Carnivora

4.2.3.1. Canis familiaris (dog). A quadrangular building somewhat like a hollow tower, dated to the middle of the 1st century AD was found at Calle Almendralejo. It contained the cremated remains of four humans under two human (uncremated) skeletons. Overlying the human remains and a thick layer of sediment the remains of some 36 dogs and one Egyptian mongoose (*Herpestes ichneumon*) were uncovered (Detry et al., 2018; Bustamante et al., 2021). These canid remains will be published in more detail in a posterior publication.

Very few remains of dog were found in the dump site outside the monument. They were scattered throughout the layers at Mérida. Dogs were certainly abundant throughout the occupation but since they were not usually eaten, they were also not dumped in the same place as other food animals.

According to Mariana Rente et al. (*in press*) the analysis of the dog teeth shows the animals were mostly between 2 and 5 years old and with low number of dental pathologies showing some degree of treatment from the humans that cared for these animals. In this case dogs were mainly pets and possibly used for other functions such as hunting, guarding or as shepherds.

4.2.3.2. Felis silvestris (cat). Cats on the contrary appear in only one context dated to the second half of the 4th century AD. Nine bones were found all of which probably belonged to a single cat that would have been aged around 6 months to one year (according to the ages of epiphysial fusion given by Smith, 1969). The size of the first molar of this cat (first molar inferior length - 80 mm and width – 77 mm) was similar to the size of wild cat (*Felis silvestris*) and may have belonged to a hunted animal.

4.2.3.3. Herpestes ichneumon (egyptian mongoose). This small mammal is a diurnal carnivore, common today in southwestern Iberia and currently expanding northwards (Barros and Fonseca, 2011; Balmori and Carbonell, 2012; Barros et al., 2016). Some historical identifications show that it probably existed throughout Iberia in the 19th century. Human pressure and habitat destruction have both resulted in the contraction of its distribution.

In Calle Almendralejo, a femur, a tibia, a pelvis and one posterior cranium of this species was found among the skeletons of the c. 36 dogs found in the ceremonial pit already described (Detry et al., 2018; Bustamante et al., 2021).

This carnivore belonging to the family Viverridae is, together with *Gennetta genetta*, the only members of this family in Europe, thought to have been introduced by man in Iberia in the past.

Medieval remains have been found in Cueva de Nerja (12th cent. - Riquelme-Cantal et al., 2008) and Muge (9th cent. – Detry et al., 2011). A skeleton was found in Gijon (northern Spain) buried among several dogs and dated to Late Antiquity (6th century).

The bones from Calle Almendralejo, were radiocarbon dated around the 1st cent. AD (104 cal BC – 57 cal AD) making them the oldest in Iberia along with another contemporary find from Gruta Pedra Furada in central Portugal (Detry et al., 2018).

The fact that this animal was among the dogs may indicate that it was in fact a pet. Mongooses are thought to have been introduced in order to control pests such as rats and house mice. Others, if reared while still very young, can be tamed, and maintained as pets.

4.2.3.4. Ursus arctos (bear). A single cubitus of this large carnivore was found at Calle Almendralejo. It comes from stratigraphic unit dated to 60 AD. In Lusitania, during the Roman period, its appearance has been consistently noted (Detry and Arruda, 2013).

It was a species certainly hunted and presumably appreciated for its fur.

4.2.4. Lagomorpha

4.2.4.1. Oryctolagus cuniculus (rabbit) and Lepus sp. (hare). The only remains of rabbit we recorded are dated to the 1st century AD, when other smaller prey remains were also more common (eg. Red partridge, see the Aves section).

It is possible that during this first phase of occupation some small game hunting occurred but became less important subsequently.

Although the rabbit is more common and easier to capture than the hare, both are present. They can be separated mainly by size – the hare is larger than the rabbit.

The hare remains could not be identified to species - *Lepus granatensis* or *Lepus europaeus* – the two hare species currently known in Iberia.

The numbers of bones of rabbits and hares are affected by recovery techniques during excavation. Thus, in the absence of sieving (e.g. as is the case of emergency excavations) they are generally underrepresented. Also, we cannot dismiss the possibility that rabbits might have a non-anthropogenic origin, with their presence potentially resulting from animals that entered the archaeological context through natural burrows. The recovered elements did not exhibit cut marks or evidence of burned bones. Fresh fractures were observed in only one bone, and complete skeletons were not located. These limited rabbit elements could plausibly be attributed to either human activity or natural occurrences.

4.2.5. Rodentia

4.2.5.1. Myoxus (glis) glis (edible dormouse). In Mérida we found one femur and one pelvis which we identify as probable *Myoxus* (*Glis*) *glis* (Fig. 19).

This species is larger than other dormice and has a long bushy tail. It puts on fat prior to hibernation (Macdonald and Barret, 1993). As its name suggests, it is edible, and it was a luxurious delicacy and represented wealth and prestige among the Romans. They were fattened in dolia (large ceramic vases known as – gliraria) (Berdeem, 2012).

The species' common habitat is deciduous woodland and it is currently distributed across Europe but in Iberia it is only found in the north, (Macdonald and Barret, 1993). The homogeneity and low genetic diversity of *G. glis* is possibly linked to a rapid expansion, which may be due to the development of woodland after the last glacial maximum and/or with the help of humans who may have kept it at home for consumption (Hürner et al., 2010).

Apicius (in the book De Re Coquinaria) and Petronius, both provide elaborate recipes for this animal and Ammianus Marcellinus mentioned that they would use scales in banquets to measure the weight of the animal served (Carpaneto & Cristaldi, 1995). According to Varro this species would be kept in enclosed areas (gliraria) with trees and walnuts, and subsequently further fattened in large ceramic vessels (dolia) with food and kept in the dark (Carpaneto & Cristaldi, 1995).

4.3. Aves

Birds are rare in this assemblage. Most were galliformes (37) and there are a few ducks and geese. The scarcity of smaller bones and remains of small birds may well be the results of retrieval bias as sieving was not undertaken during excavation.

The wild Galliformes were widespread in the Iberian Peninsula and are still common today. We only found five bones belonging to *Alectoris rufa*, four tibiotarsi from one context dated to the 1st cent. AD, decades of 80–90 AD, which curiously coincides with the context in which more oysters were found - a tendency also observed in Santarém (Davis, 2006). One wing bone (carpal-metacarpal) was found and dated to the beginning of the 1st cent. AD.

The more frequent birds were the chicken (*Gallus gallus domesticus*), with 17 remains. Most (14) are from one context - SU [1535] where we also find the red partridge, oysters and a variety of mollusks. Almost 80% of the remains came from distal parts of the limbs.

The chicken is thought to have been introduced already domesticated in the Iberian Peninsula during the Iron age by the Phoenicians (Hernandez-Carrasquilla, 1992; Garcia Petit, 2002; Davis, 2007). It has been suggested that chickens played a ritual or sporting role (for cock-fighting) rather than a supplier of eggs and meat (Perry-Gal et al., 2015).

Fig. 19. – Femur and pelvis of a possible *Glis glis* (edible dormouse). Photo José Paulo Ruas.

One tibia of a small Anatidae and one humerus of a goose were found in a context dated to the 2nd half of the 4th century. The small number of these species, often common in other sites, shows how little this species was exploited in Mérida. It is unlikely that the lack of sieving can be responsible for the scarcity of anatids since they are large birds. Whether they were wild or domesticated is not possible to determine. Domestication of the anatids is poorly understood.

A humerus of a juvenile black vulture (*Aegypius monachus*) with incompletely ossified articulations was found in stratigraphic unit dated to the second half of the 4th cent. AD (Fig. 20). Today this animal is rare but is still found in central Iberia as well as Greece, Turkey and across Asia to China (Svensson et al., 2003). It has suffered some setbacks due to human pressure and survived in the last decades in less populated regions such as the frontier between Portugal and Spain. In Roman times this species was probably resident in the Mérida region. It is possible that this animal was scavenging remains in this dump, an obvious habitat for these kinds of animals and maybe it died there.

Another possibility is that someone killed and ate and/or used the feathers and bones for other purposes. The feathers of such animal could be of special significance and very appreciated. Also, the ulnas of big prey birds such as vultures, are known to produce beautiful flutes. See the example of the Conimbriga aerofone, another big Roman city from Lusitania (Pimenta and Moreno, 2004).

4.4. Taphonomy

Our analysis tried to explore various taphonomic aspects that could have influenced this assemblage. We considered factors such as the treatment of animal carcasses by humans and other animals, along with post-depositional events that might have disturbed the remains deposited here. While our preliminary examination revealed well-preserved remains with some interesting information a more comprehensive taphonomic analysis need to be addressed in forthcoming publications.

The exceptional preservation of the remains, devoid of root marks that typically suggest the formation of a soil, indicates a rapid sedimentation and landfill process. This absence of root marks signifies that the accumulation likely underwent intentional management rather than natural deposition.

The preservation status and preferences for specific anatomical parts were challenging to ascertain comprehensively due to our restricted identification of diagnostic zones following Davis (1992). Consequently, our analysis primarily concerns the registered elements. Supplementary materials 1 indicate that most anatomical parts were found in small numbers across most periods, limiting definitive conclusions regarding their preservation or preferences. However, for example in cattle, as seen in chapter 4.2.1, during the second half of the 4th century, higher occurrences of mandibles, humerus, astragalus, calcaneum, and metapodials were observed in cattle (see Fig. 9). These bones, identified as high-density elements according to Lyman (1994), might naturally contribute to their prevalence. Notably, the tibia, despite its density, appeared in very limited numbers, despite its anatomical proximity to the astragalus and calcaneum. The inflated numbers of mandibles and metapodials might stem from their potential use in producing worked bone objects, as previously elucidated (refer to section 4.2.1).

Out of the total remains, only seven bones showed evidence of burning—three with a black colour appearance and four calcined, suggesting exposure to higher temperatures for an extended duration. Among these, one belonged to an Equid femur (displaying a blackened appearance), while the remaining were identified as *Bos taurus*. Specifically, three astragalus and one calcaneum, all from cattle, exhibited signs of cremation. Additionally, one complete metacarpal and 1 phalanx II displayed a darker colour. Remarkably, distal elements with limited dietary purposes seemed more affected by fire. These elements might have been thrown into the fire as fuel or possibly in ritualistic practices involving prolonged exposure to flames.

Cut marks were not noticed on bones of small animals such as rabbits or carnivores. No doubt if consumed these would have been cooked entire. Carnivores may not have been consumed by people.

In general cut marks on animal bones are rare in this assemblage. The main differences seem to be that we observe more chopped bones in the 1st cent. AD in bovines, and less later (Table 4). This may be because these animals were used for other purposes in later times. Red deer, however, show the opposite tendency.

Very few bones, a mere five, show any signs of carnivore damage, and all are from the 1st century. Dogs do not seem to be present surrounding this dump site, especially during the 4th century.

4.5. Animal selection and improvement

All measurements obtained in the bones and teeth from Calle Almendralejo are detailed in the Supplementary materials 2.

Measurements of bones can provide information about changes through time reflecting human selection for improvement or as an indirect result of domestication or even human over-hunting (Davis and Detry, 2013). Other environmental factors such as temperature and food availability can also influence size changes in mammals (Davis, 2019).

In many cases zooarchaeological assemblages may contain few measurable bones. The log index technique integrates in the same graph measurements of different bones so that sample size ‘appears’ to be greater. This of course is the case if we assume, not necessarily correctly, that each bone derives from a different animal. These ‘larger’ samples

Fig. 20. - Immature humerus from *Aegypius monachus* (black vulture), found in the stratigraphic unit [1600] dated to the 2nd half of the 4th cent. AD. Photo José Paulo Ruas.

Table 4
– Cut marks observed in the surface of the recorded bones.

	1st Cent. AD				4th Cent. AD			
	Chopped		Cut		Chopped		Cut	
	N	%	N	%	N	%	N	%
Bos taurus	12	10%	4	3%	9	2%	2	1%
Ovis/Capra	2	1%	1	0.50%	3	2%	0	0%
Sus sp.	6	3%	3	1%	0	0%	0	0%
C. elaphus	6	1%	4	5%	3	5%	0	0%

can show group tendencies that otherwise would be missed.

When we gather cattle width measurements (Fig. 21) from several different Portuguese sites, we see a tendency for an increase in size in the Early and Late Roman period. This trend may have begun in the Chalcolithic and came to an end in the Medieval period. Measurements of heights shows a smaller increase as discussed in Detry et al., (2022).

Our LSI technique reveals some general trends but hides certain particular events. In Mérida, metacarpals alone indicate that the trend differs in the Late Roman. Metacarpals show considerable sexual dimorphism (Fig. 9). They show a decrease in size - the average is below that of the early Roman in Mérida and Modern Beja and Carnide. It is clear that the other sites present a greater spread of measurements with a bimodal distribution as would be expected given these bones' sexual dimorphism. However, the late Roman metacarpals from Mérida are distributed in a unimodal fashion with one outlier. We suggest that the sample from late Roman Mérida comprises mainly females and/or castrates. We base this on the fact that a large portion of the measured metacarpals were sawn across the proximal part of the metaphysis to make bone utensils - these were probably mostly long hair needles. Metacarpals are especially useful for this purpose since they have a large long and straight cortical bone. In the late Roman the metacarpals were sawn compared to those from the Early Roman. The percentages of sawn metapodials were 34% in the Early Roman and 86% in the late Roman (Fig. 22). Other bones show the same tendency. We could speculate that the smaller ones belonged to castrates that have longer shafts and therefore are more useful for this task. Unfortunately, since the metapodials are all sawn we lack the length measurements to corroborate this.

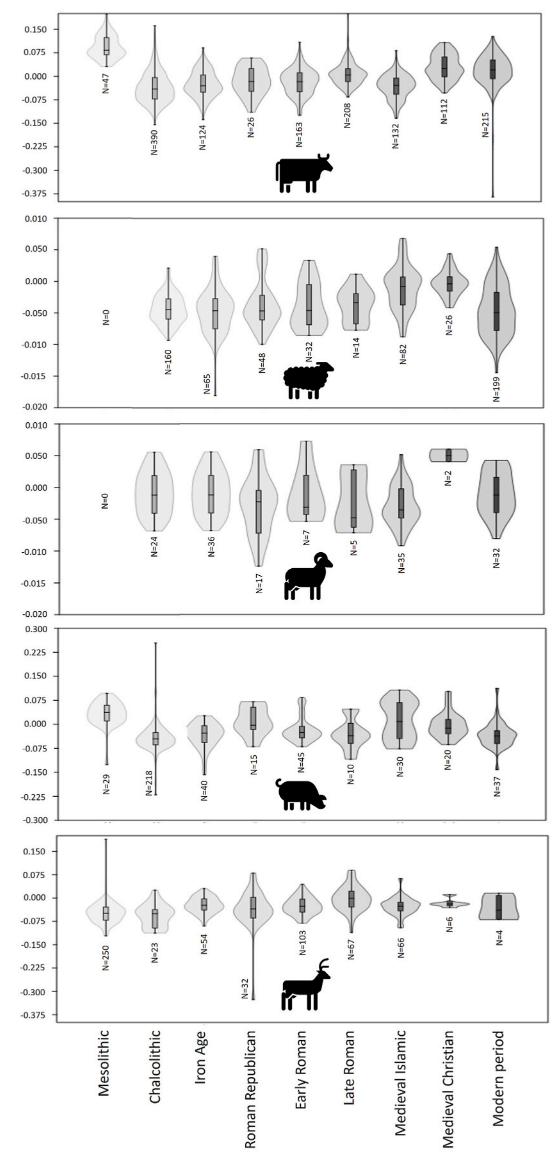


Fig. 21. – Measurements of several species and sites across different chronologies in the Holocene. The measurements of bone widths are gathered using the Logarithmic scale index (LSI) (see Detry et al., 2022 for more details).

The measurements we observe of LSI applied to the breadths of sheep bones from several sites in Portugal do not show a clear increase in size in the Roman period as observed for cattle (Fig. 15). Although in the Late Roman we do see a slight increase, followed by a greater increase in the Islamic period, as Davis (2008) noted and attributed to the Arab cultural influence and appreciation for mutton.

The larger animals from late Roman levels are from Santarém and not Mérida. In early Roman times sheep were larger in Mérida but in very small numbers. We also observe larger sheep in Early Roman times at Monte Molião. In other words the pattern of cattle improvements in newly founded cities as observed by Fernandez (2003), Colominas (2013), Nieto-Espinet et al. (2021) and Detry et al. (2022) differs from that of sheep. For sheep the situation seems more complex and probably the investment in this species is less clear than for cattle.

Suids are more difficult to analyse since pig and wild boar bones are difficult to distinguish. In Fig. 21, Mesolithic wild suids were larger than in the Chalcolithic when most were smaller animals – most probably pigs. There are some very large measurements that presumably belonged to wild boars. This corroborates what Davis and Detry (2013) found - the Chalcolithic wild boar had recovered some of their former size, while in the Mesolithic they were considerably smaller.

In the Roman period we see some strangulations on the top boxes caused by wild boar measurements, showing big game hunting in the Roman period was more important than before as was also noted by Detry and Arruda (2013) in Monte Molião and by Nieto-Espinet et al., (2021) in northwestern Iberia. The enlargement of the boxes, forming some kind of hips represent the pig measurements, if we compare that larger parts we see a decrease in size for pigs through the Roman period as observed for goat. In the Islamic period we observe a more divided box with more wild boar hunting since pig is forbidden in Islam.

As the shift in investing in cattle improvement towards the late Roman, with more and larger cattle, other animals such as pig and goat seem to have received less attention. Cattle can help transporting people and merchandise - no doubt an important part of the late Roman economy. Another may have been help in transporting the agricultural utensils - hence transforming the working of the fields and food production.

Measurements gathered from Calle Almendralejo bones are available in the supplementary materials with link in the chapter for Data availability.

5. Conclusion

A substantial number of faunal remains were retrieved from the

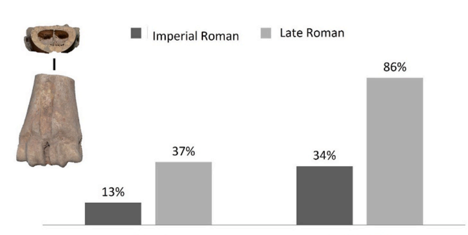


Fig. 22. – Percentage of sawn long bones. On the left percentage of all the long bones that had sawn diaphysis. On the right are the percentages of metapodials (metacarpals – MC, and Metatarsals – MT) sawn across the diaphysis.

Roman landfill near the north opening of the Roman wall in Calle Almendralejo, revealing a complex assemblage. Initial findings, while intriguing, necessitate further investigation, particularly in taphonomy, worked bones, dog remains, and ancient DNA analysis to fully comprehend the intricacies of this site.

Mollusc remains were sparse, typical for an interior site, while mammal remains, notably cattle, played a significant role in the diet and secondary products. The preference for smaller species early on shifted to a greater reliance on cattle in the late Roman levels. The use of cattle bones for utensils, as well as their strength for fieldwork and transportation, may explain this shift. Sheep exhibit a complex pattern perhaps influenced by cultural and regional factors, while pigs and goats apparently receive less consideration, with less remains and with fluctuating sizes and number.

Assemblages from the 2nd and 3rd centuries are limited, suggesting potential deposition of food waste elsewhere in the city. In contrast, remains from the 4th century are more substantial, with cattle dominating over other species, reflecting a shift in the importance of the Mérida population, possibly indicating population growth and increased economic activities.

Comparing faunal assemblages from the 1st and 2nd centuries reveals distinct differences, suggesting a less established occupation in Mérida during the earlier period, with a focus on smaller animals and hunting. In the 3rd and 4th centuries, a shift towards larger animals suggests a more prosperous and established population, possibly with increased agricultural and travel activities.

The assemblage also presents introduced animals by Romans, including the mongoose as pet and pest control, the possible dromedary for transportation, and the edible dormouse for luxurious banquets. This diversity reflects a city with social groups of high economic and social status, a growing population, and a complex economy.

Data availability

Supplementary material with the osteometric measurements related to this article can be found in the Supplementary materials.

CRediT authorship contribution statement

Cleia Detry: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Macarena Bustamante-Álvarez:** Conceptualization, Data curation, Resources, Validation, Writing – original draft, Writing – review & editing. **Francisco Javier Heras Mora:** Conceptualization, Data curation, Funding acquisition, Investigation, Resources, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.quaint.2024.05.004.

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