Journal of Archaeological Science: Reports 73 (2026) 105883

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

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

Animal husbandry and hunting in the Roman *vicus maritimus* of Cerro da Vila (Southern Portugal): insights into the coastal economy of Lusitania☆

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ARTICLE INFO

Keywords:
Zooarchaeology
Vertebrates
Animal management
Roman period
Coastal settlement
Foodways
Portugal

ABSTRACT

This study presents a zooarchaeological analysis of the vertebrate faunal assemblage from the Roman *vicus maritimus* of Cerro da Vila, southern Lusitania (modern Algarve, Portugal), with occupation spanning the 1st to 5th centuries CE. The site functioned as a diversified coastal hub integrating intensive fish-processing, agricultural production, and maritime trade, yet the role of animal exploitation in sustaining this economy has hitherto remained poorly understood. Given the limited stratigraphic resolution of the excavation records, the assemblage was treated as a whole, and the patterns discussed reflect long-term, diachronic trends rather than discrete subperiod practices. The analysis reveals an assemblage dominated by domestic mammals, particularly swine and caprines (sheep and goats), whose age-at-death profiles and skeletal element distributions may be consistent with structured husbandry strategies oriented towards both primary meat production and the procurement of secondary products, notably wool and milk. The presence of chicken, red deer, and rabbit points to dietary diversity and to the complementary role of hunting within local subsistence practices, while biometric data fall within ranges documented for Roman-period assemblages elsewhere in southern Lusitania. The recovery of remains of Egyptian mongoose suggests the introduction of a non-native species, pointing to interprovincial exchange of biological material under Roman rule. Taken together, the faunal evidence indicates that Cerro da Vila combined livestock husbandry and marine resource exploitation while also participating in broader Mediterranean trade networks, thus shedding light on the economic organisation and interprovincial connectivity that characterised Roman coastal settlements in Lusitania.

1. Introduction

The Algarve has historically embodied a strong Mediterranean resonance, constituting an integral part of the wider spatial entity that the Portuguese geographer Orlando Ribeiro designated as "Mediterranean Portugal" (Ribeiro, 1945, p. 57). The geomorphological configuration of the Barrocal (limestone uplands) and the coastal sector of the Algarve closely resembles that of other regions situated along the shores of the Mediterranean basin (Ribeiro, 1945, p. 57). Within the framework of Roman Lusitania, maritime interactions between this territory and other provinces of the Empire facilitated the establishment of a far-reaching network of communications and commercial exchanges, embedding the Algarve within the wider economic and cultural dynamics of the Roman Mediterranean (Fabião, 1999). Although a peripheral region within the *Imperium*, southern Lusitania was an important point of articulation between its territories, especially in relation to the fish-products trade. The resulting economic growth appears to have encouraged denser settlement in the region, with numerous urban centers of strong commercial character emerging in a dispersed pattern, such as *Lacobriga* (nowadays, Lagos), *Balsa* (Quinta da Torre de Aires/Tavira), *Ossonoba* (Faro), and *Baesuri* (Castro Marim). In central Algarve, specifically in the current municipality of Loulé – a region within the *Ossonobensis* sphere of influence – this territorial development is also visible with the establishment of secondary population centres based on the exploitation and export of processed fish and the transformation of agricultural products, as in the case of Loulé Velho, Marmeleiros, Retorta, and Cerro da Vila (Fig. 1).

Within this coastal settlement network, the Roman *vicus maritimus* of

☆ This article is part of a special issue entitled: 'Iberian Zooarchaeology' published in Journal of Archaeological Science: Reports.

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https://doi.org/10.1016/j.jasrep.2026.105883
Received 26 October 2025; Received in revised form 3 June 2026; Accepted 6 June 2026
Available online 13 June 2026

Cerro da Vila stands out as an industrial and commercial hub combining fish-processing, agricultural production, and maritime exchange, yet the role of animal exploitation in sustaining this system has remained poorly understood. This study addresses that gap by examining how the vertebrate faunal assemblage documents local husbandry practices, hunting strategies, and the settlement's integration into wider coastal and interprovincial economic networks in Lusitania. To this end, the following objectives were pursued: (1) to characterise the taxonomic composition, mortality profiles, and biometric patterns of the vertebrate faunal assemblage, with particular attention to domestic mammals, wild game, and avifauna; (2) to reconstruct husbandry and butchery strategies, including the balance between meat production, secondary products, and other forms of animal exploitation; (3) to assess the role of hunting and the exploitation of wild species within local subsistence practices and craft production; and (4) to situate Cerro da Vila within the coastal economy of southern Lusitania in comparison with other Roman coastal sites, discussing economic organisation, social status, and interprovincial connections, including the introduction of non-native taxa such as the Egyptian mongoose.

The earliest references to Cerro da Vila are found in the second half of the 19th century. The first, from Vilhena Barbosa, indicates that "(…) this *villa* is one of the oldest settlements in the kingdom of the Algarve […]. It is said that it existed near the sea between Faro and Albufeira, on a river, which retains the same name of Quarteira" (Barbosa, 1860, p. 53). The second, by Estácio da Veiga, a pioneering figure in Algarve archaeology, records the toponym 'Serro da Vila' in his cartographic representation for the *Archaeological Map of Portugal – Historical Times* referring to an "extinct or razed settlement" of the Roman period (Veiga, 1910, pp. 209–233). Despite these references, and for reasons still undefined to this day, there was a chronological gap in knowledge that extended until 1963, when Cerro da Vila was rediscovered, marking the beginning of archaeological research on the site. Between 1965 and 2008, various archaeological interventions allowed the identification of a Roman *vicus maritimus* (1st–5th centuries CE), consisting of diverse architectural units with residential, industrial, bathing, port, and water supply characteristics.

Established at the beginning of Augustus's principate (27 BCE-14 CE), the *vicus maritimus* of Cerro da Vila was strategically located on the banks of the paleo-estuary of the Ribeira de Quarteira (Fig. 1**C**). This location facilitated the exploitation of marine resources, leading to substantial investments in the fish-processing industry. These economic resources enabled the establishment of a comprehensive architectural program spanning from the 1st century CE to the conclusion of the Roman period. The various architectural units were designed to function in relation to a prominent *portus*, which served as a commercial hub for the export of local manufactured goods and the importation of exotic items from various imperial regions (Fig. 2).

The transformation of Cerro da Vila into a secondary settlement (*vicus maritimus*) began in the Early Imperial period, with an extensive expansion programme encompassing all structures and architectural

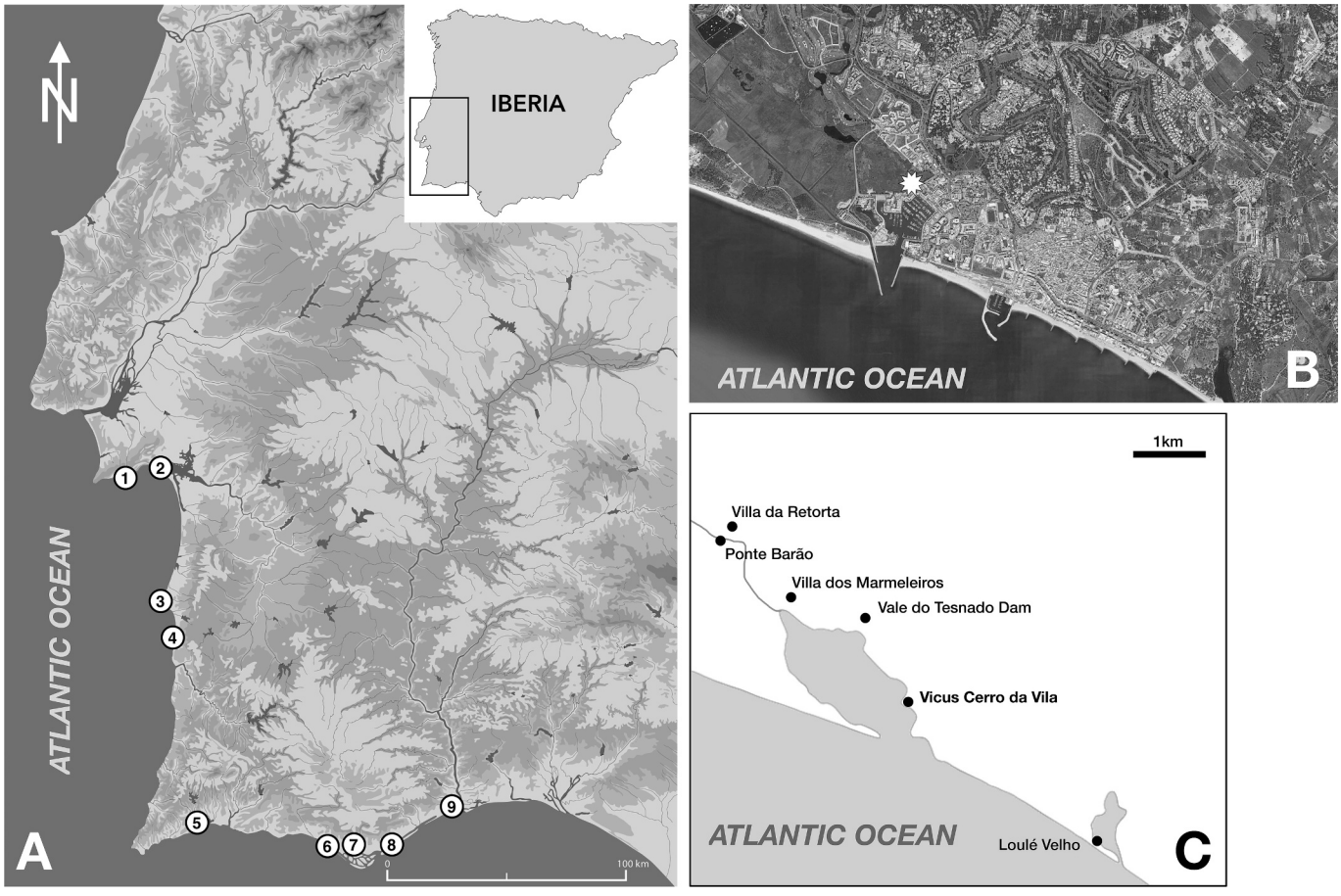

Fig. 1. Geographic and archaeological context of Cerro da Vila and related Roman sites. A: Distribution map of coastal Roman sites discussed in the text, each associated with faunal assemblages: 1. Creio; 2. Tróia; 3. Largo João de Deus (Sines); 4. Ilha do Pessegueiro; 5. Monte Molião (Lagos; roman *Lacobriga*); 6. Cerro da Vila (Vilamoura); 7. Milreu (nearby Faro; roman *Ossonoba*); 8. Quinta do Marim (Olhão); 9. Castro Marim (roman *Baesuri*). B: Contemporary aerial photograph showing the location of Cerro da Vila and its surroundings (image). C: Detail of the territory around the Ribeira de Quarteira paleo-estuary during the Roman period, highlighting the *vicus maritimus* of Cerro da Vila and the *villae* of Loulé Velho, Marmeleiros, and Retorta, along with other excavated sites.
Source: Google Earth, 2025. Cerro da Vila area, Vilamoura, Portugal. 37°4′49.25″N, 8°7′12.72″W, Eye alt ~6km. Retrieved September 25, 2025, from https://earth.google.com/web/

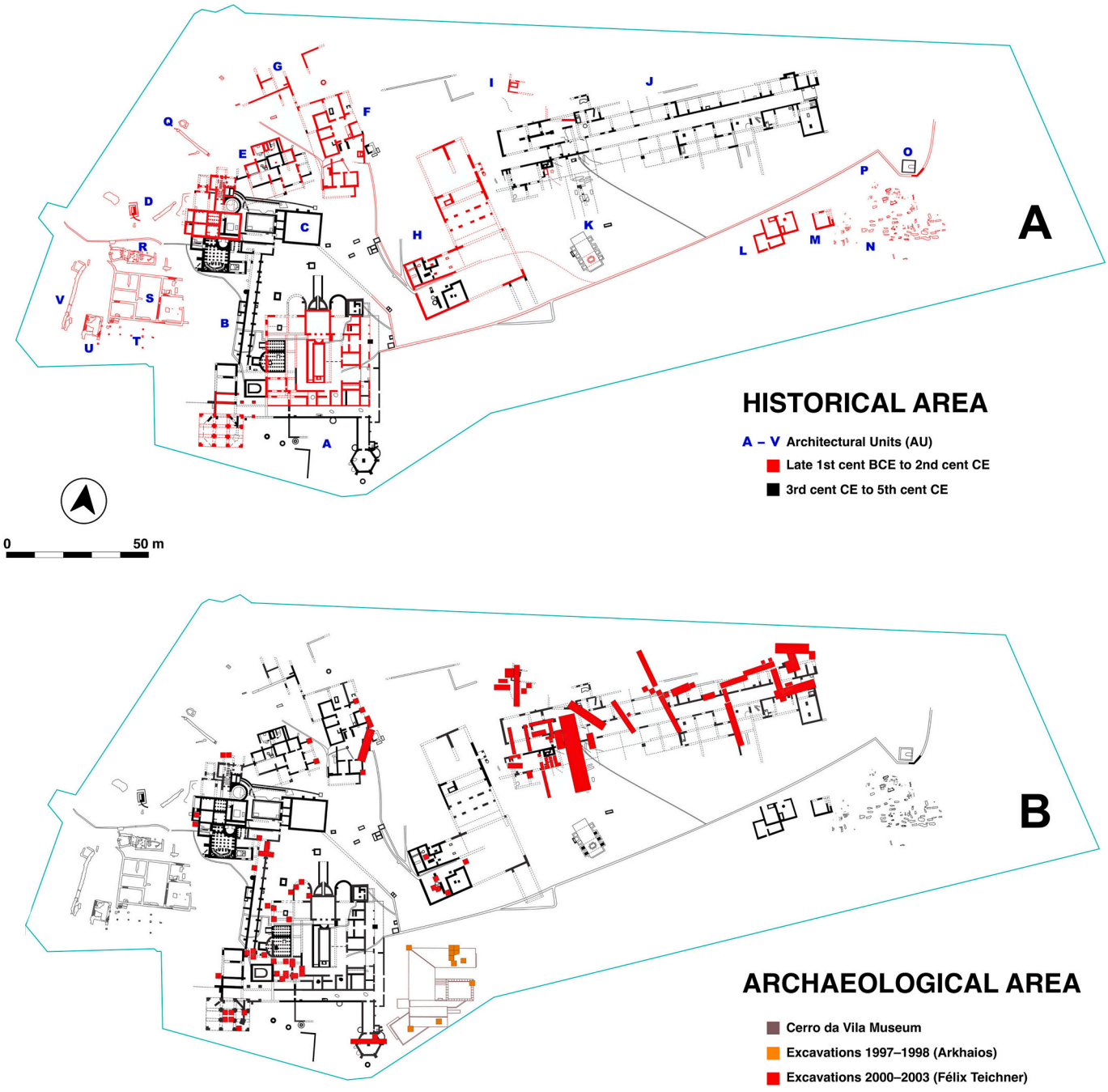

Fig. 2. Historical and archaeological areas of Cerro da Vila. A: Roman architectural evolution of the *vicus maritimus* of Cerro da Vila and its architectural units (AUs). A: Residencial Building I (Noble House). B: Corridor with latrine. C: *Thermae* (public baths). D: *Portus*. E: Residencial Building II (workers quarter). F: Residencial Building III (small house). G: Residencial Building IV. H: Factory I (fish preparations). I: Factory II (fish preparations). J: Factory III (fish preparations). K: Templiforme Mausoleum. L: Factory IV: (fish preparations). M: Factory V (fish preparations). N: Inhumation Necropolis I. O: Torriforme Mausoleum. P: Vale Tesnado dam canalization. Q–V: *Portus* (map .
Source: Teichner, 2008; data: Matos, 1987; Teichner, 2008). B: Location of the excavations conducted in 1997-1998 and 2000-2003 (map source: Teichner, 2008)

complexes. On the summit of the small elevation overlooking the paleo-estuary, levelled during the Flavian period (69–96 CE), the construction of the first peristyle residence (Noble House; Fig. 2, Architectural Unit A) was documented. Simultaneously, fish-preparations production began in Factories I and III, as well as in the productive installations located within Residential Buildings II and III. The substantial investment in these manufacturing units undoubtedly stemmed from the success of products manufactured in the initial units of this *vicus* (Teichner, 2008).

By the late 1st century CE, the economic returns from the fish-processing industry appear to have encouraged population concentration and specialised labour in the surrounding area of Cerro da Vila. During this period, the Noble House underwent expansion, while complex renovations were implemented in the manufacturing units. Additionally, a residential complex comprising various storage compartments – some fitted with *cetariae* – was constructed, extending towards the *portus* (Teichner, 2008) (Fig. 2).

Mercantile activity intensified significantly from the Antonine dynasty onwards (96–192 CE), as evidenced by the extension of the port complex, the construction of the first bathing complex, the building of a dam, and the establishment of funerary monuments for both cremation

(Temple-form Mausoleum and Tower-form Mausoleum) and inhumation (Necropolis I). This period also saw the relocation of production from Factory I to the now-expanded Factory III (Teichner, 2008) (Fig. 2). These architectural and infrastructural developments reflect the settlement's growing economic importance and its integration into broader Mediterranean trade networks. From the 5th century CE onward, significant architectural modifications were carried out in residential buildings, bathing facilities, and funerary structures. During this phase, polygonal compartments were added to the Noble House.

During the mid-5th century CE, a notable 'contraction' occurred in the residential areas, while industrial spaces were simultaneously adapted for new functions These architectural changes indicate a gradual decline in Cerro da Vila's economic projection. Despite its diminishing significance, the settlement remained inhabited until the 12th century (Almohad period). This phase coincides with the peak of sedimentation in the paleo-estuary of Ribeira de Quarteira, which ultimately led to the abandonment of the settlement (Teixeira, 2005; Teichner, 2008; Trog et al. 2015).

2. Materials and methods

2.1. Provenience of the zooarchaeological materials

Following renovation works and the establishment of the new Archaeological Museum of Cerro da Vila (Fig. 2**B**), diagnostic excavations were undertaken between 1997 and 1998 within the building's construction impact zone. Although no architectural structures were identified, the stratigraphic sequences and associated material assemblages contributed to a more detailed understanding of the successive phases of occupation in the area between Residential Building I (Noble House) and Factory I. This investigation revealed deposits attributable to the 1st–2nd centuries CE. The vertebrate fauna recovered from these contexts accounts for 30.2 % of the total number of remains (TNR) analysed in the assemblage.

New archaeological interventions associated with the research projects "*Corpus* of Mosaics in Southern Portugal" and "Rural Occupation in Southern Lusitania," conducted between 2000 and 2003, targeted Residential Building I (Noble House), the public bathhouse, Residential Buildings II–III, and Fish Processing Factories I–III. Stratigraphic and chronological analyses of these architectural units showed an extended sequence of occupation from the 1st to the 5th centuries CE, thereby refining our understanding of the development of the *vicus*. The vertebrate remains recovered from these excavations account for the remaining 69.8 % of the TNR considered in this study (Fig. 2).

Approximately 200 test pits were excavated during the fieldwork campaigns conducted between 1997 and 1998, and between 2000 and 2003. Some chronological resolution was possible through comparison with the ceramic materials from the same stratigraphic provenance. Although a temporal sequence could be established (Table 1), the limited contextualisation of most faunal remains assigned to Chronology Unit D (1st century BCE–5th century CE) substantially constrained the zooarchaeological analysis. The assemblage was therefore studied as a whole rather than by narrower chronological sub-periods, and the patterns discussed here should be interpreted as composite, diachronic trends rather than as reflections of tightly bounded Roman-period practices. This means that finer-scale variations between the early Roman Empire and Late Antiquity cannot, for now, be resolved.

Table 1
Distribution of faunal remains by chronological unit and period.

CHRONOLOGY UNIT	PERIOD	NR	NISP
A	100 BCE – 75 CE	85	28
A, B	100 BCE – 200 CE	100	37
B, C	75 – 475 CE	1	0
C	200 CE – 475 CE	3	2
A, B, C	100 BCE – 475 CE	74	49
D	1st cent BCE – 5th cent CE	811	215
TOTAL		1074	331

NR: Number of Remains, NISP: Number of Identified Specimens.

2.2. Methods

All faunal elements were recorded and counted, including remains that could not be taxonomically classified. Quantification was based on the following units: Total Number of Remains (TNR), Number of Identified Specimens (NISP), Number of Non-Identified Remains (NI), and Minimum Number of Individuals (MNI; as outlined in Lyman, 2008, pp. 38–69). The MNI was calculated per excavation year and individually for each stratigraphic unit, as these correspond to different depositional events.

The methodology employed for the study followed modern zooarchaeological parameters (e.g., Reitz & Wing, 2008; Gifford-Gonzales, 2018). Reference works such as Schmid (1972) and France (2009) were consulted, and, when needed, the material was compared with reference collections held at the Laboratory of Archaeology at the University of Algarve and the Laboratory of Archaeosciences (LARC) of Património Cultural I.P. (Moreno-García et al., 2003). For the study of avian species, we used a compilation of references specifically for chicken remains (Sadler, 1991; Tomek & Bochenski, 2009; Doherty et al., 2021), as well as the systematic list of birds found in archaeological sites in Portugal compiled and discussed by Pimenta et al. (2015). The few fish remains were identified by H. Veríssimo, as part of his ongoing Ph.D. research.

In particular cases, such as the distinction between *Ovis aries* and *Capra hircus* astragali, identification followed the criteria developed by Boessneck (1969), Zeder & Lapham (2010) and Davis et al. (2018) as this was the only element amenable to such classification.

Most swine remains could not be assigned a precise taxonomic identification. However, one lower third molar allowed complete metric analysis, and its dimensions are consistent with those of domestic pig (Payne & Bull, 1988; Albarella et al., 2005; see Supplementary Data). Given the archaeological context and the general size of the recovered elements, it is probable that the majority, if not all, of the swine remains derive from the domestic subspecies. For the identification of the Leporidae family – particularly femur, pelvis, tibia, ulna, and humerus – we used the works by Callou (1997) and Llorente Rodríguez (2010). The photographic collection of rabbit (*Oryctolagus cuniculus*) and hare *(Lepus granatensis*) compiled by the University of Salamanca was also very useful in this task (Usal – Universidad de Salamanca, 2024).

Equid remains were identified on the basis of the criteria established by Johnstone (2004) and Hanot & Bochaton (2018) for maxillary teeth and osteological elements, including the metacarpals, radius, and ulna. In some cases, specimens were further attributed to *Equus caballus* (maxilla) and *Equus asinus* (metacarpal and ulna) via ZooMS analysis based on the method of Paladugu et al. (2023).

When taxonomic classification was not possible, remains were categorized according to animal classes and size: Small-Sized Mammals (e.g., fox, cat, rabbit), Medium-Sized Mammals (e.g., sheep, goat, pig, wild boar, dog, wolf), and Large-Sized Mammals (e.g., horse, deer, cattle). Also, a few medium-sized birds remains did not allow taxonomic classification.

Information regarding mortality profiles was obtained through two methods: dental eruption and wear, applied to caprines (Payne, 1973; Zeder, 2006) and swine (Wright et al., 2014; Lemoine et al., 2014); and bone fusion, applied to the rabbit (Jones, 2006), dog (Sumner-Smith, 1966), swine (Zeder et al., 2015), red deer (Mariezkurrena, 1983), cattle (Habermehl, 1975), caprines (Zeder, 2006) and rat (Fukuda & Matsuoka, 1979).

Bone modifications were thoroughly examined, noting depth and other morphological features. We documented both deep and shallow cut marks that directly correlate with the systematic removal of consumable parts (e.g., Rixson, 1989; Seetah, 2018). Additionally, we

identified some taphonomic signatures created by carnivores, including irregular grooves, perforations, and punctures. These distinctive marks may be attributed to different predators, including canids, felids, and birds of prey (e.g., Lloveras et al., 2020).

Thermal alterations were assessed based on extent, coloration, and corresponding stage according to the classification system established by Shipman et al. (1984).

3. Results

3.1. Animals and their abundances

The faunal assemblage consists of a total of 1,074 vertebrate animal remains, of which 331 were taxonomically classified (30.8 %) (Table 2). Invertebrate animals have not been included in this study, as they were previously studied and published elsewhere (Henriques & Pratas, 2018).

Although the recovered materials are in generally acceptable condition, a significant proportion of the remains could not be classified taxonomically. This reflects advanced diagenetic alteration and weathering – driven by soil chemistry, moisture variability, and post-depositional mechanical stress – which have markedly degraded cortical integrity and produced extensive fragmentation.

Table 2
General Fauna Quantification.

CLASSES		NR	%NR	MNI	% NMI
Actinopterygii (fishes)		5	0,5	4	1,9
Reptilia		4	0,4	3	1,4
Birds		22	2,0	21	9,7
Mammalia		1030	95,9	188	87,0
IDENTIFIED REMAINS		NISP	% NISP	MNI	% MNI
MAMMALS					
Rattus cf. *rattus*	Black rat	1	0,3	1	0,5
Oryctolagus cuniculus	Rabbit	14	4,2	12	5,8
Herpestes ichneumon	Egyptian Mongoose	2	0,6	2	1,0
Canis familiaris	Dog	30	9,1	7	3,4
Equus caballus	Horse	1	0,3	1	0,5
Equus asinus	Donkey	3	0,9	2	1,0
Sus sp.	Swine	111	33,5	63	30,4
Cervus elaphus	Red deer	44	13,3	34	16,4
Cervidae	—	1	0,3	1	0,5
Bos taurus	Cattle	20	6,0	18	8,7
Capra hircus	Goat	2	0,6	2	1,0
Ovis aries / Capra hircus	Sheep or/and Goat	80	24,2	45	21,7
BIRDS					
Anas sp.	Duck	2	0,6	1	0,5
Gallus domesticus	Chicken	9	2,7	9	4,3
Alectoris cf. *rufa*	Red Partridge	2	0,6	2	1,0
REPTILES					
Testudine	Turtle	4	1,2	3	1,5
FISHES					
Pagrus pagrus	Common seabream	1	0,3	1	0,5
Sparidae (cf. *Sparus aurata*)	Gilt-head bream	3	0,9	2	1,0
Trachurus trachurus	Horse mackerel	1	0,3	1	0,5
TOTAL NISP & NMI		331		207	
NON-IDENTIFIED REMAINS		NR			
Large-Sized Mammal (LM)		122			
Large/Medium-Sized Mammal (LM/MM)		80			
Medium-Sized Mammal (MM)		489			
Medium/Small-Sized Mammal (MM/SM)		13			
Small-Sized Mammal (SM)		17			
Medium-Sized Bird		7			
Other Bird		2			
Non-Identified Animal (ND)		13			

NR: Number of Remains, NISP: Number of Identified Specimens, MNI: Minimum Number of Individuals.

Taxonomically identified remains (NISP) consist primarily of mammals and some birds, with sparse representation of fish and reptiles. Swine are among the most abundant taxa; most remains assigned to pig. Caprines follow in abundance, though only two goat remains were identified to species level (*Capra hircus*), while the remainder could be assigned only to sheep or goat. Red deer are also present.

Additional taxa, in order of abundance, were dog, cattle, rabbit, chicken, turtle, equids (both donkey and horse were identified, including through ZooMS; Paladugu et al., 2023), gilt-head bream, mongoose, ducks (non-identified to species), red-legged partridge, black rat, common seabream and horse mackerel. The turtle remains are most likely *Mauremys leprosa* (Iberian Pond turtle), the most common turtle species in Ria Formosa today and in medieval contexts (Boneta Jiménez, 2022).

As previously noted, the faunal collection is dispersed across several areas and stratigraphic units, which were considered in the MNI quantification, totalling 207 individuals, the majority of which correspond to mammals.

Edible mammals dominate the assemblage: rabbits, swine, cervids, cattle, and caprines (82.1 % NISP). These are supplemented by other animals commonly exploited for food, such as birds, fish, and perhaps turtle (6.6 %). In contrast, carnivores (including dogs and mongooses), rodents, and equids (generally not consumed) are significantly less represented (11.2 % NISP), a pattern consistent with the presence of domestic dump deposits where food remains predominate.

From a nutritional perspective, domestic mammals – sheep and goats, cattle, and swine – were clearly complemented by the consumption of large wild game (e.g., red deer) and smaller animals (e.g., rabbits, presumed wild due to the absence of *leporaria* or leporid domestication evidence in Lusitania to date), and chicken. Despite their considerably smaller individual meat yield, the widespread adoption and integration of chicken and rabbit into Roman period diets is well documented (e.g., Palladius, *Opus agriculturae*, 1.27; Varro, *De re rustica*, 3.12.6–7; Kron, 2008; MacKinnon, 2014). The low representation of these small animals in the assemblage is likely affected by recovery bias and undoubtedly does not reflect the actual dietary importance these species achieved.

The absence of systematic sieving also substantially restricted the recovery of ichthyological remains (5 NISP) and thus accounts for their underrepresentation within the assemblage, rather than reflecting variability in excavation contexts or secondary/osteological discard processes.

The representation of turtle remains – also potentially underrepresented due to taphonomic processes – likely reflects their consumption or use as raw material for tools, both of which are documented in Roman sources (e.g., Pliny the Elder, *Natural History*, IX. 12. 35–39).

Two mongoose remains (cranium and atlas from different areas; Fig. 3) provide evidence of non-autochthonous species during the Roman period. Native to Africa, this species is believed to have been introduced into Iberia precisely at that time (Detry et al., 2018).

The skeletal elements in the faunal assemblage show fairly even representation among the most abundant species (swine and caprines), suggesting no preferential selection of specific anatomical parts (Table 3). Nevertheless, the presence of femora, tibiae, scapulae, and humeri – elements with high meat yield – indicates the existence of anatomically valuable portions. The loose teeth from the principal mammalian taxa result from disaggregation of elements during recovery.

Red deer are also represented by antler remains, which may have been used as raw material for craft activities, notwithstanding the lack of visible working traces on the Cerro da Vila specimens. This is consistent with antler working practices documented at other Roman sites (e.g., Correia, 2003).

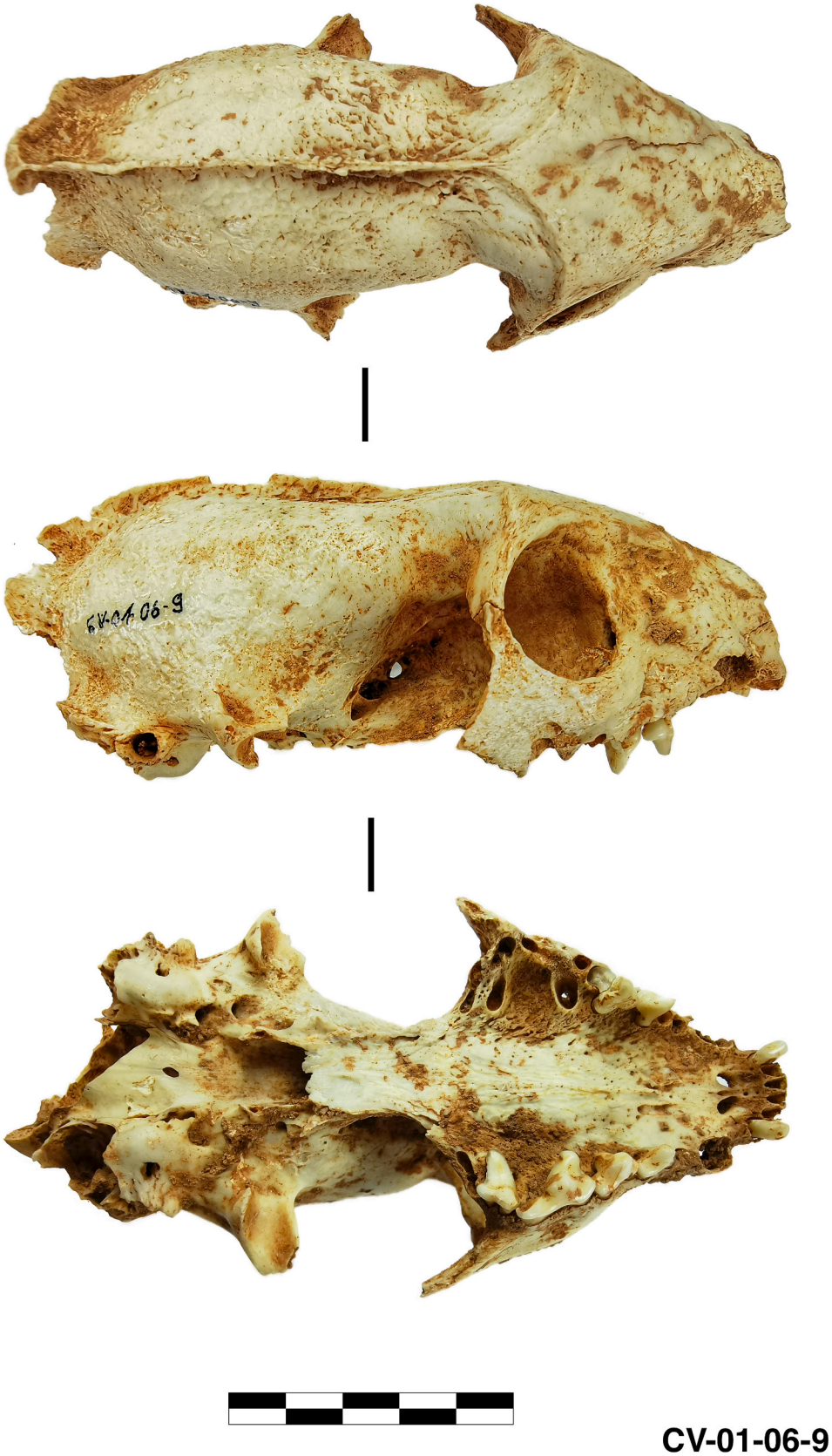

Fig. 3. Egyptian mongoose (*Herpestes ichneumon*) cranium.

Table 3
Mammal's anatomical elements (total NISP: 309).

		RR	ORY	HI	CF	EQ	SUS	CRV	BOS	CAP
CRANIAL	Antler							5		
	Horn									1
	Cranium			1			3			1
	Maxilla					1	1			
	Upper teeth*						11		5	5
	Mandible						6	2	1	1
	Lower teeth*						25			9
	Teeth*						4		1	9
AXIAL	Atlas						1			
	Axis			1				1		1
	Vertebrae				3		1			
	Ribs				2					
	Pelvis		3		2		3	1	1	2
FORELIMB	Scapula						4	5		3
	Humerus		1		2		1	2		7
	Radius				2	1	5	4	3	16
	Ulna		1		3	1	3		1	1
	Lunate							1		
	Magnum								1	
	Metacarpals				8	1	6	2		4
	Coracoid									
HINDLIMB	Femur	1	5				6	2		1
	Tibia		4		2		3	3		2
	Fibula						1			
	Astragalus							2	1	2
	Calcaneum						6	5		2
	Other tarsal									
	Metatarsals				6		9	2	2	5
OTHERS	Metapodial						3			2
	1st phalanx						4	5	2	6
	2nd phalanx						4	2	2	2
	3rd phalanx						1	1		

*Loose teeth. RR: *Rattus rattus*; ORY: *Oryctolagus cuniculus*; HI: *Herpestes ichneumon*; CF: *Canis familiaris*; EQ: *Equus asinus* and *E. caballus*; SUS: *Sus* sp.; CRV: *Cervus elaphus*; BOS: *Bos taurus*; CAP: Caprines (*Ovis aries* and/or *Capra hircus*). To notice that amongst the non-identified remains, many belong to the axial skeleton (ribs and vertebrae).

3.2. Bone modifications

Cut marks and other anthropogenic modifications, including percussion marks associated with bone fracturing, are present on 11.7 % of the assemblage. These traces occur on both taxonomically and anatomically identified specimens, predominantly in swine and caprines, which are the most abundant taxa represented, but also in rabbit, red deer, cattle, and several unclassified remains. (Table 4).

From an anatomical perspective, cut marks are more frequent on appendicular skeletal elements. However, there is also notable evidence of such anthropogenic modifications on axial elements, particularly on the ribs of animals ranging from small to large sizes (Fig. 4).

Table 4
Bone modifications (NR: 169).

		Cut Marks		Gnaw Marks		Sawing		Impact Marks		Thermo-alterations	
	NR (total)	NR	%	NR	NR	NR	%	NR	%	NR	%
Oryctolagus cuniculus	14	1	7,1 %								
Sus sp.	111	7	6,3 %	3	2,7 %					4	3,6 %
Cervus elaphus	45	4	8,9 %	3	6,7 %					1	2,2 %
Bos taurus	20	2	10,0 %							1	5,0 %
Caprines	82	5	6,1 %	5	6,1 %					2	2,4 %
Birds	13									1	7,7 %
Fishes	5									1	20,0 %
Large Mammals	122	22	18,0 %	4	3,3 %			2	1,6 %	6	4,9 %
Large/Medium-Sized Mammal	80	3	3,8 %	2	2,5 %			2		3	3,8 %
Medium-Sized Mammal	489	46	9,4 %	10	2,0 %	1	0,2 %	2	0,4 %	24	4,9 %
Medium/Small-Sized Mammal	13	1	7,7 %								
Small-Sized Mammal	17	1	5,9 %								
Total	1074	92	8,6 %	27	2,5 %	1	0,1 %	6	0,6 %	43	4,0 %
%NR with modifications		8,6 %		2,5 %		0,1 %		0,6 %		4,0 %	

NR: Number of Remains. All the percentages refer to Total NR values (i.e., percentage of remains with alterations considering the total number of NR of that animal taxa or class).

Fig. 4. Bones modifications. A: Long bone with sawing marks. B: Long bones with impact marks. C: Pelvis of *Bos taurus* with cut marks (parallel striations). D: Caprine metatarsal with cut marks (parallel striations). E: Medium sized animal rib with cut marks (chopping).

Superficial and parallel cut marks, observed on cranial bones or metapodials, can generally be associated with skinning and defleshing activities. Cut marks in the form of striations are associated with tendon extraction (NOE-Nygaard, 1989), occurring mainly on lower limb bones where this type of dense connective tissue is particularly abundant (e.g., calcaneus and astragalus). Deeper and more pronounced cut marks are usually associated with butchering (NOE-Nygaard, 1989), and are documented on elements such as the atlas, femora, pelvis, humeri, scapulae, and ribs, for disarticulating major carcass portions such as the head, axial body and limbs, often followed by the segmentation of individual skeletal elements.

Only one sawing mark was observed (Fig. 4**A**), and its occurrence may relate either to varied food-preparation practices or to the manufacture of bone ornaments and tools.

Impact marks generally result from blows delivered with pointed implements to break the bone and access its interior (often as a food preparation technique) (NOE-Nygaard, 1989). Within this faunal assemblage, such modifications were identified on three long bones (Fig. 4**B**), one rib and one tibia from medium- or large-sized animals.

Thermally altered specimens (NR = 43) constitute 4 % of the assemblage. Most of these fragments are fully affected, typically showing a black surface coloration (carbonisation) and, less frequently, grey or white (calcination). Experimental studies have shown that bone turns black, and then grey to white depending on the temperature and duration of exposure to fire (e.g., Shipman et al., 1984), this evidence is more consistent with burning episodes unrelated to culinary practices and is more plausibly associated with the disposal of refuse following consumption.

Most thermally altered specimens are small, taxonomically unidentifiable fragments. Exceptions include a few caprines and swine elements, a single cervid remain, an indeterminate bird bone, and one mackerel specimen. Anatomically, burned remains are predominantly appendicular elements.

In addition to taphonomic traces associated with human activity, the assemblage also exhibits post-depositional modifications (Table 4). These bones derive from swine, caprine, deer, and unclassified animals. Although the agents responsible for such alterations can rarely be identified with confidence, these taphonomic signatures are consistent with gnawing by canids, probably domestic animals that inhabited the settlement and consumed human food refuse. No straightforward evidence of rodent activity was observed, despite the presence of rodent bones within the assemblage.

3.3. Age estimation

Age-at-death estimation were obtained for swine, caprines, cattle, red deer, rabbit, and dog, with complementary data from domestic chicken, red-legged partridge, duck, and black rat remains. Analytical constraints stemmed from the scarcity of diagnostically viable skeletal elements and the suboptimal preservation of certain osteological specimens, which limited the scope of the study to only a subset of the overall faunal assemblage. As such, the results should be considered preliminary, requiring refinement through additional material from future archaeological interventions.

Analysis of dental eruption and wear in swine – the most frequent taxon within the Cerro da Vila assemblage – indicates comparable frequencies of neonatal/juvenile individuals (below 12 months; n = 2) and subadult and adult individuals (more than 12 months; n = 2). However, bone fusion data reveal a higher number of subadult and adult specimens (Fig. 5**A and B** and accompanying notes). This pattern suggests a husbandry strategy involving the slaughter of younger animals for tender meat, while retaining older individuals to increase overall meat yield through greater carcass weight, thereby optimizing harvest size and sustaining herd reproductive turnover.

Dental profiles and bone fusion for caprines indicate predominantly subadult to adult slaughter ages (Fig. 5**A and B**). This mortality distribution is consistent with a dual-purpose exploitation strategy focused on meat production, while remaining compatible with the secondary exploitation of sheep and goats for wool, milk, and dairy processing.

Cattle are poorly represented by elements suitable for age estimation, limiting interpretive resolution. Nevertheless, the few diagnostic remains can be assigned to a broad subadult-to-adult age class (more than 18 months; Fig. 5**B**), suggesting their primary use as multipurpose animals – particularly for traction, transport, and manure production –

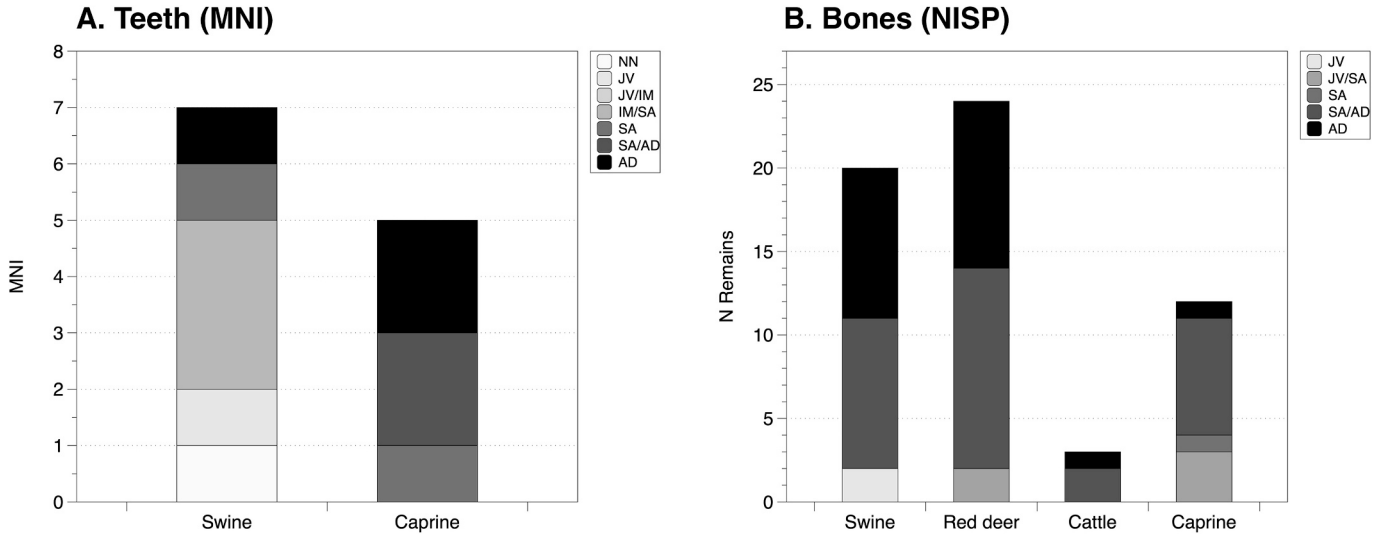

Fig. 5. Age-at-death data for the main mammal species. Panel A presents age estimation based on mandibular tooth wear, expressed as the minimum number of individuals (MNI). Panel B shows age estimation based on bone fusion, expressed as the number of identified specimens (NISP). Using NISP over MNI allowed us to better control analytical errors derived from bones MNI. The data are presented for swine and caprines using the following age categories: neonatal (NN, less than 1 month), juvenile (JV, 2 to 6 months), immature (IM, 6 to 12 months), subadult (SA, 12 to 30 months for pigs; 12 to 36 months for caprines), and adult (AD, over 30 months for pigs; over 36 months for caprines). Age classes and methods follow Lemoine et al. (2014) and Zeder et al. (2015) for pigs, Payne (1973), and Zeder (2006) for caprines, with age categories adapted from O'Connor (1988). For red deer, the categories are juvenile (JV, less than 12 months), subadult (SA, 12 to 32 months) and adult (AD, over 32 months), following Mariezkurrena (1983). For cattle, the age groups are subadult (SA, 18 to 30 months) and adult (AD, over 30 months) as per Habermehl (1975).

with female individuals also likely exploited for dairying.

Fusion evidence from red deer epiphyses reveals a high frequency of mature individuals, beyond the subadult stage (Fig. 5), which shows that hunting strategies selectively targeted fully grown animals. The choice of such individuals implies a sustained focus on venison procurement, with hide exploitation representing an additional utility.

Rabbit remains display a predominance of individuals within an optimal age class for consumption, corresponding to adult-sized individuals (over 8 months). This pattern supports opportunistic hunting practices involving small game species, despite their relatively low meat yield per individual, perhaps reflecting dietary diversity or cultural preference for this taxon.

Epiphyseal fusion in dog remains indicates the presence of at least three individuals: one young adult (less than 8 months), one probable young adult (5 to 8 months), and one individual older than six months at death (cf. Sumner-Smith, 1966).

Avian remains – including domestic chicken, red-legged partridge, and duck – were identified as skeletally mature based on complete epiphyseal fusion. Derived from both husbandry and opportunistic hunting, their survival to advanced age may reflect deliberate management strategies aimed at maximizing carcass mass.

Finally, the single black rat remain consists of an unfused femur, indicating an immature individual (less than 15/17 weeks; cf. Fukuda & Matsuoka, 1979).

3.4. Biometric data

It is now well established that the close relationship between humans and domestic animals has led, in certain regions of the Roman Empire, to measurable biometric changes in some species, influenced by economic and/or cultural factors. In Portugal, however, the available evidence for the Roman period suggests that this was not the general pattern (e.g. Davis et al., 2008). Nevertheless, in the specific case of cattle, recent studies suggest an increase in size within major urban centres (Detry & Santos, 2021; Detry et al., 2022; Detry & Santos, 2024).

The biometric data obtained from Cerro da Vila are limited but align with broader regional trends, indicating no substantial anthropogenic pressure on the principal domestic taxa (Supplementary Data). Most of the species analysed fall within the biometric ranges already established for this chronological horizon in other studies. The only exception concerns two goat astragali, whose measurements exceed the upper limit documented for the Iron Age/Roman period (Davis, 2006; Davis, 2007). This may suggest either the introduction of new breeding stock or local improvement strategies. However, given the extremely limited sample, additional material and comparative data are required before firmer conclusions can be drawn.

4. Comparative data

Comparative faunal analysis of contemporaneous coastal sites in southern Lusitania, including the *vicus maritimus* at Cerro da Vila, provides valuable insights into subsistence strategies and local economic practices. The sites included in this comparative framework comprise Monte Molião (Detry & Arruda, 2013), associated with the Roman city of *Lacobriga*; the *villa* of Milreu (Benecke, 2008), near *Ossonoba* (present-day Faro); the *villa* of Quinta do Marim (Antunes & Mourer-Chauviré, 1992), a Roman port with fish-processing structures; Castro Marim (Davis, 2007), identified as the Roman port of *Baesuri*; Ilha do Pessegueiro (Cardoso, 1993), a fish-processing establishment; Largo João de Deus in Sines (Pereira, 2020), another fish-processing facility; Creiro in

Table 5
Summary of animal abundance in selected coastal Roman-period archaeological assemblages from southern Portugal.

	NISP Mammals	Domesticated Mammals	Wild Mammals	Birds	Fish
Monte Molião (4th century BCE to 2nd century CE)	821,5*	70,6 % pigs 31,2 % caprines 25,9 % cattle 9,3 %	29,4 % leporid 19,5 % cervids 9,7 %	NISP 79 chicken 53,2 % partridge 16,5 %	No info
Milreu (1st to 7th century CE)	3689	85,2 % caprines 40,4 % pigs 31,6 % cattle 10,4 %	14,8 % cervids 13,9 % leporid 0,9 %	NISP 181 chicken 70,7 % partridge 24,9 %	NISP 28 (most Sparidae)
Cerro da Vila (1st to 5th century CE)	311	79,4 % pigs 35,7 % caprines 26,4 % cattle 6,4 %	20,3 % cervids 15,1 % leporid 4,5 %	NISP 13 chicken 69,2 % partridge 15,4 %	NISP 5 (most Sparidae)
Quinta do Marim (mid-2nd century to early 5th century CE)	192	73,4 % caprines 60,4 % cattle 5,2 % pigs 0 %	25,0 % leporid 22,4 % boar 2,6 % cervids 0 %	NISP 9 northern gannet 88,9 %	NISP 0
Castro Marim (mid-1st century BCE to mid-1st century CE)	124	60,5 % caprines 26,6 % pigs 19,4 % cattle 12,9 %	39,5 % leporid 29,0 % cervids 10,5 %	NISP 0	No info
Ilha do Pessegueiro (mid-1st century to early 5th century CE)	97	39,2 % caprines 33,0 % cattle 1,0 % pigs 0 %	60,8 % cervids 28,9 % leporid 27,8 % boar 4,1 %	NISP 0	No info
Largo João de Deus (1st to 5th century CE)	115	82,6 % caprines 24,3 % cattle 21,7 % pigs 12,2 %	15,5 % cervids 15,7 % leporid 0,9 %	NISP 6 chicken 33,3 % partridge 33,3 %	NISP 1 (Sciaenidae)
Creio (1st to 2nd century CE and 4th to 5th century CE)	85	71,8 % caprines 41,2 % pigs 18,8 % cattle 11,8 %	28,2 % cervids 22,4 % leporid 4,7 %	NISP 2 chicken 0 % partridge 50 %	NISP 1 (Congridae)
Tróia (3rd century to mid-5th century CE)	258	73,3 % caprines 39,5 % pigs 29,5 % cattle 3,1 %	21,3 % leporids 14,0 % cervids 0,8 %	NISP 54 chicken 79,6 % partridge 0 %	NISP 1085 (most Sparidae)

See text for references and Fig. 1 for locations. * Quantification according to POSAC (Parts of the Skeleton Always Counted) methodology (Davis, 1992: 14).

Setúbal (Detry & Silva, 2016), also associated with fish-processing; and Tróia (Nabais, 2014; Vaz Pinto et al., 2024), recognised as the largest fish-processing complex in the Roman Empire (Fig. 1; Table 5).

Despite local variations, the quantitative trends point to a prominent role for caprine husbandry, which dominates assemblages and, in certain cases – such as Quinta do Marim – reaches just over 60 % NISP. This pattern is consistent with structured livestock management strategies, in which goats and sheep were raised not only as staple dietary resources but also fulfilled multiple roles within coastal economies. Their versatility in providing both meat and secondary products (wool, milk) may help explain their high representation, suggesting communities that relied on animal exploitation systems potentially resilient to economic and environmental fluctuations.

A notable deviation from this pattern is observed at Ilha do Pessegueiro, where unusually high proportions of wild game – particularly red deer – are recorded. This feature may reflect seasonal provisioning practices, possibly linked to short-term exploitation episodes or logistical support of transient populations. Its prominence indicates an opportunistic reliance on abundant local wildlife, in contrast to the more husbandry-oriented economies observed elsewhere. Conversely, the absence of deer at Quinta do Marim is equally noteworthy. Given the documented abundance of deer in the Algarve during this period, this absence may indicate a deliberate socio-economic or cultural choice by the resident population – whether driven by dietary preferences, specialised caprine-focused pastoralism, or reduced reliance on hunting. These differences raise important questions regarding community identity, economic priorities, and regional integration, although potential excavation bias (e.g., limited spatial coverage and different recovery methods) should also be acknowledged.

Leporid representation reflects this variability, with proportions ranging from a striking 29 % NISP at Castro Marim to less than 1 % at Milreu and Sines. Given the abundance of these animals in the landscape, such disparities are unlikely to reflect ecological availability or hunting pressure; they are better explained by recovery methods, pointing to the methodological difficulties inherent in cross-site comparison.

Avian remains underscore both the symbolic and practical importance of domestic fowl within coastal settlements. Although they account for a modest total of 345 NISP across the dataset, Galliformes dominate, with most remains attributed to chicken. Their widespread presence – particularly at Monte Molião, Milreu, Cerro da Vila, and Tróia – is consistent with scholarship linking poultry consumption to higher socio-economic strata (Kron, 2005; Alcock, 2006; Cool, 2006). In this context, chickens likely functioned not only as a readily available food source but also as markers of status, connectivity, and participation in Roman culinary traditions circulating across the western Mediterranean.

Ichthyofaunal remains, recovered from only five sites and absent from many assemblages where they may not yet have been recovered or studied, nevertheless highlight the importance of fish within coastal subsistence economies. Of the 1,120 identified remains, nearly all derive from Tróia (1,085 NISP), where they were integral to both consumption and possibly production-related activities (Vaz Pinto, et al., 2024). The dominance of Perciformes species (e.g., grouper, seabream, snapper, gilthead bream, black seabream), complemented by smaller quantities of other taxa, suggests both culinary diversity and engagement with extensive fishing and processing economies centred on Sado's rich estuarine and adjacent marine environments. This pattern underscores the integration of certain sites into broader economic networks linking fish production to supra-local consumption.

Additional, albeit marginal, evidence of amphibians and reptiles – represented respectively by a single anuran femur at Tróia and four Testudine shell plates at Cerro da Vila – serves chiefly to confirm the presence of these faunal classes. Their scarcity, similar to that observed for fish at non-specialized sites, likely results from preservation and recovery biases rather than true absence from dietary or tool-making repertoires (MacKinnon, 2014; Boneta Jiménez, 2022, p. 42ss).

Taken together, these zooarchaeological profiles depict communities balancing animal husbandry, opportunistic hunting, fishing economies, and the collection of mollusc and crustacean, the latter also well documented at these sites (Marques Da Silva, 1997; Henriques & Pratas, 2018).

Overall, the evidence for caprine and swine husbandry, the variable contribution on wild resources, and the inclusion of status-associated foods such as chicken point to subsistence strategies that were both contextually adaptive and socially embedded. Age-at-slaughter profiles further support the interpretation of diverse herd management strategies oriented toward both meat consumption and the exploitation of secondary products (Table 6). Together, these patterns reflect not only local subsistence choices but also broader trajectories of economic and cultural integration within the Roman western provinces.

5. Synthesis and Implications: Economic dynamics at Cerro da Vila in Roman Lusitania

The *vicus maritimus* of Cerro da Vila formed part of the industrial and economic fabric of Roman coastal Lusitania, where the intensive exploitation of marine resources was central to Roman economic and territorial consolidation. Alongside the diversification of production and widespread consumption of fish and shellfish, the exploitation of mammals and birds – and, to a lesser extent, reptiles such as turtles – contributed significantly to the settlement's economic organisation and illuminates the complex interplay between maritime and terrestrial resource use.

The faunal assemblage is dominated by swine (most probably domestic pig) and caprines, supplemented by remains of other medium- and large-sized domestic mammal and birds, with chicken being the most prominent taxon. This evidence reflects a diversified strategy that balanced meat consumption with other forms of animal use. Beyond primary products such as meat, milk, and eggs, animals provided essential goods and services, including wool, hides, traction for

Table 6
Summary of age-at-death data in selected coastal Roman-period archaeological assemblages from southern Portugal.

	Swine	Red deer	Cattle	Caprines
Monte Molião (4th century BCE to 2nd century CE)	Mostly adults, but other ages too. Increase of mature animals in the Imperial period	Adults	Adults. Growing numbers of young animals in Imperial period	Mature-adult with little variation over time
Cerro da Vila (1st to 5th century CE)	Some variation, mostly adults	Subadult and adults	Adults	Young-adult and adults
Castro Marim (mid-1st century BCE to mid-1st century CE)	Young	Mostly adults	Adults	Adults
Largo João de Deus (1st to 5th century CE)	Adults	Adults	Adults	Adults
Tróia (3rd century to mid-5th century CE)	Young	Adults	(no information)	Young

See text for references and Fig. 1 for locations.

ploughing and transport, and roles in guarding, herding, pest control, and companionship.

The community's *modus vivendi* was sustained by an economy based primarily on the exploitation and processing of aquatic resources, complemented by integrated livestock husbandry and agricultural production. Zooarchaeological evidence also indicates that hunting contributed to local subsistence strategies, though whether this constituted a core economic element or a complementary activity to primary production remains to be determined.

Special attention is warranted for the status of rabbits and dogs, which raise broader questions about animal management strategies in Roman Lusitania. Regarding rabbits, their consistent presence across sites raises the question whether they were taken exclusively through hunting or whether evidence exists for semi-domestication or controlled enclosures (*leporaria*), such as those proposed by Gardeisen & Valenzuela (2010) for Lattara in southern France. To date, no such evidence has been identified in Lusitania, and their natural abundance may have rendered such management unnecessary. The role of dogs at Cerro da Vila, as at many other Roman sites, remains equally uncertain. Whether these animals were primarily associated with site-specific activities – such as fishing, hunting, or herding – or instead functioned as companion animals cannot yet be determined. The available evidence is compatible with potential use in such tasks while also reflecting the complex and variable relationships between humans and canids in Roman contexts, a topic that merits further investigation.

Evidence of commercial exchange with other Roman provinces is provided by fine wares and imported foodstuffs transported in amphorae, both well attested at Cerro da Vila (Henriques & Pratas, 2025). The assemblage also documents the introduction of the non-native Egyptian mongoose into southern Lusitania during the Roman period. This finding is significant as further evidence of broader inter-provincial connections, particularly between Lusitania and Africa – species' original range – and strengthens the hypothesis that the mongoose reached the Iberian Peninsula under Roman administration, contributing to broader patterns of anthropogenic species translocation across the empire.

The close interconnection between urban and rural sites is reflected not only in settlement architecture – through the clustering of *villae* and *vici* around urban centres – but also in broadly similar consumption patterns. Dietary practices across Lusitania were largely grounded in the domestic triad of sheep/goat, pig, and cattle, although with some distinct chronological and regional variations. In many comparative contexts, caprine exploitation is more prominent than that of pigs and cattle. Yet the site of Cerro da Vila – perhaps owing to its particular settlement character (*vicus*), legal status, and economic specialisation – displays dietary patterns closer to those of major urban centres such as Monte Molião (*Lacobriga*), most notably in the marked presence of swine. The prominence of cattle in certain assemblages may reflect diverse factors, including greater investment in animal husbandry to supply sedentary populations, provisioning of urban markets, or demand for draught power essential for transport and productive activities in commercial contexts.

Wild species also contributed significantly to dietary and economic strategies, with deer and rabbit identified in both rural and urban contexts. A distinction appears to emerge in which deer are more common at rural sites, probably reflecting their association with elite consumption patterns and economic activities. Red deer could supply a diversity of products – venison, antlers, and hides.

both for domestic use and for commercial exchange (MacKinnon, 2014). The considerable representation of red deer elements at Cerro da Vila is consistent with this interpretation, suggesting systematic exploitation of deer resources from dietary supplementation to raw material procurement for craft production. Rabbit, conversely, appears more frequently consumed in urban contexts, though this pattern can only be securely assessed through comparisons free from recovery bias, which current methodological limitations preclude. Should future research confirm a consistent urban preference for rabbit, this may reflect trade networks and market demand rather than the species' modest nutritional contribution.

Finally, bird consumption was characteristic of both rural and urban lifeways throughout Roman Lusitania. The red-legged partridge, hunted for its valued meat, and domestic chicken, prized for its reproductive efficiency and eggs, were widespread across the Roman Empire and present in diverse socioeconomic contexts (Kron, 2014). The integration of both wild and domestic avian resources reflects the sophisticated resource-management strategies that characterised Roman coastal settlements.

Despite the inherent limitations – namely the relatively small size of the faunal collection and its broad spatial and chronological distribution across an extensive settlement – this study clearly demonstrates the considerable potential of zooarchaeological assemblages to elucidate complex economic relationships in Roman provincial contexts. Future research at the site should prioritise targeted excavation, recovery, and sampling strategies aimed at improving the chronological resolution of deposits. Moreover, it should incorporate diverse analytical approaches to the faunal remains, including detailed characterisation of livestock palaeodiets and mobility patterns through isotopic analyses. Additional archaeogenetic studies would contribute significantly to clarifying the history of several animal species, including the introduction pathways of the Egyptian mongoose into Roman Iberia.

Declaration of generative AI an AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author(s) used Perplexity in order to edit the translation from European Portuguese to British English. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

CRediT authorship contribution statement

Ana Pratas: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Maria João Valente:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Conceptualization.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2026.105883.

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