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Camelids in the south of the Iberian Peninsula in Roman and medieval times. Osteological evidence from the city of Cordoba (Spain)

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ABSTRACT

This paper presents the results obtained concerning the possible presence of camelids in the city of Cordoba (Spain) in Roman and medieval times, after the review of all the faunal assemblages corresponding to these historical periods deposited in the Provincial Archaeological Museum of the city. This research has allowed the recovery and contextualization of nine dromedary bone remains corresponding to nine individuals, four of which have been dated by ^{14}C. A stable isotope analysis has also been carried out which indicates the possible arrival of these animals from other provinces of the empire in Roman times and from North Africa in medieval times. Besides, we carried out a bibliographical update of all bone remains found in the Iberian Peninsula for the periods analyzed, concluding that the main use of them was for transporting and manufacturing different tools.

1. Introduction

The increase in the analysis and study of bone collections from Roman and medieval times in Spain and Portugal, as well as in other European countries, in recent years, has made it possible to confirm the presence of camelids in both historical periods, mainly linked to their use as transport animals (Cardoso, 1992; Morales et al., 1995; Bartosiewicz & Dirjec, 2001; Fernández Rodríguez, 2003; De Grossi, 2006; Pigière & Henrotay, 2012; Vuković & Bogdanović, 2013; Balaşescu, 2014; Bartosiewicz, 2014; Vuković-Bogdanović & Blazić, 2014; Tomczyk, 2016; Marković et al., 2021) and other types of craft or cultural activities (Moreno García et al., 2007; Riquelme Cantal, 2013).

With specific reference to the presence of these animals in the Iberian Peninsula, the bone remains determined are beginning to be relatively numerous thanks to the proliferation of analyses of bone collections from the aforementioned historical periods. In the specific case of the south of the Iberian Peninsula, although dromedaries are present in the Roman period, most of the finds are concentrated in the medieval period (Fig. 1).

In this way, a picture emerges that allows us to appreciate that because these geographical regions remained under Arab control for longer, the presence of this species is more abundant (Riquelme Cantal, 1992, 1993, 1994a, 1994b, 2004, 2013, 2022; Riquelme et al., 1997). However, the disparity in the number of faunal assemblages studied in

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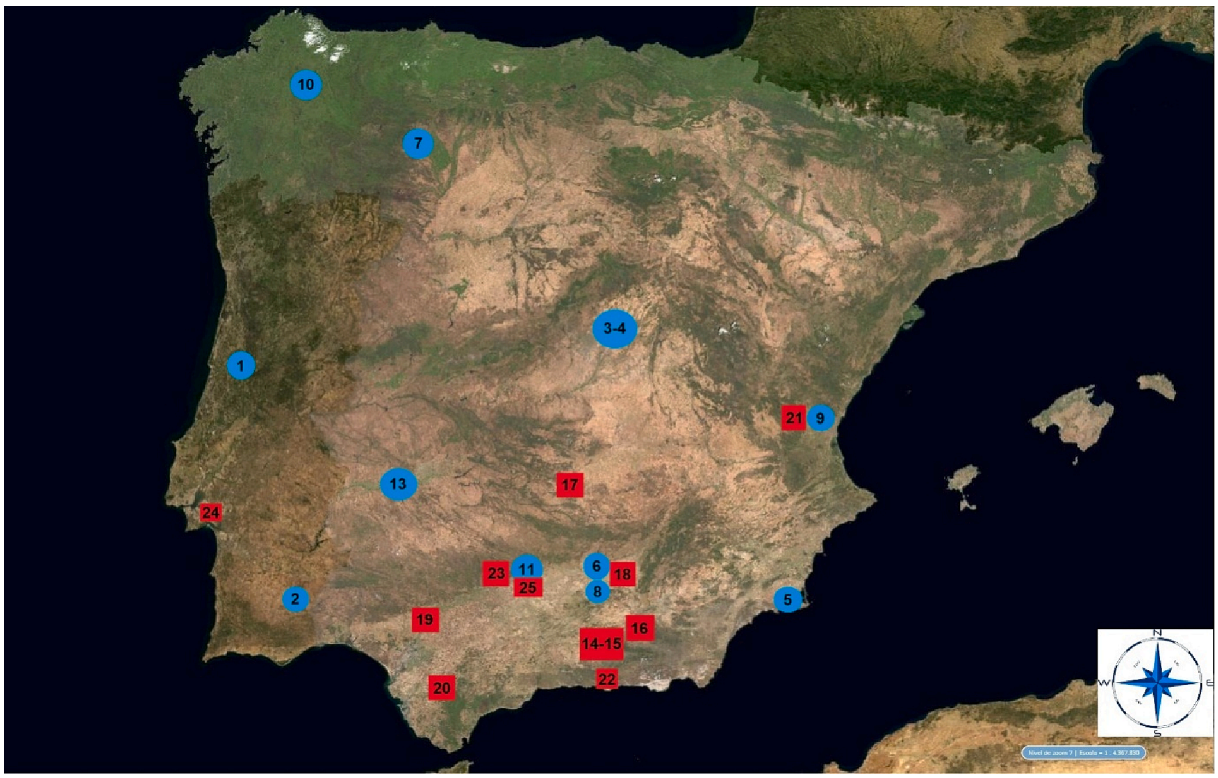

Fig. 1. Findings of camelid bone remains in the Iberian Peninsula from the Roman period. Portugal: 1. Coninbriga; 2. Mértola. Spain: 3. Complutum; 4. El Val; 5. Cartagena Amphitheatre; 6. Castulo; 7. Astorga; 8. Cortijo de los Robles; 9. Llíria (Valencia); 10. Domus del Mitreo (Mérida); 11. Cordoba; 12. Casa de Mitreo (Mérida): 13. Almendralejo St. (Mérida). 14. Granada Cathedral. 15. Espino St. (Granada). 16. San Miguel St. (Guadix); 17. Alarcos (Ciudad Real); 18. Cerro del Alcázar (Baeza); 19. San Luis St. (Seville); 20. Torrevieja (Villamartín);21. Palau de les Corts (Valencia); 22. El Maraute (Torrenueva); 23. Madīnat al-Zahrā' (Cordoba); 24. Palmela (Portugal); 25. Cordoba. Reference map: https://www.ign.es/iberpix/visor/. Iberpix is a cartographic viewer published by the National Center for Geographic Information (CNIG) and the National Geographic Institute of Spain (IGN) aimed at the consultation and visualization of maps and layers of geographic information.

Table 1
Location of sites with camelids bone remains from the Roman period in the Iberian Peninsula.

	Site	Locality	Chronology	N. of remains	REFERENCE
	Conímbriga	Coimbra	low-Imperial	1	Cardoso, 1992
Portugal	Mértola	Mértola	Roman	1	Moreno García et al., 2007
	Complutum	Alcalá de Henares (Madrid)	3rd c.-5th c. AD	1	Morales et al., 1995
	El Val	Alcalá de Henares (Madrid)	3rd c.-5th c. AD	1	Morales et al., 1995
	Amphitheatre	Cartagena (Murcia)	70–80 AD	1	Riquelme Cantal, 2004
Spain	Cástulo	Linares (Jaén)	Roman	1	Morales et al., 1995
	Astorga	León	low-Imperial	77	Fernández, 2003
	Cortijo de Los Robles	Jaén	I AD	1	Riquelme Cantal, 2013
	Llíria	Llíria (Valencia)	late-Roman	1	Iborra Eres, 2017
	Domus del Mitreo	Lugo	2nd c- 3rd c. AD	2	Fernández, pers. comm.
	Casa de Mitreo	Mérida	2nd c- 3rd c. AD	1	Bustamante and Detry, 2019
	Almendralejo St.	Mérida	2nd c- 3rd c. AD	?	Bustamante and Detry, 2019

the different Andalusian provinces means that, even today, in some of them we still have no evidence of its presence.

The most significant case of this situation is perhaps that of the city of Cordoba, since both in the Roman period (II BC–5th AD) and fundamentally in the Caliphate period (10th–11th AD) its importance with respect to the group of cities or settlements on the Iberian Peninsula was notorious. Therefore, the lack of archaeozoological data on the presence of dromedary camels seems to be due, in our opinion, to the lack of faunistic studies that could provide specific data on this subject.

The osteometric results will help to determine the dimensions and robustness of the animals and if they are directly related to the camelids' dedication to transport, an activity that requires the use of larger and more resistant ones. The isotopic analyses will also study the possibility of establishing whether these animals were born and lived on the Iberian Peninsula, or if they came from the African continent or from other provinces far from the Roman Empire.

2. The state of the art

At present, the number of camelids bone fragments amounts to a total of hundred nine chronologically well-dated fragments found in the following peninsular Roman and medieval sites. Roman: Conimbriga and Mértola (Portugal), Complutum and *villae* of El Val (Alcalá de Henares, Madrid), Cartagena (Murcia), Cástulo (Jaén), Astorga (León), Jaén city, Llíria (Valencia),Lugo, Casa de Mitreo and Almendralejo St. (Mérida), Medieval: Cathedral and Calle Espino (Granada), Calle San Miguel (Guadix, Granada), Alarcos (Ciudad Real), Cerro del Alcázar (Baeza, Jaén), Calle San Luís (Seville), Torrevieja (Villamartín, Cádiz),

Table 2
Location of sites with medieval camelids bone remains in the Iberian Peninsula.

	Site	Locality	Chronology	N. of remains	Reference
Portugal	Palmela	Setúbal	11th c. –12th c. AD.	2	Cardoso and Fernades, 2012
Spain	Cathedral	Granada	10th c. –11th c. AD.	1	Riquelme Cantal, 1992, 1994a
	Espino St.	Granada	10th c. –11th c. AD.	1	Riquelme Cantal, 1993, 1994a
	San Miguel St.	Guadix (Granada)	12th c. –15th c. AD.	5	Riquelme Cantal, 1993, 1994b
	Alarcos	Ciudad Real	AD 1195	2	Riquelme Cantal, 2004
	Cerro del Alcázar	Baeza (Jaén)	early medieval	1	Riquelme Cantal, 2004
	San Luis St.	Sevilla	early medieval	1	Moreno García et al., 2007
	Torrevieja	Villamartín (Cádiz)	9th c. – 11th c. AD	1	Riquelme Cantal, 2013
	Palau de les Corts	Valencia	Almohad	3	Martínez Valle and Cegarra López, 1994
	El Maraute	Torrenueva (Granada)	10th c. –12th c. AD.	1	García García, pers. comm.
	Madīnat al-Zahrā'	Córdoba	10th c. AD	2	Riquelme et al., 2022

Cortes Valencianas (Valencia) and Madīnat al-Zahrā' (Córdoba) (Table 1, Table 2).

In the case of Conimbriga, an important Roman city in northern Portugal, the camelids bone material is reduced to a proximal metacarpal fragment (Cardoso, 1992). It shows no butcher marks or exposure to fire. Its chronology cannot be established with any accuracy as the material comes from old excavations with a lack of field documentation, although it is reasonable to think that it is linked to the life of the city in the Imperial period.

The presence of dromedaries in Mértola (Portugal) is estimated to date from the Roman period (Moreno García et al., 2007: 198).

The two remains described below were found at two different sites in the town of Alcalá de Henares (Madrid) (Morales et al., 1995). On the one hand, in the city of Complutum, a distal fragment of the left metatarsal was found in archaeological excavations carried out in 1984. It shows no traces of butcher marks, and must have belonged to an adult individual as the epiphysis is fused. The second find consisted of a 1st phalanx located in the *villa* of El Val. It is somewhat deteriorated and the epiphyses are not very fused, which seems to indicate that it may have belonged to a sub-adult individual. The archaeological levels where both bones were found have been dated, based on the typology of the ceramic materials and numismatics, to between the 3rd and early 5th centuries AD.

Another of the bones identified comes from the excavations carried out in 1992 in the amphitheatre of the city of Cartagena (Murcia) (Riquelme Cantal, 2004). It is a posterior fragment of a mandible that does not preserve any teeth and where incisions can be clearly seen to cut the tendons that join the mandible and the skull. It also shows traces of fleshing. The stratigraphic units in which it was found are filled with material from a clearly Imperial period, although there is also some residual Republican material. The chronology of the ceramics, which are very abundant, is dated between 30 and 40 BC and 70–80 AD (Aretina and Subgallic sigillates, thin-walled wares typical of the 1st century AD, etc.). Therefore, the formation of these stratigraphic units is dated to -/+ 70–80 AD (Pérez Ballester et al., 1993).

In the city of Castulo, the find consists of a fragment of a metopod, although it has never been published (Morales et al., 1995: 369).

The finds from Astorga, both in terms of the number of remains and the number of individuals, point to the use of these animals in draught and transport work, as they were adult animals that must have died of natural causes or diseases and were thrown whole into the midden. A distal fragment of a serrated metapodial is also documented (Fernández Rodríguez, 2003).

In the study of the fauna recovered in the archaeological excavations of the Roman *villa* of Cortijo de los Robles, located in the archaeological area of Marroquíes Bajos in the city of Jaén, the presence of a distal fragment of serrated camelid metapodium was determined (Riquelme Cantal, 2013) in a sedimentary unit of the *pars urbana*. The function of this fill was to raise the level of use of the apsidal room at the eastern end, prior to the installation of the floor (a geometrically decorated mosaic). The construction of this room, like all those of the second phase of the second phase, is dated to the second half of the 2nd century AD, so the presence of this camelidsmust be related to the first phase of the Roman *villa*, founded in the mid-1st century AD and dedicated to the production of oil (López Marcos and Buzón Alarcón, 2013–2014).

In the city of Llíria (Valencia), a ritual well from the late Roman period (4th century) was excavated, where two coeval bone accumulations were determined, the remains of a meal or banquet in which portions of ovipods and the complete head of a dromedary were identified. This is the oldest record of the species in the Valencian Community (Iborra Eres, 2017: 33).

In the Domus de Mitreo in Lugo, a Roman site dated between the 2nd and 3rd centuries AD, has provided two cervical vertebrae of a camelid, most likely a dromedary. The vertebrae appear in the fill material used in some of the construction phases of the building and their unusually large size suggests, for example, that the animals were castrated to facilitate their handling or hybrids. This would be the most northerly find on the Iberian Peninsula to date (Fernández Rodríguez, pers. comm.).

In the excavation of a *taberna* in Mitreós House in Mérida, dedicated to the manufacture and sale of bone objects and dated to the 2nd and 3rd centuries AC, a sawed distal tibia belonging to *Camelus sp*. was found, most probably to *Camelus dromedarius*. Another camelid remains had already been found in Almendralejo St. in this same city, it was also serrated. Although we do not know their number their origin probably was North African, being also *Camelus dromedarius* (Bustamante Álvarez and Detry, 2019).

On the other hand, from medieval archaeological levels we have a total of twenty camelids bone fragments from urban excavations carried out in the cities of Granada (Riquelme Cantal, 1992, 1994a), Guadix (Riquelme Cantal, 1993, 1994b) in 1991 and 1992, Baeza in the campaign carried out at the Cerro del Alcázar site in 2002, the excavations carried out at the medieval site of Alarcos (Ciudad Real) in 1986 and 1987 (Riquelme Cantal, 2013), the excavation of Calle San Luis in Seville carried out in 2004 (Moreno García et al., 2007), the excavation of the Torrevieja site in Villamartín (Cádiz) in 2002 (Riquelme Cantal, 2013), the find at the Palau de les Corts (Martínez Valle and Cegarra López, 1994), a bone fragment from El Maraute, Torrenueva (Granada) (García García, pers. comm.) and the two fragments found at the site of Madīnat al-Zahrā' in Córdoba (Riquelme Cantal et al., 2022).

In the city of Granada, two bone fragments, metatarsus and 1st phalanx, have been documented in different excavations. The first comes from the excavations carried out inside the Cathedral (Riquelme Cantal, 1993, 1994a). It is a distal fragment of a serrated and burnt

metatarsal which, due to its shape and hardness, could have been used as a handle for a possibly metallic object. It was found at Caliphate occupation levels (10th-11th c.), within an enclosed archaeological area, as the bone was found inside an adobe structure filled with burnt ceramic and bone fragments. The former include fire containers and pieces for culinary use. The 1st posterior phalanx, also found in Caliphate occupation levels in the Albaicín neigh bourhood (Adroher et al., 1995; Riquelme Cantal, 1993, 1994a), is complete and shows no traces of cuts or fire. The proximal unfused epiphyses indicate the presence of a subadult individual.

The archaeological excavation carried out in the city of Guadix (Granada), where the dromedary bones were found, presents an uninterrupted stratigraphic sequence from the Bronze Age to the present day (González et al., 1993). Of the five fragments found, two radius fragments and one centrotarsal are related to the Almohad occupation (12th-13th c.) and are associated with a large assemblage of stamped pottery for storage use. An astragalus and a distal fragment of femur were found inside a pit that served as a midden during the Nasrid period (13th-14th c.), dated on the basis of the ceramic remains found inside it. The two radius fragments, proximal and distal, show cut and saw marks, the femur is quite deteriorated, and the medial and medial talus are complete. The fragments of long bones show cuts to separate the epiphyses from the diaphysis, while in the talus there are small cut mark related to the sectioning of the ligaments that join it to the tibia (Riquelme Cantal, 1993, 1994b).

At the site of Alarcos (Ciudad Real), two dromedary bone fragments have been identified: proximal femur and calcaneus (Riquelme Cantal, 2004). The bone material analysed at this site came from a pit excavated next to the castle wall, which was used after the battle of the same name between the Almohads and Christians on 19 July 195, to bury both combatants and mounts. The fragmentation of the material determined has not allowed measurements to be obtained. This finding allows us to speculate on its use as a pack animal and for military transporting, a fact that is confirmed by written sources, which indicate that it was used for transporting heavy material. So that when it was part of war expeditions it was used for transporting weapons and supplies than for the fighting itself (Levi-Provençal, 1956).

The 1st phalanx identified in Cerro del Alcázar, Baeza (Jaén) was found complete along with other faunal remains from the early medieval period inside a pit that digged in prehistoric levels (Riquelme Cantal, 2004).

In the historic centre of the city of Seville, a fragment of radio-ulna was recovered with the particularity of having been used as an anvil for the manufacture of toothed metal sickles. It was found in a pit with other faunal remains and various materials that allowed it to be dated to the Taifa-Almoravid period (Moreno García et al., 2007).

From the excavation carried out at the site of Torrevieja, Villamartín (Cádiz) in 2002, a fragment of an anvil for toothed metal sickles made from dromedary metapodium was also recovered, dated to between the second half of the 9th and the first half of the 11th century AD. Initially, the complete bone was used in this work once it had been prepared for this purpose, but as the cortex of the facets of the diaphysis was reduced in order to smooth it out again, remove the marks already made and reuse it, it would lose consistency until it ended up fracturing. The fragment recovered belongs to the distal part of the metapodial and its dimensions are 120 mm long and 80 mm wide. The anterior face is deteriorated by root marks, although under the microscope some chisel marks and traces of polishing can be seen, which would indicate the progressive lowering of the bone to create a flat surface. The posterior face has 33 rows of chisel marks transversal to the axis of the bone and is also recessed and flattened like the anterior face. The lateral faces of the bone, although they have also been lowered and prepared for this purpose, do not retain traces of the use of the chisel. The fracture in the bone seems to be a break in the same direction as the rows of chisel marks and must have been caused by the progressive thinning of the cortex. In this case, the preparation and lowering of the bone to create four facets does not include the removal of the epiphyses, at least in the case of the distal one (Riquelme Cantal, 2013).

The distribution of findings of bone anvils is wide in the Iberian Peninsula (Aguirre et al., 2004), based mainly on the use of long bones from cows and horses due to their thickness and hardness. Possibly the hardness of dromedary bones would have a decisive influence on their use as anvils in the places on the Iberian Peninsula where these animals were found. The appearance in other archaeological interventions mentioned in the text of dromedary bone fragments with saw marks (Astorga, Jaén, Granada Cathedral, Guadix, Córdoba) could indicate their use as anvils once the proximal and distal epiphyses had been removed.

From the archaeological intervention carried out at the Palau de les Corts in Valencia, three dromedary bone fragments from the Almohad period with butchery marks were recovered (Martínez Valle and Cegarra López, 1994).

At the site of El Maraute (Torrenueva, Granada), a complete first phalanx was recovered which seems to belong to an adult individual in a midden context from the 10th-12th centuries AD (García García, pers. comm.).

In the study of the fauna of the Caliphate city of Madīnat al-Zahrā' (10th century AD) belonging to the area of the southern wall, the presence of two bone fragments attributed to a dromedary was determined. They are a fragment of a metopod and a first phalanx. The first fragment belongs to the distal epiphysis and is small in size. The phalanx, on the other hand, is complete without the proximal epiphysis, without fusing, which would indicate that it is from a juvenile or subadult animal. The two bone portions determined belong to the same individual and show no marks of cuts or exposure to fire (Riquelme Cantal et al., 2022).

In the castle of Palmela (Setúbal, Portugal), a portion of a scapula and the distal end of a humerus were identified, possibly belonging to the same animal, from the 11th-12th centuries AD (Cardoso and Fernades, 2012).

3. Methodology

Until the 1990s, the presence of camelids and specifically dromedaries in the Iberian Peninsula was only known to us through medieval written sources (Arab and Christian) (Levi-Provençal, 1956; García Gómez, 1934; de Villena, 1766). The archaeological evidence of their remains, both at Roman and medieval levels, definitively confirms the introduction of these animals to the Iberian Peninsula (Riquelme Cantal, 2013). The taxonomic and taphonomic analysis of the bone remains analysed, as well as the criteria for estimating age, sex and osteometry is common in this type of work (Riquelme Cantal, 1998; Steiger, 1990). Similarly, we have used the representations of camelids made in ceramic material, metal, ivory, mosaic and mural painting, which complement the bone data and provide information on the importance of these animals in Roman and Islamic cultures, respectively. As for the difficulty in differentiating the remains of *Camelus dromedarius* and *Camelus bactrianus*, especially when the bone material is fragmented, we have used our own comparative collection and the methodology and measurements proposed by Steiger (1990).The characteristics of the bone material analysed, where it has been possible to determine its specific characteristics, indicate the presence of dromedary camels in both Roman and medieval times, without being able to specify in some specific cases whether it is one or the other species due to the fracturing of the material. Isotope analyses are based on the measurement of the isotopic composition of bone collagen ($\delta^{13}C$, $\delta^{15}N$,) as they are reasonably resistant to diagenetic processes. C and N isotopic values are essentially related to diet and, in the case of herbivorous mammals, to the vegetation available during their life cycle. To carry out the analysis of the ^{15}N and ^{13}C values of collagen, the sample was analysed by continuous flow systems (gas chromatograph connected to the mass spectrometer) (Boutton et al., 1983; Fry et al., 1993; Jefrey et al., 1994).

Table 3
Contextualisation of the camelids bone material documented in the Iberian Peninsula.

Site	Chronology	Context	Remains	Bones	Age	Alterations
1. Conímbriga	Imperial	midden	1	metacarpus	adult	no
2. Mértola	Roman	¿?	1	¿?	¿?	
3. Complutum	3th-5th AD	midden	1	metatarsal bone	adult	no
4. El Val	3th-5th AD	midden	1	1st phalanx	subadult	no
5. Cartagena	70–80 AD	midden	1	mandible	adult	cuts
6. Cástulo	Roman	midden	1	metapodial	¿?	
7. Astorga	Imperial	midden	77	metapodial	adult	sawed
8. Cortijo de Los Robles	1st AD	midden	1	metapodial	adult	sawed
9. Catedral	10th-11th AD	domestic	1	metatarsal bone	adult	sawed, burned
10. Espino St.	10th-11th AD	midden	1	1st phalanx	subadult	no
11. San Miguel St.	12th-15th AD	midden	5	radius	adult	cuts, sawed
12. Alarcos	1195 AD	pit	2	femur, calcaneus	adult	no
13. Cerro del Alcázar	MidlleAges	midden	1	1st phalanx	adult	no
14. San Luis St.	MiddleAges	midden	1	ulna-radius	adult	anvil
15. Torrevieja	9th-11th AD	midden	1	metapodial	adult	anvil
16. Llíria	Roman	ritual well	1	craneum and mandible	adult	no
17. Lugo	2nd-3th AD	stuffing	2	vertebras	adult	no
18. Valencia	Almohad time	pit	3	humerus, metapodial	adult	consumption?
19. El Maraute	10th-12th AD	midden	1	1st phalanx	adult	no
20. Madīnat al-Zahrā'	10th AD	midden	2	metapodial, 1st phalanx	young	no
21. Palmela	11th-12th AD	midden	2	scapula, humerus	young	cuts, consumption?
22. Casa de Mitreo	2nd-3th AD	Bone Workshop	1	tibia	adult	sawed
23. Almendralejo St.	2nd-3th AD	Bone Workshop	?	?	?	sawed
24. Plaza Pineda	2nd-3th AD	bone?	1	ulna + radius	adult	sawed
25. Cercadilla 1998	2nd AD	stuffing	1	mandible	adult	broken
26. Cercadilla 1992	2nd AD	stuffing	1	1st phalanx	adult	burned
27. Cercadilla 1992-M	9th. AD	domestic	1	mandible	adult	broken
28. Parcela 16A. PP O-7	11th AD	domestic	1	2nd phalanx	adult	cuts
29. Jardines Agricultura	11th AD	midden	1	1st phalanx	adult	no
30. Subestaciones	11th AD	domestic	1	1st phalanx	young	burned
31. J. Sama Naharro	9th-11th AD	piping	1	1st phalanx	adult	no
32. San Pablo'sChurch	Roman/Middle Ages	undetermined	1	astragalus	adult	no

Table 4
Radiocarbon dates obtained on the camelidsbone material from the city of Cordoba.

Site	CNA site nr.	Typeofsample	Bonefragment	Conventional chronology	CalibratedChronology	Averagecalibration
Cercadilla	5668.1.1	bone	mandible	1832 ± 29 BP	126–252 AD	189 AD
Cercadilla	5671.1.1	bone	mandible	1059 ± 29 BP	950–1030 AD	990 AD
Jardines de la Agricultura	5672.1.1	bone	1st phalanx	1071 ± 29 BP	943–1025 AD	984 AD
PP-07. Parcela 16A	6018.1.1	bone	2nd phalanx	1060 ± 25 BP	971–1029 AD	1000 AD

Table 5
Cordoba. ^{15}N and ^{13}C isotopic values of camelids bonessamples.

SAMPLE	^{15}N ‰ (Air-N_2)	^{13}C ‰ (V-PDB)	Average C/N	%N obtained	%C Obtained
1/ DRO 1.1	6.52	−20.53	4.39	4.27	9.57
2/ DRO 1.2	6.61	−20.17	3.27	6.70	15.49
3/ DRO 1.3	5.01	−20.64	3.28	8.85	20.81
4/ DRO 1.4	7.77	−18.09	3.48	8.49	20.85
5/ DRO 1.5	7.13	−21.09	3.01	7.34	15.81
6/ DRO 1.6	8.15	−18.99	2.96	5.02	10.17
7/ DRO 1.7	5.19	−20.94	3.48	7.74	18.99
8/ DRO 1.8	8.68	−16.72	3.44	7.76	18.68
9/ DRO 1.9	7.82	−18.44	3.18	5.71	12.61

4. Contextualization of the camel finds in the city of Córdoba

In order to verify the presence of dromedary camels in the city of Cordoba, a settlement of the greatest importance on the Iberian Peninsula in both Roman and Islamic times, a project was requested to review all the bone collections belonging to the aforementioned periods deposited in the city's Archaeological Museum. As a result of the analysis of the bone collections, a total of nine fragments of dromedary belonging to as many individuals were located. The stratigraphy, as well as the ^{14}C dating carried out - although only four of them were positive - certify the presence of this animal in the city of Cordoba in Roman and medieval times.With the necessary precautions, the morphology of the bone material analysed indicates the presence of dromedary camels, although the fragmentary state of most of the remains prevents an exhaustive determination, so we cannot rule out the presence of camels or even hybrids, mainly from the Roman period. On the other hand, the remains from the Muslim period do seem to clearly indicate that they belong to Camelus dromedarius from North Africa (Steiger, 1990).

From the Roman period we have three fragments: right mandible and 1st phalanx in the Cercadilla intervention and fragment of ulna + radius in the Plaza Pineda intervention. In the first case, belonging to an adult animal, there are no cut marks and the M3 is preserved. It was recovered in a late Roman pit fill that was later sealed by a medieval Islamic stratum belonging to a 12th-century farmhouse.

The date provided by its dating, 1832 ± 29 BP (Table 4), is consistent with the proven existence of a suburban *villa* prior to the *Palatium* of Cercadilla. This *villa* is located outside the walls of *Colonia Patricia Corduba*, to the northwest of the Roman city, a suburban area with an initial cemetery use that gradually gave way to farms and *vici* (Moreno

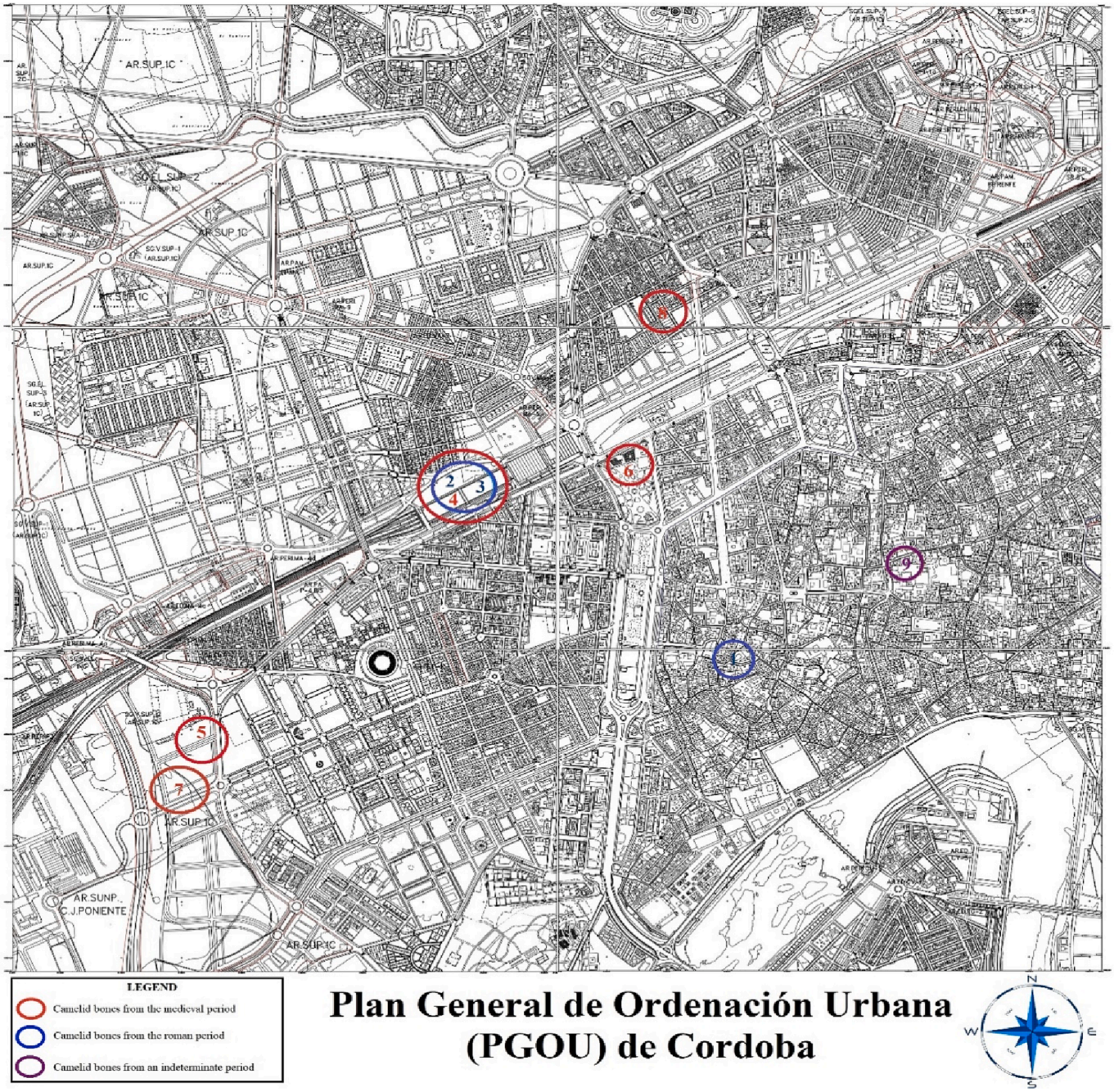

Fig. 2. Location of the finds of Roman and Andalusian dromedary bone remains in the city of Córdoba.

Almenara, 1997: 19–30) .

A complete and burnt 1st phalanx belonging to a large adult animal was also recovered from this same site, in a very fruitful stratigraphic unit due to the recovery of a juvenile torso made of coarse-grained white marble belonging to the iconography of *Dionysos*. Due to its characteristics and parallels, its researchers concluded a chronology around the middle of the 2nd century AD (Hidalgo et al., 1996:112).

As for the fragment of proximal epiphysis of ulna + radius from Plaza Pineda, it corresponds to an adult animal and was sawed to separate the diaphysis and possibly use it for craft work or as an anvil for sharpening metal sickles. It was recovered in a clayey stratum which, in general, presents materials from the Roman period: ceramics, stucco decorated with paintings and bone remains with evident signs of handling. The stuccoes, dated between the 1st and 2nd centuries AD, belonged to a luxurious *domus* that underwent several alterations (Pérez Navarro, 2004: 201-203). Below this level was another stratum of similar characteristics with fragments of overturned opus *signinum* and *caementicium*, as well as abundant bone remains and some carving debris. The bone material was interpreted as the remains of a bone manufacturing workshop located in the area towards the end of the 3rd century AD, after the *domus* was abandoned at some point during that period (Pérez Navarro, 2004: 201).

Near Plaza de Pineda, part of another *domus* built in the 1st century AD was located, which also survived until an unspecified time in the 3rd century AD (Morena López, 1999: 93-94). Towards the end of this century, the aforementioned bone manufacturing workshop must have been set up near the building (Morena López et al., 1996; Morena López, 1999). Along with needles and pins, bones with signs of work and a large amount of carving waste were found (Morena López, 1999: 94).

For the Andalusian period, we have five bone fragments: left

Fig. 3. Camelids bonesremains recovered in the city of Córdoba. Roman: 1, ulna + radius from Plaza Pineda; 2, mandible from Cercadilla; 3, 1st phalanx from Cercadilla. Andalusian: 4, Cercadilla; 5, 2nd phalanx from Plot 16A of PP O-7; 6, 1st phalanx from Jardines de la Agricultura; 7, 1st phalanx from Substations A1/2/3-Z; 8, 1st phalanx from Calle J. Sama Naharro. Indeterminate period: 9, astragal of the Compass of the Church of San Pablo.

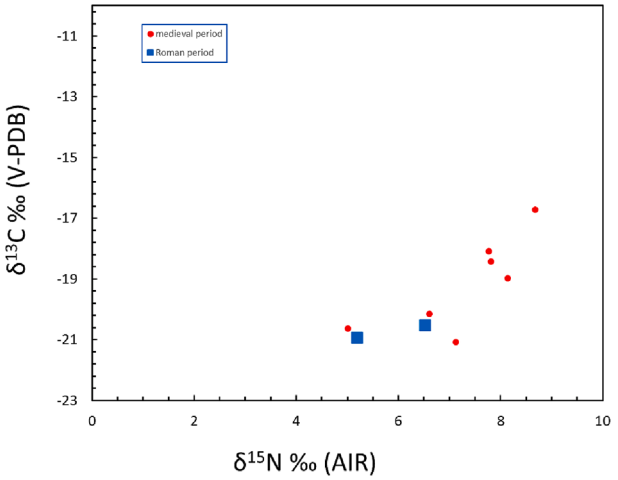

Fig. 4. Cordoba. Graphical representation of ^{15}N and ^{13}C isotopic values of camelids bones samples.

mandible from Cercadilla; second phalanx from PP O-7, Plot 16A; and three first phalanxes recovered in the Jardines de la Agricultura, Substations A1/2/3-Z and Calle Joaquín Sama Naharro interventions, respectively.

The left mandible from Cercadilla belongs to an adult animal. It has cut marks related to a possible skinning of the animal and preserves fragments of M2 and M3. The archaeological information indicates that it was recovered in a domestic context of a suburb from the Caliphate period (Hidalgo Prieto and Marfil Ruiz, 1992). It has beendated to 1059 ± 29 BP (Table 4).

The second phalanx, found in Plot 16A of PP O-7, is complete and belongs to an adult animal, with the cut marks possibly the result of skinning the animal. It was found in one of the western suburbs of

Table 6
Comparison of measurements of Roman and medieval bone material from the Iberian Peninsula (von den Driesch, 1976) with modern-day dromedary material (Steiger, 1990).

	Roman		Medieval		Actual		
radio	n°	var.	n°	var.	n°	variation	X
Bd			1	99.0	11	82.0 – 94.5	89.2
BFd			1	90.0	12	72.5 – 82.0	77.5
astrágalo	n°	var.	n°	var.	n°	variation	X
GLI			1	74.5	10	70.0 – 83.5	76.7
GLm			1	65.5	10	63.0 – 74.0	67.6
Bd			1	47.5	10	47.0 – 53.5	50.4
metacarpo	n°	var.	n°	var.	n°	variation	X
Bp	1	75.2				62.0 – 74.0	68.7
SD	1	40.2				31.0 – 38.0	34.0
metatarso	n°	var.	n°	var.	n°	variation	X
Bd	1	91.0			12	72.0 – 80.0	76.2
BTI	1	40.2			12	31.0 – 36.0	33.8
BTm	1	41.6			12	32.0 – 37.0	34.3
falange 1[a]	n°	var.	n°	var.	n°	variation	X
GL	1	(91.0)	2	86.5 – 89.0	8	80.0 – 95.0	88.9
Bp			1	37.0	8	33.0 – 39.0	35.6
SD	1	17.1	2	19.5 – 20.0	8	17.0 – 20.0	18.6
Bd			2	32.5 – 33.0	8	31.0 – 34.0	32.8

Table 7
Osteometric measures of camelids in Cordoba city(von den Driesch, 1976), 1.- Archaeological site of Cercadilla (Roman period), 2.- Archaeological site of Cercadilla (andalusí period), 3.-C/ Joaquín Sama Naharro Street, 4.- Agriculture Gardens, 5.-Plot 16A, PP O-7, 6.- Pineda Square.

1				2			3	4	5	6	
	mandible		M/3	M/2	M/3		1st phalanx		2nd phalanx	ulna + radius	
(6a)	133.0	L	51.5	(34.0)	(50.0)	GL	89.0		66.0	Bp	106.0
(12)	183.0	B	24.0	(22.0)	(22.5)	Bp	(37.0)	35.0	35.0	BFp	89.0
(13)	80.5					SD	20.0	18.5	33.0	SDO	80.5
						Bd	33.0		38.0	DPA	91.0

Caliphate Córdoba, in a stratum that clogged several rooms of a dwelling, the ones closest to the street (entrance hall, latrine and a small auxiliary space) (Clapés Salmoral, pers. comm.). It dates to the 11th century, giving a date of 1060 ± 25 BP (Table 4).

In the archaeological intervention carried out in the Agriculture Gardens, a first phalanx of an adult animal was found, with the distal epiphysis missing. The stratum to which it belonged was generated from a phase of looting of several structures from the Islamic Caliphate period, a looting that is dated to the Late Islamic period on the basis of the archaeological material recovered (Clapés Salmoral, pers. comm.). The dating for this bone gives a date of 1071 ± 29 BP, therefore also belonging to the 11th century (Table 4).

Another first phalanx recovered is the one from the archaeological intervention in Substations A1/2/3-Z. In this case it is related to a subadult animal, it has burned marks and only part of the proximal epiphysis is preserved. The bone was found in a stratum of abandonment over structural remains belonging to one of the western Caliphate suburbs of the city. It has been dated to the 11th century based on the archaeological material recovered (Pizarro Altuzarra, pers. comm.).

Finally, we have the first complete phalanx of an adult animal found in the archaeological intervention carried out in Calle Joaquín Sama Naharro. It was recovered inside the atarjea of a street belonging to a Caliphate suburb from the 10th-11th centuries located in the northwest of the city (Aparicio Sánchez, 2004: 1130; Aparicio Sánchez, 2010: 185 and 200).

From an undetermined period we include the talus of an adult animal from the Compás de la Real Iglesia de San Pablo. The stratum in which it was found corresponded to the filling of a ditch made for the execution of the foundations of a canal from the Late Medieval period (Aparicio Sánchez et al., 2021: 87–89, 96). This trench cut several superimposed layers of earth, from which fragments of tegulae, bricks and parietal facing were recovered, as well as thin slabs of marble and pottery. The chronology of the latter is Roman and Almohad. As no dating is available for the dromedary bone, it is not possible to determine with certainty which of these two periods it belongs to.

Stable carbon and nitrogen isotope analyses of collagen from dromedary bones recovered in Córdoba indicate that $\delta^{13}C$ values are relatively variable (-21.09‰ and −16.72‰ vs V-PDB), implying a diet where C3 and C4 plants were present. Considering a universal and constant source in the isotopic composition of atmospheric CO2 that has varied little during the Holocene, let alone between the Roman period and the medieval period, the less negative values can be explained by several reasons: 1. part of the medieval specimens may have come from other geographical areas, perhaps from North Africa as indicated by numerous historical sources; 2. - the introduction into agriculture of millet, which follows a C4 photosynthetic cycle, which could constitute a fraction of the diet of these individuals; 3.- periods of drought that increased the WUE (Water Use Efficiency) and that would explain slightly less negative values in the plant biomass that constitutes their diet.

Values of −16.72‰ would necessarily imply diets with less negative biomass, to give that average which constitutes the collagen signal. Therefore, in addition to possible increases in WUE, the presence of a certain fraction of C4 plants would be necessary. However, in the Iberian Peninsula and in Europe in general, the natural biomass does not include C4 plants or it would have been so insignificant that it could not contribute to a change in the isotopic signal of collagen. Therefore, only a significant presence of millet crops or major mobility shifts possibly from North Africa remain as a more realistic explanation.

The $\delta^{15}N$ values are between 5.01 and 8.68 ‰ (AIR). This variability, unlike carbon, may be normal due to changes in soil types, microbiology and biogeochemical environment which in a Mediterranean climate can give important variations in the nitrogen isotopic composition of plant biomass. In any case, it is also found that individuals with less negative carbon values have higher $\delta^{15}N$ values, which could also be related to more arid climates, where they tend to be higher, although this is not a sure rule, but a very general trend (Table 5, Fig. 3). (Fig. 4).

5. Discussion and conclusion

The spatial distribution of the finds in the lower-imperial Roman period indicates a direct relationship both with the transport of goods and with the use of their bones in handicrafts (Fig. 1). Therefore, their presence in Roman times (Table 3: 22, 23 and 24) must have been mainly due to their use as pack and transport animals between the cities of the different Roman provinces of the Iberian Peninsula and other regions of the empire, both in Western Europe and North Africa, due to their good conditions for this purpose. The mandible and 1st phalanx recovered in Cercadilla, at a time of the existence of a *villae* dedicated to agricultural exploitation, would be indicative of issues related to the transport of goods, as the size and robustness of the phalanx recovered would also seem to indicate (Fig. 2: 2 and 3). On the other hand, it is worth noting the more than probable use of some part of their skeleton, preferably long bones, as raw material in the manufacture of different objects and utensils, as seems to be documented by the remains recovered in Plaza Pineda, a proximal fragment of ulna + sawed radius (Fig. 2: 1) related to a bone manufacturing workshop from the 3rd century AD, which could indicate the reason for the scarcity of these skeletal parts in the archaeological record.

In the Andalusian period, they were more widely distributed throughout the city, suggesting a more abundant presence of these animals mainly in the suburban areas, which could indicate that they were already being bred at this time, especially in the south of the Iberian Peninsula (Fig. 1). The finding of dromedary bones in Caliphate levels puts an end to the belief that these animals arrived in the Iberian Peninsula with the Almoravids and Almohads (Riquelme Cantal et al., 2022). In fact, we know that, during the Umayyad caliphate, in reciprocity to the gifts that were given to some of the chiefs of the Berber tribes of the Maghreb to gain their support, they sent camels, gazelles and ostriches (Manzano Moreno, 2019: 163 and note 18). In addition, we have the testimony of a poet from Cordoba, Ibn Šuhayd, linked to the Umayyad dynasty, who records in a poem about a hunting scene how herds of camel-dromedaries grazed in rich green areas (Del Moral, 2019: 94-95).

Their numbers must not have been very high, judging both from written sources and from archaeological finds, which for the moment are very occasional at the sites, although their numbers may have increased considerably at two specific times. The first, with the imports made at the end of the Caliphate by Almanzor in North Africa with the specific mission of using them as transport animals in the wars against the

Christian kingdoms (Levi-Provençal, 1956). The second must have occurred with the arrival in the Iberian Peninsula of the Almoravids and Almohads, peoples who used these animals in everyday life in their places of origin (García Gómez, 1934). The scarcity of long bones in the archaeological record, also for this period, could indicate their use in handicrafts.

The possible consumption of their meat, if it was consumed, would have taken place in the Andalusian period as a specific act of reaffirmation of Muslim religiosity (Díaz García, 1982–83; García Sánchez, 1983; Martínez Valle and Cegarra López, 1994), although the anthropic manipulation of some of the bone remains recovered seems to respond more to the production of bone objects in both the Roman and medieval periods (Fernández Rodríguez, 2003; Moreno García et al., 2007; Riquelme Cantal, 1994b, 2013).

Finally, it is significant that the measurements of both Roman and medieval bone material tend to be higher than those obtained in present-day dromedary bones. This could indicate both the presence of castrated animals and hybrids, in order to obtain larger and more robust beasts of burden. In the near future, it will be necessary to carry out DNA-a analyses to be able to confirm this issue.

Something similar to the above is found in isotopic analyses of tooth enamel and bone collagen from the remains of a dromedary found in the vicus of Mamer-Bertrange (Luxembourg), which suggest that the animal was probably born in Egypt and travelled an enormous distance in its lifetime, being used as a pack animal. The first year it lived in a dry and warm environment, while later it lived in places with more moderate temperatures (Dövener et al., 2018).

Finally, although the bone remains analysed in the city of Córdoba indicate the presence of dromedary camels, the use of Bactrian camels and even hybrids mainly in the provinces of the Roman Empire (Berthon et al., 2020; Gatier, 2020), implies a logical caution in this regard that should be solved with DNA analysis as suggested by different authors (Pigière and Henrotay, 2012).

The data presented in this paper concerning the findings of dromedary bone remains in the city of Cordoba, one of the main population centres of the Iberian Peninsula in both the Roman and Caliphate periods, indicate the presence of this species, although the number of individuals must have been more numerous than the bone remains recovered suggest.

The review of bone collections in the city of Cordoba has confirmed the presence of dromedaries in both the early Roman and medieval Andalusian periods. The introduction of the dromedary into the Iberian Peninsula by the Romans considerably expands our knowledge of the spread of this ruminant and both in Hispania and in other Roman provinces of western Europe these animals would have been more linked to transport related to cities and *villae*, although in the northern provinces of the Empire the presence of Bactrian camels and hybrids has also been noted, which at least for the moment differentiates these areas of the Iberian Peninsula (Morales et al., 1995; Pigière and Henrotay, 2012; Riquelme Cantal, 2013).

In the Andalusian period, the presence of dromedaries in the city of Cordoba and at least throughout the south of the Iberian Peninsula seems to have been more numerous, and we can even think of their breeding in the region at this time. Their use would also be related to goods and military transport (Levi-Provençal, 1956; García Gómez, 1934; Riquelme Cantal et al., 2022).

In both periods analysed, the dromedary was therefore mainly used for transport and parts of its skeleton were also used in the manufacture of different bone objects. On the other hand, its possible consumption is presented as anecdotal (Díaz, 1982–83; Morales, et al., 1995; García Sánchez, 1983; Martínez Valle and Cegarra López, 1994).

Finally, the measurements of both Roman and medieval bone material obtained from many European sites are generally higher than those provided by modern camelid bones, which could indicate the presence of castrated animals and hybrids, in order to obtain animals with improved transport characteristics (Tables 6-7).

CRediT authorship contribution statement

José Antonio Riquelme Cantal: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Juan Manuel Garrido Anguita:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Antonio Delgado Huertas:** Methodology, Resources, Funding acquisition. **Laura Aparicio Sánchez:** Investigation, Writing – original draft. **Eduardo Ruiz Nieto:** Investigation, Writing – original draft. **Arsenio Granados Torres:** Validation, Resources. **Laura Arenas Gallegos:** Methodology, Investigation, Writing – original draft. **Adrián Ruiz Expósito:** . **Alejandro Beltrán Ruiz:** Resources. **Rocío Ávila Ramírez:** Writing – review & editing, Visualization. **José Clemente Martín de la Cruz:** Investigation, Writing – original draft.

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.

Data availability

No data was used for the research described in the article.

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References

Adroher, A.M., Risueño, B., López, A., Pérez, J.M., 1995. Excavación de urgencia en calle Espino, 5 (Albaicín, Granada). Anuario Arqueológico de Andalucía 1994. III, 319-328.

Aguirre, A., Etxeberria, F., Herrasti, L., 2004. El yunque de hueso para afilar la hoz metálica dentada. Munibe 56, 113–121.

Aparicio Sánchez, L., 2004. Actuación Arqueológica Preventiva en la C/ Joaquín Sama Naharro esquina a Músico Cristóbal de Morales, de Córdoba. Anuario Arqueológico de Andalucía 2004 (1), 1124–1142.

Aparicio Sánchez, L., 2010. El arrabal islámico de la C/ Joaquín Sama Naharro, Córdoba. Arte, Arqueol. e Historia 17, 183–202.

Aparicio Sánchez, L., Barbudo, J., Mª, Á., Alejandre Sánchez, F.J., 2021. Nuevos datos sobre el Real Convento de San Pablo de Córdoba: la dotación de agua y estudio de la cimentación de su iglesia. Meridies XII, 74–99.

Balaşescu, A., 2014. Camels in Romania. Anthropozoologica 49 (2), 253–264. https://doi.org/10.5252/az2014n2a07.

Bartosiewicz, L., 2014. Camels in the front line. Anthropozoologica 49 (2), 297–302. https://doi.org/10.5252/az2014n2a10.

Bartosiewicz, L., Dirjec, J., 2001. Camels in antiquity: Roman period finds from Slovenia. Antiquity 75, 279–825. https://doi.org/10.1017/S0003598X00060919.

Berthon, R., Mashkour, M., Burger, P., Çahirlar, C., 2020. Domestication, difusión and hybridization of the bactrian camel. A zooarcheological perspective. In: Labordère, D.A., Redon, B (Eds.), Les vaisseaux du désert et des steppes: les camélidés dans

Íantiquité (Camelus dromedarius et Camelus bactrianus). Archéologie(s) 2. MOM Éditions, Lyon, pp. 21-26.
Boutton, T.W., Wong, W.W., Hachey, D.L., Lee, l.S., Cabrera, M.P., Klein, P.D., 1983. Comparison of quartz and pyrex tubes for combustion of organic samples for stable carbon isotope analysis. Anal. Chem. 55, 1832–1833. 10.1021/ac00261a049.
Bustamante Álvarez, M., Detry, C., 2019. Una officina dedicada al tratamiento, manufactura y venta de objetos de hueso en Augusta Emerita (Mérida, Badajoz). Casa de Mitreo, Mérida. Zephyrus, LXXXIII, 139–163. 10.14201/zephyrus201983139163.
Cardoso, J.L., 1992. Un camelideo de Conimbriga. Conimbriga 31, 181–187.
Cardoso, J.L., Fernades, I.C., 2012. A economía alimemtar dos muçulmanos e dos cristaos do Castelo de Palmela: un contributo. Arqueol. Medieval 12, 211–233.
De Grossi, J., 2006. Cammelli nell'antichità: le presenze in Italia, in: Sala, B., Tecchiati, U. (Eds.), Archaeozoological studies in honour of Alfredo Riedel. Provincia autonoma di Bolzano. Bolzano, pp. 231–242.
Villena, E. de., 1766. Arte Cisoria ó Tratado del arte del cortar del cuchillo. Oficina de Antonio Marin, Madrid.
Del Moral, C., 2019. Imágenes de animales a través de la poesía andalusí. Quaderni di Studi Arabi, Nuova Serie. 14, 85–103.
Díaz García, A., 1983. Un tratado nazarí sobre alimentos. Al-Kalâmalà l-agdiya de al-Arbûlî. Edición, traducción y estudio con glosarios. Cuadernos de Estudios Medievales 10–11, 5–91.
Dövener, F., Oelschlägel, C., Bocherens, H., 2018. Kamele im westlichen Treverergebiet – ein nahezu vollständig erhaltenes Dromedar aus dem *vicus* Mamer-Bartringen (Luxemburg). In: Koch, M., Gaeng, C. (Eds.), Archäologie in Der Großregion: Beiträge Des internationalen Symposiums Zur Archäologie in Der Großregion in Der Europäischen Akademie Otzenhausen Vom 23. Propylaeum, Heidelberg, pp. 187–204.
Fernández Rodríguez, C., 2003. Ganadería, caza y animales de compañía en la Galicia Romana: estudio arqueozoológico. Brigantium. 15. Museo Arqueolóxico e Histórico. A Coruña.
Fry, B., Saupe, S., Hullar, M., Peterson, B.J., 1993. Platinum-catalyzed combustion of doc in sealed tubes for stable isotopic analysis. Mar. Chem. 41, 187–193. https://doi.org/10.1016/0304-4203(93)90118-8.
García Gómez, E., 1934. Bagdad y los reinos de Taifas. Revista de Occidente, Madrid.
García Sánchez, E., 1983. La alimentación en la Andalucía Islámica. Estudio histórico, y bromatológico, II. Carne, pescado, huevos, leche y productos lácteos. Andalucía Islámica. IV, 237–278.
Gatier, P.L., 2020. Le chameau de transport dans le Proche-Orient antique, in: Labordère, D.A., Redon, B. (Eds.), Les vaisseaux du désert et des steppes: les camélidés dans Íantiquité (*Camelus dromedarius* et *Camelus bactrianus*). Archéologie(s) 2. MOM Éditions, Lyon, pp. 227–255.
González, C., Adroher, A.M., López, A., 1993. Excavación de urgencia en la calle San Miguel de Guadix (Granada). Campaña de 1991. Anuario Arqueol. de Andalucía 1991, III, 190-198.
Hidalgo, R., Alarcón, F.J., Fuertes, M.C., Gónzalez, M., Moreno, M., 1996. El criptoportico de Cercadilla. Análisis arquitectónico y secuencia estratigrafica. Junta de Andalucía, Sevilla.
Hidalgo Prieto, R., Marfil Ruiz, P.F., 1992. El yacimiento arqueológico de Cercadilla: Avance de resultados. Anales de Arqueología Cordobesa 3, 277–308.
Iborra Eres, M.P., 2017. Arqueozoología de época romana en el País Valenciano. Archaeofauna 26, 23–38. https://doi.org/10.15366/archaeofauna2017.26.002.
Jefrey, S.S., William, E.S. jr., Wayne C.S., 1994. Variations in the chemical and stable isotope composition of carbon and sulfur species during organic-rich sediment alteration: An experimental and theoretical study of hydrothermal activity at Guaymas Basin, Gulf of California. Geochim. Cosmochim. Acta 58, 5065–5082. 10.1016/0016-7037(94)90232-1.
Levi-Provençal, E., 1956. Ibn al-Jatib: Histoire de ÍEspagnemusulmane (Kitâb a mâl al-a lâm). Texte árabe publié avec introduction et index par E, Levi-Provençal, Beirut.
López Marcos, A., Buzón Alarcón, M., 2013–2014.. La villa romana de Cortijo de los Robles (Jaén). Romvla 12–13, 379–414.
Manzano Moreno, E., 2019. La corte del califa. Cuatro años en la Córdoba de los omeyas, Editorial Critica, Barcelona.
Marković, N., Ivanišević, V., Baron, H., Lawless, G., Buckley, M., 2021. The last caravans in antiquity: camel remains from Caričin Grad (Justiniana Prima). J. Archaeol. Sci.: Rep. 38, 1–14. https://doi.org/10.1016/j.jasrep.2021.103038.
Martínez Valle, R., Cegarra López, M.A., 1994. Los restos óseos. In: López García, I., Marín Jordá, C., Martínez García, R., Matamoros de Villa, C. (Eds.), Hallazgos Arqueológicos En El Palau De Les Corts. Editorial Corts Valencianas, Valencia, pp. 483–493.
Morales, A., Riquelme, J.A., Liesau, C., 1995. Dromedaries in Antiquity: Iberia and beyond. Antiquity. 69 (263), 368–375. https://doi.org/10.1017/S0003598X00064772.
Morena López, J.A., López López, I.Mª., 1996. Instrumentos romanos de hueso hallados en el solar del antiguo edificio Los Leones (Córdoba). Boletín de la Real Acad. Córdoba. 128, 225-245.
Morena López, J.A., 1999. Informe–Memoria de la Intervención arqueológica de urgencia efectuada en el n°3 de la C/ Saravia (Córdoba). Anuario Arqueol. de Andalucía 1994, III, 84-95.
Moreno Almenara, M., 1997. La villa altoimperial de Cercadilla (Córdoba): análisis arqueológico. Junta de Andalucía, Sevilla.
Moreno García, M., Pimenta, C.M., López Aldana, P.M., Pajuelo Pando, A., 2007. The Signature of a Blacksmith on a Dromedary Bone from Islamic Seville (Spain). Archaeofauna 16, 193–202.
Pérez Ballester, J., San Martín Moro, P.A., Berrocal Caparrós, C., 1993. El anfiteatro romano de Cartagena 1967-1992, in: José María Álvarez Martínez, J.M., Enríquez Navascués, J.J. (Coord.), Actas del coloquio Internacional: El Anfiteatro Romano en la Hispania Romana. Mérida 1992. Junta de Extremadura, Mérida, pp. 91-118.
Pérez Navarro, C., 2004. Evolución de una *domus* desde el s. I A.C. al s. V D.C. y seguimiento arqueológico en Plaza de Pineda, 2 de Córdoba. Anuario Arqueológico de Andalucía 2001, III, 200-209.
Pigière, F., Henrotay, D., 2012. Camels in the northern provinces of the Roman Empire. J. Archaeol. Sci. 39, 1531–1539. https://doi.org/10.1016/j.jas.2011.11.014.
Riquelme Cantal, J.A., 1992. La fauna de época Califal procedente de la Catedral de Granada. Boletín de Arqueol. Medieval. 6, 193–207.
Riquelme Cantal, J.A., 1993. El dromedario en Al-Andalus: estado de la cuestión a través de los últimos descubrimientos arqueológicos en la provincia de Granada. In: Actas Del IV Congreso De Arqueología Medieval Española. Diputación de Alicante, Alicante. Tomo III, pp. 657–661.
Riquelme Cantal, J.A., 1994a. Premiers restes archéologiques de dromadaire, *Camelus dromedarius*, Linneo 1758, issus dans ÍEspagne musulmane. ÍAnthropologie 98 (4), 663–665.
Riquelme Cantal, J.A., 1994b. Nuevo hallazgo de restos óseos de dromedario en la ciudad de Guadix, (Granada). Florentia Iliberritana 4–5, 437–443.
Riquelme Cantal, J.A., 1998. Contribución al estudio arqueofaunístico durante el Neolítico y la Edad del Cobre en las Cordilleras Béticas: el yacimiento arqueológico de los Castillejos en las Peñas de los Gitanos, Montefrío (Granada). Universidad de Granada, Granada.
Riquelme Cantal, J.A., 2004. Estado de la cuestión y nuevos hallazgos de material óseo de dromedario en la península Ibérica. Arte, Arqueol. e Historia 11, 39–44.
Riquelme Cantal, J.A., 2013. Nuevas evidencias arqueológicas de la presencia de dromedario, *Camelus dromedarius, L.*, en el sur de la Península Ibérica: Cortijo de los Robles (Jaén) y Torrevieja, Villamartín (Cádiz). Cuadernos de Prehistoria y Arqueología de la Universidad de Granada 23, 347–364.
Riquelme Cantal, J.A., Montilla Torres, I., Garrido Anguita, J.M., Ruiz Nieto, E., Martín de la Cruz, J.C., Aparicio Sánchez, L., Simón Vallejo, M.D., Vallejo Triano, A., 2022. El dromedario en Al-Andalus. El registro arqueológico en el sur de la península ibérica en época islámica (siglos X a XIV). SPAL. 31 (2), 85–99. https://doi.org/10.12795/spal.2022.i31.28.
Riquelme, J.A., Liesau, C., Morales, A., 1997. Archäozoologische funde von Dromedaren auf der Iberischen Halbinsel. Anthropozoologica 25–26, 539–544.
Steiger, C., 1990. Vergleichend Morphologische Untersuchungen an Einzelknochen des postkranialen skeletts der Altweltkamele. Disertation Universitat Munchen.
Tomczyk, W., 2016. Camels on the Northeastern frontier of the Roman Empire. Papers Inst. Archaeol. 26 (1), 1–13. https://doi.org/10.5334/pia-485. Art. 2.
von den Driesch, A., 1976. A Guide to the Measurement of Animal Bones from Archaeological Sites. Harvard University, Cambridge Mass.
Vuković, S., Bogdanović, I., 2013. A camel skeleton from the Viminacium Amphitheatre. Starinar 63, 251–267. https://doi.org/10.2298/STA1363251V.
Vuković-Bogdanović, S., Blazić, S., 2014. Camels from Roman Imperial sites in Serbia. Anthropozoologica 49 (2), 281–295.