

RESEARCH PAPER

Preliminary Studies of Late Prehistoric Dog (*Canis lupus f. Familiaris* Linnaeus, 1758) Remains from the Iberian Peninsula: Osteometric and 2D Geometric Morphometric Approaches

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This paper aims to highlight developments in archaeological knowledge relating to dog remains found in deposits from Late Prehistoric contexts at sites along the Iberian Peninsula. Preliminary results from ongoing osteometric and 2D Geometric Morphometric studies applied to these remains are here presented and discussed to contextualize future studies by the author.

Keywords: Dog remains; Late Prehistory; Iberian Peninsula; Geometric Morphometrics

Introduction

Social inequality emerged during the Iberian Chalcolithic in the 3rd millennium BCE, and further widened during the Bell-Beaker horizon when preferential treatment of a select few of the human population took place. This inequality, however, is only observed in the funerary record, where differences in tomb types and grave goods are noted (Harrison 1977, Delibes 1977, Díaz-del-Río & García Sanjuán 2006). During this period, settlements comprise of features such as pits, hut structures and ditched or walled enclosures; the defensive character

of the latter has been widely discussed in recent years (Díaz del Río 2003, Molina et al. 2004, Kunst 2010, Márquez & Jiménez 2010). Settlement patterns and inhumations changed slightly during the Bronze Age: new spaces were occupied and funerary rituals also changed (Bellido 1995, Benítez de Lugo 2011, Serrano 2012). Faunal studies have shown that domestic species were consumed regularly (Morales & Liesau 1994, Rodríguez & García 2011, Liesau 2011). However, dog remains are often retrieved from different conditions and contexts, suggesting that they were subject to different treatment compared to other species.

Earlier studies have documented the presence of dog remains placed in late prehistoric deposits at settlements along the Iberian Peninsula (Daza 2015: 14–20). The findings

from the Polideportivo de Martos suggest that a *dog phenomenon* emerged during the Late Neolithic, given the proliferation of the practice of depositing the remains of complete dogs, or parts of them, inside structures (Lizcano et al. 1991, Lizcano & Cámara 2003) (**Figure 1**). This article outlines Late Prehistoric sites across the Iberian Peninsula from which deposits of dog remains have

been documented. Secondly, it presents preliminary results from traditional osteometry and two-dimensional (2D) landmark-based geometric morphometric studies, which form part of the author's doctoral research. In order to better understand this *dog phenomenon*, dog remains (mostly from Camino de las Yeseras) were analysed using morphological criteria to categorise the specimens.

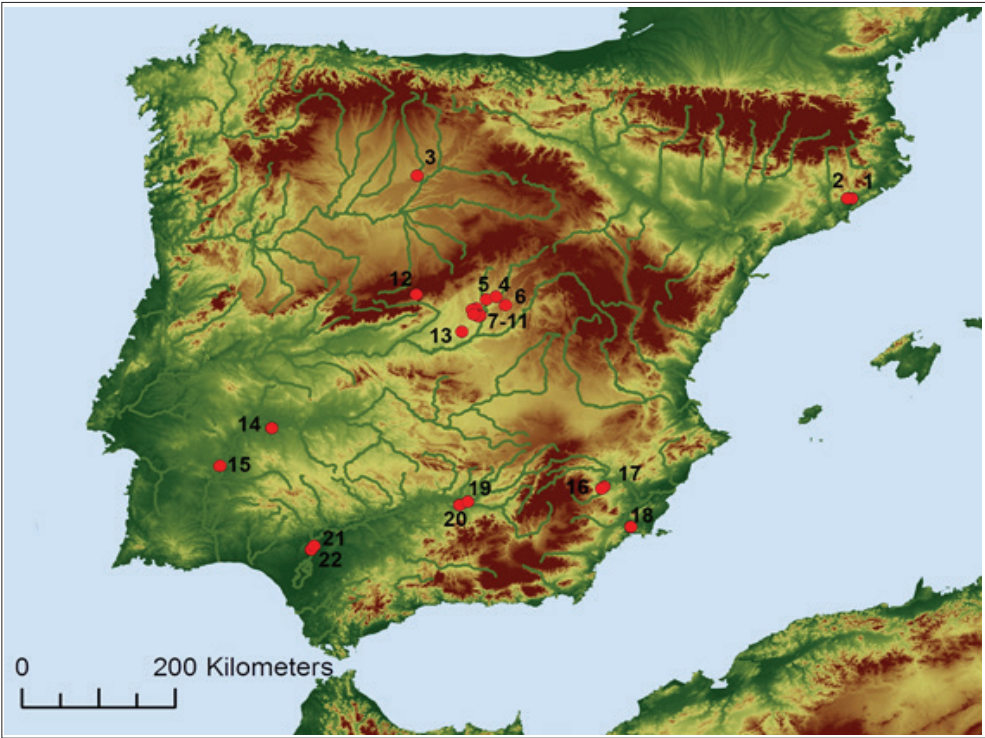


Figure 1: Iberian settlements with dog remains mentioned in the text. 1: Can Roqueta (Sabadell, Barcelona); 2: Torre Romeu (Sabadell, Barcelona); 3: La Huelga (Dueñas, Palencia); 4: Las Matillas (Alcalá de Henares, Madrid); 5: Camino de las Yeseras (San Fernando de Henares, Madrid); 6: El Perdido (Torres de la Alameda, Madrid); 7: La Loma de Chiclana (Madrid); 8: Tejar del Sastre (Madrid); 9: El Espinillo (Madrid); 10: Caserío de Perales del Río (Getafe, Madrid); 11: El Juncal (Getafe, Madrid); 12: Cerro de la Cabeza (Ávila); 13: Valladares I (Illescas, Toledo); 14: La Pijotilla (Badajoz); 15: Perdigões (Reguengos de Monsaraz, Portugal); 16: Camino del Molino (Caravaca de la Cruz, Murcia); 17: Casa Noguera (Caravaca de la Cruz, Murcia); 18: Glorieta de San Vicente (Lorca, Murcia); 19: Marroquíes Bajos (Jaén); 20: Polideportivo de Martos (Martos, Jaén); 21: c/Dolores Quintanilla Nº 6 (Carmona, Seville) 22: Valencina de la Concepción (Seville). Information on the cultural periods for each of the settlements can be found in Table 1. Author's own data plotted on map in collaboration with Patricia Ríos.

Dog Remains in the Late Prehistory of the Iberian Peninsula: A Proposal for Classifying Deposits

The faunal deposits from the archaeological sites, also defined as *special deposits* (Grant 1984), *structured deposits* (Richards & Thomas 1984) and *Associated Bone Groups* (Hill 1995) have been extensively studied by several authors to identify the species found within them. Methods of depositing and reasons for deposition have also been explored. Typologies, categories and interpretations have been put forward for these findings covering different periods and places (Grant 1989, 1991, Hill 1995, Liesau & Blasco 2006, Márquez 2006, Méniel 2008, Morris 2011, Albizuri 2011a, Liesau 2012, Liesau et al. 2013, Perri 2015).

Our study centres on the settlement of Camino de las Yeseras, a Chalcolithic ditched enclosure located in the region of Madrid (**Figure 1: 5**), at the centre of the Iberian Peninsula (Liesau et al. 2008, Blasco et al. 2011). Several dog remains were documented during the site's excavation, and from these, we were able to infer the presence of three types of contexts in which dog remains were deposited: funerary contexts, outstanding locations and pits.

Based on this study of Camino de las Yeseras' deposit types, we were able to identify these three same categories at other important sites in the Iberian Peninsula (**Table 1**).

During the Chalcolithic the presence of **dog remains in funerary contexts**, observed through the recovery of dog skeletons associated with tombs, is relatively frequent in the Iberian archaeological record. Complete articulated dog skeletons have been found in burials at sites such as El Cerro de la Cabeza in Ávila (**Figure 1: 12, Table 1: 12**), (Fabián & Blanco 2012: 110) and Casa Noguera in Murcia (**Figure 1: 17, Table 1: 19**), (García & Martínez, 2004). Similar practices have also been documented in collective burials such as those of Camino del Molino in Murcia (**Figure 1: 16,**

Table 1: 18), (Lomba et al. 2009: 153), El Perdido (**Figure 1: 6, Table 1: 4**), (Daza 2005) and Camino de las Yeseras in Madrid (**Figure 1: 5, Table 1: 5**), (Daza 2011). The latter contains the remains of two dogs with evidence of perimortem violence, and had been deposited at the intersection of two pits within a Bell-Beaker burial (**Figure 2**) (Daza 2011: 215, Liesau et al. 2013: 283).

Other examples falling under the category of **dogs in funerary contexts** include Bronze Age tombs, especially child burials, such as at Caserío de Perales del Río (**Figure 1: 10, Table 1: 6**) (Blasco et al. 1991: 56) and Camino de las Yeseras (**Figure 1: 5, Table 1: 5**), (Daza 2011: 215). This latter site includes a complete dog skeleton, together with other faunal remains, accompanying a child burial.

The presence of **dogs in outstanding locations** is a noteworthy occurrence (Liesau et al. 2013–2014: 53–54, 66). Dog remains have been linked to areas whose location or arrangement characteristics are extraordinary within the settlement. These relate to distinctive ideology, ritual purposes or the management of the space by human populations (i.e. ditched enclosures and the interruptions in them, interpreted as entrances). At Valencina de la Concepción in Seville, 32 complete dog skeletons were uncovered from a ditch (**Figure 1: 22, Table 1: 20**), (Hain 1982: 93, 140); at Marroquies Bajos in Jaén (**Figure 1: 19, Table 1: 16**) a complete specimen was recovered from inside a ditch (Burgos et al. 2001b: 425); and at El Juncal in Madrid, complete dog skeletons were recovered from structures located at the ends of the ditches (**Figure 1: 11, Table 1: 11**), (Martínez et al. 2014: 157, Martínez et al. 2015: 248–252). Similarly, two dog skulls were found inside a ditch at Perdiggões in Portugal (**Figure 1: 15, Table 1: 15**) (Valera 2008: 30). At Camino de las Yeseras a complete skeleton was located in a pit at the bottom of a ditched enclosure, next to the entrance. Another pit was found opposite, where another complete

No.	Settlement	Type of Deposit	Remains	Cultural Period	References
1.	Can Roqueta II (Barcelona)	Dog in a pit	1 complete dog in partial articulation	Bronze Age	Albizuri 2011b: 148
	Can Roqueta II (Barcelona)	Dogs in a pit	2 complete articulated dogs	Bronze Age	Albizuri 2011b: 148
2.	Torre Romeu (Barcelona)	Dog in a pit	1 dog skull	Bronze Age	Albizuri 2011b: 63; Oliva & Terrats 2005; Piña & Saña 2004.
	Torre Romeu (Barcelona)	Dog in a pit	1 complete articulated dog	Bronze Age	
3.	La Huelga (Palencia)	Dogs in a pit	2 partial articulated dogs	Bronze Age	Liesau, Esparza & Sánchez 2014.
4.	El Perdido (Madrid)	Dogs in funerary context	At least 3 articulated dogs	Chalcolithic	Daza 2015: 35–38
	Camino de las Yeseras (Madrid)	Dog in outstanding location (inside ditched enclosure and next to the entrance documented)	1 complete articulated dog	Chalcolithic	Liesau et al. 2013–2014: 60–61, 65
5.	Camino de las Yeseras (Madrid)	Dog in outstanding location (close to an entrance documented)	1 complete articulated dog	Chalcolithic	Liesau et al. 2014: 196–199, Daza 2015: 28–30
	Camino de las Yeseras (Madrid)	Dogs in funerary context	2 complete articulated dogs	Chalcolithic	Daza 2011: 214–215, Daza 2015: 31–34
	Camino de las Yeseras (Madrid)	Dogs in a pit	7 dogs, mainly represented by skulls	Chalcolithic	Liesau et al. 2008: 107, Daza 2015: 24–27
	Camino de las Yeseras (Madrid)	Dog in funerary context	1 complete articulated dog	Bronze Age	Daza 2011: 215.
6.	Caserío de Perales del Río (Madrid)	Dog in funerary context	1 complete articulated dog	Bronze Age	Blasco et al. 1991: 56.
7.	Tejar del Sastre (Madrid)	Dog in a pit	1 complete articulated dog	Bronze Age	Quero 1982: 218
8.	Loma de Chiclana (Madrid)	Dog in a pit	1 dog skull	Chalcolithic	Díaz-Andreu et al. 1992: 88
9.	Las Matillas (Madrid)	Dog in a pit	1 dog skull	Chalcolithic	Díaz del Río 2001: 201
10.	El Espinillo (Madrid)	Dog in a pit	1 complete articulated dog	Chalcolithic	Baquedano et al. 2000: 26

11.	El Juncal (Madrid)	Dogs in outstanding location (ditched enclosures)	Complete articulated dogs	Chalcolithic	Martínez et al. 2014: 157, Martínez et al. 2015: 248–252
12.	Cerro de la Cabeza (Ávila)	Dog in funerary context	1 complete articulated dog	Chalcolithic	Fabián & Blanco, 2012: 110.
13.	Valladares I (Toledo)	Dog in a pit	1 complete articulated dog	Chalcolithic	García et al. 2008: 137–138
14.	La Pijotilla (Badajoz)	Dog in a pit	1 complete articulated dog	Chalcolithic	Hurtado 1991: 50–56
15.	Perdigões (Évora, Portugal)	Dog skulls in outstanding location (ditched enclosure)	2 dog skulls	Chalcolithic	Valera 2008: 30.
16.	Marroquíes Bajos (Jaén)	Dog in outstanding location (ditched enclosure)	1 complete articulated dog	Chalcolithic	Burgos et al. 2001b: 425. Sanchez et al. 2005.
	Marroquíes Bajos (Jaén)	Dog in a pit	1 complete articulated dog	Chalcolithic	Burgos et al. 2001a: 407.
17.	Polideportivo de Martos (Jaén)	Dogs in a pit	5 complete articulated dogs	Neolithic	Lizcano & Cámara, 2003: 238
	Polideportivo de Martos (Jaén)	Dog in a pit	1 complete articulated dog	Neolithic	Lizcano & Cámara, 2003: 238
	Polideportivo de Martos (Jaén)	Dog in a pit	1 complete articulated dog	Neolithic	Lizcano & Cámara, 2003: 238
18.	Camino del Molino (Caravaca de la Cruz, Murcia)	Dogs in funerary context	More than 50 articulated dogs	Chalcolithic	Lomba et al. 2009: 153
19.	Casa Noguera, (Archivel, Caravaca de la Cruz, Murcia)	Dog in funerary context	1 complete articulated dog	Chalcolithic	García & Martínez, 2004
20.	Valencina de la Concepción (Seville)	Dog in a pit	1 complete articulated dog	Chalcolithic	Abril et al. 2010: 95
		Dogs in outstanding location (ditched enclosure)	32 complete dogs	Chalcolithic	Hain 1982: 93, 140
21.	c/ Dolores Quintanilla Nº 6 (Carmona, Seville)	Dogs in a pit	5 complete articulated dogs	Chalcolithic	Román & Conlin 2001: 135
	c/ Dolores Quintanilla Nº 6 (Carmona, Seville)	Dog in a pit	1 dog skull	Chalcolithic	Román & Conlin 2001: 530

Table 1: Dog remains found in Iberian settlements and their types of deposits (dogs in funerary contexts, dogs in outstanding locations, dogs in pits) The numbers in the left column correspond to those in Figure 1.



Figure 2: Dog remains associated with a Bell-Beaker burial from Camino de las Yeseras (Madrid). Image courtesy of Argea Consultores S.L.

skeleton was found deposited together with a stone axe (**Figure 1: 5, Table 1: 5**), (Liesau et al. 2014b) (**Figure 3**).

The final category of dog remains which were deposited within pit settlements is here referred to as **dogs in pits**. In this category, articulated individuals are distinguished from isolated or dismembered deposits, such as skulls. Examples of complete articulated skeletons are noted from La Pijotilla in Badajoz (**Figure 1: 14 Table 1: 14**), (Hurtado 1991: 50–56), Valladares I in Toledo (**Figure 1: 13, Table 1: 13**), (García et al. 2008: 137–138), Marroquíes Bajos in Jaén (**Figure 1: 19, Table 1: 16**), (Burgos et al. 2001b: 407), Valencina de la Concepción (**Figure 1: 20,**

Table 1: 20), (Abril et al. 2010: 95) and Dolores Quintanilla Street (**Figure 1: 21, Table 1: 21**), (Román & Conlin 2001: 530), the latter two in Seville. Similar deposits were also found in the Madrid region at El Espinillo (**Figure 1: 9, Table 1: 10**), (Baquedano et al. 2000: 26). Additional examples were observed at Bronze Age sites including Can Roqueta II (**Figure 1: 1, Table 1: 1**), (Albizuri 2011b: 148) and Torre Romeu in Barcelona (**Figure 1: 2, Table 1: 2**), (Albizuri 2011b: 63, Oliva & Terrats 2005, Piña & Saña 2004), La Huelga in Palencia (**Figure 1: 3, Table 1: 3**) (Liesau, Esparza & Sánchez 2014) and Tejar del Sastre in Madrid (**Figure 1: 8, Table 1: 7**), (Quero 1982: 218).

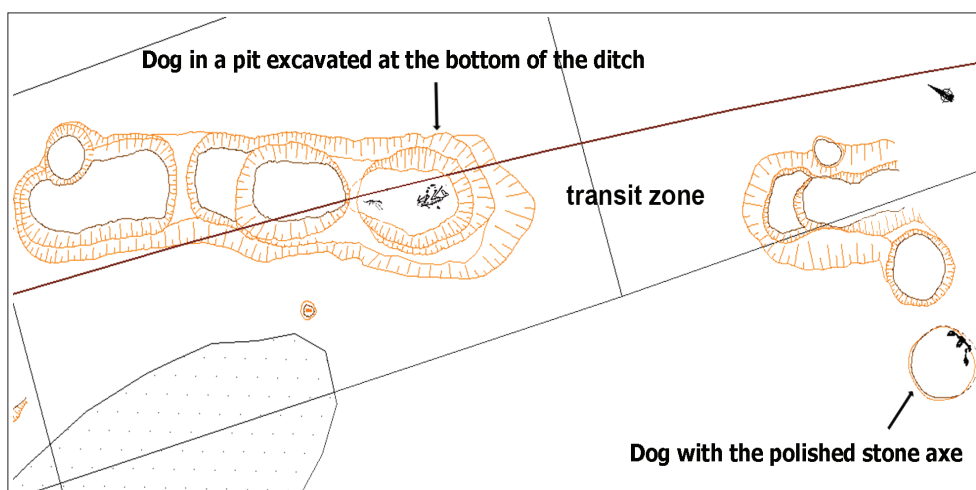


Figure 3: Plan of the entrance of the fourth ditch at Camino de las Yeseras (Madrid) with the dog remains located at both sides. Image courtesy of Argea Consultores S.L.

Disarticulated skulls from Chalcolithic strata were discovered at Dolores Quintanilla Street (**Figure 1: 21, Table 1: 21**), (Román & Conlin 2001: 530) in Seville, at Las Matillas (Díaz del Río 2001: 201) and La Loma de Chiclana (**Figure 1: 7, Table 1: 8**) (Díaz-Andreu et al. 1992: 88) in Madrid. At Camino de las Yeseras the remains of at least seven dogs were discovered in a large pit comprising the incomplete skeletons, mainly heads, of a minimum of seven individuals (**Figure 1: 5, Table 1: 5**), (Liesau et al. 2008: 107, Daza 2015: 24–27) (**Figure 4**). This is a unique case in Late Prehistoric Iberia. Later, in the Bronze Age, a dog skull has been found at one site: in a pit at Torre Romeu in Barcelona (**Figure 1: 2, Table 1: 2**), (Albizuri 2011b: 63).

Methods: Traditional Osteometry vs Geometric Morphometrics

The application of traditional osteometric methodology has been in place ever since Harcourt's (1974) publication, which revisited Koudelka's factors (1885) to estimate the shoulder height of dogs. These estimations, along with cephalic indices, have been studied for European dog remains from the

Mesolithic, and especially from the Iron Age onwards (Degerbøl 1961, Clutton-Brock 1963, Harcourt 1974, Benecke 1987, Clark 1995, De Grossi Mazzorin 2000, Sanchís & Sarrión 2004). These analyses are also useful for understanding and interpreting the *dog phenomenon*, as such indices have been applied to zooarchaeological measurement databases. These databases have produced results which allow characteristics of dog specimens to be derived from both long bones and cephalic indices. This has made it possible to compare osteometric data of wolves and dog breeds, and to allocate the archaeological specimens to morphotypes. Therefore, this provides useful data to the study of the *dog phenomenon*.

Here, traditional osteometrics have been used to compile a database. Shoulder height indices have also been used (Koudelka 1885, Harcourt 1974, Clark 1995). However, subtle changes in the shape of some bones may be difficult to detect. In order to answer some of the questions relating to the possible selection of differentiated specimens for these deposits, we used landmark-based geometric morphometrics to observe these subtle



Figure 4: Dog remains from at least seven individuals, mainly their skulls, in a large pit at Camino de las Yeseras (Madrid). Image reproduced with the permission of Argea Consultores S.L.

changes in the shape of the bones (Kendall 1977, 1981; Bookstein 1982, 1991; Toro-Ibacache et al. 2010).

The mandible was selected for this study as it is frequently found in the archaeological record as it is relatively robust, and because the mineralization of the teeth may favour its preservation. Also, flat bones are useful for two-dimensional (2D) geometric morphometric study. The configuration of the mandible may provide information relating to the musculature and behaviour of the animal, and even its degree of domestication (Wayne 1986, Zeder 2012). The differential development of mandibular components might reveal ontogenetic aspects related to the animal's mechanical traction or masticatory function (Biknevicius & Leigh 1997, Segura & Flores 2009).

Eight landmarks were selected (described in **Table 2**, shown in **Figure 5**) to characterise

the shape of the mandibles. Two statistical analyses were applied: Principal Component Analysis (PCA) and Canonical Variate Analysis (CVA). PCA is a variable reduction procedure, useful when data on a number of variables has been obtained (particularly where a large amount has been obtained and it is thought that there is some redundancy in those variables). In this case, redundancy means that some of the variables correlate with one another, possibly because they are measuring the same construct. It is possible to reduce the observed variables into a smaller number of principal components (artificial variables) that will account for most of the variance in the observed variables (Hatcher 1994: 2). CVA is a method to find the set of axes (or linear combination of variables) that allows for the greatest possible ability to discriminate between two or more groups. It can plot the mean of each group's CVA axes scores on a CVA axes plot. The CVA axes,

No. of Landmark	Description
1.	Anterior end of the symphysis between the dentary bones.
2.	Posterior edge of the canine alveolus.
3.	Posterior edge of the 2nd molar alveolus.
4.	Rearmost point of the coronoid process.
5.	Rearmost point of the angular process.
6.	Point in the mandibular ramus below posterior edge of the mandibular foramen.
7.	Point in the mandibular ramus below anterior edge of the 1st molar.
8.	Posterior end of the symphysis between the dentary bones.

Table 2: Description of the landmarks chosen.

determined by a number of known groups, can assign unknown specimens to one of the known groups.

Material

For this study 53 mandibles were sampled from a range of different canid species, including archaeological individuals (n = 13), modern breeds of dogs (n = 16), wolves (n = 5) and foxes (n = 11), in addition to other canid species such as fox (*Vulpes vulpes*), arctic fox (*Alopex lagopus*), dhole (*Cuon alpinus*) and golden jackal (*Canis aureus*) (**Table 3**). The archaeological materials were kindly provided for this study by Corina Liesau from the Department of Prehistory and Archaeology in the Universidad Autónoma de Madrid and the directors of the archaeology companies *Argea S.L.* and *Trébede, Patrimonio y Cultura S.L.* Access to the dog and wolf comparative collection was kindly granted by Professor Arturo Morales from the *Laboratorio de Arqueozoología* at the *Universidad Autónoma de Madrid*. Modern-fox mandibles from southern Iberia were kindly loaned to the author by Dr Concepción Azorit from the Department of Animal and Plant Biology and Ecology at the *Universidad de Jaén*.

Most of the archaeological samples are from Camino de las Yeseras. These derive from both from special deposits – which follow the types of deposit explored above – and

from other pits without relevant information or material. It is important to note that further research is ongoing as part of the author’s doctoral thesis, with forthcoming results exploring a number of additional specimens.

Results

Traditional indices for shoulder height suggest a mean measurement of 44–47 cm, and a 7–9 range mean for the stoutness of our specimens (Appendix 1).

The PCA analyses did not reveal groups or striking differences between these archaeological specimens (**Figure 6**), whereas the application of CVA did show a different spread to that obtained through PCA (**Figure 7**).

The archaeological mandibles appear less similar than initially interpreted. **Figure 7** shows that although the archaeological mandibles all fall within a similar range on the y-axis, a division can be observed within the results. This suggests the presence of two distinct groups within the archaeological samples. The first group in the CVA appears close to that of modern dog breeds. These specimens were recovered from special deposits at Camino de las Yeseras. Point number 1 is one of two dogs associated with the Bell-Beaker tomb which had evidence of sacrifice. Point number 7 represents a dog from a Bronze

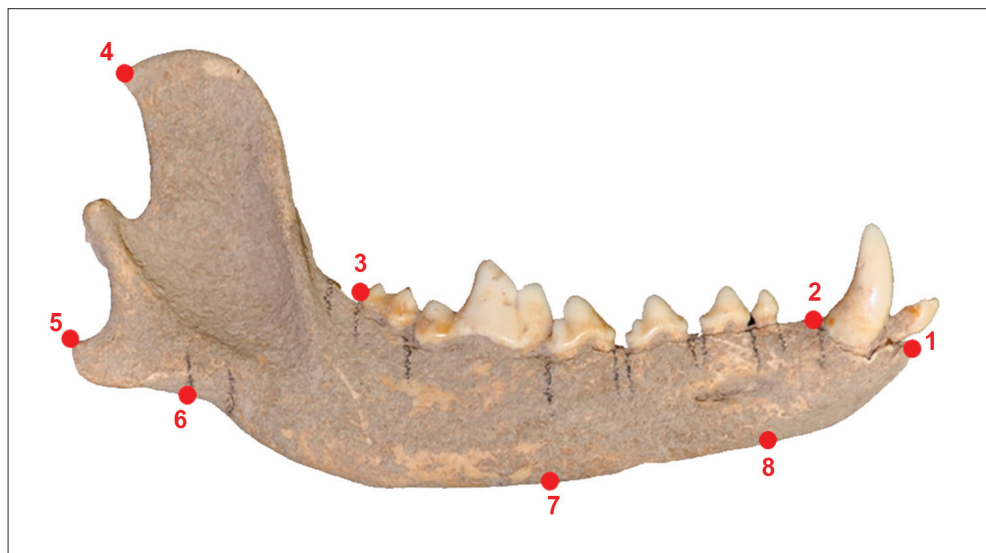


Figure 5: Lateral view of the mandible of the archaeological individual from La Huelga (Palencia). Location of the 8 landmarks proposed for the mandibles is noted.

Age child burial. Finally, point number 6 represents a dog found on one of the sides of a ditch (**Figure 3, Table 1**).

The variability put forward by CVA analyses allow to consider differences among dog mandibles in the archaeological record studied.

Discussion and Conclusions

The important social role of dogs can be inferred by the typical presence of numerous complete skeletons late prehistoric sites in the Iberian Peninsula. As previously mentioned, dog remains have been recovered from a range of different contexts, including burials, pits, and outstanding locations. The different contexts which dog remains have been recovered from may suggest that dogs were used for numerous different purposes in the Iberian Peninsula during Late Prehistory (**Figure 1, Table 1**). Additionally, this may also reflect the manner in which dogs were perceived by human societies. It may be that this varied across sites, or that dogs encompassed an important role in ideology and symbolism within Late

Prehistoric Iberia. The repeated placement of dog remains in particular as *special deposits* (Grant 1984, Hamerow 2006: 1–2) is something I consider to be sufficiently noteworthy to be considered a *dog phenomenon*.

The preparation of a catalogue of deposited dog remains allows for a series of commonalities to be observed amongst registered dog osteological remains. Differences are also noted, which leads us to propose ordering these deposits in different typologies. This research has demonstrated both the location and quantity of dog remains deposits from the Iberian Peninsula and also the different contexts in which they are placed. Important contrasts have been found which, I argue, refer to different reasons for placement. Further research will consider the importance of the archaeological data alongside bone assemblages and also investigate possible ethnographic parallels.

Morphological differences and their interpretation as indicators of a diversity of life-function is an issue that has so far not been demonstrated in dogs due to the homogeneity of the population (Sanchís & Sarrión 2004:

No.	Code	Provenance of the Material	Chronology/Breeds/ Species
1.	YESEA21-001	Camino de las Yeseras – Dog in funerary context	Chalcolithic
2.	YESEA40-003	Camino de las Yeseras – Dog in a pit	Chalcolithic
3.	YESEA40-004	Camino de las Yeseras – Dog in a pit	Chalcolithic
4.	YESEA40-005	Camino de las Yeseras – Dog in a pit	Chalcolithic
5.	YESEA40-006	Camino de las Yeseras – Dog in a pit	Chalcolithic
6.	YESEA54-010	Camino de las Yeseras – Dog in a ditch	Chalcolithic
7.	YESEA134-013	Camino de las Yeseras – Dog in funerary context	Bronze Age
8.	YESEA132-017	Camino de las Yeseras – Dog in a pit	Roman Period
9.	HUELG36C-019	La Huelga – Dog in a pit	Bronze Age
10.	SCHNAU-020	LAZ-UAM Comparative collection	Schnauzer*
11.	PODORI-021	LAZ-UAM Comparative collection	Podenco orito*
12.	PODORI-022	LAZ-UAM Comparative collection	Podenco orito*
13.	GALGO-023	LAZ-UAM Comparative collection	Greyhound*
14.	PAGUAS-024	LAZ-UAM Comparative collection	Perro de aguas*
15.	MASPIRI-025	LAZ-UAM Comparative collection	Mastiff*
16.	PASTAL-026	LAZ-UAM Comparative collection	German Shepherd*
17.	VIRING-028	LAZ-UAM Comparative collection	Viringo*
18.	BULLDOG-029	LAZ-UAM Comparative collection	Bulldog*
19.	HUSKY-030	LAZ-UAM Comparative collection	Husky*
20.	LABRA-031	LAZ-UAM Comparative collection	Labrador*
21.	BOXER-032	LAZ-UAM Comparative collection	Boxer*
22.	TERRANO-033	LAZ-UAM Comparative collection	Terranova*
23.	TECKEL-034	LAZ-UAM Comparative collection	Dachshund*
24.	CARLIN-035	LAZ-UAM Comparative collection	Pug*
25.	LASAPSO-036	LAZ-UAM Comparative collection	Lasha Apso*
26.	YORKTER-037	LAZ-UAM Comparative collection	Yorkshire Terrier*
27.	CHACAL-038	LAZ-UAM Comparative collection	Golden jackal (<i>Canis aureus</i>)
28.	CUON-039	LAZ-UAM Comparative collection	Dhole (<i>Cuon alpinus</i>)
29.	ZORROART-040	LAZ-UAM Comparative collection	Arctic fox (<i>Alopex lagopus</i>)
30.	VULPES-041	LAZ-UAM Comparative collection	Fox (<i>Vulpes vulpes</i>)
31.	CANLUP-042	LAZ-UAM Comparative collection	Wolf (<i>Canis lupus</i>)
32.	CANLUP-043	LAZ-UAM Comparative collection	Wolf (<i>Canis lupus</i>)

Contd.

No.	Code	Provenance of the Material	Chronology/Breeds/ Species
33.	CANLUP-044	LAZ-UAM Comparative collection	Wolf (<i>Canis lupus</i>)
34.	CANLUPLJ-045	LAZ-UAM Comparative collection	Wolf (<i>Canis lupus</i>)
35.	CANLUPLJ-046	LAZ-UAM Comparative collection	Wolf (<i>Canis lupus</i>)
36.	VA10002-047	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
37.	VA32203-048	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
38.	UJA10C5129-049	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
39.	UJA10C5129-049	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
40.	VA290-051	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
41.	VA32103-052	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
42.	VA31-053	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
43.	VA32003-054	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
44.	VA7702-055	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
45.	VA357/03-056	UJA Comparative collection	Fox (<i>Vulpes vulpes</i>)
46.	YESEA464	Camino de las Yeseras – Faunal remains	Bronze Age
47.	YESEA319	Camino de las Yeseras – Dog in a pit	Bronze Age
48.	YESEA04	Camino de las Yeseras – Faunal remains	Chalcolithic
49.	YESEA21	Camino de las Yeseras – Dogs in a pit	Chalcolithic
50.	YESEA55	Camino de las Yeseras – Faunal remains	Chalcolithic
51.	YESEA56	Camino de las Yeseras – Faunal remains	Chalcolithic
52.	YESEA61	Camino de las Yeseras – Dogs in a pit	Chalcolithic
53.	YESEA132	Camino de las Yeseras – Faunal remains	Chalcolithic

Table 3: Sample of mandibles used in the geometric morphometrics study. The left column shows the number used for the statistical analysis. Archaeological materials are shown in bold. All specimens with * correspond to *Canis familiaris*.

184). Demonstration of the specific use of dogs has been possible in very few cases; for example as pack animals (Albizuri et al. 2011, Liesau, Esparza & Sánchez 2014: 111), for consumption of meat (Driesch & Boessneck: 1980), or fur procurement (Sanchís & Sarrión 2004: 180). Several researchers have indicated that these dogs would play a role to assist in hunting or cattle-keeping, though

this interpretation is only possible from indirect evidence (Sanchís & Sarrión 2004: 162, 179, Ruiz et al., 2014). However, at present, osteological techniques are yet to be used on dog remains to confirm whether certain dogs were specialized for certain, specific tasks. Traditional osteometry is useful for the development of specimen databases, but in our study did not prove sufficiently valuable

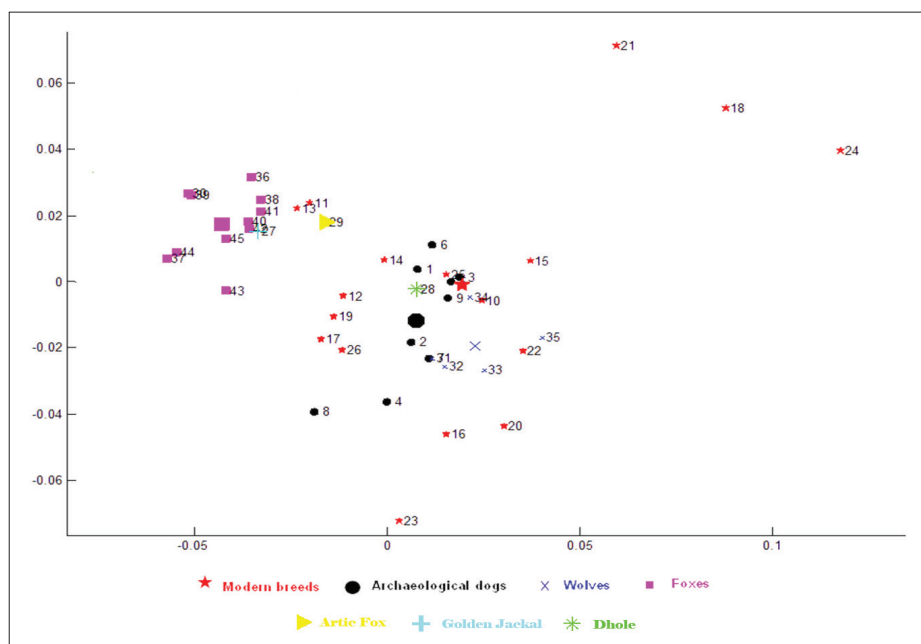


Figure 6: Analysis of the Principal Components (PC1 and PC2). The mean is represented by a large symbol for each group. While foxes or brachycephalic dogs from the modern dogs collection are clearly separated, most of the other modern breeds and archaeological specimens are largely mixed. See Table 3 for the identifying number for each individual.

when trying to identify subtle morphological differences. The limited number of results obtained when applying indices to the (often badly preserved) archaeological material, made this a difficult task to undertake. These applications show apparent homogeneity between individuals. Geometric Morphometrics could provide important information in this regard.

Geometric Morphometrics have been used to determine issues relating to the origins of domestication, providing important results in addition to the development of new lines of multi-disciplinary combined research (Larson et al. 2014, Drake et al. 2015). Here the study focuses on domestic species. Studies from later periods have allowed assignment of archaeological dog remains to different morphotypes of dogs based on differing osteometry and statistics (Morales et al. 2015). In our sample of dog remains

from Iberian Late Prehistory, we have to deal with very subtle osteological/morphological differences between individuals, and, often the remains are in a poor state of preservation. Overall the application of Geometric Morphometrics seems to have a great potential that should be further developed and investigated.

Our preliminary results from the 2D geometric morphometric study have provided interesting preliminary results regarding the selected archaeozoological material. Using the same skeletal element for different individuals, it was possible to detect slight differences in the osteological remains. Considering bone preservation, the number of mandibles present per site and the fact that mandibles usually exhibit zones useful to osteometric and morphological study, these preliminary results proved useful in guiding the author's future research.

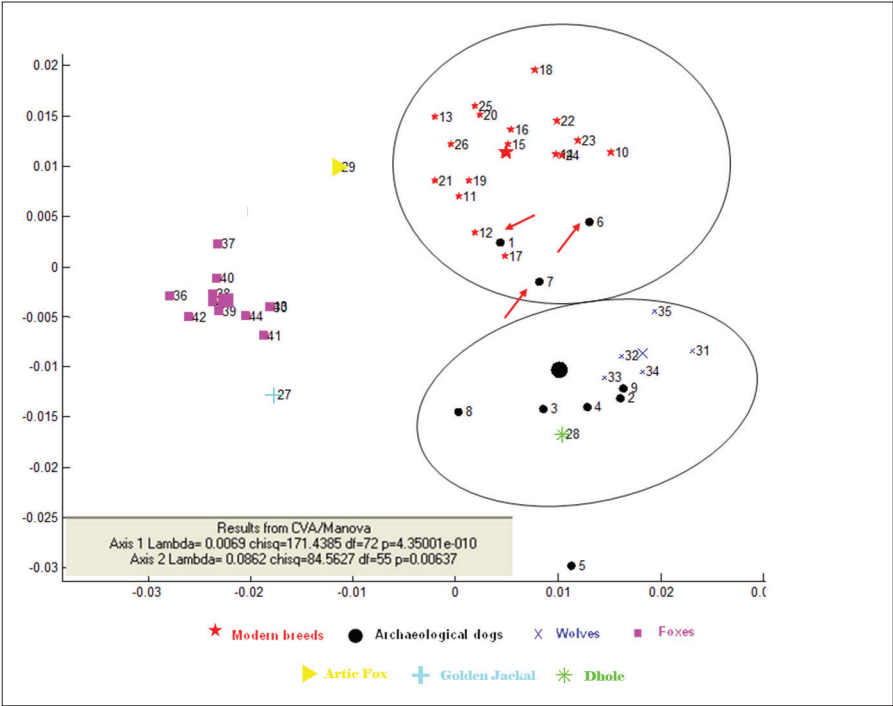


Figure 7: Canonical variate analysis (CV1 and CV2). The foxes group is, as expected, clearly separated from the rest. Although close together, two groups are defined: the wolves and archaeological individuals group, and the modern breeds group, mixed with some archaeological individuals. The identifying number for each individual is in Table 3.

The CVA analysis appears to show that there is a specific configuration of the mandible in some dog specimens from the archaeological sample. Most morphological features are subtle and relative to changes in shape, so that statistically significant differences could only be detected and discussed using the results from the geometric morphometrics analysis. This technique seems to reveal that archaeological dogs might present a morphotype variability that went undetected by the standard osteometry indices. We have begun assigning some dogs to the closest morphological group represented by modern specimens.

Following these preliminary results, further research will allow additional interpretations to be made. This aims to explore whether these dogs were intentionally selected for placement in particular deposits

because of their morphological characteristics. In such cases, this could represent a different symbolic connotation.

Ongoing PhD research by the author is extending the preliminary research presented in this paper, expanding both the sample size and the geometric morphometrics-based approach. Further results are to be subjected to rigorous statistical analysis as part of the doctoral thesis, and to consider whether the separate groupings form a distinct pattern. From this it will be possible provide a comprehensive overview of deposited dog remains in the Later Prehistory of the Iberian Peninsula.

Additional File

The additional file for this article can be found as follows:

- **Appendix 1.** Results of shoulder height and bone stoutness for specimens found in Iberian Late Prehistoric Sites through the application of indexes from some authors (Harcourt 1885, Koudelka 1974, Clark 1975) to measurements. Individual measurements with * from Sanchís and Sarrión (2004). Individual measurements with ** from Liesau, Esparza and Sánchez (2014). DOI: <https://doi.org/10.5334/pia-487.s1>

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Competing Interests

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