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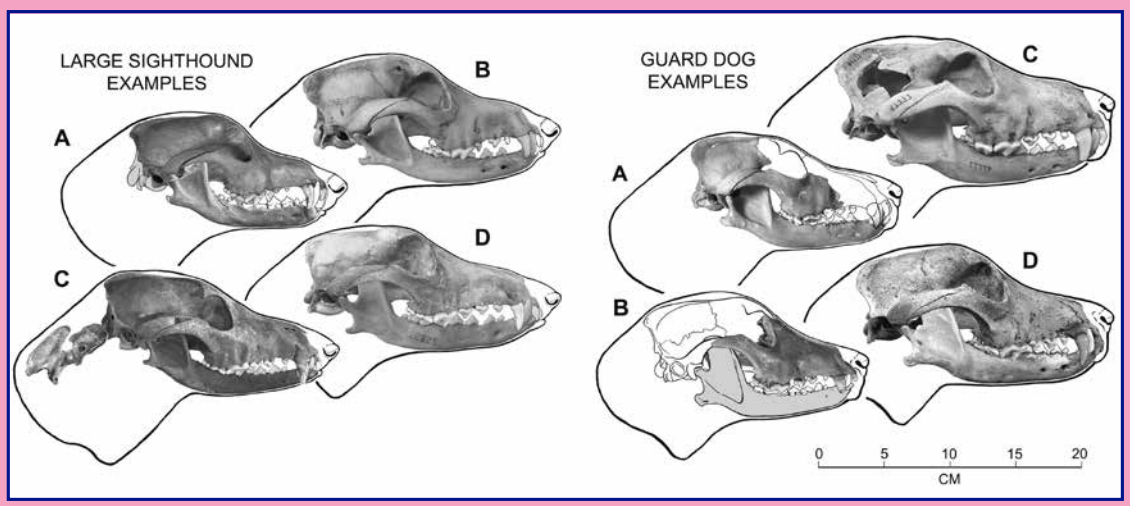

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Economy and subsistence in the Early Neolithic site of Carrascal (Oeiras, Portugal)

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ABSTRACT: Early Neolithic settlements in southwestern Iberia are rare and, so far, only a few faunal assemblages, mostly from Portuguese Estremadura, have been analysed. The zooarchaeological studies suggest that animal husbandry was introduced to the area by Neolithic marine settlers originating from the Mediterranean and that domesticated animal herding, particularly sheep, was of outmost importance to the human communities. Located in lower Estremadura, Carrascal is an open-air site, featuring several dwelling structures, a diversified set of artefacts, and a well-established chronology for its Early Neolithic occupation (cal BC). It also yielded a faunal assemblage of considerable size and variability, which includes vertebrates (mammals and fishes) and invertebrates (molluscs). The present study, which focuses on the vertebrate materials, shows that during Early Neolithic the community that inhabited Carrascal practiced a diversified set of subsistence activities in which animal husbandry was prevalent. There is an abundance of caprines (mainly sheep) and swine, followed by cattle. The age at death data suggests a mixed animal exploitation system, with swine being mostly killed at a younger age (presumably for meat), while cattle was slaughtered after reaching adulthood (perhaps for milk production) and caprines show a mixed pattern. This study also reinforces the idea that, for the Neolithic communities living in lower Estremadura, hunting was a less prevailing activity (aurochs and, perhaps, wild boar were identified, but red deer is absent in Carrascal) when compared with the human groups that lived in the central Estremadura Limestone Massif, a situation that may be due to different ecosystems and human demography.

KEYWORDS: ZOOARCHAEOLOGY, SOUTHWESTERN IBERIA, ANIMAL HUSBANDRY, DOMESTICATION

RESUMEN: Los yacimientos del Neolítico Temprano en la Iberia sud-occidental son infrecuentes y, hasta la fecha, muy pocas faunas –la mayoría de ellas de la Extremadura portuguesa– han sido estudiadas. Los análisis zooarqueológicos apuntan a que las especies domésticas fueron introducidas en esta zona por colonizadores neolíticos marineros procedentes del Mediterráneo y que las ganaderías domésticas, especialmente la ovina, habrían sido de máxima importancia para las comunidades humanas. Situado en la Baja Extremadura portuguesa Carrascal es un yacimiento a cielo abierto que consta de varias estructuras de habitación, un diversificado conjunto de artefactos y una cronología bien establecida para su ocupación neolítica temprana (cal. BC). Incorpora asimismo una colección faunística de considerable tamaño y diversidad, que incluye tanto vertebrados (mamíferos y peces) como invertebrados (moluscos). El presente análisis, centrado en los

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materiales de vertebrados, evidencian que, durante el Neolítico Temprano, la comunidad que habitó Carrascal practicaba una gama diversificada de actividades de subsistencia donde destacaba la ganadería. Se constata una abundancia de caprinos, especialmente oveja, así como de porcino, situándose el vacuno en tercera posición. La edad de sacrificio sugiere una estrategia mixta de explotación animal, con el porcino siendo sacrificado a edades más tempranas (presumiblemente para consumo cárnico) en tanto que el vacuno se sacrificaba una vez alcanzada la madurez (posiblemente para producción láctea) mostrando los caprinos un patrón mixto. Este análisis refuerza también la idea de que en las comunidades neolíticas de la Baja Extremadura la caza era una actividad secundaria (se registran uros y, quizás, jabalíes pero el ciervo no aparece) al compararlas con los grupos humanos que vivían en el macizo calcáreo de la Extremadura Central. Posiblemente las distintas demografías y ecosistemas de estos dos lugares se encuentren en las raíces de tales diferencias.

PALABRAS CLAVE: ZOOARQUEOLOGÍA, IBERIA SUD-OCCIDENTAL, GANADERÍA, DOMESTICACIÓN

INTRODUCTION

Recent works have discussed Early Neolithic communities in the Portuguese territory (5500–4500 cal BC) and their subsistence (e.g. Valente & Carvalho, 2014, 2019; Davis & Simões, 2016; Valente, 2016; Almeida *et al*., 2017; Davis *et al*., 2018), emphasizing that animal (and crop) husbandry was introduced to the area during Early Neolithic and that domesticated animal herding, particularly sheep, was of extreme importance to these communities.

For this period, most of the known sites with zooarchaeological studies are located in an area called Estremadura, in west central Portugal (Cova do Ladrão, Caldeirão, Pena d'Água, Cerradinho do Ginete, Lameiras and Encosta de Sant'Ana; Figure 1A). Their faunal assemblages include several domesticated animals and most species (sheep, goats and cattle) are exogenous to the territory, having been introduced by Neolithic marine settlers originating from the Mediterranean (Zilhão, 2000, 2001). Pig herding should also have occurred, probably crossbreeding with indigenous wild boar (Valente & Carvalho, 2014). Wild game hunting was a comparatively less prevalent activity.

The site of Carrascal, located in lower Estremadura (Figure 1B/C), features an important Early Neolithic occupation. This occupation is of high importance since it yielded a diversified set of dwellings and materials that bear witness to the lifeways of these Neolithic communities. More so, this site provided a well-preserved faunal assemblage of considerable size and variability, which includes vertebrates (mammals and fishes) and invertebrates (molluscs). The present study focusses on the vertebrate collections and aims to enrich what is known about the human subsistence and animal exploitation systems of the first Neolithic communities of southwestern Iberia.

THE EARLY NEOLITHIC SITE OF CARRASCAL

The archaeological site of Carrascal (municipality of Oeiras) is located about 12 km west of the Lisbon city center (coordinates: 38º43'29''N, 9º16'39''W), on the right bank of the Barcarena stream, a tributary of the Tagus River. Nowadays, the Tagus mouth is located ca. 3 km away from the site (Figure 1). During Early Neolithic, humans settled on a gentle part of the slope, which does not overlook the Tagus nor to the Barcarena stream, taking advantage of the shelter offered by the Upper Cenomanian hard limestone outcrops, among which simple dwelling structures were built.

These structures, featuring small ground slabs and fireplaces, were built in between the limestone blocks. One ground stone was found *in situ* as well as one polishing tool used to manufacture stone artefacts. A concave pit (*cuvette*), about 1 m in diameter, was also identified. It was dug into the limestone substrate, not very deep, and was filled up by basalt blocks. It was used as a heat structure, taking advantage of the basalt's ability to store heat.

The Early Neolithic assemblage was recovered from a thin reddish-brown layer (Layer 4), directly above the geological substrate. This layer was overlaid by another one, dating to Late Neolithic. During excavations it was sometimes difficult to

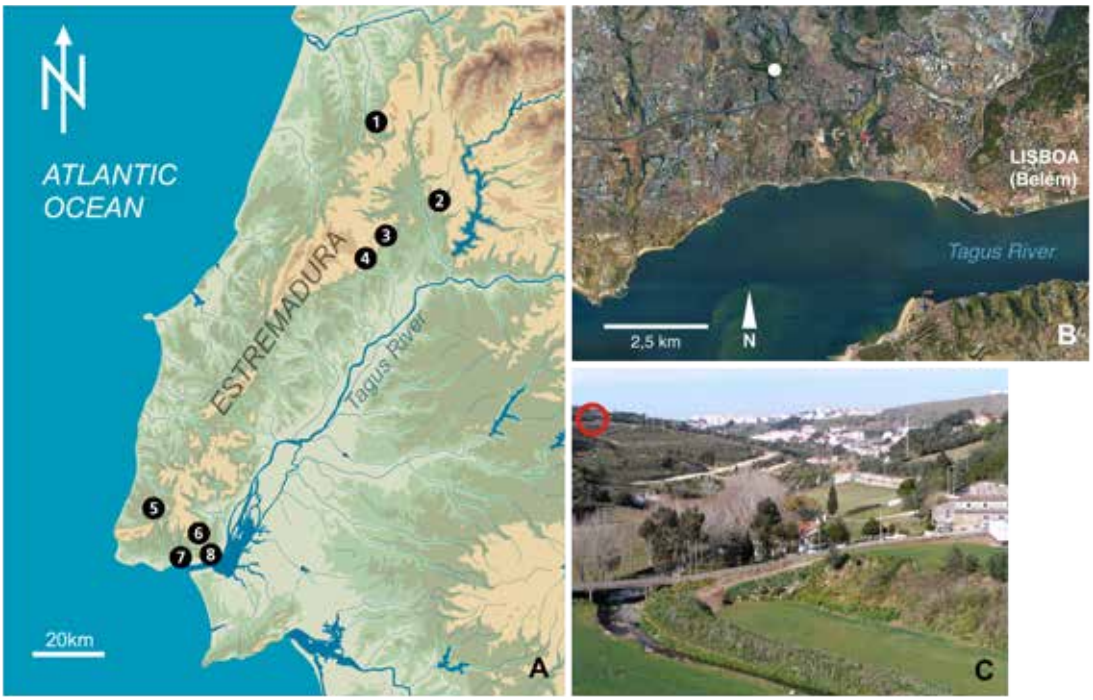

FIGURE 1

A) Map of Portuguese Estremadura with main archaeological sites mentioned in the text. Located in coastal central Portugal, Estremadura contains the Lisbon and Setubal peninsulas at the south, the Tagus River at east and, further north, the Limestone Massif. Sites: 1. Cova do Ladrão; 2. Caldeirão; 3. Pena d'Água; 4. Cerradinho do Ginete; 5. Lameiras; 6. Correio-Mor; 7. Carrascal; 8. Encosta de Sant'Ana. B) Satellite view of Carrascal setting (source: Google Earth, © Google, 2019). The site is located ca. 12 km from the city center of modern Lisbon (Belém is the southwesternmost civil parish of the municipality of Lisbon). C) View of Barcarena stream, looking north (photo by J.L. Cardoso). Carrascal is located in the left of the photo, on the right bank of the stream (which runs south). Location of Galicia within the Iberian Peninsula with location of the sites.

establish a clear separation between both layers and, consequently, it was hard to ascribe some of the materials found in the contact area between the two Neolithic deposits. To overcome this problem, we dated several terrestrial mammal bones by AMS (n=6). These dates allowed us to precisely date the Early Neolithic occupation of Carrascal to 5300–5000 cal BC (Cardoso, 2010, 2011, 2015; see Supplementary Material 1). The materials recovered in Layer 4 are in agreement with the radiocarbon data.

Polishing tools, small axes and adzes, usually of flat or lenticular section and with imperfect finishing, were made from filonian or metasedimentary basic rocks. These raw materials are from local or regional origin and their presence is best explained by their easy accessibility and exploitation. Their local or regional origin suggests the absence of raw material trade in the Early Neolithic. In this region, such trade becomes more obvious from the Middle Neolithic (4500–3200 cal BC) onwards, with the acquisition of amphibolite from the Alto Alentejo region, more than 120 km away (Cardoso, 2004). The preparation of these polished artifacts was carried out in the domestic space itself, as indicated by the existence of two polishers.

The presence of numerous flint cores at various stages of preparation, accompanied by flint flakes, shows an intense activity of on-site artifact production. Flint nodules and platelets are abundant in the local Cretaceous limestones and it is clear that intensive flint knapping was carried out at the site. The main artifact groups, based on the typological analyses of the 2003 materials (Cardoso *et al*., 2008), are the following: perforators: 4 (3.2%); side scrapers: 7 (5.6%); backed flakes: 1 (0,8%); truncations: 1 (0,8%); notches and denticulates: 21 (16,9%); flakes, blades and bladelets: 24 (19,4%); crescents: 1 (0,8%); atypical points on flake, on blade or bladelets: 5 (4,0%); pieces with use-wear marks: 56 (45,2%); and heavy-duty tools (side scraper on pebble or hammerstone) : 4 (3,2%).

As for the ceramic materials, their abundance (including large storage containers) reveals a residential type settlement, with a perennial occupation. The Cardium imprinting technique was used on less than 10% of the decorated pottery, sometimes using shells that were bigger than common cockle (*Cerastoderma edule*) (Cardoso, 2013). Occasionally, there are carefully produced ceramics, with wide neck and "almagre type" coating, decorated with thin incised lines on the vessels' body and neck, including narrow triangles filled by oblique lines. However, most of the decorated ceramics show motifs produced by incision, impression and plastic techniques, also with the presence of mixed techniques (for example, impressed and incised lines on the same piece).

ZOOARCHAEOLOGICAL METHODS

The zooarchaeological materials found in the Early Neolithic occupation of Carrascal included vertebrates (mammals and fishes) as well as invertebrates (molluscs). This study focuses on the vertebrate assemblage. The invertebrate assemblage, mostly composed of European flat oyster (*Ostrea edulis*), but also limpet (*Patella* spp.) and mussel (*Mytilus* sp.), is still to be fully analysed, as are the Late Neolithic faunal materials.

We used the current methodology for zooarchaeological studies (e.g. Reitz & Wing, 2008). Whenever possible, classification was attempted at the species level by morphological and metric observation, using the reference collections available at the University of Algarve's Archaeological Lab and at the Archaeosciences Laboratory of Direção Geral do Património Cultural (DGPC/LARC) in Lisbon.

Whenever a specific taxonomic classification was not possible, the remains were classified according to the size of the animals: medium (e.g. caprines, swine, canids) and large-sized (e.g. cattle).

In the case of caprines, the distinction between sheep (*Ovis aries*) and goat (*Capra hircus*) was based on the criteria presented by Boessneck (1969), Zeder & Lapham (2010) and Zeder & Pilaar (2010). Davis (Davis & Simões, 2016; Davis *et al*., 2018) has reviewed these criteria in samples from Portugal and suggests that the most obvious distinctions between these species are in dP4, distal humerus, distal metacarpal, astragalus and distal phalanx. As far as Carrascal is concerned, we followed Davis' suggestion and used these elements for specific classification.

To quantify the material, we used the following units: Total Number of Remains (TNR), Number of Identified Specimens (NISP), Minimum Number of Individuals (MNI; taking into account the different slaughtering ages) and Minimum Number of Elements (Klein & Cruz-Uribe, 1984; Lyman, 2008). The latter allows a better control of skeletal-part abundances and possible redundancies (Lyman, 2008: 124–128).

The age of death of animals is usually obtained through the use of two methods: the fusion of the epiphyses (Habermehl, 1961; Zeder, 2006; Zeder *et al*., 2015) and the eruption and dental wear (see references below). The first presents more difficulties: variation among animal populations, difficulty in assigning chronological time of fusion to wild species, establishing wide age groups (especially after the fusion process is completed) and difficulty in establishing valid mortality profiles, among others (Greenfield & Arnold, 2008). The second one also presents some variations according to the animal population but is more reliable and allows for age groups of greater detail. Whenever possible, we used the latter, especially for the mandibles, but also for some of the isolated lower teeth (swine: Grant, 1982; Lemoine *et al*., 2014; caprines: Payne, 1973; Grant, 1982; Greenfield & Arnold, 2008; cattle: Grant, 1982; Halstead, 1985; Jones & Sadler, 2012).

After calculating the Tooth Wear Stage (TWS), the teeth were then divided into age groups, for which we adapted the system developed by O'Connor (1988): Neonatal (dP4 without eruption or in process of eruption), Juvenile (dP/4 in wear; M/1 not in wear), Immature (M/1 in wear; M/2 not in wear), Subadult (M/2 in wear; M/3 not yet in wear), Adult (M/3 in wear, but not heavily worn), Elderly (M/3 heavily worn, with wear stage 'j' or beyond *sensu* Grant, 1982).

Regarding the osteo and odontometric data we followed the procedures proposed by Driesch (1976) and Davis (1992), for which we used a Mitutoyo Absolute 500-444 caliper.

Finally, we also analysed the following bone modifications: thermo-alteration, its extension, color and stage attribution (Shipman *et al*., 1984; Ellingham *et al*., 2015); cut marks (including striations, chop marks and punctures) and gnaw marks.

RESULTS

A total of 932 animal remains were analysed (Table 1). In general, the fauna shows a high degree of fragmentation, either caused by (Neolithic) anthropic fracturing or during the excavation. More than 94% of the material is broken, and only 36 bones (and 21 teeth) provided osteometric data. This made the classification more difficult, even of it was possible to classify ca. 37% of the assemblage to the genus or species level.

Almost all the remains belong to large or medium sized mammals (340 NISP plus 590 remains with no specific classification) and small animals are almost absent, with the exception of two fish specimens. These were identified by Sónia Gabriel (DGPC/LARC) as one Triakidae vertebra and one epural of a bony fish (i.e. Osteichthyes) (Figure 2).

	N	%
NISP (mammals)	340	36,5
Total Remains	932	—
Isolated teeth	122	13,1
Bones	810	86,9
Mammals	930	99,8
Fishes	2	0,2

TABLE 1
General faunal quantification.

SPECIES ABUNDANCES AND AGE AT DEATH

The mammals identified at Carrascal are common in the archaeofaunal record from the Early Neolithic period in the Iberian Peninsula and, in particular, in Portuguese Estremadura.

Most are domesticated animals, even if the swine status is unsure. By order of abundance, we have (Table 2): caprines (39% NISP; only sheep was identified, but goats are also a possibility), swine (38%; pig and/or wild boar), cattle and aurochs (24%; the former seems to prevail), and one remain of a medium sized canid (<1%). The unusual absence of leporids is surely due to recovery procedures during excavation (no sieving system was used).

CANIDS: dog (*Canis familiaris*, L. 1758) or wolf (*Canis lupus*, L. 1758)

Only one proximal remain of ulna was identified. It did not allow for standard measurements, but its general slender features suggest the presence of the domestic species (Figure 3). Due to its robustness and morphology, this piece might have been used as an awl, with minor modifications by polishing.

SWINE: pig (*Sus domesticus*, Erxleben 1777) and/or wild boar (*Sus scrofa*, L. 1758)

FIGURE 2
Fish remains. A) Triakidae vertebra. B) Osteichthyes epural bone.

Taxonomy	Common Name	NISP	%NISP	MNI
Canis sp.	wolf and/or dog	1	0,3	1
Sus sp.	wild boar and/or pig	127	37,4	4
Bos cf. *primigenius*	auroch	8		
Bos cf. *taurus*	cattle	13	23,5	3
Bos sp.	auroch and/or cattle	59		
Ovis aries	sheep	7	38,8	5
Capra hircus/*Ovis aries*	goat and/or sheep	125		
TOTAL		340	—	13

TABLE 2

Quantification of identified mammals (NISP and MNI).

FIGURE 3

Canid ulna. Slenderness suggests dog (*Canis familiaris*).

Swine remains total 127, making it the second most abundant taxa.

The distinction between pig and wild boar is often very difficult, more so in Western Iberia due to their overlapping size (Albarella *et al*., 2005). Davis & Moreno-García (2007: 60–62) addressed the size and specifically the shape variation of the lower third molar as a way to distinguish wild and domesticated swine remains, but the method requires the presence of this particular tooth in the collection, preferably in considerable amounts. Davis & Detry (2013) also noticed that, in the Portuguese collections, the diameter of the humerus distal trochlea at its narrowest point (HTC) and the tibia distal width (Bd) may be good distinction indicators. For the Zambujal Chalcolithic faunal assemblage, they distinguished wild boar when the humerus HTC has more than 20-22 mm and tibia Bd was superior to 29-35 mm.

Unfortunately, the Carrascal assemblage is small, only allowing a few measurements (see Supplementary Material), most of them from non-diagnostic elements. Still, the humerus data (n=3) imply the presence of pig (n=2; 18-19 mm) and perhaps also of wild boar (n=1; 21,1 mm).

Regarding elements representation, all the skeletal parts are present, with a slight predominance of the anterior member bones (Table 3). The calculated MNI is four, distributed by two juvenile/immature animals (one younger than 5 months, the other some 6-8 months old), one subadult to adult and one unequivocal adult (Table 4).

BOVINAE: cattle (*Bos taurus*, L. 1758) and auroch (*Bos primigenius*, L. 1758)

Bovines are the third taxon with the largest NISP in Carrascal, reaching a total of 80 (Table 2). General size observations and osteometrical data (available for proximal phalanxes, astragali and some upper teeth) suggest the presence of both species, cattle and aurochs (Figure 4; Supplementary Material). A few of the bovine long bones (mostly diaphyses that do not allow measurements) suggest that some animals were very small, but more specimens and metric data are needed for a better evaluation.

All the skeleton parts are present (Table 3) and the calculated MNI is three (Table 4), with one foetal individual (calcaneum) and two adults (one older than 42 months, based on the TWS of a M3 inferior: g to h, *sensu* Grant, 1982).

	Swine		Cattle		Caprine		Medium Size	Large Size
	NISP	MNE	NISP	MNE	NISP	MNE	NISP	NISP
skull							10	6
maxilla	5	4					1	
mandible	4	3	2	1	8	5	6	1
isolated tooth	30	24	35	20	39	30	13	5
atlas	4	4						
axis					1	1	1	
vertebra							40	18
rib							37	16
pelvis	1	1	1	1	4	3	4	
scapula	7	4	1	1	5	5	10	
humerus	9	6			18	9	1	
radius	7	5	2	1	15	10		
ulna	4	3	1	1	2	2	1	
carpal	1	1	6	6	1	1		
metacarpal	7	7	2	1	4	3		
femur	6	2			8	4	6	
patella								
tibia	6	4	1	1	3	3		
malleolus			2	2				
astragalus	4	4	2	2	2	2		
calcaneum	5	4	1	1	9	9		
other tarsal	4	4	2	2				
metatarsal	2	2	3	2	3	2		
metapodial	8	1	3	1	3	0		
phalanx 1	7	5	8	4	4	4		
phalanx 2	4	4	5	5	2	2		
phalanx 3	2	2	3	3	1	1		
bone ND	—	—	—	—	—	—	330	84
TOTAL	127	94	80	55	132	96	460	130

TABLE 3
NISP and MNE per skeletal part of main animal groups.

Age Class	Swine	Cattle	Caprine
Juvenile	2	1	1
Subadult/Adult	1		
Adult	1	2	3
Unknown			1
Total (MNI)	4	3	5

Age classes correspondences. Swine: Juvenile 0–12m; Subadult 12–24m; Adult 24+m (Lemoine *et al*., 2014; Zeder *et al*., 2015). Cattle: Juvenile 0–18m; Subadult 18–24m; Adult 24+m (Habermehl, 1961; Jones & Sadler, 2012). Caprine: Juvenile 0–12m; Subadult 12–30m; Adult 30+m (Payne, 1973; Zeder, 2006).

TABLE 4
Age classes for swine, cattle and caprine.

CAPRINAE: sheep (*Ovis aries*, L. 1758) (and perhaps goat: *Capra hircus*, L. 1758)

Goats and, in particular, sheep are common in the Iberian Early Neolithic. At Carrascal, there is a total of 132 remains, from which a few diagnostic elements (humeri and astragali; n=7) indicate the presence of sheep (Table 2; Figure 5). The only available astragalus measurement agrees with this idea: comparing with Davis' (2016: fig. 4 in p. 50) dispersion diagram of Dl/GLl relative to Bd/Dl, the obtained values (57,54 and 111,58) better place it within the sheep variation. Nonetheless, since the majority of the remains could not be determined to the species level, we cannot discard the presence of goats.

Like the other taxa, all the skeleton parts are present, but the distinction between the number of anterior and posterior elements is more obvious for caprines. Still, if MNE is taken into account, this discrepancy becomes minimal (9 humeri and 10 radii versus 9 calcanei; see Table 3).

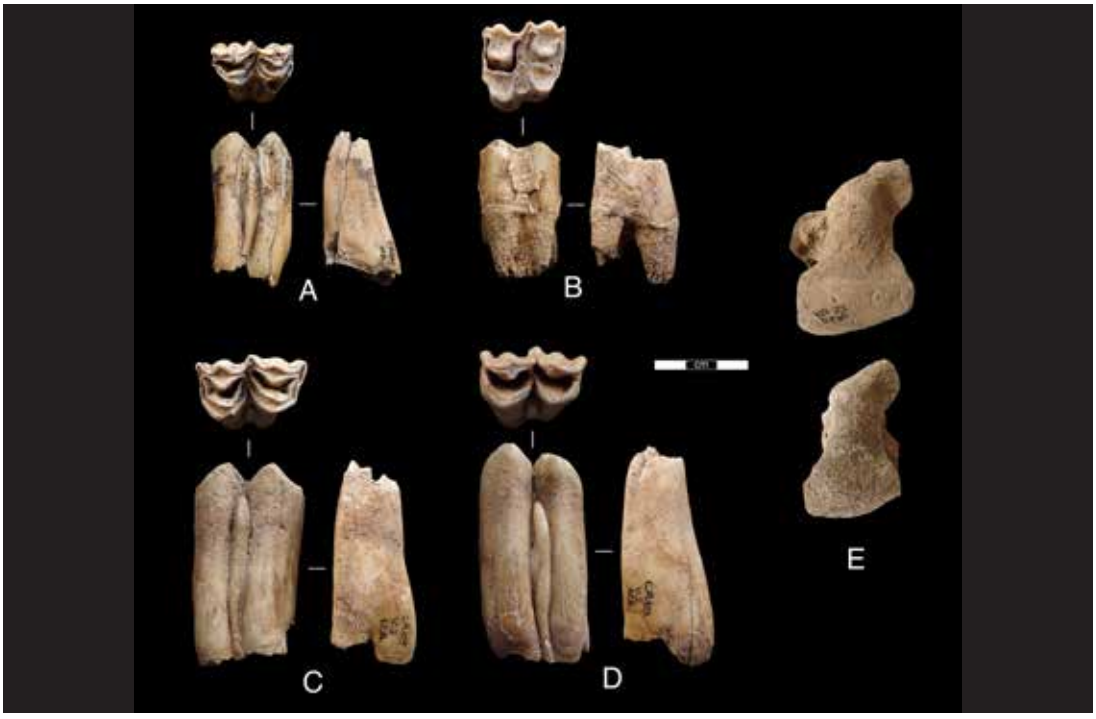

FIGURE 4
Cattle and auroch remains. A and B) Upper molars (M1 or M2) of *Bos* cf. *taurus*. E) Lunate bones (notice the difference in size, which may indicate two species: cattle and auroch).

FIGURE 5
Sheep (*Ovis aries*) remains. A) Astragalus (anterior view). B) Humerus (medial view).

The obtained MNI is five (Table 4): one juvenile (<6 months, based on one unfused, very porous proximal radius), three adults and one individual of uncertain age (immature to elderly).

BONE MODIFICATIONS

The high level of fragmentation in Carrascal suggests that the animal carcasses were quartered, with subsequent fracture of the skeletal units into smaller pieces, possibly for stew cooking in ceramic containers.

The comparatively low number of thermo-modified materials (<10%, Table 5) indicates that direct fire exposure (e.g. grilling) was a less used method to process the meat. The burning stages are mostly 2 or 3 (*sensu* Shipman *et al*., 1984), being equally divided between partial and full burning of the specimens. Only 0,6% of the materials show higher temperature features (stages 4 to 5, always affecting the totality of the bone). There are no obvious differences between taxa regarding thermo-modifying processes (Figure 6).

	Burned Stage (*sensu* Shipman et al.; 1984)		Cutmarks	Gnawed
	2-3	4-5		
Swine	6		3	
Cattle	5	1		2
Caprine	4	1		
Medium Size	48	4		
Large Size	22			
Total	85	6	3	2
%Total Remains	9,1	0,6	0,3	0,2

TABLE 5
Quantification of bone modifications.

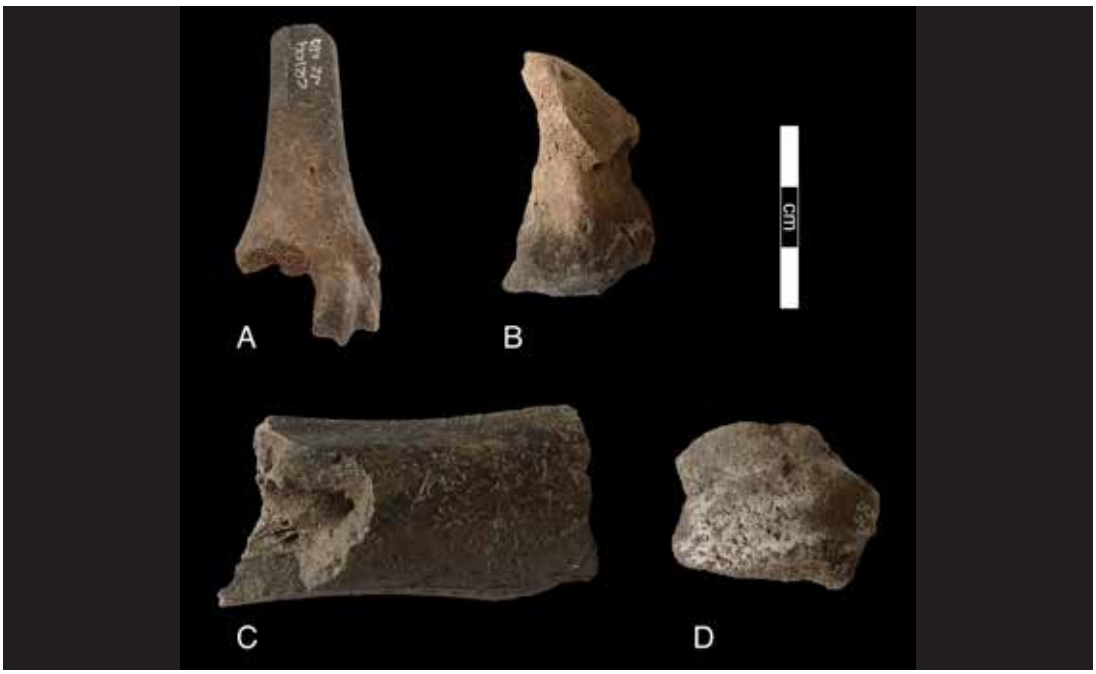

FIGURE 6
Bones with different stages of burning (Shipman *et al*., 1984). A) Caprine distal metatarsal, Stage 2-3 (brown and black). B) Swine proximal phalanx, Stage 3 (unburned and black). C) Bovine fragment of mandible, Stage 3 (black). D) Bovine fragment of metapodial (trochlea), Stage 3-4 (black and grey).

The presence of a few longitudinal and spiral fractures (<4% NISP) may indicate the exploitation of bone marrow, most obvious on caprine and bovine bones. Cut marks are minimal (0,3% of total number of remains; see Table 5), featuring short, light striae, a few of which are perpendicular to the longitudinal axis of the bone (Figure 7). These are concomitant with skeleton disarticulation processes and, perhaps, with skin, tendons and/or meat removal. A more detailed evaluation of materials is required to confirm such hypotheses.

The small number of gnawing evidences may be related to the presence of canids in Carrascal's Early Neolithic settlement.

DISCUSSION

Recent publications have focused on the Neolithic zooarchaeological dataset and its contribution to a general model for subsistence strategies in central and southern Portugal (Valente & Carvalho, 2014, 2019; Valente, 2016), or on the fast adoption

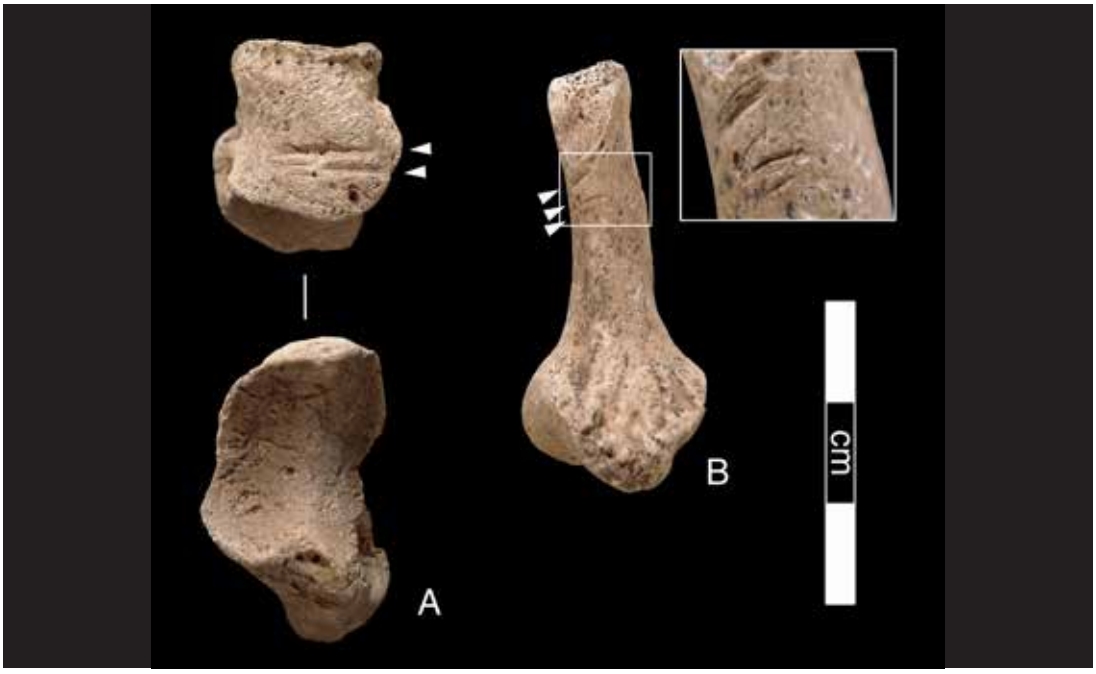

FIGURE 7

Bone remains with cutmarks. A) Swine navicular (anterior and distal views) with several perpendicular short cutmarks (on the anterior side). B) Swine proximal ulna (anterior view) with several perpendicular short cutmarks.

of husbandry in Estremadura and the importance of sheep in this process (Davis & Simões, 2016; Davis *et al*., 2018).

Several Early Neolithic settlements are known in the area where Carrascal is located (Portuguese Estremadura). They occupy caves, rock-shelters and open-air locations and some have zooarchaeological studies: Cova do Ladrão, Caldeirão, Pena d'Água, Cerradinho do Ginete, Encosta de Sant'Ana and Lameiras (Figure 1A). In general, their features suggest relatively small sedentary communities with considerable mobility, although some sites' attributes and material culture seem to support a higher degree of sedentarism. This is the case of Lameiras and Carrascal, both situated on open-air locations. These are larger sites, with a higher quantity and diversity of artifacts when compared to the other sites.

Regarding their zooarchaeological assemblages, most of the sites are characterised by a low NISP (<100; Table 6). So far, the exceptions are Caldeirão and Lameiras, located in different ecological areas. Like Carrascal, Lameiras is an open-air site found in lower Estremadura, an area characterised by a rather complex hydrographic network, which contributed to its high agricultural productivity and probably also facilitated contacts between communities. Caldeirão Cave is located further north, in the rim between the Limestone Massif of central Estremadura and the Tagus valley. This area connects the higher dry region of interior Estremadura and the lower sandy plains irrigated by the Tagus River headstreams.

At Lameiras, Early Neolithic occupations show a predominance of caprines (mostly sheep) and swine (probably pig), with some cattle and scarce remains of hunted game (Davis *et al*., 2018). Carrascal shows similar attributes: location, site functionality (open-air site with residential features) and relative faunal abundance (mostly domesticated species and rare wild animals).

As for Caldeirão, the most abundant remains belong to rabbit and swine (domesticated status still in discussion, but probably most remains belong to pig; Rowley-Cowny, 1992 *versus* Davis, 2002), followed by cattle, caprines (mostly sheep) and then red deer. Other sites located in the area (e.g. Cova do Ladrão, Pena d'Água), also show a considerable number of wild game remains (either rabbit or red deer).

Site	Type	L	EQ	S	SD	SS	CE	CC	B	BP	BT	C	CH	OA	TOT
Caldeirão	C	313	1	96			13	3			20	14		6	466
Carrascal	O			127	+	?			61	7	12	124		8	339
Cerr. do Ginete	O						1		6						7
Cova do Ladrão	C	30		8			2				4	4			48
Enc. de Sant'Ana	O	9				14	4		6			8			41
Lameiras (EN)	O	43	2	117,5	++	?		5	15	+	+	177	+	++	359,5
Lameiras (EEN)	O	15		41,5	++	?		1	21	?	+	75,5	+	++	154
Pena d'Água	R	7		13			21		15			17			73

Adapted from Valente & Carvalho (2014) and Valente (2016). Lameiras: data from Davis *et al*. (2018); EN = Early Neolithic; EEN = Evolved Early Neolithic. Carrascal: data from this work. Type (of setting). C = cave; R = rockshelter; O = open air. Taxonomy. L = leporid (*Oryctolagus cuniculus* and/or *Lepus* sp.); EQ = *Equus* sp.; S = *Sus* sp.; SD = *Sus domesticus*; SS = *Sus scrofa*; CE = *Cervus elaphus*; CC = *C. capreolus*; B = *Bos* sp.; BP = *Bos primigenius*; BT = *Bos taurus*; C = caprines; CH = *Capra hircus*; OA = *Ovis aries*. Other information: + present; ++ abundant; ? uncertain.
All numbers correspond to NISP, except Lameiras for which the quantification follows the PoSAC system (Davis, 1992).

TABLE 6
Faunal abundance and variability (main taxa) in Early Neolithic assemblages from the Portuguese Estremadura.

Ecological distinctions between lower and central Estremadura (Valente & Carvalho, 2014) and perhaps a denser human population in lower Estremadura (Davis & Simões, 2016) may justify the differences between these faunal assemblages, in particular with regard to the presence of wild game.

Taking into account the available framework for the usage of animal resources during Early Neolithic in Portuguese Estremadura, data from Carrascal are relevant for multiple reasons:

(1) It is one of the few Early Neolithic sites featuring a significant amount of identified vertebrate specimens (mostly medium– and large-sized mammals).

(2) It provided some data regarding age at death for the main taxa (caprines, swine and cattle), which, in turn, can provide information on specific animal husbandry methods. The age at death of the cattle specimens shows that they were kept alive until adulthood, thus suggesting other usages besides meat, perhaps dairying. On the other hand, swine, killed at younger ages, would be mainly used as meat providers. The caprines' pattern is less obvious but might imply mixed purposes: meat and possibly milk.

(3) It reinforces the idea that the advent of herding in Estremadura is characterised by the abundance of caprines (mainly sheep) and swine, with cattle as a supplemental species, even taking into account the latter's larger size (the ratio of medium *versus* large sized mammal remains in Carrascal is 3,4:1).

(4) It also strengthens the hypothesis that for the Neolithic communities living in lower Estremadura (Lameiras, Carrascal) hunting was a less prevailing activity when compared with the human groups of central Estremadura (Caldeirão, Cova do Ladrão, Pena d'Água), a situation that may be related with different ecosystems and human demography.

These postulates need further testing and a wider set of analyses. On a local level, in Carrascal, by studying other types of fauna (i.e. invertebrates) and cultural materials, in order to allow a better evaluation of the characteristics of its Neolithic occupations. On a broader level, by pursuing research on the social-economic framework of the Early Neolithic communities of Estremadura, as already put forward in other works (Valente & Carvalho, 2014, 2019; Valente, 2016; a more extensive perspective in Cardoso, 2010 and Carvalho, 2018).

CONCLUSION

The excavations and subsequent studies at the Early Neolithic site of Carrascal provided important data regarding the settlement features and the kind of subsistence on which it relied.

The site is characterised by several habitat structures that show its residential function, probably with perennial occupation. It yielded a high number of large ceramic containers, most likely used for storage. The assemblage also indicates intensive flint work on local raw material, along with the production of polished stone tools. Even if there are no direct evidences of cereal production, the existence of grinding artefacts and large storage containers strongly suggest that agriculture was an important economic activity.

The lack of imported rocks for the manufacture of polished stone artifacts shows the absence, at this early stage of the Neolithic, of exchange networks between this region and the Alentejo interior (this situation will change in later Neolithic stages).

The location of Carrascal, on a gentle, low altitude slope, enhanced the exploitation of several biota during the last quarter of the sixth millennium BC. The rocky riverside of the Tagus estuary, located 3 km away, was intensively exploited, as shown by the abundance of limpets (*Patella* sp.). An intensive gathering of aquatic resources at the nearby small paleo-estuary of the Barcarena stream is also confirmed by the abundance of the European flat oyster (*Ostrea edulis*). It is interesting to note that this stream was in a rapid siltation process; in fact, some 2000 years later, the presence of this species in the Late Neolithic occupation of the nearby Leceia site is residual (Cardoso, 2013). Another evidence for the exploitation of aquatic resources is the recovery of two fish specimens (undetermined bony fish and houndshark).

Simultaneously, there are clear evidences of a prevalent animal husbandry system, as revealed by the absolute predominance of domestic species, namely sheep (perhaps goat as well), swine and cattle. Age at death data suggest that swine were killed at a younger age (presumably for meat), while cattle was slaughtered after reaching adulthood (perhaps for milk production) and caprines show a mixed pattern.

Wild game is much scarcer, attesting the subsidiary importance of hunting in Carrascal's social and economic activities. The only unambiguous non-domesticated species is aurochs, even if wild boar might also be present. The absence of red deer is noteworthy, as all the other Early Neolithic assemblages in Central Portugal include some remains of cervids (even if in Lameiras, another lower Estremadura site, its presence is scarce).

We can, therefore, summarize that the Early Neolithic occupation of Carrascal, whose chronology is one of the best established in the Portuguese Estremadura region (5300–5000 cal BC), was an important residential settlement, and that its inhabitants practiced a diversified set of subsistence activities in which husbandry prevailed. Its radiocarbon dates are coherent with the general chronological information available for the earliest Neolithic in Lower Estremadura and corroborate the data obtained by the typological analysis of the ceramic and lithic productions (Cardoso, 2011, 2015). Carrascal, along with the necropolis of Correio-Mor Cave (5500–5100 cal BC; Cardoso *et al*., 1996; Cardoso, J.L., (2010): O Neolítico antigo da Baixa Estremadura: as investigações dos últimos cinco anos. Promontoria Monográfica, 15, pp. 22–48) and the settlement of Lameiras (5500–5000 cal BC; Davis & Simões, 2016; Davis *et al*., 2018; López-Dóriga & Simões, 2015), shows that this geographic area has been occupied since the mid-6th millennium BC. These first Neolithic communities of Portuguese lower Estremadura based their subsistence on domesticated animal herding, in particular sheep, and less so on wild game hunting (Valente & Carvalho, 2014, 2019).

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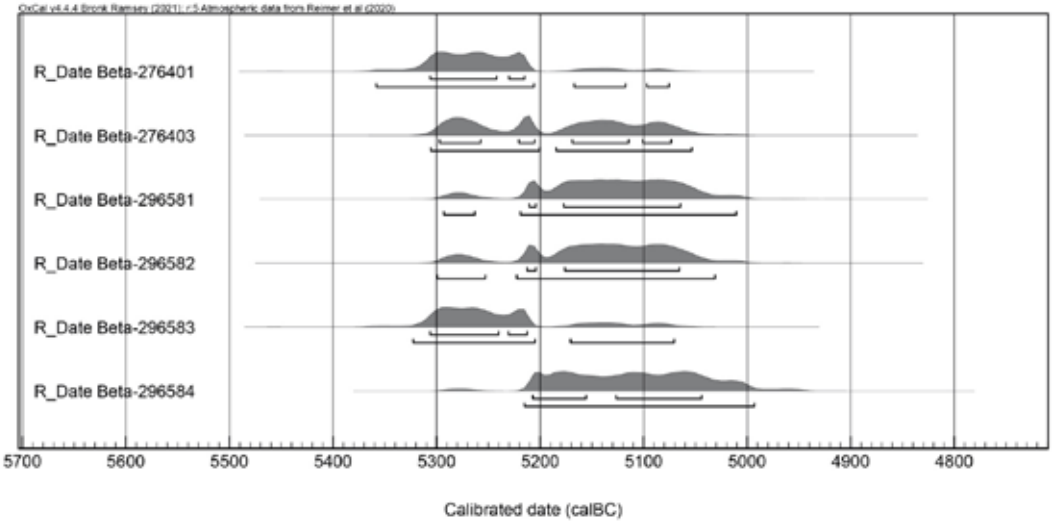
SUPPLEMENTARY MATERIAL 1. RADIOCARBON DATES.

Data according to OxCal program (v. 4.4.4; Bronk Ramsey, 2009), with calibration curve IntCal20 (Reimer et al., 2020).

Reference	Date BP	Material	Date cal BC 1 sigma	Date cal BC 2 sigma
Beta-276401	6280 ± 40	*Bos* cf. *taurus* tooth	5307–5216	5359–5076
Beta-276403	6230 ± 40	*Bos* cf. *primigenius* tooth root	5298–5074	5306–5054
Beta-296581	6190 ± 40	*Sus* sp. bone	5211–5065	5294–5011
Beta-296582	6200 ± 40	Caprine (*Ovis*/*Capra*) bone	5213–5066	5300–5032
Beta-296583	6270 + 7 – 40	*Sus* sp. bone	5307–5213	5323–5071
Beta-29684	6160 + 7 – 40	*Sus* sp. bone	5208–5045	5216–4994



SUPPLEMENTARY MATERIAL 2. OSTEOMETRIC DATA.

TAX	ELEM	F/NF	GL/GLl	Bp	Bd	GLm	Dl	BT	HTC	SD
S	AST	F	43,10			38,50				
S	AST	F	43,74			38,50				
S	AST	F	42,40			38,47				
S	FAL1	NF	—	—	13,96					
S	FAL1	NF	—	—	8,23					
S	FAL2	NF	—	—	15,44					
S	FAL2	F	25,55	16,72	14,16					
S	FAL2	F	26,51	15,92	13,32					
S	FAL2	F	22,65	15,28	14,49					
SD	HU	F						27,77	18,30	
SD	HU	F						29,31	18,54	
SD	TI	NF			30,25					
S	TI	F			29,09					
S	TI	NF			24,42					
BP	FAL1	F	—	35,61	—					
B	FAL1	F	—	—	29,75					
BT	FAL2	F	—	31,31	24,87					
BT	FAL2	F	42,69	31,81	26,84					
BT	FAL2	F	38,92	26,97	22,12					
OA	AST	F	28,50		18,28	26,96	16,40			
C	AST	F	26,26		17,24	—	—			
C	FAL1	NF	—	—	11,29					9,30
C	FAL1	F	—	12,46	—					9,98
C	FAL1	F	35,04	11,69	10,62					9,02
C	FAL2	F	27,03	12,79	10,36					
C	FAL2	NF	—	—	10,05					
OA	HU	F						24,54	13,00	
OA	HU	F						27,89	13,83	
OA	HU	F						26,54	13,31	
C	HU	F						27,95	13,87	
C	HU	F						31,69	15,00	
C	HU	F						30,96	15,68	
C	HU	F						28,51	14,48	
C	HU	F						30,29	14,70	
C	HU	F						26,06	12,90	
C	HU	F						27,53	14,45	

All measurements given in mm.

Taxonomy (TAX). B = *Bos* sp.; BP = *Bos* cf. *primigenius*; BT = *Bos* cf. *taurus*; C = caprid; S = *Sus* sp.; SD = *Sus* cf. *domesticus*; OA = *Ovis aries*. Anatomical element (ELEM). AST = astragalus; FAL1 = proximal phalanx; FAL2 = medial phalanx; HU = humerus; TI = tibia. F/NF = fused versus unfused. Measurements (following Driesch, 1976, and Davis, 1992). Bp/Bd = (Greatest) breadth of the proximal end, (Greatest) breadth of the distal end. BT = (Greatest) breadth of the trochlea. Dl = (Greatest) depth of the lateral half. GL/GLl/GLm = Greatest length, Greatest length of the lateral half, Greatest length of the medial half. HTC = Diameter of the distal trochlea at its narrowest point. SD = Smallest breadth of diaphysis.

SUPPLEMENTARY MATERIAL 3. ODONTOMETRIC DATA.

TAX	ELEM	L	B	CBC
S	M1 inf	16,69	10,10	
S	M1 inf	17,74	—	
S	M1 inf	15,90	11,50	
S	M2 inf	21,42	13,51	
S	M2 inf	22,16	13,57	
S	P3 inf	13,04	7,46	
S	P4 inf	15,08	9,50	
S	P4 inf	14,05	9,33	
B	M1/2 sup	24,00	25,97	91
BT	M1 sup	22,81	22,00	82
BP	M2 sup	27,25	25,26	97
BP	M3 sup	33,89	25,55	102
C	M1/2 inf	11,58	7,74	
C	M1/2 inf	11,93	7,33	
C	M1/2 inf	—	7,26	
C	M1/2 inf	12,41	—	
C	M1/2 inf	12,49	7,78	
C	M3 inf	21,72	7,65	
C	M3 inf	22,22	7,71	
C	P3 inf	7,05	5,91	
C	P3 inf	7,82	4,93	

All measurements given in mm.

Taxonomy (TAX). B = *Bos* sp.; BP = *Bos* cf. *primigenius*; BT = *Bos* cf. *taurus*; C = caprine; S = *Sus* sp.
Anatomical element (ELEM). M1 = first molar; M1/2 = first or second molar (undistinguished); M3 = third molar; P3 = third premolar; P4 = forth premolar. Inf = lower; Sup = upper. Measurements. L = length and B = breadth (Driesch, 1976); CBC = crown base circumference (Davis & Payne, 1993; also see Davis et al., 2018 for comparison with other Neolithic assemblages in Portugal).