Animal remains from Chalcolithic São Pedro (Redondo, Alentejo):
evidence for a crisis in the Mesolithic

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A B S T R A C T   Almost 700 animal bones and teeth from this Chalcolithic site in the Alentejo are described and compared with other zooarchaeological collections in southern Portugal and adjacent regions of Spain. Approximately half the São Pedro bones derive from wild animals like aurochs, red and roe deer, horse, wild boar, rabbit, hare and lynx. The other half includes domesticated animals like sheep, goat, cattle and pig. The São Pedro fauna like that of several other contemporary sites in the interior of Portugal and Spanish Extremadura and Andalusia includes many wild animals perhaps reflecting their relative small human population, the ephemeral nature of these settlements or even their military nature with soldiers less inclined to keep livestock. *Bos* and *Sus* are therefore present in both wild and domestic forms. Measurements of the aurochs, red deer and wild boar compared with those from other periods show that these three taxa were probably small in the Mesolithic but had recovered their larger size by Chalcolithic times. It is suggested that this may reflect over-hunting of large mammals in the Mesolithic — part of a general 'environmental stress' at that time.

R E S U M O   Cerca de 700 ossos e dentes de animais recuperados deste sítio Calcolítico no Alentejo são descritos e comparados com outras colecções zooarqueológicas da região. Cerca de metade dos ossos de São Pedro derivam de animais selvagens como o auroque, veado, corso, cavalo, javali, coelho, lebre e lince. A outra metade inclui animais domesticados como a ovelha, cabra, gado bovino e porco. A fauna de São Pedro, bem como de alguns sítios contemporâneos no interior de Portugal e na Extremadura e Andaluzia, inclui muitos animais selvagens. Este facto pode ser talvez indicador duma população humana de baixa densidade, povoamento ocasional ou o facto de se tratar de um povoado fortificado com pouca vocação produtora. *Bos* e *Sus* estão presentes em ambas as formas — selvagens e domésticos. As medidas dos auroques, veados e javalis em comparação com restos doutros períodos sugerem que estas três espécies eram mais pequenas no Mesolítico, mas recuperam os seus tamanhos normais antes do Calcolítico. É sugerido que o tamanho reduzido destes animais reflecte a sua caça em excesso durante o Mesolítico — parte de um 'stress ambiental' neste momento.

Introduction

The site

The prehistoric site of São Pedro, 318 m above sea level, is situated on a small hill overlooking the plain, adjacent to the modern town of Redondo, district of Évora, Alto Alentejo at latitude 38° 39' 01.53 N and longitude 7° 35' 05.10 W (Fig. 1). An area of some 2000 m² was extensively excavated under the direction of one of us (RM) (Mataloto & *alii*, 2007; Mataloto & *alii*, 2009; Mataloto & Boaventura, 2009). According to the finds uncovered, the site was probably occupied between the end of the 4th millennium and during most of the 3rd millennium BC. It has a complex sequence of occupation levels with evidence for the construction and demolition of various structures. We identified five principal occupations as indicated by the presence or absence of surrounding defensive structures.

In the initial occupation of the site (Phase I) structures were apparently made from perishable materials. This was followed by a period of construction with a wall — polygonal in plan — containing thick turrets on the outside. In the centre were two large circular towers. The subsequent occupation phase (III) is characterised by the abandonment and dismantling of most of the earlier constructions and the building of huts from perishable materials.

This 'open phase' was followed by renewed occupation characterised by a large circular structure with external semi-circular turrets (Phase IV) which occupied a smaller area with two large circular towers that occupied much of the interior of the fortified area. The settlement developed mainly outside this structure and comprised various different constructions — both dry-stone and perishable materials.

Following the abandonment of this fortification a new phase developed — characterised by a structure on the perimeter comprising various cabins built on stone foundations. The end of this occupation seems to be marked by the construction of a final large stone wall some 4 m wide, forming a circular structure 30 m in diameter.

From a general perspective, São Pedro was occupied during periods of stability, interspersed with periods of change and transformation. The human population of the settlement probably varied but is thought not to have ever exceeded a few "dozens".

As we describe below, these changes seem not to have influenced the fauna recovered from the site — the frequencies of the various animal taxa having remained relatively unchanged through time. The

Fig. 1 Map of Portugal showing the location of São Pedro and sites mentioned in this report.

bulk of the fauna was found in the central part of the site (sectors A, B and F) with little fauna recovered from the extra-mural sectors C, D and E. Thus food waste was deposited within the inhabited cabins. The presence of a greater stratigraphic thickness in the peripheral areas C, D and E, could reflect some kind of difference in the preservation of organic remains between the centre and periphery of the site.

The animal bones

This report describes the small collection of hand-recovered animal remains from São Pedro. The faunal collection is particularly interesting and valuable for a number of reasons. There are few well dated faunal collections known from the Chalcolithic of the Alentejo. This was approximately the time when the aurochs, or wild cattle, became extinct in the Iberian Peninsula (Castaños, 1991, 1992). It is also possible that the Chalcolithic saw the last survivors of the wild Iberian horse. We still do not know whether it became extinct before the domestic horse was introduced from the east or whether the Iberian wild horse was locally domesticated, or at least played some genetic role (i.e., they were interbred with domestic stock) in the development of the Iberian horses that became so famous in historical times.

The São Pedro collection includes many well preserved bones whose measurements contribute towards a long-term osteometric study of animals like the aurochs, wild boar and red deer in late Pleistocene and Holocene Portugal. And as we shall see they indicate that these three mammals were small in the Mesolithic and 'recovered' their size by Chalcolithic times — evidence, we suggest, of a crisis in the Mesolithic which subsequently brought about the need to adopt farming and animal husbandry.

The São Pedro faunal assemblage, with few domesticated caprines but numerous bones of wild mammals, is unusual when compared to several well known and large contemporary sites like Leceia (Cardoso & Detry, 2002) and Zambujal (Driesch & Boessneck, 1976) — both of which contain mainly domestic animals such as caprines (sheep and goat), cattle and pigs.

Material and methods

Most of the São Pedro animal bones are well preserved and were recovered in the field by hand. Certain units considered to be important were carefully sieved. Bones recovered in this manner were not kept apart.

Some 580 bones and 110 teeth and mandible fragments were recorded (see Tables 1, 2 and 3) which is sufficient to indicate approximately the percentages of the more common animals exploited at the settlement in antiquity, and, for the more abundant taxa, to provide useful measurements. For a full description of the methods used to record and count the animal bones see Davis (1992, 2002). In brief, mandibular teeth and a restricted suite of "*parts of the skeleton always counted*" (*i.e.*, a predetermined set of articular ends/epiphyses and metaphyses of girdle, limb and foot bones, or PoSACs) were recorded. In order to avoid multiple counting of very fragmented bones, at least 50% of a given part had to be present for it to be included.

Bone/tooth	Fusion	Cattle	Aurochs	Sh/G	(goat)	(sheep)	Sus	Red Deer	Rabbit	Hare	Equid	Roe	Lynx	Other
														Table 1. Numbers of teeth and bones recorded at São Pedro
dP$_4$		2		5	(1)	–	6	–			–	–	–	
P$_4$		–	–	2			5	3	–	–	1	–	–	
P$_{3/4}$											1			
M$_1$		1	–	3			10	6	–	–	1	–	–	
M$_{1/2}$		8	–	11			12	7	–	–	4	–		
M$_2$		–		5			10	2	–	–	1	–		
M$_3$		1	–	3			19	9	–	–	2	–		
Mandible							–	–	3					1 *Canis*, 1 *Vulpes* (both edentate)
Scapula	U	–	–	–			–	–	–	–	–	–	–	
	F	3	1	1			9	15	4	–	–	–	–	
	?	3	–	3			6	7	–	–	–	–	–	
Humerus	UM	–	–	–			5	–	–	–	–	–	–	
	UE	–	–	–			3	–	–	–	–	–	–	
	F	3	2	3	–	(3)	32	27	5	–	–	1	1	1 *Columba palumbus*
Radius	UM	–	–	–			1	1	–	–	–	–	–	
	UE	–	–	–			2	1	–	–	–	–	–	
	F	4	–	1			2	20	–	–	1	–	–	
Metacarpal	UM	–	–	–	–	–	½	–	–	–	–	–	–	
	UE	2	–	–	–	–	–	–	–	–	–	–	–	
	F	2½	½	1	–	(1)	2	9	–	–	1	1	–	
Ischium		1	–	5	(1)	–	15	15	7	–	2	–	–	
Femur	UM	–	–	–			–	2	3	–	–	–	–	
	UE	–	–	1			3	1	–	–	–	–	–	
	F	–	–	–			2	9	2	–	–	–	–	1 *Rattus rattus*
Tibia	UM	3	–	–			6	–	2	1	–	–	–	
	UE	2	–	–			1	1	–	–	1	–	–	
	F	1	1	5			21	33	1	–	2	2	1	
Calcaneum	U	–	–	–	–	–	3	5	1	–	2	–	–	
	F	1	–	1	(1)	–	3	18	–	–	–	–	–	
	?	–	–	1	–	–	7	19	–	–	1	–	–	
Astragalus		–	2	8	(5)	(2)	22	18	–	–	6	–	–	
Metatarsal	UM	–	–	–	–	(1)	–	–	–	–	–	–	–	
	UE	–	–	1	–	–	–	½	–	–	–	–	–	
	F	½	–	1	–	(1)	2	8	1	–	2	–	–	
Phalanx I	UM	–	–	–		–	8	–	–	–	–	–	–	
	UE	–	–	–			2	–	–	–	–	–	–	
	F	4	1	3			19	8	–	–	2	–	–	
Phalanx III		4	–	–			8	3	–	–	2	–	–	
Metapodial	UM	–	–	–			½	–	–	–	–	–	–	
	UE	½	–	–			2	–	–	–	–	–	–	
	F	1½	–	–			6½	1	–	–	3	–	–	
	?			–			½				–	–	–	
Totals		48	7½	64	(8)	(8)	250	245	29	1	35	4	2	
							N = 697							

These are the PoSACs as described in Davis (1992; 2002). Single metapodial condyles (*Sus* metapodials and broken bovid and cervid metapodials) are counted as halves, for example there were 13 fused *Sus* metapodials; hence the number given is 6½. 'Sh/G' includes caprine bones that could not be identified to species as well as those that could be identified as either sheep or goat; thus of the 8 caprine astragali, 5 were definite goat, 2 definite sheep and one unidentified sheep or goat. '*Sus*' includes both wild boar and pig, 'Roe' is roe deer, *Capreolus capreolus*. The fusion symbols are: 'F' – epiphysis fused (adult), 'UE' – unfused epiphysis and 'UM' – unfused metaphysis (juvenile). 'U' refers to scapulae with unfused coracoid or calcaneum with unfused *tuber calcis*.

English name	Portuguese name	Latin name	N	%
Cattle	Gado bovino	*Bos taurus*	48	7
Aurochs	Auroque	*Bos primigenius*	7½	1
Sheep/Goat	Ovino/Cabra	*Ovis/Capra*	64	9
Red deer	Veado	*Cervus elaphus*	248½	36
Roe deer	Corso	*Capreolus capreolus*	4	1
Pig/Wild boar	Porco/Javali	*Sus*	256	37
Equids	Equídeo –? Cavalo	*Equus cf caballus*	35	5
Rabbit	Coelho	*Oryctolagus cuniculus*	29	4
Hare	Lebre	*Lepus*	1	+
Rat	Rato	*Rattus rattus*	1	+
Lynx	Lince	*Felis lynx*	2	+
Dog	Cão	*Canis familiaris*	+	+
Fox	Raposo	*Vulpes vulpes*	+	+
Wood pigeon	Pombo torcaz	*Columba palumbus*	1	+

Table 2. Numbers (N) and percentages of teeth and bones recorded at São Pedro

These are the PoSACs as described in Davis (1992, 2002). A '+' in the numbers column refers to the identification of a non–PoSAC bone, and a '+' in the percentage column refers to a percentage less than 1%.

Table 3. Numbers of teeth and bones of mammals and birds in each phase at São Pedro

Phase	n/%	Bos	Sh/G	S	CEE	ORC	LE	EQ	CAC	Lynx	Rat	COP	N
V	N	2	2	7	9	1	0	1	0	0	0	0	22
	%												
IV	N	11	18	80	86½	8	0	5	1?	0	0	0	209½
	%	**5**	**9**	**38**	**41**	**4**	**0**	**2**	**+?**	**0**	**0**	**0**	
III	N	1	0	11	3	13	0	1	0	0	1	0	29
	%												
II	N	30	20	117	90	4	0	19	2	1	0	1	284
	%	**11**	**7**	**41**	**32**	**1**	**0**	**7**	**1**	**+**	**0**	**+**	
I	N	5	10	15	15	2	1	4	0	0	0	0	52
	%	**10**	**19**	**29**	**29**	**4**	**2**	**8**	**0**	**0**	**0**	**0**	
IV+V	N	*13*	*20*	*87*	*95½*	*9*	*0*	*6*	*1?*	*0*	*0*	*0*	*231½*
	%	*6*	*9*	*38*	*41*	*4*	*0*	*3*	*+?*	*0*	*0*	*0*	
I+II+III	N	*36*	*30*	*143*	*108*	*19*	*1*	*24*	*2*	*1*	*1*	*1*	*366*
	%	*10*	*8*	*39*	*30*	*5*	*+*	*7*	*1*	*+*	*+*	*+*	

Note that phase I is the oldest and phase V is the youngest. Percentages are calculated for phases where sample size is greater than 50. *Below, in italics, are the pooled numbers and percentages for "levels"IV+V and I+II+III.* Overall there appears to have been little change in the percentages of different taxa in the course of the site's occupation. Key: Bos – cattle and aurochs, Sh/G – sheep and goat, S – wild boar/pig, CEE – red deer, ORC – rabbit, LE – hare, EQ – horse, CAC – roe deer, COP – wood pigeon. (The 697 PoSACs in Tables 1 and 2 includes unphased finds and this explains the lower totals here.)

A mammal-bone epiphysis is described as either "unfused" or "fused"; "unfused" when there are no spicules of bone connecting epiphysis to shaft so that the two separate easily, and "fused" when it cannot be detached from the metaphysis. Caprine teeth were assigned to the eruption and wear stages of Payne (1973, 1987) and cattle and pig teeth were assigned to the eruption and wear stages of Grant (1982). Measurements taken on the humerus and metapodials are illustrated in Fig. 1 in Davis (1996). In general, other measurements taken are those recommended by Driesch (1976). Some of these are used to determine the status — wild or domestic — of the animal species in question as is illustrated in the figures herein. Measurements of teeth and bones are given in Appendix Tables 1–4.

Site/period	Region	Sheep/ Goat	Cattle/ Aurochs	Pig/wild boar	Red deer	Roe deer	Equids	Rabbit	Hare	Dog	Lynx	Fox	Badger	Cat	N	approx. % wild animals
São Pedro Redondo	Alentejo	9	8	37	36	1	5	4	+	+	+	+	–	–	697	50
Paraíso	Alentejo	41	20	27	3	–	4	1	–	4	–	–	–	–	75,5	7
Mercador	Alentejo	18	9	60	9	–	4	–	–	–	–	–	–	–	1441	12
Porto Torrão mid Chalcolithic	Alentejo	17	28	42	2	–	1	–	–	–	–	–	–	–	–	5
Porto Torrão late Chalcolithic	Alentejo	13	18	33	23	–	4	–	–	–	–	–	–	–	–	30
Perdigões (ditches 3+4)	Alentejo	14	16	49	13	–	3	4	1	1	–	–	–	–	735	18
Cerro de la Horca	Extremadura	27	11+3	17+1	17	+	16	6	1	–	–	+	+	–	853	29
"Los Castillejos"	Extremadura	6	33	13+2	18	+	25	2	+	–	+	+	–	+	2485	22
Los Barruecos IV&V	Extremadura	33	6	29+2	1	–	–	27	–	1	–	–	2	–	182	32
Hornachuelos	Extremadura	26	9	15	28	–	7	12	–	–	–	2	–	–	445	42
Castillo Alange	Extremadura	34	33	28	–	–	+	3	–	+	–	–	–	–	147	3
La Junta de los Ríos	Andalucia	7	3	30	38	–	1	20	–	–	–	–	1	–	1198	59
Cabezo Juré, Alosno	Andalucia	27	8	38	15	–	1	11	+	–	–	–	–	–	4665	26
Papa Uvas Aljaraque	Andalucia	31	36	20	5	–	+	+	+	7	–	–	–	–	1089	5
Leceia early Chalcolithic	Estremadura	42	23	35	+	–	+	–	–	–	–	–	–	–	4166	1
Leceia mid Chalcolithic	Estremadura	48	19	32	1	–	+	–	–	–	–	–	–	–	11018	1
Zambujal mid Chalcolithic	Estremadura	36	25	35	3	–	+	–	–	–	–	–	–	–	49379	3
Zambujal late Chalcolithic	Estremadura	36	22	37	4	–	+	–	–	–	–	–	–	–	23560	4
Penedo do Lexim	Estremadura	48	3	49	+	–	+	–	–	–	–	–	–	–	3001	1

Table 4. The percentages of medium and large mammals recorded at various Chalcolithic sites in the Portuguese Alentejo and Estremadura, Spanish Extremadura and Huelva district of Andalucia

References for sites are as follows: Paraíso (Davis, in press); Mercador (Moreno, 2003); Porto Torrão (Arnaud, 1993); Perdigões (Costa, 2010); Leceia (Cardoso & Detry, 2002); Zambujal (Driesch & Boessneck, 1976); Penedo do Lexim (Moreno, in prep); Cerro de la Horca (Castaños, 1992); "Los Castillejos" Fuente de Cantos (Castaños, 1997); Los Barruecos levels IV and V and Hornachuelos (Castaños, 1998b); Castillo de Alange (Castaños, 1998a); La Junta de los Ríos (Riquelme, 2008); Cabezo Juré (Riquelme, 2004); Papa Uvas I and II (Data combined; Morales, 1985; Álvarez & Chaves, 1986). N represents the total count of bones where known. Taxa whose percentages are less than 1% are denoted by a '+'. Note that some sites in the Alentejo and the majority of sites in Spanish Extremadura and Huelva contain large amounts of wild animals, while all sites in Portuguese Estremadura have few wild animals. For certain sites in Extremadura, Castaños separated the wild from the domestic form and the wild form is given as the second figure. For example at Cerro de la Horca, Castaños identified 11% domestic cattle and 3% aurochs and 17% pig and 1% wild boar. The far right column provides guesstimates of the percentage of wild animals such as deer and rabbit.

The animal remains from São Pedro will be stored in Redondo town hall.

Results and discussion

Species identified and their frequencies

The following species were found at São Pedro in decreasing order of abundance: wild boar and pig (whose remains are often difficult to distinguish, especially in the Iberian Peninsula, but both are present); red deer; caprines (sheep and goat whose remains are also difficult to identify to species level, but both are present); cattle and aurochs (also often difficult to distinguish); equid (probably all horse); rabbit; roe deer; hare; dog; fox; lynx; rat (probably intrusive) and a single bone of a pigeon (an unidentifiable large bird bone indicates the presence of another bird of considerable size).

While many of the mammals were probably domestic, the red deer (not known to have ever been domesticated), aurochs, wild boar, roe deer, hare, fox, lynx and rabbit (this last probably not domesticated until Roman or medieval times) must have been hunted. If we assume that the majority of the *Sus* was pig, and only a small proportion was wild boar (see below), then there were probably as many wild mammals as there were domesticated ones. This represents an unusually high

proportion of wild mammals. For example (Table 4) at the two large Chalcolithic sites of Zambujal (Driesch & Boessneck, 1976) and Leceia (Cardoso & Detry, 2002) in Estremadura, the proportion of domesticated animals is well above 75% and probably over 90%. Many of the other known Chalcolithic assemblages of animal bones also consisted predominantly of domesticated animals; especially caprines, cattle and pigs with less than 10% red deer. One exception in the Alentejo of Portugal is Porto Torrão (late Chalcolithic; Arnaud, 1993) with 23% red deer. It may be of some significance that the two Chalcolithic sites that contain abundant red deer are in the Alentejo and none are in Estremadura. And if we move further into the Iberian Peninsula the fauna of many (but not all) Chalcolithic sites in Extremadura and Huelva, Andalusia (*i.e.*, six out of eight recorded in Table 4) contain a high proportion of wild mammals like aurochs, red deer and rabbit (Castaños, 1991, 1992, 1997, 1998; Riquelme, 2008). One likely explanation for the varied proportions of wild mammals in the various Chalcolithic sites (we are indebted to Cleia Detry for this suggestion) is that the ratio of domesticated to wild mammals reflects the human population density. Thus sites with mainly domesticated animals like sheep, goat and cattle had large human populations — probably sedentary — while those with 30 or more percent wild mammals like red deer, were small sites where people did not have to rely so much on their domesticated livestock for meat and were able to hunt wildlife like red deer in the relatively pristine environments. If correct then it seems likely that the large 'urban' settlements like Leceia and Zambujal, were more common in Estremadura. Another possibility is that sites with a large wild component are those of a more military nature with soldiers less inclined to keep livestock and more likely to hunt for their meat supply. One word of caution is in order: Table 4 fails to sub-divide Chalcolithic sites chronologically and therefore hides possible changes with time. As more large Chalcolithic assemblages, especially multi-period ones, are studied it will be interesting to determine if the wild *versus* domestic animal ratios change in the course of time. But one thing is clear; the Chalcolithic of the Alentejo and neighbouring regions of Spain is characterised by being more varied in its fauna.

What follows is a series of more detailed descriptions of each taxon and, where relevant, a discussion of how wild and domesticated forms have been distinguished.

Sus – *wild boar/pig*

The pig, whose ancestor was the wild boar, was probably first domesticated in the Near East, although recent genetic evidence indicates a strong possibility that there were other independent centres of pig domestication (Larson & *alii*, 2005; Albarella & *alii*, 2006a). In general wild boar bones and teeth tend to be larger than those of pig but for many measurements there is overlap impeding any certain separation between wild and domestic (Payne & Bull, 1988). This distinction is even more difficult to make in the Iberian Peninsula where the wild boars are rather small. In our study (Albarella & *alii*, 2005) of *Sus* from Holocene Portugal we found that at many sites, especially Chalcolithic Zambujal, most *Sus* bones and teeth formed a cluster while there were a few somewhat larger-sized specimens. Like Driesch & Boessneck (1976) in their original study of the Zambujal bones, we also interpreted the small ones as having belonged to domesticated *Sus* (i.e., pig) and the few large specimens as wild boar. By applying this logic and assuming our interpretation was correct we can see that the plots for *Sus* bones from São Pedro (Fig. 2) have a similar distribution. We conclude therefore that like Zambujal, the majority of *Sus* bones derive from pig and only a small proportion belonged to wild boar. Another point worth noting in this figure is the apparent size increase of the presumed wild boar *after* the Mesolithic. We return to this below.
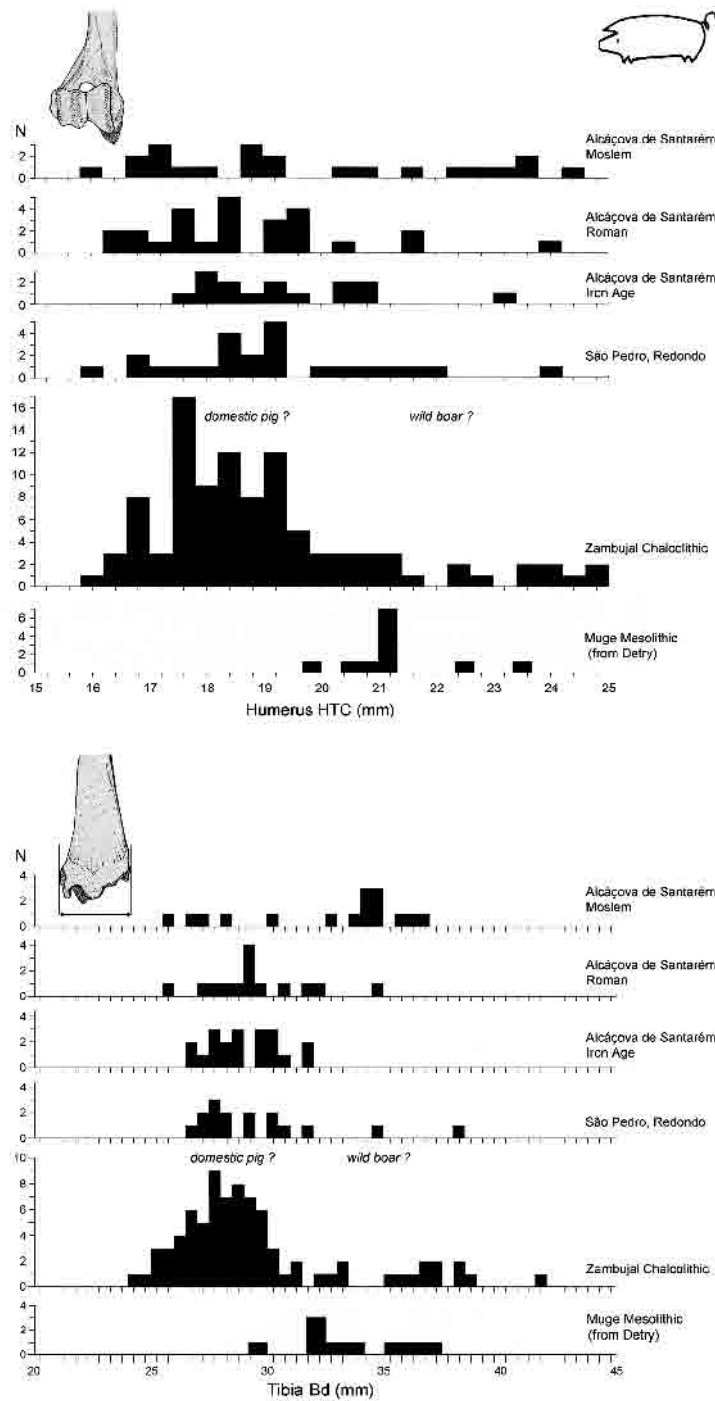
Fig. 2 Osteometric separation of wild boar from domestic pig. While separation is not complete, wild boar tends to be somewhat larger than pig — note especially the wild boar from Mesolithic Muge (Tagus estuary; Detry, 2007). These plots of the Minimum diameter of the humerus trochlea (HTC) and the distal width (Bd) of the tibia show a few specimens at Zambujal that are identified as wild boar — the humeri with HTC larger than c. 20 mm and the tibiae with Bd larger than c. 29 mm. The plot for São Pedro Redondo also comprises mainly smaller specimens presumed to have belonged to pig and one or two larger ones that probably belonged to wild boar (see also Albarella & *alii*, 2005). The apparent greater proportion of wild boar in the Moslem period at Alcáçova de Santarém may reflect the more relaxed attitude of Maghrebi Islam towards consumption of wild boar compared to pig which is strictly *harram* (see Simoons, 1994, p. 341; Moreno, 2004; Albarella & *alii*, 2005). It is also worth noting that if indeed the larger Chalcolithic specimens are wild boar then they are larger than the Mesolithic wild boar indicating that perhaps, like red deer and aurochs, this animal may have been smaller in the Mesolithic.

Ovis/Capra – *sheep/goat*

Bones of sheep and goat are generally difficult to distinguish. However some, such as the milk premolar teeth, dP_3 and dP_4; humerus; astragalus; and the metapodials (Boessneck, 1969; Payne, 1969, 1985), are relatively easy to identify. Fig. 3 shows a well preserved sheep distal metatarsal whose dorsal sulcus has rounded edges unlike that in the goat metatarsal whose edges are sharply defined.

While clearly both sheep and goat are present their scarcity (they constitute a mere 9% of the total assemblage) makes it difficult to determine whether one or the other was more common. The most common caprine bone that could be securely identified to species is the astragalus and there appear to be five goats and only two sheep, but all three humeri are sheep (Table 1). It is probably safer to merely suggest that both sheep and goat were present.

Bos – *aurochs/cattle*

Our domestic cattle are derived from the aurochs, *Bos primigenius*, probably first domesticated in the Near East. Whether other populations of wild cattle in other parts of Europe were independently domesticated is still uncertain, although current evidence points to a Near Eastern origin, at least for European cattle (Edwards & *alii*, 2007). In most parts of Europe and the Near East distinguishing between bones of the wild and domesticated forms can be done on the basis of size — with the aurochs being considerably larger, although for certain measurements there can be some overlap between the larger male cattle and smaller female aurochs. Here in Portugal, Mesolithic *Bos* (i.e., aurochs) bones are on average considerably larger than those from Iron Age to Moslem periods with little evidence for much overlap at least in measurements like tibia Bd and astragalus

Fig. 3 São Pedro – distal part of a sheep metatarsal (Sector B; UE: 2935) in anterior and plantar view. Note the poorly demarcated and rather rounded edges of the dorsal sulcus. This tends to be more sharply defined in the goat.

GLl. During these periods, the Iron Age to Moslem, this wild animal no longer existed here as it had become extinct in the Chalcolithic or Bronze Ages. [A small but significant size increase of cattle is now recognised to have occurred in Portugal after the Moslem period (Davis, 2008). This increase, presumably reflecting improvement, was small when compared to the size difference between specimens from the Mesolithic and the Iron Age to Moslem periods.] Figs. 4 to 6 are stacked histograms of measurements of several limb bones of *Bos* from Mesolithic to historical periods in southern Portugal. The aurochs — cattle distinction is fairly clear although measurements of some bones probably did overlap. If we look closely at the plots for the Zambujal astragali there does not appear to have been any overlap and Driesch & Boessneck (1976) suggested that astragali with greatest lateral length (GLl) exceeding 75 mm belonged to aurochsen. Their

scattergram ('Diagramm 2'), showing plots of astragali measurements, indicate complete separation of aurochs from domestic cattle specimens with a clear gap between the two forms. When the plots for specimens of *Bos* bones from São Pedro are compared to the Mesolithic and the Chalcolithic plots it is quite clear that we have both domestic cattle bones (note for example the three smaller metacarpals in Fig. 4 and the small tibia in Fig. 5) but also some aurochs (note the
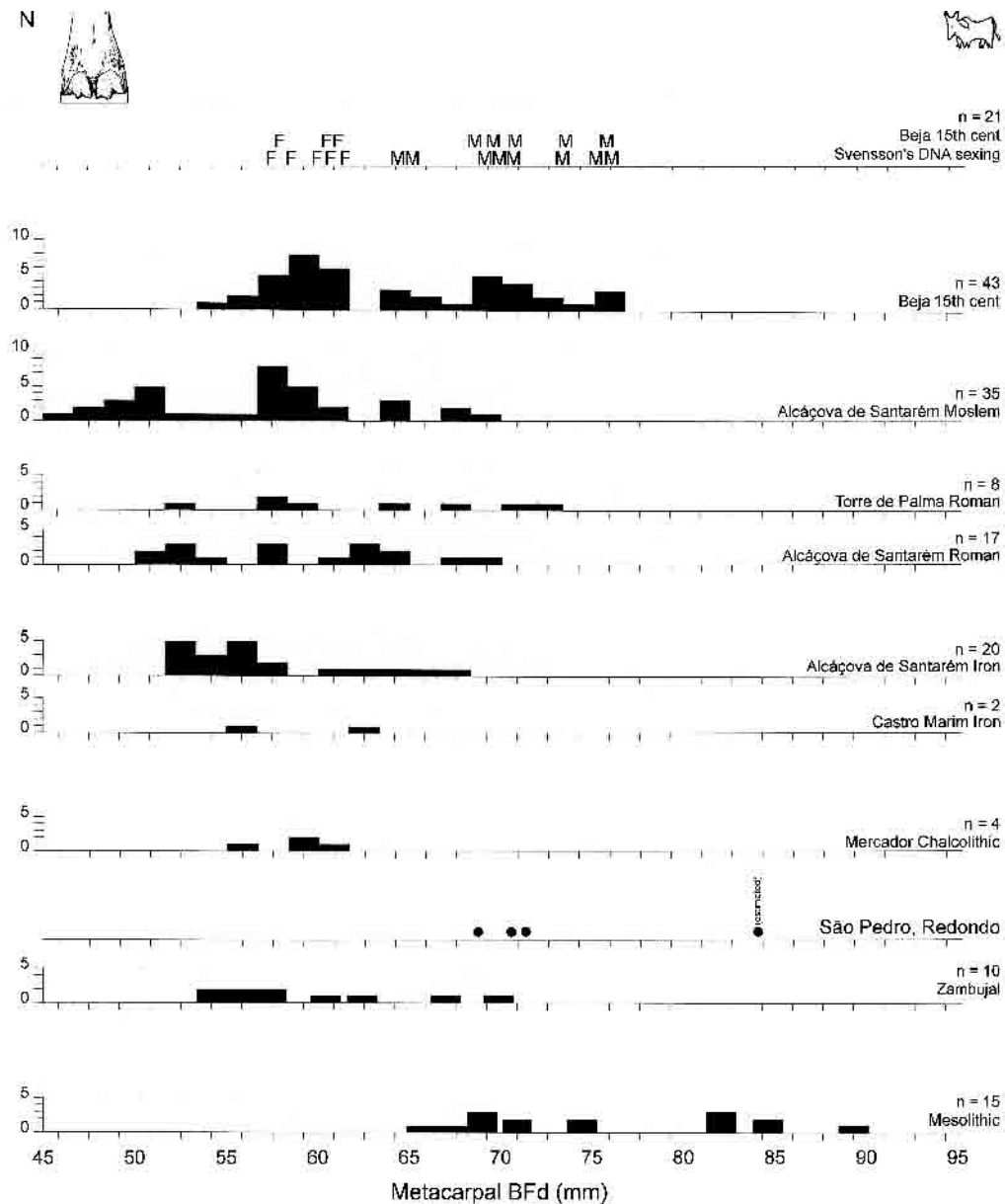

Fig. 4 Osteometric separation of cattle from aurochs, *Bos primigenius*. A series of stacked histograms of *Bos* metacarpal distal widths (BFd). These are arranged chronologically with the oldest sites at the bottom and the youngest at the top. Note the bimodal plots for the samples at Alcáçova de Santarém and Beja. A subsample of the latter has been sexed via ancient DNA by Svensson (Davis & *alii*, 2012) and indicates that the larger belonged to males and the smaller to females. The metacarpals from the Mesolithic sites at Muge and the Sado estuary (mostly data kindly supplied by Cleia Detry) appear also to form two groups presumably females (smaller) and males (larger). These Mesolithic metacarpals are larger than the domestic cattle from the later sites. (According to Driesch & Boessneck (1976), there were no aurochs metacarpals at Zambujal.) Given the considerable overlap between domestic males and wild females, it is not possible to identify the status of the three smaller specimens from São Pedro. These could be domestic males or wild females. The larger one (estimated as it comprised a single condyle only) almost certainly belonged to an aurochs.

two astragali in Fig. 6, a tibia in Fig. 5 and the large single metacarpal condyle in Fig. 4 (and see Fig. 7) whose BFd value is estimated to have been c. 84 mm). Fig. 8 shows the two large *Bos* astragali, the larger certainly aurochs and the smaller probably aurochs as indicated by their lateral lengths plotted in Fig. 6. Another point worth noting in this figure is the apparent size increase of the presumed aurochs *after* the Mesolithic. We return to this below.
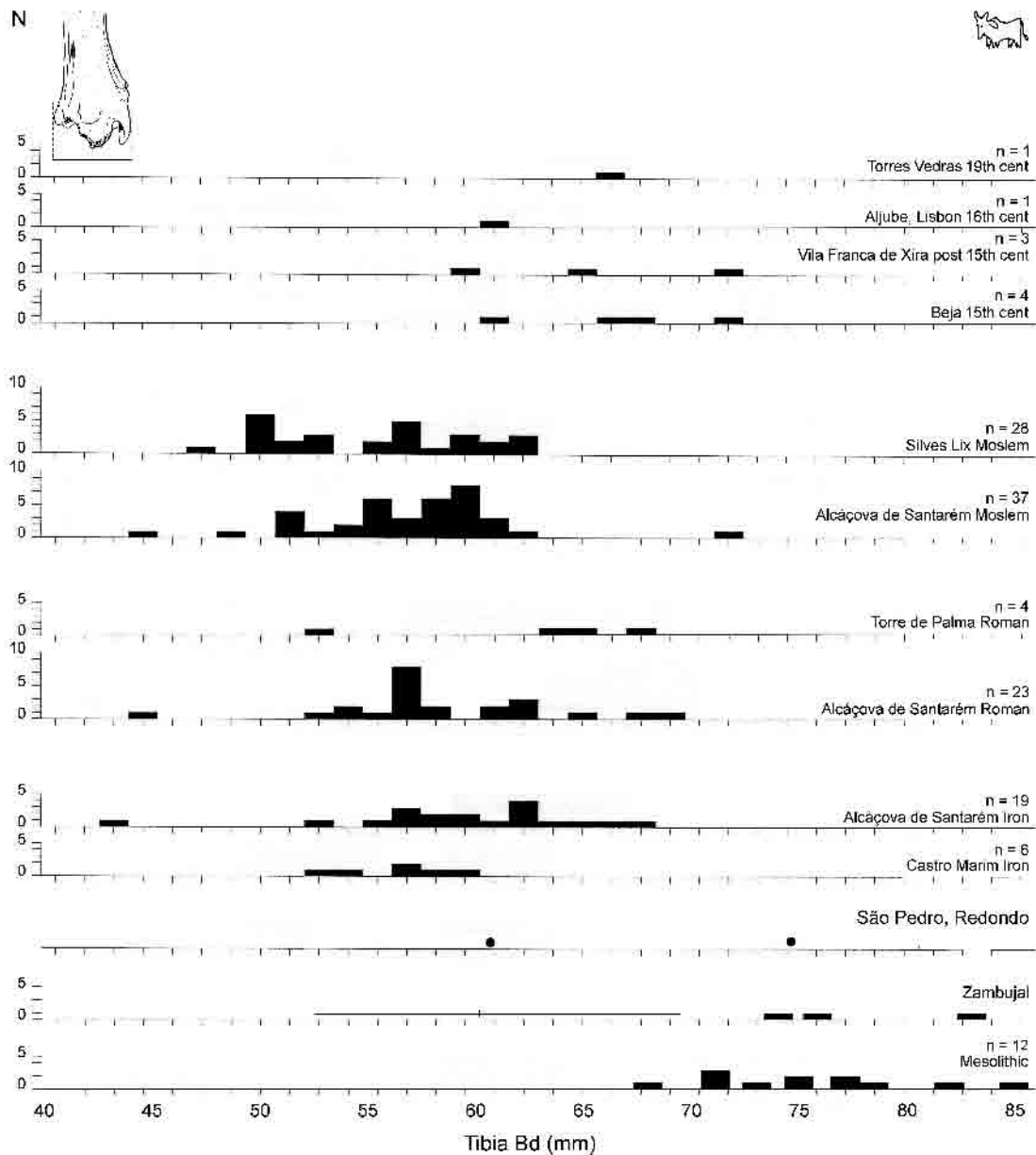

Fig. 5 Osteometric separation of cattle from aurochs, *Bos primigenius* - a series of stacked histograms of *Bos* tibia distal widths (Bd). These are arranged chronologically, with the oldest sites at the bottom and the youngest at the top. The tibiae from the Mesolithic (mostly data kindly supplied by Cleia Detry) and the three large specimens from Zambujal identified by Driesch & Boessneck (1976) as aurochs are all considerably larger than the domestic cattle specimens from the later sites and this size difference probably represents the wild-domestic size distinction. (Note that Driesch & Boessneck only published a range of 'variation' for the 86 tibiae they identified as domestic cattle — minimum 52,5 mm, maximum 69,5 mm, and mean 60,1 mm) The two specimens from São Pedro are quite different in size, the smaller almost certainly domestic and the larger wild. With so few aurochs specimens from the Chalcolithic it is not possible to identify any Mesolithic-Chalcolithic size change as with the astragali (see Fig. 6).
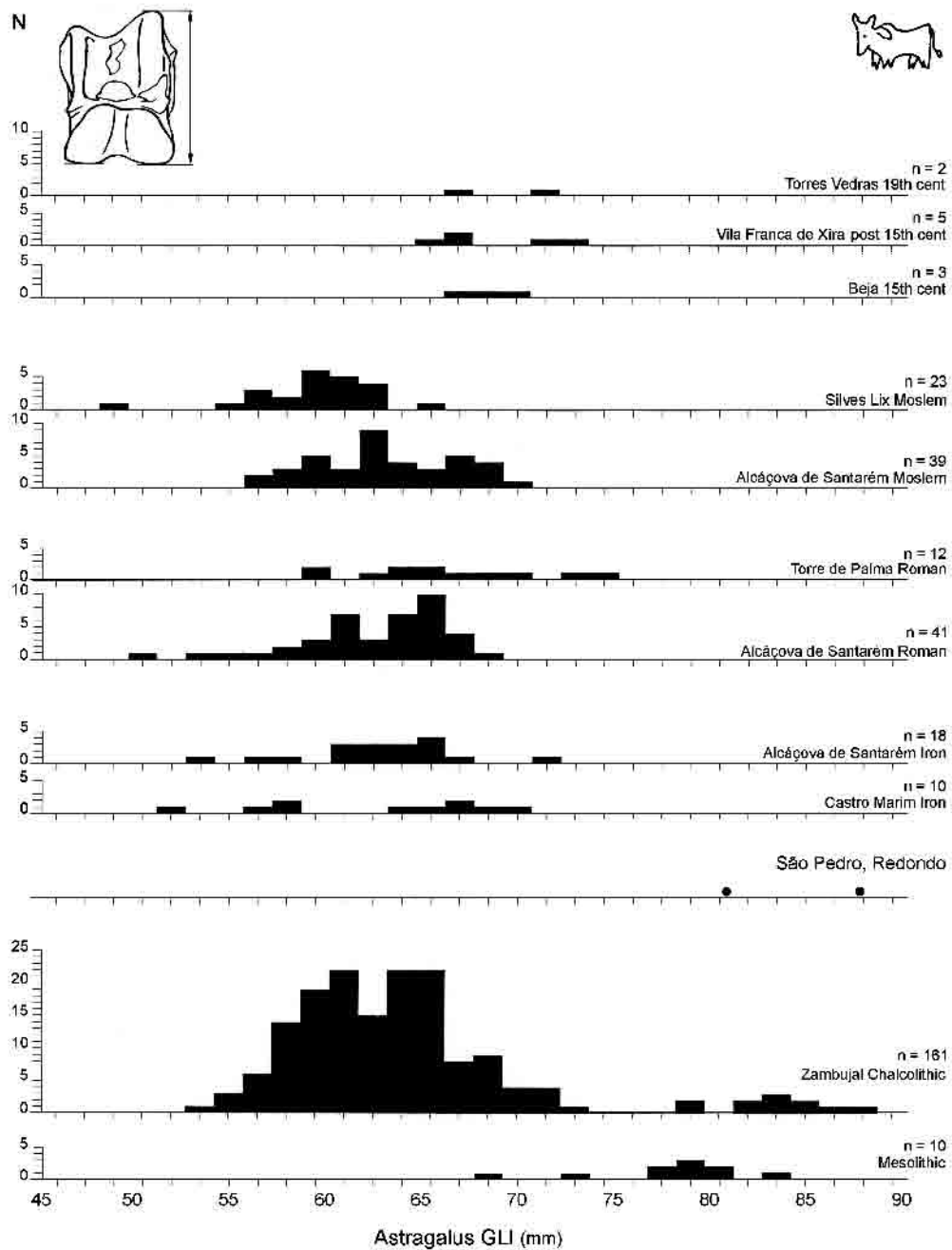
Fig. 6 Osteometric separation of cattle from aurochs, *Bos primigenius*. A series of stacked histograms of *Bos* astragalus greatest lateral length (GLl). These are arranged chronologically with the oldest sites at the bottom and the youngest at the top. The larger specimens that form a separate peak at Zambujal as well as the Mesolithic specimens from Muge (Tagus estuary; Detry, 2007) and Cabeço do Pez in the Sado estuary, are undoubtedly aurochsen while the large sample of smaller astragali from Zambujal that form a separate peak as well as those from Iron Age and later periods are presumably cattle. The two specimens from São Pedro are large and therefore probably belonged to aurochsen. One other interesting point worth noting is the apparent size increase of the aurochsen between Mesolithic and Chalcolithic, indicating that perhaps, like red deer and wild boar, this animal may have been smaller in the Mesolithic.

Equus – *horse*

The equid remains at São Pedro that could be identified to species belonged to horse — *Equus caballus*. Equid species may often be identified on the basis of the pattern of the enamel folds on the biting surfaces of adult cheek teeth in full wear (Eisenmann, 1981). Most of the São Pedro equid lower molars and lower premolars (Fig. 9) have "U" shaped lingual folds. Most, but not all, the lower molars not only have "U" shaped internal (lingual) folds but the external (buccal) folds in the molars (not the pre-molars) have a tendency to partially penetrate between the two flexids.

Fig. 7 São Pedro – domestic versus wild cattle distinction based on size. Fragments of three *Bos* distal metacarpals in anterior view. The single condyle on the left (Sector B; UE: 2674) clearly belonged to a very large animal whose distal width (BFd) is estimated to have measured approximately 84 mm. This large value makes it more likely to have belonged to aurochs (see Fig. 4). The other two distal metacarpal fragments (centre, Sector B; UE: 1465 and right, Sector A; cleaning) are smaller and are two of the three smaller ones plotted in Fig. 4 that are more likely to have belonged to domestic cattle.

Both are horse characters. A near complete mandible with P_3 to M_3 from A/B 2130 (see also Fig. 9) illustrates well these characteristics — note how all teeth have "U" shaped internal folds and while the external fold in both P_3 and P_4 show no penetration, in the three molars there is some clear penetration. The M_2 from B 2849 (a probable $M_{1/2}$) is atypical with a "V" shaped internal fold and no penetration of the external folds. It thus resembles an ass molar but the ass, or its domestic variety the donkey, was supposedly introduced at a much later time into the Iberian Peninsula by the Phoenicians (Uerpmann & Uerpmann, 1973). Given the variability of the patterns of equid tooth enamel folds, this tooth is probably an aberrant horse molar. The upper teeth (also illustrated in Fig. 9) have protocones that are somewhat elongated towards the posterior, another horse character.

Southern Europe was once inhabited by a small species of equid, the so-called Otrantine ass or *Equus hydruntinus,* first described by Ettore Regalia in 1907 from a cave in Apulia, southern Italy (see also Stehlin & Graziosi, 1935). *Equus hydruntinus* had characteristic zebra-like teeth in which the

Fig. 8 São Pedro – two large bovid astragali in plantar view. The one on the left which is well preserved is from Sector A; UE: 2368. The fragmented one on the right is from Sector B; UE: 2909. These are the two *Bos* astragali whose measurements are shown in Fig. 6. Both are clearly very large and the larger of the two *certainly* aurochs while the smaller is *probably* aurochs.
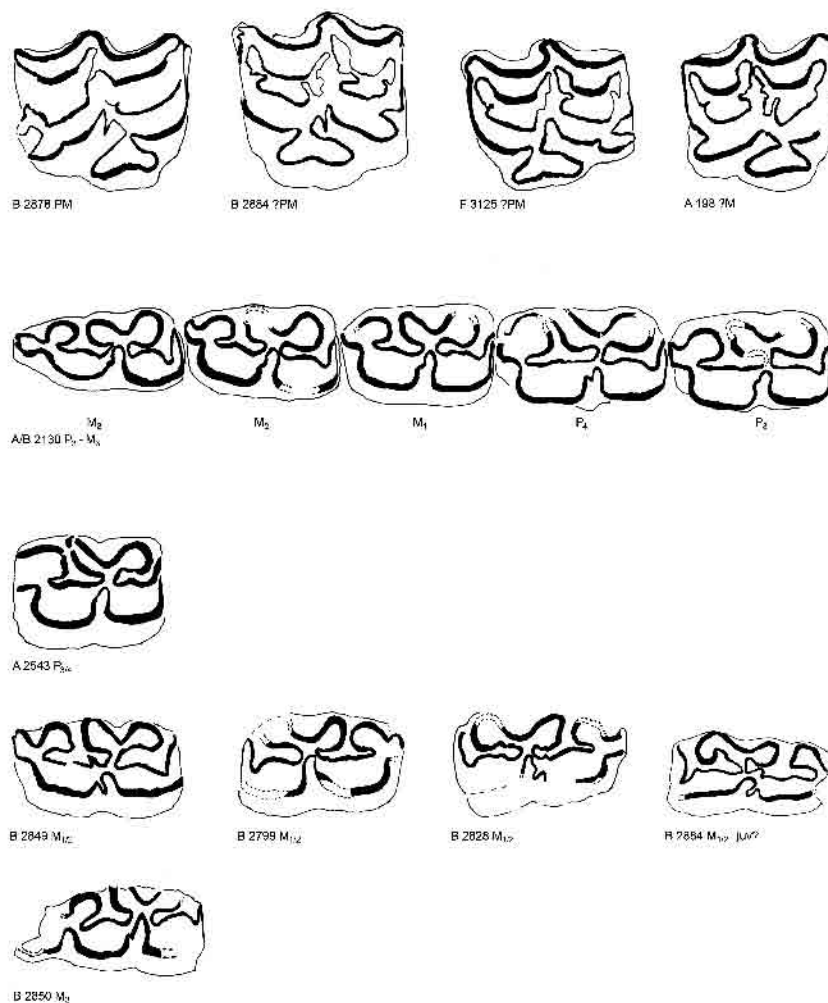
Fig. 9 Identification of 11 lower molar and premolar teeth and four upper teeth of equids from São Pedro via the pattern of enamel folds on their occlusal surfaces. These are arranged in rows from top to bottom as follows:

Upper teeth: note the posteriorly elongated protocone — a horse character.

A lower tooth row probably from the same mandible with P_3 to M_3 from A/B 2130. Note the "U" shaped internal fold in all teeth and the partial penetration of the external fold in the three molars but not in the two premolars.

A premolar.

Four molars. The one on the left has ass-like characteristics with a "V" shaped internal fold and no penetration of the external fold, and three molars with horse-like enamel folds.

A fragmentary horse third molar with "U" shaped internal fold and partial penetration of the external fold.

It is most probable that a single species of equid is represented — the horse. See appendix table 4 for measurements.

lingual folds of the lower teeth are "V" shaped and the buccal folds in the molars (but not pre-molars) penetrate completely (and not partially as in the horse) between the flexids often touching the lingual fold. Cardoso (1995) describes two upper molar teeth from Pedreira das Salemas (Loures, near Lisbon) dating to the "late Würm", which, on the basis of their small size, he identifies as *E. hydruntinus*. This species of equid is also reported from three sites in Spain (Geraards, 1997). No teeth that can be assigned to this small equid were found at São Pedro. A plot of the shaft width (SD) versus the relative distal width (BFd/GL) of equid proximal phalanges (see Fig. 7 in Davis & *alii*, 2008) provides a reasonable separation of horse from other equid taxa such as ass, half-ass and *Equus hydruntinus*. A poorly preserved equid proximal phalanx from São Pedro plots out among the horse phalanges (Fig. 10). It appears then that the only species of equid present at São Pedro was horse.
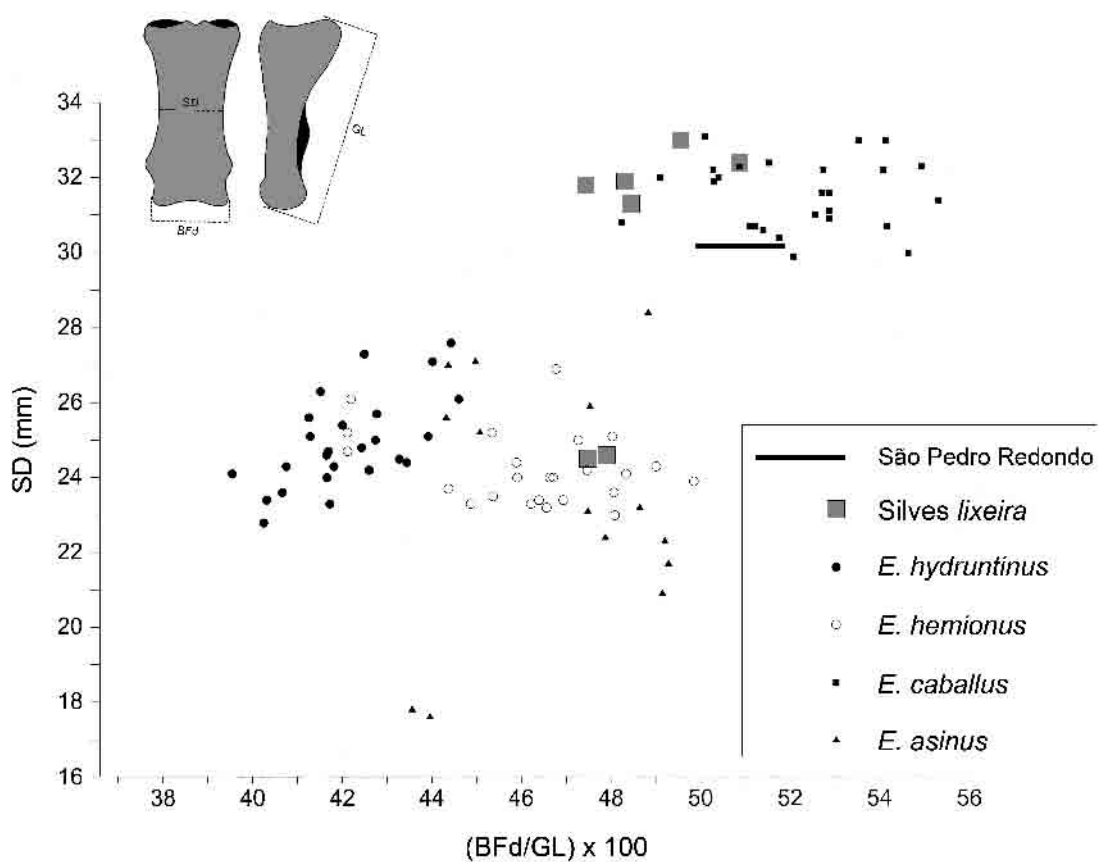
Fig. 10 São Pedro – osteometric identification of a damaged proximal equid phalanx indicating that it probably belonged to a horse. This is a scatter diagram of plots of the minimum shaft width (SD) *versus* an index: the distal width measured across the articulation (BFd) divided by the greatest length (GL). This scatter plot separates horse phalanges from those of asses/half asses and the extinct *Equus hydruntinus*. For comparative measurements see appendixes I & II in Davis & *alii* (2008). Note that while the SD value (30,1 mm) of the São Pedro specimen could be accurately measured, GL could only be estimated to lie between 49,9 and 51,9 mm. Hence it is plotted as a line rather than a point, but clearly it belonged to a horse.

The measurements of their bones are given in Appendix Table 2. Given the difficulty of distinguishing between wild and domestic horse remains it is not possible to determine whether the São Pedro horse was wild or domestic. Wild horses were once common throughout Europe and Asia, but only survived until recent times in central Asia and possibly in the Iberian Peninsula. The Iberian wild horses may have formed a relict population. Therefore the horse could have been independently domesticated in Iberia or at least it could have played some genetic role in the evolution of

the domestic horse (i.e., there could have been interbreeding between introduced domestic horse and these wild Iberian horses). It is this possibility that genetic studies of modern horses appear to support. Thus Warmuth & *alii* (2011) found that geographic variation in gene diversity and allelic richness reveals two hotspots, one in the Caspian region and one in the Iberian Peninsula — both areas with considerable expanses of open habitat in the Holocene.

Capreolus capreolus – *Roe deer*

Several small cervid bones could be identified as roe deer. These include a distal humerus (Fig. 11), a distal metacarpal (Fig. 12) and a middle phalanx (Fig. 13). This species of deer usually inhabits woodland and forest and is considered to be a certain indicator of forest conditions. Hence its occurrence at São Pedro must indicate the presence of woodland and forest in the environs of the site. This would also explain the large numbers of red deer, another woodland species, as well as the low numbers of sheep — an animal generally associated with open grasslands.

Fig. 11 São Pedro – distal part of a roe deer humerus (Sector B; UE: 2898) in anterior view. Note the laterally 'compressed' trochlea which appears somewhat tri-angular — i.e., the medial part of the trochlea is considerably deeper than the lateral part. This is typical of the cervids and contrasts with the shape of the trochlea of many bovids.

Fig. 12 São Pedro – distal part of a roe deer metacarpal (Sector B; UE: 2674) in anterior and plantar view. Note the short condyles which are also antero-posteriorly deep.

Fig. 13 São Pedro – middle phalanx of a roe deer (UE: 2994) viewed from all sides and from above and below.

Lynx pardinus – *Iberian lynx*

Two large felid bones, a distal humerus fragment (Fig. 14) and a distal tibia (Fig. 15), are both identified as having belonged to the lynx.

Fig. 14 São Pedro – distal part of a small portion of a badly damaged large felid humerus (Sector B; UE: 2674) in lateral and medial views, identified as lynx.

Fig. 15 São Pedro – distal part of a large felid tibia (Sector A; EU: 54) in all six views, identified as lynx.

Other

A carpometacarpal fragment of a large bird from Sector B, UE 2560 is unfortunately too damaged and fragmented to enable its identification to species. Given its size, it must have belonged to a bird the size of a bustard, swan or vulture.

Numbers of finds and taxa recognised

697 teeth and bones of mammals of size equal to, or greater than, a rabbit were recorded. These belonged to a total of 11 taxonomic groups (sheep and goat, wild boar and pig, and aurochs and cattle, each being treated as single taxa). It is logical to assume that the number of species identified in a site increases in some way as sample size increases. A study of 107 archaeological assemblages in Europe and the Near East indicates that in those containing between one and 10 000 recorded bones of mammals of size equal to or greater than a rabbit, there is a more-or-less straight-line relation between the decimal logarithm of the 'number of bones recorded' and the 'number of taxa found' (Fig. 16; and see Fig. 2 in Davis & Moreno, 2007) although in fact the theoretical relationship for any given assemblage turns out not to be linear (Davis & Watson, in preparation). With 697 (whose logarithm is 2,84) mammal bones belonging to 11 medium to large mammal taxa,

the plot for São Pedro is little different from other archaeological faunal collections in Europe and the Near East. Put another way, in terms of species richness there is little that is extraordinary about the São Pedro collection.
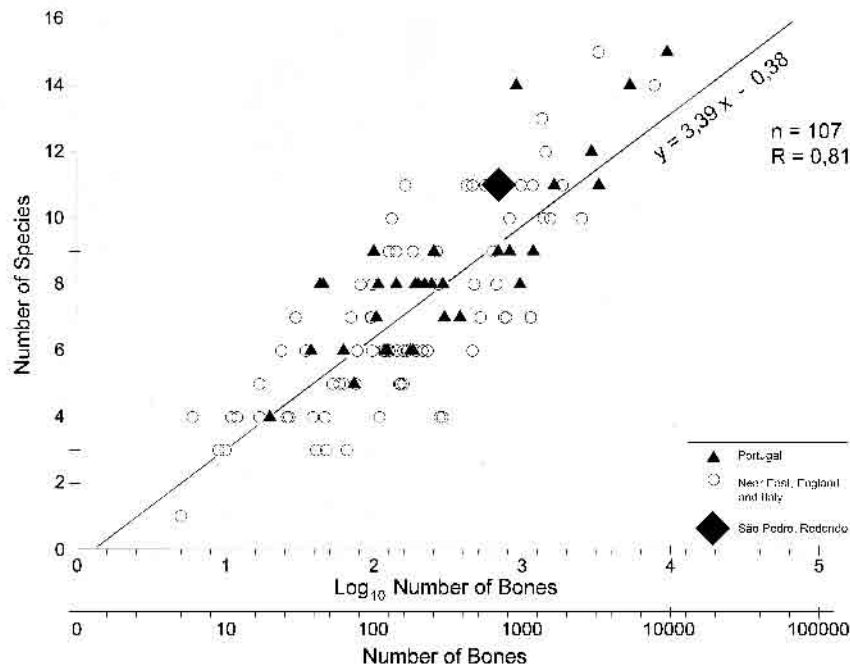

Fig. 16 Taxonomic diversity of the São Pedro fauna compared to other zooarchaeological collections (from Davis & Moreno, 2007). A plot of the number of mammal species (of size equal to or greater than a rabbit) against the decimal logarithm of the number of mammal (of size equal to or greater than rabbit) bones identified to "species" level from 107 archaeological sites/levels in Europe and the Near East studied using the recording method described in Davis (1992, 2002) and similar to the method described by Watson (1979). Faunal assemblages from Portugal are shown as filled triangles and sites from the Near East, Italy and England are shown as open circles. The numbers of bones range from 5 to 9673 and the numbers of species range from 1 to 15. The regression of $N_{species}$ on $Log_{10} N_{bones}$ is y = 3,39x + 0,38 (r = 0,81). Note the plot for São Pedro, shown as a filled diamond, lies fairly close to the line indicating that this assemblage is not especially remarkable in terms of its richness of medium and large-sized mammalian species.

Size variation – were mammals smaller in Mesolithic times and was this due to stress?

Among the many factors that biologists cite, which may influence the size of wild mammals, we can list temperature, food abundance during growth, isolation, inbreeding depression, and over-hunting. In zooarchaeology we also have to take into account age-at-death of the animals we are measuring and, when calculating average size, the sex ratio of animals in the sample. A small collection of Mesolithic red deer bones compared to red deer from the late Pleistocene of Caldeirão cave (Davis, 2002) and Holocene Portugal indicated that the Mesolithic red deer was unusually small — a size diminution that could reflect over-hunting of this large mammal at that time. For example decrease in the body size of wild boar in Białowieża Forest in Poland was considered by Miłkowski & Wójcik (1984) as having been caused by a disproportionately high harvest of adults. The red deer bone measurements from São Pedro as well as those measured by Detry (2007) from Mesolithic Muge tend to confirm the small size of the Mesolithic red deer and its size 'recovery' by the Chalcolithic (see Figs. 17 and 18). However, this animal is sexually dimorphic — males are larger than females as demonstrated by the plots in Fig. 19 for modern known-sex skeletons from the Oise, France.
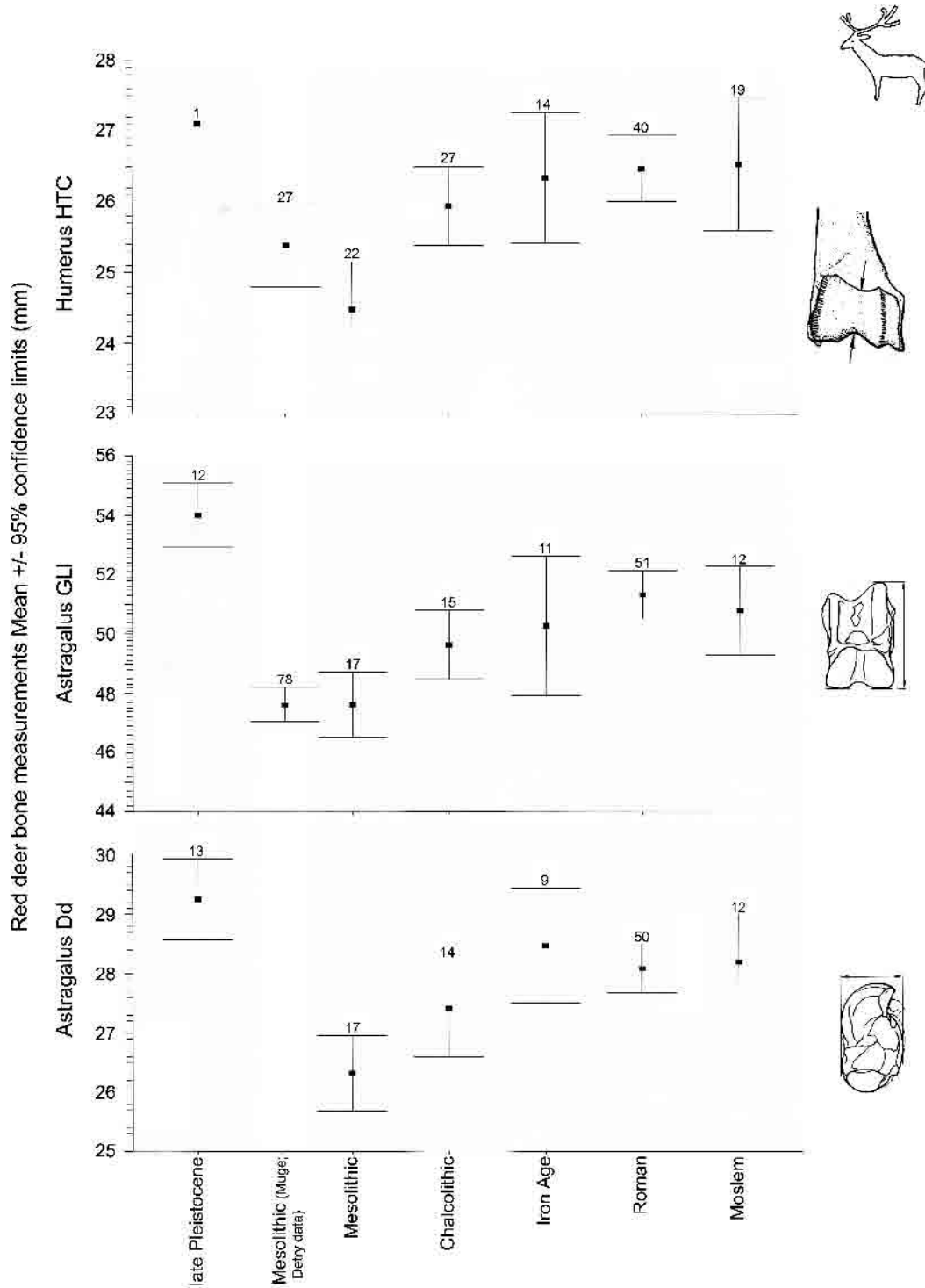
Fig. 17 Size variation of the late Pleistocene and Holocene red deer in southern Portugal. These are arranged chronologically from left to right. The means (denoted by a solid box) ± the 95% confidence limits (the vertical line) of the means of measurements of samples of late Pleistocene, and Holocene red deer from various archaeological sites in southern Portugal. The measurements are humerus HTC (the minimum diameter of the trochlea), astragalus GLl (greatest lateral length) and astragalus Dd (depth of the lateral side). Sample sizes are denoted at the top of each bar. All specimens except those from Muge (from Detry, 2007) were measured by SD. Note the small size of the Mesolithic specimens, indicating that like the aurochsen and wild boar, red deer were smaller in Mesolithic times. The size of the red deer had apparently recovered by the Chalcolithic.

This sexual size dimorphism, as in many artiodactyls in which the male carries heavy secondary sexual organs like antlers on its head, is more marked in the bones of the fore-limb (Fock, 1966; Higham, 1969; Berteaux & Guintard, 1995). Are the small Mesolithic red deer mainly females? The answer is probably not since the plots of the two measurements taken on the humerus trochlea (BT versus HTC) show that the range of these measurements for the Mesolithic is as great as in the samples from the other periods. And as Table 5 shows, the coefficients of variation (CV) of humerus BT and HTC of all the archaeological samples are similar to the CV of a mixed sex sample from present day Oise, France and these are all considerably greater than the male-only or female-only samples from the Oise. If one sex only were present in the sample then the degree of dispersion of the measurements would be smaller and it is not. Thus it is unlikely that the small average size of Mesolithic red deer is due to their having belonged to females only. Both sexes appear to have been present in all these samples.

Table 5. Coefficients of variation 'V' (= 100.sd/mean) for red deer humerus BT and HTC to show that all archaeological samples probably comprised both males and females		
Locality; period or site	**Coefficients of variation 'V'**	
	Humerus BT	**Humerus HTC**
Oise, France; Modern (both sexes)	5,7	5,7
Oise, France; Modern (males only)	*3,5*	*4,8*
Oise, France; Modern (females only)	*4,3*	*4,2*
Portugal; Moslem	8,3	7,3
Portugal; Roman	7,6	5,5
Portugal; Iron Age	8,6	6,1
Portugal; Mesolithic	5,1	6,2
Portugal; São Pedro Redondo	5,9	5,2

The mixed sex modern sample from the Oise has 'V' values of 5,7 while the 'V' calculated for the males and females separately are lower, ranging from 3,5 to 4,8 and the 'V' values for all the archaeological samples are similar to the Oise mixed sex sample.

Not only were the red deer small in the Mesolithic but, as briefly mentioned above, so too were the aurochs and wild boar. Note the smaller size of the Mesolithic *Bos* astragali (these have to be aurochsen as they pre-date the arrival of domesticated cattle in the Iberian Peninsula) when compared to the separate peak of larger *Bos*, identified as aurochsen, on the right-hand side at Zambujal (Fig. 6). Similarly, note the small size of the Mesolithic *Sus* humeri and tibiae from the Mesolithic of Muge. (These too have to be wild animals as they pre-date the arrival here in the Neolithic of domesticated pigs.) Compare them to the "peak" of presumed wild boar at Chalcolithic Zambujal (Fig. 2). Thus it is possible (but with such small samples we need to treat these results cautiously) that red deer, aurochsen and wild boar all underwent a size decrease during the Mesolithic period followed by a subsequent size increase or "recovery" by the Chalcolithic. Other mammals too may have been smaller in the Mesolithic, but we do not yet have sufficient data to verify this. A more precise dating of the recovery may become clearer when Neolithic animal bones from Portugal are studied.

Prior to the introduction of domestic ungulates like cattle, pigs, sheep and goat; the red deer, along with ibex, horse, aurochs and wild boar were the principal sources of meat in Portugal. Why were red deer, aurochs and wild boar small in the Mesolithic? Could this reflect over-hunting as Miłkowski & Wójcik (1984) suggested for Polish wild boar? We know that the period just prior to the change from hunting to domesticating animals was characterised by more severe pressure on wildlife resources. For example marine molluscs had become a major source of food in the Meso-

lithic — hence the *concheiros* or shell midden deposits we find in coastal Mesolithic Portugal. The increased frequency of wild boar bones on Mesolithic sites in Portugal was also noted (Davis & Moreno, 2007) and has been interpreted in terms of increased hunting pressure at that time. The wild boar like the pig is well known for its high reproductive capacity. A wild boar sow can produce litters as large as 12 (Dewey & Hruby, 2002). This animal would therefore be better able to withstand increased hunting than would the slower reproducers like aurochsen, horse and red deer. Hence as hunting pressure increased we would expect to see within the archaeological faunal succession a chronological shift from slow reproducing animals to fast reproducers like the wild boar. Surovell (1999) simulated what can happen to fast reproducing species of game like hares and partridges, and slow ones like the tortoise, as predation pressure rises due to increased occupation density and population. He found that the faster reproducers increase in number in the archaeological record while the slower reproducers decrease and even become extinct. Detry (2007) notes an increase in the proportion of juvenile wild boar during the Mesolithic which she also suggests was due to increased hunting of this animal, in turn due to a substantial increase in the human population in the Mesolithic. A re-analysis of Portuguese Mesolithic and Neolithic human skeletal remains (Jackes & Meiklejohn, 2004) provides evidence for increased human fertility — perhaps an increase of c. two children per woman, from c. 5 to c. 7, within the Mesolithic. On the basis of other human skeletal evidence they hypothesize a softer diet and a shift to a more sedentary lifestyle. We know from modern examples of newly settled nomads, that sedentism leads to rapid population increase (Sussman, 1972).

A similar line of reasoning may explain the shift from large and medium sized mammals to small mammals, fish and birds and the increased proportion of juvenile gazelles hunted in the Mousterian — Aceramic Neolithic of the southern Levant (Davis & *alii*, 1988; Davis, 1989, 2005) — perhaps similar to what Morales & *alii* (1998) describing the shift to marine resources at Nerja, Andalusia, refer to as the "Tardiglacial paradigm". Was there a food crisis in the Mesolithic of Portugal which brought about a diminution of the red deer, aurochsen and wild boar, led to a shift from red deer to wild boar, altered the age-profile of the wild boar, and forced people to exploit more marine resources — especially molluscs? Did excessive hunting of aurochsen, red deer and wild boar 'drive down' their body size? It is difficult to envisage how this could have happened — perhaps people hunted the larger and older adults leaving the smaller and younger ones to reproduce. The subsequent return to larger size in Chalcolithic (perhaps it already happened in the Neolithic) and later times was due to relaxation of hunting pressure on these animals — people now had domesticated livestock to supply them with the bulk of their meat. An alternative explanation, at least for the red deer, suggested by João Zilhão, is that these variations of animal size are linked to forest density with the denser forests of the Atlantic climatic optimum selecting for smaller red deer body size and a subsequent recovery being related to deforestation and the improvement and enlargement of red deer habitats. Body size of ungulates like the red deer, wild boar and roe deer has been shown to vary with food abundance a factor that may also be related to population density (see Magnell, 2004). Wolverton & *alii* (2009) argue that in the North American white-tailed deer body size as reflected in the dimensions of the astragalus is correlated with the amount of food available per animal. Environmental temperature too can influence the size of mammals (Bergmann, 1847), but there is little evidence for any substantial temperature change between the Mesolithic and the Chalcolithic in southern Portugal. We are of course comparing Mesolithic animals from the Ribatejo with Chalcolithic ones from the Alentejo. One could therefore argue that we are confusing chronological changes with geographical variation. We suspect that this is unlikely given the short distance involved. Did environmental conditions in Mesolithic Portugal deteriorate? Did the

Alentejo become overpopulated with large herbivorous mammals leading to reduced food availability per animal? These questions are difficult to answer at present but clearly size variation of Portuguese red deer, as well as aurochsen, wild boar and other animals is worth further study. Our preferred explanation at this stage is that the larger wild mammals were over-hunted in the Mesolithic, but by Chalcolithic times, with abundant domesticated livestock to furnish people with sufficient animal protein, hunting pressure was relaxed and these mammals then recovered their former size.

There is now some evidence that a post-Mesolithic size increase in certain large mammals happened elsewhere too. In their discussion of wild boar in England, Albarella & *alii* (2009) write "… we are left with the impression that British Mesolithic pigs were particularly small and that size increase did occur in later periods." They also mention that there may have been a post-Mesolithic size increase of wild boar in Switzerland. And in Italy the evidence is even clearer. Here, according to Albarella & *alii* (2006b), "the clearer separation between domestic pigs and wild boars that we can observe from the late Neolithic onwards is as much a product of a size *decrease* in domestic pigs as it is of a size *increase* in wild boars." The faunal remains from Early Bronze Age Tel Yarmouth in Israel (Davis in prep.) indicate that the aurochs may have become larger in the southern Levant between the Natufian/Pre-Pottery Neolithic B and the Early Bronze Age.

Partially digested bones

Several species of mammal, most notably the dog (and of course its ancestor, the wolf) will swallow small bones. These may remain for a while in the stomach and are either regurgitated or pass through the gut and voided with the faeces. While many bones may suffer complete digestion and therefore disappear, some survive but in a degraded state. They have a characteristic appearance due to the action of digestive juices such as stomach acids and enzymes (see Payne & Munson, 1985). Table 6 gives a listing of such bones found at São Pedro and two; a red deer middle phalanx and a pig astragalus are shown in Fig. 20. Note that they are all small bones that dogs are quite capable of swallowing.

Table 6. A list of "partially digested" bones from São Pedro						
Bone	*Taxon*	*Fusion*	*Sector*	*UE*	*Phase*	*Notes*
Proximal phalanx	*Sus*	F	A	188	5	?Semi–digested
Proximal phalanx	*Sus*	Fv	B	1548	4	
Proximal phalanx	*Sus*	F	B	2849	2	
Astragalus	*Sus*		A	2409	2	See Fig. 20
Astragalus	*Sus*		A	2720	2	
Proximal phalanx	Red deer	F	A	2368		
Middle phalanx	Red deer	F	B	1427		See Fig. 20
Terminal phalanx	Red deer		A	402		
Calcaneum	Sh/G or Sus	U	B	2492	2	Almost unrecognisable

Note they are all relatively small — the kind that dogs are capable of swallowing whole as described in Payne & Munson (1985).

The absence of this kind of damage on larger bones means that we can rule out soil acids as the causative factor. These partially digested bones present within the site presumably reflect the presence in the settlement of dogs — man's oldest friend!

Fig. 18 Scatter diagrams to show the size variation of the late Pleistocene and Holocene red deer in southern Portugal. These are plots of astragalus distal width (Bd) against greatest lateral length (GLl) for samples from various late Pleistocene sites (Caldeirão, Pego do Diabo) and Mesolithic and Chalcolithic (including São Pedro) sites. In the central plot are red deer from Iron Age, Roman and Moslem periods and above are modern male and female red deer from the Oise in France and a small sample from medieval and post-medieval Launceston Castle in Cornwall, England. The absence of any marked sexual size dimorphism in the modern Oise specimens for this bone rules out the possibility that the smallness of the Portuguese Mesolithic red deer is due to a biased representation of females. Indeed the total extension of the cloud of dispersion of the Mesolithic and the Chalcolithic samples is similar to that of the male + female animals from the Oise again suggesting both sexes in the Mesolithic were smaller.

Age at slaughter (Tables 7, 8 and 9)

There are too few teeth to draw detailed inferences concerning the slaughter strategy of the sheep/goat, cattle and pig, although both juveniles and adults are represented.

Table 7. São Pedro – wear stages (following Grant, 1982) of the **cattle** (probably mainly domestic but some wild too) mandibular teeth																		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*j/k*	*k*	*k/l*	*m*	*n*	*o*	*p*	*P*	*Total*
dP_4	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–
P_4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
M_1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
$M_{1/2}$	1	1	–	–	–	–	–	1	–	1	–	2	–	–	–	–	–	2	–
M_2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
M_3	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–

These wear stages extend from teeth just erupted with unworn enamel (*i.e.*, no dentine exposed) in stage "a" to teeth from very old animals with hardly any crown left. "P" includes teeth that could not be assigned to a wear stage.

Table 8. São Pedro – wear stages (following Payne, 1987) of the **sheep/goat** mandibular teeth																											
	0	*1*	*2*	*3*	*4*	*4/5*	*5*	*6*	*7*	*8*	*8/9*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*P*	*Total*
dP_4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	–	–	–	–	–	–	1	4
P_4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	2
M_1	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	3
$M_{1/2}$	–	–	–	–	1	1	–	–	2	1	–	4	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	11
M_2	–	–	–	–	–	–	–	–	1	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
M_3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

These wear stages extend from teeth just erupted with unworn enamel (*i.e.*, no dentine exposed) in stage "0" to teeth from very old animals with hardly any crown left. "P" includes teeth that could not be assigned to a wear stage.

Table 9. São Pedro – wear stages (following Grant, 1982) of the *Sus* (probably mainly pig but some wild boar too) mandibular teeth																
	a	*a/b*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*P*	*Total*
dP_4	1	–	–	2	1	–	–	1	–	–	1	–	–	–	–	–	6
P_4	1	–	1	–	–	–	3	–	–	–	–	–	–	–	–	–	5
M_1	3	–	–	–	–	1	2	2	1	–	–	–	–	1	–	–	10
$M_{1/2}$	4	–	–	1	1	1	1	–	1	–	2	–	1	–	–	–	12
M_2	1	–	–	2	4	1	1	–	–	–	–	–	1	–	–	–	10
M_3	8	1	4	3	1	1	–	–	–	–	1	–	–	–	–	–	19

These wear stages extend from teeth just erupted with unworn enamel (*i.e.*, no dentine exposed) in stage "a" to teeth from very old animals with hardly any crown left.

Evidence for rapid burial

Animal bones found on archaeological sites are not only butchered and therefore fragmented, but generally disarticulated. It is not generally possible, for example, to re-articulate a distal humerus with its corresponding proximal radius, or a distal tibia with its corresponding tarsal and metatarsal bones. When bones of a limb are found in articulation these may be interpreted as representing
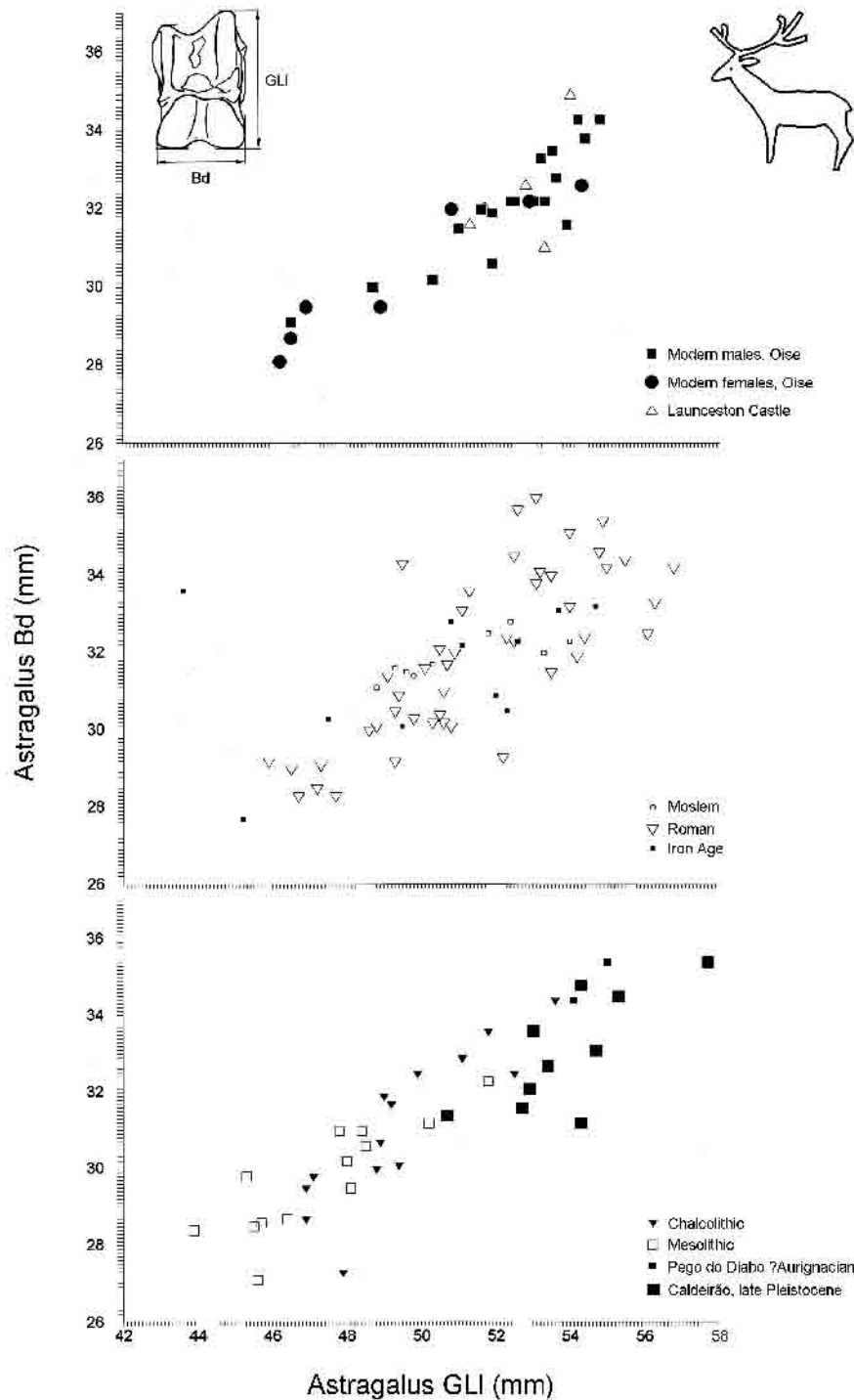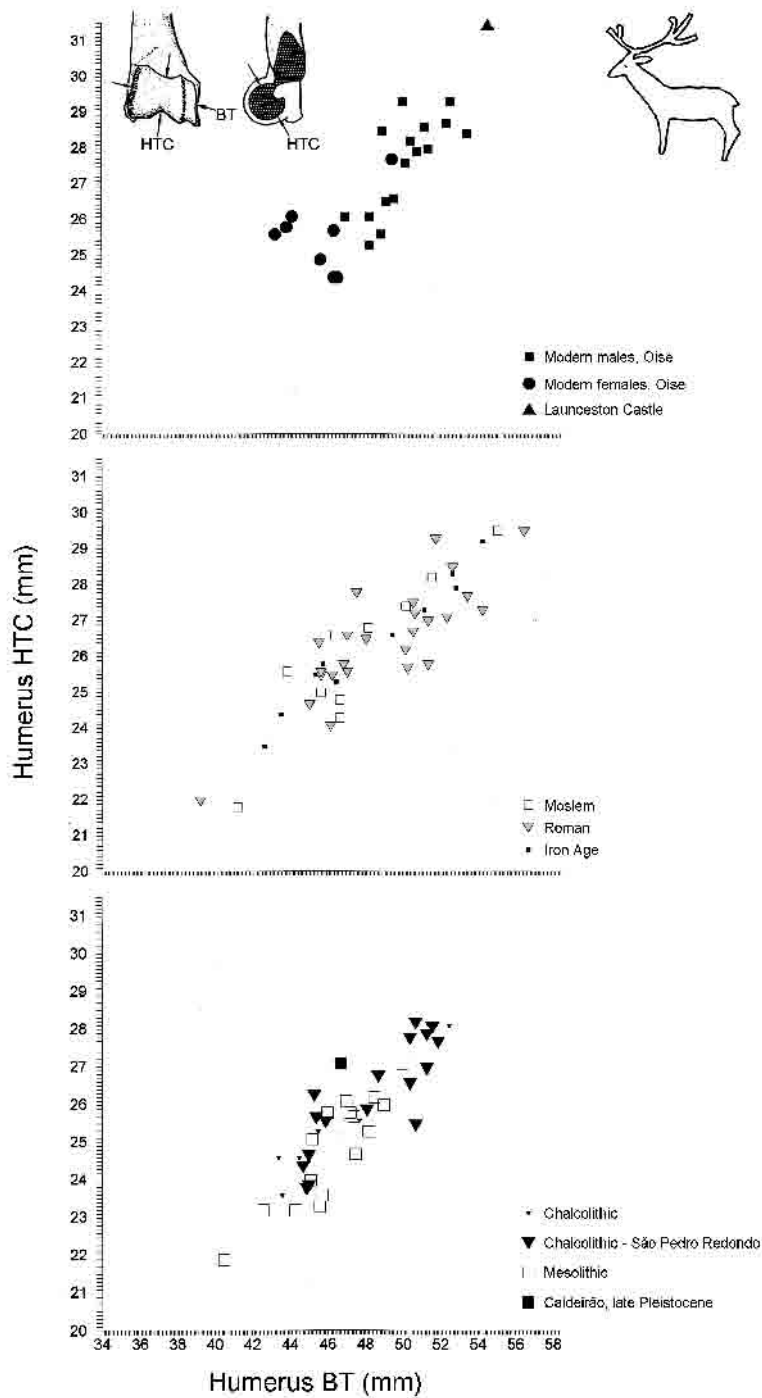
Fig. 19 Scatter diagrams to show the size variation of the late Pleistocene and Holocene red deer in southern Portugal. These are plots of the minimum diameter of the humerus trochlea (HTC) against the trochlea width (BT) for samples from various sites in southern Portugal. The lower graph includes the late Pleistocene of Caldeirão, Mesolithic sites, Chalcolithic sites, and São Pedro. Note the small size of the Mesolithic specimens. In the central plot are red deer from Iron Age, Roman and Moslem periods. The upper graph shows modern male and female red deer from the Oise in France. Apart from one very large female (perhaps an error?) the humerus appears to be markedly sexually dimorphic with males larger than females. The total extension of the cloud of dispersion of the male + female Oise specimens is similar to that from the Portuguese Mesolithic and all the other well represented periods here. This tends to argue against the idea that the small size of the Mesolithic red deer was due to their consisting primarily of females.

either a deliberate burial of the limb in question or their rapid burial. Another exception of course is the ritual burial of a whole animal such as dog or horse. In sector F, UE 3121, the following adult red deer hind-limb bones are identified: a distal tibia, astragalus, calcaneum, cubo-navicular and a proximal metatarsal. They all articulate with one another and therefore probably derive from the same limb. In life these bones are admittedly well attached to one another via a tight network of ligaments. However after death these ligaments would normally soon deteriorate and the bones would become separated and scattered or removed by dogs. The survival of the bones in UE 3121 indicates that they became incorporated fairly rapidly within the archaeological deposit. This could be evidence for the site's intensive occupation with rapid accumulation of organic debris.

Parts of the skeleton represented

Table 1 shows that for the medium to large-sized animals all parts of the skeleton are represented. There is little evidence, in any of the taxa, for any preferential preservation or selection of any specific part of the body.

Some further thoughts on faunal remains from Chalcolithic sites

As already mentioned, the scarcity of detailed published descriptions of zooarchaeological remains from 3rd millennium BC Portugal, especially the Alentejo, makes it difficult to draw many reasonable overall conclusions. Our speculations here are offered in the hope that future studies may help improve our understanding of this relatively recent period of our Prehistory.

Fig. 20 São Pedro – partially digested bones. On the left – a second or middle phalanx of a red deer (Sector B; UE: 1427), and on the right a pig astragalus (Sector A; UE: 2409) in plantar and lateral views. Note the pitted surface and partly 'dissolved' extremities. This kind of degradation is typical of bones that have been through an animal's gut and is presumably due to the combined effect of stomach acids and digestive enzymes (see Payne & Munson, 1985). It may have been caused by a dog.

Clearly São Pedro was a small community consisting of a few dozens of inhabitants who lived for the most part in this fortified settlement situated not too far from Serra d'Ossa (altitude 650 m).

Sites of a similar size and from similar environments as São Pedro in the south-western part of the Iberian Peninsula have different faunal compositions. Examples include the fauna of Monte da Tumba, which unlike São Pedro, derives mainly from domesticated animals (Antunes, 1987), and the extensively fortified settlements of Leceia (Cardoso & Detry, 2002), Zambujal (Driesch & Boessneck, 1976) and even the smaller Penedo do Lexim (Sousa, 2010, p. 361) also all have predominantly domesticated animal faunas.

One site that is similar to São Pedro in terms of its faunal composition is the small fortified settlement of La Junta de los Ríos in the Sierra de Huelva, which is also dominated by wild animals (Nocete, 2008). Like São Pedro, this site is also situated near mountains. Was it similar in terms of its economy and social profile?

The large settlements in the southern Iberian Peninsula, usually characterised by pits and situated in lowland areas, seem, since the end of the 4th millennium BC, to have faunas derived predominantly from domesticated animals. Examples include Papa Uvas (Martín, 1985, 1986), Perdigões (Costa, 2010), Valencina de la Concepción (near Seville; Abril & *alii*, 2010) and the early phases of Porto Torrão (Arnaud, 1993).

Despite the scarcity of data to hand we offer a few ideas. We note a tendency for sites with ample pit installations and situated in lowland areas, to be those whose faunas are predominantly derived from domesticated animals — perhaps settlements that could easily accommodate their flocks — in contrast to settlements situated in highland areas, or fortified and small — perhaps related to the need to both survey the surrounding territories as well as a certain degree of mobility. Nonetheless even these settlements had to rely to some extent upon domestic production as is indicated by the presence of caprines, pigs and domestic cattle.

In sum we suggest that in much of the south-western Iberian Peninsula the larger lowland settlements situated on good soils are more likely to have relied on agriculture and domesticated flocks while the smaller highland settlements, often more ephemeral, relied to a lesser extent upon their flocks.

Other, perhaps less prosaic, interpretations of the data can be made. One could perhaps link hunting with ceremonial activities. But for the time being we prefer to avoid these more complicated lines of thinking.

Conclusions and summary

The almost 700 identifiable remains of mammal bones and teeth recorded from São Pedro derived from 11 taxa — a 'number of bones' versus 'number of taxa' relation similar to that observed on other archaeological sites in Europe and the Near East. Of these, *Sus* (pig/wild boar) is, as in most Chalcolithic sites, the most common taxon. At São Pedro, but unlike many contemporary sites like Zambujal, Leceia and Penedo do Lexim, *Sus* is followed closely by red deer. Sheep and goat, it seems, only played a relatively minor role in the economy at São Pedro. The abundance of red deer may be more characteristic of Chalcolithic sites to the east and in the interior of the Iberian Peninsula. São Pedro was a fortified settlement and we wonder if its military nature might in part explain the abundance of wild (hunted) animals. Another explanation for the variation in frequencies of sheep and goat versus red deer on Chalcolithic sites may be variation in the density of human population — with densely inhabited settlements obtaining the bulk of their meat from domestic animals while

sparsely inhabited and small settlements could afford the luxury of relying more on hunting. On osteometric grounds it is clear that, as at other contemporary sites, most of the *Sus* remains belonged to pig while a small proportion belonged to its wild relative the wild boar. Measurements of several *Bos* bones from São Pedro indicate the presence of both cattle and its wild relative the aurochs (*Bos primigenius*). The equid teeth and a fragmentary proximal equid phalanx all indicate the presence of horse (*Equus caballus*). No other equid taxon could be identified. Given the near impossibility of making a wild-domestic distinction in horse bones and teeth, the domestic status of the São Pedro horse is unclear. If indeed wild horses, are these among the last to survive here before the domestic variety was introduced from the east or are these horses from São Pedro the immediate ancestors of our present-day Spanish and Portuguese breeds of horse? An answer to this question may lie in their DNA. The São Pedro red deer, and possibly the aurochs and wild boar measurements plotted along-side those from other late Pleistocene and Holocene sites reveal a substantial size decrease of these animals in the Mesolithic. Just why this happened is unclear but one possibility is that it reflects increased hunting pressure in Mesolithic times as wild game resources, especially the medium and large mammals, became scarce — a problem that also "forced" people to exploit increasing amounts of less worthwhile (in terms of energy expended per kilogram of food obtained) sources of animal protein such as shellfish which would of course explain the abundant remains of shell middens in Mesolithic coastal Portugal.

The detailed descriptions of the São Pedro bones are presented here in the hope that they will prove useful to future zooarchaeological studies of Chalcolithic sites.

Acknowledgements

Appendix

Tax	Bone	Fus	GL	Bd	Dd	BT	HTC	WCM	DEM	WCL	DEL	Phase	Sector	UE	Notes
B	HU	F					432					4	B	693	
B	MC1	F		711	371			341	281	334	259		A		cleaning
B	MC1	F		715	377			344	266	340	277	4	B	1465	Dd = approx
B	MC1	UE		690	367			323	278	321	264	4	B	82	
B	MC2	F								391	315	2	B	2674	Estimated BFd = 840; aurochs
B	MC2	F						348	300			2	A	2351	MED/LAT WCM = approx
B	TI	F		747								2	B	2884	Aurochs?
B	TI	UE		611								2	B	2746	
B	CA	F	1200									2	B	2884	
B	AS		809	511	448								A	2368	
B	AS		878	619	497								B	2909	Dd = approx; aurochs
B	MP2	UE								327	278	2	B	2849	BFd = 680-700
CAC	HU	F				257	159					2	B	2898	Definite roe deer
CAC	MC1	F		216	138			99	101	94	96	2	B	2674	
CAC	TI	F		220									B	2799	CAC?
CAC	TI	F		224									4	B	1550	CAC?
CAH	CA	F	578									1	A	2798	
CAH	AS		278	173	142							2	A	2732	
CAH	AS		289	168	152								D	402	Definite goat
CAH	AS		290	171	152							2	A	382	Definite goat
CAH	AS		299	174								2	A	2635	
CAH	AS		299	195	168							2	A	2743	
CEE	HU	F					248					2	B	2884	HTC = approx
CEE	HU	F					255					1		2137	
CEE	HU	F					258					2	B	2838	
CEE	HU	F					266					2	B	2849	
CEE	HU	F				447	244					2	B	2674	
CEE	HU	F				449	238					4	A	178	
CEE	HU	F				450	239					1		2137	BT = approx
CEE	HU	F				450	247					4	B	1543	
CEE	HU	F				453	263					4	B	1550	
CEE	HU	F				454	257						A	211	
CEE	HU	F				457	266					3	A	404	
CEE	HU	F				459	256					2	B	2850	
CEE	HU	F				481	259					2	A	2635	
CEE	HU	F				487	268					2	B	2828	
CEE	HU	F				504	266						B	546	
CEE	HU	F				504	278					4	B	1543	BT = approx
CEE	HU	F				507	255					2	B	2912	
CEE	HU	F				507	282					4	B	1543	BT = approx

Table title: **Appendix Table 1. São Pedro – measurements in tenths of a millimeter of the animal bones excluding equids**

Tax	Bone	Fus	GL	Bd	Dd	BT	HTC	WCM	DEM	WCL	DEL	Phase	Sector	UE	Notes
CEE	HU	F				513	270					4	B	1557	
CEE	HU	F				513	279					2	B	2951	
CEE	HU	F				516	281					5	A	188	both msmnts approx
CEE	HU	F				519	277					2	A	373	
CEE	MC1	F		327	217			149	150	157	154	4	A	1657	bone tool
CEE	MC1	F		370				169	163	190	182	4	A	65	
CEE	MC1	F		372	240			177	181	174	168	2	A	2484	
CEE	MC1	F		372	250			173	184	166	172	5	F	3006	
CEE	MC1	F		394	255			180	179	180	175	2	F	3133	
CEE	TI	F		393								4		82	
CEE	TI	F		395								2	E	2849	
CEE	TI	F		396								4	B	1427	
CEE	TI	F		403								2	B	2898	
CEE	TI	F		404								2	A	2351	
CEE	TI	F		405								4	F	3079	
CEE	TI	F		410								2	A	2458	
CEE	TI	F		412								2	B	2951	
CEE	TI	F		416									B	2878	
CEE	TI	F		421								4	A	274	
CEE	TI	F		426								4	B	664	
CEE	TI	F		429								4	B	1329	
CEE	TI	F		436								2	A	2484	
CEE	TI	F		441								2	A	2743	
CEE	TI	F		443								2	B	2910	
CEE	TI	F		445								4	B	664	
CEE	TI	F		445								4	B	693	
CEE	TI	F		447								4	A	65	
CEE	TI	F		447								4	A	274	
CEE	TI	F		448								4	B	1543	
CEE	TI	F		452								4	B	765	Bd = approx
CEE	TI	F		453								2	B	2828	
CEE	TI	F		458									F	3121	
CEE	TI	F		459								2	B	2850	
CEE	TI	F		459								5	F	3006	
CEE	TI	F		461								6-mod	A	158	
CEE	TI	F		473									F	3117	
CEE	TI	F		476									F	3105	
CEE	TI	UE		450								5	F	3006	
CEE	CA	F	863									2	B	2962	
CEE	CA	F	951									2	B	2884	
CEE	CA	F	965									4	B	1550	
CEE	CA	F	972										B	2734	
CEE	CA	F	976										F	3121	
CEE	CA	F	984									2	B	2746	

Tax	Bone	Fus	GL	Bd	Dd	BT	HTC	WCM	DEM	WCL	DEL	Phase	Sector	UE	Notes
CEE	CA	F	990									4	B	82	
CEE	CA	F	1007									2	A	2380	
CEE	CA	F	1009										B	2878	
CEE	CA	F	1010									2	B	2885	
CEE	CA	F	1058										A	211	GL = approx
CEE	CA	F	1096									4	B	693	
CEE	AS		469	287	265								A	211	
CEE	AS		469	295	256							2	A	2543	
CEE	AS		471	298								4	B	1539	Bd = approx Dd = 250–260
CEE	AS		479	273	250								F	3089	Bd & Dd = approx
CEE	AS		488	300	267									2994	
CEE	AS		489	307	265							4	B	693	
CEE	AS		490	319	268							4	B	706	Dd = approx
CEE	AS		492	317	272								A	211	GL = approx
CEE	AS		494	301	272							2	B	2912	
CEE	AS		499	325	285								F	3121	
CEE	AS		511	329	279								F	3116	
CEE	AS		516		287								B	2941	CEE?
CEE	AS		518	336	282							4	F	3073	
CEE	AS		525	325	285								A	2790	
CEE	MT1	F		351	230							2	B	2980	Bd & Dd approx
CEE	MT1	F		359	252							2	B	2828	
CEE	MT1	F		378	240								B	2799	Dd = approx
CEE	MT1	F		384	259							5	F	3006	
COP	HU			129								2	B	2524	*Columba palumbus*
Lynx	TI	F		228									A	54	Bd = approx
O	HU						166					4	B	1543	OVA?
O	HU	F					157					1	A	2569	probably OVA
ORC	HU	F		79			37					3	SC	2117	Prox = U
ORC	HU	F		81			38					4	B	1298	
ORC	HU	F		82			38					3	B	2595	
ORC	HU	F		85			41					4	F	3073	
ORC	HU	F		85			40					4	B	1275	feels recent!
OVA	HU	F				277	136					1	A	2568	OVA?
OVA	MC1	F		251	161			117	108	120	114	2	A	2321	
OVA	AS				170							2	A	2720	Definite OVA
OVA	AS		284	168	162									2928	Dd = approx OVA?
OVA	MT1	F		254	165								B	2935	BFd = approx definite OVA
S	HU	F					169					2	B	23	
S	HU	F					171					4		207	
S	HU	F					185					4	B	1663	
S	HU	F					191					2	B	2910	
S	HU	F					191					4	A	212	

Tax	Bone	Fus	GL	Bd	Dd	BT	HTC	WCM	DEM	WCL	DEL	Phase	Sector	UE	Notes
S	HU	F					198						B	2734	
S	HU	F					210					4	B	626	
S	HU	F					240					2	B	2849	
S	HU	F				269	159					2	A	406	
S	HU	F				269	169						A	2392	
S	HU	F				274	174					2	D	2709	
S	HU	F				290	181					4	B	1472	
S	HU	F				292	172					2	A	2521	BT = approx
S	HU	F				292	182					2	B	2746	
S	HU	F				294	183					2	A	2456	
S	HU	F				294	187					2	F	3133	
S	HU	F				298	180					2	A	346	
S	HU	F				300	185					2	B	2849	
S	HU	F				300	193					2	B	2849	
S	HU	F				305	192					4	A	65	
S	HU	F				306	188					2	B	2884	
S	HU	F				316	192					2	E	2849	
S	HU	F				332	214					4	B	1558	
S	HU	F				344	218					4	B	1550	
S	HU	F				345	202					4	A	274	
S	HU	F				356	225					4	A	226	
S	HU	F				369	207						A	54	
S	HU	UE					176					4		130	
S	HU	UE					206					1	A	2589	
S	HU	UE					211						A	2790	
S	TI	F		272								2	B	2345	
S	TI	F		275									A	213	
S	TI	F		275								2	B	2849	
S	TI	F		278								4	B	1550	
S	TI	F		282								3	B	13	Prox = unfused
S	TI	F		283									B	546	
S	TI	F		293								5	A	206	
S	TI	F		294								2	B	2879	
S	TI	F		300									B	2878	
S	TI	F		307								2	B	2849	
S	TI	F		347									B	2734	
S	TI	F		380									B	2887	
S	TI	Fv		272									B	2919	
S	TI	Fv		304								1	A/B	2130	
S	TI	Fv		315									F	3043	
S	TI	UE		266								2	A	2515	
S	CA	F	732									4	B	1275	
S	CA	Fv	803									2	A	2458	
S	AS		366									2	A	2616	

Tax	Bone	Fus	GL	Bd	Dd	BT	HTC	WCM	DEM	WCL	DEL	Phase	Sector	UE	Notes
S	AS		386										A	2368	
S	AS		390									2	A	2456	GL = approx
S	AS		395									2	B	2492	
S	AS		395									2	E	484	
S	AS		397									2	A	2484	
S	AS		399									4	B	1474	
S	AS		403									4	B	82	GL = approx
S	AS		417									2	B	2884	
S	AS		418									2	A	2749	
S	AS		422									2	B	2910	
S	AS		469										B	2878	
S	AS		517									4	F	3068	huge!

Key: Fus = state of epiphysial fusion (F fused, UE unfused, Fv fused but with suture still visible). Bones are as follows: HU – humerus, MC1 - metacarpal with both condyles, MC2 - metacarpal with a single condyle only, TI – tibia, CA - calcaneum, AS - astragalus, MT1 - metatarsal with both condyles, MP2 - metapodial (i.e., either metacarpal or metatarsal) with a single condyle only. The taxa are: B – *Bos taurus/primigenius* cattle/ aurochs, CAC – *Capreolus capreolus* roe deer, CAH - *Capra hircus* goat, CEE - *Cervus elaphus* red deer, O – sheep or goat, ORC – *Oryctolagus cuniculus* rabbit, OVA – *Ovis aries* sheep, S - *Sus* pig/wild boar, COP - *Columba palumbus* wood-pigeon. Measurements follow Driesch (1976) and Davis (1996). Approximate measurements are noted in the "notes" column. For metapodials, Bd = BFd; and for astragali, Dd = Dl.

Bone	Tax	Fus	GL	Bp	Bd	GH	LmT	GB	Dd	DEM	DEL	SD	Sector	UE	Phase	Notes
MC?	Equid	F			c. 440				339				B	701	3	
TI	Equid	F			700								B	2849	2	
TI	Equid	UE			est. 630–660								A	274	4	
AS	Equid				503	562	589	589					B	2966	2	
AS	Equid				est. 560–590	543	568	585					B	2697	2	
AS	Equid				505	588	580	582					A	2351	2	
AS	Equid				493	520	551	546					B	2828	2	
AS	Equid				447	529	522						B	2914	2	
AS	Equid				434	527	547	556					B	2849	2	
MT	Horse?	F			451				352	275	264		B	2849	2	
MT	Equid	F			est. 450–460				362	270	263		A	2351	2	
MP	Equid	F			453				354				B	1543	4	
MP	Equid	F			453								B	87	5	probably MT
P1	Horse?	F	est. 750–780	est. 470–520	389				222			301	B	1502	4	
P1	Equid	F										331	B	1543	4	both ends broken

Appendix Table 2. São Pedro – measurements in tenths of a millimeter of the equid bones

Key: Fus = state of epiphysial fusion (F fused, UE unfused). Bones are labeled as follows: MC - metacarpal, TI – tibia, AS - astragalus, MT - metatarsal, MP - metapodial (i.e., either metacarpal or metatarsal), P1 – proximal (first) phalanx. Measurements follow Driesch (1976). Some measurements are given as "est." these are estimates between two limits.

Tax	dP_4l	dP_4w	M_1l	M_1wa	M_1wb	M_2l	M_2wa	M_2wb	M_3l	M_3wa	M_3wb	$M_{1/2}l$	$M_{1/2}wa$	$M_{1/2}wb$	ACH	notes	Sector	UE	Phase
CEE											131				186		A	65	4
CEE										131	127				104		B	1663	
CEE									283	139	129				148	ACH = 148	A		
CEE									284	128	113						A	2545	2
CEE									302	130	122				213		B	2879	2
CEE									303	138					107	l.M$_1$-M$_3$ = 704 but senile	B	2879	2
CEE									322	141	131				169		B	2914	2
CEE									333	144	131				124	l.M$_1$-M$_3$ = 747		2137	1
S												143	92	94		Prob. M$_1$	A	54	
S												151	107	113		Prob. M$_1$	A	2456	2
S												160	112			Prob. M$_1$	B	664	4
S												162	99	103		Prob. M$_1$	A	2589	1
S												211	129	124			A	2568	1
S												211	132				A	2439	2
S												215	135	138			F	3043	
S												219	133	135		Prob. M$_2$	B	2849	2
S											124						B	82	4
S										148							A	346	2
S									311	143	140						A/B	2130	1
S									326	161	146						B	170	4
S									332	162	144						A	121	4
S									336	152	150					fully formed with enamel	A	274	4
S									338	166	142						A	2515	2
S									342	150	151						SC	2117	3
S									344	148	155						B	2464	2
S									349	169	152						B	2884	2
S									358	163	152						A	2392	
S									366	169	149						B	1472	4
S									379	162	149					Enamel part formed only	B	1544	4
S						198		128	327	148	138						B	546	
S						213		125									B/D	1083	3
S						216			348		161					M$_3$ length = approx	B	1474	4
S						217	129	120	275	141	132					M$_3$ half erupted	B	664	4
S						223	124	119	281	144	135						B	664	4
S			154	107	109												A	2803	2
S			161			209			361	165	159						F	3123	4
S			162	102	111	230	135	135									A	112	4
S			166			227	130	134									B	2966	2
S			170	97	104												E	2849	2
S		86	153	115	105												A	2732	2
S	187	89															A	2369	2
S	188	84															A	2321	2
S	193	82															B	2822	2
S	194	88	168	100	103												B	2849	2
S	198	84	166	89	92												A	188	5

Appendix Table 3. São Pedro – measurements in tenths of a millimeter of the red deer and *Sus* teeth

Key: l – maximum length of the crown, wa – maximum width of the anterior cusp, wb – maximum width of the posterior (or central in the case of M$_3$) cusp. ACH – the 'Anatomical Crown Height' of the central cusp of the lower third molar measured up the external face from the crown-root junction to the occlusal surface. *Sus* teeth measurements follow Payne & Bull (1988).

Sector	UE	Tax	Tooth	L_1	L_2	L_3	W_a	W_b	W_c	W_d
A	350	EQ?C	P_2	324	143	159	115	146	141	88
A	350	EQ?C	P_2	319	142	160	115	141	140	84
B	2884	EQC	$M_{1/2}$	–	141	123	115	110	98	48
B	2828	EQC	$M_{1/2}$	289	151	106	–	–	–	31
B	2849	EQ	$M_{1/2}$	278	131	112	122	138	123	54
B	2799	EQC	$M_{1/2}$	258	(139)	99	–	(130)	111	30
B	2850	EQ?C	M_3	(305)	129	93	(140)	(123)	112	27
A/B	2130	EQC	P_3	269	144	113	150	156	133	59
A/B	2130	EQC	P_4	278	168	120	146	159	(147)	67
A/B	2130	EQC	M_1	255	125	88	(134)	132	124	36
A/B	2130	EQC	M_2	250	133	88	(136)	122	111	32
A/B	2130	EQC	M_3	278	128	97	118	109	99	27

Appendix Table 4 – measurements in tenths of a millimeter of the mandibular teeth of the equids from São Pedro

The measurements are taken as described in Davis (1987, 2002). Approximate measurements are in parentheses. Note that the teeth P_3 – M_3 from UE 2130 are all from the same mandible.

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