

Zooarchaeological evidence for Moslem and Christian improvements of sheep and cattle in Portugal

Simon J.M. Davis*

Instituto Português de Arqueologia (IGESPAR), Avenida da Índia 136, P-1300-300 Lisbon, Portugal

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Abstract

This study of osteometric variation of sheep and cattle remains from archaeological sites in southern Portugal—the part that was once ruled by the Moslems—reveals an increase in size of the sheep in Moslem times and a subsequent increase of the cattle following the Christian conquest. It is assumed that a size increase reflects improvement. Sheep size increase is easy to understand given the Moslem fondness for mutton. The later size increase of the cattle is less easy to understand but could reflect a dietary switch from mutton to beef as well as the need for bovine power.

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Old Fernando, who told me the Moors were the best thing that ever happened to Spain, had at the same time the common Andaluz prejudice against eating lamb on the grounds that it was ‘Moors’ food’ and therefore not worthy of Christians (Luard, 1984 *Andalucia; A Portrait of Southern Spain*, p. 117)

1. Introduction

On April 28th 711, just 92 years following Mohammed’s flight from Mecca, Tariq bin Ziyad and 7000 Berbers invaded the Iberian Peninsula—a region that was to become an important centre of culture and learning. Not only were song, literature, and mathematics encouraged, but agronomy too. Agriculture flourished: the Moslems introduced new irrigation techniques and new plants like sugar cane, rice, cotton, spinach, pomegranates and citrus trees, to name just a few. This is referred to as the “Arab Green Revolution” (de Araújo, 1983; Glick, 1979; Guichard, 2000; Watson, 1974, 1983). In his introduction to Ibn

’al-’Awwâm’s famous *Kitâb al-Filâha* (Book of Agriculture), El Faïz (2000; 23–49) refers to the 11th and 12th centuries as *le moment andalou* in Hispano-Arab history. Seville had become a Mecca for agronomists, and its hinterland, or *Aljar-afe*, their laboratory. But while the literature speaks much of oranges and lemons, and apart from the famous Arab horses, we know little about the rest of the livestock sector in both the Moslem period and following the subsequent Christian conquest. For over five centuries Moslems ruled the southern part of what later became the Kingdom of Portugal. With the aid of the Crusaders, many of whom hailed from northern Europe, the Christians gradually advanced south and brought about the demise of Moslem rule (see Fig. 1). Both Santarém and Lisbon were captured in 1147 AD, and by 1250 AD, *Algarve*, the last bastion of Islam in the south, fell to forces of the cross under Dom Afonso III. Soon Portuguese ships were sailing the high seas in search of new lands. One hundred and sixty-one years after the capture of Lisbon, the Portuguese signed a commercial treaty with the English. The 1415 seizure of Ceuta heralded the age of the Portuguese “discoveries”. But at home not all was well. The Portuguese, like most Europeans, suffered terribly from the pestilences of the 14th century. Moreover a series of contemporary agricultural crises as well as the plague

* Tel.: +351 21 361 6557.

E-mail address: sdavis@ipa.min-cultura.pt

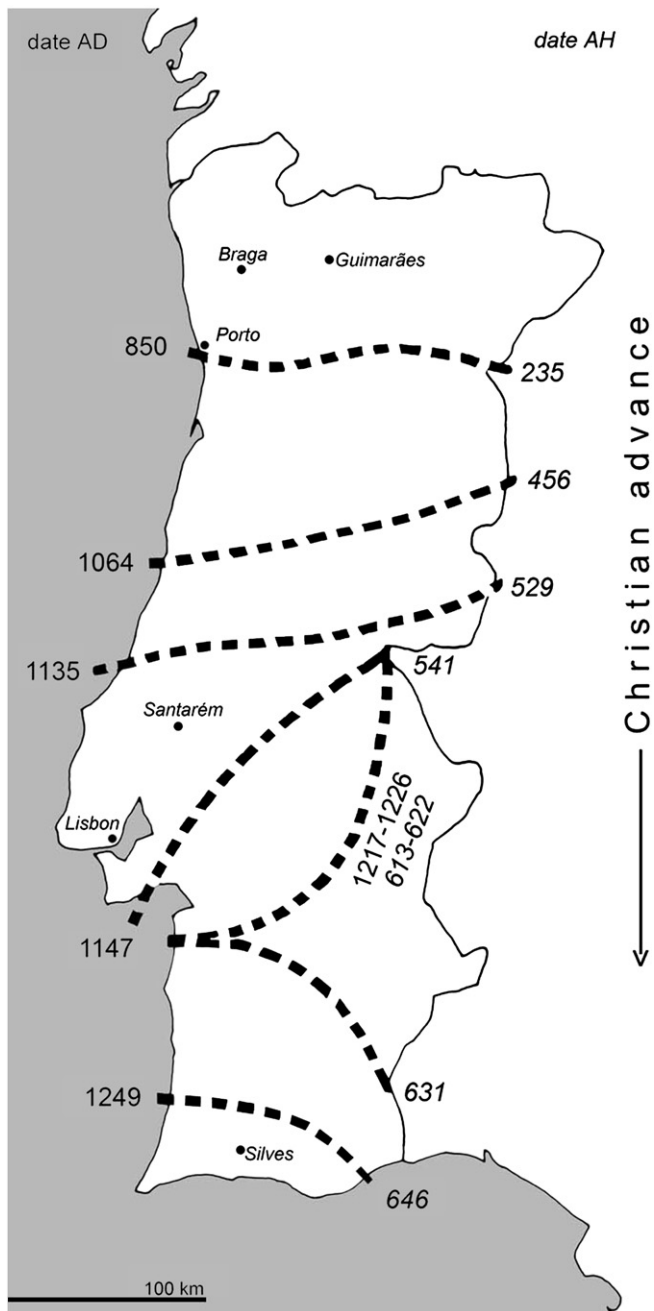


Fig. 1. Map to show the gradual seizure of Moslem Portugal by Christian forces, each thick line being the approximate frontier at a given date (*Anno Domini* on the left and *Anno Hegirae* on the right). While the far north was never under permanent Moslem rule, the northernmost frontier between Islam and Christianity was approximately along the Douro River. Algarve in the south was the last bastion of Islam that finally succumbed to forces of the cross in 1249 when Afonso III captured Faro (modified from Saraiva, 1983; Mattoso et al., 1994).

led to a severe population decline (Gerbé, 2000: chap. IX) raises the question as to what extent these historical changes affected the domestic animals in Portugal. This article considers the osteometric variation of sheep and cattle in southern Portugal—that part of the country once under Moslem rule—and aims to determine if and when sheep and cattle were improved and seeks to establish if it is possible to link

osteometry with what we know about the Moslems and Christians who lived in the Iberian Peninsula.

This study is therefore one of a number that deal with the size variation of domesticated animal remains from archaeological sites dating to the last three millennia (see Albarella, 2003; Albarella and Davis, 1996; Audoin-Rouzeau, 1997; Breuer et al., 2001; Clavel et al., 1996; Johnstone, 2004; Johnstone and Albarella, 2002; Matolski, 1970; Peters, 1998; Schlumbaum, et al., 2003; Teichert, 1984; for example).

2. Material

There are abundant collections of animal remains from archaeological sites in Portuguese museums. Most come from excavations undertaken in recent times. It is mainly the larger assemblages which form the basis for this study and include Alcáçova de Santarém with its Iron Age, Roman and Moslem period levels, Chalcolithic Leceia and Zambujal, Iron Age and Roman Castro Marim, Roman Torre de Palma, Almohad Moslem Silves, and the 15th century AD silos in Beja. These and the smaller assemblages of animal bones considered here are listed in Table 1 and their location given in Fig. 2.

An attempt was made to have each of the major periods—Chalcolithic, Iron Age, Roman, Moslem and post-Moslem—represented by at least two reasonably large assemblages; some, like the Bronze Age, remain unrepresented. Unfortunately the only sizeable post-Moslem sample comes from Beja where most of the cattle remains consist of head and feet bones—probable slaughterhouse or tannery waste. This explains the abundance of cattle teeth and metapodial measurements and scarcity of those of the astragalus, humerus and tibia (i.e. meat-bearing parts) from that site. To obtain more metric data from post-Moslem times, bones from several small unpublished collections were measured. These include a mixed but definitely post 15th century AD assemblage from the Rua Serpa Pinto in Vila Franca de Xira, a small collection of post-medieval cattle metapodials used as anvils, a few cattle bones from a 16th century bone-carving workshop in Aljube, Lisbon, and bones from a 19th century well in Torres Vedras.

The IPA zooarchaeology laboratory reference collections of modern Portuguese sheep breeds—Merino (Preto and Branco) and Churra da Terra Quente—serve as a metric baseline for the sheep. The raw measurements upon which this study is based can be found at (www.ipa.min-cultura.pt/cipa/zoo/bd/osteometricas.html). The sample sizes for each histogram are shown on the figures and range from 1 to 161. In some cases the scarcity of data explains why measurements of single specimens only are shown on the graphs. Indeed it is the general scarcity of data that makes it difficult at this stage to study just when size changes occurred during the Moslem, post-Moslem, or Chalcolithic–Iron Age periods.

3. Methods and the control of variables affecting size

Most measurements were taken by the author with vernier callipers to the nearest tenth of a millimetre in the manner recommended by Driesch (1976) and Davis (1996). The widths of

Table 1

List of sites with their locations (see also map, Fig. 2), cultural assignation and date from which *Ovis* and *Bos* bones were studied in this survey

Site	District	Period	Date	Storage location	Reference
Torres Vedras Well	Ribatejo	Christian	19th C AD	IPA	Unpublished
Santarém, scythe anvil	Ribatejo	Christian	15th–18th C AD	Various museums in Portugal	Moreno García et al., 2005
Aljube, Lisbon (bone workshop)	Ribatejo	Christian	16th C AD (2nd half)	Aljube, Alfama, Lisbon	Unpublished (C. Amaro)
Rua Serpa Pinto, Vila Franca de Xira	Ribatejo	Christian	Post 15th C AD	Crivarque, Torres Novas	Unpublished (A. Pinto)
Torre Évora Monte	Alentejo	Christian	15th C AD	Crivarque, Torres Vedras	Unpublished (A. Pinto)
Mouraria, Lisbon, scythe anvil	Ribatejo	Christian	14th–15th C AD	Various museums in Portugal	Moreno García et al., 2005
Avenida Miguel Fernandes, Beja (silos)	Alentejo	Christian	15th/16th C AD	Crivarque, Torres Novas	Martins et al., in press
Silves biblioteca (<i>lixreira</i>)	Algarve	Moslem (Almohad)	12th C AD	Museu de Silves	Unpublished (M.J. Gonçalves)
Alcáçova de Santarém	Ribatejo	Moslem	11th–12th C AD	CM de Santarém	Davis (2006)
Alcáçova de Santarém	Ribatejo	Roman	2nd C BC–5th C AD	CM de Santarém	Davis (2006)
Torre de Palma	Alentejo	Roman	most 320–400 AD	MNA Lisbon	Unpublished (McKinnon)
São Pedro Fronteira	Alto Alentejo	Roman	3rd–5th C AD	CM de Fronteira	Davis (2005)
Castro Marim	Algarve	Roman	1st C AD	CM de Castro Marim	Davis (2007)
Castro Marim	Algarve	Iron Age	8th–3rd C BC	CM de Castro Marim	Davis (2007)
Alcáçova de Santarém	Ribatejo	Iron Age	8th–3rd C BC (most 3rd)	CM de Santarém	Davis (2006)
Leceia	Estremadura	Chalcolithic	2600–1800 BC	Centro de Estudos Arqueológicos, Oeiras	Cardoso and Detry (2002)
Zambujal	Estremadura	Chalcolithic	2600–1800 BC	Museu de Torres Vedras	Driesch and Boessneck (1976)
Mercador	Alentejo	Chalcolithic		Era, Dafundo, Lisbon	Moreno-García (2003)
Caldeirão cave	Estremadura	Neolithic	4400–3700 BC	IPA	Davis (2002)
Cabeço do Pez	Alentejo	Mesolithic	6th/5th mill BC	MNA Lisbon	
Poças de São Bento	Alentejo	Mesolithic	6th mill BC (1st half)	MNA Lisbon	

Included also are their storage locations, and a bibliographic reference to the faunal report where available, or, in the case of unpublished collections, the name of the zoo-archaeologist or archaeologist responsible. C, century; mill, millennium. Storage locations include: MNA, the National Archaeology Museum, Belém, Lisbon; CM, Camera Municipal (Town Hall); IPA, Portuguese Institute of Archaeology. Note: Era and Crivarque are archaeological enterprises.

cattle lower third molars were measured at the widest point of the crown, usually near its base, in many cases this necessitated breaking out the tooth from the mandible.

Many of the samples of bones were large. Moreover, the correlation between many measurements is not always high (see Davis, 1996 for sheep). Therefore each measurement of each bone has been considered separately, and as this paper demonstrates, most appear to tell a similar story. The sizes of sheep and cattle bones from different sites are compared by plotting histograms and stacking these in chronological order. Data from the various sites within each period are pooled and mean values for each period are compared by a series of pair-wise Student's *t*-tests. The shape of sheep astragali and cattle metacarpals are considered by plotting an index—one dimension such as astragalus width, in relation to another such as astragalus depth.

Since the principal aim here is to determine human influence upon the size of two species of domesticated animals in the course of time, it is important to rule out or “control” other complicating factors that may also affect bone size. These include observer variation, the presence of closely related taxa and wild forms, age and sex.

3.1. Observer error

Different people may measure bones in slightly different ways. In this study all bones were measured by the author except

the Zambujal cattle astragali, whose measurements were read from “diagramm 2” of Driesch and Boessneck (1976).

3.2. The presence of other closely related and osteologically similar species

Bison, close relative of cattle, probably did not inhabit central and southern parts of Iberia (Estévez and Saña, 1999). However, the wild cattle or aurochs is known in the southern part of the Iberian Peninsula at least until the Chalcolithic, perhaps even a little later (Castaños, 1991; Estévez and Saña, 1999). As Driesch and Boessneck (1976) demonstrated, and as we shall see in the graphs, bones of the aurochs are considerably larger than those of domesticated cattle and generally plot out in graphs as a well defined separate peak. Hence a clear distinction is possible between bones of the wild and domesticated forms. For sheep in Portugal there is no possibility of confusion with its wild relatives as these were absent from Western Europe. However, more serious is the problem—well known to zooarchaeologists—of confusing sheep and goat bones. These two animals are closely related; indeed they are, along with the tahr, Barbary sheep, chamois, mountain goat and musk ox, both members of the same sub-family *Caprinae*, and for most bones that comprise their skeleton it is difficult or impossible to identify to the species level—definite sheep or definite goat. The morphological

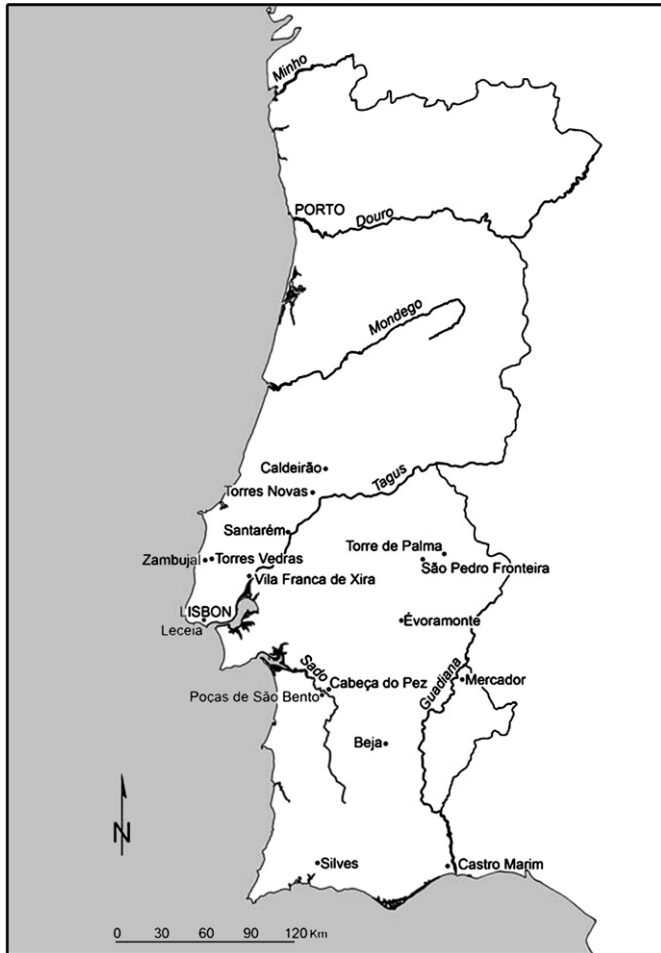


Fig. 2. Map of Portugal showing the location of archaeological assemblages studied.

criteria of Boessneck (1969) and Boessneck et al. (1964) and in addition the metric method of Payne (1969; see also Fig. 3) for metacarpals give, with some confidence, a method by which it is possible to separate sheep from goat distal humeri, distal metacarpals, calcanea, astragali and distal metatarsals. Other caprine bones and teeth such as the lower third molar and the tibia remain in the well-known zooarchaeological taxon “sheep/goat” and their measurements are not considered.

3.3. Age

Unfused epiphyses and astragali with spongy, incompletely ossified, surfaces (i.e. from juvenile animals) were excluded from the study.

3.4. Sex

In most mammals males are larger than females. This means that the average size of a sample consisting of more males will be greater than that of a sample from the same population consisting of more females. The amount of this sexual size difference may vary, not only according to species, but also according to which measurements and which bones are

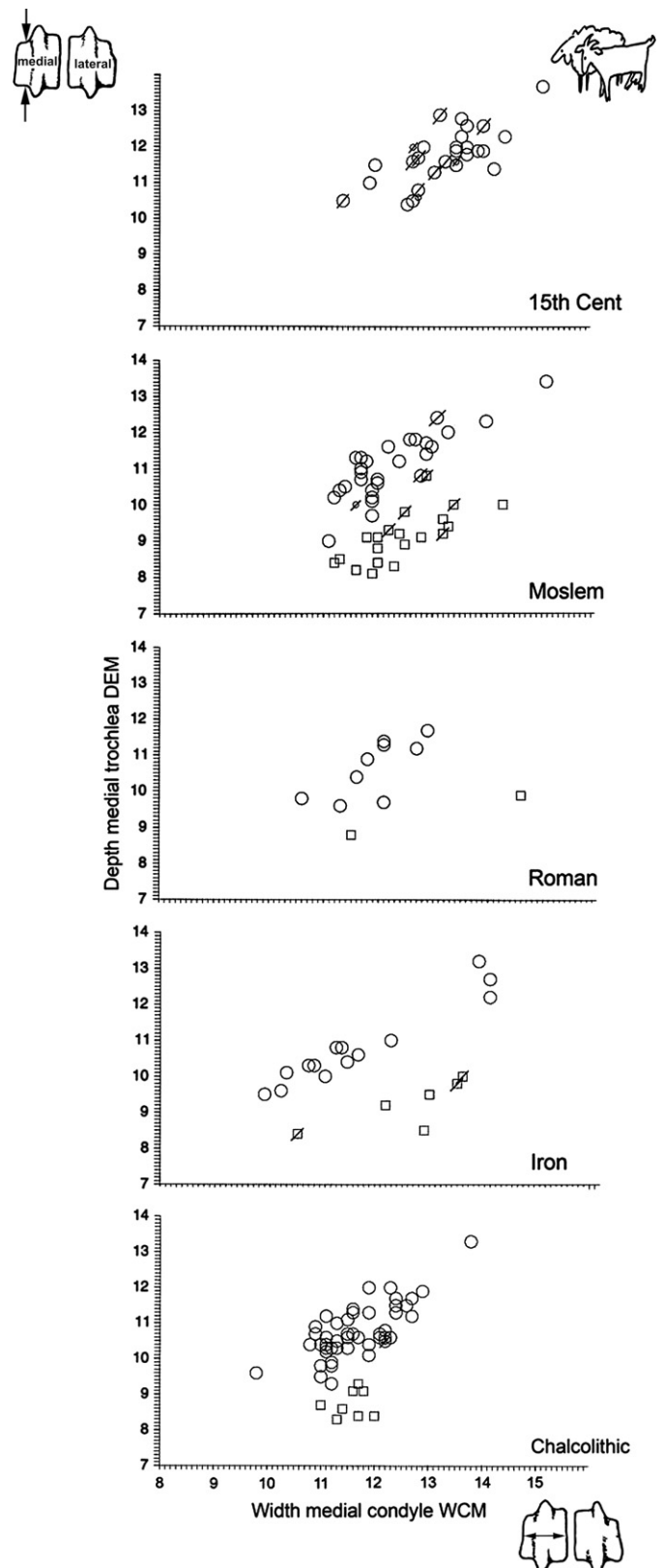


Fig. 3. The distinction between bones of sheep and goat - an osteometric method for distal metacarpals devised by Payne (1969). This makes use of the small differences in the thickness of these species' metacarpal condyles. Measurements are in millimetres. Specimens identified morphologically as sheep are shown as circles and goats as squares. Barred specimens are unfused (i.e. juvenile). A few specimens depicted by small symbols were of questionable identity.

considered. In order to discern a real size change of a species in the course of time it is therefore important to consider measurements that show little or no inter-sex difference. Examples are the humerus HTC and astragalus GLI in sheep (Davis, 2000) and molar tooth widths since artiodactyl cheek teeth tend to show little sexual size-dimorphism; (see for example Degerbøl, 1963 and Degerbøl and Fredskild, 1970: 87 for *Bos*; Payne and Bull, 1988 for *Sus*; and figure 6.1 in Steele, 2002 for *Cervus*). The third molar width has proven useful for the cattle in this study, but this measurement could not be used for the sheep due to an inability to distinguish sheep from goat molars and both taxa are common on post-Neolithic sites in southern Portugal. An alternative approach is to use measurements that show a sufficiently large difference to enable graphical recognition of each sex. In the case of cattle metacarpals the bulls have wider shafts and distal ends than the cows while length is similar in either sex (Fock, 1966). By plotting a scatter diagram of shaft robustness (“shaft width divided by length”) against relative distal width (“distal width divided by length”), bull metacarpals (and presumably oxen too) plot out towards the larger end of the distribution and cows at the smaller end. Another simpler method that works for large samples is to plot cattle distal metacarpal widths. A bimodal distribution is obtained in which the larger mode represents the bulls (and presumably oxen) and the smaller one the cows. Preliminary molecular confirmation of this is now provided by Svensson et al. (2006) who used recovered DNA to sex 26 cattle metacarpals from 12th–13th century AD Sweden where results confirm that all bull distal metacarpals are larger than those of cows. Each peak or mode may then be separately compared for the different sites. The presence of castrates, whose limb bones tend to be longer and slenderer, could be

a complicating factor, though castration probably does not affect dental dimensions. More evidence, based upon modern male, female and castrate cattle is needed.

4. Results

4.1. Sheep

Fig. 4 combines both size and shape by using the three measurements, length, width and depth, of the astragalus. In order to visually simplify the results for each sample, their means and 95% confidence limits are portrayed. This plot of size (length up the y axis) against shape (width expressed in relation to depth, along the x axis) shows that there was little if any shape change between the Iron Age and the 15th century, but the Chalcolithic sheep were considerably slenderer, while sheep from all the later periods were more robust. This does not appear to be related to breed—Merino, Churra da Terra Quente and Shetland ewes are all of similar shape, although different in size with Merinos and Churras larger than unimproved Shetlands.

The stacked histograms (Figs. 5–10) show size variation of sheep bones. In most cases there is little evidence for any substantial change between Chalcolithic and Roman times, but by the Moslem period sheep were clearly larger. The measurements where this is clearest include humerus BT (Fig. 5) and HTC (Fig. 6), astragalus GLI (Fig. 8) and Bd (Fig. 9). While the evidence for a Roman-to-Moslem size increase is clearer in some bone measurements such as those cited above (see Figs. 5, 6, 8 and 9) than in others such as metacarpal BFd (Fig. 7) and metatarsal BFd (Fig. 10), they do all show the same general trend of increasing size over time.

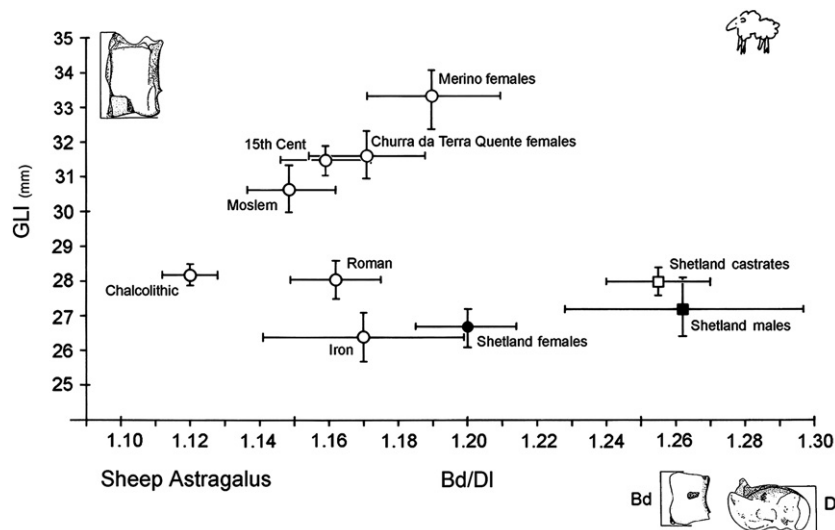


Fig. 4. Size and shape variation of Portuguese sheep compared with a sample of modern unimproved Shetland sheep (Davis, 2000) and modern Churra da Terra Quente and Merino ewes. Summary diagrams of astragalus GLI (size) in millimetres versus astragalus Bd/DI (shape). Here the mean values \pm 95% confidence limits are plotted for pooled data from the main periods, and the 13 modern Churra da Terra Quente ewes and 17 modern Merino ewes. Specimens plotting to the left are slender; those to the right are more robust. Note the males and castrates are more robust. Note also the increase in robustness between Chalcolithic and Iron Age times and the increase of size, while shape remained approximately constant, after Roman times. The statistical limits of confidence indicate that we can be reasonably certain that the Chalcolithic sheep astragali are rather different in terms of shape from the other samples in Portugal, which are mostly of similar shape and also similar to the modern Shetland and Churra ewes. Note also the small, but statistically significant size difference between Iron Age and Roman times.

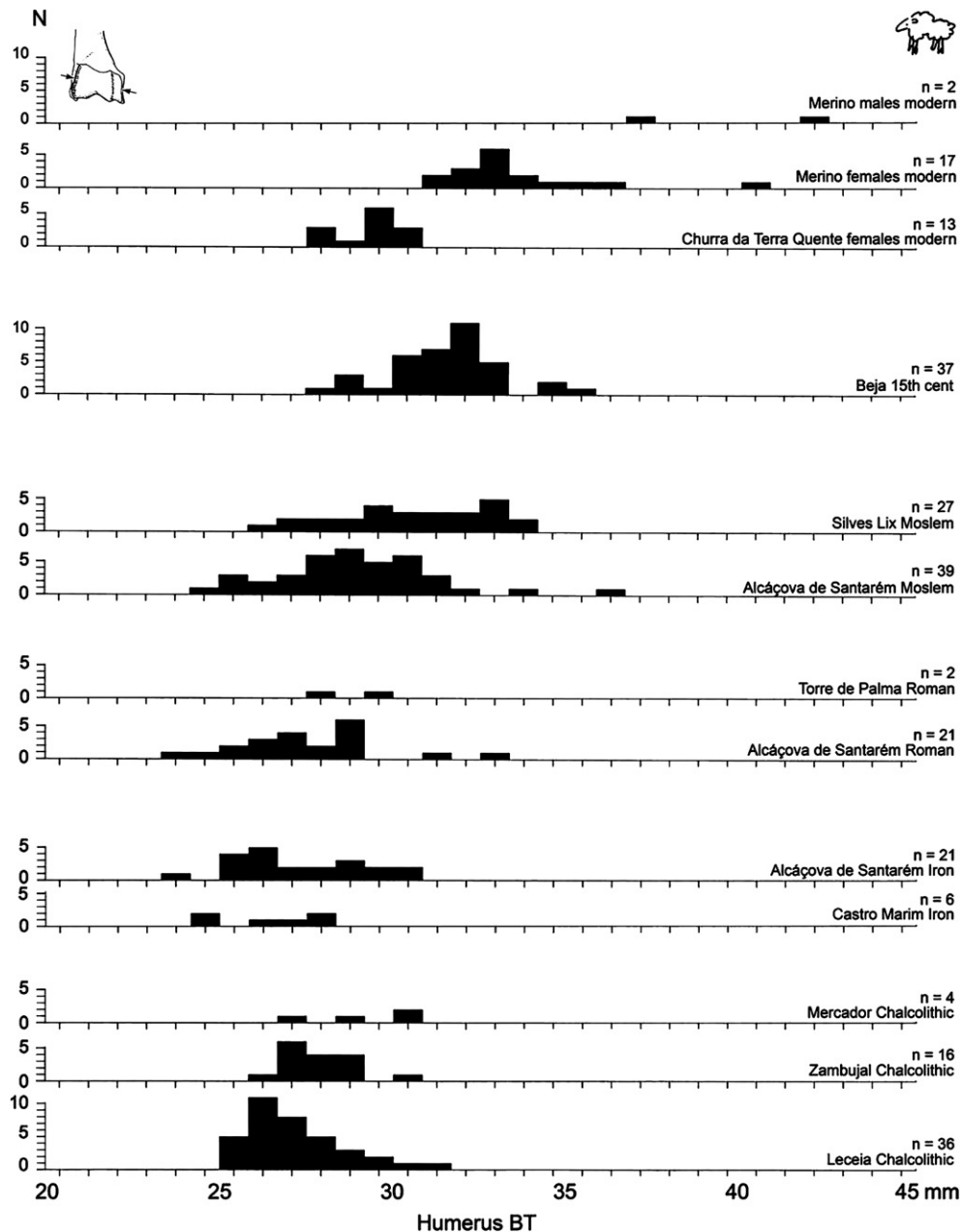


Fig. 5. The increase of sheep size in southern Portugal in the course of time. Stacked histograms of measurements of the trochlea width (BT) of sheep humeri from Chalcolithic, Iron Age, Roman, Moslem, 15th century AD Beja, and modern Churra da Terra Quente ewes, Merino ewes and two Merino males above. *n* refers to sample size. Note the increase in size between Roman and Moslem periods.

The *t*-tests in Table 2 indicate that the average differences are significant when most sheep bones from the Moslem period are compared to sheep bones from earlier periods. Following the Moslem period there was a further increase in size, though this is less apparent in the case of the astragalus. The modern Churra da Terra Quente ewes are large by Roman standards, and the Merino ewes are similar in terms of size to the sheep from 15th century Beja.

4.2. Cattle

Figs. 11–15 are stacked histograms of *M*₃ and limb-bone measurements to show the variation of *Bos* (cattle and

aurochs) size. As mentioned above, the aurochs was larger than cattle by so great a margin that measurements of its bones generally form a separate peak in the histograms. For example in Fig. 12 (metacarpal), and Fig. 14 and 15 (astragalus), there are clear separate peaks. The Mesolithic metacarpal with a distal width of 89 mm clearly belongs to the wild form, as do the Chalcolithic astragali with lengths greater than 74 mm and widths greater than 50 mm. These larger specimens are similar in size to their Mesolithic cousins, though in the case of the astragalus width there is a small specimen from that period measuring 46 mm. Hence there may be some overlap of aurochs and domestic cattle. Most of the specimens in the Chalcolithic (and subsequent periods) are smaller; they plot

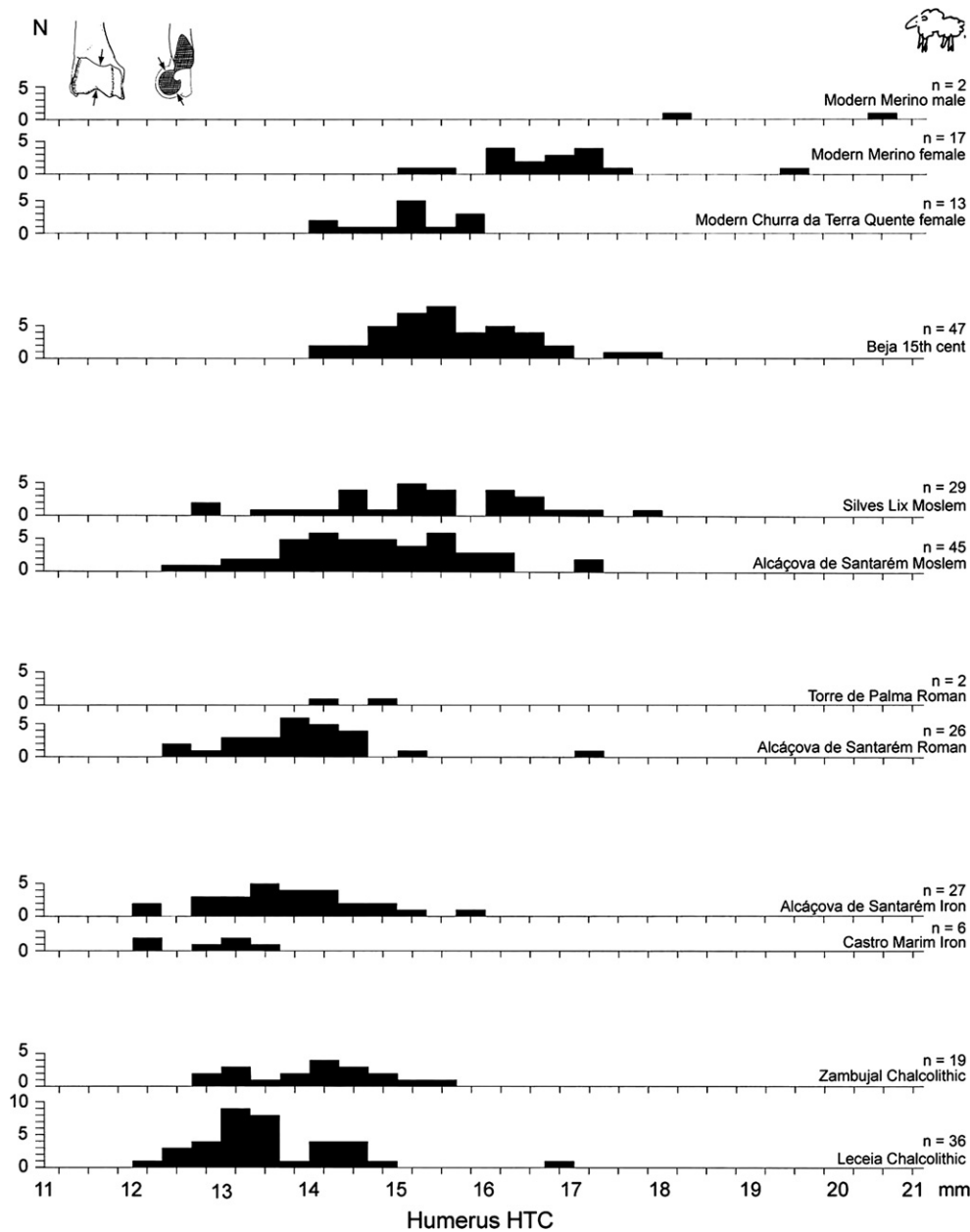


Fig. 6. The increase of sheep size in southern Portugal in the course of time. Stacked histograms of measurements of the minimum trochlea diameter (HTC) of sheep humeri from Chalcolithic, Iron Age, Roman, Moslem, 15th century AD Beja, and modern Churra da Terra Quente ewes, Merino ewes and two Merino males above. *n* refers to sample size. Note the increase in size between Roman and Moslem periods. Humerus HTC is a measurement that shows almost no sexual dimorphism so the increased size of this part of the humerus must reflect a real size increase of the sheep and not a change in the sexual composition of the samples.

further to the left. These are assumed to have belonged to domestic cattle. The absence of the large-sized specimens after the Chalcolithic corroborates the finding of Castaños (1991) and others that the aurochs disappeared from the western part of the Iberian Peninsula during or soon after the Chalcolithic.

Leaving aside the small numbers of the very much larger specimens identified as aurochs, the series of stacked histograms for each dimension of the domestic cattle indicate little change of size between Chalcolithic and Moslem periods. Most striking is the considerable size increase between the Moslem period and the 15th century ($p < 0.1\%$; Table 3;

the mean values for the Chalcolithic cattle have not been compared due to possible size overlap between small aurochs and large cattle). Note especially the plots for M_3 (Fig. 11) and metacarpals (Fig. 12).

5. Discussion

Increased robustness of the sheep between Chalcolithic and Iron Age times could be due to a shift in the proportions of sexes represented, a dietary change (improvement?) or perhaps even the introduction of new stock from elsewhere. The Iron Age, for example, saw the introduction into the Iberian

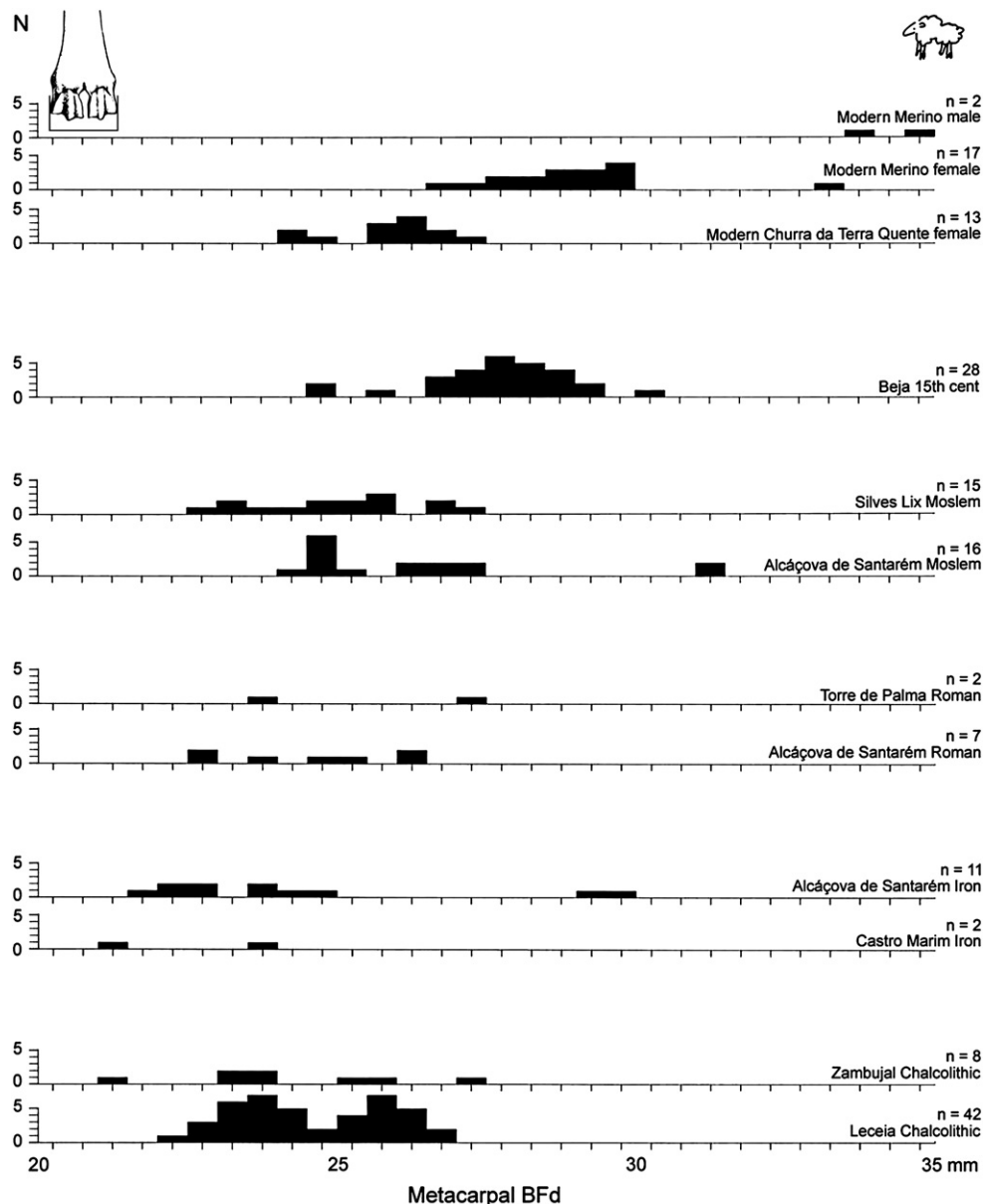


Fig. 7. The increase of sheep size in southern Portugal in the course of time. Stacked histograms of measurements of the distal width (BFd) of sheep metacarpals from Chalcolithic, Iron Age, Roman, Moslem, 15th century AD Beja, and modern Churra da Terra Quente ewes, Merino ewes and two Merino males above. *n* refers to sample size. Unlike the other bone measurements, there is no obvious size change between Roman and Moslem times—perhaps in part due to the small sample sizes in these periods.

Peninsula not only of ostrich eggs, presumably from North Africa, but also the house mouse, chicken and donkey (see for example Cardoso, 2000; Cucchi et al., 2005; Hernandez Carra-squilla, 1992; Mayor, 1996–1997; Morales Muñoz et al., 1995; Roselló and Morales, 1994; San Nicolás Pedraz, 1975). The introduction of some or all these is associated with the Phoenicians. Without more samples of sheep bones from intervening periods, especially from the Bronze Age, the Chalcolithic–Iron Age shape change in sheep here remains enigmatic.

That the increase of humerus HTC between Roman and Moslem periods is far greater than the 1% difference observed between rams and ewes in Shetland sheep (Davis, 2000) suggests that the Roman–Moslem size increase is a real one and not one due to a change in the sex ratio.

Unlike central and northern Europe (see for example Breuer, et al., 2001; Matolski, 1970; Peters, 1998; Schlumbaum, et al., 2003; Teichert, 1984), Roman cattle in southern Portugal appear to have been no larger than those in the Iron Age. This is interesting. Does it mean that the Romans in Lusitania failed to invest in the bovine sector and improve local breeds of cattle? Audoin-Rouzeau (1995) writes:

Une analyse de la répartition géographique de ces animaux indigènes et «romains» semble montrer une présence d'autant plus forte des premiers que la province est plus éloignée de l'Italie ou d'accès difficile.

Clearly, on the basis of Audoin-Rouzeau's criteria, Lusitania was *une province éloignée*! And unlike the sheep from

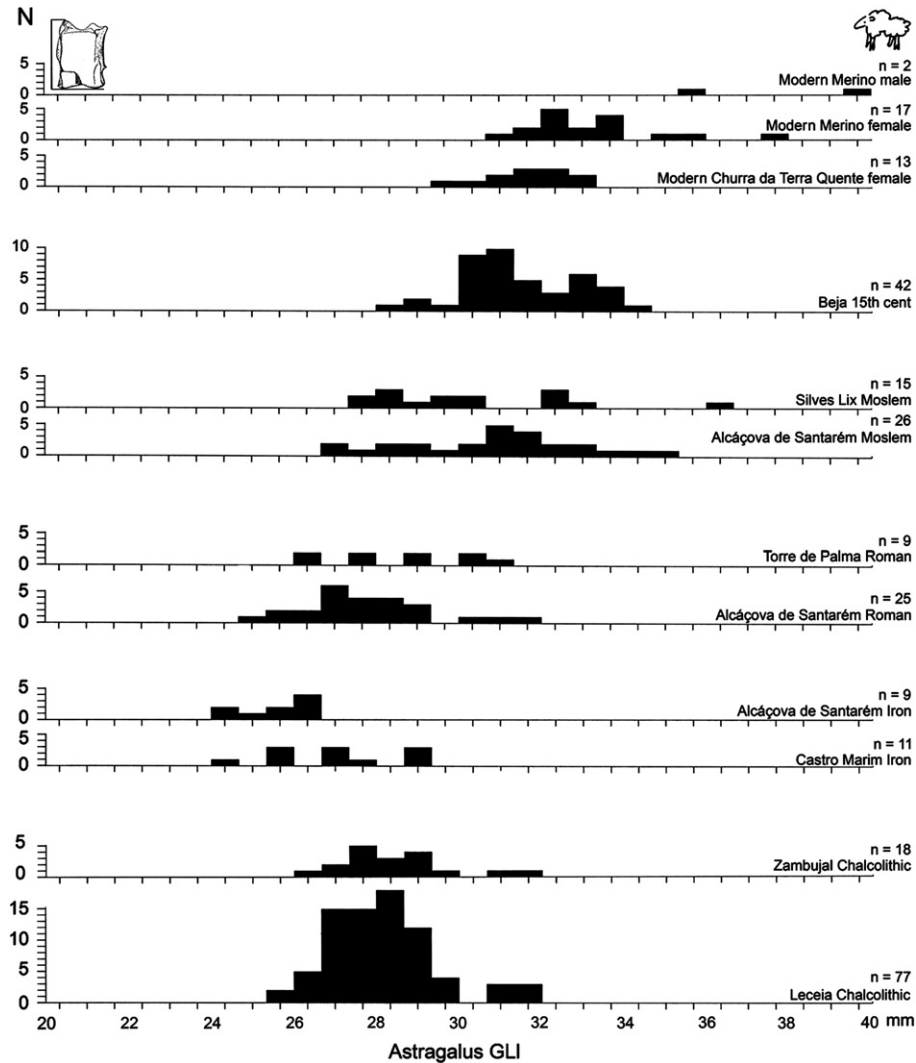


Fig. 8. The increase of sheep size in southern Portugal in the course of time. Stacked histograms of measurements of the greatest lateral length (GLI) of sheep astragali from Chalcolithic, Iron Age, Roman, Moslem, 15th century AD Beja and modern Churra da Terra Quente ewes, Merino ewes and two Merino males above. *n* refers to sample size. Note the increase in size between Roman and Moslem periods. Astragalus GLI is a measurement that shows little sexual dimorphism so its increase in the course of time must reflect a real size increase of the sheep and not a change in the sexual composition of the samples.

southern Portugal, the Portuguese cattle in the Moslem period appear to have been little different in size from their Roman ancestors. Note however that the cattle in Moslem Silves were very small.

In order to confirm that the increase in size between the Moslem period and the 15th century was geographically widespread rather than restricted to the area around Beja, an attempt was made to locate cattle remains from other post-Moslem sites. The few that I managed to find and measure are mostly similar to the Beja specimens, suggesting that the size increase of cattle following the Christian invasion of the south was a general trend in southern Portugal at that time. (The five metacarpals used as anvils from Santarém and the two metacarpals from Torres Vedras are very small and represent an enigma.)

What of the possibility of sex-ratio variations? The scatter diagram of metacarpal robustness (Fig. 16) indicates that most Iron Age specimens belonged to cows with perhaps 7 cows

and 1 bull. In the Moslem period this ratio is reversed with perhaps 14 bulls (were these castrates?) and only 5 cows, while the plots from 15th century AD Beja indicate equal numbers of sexes and the whole sample now plots out “up, and to the right”. It seems likely then that both cows and bulls have become more robust. In Fig. 12 the distal widths of the Portuguese cattle metacarpals for the larger samples (Moslem and 15th century) are bimodally distributed and both cow and bull peaks increase in size after the Moslem period. This increase of both size and robustness of the post-Moslem cattle may well reflect animals that had undergone selection for heavier carcasses providing more meat - beef animals in other words.

One other, admittedly unlikely, possibility that could be posited is a change of climate in the Iberian Peninsula at the times of these size changes. Many mammals and birds show an inverse correlation between the size of their bodies and the temperature of the environment, an observation first

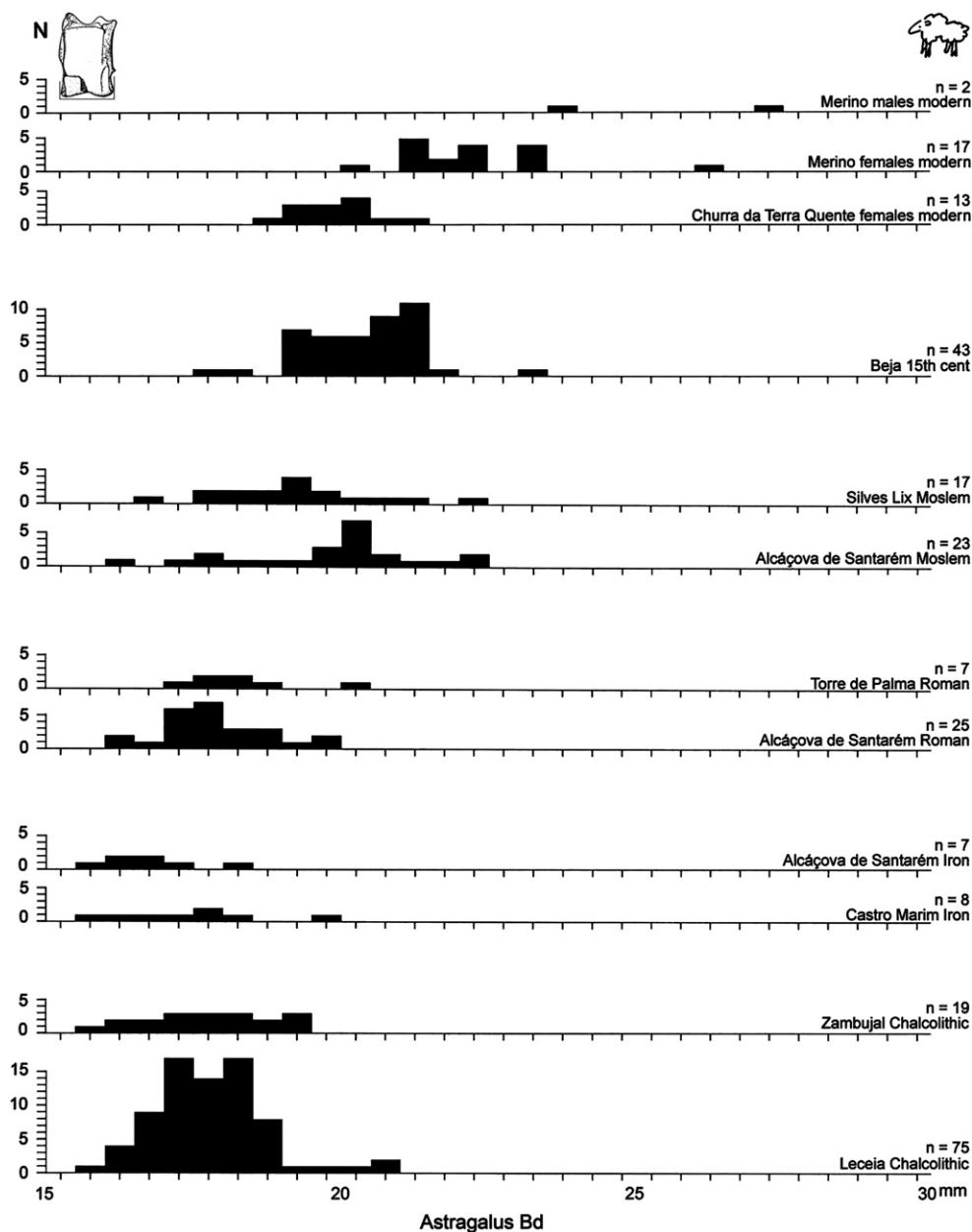


Fig. 9. The increase of sheep size in southern Portugal in the course of time. Stacked histograms of measurements of the distal width (Bd) of sheep astragali from Chalcolithic, Iron Age, Roman, Moslem, 15th century AD Beja and modern Churra da Terra Quente ewes, Merino ewes and two Merino males above. *n* refers to sample size. Note the increase in size between Roman and Moslem periods.

made by Bergmann (1847) (see also Mayr, 1956). However, the magnitudes of the Roman-Moslem sheep and post-Moslem cattle size increases would require a huge drop in temperature for which there is little evidence—compare with the changes at the end of the Pleistocene in the Near East in Davis (1981). Besides, if temperature was a factor then we would expect both taxa to have increased in size simultaneously, and they did not.

In brief, both sheep and cattle increased in size in the course of time in southern Portugal. Sheep became larger in Moslem times, while cattle did so subsequently, following the Christian conquest.

5.1. Sheep and cattle—improved by the Moslems and Christians respectively?

If we accept the assumption that a size increase in a lineage of domesticated animals signifies their improvement, then we need to understand why these animals were improved in Moslem and Christian times. Can we link improvement to what we know about the Moslems of the Iberian Peninsula and the Christians who subsequently took control and to what we know about Arab and Christian dietary preferences and farm animal exploitation? An improvement of sheep by the Moslems is hardly a great surprise given their well known

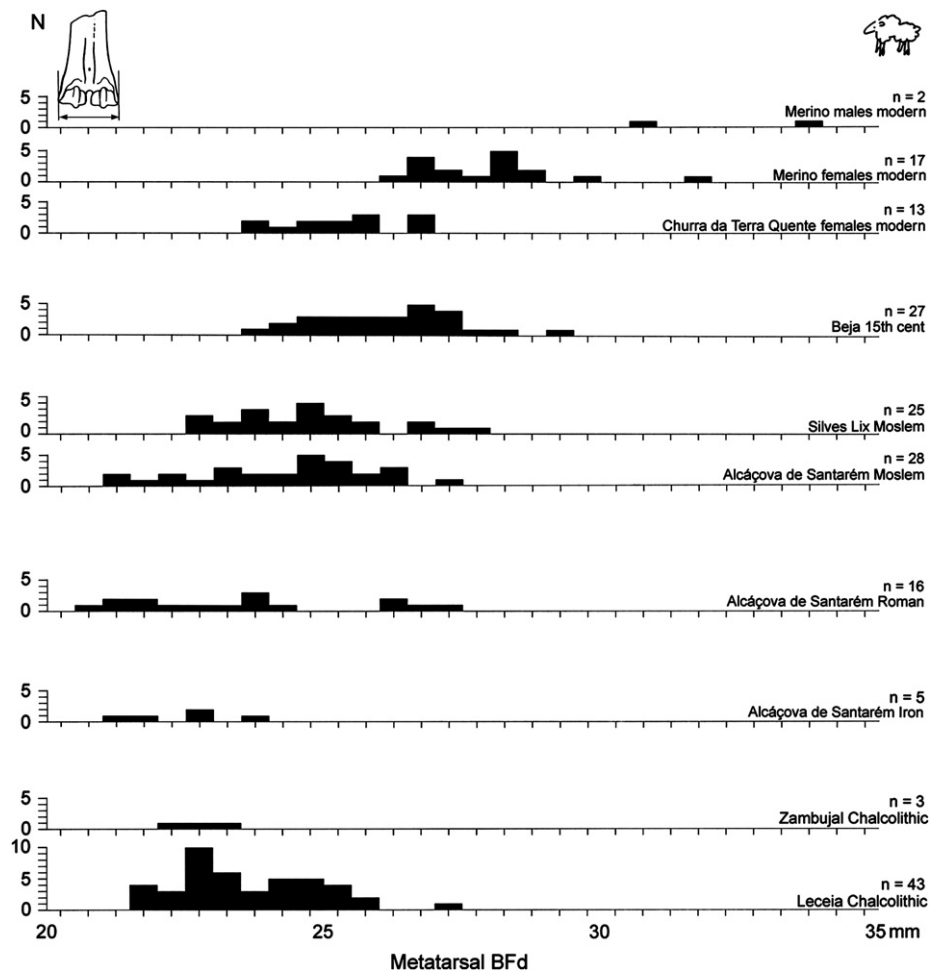


Fig. 10. The increase of sheep size in southern Portugal in the course of time. Stacked histograms of measurements of the distal width (BFD) of sheep metatarsals from Chalcolithic, Iron Age, Roman, Moslem and modern Churra da Terra Quente ewes, Merino ewes and two Merino males above. *n* refers to sample size. Note here that the size increase in the Moslem period is less apparent than in the humerus and astragalus measurements, though there is a clear trend in overall size increase from the Chalcolithic to Moslem periods.

improvements to Iberian agriculture and the esteem with which they held, and still hold, mutton. It is however a little more difficult to relate the subsequent size increase of cattle with any documented advance in the agriculture of this region associated with the Christians.

5.1.1. Sheep

Perhaps in part because Islam forbids the consumption of pork, the Arabs have a well known preference for lamb and mutton—“... the favourite meat of the people” (Khayat and Keatinge, 1959). In his review of early Arab cuisine, Rosenberger (1999) writes that in the Arab world beef was not much liked and cows and oxen gave milk or laboured in the fields. Most meat came from the vast flocks of sheep. The Arabs liked the taste of mutton and the abundant fat that it provided, and Arab physicians regarded the meat of the yearling lamb as being close to perfection. Glick (1979: 66) notes that in 400 years the pattern of agriculture that emerged in al-Andalus included an increase, over Roman times, in the economic significance of sheepherding. Glick’s interesting

remarks concerning Moslem versus Christian attitudes are relevant here. He writes (p. 103):

To a society of town-dwellers and agriculturalists the sheep was an animal primarily raised for meat; its wool was a by-product. The Christians of the later middle ages turned the equation around: they cared only for wool and ascribed a low value to the meat.

This corroborates what “Old Fernando” had to say about mutton in the quotation beginning this article. Thus the Christians, obsessed with wool production, may have preferred to eat pork and beef rather than mutton, and this is certainly the case here in Portugal today.

Age-at-death data can also shed some light upon the nature of the animal economy. A high cull of young animals suggests an emphasis upon meat as, in terms of food input and meat gained, it makes little sense to maintain sheep or cattle much beyond their second or third year. In contrast, an economy geared towards the so-called secondary products such as milk, wool and power, will maintain cattle and sheep until they are quite old. The age-at-death data for the Iron

Table 2

Significance of the mean size differences between groups of selected sheep bones from different periods as indicated by a *t*-test

Measurement	Samples compared	<i>t</i>	Probability
HU-BT	Beja 15th Cent vs. Moslem	4.44	0.000**
HU-BT	Moslem vs. Roman	3.51	0.001**
HU-BT	Roman vs. Iron Age	1.14	0.260
HU-BT	Iron Age vs. Chalcolithic	1.31	0.195
HU-HTC	Beja 15th Cent vs. Moslem	3.44	0.001**
HU-HTC	Moslem vs. Roman	4.18	0.000**
HU-HTC	Roman vs. Iron Age	1.59	0.117
HU-HTC	Iron Age vs. Chalcolithic	0.99	0.327
MC-BFd	Beja 15th Cent vs. Moslem	4.21	0.000**
MC-BFd	Moslem vs. Roman	1.18	0.247
MC-BFd	Roman vs. Iron Age	0.75	0.465
MC-BFd	Iron Age vs. Chalcolithic	1.14	0.261
MC-BFd	Moslem vs. Roman+Iron+Chalcolithic	2.68	0.009**
MC-Dd	Beja 15th Cent vs. Moslem	4.98	0.000**
MC-Dd	Moslem vs. Roman	0.80	0.430
MC-Dd	Roman vs. Iron Age	0.31	0.764
MC-Dd	Iron Age vs. Chalcolithic	0.14	0.887
Mc-Dd	Moslem vs. Roman+Iron+Chalcolithic	1.90	0.061
CA-GL	Beja 15th Cent vs. Moslem	2.21	0.033*
CA-GL	Moslem vs. Roman	2.43	0.019*
CA-GL	Roman vs. Iron Age	1.76	0.089
CA-GL	Iron Age vs. Chalcolithic	0.98	0.334
AS-GLI	Beja 15th Cent vs. Moslem	1.96	0.054
AS-GLI	Moslem vs. Roman	5.70	0.000**
AS-GLI	Roman vs. Iron Age	3.66	0.001**
AS-GLI	Iron Age vs. Chalcolithic	5.45	0.000**
AS-Bd	Beja 15th Cent vs. Moslem	2.97	0.004**
AS-Bd	Moslem vs. Roman	5.42	0.000**
AS-Bd	Roman vs. Iron Age	2.83	0.007**
AS-Bd	Iron Age vs. Chalcolithic	2.44	0.016*
AS-DI	Beja 15th Cent vs. Moslem	2.14	0.036*
AS-DI	Moslem vs. Roman	5.83	0.000**
AS-DI	Roman vs. Iron Age	3.16	0.003**
AS-DI	Iron Age vs. Chalcolithic	6.20	0.000**
MT-BFd	Beja 15th Cent vs. Moslem	4.68	0.000**
MT-BFd	Moslem vs. Roman	1.68	0.097
MT-BFd	Roman vs. Iron Age	1.30	0.209
MT-BFd	Iron Age vs. Chalcolithic	1.85	0.070
MT-BFd	Moslem vs. Roman+Iron+Chalcolithic	3.53	0.001**
MT-Dd	Beja 15th Cent vs. Moslem	5.04	0.000**
MT-Dd	Moslem vs. Roman	2.73	0.008**
MT-Dd	Roman vs. Iron Age	0.18	0.862
MT-Dd	Iron Age vs. Chalcolithic	0.59	0.559
MT-Dd	Moslem vs. Roman+Iron+Chalcolithic	4.23	0.000**

Key: **, the difference is significant at the 1% level; *, the difference is significant at the 5% level; no asterisk, no significant difference. It has been assumed that each bone derives from a different animal. The comparisons between Moslem and Roman periods are shown in boldface. In the case of metapodials, measurements from all pre-Moslem periods are pooled and this sample compared with the Moslem period sample.

Age, Roman and Moslem assemblages at Alcáçova de Santarém (Davis, 2006: 49–52) appear to corroborate the thesis here. Thus the caprines were slaughtered at a somewhat younger age in the Moslem period than in the Roman and Iron Ages indicating a shift by the Moslems towards meat. In the Moslem period fewer calves were slaughtered suggesting that cattle were now kept more for milk and power. The Almohad (Moslem; 12th century) period bones from Silves (work in progress) also indicate that the sheep and goats were kept primarily for their meat. Thus their mandibles show a distinct peak of slaughter at 2–3 years (Payne, 1973, wear stage “E”) while the majority of the cattle derive from much older animals. For example there are 13 cattle P₄s (adult fourth premolars), and no dP₄s (deciduous fourth premolars) at Silves.

Since higher meat yield in sheep is correlated with larger bones (Hammond, 1960: 131), it is logical to link the increased size of Moslem period sheep with their improved meat yield. This leads us to query how this may have happened. Did the Moslems improve the local sheep or did they import new stock from, say, the Maghreb or the Middle East? Evidence from the Cairo Genizeh indicates quite clearly that the Mediterranean world of the 11th and 12th centuries was a kind of medieval common market with the Islamic world forming a free trade area (Goitein, 1967). This communications network, shared by Christians, Jews and Moslems, expressed the notion (Glick, 1979: 27) that there was “blessing in movement” as the Arab proverb states “fi’l-haraka baraka”. Moreover, Klein (1920: 4–6) suggested that it was the Beni Merin Berbers who introduced the Merinos from northern Morocco during the Almohad expansion into southern Iberia. Not only was the Mediterranean important, but the Atlantic maritime trade between Spain, Portugal and the Maghreb at this time is also well documented (Picard, 1997). Klein (1920: 4–6) also noted that many of the pastoral terms used to this day in Spain are of Arabic origin. There are indeed several likely etymologies of the word *merino* and possible origins of this most important breed of sheep (see for example Laguna Sanz, 1986; Sanchez Belda and Sanchez Trujillano, 1986) although Riu (1983) suggests that the Merinos resulted from cross-breeding of coarse-woolled ewes with north-African fine-woolled rams in the mid 14th century. Even today Merinos tend to be reared in the southern part of Spain and Portugal and they are genetically somewhat distinct from other breeds kept in central and northern Spain (Arranz et al., 1998). A genetic (mitochondrial DNA) study of seven modern breeds of Portuguese sheep (Pereira et al., 2006) reveals the presence of maternal lineages until now only found in the Middle East and Asia. A broad north–south pattern indicates a trend with southern Portuguese sheep clearly distinct from most other breeds. This is interpreted in terms of an influx of new genetic diversity, via a maritime route, although it is impossible at the moment to know when this happened. Clearly further studies, both osteological and genetic, of sheep remains dating back over the last two or three millennia in Portugal are needed, but it is tempting to presume that

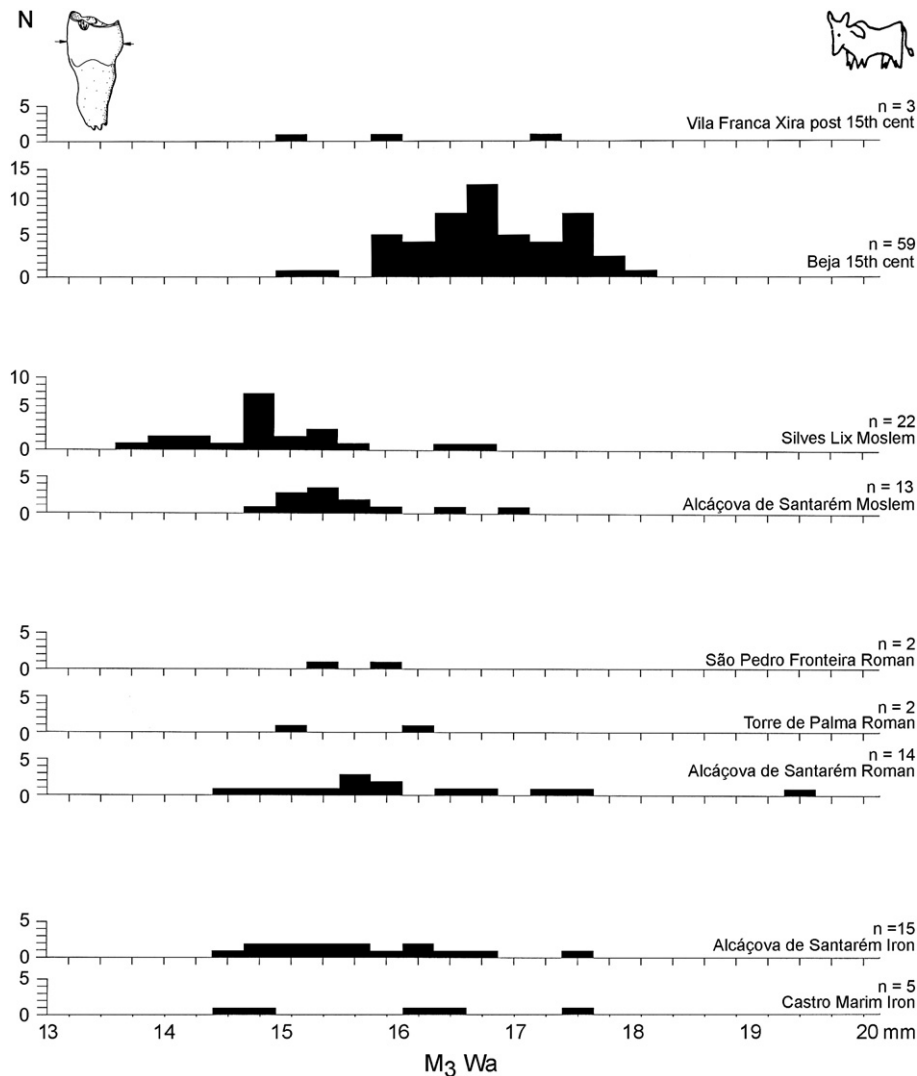


Fig. 11. Cattle size variation in southern Portugal in the course of time. Stacked histograms of the crown width of the anterior lobe of the lower third molar tooth, M_3 , from Iron Age to post-Medieval times. Note the absence of any significant size change between Iron Age and Moslem times and the subsequent increase by the 15th century AD. n refers to sample size. Artiodactyl molars are not considered to show much sexual dimorphism so that the Moslem to 15th century size increase represents a real size change of cattle in southern Portugal and not a shift in the sex ratio.

at least some live sheep accompanied the oranges and lemons into the Iberian Peninsula. So much for the Moslems' improvement of sheep, can we explain the subsequent improvement of cattle by the Christians?

5.1.2. Cattle

The obvious assumption is that a shift in emphasis from mutton to wool occurred (Glick, 1979: 103) once the Christians took over southern Portugal. Klein (1920: 25) too, writing about Christian Spain, noted that the consumption of mutton was uncommon (and it certainly is today in Portugal). He provides two explanations. First, the seasonal migrations of the merinos made their meat tough and this sheep was regarded as being more valuable for its wool. Second, in place of mutton much pork was eaten. There were two reasons for this—first because of its high quality due to the abundance of acorn

fodder, and second because its consumption removed suspicions of Judaism. In her history of Iberian husbandry, Gerbet (2000) emphasises how wool production really took off in the Iberian Peninsula in medieval times. Indeed in 1273, “Alfonso el Sabio” (“Alfonso the Learned”, 1221–1284) established the Mesta, the powerful association of sheep holders, in Castile (Klein, 1920). In other words Christianity provided the impulse for breeding cattle with heavier carcasses and greater meat yields. Today at least, the famous meat breeds of cattle, in contrast to the dairy breeds, are characterized by their wide limb bones (see for example Guintard, 1998). With the establishment of the new Christian kingdom of Portugal, it is plausible that the Crusaders, many of whom came from the north, introduced new and bigger breeding stock from their homelands. The father of D. Afonso Henriques (1111–1185), first King of Portugal, hailed from Burgundy.

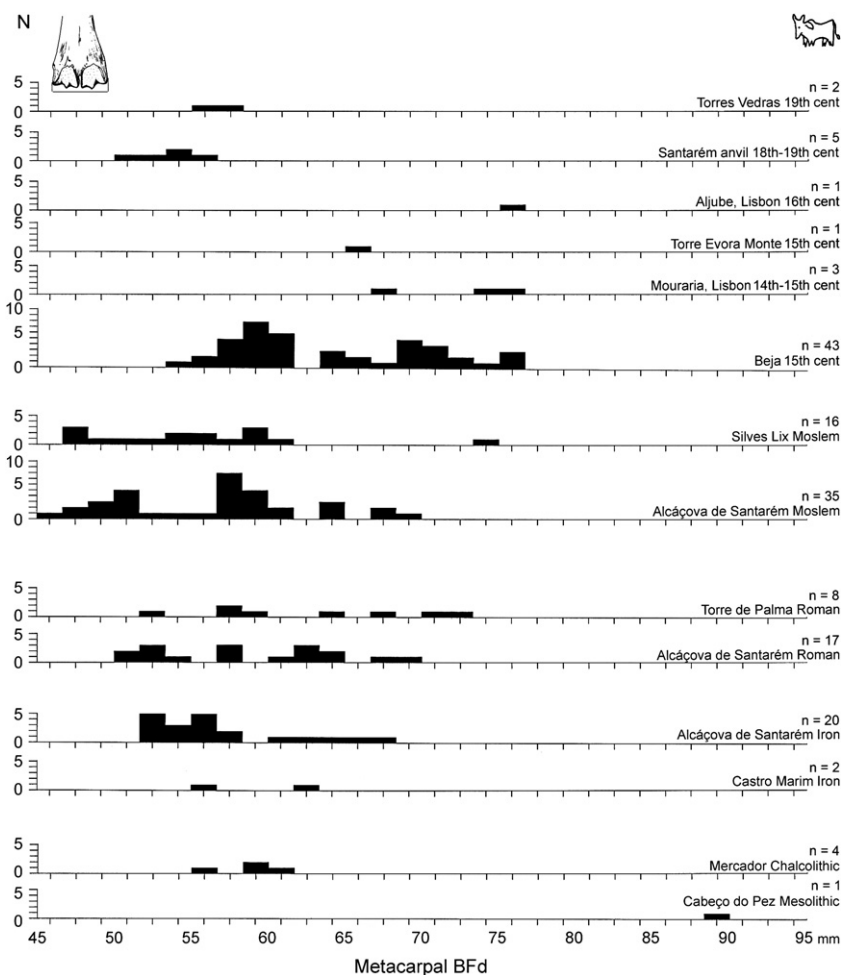


Fig. 12. Cattle size variation in southern Portugal in the course of time. Stacked histograms of the distal width (BFd) of metacarpals from the period spanning Mesolithic and Chalcolithic times to the 15th century AD with some small samples from 15th century and later times. *n* refers to sample size. Note the very large size (89 mm) of the Mesolithic specimen, presumed to be aurochs, and the absence of any significant size change between Iron Age and Moslem times of the presumed domestic cattle and the subsequent increase by the 15th century AD, although these recent large cattle did not attain the great size of the wild aurochs. The larger samples from Moslem Santarém and 15th century Beja show a bimodal distribution of their widths, presumably representing the two sexes. If correct then we can see here that both females and males increased in size between Moslem times and the 15th century.

One other speculation is that the Christians may have seen cattle as a source of power (and perhaps even a symbol of status too!) for ploughing the now enlarged estates (due to the demographic losses incurred during the terrible pestilences of the 14th and 15th centuries) and so bred larger and therefore more powerful animals. Indeed, [de Oliveira Marques \(1968\)](#) writes that although known in earlier times, the “Arado Quadrangular or Charrua” (Quadrangular, or Chariot plough), which was pulled by oxen or cows, became widespread in Portugal in the 14th, 15th and especially the 16th centuries. This plough was more complex and stronger than its predecessors, well adapted to wet and heavy soils, and was of Nordic origin.

In many parts of Europe there is now substantial zooarchaeological evidence that livestock and even fowl were improved in later Medieval and post-Medieval times ([Albarella and Davis, 1996](#); [Audoin-Rouzeau, 1997](#); [Clavel et al., 1996](#); [Davis and Beckett, 1999](#); [Matolsci, 1970](#)). A pre-15th

century AD date for improved cattle in Portugal is indeed somewhat early in comparison and may indicate an advanced state of farming here at that time. And the even earlier size increase of the sheep comes as a greater surprise. However, more recent zooarchaeological investigations by [Thomas \(2005\)](#) are revealing evidence for agricultural changes as early as the 14th century in England as [Dyer \(1981\)](#) had found in his studies of the documentary evidence. He, like Dyer, links these 14th century improvements with the Black Death (1348–1350) and the resulting demographic decline, and suggests that the demand to feed an expanding population had dissipated and the market in grain crashed. Animal husbandry became a viable alternative being less labour intensive but requiring more land—this being plentiful following the effect of the Black Death. A possible chain of explanations for these 14th century changes in England which these authors propose include a downward social distribution of access to land and the tendency for peasants to become landowners. Peasants

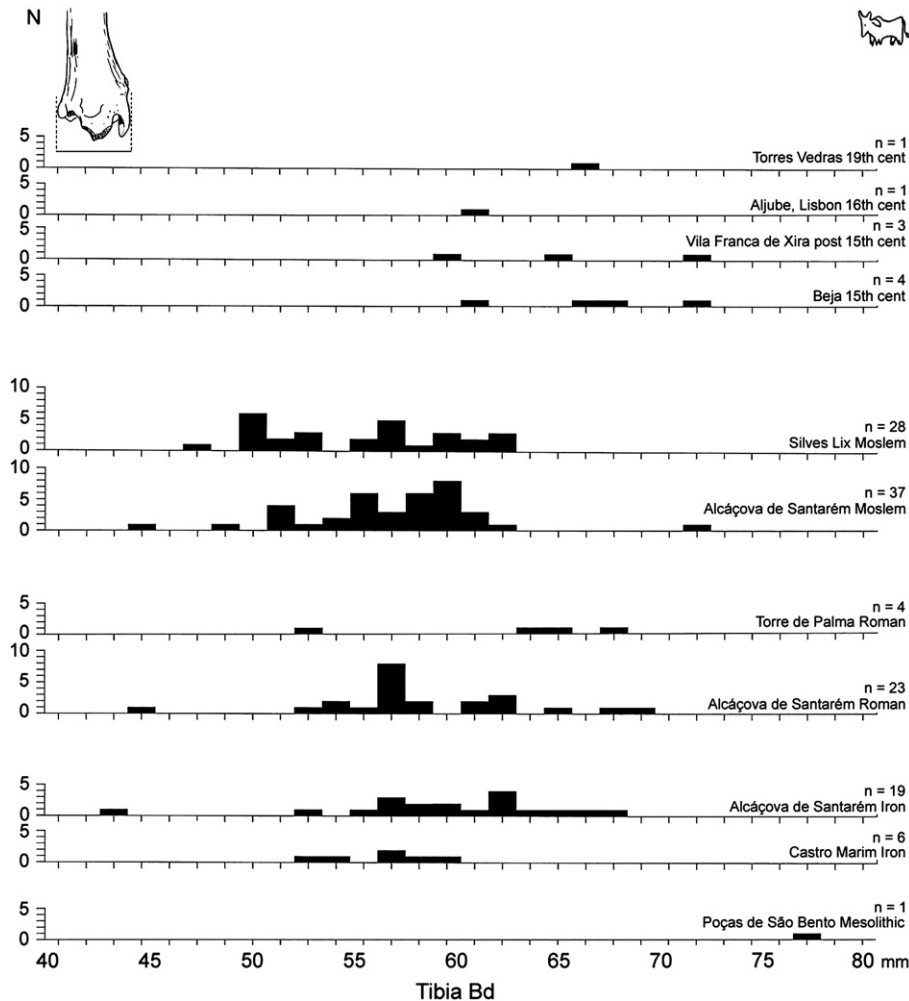


Fig. 13. Cattle size variation in southern Portugal in the course of time. Stacked histograms of the distal width (Bd) of tibiae from Mesolithic, Iron Age, Roman, Moslem and 15th century AD Beja as well as a few tibiae from post 15th century sites. *n* refers to sample size. Note first the very large size (76 mm) of the Mesolithic specimen, presumed to be aurochs, and the absence of any significant size change between Iron Age and Moslem times of the presumed domestic cattle and the subsequent increase by the 15th century AD, although these did not attain the great size of the wild aurochs.

who were in more “intimate contact” with animals were better able to take “technological initiatives”. A similar 14th century crisis and disease induced demographic decline in Portugal (de Oliveira Marques, 1980: 27–8) can be cited here to explain the apparent improvement of Portuguese cattle. According to Gerbet (2000: 306):

La crise de la deuxième moitié du XIV^e s. et du début XV^e s. entraîna une diminution du sol cultivé et une croissance de l'élevage et des pâturages.

Such a line of reasoning, although very speculative, does at least provide a link between the demographic crisis and an improvement of cattle.

6. Conclusions

This osteometric study of sheep and cattle bones from archaeological sites in southern Portugal indicates that sheep

may have undergone a shape change after the Chalcolithic for some presently unknown reason. This animal then became larger in Moslem times. Cattle underwent a size increase after the Christian conquest. A size increase of both the sheep and cattle may have been “meat-driven”; reflecting selection for heavier boned animals with greater meat yield. In the case of sheep this seems quite logical since mutton was and still is much favoured in the Moslem world. Whether new stock such as the Merino was imported from abroad or whether local animals were “improved” must remain within the realm of speculation. While the absence of any observable shape change of the sheep bones between Roman and Moslem periods tends to point in favour of a local improvement rather than import of stock, the genetic evidence based on modern sheep in the Iberian Peninsula does indicate some input from overseas, though just when this occurred is unknown (Pereira et al., 2006). Following the Christian conquest of southern Portugal the sheep took on

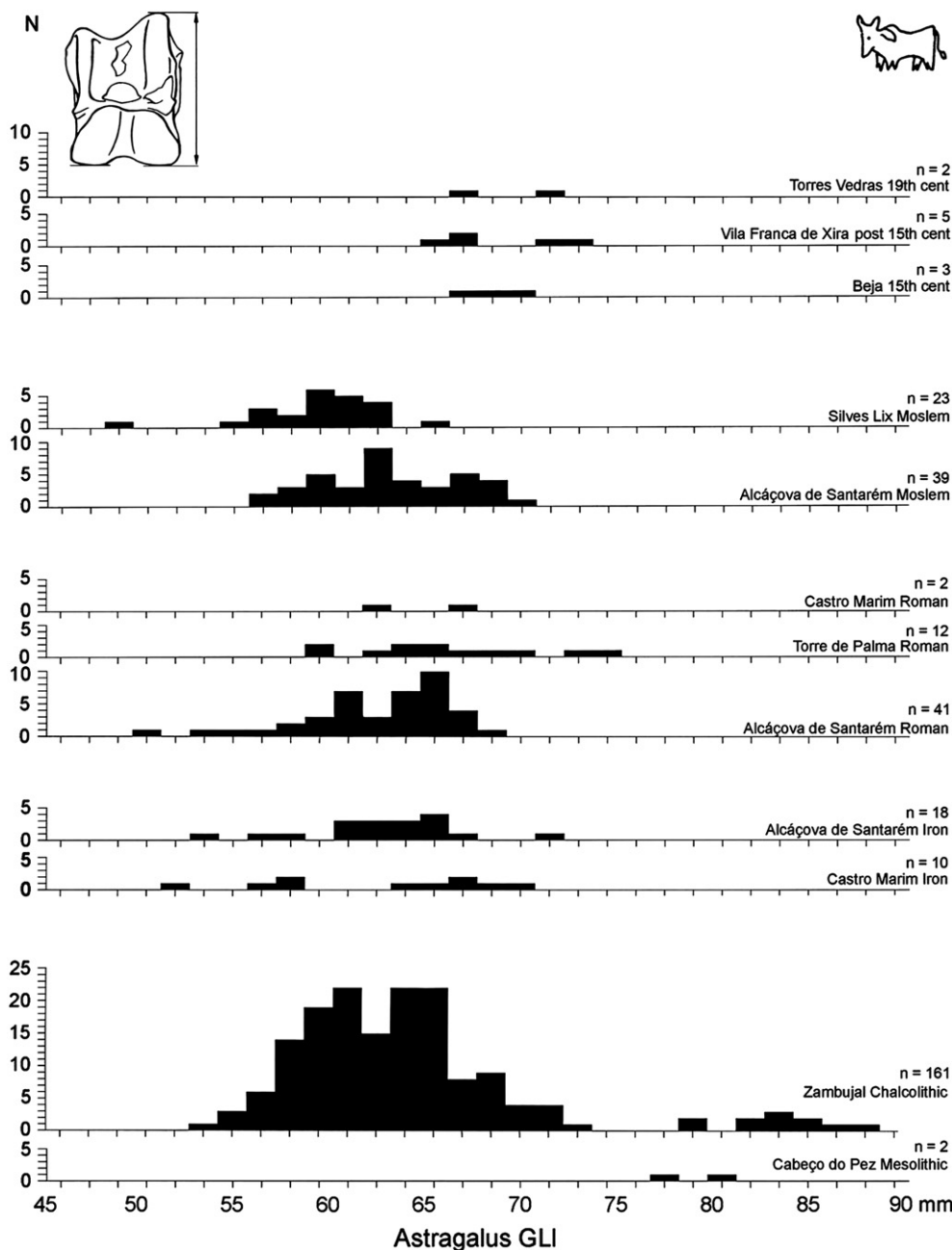


Fig. 14. Cattle size variation in southern Portugal in the course of time. Stacked histograms of measurements of the greatest lateral length (GLI) of astragali of aurochsen and cattle from Mesolithic and Neolithic sites, Chalcolithic (data from Zambujal are from [Driesch and Boessneck, 1976](#)), Iron Age, Roman, Moslem and 15th century AD Beja, as well as a few astragali from post 15th century sites. *n* refers to sample size. Note the very large size of the Mesolithic specimens, as well as the almost separate peak of 11 large specimens in the Chalcolithic all presumed to have belonged to aurochsen. The bulk of the specimens being of smaller size are presumed to be of domestic cattle. Note too the absence of any significant size change between Iron Age and Moslem times of these presumed domestic cattle and the subsequent increase by the 15th century AD, although these did not attain the great size of the wild aurochs.

a new role as provider of wool—a prime source of wealth for Medieval Portugal and Castile. However, as a source of meat this animal was relegated to a subsidiary role with beef and pork becoming the favoured meats. As with the sheep, it is impossible to verify at this stage whether the Christians improved local cattle or imported new stock from abroad. While their Crusader origins would favour a northern source, genetic analyses of Portuguese breeds of cattle favour an

African input ([Cymbron et al., 1999](#)) though this is now thought to have happened in much earlier times—during or before the Bronze Age ([Anderung et al., 2005](#)). It is hoped that continuing archaeological investigations in southern Portugal will produce more data with refined dates which should in turn improve our understanding of the relations between people and their domesticated animals during the last two millennia.

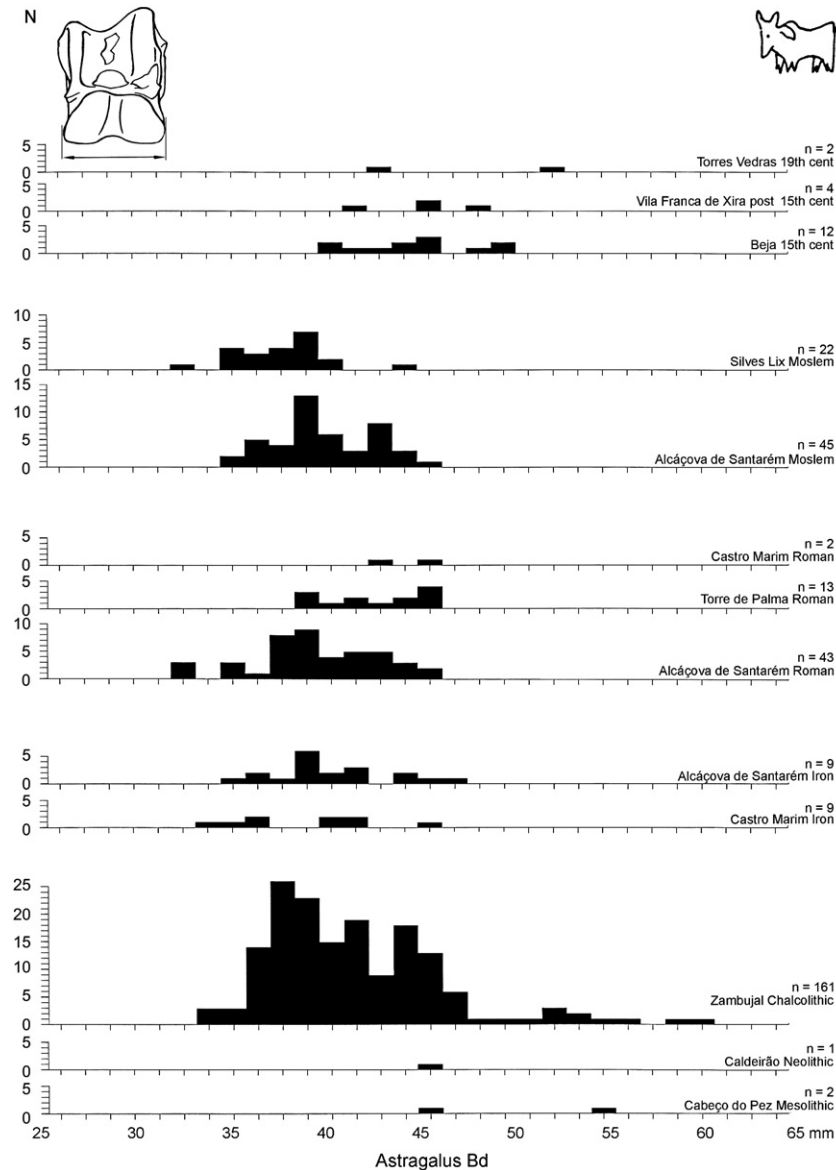


Fig. 15. Cattle size variation in southern Portugal in the course of time. Stacked histograms of measurements of the distal width (Bd) of astragali of aurochs and cattle from Mesolithic and Neolithic sites, Chalcolithic (data from Zambujal are from [Driesch and Boessneck, 1976](#)), Iron Age, Roman, Moslem and 15th century AD Beja, as well as a few astragali from post 15th century sites. *n* refers to sample size. Note the very large size of a small number of specimens (10 have Bd values >50 mm) in the Chalcolithic—presumed to have belonged to aurochs. The bulk of the specimens being of smaller size are presumed to be of domestic cattle. Note too the absence of any significant size change between Iron Age and Moslem times of these presumed domestic cattle and the subsequent increase by the 15th century AD, although these did not attain the great size of the wild aurochs.

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Table 3

Significance of the mean size differences between groups of selected cattle bones and teeth from different periods as indicated by a *t*-test

Measurement	Samples compared	<i>t</i>	Probability
M₃-length	Beja 15th Cent vs. Moslem	7.10	0.000**
M ₃ -length	Moslem vs. Roman	2.46	0.018*
M ₃ -length	Roman vs. Iron	0.98	0.333
M₃-Wa	Beja 15th Cent vs. Moslem	11.32	0.000**
M ₃ -Wa	Moslem vs. Roman	3.43	0.001**
M ₃ -Wa	Roman vs. Iron	0.91	0.371
HU-BT	Beja 15th Cent vs. Moslem	2.72	0.012*
HU-BT	Moslem vs. Roman	1.24	0.266
HU-BT	Roman vs. Iron Age	0.15	0.882
HU-HTC	Beja 15th Cent vs. Moslem	4.35	0.000**
HU-HTC	Moslem vs. Roman	1.26	0.215
HU-HTC	Roman vs. Iron Age	0.69	0.500
MC-BFd	Beja 15th Cent vs. Moslem	6.19	0.000**
MC-BFd	Moslem vs. Roman	2.50	0.015*
MC-BFd	Roman vs. Iron Age	1.83	0.074
MC-Dd	Beja 15th Cent vs. Moslem	8.69	0.000**
MC-Dd	Moslem vs. Roman	2.54	0.013*
MC-Dd	Roman vs. Iron Age	1.16	0.256
TI-Bd	Beja 15th Cent vs. Moslem	4.51	0.000**
TI-Bd	Moslem vs. Roman	2.46	0.016*
TI-Bd	Roman vs. Iron Age	0.15	0.884
AS-GLI	Beja 15th Cent vs. Moslem	2.77	0.007**
AS-GLI	Moslem vs. Roman	2.34	0.021*
AS-GLI	Roman vs. Iron Age	0.77	0.442
AS-Bd	Beja 15th Cent vs. Moslem	6.60	0.000**
AS-Bd	Moslem vs. Roman	2.27	0.025*
AS-Bd	Roman vs. Iron Age	0.79	0.433
AS-DI	Beja 15th Cent vs. Moslem	3.37	0.001**
AS-DI	Moslem vs. Roman	3.23	0.002**
AS-DI	Roman vs. Iron Age	0.36	0.723
MT-BFd	Beja 15th Cent vs. Moslem	8.98	0.000**
MT-BFd	Moslem vs. Roman	0.46	0.645
MT-BFd	Roman vs. Iron Age	0.05	0.959
MT-Dd	Beja 15th Cent vs. Moslem	11.06	0.000**
MT-Dd	Moslem vs. Roman	0.78	0.439
MT-Dd	Roman vs. Iron Age	0.75	0.461

Key: **, the difference is significant at the 1% level; *, the difference is significant at the 5% level; no asterisk, no significant difference. It has been assumed that each bone derives from a different animal. The comparisons between the Moslem period and the 15th century AD are shown in boldface. Due to the problem of distinguishing between domestic cattle and aurochs bones in the Chalcolithic, the Chalcolithic *Bos* samples are not compared with *Bos* from subsequent periods. I have, however, assumed that all *Bos* bones from the Iron Age and subsequent periods belonged to domestic cattle.

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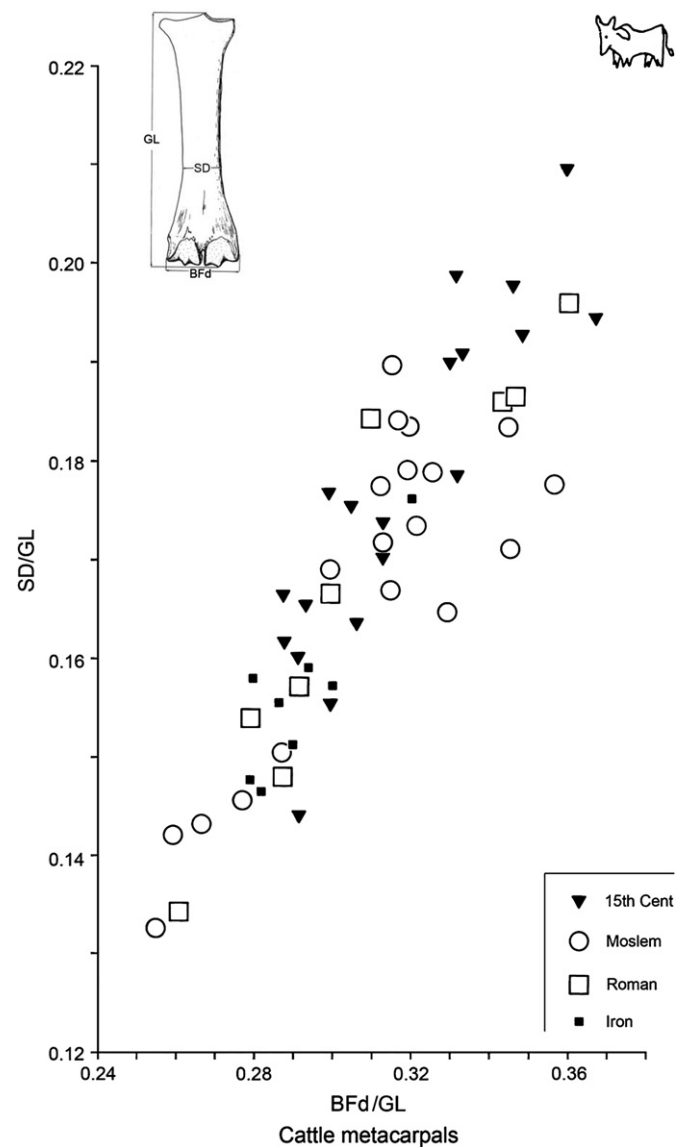


Fig. 16. Cattle metacarpal shape variation in southern Portugal in the course of time. Scatter diagram of the shaft width expressed in relation to the length versus the distal width also expressed in relation to the length, for specimens from the Iron Age, Roman, Moslem and 15th century AD at Beja. All samples appear to plot out along the same axis. The more robust specimens are towards the top right and probably belonged to males while the slenderer ones to the lower left are more likely to have belonged to females. The Moslem period sample may have comprised more males. There is a slight indication that the 15th century AD specimens were on average more robust—note that the whole area of dispersion of these appears to have shifted towards the top right.

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