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The Dynamics of Neolithisation in Europe

Studies in honour of Andrew Sherratt

Edited by

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‘Pig-menting’ the Spanish Neolithic

Angelos Hadjikoumis

Introduction

In this volume, which focuses on the different trajectories that the process of neolithisation took, this chapter contributes to the discussion by focusing on a well-defined geographical area and the relationships that evolved between humans and pigs in that area. Its primary aim is to identify and describe these relationships in the Neolithic, though data from earlier and later periods are also employed to provide a framework for comparison. This study includes an overview of previous relevant studies, discussion of the role that pigs played in the wider context of neolithisation, and presentation of a chronological and spatial overview of the pig-human relationship in prehistoric Spain. Before examining original data, it is useful to briefly review current knowledge of the neolithisation of Spain, and the role of animal domestication in this process.

Research on the emergence of the Neolithic in Spain has been characterised in the last couple of decades by the intellectual confrontation between diffusionists, also known as migrationists, and indigenists, also known as evolutionists (Bernabeu *et al.* 1999). As the above terms reveal, the former suggest the spread of a ‘Neolithic package’ including pottery and domesticated animals and plants, through migration (Juan-Cabanilles and Martí 2002; Vincent-García 1997; Zilhão 2001; Zilhão this volume), while the latter favour a gradual evolution of productive economies from the Epipalaeolithic-Mesolithic substrate (Olaria 1998; 2000; 2004–2005). Research based on genetics remains inconclusive and contradictory, and has been used both to support (Bertranpetit and Cavalli-Sforza 1991) and reject (Arnaiz-Villena and Lubell 2000) a spread of people with neolithic innovations.

The indigenist model has been challenged, on the basis of empirical data, by many researchers (e.g. Bernabeu *et al.* 1999; Fortea and Martí 1984–1985; Zilhão 1993; 2000; 2001) and its influence is currently limited. However, there are many intermediate theories between diffusionism and indigenism (for an overview of these theories in Europe, see Richards 2003, 159, and for their impact in the history of Iberian archaeology, see Hernando 1999; Jorge 2000; Martí and Juan-Cabanilles 1997; Rubio 1997; Zilhão 2003; this volume). For the spread of the Neolithic within the Iberian peninsula, two main models are currently employed, which were developed mainly having in mind the archaeological record of northeast Spain. The first is the 'dual model', which claims the existence of Neolithic sites alongside Mesolithic groups continuing their way of life relatively undisturbed (Bernabeu 2002; Juan-Cabanilles and Martí 2002). Similar models have also been proposed for other areas in Europe (*e.g.*, for Denmark, Rowley-Conwy 1985). The main alternative model, which can be called 'functional', rejects dualism and suggests the existence of a single cultural tradition, which adapted its material culture and economic activities to the available opportunities in different areas (Barandiarán and Cava 1992; 2000; Molina *et al.* 2003).

Andrew Sherratt (2007) expressed the opinion that more than one mechanism must have been responsible for the dispersal of the Neolithic lifestyle in different areas of Europe. In the case of Spain, with its broad variety of climatic, geophysical and environmental conditions, a single mechanism explaining the emergence of Neolithic innovations in all regions is unlikely (*cf.* Barnett 2000). Undeniably, some Neolithic characteristics must have been imported from outside the Iberian peninsula, such as the domestic forms of allochthonous species, but what remains to be resolved is how extensive and widespread the introductions were and how exactly neolithisation evolved as a process in different regions of the peninsula.

Most works focussing on the neolithisation of Spain, and the western Mediterranean in general, inform us of the appearance of Neolithic indicators during the sixth millennium BC (Barnett 2000). Such indicators include domestic animals and plants, Cardial pottery, polished axes and evidence of reduced mobility. In many areas of Iberia such as Valencia and Catalonia (Bernabeu 1989; Bernabeu and Martí 1992; Bosch *et al.* 2000), Andalusia (Acosta Martínez 1987; Navarete and Molina 1987; Socas *et al.* 2004), central and southern Portugal (Arias 1999; Zilhão 2000), the middle and upper Ebro basin (Alday 2000; Arias 1999; Baldellou 1994; Utrilla 2002) and the northern central *Meseta* (Kunst and Rojo 1999; Rojo *et al.* 2006), Neolithic indicators are present already from the sixth millennium BC. On the other hand, in the Atlantic fringe of Spain, geophysically isolated by the Cantabrian mountains to the south, Neolithic indicators cannot be found before the beginning of the fifth millennium BC (Arias 1999; Zilhão 2000), and their effect on local hunter-gatherers seems to have been gradual and slow (Alday 2005; Arias *et al.* 1999; González Urquijo *et al.* 1999).

Socioeconomic and technological changes do not seem to have taken place either simultaneously or uniformly in Spain (*e.g.* see Zapata *et al.* 2005 concerning agriculture). Based on currently available data, these changes seem to be more rapidly established in the Mediterranean area (Ribé *et al.* 1997), though recent archaeological developments in central Spain suggest a shorter chronological difference between areas of the *Meseta* and the Mediterranean coast (*e.g.* Rojo *et al.* 2006). The socioeconomic diversity that we encounter in Spain during the sixth and fifth millennia BC points towards a complex neolithisation process, taking place at different speeds in different regions. Sites dating to the sixth and fifth millennia BC show considerable diversity. It is not until the fourth and third millennia BC, during the Middle-Late/Final Neolithic and

Copper Age, that agriculture and animal husbandry become the dominant subsistence strategy all over Spain (Chapman 2008; *cf.* Geddes 1986; Jiménez 2008).

As mentioned earlier, animal domestication is central to discussion of the origins of the Neolithic (Arias 1999; Barnett 2000; Geddes 1986; Lewthwaite 1986; Price 2000). Although this is also the case in Spain (Altuna 1980; Jorge 2000; Mariezkurrena 1990; Zilhão 2001), pigs have, so far, received limited attention. This is partly explained by the generally low numbers of pig remains excavated, compared to those of other species, as well as the difficulty of metrically distinguishing between wild and domestic forms – also due to the relatively small size of the Iberian wild boar (Albarella *et al.* 2005; 2009; Rowley-Conwy 1995a).

In Spain, the appearance of domestic animals has been placed in the sixth millennium BC (Ribé *et al.* 1997). Although domestic species appear to predominate in some of the earliest Neolithic assemblages in the Iberian peninsula, such as Cova de l'Or, Cova de les Cendres and others in Valencia and Catalonia, hunting remained an important activity in many areas, sometimes in the vicinity of communities possessing domestic animals. In the Bascocantabrian region (Altuna 1980; González Urquijo *et al.* 1999; Mariezkurrena 1990), parts of Navarra (Mariezkurrena and Altuna 1989), Andalusia (Morales and Cantal 2004) and possibly other regions for which we do not have sufficient faunal data, such as central Spain and Galicia, hunting continues to be an important, and in some cases exclusive, source of animal protein for humans. There is a tendency for it to decrease in importance from the sixth to the fourth millennium BC, when productive economies become dominant over most of Spain. So far, there has been no available thematic work specifically addressing the role of pigs during the neolithisation process in Spain. However, what we do have available are the published zooarchaeological site reports from all over the country and a few synthetic zooarchaeological works focusing on specific provinces or autonomous communities (Altuna 1980; Castaños 1986; Mariezkurrena 1990; Morales and Cantal 2004).

The pig, in its wild form, is and has been present in Europe and Spain at least since the Upper Pleistocene (Altuna 1990; Groves 1981; Ortega *et al.* 2006). In Spain in particular, there are indications suggesting that the wild boar was becoming progressively more abundant as temperatures and deciduous forests recovered from the last glaciation (Altuna 1972; Arroyo 2004; Aura *et al.* 2002). Domestic pigs have been identified from various Early Neolithic sites of the sixth and fifth millennia BC, such as La Draga in Catalonia (Saña 2000) and Cueva de la Vaquera in the northern plateau (Morales and García 1998). Identifications of domestic pigs in pre-Neolithic times are not accepted as valid by most zooarchaeologists and this is also the case for some of the earliest Neolithic cave-sites of southern Spain (Rowley-Conwy 1995b). Some of the domestic species found in Early Neolithic levels in Spain, such as sheep, were certainly imported since their wild progenitors did not exist in the Iberian peninsula. The same cannot be assumed for pigs, since wild boars were relatively abundant immediately before and during the Neolithic period. For this reason, Altuna (1980) stated that since the wild boar is present, local domestication, or at least genetic contribution from wild pigs to the domestic stock, cannot be excluded. In the interpretation of the evidence presented in this chapter no possible scenario was excluded a priori.

According to the existing literature, during the course of the Neolithic the relationship between human and pig shows signs of increasing complexity. Before the Neolithic, hunting was the only regular form of interaction with pigs. In the Basque Country, parts of Navarra, Andalusia and possibly other areas of Iberia, bone assemblages dated to the Early Neolithic generally contain high percentages of wild species (Mariezkurrena 1990; Morales and Cantal 2004). In Catalonia, a dichotomy has been observed in the reliance on hunting between cave and open-air sites. In cave sites, hunting appears to be a quite significant activity while in open-air sites there is a greater reliance on domestic species, including pigs (Saña 1998). Though later in the Neolithic the hunting of wild pigs declined, while the importance of domestic pigs increased, this was not a sudden phenomenon (Mariezkurrena 1990).

A well-covered area with a long zooarchaeological tradition is represented by Cantabria, the Basque Country and Navarra. Jesus Altuna, who has undertaken zooarchaeological research in this area since the 1960's, studied pig remains from several prehistoric sites. In his doctoral thesis (1972) he compared the size of pre-Neolithic and Neolithic wild boar from the Bascocantabrian region with that of Neolithic central European animals and concluded that Spanish wild boar was of small to medium size. In a later work Altuna (1980), relying on the study of substantial faunal assemblages, reviewed the evolution of animal domestication from the Neolithic to the Roman period and suggested a late and slow neolithisation of the Basque Country, fully developed only by the fourth millennium BC. The main zooarchaeological argument for this view is the fact that hunting continued to be of great economic significance through the whole Neolithic, even after the appearance of domestic livestock, and only during the Eneolithic and Bronze Age was a sharp decrease observed. This was accompanied by reduction in the size of pigs.

Castaños (1986), in his doctoral thesis dealing with Pleistocene and Holocene faunal assemblages from the Basque province of Vizcaya, discusses the evolution of the relationship between pigs and humans in that area. He considers all pre-Neolithic pig remains as wild and notes an increase in wild boar numbers after the last glaciation, especially during the Mesolithic period. Using data from the extensive, multi-period assemblage of Santimamiñe, Castaños (1984) detects the presence of domestic pigs from the Neolithic onwards, based on biometry, age and sex structure of the pig population. He also notes a general size decrease in pigs after the end of the Neolithic, a trend also identified by von den Driesch (1972) and Morales (1976) mainly for southern Spain. This fact, combined with the general decrease in the importance of hunting, reduced mobility and greater expenditure on communal infrastructure and monuments observed after the Neolithic period (Chapman 1990), indicates a more intensive and probably sedentary pig husbandry strategy. Greater genetic isolation of domestic from wild pigs perhaps combined with a conscious selection of smaller-bodied, more manageable, animals or a possible deterioration in their living conditions may explain the observed size decrease. In addition, work carried out on pig remains from Italy, dating from Mesolithic to Bronze Age, has revealed similar biometric patterns suggesting a parallel trajectory in pig domestication (Albarella *et al.* 2006).

The hypothesis that domestic pigs were present in Spain at some point in the Neolithic is currently considered as a certainty by the majority of researchers working on Spanish material, though there is some disagreement concerning the timing of such appearance (Rowley-Conwy 1995a; 1995b). However, as more assemblages are studied, we become more confident that domestic pigs were indeed present in Spain since the Early Neolithic. Such occurrence has been suggested for sites dating to the sixth and fifth millennia BC, such as Cueva de la Vaquera (Morales and García 1998), La Draga (Saña 2000), Cueva Chaves (Castaños 2004) and a group of four southern Spanish cave sites (Sarsa, Parralejo, Dehesilla and Nerja) studied by Boessneck and von den Driesch (1980). It does, however, remain to be clarified on what basis such assumptions have been made and how the biometrical and morphological characters of these pigs compare with each other. There are also many other questions that still need to be fully addressed: how did pig domestication take place and at what speed? How geographically widespread and uniform was it? Which economic strategies were associated with it and how did this process evolve?

Materials and methods

The material used for this study derives from archaeological assemblages excavated in Spain, though data from an assemblage from southern France will also be used for comparative purposes. Details of the archaeological assemblages used for this chapter can be viewed in Table 10.1 and their geographical location can be found in Figure 10.1. As Figure 10.1 shows, the analysed assemblages derive from different geographic and climatic zones of Spain. As far as chronology is concerned, there is a focus on the Neolithic, especially its early phase, in order to address the general theme of this volume.

In Spain, Neolithic animal bone assemblages are usually small and contain few pig bones, and the situation is even less favourable for the pre-Neolithic record. This makes research on the early stages of pig husbandry challenging, and raises the need to investigate it in a wider chronological perspective. Consequently, two later prehistoric assemblages – Valencina de la Concepción and La Hoya – with abundant pig remains have also been analysed and are discussed here.

All assemblages were previously studied by other researchers and are fully published, with the exception of the material from the latest excavations at Cova Fosca, which is still under study at the Archaeozoology Laboratory of the Universidad Autónoma of

Figure 10.1: Map of Spain showing the geographical location of the sites mentioned in this chapter. See Table 10.1 for site numbers.

Madrid. However, all recorded specimens have been re-examined and re-identified by the author and, when appropriate, measured and their age-at-death and sex determined. The aim was not a full re-analysis of the studied assemblages but rather the collection of selected data for the purpose of my doctoral project.

The protocol used for recording information from pig bones and teeth follows a system based on that outlined by Davis (1992) and Albarella and Davis (1996), with some modifications relevant to the present project. This system is based on the identification and recording only of specific zones of specific skeletal elements.

No attempt was made to separate first and second molars when isolated. Since these teeth were measured, identification was possible at a latter stage wherever size groups could be identified. Previous work has demonstrated that, although second molars are consistently larger than first molars, overlaps can occur and therefore identifications merely based on a sight-based size assessment at recording stage may lead to errors and biases (Albarella *et al.* 2005). Permanent canines and their alveoli were – whenever possible – sexed.

All the recorded elements were also inspected for burning marks and pathological conditions, in order to take into account potential biometrical biases created by these conditions.

	Site	*Chronology*	*Location*	*Recorded specimens*	*References*
1	Cueva del Castillo	Musterian	Cantabria, Spain	1 (t)	Klein and Cruz- Uribe (1994)
2	Cueva del Mazo	Palaeolithic	Cantabria Spain	1 (t)	Limited information in: Azcuénaga Vierna (1976)
3	Cueva del Pendo	Magdalenian	Cantabria, Spain	1 (t)	Fuentes Vidarte (1980)
4	Cueva del Otero	Magdalenian	Cantabria Spain	2(pc) 8 (t)	Madariaga de la Campa (1966)
5	Cueva de Zatoya	Advanced Magdalenian-Epipalaeolithic	Navarra Spain	47 (pc) 65 (t)	Mariezkurrena and Altuna (1989) Altuna and Mariezkurrena (2001a)
6	Cueva de Cubío Redondo	Mesolithic	Cantabria Spain	2 (pc) 3 (t)	Castaños (2001)
7	Abrigo de la Peña	Epipalaeolithic	Navarra, Spain	14 (pc)	Castaños (1991-1992)
8	Cueva Chaves	Early Neolithic (sixth-fifth millennia BC, levels Ia and Ib combined)	Huesca Spain	344 (pc) 227 (t)	Castaños (2004)
9	Cova Fosca	Early Neolithic (sixth millennium BC)	Castellón Spain	55 (pc) 30 (t)	Llorente (2007)
10	La Draga	Early Neolithic (second half of sixth millennium BC)	Catalonia Spain	84 (pc) 55 (t)	Saña (2000)
11	Sant Pau del Camp	Early Neolithic (end of fifth-beginning of fourth millennium BC)	Catalonia Spain	12 (pc) 20 (t)	Colominas *et al.* (2008)
12	Cueva de la Vaquera	Early Neolithic (5500–4700 BC)	Segovia Spain	67 (pc) 12 (t)	Morales and García (1998)
13	Roucadour	Middle Neolithic (end of fifth-fourth millennium BC)	Midi-Pyrénées France	31 (pc)	Lesur *et al.* (2001)
14	La Renke	Late Neolithic (3300—2700 BC)	Álava Spain	9 (pc) 20 (t)	Altuna and Mariezkurrena (2001b)
15	Los Castillejos	Middle/Late Neolithic-Copper Age (3800–2500 BC)	Granada Spain	170 (pc) 110 (t)	Ziegler (1990)
16	Valencina de la Concepción	Copper Age (around 2100 BC)	Sevilla Spain	2122 (pc) 473 (t)	Hain (1982)
17	La Hoya	Iron Age	Álava Spain	832(pc) 708 (t)	Altuna (1980)
	TOTAL			3791(pc) 1748 (t)	

Table 10.1: Overview of assemblages and number of recorded postcranial bones (pc) and teeth (t). Teeth include loose teeth and jaws. Sites are listed in approximate chronological order. Some of the sites have a broader timespan of occupation than indicated in the table below, but only the levels used in the analysis are listed.

Ageing

The state of fusion was recorded for all epiphyses. Since the astragalus has no epiphyses, it was recorded as 'normal', 'light' or 'porous', based on its overall external appearance and weight. Although these terms are subjective they nevertheless provide a crude, but helpful way to classify the recorded astragali. For example, only 'normal' astragali, unlikely to belong to very young individuals, were used in comparison to fused bones. Although we cannot rule out that such astragali could, to a limited extent, have grown further, this is also the case for fully fused bones (Payne and Bull 1988).

Epiphyses were considered as 'fused' when no open parts were present along the fusion line and 'fusing' when an opening, however small, along the fusion line was still visible. Eruption and wear stages were recorded using the system established by Grant (1982) and the age categories 'neonatal', 'juvenile', 'immature', 'subadult', 'adult' and 'elderly' are used *sensu* O'Connor (1988) throughout this study.

Sexing

Sex determination was exclusively based on the size and morphology of lower and upper canines and their alveoli. However, this can only be reliably determined on individuals old enough to have sufficiently developed permanent canines.

Biometry

In the analyses presented below, the emphasis is on the presentation of the biometric data. Beyond the use of simple scatterplots, a size index scaling technique has been employed in order to increase sample size and allow comparisons with relevant assemblages (Meadow 1999). This method compares measurements to standard values, allowing for different measurements to be plotted on the same scale. The comparison has been achieved through the calculation of the decimal logarithm of the ratio between a specific measurement and its standard (Payne and Bull 1988). The standard used for this project is derived from pig measurements from the Neolithic site of Durrington Walls in England (Albarella and Payne 2005).

Postcranial bones

The measurements listed in Table 10.2 have been taken when possible on fused, fusing and unfused bones. The measurements follow the definitions provided by von den Driesch (1976), Payne and Bull (1988), Albarella and Payne (2005) and Albarella *et al.* (2005).

Measurements: teeth/mandible

The measurements listed in Table 10.3 were taken for upper and lower teeth as defined in Payne and Bull (1988). M3WC and M3WP – the latter only taken on the lower tooth – are the greatest widths of the central and posterior cusps of the third molar and were taken following the same criteria as the other width measurements defined by Payne and Bull (1988). No measurements were taken if the enamel had been entirely lost. No length measurements were taken on upper and lower third molars when their wear was more advanced than stage 'wb' (as defined in Albarella and Payne 2005) on both anterior cusps (see Albarella and Payne 2005). This level of wear is equivalent to stage 'g' as defined by Grant (1982) for lower teeth. The crown lengths of the first and second molars are not listed below because they were taken in a slightly different way than described in Payne and Bull (1988). Furthermore, analyses including the crown lengths of first and second molars produced very similar results to those including only cusp widths, which have also been found to be less affected by age (Payne and Bull 1988).

Anatomical Element	*Measurement*	*Description*	*Reference*
Atlas	H	Height	Albarella and Payne (2005)
	BFcr	Width of cranial articular surface	von den Driesch (1976)
Scapula	SLC	Width of collum	von den Driesch (1976)
Humerus	BT	Width of trochlea	Payne and Bull (1988)
	HTC	Minimum diameter of trochlea	Payne and Bull (1988)
Radius	GL	Greatest length	von den Driesch (1976)
MTC III and IV	GL	Greatest length	von den Driesch (1976)
Pelvis	LAR	Diameter of acetabulum	Payne and Bull (1988)
Femur	DCP	Depth of the caput femoris	Payne and Bull (1988)
Tibia	BdP	Distal width	Payne and Bull (1988)
	Dd	Depth of the distal end	von den Driesch (1976)
	GL	Greatest length	von den Driesch (1976)
Astragalus	GLl	Lateral length	von den Driesch (1976)
	GLm	Medial length	von den Driesch (1976)
Calcaneum	GL	Greatest length	von den Driesch (1976)
	GD	Greatest depth	Albarella and Payne (2005)
MTT III and IV	GL	Greatest length	von den Driesch (1976)

Table 10.2: List of postcranial measurements taken.

Element	*Measurement*	*Description*	*Reference*
dP^4, dP_4	WP	Posterior cusp width	Payne and Bull (1988)
M^1, M_1	WA	Anterior cusp width	Payne and Bull (1988)
	WP	Posterior cusp width	
M^2, M_2	WA	Anterior cusp width	Payne and Bull (1988)
	WP	Posterior cusp width	
M^3	WA	Anterior cusp width	Payne and Bull (1988)
	WC	Central cusp width	Albarella *et al* (2005)
M_3	L	Crown length	Payne and Bull (1988)
	WA	Anterior cusp width	
	WC	Central cusp width	Albarella *et al* (2005)
	WP	Posterior cusp width	
Mandible	Height	Height in front of M_1 on buccal side	von den Driesch (1976)

Table 10.3: List of maxillary and mandibular measurements taken.

Results

Sex ratios

Sex ratios, estimated on the basis of the morphology of lower and upper canines and their alveoli, were for most of the studied assemblages based on samples that are too small to allow elaborate analyses.

From the pre-Neolithic, the only assemblage which provided some indication of the male-female ratio derives from the Final Magdalenian/Epipalaeolithic levels of the cave site of Zatoya. Only a small number of canines was recorded, but nonetheless the combined total of upper and lower loose male and female canines suggests a tendency towards an equal representation (seven canines attributed to each sex) in the assemblage. Since the excavated soil was sieved we can assume that these figures were not seriously affected by recovery biases.

From the Neolithic period we have a good number of recorded canines only from the Early Neolithic cave site of Cueva Chaves. In the analysis, the two Early Neolithic levels, 'Ia' and 'Ib', are combined because they produced almost identical results, according to which male and female pigs are almost equally represented, perhaps with a slight tendency for more females than males (Figure 10.2).

For Early Neolithic La Draga the sample of sexed canines is small and hence can only be taken as a very crude indication of the sex structure of its pig population. A separate analysis of jaws (4 specimens) and loose teeth (8 specimens) indicated a female majority (3:1) in jaws and a male majority (7:1) in loose canines. In general, results based on jaws are considered as more reliable because they are less affected by recovery bias, although the produced results could also be affected by the small sample size. In view of the inconsistent results, the only safe conclusion is that both male and female pigs are represented at Early

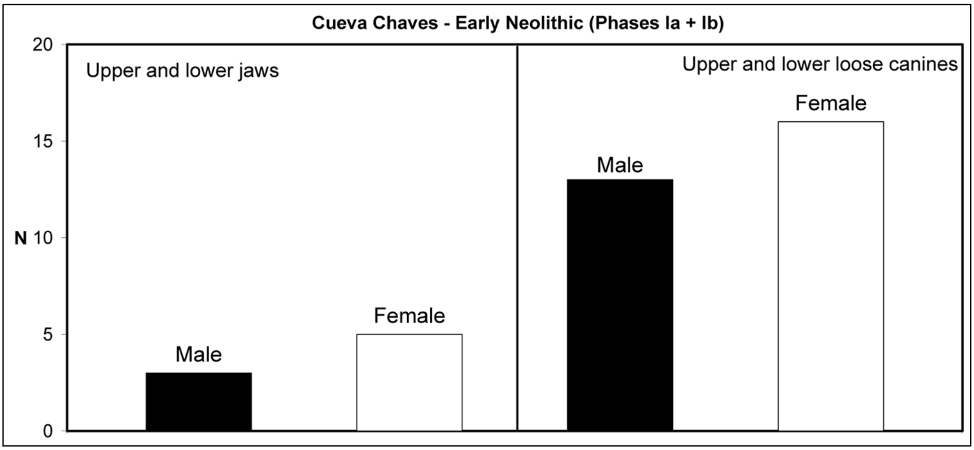

Figure 10.2: Numbers of sexed jaws (left side) and sexed loose canines (right side) for Early Neolithic Cueva Chaves.

Neolithic La Draga and the same holds true for other Neolithic assemblages with scanty sex data, *i.e.* Cova Fosca, Cueva de la Vaquera, Sant Pau and Los Castillejos.

The two post-Neolithic assemblages, Copper Age Valencina de la Concepción and Iron Age La Hoya, have provided a sufficient number of sexed jaws for reliable analyses to be carried out. In both sites, recovery was by hand and this should be taken into account in interpreting the results. At Valencina de la Concepción, when the combined total of upper and lower jaws is taken into account (Figure 10.3, left side), female pigs are much more abundant (31) than males (15). When only loose canines are taken into account (Figure 10.3, right side) the ratio is inverted in favour of the males (42 males as opposed to 20 females), but this can be attributed to a recovery bias in favour of the larger male canines. The female majority in Valencina de la Concepción is an interesting pattern that seems to deviate from the, admittedly scarce, indications we have about Neolithic and pre-Neolithic assemblages, which exhibited a tendency towards an equal male:female ratio.

There is an even more pronounced female majority in the pig assemblage of La Hoya. At La Hoya 38 jaws were identified as female while only 11 as male (Figure 10.4, left side). When only loose canines are taken into account, the female majority is reduced (Figure 10.4, right side) but again the counts based on jaws are considered more reliable because they are less affected by recovery biases.

Taking into account the sex profiles presented here and more extensive work carried out for my doctoral studies (Hadjikoumis 2010) a clear chronological tendency towards an increasing female majority from the Neolithic to the Iron Age (sixth-first millennium BC) is evident. The slight predominance of females identified in some Early Neolithic assemblages (more reliably at Cueva Chaves and hinted at La Draga) becomes a clear majority in the Copper and an overwhelming majority in the Iron Age (La Hoya).

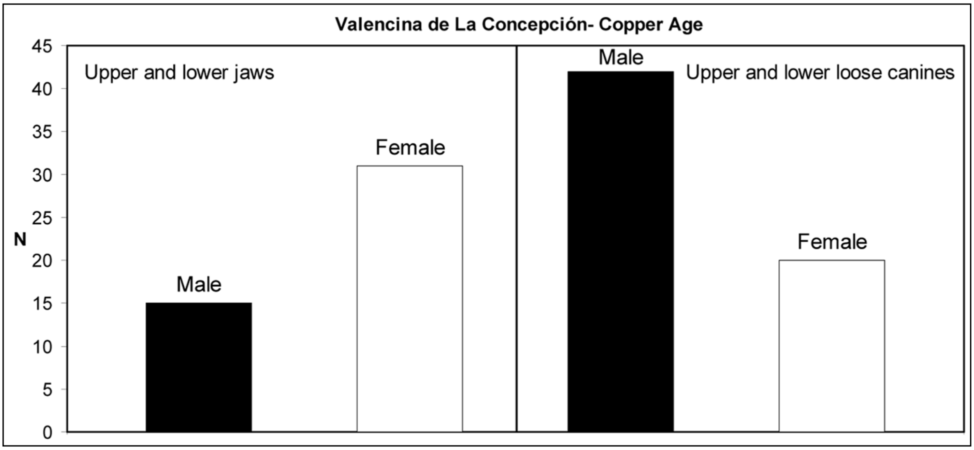

Figure 10.3: Numbers of sexed jaws (left side) and sexed loose canines (right side) for Copper Age Valencina de la Concepción.

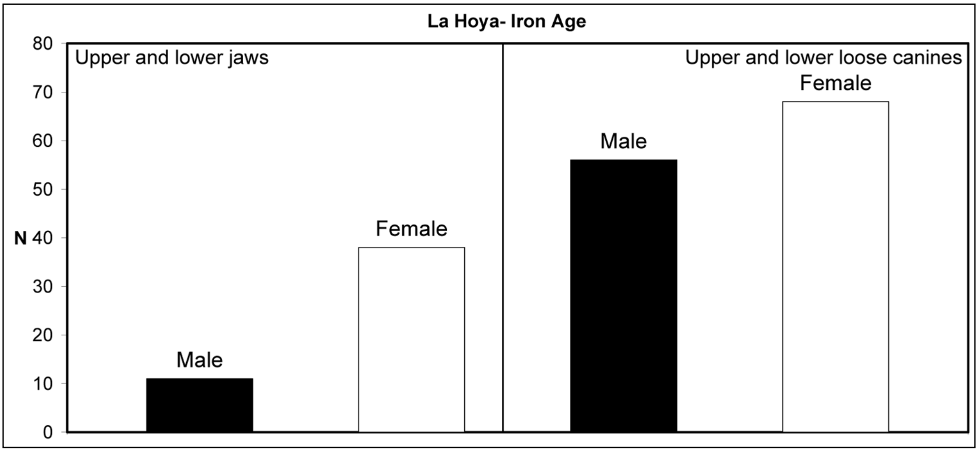

Figure 10.4: Numbers of sexed jaws (left side) and sexed loose canines (right side) for Iron Age La Hoya.

Ageing

Age-at-death data, based on bone fusion and dental eruption and wear, were recorded and analysed for two main reasons. First, to better evaluate the husbandry practices and hunting strategies reflected in the studied assemblages and, secondly, to enhance the interpretation of biometrical data as the biometry of many body parts is, to a varying extent, affected by age. As is the case with the sex data, not all the studied assemblages provided sufficient ageing data for reliable analyses to be carried out, and this is particularly the case for the pre-Neolithic assemblages.

The Early Neolithic site of Cueva Chaves presents an interesting pattern (Figure 10.5). Dental eruption and wear data (Figure 10.5, left side) reveal two mortality peaks; the first at neonatal age (23%) and the second, most prominent, at 'immature' age (41%). This pattern is corroborated by the epiphyseal fusion data (Figure 10.5, right side) which show that almost 60% of the pig population was killed before or near the first year of age. Very few pigs were killed between the first and second year, while another 31% was killed roughly between the second and the third year of age. Both tooth eruption/wear and epiphyseal fusion suggest that only a small percentage of the population reached the fourth year and beyond.

No other Early Neolithic assemblage has provided an ageing dataset as large as that of Cueva Chaves, but it is still of some value to comment on the available information from the other sites.

At La Draga, based on epiphyseal fusion, we have relatively reliable information only on early (30 specimens) and middle fusing (22 specimens) elements. These show that about 30% of the population was killed before or near the first year of age while by roughly two years of age 45% was killed. This pattern is not supported by the few aged

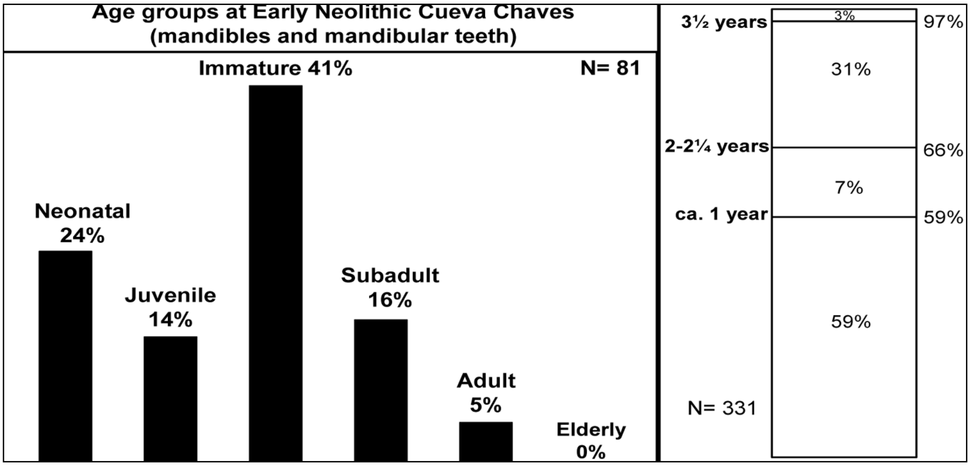

Figure 10.5: Age profiles of the Early Neolithic pig population of Cueva Chaves based on dental eruption and wear (left side) and epiphysial fusion (right side).

mandibles (twelve specimens) and loose teeth attributable to one or two age groups (nine specimens). These data suggest that almost 90% of the population was killed earlier than the end of the second year. This discrepancy between epiphyseal fusion and dental data is likely to be a consequence, at least to a certain extent, of the small size of the samples involved or contextual differences, especially because further analyses with new material recovered from La Draga revealed significant differences between contexts in the estimated age structure of the pig population (Maria Saña, pers. comm. January 2009).

Cueva de la Vaquera yielded no dental eruption/wear data worth mentioning here. The scarce epiphyseal fusion data suggest that a high percentage (42% or eight of nineteen specimens) was killed at or before the first year of age. By the end of the second year 88% of the population (fifteen of seventeen specimens) was killed. As in La Draga, these results are to be interpreted with caution due to the small sample size.

The pig assemblage from the French Middle Neolithic site of Roucadour has not been analysed by the author. However, since some postcranial measurements have been used in the biometric analyses presented later, it is of some use to provide the age structure of its pig population as presented in Lesur *et al.* (2001). According to them, based on dental eruption and wear, there is a slaughtering peak at 12–18 months (40%). 20% was killed at 0–6 months and about 25% at 6–12 months of age. Approximately 5% was attributed to each of the age intervals thereafter, *i.e.* 18–24 and 24–30 months.

As far as the two post-Neolithic sites are concerned, the samples are large enough to allow reliable analyses. Both lines of ageing evidence from Copper Age Valencina de la Concepción provide us with broadly consistent results. Dental eruption and wear (Figure 10.6, left side) show a slaughtering peak of about 40% of the population in the ‘subadult’ stage, or roughly during the second year in absolute age. Another 46%

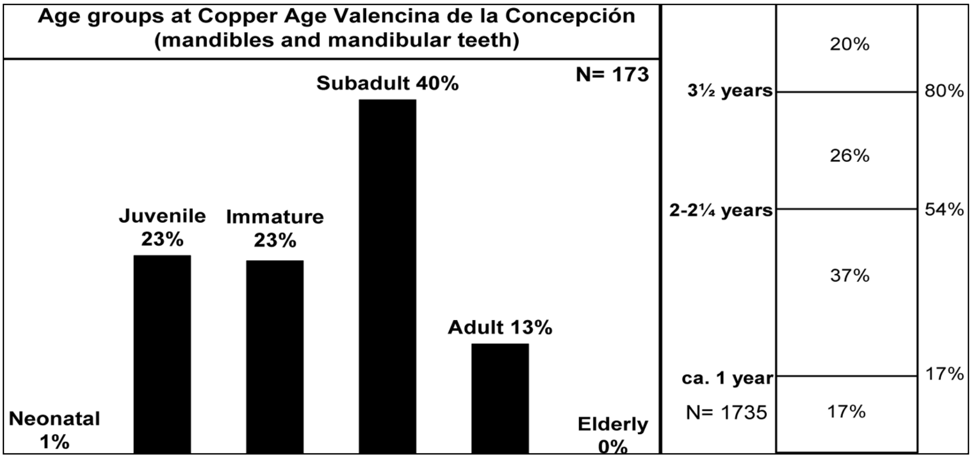

Figure 10.6: Age profile of the Copper Age pig population of Valencina de la Concepción based on, dental eruption and wear (left side) and epiphysial fusion (right side).

of this Copper Age pig population was slaughtered in equal proportions (23% each) in the 'juvenile' and 'immature' age stages, roughly equivalent to the first year. About 13% survived into the 'adult' stage, or beyond the end of the second year in absolute age. According to epiphyseal fusion data (Figure 10.6, right side), a major slaughtering peak (37%) is identified between the first and the second year, while a less pronounced peak is identified in the 2–3.5 years interval. About 20% of the population reached adulthood, while a similar percentage (17%) was killed before reaching its first year of age. Although the two lines of ageing evidence are broadly compatible, there is a tendency towards an 'older' age profile when epiphyseal fusion only is considered. This could be a product of an almost universal preservation bias against young bones, which tend to be less dense and hence more vulnerable to various taphonomic agents.

The pig population of Iron Age La Hoya has a generally similar age structure to that of Valencina de la Concepción, though some differences can also be identified. Based on dental eruption and wear (Figure 10.7, left side) La Hoya shows a pattern without a major slaughtering peak but rather a gradually increasing percentage of slaughtered animals from 'juvenile' to 'adult' stages. The results show very few neonatal individuals (3%), 18% in the 'juvenile' (roughly up to 6 months old) and 20% in the 'immature' (roughly 7–13 months old) stages. Beyond the first year, 26% of the La Hoya Iron Age pig population was culled during the second year and 33% beyond that. Epiphyseal fusion (Figure 10.7, right side) is quite consistent with tooth eruption/wear, showing a similar rate of slaughter, although – as was the case with Valencina de la Concepción – with lower survival rates in the first and higher beyond the second year.

In general, both La Hoya and Valencina de la Concepción exhibit patterns which seem to reflect periodic slaughter of animals between the 'immature' and 'subadult'

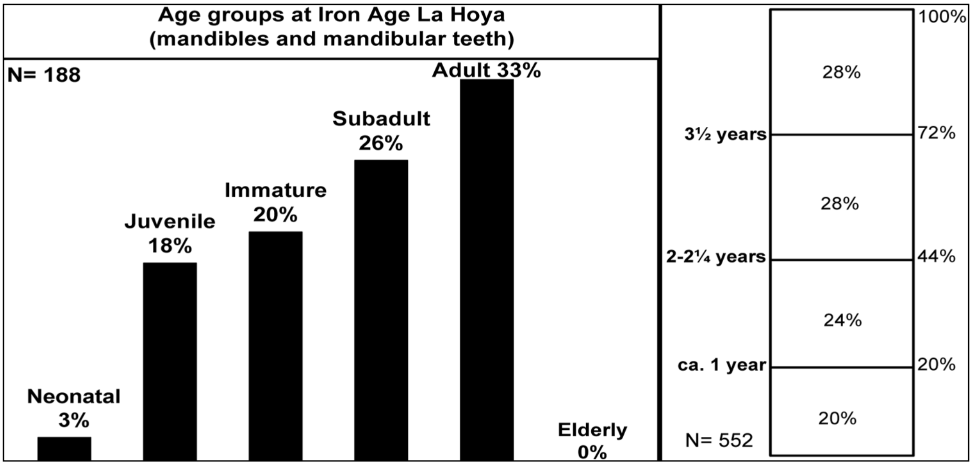

Figure 10.7: Age profile of the Iron Age pig population of La Hoya based on, dental eruption and wear (left side) and epiphysial fusion (right side)..

stages or between the first and third years of age. The low percentages of neonatal remains in both assemblages may be partly attributed to a recovery bias, since the vast majority of remains was recovered by hand. An alternative or additional reason for the low percentages of neonatal remains could be a minimization of post-natal losses by improved husbandry practices. The major difference between the age structure of Valencina de la Concepción and that of La Hoya is the higher percentage of adult pigs – older than 2–3 years in absolute age – in La Hoya compared to Valencina de la Concepción. Recently analysed data from all over Spain highlight a general tendency in prehistoric pig populations towards an 'older' age profile from the Neolithic to the Iron Age (Hadjikoumis 2010). This may be due to a gradual change in pig husbandry towards a strategy aiming at slaughtering most animals at their maximum weight.

Bone biometry

The astragalus is the bone that produced by far the most measurements. The greatest lateral length (GLl) and the greatest medial length (GLm) are plotted from individual and combined sites dating from pre-Neolithic periods to the Iron Age (Figure 10.8). It is possible to divide the measurements into two major groups, with an area of overlap, as illustrated by the two super-imposed oval shapes. The upper group consists of pre-Neolithic and Early Neolithic specimens – with two Copper Age large outliers – while the lower group consists predominately of post-Neolithic specimens. Earlier pigs are generally larger, though some overlap occurs.

Since no other postcranial element has yielded a sufficient number of measurements for an individual scatterplot to be produced, measurements from fully fused postcranial elements were combined to produce log ratio histograms. These do not include the

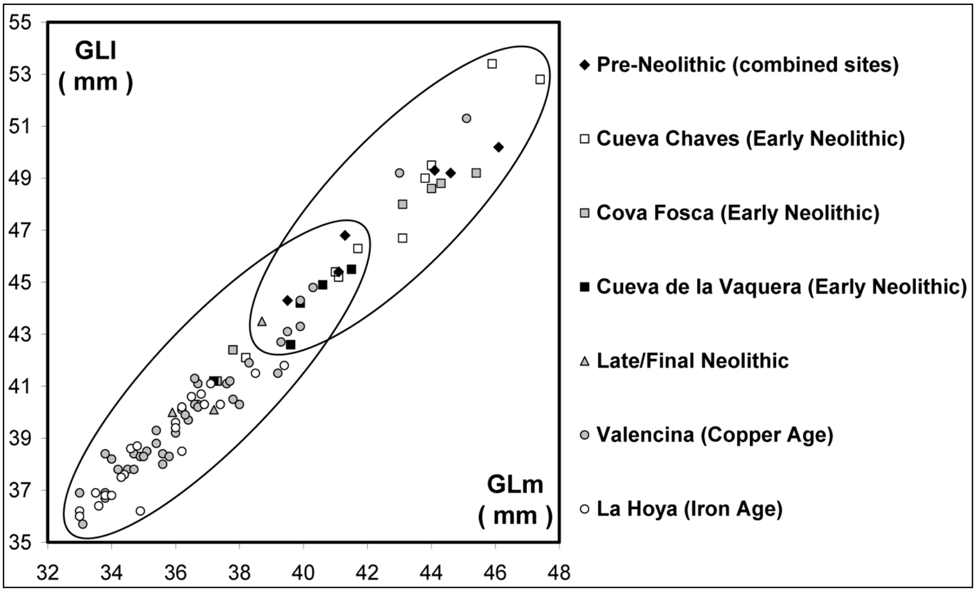

Figure 10.8: Scatterplot of astragalus measurements (GLl x GLm) from different sites (see right side). Light and porous specimens were excluded. The upper right oval includes all pre-Neolithic and most Neolithic measurements while the lower left oval includes most of the Copper and Iron Age measurements.

width of the scapula neck, known to be heavily affected by age (Payne and Bull 1988; Rowley-Conwy 2001).

In Figure 10.9 the measurements from the combined pre-Neolithic specimens are compared with those from three Early Neolithic and one Copper Age site. Figure 10.9 shows that the pigs of the three Early Neolithic cave sites, Cueva Chaves, Cova Fosca and Cueva de la Vaquera, were of similar size to the pre-Neolithic, presumably wild, pigs. Only at the site of Cueva de la Vaquera is there a tendency towards a smaller size. The measurements of the, predominately domestic, faunal assemblage of Copper Age Valencina de la Concepción offer a valuable comparison with those of early prehistoric sites. The most obvious comment is that the pigs of Valencina de la Concepción were significantly smaller than their pre-Neolithic and Early Neolithic counterparts. The mean of the population is clearly to the left of the line representing the Durrington Walls standard as is the vast majority of the individual measurements. The tail of measurements to the right of the, otherwise normal, distribution most probably represents wild individuals but this will be commented upon in greater detail in the discussion.

In the top of Figure 10.10 pig bone measurements from the Middle Neolithic assemblage of Roucadour (Umberto Albarella, personal data), considered to contain only wild pigs and wild species in general, are compared with two Early Neolithic, a Copper Age and an Iron Age site. The picture presented is similar to that of Figure

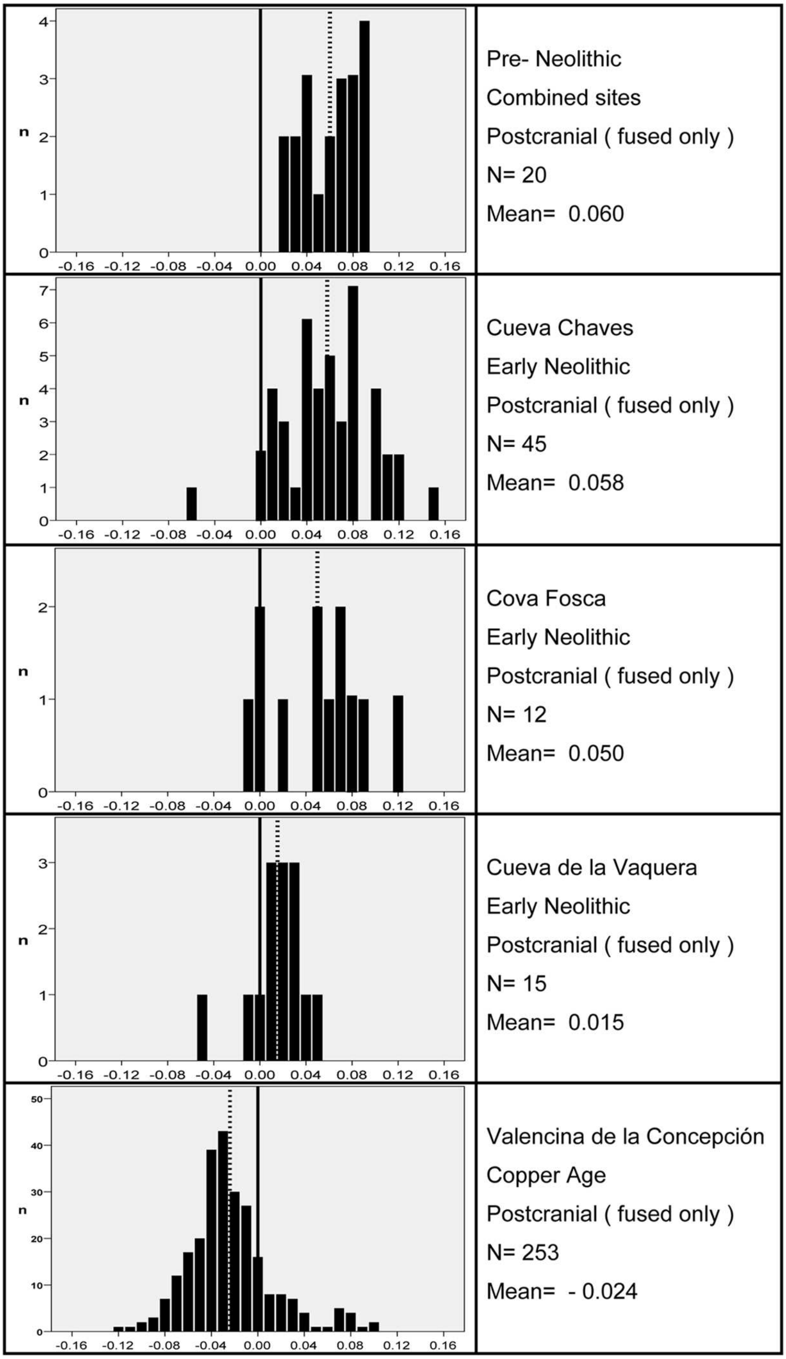

Figure 10.9: Histograms comparing pig postcranial measurements from different prehistoric sites in Spain.

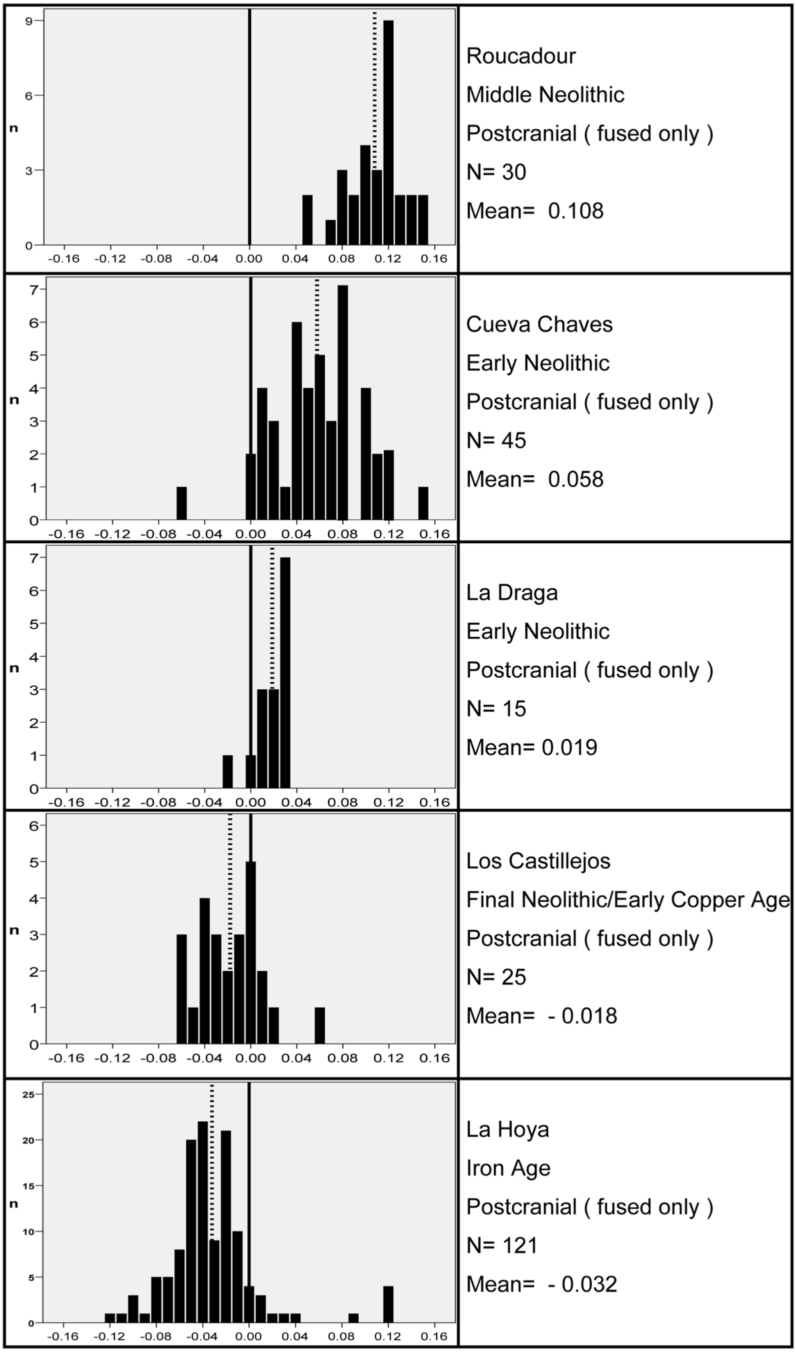

Figure 10.10: Histograms comparing pig postcranial measurements from different prehistoric sites in Spain and a site from France.

10.9, but this different set of sites allows us to make additional observations. The most obvious difference is that Middle Neolithic wild pigs from France were larger than the Early Neolithic pigs of Cueva Chaves and much larger than the pigs from the open-air Early Neolithic site of La Draga. It is interesting to note the significant size difference between the sixth and fifth millennium BC cave site of Cueva Chaves, on the one hand, and the roughly contemporary open-air site of La Draga and Early Neolithic Cueva de la Vaquera, on the other. Although the small sample sizes at La Draga and Cueva de la Vaquera mean that caution must be taken in the interpretation, the histograms clearly illustrate that some Early Neolithic populations are of intermediate size between later prehistoric and contemporary Early Neolithic populations.

Tooth biometry

In Figures 10.11, 10.12 and 10.13 all width measurements from upper and lower teeth are plotted in the form of log ratio histograms. In general the patterns emerging from the tooth measurements corroborate those derived from the postcranial bones, but some interesting differences are also manifested.

Cueva Chaves and Cova Fosca pigs had teeth of similar size to those of the pre-Neolithic sites. On the other hand, the few available measurements from the open-air Early Neolithic site of Sant Pau are similar to those from Iron Age La Hoya (Figure 10.11). Although some caution is demanded by the small sample size from Sant Pau, a significant difference in size between roughly contemporary sites is suggested, as was the case with postcranial measurements from Early Neolithic sites. In Figure 10.12 the top histogram represents tooth measurements from the Magdalenian/Epipalaeolithic levels of the site of Zatoya. The teeth from Early Neolithic La Draga and the Late Neolithic open-air site of La Renke are only slightly smaller than those from pre-Neolithic Zatoya. On the other hand, the teeth from Copper Age Valencina de la Concepción are considerably smaller than those from the other sites presented in the same figure.

In order to examine more closely the evolution in size of pig teeth, three samples of different date from the multi-period site of Los Castillejos are compared in Figure 10.13. In this case, a gradual decrease in tooth size can be observed from the Middle/Late Neolithic through to the Final Neolithic and Early Copper Age. The three histograms suggest that tooth size decreased gradually during the occupation of the site, with the main change probably occurring towards the end of the Neolithic (end of fourth millennium BC).

Discussion

The data presented in the previous section have revealed some patterns which are discussed here in the wider context of the neolithisation of Spain. Several Early Neolithic assemblages were included in this analysis in order to try to detect trends that could be

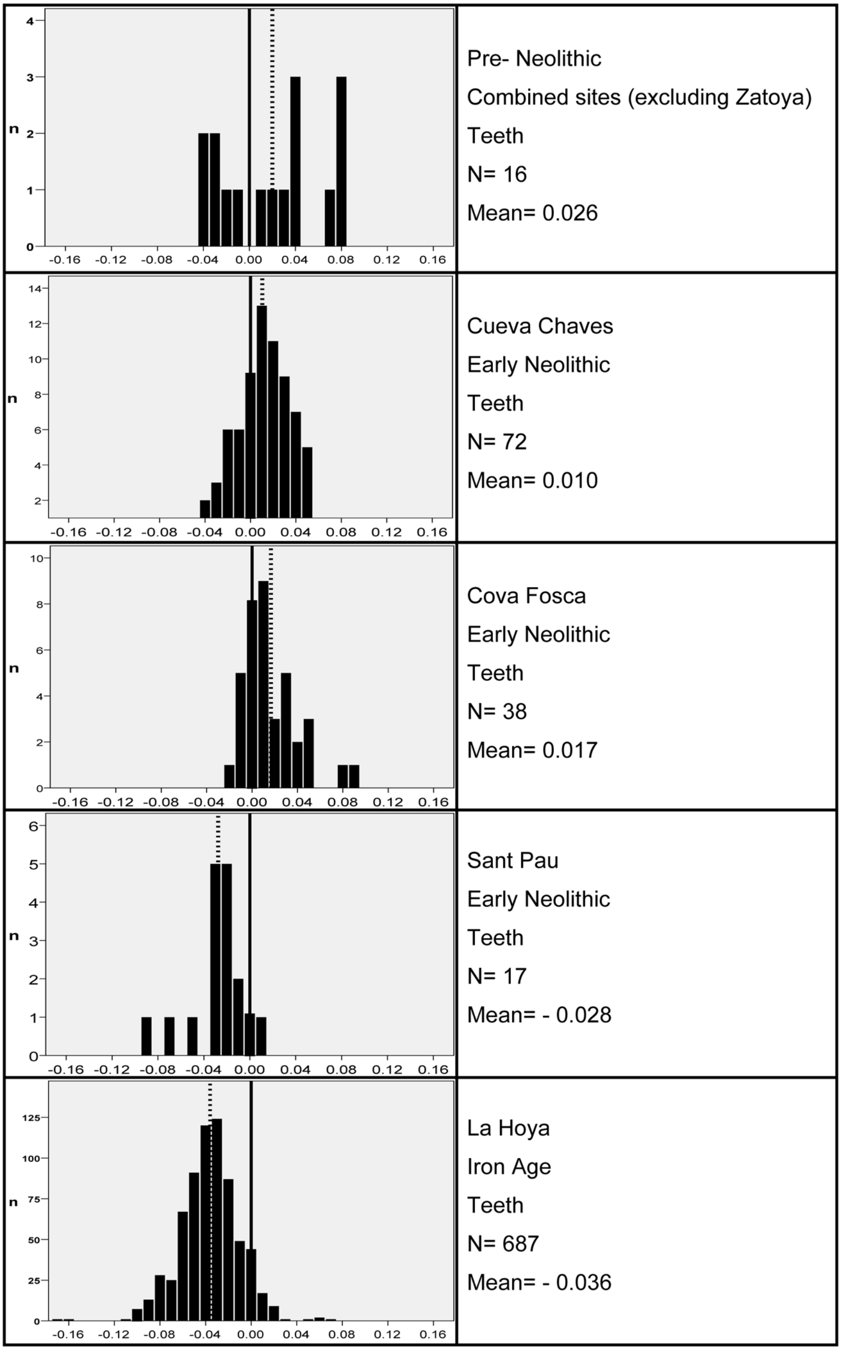

Figure 10.11: Histograms comparing pig teeth measurements from different prehistoric sites in Spain. Upper and lower teeth are combined in each sample.

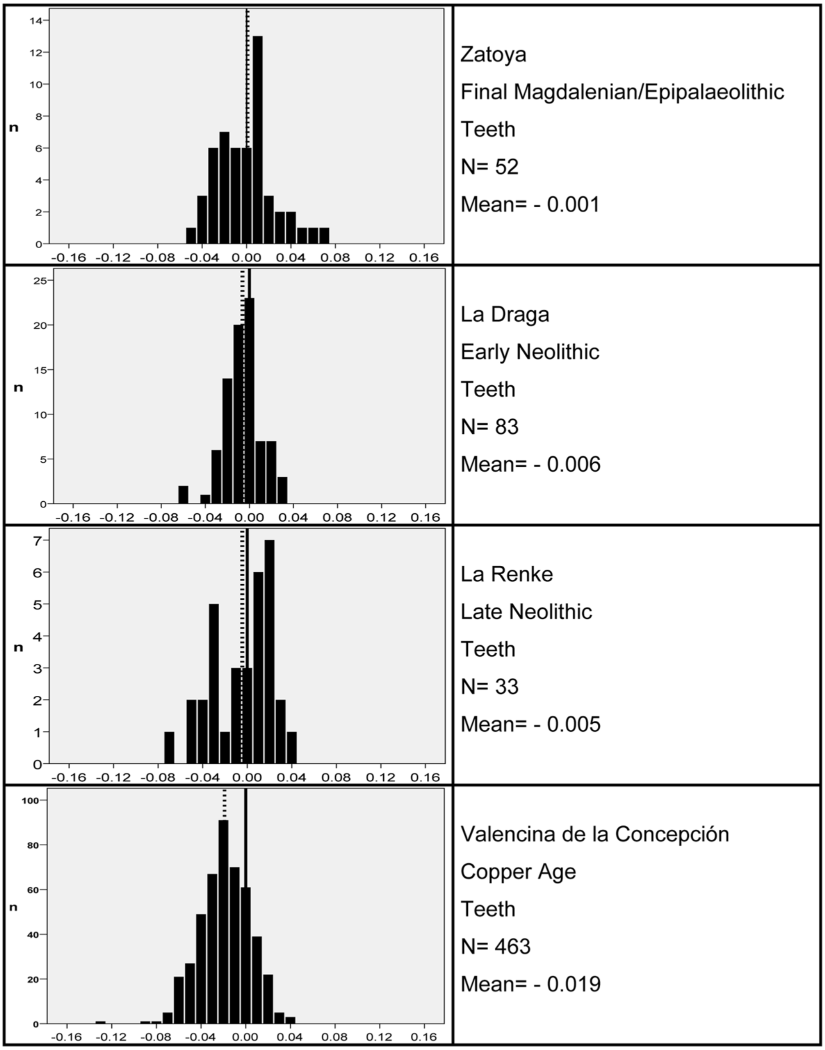

Figure 10.12: Histograms comparing pig teeth from different prehistoric sites in Spain. Upper and lower teeth are combined in each sample.

typical of this key period of transition, but for this information to be fully meaningful it is necessary to discuss it in a comparative as well as synthetic way.

The available data from pre-Neolithic periods are extremely scarce but valuable as a comparison with assemblages of later date. Many Spanish colleagues (*e.g.* Arturo Morales, pers. comm. January 2009) consider the scarcity of pre-Neolithic data a significant obstacle to a better resolution of the size of Spanish wild boar. It is here assumed that all pig remains dating before the Neolithic belong to the wild form. It

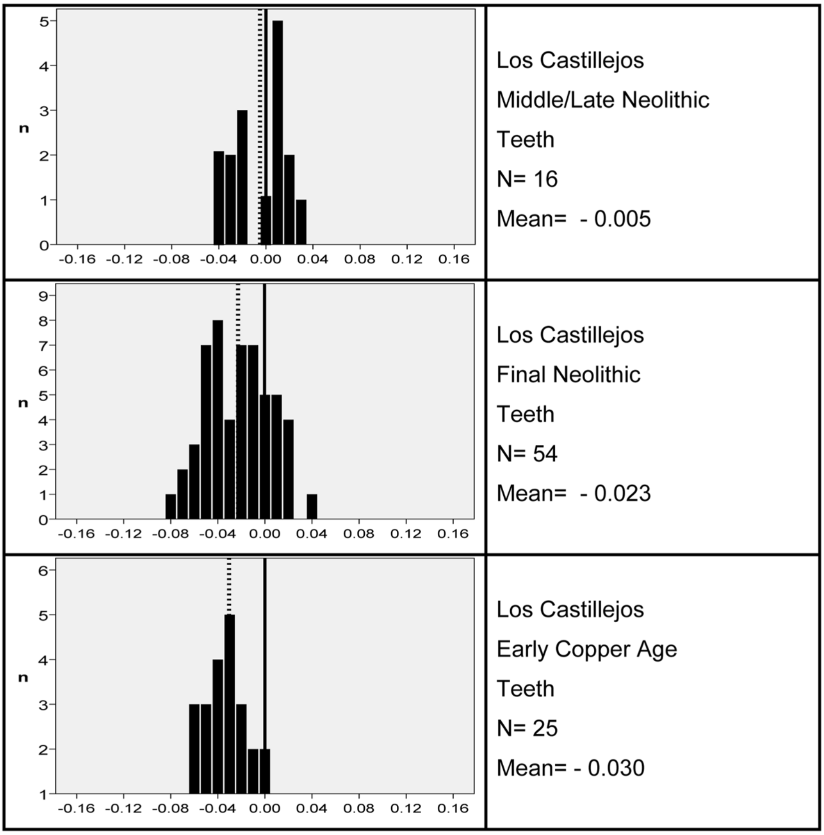

Figure 10.13: Histograms comparing pig teeth measurements from different periods of Los Castillejos (Granada, Spain). Upper and lower teeth are combined in each sample.

is, however, important to consider that wild boar size should not be regarded as a fixed baseline (Albarella *et al.* 2006), and in fact the data show that this was not the case. Wild boar size and morphology did change both in time and space and comparisons with supposedly domestic pigs must be made bearing this in mind.

As far as postcranial bone size is concerned, pre-Neolithic wild boar was generally of similar size to some Early Neolithic populations, such as those from Cova Fosca and Cueva Chaves, but larger than some other Early Neolithic populations, such as those from Cueva de la Vaquera and La Draga (Figures 10.9 and 10.10). Although the available data do not allow a detailed examination of changes in wild boar size through time and space, there are some hints that a size increase, at least in postcranial bones, occurred from the Neolithic onwards. The postcranial size of wild boar from Middle Neolithic Roucadour in France (Lesur *et al.* 2001) is considerably larger than that of its pre-Neolithic Spanish counterparts. Also the wild boar from Roucadour is clearly larger than most Early Neolithic populations from Spain, whether they were domestic or wild. This may be attributed to environmental differences between geographic regions, though it is difficult to determine whether the change is also related to the later date of the French assemblage. A less pronounced postcranial increase is indicated by some Early Neolithic measurements from Cueva Chaves and Cova Fosca, which are larger than the largest pre-Neolithic measurements. We must also consider that the vast majority of the pre-Neolithic specimens come from the northernmost part of Spain and are of Palaeolithic (rather than Mesolithic) date. Since they were probably living under colder climatic conditions, which are known to favour increased animal body size (Bergmann 1847), those wild boar were probably larger than those of Mesolithic date from more southern areas of Spain. An increase in the postcranial size of wild boar during the Neolithic, therefore, is a likely scenario. The reason for this should not have been rising temperatures *per se*, which would have had an opposite effect, but the expansion of forests over most of Spain (Burjachs and Riera 1996 for the Mediterranean facade; García-Amorena *et al.* 2008 for the northern coast; Pantaleón-Cano *et al.* 1999 for the southeast; Stevenson 2000 for east-central Spain; Zapata 2006 for the northeast) – the optimal environment for wild boar to thrive in. In relation to this, Aura *et al.* (2002, 223) mention that the increase of wild boar and roe deer populations in the Valencian region at the beginning of the Holocene is more likely to have been a result of increased humidity than increased temperature. A relaxation in hunting pressure, due to the availability of domestic animals and an increase – in numbers – of wild populations, constitutes another possible explanation for a size increase in wild boar, as has already been argued for the increase of red deer size in post-Mesolithic Portugal (Davis 2006).

In later prehistoric times, the 'tail' at the upper end of the histogram distributions (Figures 10.9 and 10.10) most probably reflects the few hunted wild individuals, and suggests a similar postcranial size to the pre-Neolithic pigs but data are too scarce to allow further discussion. Similar patterns in the evolution of wild pig postcranial size have been observed in Italy (Albarella *et al.* 2006), Portugal (Albarella *et al.* 2005) and other European countries (Albarella *et al.* 2009).

An important site for our understanding of the situation in the Early Neolithic is Cova Fosca, where postcranial bone measurements are similar to those of the pre-Neolithic wild boar. If we also take into account the fact that only wild fauna has been identified in that assemblage during the latest excavations in 1999–2003 (Llorente 2007), then the possibility that the whole pig population of Early Neolithic Cova Fosca was wild becomes the most probable scenario.

The pigs of Early Neolithic Cueva Chaves are of similar size, both in teeth and bones, but their interpretation is less straightforward. Unlike Cova Fosca, at Cueva Chaves more than half of the Early Neolithic assemblage is comprised of domestic animals (Castaños 2004). Moreover, according to the stratigraphy of the site, there is a stalagmitic level separating the Palaeolithic and the Neolithic levels. While during the Palaeolithic levels just a single pig specimen has been reported from a total of more than 1100 identified remains (Castaños 1993), in the Neolithic levels more than 1371 pig remains were identified from a total 12754. Additionally, the age structure of the pig population, especially the particularly high percentage of perinatal/neonatal remains (Figure 10.5), suggests the rearing of pigs within the cave. A similar age profile has been identified for sheep/goat (Castaños 2004). Lastly, the slight predominance of female pig jaws (Figure 10.2) may have been the result of a husbandry strategy which allowed more reproducing females than males to reach full adulthood. These trends in the age and sex profiles at Cueva Chaves may represent an early stage in the management of pigs in Spain, which evolved to a more obvious manipulation of age and sex structures at sites such as Copper Age Valencina de la Concepción (Figures 10.3 and 10.6) and Iron Age La Hoya (Figures 10.4 and 10.7). With the available data, the most probable scenario is that the pig remains from Cueva Chaves are the combined result of slaughtered domestic pigs and hunted wild boar. The proportions are difficult to estimate because, although the age structure and species composition suggest a domestic economy, the size is generally similar to that of pre-Neolithic and Cova Fosca wild boar. A plausible explanation would be that the domestic pigs of Cueva Chaves were interbreeding with, or derived from, the local wild boar stock and that is why they are of similar size.

The evidence from La Draga, also an Early Neolithic site, is different as it reveals a biometrically different, smaller-sized pig population. The level of size reduction between pre-Neolithic sites and La Draga is, however, much more pronounced in bones than teeth. As is well known from previous studies (Payne and Bull 1988), teeth are less plastic than bones and react to environmental stimuli more conservatively. Consequently, as has been demonstrated for other European areas (*e.g.* Albarella *et al.* 2006), bones will normally decrease more rapidly than teeth during the domestication process, as long as there is some level of genetic separation between wild and domestic populations. Although it can not be excluded that introduced domestic pigs could have had the observed biometrical characteristics, the relative similarity – in tooth size – between indigenous wild boar and Early Neolithic pigs from La Draga hints more at the possibility that local populations may have played a role in the domestication process.

Two more Early Neolithic assemblages remain to be considered. Cueva de la Vaquera yielded only postcranial measurements, while Sant Pau only tooth measurements. The postcranial bones from La Vaquera are of similar size to those from La Draga and, considering that La Vaquera revealed a predominately domestic economy (Morales and Garcia 1998), perhaps represent a situation similar to that at Cueva Chaves, where hunting may have been a secondary complement to the exploitation of domestic species.

The tooth measurements from Sant Pau, a site of later date within the Early Neolithic and with an almost exclusively domestic economy (Colominas *et al.* 2008), add another perspective to the interpretation of the data. Despite the small sample size and the absence of postcranial measurements, it is clear that by the fourth millennium BC some pig populations had significantly smaller teeth than other Early Neolithic populations (Figure 10.11). It seems that the tooth size of some early domestic populations of the sixth millennium BC, such as those of La Draga and Cueva de la Vaquera, were in a process of adjustment to an already decreased body size. The data from Sant Pau suggest that by the end of the fifth millennium BC some domestic pig populations had already been transformed by husbandry strategies to a size similar to those of later prehistory (Figures 10.11 and 10.12). We know that at Copper Age Valencina de la Concepción (Hain 1982) and Iron Age La Hoya (Altuna and Mariezkurrena 1990) a productive economy was fully developed. Mainly biometric information is available for the Early Neolithic pig populations of Sant Pau and La Draga, but their similarity, or tendency to approach the size of later prehistoric populations, suggests that they were the product of husbandry rather than hunting.

Despite the scarcity of assemblages from the Middle and Late/Final Neolithic, there are hints that the broad diversity in the exploitation of pigs, as is reflected in the Early Neolithic record, continued through the whole Neolithic period, at least in some areas. The postcranial size of Final Neolithic/Early Copper Age pigs of Los Castillejos is quite similar to Copper Age Valencina de la Concepción and Iron Age La Hoya. In teeth, due to the larger sample, we can count on a better chronological resolution (less combination of data is necessary) and this allows us to follow the biometrical evolution from the Middle Neolithic to the Copper Age. The results show a visible decrease in tooth size towards the end of the Neolithic (Figure 10.13). During the Middle/Late Neolithic, tooth size is more similar to La Draga and slightly smaller than the pre-Neolithic and Early Neolithic sites but by the Final Neolithic it has decreased as much as the bones. At the Late Neolithic site of La Renke, on the other hand, tooth size does not seem to have decreased from the standard of Early Neolithic La Draga and Middle/Late Neolithic Los Castillejos. Such evidence highlights the diversity and complexity of the pig domestication process, which probably occurred at different rates and in different ways across Spain. While some pig populations (*i.e.* La Draga, Cueva de la Vaquera and Sant Pau) seem to have been transformed substantially already before the end of the Early Neolithic, for others the process seems to have initiated and/or evolved slower. Such differences can perhaps be explained on the basis of potentially different sources of domestic animals, as genetic analysis has now demonstrated that the pig domestication process in Europe was the result of both local events and introduced animals (Larson *et al.* 2007). Environmental and cultural variables must also have played a role as Spain can hardly be regarded as a homogenous entity.

Pigs and the neolithisation of Spain

In the previous section an attempt to reconstruct the origins and evolution of pig domestication in Spain was made. The available data do not provide a fine resolution to this phenomenon but nevertheless their interpretation has the potential to contribute to discussion of the neolithisation of Spain.

As pointed out by several colleagues in the past (Altuna 1980; Castaños 1986; 2004; Morales and Cantal 2004; Morales and García 1998), domestic pigs make their appearance in Spain in the Early Neolithic or second half of sixth and fifth millennia BC. The evidence presented in this paper supports this view, but also provides additional information about the speed, direction and evolution of the domestication process. The evidence is unfortunately – and somewhat inevitably – uneven in its chronological and geographical spread, and can therefore only provide a fragmented, and to some extent biased, reconstruction of the story.

Andrew Sherratt's (2007) general view that the process of neolithisation was complex and that more than one mechanism was involved in its implementation and dispersal is supported by the data presented here. In the Early Neolithic, the observed diversity of interactions between humans and pigs points towards a complex domestication process. In the analysed Neolithic assemblages there are indications of diversification in the interaction between humans and pigs. In Early Neolithic Spain we encounter sites, such as Cova Fosca, where pigs were exclusively hunted, others, such as Cueva Chaves, where mixed husbandry and hunting practises probably co-existed, and yet others, such as La Draga and Sant Pau, where pig husbandry dominated and wild boar hunting was only a secondary activity. These are just examples which suggest a diverse, dynamic and complex domestication process during the Early Neolithic. The later Neolithic and post-Neolithic assemblages reveal that pig domestication in Spain evolved from the diversity observed in the Early Neolithic towards a relatively uniform pig husbandry strategy (Hadjikoumis 2010), which could be characterised as more intensive in the sense that it was aiming at maximum meat yield per animal through a conscious manipulation of the age and sex structures.

Though a Neolithic 'package' may well have existed this did not seem to spread simultaneously across Spain. Some aspects of the 'package' such as domestic sheep and goats, and cereal cultivation, not only were introduced already in their domestic form to Spain, but were also accompanied by well-developed management practices (Zapata *et al.* 2004; 2005). Some similarities in material culture (Cava 2000) and agricultural management (Stika 2005) with areas of southern France (Schuhmacher 1996; Zapata *et al.* 2004) suggest a trans-Pyrenean or coastal/maritime route or both, at least for some of the Neolithic innovations.

Many factors, which could account for the observed diversity in the timing and intensity of the use of Neolithic innovations, are mentioned in the literature. Environmental differences seem to have played a role (*e.g.* Baldellou 1987 for the region of Alto Aragon). This may be significant in explaining the differences observed between some Early Neolithic assemblages, such as the mountainous cave sites of Cueva Chaves and Cova Fosca on the one hand and the two low-lying Catalonian sites of La Draga and Sant Pau on the other. Whereas in the former hunting strategies still played a significant or exclusive – in the case of Cova Fosca – role, the latter seem to have been much more intensively engaged in a food production economy. Other factors potentially contributing to the observed diversity include the possible seasonal occupation of some cave sites and the density and socioeconomic organisation of the preceding Upper Palaeolithic and Mesolithic populations. Also, chronological differences may also help explain the described patterns, as in the course of the Neolithic period an overall tendency towards smaller size and tighter control of sex and age profiles of pig populations is suggested by the data presented here.

The presence of morphologically distinguishable domestic pigs in the Early Neolithic is confirmed, at least for northeast Spain and more specifically Catalonia. Whether domestication took place in that area or domestic pigs were introduced from a neighbouring area cannot be presently determined due to lack of multi-period assemblages – preferably including Mesolithic and Neolithic levels – which would enable us to address this issue in greater detail. Domestic pigs were also present in the Early Neolithic of Andalusia, Aragon and the central plateau, but these resembled the local wild boar more closely. Pig husbandry, as well as the importance of wild boar hunting, varied not only from region to region, but also from site to site. An example of intra-region difference is represented by the sites of Cova Fosca (Llorente 2007), with its predominant hunting economy, and La Draga (Saña 2000), which has a much more clearly defined food production economy. Yet the two sites lie in roughly the same geographic region and overlap chronologically with each other.

The relative importance of hunting and husbandry is not the only element of variation in the exploitation of pigs at different sites, as the intensity in management of domestic pigs varied too. For example, the biometric data from La Draga show reduced postcranial size, compared to teeth, which could be interpreted as the result of a tighter control of the domestic herd and a gradual morphological deviation from the wild form. Such morphological changes would be, as in the case of La Draga, first visible on bones and then teeth, due to the plasticity of bones and the conservatism of teeth against environmental stimuli. In contrast, the pig population of Cueva Chaves, here interpreted as predominantly domestic, is more distinguishable by its age and sex profile rather than its biometry. This may have been the result of a different style of pig husbandry, which possibly allowed some interbreeding between wild and domestic populations. This picture of diversity in the relationships between pigs and humans during the Early Neolithic contrasts with the relatively rapid spread of other neolithic innovations such as cereal cultivation and sheep/goat husbandry in eastern and southern Spain (Peña-Chocarro *et al.* 2005) but does not contradict it. There is no reason why some of the neolithic innovations, especially those involving exotic animal and plant species, could not have been implemented more rapidly and homogenously whereas others reflected more closely local environments and pre-existing cultural traditions.

Towards the end of the Neolithic and the beginning of the Copper Age there are indications that morphologically distinguishable pigs, as compared with some Neolithic and all pre-Neolithic populations, became widespread over most of Spain. This process was accompanied by the also widespread, but not passive (*e.g.* for Cantabria see Arias 1997), adoption of innovations such as agriculture, a sedentary way of life, and almost exclusively domestic animal economies. Similar patterns in the evolution of domestication in relation with other innovations have been attested in other Mediterranean countries such as Portugal (Jorge 2000) and Italy (Albarella *et al.* 2006). During the Copper Age and until the end of the prehistoric period in Spain, there are indications of further intensification of pig husbandry practices, reflected in the size reduction, and the tighter control of the age and sex structure of pig populations. This is not surprising as all lines of archaeological evidence document well-developed domestic economies, further technological innovations and increasing social complexity (Diáz-Andreu 1995).

From the interpretation and discussion of the analysed data it is evident that the resolution they offer for the time being is crude and hence does not enable us to construct a detailed story concerning how pig domestication articulated with the process of neolithisation in Spain. The data, however, do offer significant insights concerning the chronology, speed, geographic origin and direction of the pig domestication process in Spain, which will facilitate, and hopefully provoke, future research on the topic. As more Mesolithic and Neolithic sites are rigorously excavated in Spain the resolution of the picture presented here will inevitably be refined, but for the time being the present study at least provides a frame of reference that has so far only been available in the form of localised studies.

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