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# Farmers at the Frontier

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*edited by*

Kurt J. Gron, Lasse Sørensen  
and Peter Rowley-Conwy

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# Chapter 4

## Did early farmers keep pigs? A morphometric analysis from Italy

*Sofía Tecce and Umberto Albarella*

### **Introduction**

The emergence of farming practices is indisputably one of the key points of human evolution, and the domestication of the wild boar (*Sus scrofa*) and the emergence of the domestic pig (*Sus domesticus*) is a fundamental aspect of that process. The characteristics of the pig, namely the ample natural distribution of its wild ancestor – the wild boar – and its omnivorous diet, have shaped its relationship with humans in a way unlike any other animal (Albarella *et al.*, 2006a). Whilst the earliest evidence of pig domestication comes from western Asia (Flannery, 1983; Peters *et al.*, 1999; Vigne and Buitenhuis, 1999) and, later on, eastern Asia (Jing and Flad, 2002), pigs could have potentially been domesticated anywhere in most of North Africa and Eurasia (Davis, 1987; Clutton-Brock, 1999), due to the broad natural distribution of the wild boar. Multiple domestication events have been suggested on the basis of genetic evidence, which has also highlighted the existence of a unique Italian genotype (Larson *et al.*, 2005; 2007).

In analysing the process of pig domestication, we must also consider that the generalised omnivorous diet of the pig opens up a series of possible relationships with humans not possible in the case of herbivorous domesticates. Pig exploitation is not necessarily restricted to hunting and close domestic control, and can also take various intermediate forms (*e.g.* free-range management), as noted in historic and ethnographic examples (Albarella *et al.*, 2006a). In sum, the process of pig domestication poses a unique set of challenges and questions to its study and must be approached by taking into account climatic, environmental, geographic, chronological and cultural contexts.

In the past, the subject of early pig husbandry in Europe has mainly been limited to archaeological studies at small geographical and temporal scales, thus masking

the inherent complexities of such a process. In the particular case of the Italian Peninsula, a series of issues have hindered past studies on the emergence of animal husbandry as a new cultural and economic phenomenon; namely, the intrinsic difficulties in understanding such process in the archaeological record, the scarcity of well-dated evidence and the local focus of most studies. Only relatively recently has this issue been acknowledged in the literature and have studies of pig domestication on a wider regional and chronological context, based on large amounts of data, been attempted (e.g. Albarella *et al.*, 2006c). Previous research on Italian prehistoric sites suggests that a gradual domestication of local pigs contributed to the overall make-up of Early Neolithic life in the region (Albarella *et al.*, 2006c). The issue is, however, far from being entirely resolved, and there is an urgent need for more comprehensive studies.

Biometrical analyses from previous studies have revealed that during the Early and Middle Neolithic no clear morphometric distinction between wild boar and supposedly domestic pigs is possible, while from the Late Neolithic onwards there is a rather abrupt change, as a distinction between the two forms becomes evident (Albarella *et al.*, 2006c). This evolution could be interpreted in two ways. One possibility is that earlier pigs were all wild, and domestic pigs only appeared in the peninsula during the Late Neolithic (Rowley-Conwy, 2003; Rowley-Conwy *et al.*, 2013). Alternatively, the reason why Early and Middle Neolithic pigs do not cluster into separate morphometric groups is that the domestic forms were kept under a loose management system, and were therefore regularly interbreeding with their wild cousins (Albarella *et al.*, 2006c).

Many questions still remain unanswered and more work needs to be done in order to better comprehend how early farming communities interacted with pigs in the Italian Peninsula; particularly through the use of larger samples, more sites and through covering unexplored areas. The aim of this paper is to contribute to the understanding of the origins of domesticated pigs in Italy by analysing a larger biometrical sample, both in terms of actual data and geographic/chronological coverage. Building on previous work, the main strategy applied is the collection of comparable data from several prehistoric sites in the Italian Peninsula and Sicily in order to detect patterns of regional and chronological change, thus filling the gaps left by previous research. The analysis will mainly rely on biometrical data, which is more conducive to making comparisons between sites than other sources of evidence. The potential of the biometrical approach has been extensively demonstrated in the past (Albarella *et al.*, 2005; 2006c; 2009; Rowley-Conwy *et al.*, 2012). The rationale behind using biometry is that this can help in distinguishing between different populations and, potentially, between wild and domestic forms (but see Payne and Bull, 1988; Albarella *et al.*, 2006; Rowley-Conwy *et al.*, 2013; to appreciate the complexity of the problem). Although this paper focuses on the Early Neolithic, sites from earlier and later periods will also be considered, as domestication processes can be better understood by taking a long-term view.

## Materials and methods

To investigate how the process of pig domestication originated in Italy, a number of key archaeological assemblages have been identified for analysis on the basis of their geographical location, chronological breadth and accessibility (Fig. 4.1 and Table 4.1). All the sites are located in the Italian Peninsula and the southern islands of Sicily and Pantelleria. The main focus is on Early Neolithic sites, but additional sites from the Upper Palaeolithic to the Late Bronze Age have been included for comparative purposes. The island of Sardinia has been excluded from this study due to its specific history and archaeology, as well as its geographic isolation from the Italian Peninsula (Levine, 1983; Vigne, 1988; Wilkens and Delussu, 2002; Albarella *et al.*, 2006b).



Fig. 4.1. Location of sites included in this study. Larger symbols indicate the presence of several sites in the same area.

Table 4.1. Details of sites studied.

Region	Site	Chronology
<i>North</i>		
Trentino Alto-Adige	Galgenbühel/Dos de la Forza	Mesolithic
	Pradestel	Mesolithic
	Riparo Gaban	Mesolithic to Early Neolithic; Eneolithic to Middle Bronze Age
	Romagnano Loc	Mesolithic; Eneolithic to Early Bronze Age
Friuli-Venezia Giulia	Riparo di Biarzo	Upper Palaeolithic, Mesolithic and Neolithic
Veneto	Concordia Sagittaria	Late and Final Bronze Age
	Cornuda*	Late Neolithic
	Molino Casarotto	Middle Neolithic
	Rocca di Rivoli	Middle Neolithic
Lombardia	Lavagnone	Early Bronze Age
Liguria	Arene Candide	Upper Palaeolithic to Copper/Bronze Age
Emilia Romagna	Cattolica VGS	Early Bronze Age
	Cesena	Middle to Late Bronze Age
	Poviglio	Middle to Late Bronze Age
	Riccione Ipercoop	Middle to Late Bronze Age
	Solarolo	Middle Bronze Age
<i>Centre</i>		
Tuscany	Gorgo del Ciliego	Middle Bronze Age
Marche	Conelle*	Eneolithic/Copper Age
	Portonovo	Early Neolithic
Latium	Albano Le Macine	Middle Bronze Age
	Cinquefrondi	Eneolithic/Copper Age
	La Marmotta	Early Neolithic
	Palidoro	Upper Palaeolithic
	Pantano Borghese	Eneolithic/Copper Age
<i>South and Islands</i>		
Apulia	Coppa Navigata	Middle to Final Bronze Age
	Grotta Paglicci	Upper Palaeolithic
	Grotta Romanelli	Upper Palaeolithic
	Masseria Candelaro	Middle Neolithic
	Masseria Fragella	Early Neolithic
	Masseria Pantano	Middle Neolithic
Campania	Baselice	Early Neolithic
	Gricignano	Late Eneolithic to Early Bronze Age Transition
	Grotta della Cala	Upper Palaeolithic and Mesolithic
	Masseria di Gioia	Middle/Late Neolithic
	Mulino S. Antonio	Late Neolithic
Calabria	Broglia di Trebisacce	Middle Bronze Age
	Favella	Early Neolithic
	Grotta della Madonna	Upper Palaeolithic to Mesolithic; Middle Neolithic to Middle Bronze Age
Sicily	Torre Mordillo	Middle to Final Bronze Age
	Grotta dell'Uzzo	Mesolithic to Neolithic†
	Mursia	Middle Bronze Age

\* Data retrieved from publications: Cornuda from Riedel (1988) and Conelle from Wilkens (1999).

† The Neolithic data from Grotta dell'Uzzo mostly involve Early Neolithic specimens, although some data from the Early Neolithic/early Middle Neolithic level, with Stentinello pottery, are included.

Most of the faunal assemblages from the sites covered in this paper had previously been studied, and some results published. It was not the intention of this research to undertake a full reanalysis of the pig remains, but rather focus on our specific research questions. Most pig bone assemblages were studied or re-studied by us, but in the case of Cornuda (Riedel, 1988) and Conelle (Wilkins, 1999) only the data were re-analysed.

Measurements were taken with digital callipers, and occasionally a measuring board in the rare case of complete long bones. On teeth, measurements were taken only when there was sufficient preserved enamel on the crown surface. Calliper measurements were approximated to the tenth of a millimetre, and those taken on the measuring board to the millimetre. The measurements taken are listed in Table 4.2, following recommendations by von den Driesch (1976), Payne and Bull (1988) and Albarella and Payne (2005). To discriminate wild from domestic animals on the basis of biometry, the measurements selected for scatterplot analysis are molar tooth width (WA) and length (L) – excluding teeth exhibiting Grant’s wear stage j or higher (Grant, 1982; Albarella and Payne, 2005) – and limb measurements from fused and fusing specimens, particularly humerus BT and HTC (fused only), tibia BdP and astragalus GLL, following recommendations by Payne and Bull (1988), Albarella and Payne (2005) and Rowley-Conwy *et al.* (2012).

Due to the fact that pigs are usually slaughtered young, post-cranial bones are often unfused and thus more often destroyed by taphonomic agents (Albarella and Payne, 2005). Teeth are, however, not affected by this problem. To make the most of small sets of measurements, a scaling index technique was used, and this was applied through the calculation of log ratios (Meadow, 1999; Albarella, 2002). All measurements taken (Table 4.2) are included in the log ratio analysis. The standard used as a reference point was that compiled by Albarella and Payne (2005) for the Neolithic site of Durrington Walls (Wiltshire, UK).

Two main approaches are used to present the results of our analysis. Firstly, selected measurements from the distal tibia, distal humerus and astragalus are plotted in scatterplots, combining the sites by main area (North-Centre-South-Islands). Secondly, log ratio analysis is performed for combined post-cranial and tooth measurements for sites selected on the basis of relevant chronology and sample size. Samples for the Early Neolithic tend to be fairly small, but comparison with data from other periods enhances their interpretive value. Statistical analyses (t-test) have been performed on the biometrical samples for each region to assess their degree of similarity (Table 4.3).

## Results

### Metrics

Values for distal tibia Bd and Dd, astragalus GLL and GLM, and humerus HTC and BT through time for the Italian sites studied are plotted in Fig. 4.2 (northern and central regions) and Fig. 4.3 (southern region, including islands).



Table 4. 2. List of measurements taken.

Element	Measurement	Reference
P <sub>4</sub>	W Crown width	Albarella and Payne, 2005
dP <sub>4</sub>	L Crown length	Payne and Bull, 1988
Upper or Lower M1, M2	WA Anterior crown width	Payne and Bull, 1988
	WP Posterior crown width	Payne and Bull, 1988
dP <sub>4</sub>	L Crown length	Payne and Bull, 1988
Upper or Lower M3	WA Anterior crown width	Albarella and Payne, 2005
	WC Central crown width	Albarella and Payne, 2005
	WP Posterior crown width	Albarella and Payne, 2005
Atlas	H Height	Albarella and Payne, 2005
	BFcr Width of cranial articular surface	von den Driesch, 1976
Scapula	GLP Length of articular end	von den Driesch, 1976
Humerus	BT Width of the trochlea	Payne and Bull, 1988
	HTC Minimum diameter of trochlea	Payne and Bull, 1988
Radius	BpP Proximal width	Payne and Bull, 1988
	Bd Distal width	von den Driesch, 1976
Pelvis	LAR Diameter of acetabulum	von den Driesch, 1976
Tibia	BdP Distal width	Payne and Bull, 1988
	Dd Distal depth	von den Driesch, 1976
Astragalus	GLl Greatest lateral length	von den Driesch, 1976
	GLm Greatest medial length	von den Driesch, 1976
Calcaneum	GL Greatest length	von den Driesch, 1976
	GD Greatest depth	Albarella and Payne, 2005
Metapodials III and IV	GL Greatest length	von den Driesch, 1976

Taken together, the southern pig bone specimens tend to be smaller than the northern and central ones, although only in some cases this difference is statistically significant (Table 4.3). The smaller size of the more southern pigs is likely to be a consequence of the climatic variability between the two regions, with the smaller animals living in the warmer region, following Bergmann's rule (Blackburn *et al.*, 1999). Looking at the data for each element individually, the values for distal tibia Bd and Dd indicate that between the northern and central sites (Fig. 4.2) there is no substantial size difference between the Upper Palaeolithic and Mesolithic pigs or the Early and Middle Neolithic pigs, although the latter period does include a few slightly smaller specimens. During these periods, it is not possible to observe two distinct populations based on these measurements. There is a small size reduction between the Early and Middle Neolithic tibia Bd and Dd values, which is also statistically significant (Table 4.3). It is, however, only during later Prehistory (*i.e.* Late Neolithic to Late Bronze Age) that two populations can clearly be observed; the larger specimens likely belonging to wild boar and the smaller ones to domestic pig. This latter group overlaps with the range of the smaller specimens from earlier periods, but also includes much smaller individuals of a size not observed previously. The data from the southern sites (Fig. 4.3) appears

Table 4.3. Results of the t-test on the different biometrical samples (tibia Bd and Dd, astragalus GLL and GLM, humerus BT and HTC, and lower molars L and WA), by main geographical area. Highlighted cells indicate statistically significant values.

Sample 1	Sample 2	Tibia		Astragalus		Humerus		Lower M1		Lower M2		Lower M3	
		Bd	Dd	GLL	GLM	BT	HTC	L	WA	L	WA	L	WA
<i>North and centre</i>													
Upper Palaeolithic and Mesolithic	Early Neolithic	0.798	0.183	0.560	0.140	0.192	0.004	0.827	0.611	0.363	0.249	0.019	0.831
Upper Palaeolithic and Mesolithic	Middle Neolithic	0.187	0.555	0.640	0.384	0.827	0.422	0.274	0.285	0.829	0.162	0.008	0.078
Upper Palaeolithic and Mesolithic	Later Prehistory	0.878*	0.609*	0.916*	0.681*	0.000	0.022	0.018	0.006	0.201	0.107	0.629*	0.625
Early Neolithic	Middle Neolithic	0.033	0.013	0.826	0.271	0.127	0.015	0.186	0.013	0.158	0.977	0.880	0.231
Early Neolithic	Later Prehistory	0.804*	0.113*	0.498*	0.090*	0.000	0.000	0.001	0.000	0.019*	0.000	0.117	0.553
Middle Neolithic	Later Prehistory	0.009*	0.094*	0.595*	0.385*	0.000	0.000	0.001	0.000	0.000*	0.000	0.001	0.002
<i>South</i>													
Upper Palaeolithic and Mesolithic	Early Neolithic	-	-	-	-	0.482	0.400	0.956	0.024	-	-	-	-
Upper Palaeolithic and Mesolithic	Middle Neolithic	-	-	0.011	0.002	-	-	0.009	0.598	0.233	0.064	0.978	0.668
Upper Palaeolithic and Mesolithic	Later Prehistory	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Early Neolithic	Middle Neolithic	-	-	0.544	-	-	-	0.017	0.011	0.047	0.050*	0.448	0.250
Early Neolithic	Later Prehistory	-	-	-	-	0.006	0.001	0.086	0.445	-	-	-	-
Middle Neolithic	Later Prehistory	-	-	0.007	0.000	-	-	0.000	0.000	0.000	0.011	0.043	0.125
<i>Islands</i>													
Upper Palaeolithic and Mesolithic	Early Neolithic	0.987	0.844	0.010	-	0.018	0.002	0.566	0.366	0.586	0.183*	0.311	0.789
Upper Palaeolithic and Mesolithic	Later Prehistory	0.043	0.001*	0.000	-	0.003	0.006	0.656*	0.689*	-	-	-	-
Early Neolithic	Later Prehistory	0.061	0.042*	0.000	-	0.485	0.781*	0.414	0.801*	-	-	-	-

(Continued)

Table 4.3. Results of the *t*-test on the different biometrical samples (tibia Bd and Dd, astragalus GLL and GLm, humerus BT and HTC, and lower molars L and WA), by main geographical area. Highlighted cells indicate statistically significant values. (Continued)

Sample 1	Sample 2	Tibia		Astragalus		Humerus		Lower M1		Lower M2		Lower M3	
		Bd	Dd	GLL	GLm	BT	HTC	L	WA	L	WA	L	WA
<i>North and centre</i>	<i>South</i>												
Upper Palaeolithic and Mesolithic	Upper Palaeolithic and Mesolithic	0.909	0.369	-	-	0.219	0.138	0.340	0.873	0.435	0.009	0.034	0.256
Early Neolithic	Early Neolithic	-	-	-	-	0.486	0.688	0.826	0.193	-	-	-	-
Middle Neolithic	Middle Neolithic	-	-	0.014	0.334	-	-	0.066	0.831	0.474	0.132	0.255	0.183
Later Prehistory	Later Prehistory	0.000*	0.000*	0.000*	0.000*	0.045	0.937	0.272	0.620	0.663	0.458	0.000*	0.002*
<i>North and centre</i>	<i>Islands</i>												
Upper Palaeolithic and Mesolithic	Upper Palaeolithic and Mesolithic	0.227	0.280	0.846	-	0.341	0.510	0.000	0.000	0.247	0.749	0.334	0.099
Early Neolithic	Early Neolithic	0.319	0.074	0.029	-	0.001	0.000	0.109	0.022	0.080	0.046*	0.062	0.168
Later Prehistory	Later Prehistory	0.000*	0.001*	0.000*	0.000*	0.015	0.040	0.503	0.867	-	-	-	-
<i>South</i>	<i>Islands</i>												
Upper Palaeolithic and Mesolithic	Upper Palaeolithic and Mesolithic	0.062	0.006	-	-	0.017	0.036	0.000*	0.000	0.014	0.003	0.426	0.000*
Early Neolithic	Early Neolithic	-	-	-	-	0.004	0.005	0.306	0.533	-	-	-	-
Later Prehistory	Later Prehistory	0.676	0.941	0.044	0.072	0.039	0.125	0.637	0.960	-	-	-	-
<i>Arene Candide</i>													
Early Neolithic	Middle Neolithic	0.029	0.019	0.063	0.043	-	-	0.009	0.072*	0.244	0.900*	-	-
Early Neolithic	Later Prehistory	0.064	0.036	0.004	0.011	-	-	0.526	0.339	0.602*	0.764*	-	-
Middle Neolithic	Later Prehistory	0.679	0.573	0.034	0.088	0.000*	0.022	0.683*	0.639*	0.790	0.362	0.016	0.087
<i>Grotta del'Uzzo</i>													
Upper Palaeolithic and Mesolithic	Early Neolithic	0.987	0.751	0.010	-	0.018	0.002	0.566	0.366	-	-	0.311	0.789

\* Equal variances not assumed.

to follow the same pattern, though the sample for the Early Neolithic is small, and the Middle Neolithic is not represented at all. The later Prehistory data indicate a clear separation of the two forms, with a predominance of domestic pigs and a few large wild boar outliers.

The astragalus and the humerus provide a largely similar pattern to the tibia (Figs 4.2 and 4.3), though caution is needed because some of the period/region combinations are not well represented. The fact that a similar trend is observed for three different postcranial bones inspires greater confidence in the results.

Molar size is plotted in Figures 4.4 (North and Centre) and 4.5 (South, including islands). Overall, size between the Upper Palaeolithic and the Middle Neolithic is fairly consistent throughout the peninsula, although the Middle Neolithic of the northern sites (Fig. 4.4) exhibits a more pronounced tendency towards the smaller end of the spectrum for the first and second molars. It is only by later Prehistory that clear changes can be observed; the teeth becoming smaller, with the addition of a few larger outliers (probably wild boar).

### **Log ratio analyses**

Figures 4.6 and 4.7 show the log ratios of pig post-cranial bones and teeth for the Upper Palaeolithic, Mesolithic and Early Neolithic. The teeth of wild boar are relatively smaller than post-cranial elements in the Upper Palaeolithic and Mesolithic samples relative to the Durrington Walls standard, and this correlation continues through to the Early Neolithic, when the domestic/wild status of the pigs is unknown. This pattern had previously been observed (Albarella *et al.*, 2006c), and it is herein confirmed, using additional data. Significantly, all analysed sites show this pattern.

As already observed with the scatterplots, the Early Neolithic pigs are largely consistent in size with the Upper Palaeolithic and Mesolithic wild boar, although their log ratios show a slightly broader distribution of measurements. At the Sicilian site of Grotta dell'Uzzo, the Mesolithic wild boars are smaller in both post-cranial bones and teeth than those of the southern site of Grotta della Madonna, and this difference is statistically significant in most of the t-test results (Table 4.3). It has previously been suggested that these could be a result of insular dwarfism occurring in the Sicilian wild boar (Albarella *et al.*, 2006c). The smaller size of the Grotta dell'Uzzo animals in comparison with the peninsular ones has also been observed for red deer (*Cervus elaphus*) (Tagliacozzo, 1994). At this site, a slight decrease in size can be observed between the Mesolithic and Neolithic (mostly Early Neolithic) periods, which is, in some cases, statistically significant (Table 4.3). Changes in culling patterns have also been observed (Tagliacozzo, 1994), suggesting, if not the beginnings of a domestication event, at least an increase in hunting pressure (see also Albarella *et al.*, 2006c).

Figures 4.8 and 4.9 show the results of the log ratio analysis of post-cranial bones and teeth, respectively, for the Middle Neolithic and later Prehistory (Late Neolithic to Early Bronze Age) periods in selected sites of the Italian Peninsula. With the exception of the sites of Conelle (Marche) and Gricignano (Campania), only northern sites

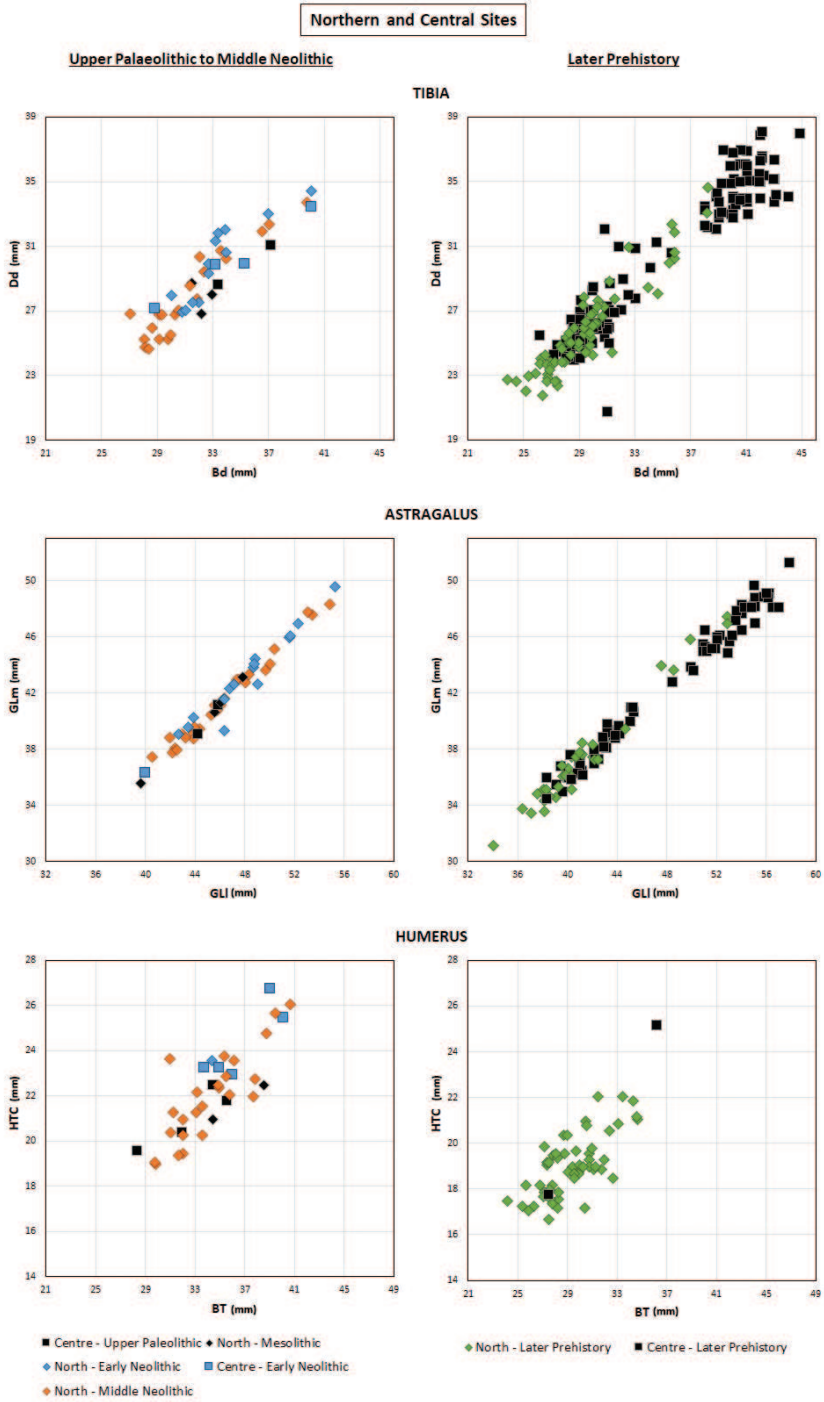


Fig. 4.2. Tibia, astragalus and humerus scatterplots of north and central sites.

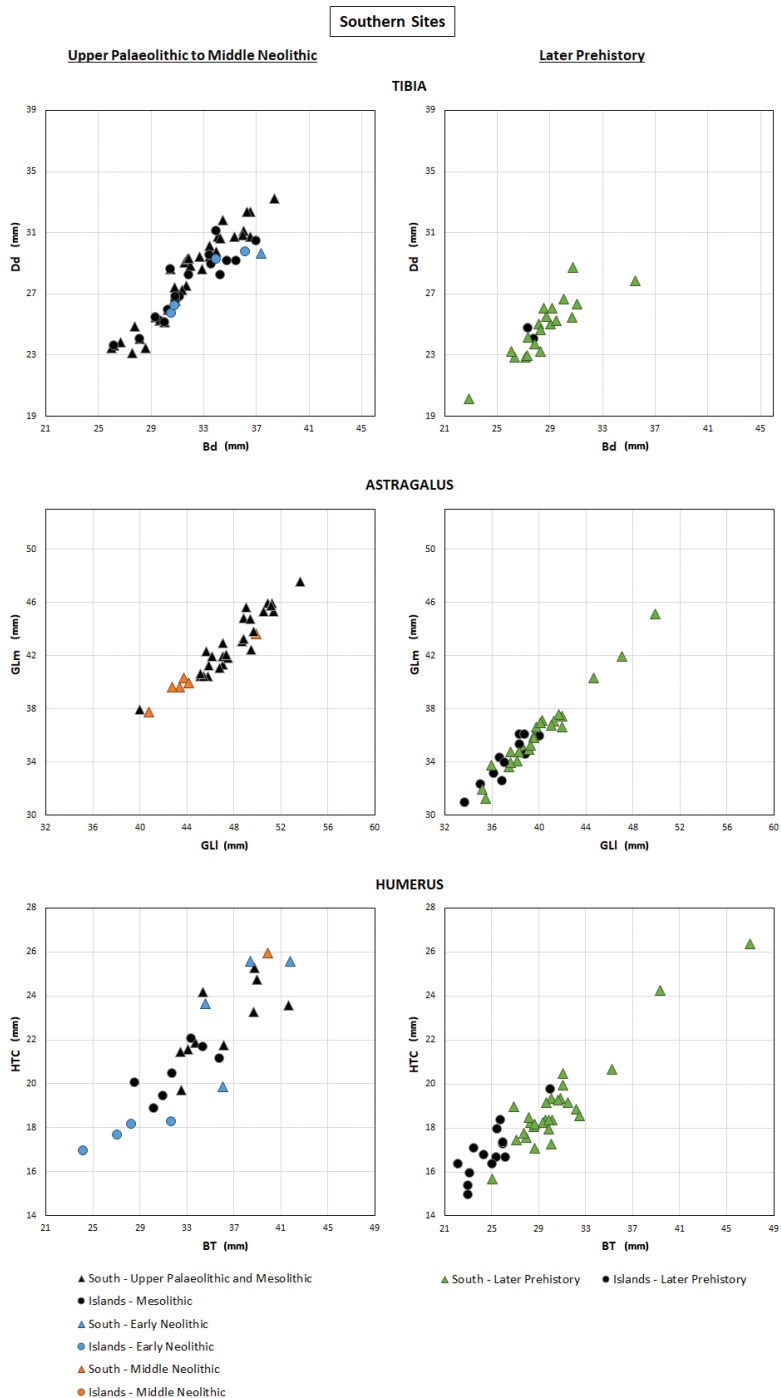


Fig. 4.3. Tibia, astragalus, and humerus scatterplots of southern sites.

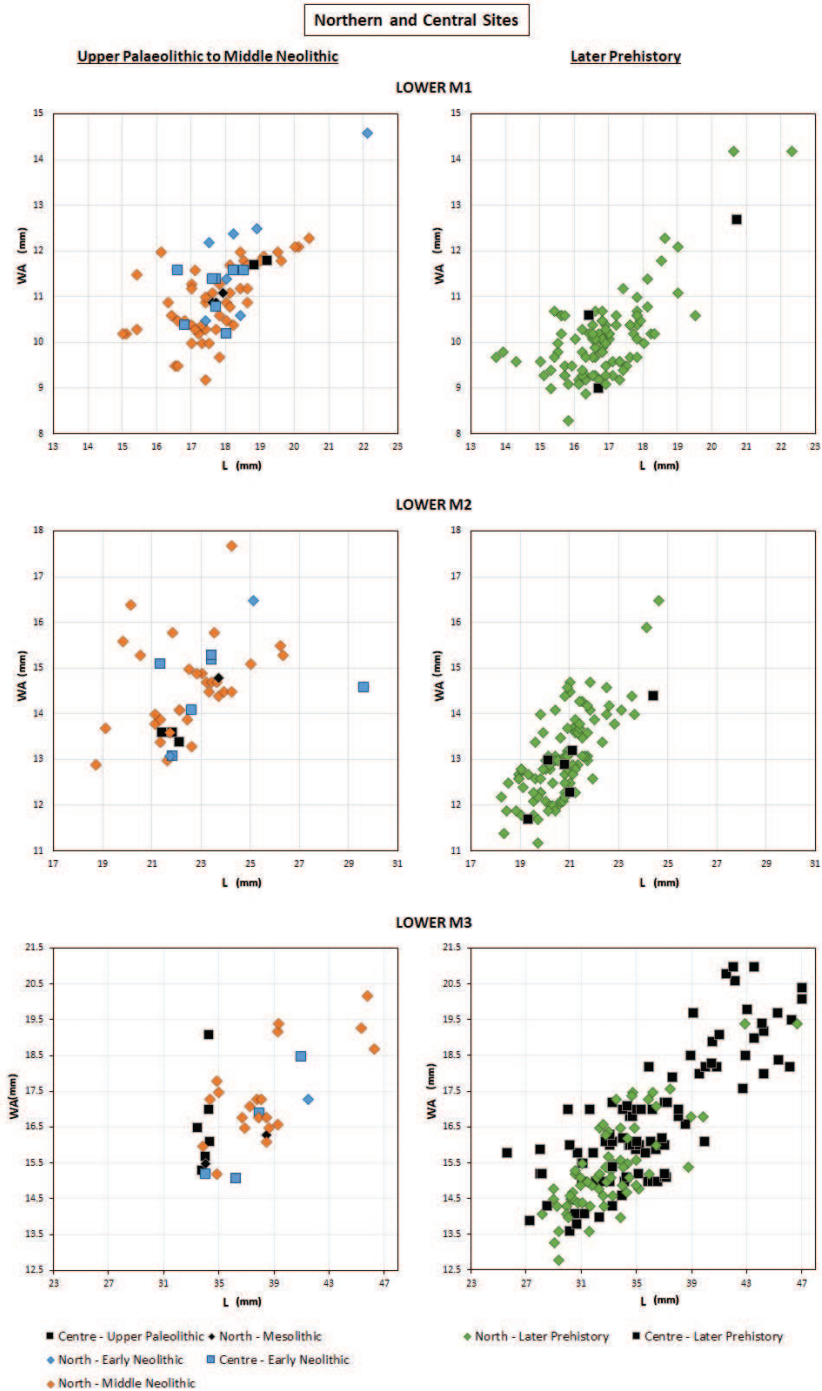


Fig. 4.4. Molar teeth scatterplots of north and central sites.

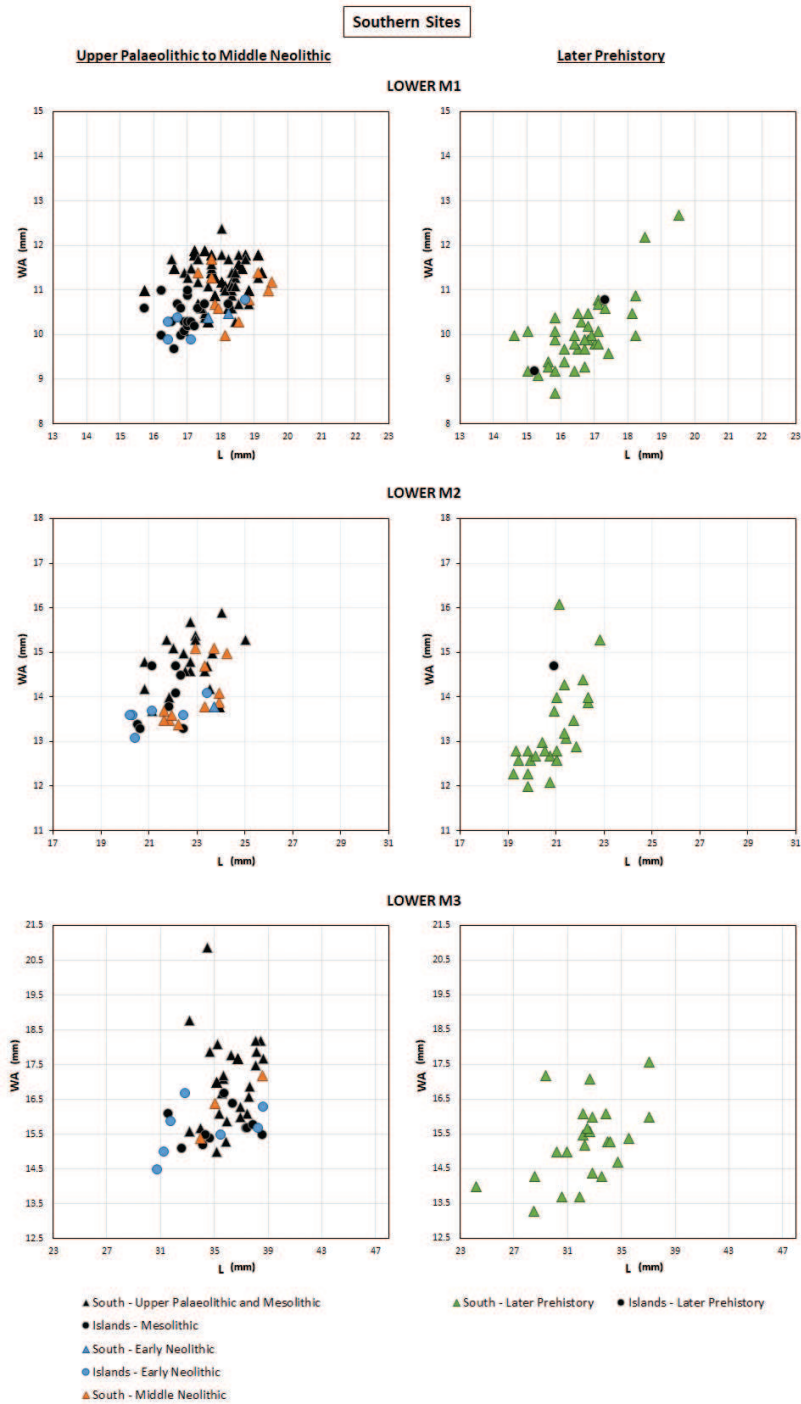


Fig. 4.5. Molar teeth scatterplots of southern sites.



provided sufficiently large data-sets. The correlation noted for the previous phases between post-cranial bones and teeth – the former being larger than the latter in comparison with the standard – continues throughout the Middle Neolithic and through later Prehistory in the sites analysed. The situation is, however, more complex here, as there is more biometric variability attested to by the increase in coefficient of variation for the later periods at Arene Candide (Table 4.3). Therefore, the means are not necessarily an expression of the average size of any of the represented populations (as is obvious in the case of case of Conelle; Fig. 4.8).

There is only a slight reduction in size between Early and Middle Neolithic, but in some cases the differences are statistically significant (Table 4.3). At Molino Casarotto, post-cranial bones are especially large, even when compared with earlier Mesolithic and Neolithic data. An increase in the size of wild boar populations after the Mesolithic has been observed for other European areas (Albarella *et al.*, 2005; 2009), as well as in Italy (Albarella *et al.*, 2006c). This probably explains much of the difference with previous periods. A higher representation of wild boar at this site would not be surprising, as this locality has a high proportion of wild fauna – red deer being the most represented species – and its inhabitants most likely met a high proportion of their subsistence needs through the exploitation of the surrounding rich woodland environment (Jarman, 1971; 1976a; Boyle, 2014a; 2014b).

Late Neolithic Cornuda and Mulino S. Antonio are even more extreme, as most pigs here are noticeably larger than in the roughly contemporary period at Arene Candide. Like Molino Casarotto, at these sites the zooarchaeological evidence indicates that the hunting of wild fauna was the main means of meat procurement for the site's inhabitants (Albarella, 1987; Riedel, 1988). For Cornuda, Riedel noticed that, although only a limited number of bones were suitable for measuring, other smaller specimens were also present, suggesting that domestic pigs might not have been altogether absent from the site (Riedel, 1988). At Mulino S. Antonio too, some of the (measured) smaller specimens are indeed likely be domestic.

The evidence from Cornuda and Mulino S. Antonio contributes to our understanding of the enigmatic pigs from Molino Casarotto. The latter are on average smaller, but still larger than the size one would expect for an assemblage comprised entirely of domestic pigs (*e.g.* Late Neolithic Arene Candide). They are thus likely to represent domestic pigs kept under loose management and periodically mixed (and/or interbred) with wild boar, rather than representing a homogenous sample of wild boar. This is also confirmed by the tooth measurement distribution, which, with its larger sample, highlights the occurrence of smaller animals that are not clearly distinguishable from the larger individuals.

In all, it seems that the log ratios show that at Cornuda only wild boar are represented, at Mulino S. Antonio there are a majority of wild boar and a small proportion of domestic pigs, while at Molino Casarotto the two forms are undifferentiated. At this site a very substantial wild component appears to be present. Middle Neolithic Arene Candide and Rivoli (see also Jarman, 1976b) present a similar situation to Molino

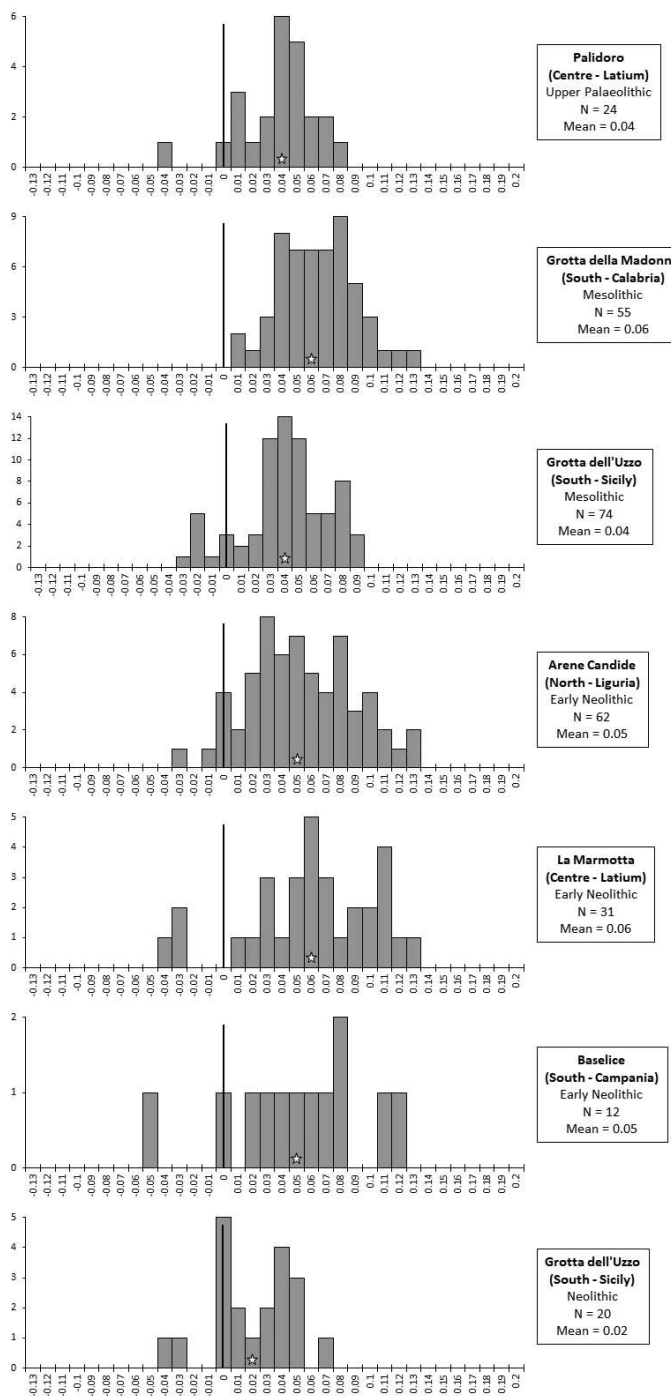


Fig. 4.6. Post-cranial log ratios for Upper Palaeolithic to Early Neolithic sites.

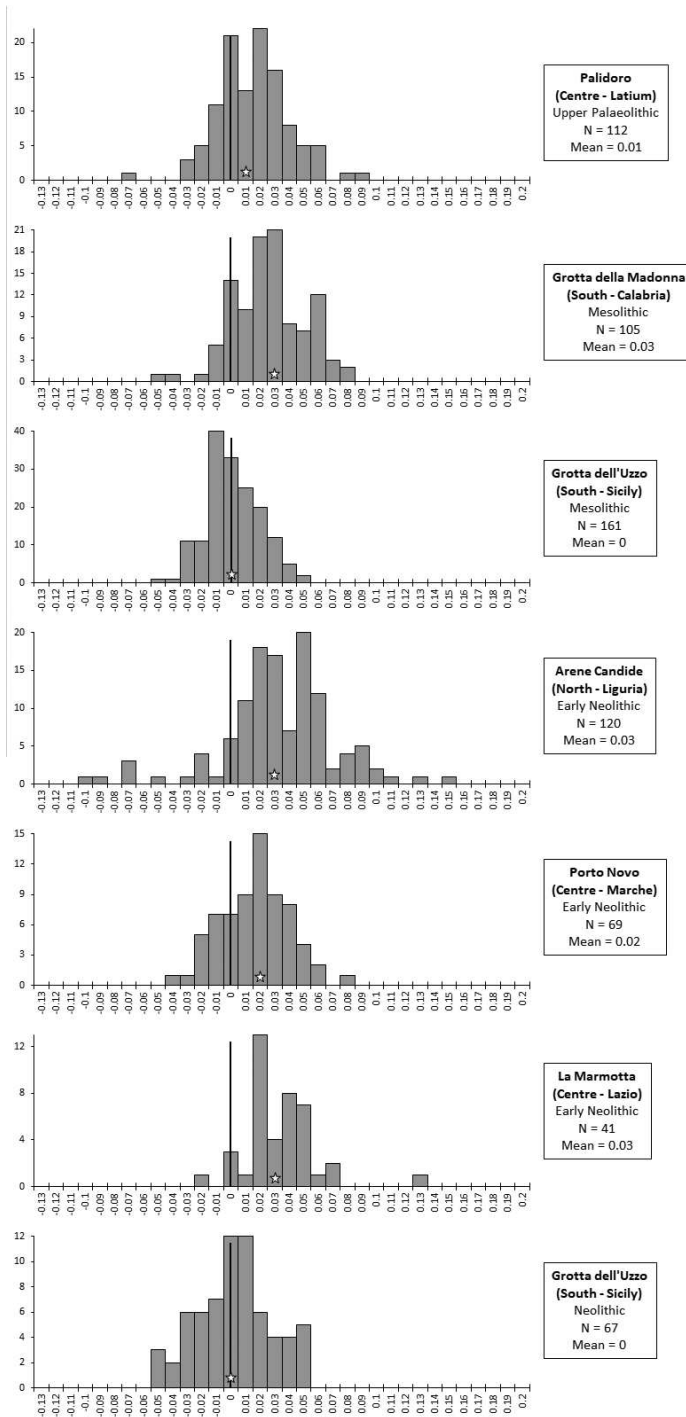


Fig. 4.7. Teeth log ratios for Upper Palaeolithic to Early Neolithic sites.

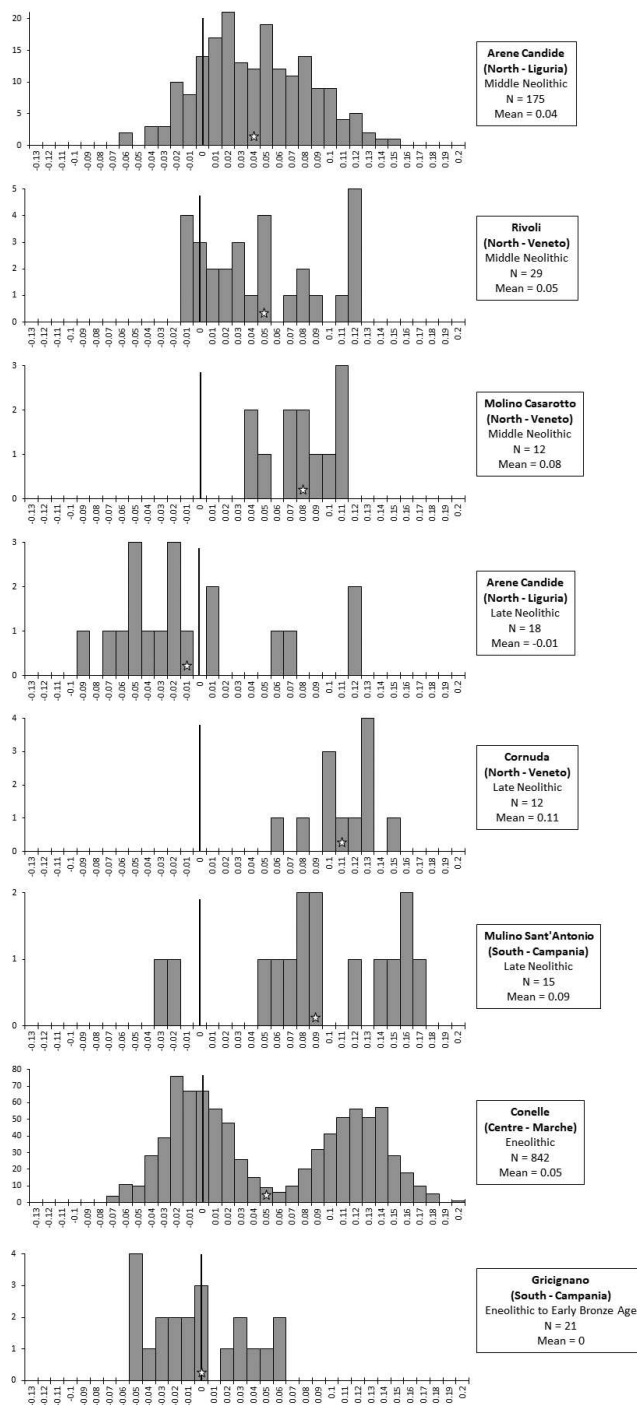


Fig. 4.8. Post-cranial log ratios for Middle Neolithic to later Prehistory sites.

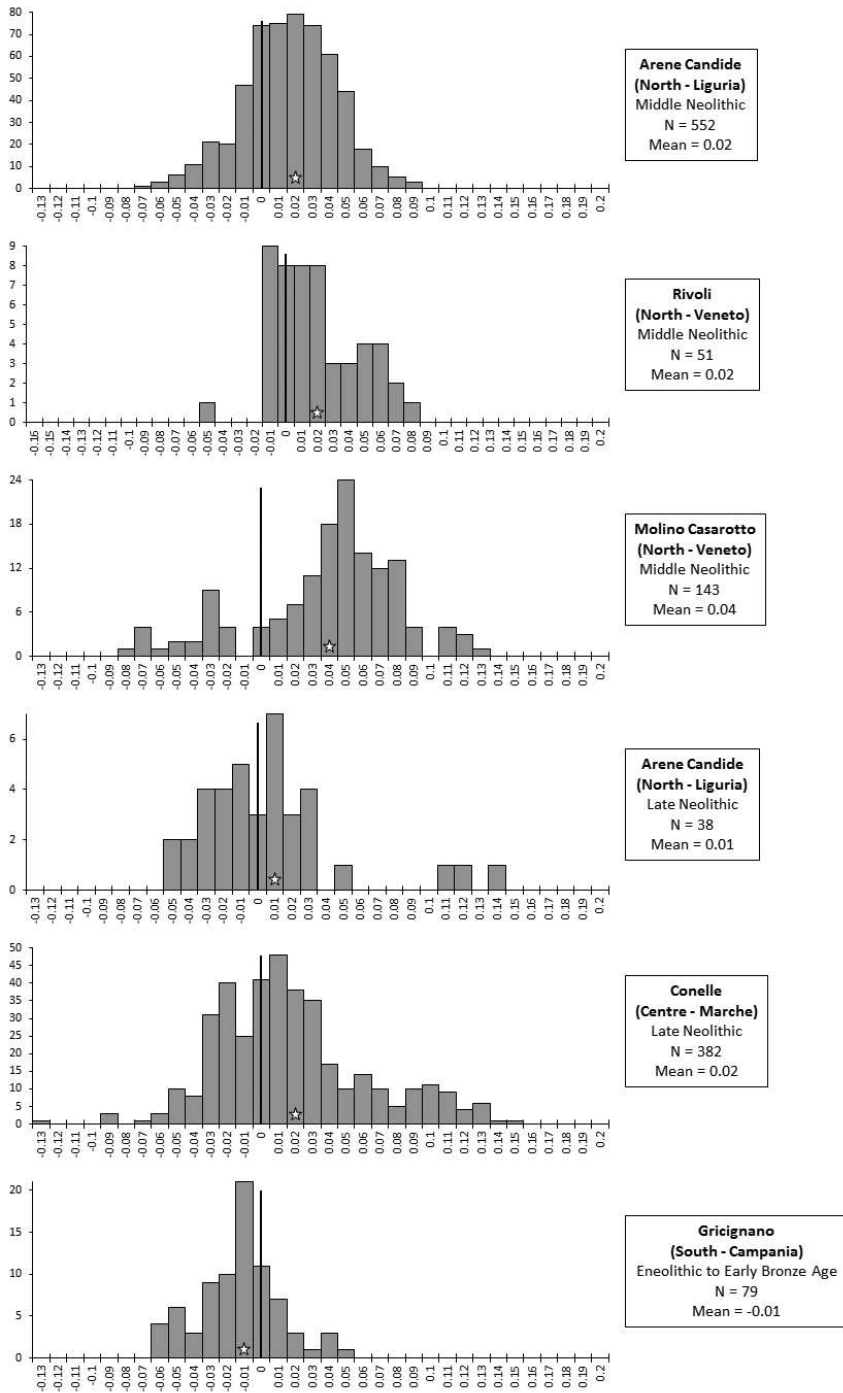


Fig. 4.9. Teeth log ratios for Middle Neolithic to later Prehistory sites.

Casarotto, but the smaller overall size at the latter indicates that at these two sites the domestic component may be greater.

The Late Neolithic to Early Bronze Age post-cranial log ratios (Fig. 4.8) suggest that by this time wild and domestic pigs had become more genetically isolated, leading to a noticeable size reduction of the domestic forms. This can be detected at Arene Candide, Conelle and Gricignano, where wild boar can by now be identified as large outliers. The significance of these differences is underscored by statistical testing (Table 4.3). The post-cranial measurements tend, on the whole, towards bimodality, echoing the scatterplot results. The case of the central Eneolithic site of Conelle is unique, as the bimodality is very obvious, clearly showing two distinct populations of likely wild and domestic pigs represented in roughly equal proportions. In a previous paper, the large size of the wild boars at this site was highlighted, especially when comparing it with Mesolithic and Neolithic data (Albarella *et al.*, 2006c), and is roughly consistent with the earlier Molino Casarotto, Cornuda and Mulino S. Antonio pigs.

The tooth log ratios (Fig. 4.9) for the Middle Neolithic data show no significant change from the Early Neolithic, and it is only during the Late Neolithic that the beginnings of a reduction in size can be seen. The late appearance of any size modification in pig teeth through time would be of no surprise if the majority of the pigs were domesticated from local wild boar, as these elements are more conservative and impervious to environmental changes than post-cranial bones (Payne and Bull, 1988).

The data from Arene Candide, spanning from Early to Late Neolithic (Fig. 4.6 to Fig. 4.9), can serve as an example of the development of pig morphology through time, permitting insight into the origins of the domestic pig in the area. The post-cranial evidence indicates only limited change from the Early to the Middle Neolithic, although during the latter period a larger spread of measurements can be seen, and in some cases the difference is statistically significant (Table 4.3). During the Late Neolithic, there is a clear shift towards smaller animals, with some elements still plotting on the larger side of the spectrum. In spite of the limited sample size, the results for this period suggest bimodality, probably indicating the presence of domestic pigs and a smaller component of wild boar. Similarly, for teeth there is little change between the Early and Middle Neolithic. The teeth from the Late Neolithic period are, in general terms, consistent with previous periods, but they do show some diminution in size and bimodality. In all, the pigs from the Late Neolithic at Arene Candide are noticeably smaller than in any preceding period, indicating a change in pig management.

## Discussion

The results from the biometrical analysis of *Sus* remains from Italian archaeological sites presented in this paper indicate consistency in body size between pre-Neolithic and Early Neolithic times, as noted in previous studies (Albarella *et al.*, 2006c). It is only in later Prehistory that a clear distinction between two pig populations, one wild and one domestic, can be observed. Therefore, we can safely assume that the

later Neolithic pigs were managed quite differently than in earlier times, with less admixture occurring between wild and domestic populations. The true nature of the Early Neolithic animals, remains however, elusive. To understand the status of these earlier suids, two main interpretations can be proposed, as previously suggested by one of us (Albarella *et al.*, 2006c):

- a) Most, if not all, of the Early Neolithic pigs are wild, and pig husbandry did not develop until the Late Neolithic at the earliest.
- b) Domestic pigs were present during the Early Neolithic, but, due to regular interbreeding with wild boar, a morphologically distinct form did not appear until the Late Neolithic.

At a first glance, the lack of a significant biometrical difference between the Upper Palaeolithic/Mesolithic and Early to Middle Neolithic pig populations would seem to support the first interpretation, and indeed some authors do embrace this view (*e.g.* Rowley-Conwy, 1997; 2003; Rowley-Conwy *et al.*, 2013). However, a closer look at the evidence available indicates a more complex reality, as previously argued by Albarella *et al.* (2006c). When comparing the data from Early and Middle Neolithic assemblages with those of the later Neolithic, Eneolithic and Bronze Age, it becomes clear that the Early Neolithic pigs hardly ever reach the size of the very large wild boar identified in later prehistory, and, on average, they are much smaller. Even considering the suggested increase in wild boar size over time, some of the sites (*e.g.* Cornuda and Mid-Neolithic Arene Candide) are too close chronologically for a natural biological development to be the explanation for the size difference. The wild boar from Cornuda plot at the very top end of the Early and Middle Neolithic pigs from Arene Candide, rather than in the middle, as one would have expected if the Arene Candide pigs had all been wild. Therefore, the suggestion that no domestic pigs were present in the Early and Middle Neolithic in Italy is unlikely.

Instead, our data are consistent with the idea that the Early and Middle Neolithic pigs are mainly domestic animals regularly interbreeding with wild boar – as would be expected in a free-range management system. The greater variability observed in Early Neolithic assemblages (*cf.* Table 4.3), when compared to Upper Palaeolithic and Mesolithic sites, and in particular Grotta dell’Uzzo, where some size reduction from the Mesolithic is apparent, supports the interpretation that Early Neolithic farmers did own domestic pigs. Jarman (1971; 1976) had also suggested the presence of domestic pigs alongside wild boar at Molino Casarotto and other northern Italian sites as early as the Middle Neolithic. The change that we see later on in the Neolithic does not represent a transition from hunting to husbandry, but rather from an extensive to an intensive management system, which is reflected in the bimodality of the later prehistoric data. This change is likely to be related to a more general agricultural intensification, perhaps also linked to a demographic increase (Palmisano *et al.*, 2017).

If we are correct in our interpretation of the Early Neolithic evidence, we are witnessing the beginnings of a slow process of pig domestication in Italy in these

periods, much like in the case of Anatolia (Hongo and Meadow, 1998; Rosenberg and Redding, 1998; Ervynck *et al.*, 2001); the question remains as to whether these early domestic pigs are from an imported stock or are locally domesticated from the native wild boar population. Perhaps it was a mix of the two. The introduction of at least some pigs of western Asian origins in the Early Neolithic of Europe has been demonstrated palaeogenetically (Larson *et al.*, 2007), but that does not rule out a potential added component of local domestication. In Italy, the evidence of a local domestication event is tantalising, particularly in view of the lack of any abrupt morphometric change between the Mesolithic and the Neolithic. Additionally, the smaller teeth in relation to post-cranial bones that seem to be a genuine characteristic of the Italian wild boar carry on through time, and the changes observed in post-cranial bones from the Late Neolithic onwards (*i.e.* size reduction and bimodality) seem to take much longer to become manifest in teeth. This would be expected in the case of a local domestication event. Albarella *et al.* (2006c) provided additional support for this interpretation by comparing the biometrical data from Italy with data from two western Asian sites (Erbaba in Turkey and Sabi Abyad in Syria, dated to the sixth millennium BC) – located in an area from where imported domestic pigs could have originated – and concluded that the Italian Neolithic pigs were more similar to the Mesolithic Italian wild boar than to either of the western Asian assemblages. Additionally, the presence of the distinct Italian wild boar genetic signature in Sardinian pigs (Larson *et al.*, 2005; 2007), which are thought to originate from feral domestic animals (Vigne, 1988), offers support to the idea of a local domestication event.

## Conclusions

Although there is little doubt that Italian early farming communities introduced and/or inherited cultural traditions of exotic origins, it is also increasingly clear that they cannot solely be characterised as an imported phenomenon. Animal husbandry was not practised by Mesolithic communities and the Neolithic does represent a very important change in this respect, but not all livestock was necessarily managed in the same way. While sheep and goats were certainly introduced, there were plenty of local wild pigs to be potentially tamed. It is likely that some domestic pigs were also imported, but our evidence suggests that their management was loose, and that the domesticates must have been free to roam and breed regularly with wild boar, thus generating a biological continuum between domestic and wild forms. For several millennia this system of pig management appears to have been widespread across the Italian Peninsula. It is only in the Late Neolithic that this dynamic seems to have been altered, with a clear change in husbandry practices; by then domestic pigs and wild boars were more commonly being kept separate, possibly in response to wider changes in agricultural practices.

As a final note, we would like to stress the importance of studying domestication processes by taking a long-term approach, as it can take millennia before their impact



can be seen in the morphology of the domesticated animal (Zeder, 2012). These early Italian pigs, though likely to be similar in appearance to the local wild boar, were active participants in the changing lifeways of Early Neolithic communities.

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