The Origins and Evolution of Pig Domestication in Italy: A Regional and Diachronic Study of Husbandry Practices

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ABSTRACT

The emergence of the Neolithic in Europe represents a key moment in human history, and the domestication of the wild boar (*Sus scrofa*) and the emergence of the pig (*Sus domesticus*) a fundamental aspect of that process. In Italy, the phenomenon of pig domestication in prehistory is still not entirely understood. The main objective of this PhD is to contribute to the understanding of the origins and development of pig domestication in prehistoric Italy, from a wide regional scale and a diachronic perspective. Some key archaeological questions addressed in this research concern how and when the process of pig domestication commenced in Italy, how it evolved thereafter, and how it compares and integrates with the wider European and Middle Eastern scenarios.

The main methodology used to tackle this objective is the collection of comparable data from several Italian prehistoric sites in order to detect patterns of regional and chronological change, from the Upper Palaeolithic to the Bronze Age. The analysis relies mainly on biometrical data, but it is complemented with evidence of kill-off patterns and sex ratios, in order to achieve a comprehensive understanding of the domestication event.

The results support the view that a domesticated pig occurred in Italy from the Early Neolithic, although it only became morphologically distinct from the Late Neolithic onwards. This change in pig size and shape seems to signify a shift from an earlier loose management strategy of pig keeping to a close domestic control of pigs in later times, articulating with historical changes in Italian societies. The Italian pig domestication process shares similarities and differences with other European and Middle Eastern cases, highlighting the diverse trajectories this process took in different areas, in tune with the regional particularities of the spread of the Neolithic in Europe.

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> *The presence of those seeking the truth is infinitely to be preferred to those who think they've found it.*
>
> Terry Pratchett – Monstrous Regiment

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Chapter 1
INTRODUCTION

1.1. Main Objectives and Research Questions

Pigs and humans have a long history of interaction spanning thousands of years. Wild and domestic pigs have played a major part in our history, not only because of their role as a meat source but also for their influence on the organization and cultural beliefs of human societies (Dawson, 1998; Nemeth, 1998). From prey to farm animals, as pets, entertainers and subjects of medical experimentation, pigs have a complex relationship in the evolution and shaping of human culture that exists up to this day. As an example, in present day there are more than 500 breeds and varieties of domestic pig, as a result of a long history of evolution and human selection (Porter, 1993).

The emergence of farming practices is indisputably one of the key points of human evolution, and the process of domestication of the wild boar (*Sus scrofa*) and the emergence of the domestic pig (*Sus domesticus*) a fundamental aspect of that evolution. The particular characteristics of pigs, namely the ample natural distribution of its wild ancestor – the wild boar – and their omnivorous diet, have shaped their relationship with humans in a way unlike other animals (Albarella et al., 2006a). Whilst the earliest evidence of pig domestication comes first from the Near East (Flannery, 1983; Peters et al., 1999; Vigne and Buitenhuis, 1999) and then the Far East (Jing and Flad, 2002), pigs could have been potentially domesticated anywhere in most of North Africa and Eurasia (Clutton-Brock, 1999; Davis, 1987), due to the broad natural distribution of the wild boar in those continents. Indeed, multiple domestications have occurred, as proven by genetic evidence (Larson et al., 2005; 2007b). Additionally, the generalized omnivorous diet of the pig opens a series of possible relationships with humans not available in the case of other herbivorous domesticates. Pig exploitation is not restricted to hunting and close domestic control, but instead can take various intermediate forms (e.g. free-range management), as can be seen in historical and ethnographic examples (Albarella et al., 2006a; 2011; Clutton-Brock, 1999; Dwyer, 1996; Grigson, 1982; Hamilton and Thomas, 2012; Redding and Rosenberg, 1998b). In sum, the process of pig domestication poses a unique set of challenges and questions to its study unlike those of other species and must be approached by taking into account the climatic, environmental, geographic, chronological, and cultural contexts.

In the past, the subject of pig husbandry in Europe has been limited mainly 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 carried out so far. Only recently has this issue been acknowledged in the literature and studies of pig domestication in a wider regional and chronological context, based on large amounts of data, have been attempted (Albarella et al., 2006c). However, a whole series of questions remain unanswered and more work needs to be done at a wider regional scale and from a diachronic perspective. The main objective of this PhD project is therefore to address these problems and contribute to the understanding of the origins and development of pig domestication in prehistoric Italy.

Previous research on Italian prehistoric sites has laid the groundwork for this research by proposing a series of hypotheses regarding the possible origins of pig domestication in the peninsula (Albarella et al., 2006c). So far the data seems to support the hypothesis of slow and gradual local pig domestication in the region, echoing the results of the biomolecular analysis (Larson et al., 2005; 2007b). Particularly, previous research has revealed that during the Early and Middle Neolithic periods no clear distinction between wild boar and domestic pig could be identified on the basis of biometry, suggesting loose management and interbreeding. From the Late Neolithic onwards there is a rather abrupt change, as a distinction between the two forms becomes evident (Albarella et al., 2006c). Genetic research has highlighted the existence of a unique Italian genotype, separating the history of these animals from those of the rest of Europe (Larson et al., 2005; 2007b). Thus, the current scenario suggests that the domestication of the pig in Italy has likely involved a mixture of introduced domestic animals and local domestication, but there are many more areas that need greater clarification and to which this project will contribute:

- Can the current hypothesis withstand scrutiny by the analysis of a larger sample, both in terms of actual data and geographic/chronological coverage?

- Unlike Spain, where a mixed scenario occurs (Hadjikoumis, 2010), in Italy it has not been possible so far to identify any example of an abrupt change in pig management between the Mesolithic and the Neolithic – can this further work identify such cases?

- Can the system of more intensive pig management suggested for the Late Neolithic be identified at other sites? Was it widespread and how does it compare with other European areas?

- Does the overall pattern of pig domestication in Italy appear to be unique or is it similar to other European areas? How can it be integrated with our overall understanding of the beginning of farming in Europe?

Building on previous work, the main methodology proposed to address these questions is the collection of comparable data from several prehistoric sites in Italy in order to detect patterns of regional and chronological change, thus filling the gaps left by previous research. The potential of the biometrical approach has been extensively demonstrated in the past (Albarella et al., 2005; 2006c; 2009). The comparative method will allow us to assess the influence of specific environmental and cultural factors on the biological variations of pig populations. Although this project focuses on the beginnings of the domestication, the time period considered for the analysis ranges from the Upper Palaeolithic to the Bronze Age. The reason behind this long chronological scale rests on the assumption that domestication processes can be better understood by taking a long-term view. The analysis will mainly rely on biometrical data, which is more akin to comparisons between sites than other sources of evidence. This data will be complemented with evidence of kill-off patterns, sex distribution, and observation of pathologies, in order to achieve a comprehensive analysis of the domestication event.

1.2. Outline of the Thesis

In the following chapter the current knowledge of the taxonomy and ecology of the wild boar and the domestic pig will be presented, followed by an up to date review of pig domestication studies in Chapter 3. An overview of relevant paleoenvironment data and of Italian prehistory, covering the chronology of this research, will be introduced in

Chapter 4. In Chapter 5, the methods used will be put forward, while in Chapter 6 the archaeological materials studied will be presented. In Chapter 7 the results of the analysis of the archaeological pig assemblages will be introduced, while in Chapter 8 these results will be compared to the information available on the topic from other European sites and regions. A thorough discussion of the results achieved and its significance for the understanding of the pig domestication process, and its contribution to our understanding of the origins of farming in Europe will be put forward in Chapter 9. Finally, Chapter 10 will conclude this work by summarizing the finds, discussing the results of the research, and presenting future avenues of inquiry.

Chapter 2
THE PIG

2.1. The Wild Boar and the Pig

2.1.a. Taxonomy and Phylogeography

The wild ancestor of the domestic pig (*Sus domesticus*) is the wild boar (*Sus scrofa*). Both animals are part of the Artiodactyla order (even-toed ungulates) and Suidae family (Table 2.1). They are moderate to large sized animals, and have well developed canines, especially the males (Groves and Grubb, 1993a; Toschi, 1965). The anatomic characteristics of pigs include many low-crowned, bunodont molars, and an unguligrade even-toed limb structure (Bracke, 2011). They have these physical properties in common with their close relatives, the peccaries (family Tayassuidae) and the hippopotamuses (family Hippopotamidae) (Powell, 2003).

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia (Linnaeus, 1758)
Order	Artiodactyla (Owen, 1848)
Family	Suidae (Gray, 1821)
– Subfamily	Suinae (Gray, 1821)
Genus	*Sus* (Linnaeus, 1758)
Species	Wild Boar: *Sus scrofa* (Linnaeus, 1758) Domestic Pig: *Sus domesticus* (Erxleben, 1777)

Table 2.1. Wild boar and domestic pig taxonomy (Source: Integrated Taxonomic Information System, http://www.itis.gov/).

The Suidae family is itself divided into three sub-families: Babyrousinae, Phacochoerinae, and Suinae (Groves and Grubb, 1993b). The latter is also subdivided into three genera: *Hylochoerus*, *Potamochoerus*, and *Sus* (Groves, 2007; Groves and Grubb, 1993b). The wild boar and domestic pig belong to the genus *Sus*. As mentioned above, it is currently accepted that the wild ancestor of the domestic pig (*Sus domesticus*) is the Eurasian wild boar (*Sus scrofa*), but they are not the only members of the genus *Sus*. Other species of pig are the smallest of the living pigs, the pygmy hog (*Sus salvanius*), and the warty pigs, called thus because the adult males develop three pairs of warts: the Javan warty pig (*Sus verrucosus*), the bearded pig (*Sus barbatus*), the Philippine warty pig (*Sus philippensis*), the Visayan warty pig (*Sus cebifrons*), and the Sulawesi warty pig (*Sus celebensis*). Hybridization between *Sus scrofa* and the warty pigs is possible, but has been recorded mostly in captivity (Groves and Grubb, 1993a).

Several sub-species of wild boar (*Sus scrofa*) have been identified, distributed in several regions of Eurasia and Africa. Groves and Grubb (1993a; see also Oliver et al., 1993) have distinguished four groups of extant subspecies, based on geographic and morphological criteria:

- The 'western races' of Europe (*Sus scrofa scrofa* and *Sus scrofa meridionalis*), North Africa (*Sus scrofa algira*), Middle East (*Sus scrofa lybicus*), and extending east into Central Asia (*Sus scrofa attila* and *Sus scrofa nigripes*).
- The 'Indian races' of the sub-Himalayan region from Iran to north India and adjacent countries (*Sus scrofa davidi, Sus scrofa cristatus, Sus scrofa affinis*).
- The 'eastern races' of Mongolia and Soviet Far East (*Sus scrofa sibiricus* and *Sus scrofa ussuricus*), Japan (*Sus scrofa leucomystax* and *Sus scrofa riukiuanus*), Taiwan (*Sus scrofa taivanus*), and China and Vietnam (*Sus scrofa moupinensis*).
- The 'Indonesian race' of the Malay Peninsula, Sumatra, Java, Bali, and neighbouring islands (*Sus scrofa vittatus*).

The number of subspecies of pig varies according to the authors (Genov, 1999; Groves, 1981; Mayer and Brisbin Jr, 1991; Oliver, 1993; Ruvinsky and Rothschild, 1998; Toschi, 1965), even to the point that some have begun to wonder whether there is actually more than one species involved (Groves, 2007). Regardless of these discussions, the variability of the species attests to the adaptability of pigs.

Studies on mitochondrial DNA of modern wild and domestic pigs from around the world have shed some light into its genetic history (Giuffra et al., 2000; Kijas and Andersson, 2001; Larson et al., 2007a,b; 2005). Larson et al. (2005) analysed mitochondrial DNA from wild and domestic pigs from around the world, and their results indicated an origin of the genus *Sus* in the Malaysian Peninsula and the islands of Sumatra, Borneo, and

Java (Figure 2.1). From that area, wild boars spread into the Indian subcontinent first, reaching Nepal and western Pakistan. In a second radiation, the South Eastern Asian wild boars expanded into continental East Asia before spreading west into North Africa and Western Europe (Larson et al., 2005; 2007a). For the case of Italy, distinct clades of central Italian wild boar have been recognized (Giuffra et al., 2000; Kijas and Andersson, 2001; Larson et al., 2005; 2007a).

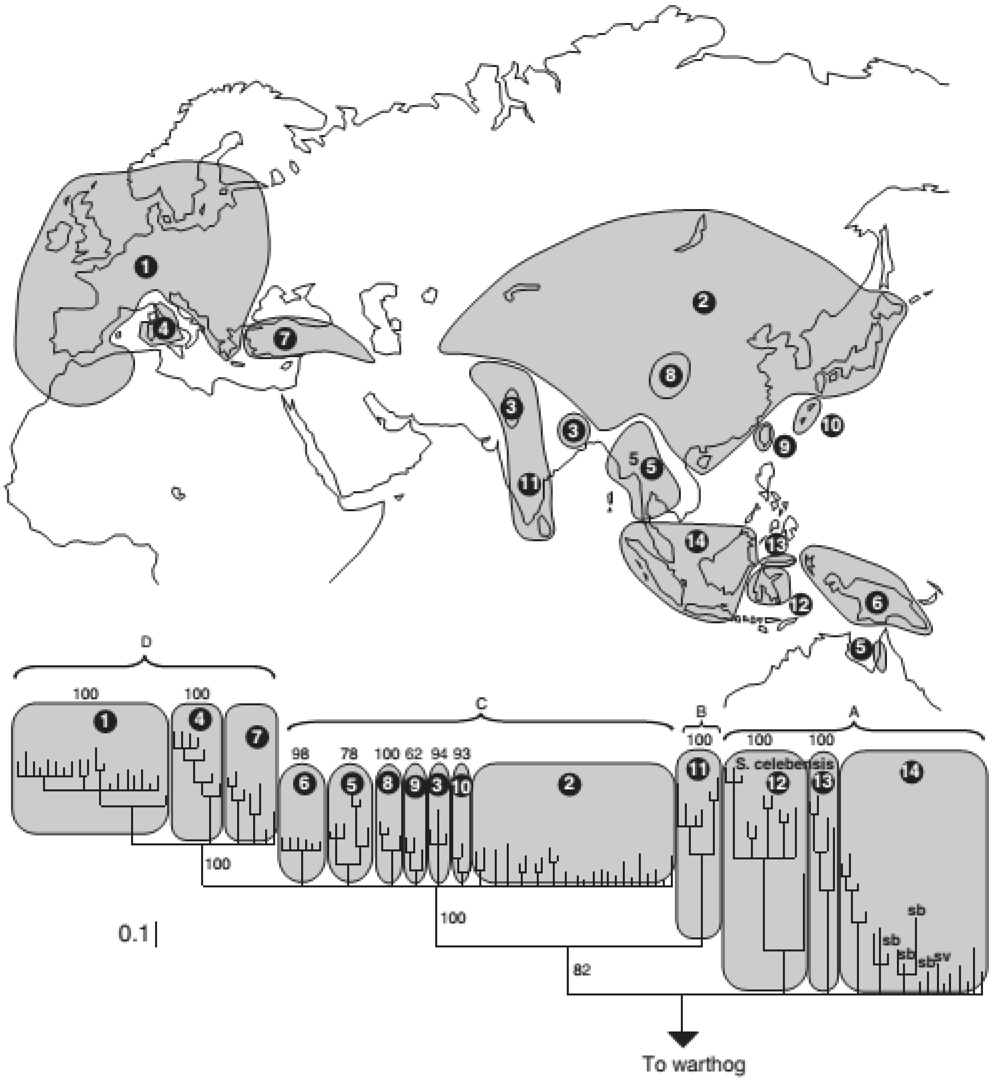

Figure 2.1. *Sus* mtDNA haplotypes map: “A Bayesian (MCMC) consensus tree of 122 *Sus* mtDNA control region haplotypes rooted by a common warthog (*Phacochoerus aethiopicus*). A total of fourteen clusters (labelled 1-14 on the tree and on the map) are contained within four major clades on the tree (A, B, C, D). Pigs from Sulawesi are *Sus celebensis*. All other tips on the tree represent wild *Sus scrofa* unless indicated by the following two-letter codes: sb, *Sus barbatus*; sv, *Sus verrucosus*. Regions 1-6 represent suggested centres of domestication” (Source: Larson et al., 2007a: 34)[1].

2.1.b. Geographic Distribution, Habitat, and Behaviour

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Unlike other domesticated animals whose wild ancestors live in restricted geographic areas, such as sheep and goat, the pig has a wild ancestor that has a very broad natural distribution (Barrios-Garcia and Ballari, 2012; Oliver et al., 1993). Indeed, the original distribution of the wild boar covers large part of Eurasia, "from western Europe to the Soviet Far East, extending southward as far North Africa, the Mediterranean Basin, and the Middle East, through India, Indo-China, Japan (including the Ryukyu Chain), Taiwan, and the Greater Sunda Islands of southeast Asia" (Oliver et al., 1993: 113). Currently, the wild boar is present in all continents but Antarctica (Figure 2.2); its broad current distribution is due partly to human agency. The great morphological and size variability of the wild boar echoes its large geographical distribution (Albarella et al., 2009). Most importantly, the natural wide distribution of this animal means that potentially it could have been domesticated anywhere in those areas (Clutton-Brock, 1999; Davis, 1987).

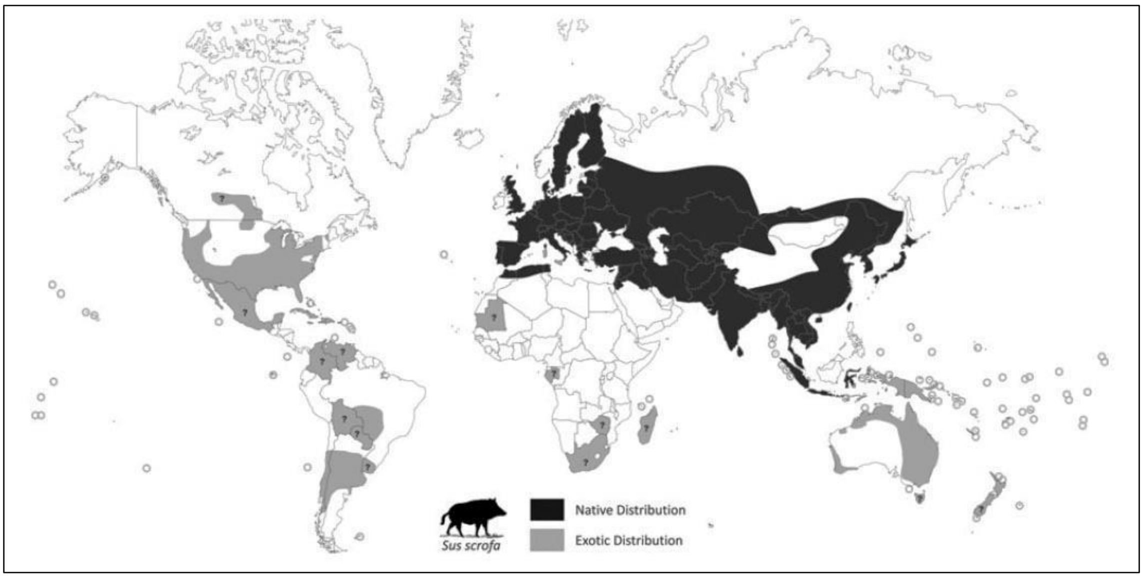

Figure 2.2. Wild boar (*Sus scrofa*) worldwide distribution, showing original presence in black and human introductions in grey and circled islands (Source: Barrios-Garcia and Ballari, 2012)[2].

The history of the wild boar has been marked by introductions in new regions, extinctions or near extinctions, and reintroductions. It has been extinct in the British Isles and Scandinavia since the second half of the 13th century, but they have been reintroduced in these areas (Albarella, 2010; Oliver and Leus, 2008). In Italy, the wild boar became almost extinct by the mid-20th century (Apollonio et al., 1988), a process

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that was halted by the introduction of allochthonous animals (Albarella et al., 2009). In Corsica and Sardinia, they were extinct before the arrival of the first human settlers, but reappear in the archaeological record around the 6th millennium cal. BC (Albarella et al., 2006b; Levine, 1983; Vigne, 1988; Wilkens and Delussu, 2002). Additionally, wild boars can hybridise with domestic pigs, and it is not uncommon for the latter to escape confinement and create entirely feral populations[3] (Albarella et al., 2006a; 2007; 2009; Redding and Rosenberg, 1998a).

The wild boar can live in a wide variety of habitats, such as woodlands, grasslands, and tropical rainforests, from plains to mountain areas (Oliver et al., 1993; Toschi, 1965). In Europe, it mainly occupies broadleaved forests and especially evergreen oak forests, but can also be found in open habitats like steppes, Mediterranean shrublands, and even farmlands, providing there is sufficient water and tree cover (Spitz, 1999). From the environment, pigs require suitable shelter, sufficient water sources, soft ground for rooting in, and mud to wallow (Grigson, 1982). Wild pigs live in a home range which vary between 3-400 ha and 15.000 ha (Janeau and Spitz, 1984; Jullien et al., 1990; Massei et al., 1997), and can migrate over distances of up to 100-150 km in times of food scarcity (Andrzejewski and Jezierski, 1978; Singer et al., 1981). Population density varies between 0.2 to 43 animals/km^2, with high inter-annual variation (Hone, 2002; Jedrzejewska et al., 1994; Kozlo, 1975). In the case of domestic pigs, they can become sedentary and prone to obesity if enough food is provided to them (Grigson, 1982). They can be driven into appropriate feeding areas (70 miles in a week, according to Diener and Robkin, 1978), but this is not an easy task, and "it is clear that pigs are at best reluctant and recalcitrant nomads" (Grigson, 1982: 299). Nevertheless, pig transhumance has been recorded in ethnographic studies (Albarella et al., 2011).

They are adaptable and generalized omnivores, although their sustenance is mostly based on vegetables (Spitz, 1986). Their diet is dependent on seasonally available energy-rich foods, mainly acorns, olives, and pine-seeds (Barrett, 1978; Jedrzejewska et al., 1994; Massei et al., 1996). Protein is the major limiting factor in body weight gains, number of breeding females, and litter size (Aumaitre et al., 1984; Massei et al., 1996). They can consume invertebrates, e.g. earthworms, and small vertebrates and fishes, including molluscs and other arthropods (Massei et al., 1996; Masseti, 2007; Oliver et

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[3] For more information on feral populations, see 2.2.b.

al., 1993); although the animal component of their diet is minimal, between 2 and 11% (Massei and Genov, 2004). They are also known to feed on eggs (Calderón, 1977; Marsan et al., 1990). Pigs have furthermore been reported to scavenge carcasses of animals who either died naturally or were killed by carnivores (Masseti, 2007). On occasions, wild boars have been known to predate larger vertebrates, such as deer fawns, goats, and lambs (Choquenot et al., 1996; Hoogerwerf, 1970); however, these incidents probably involved only a few individuals (Oliver et al., 1993). Additionally, domestic pigs will also eat rotting fruit and vegetables, excess agricultural produce and cattle and human faeces (Grigson, 1982; Trow-Smith, 1957; Vayda et al., 1961). Feeding in wild boars is generally a social activity (Oliver et al., 1993), and they feed continuously for many hours (Clutton-Brock, 1999). Regarding this latter aspect, pigs differ from other artiodactyls in that while ruminants will intermittently feed, ruminate, and sleep during the day, pigs will sleep or feed continuously for many hours. In practice, this is a benefit for the domestic pig herders, as in captivity they do not require food during the night and their feeding patterns can be accommodated to those of humans. As an additional benefit, pigs can be trained to come where they are wanted by feeding them (Clutton-Brock, 1999).

The rooting activity of the wild boar has been noted as a major cause of disturbance to plant communities (Hone, 2002; Howe and Bratton, 1976; Pirożnikow, 1998; Singer et al., 1984), and in some cases damage to agricultural crops (Andrzejewski and Jezierski, 1978; Mackin, 1970). This behaviour of wild pigs can also have a negative impact on the density of ground-dwelling small mammals, due to the habitat destruction and decrease of food availability for these animals (Massei and Genov, 2004; Singer et al., 1984). Massei et al. (1996) and Singer et al. (1981) mention that competition between the wild boar and other mammals is likely, though there currently is no study quantifying this phenomenon (Massei and Genov, 2004). Lastly, the wild pig is known to be prey to large carnivores, such as the wolf (*Canis lupus*) in northern Italy, and the youngsters may also even be prey of foxes (Massei and Genov, 2004; Meriggi et al., 1996).

The flexible diet of pigs has led Pond and Houpt to declare that “in its nutrient requirements, the pig resembles the human in more ways than any other non-primate mammalian species” (1978: 276). This feature makes the pig an ideal companion to humans, as it is suitable to recycle household refuse and therefore contributes to domestic hygiene (Grigson, 1982; Masseti, 2007; Miller, 1990). Indeed, “Even when no other sources of animal food are available, pigs, dogs and poultry can fend for themselves if allowed to range freely and scavenge their feed from open areas" (Miller, 1990: 126).

In the wild, the main farrowing season of the pig is spring. Wild boars mate from the end of October to the end of November, and the litters are born in late March-early April (Frädrich, 1972; Lauwerier, 1983; Mohr, 1960). Sows will usually have one litter of on average five or six piglets (but litters of 12 or more individuals have been recorded), depending on favourable environmental conditions (Massei et al., 1996). In very favourable circumstances they might have an additional birth in autumn (October-November). Female pigs reach puberty at approximately 9 months, but usually do not breed until their second year of age. Gestation lasts 114-140 days, and lactation 2-3 months (Grigson, 1982). In domestic state, puberty is reached at 6-18 months and breeding can start at one year of age, whereas gestation is only 112-115 days and they can produce two or three litters a year (Bennett, 1970; Grigson, 1982; Signoret et al., 1975). These characteristics of their reproductive cycle imply that pigs can increase their numbers considerably in favourable conditions, thus being able to withstand high predation and hunting pressures (Grigson, 1982).

As evidenced by their feeding patterns and in terms of general behaviour, pigs behave much more like humans and dogs than other artiodactyls. In addition to their short reproductive cycle and large litters, other characteristics of the pigs more akin to carnivores than artiodactyls are the fact that they enjoy bodily contact amongst each other, their habit of nest-building and bed-making, and their weak physical development at birth (Clutton-Brock, 1999). Regarding their social structure, wild pigs are gregarious, forming groups of usually 6-20 individuals. The basic social unit is the family group consisting of one or more females and their last litter. Peripheral to this main structure are subadults from previous litters and males during mating season (Oliver et al., 1993). They are not territorial animals, but males and females with offspring can be very aggressive. Pigs have a love of water, in the form of their wallowing in the mud and they are very good swimmers. Pigs wallow as a thermoregulatory behaviour, for grooming, for health reasons, in relation to sexual behaviour, etc. (Bracke, 2011). Finally, pigs are very intelligent animals and have an episodic memory, having been used historically as truffle hunters, in circus shows and races, etc. (Mizelle, 2011). Indeed, pigs are not only a source of meat and fat, but have also contributed to human society as cultural symbols, in medicine, and as pets, amongst other uses and relationships (Dawson, 1998).

2.1.c. Size Variability in Wild Boar

Several ontogenetic and environmental phenomena influence the variability of wild boar size. Amongst the former, age and sex are the main factors affecting size of individuals within a population. Naturally, younger unfused bones will be smaller than those of a fully adult individual, but even fully fused bones and some bones with no fusion centres like the astragalus, will continue to grow as the animal ages (Payne and Bull, 1988). The wild boar is also a highly sexually dimorphic animal, the males being larger than the females and possessing morphologically distinct canines (Herring, 1972; Payne and Bull, 1988).

Regarding the environmental factors, temperature affects the overall body size of animals. A South-North size cline has been observed for Eurasian wild boar (Albarella et al., 2009). This phenomenon is related to Bergmann's rule which states that individuals in colder environments (i.e. higher latitudes) will develop a larger body mass and the opposite will occur in warmer climates (see Bergmann, 1847; Blackburn et al., 1999; Davis, 1981; Koch, 1986; Mayr, 1963; McNab, 1971; among others for a thorough discussion on the phenomenon). Davis (1981) and Ducos and Horwitz (1997) proposed that the world-wide temperature increase at the end of the Pleistocene (10-12,000 years BP) could have been the main factor conditioning size change in Middle Eastern wild boar during this period. Related to environmental conditions is the wild boar habitat's food availability, which in turn will condition the size of these animals (Massei et al., 1996; see also Chapter 2.1.b).

Additionally, Eurasian wild boar populations increase in size on a West-East gradient, which seems to be a product of temperature and continentality changes (Albarella et al., 2009). Isolation and a concomitant higher population density in the western regions of Eurasia can also be a factor in the smaller size of these populations (Albarella et al., 2009; Magnell, 2004). The effects of island isolation in body size have also been observed for various mammals (e.g. Lister, 1993, 1989; Roth, 1990; Sondaar, 1977; Stuenes, 1989;

Vartanyan et al., 1993). The 'island rule' (Van Valen, 1973) states that there is a tendency for gigantism in rodents and marsupials and for dwarfism in carnivores, lagomorphs, and artiodactyls in islands (Foster, 1963; 1964; 1965). The reasons for this phenomenon seem to be changes in population density and inter-species competition, and in resource diversity and availability (Adler and Levins, 1994; Foster, 1964; Heaney, 1978; Lomolino, 1985; 2005; McNab, 2010). In the case of the pigs, an example of this phenomenon is the case of the island of Sardinia (Apollonio et al., 1988), and the smallest wild boar in the world today inhabits the Ryukyu archipelago of Japan.

Interspecies competition is another factor that will impact body size. When two species of similar size an ecology occupy the same habitat, selection will favour those individuals of each species with the highest difference in size (Davis, 1981; Dayan et al., 1991; 1993). Similarly, Weinstock (2000) has noted for reindeer (*Rangifer tarandus*) populations that higher continentality will reduce the level of intra-specific competition. High predator pressure will likewise influence the selection of larger and stronger limbed individuals (Davis, 1981; Ducos and Kolska Horwitz, 1997). A reduction in size of the animals following domestication has been observed for wild boar (Davis, 1981; see also Chapter 2.2). An increase in size may conversely occur as a result of a relaxation in hunting pressure (Albarella et al., 2009; Davis, 2006).

2.2. The Domesticated Animal

2.2.a. Defining Domestication

Over the years, several definitions of domestication have been proposed by specialists from both the archaeological and biological disciplines (Bökönyi, 1989; Clutton-Brock, 1999; Ducos, 1978; 1989; Hale, 1969; Meadow, 1989; Price, 1984). From a zoologist's perspective, Price defines domestication "as that process by which a population of animals becomes adapted to man and to the captive environment by some combination of genetic changes occurring over generations and environmentally induced developmental events reoccurring during each generation" (Price, 1984: 3). The process of domestication thus defined implies both genetic changes over generations and ontogenetic changes through environmental stimuli and experiences during an animal's lifetime (Price, 1984). This process also involves direct human control in the breeding choices, care (e.g. shelter and protection against predators), and feeding of the animals (Hale, 1969).

From an archaeologist's perspective, Bökönyi defines animal domestication as "[…] the capture and taming by man of animals of a species with particular behavioural characteristics, their removal from their natural living area and breeding community, and their maintenance under controlled breeding conditions for mutual benefits" (Bökönyi, 1989: 22). Zeder, similarly defines the process as "[…] a sustained multigenerational, mutualistic relationship in which one organism assumes a significant degree of influence over the reproduction and care of another organism in order to secure a more predictable supply of a resource or interest, and through which the partner organism gains advantage over individuals that remain outside this relationship, thereby benefitting and often increasing the fitness of both the domesticator and the target domesticate" (Zeder, 2015: 1). In these definitions, emphasis is placed on the symbiotic relationship between humans and animals. Indeed, a mutualistic relationship involves both partners - the human and the animal/plant - increasingly relying on each other for benefit. The difference between mutualism in nature and in domestication is that "The co-evolutionary relationships between humans and target domesticates […] are largely driven by the human ability to spontaneously invent new behaviours that maximize the return of a desired plant or animal resource and, most importantly, to pass on behaviours that best meet these goals to their offspring and to others through social learning" (Zeder, 2012a: 228). Zeder (2015) avoids to include genetic or plastic responses to domestication in the definition of the process, as she instead prefers to put the emphasis in the relationship between partners.

For both groups of authors, the process of domestication describes the transition (neither completely irreversible nor inevitable) between life in nature and in captivity (Bökönyi, 1989; Price, 1999; Zeder, 2015), but these are only two extremes in a continuum (Carlstead, 1996; Ervynck et al., 2001). Ervynck et al. (Ervynck et al., 2001: 50) define these extremes as "1) "wild" populations not experiencing (in the most simplified case) any direct or indirect influence of human behaviour"; [and] 2) "domestic" populations being characterised by survival, reproduction and nutrition under complete human control". Some authors have therefore proposed a number of intermediate stages within this continuum, for instance cultural control (Hecker, 1982; Hongo and Meadow, 1998; 2000), pre-domestic (Vigne and Buitenhuis, 1999), and intermediate stage (Ervynck et al., 2001). In this understanding of the process of domestication as a continuum, the implication is that it is an ongoing process during which morphological, genetic, and demographic shifts can still occur in its intermediate stages, and therefore we should not concentrate exclusively on the late stage of this process as it will obscure its origins (Zeder, 2011). Indeed, quoting Zeder, drawing strict lines of demarcation between the wild and domestic states "not only makes it impossible to identify any threshold moments when wild became domestic […] but also shows that drawing such distinctions actually impedes rather than improves our understanding of this process. Instead of continuing to try to pigeonhole these concepts into tidy definitional categories, a more productive approach would be to embrace the ambiguity of this middle ground and continue to develop tools that allow us to watch unfolding developments within this neither-nor territory" (2011: S231).

In the particular case of the pig, determining its wild or domestic status can be especially difficult as in many areas of the world domestic pigs live in contact with wild boar, and interbreeding occurs. Also, pigs can be kept in free-ranging conditions and can escape – such as in the pannage system recorded during medieval times in England (Grigson, 1982; Porter, 1999; Wiseman, 2000) – creating feral populations (Albarella et al., 2006a). In this light, Mayer and collaborators (Mayer et al., 1998; Mayer and Brisbin Jr, 1991) have even classified pig populations into four categories: wild, domestic, feral, and genetic hybrids; intermediates between those categories also being possible.

2.2.b. Changes in Domesticated Pigs

In animals, there are several traits that will make them more adequate candidates for domestication, and others that will have the opposite effect (Table 2.2). For the pig, the main traits that make it a good animal for domestication are its generalized omnivorous diet, sociality and gregariousness, feeding regimes, hierarchical groups, low reaction to humans, low fear reactions, and limited territoriality (Clutton-Brock, 1999; Mignon-Grasteau et al., 2005). During the process of domestication, inbreeding, genetic drift, and selection are the main genetic phenomena affecting the animals (Price, 1998). The first two produce random alterations in gene frequencies, whereas selection produces directional changes. Artificial selection, natural selection in captivity, and relaxation of natural selection are the three primary selective mechanisms in play during domestication (Price and King, 1968). Artificial selection is unique to the process of domestication and is controlled by human choice. In captivity, natural selection will eliminate those animals unable to successfully reproduce and favour those with the most numerous offspring. A reduction of selection pressure occurs over traits that lose their natural importance in captivity, such as coat colouring and predator avoidance (Mignon-Grasteau et al., 2005; Price and King, 1968). The combined action of these phenomena will produce the "domestic phenotype" (Price, 1998), which is characterized by morphological changes, both external (e.g. changes in fur and plumage colours, in body size and growth patterns, and in relative size of anatomical parts) and internal (e.g. decrease in brain size) (Clutton-Brock, 1999; Kruska, 1996); developmental changes (e.g. earlier sexual maturity) (Clark and Price, 1981; Shishkina et al., 1993); and behavioural changes (e.g. reduced fear, increased sociability, and reduced anti-predator responses) (Johnsson et al., 1996; Price, 1998).

For all domesticates, the most important behavioural changes brought by domestication are a reduction in weariness and reactivity to external stimuli, which translates into changes in brain size, organization, and function (Price, 1998). Brain size reduction seems to have happened quickly and early in the history of domestication (Zeder, 2012a), and pigs have undergone the greatest degree of brain size reduction of all domesticates (33.6%) (Kruska, 1996). Other behavioural changes linked to the domestic environment is the acceleration of attainment of sexual maturity and the retention of juvenile behaviours into adulthood (neoteny) (Price, 1999). Morphological features not present in the wild ancestors, like the presence of a layer of fat under the skin and also through the muscle, different body coat coloration, lop ears, and shortened and curled tails, are likewise connected to domestication (Berry, 1969; Clutton-Brock, 1999; Hemmer, 1990; Trut, 1999). Indeed, domesticated pigs show traits such as longer bodies, shorter legs, large and floppy ears, curly tails, and different skin colorations (Mizelle, 2011).

	FAVOURABLE CHARACTERISTICS	UNFAVOURABLE CHARACTERISTICS
Social Structure	Large gregarious social groups Hierarchical group structure Males affiliated with social group	Family groupings Territorial structure Males in separate groups
Sexual Behaviour	Promiscuous mating system Males dominant over females Sexual signals provided by movement or posture	Monogamous mating system Females dominate males/males appease females Sexual signals provided by markings or morphology
Parent-Young Interactions	Social bonds created through imprinting Female accepts young soon after parturition or hatching Precocial young	Social bonds created on basis of species characteristics Female accepts young on basis of species characteristics Altricial young
Responses to Humans	Short flight distance away from humans Low reactivity to humans or sudden changes in environment May solicit attention Readily habituated	Extreme weariness and long flight distance Easily disturbed by humans or sudden changes in environment Independent/avoids attention Difficult to habituate
Feeding Behaviour and Habitat Choice	Generalist feeder or omnivorous Wide environmental tolerance Non-shelter seeking	Specialized dietary preferences or requirements Narrow environmental tolerance Shelter seeking

Table 2.2. Favourable and unfavourable animal traits for domestication (Source: Zeder, 2012b)[4].

Domestication changes that can be observed archaeologically include a reduction in body size, a shortening of the snout (jaws and facial region), and a reduction in tooth size (Albarella et al., 2006a; Berry, 1969; Clutton-Brock, 1999; Davis, 1981; Meadow, 1989). Age and sex ratios are expected to be different between wild and domestic populations, due mainly to the different methods of exploitation involved. Finally, changes linked to the new life in captivity of these animals will have an impact on their health and an increase in pathologies can be expected (Albarella et al., 2006a).

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Just as wild pigs can become domestic through a life in captivity, the opposite process can also occur. Indeed, when domestic pigs escape human control and return to living in natural conditions, feral populations are created. Clutton-Brock defines feral animals "as those that live in a self-sustained population after a history of domestication" (1999: 33). This definition implies that feral animals must not be owned, intentionally cared for by humans, nor dependent on humans for breeding (Price, 1999). According to a study on feral pigs of the Galapagos Islands by Kruska and Röhrs (1974), some domestication changes can be reversed whereas others not. In this example, over the 150 years since the pigs were introduced onto the islands, they regained some of the body structure of their wild progenitor while maintaining a domestic pig colouration. Additionally, while some brain features regained some of its 'wild' variability, the overall smaller brain size of the domestic animal persisted. Other studied cases of feralization of domestic dogs (*Canis familiaris*) and cats (*Felis catus*), have shown that their feeding habits are still quite generalized and very much linked to the human niche (Biró et al., 2005; Boitiani and Cuicci, 1995; Campos et al., 2007). Therefore, a complete return of fully domesticated animals to their biological wild status does not seem to be possible; as they retain domestication-induced changes in brain morphology and function (Zeder, 2012a). However, these examples demonstrate that domesticated animals can return to living in their wild habitats.

Chapter 3

PIG DOMESTICATION IN ARCHAEOLOGY

The specific characteristics of pigs, reviewed in the previous Chapter, has led zooarchaeologists around the world to utilise a series of differential and complementary approaches to the study of their wild/domestic status. A commonly used marker to identify domestication is the sudden appearance of a species outside its natural range, which means it must have been introduced there by humans. However, in the case of *Sus scrofa* and *Sus domesticus*, their morphological similarity and possible inter-breeding makes species distinction based on osteological remains very difficult, if not impossible. Additionally, their introduction to a new area does not necessarily indicate that these animals were domestic, as human introductions of wild animals to create populations for hunting, for example, have been recorded (Albarella, 2010; Albarella et al., 2006a; Goulding, 2003). In spite of these difficulties, several approaches have been used to identify domestication in pigs, such as biometry, geometric morphometrics, age profiles, genetics, isotopes, and tooth wear and enamel defects (Albarella et al., 2006a; Flink and Larson, 2013; Rowley-Conwy et al., 2012).

In the following subsections, previous studies on the topic of pig domestication carried out via these approaches will be reviewed. The purpose of this literary examination is twofold: firstly, to demonstrate the efficacy of the biometrical method in pig domestication studies; and secondly, to introduce the current accepted knowledge regarding this phenomenon in prehistory. To those ends, the evidence of pig domestication in the Fertile Crescent will be reviewed first, as this is where the earliest local domestication of this animal occurred[5]. Subsequently, other relevant biometrical studies on the process of pig domestication will be examined, focusing on European cases due to their proximity to Italy; followed by an assessment of the current state of knowledge on the topic for the specific case of the Italian peninsula and Sicily. Lastly, the valuable information provided by past genetic studies on pig and wild boar mitochondrial DNA (mtDNA), and their contribution to the domestication debate will be reviewed.

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[5] Although there is evidence of domestic pigs in China as early as 8,000 BP (Jing and Flad, 2002) and in Japan from at least the Early Jomon Period (ca. 7,000-5,500 BP; Anezaki, 2007), a detailed review of these pig domestication studies has been excluded from this research. The reason behind this decision is that the focus of this review has been put on areas that might have had some connection with Italy in the past or might have shared similar histories and/or cultural idiosyncrasies.

3.1. The First Domesticated Pig: Research in the Middle East

3.1.a. Pioneering Studies on Early Pig Domestication

On the basis of the current evidence, the first pig domestication event dates from 10,500-10,000 BP in south-eastern Anatolia (Hongo and Meadow, 1998; Redding and Rosenberg, 1998a; Rosenberg and Redding, 1998; Zeder, 1999; 2008). Morphologically altered domestic pigs are not visible in the archaeological record of Central Anatolia until 8,500 BP, and of southern Levant and lowland Iran until 8,500-8,000 BP (Ervynck et al., 2001; Helmer, 2008; Hongo and Meadow, 1998; Peters et al., 1999; 2005; Price and Evin, 2017; Rosenberg and Redding, 1998; Zeder, 2008). From there, pigs seem to have spread slowly east and west, reaching the southernmost end of the Levantine corridor around 9,000-8,500 BP, the north western Zagros by 9,000 BP, lowland southwestern Iran by 6,000 BP, and central Anatolia by 8,500 BP (Zeder, 2011). Interestingly, the presence of introduced wild boar in Cyprus shortly before 12,000 BP − a millennium before the observable morphological changes associated with domestication in Middle Eastern *Sus* osteoarchaeological records − represents convincing evidence of human control of a hunted ungulate prior to its domestication, and it has been suggested as the possible initial stage of such a process (Vigne, 2011; 2013; Vigne et al., 2009). As the discussion on the current available research below will reveal, this idea makes sense when we consider the process of domestication of the pig to be a slow process, involving sometimes millennia before a morphological domestic animal can be observed in the archaeological record.

Flannery was one of the first authors to use systematic biometrical methods to study the domestication of the pig in Middle Eastern sites. From a collection of *Sus scrofa* from Iran, Iraq, Syria, and Israel, he measured the lengths of permanent teeth and tooth rows and made generalizations as to the size ranges of wild boar teeth (Flannery, 1983). Using these generalizations as a comparative tool, Flannery assessed the wild/domestic status of the *Sus* remains from several archaeological sites from the Zagros mountains and steppe, the Al-Jazira and middle Tigris, the Syrian steppe and southern Taurus, and the Levant. His conclusions were that the phenomenon of pig domestication did not occur at the same pace in all areas considered. Indeed, he found that the Zagros mountains and possibly also the southern Taurus were in the vanguard of pig domestication between 6,500 and 6,000 BC, whereas other areas such as the Deh Luran steppe and middle Tigris did not show extensive evidence of swineherding even by 5,000 BC Flannery interpreted this as a result of the incompatibilities of pig keeping with goat and sheep transhumance, which made it difficult for villages dedicated to the latter practice to keep pigs at the same time. It was the opinion of the author that villages that kept pigs would often trade with neighbouring communities that did not, thus explaining the low number of pig bones in the latter ones (Flannery, 1983).

Flannery's work represented an important step forward in the study of pig domestication in the Middle East. However, further studies towards refining the biometrical methods demonstrated that tooth widths and not lengths were more adequate for this kind of analysis, as tooth lengths decrease after a certain age and can also be more difficult to measure (Payne and Bull, 1988). These and other fundamental observations on the biometrical analysis of *Sus* remains were part of a study by Payne and Bull (1988), results which are still key for morphological studies to this day. As part of this study, the authors re-analysed the measurements from pig bones from Jarmo, an Iraqi Neolithic site (7th/6th millennia BC – Pre-Pottery and Pottery Neolithic), measured and interpreted originally by Stampfli (1983). Applying the methods of the log ratio technique[6] and the coefficient of variation they were able to detect heterogeneity in the Jarmo sample (i.e. the presence of two distinct populations, wild and domestic), in a case where Stampfli's original metrical analyses did not indicate a clear separation between populations (Payne and Bull, 1988). The authors thus demonstrated the advantages of these statistical analyses in the study of pig domestication.

On a more recent study, Price and Arbuckle (2015) offered a re-analysis of the pig remains from Jarmo, taking advantage of the recent advances in the study of pig domestication. In this paper, Flannery's (1983) original observations for this site – namely that the domestic pigs were absent at Jarmo in the pre-pottery levels, only to appear with the arrival of ceramics – are re-discussed. Flannery's interpretation was based on an increase of *Sus* remains and on a decrease of molar tooth lengths in the Pottery Neolithic (Flannery, 1983). Price and Arbuckle's (2015) analysis was based instead on kill-off patterns and biometrical analysis of both teeth and postcranial bones.

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[6] See Meadow (1999) for a thorough description of the method.

The results of the mortality patterns revealed an emphasis of juvenile pig consumption during the pottery levels, as most were killed before one year of age (78%) and the majority before the second year (97%) (Price and Arbuckle, 2015). The postcranial biometrical analyses indicated the presence of morphologically domestic pigs at Jarmo during the Pottery Neolithic. The tooth biometry, however, showed a pig of intermediate size between the larger modern wild boar/pigs from the region's earlier sites, and the smaller later Neolithic pigs from other sites in the region. In the case of the Pre-Pottery Neolithic samples, the tooth measurements tend to fall at the smaller end of the size range of the Pottery samples. Therefore, the authors concluded that the Jarmo dental measurements of pigs represented an intermediate stage between the wild boar and later domesticates, and that this transitional state could have been present as early as the 8th millennium BC at Jarmo (Price and Arbuckle, 2015).

In sum, the authors supported Flannery's original idea that the Pottery Neolithic pigs at Jarmo were domestic, but also suggested that they might have also been present on the pre-pottery levels. The pigs from Jarmo would have displayed a 'transitional' morphology – likely as a result of extensive management strategies in the piedmont oak forests with little human control over the pigs' diet and reproduction – and the domesticates' phenotypic change would have continued for millennia (Price and Arbuckle, 2015). Additionally, the authors mentioned that these initial husbandry practices could have been responsible for the slow spread of swine husbandry in the area, as they would require access to specific environments to be successful, i.e. environments with sufficient natural resources to sustain free-ranging pig populations. This meant that southern sites with no access to these spaces would only have been able to incorporate pig husbandry once they adopted intensive management practices, involving stall feeding and penning (Price and Arbuckle, 2015).

3.1.b. Ethnographical Models on Pig Domestication

Rosenberg and Redding have studied the pig osteological remains from the site of Hallan Çemi, located in the foothills of the Taurus mountains (Turkey) and occupied towards the end of the 11th millennium BP, roughly equivalent to the 9th millennium BC (Redding and Rosenberg, 1998b; Rosenberg, 1994; Rosenberg et al., 1995; Rosenberg and Redding, 1998). Although pigs were not the most abundant taxa, their molar sizes, butchering patterns, sex ratios, and mortality profiles, led the authors to conclude that the Hallan Çemi inhabitants were conducting some form of pig husbandry by at least the end of the 11th millennium BP (Rosenberg, 1994; Rosenberg et al., 1995; Rosenberg and Redding, 1998). This idea went contrary to the current conception that ovicaprids were the first animals domesticated and that pigs were peripheral in this process (Redding and Rosenberg, 1998a; Rosenberg and Redding, 1998). The authors proposed instead a model of early pig use and domestication in the Middle East based on the ethnographical data on pig management from New Guinea (Redding and Rosenberg, 1998a). The authors take Dwyer's (1996) categories of pig use, based on his observations in New Guinea, as an analytical tool to model possible early domestication scenarios in the Middle East. These categories, which are not mutually exclusive, are:

- *Reproductive alienation*: all captive pigs are alienated from breeding, and all piglets are captured and selected from the wild population.
- *Female breeding*: all captive pigs are the result of matings between wild boars and domestic sows. The managed/domestic population consists only of females and their offspring, and genetic changes are the result of female selection for breeding.
- *Male and female breeding*: all captive pigs are the result of matings between domestic boars and sows (Dwyer, 1996; Redding and Rosenberg, 1998a).

The benefits of the first two management strategies are that the herders avoid the problem of keeping large and aggressive males, while requiring minimal labour to maintain the managed population as they are allowed to roam and feed freely. Additionally, as pigs are difficult to herd, the female breeding strategy would require that the human population be at least partly sedentary. These two strategies require a local wild population for reproduction and that pigs and humans are not competing for the same food resources or that there be enough resources to support both populations (Redding and Rosenberg, 1998a). Redding and Rosenberg focussed on the female breeding scenario to propose a model of early pig management in the Middle East. Their argument was that "in areas inhabited by wild pigs, such as the ancient Middle East, female breeding of pigs would provide a readily available source of energy, fat, and protein that could have functioned as a very effective, low-cost form of insurance" (Redding and Rosenberg, 1998a: 67). In this scenario, the female pigs could be obtained from the wild initially and reared within the settlement[7]. These sows would be left to roam and feed within and around the settlement, where they would freely mate with wild boars. The male offspring would be consumed, and the female offspring could be either consumed or kept for further breeding. The pigs would therefore not have to be kept in large numbers, as they would only represent a reserve for when other sources of energy, fat, and protein were not available. Pigs fecundity, low labour maintenance, tame nature of the young and their nesting behaviour would make pigs ideal for this kind of "subsistence insurance" strategy[8]. However, as one of the requirements for the success of this strategy is that there be no competition for food between humans and pigs, when a human group shifts their subsistence to wild cereals or their cultivation, the extra effort required to keep pigs away from these food sources would make the female breeding strategy unviable. In this case, the male and female breeding strategy would be adopted instead or pig rearing would be dropped out of the main subsistence strategy completely (Redding and Rosenberg, 1998a).

Redding and Rosenberg proposed the following archaeological implications of the female breeding model (below, in italics), with their concomitant observations in the Hallam Çemi material:

- *Any reduction of molar tooth size in the female sows resulting from human involvement in the management of pigs would be mitigated or lost due to their inter-breeding with wild populations.* In the Hallam Çemi pig assemblages, tooth measurements did not provide evidence of bimodality/different populations, indicating instead a 'wild' size pattern.
- *The heavy consumption of young pigs could be seen in the mortality profiles.* The mortality information of Hallam Çemi – provided only by fusion data – showed that 40% of the pigs were killed before one year of age, and 46% before three years of age, mirroring the pattern of later Middle Eastern sites with a clear presence of domestic pigs. Moreover, this mortality pattern was contrary to those of sheep/goat and red deer, which were procured on site likely by hunting[9].

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[7] In this respect, Hongo and Meadow (1998) suggest that pigs, much like dogs, could have been initially attracted to human settlements to scavenge, thus forming the pre-conditions for a mutualistic relationship that, combined with the fact that young pigs are easy to catch, could have led to the beginnings of domestication of this species.

[8] This idea of pig husbandry as a risk-reducing strategy has also been proposed as a way of complementing the exploitation of sheep/goat – animals that could also be exploited for milk (Peters et al., 2013; Vigne and Helmer, 2007).

[9] This conclusion is however criticized by Starkovich and Stiner (2009), who read the pig mortality data at Hallam Çemi as more consistent with Palaeolithic hunting patterns.

- *A sex ratio biased towards males would result from their preferential consumption.* A small sample of canines and pubis fragments from Hallam Çemi allowed for the identification of 11 male and 4 female specimens. Although the sample is clearly small, it did indicate a male bias.
- *Body part representation would reflect consumption at the site.* Body part distribution of the Hallam Çemi assemblages showed that pig butchery was taking place on site, with both meat and non-meat bearing bones present (Redding and Rosenberg, 1998a).

In sum, the results from the application of their model supported Redding and Rosenberg's hypothesis of female breeding as an early pig management strategy in the Middle East. According to the authors' interpretation, the evidence supports the idea of initial wild boar hunting, to be later in time replaced or complemented with pig husbandry based on the female breeding system of management. After the shift from nut to cereal subsistence at Hallam Çemi, the pigs did not disappear from the sequence, but instead there is evidence of a progressive morphological change, possibly a result of changes in management related to those alterations in subsistence. Redding and Rosenberg's paper supports the idea that the beginnings of pig domestication would not necessarily have an immediate impact on the morphology of the captive population because of the several ways in which pigs can be managed. The authors thus support an earlier than previously thought date for the origins of pig domestication in the Middle East (Redding and Rosenberg, 1998a). This study is also an example of the explanatory and model-building power of the ethnographic evidence.

Redding and Rosenberg's support for an early domestication of the pig in Hallan Çemi did not go unchallenged, however. Peters et al. (1999) criticized the previous authors' conclusions as they did not consider the evidence strong enough to support an effective domestication of the pig. Indeed, according to these authors, the biometrical data fell well within the range for wild boar from southwestern Asia, the age and sex profiles could also have been indicative of Epipalaeolithic and Mesolithic hunter-gatherer assemblages, and the body part representation need not necessarily have meant exploitation of domestic pigs. For Peters et al., the most convincing early evidence of domestication of suids in the Levant came from the Late Pre-Pottery Neolithic B (approximately 8,600-8,000 BP) sites of Hayaz Tepe, Tell Halula, and Gürcütepe, which exhibited significantly smaller pig bones than Pre-Pottery Neolithic A (approximately 10,000 to 9,600 BP) and Pre-Pottery Neolithic B (approximately 9,600 to 8,600 BP) sites. The authors do concede, though, that if a visible reduction in size is only observed in an advance stage of domestication, then the possible earlier date for this process in pigs could have been during the Middle Pre-Pottery Neolithic B (approximately 9,000-8,600 BP), such as in the site of Cayönu Tepesi. These conclusions would place the domestication of the pig well after that of sheep and goat (Peters et al., 1999). This paper reflects the difficulty of interpreting the evidence for the earlier domestication of *Sus*, and how the different author's conceptions of what is 'domestic' colour their interpretations of results.

3.1.c. Further studies

The site of Çayönü Tepesi in southeastern Anatolia, of an occupational sequence spanning from 10,200 to 7,500 years BP, has also been a focus of early pig domestication research. Hongo and Meadow (1998; 2000) analysed the pig bones from this site, which happens to be the most represented taxon in all the sequence, especially during the earlier part (approximately 10,000 to 9,000 BP). The mortality patterns of pigs, based on epiphyseal fusion, indicated a large proportion of individuals surviving adulthood (one year old). These observations hold true for the phases of occupation of the site up until approximately 9,000 BP. The authors mention that this pattern is not what one would expect from a domestic population; but note, however, that it is not inconsistent with the exploitation of a free-ranging pig population. On the latest phase of occupation analysed (*ca.* 9,000-8,500 BP), the pattern changes in that the survivability into adulthood decreases dramatically, likely indicating a change in management. Finally, in terms of size, the authors observed a small overall shift towards smaller individuals from 9,000 BP (Hongo and Meadow, 1998; 2000). These results did not allow the authors to firmly postulate the domesticated status of the pigs from Çayönü Tepesi, or at least not for the earlier stages of occupation. However, a series of possible scenarios were put forward, mainly that during the earlier phase of occupation pigs and humans had established a mutualistic relationship which in time turned into some form of domestic control in which pigs were possibly kept in free-ranging conditions, until at least 8,500 BP (Hongo and Meadow, 1998; 2000). This study therefore gave support the idea that the process of pig domestication can be better understood by taking into account several sources of evidence, and also that it could take up to several millennia for the changes in pig management to have a clear impact in the morphology of the animal (i.e. size changes).

Ervynck et al. (2001) have also tackled the study of pigs from Çayönü Tepesi, re-analysing the material and utilising new methods and approaches. The re-analysis of the kill-off patterns, based both on epiphyseal fusion and on tooth eruption and wear, indicated a gradual trend towards the slaughter of younger animals through time. Although the possibility of this pattern being the result of increased hunting pressure is mentioned by the authors, they considered the fact that it can be seen in other Neolithic sites as a stronger explanatory comparison. Indeed, the authors proposed that the slaughter of increasingly young pigs could have been a deliberate choice linked to specific economic strategies, as well as a result of faster growing animals (Ervynck et al., 2001). The biometrical analysis of tooth length and widths did not exhibit a clear bimodal pattern but instead showed a trend of size decrease of dentition and an increase in size variation through time, with narrower teeth appearing during the later phases of occupation. The postcranial measurements echoed this trend towards smaller animals through time, albeit more subtlety. One explanation offered by the authors for these phenomena is that it could have been a result of the younger age of slaughtering of the animals through time. Other possible explanations offered, in the case of an all wild population, were climate change, over-hunting, and development of agriculture leading to deterioration of the forest vegetation. However, these possibilities were not supported, according to the authors, by the fact that the presence of wild boar remained consistent throughout the Pre-pottery occupation of the site (Ervynck et al., 2001). Finally, Ervynck et al. leaned towards another explanation: the possibility that these size changes reflect conscious or unconscious human selection. This hypothesis is supported by the fact that the gradual change in size is more noticeable in the third molar, and because the postcranial size decrease is not in sync with that of the teeth. These two facts taken together meant that the animals changed both in size and proportions. Also, a shortening of the dental row could be linked to alterations in the size and shape of the cranium. All these observations led Ervynck et al. (2001) to suggest the possibility that they could be a result of human selection choices, whether deliberate or not.

To sum up, the work by these authors on the pig remains from Çayönü Tepesi supported, once again, the hypothesis that an intermediary stage of domestication of this animal exists and can be seen in this material; that this process of change takes a long period of time; that it does involve morphological change to the animals; and that in the first stages it does not necessarily have to involve direct human intervention on the animal populations, even suggesting that changes within the *Sus* populations could have started early in the Holocene (Ervynck et al., 2001).

On a different study, Price and Evin (2017) set out to investigate long-term evolution of pig domestication in the Fertile Crescent through teeth, tibia, and astragalus biometrical analyses, and teeth geometric morphometrics. The 11 sites studied span from the Epipalaeolithic to the Early Bronze Age, and included Hallan Çemi, Cayönü Tepesi, Jarmo, and Domuztepe (Price and Evin, 2017). Their results led the authors to observe that the domestic pig size decreased substantially over time. Domestic pigs appeared in the 9th to 8th millennium BC and continued to decrease in size not only in the first period of domestication but also in the following millennia. Additionally, Price and Evin suggested that extensive pig husbandry might have been the dominant pig management strategy in the Fertile Crescent up until the 6th millennium, accompanied by wild boar hunting. This strategy would have led to hybridization and feralization, which would have contributed to the blending of wild and domestic characters in the pig populations. This continuous introgression of wild boar genotypes and phenotypes into the managed stock would have been partly responsible for the slow pace of change in pig morphology (Price and Evin, 2017). This study consequently provides further support to some of the ideas around the beginnings of pig domestication in the Middle East that have been developed by previous authors during the last decades.

Finally, Weber and Price (2016) presented an interesting study on pigs from a different perspective, focusing on dental calculus of zooarchaeological remains from 10th to 3rd millennium BC sites in the Fertile Crescent, including data from sites such as Hallam Çemi (10th millennium BC) and Domuztepe (6th millennium BC). Plant microremains were obtained from *Sus*'s tooth calculus, which allowed the authors to reconstruct their ancient diets. The results indicated pig and wild boar diets primarily based on domestic cereals and supplemented by wild foods for the periods considered. In the specific case of the wild boars, the Hallam Çemi data, although limited, indicated a diet based on grasses and tubers. In the case of the Late Neolithic Domuztepe, one specimen showed evidence of acorn and wild grass consumption, while the other two evidenced consumption of processed/cooked food, same as the domestic pigs from the site which were fed household refuse. This latter evidence is interesting, as it indicated an ongoing relationship between wild boar and human settlements, even after domestication. Similarly, the evidence for the diet of domestic pigs at this site suggested that they were kept close to the settlement, although the authors stated that it is not possible to say if they were allowed to forage or kept in pens (Weber & Price, 2016). Hence, this short study showed the value that alternative methods have in contributing to the question of pig domestication.

In summary, as can be seen from this review, the idea of a gradual and slow change in pig morphology in the initial stages of its domestication process is accepted by most authors. The discussion between archaeologists continue, however, as to where the initial control of the pigs begins in the archaeological sequences of the Middle East. One thing can be stated for certain is the fundamental contribution that the analysis of pig remains from different methods and perspectives combined represents to the study of the origins of this animal's domestication.

3.2. Studies on Pig Domestication in Europe

To further demonstrate the effectiveness of the biometrical approach used in this PhD research, in this sub-section several comparable studies from Spain, Portugal, Scandinavia, and Britain are reviewed. However, the only works comparable in scale to the present research are those by Hadjikoumis (2010; 2011) for Spain and Viner for Britain (Viner, 2011; Viner-Daniels, 2014).

3.2.a. Iberian Peninsula

The studies by Hadjikoumis (2010; 2011) and Albarella et al. (2005) on the beginnings and development of pig husbandry in Spain and Portugal, respectively, represent biometrical studies akin to the research presented in this thesis. In the case of Spain, domestic pigs appeared in the archaeological record from the Early Neolithic (second half of 6th and 5th millennia BC), and the information from those periods suggested diverse interactions between people and pigs (Hadjikoumis, 2010; 2011). Indeed, biometrical and ageing evidence indicated that, in some Early Neolithic sites, pigs were being exclusively hunted (assemblages dominated by pigs of a comparable size to pre-Neolithic wild boar); whereas in others, mixed husbandry and hunting practices probably coexisted (assemblages characterized by pigs of similar size to wild boar, but combined with a high perinatal/neonatal mortality and predominance of females); and further, in other sites pig husbandry clearly dominated over hunting (assemblages consisting of smaller-sized pigs). Many factors could have contributed to this diverse panorama of pig domestication according to the author, such as environmental factors and pre-existing cultural traditions. The results of these analyses also showed that some of the Early Neolithic Spanish pigs had smaller postcranial bones than the Upper Palaeolithic and Mesolithic wild boar of the same areas (Hadjikoumis, 2010; 2011). Hadjikoumis thus detected a postcranial size increase in wild boar during Neolithic times, much like it was observed in other areas of Europe, including Italy (Albarella et al., 2005; 2006c; 2009; see also Chapter 3.3). This was explained as likely due to a relaxation in hunting pressure and/or an expansion of the forests over most of Spain resulting from rising temperature and humidity (Hadjikoumis, 2010; 2011).

During later Neolithic and post-Neolithic times, however, the evidence indicated that pig domestication in Spain became more uniform, as the sites pointed to an intensive pig exploitation strategy. Additionally, during these later periods, a morphologically distinguishable pig became widespread throughout most of Spain (Hadjikoumis, 2010; 2011). These biometrical analyses therefore showed a non-uniform 'neolitization' process in Spain in terms of pig management, and a change towards more homogeneous practices by the end of the Neolithic. Further biometrical studies on Spanish pig assemblages have supported these initial observations (Navarrete Belda and Saña Seguí, 2017).

The case of Portugal, mainly based on the analysis of two Chalcolithic sites (Zambujal and Leceia, dated to *ca.* 2,600-1,800 BC and thus contemporary to the Italian Bronze Age), is similar to that of neighbouring Spain (Albarella et al., 2005). From the analysis, the authors concluded the following:

- The size of the Portuguese wild boars from the Mesolithic to modern times fluctuated, possibly in response to climatic factors and/or changes in hunting pressure in relation to the use of domesticates.
- Chalcolithic wild boars were larger than Mesolithic and modern wild boars, but of comparable size to modern wild boars from central Europe.
- The size of Chalcolithic domestic pigs seems to have been homogeneous between the sites studied and smaller than contemporary animals from Britain (Albarella et al., 2005).

These results thus echoed Hadjikoumis' (2010; 2011) observations for the prehistoric Spanish data.

3.2.b. Scandinavia and Northern Germany

Shifting the lens to northern Europe, prehistoric Scandinavia has also been the focus of pig studies. Rowley-Conwy and Dobney (2007) studied the pig remains from several sites in Denmark and the island of Gotland in Sweden, from mainly a biometrical perspective. The Mesolithic wild boar in Denmark is known to be very large, as already demonstrated by Albarella et al. (2009). The results of Rowley-Conwy and Dobney's study further indicated a shape difference in wild boar lower third molars during the Late Mesolithic between Zealand island and continental Jutland. This meant that the Jutland and Zealand wild boar populations began differentiating almost as soon as a rise in sea levels resulted in a physical barrier between the two landmasses, and therefore became an effective barrier to gene flow. The biometrical comparisons therefore proved that in less than a 1,000 years the genetic isolation between the two wild boar populations could be seen in tooth shape (Rowley-Conwy and Dobney, 2007).

Rowley-Conwy and Dobney (2007) also examined the pig remains from several Middle Neolithic and post-Neolithic (Late Bronze and Iron Ages) Danish sites. These pigs' lower third molars were shown to be substantially smaller than the ones from previous periods (representing most likely domestic pigs), with a few large outliers (presumably wild boar). Given the presence elsewhere in Eurasia of domestic pigs which were contemporary to the Scandinavian Mesolithic wild boars, the question addressed by the authors was whether the domestic suids identified from the Middle Neolithic onwards were introduced or locally domesticated. The observed discontinuity between the large sizes of Mesolithic wild boar in contrast with the smaller pigs from the Middle Neolithic onwards, would seem to suggest an introduced domesticated pig population, as otherwise a more gradual size difference would be expected, according to the authors. However, they also note that they do not have samples for the Early Neolithic, leaving a roughly 700-year gap between the end of the Late Mesolithic (*circa* 3,900 BC) and the Middle Neolithic samples (approximately 3,300-3,000 BC) (Rowley-Conwy and Dobney, 2007). This missing data could prove or disprove a local domestication process. This issue points to just how important having a comprehensive chronological data set is for a more complete interpretation, a fact influenced by the limitations of the available archaeological evidence in some areas.

3.2.b.i. Wild boar or domestic pigs? The Debate over the Mesolithic *Sus* Evidence from Northern Europe

A study by Krause-Kyora et al. (2013) of pig zooarchaeological evidence from southern Scandinavia and northern Germany, heavily based on genetic and geometric morphometric analyses, is quite interesting as it generated an intense debate between these authors (Evin et al., 2014b; Krause-Kyora et al., 2013) and Rowley-Conwy and Zeder (2014a,b) regarding how the evidence should be interpreted. The whole debate will be reviewed in this section as it offers a valuable example on how a seemingly straightforward evidence can lead to different and contending interpretations of the lifeways of past communities.

The debate originated with the work of Krause-Kyora et al. (2013), who analysed a series of archaeological pig remains from several sites from the coexisting late Mesolithic Ertebølle and Early Neolithic Linearbandkeramik (LBK) and post-LBK (Stichbandkeramik and Rössen) cultures (*ca.* 5,500-4,200 cal. BC). The archaeological evidence previously available from these cultures indicated that contacts and trade of stone axes and pottery between the two groups were common, although there was no indication before the publishing of the Krause-Kyora et al. paper that the Ertebølle populations adopted any agricultural elements of their Neolithic neighbours into their hunter-gatherer lifestyle (Andersen, 2008; Andersen et al., 2010; Klassen, 2002; Verhart, 2012). Krause-Kyora et al. (2013) performed a series of ancient mitochondrial

DNA (mtDNA), MC1R gene (associated with the different coat colour patterns in pigs), and geometric morphometrics (GMM) analyses on the pig remains. Their results can be summarized as follows (Krause-Kyora et al., 2013):

- Pig remains from LBK, post-LBK, and Ertebølle sites shared a similar composition of mtDNA clades, with the presence of both Near Eastern and European haplotypes, but the Ertebølle *Sus* had significantly larger molars. (As will be discussed in more detail in Chapter 3.4, the Near Eastern mtDNA haplotype was introduced in Europe by imported domestic pigs).
- Specimen E24 (a complete male mandible with the third and fourth premolars, and first and second molars present) from the Ertebølle site of Grube-Rosenhof and dated to *ca.* 4,500 cal. BC, was identified to have a Near Eastern mtDNA haplotype and to be homozygous for the MC1R E^p allele 501, indicating the possession of a 'black spotted' coat colour, a domestic phenotype. Additionally, GMM analyses of the second molar also revealed a 'domestic shape', and the third premolar on the right side was rotated, a pathology observed more often in domestic than in wild animals. Biometrical analyses of E24 indicated that the specimen was very large. Due to the combination of all these features and despite its large size, this specimen was interpreted by the authors to be a domestic pig.
- Other specimens from Ertebølle and LBK/post-LBK sites which possessed a European mtDNA haplotype and a MC1R allele associated with wild coat colour and/or a wild tooth shape according to the GMM analyses, were considered by the authors to belong to wild boar.
- Other specimens from Ertebølle and LBK sites which were smaller than modern wild boar and possessed European mtDNA haplotypes puzzled the authors. Although not explicitly said, it is likely that the authors favoured a domestic classification of some of these specimens which also showed one other feature associated with domesticated pigs (e.g. domestic coat colour and 'domestic' shape).

Thus, and specially from the evidence of specimen E24 and specimens with a European mtDNA haplotype combined with 'domestic' features, the authors concluded that "[…] the northern European Mesolithic Ertebølle hunter-gatherers did not only possess domestic pigs like those of their agricultural neighbours, but that these animals were present in the region ~500 years earlier than has been previously demonstrated" (Krause-Kyora et al., 2013: 2). Additionally, the presence of specimen E24, interpreted as a domestic pig, in a Mesolithic Ertebølle site "[…] reveals evidence that Ertebølle hunter-gatherers had access to and acquired several kinds of domestic pig either directly or indirectly from their post-LBK neighbours (Stichbandkeramik and Rössen)" (Krause-Kyora et al., 2013: 4).

Needless to say, the evidence thus presented and interpreted by Krause-Kyora et al. (2013) would have enormous implications to our understanding of the beginnings of pig domestication in northern Europe. However, their interpretation of the data was highly criticized by Rowley-Conwy and Zeder (2014a). Indeed, these authors criticised the domestic classification by Krause-Kyora et al. of specimen E24 and others based on the evidence presented, as follows (Rowley-Conwy and Zeder, 2014a):

- When comparing the biometry of E24's second molar with biometrical data from other northern European Neolithic and Mesolithic sites, this specimen plotted on the larger side of the spectrum, well above the metrics of domestic pigs from Neolithic sites and within the Mesolithic wild boar range.
- The presence of the Near Eastern mtDNA haplotype in E24 and other specimens identified as domestic on this basis, does not automatically mean that it belonged to a domestic pig. Indeed, domestic pigs can be managed on a free-range system, and that was more likely the case in earlier times; which means that domestic pigs can more easily escape and breed with native wild boar. In these circumstances, the resulting litter of a female escapee with a male wild boar would carry the Near Eastern haplotype, but would be, for all intents and purposes, a wild boar.
- There is no support for the assertion that the domestic form of the MC1R allele would immediately disappear in the wild, as its presence in wild boar today is in fact used today to identify hybrids.
- The use of 'domestic' tooth shape as identified through GMM is considered by Krause-Kyora et al. (2013) to be a stronger argument in favour of the domestic status of these animals than traditional biometry. For example, E24 is classed as domestic despite its large size due to, in part, its 'domestic' tooth shape. However, the evidence they cite to support their claim that GMM discriminates more accurately between wild and domestic pigs than traditional biometry is skewed and inaccurately characterised. If E24 does indeed have a 'domestic' shape, it could have been inherited from feral domestic pigs.

In sum, the evidence presented by Krause-Kyora et al. (2013) is more likely indicating instead of the presence of domestic pigs in Mesolithic Ertebølle, the presence of wild boars of domestic ancestry hunted by these communities. According to Rowley-Conwy and Zeder, the evidence presented "[…] is not an indication that Mesolithic people 'possessed' domestic pigs or that possessing these animals somehow paved the way for the eventual adoption of an agricultural way of life" (2014a: 821).

Evin et al. (2014b) responded to the criticism by clarifying that it was not their intention to suggest that the Mesolithic Ertebølle kept and reared domestic pigs, but instead that specimen E24 possessed multiple domestic characteristics and that its presence in a Mesolithic context raised questions about the nature of the interaction between the Ertebølle and LBK/post-LBK communities. Most of their response was dedicated to defending the validity of the GMM method, which remains still quite a new approach, and maintained their claim that tooth shape is more accurate than size to identify the status of the specimen[10]. They also reiterated their claim that E24 is not a wild boar, due to the following (2014b):

- Due to the fact that E24 is homozygous for the MC1R allele, it is unlikely this animal was a first generation hybrid between a domestic pig and a wild boar because there is a strong selection against domestic alleles in nature. Therefore, the authors conclude this indicates that E24 had been living in a domestic context, even if it did have a proportion of wild ancestry.
- The Near Eastern mtDNA haplotype E24 has was introduced by imported domestic pig populations. Therefore, it suggests E24 derived at least in part from domestic stock.
- Even though E24 second molar is very large and consistent with wild boar size, its domestic shape indicates its similarity to domestic pigs. Because first generation hybrids posses a tooth size more similar to the domestic range, the fact that E24 is large suggests that, if it was a hybrid, it was not a first generation cross.

To summarize, the only piece of evidence that would seem to contradict the authors' claim that E24 is not a wild boar is its large size. Evin at al. (2014b) therefore conclude that E24 acquired a significant portion of its ancestry from domestic pigs. The authors

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[10] It is not mentioned in the debate, but it is worth adding that biometry provides not only tooth size information but can also be used to study shape (Albarella, 2002), as this research is a good example of (see Chapter 7.3.a).

do not want to constrain their interpretation by using mutually exclusive terminology, and hence do not go as far as to say that E24 is domestic, as they seem to have done in their previous paper (Krause-Kyora et al., 2013). However, they do state that it is not a wild boar (Evin et al., 2014b). They conclude their response with a more tempered interpretation that the one reached in their previous paper, by stating that the evidence from prehistoric northern Germany "[…] represent not only the first animals with clear evidence of a domestic ancestry definitely identified from a Mesolithic site in continental northern Europe, but also direct (proxy) evidence for the earliest presence of domestic animals in the region" (Evin et al., 2014b: 830).

The debate concluded with one last response by Rowley-Conwy and Zeder (2014b). They begin their response by acknowledging Evin et al.'s (2014b) attempt at distancing themselves from the more contentious statements made in their first paper; that is, that Mesolithic Ertebølle people acquired domestic pigs and that this contributed to the local domestication of the European wild boar and the eventual adoption of domesticated animals by foragers (Krause-Kyora et al., 2013; Rowley-Conwy and Zeder, 2014b). However, Rowley-Conwy and Zeder (2014b) criticise the insistence of the former authors to imply that domestic pigs were indeed part of the Ertebølle life. Indeed, if both Evin et al. (2014b) agree with Rowley-Conwy and Zeder (2014a) in that there is no evidence that Ertebølle hunter-gatherers tended or managed these pigs in a manner consistent with a domestic relationship and differently from wild boars, then "it is hard to see how their consumption by Ertebølle hunters has any bearing on the process of domestication of local wild boar or the eventual adoption of agriculture by Ertebølle successors some 1000 years later. […] The acquisition of a domestic animal or two from their neighbours, either through trade or stealth, if it does not lead to the development of a domestic partnership between the animal and its keepers, says little about either local domestication or the assimilation of agricultural practices in the region" (Rowley-Conwy and Zeder, 2014b: 836). None of the authors dispute the fact that the evidence originally presented indicates anything else than animals which possess a mixture of domestic and wild traits. This mixture, Rowley-Conwy and Zeder (2014b) add, makes it unlikely that these animals behaved in any way like domestic pigs, and their large size alone would be an indication that they were not manages by the Neolithic communities as they did not possess animals that large. According to these authors, the evidence from E24 as reviewed by Evin et al. (2014) is still very much compatible with what would be expected of an animal which would have been the product of liaisons by an escaped/feral domestic female and a male wild boar: the domestic coat coloration, the Near Eastern haplotype, and the domestic tooth shape could all be a result of hybridization, and there is no evidence to support the idea that these traits would not be kept long in the wild. Additionally, Evin et al. (2014) mention that a first generation hybrid would not be as large as E24, offering even more support that this specimen does not belong to a recent hybrid nor to a domestic pig, but its domestic ancestry is indeed more distant (Rowley-Conwy and Zeder, 2014b). Rowley-Conwy and Zeder thus conclude that "[…] we can suggest a clear status call: despite possessing some domestic ancestry, E24 was most likely behaviourally a wild boar, hunted by the inhabitants of Rosenhof like their other wild prey – perhaps made more vulnerable to human predation by its spotted coat, an example of the selection against homozygosity in this coat colour trait among wild boar in action" (2014b: 838). The overarching conclusion of this final response is, though, that much care must be taken when interpreting the evidence.

This long debate demonstrates how the same evidence can be interpreted differently by the authors and how we must be careful in our interpretations and conclusions. Behind this debate is also a strong discussion of old vs new methods. New methods can be exciting, but in my opinion, they must be thoroughly tested before we can say with certainty that they are a much better alternative or even a replacement of traditional methods which have been proven time and again to offer consistent results. In the case of GMM, Rowley-Conwy and Zeder in my opinion rightly point out that there is still a "[…] lack of a clear understanding of the factors responsible for molar shape and how these factors are related to processes, like domestication, that molar shape is purported to measure. Demonstrating a clear and unequivocal relationship between the domestication relationship and a proposed marked of this relationship is an important prerequisite for any method used to document domestication" (2014b: 837). Regardless, this debate proves that through the complementary use of different types of analyses and evidence our interpretations will have stronger support.

3.2.c. Britain

In the case of Britain, Viner (Viner, 2011; Viner-Daniels, 2014) studied the evolution of pig management in the Neolithic from mainly a biometrical perspective. In Britain, the main domesticated animals appeared, seemingly abruptly, around 3,800-3,700 BC (Viner, 2011). From a series of Mesolithic and Early Neolithic sites, and one Late Neolithic site (Durrington Walls), Viner analysed the age and sex profiles, and biometrical data of pig remains, in order to identify temporal trends in the management of these animals. Regarding the Early Neolithic, the data indicated that, in terms of age at death, sex distribution, and physical characteristic, these pigs were similar to the Mesolithic wild boar, even with a chronological gap between the sites from both periods. However, a trend towards the use of younger animals was detected in the Early Neolithic, and the Late Neolithic data showed that most animals were killed before even reaching maturity. Viner interpreted this slow evolution as an indication of the continuing change in pig management during the Neolithic, although the author also acknowledged that the Late Neolithic evidence came from the site of Durrington Walls, which has been construed as having a ceremonial function, and therefore the pig age profiles from this site could be reflecting this fact (Viner, 2011).

Additionally, the biometrical data for the Early Neolithic suggested a diminution on the size of postcranial bones and teeth during this period in comparison with the Mesolithic wild boar. When comparing teeth and postcranial bones measurements separately and by period, Viner observed that teeth from Early and Late Neolithic were similar but smaller than those from the Mesolithic, whereas the Early Neolithic postcranial bones were of intermediate size between the Mesolithic and Late Neolithic ones. This particular pattern was interpreted by the author as possibly representing a situation of small domestic animals being introduced into Britain during the Early Neolithic and being allowed to interbreed with local wild boar thereafter as a result of loose management strategies. Furthermore, the inter-site comparison of Early Neolithic assemblages showed that in some dental dimensions were larger, indicating different levels of hybridisation between sites (Viner, 2011).

In the case of the British Late Neolithic, the data presented by Viner suggested a closer control of the pigs during this period, indicated by a change of male/female ratio, an increase in younger animals, and the biometrical changes already mentioned. Size reduction was not very pronounced in the Late Neolithic, but the range of measurements was more restricted than in previous periods. Then again, the ritual nature of the sampled site for this period, Durrington Walls, could be affecting the nature of the pig population represented, and it is uncertain whether it could be regarded as representative of the whole Late Neolithic pig management in Britain (Viner, 2011). To sum up, as concerns the British data, the biometrical approach presents a different picture than in other areas mentioned in this review; that is, a picture of introduced domestic pigs who probably interbred with the local wild boar population.

In conclusion, the available studies of pig domestication for other European areas show a diversity of situations. The evidence indicated that the roles played by introduced domestic pig populations and local domestication of wild boar in different European regions were varied, and so the process of pig domestication in Europe does not seem to have followed the same trajectory in different countries.

3.3. Current Perspectives on Pig Domestication in Italy

Regarding previous studies on pig domestication focused specifically on sites from the Italian peninsula and Sicily, our areas of study, the paper by Albarella et al. (2006c) is to date the most comprehensive work on the subject. The aim of that paper was to collect comparable biometrical data from several prehistoric sites in Italy to identify patterns of regional and chronological change in the pig populations. The sites included, spanning from the Palaeolithic to the Bronze Age, were: Palidoro, Grotta della Madonna, Grotta dell'Uzzo, La Marmotta, Masseria Candelaro, Mulino S. Antonio, Conelle di Arcevia, La Starza, Torre Mordillo, Arene Candide, Rocca di Rivoli, Cornuda, Concordia Sagittaria, and Molino Casarotto. The modern pig specimens used for comparison were Maremman wild boars from the early 20th century, regarded to be genuinely native to the Italian Peninsula (Albarella et al., 2006c). The results of the biometrical analyses from Grotta dell'Uzzo, Grotta della Madonna, and Palidoro (all southern sites) indicated that, before domestication, the wild boars were very large at the peak of the last glacial period, and by the time the temperature started to increase in the later stages of the Palaeolithic, their body size had decreased to the point that they appear small in comparison with contemporary animals found in central and northern Europe. The authors explained this reduction in size as a consequence of climatic amelioration, possibly combined with increased hunting pressure. Scant evidence from Arene Candide, in the north of the peninsula, hinted at the possibility that northern wild boars could have been larger there. Sicilian wild boars were at the lower end of the size scale, something that could have been related to insular dwarfism. In the case of the Mesolithic wild boars, they were observed to be on average of a similar size to modern Italian Maremman wild boars (Albarella et al., 2006c). Additionally, the pre-Neolithic wild boar seemed to have been large boned in relation to teeth, when compared with modern Turkish wild boar. One explanation offered for this phenomenon by the authors was that it could be a characteristic typifying early Holocene wild boars from southern Europe, as supported by the evidence from the Portuguese Mesolithic (Albarella et al., 2006c; 2009).

The evidence from this research showed that the Early to Middle Neolithic pigs were on the whole indistinguishable from the Mesolithic standards (Albarella et al., 2006c). Three possible explanations for this were proposed by the authors: (1) that all or most Neolithic pigs were wild, and pig husbandry did not begin until the Late Neolithic; (2) that these were imported domestic animals of a size comparable to the native wild boar; or (3) that Neolithic pigs were locally domesticated, which caused a steady but very gradual progress of size decrease through time. Regarding the first hypothesis, since there was evidence of a size increase in wild boar after the Mesolithic and larger sized wild boar had been observed in the later sites of Cornuda, Conelle, Molino Casarotto, and in Bronze Age sites, Albarella et al. proposed that the bulk of the assemblages were not made of wild specimens but instead they were remains of domestic pigs with a variable component of wild boar. Thus these two populations could not have been easily distinguishable (Albarella et al., 2006c). The bigger pigs – presumably wild boar – found in those sites were quite larger than their Mesolithic counterparts. Therefore, the question arised as to whether the contemporary pigs of relative smaller size but of dimensions equivalent to the earlier wild boar represented the true scale of the post-Mesolithic wild boar. Since the post-Mesolithic size increase in wild boar also occurred in other European regions (e.g. Albarella et al., 2005; 2009) it could not be due to local factors. The climatic deterioration that occurred in the continent after 3,000 BC could instead have been responsible for this phenomenon. Another possibility suggested was a gradual relaxation of hunting pressure, following the advent of animal husbandry; but this seemed to be less likely as the Mesolithic settlement was not that dense and therefore unlikely to have generated a very high degree of hunting pressure (Albarella et al., 2006c).

Regarding the two last hypotheses previously mentioned, i.e. whether these were introduced domesticates or locally domesticated animals, the authors stated that there was no compelling evidence for the introduction of domesticated pigs in significant numbers. Indeed, based on the genetic evidence (reviewed in more detail in the next sub-section) that proposed the occurrence of two or more independent pig domestication events in Europe (Larson et al., 2005), Albarella et al. indicated that "The genetic signature of the Italian wild boar seems to be distinctive and, outside of the peninsula, it has only been found in Sardinia. If we accept the commonly held suggestion that Sardinian wild boars originate from domestic animals that became feral in prehistoric times (no wild boars were present in Sardinia before the Neolithic), the inevitable conclusion is that, at some point in the past, Italian wild boars must have been locally domesticated and that the Italian peninsula is indeed the place of origin of Sardinian 'wild' and domestic pigs" (2006c: 217). In light of the morphological evidence presented by the authors, such as a slight reduction in size and changes in kill-off patterns at Grotta dell'Uzzo and the possible reduction in bone but not tooth size at Masseria Candelaro, the presence of a slow and gradual process of transformation of the Mesolithic wild boars into domestic pigs was proposed. If these domestic pigs had been imported, said the authors, these regional differences reflecting the body size of the native wild boar would not have been expected; instead, these pigs would have had some characteristic comparable to their Middle Eastern counterparts and some kind of discontinuity with the native population, which was not detected in this research (Albarella et al., 2006c).

This evidence led the authors to support the occurrence of local domestication event in Italy, with or without a small number of introduced animals. In this scenario, the difficulty of distinguishing wild boar from domestic pigs in the Early to Middle Neolithic assemblages would have been most likely due to a loose management strategy, such as the medieval English pannage system (Grigson, 1982; Porter, 1999; Wiseman, 2000), that would have allowed the domestic pigs to freely interbreed with wild boar, thus limiting the scope of the biometrical changes related to domestication (Albarella et al., 2006c). This view of an morphologically 'intermediate' pig has also been supported by other authors, such as Jarman (1971; 1976a) who studied the materials from Molino Casarotto and Rocca di Rivoli.

The results of this research for the Late Neolithic and Bronze Age periods show a marked change, as a reduction in body size of many pig populations and of different relative body part sizes was now clearly observable, which the authors took to signify a change in management strategies. Indeed, while the evidence for the previous Neolithic periods was consistent with a free-ranging management of the pigs, during the Late Neolithic and Bronze Age a greater separation between populations would have been instead indicative of a more controlled system of management (Albarella et al., 2006c). The post-Mesolithic size increase of wild boar, combined with a size decrease in domestic pig during the same time, could also have contributed to the separation between populations seen during the later prehistory (Albarella et al., 2006c).

To conclude, for Albarella et al. the introduction of pig husbandry in Italy could have been not so much as a product of the introduction of the domesticated animals but instead an introduction of ideas that led to the slow and gradual process of domestication of the native wild boar (Albarella et al., 2006c).

In spite of this research, Rowley-Conwy et al. (2013) expressed in a later paper a different opinion on the matter of the presence of domestic pigs in the Po valley and Liguria (northern Italy) during the Early and Middle Neolithic. These authors supported the view that no pig domestication took place in Italy until the Late Neolithic, basing their opinion mostly on the fact that no bimodality is visible in the biometrical data until the Late Neolithic (the analysis had a strong focus on the site of Arene Candide) and on the coefficient of variation (the standard deviation expressed as a percentage of the mean) values mainly for the astragalus (see also Rowley-Conwy, 2003, 1997; Rowley-Conwy et al., 2013). Regarding the former observation, their analyses did not seem to take into consideration the conclusions from Near Eastern studies on the beginnings of pig domestication in the area, namely that frequent interbreeding with wild boar limits the scale of the impact of the domestication process on pig morphology, taking up to two millennia for a fully morphologically distinct domestic pig can be identified in the archaeological record (see Chapter 3.1). For these authors, it would seem that either the introduction of foreign domestic stock was fundamental to the beginnings of domestication in Italy, and therefore a clear-cut bimodality should be seen in the data; that the changes related to domestication in pig morphology were faster than previously considered for the Near East; and/or that no interbreeding could have occurred to disguise those changes in the bones. In my opinion, none of these hypotheses is supported by the currently available evidence.

Rowley-Conwy et al.'s (2013) second main evidential support for their hypothesis of the absence of pig domestication in Italy until the Late Neolithic is based on the coefficient of variation of, mainly, the astragalus. The coefficient of variation of the Arene Candide Early and Middle Neolithic pig assemblages is 7.2, a value in tune with the 6.0 of Durrington Walls, a Neolithic site in Britain that has been demonstrated to have a single pig population (Albarella and Payne, 2005; Rowley-Conwy et al., 2013). The Arene Candide assemblages for the Late Neolithic and Bronze Age, however, have a coefficient of variation of 12.6, a much higher value, suggesting the presence of two pig populations of different sizes. The metrical evidence from other sites from the Po valley also indicated a size decrease in lower M3 lengths from the later part of the Middle Neolithic (Rowley-Conwy et al., 2013). Based on this evidence, Rowley-Conwy et al. suggested that a clearly detectable domestic pig population could only be identified from the Late Neolithic onwards, and that there was little or no interbreeding between the wild and domestic pigs. They did not adhere to the idea that domestic pigs were present before that time nor that the concept of an 'intermediate' pig, as proposed by Jarman (1971; 1976a), was applicable (Rowley-Conwy et al., 2013); although they did not offer an explanation as to why the low coefficient of variation could not have been reflecting such an 'intermediate' state. This interpretation, which points to the abrupt change in size as the marker for the presence of domestic animals, would indicate either the introduction of an entire new domestic pig population during the Later Neolithic (which, the authors explicitly state, cannot currently be proven) or it would suggest that the process of pig domestication was not so gradual in terms of morphological changes as previous authors had suggested (see 3.1). It is my personal opinion that this is a simplistic way of interpreting the coefficient of variation, as it is not viable to establish a clear-cut threshold to determine when two populations are present, as many factors can influence the variability of the sample (see Rowley-Conwy et al., 2012). A more plausible explanation could be that the significant changes in size observed in the Late Neolithic signified a change in management practices, involving the keeping of more closely controlled pigs.

As can be seen from this brief review, not many attempts have been made so far to produce a comprehensive study, both geographical and chronological, of the process of pig domestication for the Italian peninsula and Sicily, although the data available provides a strong starting point for the present research.

3.4. Genetic Studies on Pig Domestication

The evidence provided by the studies on European and Middle Eastern pig DNA during the last decades has been so important in the development of pig domestication studies, that the review of the most relevant papers on the subject deserves its own sub-section. Key papers by Giuffra et al. (2000) and Kijas and Andersson (2001) demonstrated, through the mitochondrial DNA (mtDNA) analysis of modern Asian and European wild boars and domestic pigs, the presence of three distinct mtDNA clades, one Asian and two European. Of the latter, one clade was composed of the majority of the European wild boars sampled, the Israeli wild boars, most of the European domestic pigs, and the domestic pig sample from Cook Island (Giuffra et al., 2000). The second European clade was interesting because it included only three wild boars from Italy (Giuffra et al., 2000). Moreover, all mtDNA haplotypes of domestic pigs of presumed European origin belonged to the first European clade. The authors observed that while some domestic pigs' mtDNA sequences were closely related to European wild boar sequences, others clustered with Asian wild boar sequences, thus providing conclusive evidence for the independent domestication of pigs in both continents (Giuffra et al., 2000).

Building up on this original work showing independent pig domestication events, Larson et al. (2005) sequenced mtDNA from wild boar and domestic pigs from Eurasia in order to investigate the relationship between both species[11]. Their results indicated that modern European domestic pigs fall within the European cluster and lack any affinity with Middle Eastern wild boar lineages. These results led the authors to observe that "The lack of Turkish, Armenian, or Iranian signatures within modern European breeds implies that, even if domesticated Near Eastern pigs entered central Europe with early Near Eastern farmers, those lineages have left no descendants among the modern European domestic pigs" (Larson et al., 2005: 1619). Larson et al.'s study also revealed two core lineages which are only present in European pigs, indicating the independent domestication of at least two European wild boar lineages. In this respect, the authors propose Germany and Italy as possible centres of local domestication. The case for an Italian wild boar domestication is substantiated by the presence in Sardinia of the

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[11] See also Chapter 2.1.a for a discussion of some of the results of this paper.

Italian wild boar clade found currently in the Maremma region of modern Tuscany and Latium. Since the pigs in Corsica and Sardinia has been interpreted as a product of human-mediated dispersal of this species, the presence of the Italian clade in some of the pigs from the latter island would suggest that if their "ancestors […] were originally introduced as domestic animals (that have since gone feral), these individuals must represent a lineage of pigs independently domesticated on the Italian mainland" (Larson et al., 2005: 1620). The evidence presented in this paper also supports the case of independent pig domestication events in several locations in Asia (Larson et al., 2005), once again demonstrating the viability of the wild boar for independent domestication within its wide original distribution.

After these studies set the basis for independent pig domestications in Europe, Larson et al. (2007b) continued the research by including in their study mtDNA sequences of ancient pigs from Eurasia, in order to identify temporal trends in the presence of the mtDNA clades. Their results supported a modern phylogeographic boundary between the Near Eastern and European pig haplotypes, and clearly separated four ancient clades: two Near Eastern, one European, and one only present in the Italian peninsula (Figure 3.1 A and B). From the analysis of ancient pig mtDNA samples, the authors observed that none of the pre-Neolithic European wild boar samples possessed the Near Eastern haplotypes (Figure 3.1 C). Also, four samples from Romania, close to the phylogenetic boundary, possessed the European haplotype by the Neolithic and post-Neolithic period (Figure 3.1 D). Following these observations, they suggested that the modern phylogeographic boundary between European and Near Eastern wild boar populations has been intact since at least the early Holocene, and they concluded that samples found on either side that possess haplotypes not matching those of local wild boar most likely represent domestic pigs introduced by humans and deriving from exotic wild boar lineages (Larson et al., 2007b). The data, as shown in Figure 3.1 D, indicated that pigs with Near Eastern ancestry crossed this boundary during the Neolithic and began to appear in European contexts. After the introduction of these Near Eastern pigs into Europe, their evidence disappears in the samples from the Bronze Age (Figure 3.1 E) by at least the IV millennium BC, being completely replaced by domestic pigs of European origin (Larson et al., 2007b).

Additionally, Larson et al. (2007b) investigated the relationship between the two proposed routes of spread of the Neolithic package (Danube-Rhine basins and maritime routes; see also Chapter 4.2) and the results from their analysis. The authors suggested that the results corresponding to the Y1 Near Eastern haplotype were consistent with their spread along the northern route; whereas the distribution of the Near Eastern haplotype Y2 would have been consistent with a Mediterranean dispersal (Figure 3.1D) (Larson et al., 2007b). Interestingly, the Y2 haplotype has also been detected in a modern Corsican feral pig (Figure 3.1 F), suggesting, according to the authors, that Near Eastern pigs could have been introduced to the island by Neolithic settlers (Larson et al., 2007b). But it could also have been a later introduction, as Lega et al. (2017) proposed for Sardinia and Sicily (see below in this section). The results from the analysis of Armenian pig samples indicated that European domestic pigs spread back eastward into Armenia by the VII century BC, apparently to completely replace the earlier Near Eastern domestic pigs (Larson et al., 2007b).

More importantly from the geographic perspective of this research, the presence of Italian haplotypes, currently restricted to the Maremma region, in modern wild pigs and one Bronze Age sample from Sardinia (Figure 3.1 E), points strongly to the possibility that indigenous Italian wild boar could have been independently domesticated (Larson et al., 2005; 2007b). Indeed, Larson et al. (2007b) identified the Italian haplotype in numerous ancient pig samples, including Mesolithic Pupicina cave (Croatia), Early and Middle Neolithic Grotta della Madonna (southwestern Italy), Middle Bronze Age Arrubiu (Sardinia), and in several medieval wild boar samples from Tuscany and Rome. These results led the authors to state that "[…] not only were indigenous Italian wild boar distributed beyond their current restricted region of Maremma in Northwest Italy, but the presence of the Italian haplotype in Bronze Age central Sardinia [Figure 3.1 E] also suggests either an independent domestication of native Italian wild boar or the incorporation of female Italian wild boar into domestic stocks that were subsequently imported to Sardinia by at least the end of the 2nd millennium BC" (Larson et al., 2007b: 15279). A later study by Maselli at al. (2016) identified the presence of the Italian and European haplotypes in Sardinia already by 4,000-2,000 BC. This evidence offers strong support to the hypothesis of a possible local domestication of Italian wild boar.

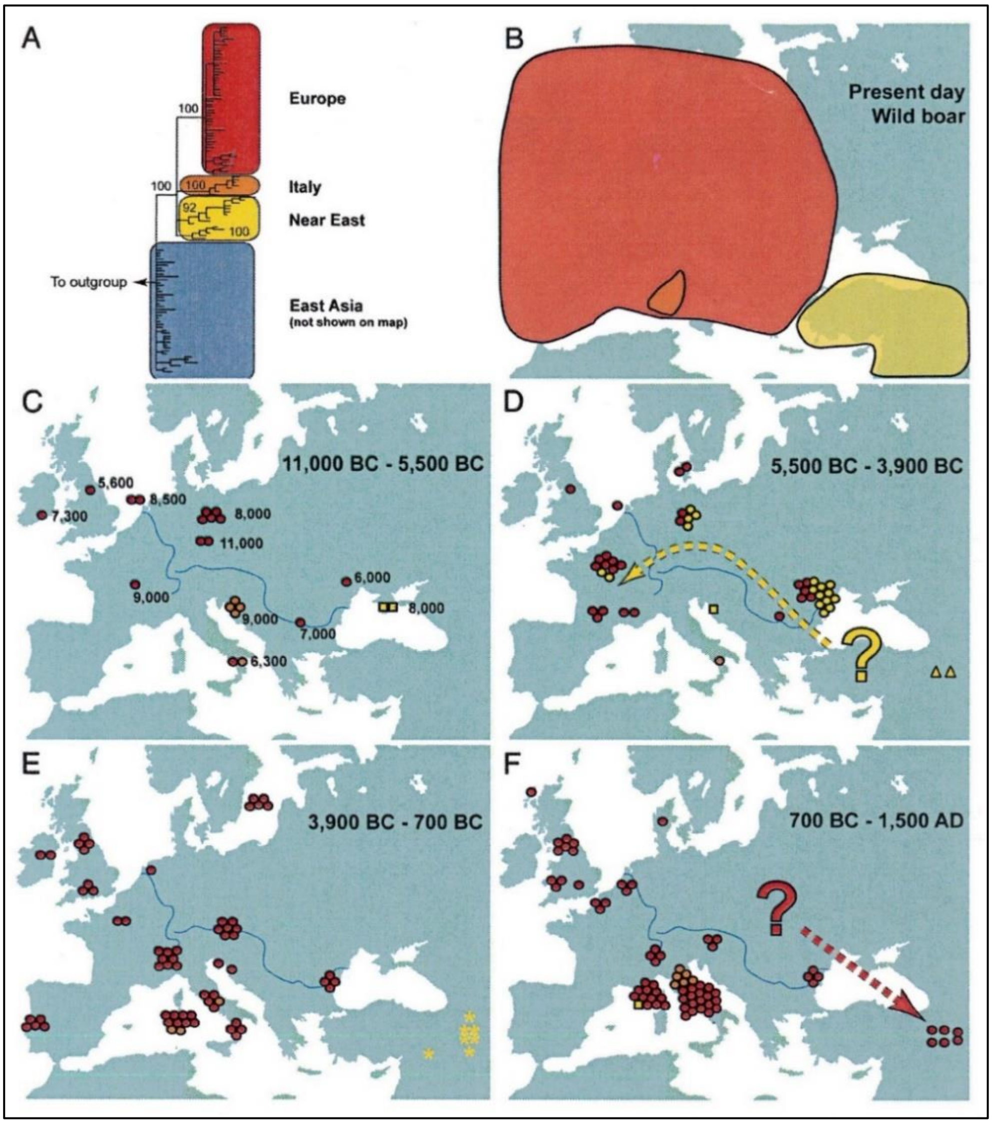

Figure 3.1. Maps depicting the shifting geographical positions of European and Near Eastern pig haplotypes over the past 13,000 years (A and B), and time series maps of locations in which these haplotypes have been identified on ancient pig samples (Modified from: Larson et al., 2007b). "(A) Bayesian (Monte Carlo-Markov chain) consensus tree of 112 modern wild *Sus* mtDNA control region haplotypes rooted by a common warthog (*Phacochoerus aethiopicus*). Red, orange, and yellow represent three clusters on the tree that correspond to specific regions on the map in B (Europe, Italy, and the Near East, respectively), where the majority of pigs possess haplotypes within that cluster. Posterior probabilities of the major nodes are listed for each of the branches. […] [On maps C-F] Each symbol corresponds to a single sample, and the colors correspond to those used in A and represent the cluster on the tree to which the samples belong. The four Near Eastern haplotypes discussed [in the original paper by Larson et al.] (Y1, Y2, A1, and A2) are represented by yellow circles, squares, asterisks, and triangles, respectively. Numbers to the right of the sample locations in C represent approximate sample ages (in calibrated years BC). […] Clustered symbols represent multiple samples from the same or geographically proximate sites. The upper and lower blue lines indicate the Rhine and Danube rivers, respectively. The dotted yellow arrow in D depicts the hypothesized Danubian trajectory along which the Y1 haplotype was transported, and the dotted red arrow in F highlights the movement of European domestic pigs transported into Armenia. The question marks at the origins of the arrows reflect the uncertainty regarding the precise locations from where the dispersal routes began. C-F very broadly represent the European Mesolithic, the European Neolithic, the Bronze Age, and all subsequent ages to the medieval period, respectively" (Larson et al., 2007b: 15278)[12].

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In sum, the study by Larson et al. (2007b) introduced a series of valuable arguments towards our understanding of the pig domestication phenomenon in Eurasia. Ottoni et al. (2012) further explored these results through the analysis of Near Eastern pig mtDNA samples. Their results suggest the dispersal of the first domesticated pigs from the Upper Tigris to western Anatolia, where they would have picked up the Y1 haplotype through admixture with the local wild boar. From this area, the Y1 haplotype would have been carried into Europe with these domestic pigs as far as the Paris basin, as supported by the data collected by Larson et al. (2007b). Through further admixture with local wild boar, the introduced haplotypes were progressively lost in favour of the local European haplotypes (Ottoni et al., 2012). This dynamic of haplotype replacement and admixture or not with local population cannot help but bring back the question of differential pig management and selection strategies through time (Frantz et al., 2015; Larson and Burger, 2013; Lega et al., 2016; Marshall et al., 2014; Tsai et al., 2016).

Within the same lines of research but focussing on the Italian peninsula, Vai et al. (2015) performed a mtDNA analysis of ancient pig samples from the northern Italian site of Riparo di Biarzo, dated from the Upper Palaeolithic to the Bronze Age and located in the crossroads between the Italian peninsula, the Balkans, and Central Europe. The results of samples from the Upper Palaeolithic, Mesolithic, and Neolithic samples indicated the presence of three major mtDNA haplotypes: the European E1, the Near Eastern Y2, and the Italian E2. The most represented haplogroup in the Palaeolithic wild boar samples was the Italian, with some European haplotypes also present. Of the three Mesolithic stratigraphic units sampled, the oldest one consisted only of Italian haplotypes, the middle one presented only Near Eastern haplotypes, and the most recent was dominated by the European haplotype but also had the Near Eastern haplotype. Lastly, for the Neolithic samples, only pigs with European haplotypes were observed. The presence of pigs of Near Eastern origin during the Mesolithic sequence has been highlighted as quite interesting by the authors, as it conflicts with the notion of the presence of this haplotype as signifying the occurrence of domestic pigs, due to the fact that the material sampled pre-dates the introduction of the Neolithic package in the area by at least two millennia (Vai et al., 2015). Based on these results, the authors proposed the hypothesis that “the history of modern European pig breeds might be simplified to a continuous process of local domestication without the need of a Near

Eastern wave of introgression" (Vai et al., 2015: 6), an hypothesis that would need to be further investigated with the inclusion of more samples.

Lastly, furthering this research into Italian samples, Lega et al. (2017) sampled mtDNA of pig remains from sites in Southern Italy and Sardinia, dated from the Mesolithic to Roman Age. Their results revealed the presence of the following haplotypes by period: two European for the Mesolithic and the Neolithic; and two European, one Italian, and one Near Eastern (in Sicilian and Sardinian samples only) for the Bronze Age (Lega et al., 2017). The Sardinian Neolithic data indicated that domestic pigs of European signature were imported to the island during the Sardinian Late Neolithic/European Bronze Age, at a moment where the replacement of Near Eastern haplotypes by European haplotypes in pigs was already advanced. During the Bronze Age, however, the Near Eastern haplotype was also detected at Sardinia and Sicily, and the authors suggests that their presence during this time could have been a result of the connections of these islands with the trading activities of the Sea People in the Mediterranean Basin at this time (Lega et al., 2017)[13]. Regarding the Italian haplotype, the presence of a domestic sample with this signature during the Bronze Age led the authors to suggest that "[…] the indigenous Italian wild boar was effectively domesticated, or that female Italian wild boars were incorporated into domestic stocks in this region during the Bronze Age. Our data suggests that domestic pigs with Italian signature were imported to Sardinia by at least the end of the second millennium BC through sea trading between the Peninsula and the island cultures. Sardinian feral pigs carrying E2 [European] haplotypes are still present today and may represent the last-standing genetic evidence of the domestication of the endemic wild boar" (2017: 158). Finally the authors stated that their results point to the preferential domestication since the Neolithic of A-side European haplotypes (common in Central Europe and Italy), at the expense of C-side ones (common in Iberia and Eastern Europe) (Lega et al., 2017). This study thus offers additional support to the possibility of an independent pig domestication event in Italy.

3.5. Summary

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[13] See also Meiri et al. (2017) for a similar interpretation of the results of mtDNA analysis from Greek and Israeli samples.

The review of the current knowledge on the process of pig domestication in the Middle East and Europe presented in this chapter, has demonstrated the value that biometry has to this day as a key tool to investigate this phenomenon, accompanied with other sources of evidence. Decades of study of the beginnings of pig domestication in the Near East has shown that this is a slow and gradual process, and that it might take up to two millennia before a fully morphologically distinct domestic pig can be observed in the archaeological record. Biometry can help identify that 'transitional' stage between a wild boar and a fully distinct domesticated pig (e.g. Ervynck et al., 2001; Hongo and Meadow, 1998; Payne and Bull, 1988; Price and Arbuckle, 2015). Additionally, ethnographical models have proven a valuable tool in modelling the beginnings of the domestication process and its archaeological implications (Redding and Rosenberg, 1998b; Rosenberg and Redding, 1998).

In Europe, the studies of the pig domestication process have further supported the effectiveness of the biometrical method (e.g. Albarella et al., 2005; 2006c; Hadjikoumis, 2010; Rowley-Conwy and Dobney, 2007; Viner, 2011). The studies reviewed have as well shown how the evidence can be interpreted differently between the different authors, especially when new methods are introduced (Evin et al., 2014b; Krause-Kyora et al., 2013; Rowley-Conwy and Zeder, 2014a,b). Irrespective of the promise of new methods, such as geometric morphometrics, biometry in domestication research is still a proven strong and reliable method that produces consistent, reproduceable, and comparable results, in spite of its limitations (Albarella, 2002; Rowley-Conwy et al., 2012; Rowley-Conwy and Zeder, 2014b). In the Italian research, the preliminary results available to this date testify to the potential of the biometrical method (Albarella et al., 2006c), and provide an excellent starting point to this research.

Finally, biometrical data must always be complemented with other types of evidence, if possible, to obtain a more complete picture of the domestication processes. In this respect, the studies of mitochondrial DNA of pigs, both ancient and modern, have provided key results that help shape our interpretation of the zooarchaeological data. In the particular case of Italy, the genetic evidence has offered support to the possibility of a local domestication of wild boar in the peninsula (e.g. Larson et al., 2007b; Lega et al., 2017; Vai et al., 2015). Hopefully, the research presented in this thesis and future developments will help decipher the picture.

Chapter 4

A REVIEW OF ITALIAN PREHISTORY

In this section a comprehensive review of Italian prehistory will be presented, in order to understand the context in which pig domestication has developed in Italy. The first part of the chapter will focus on a review of the paleoenvironmental context, while the second part will consist of a detailed revision of the current knowledge on the archaeological data available for the Italian peninsula, from the Upper Palaeolithic to the Late Bronze Age[14]. The emphasis of the discussion will be placed in the past subsistence practices of this prehistoric communities, but other types of data, such as ceramics and settlement patterns will also be discussed, as they also reflect the past lifeways of these populations.

4.1. Past Climate and Environment in the Italian Peninsula

Given the proven influence of temperature on animal body size (Davis, 1981), and the obvious implications that significant changes in environmental conditions have on human lifestyles, it is worth revising the current knowledge on paleoenvironments for the time periods covered by this research project. Due to the large chronological breadth of this review, the dates will be presented in years BP, with approximate equivalencies in years BC when referring to Holocene events (post-10 Kya BP).

Several sources of evidence give us insights on the past climates and environments of Europe in general and the Italian peninsula in particular, such as tree rings, pollen records, ocean sediments and ice cores. Regarding the deep-sea cores, the ratio of oxygen isotopes (O^{16}/O^{18}) in the calcium carbonate of foraminifera provides information on past ice volumes and indirectly of temperature fluctuations (Burroughs, 2005). The classic standard proposed to evaluate climatic variations during the Pleistocene are the oxygen isotopic values registered in the core V28-238 from the Pacific Ocean (Shackleton and

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[14] In this research, the long-term approach is taken due to previous research into pig domestication demonstrating that it might take millennia before a fully morphological domestic animal can be observed in the archaeological record (see Chapter 3.1). The inclusion of material as far back as the Upper Palaeolithic is warranted for two main reasons: (a) in order to understand how the wild boar morphology evolved in the long term, before the arrival of the Neolithic in Italy; and (b) in order to complement the limited nature of the Italian Mesolithic pig assemblages.

Opdyke, 1976), but some more recent studies of ice-cores from Antarctica (EPICA Community Members, 2004) and Greenland (Greenland Ice Core Project Members, 1993; Grootes et al., 1993) have also contributed to our knowledge on the topic. From these studies, a set of 19 stages starting from the Matuyama-Bruhnes magnetic reversal (*ca.* 750 Kya BP) have been defined to describe the principal glacial and interglacial periods (Figure 4.1). For the last interglacial, last glacial maximum (LGM), and the warming thereafter (i.e. since *ca.* 130 Kya BP) a set of five stages have been defined: Oxygen Isotope Stages One to Five (OIS1 to 5; Figure 4.1) (Burroughs, 2005). The timeframe of this research has been defined as spanning from the Upper Palaeolithic to the Bronze Age (*ca.* 32 Kya to 3 Kya BP/30 Kya to 1 Kya BC), and therefore this paleoenvironmental review will be focused on the last years of OIS3 and on OIS2 to 1 (Figure 4.1; Table 4.1). Additionally, and for the purpose of this discussion, it is worth defining some terminology: 'Dansgaard/Oeschger (DO) events' are interstadials (i.e. warmer periods), whilst 'Heinrich events' are short-lived particularly cold events that represent the most extreme expressions of glacial conditions during a stadial (Burroughs, 2005; Dansgaard and Oeschger, 1989; Heinrich, 1988; Hemming, 2004). Table 4.1 shows the chronology of these events and other stadial and interstadials (starting at 58 Kya BP), which are also marked in Figure 4.1.

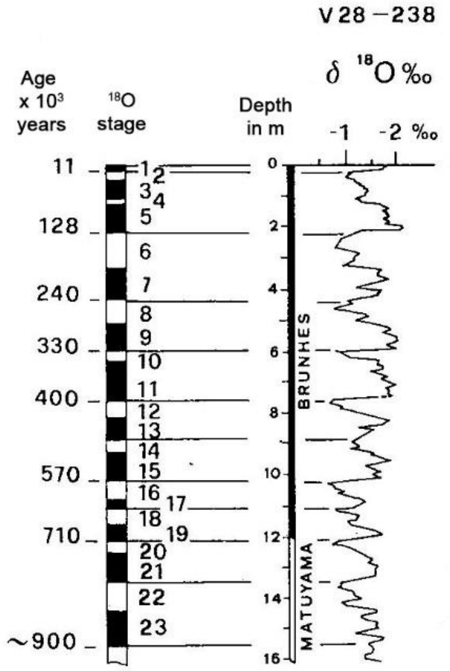

Figure 4.1. Proportion of oxygen-18 ($\delta^{18}O$) per thousand (‰) in the shells of foraminifera from the V28-238 ice core of the Pacific Ocean (Source: Guidi and Piperno, 1993. Translated by S. Tecce)[15].

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OIS	AGE (Kya B.P.)	DANSGAARD/ OESCHGER EVENTS (Kya)	HEINRICH EVENTS (Kya)	INTERSTADIALS AND OTHER EVENTS (Kya)
1	0-10			Holocene climatic optimum (5-6 Kya) 8.2 Kya cold event
2	10-20	1 (14.5)	H0 (12.9) H1 (16.5)	Younger Dryas (12.9-11.6 Kya) Bølling warm stage (14.5 Kya)
	20-30	2 (23.4) 3 (27.4) 4 (29.0)	H2 (23.5)	Denekamp interstadial (30-25 Kya)
3	30-40	5 (32.3) 6 (33.6) 7 (35.3) 8 (38.0)	H3 (32.0) H4 (39.5)	Hengelo interstadial (38-36 Kya)
	40-50	9 (40.1) 10 (41.1) 11 (42.5) 12 (45.5) 13 (47.5)	H5 (47)	Moershoofd interstadial (46-44 Kya)
	50-60	14 (52.0) 15 (54.0) 16 (57.0) 17 (58.0)		Glinde (51-48 Kya) Oerel (58-54 Kya)

Table 4.1. Chronology of stadials and interstadials during Oxygen Isotope Stages (OIS) 1 to 3 (Modified from: Burroughs, 2005)[16].

The OIS3 starts at the end of the Heinrich event 6, *ca.* 59 Kya BP, at a point in which the climatic conditions started to fluctuate more, with the presence of warmer periods. For much of this period, most of northern Eurasia was habitable. After Heinrich event 5 (*ca.* 45 Kya BP), there was a relatively mild period coinciding with the Upper Palaeolithic Revolution. Across the Mediterranean during this time, there were changes in precipitation regimes and the temperatures were hospitable in comparison with farther north (Burroughs, 2005). The conclusion of the OIS3 is marked by the end of Heinrich event 3 at around 28 Kya BP.

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The OIS2 extends up to 15 Kya BP, and includes the LGM, which falls in between the Heinrich events 2 and 1 (*ca.* 23 Kya and 16.5 Kya BP). The global average temperature at the height of the LGM was at least 5°C lower than it is today, and the climate changes led to shrinkage of the forests and expansion of the deserts (Burroughs, 2005). Annual precipitations were reduced to 440-540 mm (Cremaschi and Chiesa, 1993). During this period of extreme cold, the extent of the Fennoscadian ice sheet – which reached its greatest coverage at around 21 Kya BP (Figure 4.2) – reduced much of the region north of the Alps to a polar desert. In the Mediterranean, the scenario was one of an arid semi-desert, with thick woody vegetation and occasional small pockets of open woodland. Lake levels were high, possibly as a consequence of relatively elevated winter rainfall, but without making much moisture available to plants as lower year-round temperatures would have suppressed evaporation from the lakes (Burroughs, 2005). The yearly fluctuations would have made the life during the LGM specially challenging, "[t]hey would have required an extraordinarily adaptable, flexible and migratory lifestyle to adjust to changing environmental conditions. At the simplest level, it is probably true to say that even now such a climate would make any form of agriculture, as we currently know it, virtually impossible" (Burroughs, 2005: 101–102). In this context, regions of relative ecological stability were key to survival, and the Italian peninsula was one of them. Indeed, at around 20 Kya, northern Italy was one of the farthest septentrional areas people were living in Europe (Burroughs, 2005). An important correlation of the extreme glaciations of this period is the lowering of the sea levels between 100-130m below current levels, and the concomitant exposition of areas of living space (Figure 4.2) (Burroughs, 2005; Cremaschi and Chiesa, 1993). Unfortunately, all evidence of coastal habitation has been lost to the rising sea levels of the Holocene.

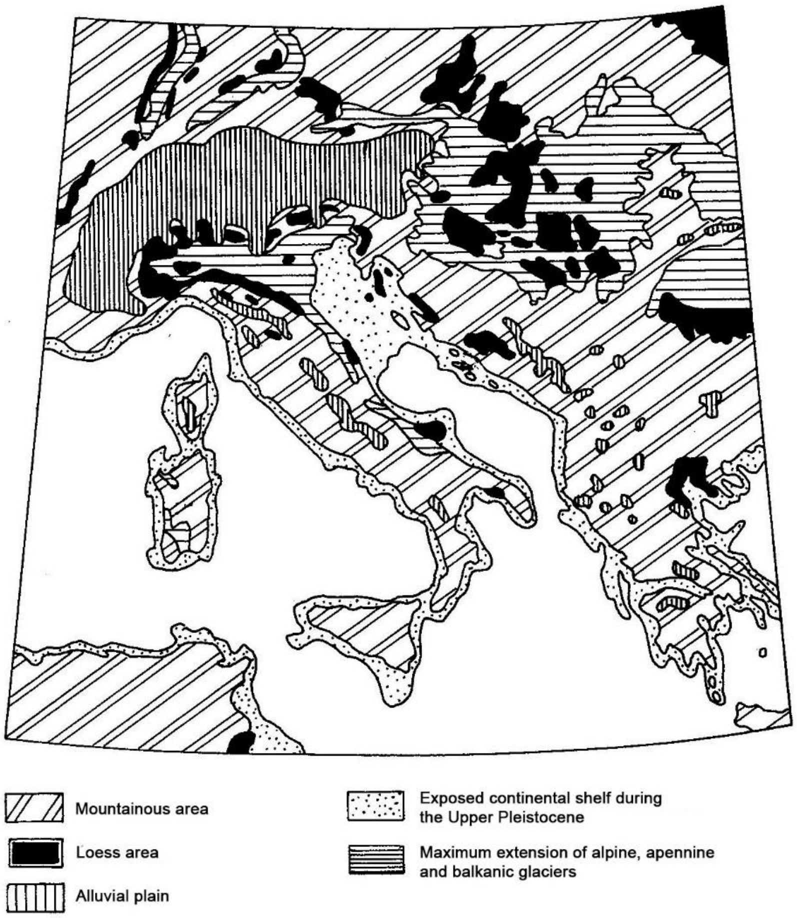

Figure 4.2. Distribution of loess, extent of the ice sheets, and exposed continental shelf in the Italian peninsula during the Upper Pleistocene (Source: Guidi and Piperno, 1993. Translated by S. Tecce)[17].

During the last interglacial, the faunal remains from the Italian peninsula point to the presence of straight-tusked elephant (*Paleoloxodon antiquus*), hippopotamus (*Hippopotamus amphibius*), steppe rhinoceros (*Dicerorhinus hemitoechus*), and big carnivores such as the hyena (*Crocuta crocuta*), the lion (*Panthera leo*), and the leopard (*Pardus pardus*). Other animals present during this time are fallow deer (*Dama dama*), aurochs (*Bos primigenius*), steppe bison (*Bison priscus*), and equids (*Equus ferus*). In places where there is woodland cover, there are also red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), giant deer (*Megaloceros giganteus*), wild boar (*Sus scrofa*), and brown bear (*Ursus arctos*). During the initial phase of the LGM, the fallow deer continue to be the most abundant animal of the Mediterranean strip; the pachyderms are also present, while equids and bovids become increase in number. In northern Italy, there is more woodland fauna, with presence of red deer, roe deer, aurochs, and wild boar. When the climatic conditions became colder and dryer, during the LGM, steppe environments'

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species became more frequent, such as alpine ibex (*Capra ibex*), chamois (*Rupicapra rupicapra*), steppe bison, elk (*Alces alces*), woolly mammoth (*Elephas primigenius*), and equids (limited to the southern Adriatic areas). The wild boar and the fallow deer survived in southern Italy (Caloi et al., 1986; Cassoli and Tagliacozzo, 1986; Sala, 1980; 1983a). The faunal remains from the last part of the LGM in the Adriatic area were from species that live in steppe-like open environments (e.g. equids, ibex, chamois), whereas in the Tyrrhenian area the forest species were dominant (e.g. red deer, roe deer, wild boar) (Cremaschi and Chiesa, 1993; Tagliacozzo, 1993b).

The beginning of the end of the LGM is marked by the Heinrich event 1 and the collapse in part of the Laurentide ice sheet in North America. This led to a surge of icebergs out into the North Atlantic and the last Heinrich event at around 16.5 Kya BP. Pollen records for northern Europe show that this last cold interval was followed by a sudden and deep warming event (the Bølling interstadial) around 14.5 Kya BP, which coincided with a rapid rise in sea level. These events impacted on the sea temperatures and led to a rapid warming of the northern hemisphere. However, and after a few hundred years, the period known as Older Dryas brought back colder conditions. The next interstadial, the Allerød (*ca.* 14 Kya BP), signified a return to warmer conditions, while during the stadial Younger Dryas (*ca.* 14.4 to 11.7 Kya BP) the climate dropped back into near glacial conditions. In Europe, during this period, summer temperatures were 5-8°C lower that today, and in midwinter they dropped to 10-12°C lower. There was also a disappearance of woodland cover and a return to dry steppe and steppe-tundra environments (Barber et al., 1999). By this time, after 14 Kya BP, the second pulse of megafaunal extinctions took place, with its concomitant effects on vegetation structure and diversity (Johnson, 2009; Koch and Barnosky, 2006). At the end of this stadial, temperatures returned to the warmer values that had characterized the Allerød, marking the beginning of the Holocene, with only a brief cold interruption at around 11.25 Kya BP (Preboreal Oscillation). Regarding the northern ice sheets, the Fennoscandian disappeared at around 8.5 Kya BP/6.6 Kya BC, whilst the Laurentide lasted until around 6 Kya BP/4Kya BC. The disappearance of this last big ice sheet caused one last short-lived cooling event between approximately 8.2 and 8 Kya BP/6.2 and 6 Kya BC (Barber et al., 1999).

The transition from the Younger Dryas to the Holocene marks the beginning of a period of warmer and wetter climates and less dramatic oscillations than those that characterized the Pleistocene. By around 10 Kya BP/8 Kya BC the temperature had risen to something comparable to modern values, and apart from the brief return to colder climates mentioned at the end of the previous paragraph, the Holocene was a period of climatic stability, reaching an optimum around 6 Kya BP/4 Kya BC (Burroughs, 2005). This climate amelioration led to the expansion of the forests to high latitudes in the northern hemisphere, reaching their maximum expansion around 7 Kya BP/5 Kya BC, some 200 to 300 km farther north than their present extent. This phase is called the 'Atlantic' period, and featured summer temperatures 2-3°C warmer than modern values, with tree-cover expanding not only farther north but also higher into the upland areas than today (Burroughs, 2005). However, the Holocene did not lack periods of considerable and abrupt variations in climate that affected human life. Indeed, several periods of significant rapid and deteriorating climate change have been identified, which are relevant to this discussion due to their chronology: 9 to 8 Kya BP/7 to 6 Kya BC; 6 to 5 Kya BP/4 to 3 Kya BC; 4.2 to 3.8 Kya BP/2.2 to 1.8 Kya BC; 3.5 to 2.5 Kya BP/1.5 Kya BC to 500 years AD (Mayewski et al., 2004). Regardless of this changeability, the fundamental drop in climatic variability during the Holocene in comparison with the Pleistocene was to be a key factor in defining future human trajectories, as it is thanks to this that agriculture became a possibility (Richerson et al., 2001).

The end of the Younger Dryas marked a renewed expansion of the forests, the preferred habitat of the wild boar, into Europe. The information provided by pollen diagrams show the expansion of birch (*Betula*) and pine (*Pinus*) first, reaching Denmark by 10.5 Kya BP/8.5 Kya BC, closely followed by hazel (*Corylus*) and then elm (*Ulmus*). Around 8.5 Kya BP/6.5 Kya BC, lime (*Tilia*); oak (*Quercus*), which appears in the south and Italian peninsula as early as 10 Kya BP/8 Kya BC; and alder (*Alnus*) occupy the continent, following different trajectories. Around 5.7 Kya BP/3.7 Kya BC there was a severe decline in elm (*Ulmus*) in Europe, probably due to climatic deterioration (Burroughs, 2005). The pollen records for northern Europe also evidence a sequence of four general climatic periods during the Holocene (Burroughs, 2005; Cattani, 1993; Cremaschi and Chiesa, 1993), covering the chronological breadth of this research:

- the Preboreal and Boreal (11.9 to 9 Kya BP/9.9 to 7 Kya BC): a rapid transition period followed by a warm and dry period that manifested the more continental nature of the early Holocene in Europe, with warmer summers than present but colder winters;

- the Atlantic (9 to 6 Kya BP/7 to 4 Kya BC): a warm and wet period;
- and the Sub-Boreal (6 to 2.5 Kya BP/4 Kya to 500 BC): a warm and dry period, including a period of climatic deterioration around 5 Kya BP/3 Kya BC.

During the Atlantic period, at around 8.4 to 6 Kya BP/6.4 to 4 Kya BC, there is the maximum contraction of the alpine glaciers (Orombelli and Porter, 1982). After this period, two glacial advances relevant for our study have been documented: from 5.3 to 5 Kya BP/3.3 to 3 Kya BC, and around 3 Kya BP/1 Kya BC. Regarding the coastline, during the Preboreal it was 60/50m lower than current levels, 40/20m lower during the Boreal, and 15m lower during the Atlantic. By the end of this latter period, the coast line reached current levels (Cremaschi and Chiesa, 1993).

With the beginning of the Holocene period, the faunal remains from Italy show that some species – e.g. ibex, chamois, marmot (*Marmota marmota*) – are now restricted to mountainous areas. The expansion of the forests, however, led to an increase in red deer and wild boar, alongside roe deer and carnivores, but a disappearance of fallow deer, wild equids, and crested porcupine (*Hystrix cristata*) (Cremaschi and Chiesa, 1993).

From an ecological point of view, while human communities during the Upper Pleistocene in Italy occupied steppe niches, during the Holocene the niche availability increased, and people progressively occupied mountainous areas, both in the Alps and Apennines. With the introduction of agricultural practices, site distribution started to be connected to water sources and appropriate soils for cultivation. Finally, during the Bronze Age in the Po valley, there is evidence of systematic deforestation and soil erosion (Cattani, 1993; Cremaschi and Chiesa, 1993).

4.2. Background on Italian Prehistory: From the Upper Palaeolithic to the Bronze Age

The first evidence for *Homo sapiens sapiens* in the Italian peninsula dates from 33 Kya BP, with the Uluzzian and Aurignacian lithic industries (Guerreschi, 1993). For the purposes of this research, we will begin this review in the Upper Palaeolithic, beginning at about 30 Kya BC, and finish with the end of the Bronze Age, at 1,000 BC approximately. The section is then subdivided by broad cultural periods, bearing in mind that the development of the diverse ways of life did not occur at the same time throughout the whole peninsula. Although the emphasis of this review will be placed on economy and subsistence, mention of settlement patterns, material culture, art, and social organization will also be made.

4.2.a. Upper Palaeolithic (30,000 to 8,000 BC)

During the Late Pleistocene, in the extreme conditions of the full glacial, Upper Palaeolithic populations retreated to 'refugia' areas, creating the conditions for the development of more complex social relations and ideologies (Barker, 2006; Gamble, 1999; Jochim, 1998). In the millennia after the Last Glacial Maximum, people swiftly repopulated Europe (Charles, 1996; Housley et al., 1997; Terberger and Street, 2002). A few lithic traditions have been identified for the Italian peninsula during the Upper Palaeolithic. A summary of these traditions and related subsistence and settlement patterns can be seen in Figure 4.3 and Table 4.2.

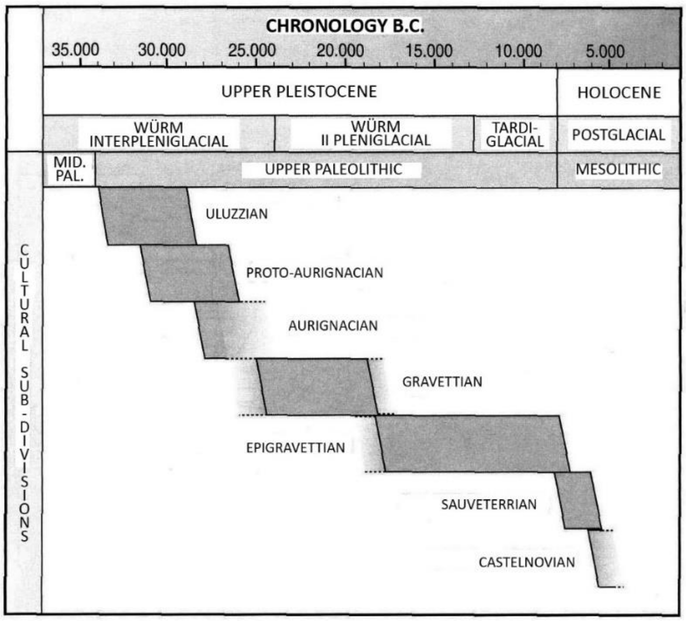

Figure 4.3. Chronology of Upper Palaeolithic and Mesolithic cultural traditions (Modified from: Guidi and Piperno, 1993)[18].

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UPPER PALAEOLITHIC LITHIC TRADITIONS	
AURIGNACIAN (30-25 Kya BC)	Related to the first *Homo sapiens sapiens* to appear to Europe. Open-air and cave sites, no known residential structures and unknown hunting strategies. Grotta del Fossellone (Lazio): animals frequently hunted were red deer (*Cervus elaphus*) and wild ass (*Equus hydruntinus*), then aurochs (*Bos primigenius*), fallow deer (*Dama dama*), roe deer (*Capreolus capreolus*), chamois (*Rupicapra rupicapra*), wild horse (*Equus ferus*), wild boar (*Sus scrofa*), and also birds. The hunt does not seem to have been specialized on a particular species or environment. Human diffusion is more homogenous than in past periods, albeit still scarce. Caves and rock shelters are the preferred settlement locations, and the group size seems to be bigger than before.
GRAVETTIAN (25-18 Kya BC)	Open-air and cave sites. Same animals hunted as in previous period. Not much is known about the hunting strategies. Site distribution seems to point to a distribution coming from southern France, along the Tyrrhenian Sea, and disappears as it reaches the south of the peninsula. The lack of evidence from the Adriatic (except for Grotta Paglicci, Apulia) is most likely due to gaps in/lack of research.
EPIGRAVETTIAN (18-8/6 Kya BC)	From this period onwards, the lithic cultures start to have a clear 'Italian' or local development, in contrast with previous periods where there was a clear European trend, albeit with some local specificities. There is an increase in sites along the whole country, especially during the later phase. The climatic improvement of this period led to a demographic increase, and the sites show larger dimensions and longer occupations. The animals hunted depend on the moment and environment, as it is possible to encounter, contemporarily, periglacial, pre-alpine, steppe, mixed oak, and maquis shrubland environments. The animals hunted were the elk (*Alces alces*), ibex (*Capra ibex*), marmot (*Marmota marmota*), wild horse, wild ass, chamois, red deer, wild boar, and/or roe deer, according to the area where the hunt took place. The only find of reindeer (*Rangifer tarandus*) belongs to this period, from the site of Balzi Rossi (Ventimiglia, Liguria region). Also, frequently consumed were birds and fish. The collection of edible hard-shell molluscs, such as *Trochus* and *Patella*, is a productive activity in development during this period. In general, there is an exploitation of all the possible animal resources from the environment.

Table 4.2. Upper Palaeolithic lithic traditions in Italy, with related subsistence and settlement patterns (Guerreschi, 1993). Dates are approximate.

The site distribution for this period was uneven, with several unoccupied areas. Large empty spaces were present in the Piemonte and Lombardy, the Po valley, most of the interior of southern Italy, Calabria, and most of the Adriatic coast. This distribution surely reflected geographical characteristics and human choice, although it also echoes the bias in archaeological investigations (Bietti, 1990).

Several changes in terms of subsistence have been identified for the Upper Palaeolithic in Italy. A transformation from non-specialized hunting methods of the Middle

Palaeolithic to highly specialized hunting strategies, both in terms of species and prey age, has been proposed for this period (Barker, 1981). Indeed, Tagliacozzo (1993b) mentions that deer were mainly hunted when less than one year of age – possibly in relation to the softness of the fur – or between four and eight years, optimal age for the exploitation of their meat. Wild boar was present in the forested areas – increasingly so as these areas became more widespread with the climatic ameliorations – and was hunted occasionally.

Changes in settlement patterns have also been proposed for this time. Whereas during the Middle Palaeolithic the sites were located in the coastal plains, lower valleys, and only occasionally in the Apennine region, during the Upper Palaeolithic the specialized hunting of migratory animals such as the wild ass (*Equus hydruntinus*) and the red deer led to seasonal occupations – coasts and Apenninic valley forests during winter and high valleys and Apennine during summer (Barker, 1981; Tagliacozzo, 1993b). Indeed, during the final phase of the Epigravettian, the glacials of the alpine region were retreating, with the concomitant expansion of forests and animals, and therefore humans, into this area. Starting at 600 m.a.s.l., humans and animals expand up to 1,000 m.a.s.l. first, then up to 1,600 m.a.s.l. during the Late Epigravettian, and finally up to 1,800 to 2,300 m.a.s.l. during the Mesolithic. These mountain settlements in the alpine meadow were used during the summer, whereas during winter people would occupy the pre-alpine areas and mountain valleys of deciduous open forests. No human occupation has been so far detected in the intermediate environment of dense conifer forests (Guerreschi, 1993). One of these winter occupations could have been represented by Grotta Paglicci (Apulia), as indicated by its ideal ambush location, lithic evidence, and scarcity of meat-bearing bones (Donahue, 1988). However, the main author behind this model (Barker, 1981) concedes that it is relatively simplistic and that "many Palaeolithic hunting bands might have remained on the lowlands throughout the year, ambushing the herds of deer and horse as they made their way to and from the uplands and drying or catching the meat, and augmenting this in other seasons with other game and other food sources" (Barker, 1999: 6). The consensus amongst the authors seems to be that while there was a specialization in hunting techniques, focused on seasonal hunting of large mammals, this was complemented with a considerable diversity in hunting systems, related to prey opportunities of the particular locality and season (Barker, 2006).

For the specific case of the wild boar, while it was not the main hunted prey during this period, its appearance in the assemblages could be explained as a product of opportunistic hunting where the chance to do so presented itself (i.e. near their natural habitats).

4.2.b. Mesolithic (8,000 to 5,000 BC)

The boundary between the Upper Palaeolithic and Mesolithic periods coincides with that between Pleistocene and Holocene: 8,050±150 years BC, the radiocarbon date corresponding to the Scandinavian glacier division into two (Guerreschi, 1993). The ecological changes that took place during this time led to a very different configuration for the Holocene than for the previous period: extended forest coverage, retreat of permanent snowlines, flooding of the coastal plains, development of present-day configuration of rivers and lakes, etc. (see Chapter 4.1). In terms of fauna, these changes – particularly the expansion of the forests – favoured smaller ungulates (e.g. red deer, roe deer, and pig) rather than the larger Pleistocene fauna that inhabited the tundra (Barker, 2006). Animals such as horse, elk, and bison became very rare or disappeared (Guerreschi, 1993). There was also an increasingly rich and varied fauna of smaller sized mammals, such as beaver (*Castor fiber*), otter (*Lutra lutra*), hare (*Lepus europaeus*), badger (*Meles meles*), and fox (*Vulpes vulpes*). The richest locations in terms of food diversity and availability for Mesolithic settlements were now the coasts, estuaries, lakes, and rivers, which provided habitats for fishes, molluscs, and sea mammals, as opposed to the interior regions (Barker, 2006). The areas where Mesolithic sites are most represented are on the eastern and central Alps and the Apennine territories of eastern Liguria, Tuscany, and Emilia-Romagna. Very few occupations have been recorded for the Po Valley during this period, and are scarce in southern Italy in general (Biagi, 2003).

In this context of environmental change, the economy became more diversified, and the settlement patterns were linked to the specific environments. The use of caves and rock shelters diminished in favour of open air sites (Guerreschi, 1993). Some subsistence examples from sites in the Trento valley (Romagnano Loc III, Pradestel and Vatte di Zambana) show evidence of hunting of mostly mammals, such as the beaver, fox, wolf

(*Canis lupus*), badger, otter, pine marten (*Martes martes*), brown bear, wildcat (*Felis silvestris*), lynx (*Lynx lynx*), wild boar, ibex, chamois, roe deer, and red deer. There is also evidence of exploitation of molluscs, tortoise (Testudinidae), fish, birds, and birds' eggs. In sum, the prey captured points to the exploitation of a variety of environments during this time (Guerreschi, 1993). Nonetheless, the hunt for large mammals was still the main source of food during the Mesolithic, especially red deer and wild boar (Pluciennik, 2008; Tagliacozzo, 1993b).

This increased diversification of subsistence activities was probably linked to a seasonal occupation of the sites in response to resource availability. Nonetheless, there are also indicators of increased sedentism, especially during the Late Mesolithic, probably as a consequence of the rising emphasis placed on fishing and shellfish collection (Barker, 1999). An interesting case in this respect is the site of Grotta dell'Uzzo, in Sicily. During the Mesolithic occupation of this cave, the economy was based on the hunting of red deer and wild boar, alongside the exploitation of marine resources (Cassoli et al., 1987; Tagliacozzo, 1993b). The sedentary quality of the site is confirmed by the introduction of migratory birds who nest both in summer and winter in the island. At Grotta dell'Uzzo, the process of diversification of the exploited resources was gradual, beginning with the gathering of molluscs, followed by an increased fishing activity and, by 6,600/6,200 BC, the exploitation of marine mammals (Tagliacozzo, 1993b). The increasing importance of marine foods during this time at the site could have been related to rising sea levels bringing these resources nearer to the cave (Barker, 1999). Barker (1999: 9) states that "The changing use of the cave was part of a widespread trend at this time in the central and western Mediterranean towards increased sedentism, especially at sites at key ecotonal locations with access to a wide range of resources (in this case, in the sea, at the shore and inland […]) capable of sustaining extended periods of occupation […]. The trend was one of the critical contexts that underpinned the transition to farming […]".

In terms of technological changes, the Italian Mesolithic is part of a vaster phenomenon that sees the appearance of an industry with homogenous characteristics in all Europe. The greatest difference with the previous Epigravettian resides on lithic technology. Phenomena such as microliths, bilateral retouches, micro burins, and tool standardization, are accentuated. In northeast Italy, the differences between Late

Epigravettian and early Mesolithic tool kits are more quantitative than qualitative, leading us to think of a probable 'evolutionary' link between the two (Guerreschi, 1993). In some areas of Italy, the Mesolithic is not represented, and the Epigravettian seems to be replaced directly by Neolithic traditions, but this might very well be due to a gap in knowledge (Guerreschi, 1993). The Mesolithic lithic traditions identified in Italy are the Sauveterrian (7,950 to 5,850 years BC) and the Castelnovian (5,500 to 4,500 years BC). The end of the Castelnovian corresponds to the beginning of the Neolithic.

Regarding hunting, fishing and gathering strategies, they must have been quite developed. It is possible that the use of the bow was common, while thrown and projectile weapons were already perfected. During the Mesolithic, tools made of bone and antler, especially from deer, are more common; and during the second half of this period, the denticulated harpoon made of antler was introduced (Guerreschi, 1993). The wild boar gained a greater importance in the diet of the Mesolithic people as the environmental changes led to the spread of the forests, its natural habitat, and to the decline of the larger animals that were characteristic of the Pleistocene. The general changes in lifestyle introduced during this period set the basic conditions for the introduction of agriculture in the Italian peninsula, as will be discussed in the following sub-section.

4.2.c. Neolithic (6,000 to 3,000 BC)

The first domesticated plant and animals, including the pig (*Sus domesticus*), made their first appearance in the Fertile Crescent from approximately the mid-10th millennium BC, according to current knowledge (Ervynck et al., 2001; Helmer et al., 2005; Peters et al., 1999; Zeder, 2008; 2011). From there, the 'Neolithization' (i.e. the introduction and development of pastoral farming; Zvelebil and Lillie, 2010) spread westward into Anatolia and Northern Levant, and then into Europe, where it disseminated following two main routes: through the Danube and Rhine valleys into northwest Europe, associated with the adoption and preferential cultivation of emmer and einkorn; and along the northern coastline of the Mediterranean Sea, characterized by the preferential use of naked wheat varieties (Figure 4.4) (Bar-Yosef, 1998; Broodbank, 2006; Colledge et al., 2004; 2005; Horejs et al., 2015; Özdoğan, 2011; Reingruber, 2011; Tresset and Vigne, 2011; Zeder, 2008; 2017; Zilhão, 2001). Several models have been proposed to explain the spread of this Neolithic package through Europe, such as the ‘wave of advance’ model (Ammerman and Cavalli-Sforza, 1973; 1984), the ‘agricultural frontier’/‘availability’ model (Zvelebil, 1986; Zvelebil and Lillie, 2010; Zvelebil and Rowley-Conwy, 1984), and the ‘maritime pioneer colonization’ model (Zilhão, 2001); however, a detailed discussion of these models exceeds the scope of this research. Sufficient to say at this point that the spread of the Neolithic ideas into Europe seem to have been initiated by colonists originating in the Mediterranean regions of Anatolia and Northern Levant, who spread out via seafaring through pre-existent exchange routes first into Cyprus (*ca.* 10th-8th millennium BC), and then Crete and the rest of the Aegean (from *ca.* 7th millennium B.C) (Broodbank, 2006; Horejs et al., 2015; Özdoğan, 2011; Reingruber, 2011; Zeder, 2017). These pioneering colonists appear to have brought domesticated plants and animals from their points of origin, and occupied areas devoid of Mesolithic settlements and suitable for agriculture (Broodbank, 2006; Horejs et al., 2015; Reingruber, 2011; Zeder, 2017). From that point onwards, the spread of the Neolithic lifeways throughout Europe seem to have involved the selective adoption and adaptation of Neolithic elements by the indigenous populations (Zeder, 2008).

The earliest dates for the Italian Neolithic come from the south-east of the peninsula, approximately between 6,150 and 5,950 cal. BC in Apulia and Basilicata, in association with Adriatic Impressed Ware pottery (Figure 4.5 and Table 4.3). The Neolithic innovations would have arrived in these regions of Italy via maritime colonization (Biagi, 2003; Skeates, 2003). From there, the Neolithic package seems to have spread southwards first (southern Apulia and Calabria) and then to the northwest (Molise, Abruzzo, and southern Marche), after a delay of up to 400 years. In the northwest and northeast of Italy, the earliest Cardial and Impressed Ware Neolithic date around 5,800/5,600 cal. BC (Skeates, 2003). The latest area to show Neolithic evidence is the Po plain, around 5,300/4,950 cal. BC, associated with the Vhò-Fiorano pottery traditions (Skeates, 2003; Starnini et al., 2018).

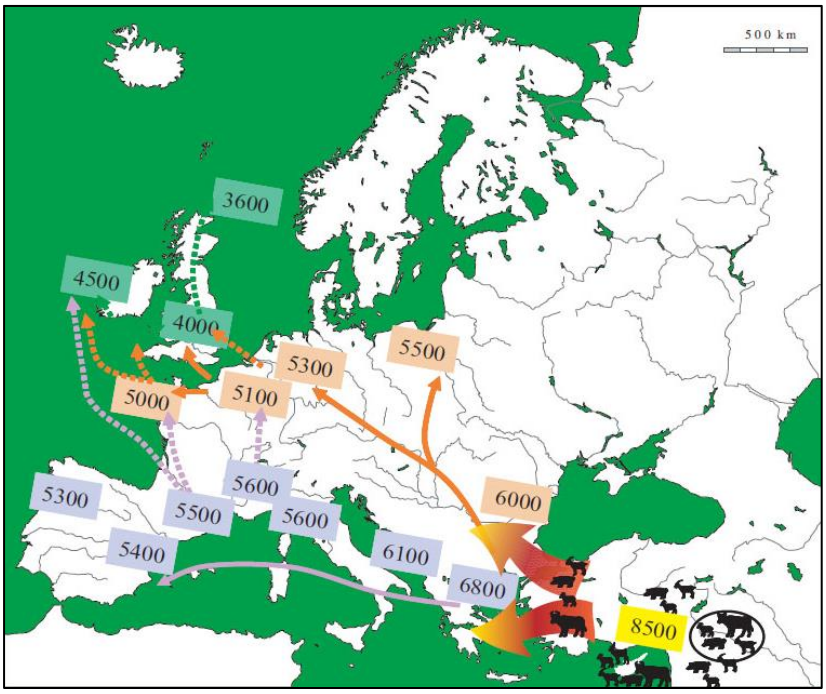

Figure 4.4. Chronology and main routes of dissemination of the Neolithic package (Source: Tresset and Vigne, 2011)[19].

Figure 4.5. Map showing the earliest radiocarbon dates (Cal BC) available for the Neolithic in the Italian provinces. Sardinia is included for reference only (Source: Skeates, 2003)[20].

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[19] Reproduced from Tresset A and Vigne JD (2011) Last hunter-gatherers and first farmers of Europe. Comptes Rendus Biologies 334(3): 182–189. Copyright © 2011 Elsevier Masson SAS. All rights reserved.

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EARLIEST NEOLITHIC DATES (Cal B.C.)	PROVINCES (REGIONS)	ASSOCIATED POTTERY
EASTERN PENINSULAR ITALY		
6,150-5,950	Bari, Foggia, Matera, and Potenza (Apulia and Basilicata)	Impressed and Painted Ware
5,800	Brindisi and Lecce (southern Apulia)	Impressed Ware
5,800-5,750	Cosenza and Catanzaro (Calabria)	Cardial and Stentinello Impressed Ware
5,500	Campobasso, Chieti, Pescara, and Macerata (Molise, Abruzzo, and southern Marche)	Adriatic Impressed, Incised, and Painted Ware
5,400	Terni and Perugia (Umbria)	Adriatic Impressed, Incised, and Painted Ware
5,250	Ancona (Marche)	Adriatic Impressed, Incised, and Painted Ware
SICILY		
5,650	Trapani, on the northwest coast	Impressed and Stamped Ware
5,050	Agrigento, on the southwest coast	Impressed and Stamped Ware
WEST PENINSULAR ITALY		
6,300-6,050*	Siena, Viterbo, and L'Aquila (Tuscany and Lazio)	Cardial Impressed, Impressed, and Incised Ware
5,400-5,150	Terni, Rome, and Firenze (Tuscany and Lazio)	
NORTHWEST ITALY		
5,800	Savona (Liguria)	Ligurian Impressed Ware
5,650	Corsica and Sardinia	Cardial Impressed Ware
5,450	Piacenza (Emilia-Romagna)	
NORTHEAST ITALY		
5,650-5,600	Trieste and Udine (Friuli-Venezia Giulia); Ravenna and Modena (Emilia-Romagna); Lucca (Tuscany)	Vlaška style (Trieste)
5,500-5,400	Pordenone, Vicenza, Verona, and Trento (Friuli, Veneto, Trentino-Alto Adige)	Fagnigola, Fiorano, and Impressed Ware
PO PLAIN		
5,300-4,950	Varese, Cremona, and Reggio Emilia (Lombardy and Emilia-Romagna)	Vhò, Fiorano, and Square Mounted Pottery

* The Neolithic character of the sites in question is not clear, as evidence available is suggestive of hunter-gatherer economies.

Table 4.3. Earliest Neolithic dates in Italy, and associated pottery (Skeates, 2003)[21]. Corsica and Sardinia are included for reference only.

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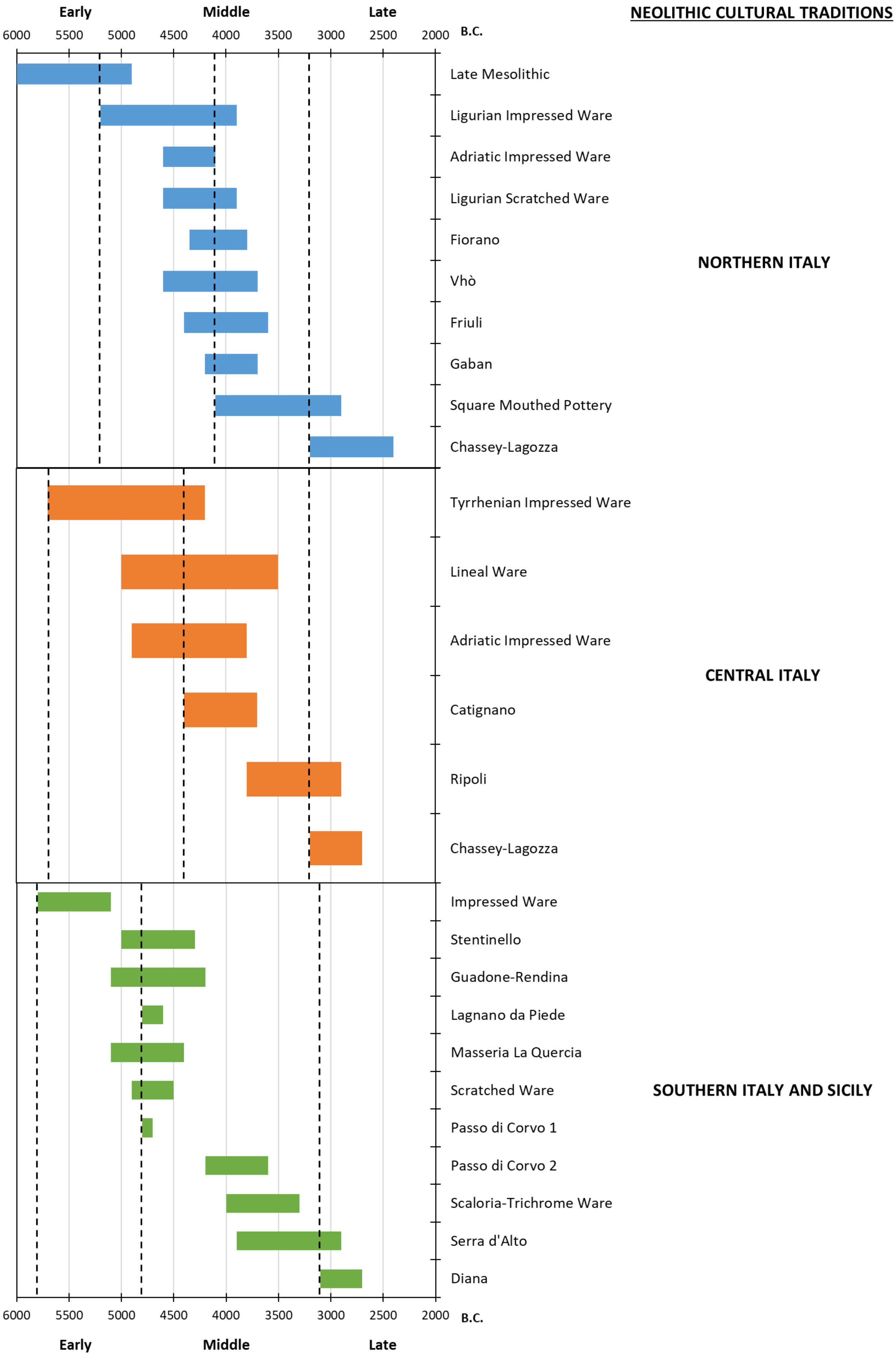
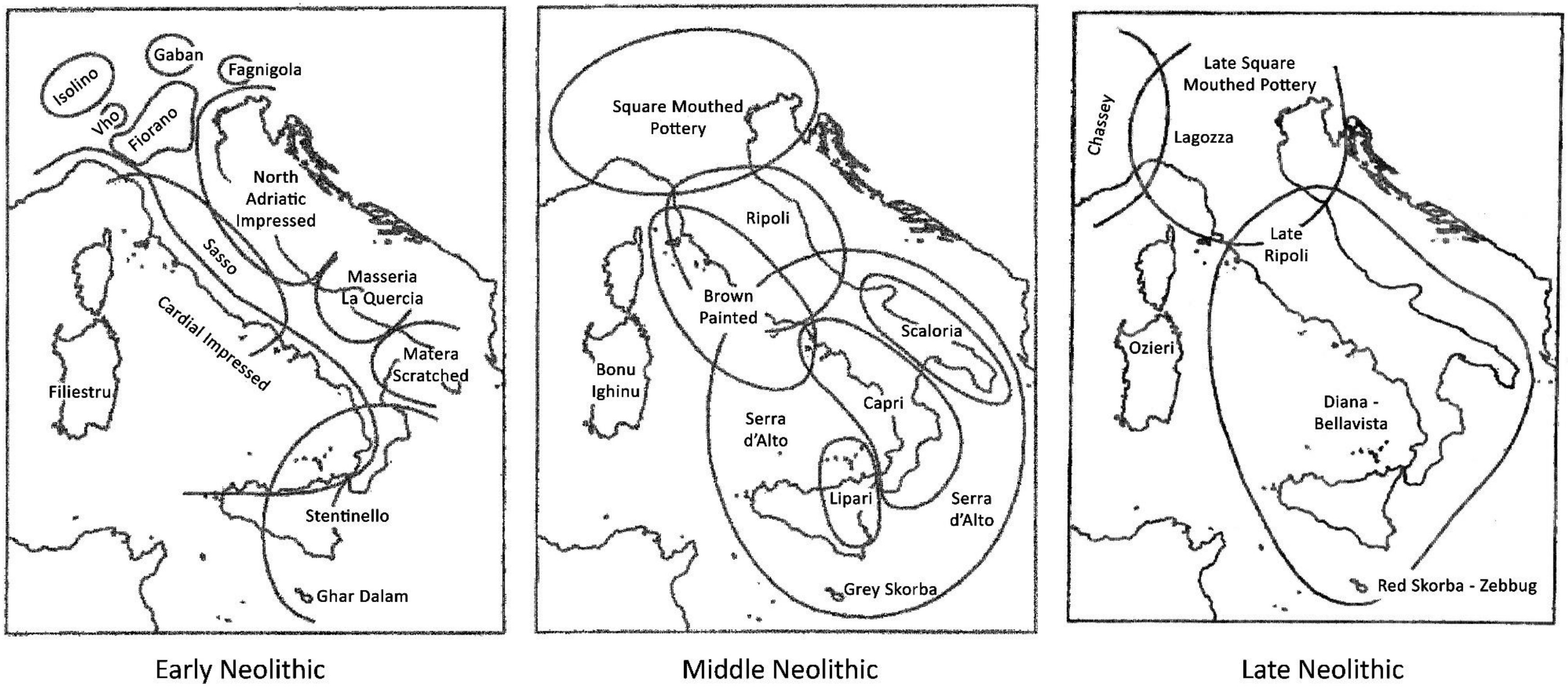


Figure 4.6. Chronology of Neolithic cultural traditions in Italy (Guidi and Piperno, 1993). Dashed lines indicate separation between sub-periods (Early, Middle, and Late Neolithic).



Early Neolithic

Middle Neolithic

Late Neolithic

Figure 4.7. Location of Neolithic ceramic cultures in Italy through time (Modified from: Malone, 2003)[22].

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The Neolithic period is usually divided into 'Early', 'Middle', and 'Late' phases, based typically on changing pottery styles (Figures 4.6 and 4.7). The dates for this periodization are diverse in the different main areas of Italy (see Figure 4.6), but they can be roughly summarized as follows:

- Early Neolithic: 5,800 to 5,000/4,100 BC.
- Middle Neolithic: 5,000/4,100 to 3,200 BC.
- Late Neolithic: 3,200 to 2,500 BC, overlapping in some cases with the Eneolithic/Copper Age period.

Due to the complexity of the Neolithic period, the evidence for settlement patterns, economy and subsistence, and material culture and social complexity will be discussed in turn in the following sub-sections.

4.2.c.i. Settlement

The preferred locations for Neolithic settlement were the coastal plains, river valleys, and basins, especially during the earlier Neolithic when sea levels were much lower than today. The riverine-lacustrine locations selected by Mesolithic hunter-gatherers were key to the transition to more permanent settlements, and many early Neolithic occupations took advantage of those areas and the access to different ecozones they provided. The earliest farming technology was still not developed enough for the exploitation of heavy or wet land, and therefore the light alluvial soils and loess were those ideal for primitive farming during the 7th-6th millennia BC (Jameson et al., 1994). These damp and wooden landscapes preferred by the earliest farmers were not particularly suited for extensive stock-keeping, and it is assumed that the crops were grown in garden patches around the settlements and complemented by the gathering of wild foods of the forests, as an insurance against crop failure and food shortage (Barker, 1999). By the late 6th-early 5th millennia BC, however, new technological developments allowed the expansion from lowlands to interfluves and high terraces, low hills and the protected inland tectonic lake basins and river valleys. Indeed, by the late 4th millennium BC, separate foraging sites are no longer found, and the evidence points to the gradual expansion of agricultural settlement all throughout the peninsula (Barker, 1985). The appearance of new Neolithic settlements does not imply that hunting and gathering practices were completely abandoned, as these activities continued especially in the rugged coasts and hillsides. Caves and rock shelters were used for temporary/seasonal habitation, burial and cult. Mineral resources, grazing, timber and arboreal products were also available in the uplands. Not all Neolithic sites coincide with previous Mesolithic occupations, as some new sites appear during this period in locations specifically chosen to take advantage of agricultural opportunities (Malone, 2003).

In terms of the settlements themselves, there seems to be a pattern of small residential units during the Early Neolithic, probably of one or two households rather than hamlets or villages. Indeed, typical Neolithic settlements of southern Italy were located on terraces and hillsides, in many cases without ditches or defence. Exceptions are sites with substantial ditched enclosures located in the Tavoliere plain and in the Bradano and Ofranto Valleys, in south-east Italy (Barker, 1985; 1999; 2006; Brown, 1991; Cassano and Manfredini, 1983; Delano Smith, 1987; Malone, 2003; Sargent, 1983). These sites are in areas of soils, hydrology, drainage, and local resources optimal for early agriculture. Many of these sites have numerous "C"-shaped ditched enclosures that may have acted as boundaries of individual units of domestic huts, pens, and storage facilities. The size of these ditched sites varied, with Passo di Corvo (Apulia) being one of the largest (Tinè, 1983). Estimates of population levels suggest relatively large communities for these sites. During the Late[';;;0pppppppppppppppppppppppppp ppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppp ppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppppp ppppppppppppp Neolithic, the ditched settlements and dense settlement areas of the Tavoliere, Materano, and south-east Sicily were abandoned – possibly due to land exhaustion, ground water, and salination – and new occupations expanded into interfluves, higher terraces, and a much wider landscape. In the rest of the peninsula, the Late Neolithic settlements were much larger than before, consisting of substantial hamlets of rectangular houses, in some cases within enclosed ditches, and exhibited features such as grain silos (Barker, 1999). Throughout this time, "Settlement appears to have expanded into interfluves, higher terraces, and a much wider landscape than in the earlier Neolithic, documented by extensive spreads of distinctive, durable pottery, and lithic material. Upland exploitation continued, and caves were occupied, perhaps by shepherds and hunting expeditions, and defensive site locations were sometimes used. In the lowlands, the impression is of a landscape packed with farms, hamlets, and small villages" (Malone, 2003: 256–257).

The Neolithic settlement of central Italy can be divided between the Adriatic east and the Tyrrhenian west. In the east, farming communities expanded northwards along the Adriatic coast; while the west was settled in what seemed to be random episodes from different directions. The Early and Middle Neolithic settlements in this area were mostly located above strategic rivers dominating lands suitable for agricultural activities. The uplands formed part of the seasonal settlement cycle of these agricultural communities, including settlements in the Apennine's internal lake basins. By the Late Neolithic, eastern central Italy exhibited large settlements, favouring larger and fortified locations. Unfortunately, not much information is currently available in this respect for the western side (Barker, 1981; 1985; 2006; Grifoni Cremonesi, 1993; Malone, 2003; Skeates, 1998). By the late 4th millennium BC, settlement in central Italy "expanded from ridge locations to the margins of alluvial valleys on the lowlands, and into the intermontane basins of the Apennines" (Barker, 1985: 67)

The Neolithic settlement of northern Italy is characterized from the beginning of the period by marked regional patterns and continuity from Mesolithic communities. Indeed, the preferred occupation areas were consistent with those of the previous period: caves from Liguria to Istria, open lakeside locations around the Po plain and lakes, mountain streams in the lower Alps and along the Adriatic coast (Bagolini, 1993; Malone, 2003).

4.2.c.ii. Economy and Subsistence

The economic intensification (i.e. broad-spectrum foraging, small mammal hunting, and emphasis on marine and lacustrine resources) and emerging social complexity that occurred during the Mesolithic period set the basis for the development of Neolithic economies. The earliest evidence for domesticated crops (cereals) comes from the Tavoliere (Apulia) and south-east Italy. Of these first crops to appear in the Early Neolithic archaeological record, barley (*Hordeum vulgare*) could have been the most important as it is a reliable crop for newly cleared land and salty coastal soils. Other main cereals were emmer wheat (*Triticum dicoccum*), einkorn (*Triticum monococcum*), spelt (*Triticum spelta*), and later on bread and durum wheat (*Triticum aestivum* and *Triticum durum* respectively). Legumes, such as lentil (*Lens culinaris*), and wild collected fruits (e.g. grape, *Vitis* sp., and olive, *Olea europaea*) were also valuable. By the Late Neolithic a greater variety of cultivated plants were in use (Bagolini, 1993; Cipolloni Sampò, 1993; Grifoni Cremonesi, 1993; Malone, 2003).

In terms of animal exploitation, the importance of hunting as the main method of animal product acquisition declined progressively as the first domesticated animals appeared in Italy during the Early Neolithic. Nonetheless, different sites had different methods of animal exploitation: in some, farming was the main economic activity, whereas in others hunting was still important and a mixed economy was taking place (Boyle, 2014a; Tagliacozzo, 1993b). Domesticated sheep (*Ovis aries*) and also goat (*Capra hircus*) dominate the Early Neolithic assemblages (Tagliacozzo, 1993b). These animals were certainly introduced, as their wild progenitors were not present in Italy at the time. The origins of domesticated cattle (*Bos taurus*), pig (*Sus domesticus*), and dog (*Canis familiaris*) are not so clear, as the wild ancestors of these species were native to the Italian peninsula and the possibility of a local domestication cannot be ignored. The exploitation of domestic cattle and pig are not as important as ovicaprids at the beginning of the Neolithic, but their importance increases nonetheless during the Middle and Late Neolithic, especially in the case of cattle (Rowley-Conwy et al., 2013; Tagliacozzo, 1993b). Pigs had a more important role in sites where there was available woodland cover (Tagliacozzo, 1993b). The dog shows signs of a long history of domestication from the Upper Palaeolithic (Galibert et al., 2011; Tagliacozzo, 1993b). The most common wild species present in the assemblages are fox and hare, but there is also presence of bear (Ursidae), wolf, badger, otter, wild boar, red deer, roe deer, and aurochs (Tagliacozzo, 1993b).

These mixed farming practices are especially evidenced in southern Italian sites. In central Italy, these practices became dominant during the Middle to Late Neolithic (5th-4th millennia BC), in conjunction with an increase of cattle and pig, sometimes even outnumbering ovicaprids. In central-western side of the peninsula, typical Neolithic communities combined the exploitation of wild and domestic animals, and upland herding either supplemented or dominated the traditional hunting of deer, wild boar, and other game (Barker, 1981; 1985; 1999; Tagliacozzo, 1993b). Other sites were more specialized in the exploitation of a specific animal, such Mulino Sant'Antonio (Campania) for pig (Albarella, 1987). In some Late Neolithic sites, mixed agriculture complemented the herded and hunted animal stock, an economic trend that continued into the Bronze Age in the Apennines (Malone, 2003).

In the case of Northern Italy, the impact of agriculture was more gradual than in the south and central parts of the country. The Mesolithic practices of hunting and gathering persisted in this part of the peninsula during the Early and Middle Neolithic, though the exploitation of local resources such as deer, wild boar, badger, small mammals, fish, molluscs, and birds, with low percentages of domesticates (Barker, 1985; Malone, 2003; Tagliacozzo, 1993b). This situation can be seen, for example, in the site of Molino Casarotto, in Veneto (Boyle, 2014a,b). The domesticated plants and animals gained an increasing relevance as the period progresses, especially in the case of ovicaprids. By the later 5th-4th millennia BC, the significant increase of polished axes in the archaeological record signified woodland clearance and the development of extensive pastures and fields. By this time, hunting and gathering was replaced in many cases by a mixed economy of agriculture and pastoralism (Malone, 2003).

As the Neolithic progressed in the north, settlement expanded into more marginal areas, showing extensive food procurement, and lakeside and riverside lowland locations were more intensively used. By the 4th millennium BC, mixed cereal and stock farming was strongly established, with emmer and barley the main crops and sheep/goat and cattle the primary domestic animals exploited (Barker, 1985). However, the economy of northern Italy was much more mixed than in the south and centre, with no species representing more than about 40% of the total bone fragments by the later Neolithic (Castelletti et al., 1987).

4.2.c.iii. Material Culture and Social Organization

The earliest pottery to be found in archaeological assemblages from Italy is the Cardial Impressed ware during the 8th-7th millennia BC in the southern and western regions of the peninsula, Sicily, Corsica and Liguria (Lewthwaite, 1981; 1986; Skeates and Whitehouse, 1997; Whitehouse, 1987). Rare sherds of impressed/incised pottery have been found in some Mesolithic contexts, but without any additional evidence of Neolithic production. Soon after the appearance of impressed pottery, painted pottery rapidly expanded in southern Italy and Sicily. During the Early Neolithic, pottery spread gradually from the south to central and northern Italy. The ceramic traditions of the Middle and Late Neolithic periods consist of an "increasingly homogeneous cultural mosaic typified by painted and decorated finewares" (Malone, 2003: 273). During the 4th millennium BC, in the later and final Neolithic, three distinct areas of pottery styles can be identified in Italy: Diana in the south, Ripoli in the centre, and Lagozza in the north (Bagolini, 1993; Cipolloni Sampò, 1993; Grifoni Cremonesi, 1993). During the latest Neolithic, these cultures become gradually more regionalized, signifying the beginning of the Eneolithic/Copper Age period (Cardarelli, 1993; Guidi, 1993; Malone, 2003; Pellegrini, 1993). Figures 4.6 and 4.7 show the development of these ceramic traditions through time in the different Italian areas.

Regarding the lithic industries, Mesolithic traditions continued onto the Neolithic, coexisting with new techniques introduced during this latter period. The development of ground stone technology, with utilitarian clearing axes and grindstones, is characteristic of the Neolithic. The increased production of these items during the later Neolithic and Eneolithic/Copper Age (later 4th-early 3rd millennia BC) signified more woodland clearance and agriculture (Barker, 1999; 2006). The case of obsidian is interesting during this period, as it indicates intensive trade networks (Ammerman and Polglase, 1993; Barfield, 1987; 1990; Barker, 1999; Leighton and Dixon, 1992; Malone, 1985; Tykot, 1996). Indeed, although the earliest movement of this material dates probably from the 8th-7th millennia BC, "frequent obsidian distribution began in the Cardial/Impressed ware Neolithic, evidenced at Arene Candide in Liguria, and at early sites throughout southern Italy, dating from sixth-fifth millennia BC By the later-mid-Neolithic, the traffic in obsidian from all the west Mediterranean sources became intense, with a peak in the late Neolithic of the late fourth millennium" (Malone, 2003: 286). Other items exchanged over large distances during the Neolithic were *Spondylus* shells, pigments, fine pottery, and raw material for primitive metallurgy. Regarding the latter, it is interesting to note that there is evidence for early experimental metallurgy in Italy from the later 4th millennium BC (Barker, 1999; Malone, 2003).

In terms of artistic production and its links with ritual practices, many caves since the Epipalaeolithic period evidence artistic products such as cave art, painted pebbles, and spreads of ochre; especially in relation to burials, circles of stones, and other potentially symbolic features. These traditions continued through the Neolithic period. The first evidence of monumental sites appeared during the Late Neolithic, particularly on islands (Malone, 2003). As settlement during the Neolithic expanded into open locations, caves became increasingly linked to burial and ritual practices. Cave burials were already recorded for the Mesolithic in Italy, and this practice continued onto the early Bronze Age. During the Early Neolithic, burials appeared less formal than during the previous period, with bodies being disposed of in living areas and simple cemeteries. The Middle Neolithic saw the emergence of discrete cemeteries, sometimes with many individuals and an emphasis on the individual itself, the grave structure and grave goods. These cemeteries set the trend for more formalized areas of burial in the Late Neolithic. Rituals taking place in these caves probably played an important role in maintaining social cohesion, especially during the Early Neolithic (Barker, 1999; Malone, 2003; Pluciennik, 1994; Skeates, 1991; 1994b; 1997b; Whitehouse, 1990; 1992).

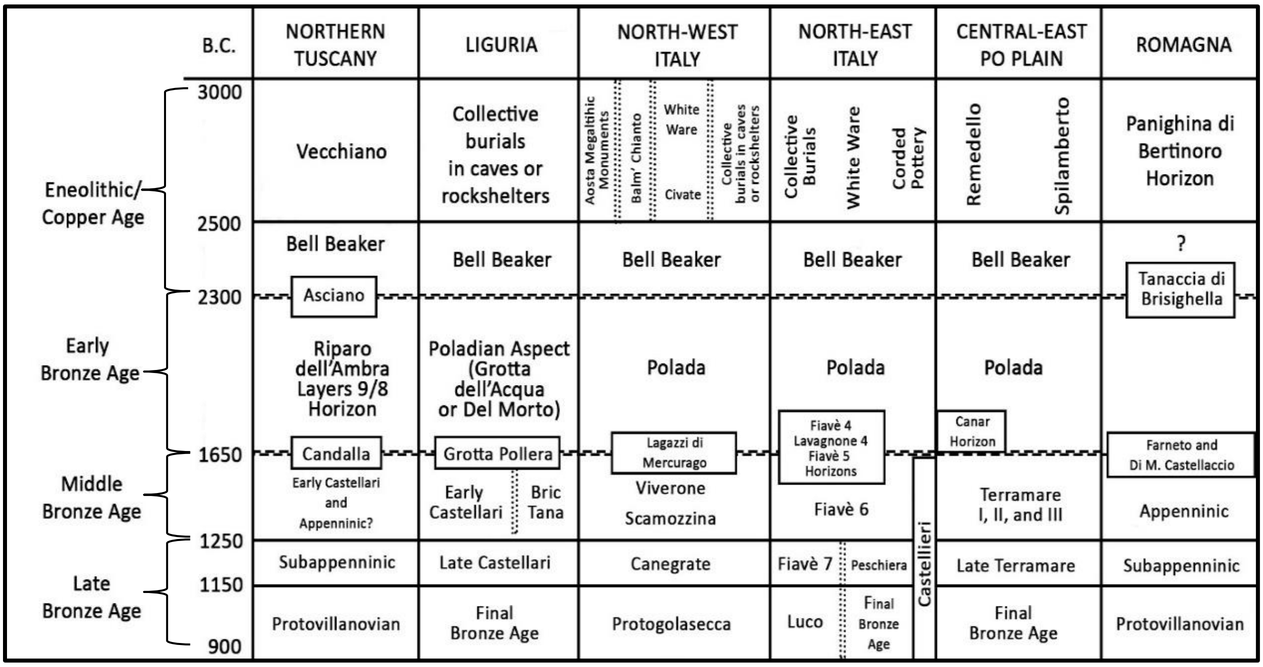
The Neolithic funerary and settlement evidence give the impression of small-medium-scale social groups during this time. During the Early Neolithic, the evidence points to tribal societies without marked ranking. The scale of the cemeteries is consistent with self-sufficient tribal societies and indicate an egalitarian status of the individuals with limited grave goods and paired burials. For the later Neolithic, the evidence points at increasingly complex societies, with social competition, especially amongst males. This process of increasing complexity will continue on in the following Epipalaeolithic and Bronze Age periods, with hierarchical settlements and much more evidence of accumulated wealth (Barker, 1999; Malone, 2003).

4.2.d. Eneolithic/Copper Age (3,000 to 2,300 BC)

The Eneolithic/Copper Age period in Italy can be chronologically placed between 3,000 and 2.300 years BC (Skeates, 1996). It is worth noting that during the 3rd millennium BC in this area of the Mediterranean, there is evidence of climatic instability, particularly a trend towards increased aridity, which might have contributed to the social changes evidenced during this period (Barker, 1999). As mentioned previously, the earliest copper objects in Italy date from around the late 4th millennium BC However, the widespread use of this metal, and the concomitant knowledge of its production, only occurred through the later Neolithic exchange systems. The exploitation of mines and quarries during the early Eneolithic/Copper Age was accompanied by an increasing occupation of mountain landscapes (Barker, 1999). In northern Italy, the highland settlements were located on defensive strategic points on the landscape. These sites seemed to continue a tradition started during the Neolithic, possibly linked to an increasing control over the contact routes through the mountain valleys and over the resources of those areas (Cardarelli, 1993). Meanwhile, in the lowland areas of Italy the evidence points to an expansion and intensification of agricultural practices; including woodland clearance, the use of drier and less fertile soils for cultivation, the use of a wider range of crops, and an increased importance in animal secondary products (Barker, 1999; Hunt & Eisner, 1991; Skeates, 1997).

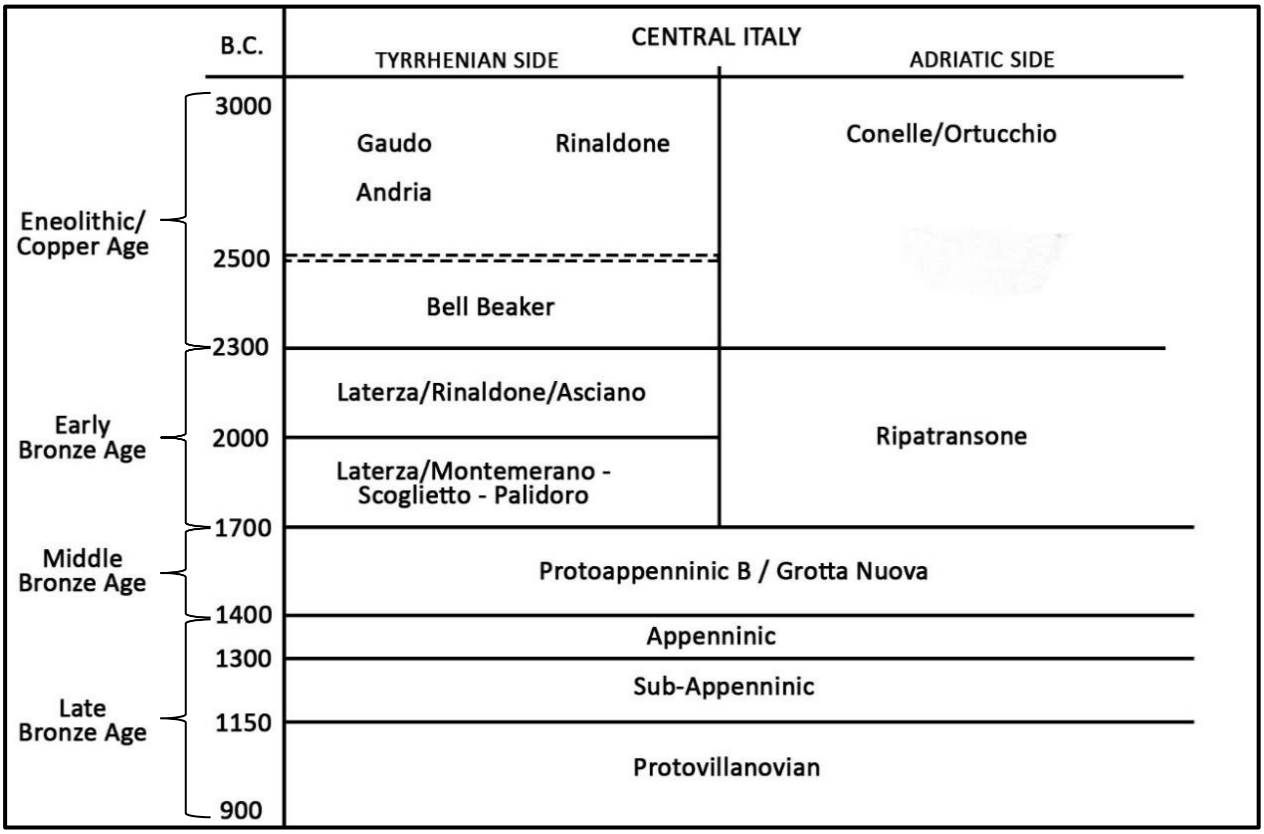
Besides a mainly cereal agriculture, the rearing of domestic animals became quite important, especially of cattle and ovicaprids, and secondarily of suids. The horse (*Equus caballus*) appears in the archaeological record during this period (Tagliacozzo, 1993b). The predominance of cattle and sheep/goat coincided with the seasonal use of mountain pastures. The movement of people in relation to these pastoral activities was of key importance during this period, having possibly contributed to an intensification of trade and exchange (Cardarelli, 1993). However, in terms of long-distance trade, there seems to have been a decline in this period in comparison with the later Neolithic (Barker, 1999; Skeates, 1992). Finally, the inhumations, grave goods, and mobiliary art of Italian Eneolithic/Copper Age societies indicate an increasing social inequality, with the emergence of a high status warrior caste (Barker, 1999). Barker interprets these changes as “the beginning of distinct social hierarchies at the regional scale, in which rival lineages and clans competed to control access to resources at the expense of their neighbours, and mobilized production in support of their needs for materials for consumption and exchange” (1999: 16).

In terms of material culture, different traditions developed throughout the peninsula during this time (Tables 4.4 to 4.6). In the north of the peninsula, two main areas can be identified: one on the western and Alpine regions, associated with collective burials and different pottery traditions, such as Vecchiano; and another one on the central-east Po plain (eastern Lombardy, Veneto, and Emilia) characterized by individual burials and pottery traditions such as Remedello and Spilamberto (Table 4.4) (Cardarelli, 1993). In the centre, the Tyrrhenian and Adriatic side show different developments, with the former exhibiting pottery of Gaudo and Rinaldone type, while the latter saw the presence of the Conelle and Ortucchio styles (Table 4.5) (Guidi, 1993). The south of the peninsula was characterised by the Piano Conte tradition (Apulia and Calabria), followed by Gaudo (Campania) in the Tyrrhenian side, and Andria-Gioia del Colle (Apulia) in the Adriatic. In Sicily, the Conca d'Oro cultural phase was present in the west, while the east saw a variety of cultural traditions (Table 4.6) (Pellegrini, 1993). On a later moment of the Eneolithic period, the Bell Beaker style makes its appearance in a large part of the Italian peninsula, reaching most of the north, the Tyrrhenian side in the centre, and Sicily associated with the Moarda style (Tables 4.4 to 4.6) (Cardarelli, 1993; Guidi, 1993; Pellegrini, 1993). This cultural tradition, widely distributed through Europe during this time, was likely connected to the flow of people and ideas around Europe, possibly through marriage alliances (Brodie, 1997; Price et al., 1998; 2004; Vander Linden, 2007). The Bell Beaker phenomenon was scarcely represented in the south of the peninsula, however, where the Laterza tradition was widespread (Table 4.6) (Pellegrini, 1993).



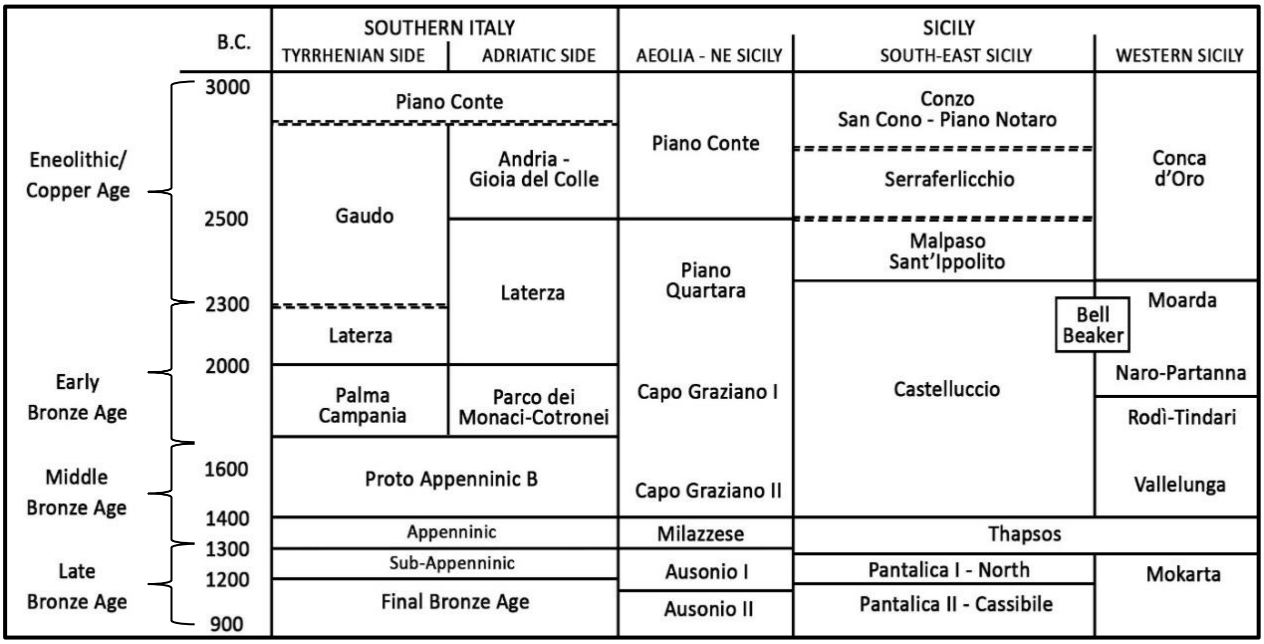
	B.C.	NORTHERN TUSCANY	LIGURIA	NORTH-WEST ITALY	NORTH-EAST ITALY	CENTRAL-EAST PO PLAIN	ROMAGNA
Eneolithic/ Copper Age	3000	Vecchiano	Collective burials in caves or rockshelters	Aosta Megalithic Monuments Balm' Chianto White Ware Civate Collective burials in caves or rockshelters	Collective Burials White Ware Corded Pottery	Remedello Spilamberto	Panighina di Bertinoro Horizon
	2500	Bell Beaker	Bell Beaker	Bell Beaker	Bell Beaker	Bell Beaker	?
	2300	Asciano					Tanaccia di Brisighella
Early Bronze Age		Riparo dell'Ambra Layers 9/8 Horizon	Poladian Aspect (Grotta dell'Acqua or Del Morto)	Polada	Polada	Polada	
	1650	Candalla	Grotta Pollera	Lagazzi di Mercurago	Fiavè 4 Lavagnone 4 Fiavè 5 Horizons	Canar Horizon	Farneto and Di M. Castellaccio
Middle Bronze Age		Early Castellari and Appenninic?	Early Castellari Bric Tana	Viverone Scamozzina	Fiavè 6 Castellieri	Terramare I, II, and III	Appenninic
Late Bronze Age	1250	Subappenninic	Late Castellari	Canegrate	Fiavè 7 Peschiera	Late Terramare	Subappenninic
	1150	Protovillanovian	Final Bronze Age	Protogolasecca	Luco Final Bronze Age	Final Bronze Age	Protovillanovian
	900						

Table 4.4. Eneolithic/Copper and Bronze Age cultural traditions of Northern Italy (Modified from: Guidi and Piperno, 1993).



	B.C.	CENTRAL ITALY TYRRHENIAN SIDE	 ADRIATIC SIDE
Eneolithic/ Copper Age	3000	Gaudo Rinaldone Andria	Conelle/Ortucchio
	2500	Bell Beaker	
Early Bronze Age	2300	Laterza/Rinaldone/Asciano	Ripatransone
	2000	Laterza/Montemerano - Scoglietto - Palidoro	
Middle Bronze Age	1700	Protoappenninic B / Grotta Nuova	
Late Bronze Age	1400	Appenninic	
	1300	Sub-Appenninic	
	1150	Protovillanovian	
	900		

Table 4.5. Eneolithic/Copper and Bronze Age cultural traditions of Central Italy (Modified from: Guidi and Piperno, 1993).



	B.C.	SOUTHERN ITALY TYRRHENIAN SIDE	 ADRIATIC SIDE	 AEOLIA - NE SICILY	SICILY SOUTH-EAST SICILY	 WESTERN SICILY
Eneolithic/ Copper Age	3000	Piano Conte		Piano Conte	Conzo San Cono - Piano Notaro	Conca d'Oro
		Gaudo	Andria - Gioia del Colle		Serraferlicchio	
	2500		Laterza	Piano Quartara	Malpaso Sant'Ippolito	
	2300	Laterza			Castelluccio Bell Beaker	Moarda
Early Bronze Age	2000	Palma Campania	Parco dei Monaci-Cotronei	Capo Graziano I		Naro-Partanna
						Rodì-Tindari
Middle Bronze Age	1600	Proto Appenninic B		Capo Graziano II		Vallelunga
	1400	Appenninic		Milazzese	Thapsos	
Late Bronze Age	1300	Sub-Appenninic		Ausonio I	Pantalica I - North	Mokarta
	1200	Final Bronze Age		Ausonio II	Pantalica II - Cassibile	
	900					

Table 4.6. Eneolithic/Copper and Bronze Age cultural traditions of Southern Italy and Sicily (Modified from: Guidi and Piperno, 1993)[23].

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[23] Tables 4.4-4.6: Copyright (1993) Gius. Laterza & Figli S.p.a. Reproduced with permission.

4.2.e. Bronze Age (2,300 to 900 BC)

The following period in Italy, the Bronze Age, can be roughly sub-divided as follows (Barfield, 1994; Barker and Stoddart, 1994; Cardarelli, 1993; Guidi, 1993; Pellegrini, 1993):

- Early Bronze Age: 2,300 to 1,600 years BC.
- Middle Bronze Age: 1,600 to 1,300 years BC.
- Late Bronze Age: 1,300 to 1,150 years BC.
- Final Bronze Age: 1,150 to 900 years BC.

Due to the complexity of the archaeological evidence available, the same organizational scheme put forward for the Neolithic period will be used: settlement patterns, economy and subsistence, and material culture and social organization.

4.2.e.i. Settlement

A key development introduced during the Eneolithic/Copper Age throughout Italy, but that became widespread during the Early Bronze Age, was the plough (Cardarelli, 1993; Guidi, 1993; Pellegrini, 1993). This technological advancement allowed the occupation of territories with agricultural soils previously unsuitable for cultivation and for more stable occupations (Cardarelli, 1993; Guidi, 1993). In terms of the settlement themselves, in Northern Italy during the Early Bronze Age, some sites, especially those in the mountains, exhibited a continuous occupation between the Eneolithic/Copper Age and this period. The sites located on fluvial plains in this area of the peninsula were rare, but instead a series of pile dwellings located in lake areas or wetlands became abundant, for example in the site of Fiavè (Veneto). These villages were from around half a hectare to three to four hectares in size, and they demonstrate a clear interest of these populations to have a consistent water supply (Cardarelli, 1993). During the later Early Bronze Age and Middle Bronze Age, in a period of demographic increase (Cavazzuti et al., 2019; Palmisano et al., 2017; 2018), the Po plain, previously scarcely or not at all populated, started being densely settled in what is known as the first substantial anthropic modification of this landscape (the 'Terramare' settlements). These new settlements signified the possibility of these populations to now exploit the clay soils of this area, made possible by the introduction of the plough and animal traction (Cardarelli, 1993). During the Late and Final Bronze Age (12th century BC), however, the pile dwellings and 'Terramare' settlements ceased to exist. An explanation put forward for this major change in the population landscape of the area is a climatic deterioration during that time, but it could also have been a result of social and political instabilities. Sites in high altitudes, though, seemed to continue until at least the first stages of the Final Bronze Age (Cardarelli, 1993).

In the case of Central Italy, there was a frequent continuation of occupation from the Copper Age to the Early Bronze Age, with sites located near fluvial valleys with areas rich in metals. By the beginning of the Middle Bronze Age, the soil fertility of wetland areas became a key element of settlement choice at a time of climatic aridity, and all these zones became occupied. At the same time, highlands sites also increased in number. It seems that during this period the concept of territory relative to specific centres became established as an integrated system of settlement, in relation to the necessity to exploit different ecological areas and to a population increase (Guidi, 1993). This scenario changed substantially in the final part of the Middle Bronze Age, in correlation with a general increase in the number of highland sites, possibly related to these places acting as refuge from danger and/or shelter for herded animals. The preferred locations for settlements during this period were the river plains on the Tyrrhenian side, on river confluences, and on the coastal promontories on the Adriatic side. These choices, and the concomitant increase of the occupied surface, marked the beginning of the gradual process of selection and concentration of settlements that characterizes the Late Bronze Age (Guidi, 1993). The situation was different on inland central Italy, as here the cooperation between single communities was the norm. During the 12th century BC, there was a rise in importance of the agricultural economy, metallurgy, and trade. This translated into an increase of settlements located close to metal deposits and sites in coastal areas. During this time, sites occupied a larger area and there was a tendency to more rigid site hierarchies, likely linked to rising elites (Guidi, 1993).

In general terms, in peninsular Southern Italy during the Early Bronze Age and the previous Copper Age, the settlements were sparse over the territory, of low density, and presumably of short duration. The use of caves, already common during the Neolithic, continued into the Bronze Age (Pellegrini, 1993). With the beginning of the Middle Bronze Age, alongside an increase in the number of sites, some settlements were positioned based on the agricultural potential of the land and control over communication routes (Pellegrini, 1993). During the Final Bronze Age, in some centres, especially in Apulia and Basilicata, destruction events took place. In some cases, the sites were abandoned after those events, whilst others were reconstructed. Additionally, new settlements appeared. Some sites that were already active in previous periods, such as Coppa Nevigata (Apulia), continued to be occupied. In Calabria, there was a quantitative diminution of sites, and at the same time, an increase in extension of those remaining (Pellegrini, 1993). Finally, in the case of Sicily during the Early Bronze Age, the settlements – small villages – were spread out based on the agricultural potential of the land but also on the control of communication routes, both internal and maritime. During the Middle to Late Bronze Age, there was an apparent numeric reduction of settlements, which might be linked to changes in territory planning (Pellegrini, 1993).

4.2.e.ii. Economy and Subsistence

The archaeobotanical evidence for Northern Italy points to a mixed agriculture during the Bronze Age. Also in this part of the peninsula, during the Middle Bronze Age, there is evidence near pile settlements of relevant deforestations and of an increase of cultivated species. There is as well evidence of the diffusion of haymaking. Fruit and vegetable gathering, and hunting, however, had a much lesser role in the economy during this period (Cardarelli, 1993). In Central Italy, there was a broad spectrum of economic activities taking place since the Copper Age, pastoral activities and animal rearing being of key importance. During the Middle Bronze Age in this region, the predominant subsistence was based on the integration of agricultural and pastoral activities. There was also a broad diffusion of seasonal transhumance (Guidi, 1993). In the case of Southern Italy, for most of the Copper and Bronze Age, the main activity was a subsistence economy, without imports or exports. The move from the Neolithic to the metal ages does not seem to have involved profound changes in agricultural practices, apart from their development and strengthening with the introduction of the plough. From the Copper Age, there is evidence of the exploitation of a larger variety of resources, including animal secondary products, linked probably to the deterioration of the soil due to its agricultural overexploitation. The greater interest for hillside areas, with their woodlands, could also be connected to this fact, as they were useful for pig rearing, for example (Pellegrini, 1993).

Throughout the peninsula, animal husbandry took a specialized form. Cattle, sheep/goat, and pigs were the main sources of protein, and there was a progressive diversification of domestic animals' regional types (Tagliacozzo, 1993b). There seems to be a substantial size decrease of the main domestic stock from the Neolithic to the Iron Age (De Grossi Mazzorin, 1988). Cattle exhibited a size decrease and shape changes in the Middle Bronze Age (Cardarelli, 1993). Ovicaprids were also small-sized animals, smaller than the central European ones (Cardarelli, 1993). Both cattle and sheep/goat were used also for secondary products such as milk, wool (ovicaprids), and traction (cattle) (Cardarelli, 1993; Guidi, 1993; Pellegrini, 1993); all evidenced by the fact that these animals were mainly butchered as adults (Tagliacozzo, 1993b). Pigs, on the other hand, were killed young (Tagliacozzo, 1993b), as it is usually the case for animals exploited almost exclusively for their meat. The horse, already introduced during the Eneolithic/Copper Age, became more frequent during the Middle Bronze Age (Cardarelli, 1993; Tagliacozzo, 1993b). These animals seem to have been used for transport and warfare, and they might also have been symbols of status. The use of this animal, in conjunction with the introduction of the radiated wheel, denotes an increase in the movement capabilities of these populations (Cardarelli, 1993). The donkey (*Equus asinus*) saw its appearance in the archaeological record during the Late and Final Bronze Age (Tagliacozzo, 1993b). In terms of hunting, even though marginal during this period, it was mostly directed towards red deer, roe deer, and wild boar (Cardarelli, 1993).

In northern Italy, cattle were already well distinct morphologically from aurochs in the Eneolithic/Copper Age period, albeit still of rather large size. From the Bronze Age, regional differences can be observed in this animal for this area of the Italian peninsula, particularly evident in the size and shape of the horncores. A general progressive size reduction can be observed in cattle throughout this period. The sheep and the goat, in northern Italy, were of small size during the Neolithic and Bronze Age, with the goat generally larger than the sheep (Tagliacozzo, 1993b). Bronze Age domestic pigs can be differentiated from the wild boar mainly by their smaller size. Pig size during this period was conditioned mostly by the ecological context and the possibility of interbreeding with wild boar (Tagliacozzo, 1993b). Horse remains were rare and dogs exhibited larger sizes and greater variability during the Bronze Age than the Neolithic (Tagliacozzo, 1993b).

Regarding central and southern Italy, sheep and goats were of small size, and there is evidence for a size reduction in cattle, albeit without regional diversification. The exploitation of sheep and goat was focused on the production of milk and wool, whereas cattle were used mainly for traction and transportation, as is shown by the fact that they were butchered when adult or elderly. Pigs show a greater variability – likely due to the possibility of inter-breeding with wild boar – and were generally killed at a young age. The horse was more common during the Middle Bronze Age and became widespread during the Late and Final Bronze Age. The dog exhibited a gradual size increase from the Early Bronze Age to the Iron Age (Tagliacozzo, 1993b). Pastoral activities seem to have been practiced by groups within villages operating a mixed economy, and not by true fully pastoral communities (Tagliacozzo, 1993b).

4.2.e.iii. Material Culture and Social Organization

The Bronze Age period in Italy saw the spread of different cultural traditions throughout the country, after the Bell Beaker phenomenon that characterised the last stages of the Eneolithic/Copper Age (Tables 4.4 to 4.6). In most of northern Italy, the Early Bronze Age is associated with the Polada cultural tradition, while the Middle Bronze Age was characterized by a variety of cultures in the different regions, with the development of the Terramare culture in the Po plain. Finally, the Late Bronze Age in the north saw the decline and disappearance of the Terramare settlements, alongside the development of cultural traditions during the Final Bronze Age that anticipated the upcoming Iron Age (Table 4.4) (Cardarelli, 1993). The centre of the peninsula saw during the Early Bronze Age, the development of different trajectories for the Tyrrhenian and Adriatic side, with the former evidencing cultural sequences related to the Laterza tradition, and the latter the development of the Ripatransone culture. The Middle Bronze Age in the centre witnessed the presence first of the Protoappenninic B and Grotta Nuova, followed by the more uniform traditions of the Appenninic and Sub-

Appenninic. The Late Bronze Age was characterized by the Protovillanovian culture (Table 4.5) (Guidi, 1993). Lastly, the south of the peninsula and Sicily during the Early Bronze Age, has evidence of several cultural traditions, including the Laterza in the peninsula. The Middle to Late Bronze Age in the south of the peninsula saw the development of the Protoappenninic B, Appenninic, and Sub-Appenninic cultures, same as in the centre. In Sicily, the Thapsos culture was developed during the Middle Bronze Age, representing a phase of intense contacts with the Aegean, while the Late Bronze Age represented the period of maximum contact with the Mycenaean culture (Table 4.6) (Pellegrini, 1993).

With regards to metallurgy, during the Early Bronze Age, semi-specialized and specialized craftsmen made an appearance, especially metalworkers. By the Final Bronze Age, there was a great development of metallurgical production, with a progressive shaping of regional traditions (Cardarelli, 1993).

Regarding social organization during the Bronze Age, the evidence from the statue menhirs and carved stones from northern Italy indicates a ranked society on which the control of production and means of production was done through religious mediation and, at least partly, by the warrior class. During the Final Bronze Age, in the same area, the existence of certain high-status individuals, male and female, is evidenced in various necropolis. The society of the Final Bronze Age appears characterized by a greater incidence of trade and craftsmanship rather than by a major change in the social structure (Cardarelli, 1993). In central Italy, the Early Bronze Age was characterized by tribal communities of patriarchal organization, with stable social differentiation evident in burials. During the Middle to Final Bronze Age, the federative model of perilacustrine settlements is opposed to the integrated settlement system based on intensive agriculture and seasonal transhumance (Guidi, 1993). In Sicily, there is evidence during the later Middle Bronze Age, of an elite linked to the Aegean world and based on the control of the economic activities (Pellegrini, 1993).

Chapter 5

METHODOLOGY

5.1. Recording Protocol and Identification

The anatomical and taxonomical identification was done with the help of Schmid's anatomical atlas (1972), reference collections (where available), and my previous knowledge of pig osteology acquired during my studies (Licentiate and MSc degrees) and my professional experience. The recording protocol used follows a diagnostic zone approach as proposed by Davis (1992) and Albarella and Davis (1994), but modified to suit the research questions of this particular project.

Naturally, only *Sus* bones were recorded. The criterion in the selection of recordable skeletal parts is that they were able to provide ageing and/or biometrical information. The following parts of the skeleton were recorded when more than half of the specified area was present:

- Upper and lower teeth occlusal surface of deciduous 4th premolar (dP4), permanent 4th premolar (P4), 1st molar (M1), 2nd molar (M2), and 3rd molar (M3)
- Upper and lower canines (if complete section present), and alveoli
- Atlas
- Scapula glenoid cavity (if coracoid process present)
- Humerus distal
- Humerus proximal head
- Radius distal
- Radius proximal
- Ulna proximal articulation
- Complete III and IV metacarpals (MC III and MC IV)
- Pelvis (acetabulum from ischium and only if fusion data available or measurement possible)
- Femur distal
- Femur proximal head
- Tibia distal
- Tibia proximal

- Astragalus (lateral half)
- Calcaneum (only if it is possible to measure)
- Complete III and IV metatarsals (MT III and MT IV)
- Phalanges 1 and 2 proximal (only from central digits)

For proximal and distal long bone ends is meant either the epiphysis or the unfused metaphysis, except when specified. Regarding teeth, if a jaw had teeth on both the left and right side, as many different teeth as possible were recorded as they were on just one side, then the situation is explained in comments. For example, a jaw that had P4, M1 and M2 on the left side and P4 on the right side will be recorded as 'left' with P4, M1 and M2. If a deciduous tooth and the permanent tooth placed beneath were both present and visible, only the deciduous tooth is recorded, and a mention of the situation will be made in comments.

Modifications on the surface of the bones, such as thermo-alteration, butchery and gnawing marks, and pathologies, were noted when observed. In the case of teeth, the presence of linear enamel hypoplasia was recorded when one or more lines were observed. "Non-countable" elements are those which were not used for any quantitative analysis and include bone specimens which are not included in the list of regularly recorded teeth and postcranial bones but were worth recording for any specific reason (e.g. anomalous size or pathologies).

Additionally, the NISP or Minimum Number of Identified specimens was calculated to systematise the pig data, following Lyman (1994; 2008). The quantifications were done taking each chronological period within a site as a unit. The NISP was obtained by tallying the number of specimens which were recorded following the recording protocol described above.

5.2. Ageing and Sexing

In order to determine age at death, the fusion states of the bones and the eruption and wear stages of teeth were recorded. For long bones, the fusion of the epiphyses was recorded for both proximal and distal ends. These were recorded as 'fused' when the diaphysis and epiphysis were completely joined, as 'fusing' when a fusing line was still visible between epiphysis and diaphysis, and as 'unfused' when both areas of the bone were completely separated due to young age (Albarella and Payne, 2005; Bull and Payne, 1982). For other postcranial bones, such as atlas, pelvis, and scapula, the same categories were used but refer to the fusion state of their respective fusion centres. For the astragalus, which does not provide fusion data, it was observed whether the bone was porous and/or light, as in young individuals, versus the denser structure of adult astragali. For the interpretation of fusion stages, Silver (1969) was followed[24]. Table 5.1 shows how the age stages are defined according to this system, detailing the postcranial bones and ossification centres that make up each category. Neonatal bones, identified on the basis of their small size and porosity, were not included in this analysis and were counted separately.

Eruption stages for teeth in jaws were recorded as 'in crypt', 'visible', 'erupting', 'half-erupted', and 'unworn', following Ewbank et al. (1964). For erupted teeth and loose teeth, wear was recorded following both Grant (1982) and Wright et al. (2014). To reconstruct age at death from teeth in jaws, the systems provided by O'Connor (1988) and Wright et al. (2014) were used for jaws with at least two teeth present or an unworn deciduous 4th premolar.

Due to the high sexually dimorphic canine teeth of pigs, sex was recorded for upper and lower canine teeth and their alveoli in jaws. Pig male canines are larger and morphologically distinct from those of females (Mayer and Brisbin Jr, 1988), and the distinction between the two can be made macroscopically. This identification was only possible if the teeth were loose and with a complete section preserved, when they were in the jaws and sufficiently developed/erupted, or when there was a complete alveolus without tooth present in the jaw.

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[24] A more recent system by Zeder et al. (2015) was considered, but the small sample sizes involved in this study were not suited for the level of detail required.

BONE	OSSIFICATION CENTRE	SILVER (1969)	
		FUSION STAGE	AGE
Atlas	Body and Arch	Early	3-6 months
Pelvis	Acetabulum		1 year
Scapula	Bicipital tuberosity		
Radius	Proximal epiphysis		
2nd Phalanx	Proximal epiphysis		
Humerus	Distal epiphysis		
1st Phalanx	Proximal epiphysis	Intermediate	2 years
Tibia	Distal epiphysis		
Metacarpal	Distal epiphysis		
Metatarsal	Distal epiphysis		2.25 years
Calcaneum	Tuber calcis		2-2.5 years
Femur	Head	Late	3.5 years
Radius	Distal epiphysis		
Femur	Distal epiphysis		
Tibia	Proximal epiphysis		
Humerus	Head		
Ulna	Olecranon		3-3.5 years

Table 5.1. Silver (1969) postcranial fusion age categories.

5.3. Biometry

Measurements were taken with digital callipers or a measuring board on epiphysis (fused or unfused), complete fused long bones, other postcranial bones (not long bones), and teeth. On teeth, measurements were taken only when there was enough enamel preserved to be able to do so. For a full description of how measurements were taken see the cited bibliography (Albarella and Davis, 1994; Albarella and Payne, 2005; Davis, 1992; Payne and Bull, 1988; Von den Driesch, 1976). All measurements were taken in millimetres with one decimal point (i.e. approximated to the tenth of millimetre), apart from those taken in a measuring box, which were approximated to the millimetre. The measurements taken are listed in Table 5.2, following recommendations by von den Driesch (1976), Payne and Bull (1988), and Albarella and Payne (2005).

In order to reduce issues resulting from inter-observer reliability, a thorough practice was conducted between the author and Umberto Albarella, a zooarchaeologist with years of experience in biometrical research, before the studies of the assemblages commenced. This practice was meant to achieve consistency between the measurements taken by the author of this research and the extensive data contributed by U. Albarella. When data collected by other authors was included in the analyses, care was taken to ensure that the same biometrical protocols were followed. Although in these cases a certain degree of inter-observer variability can be expected, it is not considered to have had a major impact in the results due to the detail of the biometrical protocols used in all cases. Regarding intra-observer reliability, care has been taken by this author to be consistent in all measuring events, including using the same set of callipers at all times.

Due to the natural variability within pig populations, some measurements are better than others for different purposes (Albarella and Payne, 2005; Payne and Bull, 1988; Rowley-Conwy et al., 2012). Some postcranial measurements can be very age-dependent and subject to substantial post-fusion growth (Payne and Bull 1988). Shaft measurements, as well as that of the scapula neck are particularly affected by this issue, but some articular ends, such as scapula GLP and radius BpP, can also carry on growing post-fusion. Humerus distal width (Bd) increase after epiphyseal fusion has also been recorded, and the astragalus can also continue to grow as the animal grows older, though not so much as it is constrained within an articulation. Tooth widths are not affected by this, as they are measured near the base of the tooth, but tooth lengths are affected by age-related wear (decreasing rather than increasing in size). Due to this latter fact, tooth lengths from specimens of a wear stage of j or older (sensu Grant, 1982) were excluded from the analyses. Regarding sexual dimorphism, differences are more noticeable in forelimb elements but less so on hind-limbs, and almost none in teeth. In all anatomical elements, the residual individual variability, based on environmental and genetic factors, has a low impact (Payne and Bull, 1988). Therefore, to discriminate wild from domestic animals on the basis of biometry, the best measures to use are molar tooth widths and hind-limb measurements, particularly humerus BT and HTC, tibia BdP, and astragalus GLl (excepting the more juvenile porous and light elements) (Albarella and Payne, 2005; Payne and Bull, 1988; Rowley-Conwy et al., 2012). For determination of seasonality, scapula SLC and long bone shaft widths are better suited, as these grow rapidly with age (Rowley-Conwy, 1998; 2001; Rowley-Conwy et al., 2012).

	BONE	MEASUREMENT		REFERENCE
TEETH	P_4	W	Crown width	Albarella and Payne 2005
	dP^4 upper or lower M1, M2, and M1/2	L	Crown length	Payne and Bull 1988
		WA	Anterior crown width	Payne and Bull 1988
		WP	Posterior crown width	Payne and Bull 1988
	dP_4 upper or lower M3	L	Crown length	Payne and Bull 1988
		WA	Anterior crown width	Payne and Bull 1988
		WC	Central crown width	Payne and Bull 1988
		WP	Posterior crown width	Payne and Bull 1988
	Complete hemi-mandible	H	Height in front of M_1	Von den Driesch 1976
POSTCRANIAL BONES	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
		SLC	Width of neck	Von den Driesch 1976
	Humerus	GL	Greatest length from the head	Von den Driesch 1976
		GLC	Maximum length	Von den Driesch 1976
		SD	Smallest width of shaft	Von den Driesch 1976
		Bd	Distal width	Payne and Bull 1988
		BT	Width of the trochlea	Payne and Bull 1988
		HTC	Minimum diameter of trochlea	Payne and Bull 1988
	Radius	GL	Maximum length	Von den Driesch 1976
		SD	Smallest width of shaft	Von den Driesch 1976
		BpP	Proximal width	Payne and Bull 1988
		Bd	Distal width	Von den Driesch 1976
	Ulna	DPA	Depth at the processus anconaeus	Von den Driesch 1976
		BPC	Width across coronoid process	Von den Driesch 1976
	Pelvis	LAR	Diameter of acetabulum	Von den Driesch 1976
	Femur	GLC	Greatest length from the head	Von den Driesch 1976
		GL	Maximum length	Von den Driesch 1976
		SD	Smallest width of shaft	Albarella and Payne 2005
		DPC	Diameter of caput	Payne and Bull 1988
	Tibia	GL	Maximum length	Von den Driesch 1976
		SDap	Smallest antero-posterior width of shaft	Albarella and Payne 2005
		SDml	Smallest medio-lateral width of shaft	Albarella and Payne 2005
		Bd	Distal width	Payne and Bull 1988
		Dd	Distal depth	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
	Metapodials	GL	Greatest length	Von den Driesch 1976
	Foetal and Neonatal Bones	GL	Greatest length	Von den Driesch 1976
		SD	Smallest width of shaft	Von den Driesch 1976

Table 5.2. List of measurements taken on the animal bone assemblages.

Due to the natural porosity and therefore fragility of pig bones, a problem exacerbated by the fact that they are usually slaughtered young, postcranial bones from this animal are usually fragmented and measurable bones from archaeological assemblages tend to be scarce (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 will be used, and this will be applied through the calculation of log ratios (Albarella, 2002; Meadow, 1999). The standard used as a reference point will be the one compiled by Albarella and Payne (2005) for Neolithic pigs from Durrington Walls.

5.4. Statistical analyses

Several statistical analyses have been performed on the biometrical data in order to describe the samples, summarize the data, and compare assemblages. For each set of measurements within each sample (per site and period), the minimum, maximum, and mean have been calculated. For samples of over 5 measurements, the standard deviation and coefficient of variation – i.e. the standard deviation as a percentage of the mean – have also been calculated. All these calculations have been made with Excel software, and a detailed description of the methods involved can be seen in any general statistics manual (e.g. Freedman et al., 2007; Hinton, 2014).

Additionally, independent samples t-tests have been conducted in order to assess the degree of similarity between the different biometrical datasets, combined by each of the main regions (North-Centre-South-Islands) and for the site of Arene Candide. The t-test is a parametric test which determines whether there is a significant difference between the means of two groups (Dekking, 2010; Freedman et al., 2007; Kim, 2015; Manly, 1986). Some authors have argued that parametric tests such as this should only be used when the data fulfils the conditions of normality, equal variance, and independence (Bryman and Cramer, 2012; Kim, 2015). However, the need to meet these three criteria has been strongly questioned in the past (see Bryman and Cramer, 2012). Also, although the t-test requires that the samples be normally distributed, it is so robust that even if the distributions are only vaguely normal the test is still likely to be valid (Hinton, 2014). An additional benefit of the t-test is that it can be effective even in cases of small samples, although it is always preferable to use larger sets of data (De Winter, 2013).

Lastly, due to the large number of t-tests employed, a Bonferroni adjustment has been used to modify the significance levels accordingly in order to control the probability of a type I error (Bland and Altman, 1995; Manly, 1986). The results of this correction indicated a statistic significance of $p \leq 0.001$ for the regional t-test correlations, and of $p \leq 0.008$ for the Arene Candide correlations. However, it must be kept in mind that the indication of 'statistical significance' is used only to highlight when the probability value is particularly low but does not mean that different p results are indicating a false, absent or improbable correlation (See also Ho et al., 2019; Van de Schoot et al., 2011; Wasserstein et al., 2019). All t-tests were conducted using IBM SPSS software, which includes a Levene's test for equality of variances.

Chapter 6

SITES STUDIED

To tackle the main research question on how the process of pig domestication developed in Italy, a number of key Italian archaeological assemblages have been identified for analysis, on the basis of their location, chronological breadth and accessibility (Figure 6.1 and Tables 6.1 to 6.3). These sites are all located in the Italian peninsula and the southern islands of Sicily and Pantelleria. Although not all Italian regions are represented in this study, as unfortunately some did not provide suitable or accessible material for our study, there is a good spread of sites across the research area. 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 (Albarella et al., 2006c; Levine, 1983; Vigne, 1988; Wilkens and Delussu, 2002). All sites comprise a chronology ranging from the Upper Palaeolithic to the Late Bronze Age.

Most of the faunal assemblages from these sites have previously been studied by other archaeologists, and some results have been published. However, the intention of this research was not to re-analyse the animal bones, but rather focus on the study of the pig bones from the perspective of our specific research questions. All the animal bone assemblages included in this research were studied personally by S. Tecce, except in some cases where the data was kindly provided by Umberto Albarella (these cases are noted on Tables 6.1 to 6.3). In these instances, the methodology used for the measurement collection followed recommendations by Payne and Bull (1988), Albarella and Payne (2005), and von den Driesch (1976), and are in line with the methodology followed in this research.

Figure 6.1. Location of Italian sites studied. Larger circles indicate the presence of several sites within the same area.

REGION	SITE	CHRONOLOGY	LOCATION OF ANALYSIS OR DATA SOURCE
NORTH			
Trentino-Alto Adige	Galgenbühel/Dos de la Forca	Mesolithic	Department of Physical Sciences, Earth and Environment of the University of Siena (Siena)
	Pradestel	Mesolithic	Museo delle Scienze (Trento)
	Riparo Gaban	Mesolithic	
	Romagnano Loc	Mesolithic	
Friuli-Venezia Giulia	Riparo di Biarzo	Upper Palaeolithic (Late Epigravettian)	Museo Friulano di Storia Naturale (Udine)
		Upper Palaeolithic (Late Epigravettian)/Mesolithic	
		Mesolithic	
		Mesolithic/Neolithic	
Liguria	Arene Candide	Upper Palaeolithic	U. Albarella
CENTRE			
Latium	Palidoro	Upper Palaeolithic	Prehistoric Ethnographic Museum ‘Luigi Pigorini’ (Rome)
SOUTH			
Apulia	Grotta Paglicci	Upper Palaeolithic	Department of Physical Sciences, Earth and Environment of the University of Siena (Siena)
	Grotta Romanelli	Upper Palaeolithic (Late Epigravettian)	U. Albarella
Campania	Grotta della Cala	Upper Palaeolithic (Uluzzian, Aurignacean and Gravettian)	Department of Physical Sciences, Earth and Environment of the University of Siena (Siena)
		Mesolithic	
Calabria	Grotta della Madonna	Upper Palaeolithic	Prehistoric Ethnographic Museum ‘Luigi Pigorini’ (Rome)
		Mesolithic	
ISLANDS			
Sicily	Grotta dell'Uzzo	Upper Palaeolithic/Mesolithic	U. Albarella
		Mesolithic and Mesolithic/Neolithic Transition	

Table 6.1. List of Upper Palaeolithic and Mesolithic sites included in this study.

REGION	SITE	CHRONOLOGY	LOCATION OF ANALYSIS OR DATA SOURCE
NORTH			
Trentino-Alto Adige	Riparo Gaban	Early Neolithic	Museo delle Scienze (Trento)
		Mesolithic/Neolithic	
		Neolithic	
Veneto	Cornuda	Late Neolithic	Riedel (1988)
	Molino Casarotto	Middle Neolithic	Cambridge University (U.K.)
	Rocca di Rivoli	Middle Neolithic	U. Albarella
Liguria	Arene Candide	Early Neolithic	Museo Archeologico Del Finale (Finale Ligure), Museo di Archeologia Ligure (Genoa Pegli), Genova Sopraintendenza deposit of the Palazzo Reale (Genoa)
		Early to Middle Neolithic Transition	
		Middle Neolithic	
		Late Neolithic	
		Late Neolithic and Copper/Bronze Age	
CENTRE			
Emilia-Romagna	Portonovo	Early Neolithic	Department of History and Cultures of the University of Bologna (Ravenna)
Latium	La Marmotta	Early Neolithic	U. Albarella
SOUTH			
Apulia	Masseria Candelaro	Middle Neolithic	U. Albarella
	Masseria Fragella	Early Neolithic	Department of History and Cultures of the University of Bologna (Ravenna)
	Masseria Pantano	Middle Neolithic	
Campania	Baselice	Early Neolithic	Department of History and Cultures of the University of Bologna (Ravenna)
	Masseria di Gioia	Middle/Late Neolithic	Department of History and Cultures of the University of Bologna (Ravenna)
	Mulino Sant'Antonio	Late Neolithic	Albarella (1987-88)
Calabria	Favella	Early Neolithic	Prehistoric Ethnographic Museum 'Luigi Pigorini' (Rome)
	Grotta della Madonna	Middle Neolithic	Prehistoric Ethnographic Museum 'Luigi Pigorini' (Rome)
	Grotta della Madonna	Late Neolithic	Prehistoric Ethnographic Museum 'Luigi Pigorini' (Rome)
ISLANDS			
Sicily	Grotta dell'Uzzo	Early Neolithic	U. Albarella
		Middle Neolithic	
		Early to Middle Neolithic	

Table 6.2. List of Neolithic sites included in this study.

REGION	SITE	CHRONOLOGY	LOCATION OF ANALYSIS OR DATA SOURCE
NORTH			
Trentino-Alto Adige	Riparo Gaban	Eneolithic/Copper Age	Museo delle Scienze (Trento)
		Early Bronze Age	
		Middle Bronze Age	
	Romagnano Loc	Eneolithic/Copper Age	
		Early Bronze Age	
Veneto	Concordia Sagittaria	Late and Final Bronze Age	U. Albarella
Lombardia	Lavagnone	Early Bronze Age	Department of History and Cultures of the University of Bologna (Ravenna)
Liguria	Arene Candide	Late Neolithic and Copper/Bronze Age	Museo Archeologico Del Finale (Finale Ligure), Museo di Archeologia Ligure (Genoa Pegli), Genova Sopraintendenza deposit of the Palazzo Reale (Genoa)
		Copper/Bronze Age	
CENTRE			
Emilia-Romagna	Cattolica VGS	Early Bronze Age	Department of History and Cultures of the University of Bologna (Ravenna)
	Cesena	Middle Bronze Age	
		Late Bronze Age	
	Poviglio	Middle and Late Bronze Age	Department of History and Cultures of the University of Bologna (Ravenna)
	Riccione Ipercoop	Middle and Late Bronze Age	
	Solarolo	Middle Bronze Age	
Marche	Conelle	Eneolithic/Copper Age	Wilkens (1999)
Tuscany	Gorgo del Ciliegio	Middle Bronze Age	Department of Physical Sciences, Earth and Environment of the University of Siena (Siena)
Latium	Albano Le Macine	Middle Bronze Age	Prehistoric Ethnographic Museum 'Luigi Pigorini' (Rome)
	Cinquefrondi	Eneolithic/Copper Age	
	Pantano Borghese	Eneolithic/Copper Age	
SOUTH			
Apulia	Coppa Nevigata	Middle Bronze Age	Professor M. Moscoloni private residence (Rome)
		Late and Final Bronze Age	
Campania	Gricignano	Late Eneolithic to Early Bronze Age Transition	Prehistoric Ethnographic Museum 'Luigi Pigorini' (Rome)
	La Starza	Middle Bronze Age	U. Albarella
	Santa Maria a' Peccerella	Copper/Early Bronze Age	Department of History and Cultures of the University of Bologna (Ravenna)
Calabria	Broglio di Trebisacce	Middle Bronze Age	Prehistoric Ethnographic Museum 'Luigi Pigorini' (Rome)
	Grotta della Madonna	Eneolithic/Copper Age	
		Early Bronze Age	
		Middle Bronze Age	
	Torre Mordillo	Middle Bronze Age	U. Albarella
		Late and Final Bronze Age	
ISLANDS			
Sicily	Mursia	Middle Bronze Age	Department of History and Cultures of the University of Bologna (Ravenna)

Table 6.3. List of Eneolithic/Copper and Bronze Age sites included in this study.

All the sites' materials were analysed in the Italian museums and stores of the Soprintendenza of the area where they are stored, except for the material of Molino Casarotto, which was studied at the University of Cambridge where it is currently being kept. Other sites of interest for comparative purposes that were not studied personally by the author are also included here, and the data presented comes from their respective publications. These are Conelle (Wilkens, 1999), Cornuda (Riedel, 1988), and Mulino Sant'Antonio (Albarella 1987-88). The site of Conelle (Marche), dated to the second half of the 4th/beginning of the 3rd millennium BC (Cazzella and Moscoloni, 1999), deserves a special mention. This is a key site that was identified for this research as it is unique in Mediterranean archaeology due to its rich pig bone assemblage that has a clear biometric bimodality, indicating the presence of approximately similar numbers of wild and domestic pigs (Albarella *et al.* 2006b). Unfortunately, access to the faunal assemblage of this site has not been possible due to the inability of the Soprintendenza Archeologica delle Marche (Sede Ancona) staff to locate them, and despite a personal visit to the store. We therefore had no other option but to rely only on the published data for this site. As a final note, in all cases where the data used was not collected personally by the author of this research, care was taken to include in this study only measurements taken following the same principles applied here (see Chapter 5).

The details of the location and chronology for each site can be seen in Tables 6.1 to 6.3, alongside the details of where this material was collected or the source, if the material was not personally studied by this author. Figure 6.1 offers further detail on the location of the sites studied. The assignation of a particular chronological period of the sites studied follows the bibliography for each location, and it is a product of radiocarbon chronology data combined with the material culture associated to the finds. In some situations, the period to which a site has been assigned follows decisions made in previous studies by other authors; these cases are mentioned in the text.

In the following subsections, a brief discussion on the stratigraphy, chronology, and general zooarchaeological data (focused on mammals) available for each of the sites studied will be presented, separated by broad geographical area (North, Centre, and South Italy) and regions. The site review for each region is organized geographically, from West to East and North to South. Mention will be made at the presence of specimens identified by the authors of the original analyses as domestic pig (*Sus* *domesticus*) or wild boar (*Sus scrofa*). In most cases, the differentiation between the two species was done by the authors based on observable size differences to the naked eye; i.e. very large specimens are registered as wild boar, while the smaller ones are recorded as domestic pig. An example of those visible size differences can be seen in Figure 6.2. However, in this research no differentiation between the two species was made during the recording of the material, not to bias the results of the biometrical analysis. A comprehensive list of the most represented macro mammalian taxa identified in the sites studied by previous authors can be seen in the Appendix.

Figure 6.2. Size comparison between different pig specimens. Top: two fused distal humerus epiphyses from different sites and chronologies (Left: Grotta della Madonna [Upper Palaeolithic]; Right: Favella [Early Neolithic]). Bottom: two fused proximal radius epiphyses from the same context (Arene Candide [Middle Neolithic I]). Photos by S. Tecce.

6.1. Northern Italy

6.1.a. Sites in Trentino-Alto Adige and Friuli-Venezia Giulia: Galgenbühel/Dos de la Forca (Alto Adige), Pradestel, Riparo Gaban, Romagnano Loc III, and Riparo di Biarzo (Friuli-Venezia Giulia)

The Alpine area of the Italian regions of Alto Adige, Trentino, and Friuli-Venezia Giulia is home to a series of sites included in this study, which are here grouped together due to their chronological and geographical similarities. Mostly dated to the Mesolithic, these sites are located in an area that would have been forested from Boreal times, an environment which would have been adequate for the occurrence of wild boar and red deer (Boscato and Sala, 1980).

In the northern Alpine region, there is the Mesolithic site of Galgenbühel/Dos de la Forca, located on the left shore of the Adige River Valley, at approximately 30 km south of the town of Bolzano, South Tyrol. The systematic excavations of the site were conducted by M. Bazzanella and U. Wierer between 1999 and 2002, and they evidenced periodic occupations by hunter-gatherer groups. Several radiocarbon dates place the occupations between the middle/end of the 9th and middle of 8th millennium BC, in calibrated chronology; that is, from the end of the Preboreal to the middle Boreal periods. The lithic technology exhibited techno-typological features of the Middle Sauveterrian (Bassetti et al., 2009; Wierer and Boscato, 2006). The zooarchaeological remains from the site were recovered by hand and by wet sieving, using a 1mm mesh. Wild boar, ibex (*Capra ibex*), chamois (*Rupicapra rupicapra*), red deer (*Cervus elaphus*), and roe deer (*Capreolus capreolus*) dominate the assemblage, with the wild boar as the most represented species (Wierer et al., 2016; Wierer and Boscato, 2006).

Further south, on the stretch of the Adige valley of the Trento area, there are the rockshelter sites of Pradestel, Romagnano Loc, and Riparo Gaban. Pradestel is located along the Adige river in the locality of Ischia Podetti, at 225 m.a.s.l., and was excavated in 1975 and 1976. A study of the lithic industries has evidenced Sauveterrian material for the lower stratigraphic layers, Castelnovian for the middle layers, and one top layer containing Early Neolithic pottery. A series of calibrated radiocarbon dates place the occupation between 10,210-10,366 (middle Sauveterrian) to 7,616-7,683 (recent

Castelnovian, Early Neolithic) years BP, corresponding to *ca.* 8,500-5,600 cal. BC (Alessio et al., 1978; Bartolomei, 1974; Bisi et al., 1987; Boscato and Sala, 1980; Dalmeri et al., 2001; 2009; Skeates, 1994a). The site of Romagnano Loc III is located on the right shore of the river Bondione, where it meets the Adige river, a few kilometres south of Trento. The site was excavated from 1971 to 1973 by A. Broglio and unearthed a complete Mesolithic sequence (Sauveterrian and Castelnovian), followed by Neolithic (including layers with Square-Mouthed Pottery), Copper-Bronze Age, and Iron Age levels. Several radiocarbon dates are available for this site (Alessio et al., 1978; Boscato and Sala, 1980; Broglio and Kozlowski, 1983; Dalmeri et al., 2001):

- Mesolithic: *ca.* 9,500-6,500 cal. BC;
- Early Neolithic: *ca.* 5,500-4,500 cal. BC;
- Middle Neolithic (middle phase of Square Mouthed pottery): *ca.* 4,500-4,200 cal. BC;
- Early Bronze Age (Polada culture): *ca.* 2,300-1,800 cal. BC;
- Final Bronze Age (Luco culture): *ca.* 1,400-400 cal. BC.

Lastly, the site of Riparo Gaban is located on the western slope of Monte Calisio, in Trento, and was excavated in the 1970s by B. Bagolini and again in the 1980s by S. J. Kozlowski, M. Lanzinger and G. Dalmeri. The chronology of this site spans from the Mesolithic (Sauveterrian and Castelnovian) to the Early Iron Age (Bisi et al., 1987; Dalmeri et al., 2009; Kozlowski and Dalmeri, 2002), although the *Sus* material included in this research comes from the Mesolithic, Early Neolithic, Eneolithic, and Early and Middle Bronze Age periods only. The Early Neolithic of this site was used by Bagolini to define the local Early Neolithic group "Gruppo Gaban", radiocarbon dated to 5,200-4,170 cal. BC (Bagolini and Biagi, 1990; Bisi et al., 1987; Dalmeri et al., 2009; Kozlowski and Dalmeri, 2002; Skeates, 1994a). A radiocarbon date of 2,853-2,399 cal. BC is also available for the Eneolithic period for this site (Nisbet and Biagi, 1987).

All three Alpine sites mentioned above have similar chronologies, and their zooarchaeological assemblages share very similar features, and they will be described here together. The main ungulate species present throughout the Mesolithic sequences are red deer, wild boar and roe deer, with presence in some cases (Pradestel and Romagnano) of chamois and ibex. Remains from several carnivores, birds, and fish were also identified, with some remains also of European pond turtle (*Emys orbicularis*)

(Boscato and Sala, 1980; Kozlowski and Dalmeri, 2002; Thun Hohenstein et al., 2016). All considered, these sites indicate for the Mesolithic a hunter-gatherer subsistence based mostly on red deer, with some occurrence of wild boar, indicating the exploitation of the nearby forested areas, with a secondary role of semi-aquatic and carnivore species (Wierer and Boscato, 2006). In the later periods of occupation, the wild boar is more sparsely represented (Boscato and Sala, 1980).

In the Eastern Alps the evidence comes from the site of Riparo di Biarzo, located in the Natisone Valley of the Julian Prealps. This site was excavated by A. Guerreschi and F. Bressan in 1982-1984 and consists of a continuous stratigraphy spanning from the Upper Palaeolithic (Late Epigravettian) to the Bronze Age, but the *Sus* material included in this study come from the Upper Palaeolithic to Mesolithic/Neolithic levels only. A radiocarbon date of 11,100 ± 125 uncalibrated years BP is available for the Late Epigravettian layer 5 (Bertolini et al., 2012). The recovery of the faunal remains was done by hand and also by dry and wet sieving (Bertolini et al., 2012; 2016). In the Upper Palaeolithic levels (layer 5), the most abundant species is indisputably the wild boar, followed by smaller numbers of red deer, chamois, brown bear (*Ursus arctos*), ibex, and roe deer bones. In levels 4 and 3B, corresponding to the Mesolithic Sauveterrian (Guerreschi, 1996), the wild boar dominance continues, followed in abundance by roe deer, red deer, elk (*Alces alces*), brown bear, and chamois and ibex (Bertolini et al., 2016). Layer 3A has presence of Mesolithic Castelnovian lithic industry, as well as some Impresso pottery in the most superficial part of the layer (Bertolini et al., 2012; Bressan, 1996). In this case, wild boar, red deer and roe deer are the best represented species, followed by badger (*Meles meles*) and chamois, and with an absence of ibex (Bertolini et al., 2016), suggesting a change of environmental conditions as these latter animals prefer open environments (Rowley-Conwy, 1996). Domestic sheep/goat (*Ovis/Capra*) appear in small numbers in layer 3A, which has some Neolithic admixture, as well as *Bos* sp. (Bertolini et al., 2016; Rowley-Conwy, 1996). Carnivores and a few bird remains are also present (Bertolini et al., 2016).

The predominance of the wild boar at Riparo di Biarzo is unique in Late Palaeolithic assemblages of northern Italy (Bertolini et al., 2012; 2016). The Natisone Valley, during Epigravettian and Mesolithic times, was characterized by the presence of mixed forest and rich undergrowth, the ideal habitat for wild boar. Hunting of pigs was focused predominantly on young individuals during these periods, and the high presence of female individuals suggests that females with young were mostly targeted. This age composition suggests that *Sus* hunting activities would have taken place around the end of spring and beginning of summer, but the presence also of some adult and elderly individuals does not rule out an all-year round occupation of the site (Bertolini et al., 2016). Additionally, DNA analyses have been conducted on pig material from Riparo di Biarzo (Vai et al., 2015), as discussed previously in Chapter 3.4.

6.1.b. Sites in Veneto: Rocca di Rivoli, Cornuda, Molino Casarotto, and Concordia Sagittaria

Rocca di Rivoli is situated on Monte Rocca (province of Verona), a promontory of Jurassic limestone that dominates the northern edge of the Chiusa gorge, through which the Adige river flows out of the Alpine foothills and on to the Po plain. From Neolithic times onwards, this location served as a strategic defensive position for the control of this important line of communication (Barfield and Bagolini, 1976). The *Sus* data from this site included in this study were originally collected by Lisette Piper, as part of her University of Birmingham undergraduate dissertation, supervised by Umberto Albarella. The material derives from the 1963 and 1965-1968 excavations of the site directed by L. H. Barfield and B. Bagolini, in particular from the Middle Neolithic assemblages associated with Square Mouthed Pottery culture. Although evidence of occupations of the site date from Neolithic, Early Bronze Age, Lombard and Medieval times, extensive intact deposits were only recovered for the first two periods mentioned. The Neolithic pottery present at the site is of Square Mouthed type, and three phases were defined from the site: Rivoli-Chiozza and Rivoli-Castelnovo I and II. The material culture from the site links Rivoli to other Square Mounted Pottery sites, such as Arene Candide, and with sites from the Lagozza culture and other groups in the Alpine region (Barfield and Bagolini, 1976). Several radiocarbon dates are available for this site: 4,840-4,250 cal. BC (Rivoli-Rocca phase), 4,670-4,040 cal. BC (Rivoli-Chiozza phase), and 4,360-3,690 cal. BC (Rivoli-Castelnovo phase) (Shotton et al., 1970; Skeates, 1994a; Williams and Johnson, 1976). Although the late phase of the Square Mouthed and the Lagozza cultures are considered to be Late Neolithic (Bagolini, 1993), for the purpose of consistency with previous studies, the data from Rivoli will be grouped as Middle Neolithic in this research.

Regarding the zooarchaeological evidence from Rivoli, Jarman (1976b) carried out the original analysis of the late Square Mouthed pottery levels, with a re-analysis of all the Neolithic material by Piper (2010). In terms of the recovery of the material, it is not clear from the literature whether dry or wet sieving was carried out at the site, although Jarman mentions that “There is no indication that factors of deposition, preservation, or collection seriously biased the sample” (1976b: 159; see also Piper 2010). According to Piper’s (2010) re-analysis of the assemblage, the ovicaprids were the most important taxon on site, followed by pigs, *Bos* sp. (assumed to be *Bos taurus*, i.e. cattle), and wild animals (mostly red deer). Regarding the pigs, the mortality data indicated that most of these animals were slaughtered between 9 and 24 months of age, while the sexing data showed that more than two-thirds of the animals sexed were female (Jarman, 1976b). In terms of the wild vs. domestic status of these animals, the paleoenvironmental evidence for the surrounding environment indicated suitability for both domestic and wild pigs, and the biometrical evidence did not show a clear bimodality. A detailed biometrical analysis of the Middle Neolithic assemblages indicated that a large-sized domestic population was likely present at Rivoli (Albarella et al., 2006c; Piper, 2010).

Another site in the Veneto region is Cornuda, a Late Neolithic site (late Square Mouthed pottery period, *ca.* 3,000 years BC) located in the piedmont of the Alps, in the administrative territory of the same name in the Treviso province. The site is located on a steep slope, and the local environmental conditions would not have been very favourable for agriculture, but they would have been still more adequate than the swampy and heavily forested area of the nearby plain (Riedel, 1988). The measurements included in this study come from Riedel’s (1988) work and follow von den Driesch (1976). The excavations of the site were not undertaken in a systematic fashion, as it was a rescue operation; regardless, Riedel mentions that the recovery must have been accurate given the “large quantity of small fragments [of bone] and the presence of bones of all parts of the skeleton” (1988: 71). Regarding the taxonomic composition of the assemblage, the wild animals (aurochs [*Bos primigenius*], red deer, roe deer, wild boar, dog [*Canis familiaris*], brown bear, badger, and beaver [*Castor fiber*]) are more numerous than the domestic (cattle, ovicaprids, and pig), with red deer as the most represented animal, in terms of MNI[25], followed by domestic and wild pig (Riedel, 1988). Concerning the ageing data, adult individuals are prevalent in the assemblage, especially in the wild taxa. In pigs, the author identified two young domestic individuals, and six domestic and six wild adult individuals. The female/male ratio in wild and domestic pigs is equal (Riedel, 1988). Even though Riedel talks about domestic and wild pig present in the assemblage from Cornuda, he does recognize the difficulty of distinguishing one from the other from a highly fragmented assemblage. However, he also observes that the differences between slender domestic bones and stout and larger wild bones is quite clear in the pigs from the site. Through comparison with wild pigs from the Neolithic site of Polling (Bavaria) and with domestic pigs from the Bronze Age site of Barche (Solferino, Veneto), Riedel concludes that the wild pig from Cornuda is similar to the Polling one, whereas the domestic pigs are too scarce to draw conclusions, although he supposes they would have been similar to Chalcolithic/Neolithic and Bronze Age sites of the region (Riedel, 1988). In sum, the large presence of wild game and the lesser abundance of domestic animals, led Riedel to suggest hunting as the most common source of meat supply for the inhabitants at Cornuda, perhaps at the same time as a primitive form of agriculture was taking place (Riedel, 1988). The author suggests that at this site a long lasting game economy is evidence of the strong diversifications and irregular developments of the Neolithic sites (Riedel, 1988), an opinion shared by other authors (cf. Albarella 1987-88 for Mulino Sant'Antonio; Boyle 2014a, 2014b for Molino Casarotto).

The site of Molino Casarotto is located in the Berici Hills region, not far from Lake Fimon in the province of Vicenza. The site was excavated in the early 1970s by Lawrence Barfield, Alberto Broglio and Bernardino Bagolini, and has yielded evidence of pile-structures and early Square Mouthed Pottery (Barfield, 1972; Boyle, 2014a; Jarman, 1976a). During excavation, no stratigraphical relationship was observed in the excavated layers, and the material excavated has been treated like a palimpsest. Concerning the faunal remains, these were recovered via hand collection, and wet and dry sieving was carried out during the excavations (Boyle, 2014a). The presence of early Square Mouthed Pottery, combined with the lithic evidence and radiocarbon dates

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[25] MNI or Minimum Number of Individuals; see Lyman (1994; 2008) for a detailed description of quantification methods in zooarchaeology.

within the range of 3,640 and 3,190 cal. years BC, place the occupation of the site in the Middle Neolithic (Bagolini and Biagi, 1990; Boyle, 2014a; Jarman, 1976a). During these times, the area around the site would have been characterized by temperate deciduous mixed oak forest, beech woodland, temperate grassland and lakeside vegetation (Barfield et al., 1986; Boyle, 2014a). The pig data used in this research has been collected at the Department of Archaeology of the University of Cambridge (UK). As is the case of Cornuda, the faunal assemblage from Molino Casarotto is dominated by wild taxa, in particular and in order of abundance: red deer, wild boar, and roe deer. The domestic taxa present are sheep/goat, cattle, and dog (Boyle, 2014a). The wild/domestic status of the pigs on Molino Casarotto remains unclear from previous research. Jarman (1971; 1976a) observed that there is no evidence of two distinct populations of pigs as regards size, and he posits that it is not possible to distinguish wild from domestic pigs on size alone during this period, as it is probable that they would not have been genetically isolated due to a loose system of management. The author instead supports the interpretation of one pig population at Molino Casarotto (whether domestic, wild, or a mix of both) being exploited in essentially the same way, likely through a closer control of the pig herds than in a hunting strategy. Rowley-Conwy (2003), however, is not entirely convinced that one single population is present at Molino Casarotto, as a coefficient of variation of 8 for lower third molar lengths is slightly larger than expected from a single population – following the observations of Payne and Bull (1988) –, and the distribution of those measurements shows a peak of small individuals and a tail of larger ones, which leads the author to suggest for the site the presence of a main population of domesticates that is being supplemented by the hunting of a few wild boar (see also Albarella et al., 2006c, and review of Rowley-Conwy et al., 2013, in Chapter 3.3). Notwithstanding this debate, the predominance of wild taxa on site led Boyle (2014a,b) to suggest that Molino Casarotto could have been part of an agropastoral system in which the exploitation of the surrounding woodland resources was key in the context of an environment of low arable potential. Same would have been the case of other northern Neolithic sites where wild fauna predominates, such as Cornuda. However, the wild/domestic distribution of Molino Casarotto does not necessarily mean that the domestic stock was not key to the economy, the only thing that can be said for certain is that "The site was probably a short-term location where game could be obtained to supplement the staples of a domestic subsistence economy even at times of abundance. It was a specialized location, used for hunting, but one to which domestic stock was brought" (Boyle, 2014a: 157).

The final site from the Veneto region to be included in this research is Concordia Sagittaria, located within the modern town of the same name, 30km northeast of Venice. The site's location would have been an important line of communication between the eastern Po Plain and the Friuli area, as well as between the inland and the coast. The site's occupation which is of interest to this research dates from the Late Bronze Age (13th-12th centuries BC) and Final Bronze Age (11th-10th centuries BC) (Tagliacozzo et al., 1996; 2005b). The zooarchaeological analysis of the materials from the 1991 excavation of the site indicated that the best represented taxa are domestic pig (identified by the authors as the domestic variant on the basis of size) and cattle, with fewer remains of ovicaprids, and even less of horse (*Equus caballus*) and dog. Wild animals are mostly represented by red deer, and wild boar is also present (again, identified on the basis of their larger size). Regarding pig mortality, these animals were killed mostly between 12 and 24 months of age, and some adult and elderly individuals were also noted. In terms of sex, 9 females and 12 males were identified (Pino Uría and Tagliacozzo, 2001; Tagliacozzo et al., 1996; 2005b). Measurements of pig teeth and bones from Concordia Sagittaria were included in Albarella et al.'s (2006c) work, indicating a pattern of mainly supposedly domestic pigs of a body size smaller than the main distribution of Middle to Late Neolithic animals, with two larger postcranial specimens of likely wild boar size. Bones were also observed to be relatively larger than teeth. The patterns thus observed were similar to those of other Bronze Age sites included in this study (Albarella et al., 2006c).

6.1.c. Lavagnone (Lombardy)

Lavagnone is a pile-dwelling site situated 3 km south of Desenzano del Garda, in the Brescia province (Lombardy). The site was originally excavated in 1971 and 1979 by B. Barich and R. Perini, and research was resumed in 1991 by R. de Marinis and M. Rapi (Carri, 2014; De Marinis et al., 2005). Late Mesolithic and Neolithic industries have been found, and the site was probably also settled during the Eneolithic, but the Bronze Age phases are better represented (De Marinis et al., 2005) and the zooarchaeological material studied comes from the Early Bronze Age (2001 excavation). A series of dendrochronological dates place the earliest Bronze Age occupation between 2,070 and 1,916 years BC (Carri, 2014), with earlier radiocarbon dates having placed the Early Bronze Age Polada culture occupation of the site at *ca.* 2,500-1,700 cal. BC (Alessio et al., 1991). At the beginning of the Bronze Age, the Lavagnone basin was a closed lake; however, due to continued anthropic pressure over the environment through time, the lake was transformed into a peat bog by the end of the Middle Bronze Age (De Marinis et al., 2005). Previous zooarchaeological work of the Early Bronze Age assemblages from Lavagnone was carried out by Curci (2013), and indicated a predominance of domestic animals, with ovicaprids (sheep and goat in similar proportions) dominating, followed by domestic pig, cattle, and dog. The domestic pigs were killed mostly at a juvenile and sub-adult age stage, with also some animals killed when only a few months old. The pig specimens that could be sexed indicated a majority of males, which the author interprets as the females being kept for reproduction (Curci, 2013). Regarding ovicaprids and cattle, their exploitation was focused on primary and secondary resources. Cattle was probably the main meat provider, complemented by sheep/goat and pig meat. A small proportion of wild animals was also present, in particular red deer but also some wild boar, identified on the basis of their larger size (Curci, 2013).

6.1.d. Arene Candide (Liguria)

Arene Candide, a cave located in the promontory of Caprazzoppa near the town of Finale Ligure in the Liguria region, is a key site in Northern Italian prehistory due to its rich occupational evidence, including human burials, dating from the Upper Palaeolithic to the Middle Bronze Age and even extending to Roman and Post-Roman times. The cave of Arene Candide opens directly on a line with the seashore, and up until the beginning of the 20th century it was accessible from the coast, but unfortunately human modification of the surrounding environment has made this no longer possible. The first excavations of the cave took place intermittently between 1864 and 1887; however, the first excavations that used archaeological stratigraphy began in 1940 under the direction of L. B. Brea and L. Cardini. A series of eight archaeological campaigns were carried out between 1940 and 1950, unearthing a total of 28 layers. More recent excavations were carried out by S. Tiné between 1972-1977 (Maggi et al., 1997; Tiné, 1999). Dry sieving took place during the excavations (Maggi et al., 1997). Details of the excavated layers from 1940 onwards, and their respective chronology and material cultures can be seen on Table 6.4. It is worth noting that the Square Mouthed Pottery 'Phase 2' corresponds to the late phase of this culture, which is usually assigned to the Late Neolithic (Bagolini, 1993). However, in past zooarchaeological studies the materials from those layers have been combined with the Middle Neolithic assemblages (Rowley-Conwy, 1997a), and for the sake of consistency, the same chronological categorization will be followed in the present research.

STRATIGRAPHICAL LAYERS		CHRONOLOGY BP	CHRONOLOGY BC	PERIOD – CULTURE
1940-1950 Excavations	1972-1977 Excavations			
P13-P10	N/A	25.600 - 23.400	-	Upper Palaeolithic – No lithic evidence
P9-P1	N/A	20.400 - 18.500	-	Upper Palaeolithic – Late Gravettian/Early Epigravettian
M	N/A	11.700 - 9.900	-	Upper Palaeolithic – Late Epigravettian
27-25	15-14	6.900 - 6150	5.800 - 5.100/5.000	Early Neolithic – Impressed Ware
N/A	13	6.300 - 5.800	5.250 - 4780	Early to Middle Neolithic Transition – Pollera
24-18	12d-9	6.000 - 5.700	4.900 - 4.500	Middle Neolithic – Square Mouthed Pottery, Phase 1
15-17		5.600 - 5.400	4.500 - 4.300	Middle Neolithic – Square Mouthed Pottery, Phase 2
14-8	8-1	5.300 - 4.800	4.300 - 4.200	Late Neolithic – Chassey Culture/Protolagozza
6-7	N/A	5.300 - 3.200	4.300 - 1.400	Late Neolithic with Copper Age intrusions
5-2	Eneolithic	4.700 - 3.200	3.600/3.500 - 1.400	Copper/Early and Middle Bronze Age

Table 6.4. Summary of stratigraphy and chronology of Arene Candide (Cassoli and Tagliacozzo, 1994; Maggi, 1997; Tiné, 1999).

The Upper Palaeolithic evidence from Arene Candide comes from the 1940-1950 excavations of the site. The occupation of the cave during this time is characterized, in zooarchaeological terms, by a large variety of animal remains, reflecting the environmental changes of this period. Cassoli and Tagliacozzo (1994) subdivided this period into three phases based on the evidence (see Table 6.4 for the chronological context of each). The oldest phase is characterized by the regular use of the cave by carnivores and only occasionally by humans, being difficult to determine which species were clearly exploited by the latter. During the following phase, the cave was still often used by carnivores, but the human frequentation became more common, and there is evidence of lithic material of Late Gravettian/Early Epigravettian origin. In this case, it is again difficult to distinguish the remains of human vs. carnivore hunting, although it can be said with relative certainty that ibex and red deer were hunted, and likely also aurochs and hare (*Lepus* sp.). The presence of mammoth (*Mammuthus primigenius*) and elk in the context of the human burial of the 'Young Prince' indicated the ritual use of those animals. In contrast with these two older phases described, in the third phase the human occupation became more intensive, with evidence of Late Epigravettian lithic tools and 15 burials, and the carnivore occupation became less frequent. Hunting was focused on red deer, roe deer, and wild boar, but ibex, chamois, elk, brown bear, wolf (*Canis lupus*), and wildcat (*Felis silvestris*) were also present. Regarding the wild boar, young animals under two years old were hunted by preference, and adult females were captured more often than males. The cave during this time seems to have been occupied seasonally, mostly between summer and the beginning of winter, but also occasionally in other times of the year. As a final observation regarding the Upper Palaeolithic at Arene Candide, it is worth mentioning that the fauna recovered in the two older phases indicates the presence of a cold and arid climate, unlike what is observed for the later phase. Indeed, the third phase has the presence of species that live in more warm and humid, woodland, environments (Cassoli and Tagliacozzo, 1994).

From the Neolithic onwards, the archaeological material comes from the 1940-1950 and 1972-1977 excavations of Arene Candide, studied by Rowley-Conwy (1997a) and Sorrentino (1999) respectively. Regarding the Early Neolithic period at the cave, there does not seem to be material evidence to support a continued occupation from the Mesolithic. Instead, the elements of the Early Neolithic material culture seem to be intrusive, and combined with the presence of imported domestic sheep, it would appear to indicate the colonization of the cave at this time by new Neolithic populations, perhaps migrants (Rowley-Conwy, 2011). The environment during the Early Neolithic would have been characterised by the presence of a mixed forest, with low anthropogenic impact, but also rocky landscapes and open areas (Branch et al., 2014; Maggi et al., 1997). In general terms, the cave of Arene Candide was used mainly for the stabling of herbivores since Neolithic times. This activity was intermittent, possibly seasonal. The presence of shed deciduous teeth of sheep/goat, indicates the possibility that these animals were kept penned in the cave, supporting this interpretation (Maggi et al., 1997).

During the Middle Neolithic period, as in the previous one, the cave was used as an herbivore stable and human occupation area, either alternatively or using different areas of the cave. The early layers of this period provided pottery fragments that suggest contacts with the pre-Square Mouthed Pottery groups of the Po plain. At the time of the accumulation of layers 22 to 19, a major episode of domestic occupation occurred, coinciding with was described by the authors as 'Phase 1' of the Square Mouthed Pottery period (Maggi et al., 1997). This was an interval spanning one or two centuries of intensive and seemingly permanent domestic occupation in the central part of the cave, facing the entrance, while the darker areas were used as stables. These layers yielded a large part of the archaeological remains, and most of the human burials are located here, including one case of spinal tuberculosis, a disease which relates to dairy cattle domestication and demographic increase during the Neolithic. In terms of the landscape, it was a diverse space that included woodlands dominated by deciduous oak, and there is evidence of anthropogenic impact, likely due to a more complex system of woodland management (Branch et al., 2014; Maggi et al., 1997). During the 'Phase 2' of the Square Mouthed Pottery, the site continued to be used as a stable, with minor domestic episodes and periods of abandonment detected (Maggi et al., 1997).

During the Late Neolithic, major changes are observed in Arene Candide, and the authors have suggested that it could have represented immigration of people from southern France (e.g. Rowley-Conwy, 2011; Rowley-Conwy et al., 2013). An increase in sheep size suggests the introduction of new breeds, and this could be supporting the idea that the Chassey culture might have initiated the exploitation of highland pastures by means of mobile pastoralism (Branch et al., 2014; Maggi et al., 1991; 1997). Again, during this period the cave was used for stabling animals, with short periods of abandonment. A larger impact of human activities on the environment is suggested by the decline in number of forest species (Branch et al., 2014; Maggi et al., 1997).

The most represented taxon throughout the Neolithic to Bronze Age occupation of the site is sheep/goat, followed by pig, and with smaller numbers of *Bos*, probably domestic cattle. Red and roe deer, and hare are also present in small numbers, with red deer as the most abundant of these wild animals, even overcoming cattle in abundance during the Early Neolithic layers (Rowley-Conwy, 1997a; Sorrentino, 1999). Regarding the domestic animals, sheep dominate the Arene Candide zooarchaeological assemblages from the start of the Neolithic sequence, domestic goat appearing only from the Middle Neolithic. In terms of husbandry practices, the sheep from the Early Neolithic period seem to have been kept for meat and milk exploitation; but by the Middle Neolithic, when domestic goat is introduced, sheep were likely killed mostly for meat, while goats provided milk. Later in time, goats become more common, and they too seem to have been then killed also for meat. In terms of size, sheep become smaller from the Early to the Middle Neolithic, only to increase in size again during the Late Neolithic, perhaps due to the introduction of new breeds, as mentioned above (Rowley-Conwy, 1997a).

Pigs are the second most represented domestic species throughout the Neolithic and post-Neolithic sequence of Arene Candide. This animal seems to have been killed, in general terms, relatively adult, with also presence of very young individuals (Sorrentino, 1999). It is only possible to recognize two distinct pig populations based on size from the Late Neolithic onwards. This fact, along with the presence of shed pig teeth from this period only whilst sheep and cattle shed teeth can be found in the earlier Neolithic periods, led Rowley-Conwy to suggest that domestic pig only appear on Arene Candide in the Late Neolithic, and all pigs from the Early and Middle Neolithic are wild (Rowley-Conwy, 1997a; 2000; 2003; Rowley-Conwy et al., 2013). However, there is also the possibility that the earlier Neolithic pigs could be the result of husbandry practices involving interbreeding with wild boar, and indeed Sorrentino (1999) identifies the *Sus* remains from the later excavations as domestic (see also Albarella et al., 2006c).

Arene Candide continued to be in use during the Eneolithic/Copper Age, and possibly Early Bronze Age. Unfortunately, the layers representing this occupation contain intrusive elements from the Middle Bronze Age, and therefore these periods were considered together in the analyses. The zooarchaeological trends mentioned for the Late Neolithic continue in these periods (Rowley-Conwy, 1997a). The Bronze Age did not mark the end of the history of Arene Candide, however, as traces of human occupation continue on until the first half of the 7th century AD (Maggi et al., 1997); but of course, those periods are beyond the scope of this research.

6.2. Central Italy

6.2.a. Sites in Emilia-Romagna: Santa Rosa di Poviglio, Solarolo, Riccione-Ipercoop, Cesena Foro Annonario, and Cattolica VGS

The region of Emilia-Romagna is home to a series of Bronze Age sites, which are from North to South: Santa Rosa di Poviglio, Solarolo, Riccione Ipercoop, Cesena Foro Annonario, and Cattolica. The first site mentioned, Poviglio, is situated in an alluvial plain, about 3 km south of the Po River. The area today is poorly drained, but geomorphological evidence suggests that the site was located near a paleochannel of the Po river in the past (Cremaschi, 2004; Cremaschi et al., 1980). The site consists of two dwelling areas, 'Villaggio Piccolo' and 'Villaggio Grande', which date back to the Middle Bronze Age and the Late Bronze Age, respectively (Cremaschi, 2004). The second site, Solarolo, is located in the municipality of the same name, in the Ravenna province. Several excavations have taken place at this site since 2006, unearthing materials dated between the Middle Bronze Age and the Late Bronze Age (Cattani, 2009; 2013). The third site, Riccione-Ipercoop, lays in the municipality of Riccione, near the coast of the Adriatic Sea. The 2008-2009 excavations of this site led to the recovery of a small faunal assemblage dated to the Middle and Late Bronze Age (Maini, 2013b). The fourth studied site is Cesena, located in the urban centre of the city of the same name. Archaeological excavations that took place in 2012 and 2013 led to the recovery of materials from also the Middle to the Late Bronze Age. Finally, the fifth site of Cattolica is situated near the old coastline of the Adriatic Sea, in the city of the same name. This site, excavated during 2007 and 2008, was occupied from the Early Bronze Age to the Early Middle Bronze Age (Miari and Valli, 2013).

The zooarchaeological information available for these sites follow a general pattern, and therefore will be discussed jointly. In all these Bronze Age sites from Emilia-Romagna, the most represented species are domestic: sheep/goat, pig, and cattle, with some presence of dog and horse. Some wild species are also present, namely red deer, wild boar, roe deer, and other small mammals, but their minor numbers indicate that hunting was only an occasional activity. This fact was perhaps linked to the extensive anthropic modification of the environments during this time, which lead to a reduction of the woodland cover. The ovicaprids are in general the most represented species, followed by pig and then cattle. The exceptions are the sites of Riccione, where cattle are most abundant, and Poviglio, where sheep/goat and cattle share very similar proportions. Through time in the area of Emilia- Romagna, pigs maintain roughly the same importance in the assemblages, while changes mostly occur in the proportions of sheep/goat and cattle. The mortality data from all main domesticates indicate that they were all mostly kept for primary products, although cattle was likely used also in traction and there is a high possibility that sheep/goat were also used for milk and wool. In the particular case of the pig, the mortality data indicate the killing of young animals, although some adult animals are also present, which could be due to the keeping of animals for reproduction (Maini, 2013b,a; 2015; Maini and Curci, 2009; 2013a,b; Miari et al., 2014; Riedel, 1989b,a; 2004).

6.2.b. Sites in Marche: Conelle and Portonovo

In the region of Marche, the sites of Conelle and Portonovo have provided relevant information for this research. The Eneolithic site of Conelle, located in the municipality of Arcevia in the province of Ancona, is key for our research due to its large *Sus* assemblage. Unfortunately, however, the author of this research did not have the possibility of viewing the material personally, as mentioned previously, and therefore biometrical data from Wilkens (1999) has been used instead. This site was discovered at the end of the 19th century, and was excavated from 1958 to 1969 by M. Puglisi (Cazzella, 1999). Several radiocarbon dates place the occupation of the site approximately between 3,630 and 2,640 years BC, within the Eneolithic period (Calderoni and Cazzella, 1999; Cazzella et al., 1994). Regarding the zooarchaeology of the site, hunting of particularly wild boar but also red deer seems to have been of key importance throughout the sequence, a valuable source not only of meat but also of raw materials for tool manufacture (tusks and antlers, respectively). It may therefore not be a coincidence that for both species males predominate. Complementing this activity, exploitation of domestic pig and cattle was important as well, while ovicaprids played a minor role in the economy. In terms of mortality, the data for cattle indicates their use primarily as traction but also as a meat source, while the ovicaprids possibly provided wool and meat. The pigs from the earliest level of Conelle were killed mostly as adults and the young animals were not older than 8-12 months. In the later levels, there is a larger number of younger individuals, and some elderly animals were also identified in the later level of the site (Wilkens, 1999). A key feature of the Conelle *Sus* biometrical data is that there is a clear bimodality that indicates the presence of two distinct populations, wild and domestic (Albarella et al., 2006c). For cattle, Wilkens also observed the presence of two distinct breeds on a morphological basis (Wilkens, 1999).

Further south is the site of Portonovo, located in the Mount Cornero Natural Park, a few kilometres away from the city of Ancona. This is an Early Neolithic site dated to the middle of the 6th millennium BC. The site is characterized by the presence of five circular structures, interpreted so far as ovens for the preparation of cereals for storage, and also several human inhumations (Conati Barbaro et al., 2013; 2014). The general zooarchaeological analysis is for this site is still in progress at the time of the writing of this thesis, and no publications are currently available.

6.2.c. Gorgo del Ciliegio (Tuscany)

The region of Tuscany is represented in this research only by one site, Gorgo del Ciliegio. This site was discovered in 2000 and the material analysed comes from several excavations conducted since 2004. It is a site dated to the Middle Bronze Age, around the beginnings of the Apennine period, with one radiocarbon date placing the occupation around 1,440 years BC (Arrighi et al., 2007; Moroni Lanfredini and Arrighi, 2010). The analysis of the faunal remains from the site indicates an economy based mainly on the exploitation of sheep/goat for meat, wool, and milk. Other domestic animals present are pig and cattle. Regarding pigs, mortality data indicates the consumption of young and subadult individuals, whereas the exploitation of cattle points to their use for meat, milk, and traction. The least represented domestic species is the dog. There is also some evidence of hunting of red and roe deer, but the presence of wild boar is excluded, although a biometric study towards the distinction between domestic pig and wild boar is not provided (Arrighi et al., 2007).

6.2.d. Sites in Latium: La Marmotta, Albano Le Macine, Cinquefrondi, Palidoro, and Pantano Borghese

The region of Latium is represented in this study by several sites. The first is La Marmotta, located in the Bracciano Lake, slightly north from Rome. The site is an Early Neolithic village with a rich agricultural economy, located on the south eastern shore of Lake Bracciano, north of the locality of Pizzo Prato. It was occupied from *ca.* 5,600 to 5,150 years BC, and with elements from the Tyrrhenian Cardial Ware and Painted Ware pottery complexes (Fugazzola Delpino, 2002; Fugazzola Delpino et al., 2002; Tagliacozzo, 2005). It is considered to be the earliest Neolithic lakeshore settlement in Western Europe so far (Fugazzola Delpino et al., 2002). The results of the zooarchaeological analysis of the material from the 1992-1998 excavations indicate the predominance of domesticated animals, especially ovicaprids, followed by pig, cattle, and dog. A smaller number of wild animals are also present: wild boar, red deer, roe deer, aurochs, hare, hedgehog, and various carnivores. The analysis of a sector excavated in 1998 evidenced a different proportion of domesticates, with pigs being the most represented animals, followed by ovicaprids and cattle and dog is small proportions (Fugazzola Delpino et al., 2002). The evidence for sheep/goat suggests these animals were exploited for meat and possibly milk, while cattle were used for traction as well as meat. Pigs were killed mostly juvenile, and male canines are prevalent (Cassoli and Tagliacozzo, 1995; Fugazzola Delpino, 2002; Tagliacozzo, 2005). Although Tagliacozzo (2005) is of the opinion that the majority of the pigs from the site are domestic, in terms of their size, they are comparable to earlier, pre-Neolithic sites, so the possibility that these pigs could be wild cannot be entirely excluded, though their status as domestic remains more likely (Albarella et al., 2006c).

The second site is Albano Le Macine, a late Early Bronze Age-early Middle Bronze Age site located on the coast of the Lake Albano, to the south of the city of Rome. The *Sus* data studied comes from the 2001-2003 excavations of the site. Unlike other Neolithic and Bronze Age sites discussed here, Le Macine has a larger proportion of wild animals than domestic, a fact likely linked to the surrounding woodland environment. Red deer is the most represented taxon in the assemblage, but other wild animals present are wild boar and roe deer, along smaller numbers of hare and carnivores. Of the domestic animals, ovicaprids are the best represented, followed in abundance by pig, dog, and lastly cattle. Regarding the mortality profiles of the main domesticates, although the data is scarce, they indicate their use primarily for meat, but possibly also for secondary products in the case of sheep/goat and cattle (Tagliacozzo et al., 2012).

The third site researched from Latium is Osteria del Curato-Via Cinquefrondi ('Cinquefrondi' for short), which is an Eneolithic/Copper Age site located northwest of Lake Albano, near the city of Rome, excavated in 2004 and 2005. A series of radiocarbon dates place the occupation of the site between *ca.* 2,800 and 2,200 years BC, with evidence of Laterza and Ortucchio pottery traditions (Angle et al., 2015; Anzidei et al., 2007). The zooarchaeological analysis of this site indicates a predominance of ovicaprids, mostly adults, followed in abundance by cattle, with a balanced representation of adults and young individuals, and pigs, mostly juveniles. Regarding the sheep/goat and cattle, their mortality profiles indicate a use of meat and secondary products, mostly the former for cattle and the latter for ovicaprids. The only wild species present is the red deer, only represented by two specimens; no mention of the presence of wild boar is made on the original report, but hunting lithic tools were found (Angle et al., 2015).

The fourth site is Palidoro, which is located 30 km northwest of Rome. The site was excavated in 1955 by P. F. Cassoli and in 1956 by V. G. Chiappella, and the small proportion of unidentified faunal specimens hint to the lack of sieving during these excavations. The occupation of the site dates to the Upper Palaeolithic (Early-Middle Epigravettian). Radiocarbon dating places this occupation between approximately 15,900-13,900 BP/17,000-14,500 BC (Alessio et al., 1976). The most represented species throughout the sequence are, in order of abundance: red deer, aurochs, wild ass (*Equus hydruntinus*), and wild boar. Hunting was not specialized, but instead for all species a broad age spectrum and both sexes were captured. Seasonality data indicates that the site was occupied on a semi-permanent basis, during autumn-spring. The presence of red deer throughout the sequence points to uniform temperate-humid climatic conditions and forest cover (Ruiu and Tagliacozzo, 2016).

The final site from Latium included in this research is Pantano Borghese, excavated intermittently between 2008 and 2010. This site is located to the south-east of the city of Rome, in the municipality of Montecompatri. The majority of Laterza pottery, and the radiocarbon chronology of approximately 2,500-2,400 years BC, place the occupation of the site in the final Eneolithic. Above the Eneolithic levels are an early Middle Bronze Age and a Roman level. Several human and animal burials were uncovered during the excavations (Angle et al., 2012a,b; 2015). The pig data from the site represents a sample from the Eneolithic levels, as the assemblage is still in course of study by A. Tagliacozzo. The broad zooarchaeological study is still in progress, but some preliminary results are available. Particularly for the Eneolithic period, the preliminary data indicates the predominance of sheep/goat and cattle, followed by pig, and small numbers of dog. In terms of mortality patterns, in ovicaprids, cattle, and pigs, there is a balance between adult and sub-adult individuals. For ovicaprids and cattle, this was interpreted as a use of these animals for meat but also secondary products. The wild taxa are represented only by a few specimens of red deer, and no mention is made to the presence of wild boar (Angle et al., 2012b; 2015).

6.3. Southern Italy

6.3.a. Sites in Apulia: Coppa Nevigata, Grotta Paglicci, Masseria Candelaro, Masseria Fragella, and Masseria Pantano, and Grotta Romanelli

The Apulia region is home to several sites included in this research, all located in the Foggia province, with the exception of Grotta Romanelli, which is located in the Lecce province. The first, Coppa Nevigata, is a fortified settlement located in the Tavoliere littoral plain, to the southwest of the town of Manfredonia. The site was excavated from 1967 to 1975 and from 1983 to the present, and it has evidence of several occupations during the Neolithic, Eneolithic, and, after a period of abandonment, continuously from the Bronze to the Early Iron Age (Cassano et al., 1987; Cazzella et al., 2012; Cazzella and Moscoloni, 1994). Today, the site is 7 km away from the coast, but during the Bronze Age it was positioned at the shore of a lake basin that connected with the Adriatic Sea, an ideal location for maritime and inland trade. Indeed, during the Bronze to Iron Age occupation of the site, there is abundant evidence of contacts with the Eastern Adriatic and the Aegean, for example in the production of purple dye and olive oil, and the presence of Aegean pottery (Cazzella et al., 2005; 2010; Cazzella and Recchia, 2005; Recchia, 2009). One of the striking features of Coppa Nevigata is the presence of a wall that fortified the settlement from 1,700 years BC (Cazzella et al., 2010; 2012; Cazzella and Recchia, 2013). In terms of chronology, the Bronze Age occupation of the site covers the Proto-Appennine, Appennine, and Sub-Appennine pottery styles, covering a period from 3,800 to 3,100 years BC (Cassano et al., 1987; Cazzella et al., 2012; Cazzella and Moscoloni, 1994).

Previous zooarchaeological research of Coppa Nevigata evidenced a rich assemblage of domestic and wild animals, no doubt as a result of the site's location in an area where different biotopes met, such as the forest, open forest, and coastal marsh (Bökönyi and Siracusano, 1987; Cassano et al., 1987; Siracusano, 1990; 2012). The information available refers to the Bronze Age occupation of the site, as there is no bone data available for the Neolithic levels (Siracusano, 2012). The pig material included in this research corresponds to the Middle and Late Bronze Age. In terms of the wild/domestic faunal composition of the assemblages, there is an interesting particularity of Coppa Nevigata, which is that the wild fauna increases throughout the Bronze Age, both in quantity of remains and taxa diversity, while it is usually – but not always – the contrary situation that is observed during the Bronze Age. There is also evidence of turtle (Chelonii), molluscs, birds and fishes. All this indicates that the inhabitants of the site complemented their meat intake with hunting activities (Bökönyi and Siracusano, 1987; Siracusano, 1989a,b; 1990; 1991b; a,a; 2001b; 2012). This particularity might be related to changing climatic circumstances taking place during the Bronze Age, and/or as a means to meet the meat requirements of the population during winter within an incipient transhumant system (Bökönyi and Siracusano, 1987; Siracusano, 1990; 1991a; 2001a; 2012). Of the wild mammal species, the red deer is the most abundant during all the analysed periods, followed by roe deer, hare, and wild boar. The smaller numbers of wild boar seem to be related to a dry environment. Additionally, the larger number of red deer during the Late Bronze Age could have been a consequence of an increase of woodland areas in response to a climatic change (increased humidity and cold) during this time (Bökönyi and Siracusano, 1987; Siracusano, 1990).

Domestic animals are in all periods much more common than wild species. All the main domesticates are present, with sheep/goat as the most abundant, followed by cattle, pig, and a small proportion of dogs. Horse and donkey (*Equus asinus*) are present only during the Late Bronze Age (Bökönyi and Siracusano, 1987; Siracusano, 1989a,b; 1990;

1991b; a,a; 2001a; 2012). The mortality profiles indicate that ovicaprids and cattle were exploited both for meat and secondary products; pigs were killed mostly young, with a small proportion of adults kept alive for reproduction (Bökönyi and Siracusano, 1987; Siracusano, 1989a,b; 2012). A change in mortality patterns for cattle and pig from the Early Sub-Appennine to the Late Sub-Appennine periods (Late Bronze Age) was observed: an increase in the age at death of cattle and a reduction in the case of pigs. For the pigs, this change was interpreted as the result of a strategy specialized in their optimal meat exploitation, as a means to compensate for the lower meat availability during winter months in a transhumant system of animal management (Siracusano, 1990; 1991a; 2001a; 2012). As a final note for Coppa Nevigata, in terms of domestic pig size, the authors of the original zooarchaeological analyses make an interesting observation: "[…] i maiali sono di piccolo taglia con un cranio fortemente accorciato, come è chiaramente mostrato da un osso lacrimale complete con entrambe le misurazioni equivalenti a 21 mm, tali da ottenere un indice lacrimale uguale a 1.0, suggerendo una discendenza locale dal cinghiale del tipo mediterraneo [*the pigs are of small size with a very shortened skull, as is clearly shown by a complete lacrimal bone with both measurements equivalent to 21 mm, such as to obtain a lacrimal index equal to 1.0, suggesting a local descent from the wild boar of the Mediterranean type*]" (Bökönyi and Siracusano, 1987: 207; my translation). In other words, based on the size of the lacrimal bone only, the authors suggest the possibility that these domestic pigs could be descendant of local wild boar, i.e. local domestication.

The second site from Apulia which is included in this research is Grotta Paglicci, which is a cave situated near the town of Rignano Garganico in Foggia, within the Gargano National Park. This site was excavated by the University of Siena since 1971, unearthing an extensive sequence covering approximately 24,000 years, with lithic archaeological evidence mainly of Aurignacian, Gravettian and Epigravettian origins (Palma di Cesnola, 2003; 2004). Grotta Paglicci has the only Palaeolithic wall paintings known in all of Italy (Zorzi, 1962). In terms of this research on pigs, the *Sus* material included comes from Gravettian and Epigravettian levels (*ca.* 28,000 to 11,000 years BP). Despite the much longer history of occupation of the site, we will focus this review only on those relevant periods. The zooarchaeological remains recovered from the site correspond, for the most part, to anthropic activity, while the rest entered the cave as a product of its use by carnivores – especially spotted hyena (*Crocuta crocuta*) – while unoccupied by humans. Hunting by the Grotta Paglicci inhabitants was focused on large mammals, the presence and frequency of which was determined by the environmental contexts of each period. These animals were horse, wild ass, wild boar, aurochs, ibex, chamois (*Rupicapra* cf. *pyrenaica*), and red deer. The presence of the wild boar is never observed in high percentages, being most frequent in humid temperate periods with deciduous forest cover and dense undergrowth, although it is also present in colder periods. This animal is mostly represented by cranial bones and loose teeth. Indeed, in terms of anatomical representation, the large mammals are mostly represented by heads and limb portions, the latter which were very fragmented for marrow extraction (Boscato, 1994; 2004; Sala, 1983b). Finally, the zooarchaeological analysis and isotopic studies on animal bones and teeth also allowed for a reconstruction of the different climatic variations that occurred during the occupational history of the site, of which the type most beneficial for the development of the wild boar was already mentioned (Bartolomei, 2004; Boscato, 1994; 2004; Huertas et al., 1997; Iacumin et al., 1997; Sala, 1983b).

The third site from Apulia included in this study, Masseria Candelaro, is a Neolithic entrenched village located in the locality of Manfredonia, at the foot of Mount Aquilone and on the left margin of the Candelaro river. It was excavated in 1978 and from 1985 to 1993, and it covers a chronology from the Early Neolithic (impressed and some Guadone pottery traditions) to the Middle Neolithic (Passo di Corvo, and Serra d'Alto pottery traditions), from *ca.* 5,700 until 4,200 years B.C (Cassano and Manfredini, 2005; Curci et al., 2005; Skeates, 1994a). The surrounding environment of the site in the past consisted of open environments of low vegetation, ideal for the pasturing of ovicaprids and cattle, and there were probably humid and woodland settings also nearby, judging from the wild fauna present at the site. The preservation of the materials from the site is not good due to the high limestone content of the sediment, and there was no sieving done on site, although small fragments such as micromammals and fish were identified in the zooarchaeological analysis (Curci et al., 2005). During the Early Neolithic phases, the scant zooarchaeological evidence indicates the presence of only domestic animals, two bone specimens of ovicaprids and three of pig, identified as domestic by the authors on the basis of their size (Curci et al., 2005). The more abundant Middle Neolithic material shows a predominance of domestic animals and smaller evidence of wild mammals, birds, reptiles, amphibians and fish. Regarding the mammals, the most common species are, in order of abundance, ovicaprids, cattle and pig, dog, hare, and roe deer. The small number of wild species indicate that hunting at Masseria Candelaro was only an occasional activity, and the main meat intake came from domestic species, primarily ovicaprids, although, due to their larger dimensions, cattle was also a main source of meat (Curci et al., 2005). No *Sus* remains were attributed to the wild species in this analysis, although mention is made to one wild boar specimen identified in the material from the 1978 excavations (Bökönyi, 1983; Curci et al., 2005). In terms of mortality patterns, the data for sheep/goat and cattle point to their use mainly as a meat source. Pigs were killed mostly as juveniles and sub-adults, which is consistent to their main use as a meat source (Curci et al., 2005). The *Sus* data from this site comes only from Middle Neolithic levels.

As well in the Foggia region, there is the site of Masseria Fragella, situated in the locality of Vaccarella of the Lucera city. Excavated in 2008, it is a Neolithic village dated on the whole to *ca.* 5,700-5,000 years BC, covering the Early and Middle Neolithic, with evidence of Scaloria Alta pottery in the case of the latter period (Maini, 2017; Tunzi et al., 2012). The pig material from this site included in this study comes from the Early Neolithic period of occupation. The zooarchaeological analysis of Masseria Fragella indicates the presence of domesticated animals, in order of abundance: ovicaprids, cattle, pigs, and dog. Wild fauna is present in small numbers and represented by fox and turtle; no mention is made to the possibility of wild boar being present on site (Maini, 2017). Sheep/goat and cattle were killed at different age stages, young and adult, while pigs were killed mostly young, but some adult individuals were also identified (Maini, 2017). No interpretation was offered at this stage of the zooarchaeological analysis in terms of the possible use of these animals from the mortality data, likely as a consequence of the small sample size, although for the pigs we can venture that they were used mostly for the meat with some adults kept for reproduction, as is often the case with these animals.

Masseria Pantano, a Neolithic village situated in the city of Foggia, is the last site from the Foggia region included in this study. Excavated in 2011, the site presents evidence of Impressed, Masseria La Quercia, and Lagnano da Piede pottery, which, combined with a radiocarbon date of *ca.* 5,500 years BC, places the site's occupation in the Early and Middle Neolithic (Curci et al., 2016). In all periods, the faunal remains belong to domestic animals; no wild fauna was identified – again, no mention is made of the possible presence of wild boar. Of the domesticates, sheep/goat dominates, followed closely by pig and then cattle, with some remains also of dog, which are closely linked to the funerary features of the site during the Early Neolithic. In terms of the mortality profiles, the evidence available points to the use of these animals mainly as meat producers, although a possible use of ovicaprids and cattle for secondary products cannot be yet excluded due to the scarcity of the data available. There is a lack of very young pigs, but the sub-adults are more abundant than the adults (Curci et al., 2016). The pig material from this site included in this analysis comes from the Middle Neolithic contexts of the site.

The last Apulian site to be reviewed comes from the south of the province, in the Lecce region. It is the Palaeolithic site of Grotta Romanelli, a cave located 7.4 m.a.s.l. in the Otranto-Santa Maria di Leuca Coast and Bosco di Tricase regional natural park. Excavated for the first time as early as 1914, the pig material included in this study comes from the 1954-1970 excavations by L. Cardini. The site has evidence of Mousterian lithic industry and also abundant Final Epigravettian lithic artefacts (Cassoli and Tagliacozzo, 1997; Sardella et al., 2018). Two sets of radiocarbon dates place the occupation of the Late Epigravettian layers to *ca.* 11,900-9,000 BP/13,500-7,900 BC (Alessio et al., 1965; Bella et al., 1958; Cassoli and Tagliacozzo, 1997; Vogel and Waterbolk, 1963). During this phase of occupation, different paleoenvironments seem to have coexisted in the area, according to the paleoecological evidence: "[…] littoral, with desert sands and marshy zones in the coastal plain in front of the cave, a cliff and coastal rock face zone with wooded areas, and a steppe-like plateau in the higher area further inland" (Cassoli and Tagliacozzo, 1997: 303). In terms of the faunal analysis, the most frequent taxa on the site are red deer, red fox (*Vulpes vulpes*), wild ass, and aurochs. There is also evidence of wild boar, roe deer, and hare. Carnivores, birds, sea mammals, and fishes are also present (Cassoli et al., 2003; Cassoli and Tagliacozzo, 1997; Fiore, 2003; Tagliacozzo, 2003).

6.3.b. Sites in Campania: Baselice, Masseria di Gioia, Santa Maria a' Peccerella, La Starza, Mulino Sant'Antonio, Gricignano, and Grotta della Cala

Several sites from the region of Campania were identified for this research. The site of Baselice, located in the municipality of the same name in the Benevento province, has evidence of Early and Middle/Late Neolithic occupation, although the majority of zooarchaeological remains belong to the former period. The site was excavated in 2001 and 2007, and the zooarchaeological remains indicate that domesticated animals make up most of the animal economy. The predominance of each of the main domesticates varies depending on the zooarchaeological quantification method used, with pigs as either the second or third main species. In terms of mortality profiles, all animals seem to have been used for meat (Curci et al., 2012; Curci and Langella, 2005), and although not explicitly said by the authors, some indication of the use of ovicaprids and cattle for secondary products/traction is implied by the data. Regarding the sexing of domestic pigs, one male and one female juvenile individual were identified, alongside an adult female. Lastly, wild animals are also present in low numbers, and include roe deer, wild boar and red deer as the most hunted species. The occurrence of these species is indicative of the presence of woodland areas around the site (Curci et al., 2012; Curci and Langella, 2005).

Masseria di Gioia, also located in Benevento, was excavated in 1996 and has evidence of Serra d'Alto and Diana pottery styles, referable to the Middle and Late Neolithic (4th millennium BC). Once again, the zooarchaeological assemblage is made up mostly of domestic animals, dominated by sheep/goat, which were mostly killed in juvenile age. Cattle follow in abundance, with animals killed both in young and adult age (Curci and Langella, 2005). These age of death profiles seem to point mainly to a meat exploitation for these animals, with traction being also a use for cattle. Domestic pigs are the third most abundant species, being killed young (but not extremely young) and in adult age up to four years. Wild animals are present in small numbers, and only marten (*Martes* sp.) and hare were identified (Curci and Langella, 2005).

The last site included in this study from the Benevento province is Santa Maria a' Peccerella, a site with funeral structures excavated in 2000. The cultural context of the site corresponds to the Laterza culture, placing its occupation in the late Eneolithic/Early Bronze Age (3rd millennium BC). The animal bone assemblage is dominated by ovicaprids, cattle, and pig, in that order (Curci and Langella, 2005). From the age of death data, ovicaprids and pig seem to have been exploited mainly for meat, while cattle could have also been used for traction. There is no clear evidence of hunting activities taking place at the site, although some red deer antler fragments were recovered (Curci and Langella, 2005).

Further south-west, the Late Neolithic site of Mulino Sant'Antonio, in the municipality of Avella in the Avellino province, is a special case due to the larger proportion of wild species in its assemblage. On the basis of MNI, there is a clear predominance of red deer, followed closely by pig (Albarella 1987-88). Roe deer and sheep/goat are the third and fourth most represented taxa, respectively. The author is careful not to assume beforehand the domestic/wild status of the pig remains, although given the importance of hunting in the site, it is likely that a considerable number of the *Sus* remains belong to wild boar as some specimens have been noted by the author to be very large in size (Albarella 1987-88). The presence of a rich assemblage of forest species (cervids, brown bear, badger, marten, red squirrel [*Sciurus vulgaris*]) and semi-forest species (hare, fox) indicates a surrounding environment optimal for a hunting economy. The domestic species other than pigs present, are represented by the mentioned small percentage of sheep/goat and a much smaller number of cattle. It is important also to note that although dry sieving was done during the excavations, no wet sieving was involved, and therefore the possibility exist of the loss of the smaller specimens. All in all, the interpretation for the economy of this site is that, although no stranger to the 'benefits' of an agricultural economy, it seems the surrounding environment was rich enough that hunting was in fact more productive than husbandry and/or that it was not suitable for the upkeep of a herd of cattle, sheep or goats (Albarella 1987-88); much like in the case of Cornuda and Mulino Casarotto, discussed in previous sections.

La Starza is another site in the Avellino province. The zooarchaeological data presented here comes from the 1980-1990s excavations by C. A. Livadie and is dated to the Middle Bronze Age or Protoapennine (*ca.* middle 2nd millennium BC). The assemblage is dominated by domesticated species, particularly sheep/goat, while cattle and pig follow in relatively similar proportions. The mortality profiles of these taxa indicate that they provided most of the meat intake of the site, without discarding the possibility of ovicaprids providing also secondary resources and cattle being used for traction. Equids were also identified at the site for the later Apennine period, although a comprehensive study of those assemblages has not been published to date (Albarella, 1999). A biometrical analysis of pig remains indicates the presence of a predominately domestic population, with a small number of wild boar (Albarella, 1999; Albarella et al., 2006c). Wild animals are also present, but in small numbers; red deer is the most numerous, followed by roe deer and also wild boar, whose exact proportions cannot be ascertained due to the potential mixing with domestic pigs (Albarella, 1999).

Another site considered for this research is Gricignano d'Aversa, located in the municipality of the same name, in the Caserta province. It is an Eneolithic/Early Bronze Age site with elements of the Laterza *facies*, dated *ca.* 4,100-3,500 non calibrated years BP (Fugazzola Delpino et al., 2003; Tagliacozzo comm. pers.); roughly equivalent to 2,100 to 1,500 years BC. The large faunal assemblage recovered from the excavations that took place since 1998 is still ongoing analysis, but a sample has been studied. The preliminary results indicate the predominance of ovicaprids, followed by cattle and pig. Mortality data indicates that sheep/goat were used for meat but also secondary products, while cattle was used for meat and traction. Pigs were killed mainly young. Some specimens of red deer and fox were also identified (Albertini et al., 2007; Fugazzola Delpino et al., 2003). Additionally, the site has some interesting ritual features involving cattle bones (Tagliacozzo et al., 2005a).

The last site from Campania included in this study is Grotta della Cala, a cave site located east of the village of Marina di Camerota, Salerno province, and very close to the present coastline, which in the past would have been only a few hundred metres away (Moroni et al., 2016). The site has been excavated in several occasions since 1966, and sieving took place during the digs. The cave has a long non-continuous occupation spanning from the Middle Palaeolithic to the Copper Age; however, the pig material studied comes from the Upper Palaeolithic (Uluzzian, Aurignacian, and Early Gravettian) and from the Mesolithic layers only. Throughout its sequence, the ungulates dominate in variable proportions according to the climatic changes of these periods. It is understood that the majority of the zooarchaeological material derives from human action, as there is not convincing evidence to support a regular use of the cave by carnivores. Regarding the Uluzzian layers, radiocarbon dated to *ca.* 29,120 years BP, the most represented species were, in order of abundance, fallow deer (*Dama dama*), red deer, wild boar, roe deer, horse, aurochs, chamois, ibex, rhinoceros (*Stephanorhinus* cfr *hemitoechus*), and several species of carnivores. This evidence points to the existence of different environmental areas near the site, including a forested area where the wild boar would have lived. The later Aurignacian layers, dated to *ca.* 27,050-29,850 years BP, see an increase in red deer numbers, which leads to this species substitute the fallow deer as the best represented taxa. Several species diminish in number, including the wild boar, during this time, indicating a colder climate and a more open vegetational cover (Benini et al., 1997). Regarding the Early Gravettian assemblages, dated to *ca.* 26,880-26,380 years BP, the most represented species is the red deer, followed by roe deer, chamois, wild boar, ibex, and aurochs. During this time there is no longer presence of fallow deer and horse. The environmental context derived from the faunal evidence points to an open forest area possibly linked to cold climate (Boscato et al., 1997). Finally, the Mesolithic layer, dated to *ca.* 8,370-8,060 years BP (7,579-6,687 years BC), indicates the predominance of woodland species (red deer, wild boar, and roe deer, in order of abundance) with the occasional occurrence of forest steppe animals (chamois, ibex, and aurochs) and medium-sized prey (carnivores and lagomorphs). This evidence points to a climatic amelioration during this period. There is also evidence for the exploitation of malacofauna during the Mesolithic. Lastly, the biometry of the wild boar during this phase indicates the presence of animals larger than those of the present Italian population, which are largely introduced (Moroni et al., 2016).

6.3.c. Sites in Calabria: Grotta della Madonna, Broglio di Trebisacce, Torre Mordillo, and Favella

Of the sites included in this study located in the Calabria region, Grotta della Madonna is without doubt the best known. Situated on the Tyrrhenian coast, immediately south of the town of Praia a Mare in the Cosenza province, the Grotta della Madonna cave opens on a cliff at around 500 m from the modern coastline. The importance of this site, excavated in 1957-1970 and again in 2008-2011, lies on its long occupational history from the Late Palaeolithic to the Middle Ages. It has been one of the key sites traditionally used since the mid-20th century for the reconstruction of the different cultural phases of the Southern Italy prehistory (Bernabò Brea and Cavalier, 2000; Fiore et al., 2016; Tagliacozzo, 2000; Tagliacozzo et al., 2016). The history of the Grotta della Madonna's occupation, according to its stratigraphy, can be summarized as follows:

- The first recorded occupations of the cave come from the Upper Palaeolithic (Late Epigravettian lithic industry), dated to *ca.* 12,000-9,000 years BP, and are followed by a Mesolithic occupation (Undifferentiated Epipalaeolithic lithic industry) dated to *ca.* 8,400-6,400 cal. years BC, which point to an intense use of the cave during that time (Alessio et al., 1965; 1967; Cardini, 1972; Tagliacozzo, 2000; Tagliacozzo et al., 2016).
- After a hiatus (no occupation is recorded during the Early Neolithic), the cave was re-occupied during the early Middle Neolithic with red-band painted pottery and some Impressed Ware, *ca.* 6,500-6,100 cal. years BC (Alessio et al., 1967).
- The following strata evidence a few pottery sherds from the Late Neolithic Diana or evolved phases of Serra d'Alto styles; but the scarcity of biological and cultural record suggests that this layer could have represented a hiatus in the human occupation of the site. The radiocarbon date for this level is *ca.* 4,500-4,200 cal. years BC (Alessio et al., 1967).
- The next phase of occupation contains evidence of Late Neolithic Spatarella-Diana and Eneolithic Piano Conte pottery styles, and it represents a period of low intensity of occupation. Radiocarbon dates of *ca.* 4,000-3,300 cal. years BC are available for these levels (Alessio et al., 1966; 1967).
- The upper levels of the cave correspond to the Late Eneolithic-Early Bronze Age Laterza culture, and the Middle Bronze Age Proto-Appennine and Appennine cultures. During these periods the cave was intensely utilized (Calcagnile et al., 2010; Tagliacozzo et al., 2016). Radiocarbon dates for these strata are within the range of *ca.* 1,200-450 cal. years BC (Alessio et al., 1967).

Grotta della Madonna's long occupational history has allowed the reconstruction of the changing modes of animal exploitation through time. It is worth mentioning that during the 1965-1970 excavations sieving was carried out on site with a 1 cm mesh, and the sediment was afterwards again wet sieved with a 2 mm mesh (Tagliacozzo, 2000). In the Mesolithic, the hunted species were, in order of abundance, wild boar, red deer, and roe deer. Almost no bovid remains are present during this phase. Wild boars were killed mainly as young and young-adult, and the age at death profiles' analysis indicated a season of capture between the end of spring and beginning of autumn, while the cervids were mostly adults. There is also presence of a small quantity of carnivores – wolf and badger –, alongside turtles/tortoises (*Emys* cf. *orbicularis* and *Testudo hermanni*), molluscs, micrommamals, and rare bird and fish remains (Fiore et al., 2016). However, fishing never played an important role in the diet of the Grotta della Madonna inhabitants, as it is also the case for other sites of the region, even if the site was located close to the coast (Tagliacozzo, 2000). Overall, it seems that the Mesolithic occupations of the site consisted of short and repeated visits, where whole carcases – minus the heads in most cases, indicating primary processing occurring off-site – were brought back to the cave and processed for consumption, and the variety of taxa exploited points to an excellent knowledge of the territory and its resources by these populations (Cardini, 1972; Fiore et al., 2004; 2016; Tagliacozzo et al., 2016). The Mesolithic occupation of the cave is followed by a Middle Neolithic phase characterised by Bande Rosse pottery, and by this time the assemblage is dominated by domesticated animals, with a small proportion of wild animals. Amongst the former, sheep/goat are the most abundant, followed by pig and cattle. The mortality profiles of these animals indicate an exploitation based primarily on meat production. Regarding the wild taxa, red deer, roe deer, edible dormouse (*Glis glis*), wild boar, and some carnivores are all present. The occurrence of these animals, also in following periods of occupation, indicate the presence of forested areas near the cave. In terms of the domestic pig/wild boar distinction, the authors mention that it was undertaken on the basis of size, although they clarify that this distinction was only carried out on adult individuals (Tagliacozzo, 2000). All in all, during this period of occupation of Grotta della Madonna, the main animal contribution was represented by caprine farming, complemented by meat from pigs and cattle, with only a minor role of secondary products. Hunting of red and roe deer, and occasionally of wild boar, as well as some terrestrial turtle gathering and fishing, also played some role (Tagliacozzo, 2000).

During the following stages of occupation of the Grotta della Madonna cave, the importance of the main domesticates is maintained and becomes more accentuated as the hunting of wild animals decreases in importance. Indeed, during the next Middle Neolithic phases and in the Late Neolithic phase of Diana pottery, there is an increase in the importance of ovicaprids at the expense of pigs, and a decrease of wild taxa. The main use of the domestic animals, based on the mortality data, was still based on meat production. In the Eneolithic (initial Gaudo pottery style), the importance of sheep/goat slightly diminishes in favour of pig farming, and hunting becomes somewhat more relevant. A change in mortality patterns is also detected for the ovicaprids, with a greater presence of adult and even elderly individuals; this change points to an increasing importance of secondary products. This trend continues onto the Bronze Age, where the role of sheep/goat farming decreases further in favour of the exploitation of pigs and cattle. Again, the age at death profiles of ovicaprids and also cattle point to an increasing specialization in the exploitation of secondary products. In the case of pig, its role as a meat provider becomes stronger through time, with the animals being killed progressively younger (Facciolo and Tagliacozzo, 2004; Tagliacozzo, 2000).

Broglio di Trebisacce is an open-air site located on the northern Ionian Sea, in the Trebisacce municipality of the Cosenza province. Located at 180 m.a.s.l., the site has a dominating position over the Sybaris plain and the coastal access between this area and the region of Basilicata. The site has a chronology spanning from the second phase of the Middle Bronze Age (1,700-1,350 cal. years BC) to the Early Iron Age (*ca.* 720 years BC). It has been excavated since 1979, and it covers 11 ha in its maximum expansion (Elevelt and Tagliacozzo, 2009; Tagliacozzo, 1994b). The Trebisacce site is part of a larger network of sites in Ionian Calabria, and contains pottery of Mycenaean origin, both imported and locally produced (Jones et al., 1994). The animal bone material was collected by hand and also sieved with a 1 cm mesh (Elevelt and Tagliacozzo, 2009; Tagliacozzo, 1994b). The Middle and Late Bronze Age animal remains recovered in different seasons of excavation were analysed in different stages by several authors (Cassoli, 1984; Elevelt and Tagliacozzo, 2009; Gliozzi, 1984; Tagliacozzo, 1994b), and the combined results will be summarize in the following paragraphs.

The most represented taxa in the assemblages are the main domesticates: ovicaprids, pigs, cattle, small numbers of dog, and one specimen of *Equus* of asinine characteristics. The pastoral economy at Broglio di Trebisacce was well developed, with sheep and goat the best represented domestic category. These animals exhibited a mortality pattern indicative of their use mainly for secondary products, with a slight increase of young individuals during the Late Bronze Age. The exploitation of ovicaprids was complemented by the use of pigs for their meat and cattle for secondary products, traction, and meat to a lesser degree. Additionally, during the Late Bronze Age, this latter species sees a slight increase in the number of adult individuals killed. Dogs, always represented in small numbers, were occasionally eaten (Cassoli, 1984; Elevelt and Tagliacozzo, 2009; Gliozzi, 1984; Tagliacozzo, 1994b).

The wild animals of Broglio di Trebisacce are represented by red deer, roe deer, wild boar, and small numbers of hare, carnivores, turtles, molluscs, and birds. Red deer is the most hunted species, and it is represented by mostly male adult individuals, whose antlers were valued as raw materials. Wild boar is scarce, although the authors make concessions about the difficulty of distinguishing wild vs domestic varieties (Elevelt and Tagliacozzo, 2009; Tagliacozzo, 1994b). Carnivores were exploited perhaps not so much for their meat but for their fur, and the role of turtle and mollusc gathering, and bird hunting was minimal. Hunting activities, mostly directed towards red deer, increase in importance through time, especially during the Late Bronze Age (Cassoli, 1984; Elevelt and Tagliacozzo, 2009; Gliozzi, 1984; Tagliacozzo, 1994b).

The site of Torre Mordillo can be found some distance south-west of Broglio di Trebisacce, also in the Cosenza province. It is part of the same network of sites as Trebisacce and enjoying the same strategic location on the Sibari plain, overlooking over both the inland and marine territories. Torre Mordillo had a continuous occupation covering the Middle to Late Bronze Age, although there is also scant evidence of an Early and Middle Neolithic occupation. Excavated from 1987 to 1990, the site covered 14 ha in its maximum extension and has evidence of large fortifications. As well as at Broglio di Trebisacce, there is evidence at this site of Mycenaean pottery, both imported and locally produced, with more stylistic and typological variety than those found in the ceramics of the former site (Arancio et al., 1995). The animal bone from the Late Bronze Age indicates an economy based mainly on the exploitation of pigs and cattle, the former for meat (15% killed under six months, while 60% killed under three years) and the latter for secondary products, traction, and meat (mostly killed as adults). Sheep and goat farming complemented these activities, with these animals being used primarily for secondary production. A small number of horse and dog specimens complete the domestic assemblage. Lastly, a small proportion of wild animals are also represented (red deer, fox, wildcat, birds, turtles, and very rare fish bones), indicating that hunting played only a small role in the economy of Torre Mordillo (Arancio et al., 1995). The pig data included in this research comes from the Middle and Late Bronze Age levels.

The last site from the Calabria region included in this study, and indeed from peninsular Italy, is Favella. Located on the Sybaris plain, not far from the Ionian coast, this site has an Early Neolithic occupation, characterised by an 'archaic' impressed pottery and dated to *ca.* 7,000 years BP/5,000 years BC, and there is also evidence of a more recent Neolithic occupation (Natali and Tiné, 2002; Sorrentino, 1996; Tagliacozzo, 2005). It has been excavated in 1962, 1964, and from 1990 to the present, and the technique of recovery of faunal remains has varied in the different excavations: in some cases, dry sieving was carried out with 0.4-0.5 cm meshes and in others wet sieving was also undertaken. Consequently, the degree of recovery bias is variable according to the year of excavation (Tagliacozzo and Pino Uria, 2009). The site consists of several structures, whose zooarchaeological assemblages have been studied by different researchers (Albertini, 2009; Pino Uria, 2009; Pino Uria and Tagliacozzo, 2004; Sorrentino, 1996; Tagliacozzo, 2005; Tagliacozzo and Pino Uria, 2009); here we will present a summary of those results for the Early Neolithic period. Mammals are the animals most represented in the assemblage, followed by fishes, and small quantities of turtles and birds. Domestic species dominate, with the hunting of wild boar, aurochs, red deer, roe deer, and some carnivores (fox and wildcat) playing a marginal role in the economy. Regarding the domestic/wild pig distinction, the authors recognize the difficulty of separating the two species in the archaeological record, and concede that some of the domestic specimens, especially the young, could have been wild, but suggest that mostly were domestic (Tagliacozzo and Pino Uria, 2009). In order of abundance, the domestic taxa present are sheep and goat, cattle, pigs, and a small number of dogs. The mortality patterns of all the three main domesticates indicates a high proportion of sub-adults kills, and this in turn points to the importance of these animals as a source of meat for these populations. The presence of very young and adult individuals in the caprine and bovine categories implies the use of these animals for secondary products as well, and traction in the case of cattle. The adult individuals were also most likely kept for reproduction purposes, and this would apply to the pig too (Pino Uria and Tagliacozzo, 2004; Sorrentino, 1996; Tagliacozzo, 2005; Tagliacozzo and Pino Uria, 2009). Lastly, the presence of fishes in some frequencies indicates that this activity provided complementary subsistence resources (Albertini, 2009; Tagliacozzo, 2005; Tagliacozzo and Pino Uria, 2009). There is also evidence of animal bone used for tool manufacture (Pino Uria, 2009; Tagliacozzo and Pino Uria, 2009).

6.3.d. Sites in Sicily: Grotta dell'Uzzo (Sicily) and Mursia (Pantelleria)

The *Sus* evidence for Sicily is represented by the sites of Grotta dell'Uzzo, a key settlement in the study of the Mesolithic/Neolithic transition, and Mursia. At Grotta dell'Uzzo, the Mesolithic/Neolithic transition and the periods before and after are well documented in its archaeological sequence, similarly to the site of Franchthi Cave in Greece. The site is located on the east side of the San Vito lo Capo peninsula, in the Trapani province (north-west part of the island). Grotta dell'Uzzo is one of the many caves and rock shelters that dot the gorge, and it is still used today by shepherds to shelter their flocks. It was excavated between 1975 and 1983, and the works involved wet sieving with a 2mm mesh on site, thus allowing for a very good level of recovery. The site has a chronology covering the Mesolithic and Neolithic, dated from the mid-10th to the mid-6th millennium cal. BC (Calligaris et al., 1991; Meulengracht et al., 1981; Piperno et al., 1980; Tagliacozzo, 1994a). The site's stratigraphy has been organized in several phases of occupation according to its chronology: Mesolithic I and II, a transitional level between Mesolithic and Neolithic, and Neolithic I and II. In terms of material culture, the lithic industry undergoes a transformation in the transitional period, losing elements characteristic of the Mesolithic industries and seeing the rapid appearance of new types and the acquisition of new techniques of blade production. The characteristic element during this time is the transverse arrowhead, made with the microburin technique, which is similar to those typical of the Early Neolithic. The first appearance of pottery occurs in the first Neolithic phase, and it is of the cardial style, impressed and incised. A second pottery horizon is characterized by the association of some of the preceding motifs in more organized patterns. The third pottery horizon is characterized by the Middle Neolithic pottery of Stentinello style, dated to the beginning of the 6th millennium cal. BC. Another archaeological feature of the cave is that is what used for burials throughout the Mesolithic (Piperno et al., 1980; Tagliacozzo, 1994a).

In the following paragraphs the ample zooarchaeological evidence of Grotta dell'Uzzo (Cassoli et al., 1987; Piperno et al., 1980; Tagliacozzo, 1993a; 1994a) will be summarized. Below the first Mesolithic levels, some material dated to the end of the Pleistocene was recovered. This scant archaeological evidence, however, points to a combination of remains accumulated naturally and those resulting from an occasional occupation of the cave by human groups. There was no available data from this period that could be used in this study. It is only with the beginning of the Mesolithic I phase that the accumulation of remains can certainly be attributed to a regular occupation of the cave by humans. The faunal assemblage from this phase consists of birds, micromammals, and macromammals. Among the latter, red deer is the most represented species, followed by wild boar, fox, and a small number of other carnivores, aurochs, and mustelids. Red deer, represented by all anatomical parts, were hunted mostly between three and five years old, and it is worth anticipating that the hunting of this animal is a tradition that continues, with variable intensity, throughout the site's sequence. In terms of size, the red deer was smaller than both its contemporary continental counterpart and that from other parts of Sicily. The wild boar, which occurs in smaller numbers than red deer, are present in the adult and young/young adult categories, and one female and two males were identified. In this Mesolithic level the first evidence of marine molluscs appears, and bird remains are frequent with the presence of many species. The numerous finds of micromammals and microfauna indicate that the cave was not yet occupied in a continuous or stable manner. The animals present indicate an environment similar to present day but with more forest cover and a more humid climate. In sum, the zooarchaeological evidence indicates that during this period of occupation of the cave, the main means of subsistence was the hunting of red deer, wild boar, and fox. This was complemented with bird hunting and collection of marine molluscs (Cassoli et al., 1987; Piperno et al., 1980; Tagliacozzo, 1994a).

The following phase of occupation at Grotta dell'Uzzo, Mesolithic II, has extensive evidence of human activity, with many bones showing burning and butchery marks. In this phase, the mammals have an increased presence, at the expense of birds and micromammals, and there is also an increase in the frequency of marine molluscs. Fish remains are also present, and they increase in the later stages of this period, alongside marine mammals (seals and cetaceans). Birds decline in number and variety of species, while the collection of marine molluscs increased in importance. Red deer is still the most commonly hunted animal, but wild boar and aurochs have a larger presence than before. The head and limb bones of red deer are present in the assemblage, with evidence of its antler being removed from the skull. Indeed, the hunting of this animal mostly targeted young-adult males, which provide a good return of antlers and meat. Regarding the wild boar, its size is smaller than the continental size for this period, and it is mostly represented by teeth, jaws, and limbs, perhaps because these parts are usually better preserved. There is a larger number of young wild boar than in the previous period and very few adults (>3-4 years) (Cassoli et al., 1987; Piperno et al., 1980; Tagliacozzo, 1994a). This has been interpreted by the authors as possibly reflecting a selective hunting strategy (Tagliacozzo, 1994a). The fox was also hunted during this time, but in smaller numbers than before. The first Sicilian pre-Neolithic specimen of wildcat was found in the later stage of this period. To sum up, this later Mesolithic period saw the continuation of large mammal hunting as the primary subsistence activity, but now complemented with the exploitation of marine resources. These changes were likely connected to a greater stability of occupation of the cave, which was also probably connected with the reduction of bird and micromammal remains. The increase in wild boar and the presence of aquatic birds, European water vole (*Arvicola terrestris*), toads (*Bufo*), and European pond turtle indicate the existence of more extensive wetland than today (Cassoli et al., 1987; Piperno et al., 1980; Tagliacozzo, 1994a).

The next Mesolithic phase in Grotta dell'Uzzo is considered to be a transitional phase into the Neolithic due to the evidence of technological and economic changes that later would, in a fully developed manner, characterize the Early Neolithic. The main changes are the enlargement of the subsistence base (a 'broad spectrum' revolution), linked to a more intensive use of marine resources, a semi or fully sedentary occupation of the cave, and the presence in the lithic assemblages of Early Neolithic techniques (Cassoli et al., 1987; Costantini, 1989; Piperno et al., 1980; Tagliacozzo, 1994a). In general terms, the zooarchaeological assemblage from this phase is characterized by a considerable increase in fish and molluscs, both in quantity and diversity of taxa, the presence of cetaceans and crustaceans, and the marked decline in micromammals and birds. Concerning the mammalian taxa, red deer continues to predominate, followed by wild boar, while aurochs is almost absent. Indeed, the disappearance of the aurochs can be placed in this phase, as the local environment was probably unsuitable for large bovid herds. Red deer continues to be, in this phase, the primary food source, although their proportion sees a slight diminution from previous phases. The mortality data for this species show a further decrease in the number of young individuals hunted and an increase in young adults aged 3-5 years. Once again, the data suggests the targeting of young adult males (probably directed towards the bachelor herd), which are an optimal source of antlers, meat, and hides. A size reduction is also detected in red deer, likely due to local isolation and/or hunting pressure.

The killing pattern of wild boar is similar to that of the previous phase, except that there is an increase in the proportion of individuals killed under the age of two – including some very young animals under six months old – and adults of more than 3-4 years of age are very rare. Additionally, males seem to predominate in this phase, unlike in previous times where both sexes were roughly equally represented (Cassoli et al., 1987; Piperno et al., 1980; Tagliacozzo, 1993a; 1994a). The authors observed as well for this species that, in terms of size, there does not seem to be clear differences with the previous periods, although they do note the occurrence of some particularly small individuals. These characteristics of wild boar exploitation, namely their increase in numbers and in the exploitation of younger individuals, could be hinting, according to the authors, to the beginnings of a process of local domestication (Tagliacozzo, 1994a).

Other mammalian species present in the cave during this time are foxes, which continue to be common, wildcat, which sees a small increase in numbers, and some *Canis* – wolf or perhaps domestic dog. The presence of cetaceans during this phase deserve a special mention, as neither the specialized navigational techniques nor the specialized toolkit required for cetacean hunting was identified in the archaeological record. It is therefore possible that these remains represent animals beached due to natural causes that the inhabitants of the cave collected. However, the authors mention that these remains do coincide with a general increase in the exploitation of marine resources during this phase, and this leads to question the true nature of how these animals came to be in the cave (Cassoli et al., 1987; Piperno et al., 1980; Tagliacozzo, 1993a; 1994a).

Above the Mesolithic/Neolithic transition level lays the Neolithic I phase, which has, on its middle levels, a radiocarbon date of *ca.* 5,800-5,600 cal. years BC, leaving an approximately 1,000 years gap from the preceding phase, dated on the lower levels to *ca.* 7,000-6,700 cal. years BC. Therefore, the transition from Mesolithic to Neolithic occurred in this 1,000 years (Tagliacozzo, 1994a). The Neolithic I phase, characterized, as mentioned before, by impressed cardial style pottery, sees the gradual introduction of the first domesticated animals: sheep and goat, cattle, and dogs, in that order of abundance. The pigs present in this phase were also likely domesticated, accompanied by rare remains of wild boar. Red deer is still the most represented species, albeit declining in importance, with fox and wildcat also present. Red deer hunting continues to be preferentially aimed at individuals three to five years old, and their size continues to be small. Birds show a further reduction in number of species present, but with also some new additions, including birds that winter in Sicily, indicating a year-round occupation of the site. Fishing and marine molluscs are abundant, representing an important part of the Neolithic economy of this communities. The presence of hooks made of bone, previously unknown in the record, reinforce the relevance of the fishing activity. Crustaceans also increase in numbers, including the presence of sea urchins (Echinidae), another indicator of the intense marine exploitation characterising this phase. Furthermore, rare remains of Mediterranean monk seal (*Monachus monachus*) and loggerhead turtle (*Caretta caretta*) were also recovered (Cassoli et al., 1987; Piperno et al., 1980; Tagliacozzo, 1993a; 1994a).

Sheep and goats from Neolithic I at Grotta dell'Uzzo were clearly introduced, given the absence of the wild form in Sicily. All anatomical elements of these taxa are represented, with a clear majority of juvenile individuals killed for meat and only a few adults kept for reproduction. Both sheep and goat are of a size comparable to those found in the Italian mainland. The presence of domestic cattle of various ages likely represents introduced animals, as they evidence a clear reduction in size from the Mesolithic aurochs. The rarity of the aurochs in the preceding period also makes the hypothesis of a local domestication unlikely. Their rearing could not have been an important economic activity, though, as the surrounding environment does not offer extensive pasture land (Cassoli et al. 1987; Tagliacozzo 1993; Tagliacozzo 1994; Piperno et al. 1980).

The pigs are mostly identified as domestic by the authors, with remains of wild boar still occurring, although the distinction of the young individuals of these species is difficult (Tagliacozzo, 1994a). Their continued importance is attested by the similar frequencies between this period and the previous ones, and for the first time in the cave's sequence they outnumber the red deer, based on MNI. A slight change in pig mortality patterns can be observed in this phase, with an increase in the number of animals killed before one year of age, including as well some sucklings. A lower proportion of individuals are older than 2-3 years of age and none older than 4-6 years, with only three males and two females identified (Cassoli et al., 1987; Piperno et al., 1980;

Tagliacozzo, 1993a; 1994a). In terms of size, the authors comment on the generally smaller size and more gracile shape of these pigs in comparison with preceding periods, but this could be due to the higher proportion of juveniles, and indeed a single height calculation falls within the range of the wild boar. The lack of a clear break in size from the Mesolithic to the Neolithic, combined with a higher proportion of animals killed young and very young than before, mostly males, led the authors to suggest a possible local domestication of the pig in Grotta dell'Uzzo, as mentioned before. This phenomenon could have commenced at the end of the Mesolithic, when a tighter control over the wild boar populations can be seen, with an increase in the hunting of progressively younger animals (Tagliacozzo, 1994a).

In sum, during the first Neolithic phase at Grotta dell'Uzzo, we witness the gradual and progressive introduction of a domestic economy, probably linked to the development of extensive contacts by sea and inland with other communities, which did not signify the complete replacement of their previous life style, but instead complemented the existing system of hunting and exploitation of marine resources that was well established by the Mesolithic and the end of the Mesolithic (Tagliacozzo, 1994a).

The final phase represented at Grotta dell'Uzzo corresponds to the later Early Neolithic and the earliest phases of the Middle Neolithic occupation of the cave, characterized by abundant pottery of Stentinello style, the use of obsidian, and lithic blade technology. The quantity of animal bone material recovered in the excavations is smaller than for previous phases, a fact possibly related to the progressive abandonment of the cave and its transformation into a shelter for shepherds and their flock (Tagliacozzo, 1994a). In the zooarchaeological assemblage for this phase, there is once again an increase in the proportion of macromammals at the expense of birds and micromammals, while fish continues to be an important food source. Wild animals see a progressive decline in numbers during this phase in favour of the main domesticates. Of the former, red deer is still the most abundantly hunted animal, but sees a considerable decrease in frequency, indicating the marginality of hunting after several millennia of intensive use of wild resources. Red deer is represented by individuals of all ages, but predominantly young adults. Fox and wildcat are also present, but also in declining numbers, and hare appears for the first time. Birds are no longer hunted. Fish remains show a slight drop in numbers, but still play an important role in the diet. The presence of grouper

(*Epinephelus* sp.), a deep-water taxon which has been the most abundant fish exploited in the cave since the transitional phase, hints at the possibility that underwater fishing with wooden fish-spears may have been practised. The collection of molluscs and crustaceans still occurred in this phase, but with lesser intensity than before (Cassoli et al., 1987; Piperno et al., 1980; Tagliacozzo, 1993a; 1994a).

Domesticated species attained the main role in the economy of the Neolithic II Grotta dell'Uzzo communities. They are represented, in order of abundance, by ovicaprids, pigs, cattle, and dogs. Sheep and goat increase in numbers progressively, goats becoming more frequent than sheep. In terms of mortality patterns, ovicaprids were mostly killed during their first year, followed in abundance by adults killed between three and eight years old, and lastly, by individuals killed under the age of two. This pattern indicates that pastoralism had become more complex in this period, possibly in relation to the exploitation of secondary resources, likely goat's milk. Cattle, more common than in the previous phase, are represented by both very young and adult individuals (Piperno et al., 1980; Tagliacozzo, 1993a; 1994a). All remains of pigs, less common than in the previous phase, were identified as domestic with a clear size reduction, and no wild boar was present, although the authors concede that some of the young animals could belong to the latter species. Indeed, the authors state that "The [pig] remains are completely different from those found in earlier levels and suggest the presence of a long domesticated variety. The occurrence of remains showing an anomalous dentition, reflecting the shortening of the facial part, represents a certain proof of domestication" (Tagliacozzo, 1994a: 32). The age at death data of these pigs show a further increase in the quantity of animals killed before the age of two, many of which were killed under the age of one. Adult animals also occur, but no sexing data is available for this period (Piperno et al., 1980; Tagliacozzo, 1993a; 1994a).

The data from the Neolithic II levels represents the last evidence we have of the prehistoric occupations of Grotta dell'Uzzo. Overall, the occupation of the cave sees a progressive adoption by the original Mesolithic communities of a Neolithic subsistence, albeit keeping true to their traditional hunting and fishing practices, to finally culminate in the last phase of occupation into a fully developed domestic economy.

Finally, the southernmost site included in this study is the Bronze Age village of Mursia, located in the island of Pantelleria. The site is situated in a small rocky promontory in the northern limit of the lava flow that runs from the Gelkamar mount to the sea, on the North-Western part of the island. This location provides strategic control over the sea and surrounding territory. Mursia was excavated in several occasions, starting with a very early systematic excavation by P. Orsi at the end of the 19th century, followed by several campaigns between 1966-1971, 1995-97, and finally from 2001 to the present (Cattani et al., 2012). The site is linked to the monumental necropolis of I Sesi, featuring a series of stone building enclosures (*capanne*) with a well-structured organization over 1 ha, which saw modifications throughout the phases of occupation (Ardesia et al., 2006; Cattani, 2016; Cattani et al., 2012). The radiocarbon dating of Mursia places the occupation of the site between 2,195 and 1,320 years BC, corresponding to the peninsular Middle Bronze Age, and the Sicilian late Early Bronze Age and Middle Bronze Age (Ardesia et al., 2006; Cattani et al., 2012).

Wilkens (1986; 1987) carried out an analysis of the animal remains recovered from the 1966-1971 excavations. The main domesticates are sheep/goat, cattle, and pig, in that order of abundance. Ovicaprids were the base of the animal economy at Mursia, with goats more abundant than sheep, which can be explained with their higher suitability to the dry environment and Mediterranean vegetation of the island. These animals were small and gracile, and their mortality data indicates a high proportion of both sheep and goat killed before two years old, with also a high percentage of goats killed between two and three and a half years, but no so much for the sheep, which sees a higher frequency of survival after three years. Cattle are the second most represented domestic animal, and they are also of small size. Most animals were killed mostly before one year of age or after four years, indicating their use both for meat and secondary products/traction. Finally, pigs were not very abundant in these assemblages, probably due to the arid environmental conditions of the island. Also of small size, they were typically killed before two years of age, with only a small number reaching three and a half years (Wilkens, 1987). Hunting was scarce, and directed to sea mammals (Mediterranean monk seal) and birds, given the lack of large wild mammals in the island, while a small amount of mollusc gathering and fishing was also practised all year round (Wilkens, 1986; 1987).

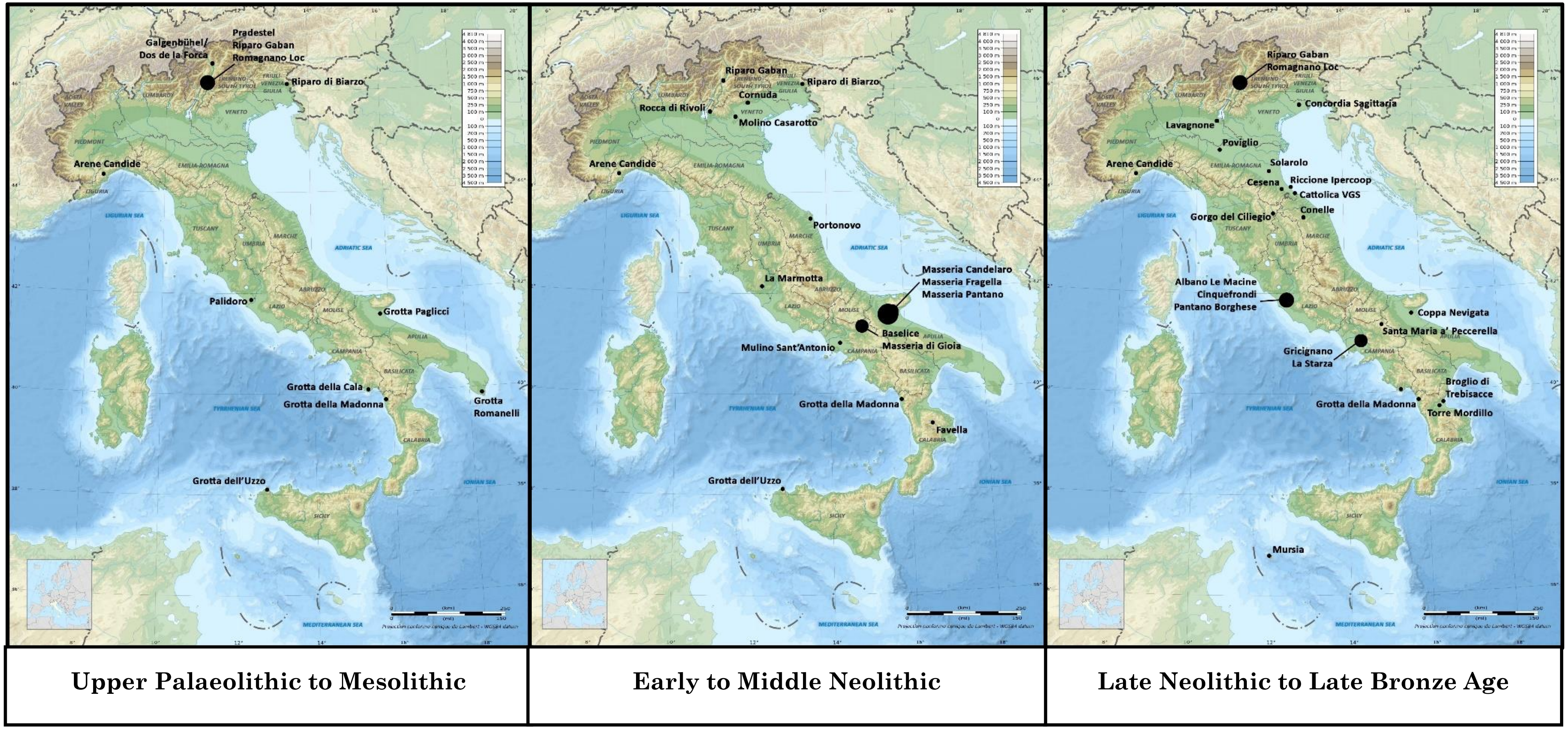
The zooarchaeological analysis of the material from the 2001 to the present excavations of Mursia is currently under study at the University of Bologna, and not yet published at the time of writing of this thesis. The pig material from the site included in this research corresponds to the *capanna* B14, exceptional for its size and used during the earliest phases of occupation of the site, with a chronology dating to the 18th and 16th centuries BC (Ardesia et al., 2006; Debandi, 2015).

Chapter 7

RESULTS: PIGS IN ITALY

In this chapter, the results of the sex, age, and biometry studies will be presented. The analyses will focus on the following chronological periods: Upper Palaeolithic and Mesolithic; Early, Middle, and Late Neolithic; Eneolithic; and Early, Middle, and Late Bronze Age. For the biometrical scatterplot analysis, the sites will be grouped into main areas (North-Centre-South-Islands) to make the most of small samples; for the rest of the analyses, sites will be considered individually. A map detailing the studied sites' locations has been presented in the previous chapter (Figure 6.1), but in Figure 7.1 the sites studied can be seen in the map according to their chronology. Tables 7.1 to 7.4 summarize the data collected for each site, on the basis of NISP. A total of 4,824 postcranial bones and 3,163 teeth (loose teeth and jaws) from Sus have been recorded for this research, for a grand total of 7,987 specimens. During the analysis, abbreviations of common anatomical elements and quantification methods will be used, which have been defined in Chapter 5.

Pathologies were observed but were found to be scarce. Very few postcranial bone specimens (total 19 NISP from Molino Casarotto, Arene Candide, Coppa Nevigata, and Grotta della Madonna) exhibited exostosis or shape abnormalities. On molar teeth, the presence of linear enamel hypoplasia (LEH) was recorded only when severe (see example in Figure 7.2) and therefore observed in a limited number of cases (never in more than 6 NISP per site). For this reason, a detailed study on the occurrence of LEH in pig teeth was left out of the analysis.



Upper Palaeolithic to Mesolithic | **Early to Middle Neolithic** | **Late Neolithic to Late Bronze Age**

Figure 7.1. Location of the Italian sites studied, according to their chronology.

REGION	SITE	CHRONOLOGY	NISP POST-CRANIAL BONES	NISP TEETH	NISP TOTAL
NORTH					
Trentino-Alto Adige	Galgenbühel/ Dos de la Forca	Mesolithic	1	2	3
	Pradestel	Mesolithic	9	15	24
	Riparo Gaban	Mesolithic	10	5	15
	Romagnano Loc	Mesolithic	11	10	21
Friuli-Venezia Giulia	Riparo di Biarzo	Upper Palaeolithic (Late Epigravettian)	7	29	36
		Upper Palaeolithic (Late Epigravettian)/Mesolithic	-	5	5
		Mesolithic	18	5	23
		Mesolithic/Neolithic	3	3	6
Liguria	Arene Candide	Upper Palaeolithic	4	2	6
CENTRE					
Latium	Palidoro	Upper Palaeolithic	52	135	187
SOUTH					
Apulia	Grotta Paglicci	Upper Palaeolithic	74	193	267
	Grotta Romanelli	Upper Palaeolithic (Late Epigravettian)	2	2	4
Campania	Grotta della Cala	Upper Palaeolithic (Uluzzian, Aurignacean and Gravettian)	2	9	11
		Mesolithic	7	6	13
Calabria	Grotta della Madonna	Upper Palaeolithic	208	135	343
		Mesolithic	289	67	356
ISLANDS					
Sicily	Grotta dell'Uzzo	Upper Palaeolithic/Mesolithic	6	-	6
		Mesolithic and Mesolithic/Neolithic Transition	156	116	272
TOTAL			**859**	**739**	**1598**

Table 7.1. NISP counts of Upper Palaeolithic and Mesolithic sites studied.

REGION	SITE	CHRONOLOGY	NISP		
			POST-CRANIAL BONES	TEETH	TOTAL
NORTH					
Trentino-Alto Adige	Riparo Gaban	Early Neolithic	9	11	20
		Mesolithic/Neolithic	3	3	6
		Neolithic	1	-	1
Veneto	Cornuda	Late Neolithic	37	3	40
	Molino Casarotto	Middle Neolithic	72	63	135
	Rocca di Rivoli	Middle Neolithic	137	191	328
Liguria	Arene Candide	Early Neolithic	240	86	326
		Early to Middle Neolithic Transition	5	15	20
		Middle Neolithic	430	212	642
		Late Neolithic	59	24	83
		Late Neolithic and Copper/Bronze Age	11	-	11
CENTRE					
Marche	Portonovo	Early Neolithic	40	31	71
Latium	La Marmotta	Early Neolithic	62	20	82
SOUTH					
Apulia	Masseria Candelaro	Middle Neolithic	20	23	43
	Masseria Fragella	Early Neolithic	10	14	24
	Masseria Pantano	Middle Neolithic	9	4	13
Campania	Baselice	Early Neolithic	18	4	22
	Masseria di Gioia	Middle/Late Neolithic	10	2	12
	Mulino Sant'Antonio	Late Neolithic	14	7	21
Calabria	Favella	Early Neolithic	12	6	18
	Grotta della Madonna	Middle Neolithic	34	19	53
		Late Neolithic	3	3	6
ISLANDS					
Sicily	Grotta dell'Uzzo	Early Neolithic	9	13	22
		Middle Neolithic	11	8	19
		Early to Middle Neolithic	20	22	42
TOTAL			**1276**	**784**	**2060**

Table 7.2. NISP counts of Neolithic sites studied.

REGION	SITE	CHRONOLOGY	NISP		
			POST-CRANIAL BONES	TEETH	TOTAL
NORTH					
Trentino-Alto Adige	Riparo Gaban	Eneolithic/Copper Age	8	10	18
		Early Bronze Age	26	25	51
		Middle Bronze Age	7	7	14
	Romagnano Loc	Eneolithic/Copper Age	-	1	1
		Early Bronze Age	1	2	3
Veneto	Concordia Sagittaria	Late and Final Bronze Age	52	67	119
Lombardia	Lavagnone	Early Bronze Age	174	118	292
Liguria	Arene Candide	Late Neolithic and Copper/Bronze Age	11	-	11
		Copper/Bronze Age	115	55	170
CENTRE					
Emilia Romagna	Cattolica VGS	Early Bronze Age	52	89	141
	Cesena	Middle Bronze Age	48	19	67
		Late Bronze Age	117	86	203
	Poviglio	Middle and Late Bronze Age	31	23	54
	Riccione Ipercoop	Middle and Late Bronze Age	4	6	10
	Solarolo	Middle Bronze Age	200	147	347
Marche	Conelle	Eneolithic/Copper Age	758	260	1018
Tuscany	Gorgo del Ciliegio	Middle Bronze Age	8	35	43
Latium	Albano Le Macine	Middle Bronze Age	57	30	87
	Cinquefrondi	Eneolithic/Copper Age	12	18	30
	Pantano Borghese	Eneolithic/Copper Age	10	7	17

Table 7.3. NISP counts of Eneolithic/Copper and Bronze Age sites studied (North and Centre). Totals in Table 7.4.

REGION	SITE	CHRONOLOGY	NISP		
			POST-CRANIAL BONES	TEETH	TOTAL
SOUTH					
Apulia	Coppa Nevigata	Middle Bronze Age	223	153	376
		Late and Final Bronze Age	146	61	207
Campania	Gricignano	Late Eneolithic to Early Bronze Age Transition	54	38	92
	La Starza	Middle Bronze Age	104	85	189
	Santa Maria a' Peccerella	Copper/Early Bronze Age	4	2	6
Calabria	Broglio di Trebisacce	Middle Bronze Age	121	120	241
	Grotta della Madonna	Eneolithic/Copper Age	6	4	10
		Early Bronze Age	24	13	37
		Middle Bronze Age	59	64	123
	Torre Mordillo	Middle Bronze Age	5	2	7
		Late and Final Bronze Age	58	30	88
ISLANDS					
Sicily	Mursia	Middle Bronze Age	194	63	257
TOTAL			**2689**	**1640**	**4329**

Table 7.4. NISP counts of Eneolithic/Copper and Bronze Age sites studied (South and Islands). Totals include data from Table 7.3.

Figure 7.2. Example of severe linear enamel hypoplasia (LEH) recorded, from the site of Palidoro (Upper Palaeolithic). Photo by S. Tecce.

Before moving on to the presentation of results, it is worth mentioning that certain colour 'conventions' were followed in the presentation of the data, for the sake of clarity. In all figures and in colour tables, the following colours are associated with specific periods:

- Grey (boxplots), Black (scatterplots), or Yellow (log ratios): Upper Palaeolithic;
- Black: Mesolithic or Upper Palaeolithic and Mesolithic combined;
- Blue: Early Neolithic;
- Orange: Middle Neolithic;
- Purple: Late Neolithic;
- Pink: Eneolithic;
- Green: Bronze Age or later prehistoric periods combined (from Late Neolithic onwards).

Other colours or different shades of the main colour were also used to signify data covering more than one period.

7.1. Age Profiles

In this section the results of the age at death analysis will be presented, based both on postcranial fusion and tooth wear stages. This information provides information on kill-off patterns and complements the biometrical data, as the dimension of some bones can be affected by age (Payne and Bull, 1988). Both sources of data are combined in the interpretations, although it is important to note that postcranial bones are more influenced by taphonomic and recovery factors than jaws. The procedure followed for the assignation of age stages is described in Chapter 5.2. A list of foetal/neonatal postcranial bones identified can be found in Table 7.5.

Not all sites provided a meaningful sample to conduct a comprehensive analysis of age at death. In order to calculate frequencies of each age category, an arbitrary threshold was set of at least 20 NISP for jaws and 40 NISP postcranial bones. An exception to this rule has been made in the case of Grotta dell'Uzzo Early to Middle Neolithic postcranial fusion ageing (N=25), in order to compare these results with what was previously observed regarding changes in age profiles during these periods by other authors (Tagliacozzo, 1993a; 1994a; see also Chapters 4.2.b-c and 6.3.d). The results of the sites that met these criteria can be seen in Table 7.6 and Figure 7.3 (tooth wear), and in Table 7.7 and Figure 7.4 (postcranial fusion).

NEONATAL BONES						
AREA	SITE	CHRONOLOGY	NISP			
			NN	%NN	OTHER	TOTAL
North	Arene Candide	Early Neolithic	4	**2**	210	214
		Middle Neolithic	10	**3**	364	374
		Late Neolithic	5	**10**	46	51
		Early/Middle Neolithic Transition	4	**-**	2	6
		Copper/Bronze Age	1	**1**	93	94
	Lavagnone	Early Bronze Age	25	**16**	135	160
	Molino Casarotto	Middle Neolithic	3	**5**	58	61
	Riparo Gaban	Eneolithic	6	**-**	4	10
	Rivoli	Middle Neolithic	2	**2**	94	96
	Solarolo	Middle Bronze Age	20	**13**	138	158
Centre	Palidoro	Upper Palaeolithic	4	**9**	42	46
South	Broglio di Trebisacce	Middle Bronze Age	2	**2**	96	98
	Coppa Nevigata	Middle Bronze Age	5	**3**	181	186
	Grotta della Madonna	Middle Neolithic	3	**-**	27	30
		Early and Middle Bronze Age	7	**9**	71	78
Island	Grotta dell'Uzzo	Early Neolithic	1	**1**	143	144
	Mursia	Middle Bronze Age	25	**13**	162	187

Table 7.5. NISP and NISP% of neonatal postcranial bones identified. Percentages are calculated in samples of over 40 total NISP only. NN=neonatal bones; %NN=percentage of neonatal bones; OTHER=non-neonatal bones.

CHRONOLOGICAL GROUPS	AREA	SITE	CHRONOLOGY	TEETH - AGE CATEGORIES (NISP FREQUENCY)												
				NN	%	JU	%	IM	%	SA	%	AD	%	EL	%	TO-TAL
Upper Palaeolithic and Mesolithic	Centre	Palidoro	Upper Palaeolithic	-	**-**	4	**13**	3	**10**	6.5	**22**	16	**53**	0.5	**2**	30
	South	Grotta Paglicci	Upper Palaeolithic	-	**-**	1.5	**3**	28.5	**50**	9	**16**	18	**32**	-	**-**	57
		Grotta della Madonna	Upper Palaeolithic and Mesolithic	-	**-**	2	**3**	38.5	**57**	12	**18**	15.5	**23**	-	**-**	68
	Islands	Grotta dell'Uzzo	Mesolithic	-	**-**	3.5	**15**	11	**48**	5	**22**	3.5	**15**	-	**-**	23
Early to Middle Neolithic	North	Arene Candide	Early Neolithic	1	**5**	3	**14**	8.5	**39**	6.5	**30**	3	**14**	-	**-**	22
			Middle Neolithic	3	**3**	9.5	**8**	59	**51**	22	**19**	22.5	**19**	-	**-**	116
		Molino Casarotto	Middle Neolithic	-	**-**	-	**-**	4	**20**	5.5	**28**	10.5	**53**	-	**-**	20
Eneolithic/Copper to Bronze Age	North	Arene Candide	Copper/Bronze Age	1	**5**	3	**14**	7	**33**	2.5	**12**	7	**33**	0.5	**2**	21
		Concordia Sagittaria	Late Bronze Age	-	**-**	-	**-**	2	**5**	6	**15**	33	**81**	-	**-**	41
	Centre	Lavagnone	Early Bronze Age	-	**-**	1	**2**	11.5	**25**	19	**41**	14.5	**32**	-	**-**	46
		Cattolica	Early Bronze Age	-	**-**	1	**3**	10.5	**26**	16.5	**41**	12	**30**	-	**-**	40
		Solarolo	Middle Bronze Age	-	**-**	7	**9**	21	**28**	19.5	**26**	27.5	**37**	-	**-**	75
		Cesena	Middle and Late Bronze Age	-	**-**	4.5	**8**	8.8	**15**	18.8	**31**	26.8	**45**	1	**2**	60
	South	La Starza	Middle Bronze Age	-	**-**	2	**8**	9.5	**40**	6.5	**27**	6	**25**	-	**-**	24
		Broglio di Trebisacce	Middle Bronze Age	-	**-**	3.5	**11**	7.5	**24**	9.5	**31**	10.5	**34**	-	**-**	31
		Coppa Nevigata	Middle and Late Bronze Age	-	**-**	4	**5**	22.5	**29**	31.5	**40**	21	**27**	-	**-**	79
	Islands	Mursia	Middle Bronze Age	1	**5**	7	**32**	7	**32**	3	**14**	4	**18**	-	**-**	22

Table 7.6. NISP frequencies and percentages of tooth age categories, for samples totalling over 20 NISP. The percentage of the most represented category for each site is marked in bold. In situations when a tooth was attributed to belonging to either two contiguous age categories (e.g. Immature/Subadult or Subadult/Adult), a value of 0.5 was added to each category involved. NN=neonatal; JU=juvenile; IM=immature; SA=subadult; AD=adult; EL=elderly.

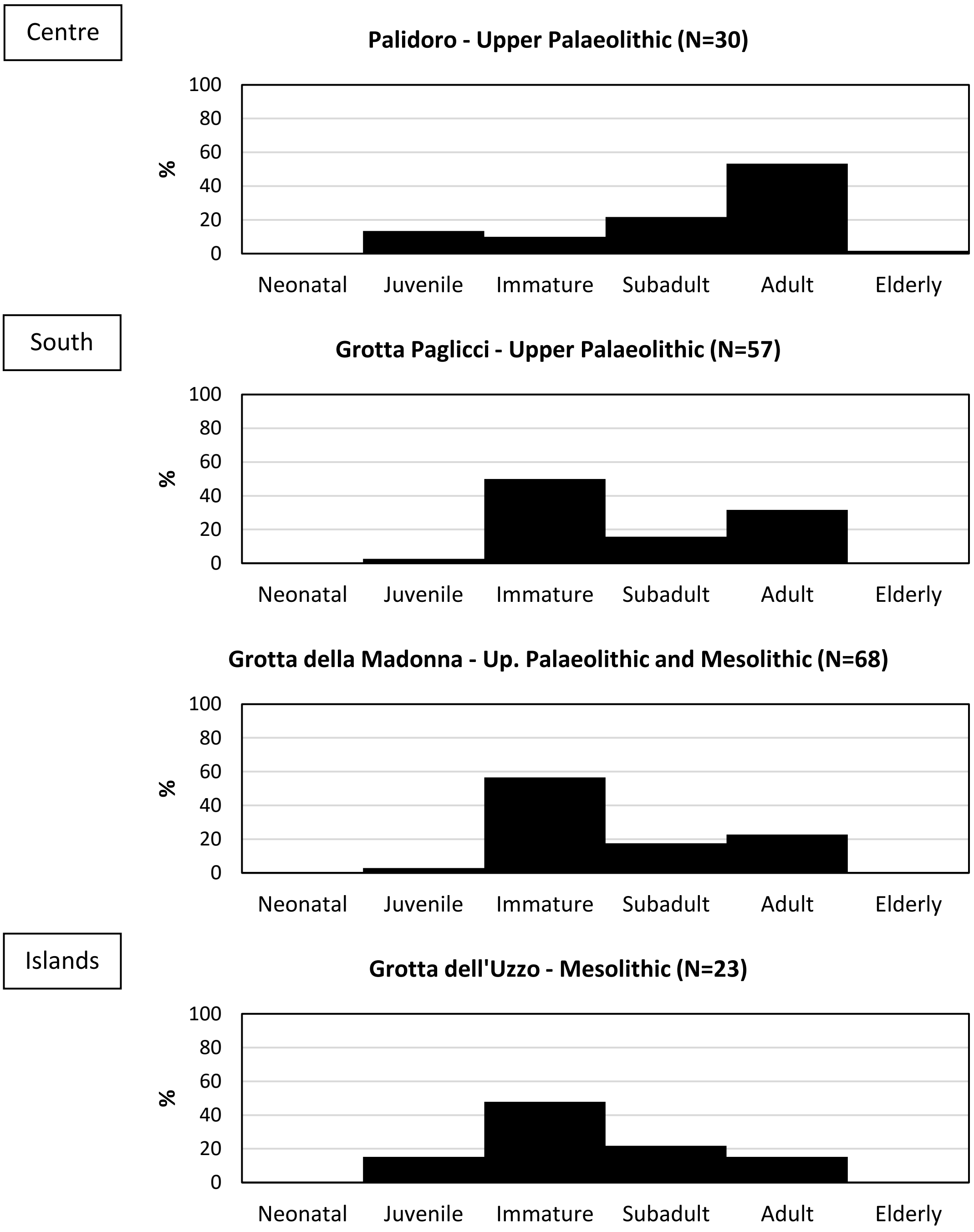


Figure 7.3. (1/4) NISP percentage of teeth by age category (by period, and north to south).

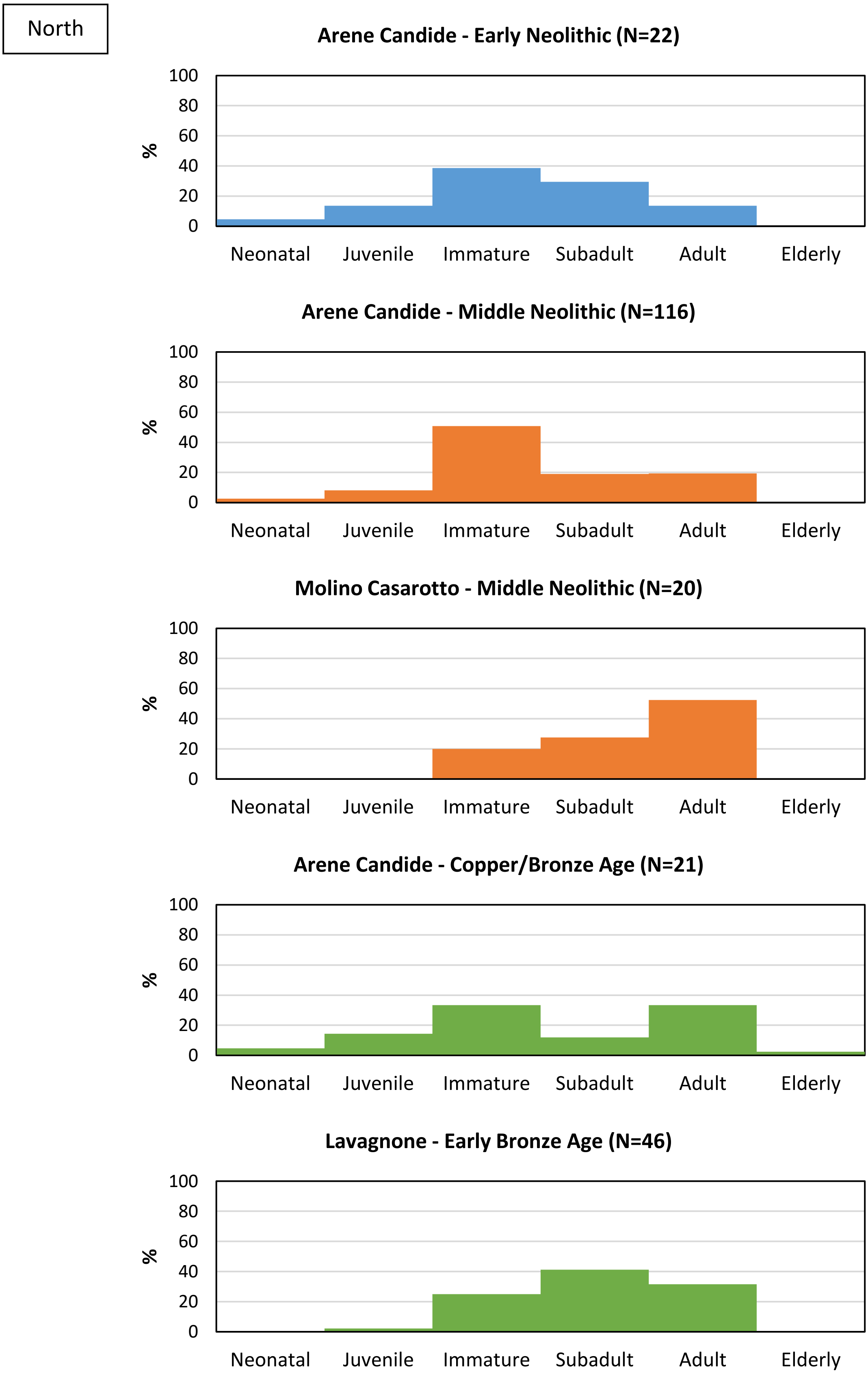
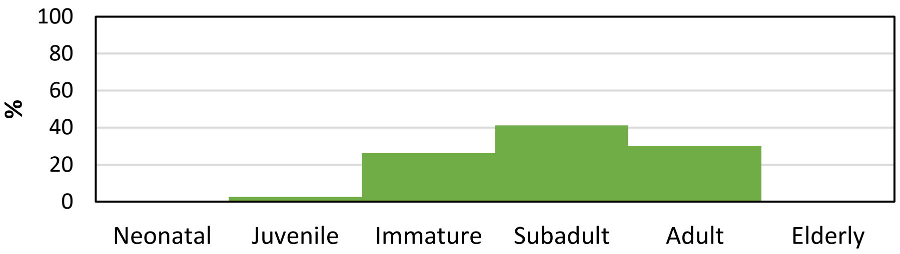


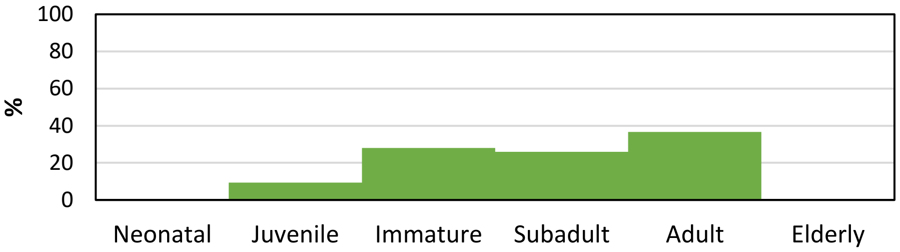
Figure 7.3. (2/4) NISP percentage of teeth by age category (by period, and north to south).

Centre

Cattolica - Early Bronze Age (N=40)

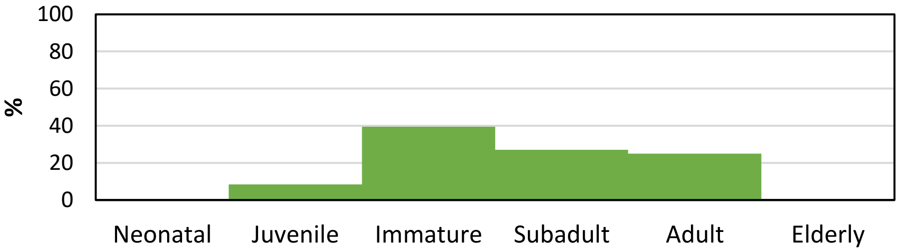


Solarolo - Middle Bronze Age (N=75)

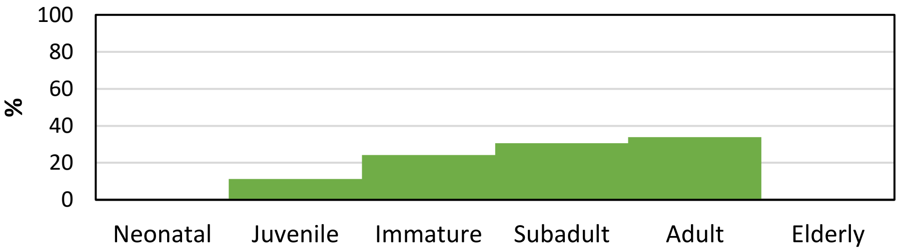


South

La Starza - Middle Bronze Age (N=24)



Broglio di Trebisacce - Middle Bronze Age (N=31)



Islands

Mursia - Middle Bronze Age (N=22)

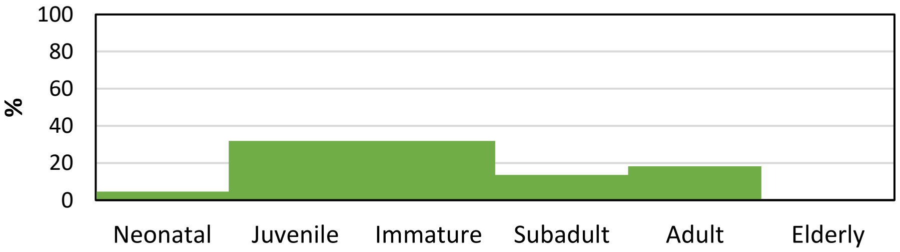


Figure 7.3. (3/4) NISP percentage of teeth by age category (by period, and north to south).

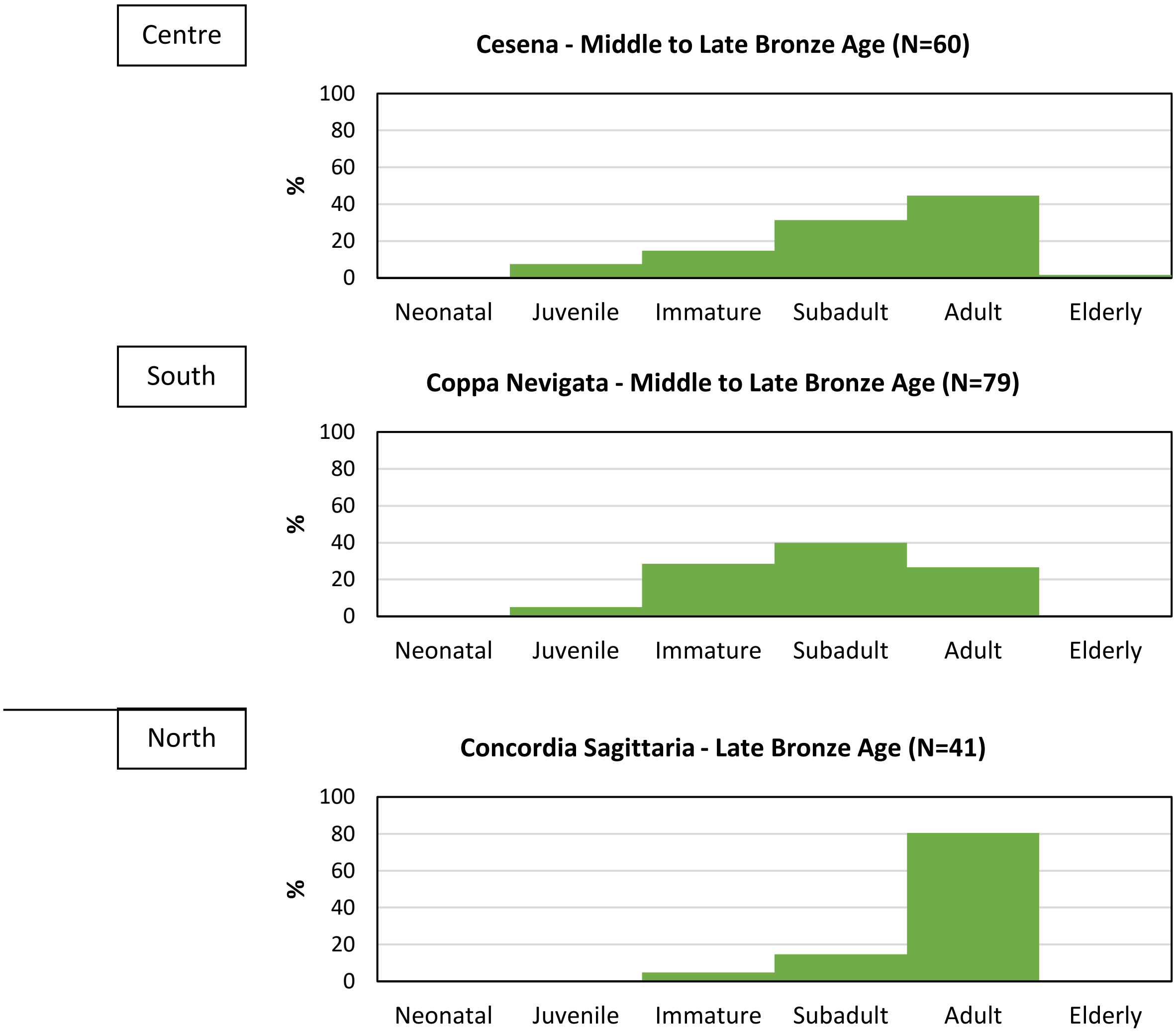


Figure 7.3. (4/4) NISP percentage of teeth by age category (by period, and north to south).

CHRONOLOGICAL GROUPS	AREA	SITE	CHRONOLOGY	POSTCRANIAL FUSION (NISP)									
				EF (F)	EF (UF)	%EF (F)	IF (F)	IF (UF)	%IF (F)	LF (F)	LF (UF)	%LF (UF)	TOTAL
Upper Palaeolithic to Mesolithic	Centre	Palidoro	Upper Palaeolithic	25	5	**83**	7	1	**88**	3	1	**75**	42
	South	Grotta Paglicci	Upper Palaeolithic	30	1	**97**	24	2	**92**	5	1	**83**	63
		Grotta della Madonna	Upper Palaeolithic	62	40	**61**	30	37	**45**	5	16	**24**	190
			Mesolithic	95	31	**75**	70	53	**57**	8	12	**40**	269
	Islands	Grotta dell'Uzzo	Mesolithic	27	11	**71**	21	36	**37**	1	1	**50**	97
Early to Middle Neolithic	North	Arene Candide	Early Neolithic	47	36	**57**	57	37	**61**	6	27	**18**	210
			Middle Neolithic	119	34	**78**	85	64	**57**	7	55	**11**	364
		Molino Casarotto	Middle Neolithic	33	1	**97**	18	4	**82**	-	2	**-**	58
		Rivoli	Middle Neolithic	30	5	**86**	29	24	**55**	2	5	**29**	95
	Centre	La Marmotta	Early Neolithic	21	3	**88**	10	4	**71**	4	4	**50**	46
	Islands	Grotta dell’Uzzo	Early to Middle Neolithic	7	5	**58**	7	5	**58**	-	1	**-**	25
Late Neolithic to Bronze Age	North	Arene Candide	Late Neolithic	16	3	**84**	13	8	**62**	-	6	**-**	46
			Copper/Bronze Age	30	10	**75**	23	20	**54**	1	9	**10**	93
		Lavagnone	Early Bronze Age	43	14	**75**	17	30	**36**	5	26	**16**	135
		Concordia Sagittaria	Late Bronze Age	23	-	**100**	14	5	**74**	1	1	**50**	44
	Centre	Solarolo	Middle Bronze Age	53	13	**80**	32	15	**68**	9	16	**36**	138
		Albano Le Macine	Middle Bronze Age	11	7	**61**	3	11	**21**	1	16	**6**	49
		Cesena	Middle Bronze Age	14	4	**78**	7	5	**58**	3	7	**30**	40
			Late Bronze Age	37	6	**86**	22	16	**58**	2	16	**11**	99
	South	Gricignano	Late Eneolithic to Early Bronze Age	22	2	**92**	7	6	**54**	3	10	**23**	50
		Grotta della Madonna	Middle Bronze Age	11	7	**61**	9	18	**33**	-	5	**-**	50
		La Starza	Middle Bronze Age	25	6	**81**	8	4	**67**	1	9	**10**	53
		Broglio di Trebisacce	Middle Bronze Age	31	4	**89**	26	27	**49**	-	8	**-**	96
		Coppa Nevigata	Middle Bronze Age	51	27	**65**	18	59	**23**	1	25	**4**	181
			Late Bronze Age	26	15	**63**	17	46	**27**	4	17	**19**	125
		Torre Mordillo	Middle to Late Bronze Age	20	2	**91**	11	7	**61**	1	-	**100**	41
	Islands	Mursia	Middle Bronze Age	44	19	**70**	35	25	**58**	7	32	**18**	162

Table 7.7. NISP frequencies and percentages of postcranial fusion age categories, for samples totalling over 40 NISP. (F)=fused and fusing; (UF)=unfused; EF=early fusion (less than one year old); IF=intermediate fusion (two to three years old); LF=late fusion (three years old and older). Neonatal bones are excluded from the count.

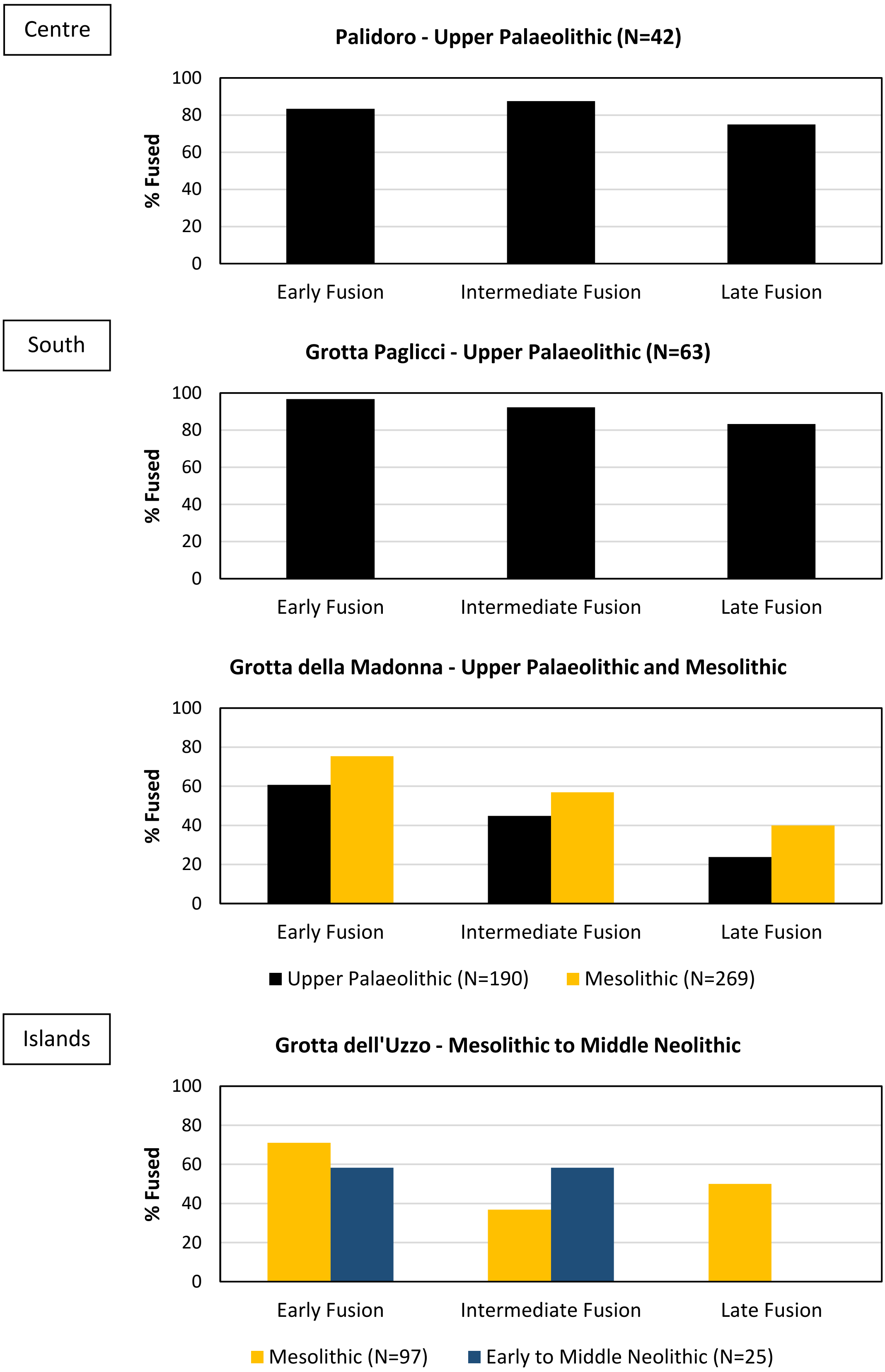
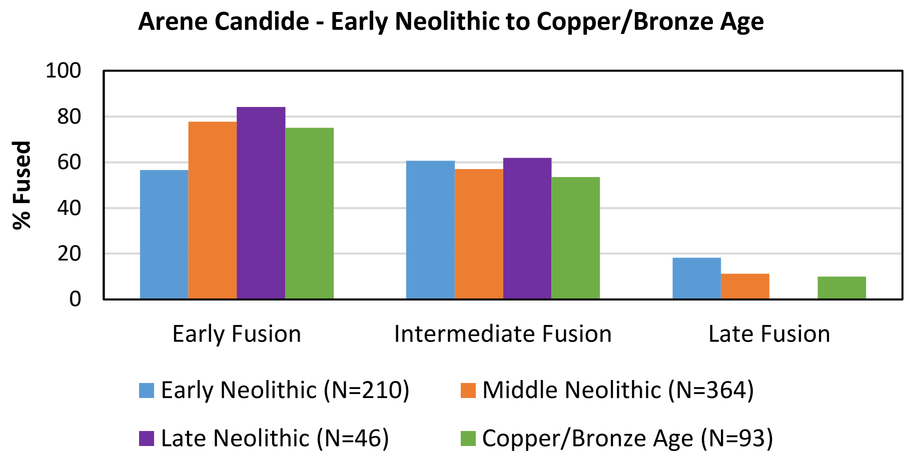
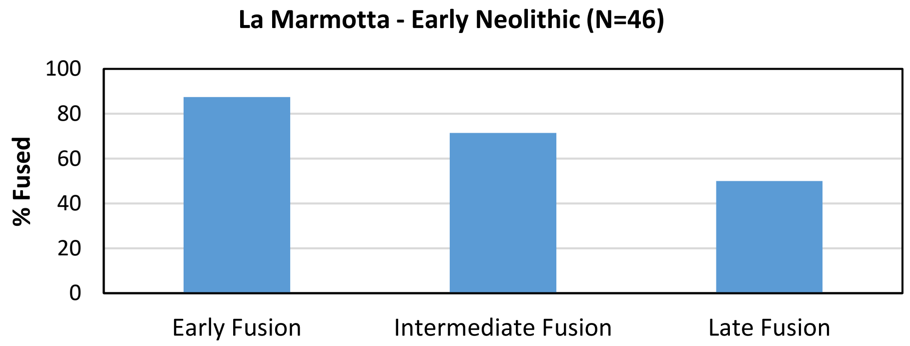


Figure 7.4. (1/5) NISP percentage of postcranial bones fused by age category (by period, and north to south). Early Fusion: less than one year old; Intermediate Fusion: between two and three years old; Late Fusion: three years old and above. Neonatal bones were excluded.

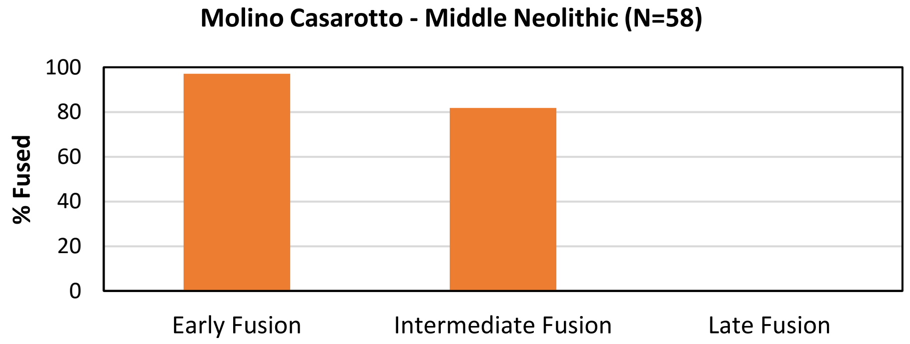
North



Centre



North



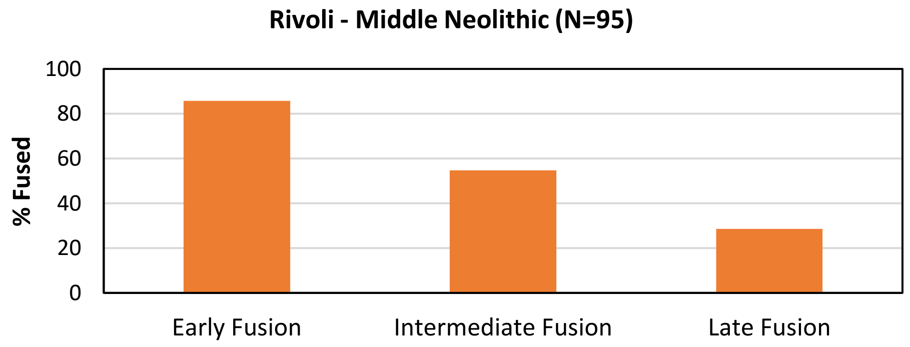


Figure 7.4. (2/5) NISP percentage of postcranial bones fused by age category (by period, and north to south). Early Fusion: less than one year old; Intermediate Fusion: between two and three years old; Late Fusion: three years old and above. Neonatal bones were excluded.

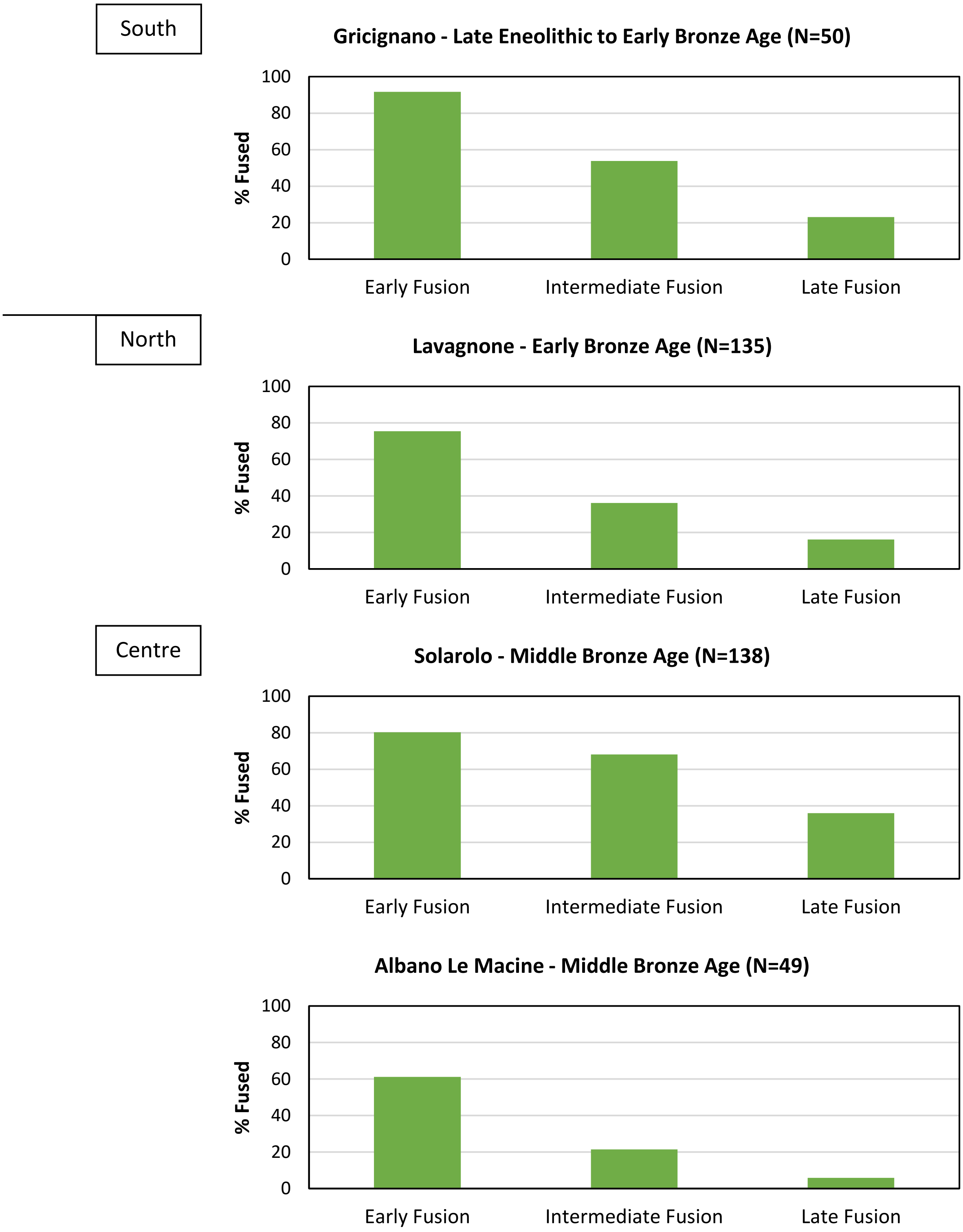
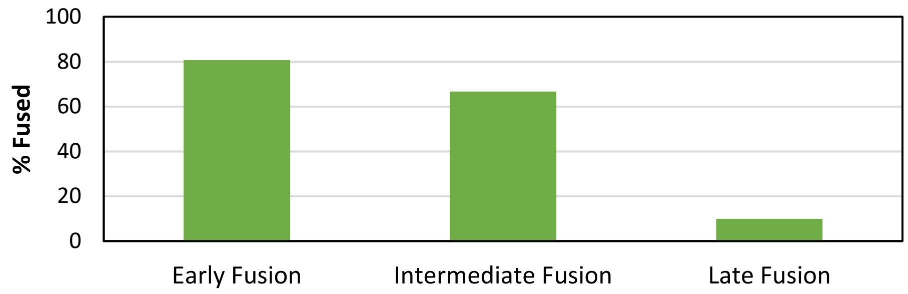


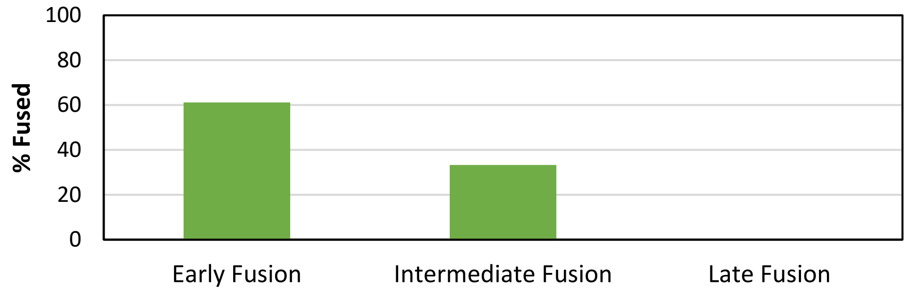
Figure 7.4. (3/5) NISP percentage of postcranial bones fused by age category (by period, and north to south). Early Fusion: less than one year old; Intermediate Fusion: between two and three years old; Late Fusion: three years old and above. Neonatal bones were excluded.

South

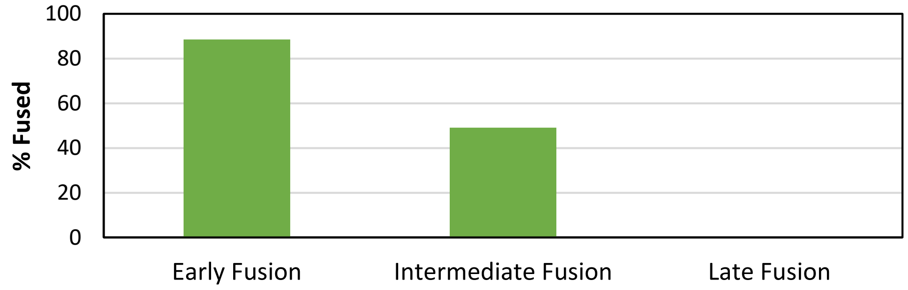
La Starza - Middle Bronze Age (N=53)



Grotta della Madonna - Middle Bronze Age (N=50)



Broglio di Trebisacce - Middle Bronze Age (N=96)



Islands

Mursia - Middle Bronze Age (N=162)

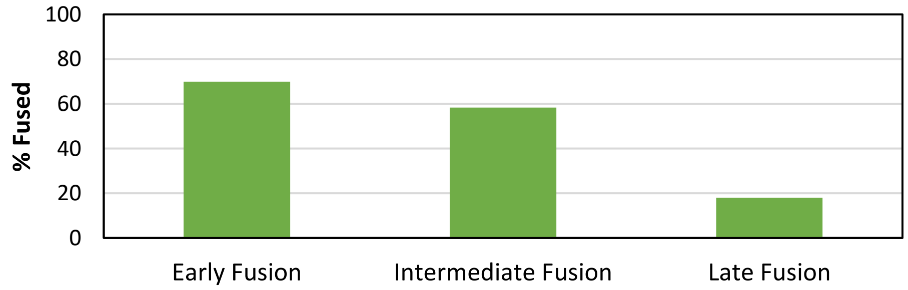
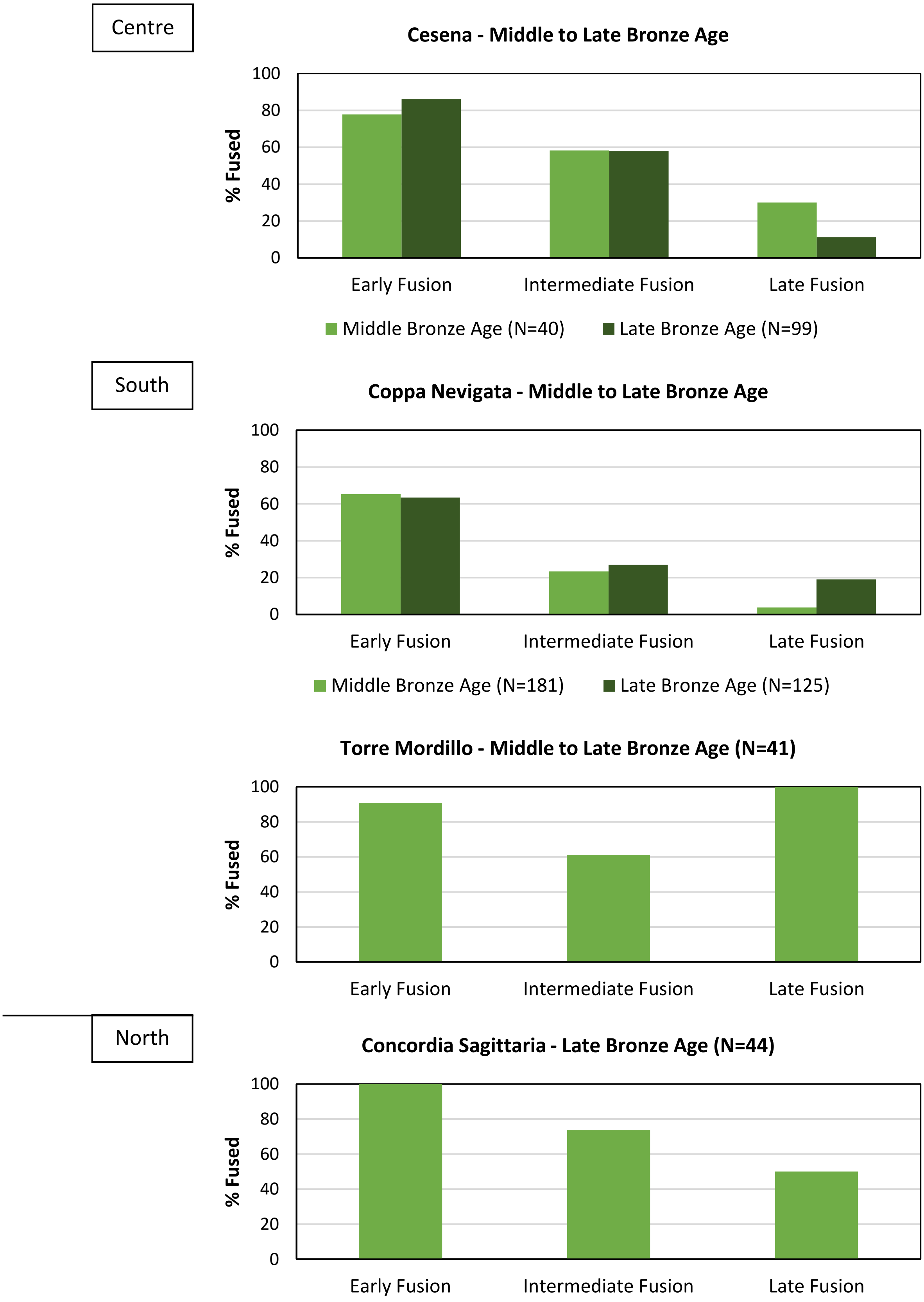


Figure 7.4. (4/5) NISP percentage of postcranial bones fused by age category (by period, and north to south). Early Fusion: less than one year old; Intermediate Fusion: between two and three years old; Late Fusion: three years old and above. Neonatal bones were excluded.



Centre

Cesena - Middle to Late Bronze Age

South

Coppa Nevigata - Middle to Late Bronze Age

Torre Mordillo - Middle to Late Bronze Age (N=41)

North

Concordia Sagittaria - Late Bronze Age (N=44)

Figure 7.4. (5/5) NISP percentage of postcranial bones fused by age category (by period, and north to south). Early Fusion: less than one year old; Intermediate Fusion: between two and three years old; Late Fusion: three years old and above. Neonatal bones were excluded.

The tooth wear and postcranial fusion data from the central site of Palidoro and the southern sites of Grotta Paglicci and Grotta della Madonna (Tables 7.6-7.7 and Figures 7.3-7.4), offer a glimpse of the kill-off patterns of the Upper Palaeolithic and Mesolithic wild boar in the Italian peninsula. Palidoro's tooth wear data is dominated by animals killed at an adult stage, which makes for approximately half of the assemblage, followed in abundance by subadults, juveniles, and immatures, with also a small number of elderly individuals present. The postcranial fusion is consistent with this pattern, with most animals killed between two-three years of age, and some older. Four foetal/neonatal bones (Table 7.5) have also been identified in this assemblage, suggesting the hunting of wild boar during gestation/farrowing periods (March-April-May). The tooth wear evidence from the southern sites of Grotta Paglicci and Grotta della Madonna are dominated, instead, by immature individuals, followed by the adult and subadult categories. A very small number of juveniles is also present in these sites. The postcranial data for Grotta Paglicci shows instead the prevalence of adults over three years of age, whilst the data from Grotta della Madonna indicates that at least half of the animals hunted were adults or perhaps even elderly. Finally, the tooth wear data from the Mesolithic levels of the Sicilian site of Grotta dell'Uzzo shows that the immature category make almost half of the sample, followed by the subadult, and adult and juvenile categories. The postcranial fusion data shows that most animals were killed between one and three years or older. In sum, the ageing information for the Upper Palaeolithic and Mesolithic indicates a generalised hunting strategy in terms of prey age, although Palidoro might have been more focused on adult individuals. The southern sites' tooth wear data shows a representation of the younger animals which is lost in the postcranial evidence. This could be due to taphonomic biases or it could be reflecting a real differential processing strategy of the carcasses according to age.

The Early Neolithic period ageing data is, unfortunately, very scarce, with only northern Arene Candide and central La Marmotta offering a significant sample of jaws and/or postcranial fusion data for a study of age at death profiles (Tables 7.6-7.7 and Figures 7.3-7.4). Arene Candide's tooth wear assemblage is dominated by immature and subadult individuals, followed by adults and juveniles, and a small number of neonates. One shed tooth (deciduous 4th premolar) was identified, suggesting that at least some pigs were living in the cave; this is important, as it was previously suggested that such occurrence only started in the Late Neolithic (Rowley-Conwy, 1997b). The postcranial fusion data for this site indicates that most animals died before the age of two – including the presence of four neonatal bones (Table 7.5) –, followed by those aged between two and three years old and with only a small percentage surviving over the age of three. This site therefore sees a decline in adult numbers, when compared with sites from previous periods. The Latium site of La Marmotta indicates, through postcranial fusion data, the survival of a slightly larger number of adult individuals than at Arene Candide, with an overall focus on animals killed between two and three or more years of age. Unfortunately, no significant ageing data is available for the south of the peninsula. A very small sample of postcranial fusion data from the Early Neolithic and early Middle Neolithic Grotta dell'Uzzo shows a decrease in age of death from the previous Mesolithic period, with all animals killed before three years of age and an increase in those killed before one year old, including one neonate specimen. This deserves a mention, in spite of the small sample size, as this pattern had been previously observed in the original analyses of the site and has been suggested to be a result of changes due to a possible incipient process of domestication (Tagliacozzo, 1994a). In sum, the very scant Early Neolithic data only allows us to mention, for the case of Arene Candide, the slaughter of mainly immature and subadult pigs, indicating a shift towards younger age classes than during the Upper Palaeolithic and Mesolithic. Also, the presence of neonatal bones in this location could be pointing to the breeding of animals on site (if domestic) or their hunting during gestation/farrowing time (if wild). Whether or not these changes reflect animal management modifications related to an incipient process of domestication – i.e. the killing of the young for meat and the keeping of only a small number of adults for reproduction – it is not possible to assert with certainty at this stage.

The Middle Neolithic ageing data comes from the northern sites of Arene Candide, Rivoli, and Molino Casarotto, with insufficient data available from other Italian areas (Tables 7.6-7.7 and Figures 7.3-7.4). The tooth data from the first site indicates the predominance of immature animals in the assemblage, followed by adult and subadult animals, and with a smaller number of juvenile and neonate individuals. Also, in this period one shed tooth (deciduous 4th premolar) was identified, suggesting again the likelihood of pigs living in the cave. The postcranial fusion data shows the slaughtering of animals mainly between one and two years old, with ten neonate specimens also identified, and only a few survived over three years old. This evidence points to the continuation and perhaps intensification of a trend towards the killing of younger individuals and keeping of a small number of adults observed for the Early Neolithic in this site, which could be consistent with an incipient form of pig domestication. The postcranial fusion data from Rivoli is also consistent with this scenario and includes two (Table 7.5) neonatal bones as well. Molino Casarotto's teeth ageing data shows a different picture, although on a smaller sample, evidencing a large proportion of adults, followed by subadult and immature individuals. The postcranial fusion data for this site, however, shows animals killed mostly at two years of age, with no late fusion fused specimens and three neonatal bones (Table 7.5). The different kill-off pattern of pigs at the site of Molino Casarotto is probably related to the high impact hunting still had on the economy of the site, as evidenced by the high proportion of wild fauna present (Boyle, 2014a,b). Therefore, the variable pig kill-off pattern shown by the data could be reflecting the combination of husbandry of domestic pigs and hunting of wild boar, and their concomitant differential killing and processing patterns. Once again, the presence of neonatal bones at this site and at Arene Candide could represent casualties of on-site breeding and/or pig hunting during gestation/farrowing times.

The Late Neolithic ageing data is very scarce, unfortunately, and only Arene Candide has provided significant postcranial fusion data for an interpretation on kill-off patterns during this time (Tables 7.6-7.7 and Figures 7.3-7.4). This data shows the preferential slaughter of pigs over one but less than three years of age, with no fused specimens in the late fusion category and the presence of five neonatal bones (Table 7.5). A very small sample of teeth indicates the prevalence of the juvenile and immature categories, followed by subadults and with a low number of adults. Caution is needed, due to the limitation of the data, but there is a possible intensification of the trend towards the killing of younger animals already noted for the Early and Middle Neolithic in Arene Candide, and the likelihood that the neonatal bones represent the breeding of pigs on site. A brief mention can be made of the Late Neolithic southern site of Mulino Sant'Antonio, not personally analysed by the author but included in the biometrical analysis. The ageing information for this site indicates a similar pattern to the one observed for Arene Candide, with pigs being mostly killed between one and a half and two years old, and the presence of the mandible of an elderly individual as well. The assemblage was interpreted as being likely composed of mostly domestic animals being killed young for their meat, alongside the smaller presence of other age stages representing the combination of remains from domestic and wild animals (Albarella 1987-88). It is possible that Late Neolithic Arene Candide could be reflecting the same scenario.

The ageing evidence from the Eneolithic period onwards is more abundant and will be reviewed by general areas. Beginning with the north and centre of the peninsula (Tables 7.6-7.7 and Figures 7.3-7.4), the Copper/Bronze Age periods at Arene Candide show, in the tooth wear data, the predominance of both immature and adult individuals, followed by the juvenile and subadult categories. There is also a small percentage of neonates and a smaller quantity of elderly individuals. The postcranial fusion information indicates most animals killed between one and two years old, with one neonate bone recovered. The Early Bronze Age period at Lavagnone and Cattolica show a similar pattern. Indeed, the tooth wear data from these sites is dominated by the subadult category, followed by adult and immature individuals, and a low percentage of juveniles. The site of Cattolica has evidence of one shed deciduous 4th premolar tooth, indicating the possibility of the pigs living on site. The postcranial fusion data from Lavagnone indicates the killing mostly of animals before two years old, and a total of 25 neonate specimens were identified. The Middle Bronze Age site of Solarolo continues the trend described for the earlier phase of this period, with a slightly larger proportion of adults, followed by immature and subadult, and finally juveniles. One shed deciduous 4th premolar tooth was identified in the assemblages from this site, hinting at the animals living on site. The postcranial fusion data for this site shows animals killed mostly between one and two years old, and 20 neonate specimens were identified. Also of Middle Bronze Age chronology, the postcranial fusion information from central Albano Le Macine indicates the high prevalence of younger individuals, killed less than two years old. Moving on in time, the Middle to Late Bronze Age tooth wear data from central Cesena shows the predominance of adults, followed by subadults, immatures, juveniles, and a small number of elderly individuals. The postcranial fusion evidence from this site indicates the slaughter of animals mainly before three years old. The Late Bronze Age site of Concordia Sagittaria's teeth wear data evidences a very high proportion of adults accompanied by a smaller percentage of subadults and immature individuals. The postcranial fusion data also shows the presence of individuals killed mostly at two years or older. Lastly, the central Eneolithic site of Conelle, although not personally studied by the author, deserves a mention due to the inclusion of its biometrical data in the analysis. Wilkens (1999) noted the presence of adult and subadult individuals in the bone sample attributed to wild boar (48 individuals attributed to age stages). The domestic pig sample was dominated, instead, by the subadult category, followed by immature and adult animals, with presence also of juveniles and neonates, on a sample of 141 individuals. In sum, the kill-off patterns reflected in the data discussed are suggestive of an economy of animals killed young for the meat, with adult and older animals kept alive most likely for reproduction purposes. At the same time, sites with a higher proportion of adults could be indicative of the primitiveness of the pig domestication process, as the pigs would still take quite long to reach the desired weight for slaughter. The presence of neonatal bones, especially in Bronze Age sites (Table 7.5), indicates the strong likelihood that pigs were bred on site.

The Bronze Age period in the southern sites echoes the patterns observed in the north (Tables 7.6-7.7 and Figures 7.3-7.4). The postcranial fusion data from the Late Eneolithic to Early Bronze Age of Gricignano shows a majority of pigs killed between two and three years old, while the Eneolithic to Middle Bronze Age periods at Grotta della Madonna indicate that the pigs were killed mostly before two years old, with as well the presence of seven neonatal bones (Table 7.5). Two shed deciduous 4th premolar teeth were also identified in this site, suggesting pigs living in the cave. For the Middle Bronze Age, the tooth wear data from La Starza points at the slaughtering of mostly immature individuals, followed by subadults and adults, and with some number of juveniles also present. The postcranial fusion evidence from this site shows the survival of mainly adults over two years old. Broglio di Trebisacce, also of Middle Bronze Age chronology, indicates through tooth wear data the predominance of adults and subadults in the assemblage, followed by the immature and juvenile categories. The postcranial fusion data from this site shows the slaughter of mainly animals between one and two years old, with two neonatal bones present (Table 7.5). Continuing on this period, the island site of Mursia's tooth wear data displays the prevalence of juvenile and immature individuals, followed by adult and subadults, and with the presence also of neonates; while the postcranial fusion shows the killing of animals generally between one and two years old. A total of 25 neonatal bones were also identified (Table 7.5). The Middle to Late Bronze Age of Coppa Nevigata exhibits, in its tooth wear data, the predominance of the subadult category, followed by the immature, adult, and juvenile categories. The postcranial fusion numbers indicate the killing of animals of mostly less than two years old. Finally, the Late Bronze Age site of Torre Mordillo's postcranial fusion information points at the prevalence of animals of adult age. To sum up, the ageing data presented for the south of the peninsula is – with a few exceptions – consistent with what was observed for the north and central areas: the killing of mostly young animals for meat and the keeping of older animals for reproduction. Therefore, the interpretation provided for the north and central Italian regions can also be applied to the southern case.

7.2. Sex Ratios

Sex determination of the pig samples has been done according to upper and lower canine and canine alveoli sizes and morphology (see Chapter 5.2). The importance of sex discrimination in the archaeological samples resides in the information it provides on the nature of the site's occupation, the hunting and husbandry strategies, and the possible effect the sex of the individuals could have on the biometrical results (due to sexual dimorphism). Jaws and loose teeth have been tallied separately according to sex, as loose canines are much more likely to be affected by recovery bias than canines in jaws when sieving has not been done during excavation. Not all sites have provided sufficient canine samples for a comprehensive analysis of sex distributions. A threshold of 10 NISP for loose teeth and jaws has been established in order to calculate percentages. Only a small number of sites from the Upper Palaeolithic, Middle Neolithic, and Early to Late Bronze Age met this criterion (Table 7.8 and Figure 7.5), and these sites will be discussed in the following paragraphs. The small sample size for most of these sites, however, make an interpretation of sex distributions through time difficult, and therefore the observations offered here can only be considered tentative.

AREA	SITE	CHRONOLOGY	JAWS																	LOOSE TEETH									GT
			FEMALE						MALE						TOTAL	FEMALE				MALE				TOTAL	
			Mand		Maxi		F	%F	Mand		Maxi		M	%M		Mand	Maxi	F	%F	Mand	Maxi	M	%M		
			AL	C	AL	C			AL	C	AL	C													
North	Arene Candide	Middle Neolithic	-	4	2	7	**13**	**62**	1	6	-	1	**8**	**38**	21	3	2	**5**	**26**	8	6	**14**	**74**	19	40
	Molino Casarotto	Middle Neolithic	1	-	2	-	**3**	**-**	-	2	-	-	**2**	**-**	5	5	3	**8**	**67**	3	1	**4**	**33**	12	17
	Lavagnone	Early Bronze Age	-	-	1	-	**1**	**-**	-	1	-	1	**2**	**-**	3	2	2	**4**	**13**	21	7	**28**	**88**	32	35
	Solarolo	Middle Bronze Age	-	1	2	3	**6**	**40**	-	2	1	6	**9**	**60**	15	9	4	**13**	**42**	10	8	**18**	**58**	31	46
	Cesena	Late Bronze Age	-	1	-	3	**4**	**36**	3	3	1	-	**7**	**64**	11	7	-	**7**	**44**	8	1	**9**	**56**	16	27
	Concordia Sagittaria	Late Bronze Age	3	4	-	-	**7**	**58**	1	4	-	-	**5**	**42**	12	-	-	**-**	**-**	-	-	**-**	**-**	-	12
Centre	Palidoro	Upper Palaeolithic	-	-	-	-	**-**	**-**	-	-	-	1	**1**	**-**	1	7	5	**12**	**46**	9	5	**14**	**54**	26	27
South	Grotta della Madonna	Upper Palaeolithic	-	1	-	5	**6**	**43**	1	4	1	2	**8**	**57**	14	1	1	**2**	**-**	4	3	**7**	**-**	9	23
	Grotta Paglicci	Upper Palaeolithic	-	-	-	1	**1**	**-**	2	1	-	1	**4**	**-**	5	4	5	**9**	**45**	7	4	**11**	**55**	20	25
	Broglio di Trebisacce	Middle Bronze Age	-	-	-	-	**-**	**-**	-	2	-	1	**3**	**-**	3	7	1	**8**	**19**	14	21	**35**	**81**	43	46
	Coppa Nevigata	Middle Bronze Age	-	1	1	-	**2**	**-**	1	2	-	3	**6**	**-**	8	2	-	**2**	**11**	9	7	**16**	**89**	18	26

Table 7.8. Sexing data on canine teeth and alveolus in jaws, and on loose canine teeth (NISP). Percentages were calculated for samples of over 10 NISP total. MAND=mandibles; MAXI=maxillae; AL=alveolus; C=canine tooth; F=total NISP female; %F=NISP% female; M=total NISP male; %M=NISP% male; GT=grand total NISP of jaws and loose teeth for both sexes.

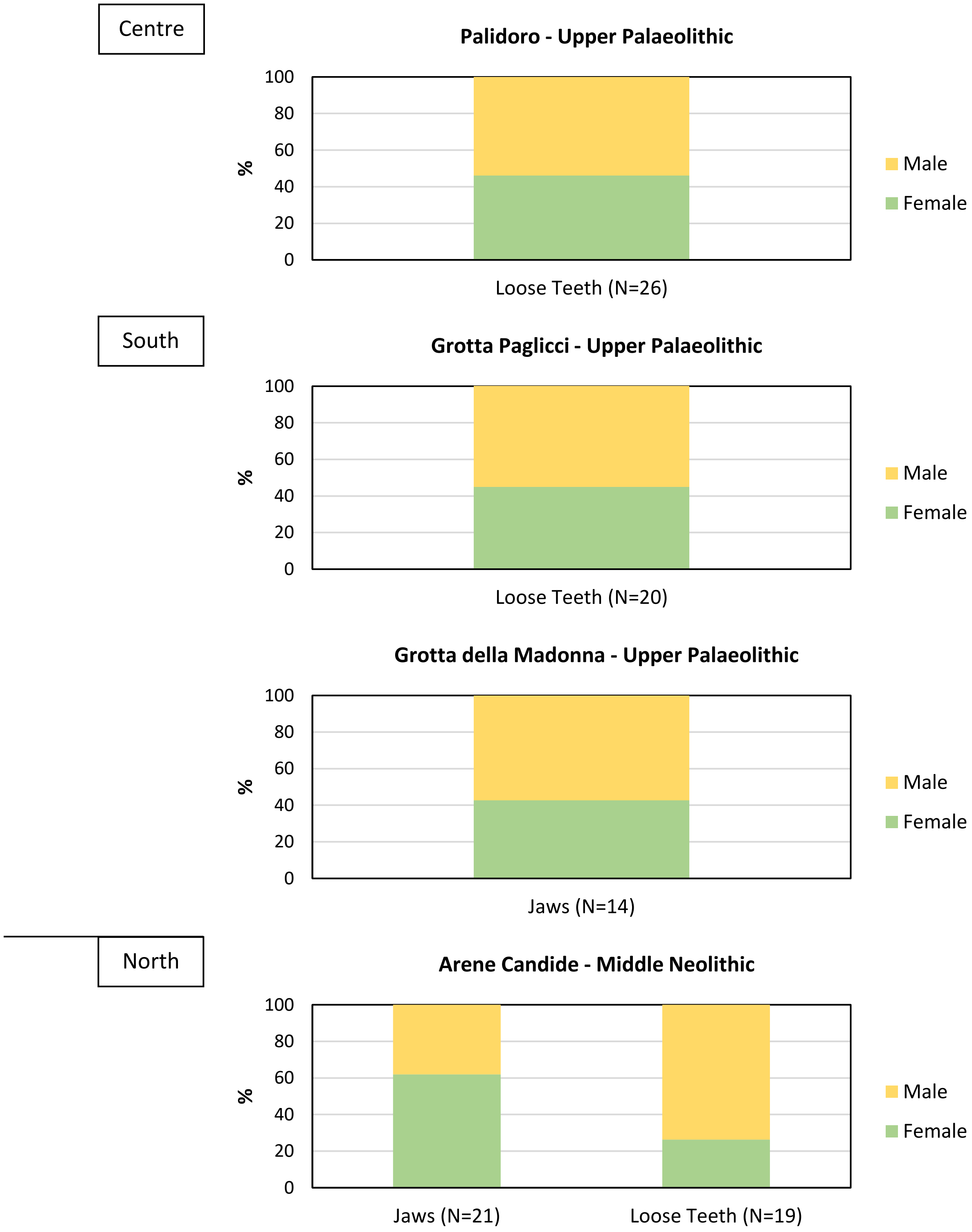


Figure 7.5. (1/3) Proportion (NISP%) of male and female canines and alveoli for sites with over 10 total NISP of jaws and loose canines attributable to sex (by period, and north to south).

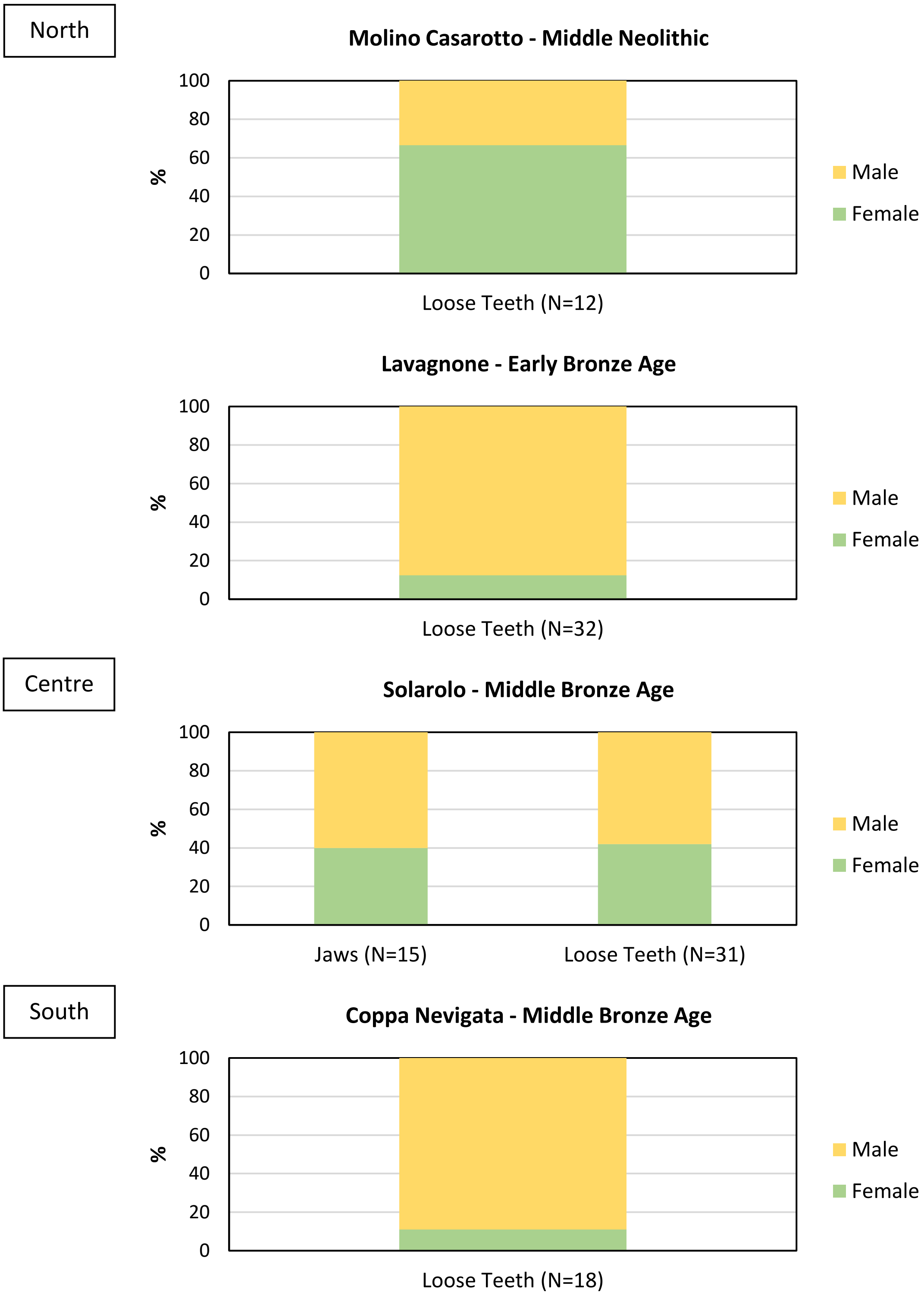


Figure 7.5. (2/3) Proportion (NISP%) of male and female canines and alveoli for sites with over 10 total NISP of jaws and loose canines attributable to sex (by period, and north to south).

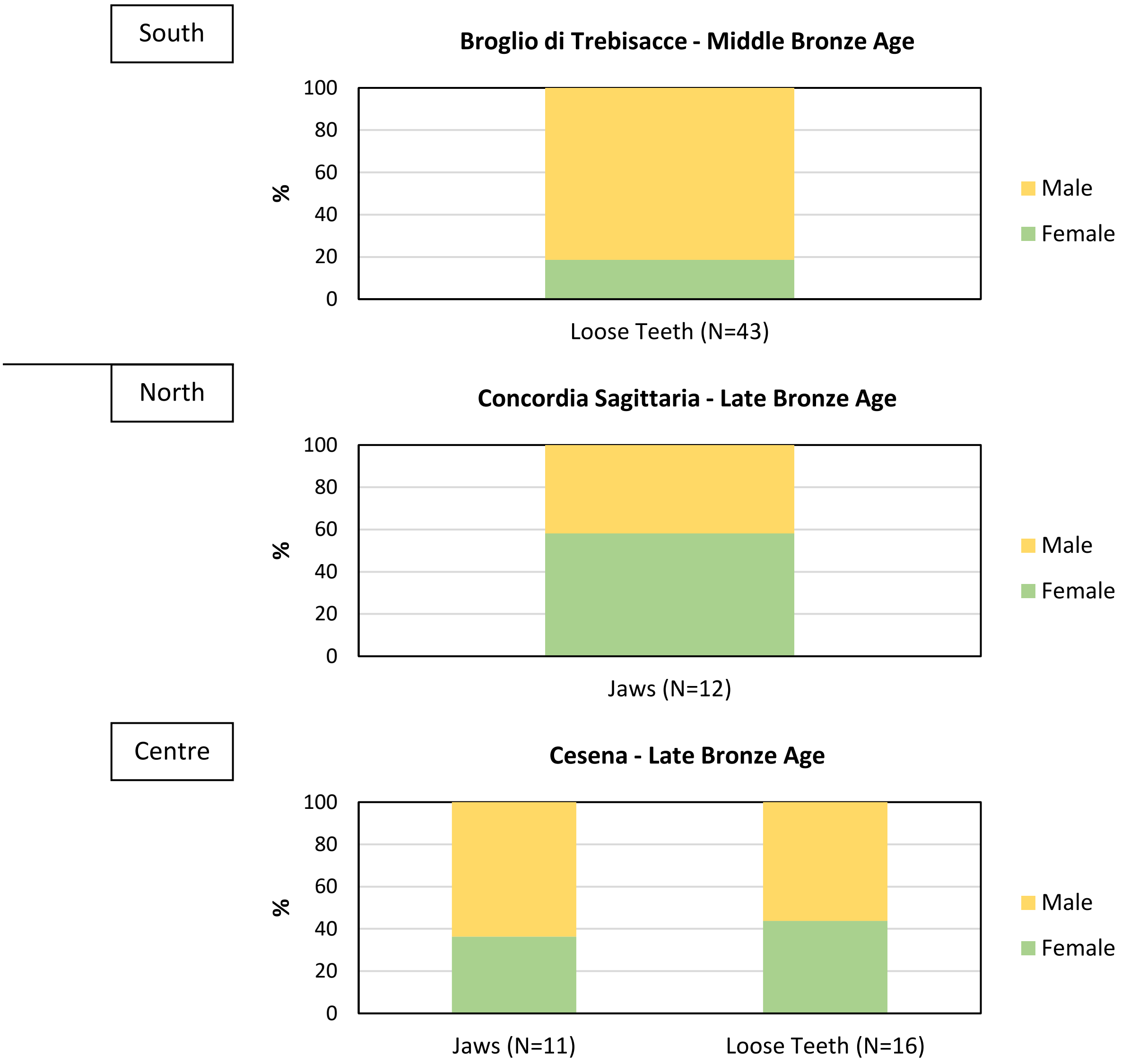


Figure 7.5. (3/3) Proportion (NISP%) of male and female canines and alveoli for sites with over 10 total NISP of jaws and loose canines attributable to sex (by period, and north to south).

Regarding the Upper Palaeolithic data (Table 7.8 and Figure 7.5), the central site of Palidoro and the southern sites of Grotta Paglicci and Grotta della Madonna indicate a similar proportion of males and females present in the assemblages, both on the basis of jaws and loose teeth, although the data from Palidoro and Grotta Paglicci comes from assemblages not sieved or of unknown sieving. Thus, the little information available for the Upper Palaeolithic period would seem to indicate an indiscriminate hunting of male and female wild boars.

During the Middle Neolithic (Table 7.8 and Figure 7.5), only the northern site of Arene Candide provided a sufficient sample size of jaws to analyse sex proportions, and it indicates a predominance of females. However, the loose teeth from this site indicate male domination. Despite sieving at the site, the results from jaws are still considered to be more reliable. The loose canine data from the northern site of Molino Casarotto, also sieved, also show a predominance of females. This female dominance in the assemblages might be indicating a typical husbandry pattern, with males killed younger and, therefore, with canines which may not have been fully developed to be identified as males, or more fragile and thus more often lost in the archaeological record. Regarding this observation, it is interesting to note the identification of four deciduous canines in the Arene Candide material for this period.

The next periods that have enough sexing data are the Early to Late Bronze Age (Table 7.8 and Figure 7.5). The northern Early Bronze Age site of Lavagnone, of unknown sieving, has a large proportion of loose male canines. The same situation can be observed in the loose canine data from the southern Middle Bronze Age sites of Broglio di Trebisacce (sieved) and Coppa Nevigata (unknown sieving). The northern Middle Bronze Age site of Solarolo, of unknown sieving, indicate a very slight predominance of males, both on the basis of jaws and loose teeth. For the Late Bronze Age period, the data from the northern site of Concordia Sagittaria, based on jaws, suggests the killing of slightly more females than males; while the data from central Cesena, based on both jaws and loose canines, denotes the opposite trend. In sum, the sexing data for these periods show different scenarios in the sites studied.

7.3. Biometry

To study the biometrical evidence, two main approaches are adopted. Firstly, selected measurements are plotted in scatterplots, combining the sites by main area (North-Centre-South-Islands). Secondly, log ratio analysis is performed for combined postcranial and tooth measurements for sites with a sample size of over 10 measurements. All measurements taken are included in this analysis, although it is worth noting that, due to the natural variability within pig populations, some measurements are better than others for different purposes, as it was discussed in more detail in Chapter 5. For the discrimination of wild and domestic animals on the basis of biometry, hind-limb measurements from fused and fusing specimens and molar tooth widths and lengths – excluding specimens at a wear stage j or higher (sensu Grant, 1982) – were prioritized.

A summary of the biometrical data obtained in the analyses of the *Sus* zooarchaeological remains, alongside the data from the sites of Cornuda, Rocca di Rivoli, Mulino Sant'Antonio, Conelle, and La Starza, not personally studied by this author (see Chapter 6), can be seen in Tables 7.9-7.17 (postcranial bones) and 7.18-7.34 (teeth). This summary includes statistical analyses (standard deviation and coefficient of variation – i.e. the standard deviation as a percentage of the mean) in samples over 5 specimens. The main bulk of the data comes from sites from Eneolithic to Late Bronze Age, with the Late Neolithic period being the least represented period in terms of raw data. 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 (Tables 7.35-7.37). This is likely to be a consequence of the climatic variability between the two regions, with the smaller animals living in the warmer southern region (Blackburn et al., 1999; Meiri and Dayan, 2003). The data from the Sicilian islands also deserves a special mention. It is possible to observe that, in general terms, the measurements are smaller than in the continental data, and in some cases this difference is statistically significant (Table 7.35-7.37). As it will be discussed in more detail in the log ratio analysis, this relationship has been previously observed by other authors (Albarella et al., 2006c; Tagliacozzo, 1994a), and it could be due to insular dwarfism (Lomolino, 1985; 2005).

REGION	SITE	CHRONOLOGY	MEASUREMENT	ASTRAGALUS		ATLAS	CALCANEUS		FEMUR	HUMERUS		RADIUS		SCAPULA	TIBIA		ULNA	
				GLl	GLm	BFcr	GL	GD	DC	BT	HTC	Bd	BpP	SLC	Bd	Dd	BPC	DPA
NORTH																		
Trentino-South Tyrol	Galgenbühel/ Dos de la Forca	Mesolithic	N	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
			Min.	-	-	-	-	-	-	-	-	-	-	-	31.4	28.8	-	-
	Pradestel	Mesolithic	N	1	1	-	-	-	-	1	1	1	-	-	-	-	-	-
			Min.	46	41.4	-	-	-	-	38.5	22.5	41.9	-	-	-	-	-	-
	Romagnano Loc	Mesolithic	N	2	2	-	-	-	-	-	-	-	-	-	1	1	-	-
			Min.	45.5	40.7	-	-	-	-	-	-	-	-	-	32.9	28.1	-	-
			Max.	46.2	41.6	-	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	45.9	41.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Friuli-Venezia Giulia	Riparo di Biarzo	Mesolithic	N	1	2	-	-	-	-	1	1	-	-	-	1	1	1	1
			Min.	47.8	43.2	-	-	-	-	34.4	21	-	-	-	32.1	26.9	27	47.8
			Max.	-	46.7	-	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	-	45	-	-	-	-	-	-	-	-	-	-	-	-	-
Liguria	Arene Candide	Upper Palaeolithic	N	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Min.	43.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Max.	48.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	46.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CENTRE																		
Lazio	Palidoro	Upper Palaeolithic	N	2	2	1	1	1	2	4	6	-	1	11	3	3	-	-
			Min.	44.2	39.1	57.7	88.6	33.2	26.1	28.3	19.6	-	32.9	22.8	33.3	28.7	-	-
			Max.	45.8	41.2	-	-	-	34.6	35.5	22.5	-	-	28.3	37.1	31.1	-	-
			Mean	45	40.2	-	-	-	30.4	32.5	21.4	-	-	25.7	34.6	29.6	-	-
			Std.Dev.	-	-	-	-	-	-	-	1.1	-	-	1.7	-	-	-	-
			V	-	-	-	-	-	-	-	**5.3**	-	-	**6.8**	-	-	-	-

Table 7.9. Summary of postcranial measurements of North and Central sites, from Upper Palaeolithic to Mesolithic. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASURE-MENT	ASTRAGALUS		ATLAS		CALCANEUS		FEMUR	HUMERUS		MC IV	PELVIS	RADIUS		SCAPULA		TIBIA		ULNA
				GLl	GLm	H	BFcr	GL	GD	DC	BT	HTC	GL	LAR	Bd	BpP	GLC	SLC	Bd	Dd	DPA
SOUTH																					
Apulia	Grotta Paglicci	Upper Palaeolithic	N	6	7	1	-	3	2	-	4	5	1	2	2	4	3	2	7	6	1
			Min.	45.6	40.5	49.1	-	80.5	32.1	-	32.4	19.7	90.1	34.3	42	29.8	32.9	24.7	32.8	28.7	40.7
			Max.	49.4	44.9	-	-	93	34.4	-	33.7	21.9	-	36.3	42.8	36.9	44.3	27.4	36.5	32.4	-
			Mean	47.5	42.2	-	-	86.7	33.3	-	32.9	21	-	35.3	42.4	33.9	38.1	26.1	35.2	31	-
			Std.Dev.	1.6	1.5	-	-	-	-	-	-	0.9	-	-	-	-	-	-	1.3	1.3	-
			V	**3.5**	**3.6**	**-**	**-**	**-**	**-**	**-**	**-**	**4.4**	**-**	**-**	**-**	**-**	**-**	**-**	**3.8**	**4.1**	**-**
Campania	Grotta della Cala	Mesolithic	N	2	2	-	-	-	-	-	-	-	-	-	-	-	1		-	-	-
			Min.	45.1	40.5	-	-	-	-	-	-	-	-	-	-	-	37.5		-	-	-
			Max.	50.5	45.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	47.8	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calabria	Grotta della Madonna	Upper Palaeolithic	N	6	6	3	2	4	5	1	2	3	-	1	-	5	-	6	8	8	-
			Min.	45.8	41.3	45.6	61.9	88.9	33.9	30.2	38.6	23	-	38.5	-	32.7	-	24.2	25.9	23.5	-
			Max.	53.6	47.6	60.4	63.4	97.7	36.7	-	41.6	23.6	-	-	-	38.5	-	31.3	38.3	33.3	-
			Mean	50	44.7	51.9	62.7	92.9	34.8	-	40.1	23.3	-	-	-	35.7	-	27.1	32.6	28.8	-
			Std.Dev.	2.9	2.5	-	-	-	1.1	-	-	-	-	-	-	2.3	-	2.7	4.1	3.3	-
			V	**5.9**	**5.6**	**-**	**-**	**-**	**3.2**	**-**	**-**	**-**	**-**	**-**	**-**	**6.5**	**-**	**10**	**12.6**	**11.4**	**-**
		Mesolithic	N	12	14	1	1	6	5	1	3	3	-	2	1	2	-	1	6	5	-
			Min.	45.1	40.5	56.3	62.7	87.3	31.9	31.7	36.1	21.8	-	35.6	44	35.9	-	33.8	31.5	28.9	-
			Max.	51.1	45.8	-	-	98.7	38.3	-	38.9	25.3	-	37.3	-	36.8	-	-	36.2	32.4	-
			Mean	47.7	43	-	-	92.6	35.6	-	37.9	24	-	36.5	-	36.4	-	-	33.1	29.9	-
			Std.Dev.	1.8	1.7	-	-	3.7	2.5	-	-	-	-	-	-	-	-	-	1.8	1.4	-
			V	**3.8**	**4**	**-**	**-**	**4**	**6.9**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**5.5**	**4.8**	**-**
Sicily	Grotta dell'Uzzo	Upper Palaeolithic/ Mesolithic	N	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
			Min.	-	-	-	-	-	-	-	33.8	22.7	-	-	-	-	-	-	-	-	-
		Mesolithic	N	44	-	-	-	10	10	1	4	5	-	-	-	-	-	1	9	10	-
			Min.	38.9	-	-	-	79.5	29.4	26.8	30.1	18.4	-	-	-	-	-	22.3	31.1	24.1	-
			Max.	50.7	-	-	-	92.4	34.4	-	36	22	-	-	-	-	-	-	36.9	33.9	-
			Mean	45.8	-	-	-	86.5	32.6	-	32.8	19.9	-	-	-	-	-	-	34	29.2	-
			Std.Dev.	2.7	-	-	-	5.2	1.7	-	-	1.4	-	-	-	-	-	-	1.6	2.6	-
			V	**5.9**	**-**	**-**	**-**	**6**	**5.1**	**-**	**-**	**7.2**	**-**	**-**	**-**	**-**	**-**	**-**	**4.8**	**8.9**	**-**

Table 7.10. Summary of postcranial measurements of Southern and Island sites, from Upper Palaeolithic to Mesolithic. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONO-LOGY	MEASURE-MENT	ASTRAGALUS		ATLAS		CALCANEUS		FEMUR	HUMERUS		MC III	MC IV	MT III	MT IV	PELVIS	RADIUS		SCA-PULA	TIBIA		ULNA	
				GLl	GLm	H	BFcr	GL	GD	DC	BT	HTC	GL	GL	GL	GL	LAR	Bd	BpP	SLC	Bd	Dd	BPC	DPA
NORTH																								
Trentino-South Tyrol	Riparo Gaban	Early Neolithic	N	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
			Min.	51.8	-	43.3	-	-	37.2	-	-	-	-	-	-	-	-	-	38.1	-	-	-	-	-
Friuli-Venezia Giulia	Riparo di Biarzo	Mesolithic/ Neolithic	N	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
			Min.	-	-	-	-	-	-	-	29.9	22.2	-	-	-	-	-	-	-	-	-	-	-	-
		Neolithic	N	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Min.	41.1	37.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Veneto	Cornuda*	Late Neolithic	N	8	-	-	2	2	-	-	-	-	-	-	-	-	2	-	2	1	4	2	-	-
			Min.	47.1	-	-	65	99.8	-	-	-	-	-	-	-	-	42.2	-	37	42	22.3	37	-	-
			Max.	57	-	-	70.7	108	-	-	-	-	-	-	-	-	47	-	40	-	30.2	39.7	-	-
			Mean	53.2	-	-	67.9	103.9	-	-	-	-	-	-	-	-	44.6	-	38.5	-	26.4	38.4	-	-
			Std.Dev.	3.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			V	**6**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rocca di Rivoli*	Middle Neolithic	N	5	-	-	-	4	-	-	5	5	-	-	-	-	3	-	-	-	3	7	-	-
			Min.	42.1	-	-	-	98.6	-	-	30.9	19.4	-	-	-	-	33.5	-	-	-	22.4	30	-	-
			Max.	54.4	-	-	-	105.5	-	-	35.4	23.8	-	-	-	-	37.3	-	-	-	28.2	40.8	-	-
			Mean	48.7	-	-	-	103	-	-	33.3	22.3	-	-	-	-	37.1	-	-	-	24.7	32.5	-	-
			Std.Dev.	5.7	-	-	-	-	-	-	2.1	1.8	-	-	-	-	-	-	-	-	-	3.8	-	-
			V	**11.7**	-	-	-	-	-	-	**6.3**	**8.1**	-	-	-	-	-	-	-	-	-	**11.7**	-	-
	Molino Casarotto	Middle Neolithic	N	2	2	-	-	-	-	-	-	-	-	-	1	-	2	-	5	4	1	1	-	-
			Min.	45.5	41.2	-	-	-	-	-	-	-	-	-	111.8	-	36.6	-	34.4	28.1	37	32.4	-	-
			Max.	53	47.8	-	-	-	-	-	-	-	-	-	-	-	42.6	-	38.2	36.3	-	-	-	-
			Mean	49.3	44.5	-	-	-	-	-	-	-	-	-	-	-	39.6	-	35.8	32.2	-	-	-	-
			Std.Dev.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	-
			V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**4.3**	-	-	-	-	-

Table 7.11. (1/2) Summary of postcranial measurements of Northern sites, from Early to Late Neolithic. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONO-LOGY	MEASURE-MENT	ASTRAGALUS		ATLAS		CALCANEUS		FEMUR	HUMERUS		MC III	MC IV	MT III	MT IV	PELVIS	RADIUS		SCA-PULA	TIBIA		ULNA	
				GLl	GLm	H	BFcr	GL	GD	DC	BT	HTC	GL	GL	GL	GL	LAR	Bd	BpP	SLC	Bd	Dd	BPC	DPA
NORTH (continued)																								
Liguria	Arene Candide	Early Neolithic	N	16	16	3	1	-	-	1	1	1	3	1	1	1	1	1	5	8	10	10	-	2
			Min.	42.6	39.1	51.3	62.6	-	-	28.7	34.3	23.6	80.1	81.2	91.8	99.1	42.4	44.6	27.8	23.1	30	27.1	-	40.1
			Max.	55.2	49.6	53.4	62.6	-	-	-	34.3	23.6	99.1	-	-	-	-	-	34.5	29.6	40	34.5	-	43.5
			Mean	48.1	43	52.3	62.6	-	-	-	34.3	23.6	87.27	-	-	-	-	-	31.2	26.1	33.6	30.4	-	41.8
			Std.Dev.	3.4	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.4	2.9	2.4	-	-
			V	**7.1**	**7.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**9.2**	**8.7**	**8**	**-**	**-**
		Middle Neolithic	N	28	28	10	7	9	10	-	16	17	3	3	3	2	11	3	15	12	22	20	1	1
			Min.	40.5	37.5	45.9	55	80.7	29.2	-	29.7	19	72.3	73.7	84.1	99.2	31.4	33.7	28.4	20.8	26.8	24.7	24.4	40.7
			Max.	54.8	48.4	59	63.4	97.9	38.9	-	40.6	26.1	94.3	94.6	86.2	104.2	43.6	45.8	40.5	28.9	39.7	33.8	-	-
			Mean	45.8	41.5	51.9	60.3	91.3	35.3	-	34.7	22.3	84.4	82.3	85.1	101.7	36.8	41.6	32.2	24	30.9	27.9	-	-
			Std.Dev.	3.5	3	4.1	3.2	6	2.9	-	3.5	2	-	-	-	-	3.6	6.9	3.9	2.6	3.3	2.6	-	-
			V	**7.7**	**7.2**	**7.8**	**5.3**	**6.6**	**8.3**	**-**	**10**	**9.2**	**-**	**-**	**-**	**-**	**9.8**	**-**	**12.1**	**10.7**	**10.7**	**9.5**	**-**	**-**
		Late Neolithic	N	2	2	2	2	1	1	-	1	2	-	2	-	1	3	2						
			Min.	36.3	33.8	81	31.8	27.4	15.9	-	109.7	31.6	-	26.1	-	21	26.2	24.1						
			Max.	47.5	44	105.2	41.4	-	-	-	-	32.3	-	28	-	-	29.1	25.7						
			Mean	41.9	38.9	93.1	36.6	-	-	-	-	32	-	27.1	-	-	28.1	24.9						

Table 7.11. (2/2) Summary of postcranial measurements of Northern sites, from Early to Late Neolithic. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONOLOGY	MEASUREMENT	ASTRAGALUS		CALCANEUS		FEMUR	HUMERUS		MC IV	PELVIS	RADIUS		SCAPULA	TIBIA	
				GLl	GLm	GL	GD	DC	BT	HTC	GL	LAR	Bd	BpP	SLC	Bd	Dd
CENTRE																	
Marche	Portonovo	Early Neolithic	N	1	2	1	1	-	-	-	2	1	-	1	2	-	-
			Min.	39.9	36.4	99.7	37.9	-	-	-	80.5	37.1	-	29.3	19.7	-	-
			Max.	-	44.4	-	-	-	-	-	97.2	-	-	-	33.2	-	-
			Mean	-	40.4	-	-	-	-	-	88.9	-	-	-	26.5	-	-
Lazio	La Marmotta	Early Neolithic	N	7	-	4	4	2	5	7	-	-	-	-	-	4	6
			Min.	38.4	-	88.9	33.6	31.6	33.7	18.1	-	-	-	-	-	28.8	26.9
			Max.	49.8	-	103.5	39.4	34.5	40	26.8	-	-	-	-	-	40	33.7
			Mean	44.4	-	96.2	36.5	33.1	36.7	23.5	-	-	-	-	-	34.3	30.2
			Std.Dev.	3.8	-	-	-	-	2.7	2.7	-	-	-	-	-	-	2.9
			V	**8.6**	**-**	**-**	**-**	**-**	**7.3**	**11.7**	**-**	**-**	**-**	**-**	**-**	**-**	**9.7**

Table 7.12. Summary of postcranial measurements of Central sites, from Early Neolithic. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASURE-MENT	ASTRAGALUS		ATLAS		CALCANEUS		HUMERUS		MC IV	PELVIS	RADIUS	SCAPULA		TIBIA	
				GLl	GLm	H	BFcr	GL	GD	BT	HTC	GL	LAR	BpP	GLC	SLC	Bd	Dd
SOUTH																		
Apulia	Masseria Candelaro	Middle Neolithic	N	3	-	-	-	-	-	-	-	-	1	-	-	-	2	2
			Min.	36.2	-	-	-	-	-	-	-	-	3	-	-	-	28.6	26
			Max.	44.8	-	-	-	-	-	-	-	-	-	-	-	-	31.4	26.1
			Mean	39.4	-	-	-	-	-	-	-	-	-	-	-	-	30	26.1
	Masseria Fragella	Early Neolithic	N	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
			Min.	-	-	-	-	-	-	-	-	-	31.6	-	-	-	-	-
	Masseria Pantano	Middle Neolithic	N	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-
			Min.	44.1	40	42.9	58.1	85.7	29.3	-	-	-	-	-	-	-	-	-
Campania	Baselice	Early Neolithic	N	-	-	-	-	1	1	3	3	-	-	1	1	2	1	1
			Min.	-	-	-	-	92.4	33.5	34.5	19.9	-	-	33.2	32.6	20.2	37.3	29.7
			Max.	-	-	-	-	-	-	41.7	25.6	-	-	-	-	-	-	-
			Mean	-	-	-	-	-	-	37.4	23.1	-	-	-	-	-	-	-
	Masseria di Gioia	Middle to Late Neolithic	N	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
			Min.	40.7	37.8	-	-	-	-	-	-	-	-	-	-	-	-	-
			Max.	42.7	39.7	-	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	41.7	38.8	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mulino Sant' Antonio*	Late Neolithic	N	1	2	2	-	1	-	-	-	-	-	-	2	4	-	-
			Min.	49.8	42.5	56.9	-	105	-	-	-	-	-	-	42.1	22	-	-
			Max.	-	45.2	57.2	-	-	-	-	-	-	-	-	51.2	35.3	-	-
			Mean	-	43.9	57.1	-	-	-	-	-	-	-	-	46.7	27	-	-
Calabria	Grotta della Madonna	Middle Neolithic	N	3	3	-	-	-	-	1	1	1	-	1	-	-	-	-
			Min.	43.3	39.7	-	-	-	-	39.8	26	99.5	-	36.4	-	-	-	-
			Max.	49.8	43.7	-	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	45.6	41.3	-	-	-	-	-	-	-	-	-	-	-	-	-
	Favella	Early Neolithic	N	-	-	-	1	-	-	1	1	-	1	-	-	1	-	-
			Min.	-	-	-	62.4	-	-	38.3	25.6	-	41.8	-	-	23	-	-

Table 7.13. Summary of postcranial measurements of Southern sites, from Early to Late Neolithic. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data from publication (Albarella, 1987-88).

REGION	SITE	CHRONOLOGY	MEASUREMENT	ASTRAGALUS	CALCANEUS		HUMERUS		TIBIA	
				GLl	GL	GD	BT	HTC	Bd	Dd
ISLANDS										
Sicily	Grotta dell'Uzzo	Early Neolithic	N	1	-	-	-	-	-	1
			Min.	46.1	-	-	-	-	-	29.8
		Middle Neolithic	N	4	1	1	1	1	-	1
			Min.	43.9	81.1	31.2	31.6	18.3	-	29.8
			Max.	46.2	-	-	-	-	-	-
			Mean	45	-	-	-	-	-	-
		Early to Middle Neolithic	N	12	2	2	1	1	3	5
			Min.	36.8	80.8	30.6	31.6	18.3	30.5	25.8
			Max.	46.2	81.1	31.2	-	-	33.9	29.8
			Mean	43.4	81	30.9	-	-	31.7	28.2
			Std.Dev.	2.7	-	-	-	-	-	2
			V	**6.3**	**-**	**-**	**-**	**-**	**-**	**7**

Table 7.14. Summary of postcranial measurements of Island sites, from Early to Middle Neolithic. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	ASTRAGALUS		CALCANEUS		HUMERUS		MC IV	MT III	PELVIS	RADIUS		SCAPULA		TIBIA	
				GLl	GLm	GL	GD	BT	HTC	GL	GL	LAR	Bd	BpP	GLC	SLC	Bd	Dd
NORTH																		
Trentino-South Tyrol	Riparo Gaban	Eneolithic	N	-	-	-	-	2	2	-	-	-	-	1	-	-	-	-
			Min.	-	-	-	-	27.8	19.5	-	-	-	-	26.8	-	-	-	-
			Max.	-	-	-	-	34.6	21.1	-	-	-	-	-	-	-	-	-
			Mean	-	-	-	-	31.2	20.3	-	-	-	-	-	-	-	-	-
		Early Bronze Age	N	1	2	-	-	4	4	-	-	-	-	1	2	2	1	1
			Min.	39.6	35.6	-	-	29.8	18.5	-	-	-	-	28.1	33.7	21.6	30	26.9
			Max.	-	37.8	-	-	33	21	-	-	-	-	-	33.9	22.7	-	-
			Mean	-	36.7	-	-	31.5	19.8	-	-	-	-	-	33.8	22.2	-	-
	Romagnano Loc	Late Bronze Age	N	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
			Min.	-	-	-	-	28.2	17.9	-	-	-	-	-	-	-	-	-
Veneto	Concordia Sagittaria	Late Bronze Age	N	1	-	1	2	10	12	-	-	-	-	-	-	-	12	11
			Min.	41.6	-	81	27.7	27.4	19	-	-	-	-	-	-	-	27.3	22.7
			Max.	-	-	-	-	34.5	22.1	-	-	-	-	-	-	-	33.9	31
			Mean	-	-	-	-	31.4	20.1	-	-	-	-	-	-	-	29.9	26.4
			Std.Dev.	-	-	-	-	2.3	1.1	-	-	-	-	-	-	-	1.9	2.3
			V	-	-	-	-	**7.3**	**5.6**	-	-	-	-	-	-	-	**6.5**	**8.8**
Lombardy	Lavagnone	Early Bronze Age	N	4	4	2	2	2	2	-	-	5		7	9	7	4	5
			Min.	38.3	34.6	78.4	30.7	28.7	17.2	-	-	31.3	-	29	28.7	19.4	28.9	23.6
			Max.	42.1	37.3	101.3	39.2	30.3	19.6	-	-	33.4	-	39.8	42.9	29.3	29.9	26
			Mean	39.9	35.7	89.9	35	29.5	18.4	-	-	32.5	-	32	33.9	23	29.5	24.8
			Std.Dev.	-	-	-	-	-	-	-	-	1	-	3.6	3.9	3.3	-	0.9
			V	-	-	-	-	-	-	-	-	**3**	-	**11.1**	**11.6**	**14.4**	-	**3.6**
Liguria	Arene Candide	Late Neolithic-Copper/Bronze Age	N	2	2	-	-	1	1	-	-	-	-	-	-	1	-	-
			Min.	41.1	38.5	-	-	28.4	18.8	-	-	-	-	-	-	22.1	-	-
			Max.	52.8	47.5	-	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	47	43	-	-	-	-	-	-	-	-	-	-	-	-	-
		Copper/Bronze Age	N	7	7	4	4	2	4	1	1	5	1	3	-	4	12	11
			Min.	38.1	33.6	73.8	27.3	29.6	18.8	76.6	91.2	29.3	35.2	24.4	-	18.6	26.1	23.1
			Max.	49.8	45.9	109.6	42.6	29.8	23.4	-	-	42.6	-	36	-	22.5	38.2	34.7
			Mean	41.8	38	91.2	35.3	29.7	20.5	-	-	34.7	-	30.1	-	20.8	30.7	27.3
			Std.Dev.	3.9	3.8	-	-	-	-	-	-	5.3	-	-	-	-	4.6	4.3
			V	**9.2**	**10.1**	-	-	-	-	-	-	**15.3**	-	-	-	-	**14.8**	**15.6**

Table 7.15. Summary of postcranial measurements of Northern sites, from Late Neolithic/Eneolithic to Late Bronze Age. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASURE-MENT	ASTRAGALUS		ATLAS		CALCANEUS		FEMUR	HUMERUS		MC III	MC IV	MT III	MT IV	PELVIS	RADIUS		SCAPULA		TIBIA		ULNA	
				GLl	GLm	H	BFcr	GL	GD	DC	BT	HTC	GL	GL	GL	GL	LAR	Bd	BpP	GLC	SLC	Bd	Dd	BPC	DPA
CENTRE																									
Emilia-Romagna	Poviglio	Middle to Late Bronze Age	N	3	3	1	1	-	-	-	5	5	-	-	-	-	-	-	2	2	2	-	-	-	-
			Min.	37.5	34.9	38.2	47.6	-	-	-	25.6	17.3	-	-	-	-	-	-	25.2	29.2	18.2	-	-	-	-
			Max.	40.9	37.8	-	-	-	-	-	30.7	20.4	-	-	-	-	-	-	30.1	32.8	21.8	-	-	-	-
			Mean	39.2	36	-	-	-	-	-	27.6	19.1	-	-	-	-	-	-	27.7	31	20	-	-	-	-
			Std.Dev.	-	-	-	-	-	-	-	2.1	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-
			V	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**7.4**	**6.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Solarolo	Middle Bronze Age	N	8	7	8	4	1	1	2	10	11	1	5	1	5	13	1	6	1	5	8	8	-	-
			Min.	38	34.7	39.2	52.2	98.6	39.3	22.7	25.3	16.7	68.1	70.3	85.2	84.9	28.6	30.5	25	31.8	19.7	25.8	23.2	-	-
			Max.	52.8	47	49	56.1	-	-	26.1	31.7	20.8	-	78.8	-	98.8	40.5	-	30	-	21.8	31.3	26.4	-	-
			Mean	41.3	37.3	44.2	54.4	-	-	24.4	28.5	18.5	-	73.1	-	91.2	30.8	-	27.7	-	20.9	28.1	24.8	-	-
			Std.Dev.	4.9	4.4	3.7	-	-	-	-	1.8	1.3	-	3.8	-	6.2	3.1	-	1.9	-	0.9	1.7	0.9	-	-
			V	**11.8**	**11.8**	**8.3**	**-**	**-**	**-**	**-**	**6.2**	**6.8**	**-**	**5.2**	**-**	**6.8**	**9.9**	**-**	**6.9**	**-**	**4.1**	**6.1**	**3.7**	**-**	**-**
	Cesena	Middle Bronze Age	N	1	1	1	-	-	-	-	5	5	-	-	1	-	2	-	2	3	3	4	4	1	1
			Min.	42	38.4	43.9	-	-	-	-	27.1	17.9	-	-	84.5	-	27.8	-	27.8	33.7	22.6	25.1	21.8	21.2	34.1
			Max.	-	-	-	-	-	-	-	31.4	22.1	-	-	-	-	29.1	-	27.9	36.8	24.6	29.8	26.8	-	-
			Mean	-	-	-	-	-	-	-	29.5	19.5	-	-	-	-	28.5	-	27.9	35	23.7	27.4	23.8	-	-
			Std.Dev.	-	-	-	-	-	-	-	2.1	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-
			V	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**7.2**	**8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
		Late Bronze Age	N	5	5	1	1	-	-	1	9	10	2	2	1	2	11	-	5	4	4	10	8	1	1
			Min.	38.1	34.4	38.7	49.4	-	-	32.5	25.8	17.1	67.1	76.2	77.2	90.8	30	-	26.5	32.5	21.2	25.3	22.7	20.6	31.7
			Max.	44.6	39.5	-	-	-	-	-	29.9	19.6	83.4	77.7	-	99.9	33.5	-	29.7	37.4	24.7	35.8	30.7	-	-
			Mean	40.8	37.2	-	-	-	-	-	28	18.3	75.3	77	-	95.4	31.6	-	28	34.7	22.6	28.8	25.2	-	-
			Std.Dev.	2.4	1.8	-	-	-	-	-	1.4	0.9	-	-	-	-	1.4	-	1.4	-	-	3	2.7	-	-
			V	**5.9**	**4.9**	**-**	**-**	**-**	**-**	**-**	**5**	**4.7**	**-**	**-**	**-**	**-**	**4.5**	**-**	**4.9**	**-**	**-**	**10.2**	**10.9**	**-**	**-**
	Riccione Ipercoop	Middle to Late Bronze Age	N	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
			Min.	-	-	-	-	-	-	-	24.1	17.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cattolica	Early Bronze Age	N	4	3	-	-	-	-	-	3	2	-	-	-	-	3	-	1	-	-	2	2	-	-
			Min.	37	33.5	-	-	-	-	-	25.9	17.6	-	-	-	-	28.6	-	24.2	-	-	29.2	27.4	-	-
			Max.	48.5	43.7	-	-	-	-	-	29.3	18.8	-	-	-	-	31.9	-	-	-	-	35.8	30.3	-	-
			Mean	40.6	37.3	-	-	-	-	-	27.8	18.2	-	-	-	-	30.4	-	-	-	-	32.5	28.9	-	-

Table 7.16. (1/2) Summary of postcranial measurements of Central sites, from Eneolithic Late Bronze Age. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data from publication (Wilkens, 1999).

REGION	SITE	CHRONOLOGY	MEASURE-MENT	ASTRAGALUS		ATLAS		CALCANEUS		FEMUR	HUMERUS		MC III	MC IV	MT III	MT IV	PELVIS	RADIUS		SCAPULA		TIBIA		ULNA	
				GLl	GLm	H	BFcr	GL	GD	DC	BT	HTC	GL	GL	GL	GL	LAR	Bd	BpP	GLC	SLC	Bd	Dd	BPC	DPA
CENTRE (continued)																									
Tuscany	Gorgo del Ciliegio	Middle Bronze Age	N	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
			Min.	-	-	-	-	-	-	-	27.4	17.8	-	-	-	-	-	-	-	-	-	-	-	-	-
Marche	Conelle*	Eneolithic	N	76	75	-	-	23	-	1	117	-	17	17	5	5	104	19	97	45	55	139	135	1	1
			Min.	38	35	-	-	67.7	-	34	26.7	-	69.7	72.3	77.5	88.2	28.9	33	25.7	32.7	19.4	26.1	20.8	33.4	53.1
			Max.	57.8	51.3	-	-	110.1	-	-	47.1	-	98	105.2	104	115	52.3	51	43.9	56	39.9	44.8	38.1	-	-
			Mean	48	42.7	-	-	101.8	-	-	36.6	-	84.5	86.3	88	98.2	35.1	45.8	35.9	41.1	28	35	30.3	-	-
			Std.Dev.	6.1	4.8	-	-	8.4	-	-	5.5	-	12	1.9	12.2	12.7	5.2	3.7	5.2	7.6	5.5	6.7	4.6	-	-
			V	**12.7**	**11.2**	**-**	**-**	**8.3**	**-**	**-**	**15**	**-**	**14.2**	**13.8**	**13.9**	**12.9**	**14.8**	**8.1**	**14.5**	**18.5**	**19.6**	**19.1**	**15.2**	**-**	**-**
Lazio	Albano Le Macine	Middle Bronze Age	N	1	1	-	-	-	-	-	1	1	-	-	-	-	1	1	4	-	1	1	1	-	-
			Min.	42.9	38.2	-	-	-	-	-	36.1	25.2	-	-	-	-	29.4	27.6	28.1	-	21.8	34.1	29.7	-	-
			Max.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37.9	-	-	-	-	-	-
			Mean	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.6	-	-	-	-	-	-
	Cinquefrondi	Eneolithic	N	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
			Min.	38.3	34.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23.5	-	-	-	-
			Max.	40.5	35.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	39.7	35.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pantano Borghese	Eneolithic	N	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	3	-	-	-	-
			Min.	-	-	-	-	-	-	-	-	-	-	74.5	-	-	-	34.4	-	-	23.2	-	-	-	-
			Max.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24.9	-	-	-	-
			Mean	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23.8	-	-	-	-

Table 7.16. (2/2) Summary of postcranial measurements of Central sites, from Eneolithic Late Bronze Age. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data from publication (Wilkens, 1999).

REGION	SITE	CHRONOLOGY	MEASUREMENT	ASTRAGALUS		ATLAS		CALCANEUS		FEMUR	HUMERUS		MC III	MC IV	MT III	MT IV	PELVIS	RADIUS		SCAPULA		TIBIA		ULNA	
				GLl	GLm	H	BFcr	GL	GD	DC	BT	HTC	GL	GL	GL	GL	LAR	Bd	BpP	GLC	SLC	Bd	Dd	BPC	DPA
SOUTH																									
Apulia	Coppa Nevigata	Middle Bronze Age	N	9	11	3	2	1	2	-	5	5	1	2	-	1	8	-	10	-	3	4	4	-	-
			Min.	35.9	32.8	43.2	52.6	70.1	27.3	-	28.1	18.3	76.2	67.2	-	82	29	-	25.8	-	20.6	27.2	23	-	-
			Max.	41.9	37.6	61.9	64.1	-	28.8	-	32.1	20.5	-	67.7	-	-	33.1	-	30.4	-	22.4	31	26.7	-	-
			Mean	40	35.8	49.8	58.4	-	28.1	-	30	18.9	-	67.5	-	-	30.8	-	27.8	-	21.3	29.3	25.3	-	-
			Std.Dev.	1.9	1.5	-	-	-	-	-	1.6	0.9	-	-	-	-	1.6	-	1.7	-	-	-	-	-	-
			V	**4.8**	**4.3**	**-**	**-**	**-**	**-**	**-**	**5.2**	**4.8**	**-**	**-**	**-**	**-**	**5.1**	**-**	**6.1**	**-**	**-**	**-**	**-**	**-**	**-**
		Late Bronze Age	N	9	8	2	1	1	1	1	3	3	1	-	-	-	3	-	3	1	2	3	3	-	-
			Min.	35.1	31.3	46.1	59.8	71	27.2	19.9	28.5	17.3	63.8	-	-	-	27	-	26.2	32	18.3	27.8	23.3	-	-
			Max.	47	42	48	-	-	-	-	30	19.4	-	-	-	-	31	-	34.8	-	19.6	35.4	27.9	-	-
			Mean	39.5	35.5	47.1	-	-	-	-	29.5	18.3	-	-	-	-	29.6	-	29.8	-	19	30.5	25	-	-
			Std.Dev.	3.5	3.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			V	**8.9**	**9.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Campania	Santa Maria a' Peccerella	Eneolithic	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	2	-	-	-	-
			Min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27.1	35.5	24.6	-	-	-	-
			Max.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35.8	25.6	-	-	-	-
			Mean	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35.7	25.1	-	-	-	-
	Gricignano	Late Eneolithic to Early Bronze Age	N	1	2	-	-	-	-	-	3	4	-	-	-	-	4	-	3	-	3	4	3	1	1
			Min.	44.6	35.9	-	-	-	-	-	28.2	18.3	-	-	-	-	29.7	-	29.6	-	24	27.5	25	19.3	34.1
			Max.	-	40.4	-	-	-	-	-	35.2	22.4	-	-	-	-	35.9	-	33.7	-	25.7	30.4	26.1	-	-
			Mean	-	38.2	-	-	-	-	-	31.4	20.2	-	-	-	-	31.4	-	31	-	25.1	28.9	25.7	-	-
	La Starza*	Middle Bronze Age	N	2	2	-	-	-	1	-	4	4	1	-	-	-	5	-	3	5	5	2	-	-	-
			Min.	40.9	36.8	-	-	-	39.3	-	28.8	18.5	94.2	-	-	-	28.7	-	28.1	35	22.7	28.5	-	-	-
			Max.	48.1	43.1	-	-	-	-	-	34.9	22.1	-	-	-	-	37	-	30.2	48.5	31.6	29	-	-	-
			Mean	44.5	40	-	-	-	-	-	32.1	19.9	-	-	-	-	32.2	-	28.3	38.7	25.2	28.8	-	-	-
			Std.Dev.	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	-	-	5.7	3.7	-	-	-	-
			V	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4.3**	**-**	**-**	**14.7**	**14.7**	**-**	**-**	**-**	**-**

Table 7.17. (1/2) Summary of postcranial measurements of Southern and Island sites, from Eneolithic Late Bronze Age. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONOLOGY	MEASUREMENT	ASTRAGALUS		ATLAS		CALCANEUS		FEMUR	HUMERUS		MC III	MC IV	MT III	MT IV	PELVIS	RADIUS		SCAPULA		TIBIA		ULNA	
				GLl	GLm	H	BFcr	GL	GD	DC	BT	HTC	GL	GL	GL	GL	LAR	Bd	BpP	GLC	SLC	Bd	Dd	BPC	DPA
SOUTH (Continued)																									
Calabria	Grotta della Madonna	Eneolithic	N	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
			Min.	36.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52.5
		Middle Bronze Age	N	2	2	-	-	1	1	-	2	3	1	-	-	-	1	-	1	-	2	2	1	-	-
			Min.	37.4	33.7	-	-	67	25.4	-	26.8	16.1	64.9	-	-	-	31.1	-	27.6	-	21.1	26	23.3	-	-
			Max.	38.1	34.1	-	-	-	-	-	31	20	-	-	-	-	-	-	-	-	21.6	26.4	-	-	-
			Mean	37.8	33.9	-	-	-	-	-	28.9	18.4	-	-	-	-	-	-	-	-	21.4	26.2	-	-	-
	Broglio di Trebisacce	Middle Bronze Age	N	4	4	-	-	1	1	-	1	1	1	-	-	1	3	-	2	-	2	6	5	-	-
			Min.	37.5	34	-	-	72.2	26.3	-	46.9	26.4	74.9	-	-	84	30.5	-	24.7	-	21.6	22.8	20.2	-	-
			Max.	40.2	37.2	-	-	-	-	-	-	-	-	-	-	-	32.3	-	25	-	23.2	28.1	25.1	-	-
			Mean	38.5	35.3	-	-	-	-	-	-	-	-	-	-	-	31.4	-	24.9	-	22.4	26.4	22.9	-	-
			Std.Dev.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.9	1.8	-	-
			V	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**7.1**	**7.7**	**-**	**-**
	Torre Mordillo	Middle Bronze Age	N	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
			Min.	-	-	-	-	-	-	-	28.6	17.1	-	-	-	-	-	-	-	-	-	-	-	-	-
			Max.	-	-	-	-	-	-	-	29.8	18	-	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	-	-	-	-	-	-	-	29.2	17.6	-	-	-	-	-	-	-	-	-	-	-	-	-
		Late Bronze Age	N	8	-	-	-	3	2	1	9	10	-	-	-	-	-	-	-	-	-	8	7	-	-
			Min.	34.3	-	-	-	71.1	26	24	27	16.4	-	-	-	-	-	-	-	-	-	22.2	21.8	-	-
			Max.	41.9	-	-	-	73.4	27.4	-	39.3	24.3	-	-	-	-	-	-	-	-	-	30.5	24.9	-	-
			Mean	38.6	-	-	-	72.6	26.7	-	30.9	18.9	-	-	-	-	-	-	-	-	-	28	23.7	-	-
			Std.Dev.	2.5	-	-	-	-	-	-	3.6	2.1	-	-	-	-	-	-	-	-	-	2.7	1.1	-	-
			V	**6.5**	**-**	**-**	**-**	**-**	**-**	**-**	**11.6**	**11.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**9.6**	**4.8**	**-**	**-**
Sicily	Mursia	Middle Bronze Age	N	10	10	3	3	3	2	2	5	4	-	2	3	2	5	2	4	8	7	2	2	-	-
			Min.	33.6	31	39.1	48.6	67.6	26.5	20	22.9	15	-	66.2	75.1	76.5	26.5	27.8	22	26.2	15.9	27.3	24.1	-	-
			Max.	40	36.1	48.4	57	72.1	27.5	26.1	29.9	19.8	-	72.1	80.2	81.7	31	35.8	28.7	36.1	25	27.7	24.8	-	-
			Mean	37.4	34.3	42.6	53.1	70.3	27	23.1	26.4	17.5	-	69.2	77.5	79.1	28.7	31.8	25.1	31	20.2	27.5	24.5	-	-
			Std.Dev.	1.8	1.7	-	-	-	-	-	2.6	-	-	-	-	-	1.7	-	-	3.3	3.1	-	-	-	-
			V	**4.8**	**4.9**	**-**	**-**	**-**	**-**	**-**	**9.7**	**-**	**-**	**-**	**-**	**-**	**5.8**	**-**	**-**	**10.7**	**15.4**	**-**	**-**	**-**	**-**

Table 7.17. (2/2) Summary of postcranial measurements of Southern and Island sites, from Eneolithic Late Bronze Age. All fused and fusing specimens were included from long bone measurements, except for the humerus, where only fused specimens were included. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
NORTH																		
Trentino-South Tyrol	Pradestel	Mesolithic	N	1	2	2	1	-	1	1	1	-	-	1	1	1	1	1
			Min.	19.3	6.4	7.3	8.8	-	17.9	11.1	11.7	-	-	14.9	34	15.5	15.3	12.7
			Max.	-	6.6	7.9	-	-	-	-	-	-	-	-	-	-	-	-
			Mean	-	6.5	7.6	-	-	-	-	-	-	-	-	-	-	-	-
	Riparo Gaban	Mesolithic	N	-	-	-	-	-	-	-	-	2	-	1	1	2	1	2
			Min.	-	-	-	-	-	-	-	-	23	-	17.2	38.4	16.3	16.7	14.6
			Max.	-	-	-	-	-	-	-	-	24.5	-	-	-	17.7	-	15.4
			Mean	-	-	-	-	-	-	-	-	23.8	-	-	-	17	-	15
	Romagnano Loc	Mesolithic	N	-	-	-	1	-	1	1	1	1	1	1	-	-	-	-
			Min.	-	-	-	8.9	-	17.7	10.9	11.9	23.7	14.8	15.5	-	-	-	-
Friuli-Venezia Giulia	Riparo di Biarzo	Upper Palaeolithic	N	-	1	-	1	2	-	1	-	-	-	-	-	-	1	1
			Min.	-	7.4	-	9.5	7	-	11.8	-	-	-	-	-	-	16.5	13.3
			Max.	-	-	-	-	7.6	-	-	-	-	-	-	-	-	-	-
			Mean	-	-	-	-	7.3	-	-	-	-	-	-	-	-	-	-
		Upper Palaeolithic/ Mesolithic	N	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-
			Min.	20	7.1	8	9.4	-	-	-	-	-	-	-	-	-	-	-
Liguria	Arene Candide	Upper Palaeolithic	N	1	-	-	1	-	1	1	1	-	-	-	-	-	-	-
			Min.	19.5	-	-	8.7	-	18	11	12	-	-	-	-	-	-	-
CENTRE																		
Lazio	Palidoro	Upper Palaeolithic	N	2	2	2	2	9	3	5	7	3	5	5	8	10	12	8
			Min.	19.9	6.9	7.8	9.3	8.1	18.2	11	10.3	21.4	13.4	14.3	33.4	15.3	14.8	11.9
			Max.	20.3	7.1	8.3	9.6	10.2	19.2	11.9	12.4	22.1	14.9	15.3	34.8	19.1	17.2	14.1
			Mean	20.1	7	8.1	9.5	8.8	18.7	11.6	11.8	21.8	13.9	14.6	34.1	16.4	15.8	13.1
			Std.Dev.	-	-	-	-	0.6	-	0.4	0.7	-	0.6	0.4	0.4	1.1	0.8	0.8
			V	**-**	**-**	**-**	**-**	**6.6**	**-**	**3.1**	**5.9**	**-**	**4.3**	**2.8**	**1.2**	**6.7**	**5.2**	**5.9**

Table 7.18. Summary of lower teeth measurements of North and Central sites, from Upper Palaeolithic to Mesolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
SOUTH																		
Apulia	Grotta Paglicci	Upper Palaeolithic	N	17	18	19	22	16	27	29	31	11	12	11	18	16	19	16
			Min.	18.7	6.7	7.9	8.9	7.5	15.7	10.3	11.3	20.8	13.7	14.3	33.1	15.3	14.9	12.3
			Max.	21.2	7.4	9	10.4	11.1	20.2	11.9	12.9	23.5	15.7	15.8	38.4	20.9	18.4	15.8
			Mean	20	7	8.2	9.4	9.2	18	11.3	12.2	22.5	14.7	15.2	35.9	17	16.4	13.7
			Std.Dev.	0.8	0.2	0.4	0.4	0.8	0.9	0.4	0.5	0.9	0.5	0.5	1.6	1.4	0.9	1
			V	**4.1**	**3.5**	**4.3**	**3.9**	**8.9**	**5.1**	**3.7**	**3.8**	**4.2**	**3.7**	**3.1**	**4.5**	**8.3**	**5.5**	**7.4**
	Grotta Romanelli	Upper Palaeolithic	N	-	-	-	-	-	1	2	2	1	1	1	1	2	1	1
			Min.	-	-	-	-	-	17.5	10.4	10.9	23.9	13.8	15.4	36.9	14.6	16.6	13.6
			Max.	-	-	-	-	-	17.5	10.7	11.8	-	-	-	-	16	-	-
			Mean	-	-	-	-	-	17.5	10.6	11.4	-	-	-	-	15.3	-	-
Campania	Grotta della Cala	Upper Palaeolithic	N	-	-	-	-	2	1	1	-	1	-	-	-	1	1	-
			Min.	-	-	-	-	9.4	18.2	11.4	-	22.8	-	-	-	17.6	17.4	-
			Max.	-	-	-	-	9.5	-	-	-	-	-	-	-	-	-	-
			Mean	-	-	-	-	9.5	-	-	-	-	-	-	-	-	-	-
		Mesolithic	N	2	1	2	2	1	3	3	3	1	1	1	2	2	1	1
			Min.	20.6	7	8.5	9.3	9.5	16.9	10.1	10.6	22.9	15.3	15.8	35.1	17	16.4	13.5
			Max.	20.8	-	8.7	9.4	-	18.2	11.7	11.9	-	-	-	36.7	17.7	-	-
			Mean	20.7	-	8.6	9.4	-	17.5	11	11.5	-	-	-	35.9	17.4	-	-
Calabria	Grotta della Madonna	Upper Palaeolithic	N	18	20	20	19	15	19	22	23	7	7	7	5	5	5	5
			Min.	18.3	6.5	7.4	8.6	7.3	16.5	10.5	11.2	20.8	14	14.4	33.1	16.1	15.5	12.1
			Max.	21.4	7.4	8.6	9.9	10.4	19.1	12	13	25	15.9	15.7	38.6	18.8	17.5	15.1
			Mean	20.3	7	8.1	9.4	9	17.9	11.3	12.1	22.9	14.9	15.1	36.3	17.1	16.4	14
			Std.Dev.	0.7	0.2	0.3	0.3	1	0.7	0.4	0.5	1.4	0.6	0.5	2.1	1.1	1	1.2
			V	**3.7**	**3.1**	**3.9**	**2.9**	**10.8**	**3.8**	**3.4**	**4**	**6.2**	**3.9**	**3.4**	**5.9**	**6.6**	**5.8**	**8.3**
		Mesolithic	N	5	3	6	9	7	13	14	14	1	3	2	4	5	4	5
			Min.	19.2	6.8	7.7	8.9	7.7	17.3	10.3	11	22.9	15.4	15.8	34.6	15	15.1	12.6
			Max.	20.4	6.9	8.5	9.4	9.9	18.8	12.4	12.5	22.9	16	16.2	38.1	18.8	17.4	14.6
			Mean	19.7	6.8	8.2	9.2	9.1	18.1	11.2	11.8	22.9	15.8	16	36.5	17.6	16.4	13.4
			Std.Dev.	0.4	-	0.3	0.2	0.8	0.5	0.6	0.5	-	-	-	-	1.5	-	0.8
			V	**2.2**	**-**	**3.4**	**1.7**	**8.3**	**2.7**	**5.4**	**3.9**	**-**	**-**	**-**	**-**	**8.4**	**-**	**6.1**

Table 7.19. Summary of lower teeth measurements of Southern sites, from Upper Palaeolithic to Mesolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
ISLANDS																		
Sicily	Grotta dell'Uzzo	Mesolithic	N	21	-	-	24	-	20	21	21	8	9	8	11	18	23	18
			Min.	18.3	-	-	8.1	-	15.7	9.7	10.5	20.5	13.3	13.7	31.5	14.6	14	11
			Max.	20.7	-	-	9.2	-	18.2	11	11.7	22.4	14.7	15	38.5	17.5	17.3	13.9
			Mean	19.3	-	-	8.6	-	16.9	10.4	11.1	21.6	13.9	14.2	35.5	15.7	15.4	12.5
			Std.Dev.	0.7	-	-	0.3	-	0.5	0.3	0.4	0.8	0.6	0.4	2.3	0.8	0.8	0.9
			V	**3.8**	**-**	**-**	**3.2**	**-**	**3.1**	**3.4**	**3.2**	**3.6**	**4.3**	**3**	**6.4**	**5.2**	**5.4**	**7.3**

Table 7.20. Summary of lower teeth measurements of Island sites, from Upper Palaeolithic to Mesolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Upper dP4			Upper M1			Upper M2			Upper M3			
				L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC	WP
NORTH																
Trentino-South Tyrol	Galgenbühel/ Dos de la Forca	Mesolithic	N	1	1	2	2	2	2	-	-	-	-	-	-	-
			Min.	14.6	11.3	10.3	17.7	13.7	12.9	-	-	-	-	-	-	-
			Max.	-	-	11.7	18.8	14.7	14.5	-	-	-	-	-	-	-
			Mean	-	-	11	18.3	14.2	13.7	-	-	-	-	-	-	-
	Riparo Gaban	Mesolithic	N	1	1	1	-	-	-	-	-	-	-	-	-	-
			Min.	14	9.9	10.8	-	-	-	-	-	-	-	-	-	-
	Romagnano Loc	Mesolithic	N	-	-	-	-	-	-	-	-	-	-	-	1	-
			Min.	-	-	-	-	-	-	-	-	-	-	-	15.6	-
Friuli-Venezia Giulia	Riparo di Biarzo	Upper Palaeolithic	N	-	-	1	-	-	-	-	-	-	3	3	3	3
			Min.	-	-	11.8	-	-	-	-	-	-	31.1	19.1	16.3	12
			Max.	-	-	-	-	-	-	-	-	-	34.9	20.4	17.6	13
			Mean	-	-	-	-	-	-	-	-	-	32.8	19.7	16.7	12.6
		Mesolithic	N	1	1	1	1	-	-	-	-	-	-	-	-	-
			Min.	13.9	10.5	9.9	17.8	-	-	-	-	-	-	-	-	-
CENTRE																
Lazio	Palidoro	Upper Palaeolithic	N	2	2	4	1	6	7	8	4	6	9	11	11	11
			Min.	14.1	11.3	11	18.3	14	13.4	21.8	16.9	15.8	28.1	17.8	15.3	10.3
			Max.	15.3	11.7	11.4	-	15.1	14.5	24.8	18.1	18	37.7	20.5	17.6	13.2
			Mean	14.7	11.5	11.3	-	14.5	13.9	23	17.5	16.9	33.2	19.3	16.1	11.8
			Std.Dev.	-	-	-	-	0.4	0.4	1.2	-	0.9	2.6	0.9	0.6	0.8
			V	**-**	**-**	**-**	**-**	**2.5**	**2.6**	**5.4**	**-**	**5.3**	**7.8**	**4.5**	**4**	**6.6**

Table 7.21. Summary of upper teeth measurements of Northern and Central sites, from Upper Palaeolithic to Mesolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Upper dP4			Upper M1			Upper M2			Upper M3			
				L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC	WP
SOUTH																
Apulia	Grotta Paglicci	Upper Palaeolithic	N	20	19	20	18	18	21	5	6	6	12	14	13	12
			Min.	14.3	11.1	11.2	17.5	13.7	11.6	18.4	16.2	14.1	27.9	18.1	13.7	9.7
			Max.	15.9	13	12.8	18.9	15.5	15.1	23.9	18.9	18.6	36.8	20	17.1	12.7
			Mean	14.9	11.9	11.8	18.4	14.7	14	21.7	18	16.7	33.2	19.2	15.8	11.5
			Std.Dev.	0.5	0.5	0.5	0.4	0.5	0.8	2.1	1	1.7	2.4	0.8	1.1	0.8
			V	**3.2**	**4.4**	**4.3**	**2.3**	**3.3**	**5.5**	**9.5**	**5.8**	**9.9**	**7.1**	**4**	**7**	**7.3**
Campania	Grotta della Cala	Upper Palaeolithic	N	-	-	-	1	1	1	-	-	-	-	-	-	-
			Min.	-	-	-	18.5	14.4	13.9	-	-	-	-	-	-	-
		Mesolithic	N	1	1	1	-	-	-	-	-	-	-	-	-	-
			Min.	15.8	11.1	11.4	-	-	-	-	-	-	-	-	-	-
Calabria	Grotta della Madonna	Upper Palaeolithic	N	14	13	14	19	25	22	6	7	6	6	9	4	5
			Min.	13.5	10.6	10.6	16.8	13.1	12.8	22	17.5	16.5	32.6	17.9	14.9	10.8
			Max.	15.3	12.4	11.9	19.8	15.5	15.2	24	18.6	18.7	38.8	20.6	17.2	14.6
			Mean	14.4	11.5	11.3	18	14.3	14	23.1	18.1	17.3	35.7	19.4	16.1	12.9
			Std.Dev.	0.5	0.5	0.4	0.8	0.6	0.6	0.8	0.4	0.9	2.2	0.8	-	1.5
			V	**3.5**	**3.9**	**3.3**	**4.4**	**4**	**4.4**	**3.5**	**2.2**	**5.2**	**6.1**	**4.2**	**-**	**11.6**
		Mesolithic	N	3	2	3	4	6	5	2	2	2	2	2	2	2
			Min.	14.6	10.8	10.9	17.6	13.5	13.2	21.2	17.3	16.3	32.5	19.4	15.9	11.5
			Max.	15.8	11.3	11.5	19.2	14.4	14.1	24.3	18.2	17.7	33.4	19.6	16.1	12.1
			Mean	15.2	11.1	11.3	18.3	13.9	13.6	22.8	17.8	17	33	19.5	16	11.8
			Std.Dev.	-	-	-	-	0.4	0.4	-	-	-	-	-	-	-
			V	**-**	**-**	**-**	**-**	**2.7**	**3.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 7.22. Summary of upper teeth measurements of Southern sites, from Upper Palaeolithic to Mesolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
NORTH																		
Trentino-South Tyrol	Riparo Gaban	Early Neolithic	N	2	2	3	2	2	1	1	1	-	-	-	-	-	-	-
			Min.	20.5	6.6	7.6	9.1	7.4	18	11.4	12.1	-	-	-	-	-	-	-
			Max.	20.6	6.8	8.4	9.3	9.2	-	-	-	-	-	-	-	-	-	-
			Mean	20.6	6.7	8	9.2	8.3	-	-	-	-	-	-	-	-	-	-
Veneto	Rocca di Rivoli*	Middle Neolithic	N	1	-	-	3	-	4	6	6	5	5	7	4	8	7	-
			Min.	19.2	-	-	8.5	-	17	10.2	11	21.1	13.8	13.9	33.8	14	15.3	-
			Max.	-	-	-	9.1	-	18.5	12.3	12.9	25	16.2	16.2	39.2	17.8	16.7	-
			Mean	-	-	-	8.7	-	17.5	11.2	11.8	22.5	14.6	14.8	36.6	16.2	16	-
			Std.Dev.	-	-	-	-	-	-	0.8	0.8	1.6	1	0.8	-	1.1	0.4	-
			V	**-**	**-**	**-**	**-**	**-**	**-**	**7.1**	**6.8**	**7.1**	**6.8**	**5.4**	**-**	**6.8**	**2.5**	**-**
	Molino Casarotto	Middle Neolithic	N	5	4	5	4	8	7	7	7	9	9	11	9	8	9	10
			Min.	19.6	6.8	7.8	9	7.8	15.1	10.2	10.4	18.7	12.9	13.2	32.5	16.1	14.5	10.3
			Max.	21.1	7.1	8.3	9.7	10.2	20.4	12.3	13	26.3	17.7	16.9	46.2	20.2	19.3	16.9
			Mean	20.4	7	8	9.4	9.3	18.9	11.8	12.4	23.3	14.9	15.3	40.1	18.1	17.6	14.1
			Std.Dev.	0.6	0.1	0.2	0.4	0.8	1.8	0.7	0.9	2.3	1.5	1.2	4.6	1.4	1.5	1.9
			V	**2.7**	**-**	**2.6**	**-**	**9.1**	**9.6**	**6**	**7.2**	**10**	**9.8**	**8**	**11.6**	**7.9**	**8.7**	**13.6**

Table 7.23. (1/2) Summary of lower teeth measurements of Northern sites, from Early to Late Neolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
NORTH (continued)																		
Liguria	Arene Candide	Early Neolithic	N	7	10	8	10	4	6	6	6	2	2	2	1	1	1	1
			Min.	19.7	6.2	7.5	8.2	8.5	17.4	10.5	11.5	21.7	13.1	13.4	41.4	17.3	17.2	13.7
			Max.	21.4	9.5	8.7	9.7	10.4	22.1	14.6	14.1	25.1	16.5	16	-	-	-	-
			Mean	20.7	7.1	8.2	9.2	9.6	18.8	12.1	12.4	23.4	14.8	14.7	-	-	-	-
			Std.Dev.	0.7	0.9	0.5	0.5	-	1.7	1.5	1	-	-	-	-	-	-	-
			V	**3.5**	**12.8**	**5.8**	**5.5**	-	**9.3**	**12.4**	**7.7**	-	-	-	-	-	-	-
		Early/Middle Neolithic Transition	N	2	3	3	2	2	4	4	4	1	1	1	-	-	-	-
			Min.	19	6.5	7.3	8.4	8.9	17.5	10	10.3	23.9	15	15.1	-	-	-	-
			Max.	20.6	7.1	7.9	9.9	9.3	20.2	11.3	12.1	-	-	-	-	-	-	-
			Mean	19.8	6.8	7.6	9.2	9.1	18.4	10.8	11.3	-	-	-	-	-	-	-
		Middle Neolithic	N	35	37	37	39	14	39	44	44	18	19	19	9	9	11	11
			Min.	17.8	5.7	6.6	7.6	8.7	15	9.2	9.7	19.1	13.3	13	34.3	16.5	15	11.7
			Max.	22.1	7.6	8.8	10.4	9.9	19.6	12	13.4	24.6	16.4	16.2	39.3	19.4	17.5	14.1
			Mean	20	6.6	7.7	8.8	9.2	17.4	10.7	11.4	22.1	14.6	14.7	36.7	17.3	15.8	13
			Std.Dev.	1.1	0.5	0.5	0.6	0.3	1	0.7	0.8	1.6	0.8	0.9	1.7	0.9	0.8	0.7
			V	**5.4**	**7.3**	**6.9**	**6.9**	**3.4**	**5.8**	**6.5**	**6.9**	**7.1**	**5.8**	**6**	**4.7**	**5.1**	**5**	**5.5**
		Late Neolithic	N	3	3	5	5	3	3	3	-	1	1	2	3	4	4	2
			Min.	18.3	6	6.6	7.7	12.5	10.1	10.1	-	22.3	14.2	11.3	16	12.7	12.5	22.5
			Max.	19.6	6.7	7.8	8.8	14.1	11.3	10.8	-	-	-	14.4	17.3	13.9	13.6	23.1
			Mean	18.9	6.4	7.1	8.4	13.2	10.6	10.5	-	-	-	12.9	16.5	13.1	12.9	22.8
			Std.Dev.	-	-	0.4	0.5	-	-	-	-	-	-	-	-	-	-	-
			V	-	-	**6.3**	**5.5**	-	-	-	-	-	-	-	-	-	-	-

Table 7.23. (2/2) Summary of lower teeth measurements of Northern sites, from Early to Late Neolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
CENTRE																		
Marche	Portonovo	Early Neolithic	N	2	2	2	2	3	3	4	3	3	3	3	2	2	4	3
			Min.	20.2	6.6	7.7	8.8	8.3	16.6	10.2	11.3	21.3	13.1	13.2	34	15.2	15.2	12.4
			Max.	20.6	7	8.4	9.1	10.2	18	11.6	11.9	23.4	15.2	15.7	37.9	16.9	17.6	13.8
			Mean	20.4	6.8	8.1	9	9.4	17.1	10.9	11.7	22.2	14.5	14.4	36	16.1	16.6	13.3
Lazio	La Marmotta	Early Neolithic	N	4	-	-	4	-	5	6	6	4	4	4	2	2	2	2
			Min.	20	-	-	9	-	17.6	10.8	11.4	22.6	14.1	14.7	36.2	15.1	15.7	12.3
			Max.	20.8	-	-	9.5	-	18.5	11.6	12.6	29.6	15.3	16	40.9	18.5	17.2	13.9
			Mean	20.3	-	-	9.2	-	17.9	11.4	11.9	24.7	14.8	15.3	38.6	16.8	16.5	13.1
			Std.Dev.	-	-	-	-	-	0.4	0.3	0.5	-	-	-	-	-	-	-
			V	-	-	-	-	-	**2.2**	**2.6**	**3.9**	-	-	-	-	-	-	-

Table 7.24. Summary of lower teeth measurements of Central sites, from Early Neolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
SOUTH																		
Apulia	Masseria Candelaro	Middle Neolithic	N	5	-	-	8	-	10	13	12	9	8	9	3	2	3	3
			Min.	20	-	-	8.5	-	17.7	10	10.6	21.6	13.4	13.5	33.9	15.4	15.5	12.3
			Max.	21.4	-	-	9.3	-	19.5	11.7	12.7	23.9	15.1	16.3	37.1	16.4	16.6	12.7
			Mean	20.6	-	-	8.9	-	18.5	10.9	11.9	22.9	14.2	15	35.3	15.9	15.9	12.5
			Std.Dev.	0.6	-	-	0.3	-	0.7	0.5	0.6	0.9	0.7	1	-	-	-	-
			V	**2.8**	**-**	**-**	**3.1**	**-**	**3.8**	**4.3**	**5**	**3.9**	**4.9**	**6.6**	**-**	**-**	**-**	**-**
	Masseria Fragella	Early Neolithic	N	1	1	1	1	1	2	2	3	1	1	1	-	-	-	-
			Min.	19.9	6.5	7.6	8.8	8.9	17.6	10.4	11.3	23.7	13.8	14.5	-	-	-	-
			Max.	-	-	-	-	-	18.2	10.5	12.1	-	-	-	-	-	-	-
			Mean	-	-	-	-	-	17.9	10.5	11.7	-	-	-	-	-	-	-
	Masseria Pantano	Middle Neolithic	N	-	-	-	-	1	1	1	1	2	2	2	1	1	1	1
			Min.	-	-	-	-	10.1	17.3	11.4	12.3	23.3	13.8	14.1	38.5	17.2	17.2	14.8
			Max.	-	-	-	-	-	-	-	-	24.2	15	16.2	-	-	-	-
			Mean	-	-	-	-	-	-	-	-	23.8	14.4	15.2	-	-	-	-
Campania	Masseria di Gioia	Middle to Late Neolithic	N	-	-	-	-	-	-	1	1	1	1	1	-	1	1	-
			Min.	-	-	-	-	-	-	10.7	11.3	21.6	13.5	14	-	16.2	13.5	-
	Mulino Sant' Antonio*	Late Neolithic	N	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-
			Min.	-	-	-	-	-	-	-	-	-	-	-	34.6	16.7	-	-
			Max.	-	-	-	-	-	-	-	-	-	-	-	40.7	17.8	-	-
			Mean	-	-	-	-	-	-	-	-	-	-	-	36.9	17.3	-	-
Calabria	Grotta della Madonna	Middle Neolithic	N	3	2	3	3	-	-	-	-	1	1	1	-	-	-	-
			Min.	19.5	6.5	7.7	8.1	-	-	-	-	21.9	13.6	14.7	-	-	-	-
			Max.	20.2	7	7.8	9.3	-	-	-	-	-	-	-	-	-	-	-
			Mean	19.7	6.8	7.8	8.6	-	-	-	-	-	-	-	-	-	-	-
		Late Neolithic	N	-	-	1	-	-	-	1	-				1			
			Min.	-	-	7.7	-	-	-	10.4	-				29.1			
	Favella	Early Neolithic	N	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-
			Min.	-	-	-	-	-	-	-	-	23.5	-	-	34.1	-	-	-

Table 7.25. Summary of lower teeth measurements of Southern sites, from Early to Late Neolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data from publication (Albarella, 1987-88).

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
ISLANDS																		
Sicily	Grotta dell'Uzzo	Early Neolithic	N	1	-	-	2	-	2	2	2	3	3	3	5	5	6	5
			Min.	21.4	-	-	8.4	-	17.1	9.9	10.8	20.2	13.6	12.6	30.7	14.5	14.3	9.4
			Max.	-	-	-	9.4	-	18.7	10.8	11.6	21.1	13.7	14.7	38.2	16.7	16.1	12.7
			Mean	-	-	-	8.9	-	17.9	10.4	11.2	20.5	13.6	13.7	32.9	15.6	15.5	11.4
		Middle Neolithic	N	1	-	-	1	-	1	2	2	-	-	-	1	1	1	1
			Min.	18.3	-	-	8.7	-	16.7	10.2	11	-	-	-	35.4	15.5	14.9	12.1
			Max.	-	-	-	-	-	-	10.4	11.2	-	-	-	-	-	-	-
			Mean	-	-	-	-	-	-	10.3	11.1	-	-	-	-	-	-	-
		Early to Middle Neolithic	N	6	-	-	10	-	5	6	6	6	6	6	7	9	9	7
			Min.	18.3	-	-	8.4	-	16.4	9.9	10.6	20.2	13.1	12.6	30.7	14.5	14.3	9.4
			Max.	21.4	-	-	9.5	-	18.7	10.8	11.6	23.4	14.1	15	38.6	16.7	16.1	13.5
			Mean	20.5	-	-	8.9	-	17.1	10.3	11.1	21.3	13.6	13.9	34.1	15.7	15.4	11.8
			Std.Dev.	1.3	-	-	0.4	-	1	0.3	0.3	1.3	0.3	1	3.3	0.7	0.6	1.4
			V	**6.1**	**-**	**-**	**4.4**	**-**	**5.6**	**3.3**	**3.1**	**6.2**	**2.3**	**7.3**	**9.7**	**4.4**	**3.8**	**11.5**

Table 7.26. Summary of lower teeth measurements of Island sites, from Early to Middle Neolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Upper dP4			Upper M1			Upper M2			Upper M3			
				L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC	WP
NORTH																
Trentino-South Tyrol	Riparo Gaban	Early Neolithic	N	-	-	-	-	-	-	-	-	-	3	1	1	2
			Min.	-	-	-	-	-	-	-	-	-	32.3	18.4	15.3	12.3
			Max.	-	-	-	-	-	-	-	-	-	40.1	-	-	13
			Mean	-	-	-	-	-	-	-	-	-	36.2	-	-	12.7
Veneto	Cornuda*	Late Neolithic	N	-	-	-	-	-	-	-	-	-	3	-	-	-
			Min.	-	-	-	-	-	-	-	-	-	32.2	-	-	-
			Max.	-	-	-	-	-	-	-	-	-	43	-	-	-
			Mean	-	-	-	-	-	-	-	-	-	37.3	-	-	-
	Molino Casarotto	Middle Neolithic	N	1	1	1	4	4	4	9	9	9	8	9	9	9
			Min.	15.4	11.6	10.8	15	12.6	12.4	19.8	15.8	14.7	33.5	19.5	16.2	12.3
			Max.	-	-	-	20.3	16	16.5	25.9	20.4	20	43.6	22.9	21.4	17.3
			Mean	-	-	-	17.3	14.3	14.2	23.2	18.5	18	38.9	21.3	18.5	14.5
			Std.Dev.	-	-	-	-	-	-	2.1	1.6	1.9	3.6	1.2	1.4	1.6
			V	**-**	**-**	**-**	**-**	**-**	**-**	**8.9**	**8.8**	**10.7**	**9.2**	**5.6**	**7.8**	**11.1**
Liguria	Arene Candide	Early Neolithic	N	7	8	8	7	9	9	6	8	8	8	9	8	7
			Min.	14.1	11.2	11.2	14.1	11.7	11.5	19	15	14.2	33.6	17.8	16.2	12.2
			Max.	15.2	12.4	12.3	18.9	15.7	15.1	24.4	19.4	18.5	44.2	22.6	18.6	15.2
			Mean	14.6	11.7	11.6	17.9	14.5	14.2	23	18.2	17.4	38.5	20.2	17.3	13.3
			Std.Dev.	0.4	0.5	0.4	1.7	1.2	1.1	2.1	1.5	1.4	3.6	1.5	1	1.1
			V	**2.8**	**4**	**3.1**	**9.4**	**8.1**	**7.7**	**9**	**8**	**8.1**	**9.4**	**7.6**	**5.7**	**8**
		Early/Middle Neolithic Transition	N	2	2	2	4	3	2	-	-	-	-	-	-	-
			Min.	13.5	11.4	11.3	17.1	13.6	14.5	-	-	-	-	-	-	-
			Max.	13.7	11.4	11.4	18.5	14.9	14.5	-	-	-	-	-	-	-
			Mean	13.6	11.4	11.4	18	14.4	14.5	-	-	-	-	-	-	-
		Middle Neolithic	N	26	36	35	45	49	50	22	22	20	8	10	11	7
			Min.	12.5	10.2	10.4	16.5	12.2	12.6	21.6	16.7	15.5	30.5	18.5	15.2	11.8
			Max.	16.4	12.2	12	19.5	15.5	15.5	26.4	20.2	18.8	40.4	21.7	18.4	15.1
			Mean	14.4	11.4	11.3	17.9	14.4	14.2	23.1	18	17.3	35.3	19.9	17.1	13.6
			Std.Dev.	0.8	0.5	0.4	0.8	0.7	0.6	1.1	0.9	0.9	3	1.1	1.1	1.1
			V	**5.5**	**4**	**3.9**	**4.3**	**4.9**	**4.1**	**4.6**	**5.2**	**5.3**	**8.6**	**5.6**	**6.7**	**7.8**
		Late Neolithic	N	3	3	3	3	4	4	1	1	1	-	-	-	-
			Min.	12.5	10.1	10.1	16	12.7	12.5	21.1	16.6	16.3	-	-	-	-
			Max.	14.1	11.3	10.8	17.3	13.9	13.6	-	-	-	-	-	-	-
			Mean	13.2	10.6	10.5	16.5	13.1	12.9	-	-	-	-	-	-	-

Table 7.27. Summary of upper teeth measurements of Northern sites, from Early to Late Neolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Upper dP4			Upper M1			Upper M2			Upper M3			
				L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC	WP
CENTRE																
Marche	Portonovo	Early Neolithic	N	5	5	6	7	7	7	4	3	4	3	2	3	3
			Min.	14.2	11.2	10.9	16	14.1	13.9	22.3	16.8	16	33	18.6	15.5	12.4
			Max.	15.5	12	12.1	18.9	15.2	14.7	23.6	17.8	17.6	38.2	19.4	17.5	14
			Mean	14.8	11.6	11.3	18	14.4	14.4	22.9	17.2	17	35.2	19	16.4	13.2
			Std.Dev.	0.5	0.4	0.4	1	0.4	0.3	-	-	-	-	-	-	-
			V	**3.2**	**3.1**	**3.9**	**5.3**	**2.6**	**2.2**	-	-	-	-	-	-	-
SOUTH																
Apulia	Masseria Fragella	Early Neolithic	N	2	2	2	2	1	2	3	3	3	2	1	1	1
			Min.	14.9	11.7	10.7	17.9	14.7	13.7	20.1	15.4	16.2	32.6	19.4	17.6	13.4
			Max.	16	11.9	11.7	18.2	-	14.7	25	18.4	18	34.6	-	-	-
			Mean	15.5	11.8	11.2	18.1	-	14.2	22.5	17	17.2	33.6	-	-	-
	Masseria Pantano	Middle Neolithic	N	-	-	-	-	-	-	-	-	-	2	2	2	2
			Min.	-	-	-	-	-	-	-	-	-	34.5	20.1	17.2	12
			Max.	-	-	-	-	-	-	-	-	-	35.6	20.9	17.3	14
			Mean	-	-	-	-	-	-	-	-	-	35.1	20.5	17.3	13
Campania	Baselice	Early Neolithic	N	1	1	1	1	1	1	-	-	-	-	-	-	-
			Min.	13.7	10.6	11.1	18.4	14.2	13.9	-	-	-	-	-	-	-
	Mulino Sant' Antonio*	Late Neolithic	N	-	-	-	-	-	-	-	-	-	4	4	-	-
			Min.	-	-	-	-	-	-	-	-	-	31	18.9	-	-
			Max.	-	-	-	-	-	-	-	-	-	36.5	20.8	-	-
			Mean	-	-	-	-	-	-	-	-	-	34.1	19.9	-	-
Calabria	Grotta della Madonna	Middle Neolithic	N	1	1	1	1	1	1	2	2	2	2	2	2	1
			Min.	15	12.4	11.7	18	14.6	14.2	17.5	13.7	14.2	33.9	20.1	14.3	12.3
			Max.	-	-	-	-	-	-	22.1	17.2	16.9	35.8	21.5	16.1	-
			Mean	-	-	-	-	-	-	19.8	15.5	15.6	34.9	20.8	15.2	-
	Favella	Early Neolithic	N	-	-	-	1	1	2	2	2	1	1	1	2	1
			Min.	-	-	-	17	14.2	13.7	22.2	16.5	16.1	33.9	20.5	16.5	12
			Max.	-	-	-	-	-	14.7	22.7	18.8	-	-	-	18.5	-
			Mean	-	-	-	-	-	14.2	22.5	17.7	-	-	-	17.5	-

Table 7.28. Summary of upper teeth measurements of Central and Southern sites, from Early to Late Neolithic. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONOLOGY	MEASURE-MENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
NORTH																		
Trentino-South Tyrol	Riparo Gaban	Eneolithic	N	2	3	3	3	-	1	2	2	1	1	1	-	-	-	-
			Min.	19.5	6	7	7.8	-	16.6	9.3	9.8	20.4	14.1	13.4	-	-	-	-
			Max.	20	6.8	7.8	8.7	-	-	11.3	11.1	-	-	-	-	-	-	-
			Mean	19.8	6.5	7.5	8.4	-	-	10.3	10.5	-	-	-	-	-	-	-
		Early Bronze Age	N	1	1	-	1	2	-	1	-	3	3	3	3	3	4	3
			Min.	18.5	6.3	-	8.3	8.3	-	10.2	-	19.8	12.3	13	28.9	14.5	13.6	9.7
			Max.	-	-	-	-	8.7	-	-	-	22.3	13.4	14.1	32.9	16.4	15.1	12.5
			Mean	-	-	-	-	8.5	-	-	-	20.7	12.9	13.6	31.2	15.3	14.4	11.2
		Middle Bronze Age	N	2	2	2	2	-	2	3	3	1	2	1	-	1	1	-
			Min.	18.4	6.6	7.1	8.5	-	16.7	9.2	9.7	21.7	13.1	13.8	-	12.3	10.7	-
			Max.	19.8	6.7	7.5	8.6	-	16.9	10.4	10.8	-	13.2	-	-	-	-	-
			Mean	19.1	6.7	7.3	8.6	-	16.8	10	10.4	-	13.2	-	-	-	-	-
	Romagnano Loc	Eneolithic	N	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
			Min.	-	5.6	-	-	-	-	-	-	-	-	-	-	-	-	-
Veneto	Concordia Sagittaria	Late Bronze Age	N	2	-	-	2	-	12	27	27	25	36	34	23	34	29	24
			Min.	18.6	-	-	8.4	-	15.3	8.5	9.3	18.9	11.9	11.8	29	13.3	13.6	10.2
			Max.	21.6	-	-	9.6	-	19.5	10.7	11.9	23.5	14.4	15.5	39.8	17.6	16.3	13.4
			Mean	20.1	-	-	9	-	16.8	9.9	10.7	21	13.3	13.6	33.9	15.6	14.8	11.9
			Std.Dev.	-	-	-	-	-	1.3	0.6	0.7	1.1	0.8	0.9	3.1	1.1	0.7	0.8
			V	**-**	**-**	**-**	**-**	**-**	**7.7**	**6**	**6.2**	**5.1**	**6.1**	**6.3**	**9.3**	**7.1**	**4.9**	**6.6**
Lombardy	Lavagnone	Early Bronze Age	N	10	11	10	10	11	16	18	19	11	12	12	3	8	6	3
			Min.	18	6.1	6.9	8.4	7.9	16	9.3	9.7	19.8	12.3	12.9	30.9	13.8	13.6	11
			Max.	21	6.8	8.1	9.4	9.2	18.2	11.2	11.4	23.6	14.7	14.4	33.1	17	15.9	11.8
			Mean	19.4	6.5	7.4	8.8	8.4	17.1	10.1	10.6	21.2	13.4	13.6	32.3	15.2	14.8	11.4
			Std.Dev.	0.8	0.2	0.4	0.3	0.4	0.5	0.5	0.5	1	0.7	0.5	-	1	0.9	-
			V	**4.3**	**2.7**	**5**	**3.6**	**4.9**	**3.2**	**4.7**	**4.4**	**4.8**	**5.6**	**3.8**	**-**	**6.3**	**5.9**	**-**
Liguria	Arene Candide	Copper/Bronze Age	N	10	9	9	9	3	4	4	4	4	4	5	4	6	6	5
			Min.	17.9	6.1	6.8	8.1	8.7	16.2	9.8	10.3	20.3	13.5	12.9	32.3	14.8	14.1	11.3
			Max.	21.1	7	8.3	9.4	9.2	17.8	11	11	22.8	14.7	14.7	35.1	17.3	16.4	13.2
			Mean	19.5	6.5	7.5	8.6	8.9	16.8	10.4	10.6	21.4	14	13.7	33.8	16	15.4	12
			Std.Dev.	1	0.3	0.5	0.4	-	-	-	-	1.1	0.5	0.8	1.2	0.9	0.9	0.8
			V	**5**	**4.9**	**6.8**	**5**	**-**	**-**	**-**	**-**	**4.9**	**3.7**	**5.5**	**-**	**5.7**	**6.2**	**6.4**

Table 7.29. Summary of lower teeth measurements of Northern sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

EGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
CENTRE																		
Emilia-Romagna	Poviglio	Middle to Late Bronze Age	N	4	4	4	4	3	5	5	5	4	4	4	2	3	2	2
			Min.	18.2	5.8	6.8	7.5	8	16.6	9.9	10.1	18.4	11.9	12.7	42.8	19.4	18.8	14.6
			Max.	19.5	6.4	7.4	8.5	10.8	19	12.3	13.3	24.6	16.5	17	46.6	19.9	19.6	16.5
			Mean	18.9	6.2	7.2	8.1	9.4	18.1	11.3	12.1	22	14.4	14.9	44.7	19.6	19.2	15.6
			Std.Dev.	-	-	-	-	-	1	1.1	1.5	-	-	-	-	-	-	-
			V	-	-	-	-	-	**5.3**	**9.6**	**12.2**	-	-	-	-	-	-	-
	Solarolo	Middle Bronze Age	N	14	15	15	15	8	21	23	23	16	17	17	13	16	15	12
			Min.	16.5	5.5	6	7.5	6.5	14.3	8.3	9.1	18.3	11.2	11.7	28.1	13.6	12.5	10.3
			Max.	19.9	6.7	7.2	8.6	8.9	17.8	10.1	10.9	21.6	13.2	13.9	36.1	17.5	15.3	12.1
			Mean	18.4	6.1	6.9	8.2	8.2	16.3	9.5	10	20	12.4	13	31.4	14.7	14.1	11.4
			Std.Dev.	1	0.3	0.3	0.3	0.7	0.8	0.4	0.5	0.9	0.6	0.7	2	0.9	0.8	0.5
			V	**5.2**	**4.9**	**4.6**	**3.4**	**9**	**5.1**	**4.7**	**5.1**	**4.6**	**4.7**	**5.3**	**6.4**	**6.2**	**5.3**	**4.8**
	Cesena	Middle Bronze Age	N	2	2	3	3	2	2	5	3	5	5	5	2	4	4	2
			Min.	17.4	5.9	6.6	7.6	8.3	16.2	9.1	9.7	18.9	12	12	31.5	13.6	12.7	12.1
			Max.	18	6	7.1	8.8	8.4	16.3	11	10.2	21.2	14	13.9	32.9	15.7	15.1	12.1
			Mean	17.7	6	6.8	8.1	8.4	16.3	9.6	9.9	20	12.6	13	32.2	14.4	14	12.1
			Std.Dev.	-	-	-	-	-	-	0.8	-	0.8	0.8	0.7	-	-	-	-
			V	-	-	-	-	-	-	**8.5**	-	**4.2**	**6.3**	**5.3**	-	-	-	-
		Late Bronze Age	N	6	6	6	6	13	12	15	14	14	17	16	10	13	14	11
			Min.	18	6.2	7.3	8.2	7	13.7	9.4	9.7	18.2	11.7	12.2	28.9	12.8	12.8	9.7
			Max.	19.8	6.6	7.8	9	9.3	19	11.1	11.7	22.5	14	14.1	33.8	16.6	15.5	13.1
			Mean	18.9	6.5	7.6	8.7	8.2	16	10.1	10.6	20.1	12.6	13	31	14.9	14.1	11.2
			Std.Dev.	0.6	0.2	0.2	0.3	0.7	1.5	0.5	0.8	1.2	0.7	0.6	1.5	0.9	0.9	1
			V	**3.3**	**2.7**	**2.2**	**3.2**	**7.9**	**9.7**	**5.1**	**7.2**	**6**	**5.6**	**4.4**	**4.7**	**5.7**	**6.1**	**8.8**
	Riccione Ipercoop	Middle to Late Bronze Age	N	-	-	-	-	3	-	1	-	1	1	1	3	2	2	2
			Min.	-	-	-	-	8	-	9.5	-	19.5	12.1	13	33.2	14.9	14.7	12.2
			Max.	-	-	-	-	8.4	-	-	-	-	-	-	34.8	16.5	15.5	12.6
			Mean	-	-	-	-	8.3	-	-	-	-	-	-	34	15.7	15.1	12.4

Table 7.30. (1/2) Summary of lower teeth measurements of Central sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
CENTRE																		
Emilia Romagna	Cattolica	Early Bronze Age	N	4	5	5	6	9	26	26	24	11	13	12	6	9	7	6
			Min.	17.8	5.6	6.6	7.5	8	15.3	9.3	9.6	18.9	12.3	12.7	29.9	13.9	13.6	11.2
			Max.	18.5	6.5	7.5	9	9.1	20.6	14.2	13.4	21.9	15.8	14.5	34.9	17.4	15.3	12.4
			Mean	18.1	6	7	8.4	8.6	17	10.3	10.7	20.8	13.4	13.6	33.5	15.4	14.5	11.7
			Std.Dev.	-	0.4	0.4	0.6	0.4	1.1	0.9	0.8	0.9	1	0.5	2	1.1	0.6	0.6
			V	**-**	**6.6**	**5.1**	**7.4**	**4.2**	**6.4**	**9**	**7.6**	**4.3**	**7.3**	**3.5**	**5.9**	**7.2**	**4.4**	**4.9**
Tuscany	Gorgo del Ciliegio	Middle Bronze Age	N	-	-	-	-	-	1	1	1	2	2	3	2	2	2	2
			Min.	-	-	-	-	-	16.7	9	9.8	19.3	11.7	12.4	27.2	13.9	14.3	10.3
			Max.	-	-	-	-	-	-	-	-	20.8	12.9	16.3	32.2	15.8	15.1	10.7
			Mean	-	-	-	-	-	-	-	-	20.1	12.3	13.9	29.7	14.9	14.7	10.5
Marche	Conelle*	Eneolithic	N	64	-	-	57	-	-	-	-	-	-	-	99	89	-	-
			Min.	16.9	-	-	7.6	-	-	-	-	-	-	-	25.6	14	-	-
			Max.	22	-	-	9.6	-	-	-	-	-	-	-	47.5	21	-	-
			Mean	19.4	-	-	8.4	-	-	-	-	-	-	-	37.2	16.8	-	-
			Std.Dev.	1	-	-	0.4	-	-	-	-	-	-	-	5	1.8	-	-
			V	**5.2**	**-**	**-**	**4.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**13.4**	**10.7**	**-**	**-**
Lazio	Albano Le Macine	Middle Bronze Age	N	3	4	5	4	3	2	2	3	3	3	3	4	5	5	5
			Min.	18.4	5.5	6.6	7.8	8	16.4	9.2	9.4	20.1	12.3	12.2	28.5	14.3	13.4	8.3
			Max.	19.7	6.6	7.5	8.6	9.2	16.9	10.6	10.8	24.4	14.4	15.4	35.6	17	16.5	12.6
			Mean	19.3	6.3	7.1	8.3	8.7	16.7	9.9	10.2	21.8	13.2	13.9	31.9	16	15.4	11.1
			Std.Dev.	-	-	0.4	-	-	-	-	-	-	-	-	-	1.1	1.2	1.7
			V	**-**	**-**	**5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**7**	**7.6**	**15.8**
	Cinquefrondi	Eneolithic	N	-	-	-	-	3	2	2	2	1	1	1	4	3	4	2
			Min.	-	-	-	-	6.9	20.7	12.7	11.6	21.1	13.2	13.7	30.1	13.6	13.1	11.4
			Max.	-	-	-	-	9.7	21.6	13.3	13.3	-	-	-	33.2	15.4	15.1	12.1
			Mean	-	-	-	-	8.2	21.2	13	12.5	-	-	-	31.6	14.3	14.1	11.8
	Pantano Borghese	Eneolithic	N	-	-	-	-	-	-	-	-	-	-	1	-	2	2	-
			Min.	-	-	-	-	-	-	-	-	-	-	13.4	-	14.4	11.2	-
			Max.	-	-	-	-	-	-	-	-	-	-	-	-	15.7	15.1	-
			Mean	-	-	-	-	-	-	-	-	-	-	-	-	15.1	13.2	-

Table 7.30. (2/2) Summary of lower teeth measurements of Central sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data from publication (Wilkens, 1999).

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
SOUTH																		
Apulia	Coppa Nevigata	Middle Bronze Age	N	10	13	11	13	13	14	17	19	15	17	13	7	11	9	9
			Min.	18.5	5.7	6.8	6.8	7.8	15.6	9.2	8.9	19.2	12	12.2	24.1	14	13.3	9.2
			Max.	21.4	7.3	8.8	9.3	9.3	19.5	12.7	12.6	22.3	16.1	16.2	34.1	18.4	15.8	12.7
			Mean	19.4	6.5	7.5	8.4	8.5	16.8	10.3	10.8	20.6	13	13.4	30.9	15.1	14.4	11.6
			Std.Dev.	0.9	0.5	0.6	0.7	0.5	1.1	1	1	0.9	0.9	1.1	3.7	1.4	0.8	1.1
			V	**4.7**	**7.5**	**8.7**	**8.2**	**6**	**6.5**	**9.5**	**8.9**	**4.3**	**7.2**	**8.4**	**12.1**	**9.4**	**5.3**	**9.6**
		Late Bronze Age	N	5	4	4	7	5	8	9	7	5	6	6	6	6	5	7
			Min.	17.7	6.2	6.9	8	8.1	14.6	9.1	10.1	19.3	11.7	12.5	28.4	13.3	13.1	8.7
			Max.	19.4	6.5	7.9	9.1	9.2	17.1	11.6	11.2	22.8	15.3	15.9	37	17.6	16.5	13.4
			Mean	18.8	6.3	7.4	8.5	8.7	15.9	10	10.6	20.9	13.1	13.8	32.4	15	14.4	10.8
			Std.Dev.	0.7	-	-	0.4	0.4	0.9	0.7	0.4	1.4	1.2	1.2	2.9	1.6	1.3	1.4
			V	**3.5**	**-**	**-**	**4.2**	**5**	**5.6**	**7.4**	**3.8**	**6.7**	**9**	**8.7**	**8.9**	**10.4**	**8.8**	**13.4**
Campania	Santa Maria a' Peccerella	Eneolithic	N	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
			Min.	-	-	-	-	-	-	-	11.9	-	-	-	-	-	-	-
	Gricignano	Late Eneolithic to Early Bronze Age	N	1	1	1	2	3	2	2	2	3	4	5	8	7	9	8
			Min.	20.6	6.5	7.4	8.1	8.4	16.6	10	10.4	20.9	13.5	13.5	30.5	13.7	13.8	10.4
			Max.	-	-	-	8.4	8.9	18.2	10.3	10.8	21.7	14.3	14.7	37.7	17.1	15.9	13.2
			Mean	-	-	-	8.3	8.6	17.4	10.2	10.6	21.3	13.8	14	33.3	15.6	14.7	12
			Std.Dev.	-	-	-	-	-	-	-	-	-	-	0.5	2.3	1	0.8	1
			V	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3.3**	**6.8**	**6.6**	**5.2**	**8.2**
	La Starza*	Middle Bronze Age	N	8	8	-	8	4	16	18	15	10	11	9	3	5	5	-
			Min.	18.1	6.1	-	8.1	7.9	16	9.5	10.3	19.3	12.5	12.5	30.5	14.5	14.1	-
			Max.	20.9	6.8	-	9.5	8.8	18.5	10.8	11.5	22.4	14.3	14.2	34.3	15.8	15.1	-
			Mean	19.4	6.5	-	8.8	8.2	17.2	10.2	10.8	21.1	13.4	13.5	32.8	15.1	14.7	-
			Std.Dev.	1.1	0.2	-	0.5	-	0.7	0.4	0.4	0.9	0.6	0.6	-	0.5	0.6	-
			V	**5.7**	**3.1**	**-**	**5.7**	**-**	**4.1**	**3.9**	**3.7**	**4.3**	**4.5**	**4.4**	**-**	**3.3**	**4.1**	**-**

Table 7.31. (1/2) Summary of lower teeth measurements of Southern and Island sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Lower dP4				Lower P4	Lower M1			Lower M2			Lower M3			
				L	WA	WC	WP	W	L	WA	WP	L	WA	WP	L	WA	WC	WP
SOUTH (continued)																		
Calabria	Grotta della Madonna	Late Neolithic	N	-	-	1	-	-	-	1	-	-	-	-	1	-	-	-
			Min.	-	-	7.7	-	-	-	10.4	-	-	-	-	29.1	-	-	-
		Eneolithic	N	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-
			Min.	19.1	6.1	7.2	8.1	-	-	-	-	-	-	-	-	-	-	-
		Early Bronze Age	N	-	1	1	1	-	1	1	1	-	-	-	-	-	1	1
			Min.	-	6.4	7.2	8.2	-	17	9.8	10.5	-	-	-	-	-	13	10.5
		Middle Bronze Age	N	4	6	7	7	3	1	1	1	-	-	-	1	2	4	4
			Min.	18.7	5.9	7	8.4	6.2	17.1	9.8	10.5	-	-	-	34.7	14.7	14.1	11.1
			Max.	20.6	6.7	7.9	9.5	8.3	-	-	-	-	-	-	34.7	16	15	12.8
			Mean	19.3	6.3	7.5	8.9	7.5	-	-	-	-	-	-	34.7	15.4	14.7	11.8
			Std.Dev.	-	0.4	0.3	0.4	-	-	-	-	-	-	-	-	-	-	-
			V	**-**	**5.9**	**4.3**	**4.3**	-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Broglio di Trebisacce	Middle Bronze Age	N	5	8	7	8	5	4	4	4	-	2	1	3	5	8	7
			Min.	18.4	6	6.8	7.8	8.1	15	8.7	9.8	-	13.1	13.5	30.5	15.2	12.5	10.1
			Max.	20	6.8	7.5	9	8.6	17.1	10.8	10.8	-	13.4	-	32.6	16	15.5	11.4
			Mean	19	6.3	7.2	8.4	8.4	15.9	9.8	10.4	-	13.3	-	31.8	15.7	14.4	10.9
			Std.Dev.	0.7	0.3	0.2	0.4	0.2	-	-	-	-	-	-	1.1	0.3	0.9	0.5
			V	**3.5**	**4.9**	**3.2**	**4.8**	**2.5**	**-**	**-**	**-**	**-**	**-**	**-**	**3.5**	**1.9**	**6.1**	**4.9**
	Torre Mordillo	Middle Bronze Age	N	1	-	-	-	-	1	1	1	1	1	1	-	-	-	-
			Min.	19.5	-	-	-	-	16.7	9.9	10.7	21	12.6	13.3	-	-	-	-
		Late Bronze Age	N	2	-	-	5	-	9	12	11	5	7	5	5	6	8	6
			Min.	19	-	-	7.7	-	16.1	8.8	9.2	19.3	11.7	12.2	30.1	13.7	12.4	10.7
			Max.	19.4	-	-	8.9	-	18.2	10.9	11.4	22.3	14.4	14.7	37	17.1	16.1	12.3
			Mean	19.2	-	-	8.4	-	17	9.7	10.2	21	13	13.5	33.1	15.3	14.2	11.4
			Std.Dev.	-	-	-	0.5	-	0.8	0.6	0.7	1.2	1.1	1	2.6	1.4	1.1	0.6
			V	**-**	**-**	**-**	**5.6**	**-**	**4.5**	**6.1**	**6.8**	**5.8**	**8.3**	**7.5**	**7.7**	**9.1**	**7.5**	**5.2**
ISLANDS																		
Sicily	Mursia	Middle Bronze Age	N	7	10	8	6	2	3	3	4	1	2	1	1	1	1	1
			Min.	17.9	5.8	6.8	7.9	8.8	15.2	9.2	10.2	20.9	12.5	14.6	30.6	14.9	13	10.2
			Max.	19.5	6.3	7.4	8.6	9.1	17.3	10.8	11.4	-	14.7	-	-	-	-	-
			Mean	18.9	6.1	7.1	8.3	9	16	10.2	10.7	-	13.6	-	-	-	-	-
			Std.Dev.	0.5	0.2	0.3	0.2	-	-	-	-	-	-	-	-	-	-	-
			V	**2.8**	**3.5**	**3.6**	**2.9**	-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 7.31. (2/2) Summary of lower teeth measurements of Southern and Island sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Upper dP4			Upper M1			Upper M2			Upper M3			
				L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC	WP
NORTH																
Trentino-South Tyrol	Riparo Gaban	Eneolithic	N	-	1	1	1	1	1	1	1	1	-	-	-	-
			Min.	-	10.9	11.6	17.6	14.3	13.9	19	16.5	15.4	-	-	-	-
		Early Bronze Age	N	2	2	2	1	3	3	3	4	2	3	3	3	2
			Min.	13.1	10.3	9.8	17.4	13	12.7	19.6	15.9	15.1	30	18.1	15.1	11.1
			Max.	14	11	10.6	-	13.7	13.7	20.5	17.1	17.3	33.2	20	18	12.4
			Mean	13.6	10.7	10.2	-	13.3	13.3	20.1	16.6	16.2	31.2	18.8	16.5	11.8
Lombardy	Lavagnone	Early Bronze Age	N	5	8	10	18	19	23	15	13	15	8	9	10	8
			Min.	13.2	10.1	10.2	16	12.1	12	19	15.4	14.4	27.8	16.9	12.7	9.5
			Max.	14.8	11.5	11	19	14.8	14.6	22.3	18	17.5	33.7	18.9	16.4	13
			Mean	13.9	10.9	10.7	17.3	13.3	13.3	20.6	16.4	15.8	30.5	17.9	15.2	10.8
			Std.Dev.	0.6	0.5	0.3	0.8	0.8	0.7	1	0.7	1	2.1	0.8	1.1	1.2
			V	**4.2**	**4.7**	**2.6**	**4.8**	**5.7**	**5.3**	**4.7**	**4.6**	**6.3**	**6.7**	**4.5**	**6.9**	**11.1**
Liguria	Arene Candide	Copper/Bronze Age	N	5	5	5	4	6	5	3	3	3	2	2	3	3
			Min.	13.3	10.7	10.5	17.1	13.1	13	15.8	15.7	14.2	29.6	17.1	15.4	11.5
			Max.	14.6	12.1	11.1	18.5	14.3	14.7	21.3	17.9	16.8	29.7	17.3	17.4	12.8
			Mean	14.2	11.5	10.8	17.7	13.5	13.6	18.9	16.6	15.7	29.7	17.2	16.1	12
			Std.Dev.	0.6	0.6	0.2	-	0.5	0.6	-	-	-	-	-	-	-
			V	**3.9**	**5.2**	**2**	**-**	**3.5**	**4.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 7.32. Summary of upper teeth measurements of Northern sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Upper dP4			Upper M1			Upper M2			Upper M3			
				L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC	WP
CENTRE																
Emilia-Romagna	Poviglio	Middle to Late Bronze Age	N	-	-	-	1	-	2	3	3	3	1	1	1	1
			Min.	-	-	-	16.4	-	12.3	18.3	14.6	14.5	28.1	17.7	14.7	10.6
			Max.	-	-	-	-	-	13.9	22.2	17.6	16.2	-	-	-	-
			Mean	-	-	-	-	-	13.1	20	16.1	15.4	-	-	-	-
	Solarolo	Middle Bronze Age	N	13	13	12	23	27	29	22	21	24	17	17	17	14
			Min.	12.5	10	9.5	14.8	11.9	11.9	17.9	13.6	13.6	26.2	14.7	13.6	10.2
			Max.	14.4	12	11.7	18.6	14	13.8	21.2	16.8	16.2	34.8	19.2	16.7	12.7
			Mean	13.5	10.6	10.6	16.4	13	12.9	19.6	15.5	15.1	29.8	17.5	15.2	11.4
			Std.Dev.	0.6	0.6	0.6	0.9	0.6	0.5	0.9	0.7	0.7	2.4	1	0.9	0.8
			V	**4.7**	**5.3**	**6**	**5.2**	**4.4**	**4.2**	**4.6**	**4.7**	**4.7**	**8**	**5.9**	**6.1**	**7.3**
	Cesena	Middle Bronze Age	N	2	3	3	3	4	4	1	2	2	1	2	1	1
			Min.	12.8	10.1	10.2	16.4	12.2	12.2	21.3	17.1	14.9	29.2	17.2	16.4	12.7
			Max.	13	10.5	11	17.6	13.6	13.7	-	17.2	16.9	-	18.6	-	-
			Mean	12.9	10.4	10.5	16.9	13	12.9	-	17.2	15.9	-	17.9	-	-
		Late Bronze Age	N	2	2	2	7	7	8	9	11	12	9	10	12	10
			Min.	12.9	10.6	10.1	14.5	12.3	12.1	17.9	14.5	13.4	25.2	16.3	14.2	10.1
			Max.	14.6	11.5	11.7	17.4	14.4	14	21	16.5	15.7	32.1	18.2	16.3	11.6
			Mean	13.8	11.1	10.9	16	13.1	12.9	19.9	15.6	14.9	28.4	17.2	15	10.8
			Std.Dev.	-	-	-	1	0.7	0.6	0.9	0.7	0.8	2.4	0.7	0.7	0.5
			V	-	-	-	**6.1**	**5.6**	**4.8**	**4.6**	**4.6**	**5.4**	**8.5**	**4.3**	**4.8**	**4.9**
	Cattolica	Early Bronze Age	N	3	4	3	15	12	14	10	6	8	-	2	2	-
			Min.	13.3	10.5	10.3	15.3	12.1	12.1	19.1	15.3	14.7	-	17.9	17.1	-
			Max.	16.2	12.5	12.9	18.4	14.1	14.4	24.4	18.9	17.4	-	19.7	18	-
			Mean	14.9	11.8	11.8	16.7	13	13	21.6	16.8	15.7	-	18.8	17.6	-
			Std.Dev.	-	-	-	0.7	0.7	0.7	1.6	1.4	1	-	-	-	-
			V	-	-	-	**4.2**	**5.5**	**5.6**	**7.6**	**8.2**	**6.1**	-	-	-	-

Table 7.33. (1/2) Summary of upper teeth measurements of Central sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data from publication (Wilkens, 1999).

REGION	SITE	CHRONOLOGY	MEASUREMENT	Upper dP4			Upper M1			Upper M2			Upper M3			
				L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC	WP
CENTRE (continued)																
Tuscany	Gorgo del Ciliegio	Middle Bronze Age	N	2	1	2	5	6	7	6	6	7	6	5	8	8
			Min.	14.6	11.2	10.9	17	12.8	12.5	19.9	14.3	14	26.9	15.6	13.4	9.2
			Max.	15.3	-	11.9	20.5	14.8	14.4	23.9	19.1	17.7	38.2	20.8	19.2	16.2
			Mean	15	-	11.4	18.1	13.6	13.2	21	16	15	31	17.8	16.2	12.1
			Std.Dev.	-	-	-	1.4	0.9	0.8	1.5	1.7	1.3	3.8	2	1.8	2.2
			V	**-**	**-**	**-**	**7.8**	**6.7**	**6.3**	**7.1**	**10.5**	**8.5**	**12.4**	**11.2**	**11.3**	**18.1**
Marche	Conelle*	Eneolithic	N	58	57	-	-	-	-	-	-	-	37	36	-	-
			Min.	11.6	10.2	-	-	-	-	-	-	-	28.3	17	-	-
			Max.	16.6	13	-	-	-	-	-	-	-	42.1	25.9	-	-
			Mean	14.5	11.5	-	-	-	-	-	-	-	33.7	19.6	-	-
			Std.Dev.	0.9	0.6	-	-	-	-	-	-	-	3.4	1.9	-	-
			V	**6.2**	**5.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**10.1**	**9.7**	**-**	**-**
Lazio	Albano Le Macine	Middle Bronze Age	N	1	3	4	4	4	5	3	3	3	-	-	-	-
			Min.	14.7	11.3	10.5	16.5	13.8	13.5	21.3	15.6	14.8	-	-	-	-
			Max.	14.7	12	12	19.9	14.9	14.8	24.8	18.8	18.6	-	-	-	-
			Mean	14.7	11.5	11.2	18.4	14.4	14.1	23.2	17.7	16.7	-	-	-	-
			Std.Dev.	-	-	-	-	-	0.6	-	-	-	-	-	-	-
			V	**-**	**-**	**-**	**-**	**-**	**4.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Cinquefrondi	Eneolithic	N	-	-	-	-	-	-	-	-	-	1	1	1	1
			Min.	-	-	-	-	-	-	-	-	-	32.3	18.5	15.7	10.9
	Pantano Borghese	Eneolithic	N	-	-	-	3	1	3	2	2	1	-	-	-	-
			Min.	-	-	-	16.3	13.6	12.3	20	15.8	14.7	-	-	-	-
			Max.	-	-	-	17.6	-	14.7	20	16.8	-	-	-	-	-
			Mean	-	-	-	17.1	-	13.4	20	16.3	-	-	-	-	-

Table 7.33. (2/2) Summary of upper teeth measurements of Central sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data from publication (Wilkens, 1999).

REGION	SITE	CHRONOLOGY	MEASUREMENT	Upper dP4			Upper M1			Upper M2			Upper M3			
				L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC	WP
SOUTH																
Apulia	Coppa Nevigata	Middle Bronze Age	N	8	10	5	20	20	23	9	11	10	5	5	6	6
			Min.	12.8	9.9	9.7	15.2	12.4	12.2	20	14.2	13.8	26.5	15.8	13.7	8.9
			Max.	15.6	12.3	11.2	18.2	14.4	15.2	22.7	17.8	16.7	32.3	18.1	16.4	11.3
			Mean	13.8	11.1	10.6	16.8	13.5	13.6	21.2	16.1	15.5	29.9	17.2	15.4	10.2
			Std.Dev.	1.1	0.8	0.6	0.9	0.6	0.8	0.9	1.4	1	2.4	0.9	1	0.8
			V	**7.7**	**7.5**	**5.7**	**5.6**	**4.4**	**5.8**	**4.1**	**8.5**	**6.6**	**8.1**	**5.5**	**6.2**	**8**
		Late Bronze Age	N	6	5	4	11	11	12	8	7	7	2	2	2	2
			Min.	12.3	10.3	10	15.9	12.8	11.9	18	14.3	13.9	29.6	16.7	14.5	9.5
			Max.	14	10.6	10.7	17.3	14.2	13.8	22	17.2	16.8	30.1	17	15.1	12.1
			Mean	13.3	10.5	10.2	16.9	13.3	12.9	20.1	15.4	14.9	29.9	16.9	14.8	10.8
			Std.Dev.	0.7	0.1	-	0.4	0.4	0.6	1.2	1	0.9	-	-	-	-
			V	**5.4**	**1.2**	-	**2.7**	**3.1**	**4.8**	**6.2**	**6.5**	**6.3**	-	-	-	-
Campania	La Starza*	Middle Bronze Age	N	10	11	10	16	14	17	7	8	8	1	3	1	-
			Min.	13.5	10.5	10.1	15.7	12.6	11.9	20.3	14.3	15	29.3	17	15.5	-
			Max.	15.8	12	11.7	18.6	14.8	14.5	22.8	17.8	16.6	-	19.4	-	-
			Mean	14.3	11.1	10.5	17.1	13.6	13.3	21.3	16.1	15.8	-	18.3	-	-
			Std.Dev.	0.6	0.5	0.5	0.9	0.7	0.7	0.9	1.1	0.6	-	-	-	-
			V	**4.2**	**4.5**	**4.8**	**5.3**	**5.1**	**5.3**	**4.2**	**6.8**	**3.8**	-	-	-	-
Campania	Gricignano	Late Eneolithic to Early Bronze Age	N	3	3	4	3	3	8	8	5	8	2	3	5	4
			Min.	13.4	10.8	10.6	15.5	12.2	12.1	20.4	15.7	15.1	32.2	17.7	12.7	9.8
			Max.	14.5	11.7	11.6	16.7	13.6	13.7	22.2	16.9	17.2	32.8	20.9	18.4	11.7
			Mean	13.9	11.2	11	16.3	13	13.2	21.2	16.5	15.8	32.5	18.9	15.6	10.4
			Std.Dev.	-	-	-	-	-	0.5	0.6	0.5	0.7	-	-	2.1	-
			V	-	-	-	-	-	**3.9**	**2.9**	**2.9**	**4.4**	-	-	**13.3**	-

Table 7.34. (1/2) Summary of upper teeth measurements of Southern and Island sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella.

REGION	SITE	CHRONOLOGY	MEASUREMENT	Upper dP4			Upper M1			Upper M2			Upper M3			
				L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC	WP
SOUTH																
Calabria	Grotta della Madonna	Eneolithic	N	1	1	1	-	-	-	-	-	-	-	-	-	-
			Min.	13.1	11.4	11.2	-	-	-	-	-	-	-	-	-	-
		Early Bronze Age	N	2	3	4	1	1	1	-	-	-	1	1	1	1
			Min.	13	9.9	9.6	17.5	13.9	13.8	-	-	-	33.9	18.7	16.5	11.4
			Max.	13.6	11.1	10.5	-	-	-	-	-	-	-	-	-	-
			Mean	13.3	10.5	10.2	-	-	-	-	-	-	-	-	-	-
		Middle Bronze Age	N	5	6	6	3	4	4	1	1	1	1	1	1	1
			Min.	12.8	9.6	9.4	14.8	12.1	11.8	21.1	15.3	14.4	33.9	18.3	15.8	12.1
			Max.	14	10.9	10.6	17.1	13.1	13.4	-	-	-	-	-	-	-
			Mean	13.4	10.3	10	16	12.5	12.6	-	-	-	-	-	-	-
			Std.Dev.	0.5	0.4	0.5	-	-	-	-	-	-	-	-	-	-
			V	**3.7**	**4.3**	**4.6**	-	-	-	-	-	-	-	-	-	-
Calabria	Broglio di Trebisacce	Middle Bronze Age	N	4	5	7	10	14	17	13	10	11	7	9	9	6
			Min.	13.3	10.1	9.7	15.5	12.1	12.1	18.7	14.8	14.1	28.6	16	14.1	10.6
			Max.	15.5	11.4	11.3	17.7	13.3	13.7	21.3	16.7	16	33.7	19	17.2	12.6
			Mean	14.5	10.7	10.5	16.5	12.8	12.8	20.2	15.6	15.1	31	17.7	15.4	11.5
			Std.Dev.	-	0.5	0.6	0.7	0.3	0.4	0.7	0.6	0.5	1.8	0.8	1	0.8
			V	-	**4.6**	**5.7**	**4.2**	**2.5**	**3.4**	**3.6**	**3.7**	**3.2**	**5.9**	**4.6**	**6.4**	**6.6**
ISLANDS																
Sicily	Mursia	Middle Bronze Age	N	7	10	10	7	9	8	5	5	5	6	5	4	3
			Min.	12.5	9.8	9.8	15.9	11.4	12.2	20.2	16.3	16	28	16	13.9	7.6
			Max.	14.2	10.8	10.6	17.4	14.1	14	21.5	17.5	17	32.7	19	15.9	11.2
			Mean	13.5	10.4	10.3	16.8	12.9	13.2	20.7	17	16.4	30.2	17.5	15.1	9.1
			Std.Dev.	0.6	0.3	0.3	0.5	0.8	0.6	0.5	0.5	0.4	1.5	1.1	-	-
			V	**4.2**	**2.6**	**2.6**	**3.2**	**6**	**4.8**	**2.5**	**2.9**	**2.5**	**5**	**6.3**	-	-

Table 7.34. (2/2) Summary of upper teeth measurements of Southern and Central sites, from Eneolithic to Late Bronze Age. N=NISP; Min.=minimum measurement; Max.=maximum measurement; Std.Dev.=standard deviation; V=coefficient of variation. *Data kindly provided by U. Albarella

The data summarized in boxplots (Figures 7.6 to 7.21), for sites with samples above 5 specimens, serves as a visual guide to the range of pig measurements through time. From the postcranial and teeth data, the occurrence of a wild boar size increase after the Mesolithic is clear, as it has been previously observed in Italy and other European areas (Albarella et al., 2005; 2006c; 2009). Additionally, a clear overall reduction in size can be observed in all cases from the Late Neolithic onwards, with the presence of outliers more common in these latter periods as well. This change is more marked in the postcranial data but can also be seen in the tooth measurements.

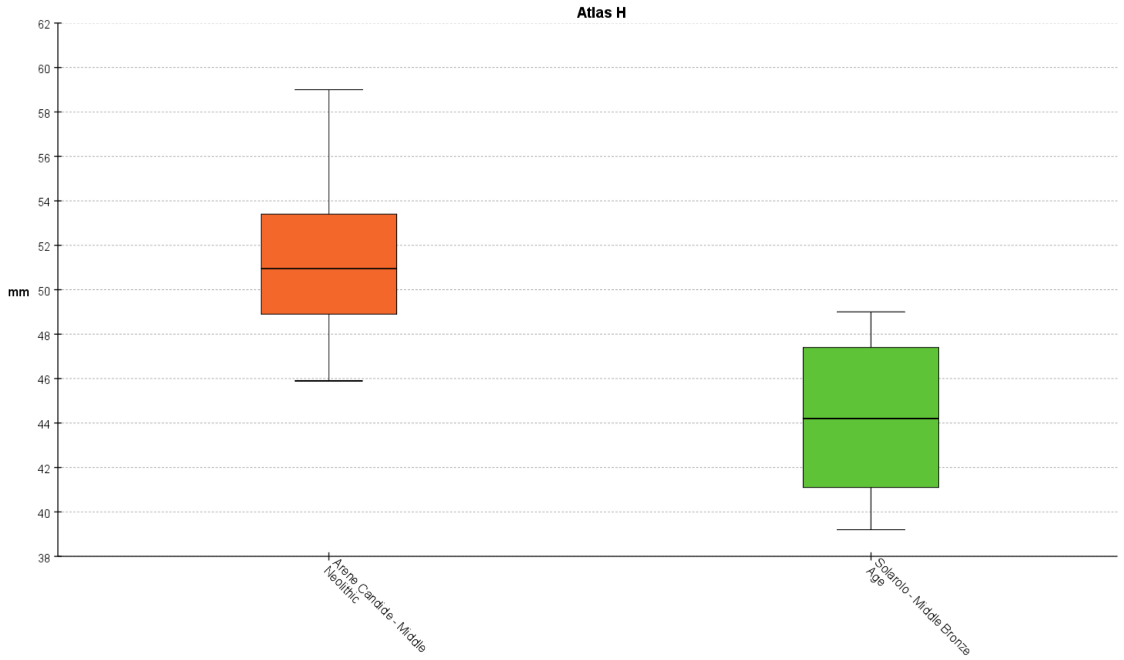


Figure 7.6. Atlas H boxplot, for sites with samples above 5 measurements. The length of the box contains 50% of cases. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

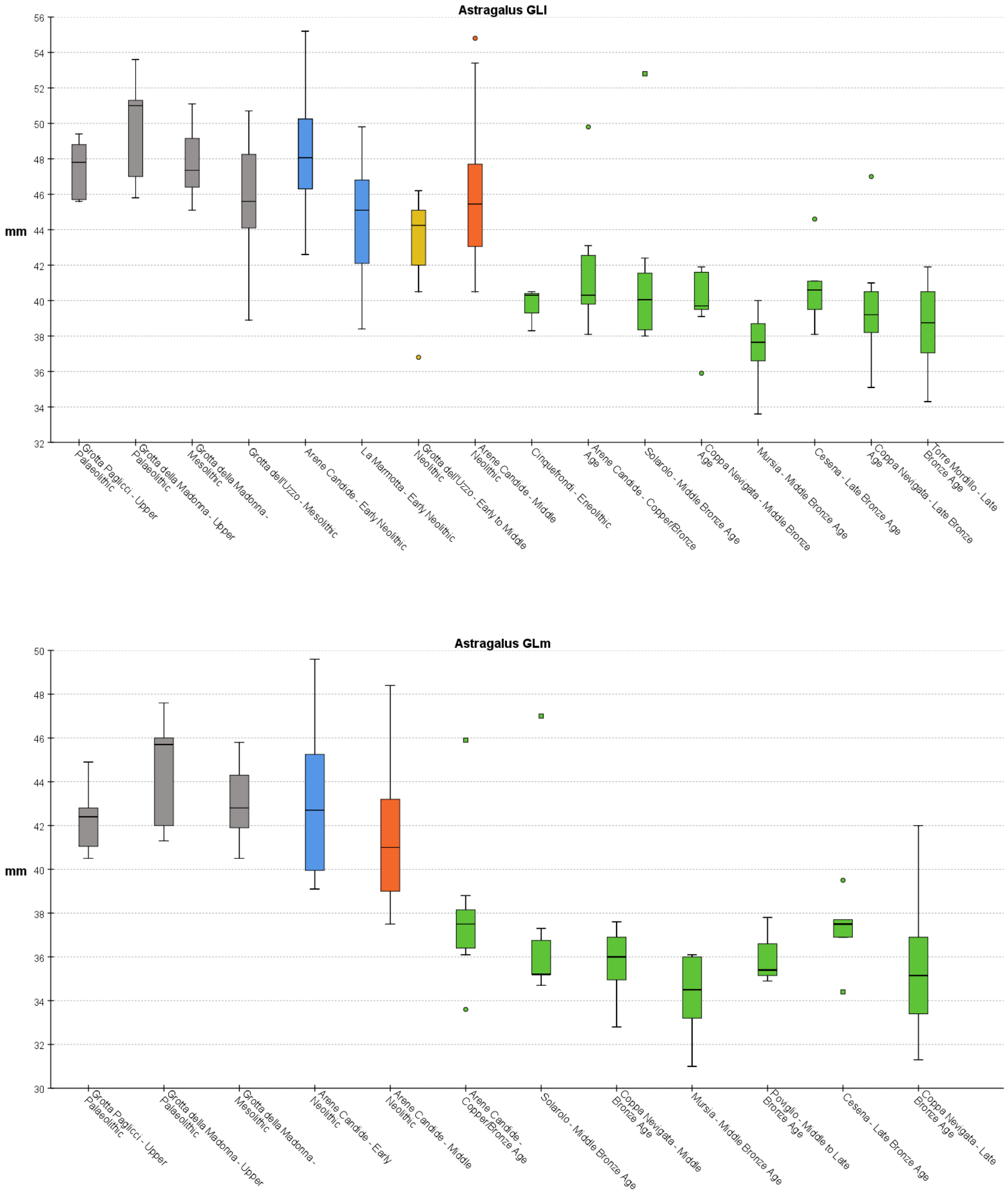


Figure 7.7. Astragalus GLl and GLm boxplots, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

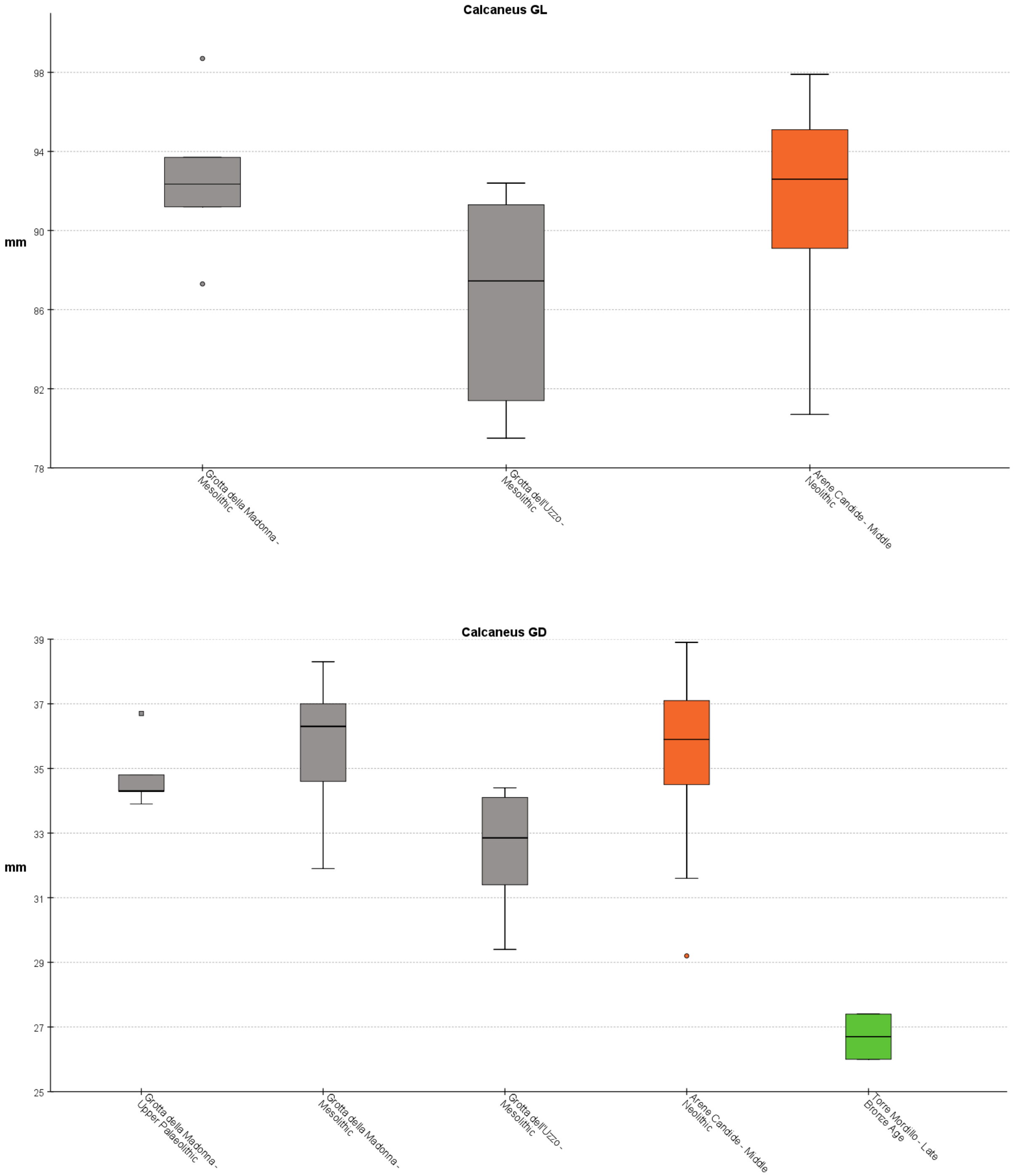


Figure 7.8. Calcaneus GL and GD boxplots, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

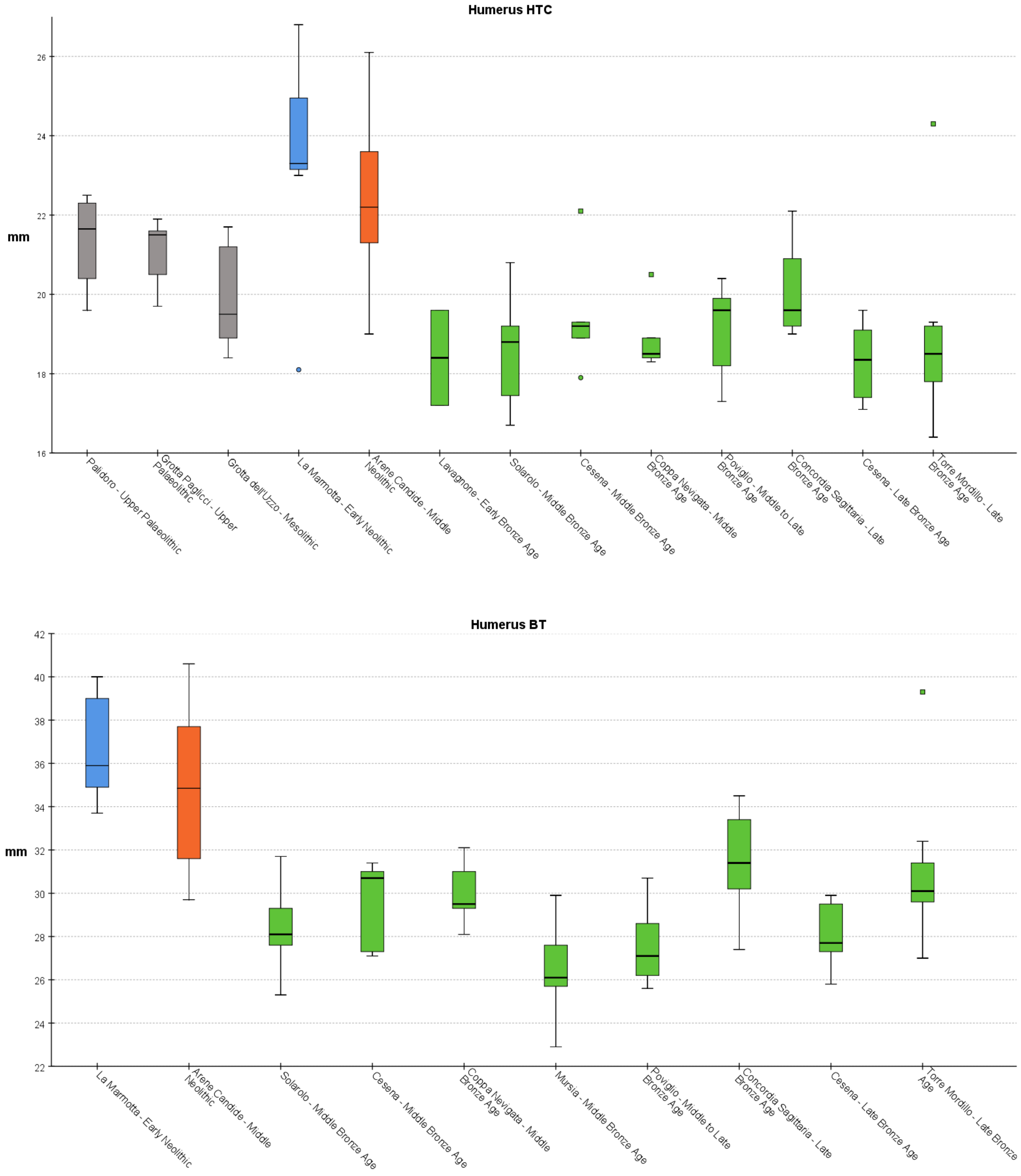


Figure 7.9. Humerus BT and HTC boxplots, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

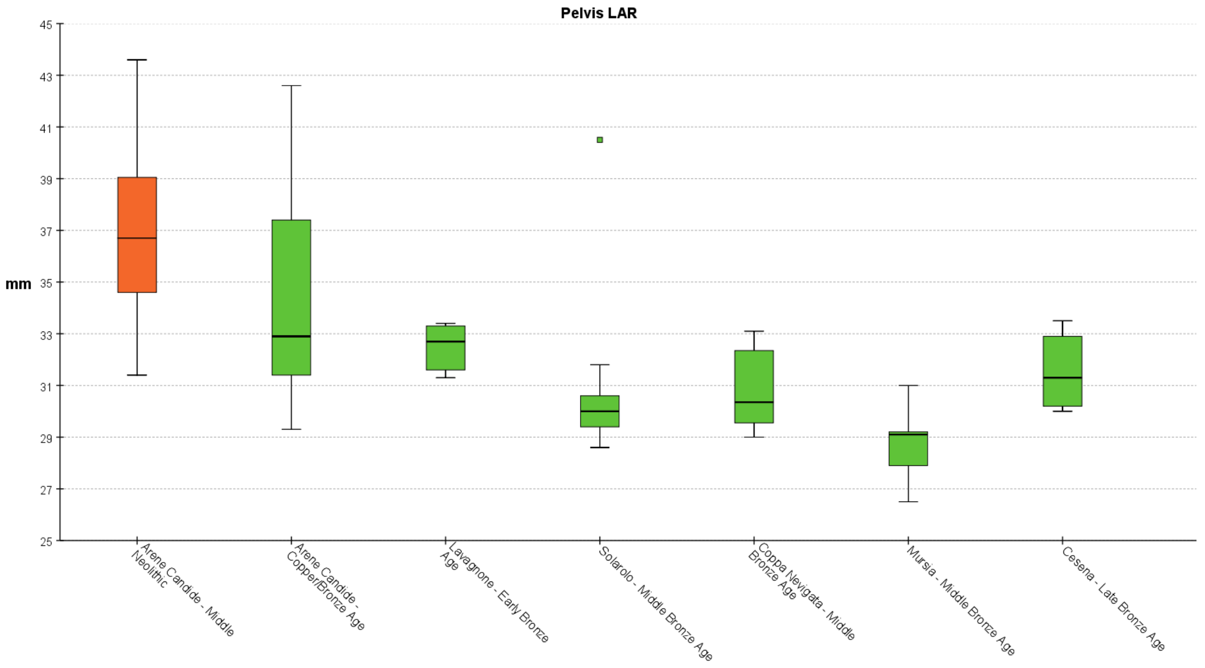


Figure 7.10. Pelvis LAR boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

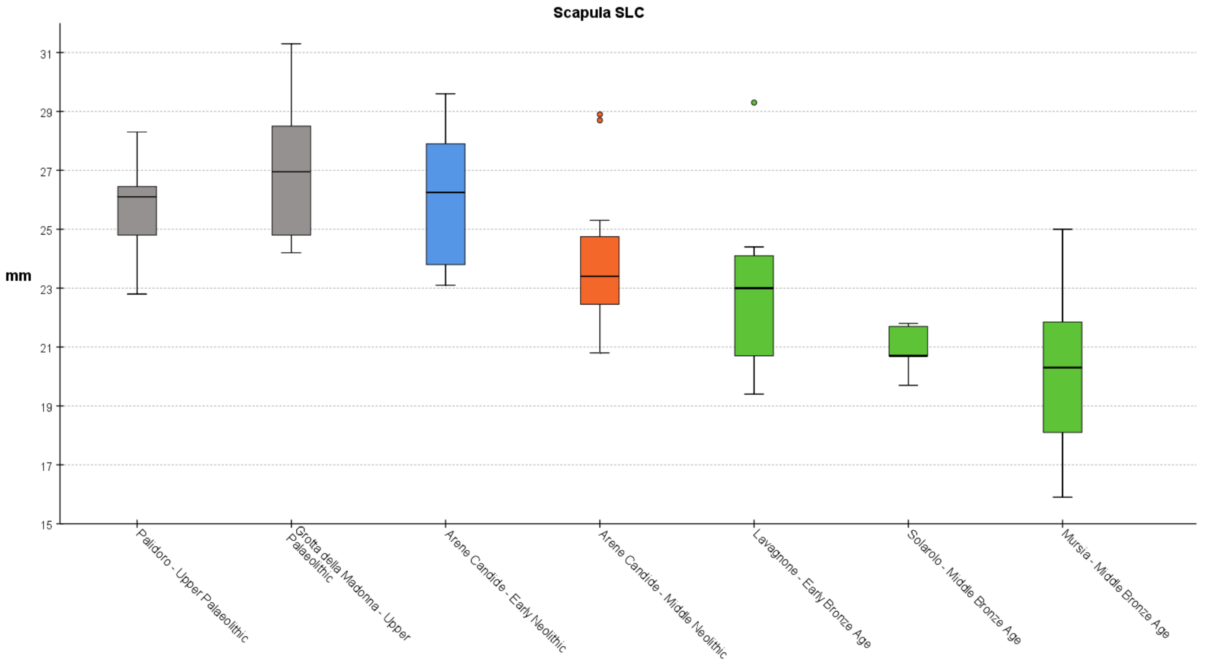


Figure 7.11. Scapula SLC boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

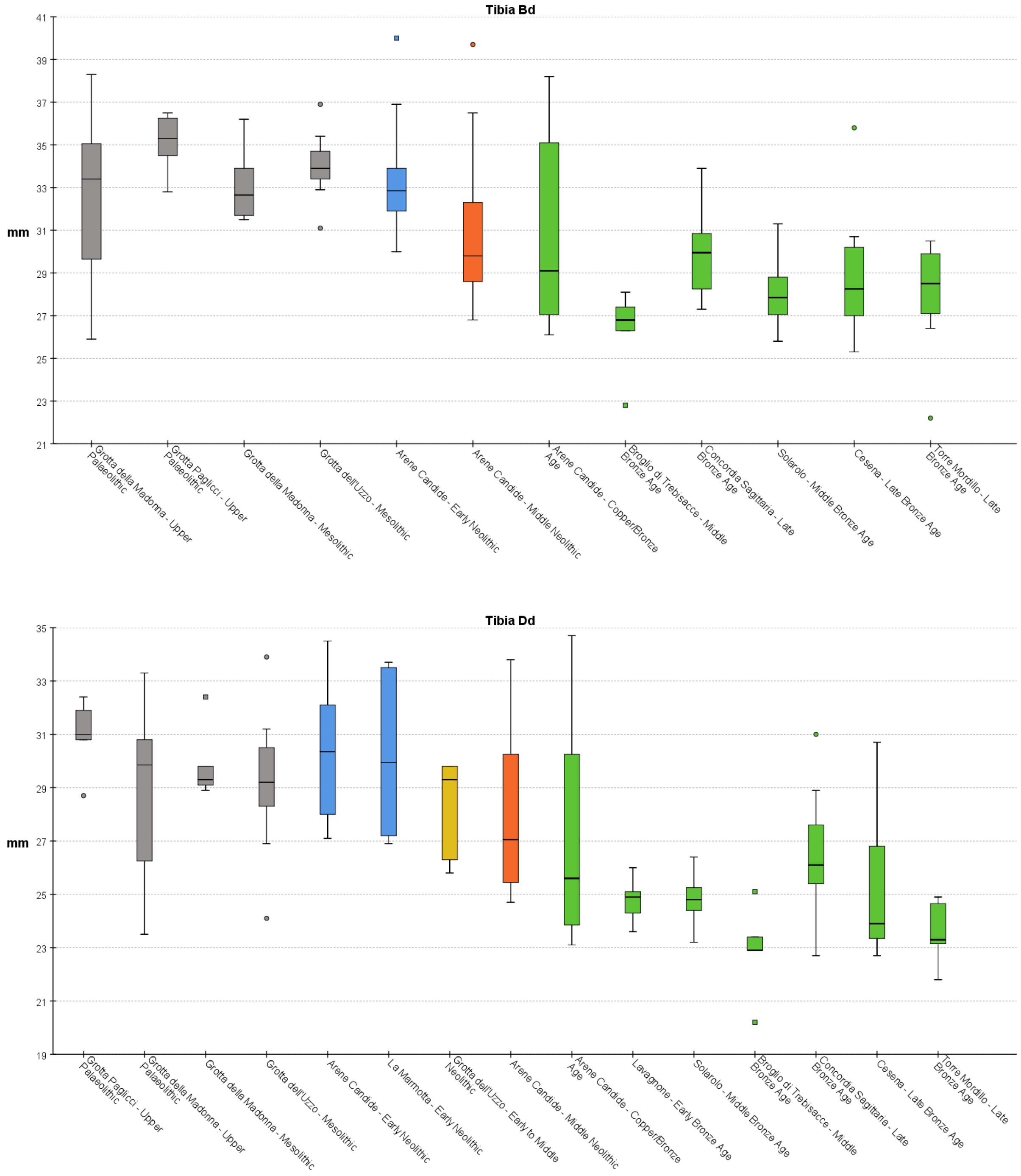


Figure 7.12. Tibia Bd and Dd boxplots, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

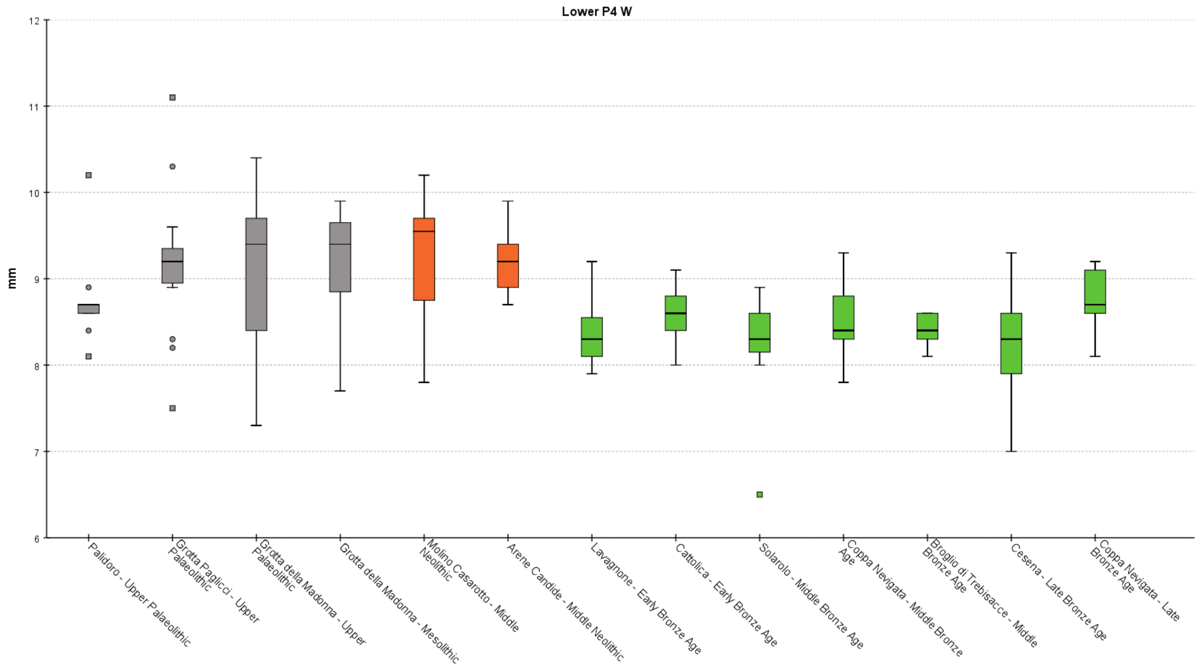


Figure 7.13. Lower P4 W boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

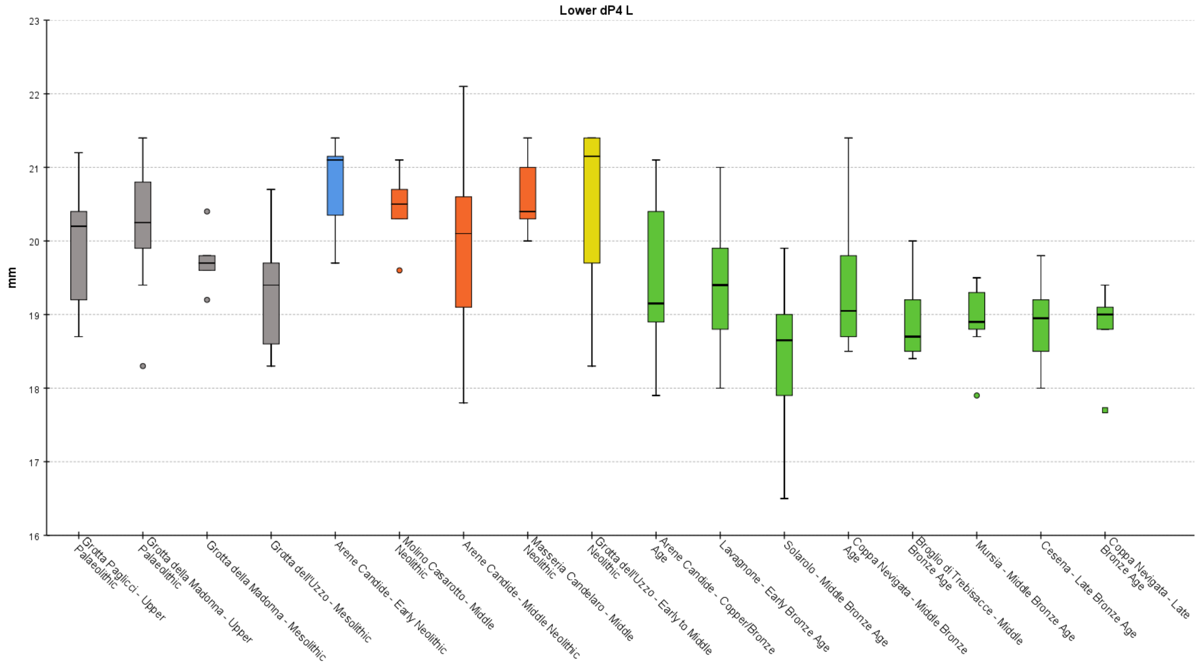
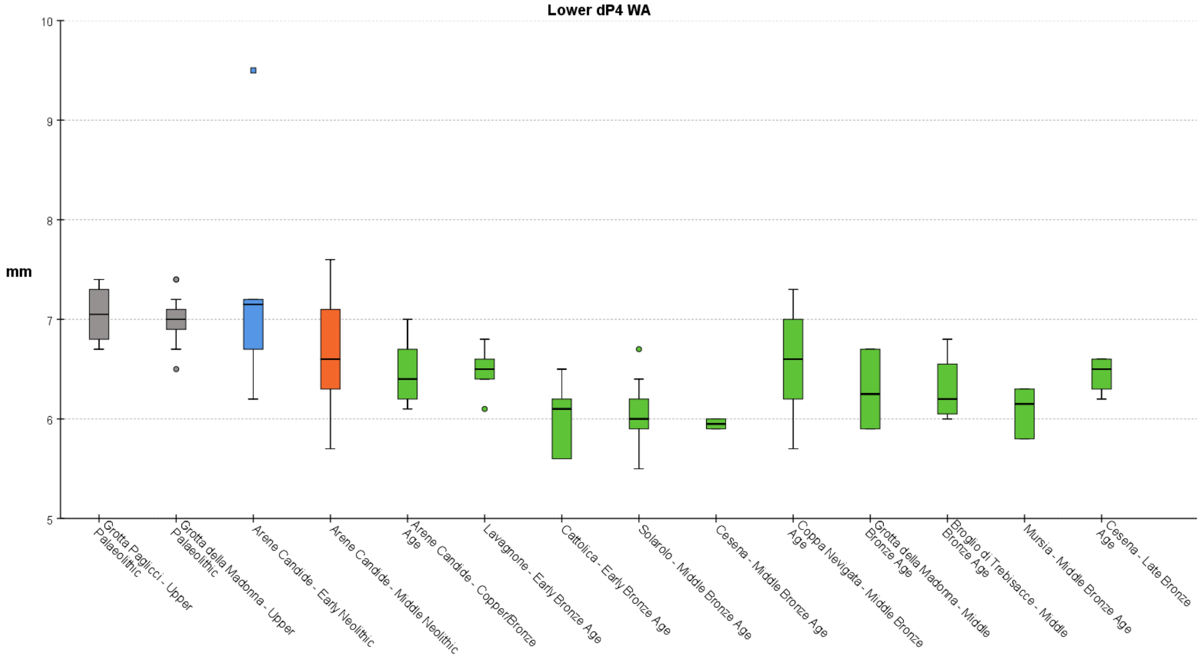


Figure 7.14. (1/3) Lower dP4 L, WA, WC, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.



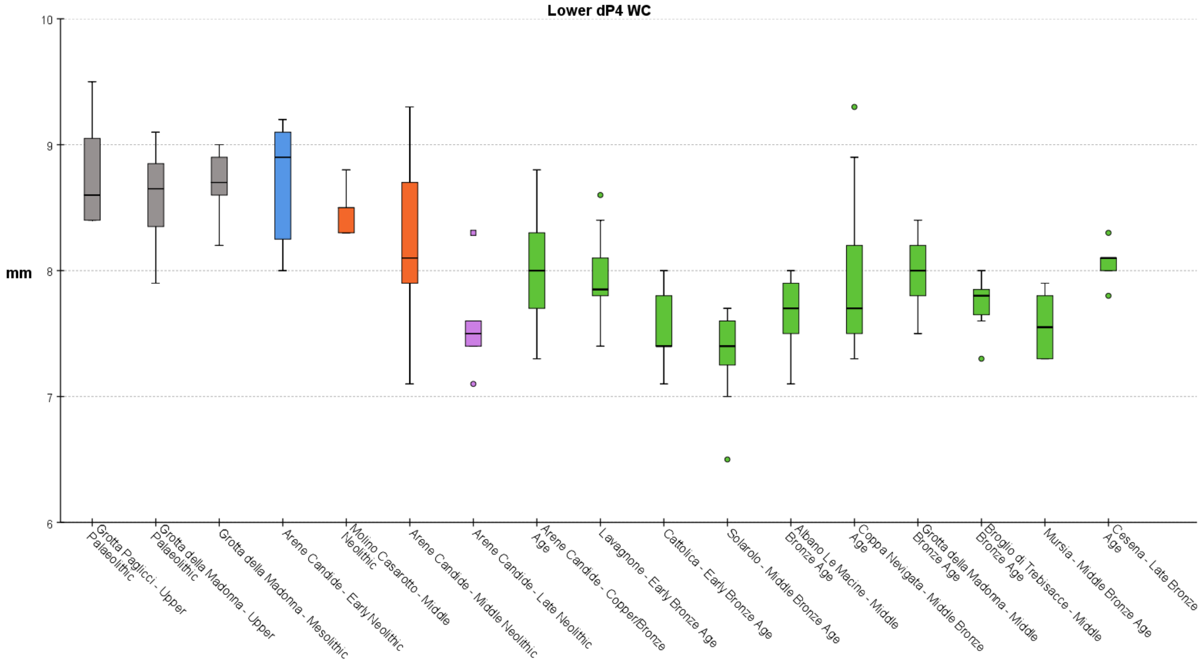


Figure 7.14. (2/3) Lower dP4 L, WA, WC, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

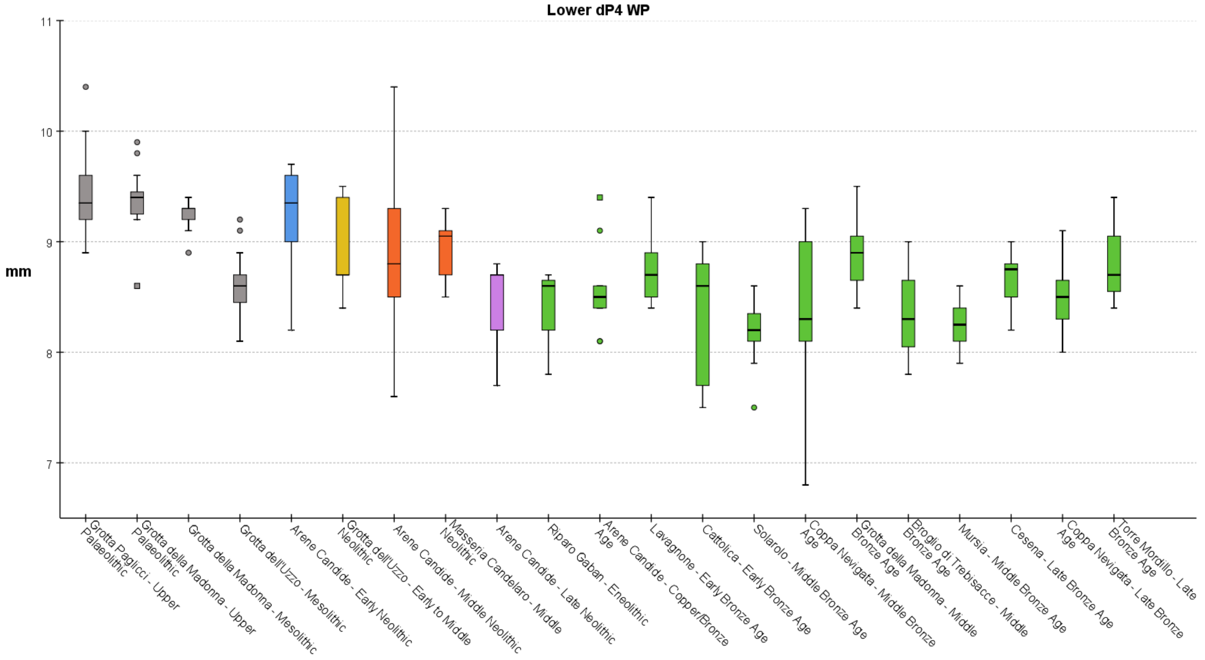


Figure 7.14. (3/3) Lower dP4 L, WA, WC, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

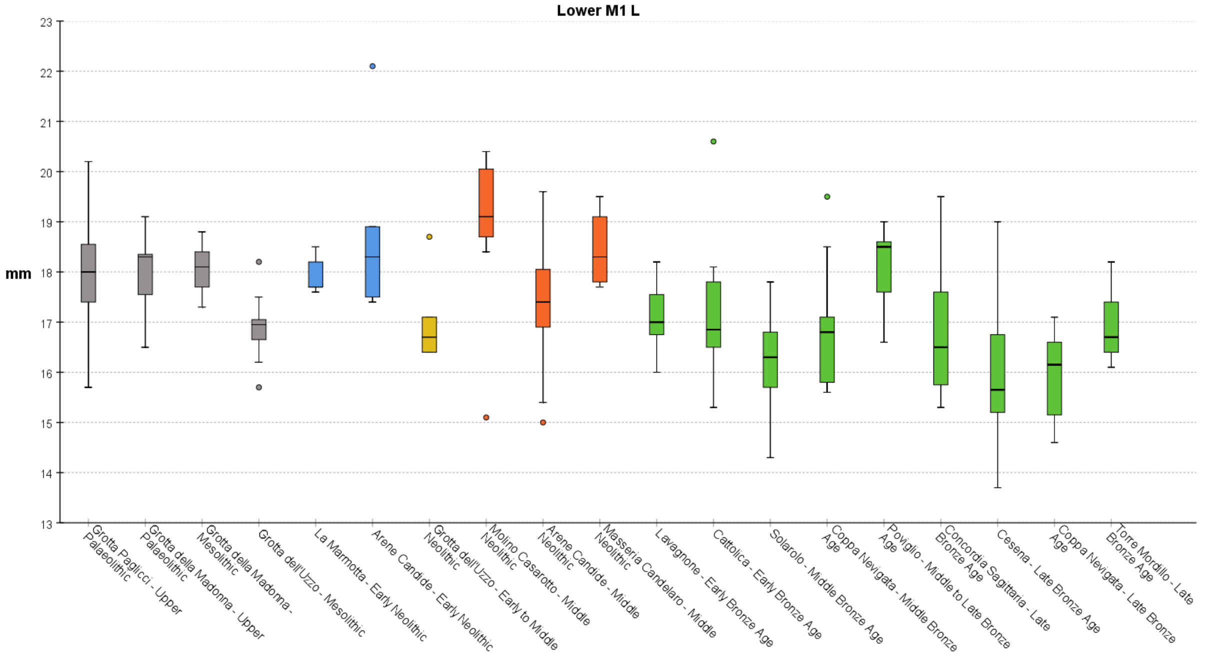
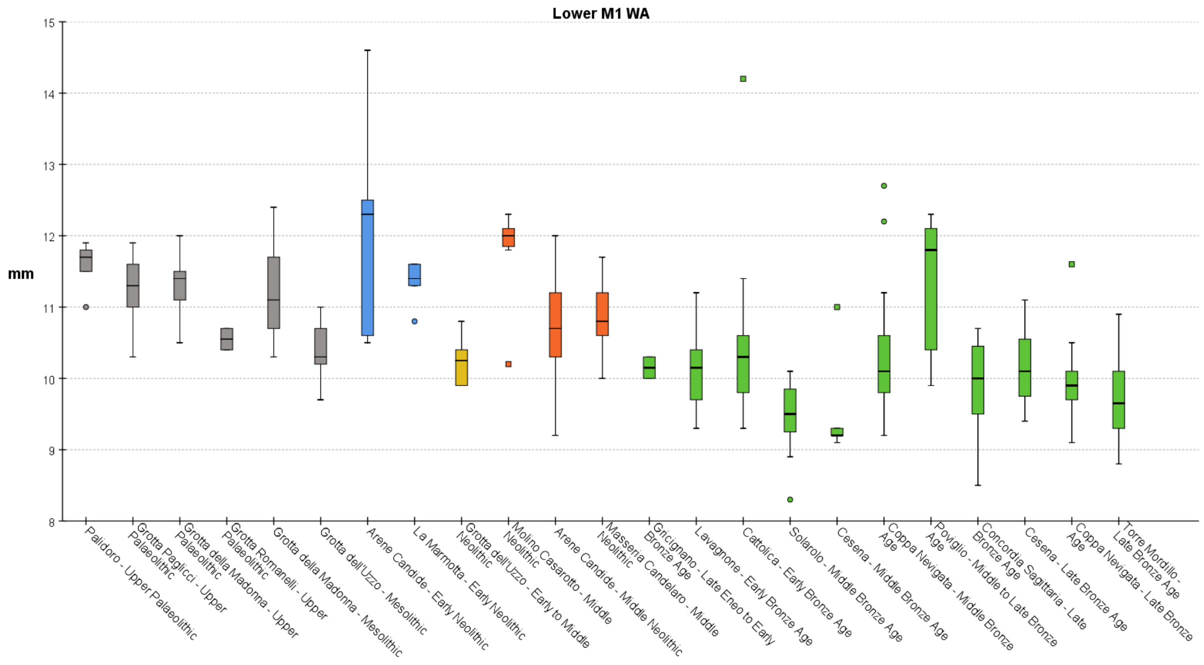


Figure 7.15. (1/2) Lower M1 L, WA, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.



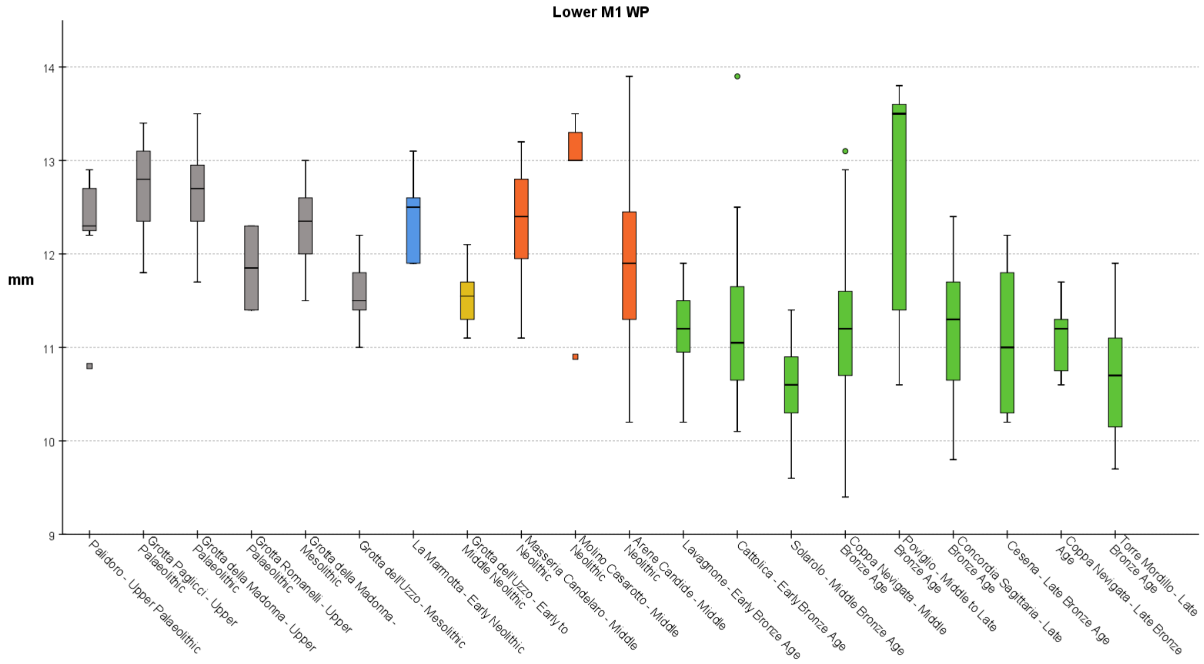


Figure 7.15. (2/2) Lower M1 L, WA, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

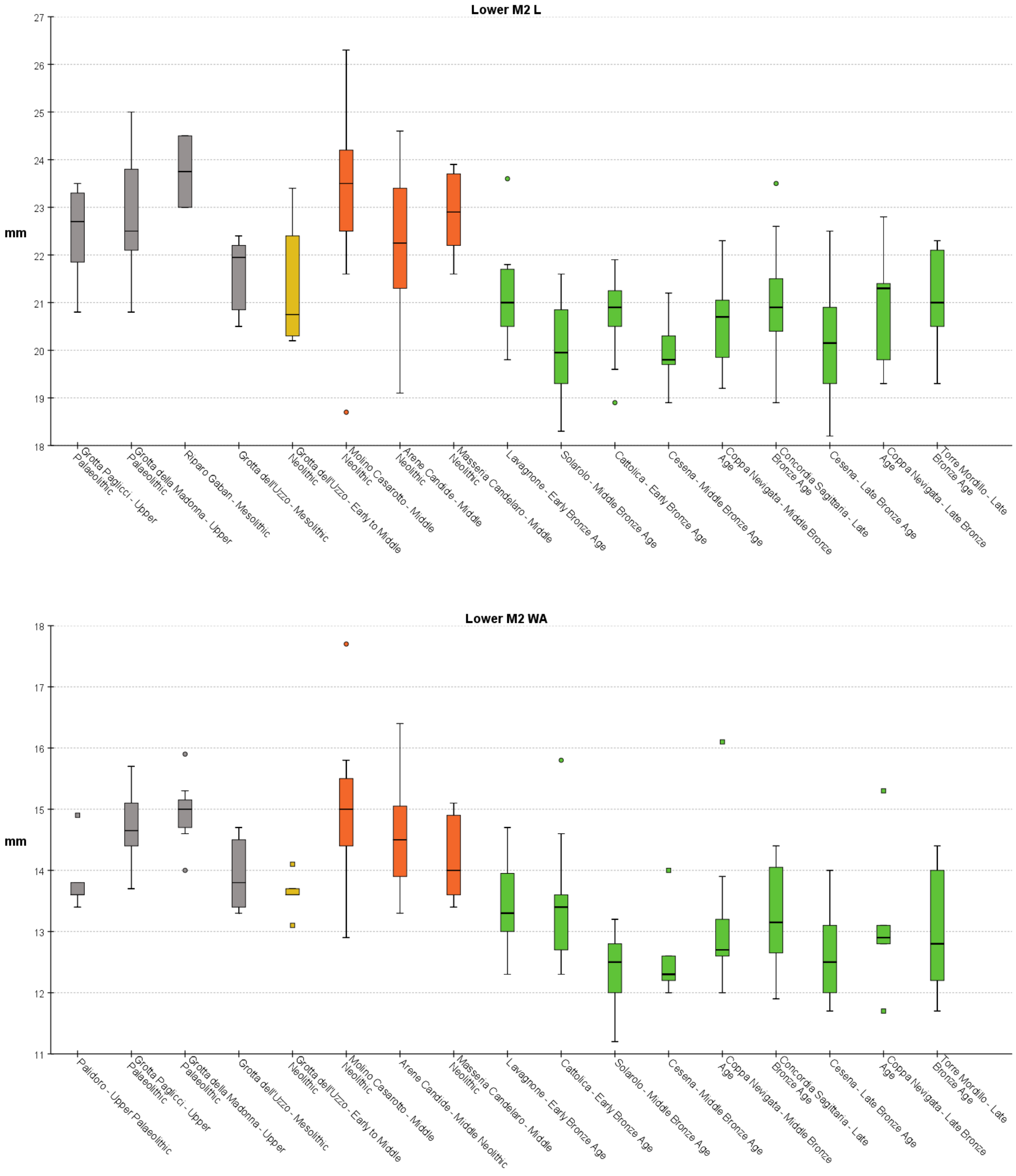


Figure 7.16. (1/2) Lower M2 L, WA, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

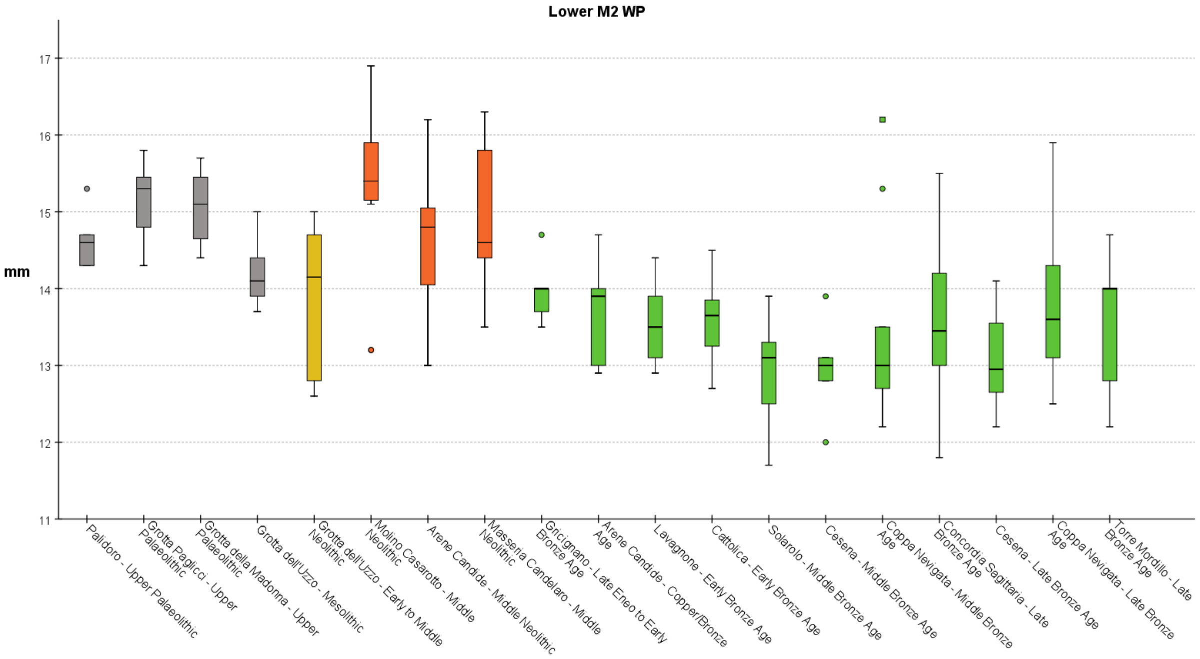


Figure 7.16. (2/2) Lower M2 L, WA, and WP boxplot, for sites with samples above 5 measurements

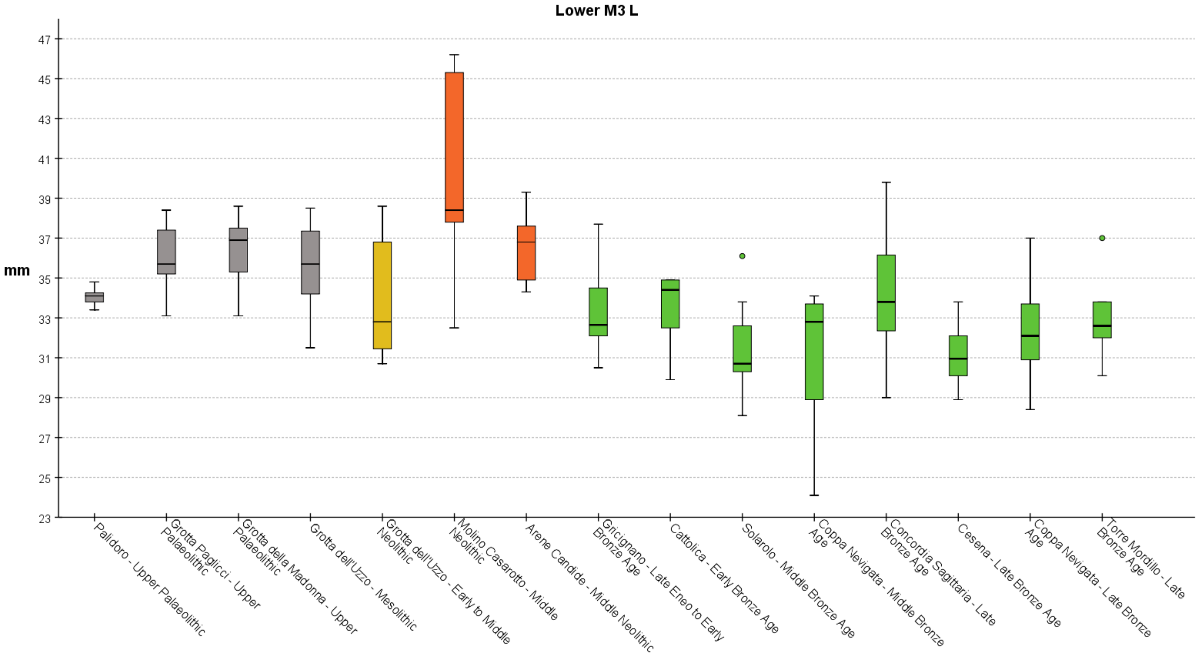


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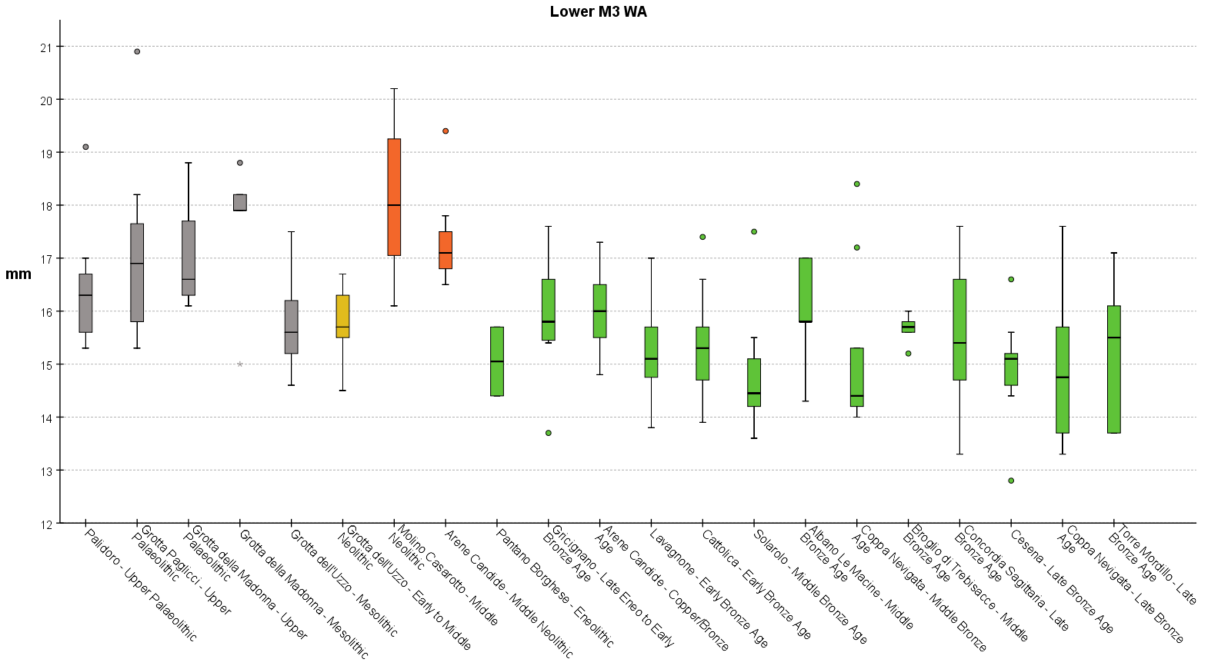
Figure 7.17. (1/3) Lower M3 L, WA, WC, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.



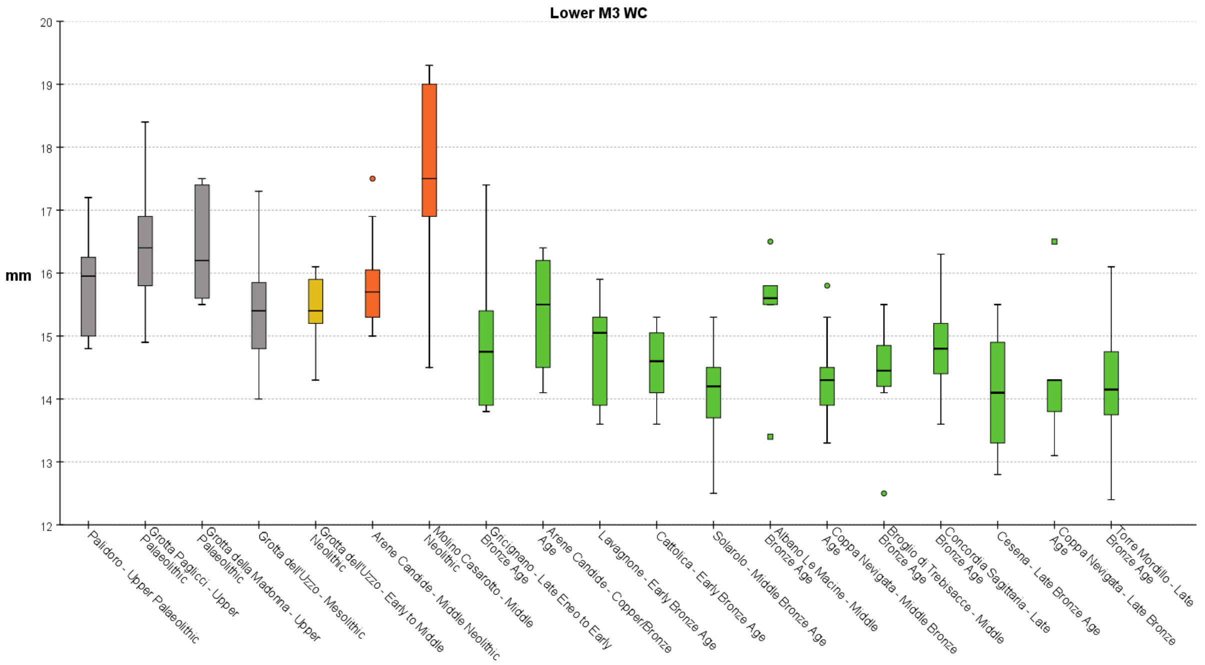


Figure 7.17. (2/3) Lower M3 L, WA, WC, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

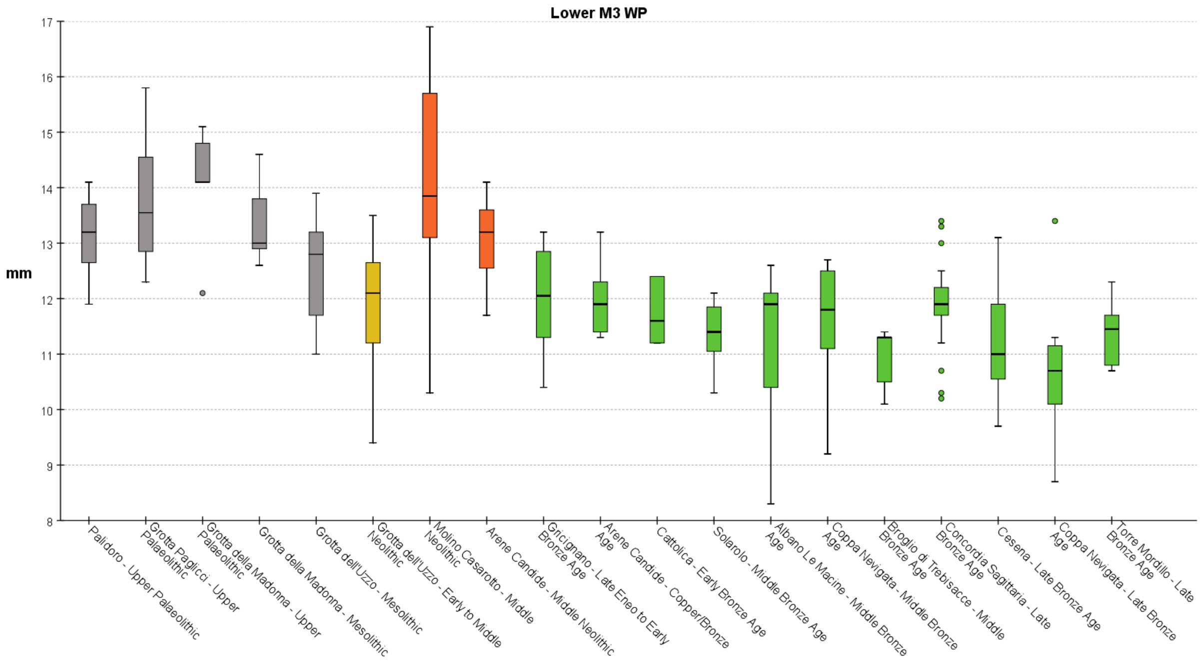


Figure 7.17. (3/3) Lower M3 L, WA, WC, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

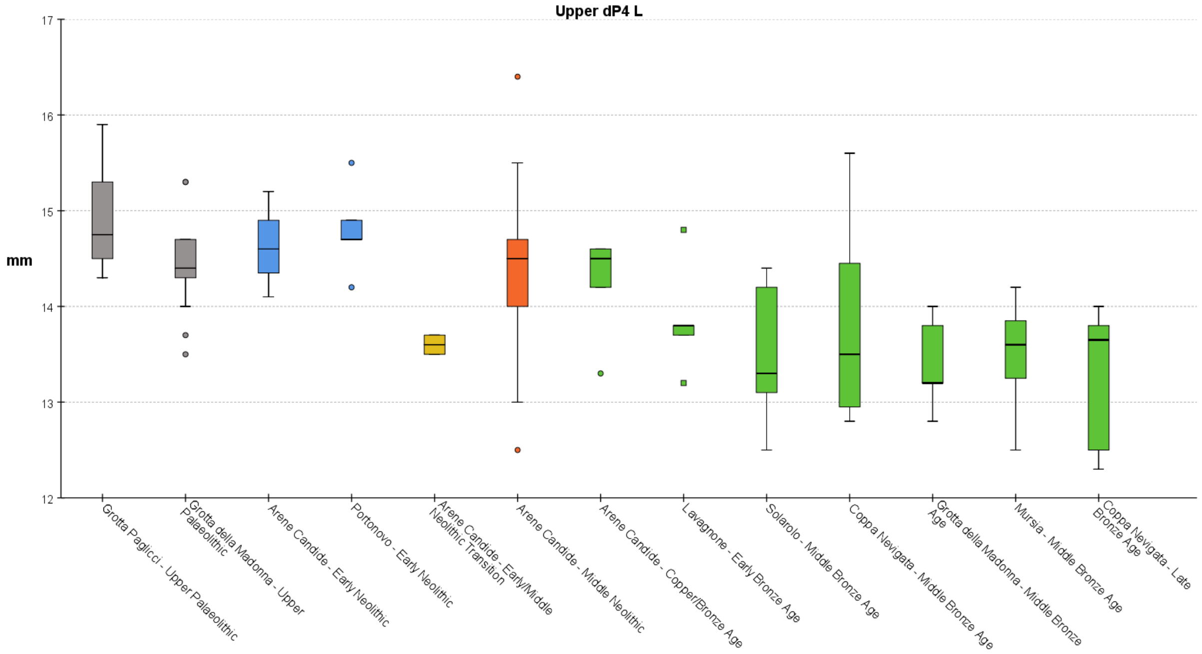


Figure 7.18. (1/2) Upper dP4 L, WA, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

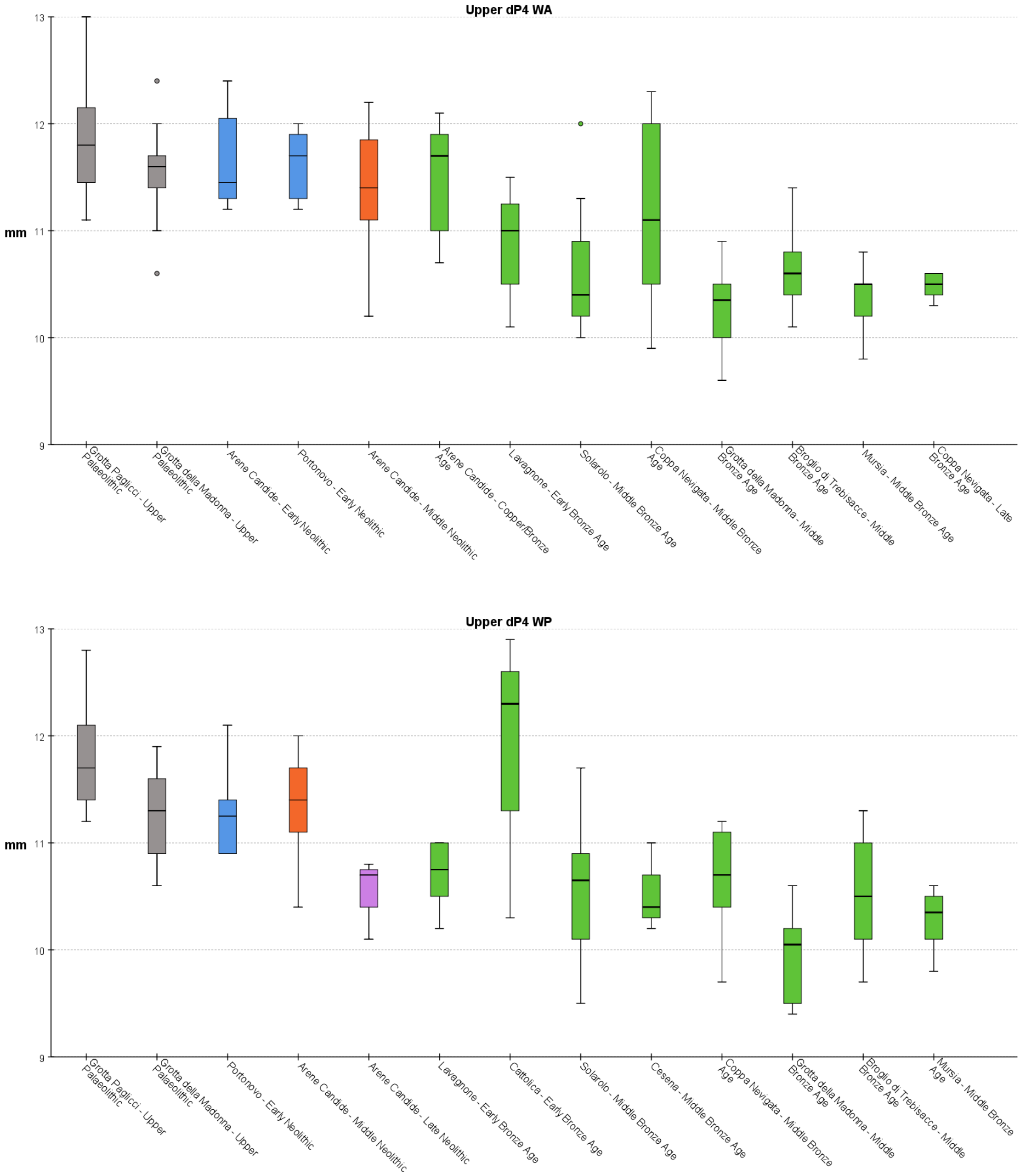


Figure 7.18. (2/2) Upper dP4 L, WA, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

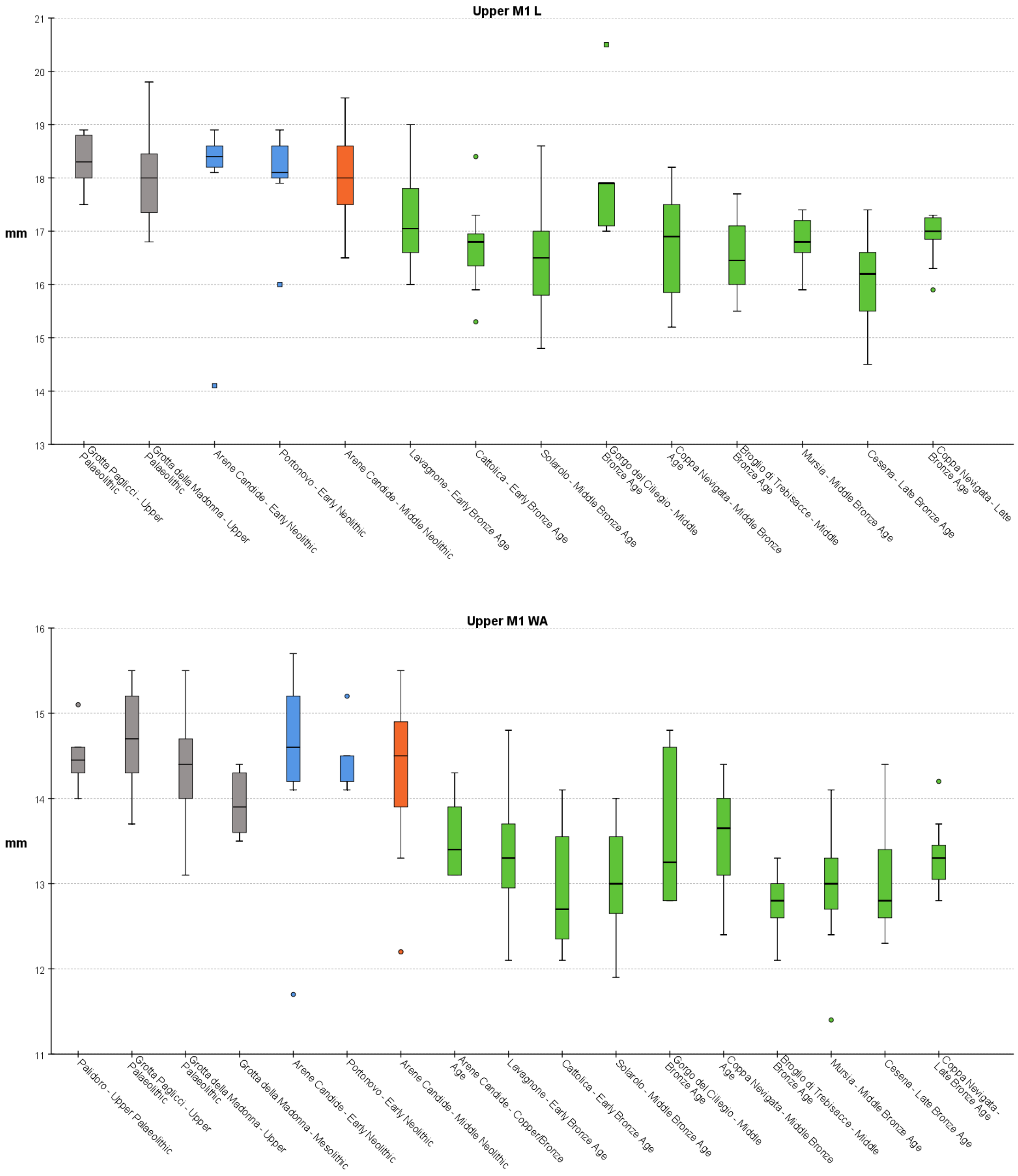


Figure 7.19. (1/2) Upper M1 L, WA, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

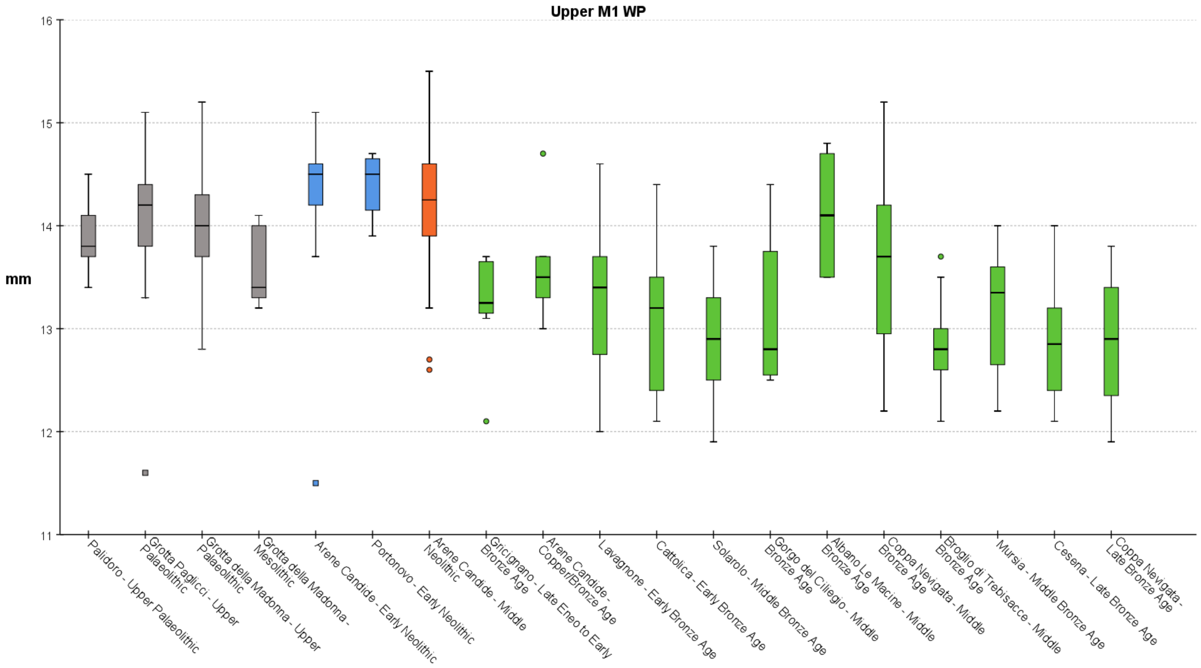


Figure 7.19. (2/2) Upper M1 L, WA, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

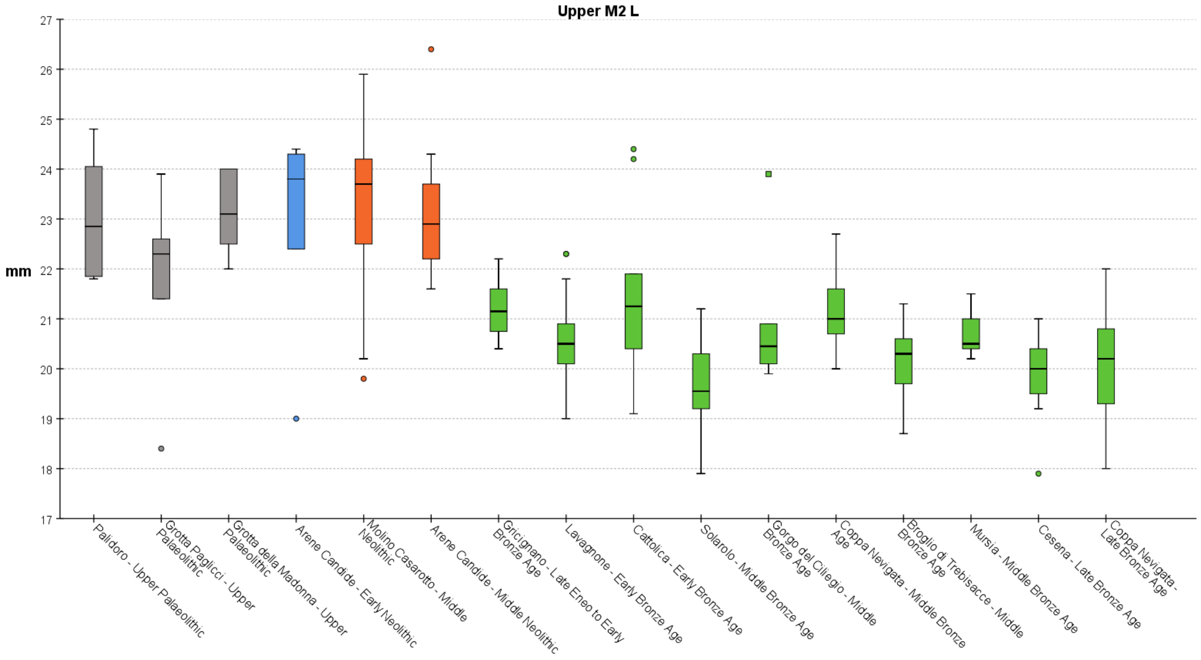


Figure 7.20. (1/2) Upper M2 L, WA, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

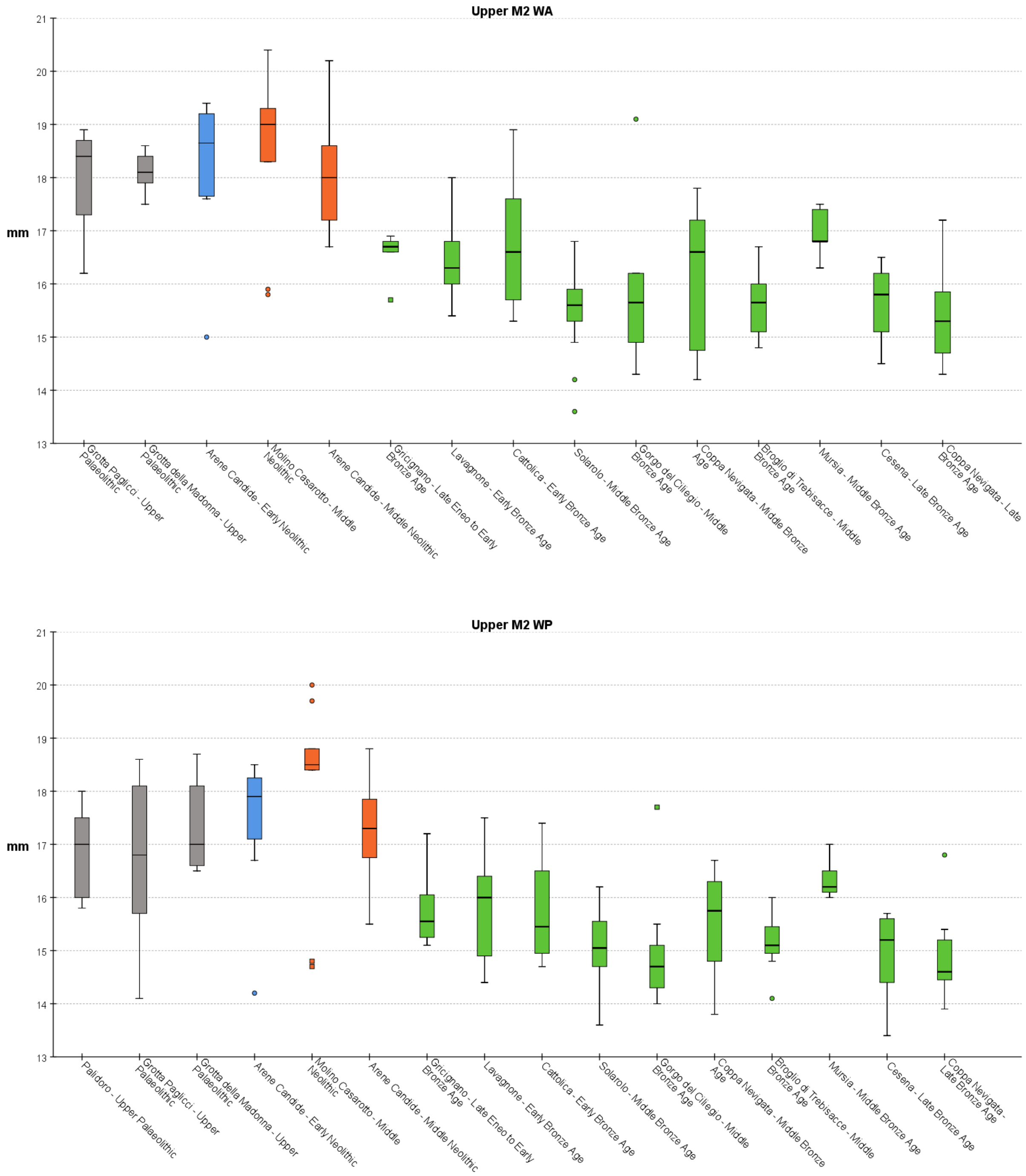


Figure 7.20. (2/2) Upper M2 L, WA, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

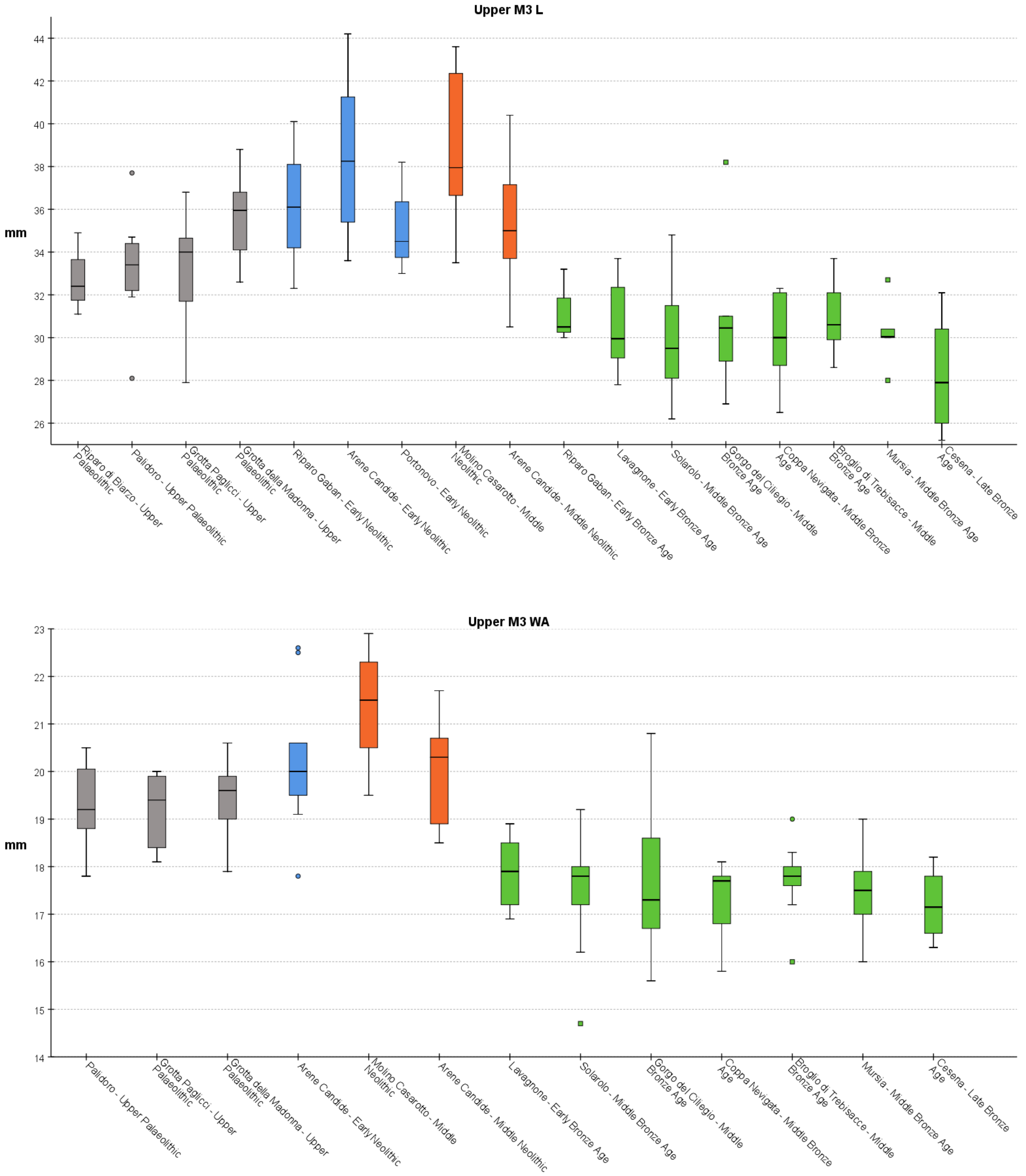


Figure 7.21. (1/2) Upper M3 L, WA, WC, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

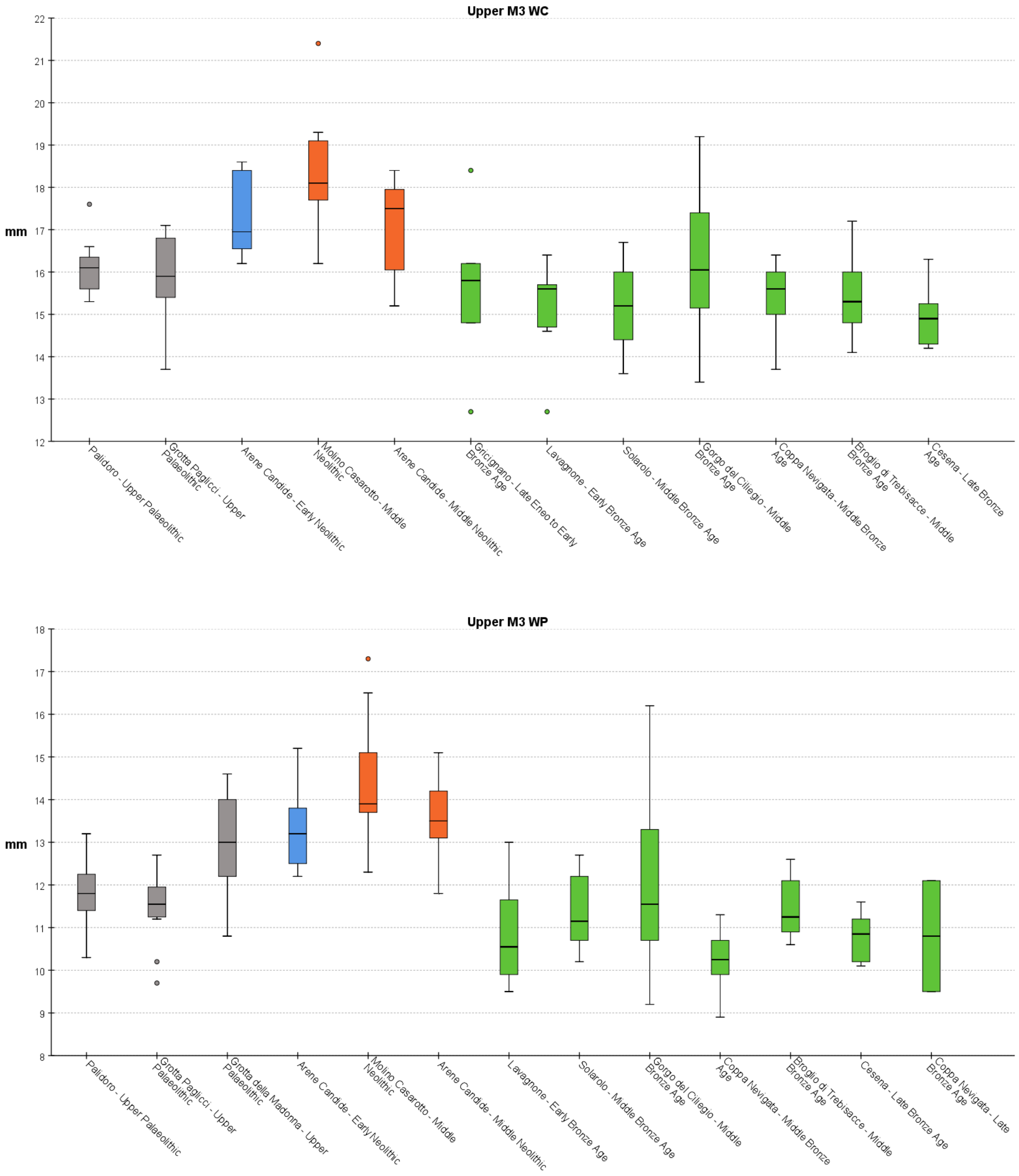


Figure 7.21 (2/2). Upper M3 L, WA, WC, and WP boxplot, for sites with samples above 5 measurements. The line across the inside of the box represents the median value. The whiskers protruding from the box go out to the variable's smallest and largest values. The circles and asterisks, if present, represent outliers and extreme points respectively.

Statistical analyses (t-test) have also been performed on the biometrical samples for each region and for the site of Arene Candide in order to assess their degree of similarity, and the results can be seen in Tables 7.35-7.38.

Sample 1	Sample 2	ASTRAGALUS		CALCANEUS		HUMERUS		TIBIA	
		GLl	GLm	GL	GD	BT	HTC	Bd	Dd
NORTH & CENTRE									
Upper Palaeolithic & Mesolithic	Early Neolithic	0.131	0.104	-	-	0.362	0.025	0.798	0.183
Upper Palaeolithic & Mesolithic	Middle Neolithic	0.430	0.384	-	-	0.827	0.422	0.187	0.555
Upper Palaeolithic & Mesolithic	Late Neolithic	0.677*	0.818*	-	-	-	-	0.026	0.026
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	0.519*	0.685*	-	-	0.000	0.002	0.843*	0.582*
Early Neolithic	Middle Neolithic	0.230	0.183	0.084	0.192	0.295	0.052	0.033	0.013
Early Neolithic	Late Neolithic	0.098	0.183	0.791*	0.941*	-	-	0.026	0.008
Early Neolithic	Eneolithic to Bronze Age	0.131*	0.053*	0.258*	0.401*	0.000	0.000	0.844*	0.123*
Middle Neolithic	Late Neolithic	0.140	0.700*	0.906*	0.602	-	-	0.153	0.139
Middle Neolithic	Eneolithic to Bronze Age	0.668*	0.385*	0.918*	0.982*	0.000	0.000	0.008*	0.086*
Late Neolithic	Eneolithic to Bronze Age	0.391	0.596	0.839	0.752	-	-	0.130*	0.077*
SOUTH & ISLANDS									
Upper Palaeolithic & Mesolithic	Early Neolithic	-	-	-	-	0.806*	0.911*	0.592	0.376
Upper Palaeolithic & Mesolithic	Middle Neolithic	0.517	0.043	0.181	0.036	0.628	0.939*	-	-
Upper Palaeolithic & Mesolithic	Late Neolithic	-	-	-	-	-	-	-	-
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	0.000	0.000	0.000*	0.000*	0.002	0.000	0.000	0.000
Early Neolithic	Middle Neolithic	-	-	-	-	0.710	0.874	-	-
Early Neolithic	Late Neolithic	-	-	-	-	-	-	-	-
Early Neolithic	Eneolithic to Bronze Age	-	-	-	-	0.141	0.183*	0.000	0.001
Middle Neolithic	Late Neolithic	-	-	-	-	-	-	-	-
Middle Neolithic	Eneolithic to Bronze Age	0.001	0.000	0.000	0.001	0.103	0.574*	-	-
Late Neolithic	Eneolithic to Bronze Age	-	-	-	-	-	-	-	-

Table 7.35. (1/3) Results of the t-test statistical analyses of postcranial biometrical data by main areas. Upper Palaeolithic to Middle Neolithic Island data corresponds to the site of Grotta dell'Uzzo, while the Eneolithic to Bronze Age data from that same area belongs to the site of Mursia. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results ($p \leq 0.001$).

Sample 1	Sample 2	ASTRAGALUS		CALCANEUS		HUMERUS		TIBIA	
		GLl	GLm	GL	GD	BT	HTC	Bd	Dd
SOUTH									
Upper Palaeolithic & Mesolithic	Early Neolithic	-	-	-	-	0.482	0.400	-	-
Upper Palaeolithic & Mesolithic	Middle Neolithic	0.517	0.043	-	-	-	-	-	-
Upper Palaeolithic & Mesolithic	Late Neolithic	-	-	-	-	-	-	-	-
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000
Early Neolithic	Middle Neolithic	-	-	-	-	-	-	-	-
Early Neolithic	Late Neolithic	-	-	-	-	-	-	-	-
Early Neolithic	Eneolithic to Bronze Age	-	-	-	-	0.004	0.000	-	-
Middle Neolithic	Late Neolithic	-	-	-	-	-	-	-	-
Middle Neolithic	Eneolithic to Bronze Age	0.004	0.002	-	-	-	-	-	-
Late Neolithic	Eneolithic to Bronze Age	-	-	-	-	-	-	-	-
ISLANDS									
Upper Palaeolithic & Mesolithic	Early Neolithic	-	-	-	-	0.007	0.008	0.628	0.283
Upper Palaeolithic & Mesolithic	Middle Neolithic	-	-	-	-	-	-	-	-
Upper Palaeolithic & Mesolithic	Early to Middle Neolithic	-	-	0.008*	0.198	0.018	0.002	0.309	0.164
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	-	-	0.001	0.001	0.003	0.006	0.001	0.001
Early Neolithic	Middle Neolithic	-	-	-	-	-	-	-	-
Early Neolithic	Eneolithic to Bronze Age	-	-	-	-	0.810	0.941	0.175	0.241
Middle Neolithic	Eneolithic to Bronze Age	-	-	-	-	-	-	-	-
Early to Middle Neolithic	Eneolithic to Bronze Age	-	-	0.022	0.022	0.485	0.781*	0.028*	0.042*

Table 7.35. (2/3) Results of the t-test statistical analyses of postcranial biometrical data by main areas. Upper Palaeolithic to Middle Neolithic Island data corresponds to the site of Grotta dell'Uzzo, while the Eneolithic to Bronze Age data from that same area belongs to the site of Mursia. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results ($p \leq 0.001$).

Sample 1	Sample 2	ASTRAGALUS		CALCANEUS		HUMERUS		TIBIA	
		GLl	GLm	GL	GD	BT	HTC	Bd	Dd
NORTH & CENTRE	**SOUTH & ISLANDS**								
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	0.345	0.003	-	-	0.763	0.552	0.788	0.382
Early Neolithic	Early Neolithic	-	-	-	-	0.504	0.264*	0.695	0.230
Middle Neolithic	Middle Neolithic	0.620	0.731	0.115	0.064	0.521	0.974*	-	-
Late Neolithic	Late Neolithic	-	-	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.000*	0.000*	0.004*	0.006*	0.122	0.857	0.000*	0.000*
NORTH & CENTRE	**SOUTH**								
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	0.345	0.003	-	-	0.219	0.138	0.909	0.369
Early Neolithic	Early Neolithic	-	-	-	-	0.315	0.992	-	-
Middle Neolithic	Middle Neolithic	0.620	0.731	-	-	-	-	-	-
Late Neolithic	Late Neolithic	-	-	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.000*	0.000*	0.004*	0.006*	0.019	0.697	0.000*	0.000*
NORTH & CENTRE	**ISLANDS**								
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	-	-	-	-	0.341	0.510	0.486	0.528
Early Neolithic	Early Neolithic	-	-	-	-	0.004	0.004	0.854	0.190
Middle Neolithic	Middle Neolithic	-	-	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.000*	0.000*	0.003*	0.007*	0.017	0.044	0.000*	0.001*
SOUTH	**ISLANDS**								
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	-	-	0.057	0.016	0.017	0.036	0.607	0.559
Early Neolithic	Early Neolithic	-	-	-	-	0.009	0.035	-	-
Middle Neolithic	Middle Neolithic	-	-	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.022	0.056	0.457	0.565	0.024	0.092	0.570	0.893

Table 7.35. (3/3) Results of the t-test statistical analyses of postcranial biometrical data by main areas. Upper Palaeolithic to Middle Neolithic Island data corresponds to the site of Grotta dell'Uzzo, while the Eneolithic to Bronze Age data from that same area belongs to the site of Mursia. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results (p≤0.001).

Sample 1	Sample 2	LOWER DP4			LOWER M1			LOWER M2			LOWER M3		
		L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC
NORTH & CENTRE													
Upper Palaeolithic & Mesolithic	Early Neolithic	0.033	0.706	0.597	0.989	0.440	0.663	0.521	0.258	0.694	0.019	0.568	0.142
Upper Palaeolithic & Mesolithic	Middle Neolithic	0.722	0.594	0.224	0.337	0.131*	0.010*	0.346	0.169	0.630	0.008	0.021	0.037
Upper Palaeolithic & Mesolithic	Late Neolithic	0.065	0.052	0.046	-	-	-	0.802	0.800	0.689	-	-	-
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	0.043	0.001	0.000	0.015	0.000	0.000*	0.000	0.000	0.000	0.629*	0.011	0.002
Early Neolithic	Middle Neolithic	0.084	0.586	0.182	0.237	0.014	0.014	0.158	0.925	0.979	0.880	0.231	0.569
Early Neolithic	Late Neolithic	0.001	0.057	0.024	-	-	-	0.696	0.689	0.575	-	-	-
Early Neolithic	Eneolithic to Bronze Age	0.000	0.000	0.000	0.001	0.000	0.000	0.018*	0.000	0.000	0.118	0.006	0.000
Middle Neolithic	Late Neolithic	0.073	0.374	0.186	-	-	-	0.794	0.689	0.546	-	-	-
Middle Neolithic	Eneolithic to Bronze Age	0.000	0.000*	0.000*	0.000	0.000	0.000	0.000*	0.000	0.000	0.001	0.000	0.000
Late Neolithic	Eneolithic to Bronze Age	0.946	0.692	0.925	-	-	-	0.020	0.051	0.125	-	-	-
SOUTH & ISLANDS													
Upper Palaeolithic & Mesolithic	Early Neolithic	-	-	-	0.589	0.016	0.087	0.025	0.000*	0.046	0.166	0.133	0.308
Upper Palaeolithic & Mesolithic	Middle Neolithic	0.228	0.141	0.014	0.037	0.114	0.792	0.134	0.865	0.251	0.842	0.502	0.686
Upper Palaeolithic & Mesolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.300	0.310	-
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	0.000	0.000*	0.000*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000*
Early Neolithic	Middle Neolithic	-	-	-	0.531	0.121	0.154	0.280	0.044*	0.084	0.161	0.331	0.199
Early Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.110	0.060	-
Early Neolithic	Eneolithic to Bronze Age	-	-	-	0.023	0.382	0.039	0.418	0.015*	0.508	0.629	0.690	0.012
Middle Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.331	0.096	-
Middle Neolithic	Eneolithic to Bronze Age	0.649	0.239	0.395	0.000	0.000	0.000	0.000	0.005	0.000	0.021	0.161	0.000
Late Neolithic	Eneolithic to Bronze Age	-	-	-	-	-	-	-	-	-	0.007	0.030	-

Table 7.36. (1/3) Results of the t-test statistical analyses of lower teeth biometrical data by main areas. Upper Palaeolithic to Middle Neolithic Island data corresponds to the site of Grotta dell'Uzzo, while the Eneolithic to Bronze Age data from that same area belongs to the site of Mursia. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results (p≤0.001).

Sample 1	Sample 2	LOWER dP4			LOWER M1			LOWER M2			LOWER M3		
		L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC
SOUTH													
Upper Palaeolithic & Mesolithic	Early Neolithic	-	-	-	-	0.019	0.078	-	-	-	-	-	-
Upper Palaeolithic & Mesolithic	Middle Neolithic	0.228	0.141	0.014	0.170	0.030	0.392	0.526	0.136	0.936	0.830	0.166	0.646
Upper Palaeolithic & Mesolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.352	0.773	-
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	0.000	0.000*	0.000*	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000
Early Neolithic	Middle Neolithic	-	-	-	-	0.190	0.279	-	-	-	-	-	-
Early Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	-	-	-
Early Neolithic	Eneolithic to Bronze Age	-	-	-	-	0.463	0.082	-	-	-	-	-	-
Middle Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.448	0.151	-
Middle Neolithic	Eneolithic to Bronze Age	0.713	0.313	0.495	0.000	0.000	0.000	0.000	0.003	0.000	0.038	0.139	0.000
Late Neolithic	Eneolithic to Bronze Age	-	-	-	-	-	-	-	-	-	0.007	0.030	-
ISLANDS													
Upper Palaeolithic & Mesolithic	Early Neolithic	-	-	-	0.087	0.750	0.593	0.002	0.051*	0.152	0.082	0.478	0.871
Upper Palaeolithic & Mesolithic	Middle Neolithic	-	-	-	-	0.592	0.855	-	-	-	-	-	-
Upper Palaeolithic & Mesolithic	Early to Middle Neolithic	-	-	-	0.915	0.254	0.988	0.042	0.306	0.422*	0.311	0.424	0.897
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	-	-	-	0.081	0.684*	0.298	-	-	-	-	-	-
Early Neolithic	Middle Neolithic	-	-	-	-	0.924	0.845*	-	-	-	-	-	-
Early Neolithic	Eneolithic to Bronze Age	-	-	-	0.345*	0.851	0.511	-	-	-	-	-	-
Middle Neolithic	Eneolithic to Bronze Age	-	-	-	-	0.888	0.555	-	-	-	-	-	-
Early to Middle Neolithic	Eneolithic to Bronze Age	-	-	-	0.414	0.901	0.442	-	-	-	-	-	-

Table 7.36. (2/3) Results of the t-test statistical analyses of lower teeth biometrical data by main areas. Upper Palaeolithic to Middle Neolithic Island data corresponds to the site of Grotta dell'Uzzo, while the Eneolithic to Bronze Age data from that same area belongs to the site of Mursia. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results ($p \leq 0.001$).

Sample 1	Sample 2	LOWER dP4			LOWER M1			LOWER M2			LOWER M3		
		L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC
NORTH & CENTRE	**SOUTH & ISLANDS**												
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	0.465	0.541	0.408	0.170	0.530	0.494*	0.113	0.778	0.887	0.548	0.828	0.549
Early Neolithic	Early Neolithic	-	-	-	0.729	0.056	0.056	0.157	0.025*	0.147	0.030	0.183	0.089
Middle Neolithic	Middle Neolithic	0.452	0.976	0.872	0.148	0.625*	0.235	0.377	0.207	0.794	0.173	0.021	0.346
Late Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	-	0.837	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.115	0.089	0.203	0.545	0.802	0.747	0.358	0.200	0.375	0.000*	0.985	0.253
NORTH & CENTRE	**SOUTH**												
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	0.465	0.541	0.408	0.579	0.878	0.513	0.466	0.121	0.257	0.618	0.117	0.009
Early Neolithic	Early Neolithic	-	-	-	-	0.183	0.239	-	-	-	-	-	-
Middle Neolithic	Middle Neolithic	0.452	0.976	0.872	0.081	0.973*	0.054*	0.377	0.207	0.794	0.255	0.050	0.640
Late Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	-	0.837	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.091	0.033	0.085	0.615	0.845	0.811	0.366	0.289	0.472	0.000*	0.985	0.253
NORTH & CENTRE	**ISLANDS**												
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	-	-	-	0.001	0.000	0.000	0.018	0.164	0.102	0.334	0.137	0.235
Early Neolithic	Early Neolithic	-	-	-	0.809	0.153	0.110	0.091	0.140	0.129	0.030	0.183	0.089
Middle Neolithic	Middle Neolithic	-	-	-	-	0.286	0.038*	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.918	0.385	0.288	0.477	0.753	0.648	-	-	-	-	-	-
SOUTH	**ISLANDS**												
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	-	-	-	0.000	0.000	0.000	0.019	0.000	0.000	0.892	0.000*	0.000
Early Neolithic	Early Neolithic	-	-	-	-	0.861*	0.645*	-	-	-	-	-	-
Middle Neolithic	Middle Neolithic	-	-	-	-	0.092	0.073	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.453	0.084	0.079	0.467	0.772	0.639	-	-	-	-	-	-

Table 7.36. (3/3) Results of the t-test statistical analyses of lower teeth biometrical data by main areas. Upper Palaeolithic to Middle Neolithic island data corresponds to the site of Grotta dell'Uzzo, while the Eneolithic to Bronze Age data from that same area belongs to the site of Mursia. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results ($p \leq 0.001$).

Sample 1	Sample 2	UPPER dP4			UPPER M1			UPPER M2			UPPER M3		
		L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC
NORTH & CENTRE													
Upper Palaeolithic & Mesolithic	Early Neolithic	0.261	0.018	0.004	0.645	0.846	0.350	0.844	0.705	0.447	0.015	0.273	0.105
Upper Palaeolithic & Mesolithic	Middle Neolithic	0.749	0.357*	0.018	0.484	0.613	0.379	0.566	0.158	0.110	0.009	0.005	0.004
Upper Palaeolithic & Mesolithic	Late Neolithic	0.263	0.527	0.717	0.026	0.001	0.021	-	-	-	-	-	-
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	0.929	0.938	0.674	0.043	0.000	0.004	0.000	0.002	0.006	0.402	0.001	0.055
Early Neolithic	Middle Neolithic	0.491	0.008	0.081	0.906	0.711	0.742	0.727	0.315	0.400	0.893	0.186	0.109
Early Neolithic	Late Neolithic	0.012	0.003	0.002	0.113	0.011	0.007	-	-	-	-	-	-
Early Neolithic	Eneolithic to Bronze Age	0.032*	0.001	0.002	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Middle Neolithic	Late Neolithic	0.155	0.010	0.012	0.030	0.004	0.002	-	-	-	-	-	-
Middle Neolithic	Eneolithic to Bronze Age	0.384	0.016*	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Late Neolithic	Eneolithic to Bronze Age	0.288	0.361	0.486	0.448	0.689	0.615	-	-	-	-	-	-
SOUTH & ISLANDS													
Upper Palaeolithic & Mesolithic	Early Neolithic	0.838	0.442	0.198	0.196	0.690	0.756	0.308	0.054	0.993	0.626	0.240	0.141
Upper Palaeolithic & Mesolithic	Middle Neolithic	-	-	-	-	-	-	0.394*	0.410*	0.060	0.498	0.003	0.568
Upper Palaeolithic & Mesolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.997	0.178	-
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	0.000	0.000	0.000	0.000*	0.000	0.000	0.000	0.000*	0.000	0.000	0.000	0.272
Early Neolithic	Middle Neolithic	-	-	-	-	-	-	0.196	0.375	0.479*	0.097	0.316	0.494
Early Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.673	0.930	-
Early Neolithic	Eneolithic to Bronze Age	0.029	0.022	0.040	0.039	0.004	0.020	0.001	0.149	0.003	0.117	0.009	0.051
Middle Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.537	0.237	-
Middle Neolithic	Eneolithic to Bronze Age	-	-	-	-	-	-	0.763*	0.783*	0.987	0.001	0.000	0.232
Late Neolithic	Eneolithic to Bronze Age	-	-	-	-	-	-	-	-	-	0.009	0.001	-

Table 7.37. (1/3) Results of the t-test statistical analyses of upper teeth biometrical data by main areas. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results (p≤0.001).

Sample 1	Sample 2	UPPER dP4			UPPER M1			UPPER M2			UPPER M3		
		L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC
SOUTH													
Upper Palaeolithic & Mesolithic	Early Neolithic	0.838	0.442	0.198	0.196	0.690	0.756	0.308	0.054	0.993	0.626	0.240	0.141
Upper Palaeolithic & Mesolithic	Middle Neolithic	-	-	-	-	-	-	0.394*	0.410*	0.060	0.498	0.003	0.568
Upper Palaeolithic & Mesolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.997	0.178	-
Upper Palaeolithic & Mesolithic	Eneolithic to Bronze Age	0.000	0.000	0.000	0.000*	0.000	0.000	0.000	0.000*	0.000	0.000	0.000	0.412
Early Neolithic	Middle Neolithic	-	-	-	-	-	-	0.196	0.375	0.479*	0.097	0.316	0.494
Early Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.673	0.930	-
Early Neolithic	Eneolithic to Bronze Age	0.044	0.051	0.083	0.047	0.005	0.023	0.001	0.104	0.002	0.165	0.011	0.073
Middle Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	0.537	0.237	-
Middle Neolithic	Eneolithic to Bronze Age	-	-	-	-	-	-	0.764*	0.820	0.887	0.002	0.000	0.305
Late Neolithic	Eneolithic to Bronze Age	-	-	-	-	-	-	-	-	-	0.018	0.001	-
NORTH & CENTRE	**SOUTH & ISLANDS**												
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	0.110	0.011	0.001	0.985	0.942	0.766	0.566	0.484	0.414	0.249	0.753	0.435
Early Neolithic	Early Neolithic	0.642	0.395	0.226	0.888	0.886	0.749	0.643	0.290	0.847	0.178	0.917	0.789
Middle Neolithic	Middle Neolithic	-	-	-	-	-	-	0.005	0.004	0.049	0.271	0.912	0.082
Late Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.005	0.023	0.026	0.230	0.831	0.449	0.105	0.916	0.450	0.106	0.831	0.830
NORTH & CENTRE	**SOUTH**												
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	0.110	0.011	0.001	0.985	0.942	0.766	0.566	0.484	0.414	0.249	0.753	0.435
Early Neolithic	Early Neolithic	0.642	0.395	0.226	0.888	0.886	0.749	0.643	0.290	0.847	0.178	0.917	0.789
Middle Neolithic	Middle Neolithic	-	-	-	-	-	-	0.005	0.004	0.049	0.271	0.912	0.082
Late Neolithic	Late Neolithic	-	-	-	-	-	-	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.013	0.118	0.112	0.245	0.732	0.414	0.128	0.535	0.839	0.390	0.975	0.632

Table 7.37. (2/3) Results of the t-test statistical analyses of upper teeth biometrical data by main areas. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results (p≤0.001).

Sample 1	Sample 2	UPPER dP4			UPPER M1			UPPER M2			UPPER M3		
		L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC
NORTH & CENTRE	**ISLANDS**												
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	-	-	-	-	-	-	-	-	-	-	-	-
Early Neolithic	Early Neolithic	-	-	-	-	-	-	-	-	-	-	-	-
Middle Neolithic	Middle Neolithic	-	-	-	-	-	-	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.121	0.000*	0.025	0.693	0.674	0.983	0.524	0.086	0.046	0.254	0.591	0.515
SOUTH	**ISLANDS**												
Upper Palaeolithic & Mesolithic	Upper Palaeolithic & Mesolithic	-	-	-	-	-	-	-	-	-	-	-	-
Early Neolithic	Early Neolithic	-	-	-	-	-	-	-	-	-	-	-	-
Middle Neolithic	Middle Neolithic	-	-	-	-	-	-	-	-	-	-	-	-
Eneolithic to Bronze Age	Eneolithic to Bronze Age	0.712	0.015*	0.122	0.907	0.533	0.708	0.956	0.040	0.022	0.221	0.599	0.387

Table 7.37. (2/3) Results of the t-test statistical analyses of upper teeth biometrical data by main areas. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results ($p \leq 0.001$).

	Sample 1	Sample 2	ASTRAGALUS		CALCANEUS		HUMERUS		TIBIA	
			GLl	GLm	GL	GD	BT	HTC	Bd	Dd
ARENE CANDIDE	Early Neolithic	Middle Neolithic	0.063	0.043	-	-	0.444	0.912	0.029	0.019
	Early Neolithic	Late Neolithic	0.055	0.548*	-	-	-	-	0.023	0.013
	Early Neolithic	Eneolithic to Bronze Age	0.001	0.002	-	-	0.202	0.225	0.122*	0.084
	Middle Neolithic	Late Neolithic	0.154	0.723*	0.906*	0.602	-	-	0.205	0.134
	Middle Neolithic	Eneolithic to Bronze Age	0.011	0.019	0.612*	0.301	0.000*	0.067	0.941*	0.860
	Late Neolithic	Eneolithic to Bronze Age	0.988	0.812	0.814	0.835	-	-	0.448	0.370

Sample 1	Sample 2	LOWER dP4			LOWER M1			LOWER M2			LOWER M3		
		L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC
Early Neolithic	Middle Neolithic	0.113	0.158	0.216	0.009	0.071*	0.005	0.244	0.895	0.900	-	-	-
Early Neolithic	Late Neolithic	0.006	0.086	0.058	-	-	-	0.784*	0.818	0.846	-	-	-
Early Neolithic	Eneolithic to Bronze Age	0.018	0.038	0.023	0.203	0.057	0.007	0.506*	0.712*	0.448	-	-	-
Middle Neolithic	Late Neolithic	0.099	0.369	0.155	-	-	-	0.466	0.792	0.738	-	-	-
Middle Neolithic	Eneolithic to Bronze Age	0.254	0.415	0.153	0.704	0.338	0.079	0.809	0.242	0.136	0.021	0.016	0.218
Late Neolithic	Eneolithic to Bronze Age	0.364	0.585	0.507	-	-	-	0.251	0.416	0.436	-	-	-

Sample 1	Sample 2	UPPER dP4			UPPER M1			UPPER M2			UPPER M3		
		L	WA	WP	L	WA	WP	L	WA	WP	L	WA	WC
Early Neolithic	Middle Neolithic	0.783	0.156	0.146	0.925	0.726	0.921	0.841	0.889	0.851	0.072	0.655	0.807
Early Neolithic	Late Neolithic	0.060	0.015	0.003	0.224	0.052	0.054	-	-	-	-	-	-
Early Neolithic	Eneolithic to Bronze Age	0.347	0.495	0.002	0.841	0.245	0.388	0.044	0.439	0.523	0.110	0.053	0.035
Middle Neolithic	Late Neolithic	0.173	0.006	0.004	0.004	0.001	0.000	-	-	-	-	-	-
Middle Neolithic	Eneolithic to Bronze Age	0.639	0.811	0.020	0.587	0.075	0.079	0.124*	0.113	0.173	0.036	0.000*	0.096
Late Neolithic	Eneolithic to Bronze Age	0.230	0.095	0.188	0.060	0.162	0.165	-	-	-	-	-	-

Table 7.38. Results of the t-test statistical analyses of the biometrical data of the site of Arene Candide. Results marked * signify equal variances not assumed, otherwise all other results are with equal variances assumed. Highlighted results indicate statistically significant results ($p \leq 0.05$).

Before proceeding with the detailed discussion of the results of the biometrical analyses, it is worth commenting on the results of the coefficient of variation (V), determined for each set of measurements taken on the pig bone assemblages (Tables 7.9 to 7.34). This index, calculated in samples bigger than 5 specimens, offers an indication as to the diversity of the sample and is expected to be greater when more than one population is represented (Payne and Bull, 1988; Rowley-Conwy et al., 2012). As an example, the data from Late Neolithic Durrington Walls (UK) has a V of 6.0 for the astragalus (Albarella and Payne, 2005), similarly to the modern wild boar data from Kızılcahamam (Turkey), which has a V of 5.7 for the same element (Payne and Bull, 1988). These values may therefore be consistent with the presence of a single population, whereas higher values may alert us to the possibility that two or more populations are involved, such as in the case of Chalcolithic Zambujal (Portugal) with a V of 8.2 (Albarella et al., 2005; Rowley-Conwy et al., 2012). However, care is needed in the interpretations as "V is not the perfect statistic: in small samples it may be unduly influenced by individual outliers, and it is not clear how large it must be before we can conclude that two populations must be present" (Rowley-Conwy et al., 2012: 16). Regardless of these limitations, the coefficient of variation is still a useful tool when construed with care, especially when sample sizes are small. To minimize the influence of sex and ageing factors on the coefficient of variation, the following discussion will be focused on the astragalus, tibia, humerus, and molar teeth's widths (except third molar posterior width), which should be less impacted by these aspects.

The coefficients of variation of the Italian pig postcranial bone data (Tables 7.9-7.10) from the Upper Palaeolithic and Mesolithic samples exhibit the following ranges: 3.5-5.9 for the astragalus, 4.4-7.2 for the humerus, and 3.8-12.6 for the tibia. In most cases, values lower than 7 are probably reflecting the presence of one wild boar population, although large values (11.4 and 12.6) can be seen for the tibia measurements from Upper Palaeolithic Grotta della Madonna. Regarding this latter observation, the mean for those measurements is, however, similar to that of the other sites, which combined with their high standard deviation would appear to suggest that this assemblage includes the presence of some larger and smaller animals (see also Figure 7.12). Regardless of these observations, one must not forget that the sample size for this site and element discussed is not very large (N=8), meaning that a few outliers could be having an enlarged impact in the coefficient of variation results.

The coefficient of variation from the Early Neolithic postcranial samples from the sites of Arene Candide and La Marmotta (Tables 7.11-7.12) range from 7.1 to 8.6 (astragalus), 7.3 to 11.7 (humerus), and 8 to 10.7 (tibia), indicating on average larger values than during the previous periods. This could be indicating a larger variability in the pig populations during this period. The Middle Neolithic postcranial V values from Arene Candide and Rivoli (Table 7.11) are consistent with the values for the previous period, with only slightly larger values in the case of the tibia for Arene Candide and astragalus and tibia for Rivoli. A couple of coefficients of variation are also available for Early to early Middle Neolithic Grotta dell'Uzzo (6.3 for astragalus GLl and 7 for tibia Dd; Table 7.14), not evidencing much change from the previous periods of occupation. The Late Neolithic data is very scant, with only the astragalus of Cornuda showing a V of 6 (Table 7.11).

The coefficients of variation of the Eneolithic to Late Bronze Age postcranial pig data (Tables 7.15-7.17) fall within the ranges of 4.8 to 12.7 (astragalus), 4.7 to 15 (humerus), and 4.9 to 19.1 (tibia). The variability in the V values for these periods is bigger than before and reflect greater inter-site variability. The larger V values correspond to the Eneolithic site of Conelle, which shows a clear bimodality in the postcranial data (see Chapters 7.3.a and 7.3.b). During these periods, it is quite likely that the larger V values could be reflecting the presence of two distinct populations in the assemblages, one wild and one domestic.

For the tooth data, the Upper Palaeolithic and Mesolithic molar teeth widths samples' coefficients of variation from Central and Southern sites (Tables 7.18-7.22) exhibit a range of 2.8 to 8.4 (lower teeth) and 2.2 to 9.9 (upper teeth), with larger values, on average, for the third molar. The overall smaller values registered likely reflect the natural conservativeness of teeth, which are less affected by environmental factors. The larger values observed for Grotta della Madonna's Upper Palaeolithic tibia's V are not reflected here. There is no indication that these numbers reflect anything other than the natural variability in wild boar populations.

Regarding the same values for Neolithic period (Tables 7.23-7.28), the Early Neolithic of Arene Candide, Portonovo, and La Marmotta range from 2.6 to 12.4 (lower teeth) and 2.2 to 8.1, with the higher numbers corresponding to the first site. The Middle Neolithic coefficient of variations from Rivoli, Molino Casarotto, Arene Candide, and Masseria Candelaro show slightly larger values, 4.3 to 9.8 (lower teeth) and 4.1 to 10.7 (upper teeth), with the second site falling in the higher range. Grotta dell'Uzzo's Early to early Middle Neolithic lower teeth coefficient of variations fall within the range of 2.3 to 7.3. All in all, the molar widths V values for all these sites fall within the range observed for the Upper Palaeolithic and Mesolithic. The tooth width evidence thus does not seem to suggest a higher pig population variability during the Early and Middle Neolithic than before, although in some cases they are slightly larger. The Late Neolithic data is once more very scarce, with only two V values available (6.3 and 5.5) for a lower deciduous fourth premolar from Arene Candide.

Lastly, the molar teeth widths' coefficients of variation for the Eneolithic to Late Bronze Age assemblages (Tables 7.29-7.34) range from 1.9 to 13.4 (lower teeth) and 2.5 to 13.3 (upper teeth). Overall, and unlike for the postcranial V values, these periods do not seem to evidence a much greater variability than before, once again likely reflecting the natural conservativeness of teeth to change.

7.3.a. Scatterplots

The scatterplots for the postcranial measurements of the North and Centre, and South and Island sites are plotted in Figures 7.22 to 7.27. The values for distal tibia Bd and Dd indicate no substantial size difference for the North and Central sites between the Upper Palaeolithic and Mesolithic and the Early and Middle Neolithic pigs, although the latter period does include a few slightly smaller specimens (Figure 7.22). 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. It is, however, only during the 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 while the smaller ones to domestic pig. This latter group overlaps the range of the smaller specimens from earlier periods, but also includes much smaller cases not observed previously. The data from the Southern sites (Figure 7.23) appears to follow the same pattern, though the sample for the Early Neolithic is small, and the Middle and Late Neolithic are not represented at all. The data from the Eneolithic onwards indicates clear separation of the two forms, with a predominance of domestic pigs and a few large wild boar outliers. The difference between these latter periods and the data available from previous times is statistically significant (Table 7.35).

Regarding the values of astragalus GLl and GLm, no considerable change in size can be seen between Upper Palaeolithic/Mesolithic and Early to Middle Neolithic pigs from the

Northern and Central sites (Figure 7.24), much like in the case of the distal tibia, although in latter periods a greater spread can be seen in the scatterplots (the sample size for the Upper Palaeolithic and Mesolithic is quite small though). The Southern data (Figure 7.25) regrettably lacks any Early Neolithic samples, and therefore it can solely be observed that the Middle Neolithic specimens seem only slightly smaller than the Upper Palaeolithic/Mesolithic ones. Regarding the periods from Late Neolithic onwards in all areas, the presence of two populations can once again be observed, with the occurrence of smaller animals than in previous times. The difference between the Upper Palaeolithic and Middle Neolithic, and the later periods is statistically significant in the Southern data (Table 7.35).

The humerus HTC and BT data for the Early and Middle Neolithic falls once again within the range of the Upper Palaeolithic and Mesolithic data in all areas (Figures 7.26 and 7.27), even though the Early Neolithic available values – and Middle Neolithic ones for the Southern sites –are limited. The few data available for the Early Neolithic of the Southern sites (Figure 7.27) indicates the presence of some smaller specimens than the previous periods, but this could be due to the small sample size and it is not statistically significant (Table 7.35). Additionally, the Grotta dell'Uzzo's humerus measurements are smaller than the continental ones, although this pattern is not visible in the case of the tibia. During the later prehistoric periods, a tendency towards smaller animals is again observable in all areas, although the larger outliers observed in the Northern and Central data for distal tibia and astragalus are, in this case, not so evident. In some cases, the difference between the later prehistoric periods and the earlier ones is statistically significant (Table 7.35).

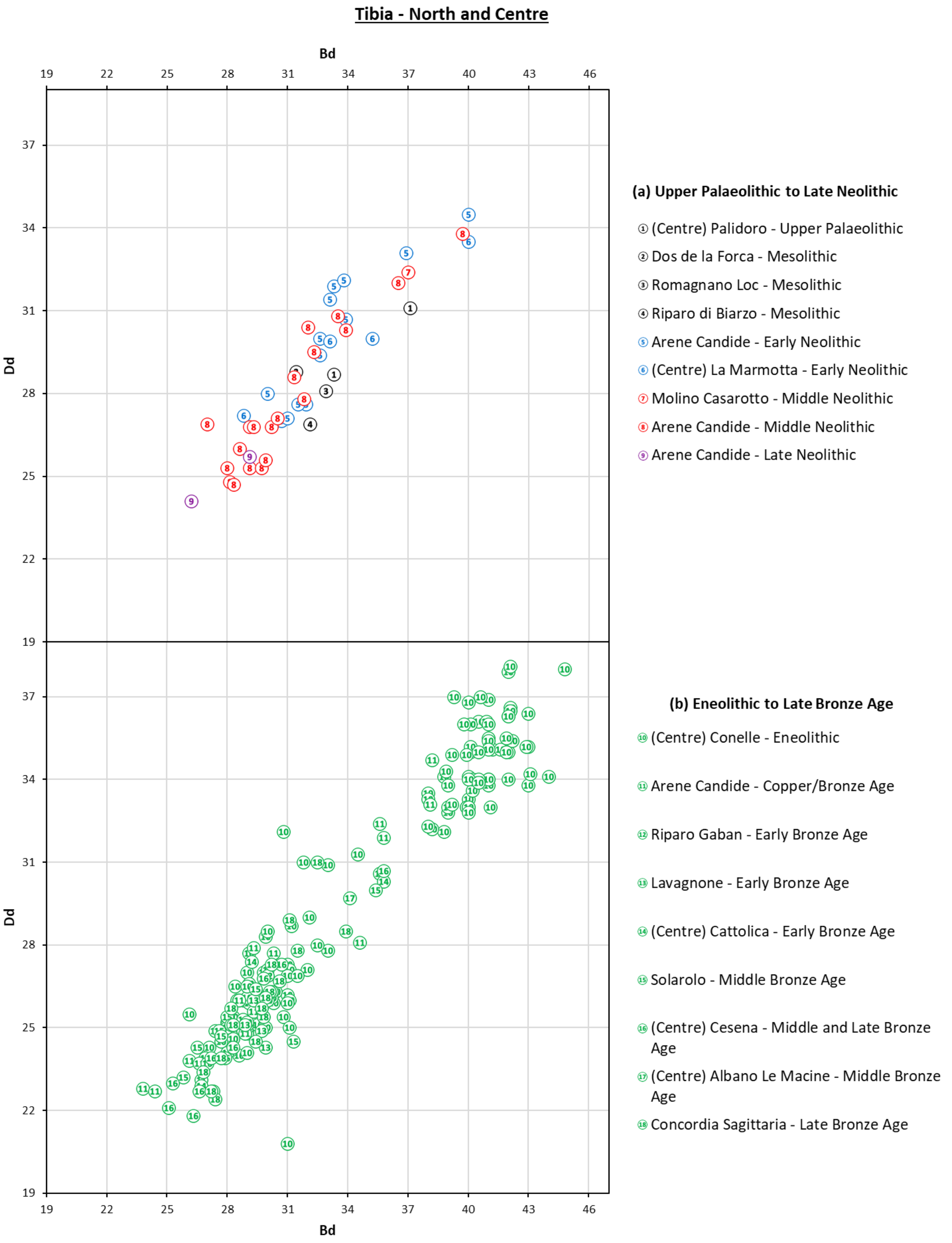


Figure 7.22. Tibia Bd and Dd scatterplots, for North and Central sites: (a) Upper Palaeolithic to Late Neolithic; (b) Eneolithic to Late Bronze Age.

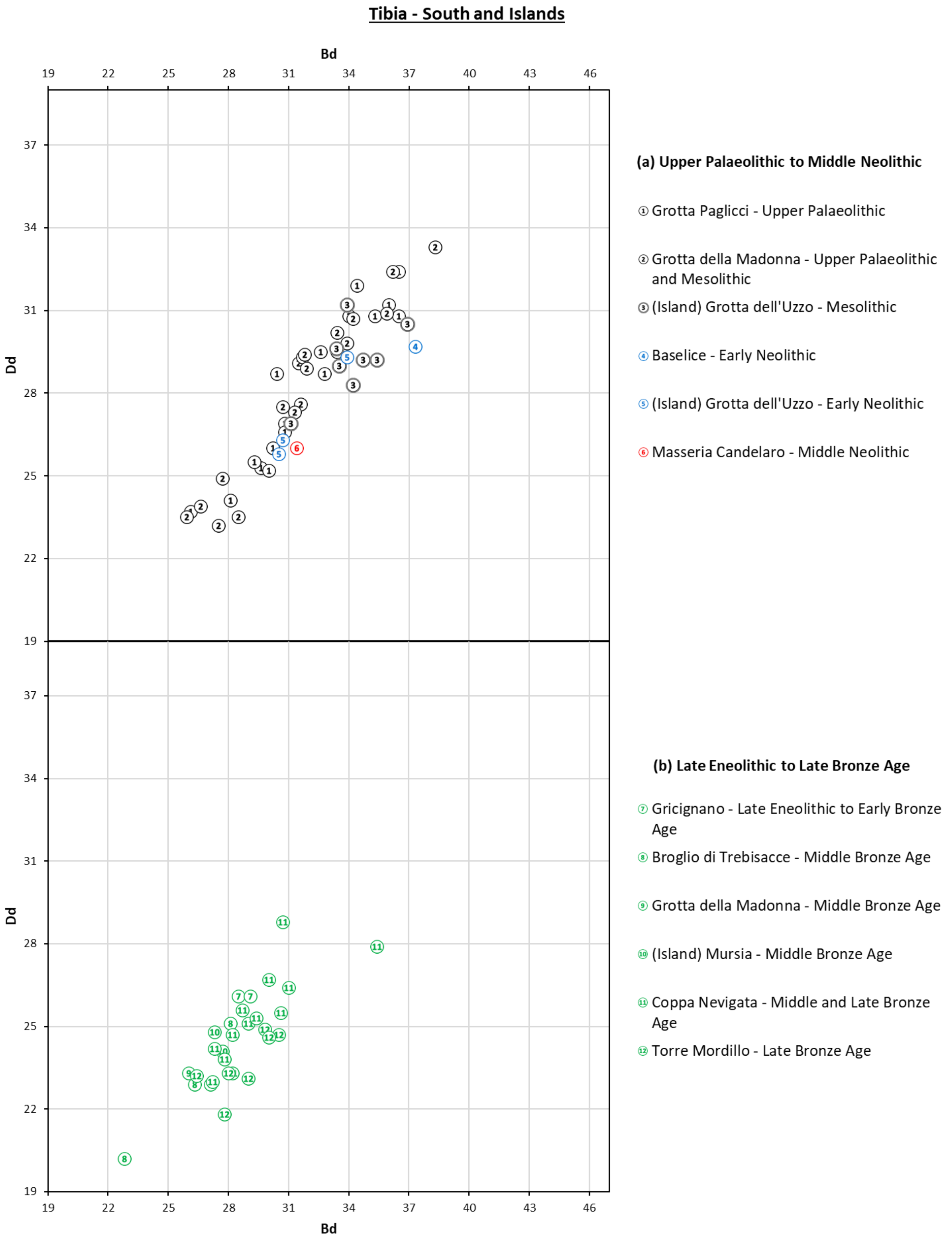


Figure 7.23. Tibia Bd and Dd scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

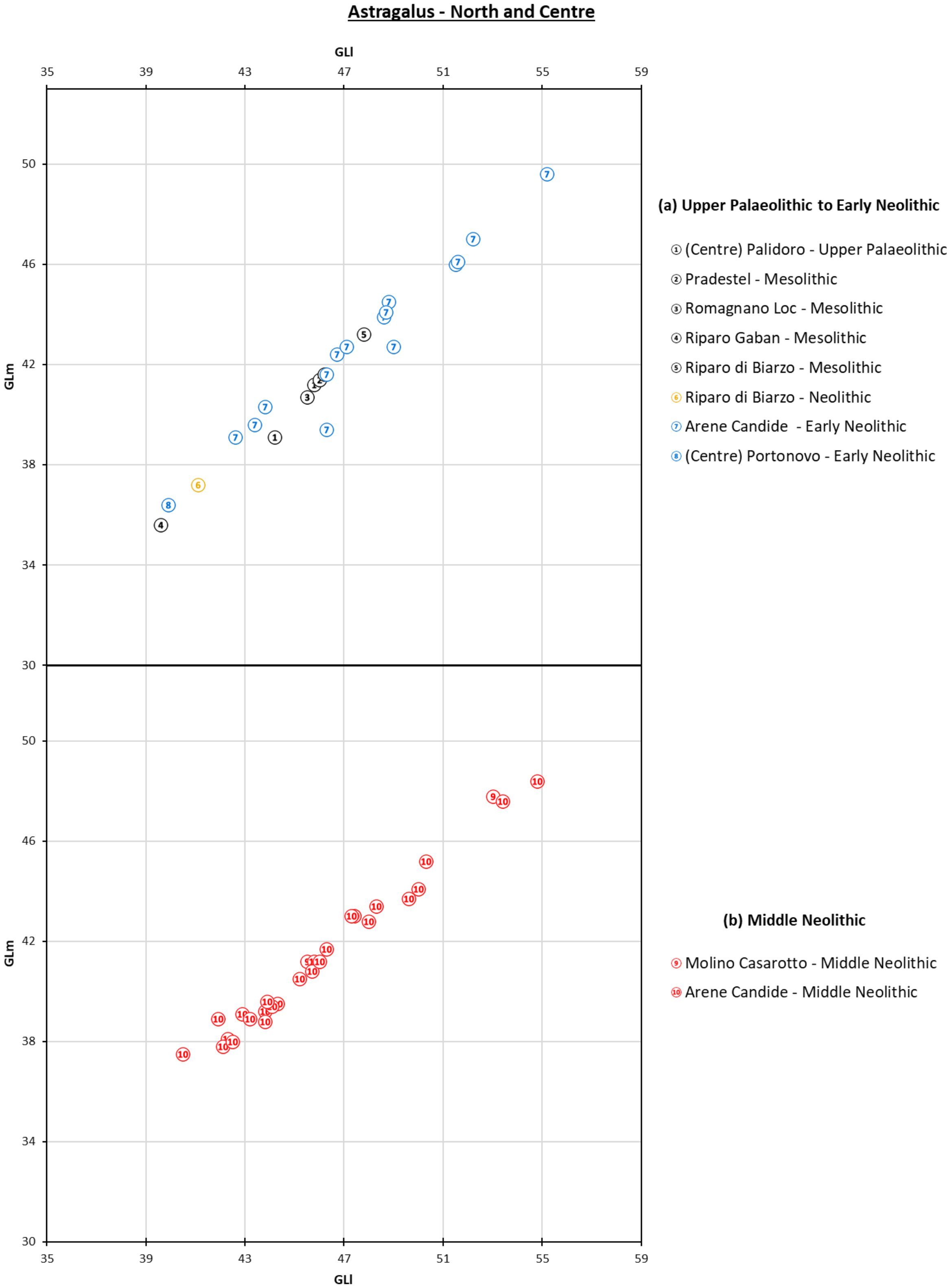


Figure 7.24. (1/2) Astragalus GLl and GLm scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

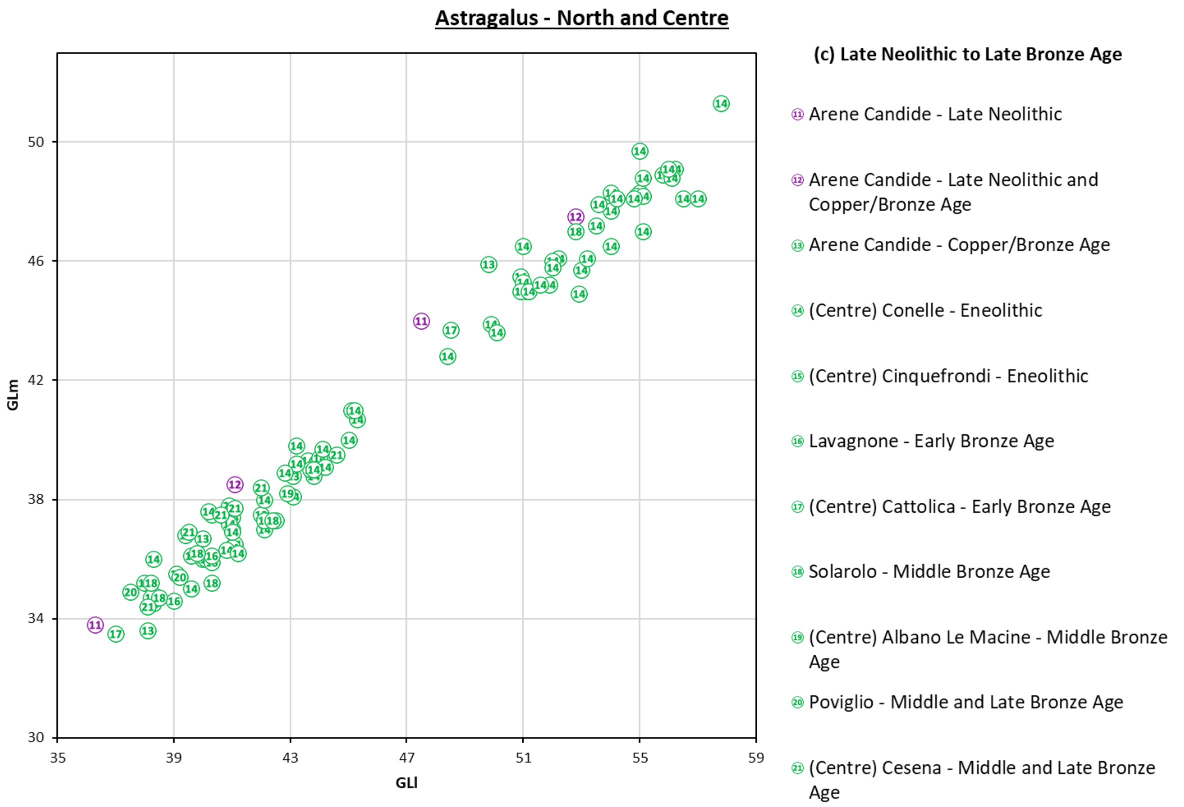


Figure 7.24. (2/2) Astragalus GLl and GLm scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

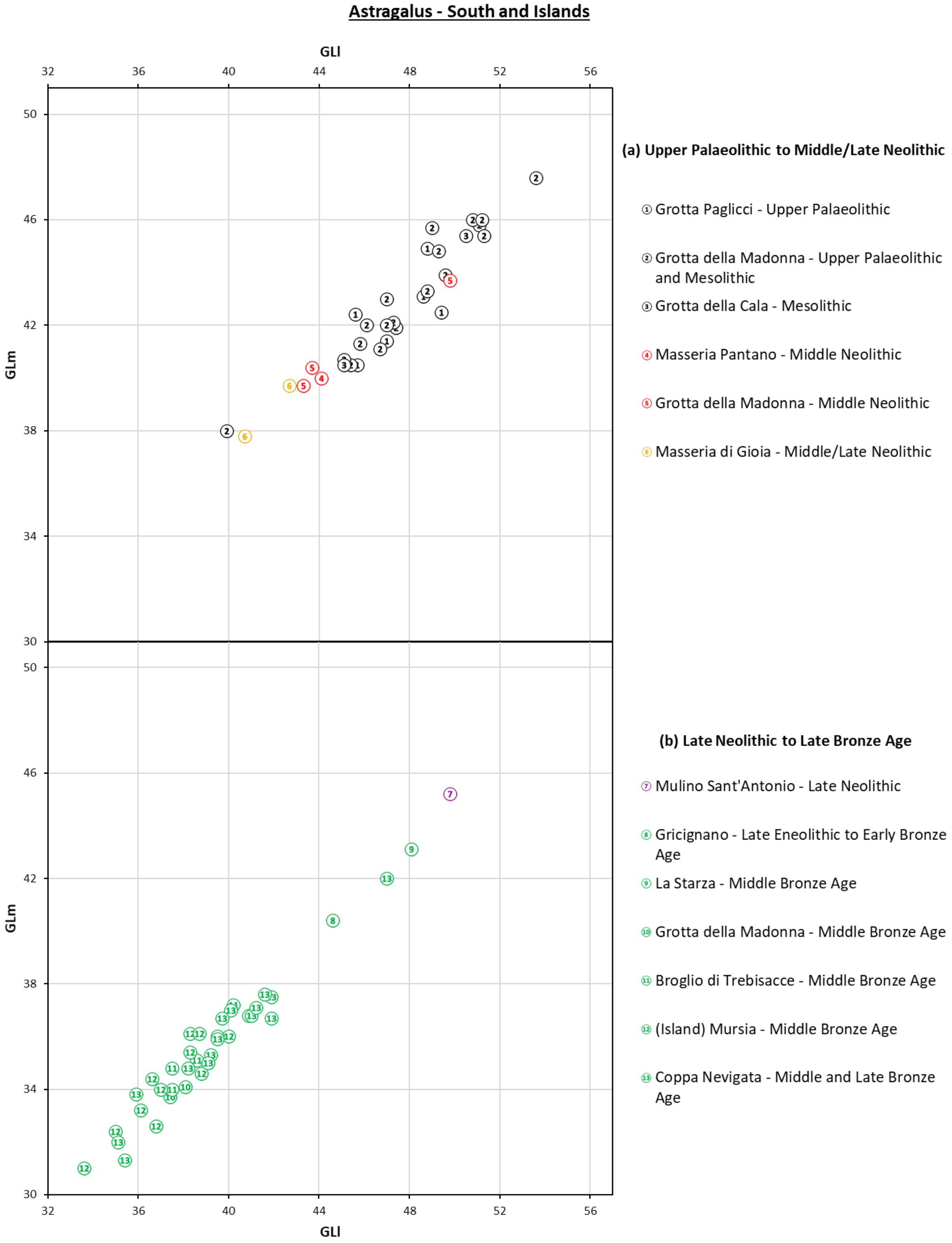


Figure 7.25. Astragalus GLl and GLm scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle/Late Neolithic; (b) Late Neolithic to Late Bronze Age.

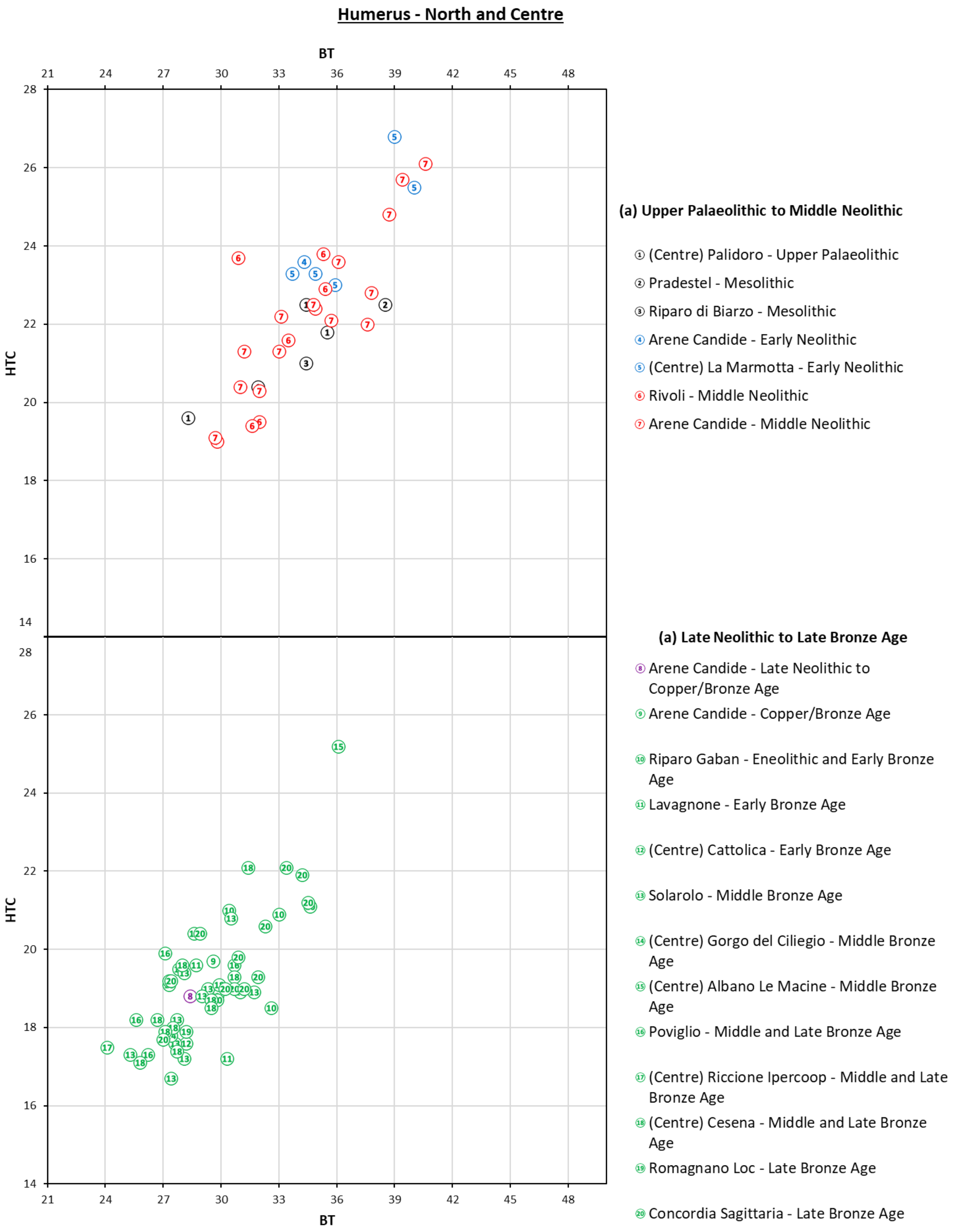


Figure 7.26. Humerus BT and HTC scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

Figure 7.27. Humerus BT and HTC scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

Regarding the teeth, the length and width measurements for lower and upper deciduous fourth premolar (dP4), first molar (M1), second molar (M2), and third molar (M3) through time for the Italian sites are plotted in Figures 7.28 to 7.59. The Upper Palaeolithic and Mesolithic wild boar teeth are mostly consistent in size all over the Italian peninsula, although the data available from the northern and central sites is limited. The Sicilian Upper Palaeolithic and Mesolithic wild boar teeth from Grotta dell'Uzzo are smaller than their continental counterparts, as was also seen in the case of the humerus, and this difference is statistically significant in most cases (Table 7.36).

Overall, in all teeth, the size from Upper Palaeolithic to Middle Neolithic is fairly consistent throughout the peninsula, although the Middle Neolithic for the northern and central sites exhibits a more pronounced spread towards the smaller end of the spectrum for the first and second molars (Figures 7.36 to 7.51). Slightly larger teeth can also be seen in these Middle Neolithic samples, suggesting once again the presence of a larger wild boar than in previous periods. The Middle Neolithic samples from the southern end of the Italian peninsula is too small to be able to observe whether this pattern is echoed in this area or not. It is only from the Late Neolithic period onwards that clear changes in size can be observed in all areas, the teeth becoming smaller, with the addition of a few larger outliers (probably wild boar). In some cases, these differences are statistically significant (Table 7.36). This pattern, however, is less marked than in the postcranial bones, and no clear-cut bimodality can be seen in the samples.

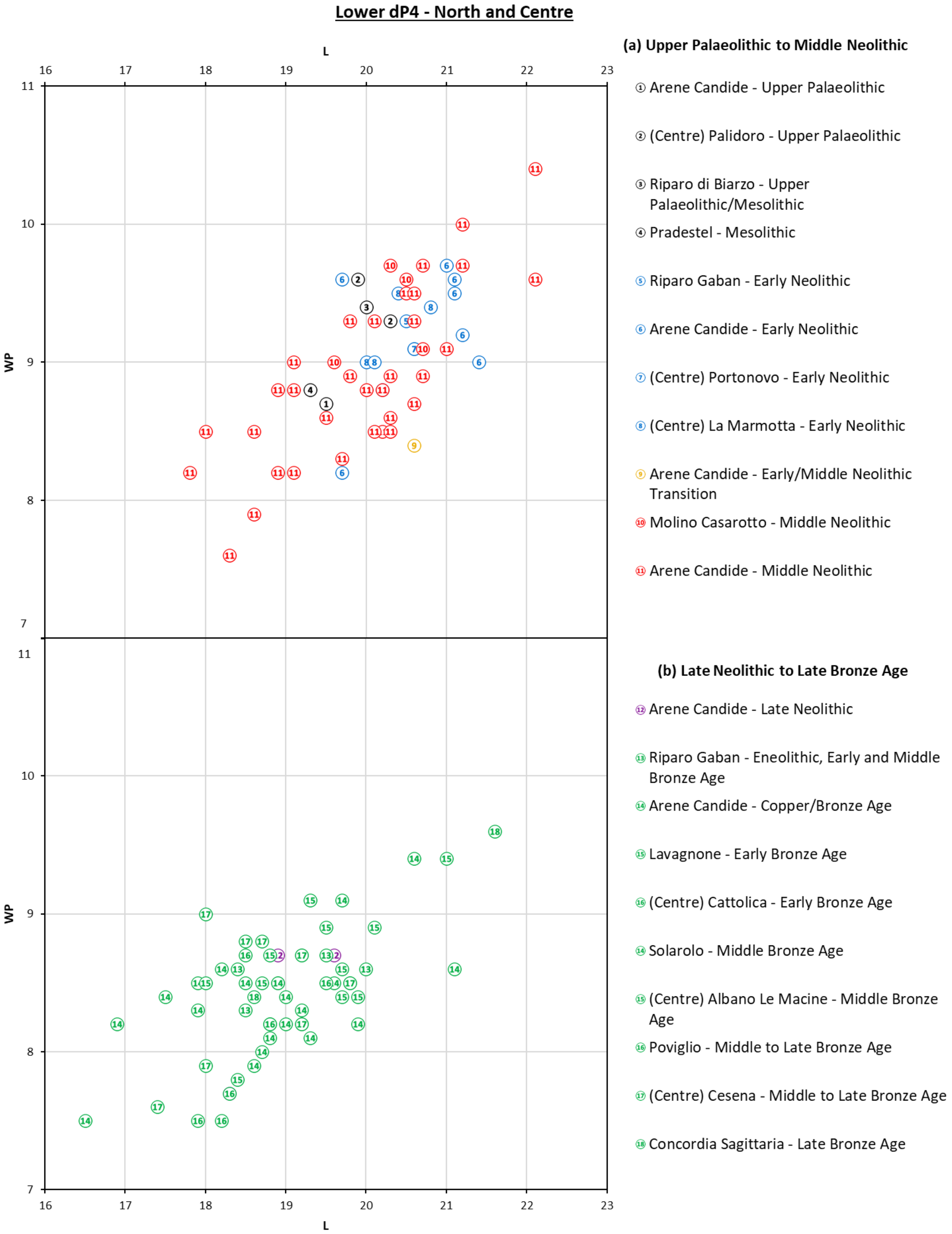


Figure 7.28. Lower dP4 length and posterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

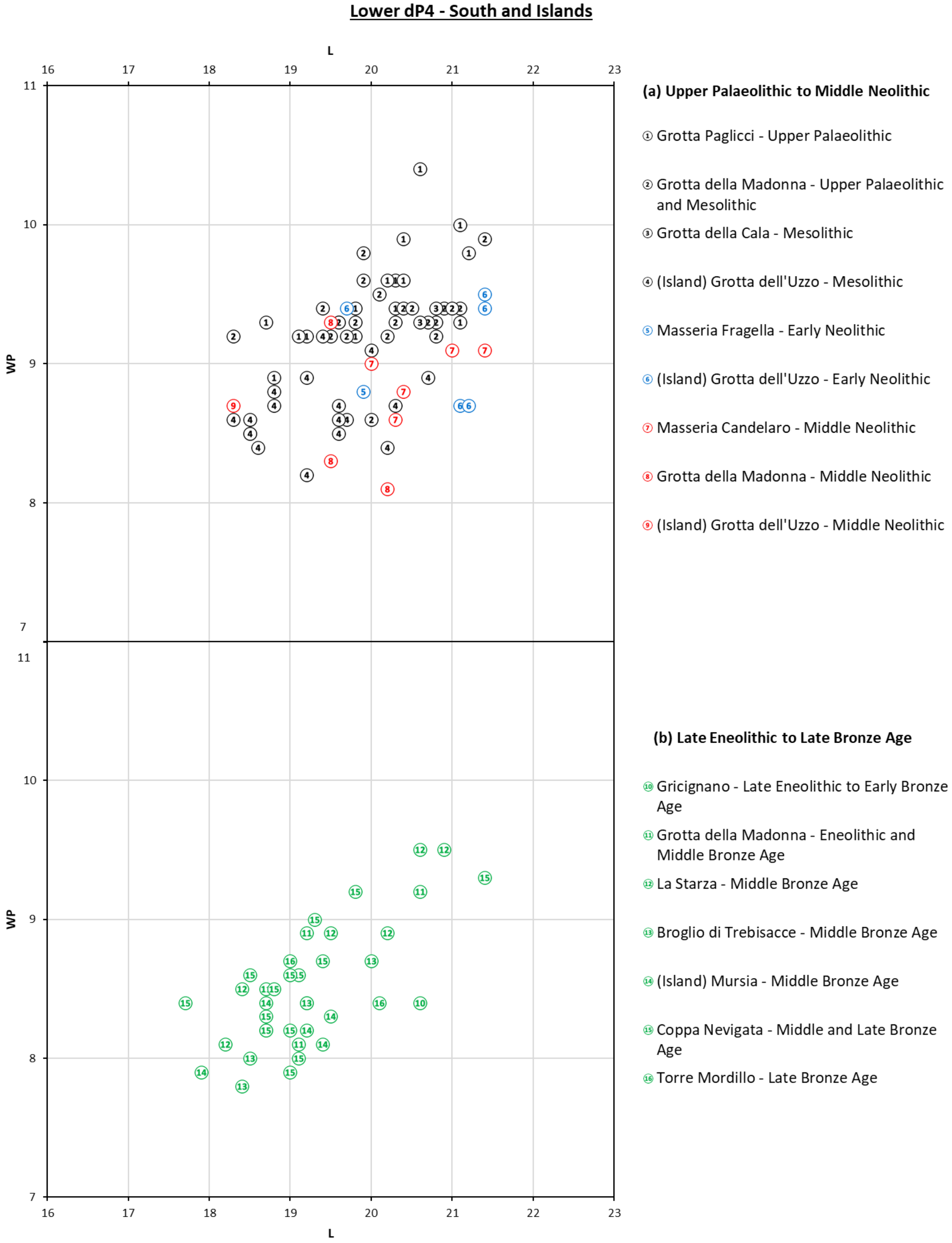


Figure 7.29. Lower dP4 length and posterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

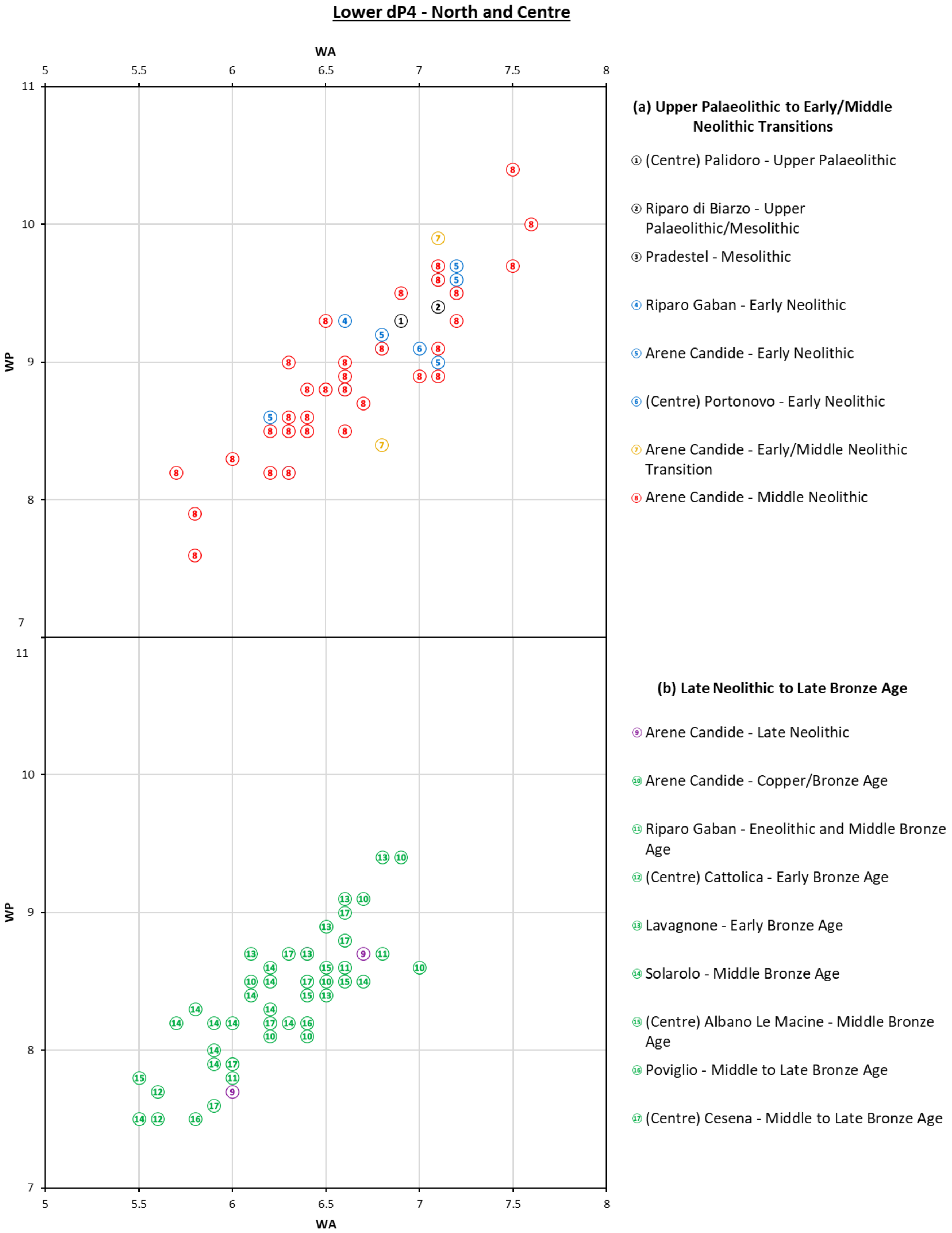


Figure 7.30. Lower dP4 anterior and posterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Late Neolithic to Late Bronze Age.

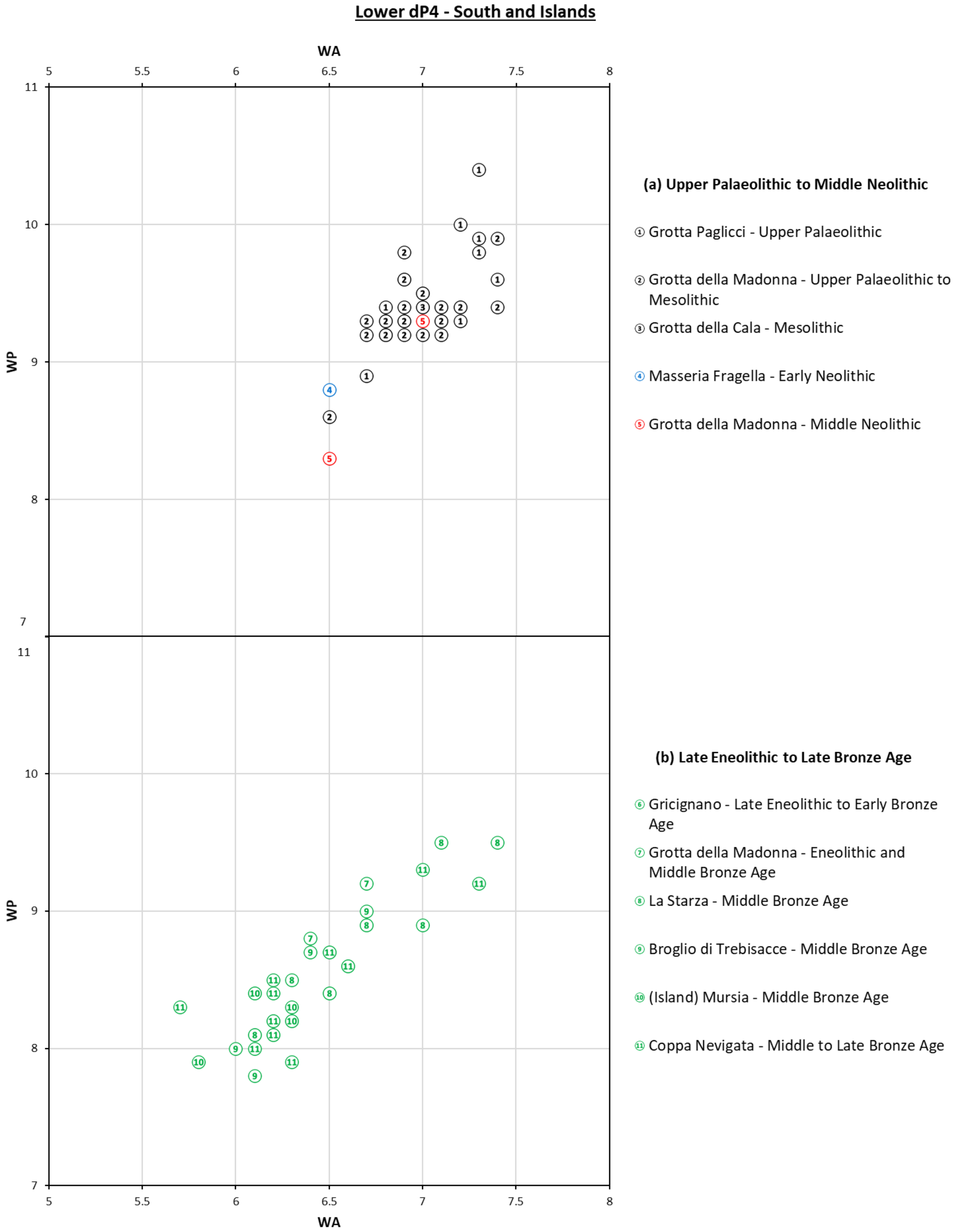


Figure 7.31. Lower dP4 anterior and posterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

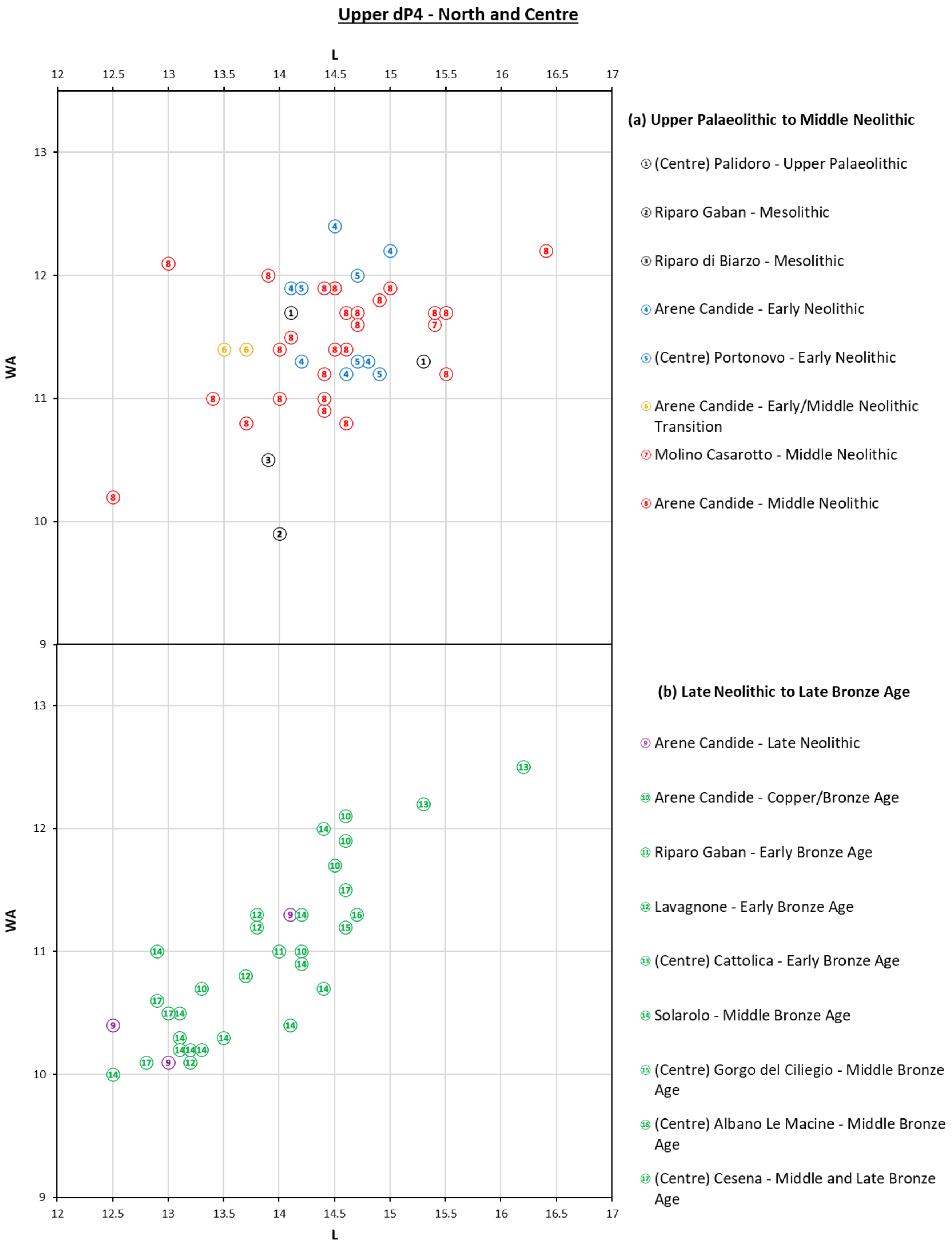


Figure 7.32. Upper dP4 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

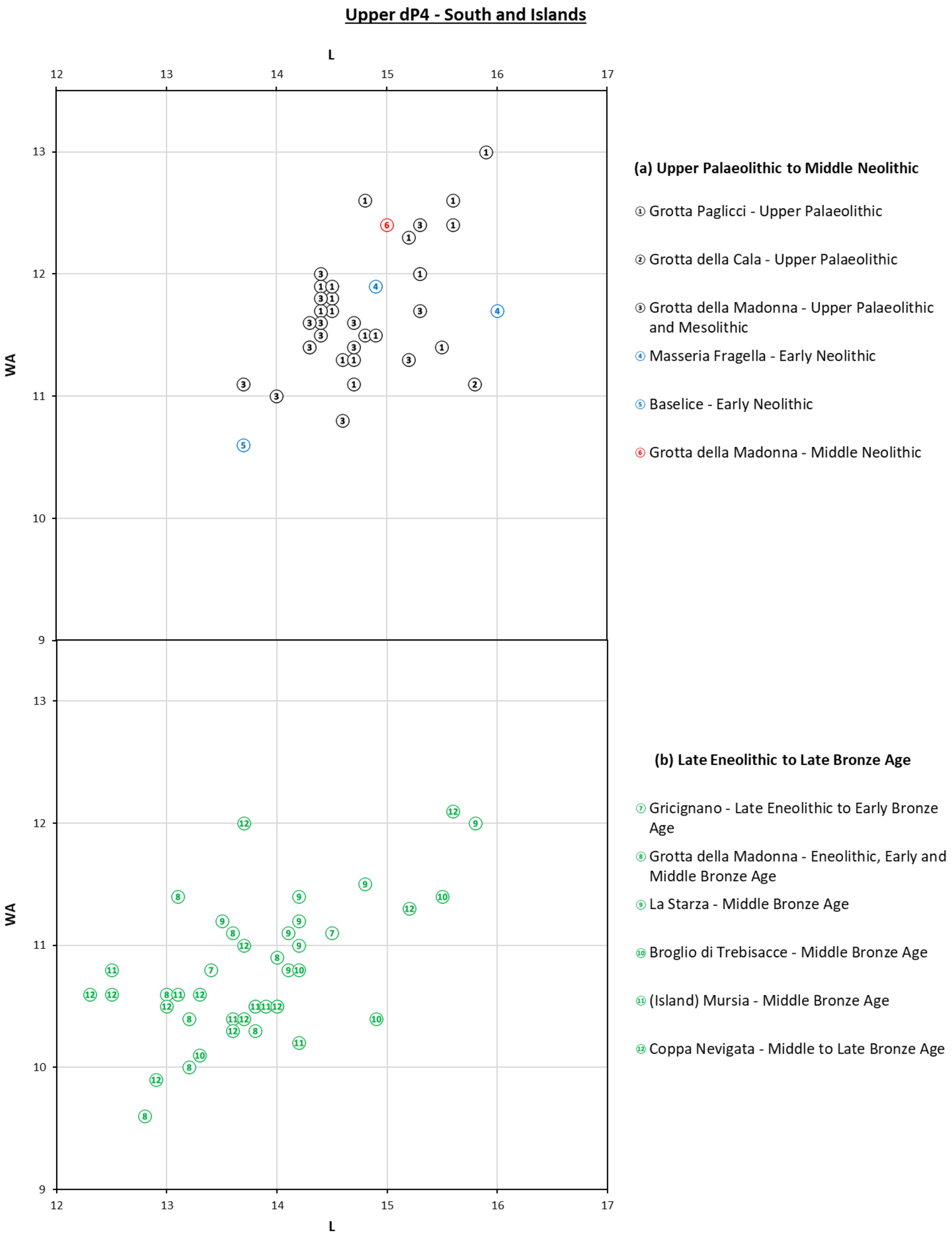


Figure 7.33. Upper dP4 length and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

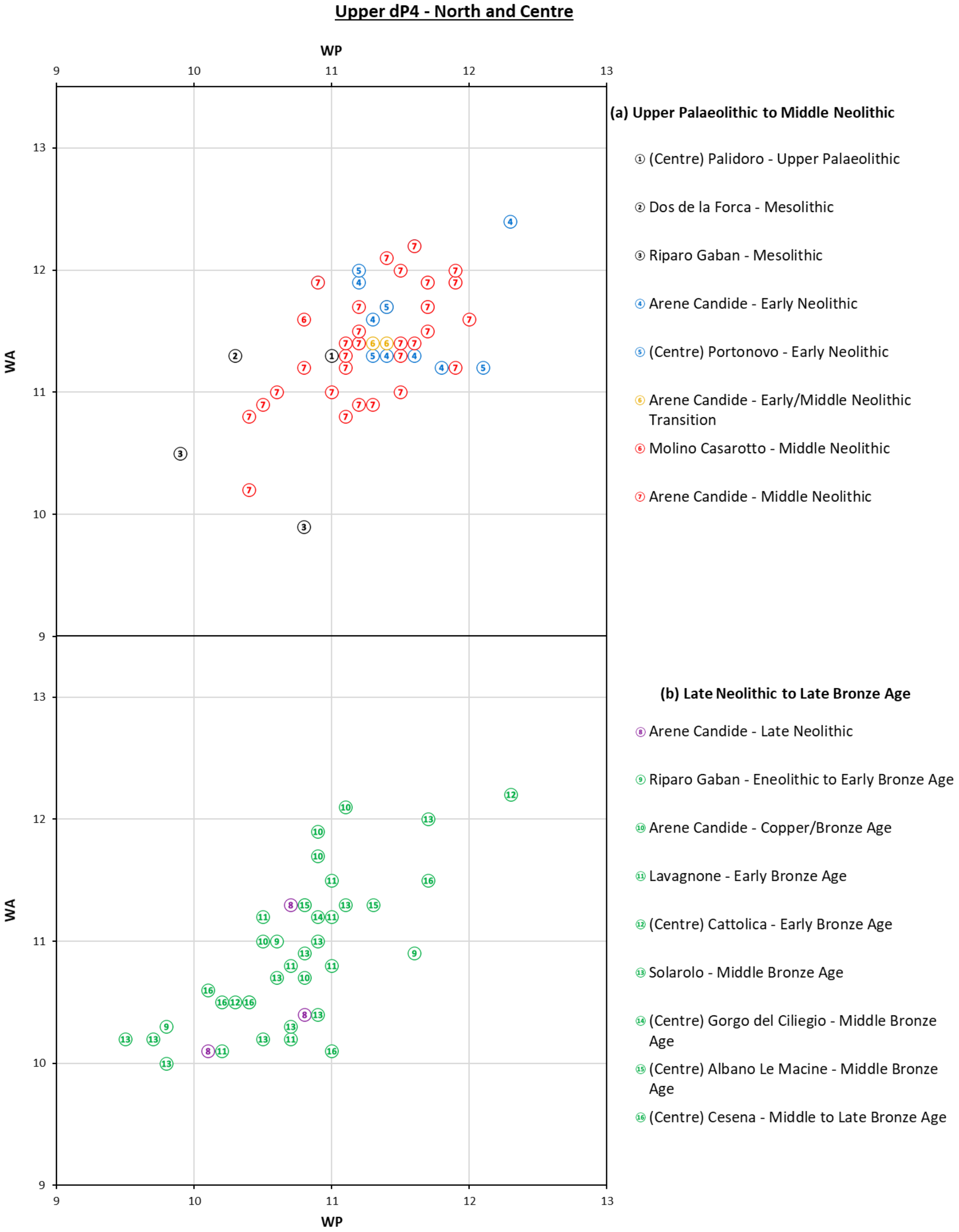


Figure 7.34. Upper dP4 posterior and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

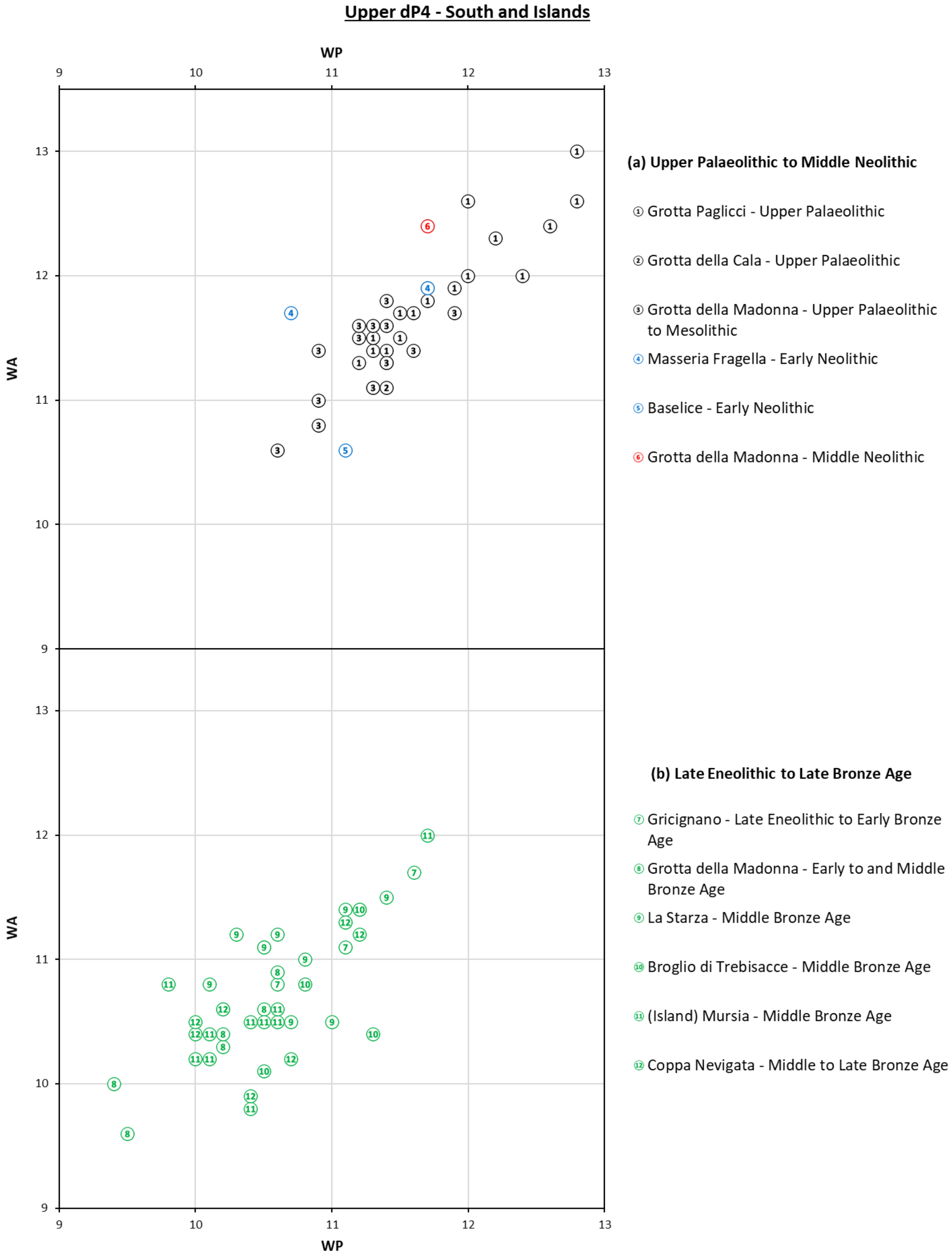


Figure 7.35. Upper dP4 posterior and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

Figure 7.36. (1/2) Lower M1 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

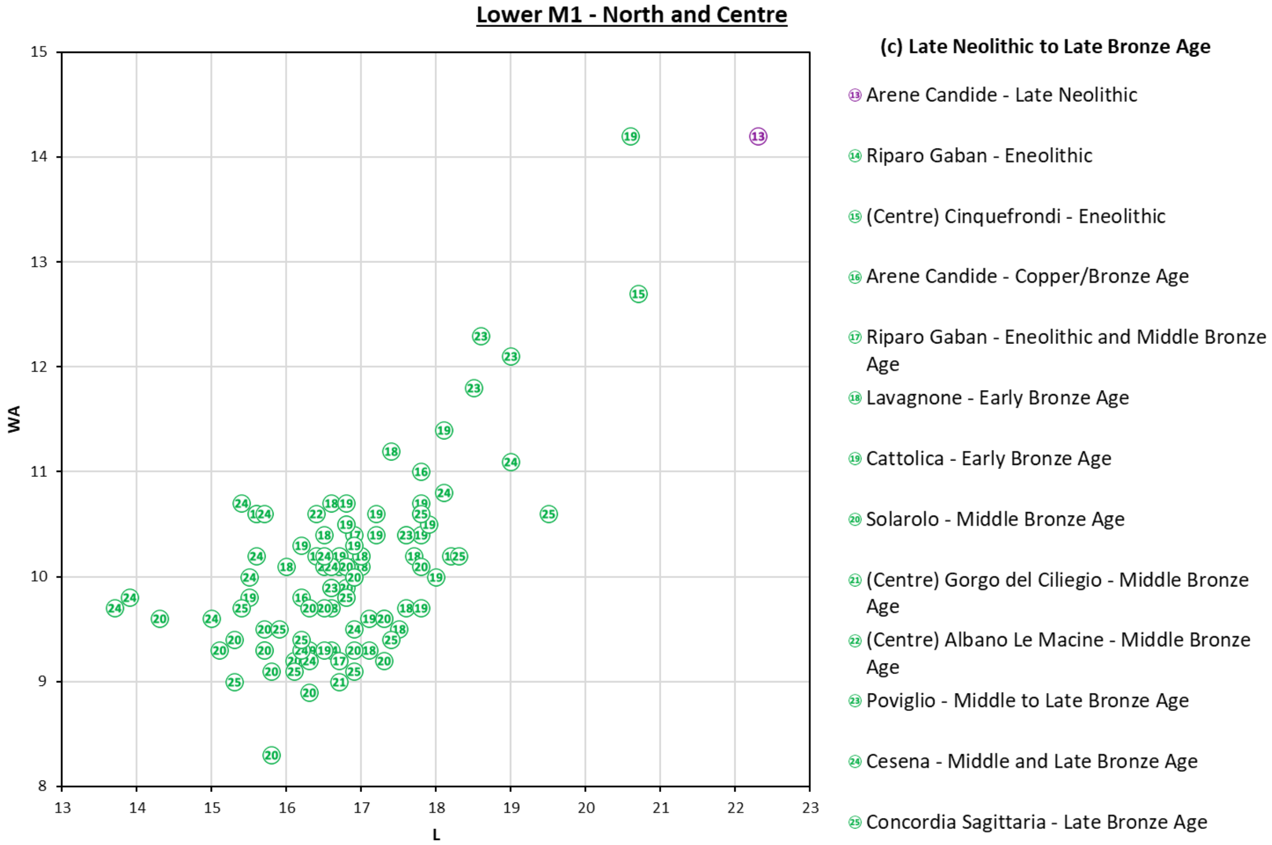


Figure 7.36. (2/2) Lower M1 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

Figure 7.37. Lower M1 length and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

Figure 7.38. (1/2) Lower M1 posterior and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

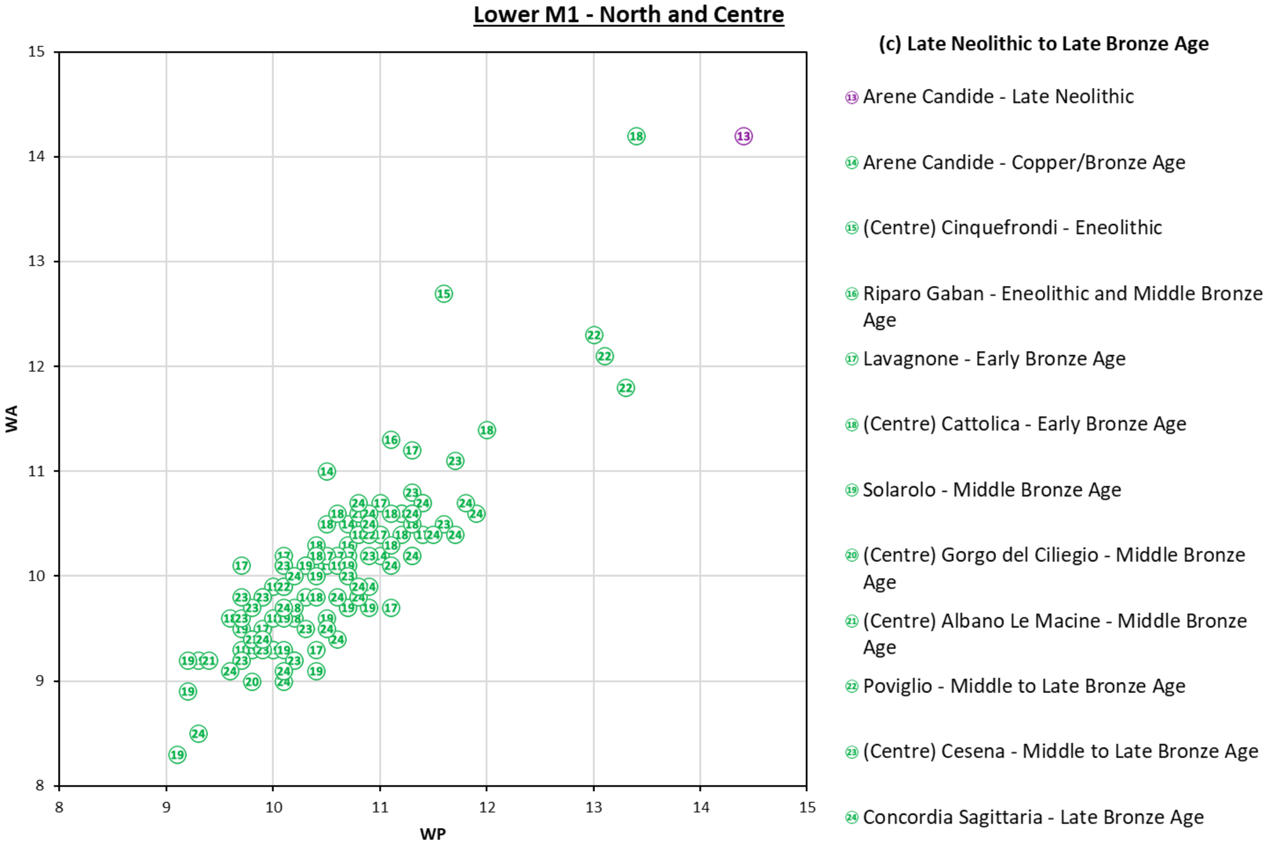


Figure 7.38. (2/2) Lower M1 posterior and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

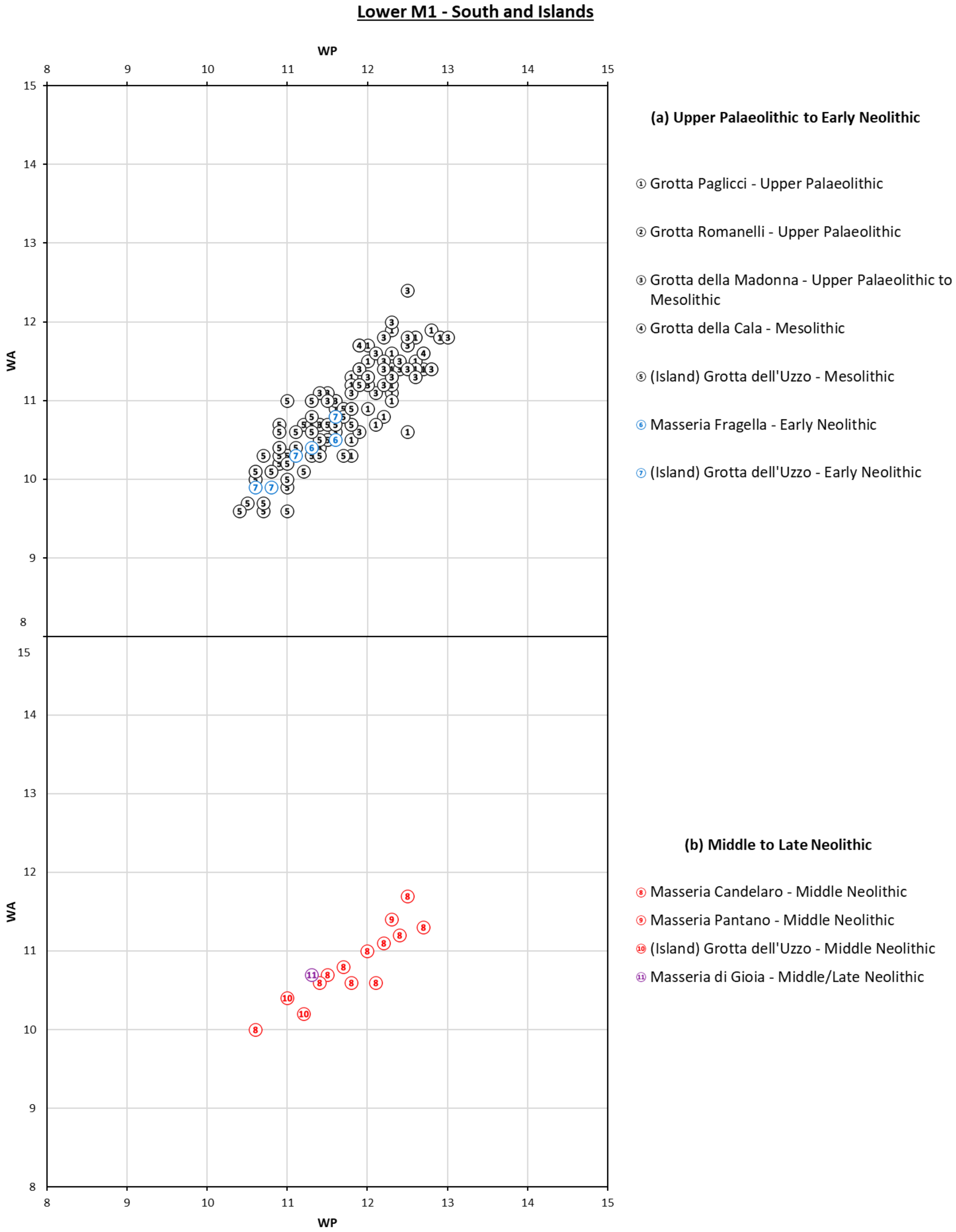


Figure 7.39. (1/2) Lower M1 posterior and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle to Late Neolithic; (c) Late Eneolithic to Late Bronze Age.

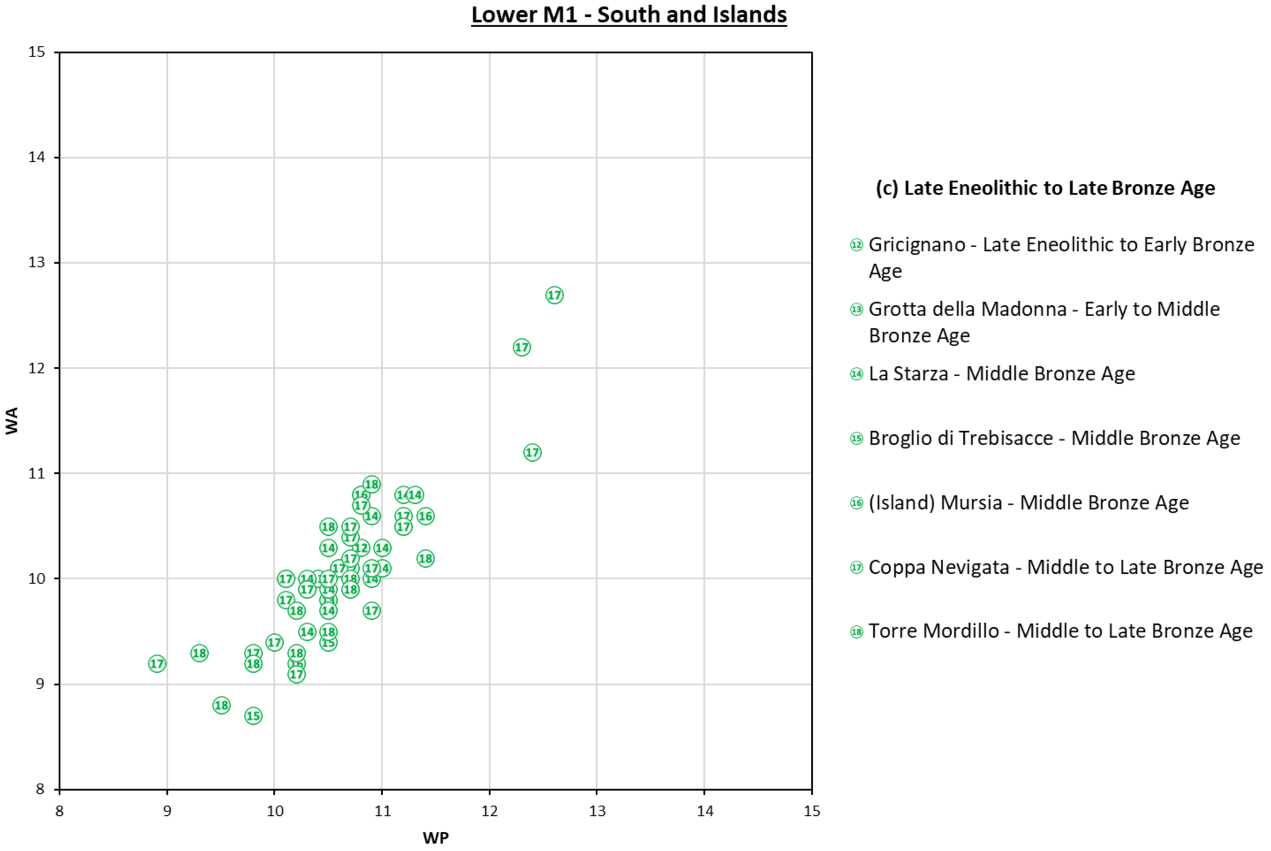


Figure 7.39. (2/2) Lower M1 posterior and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle to Late Neolithic; (c) Late Eneolithic to Late Bronze Age.

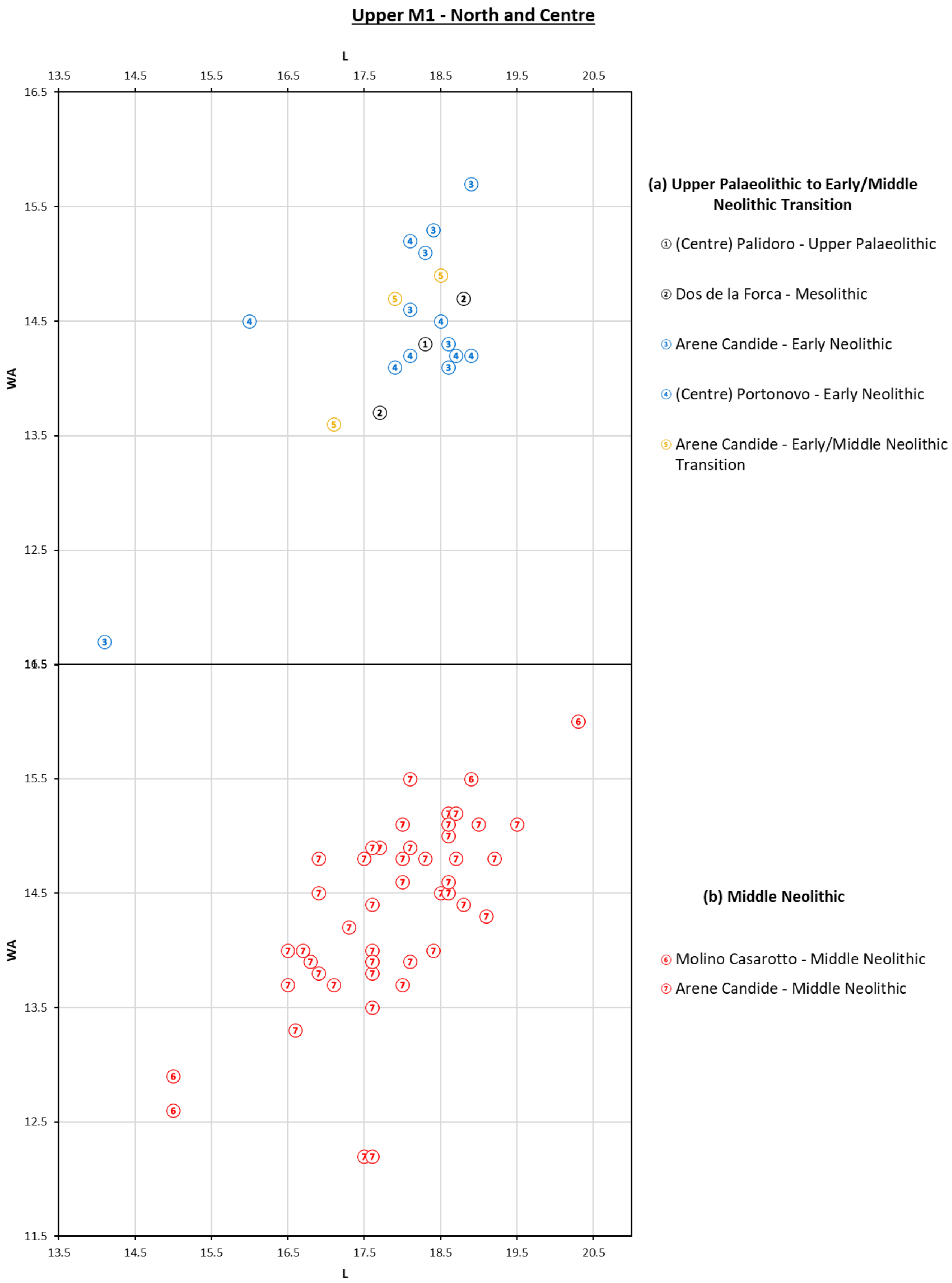


Figure 7.40. (1/2) Upper M1 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

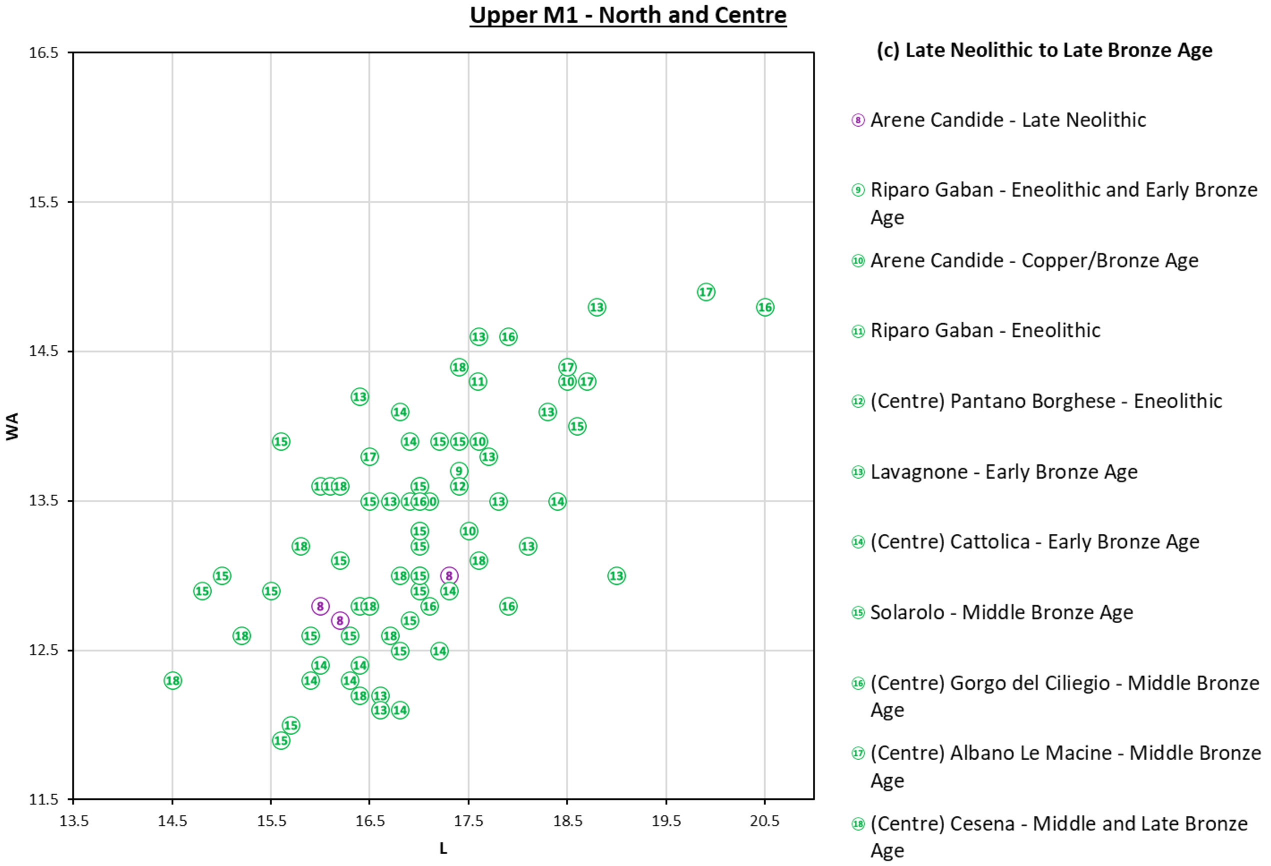


Figure 7.40. (2/2) Upper M1 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

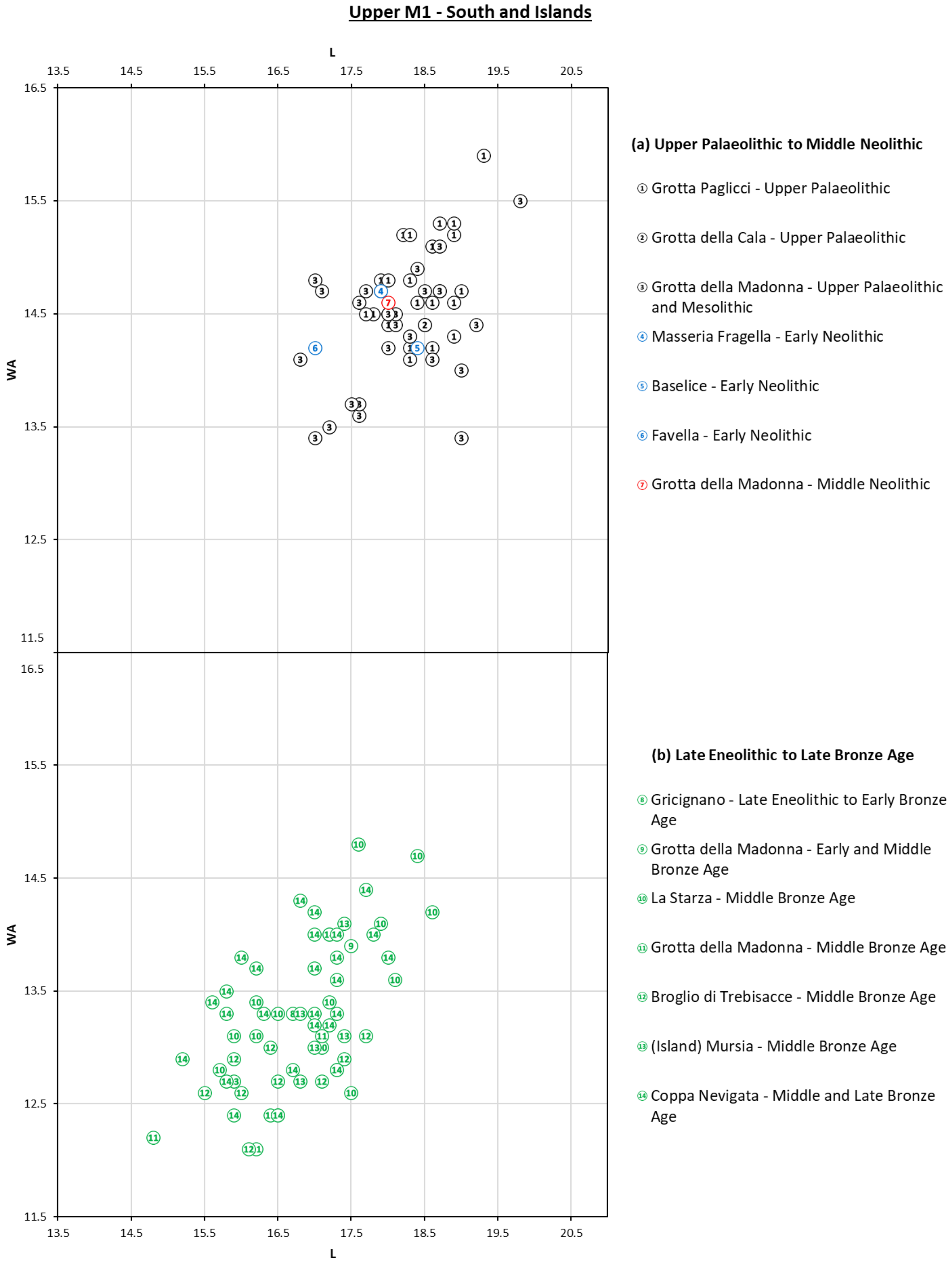


Figure 7.41. Upper M1 length and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

Figure 7.42. (1/2) Upper M1 posterior and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle to Late Neolithic; (c) Eneolithic to Late Bronze Age.

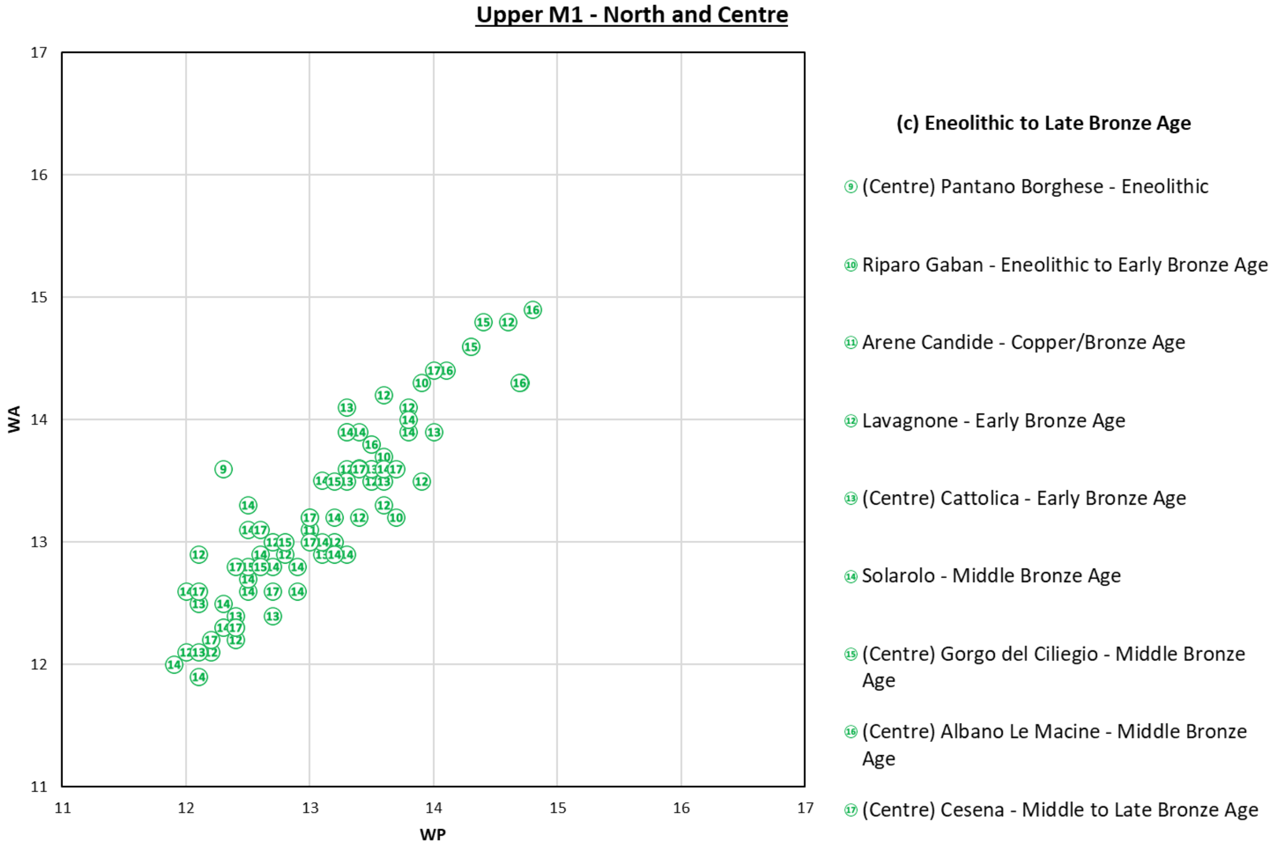


Figure 7.42. (2/2) Upper M1 posterior and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle to Late Neolithic; (c) Eneolithic to Late Bronze Age.

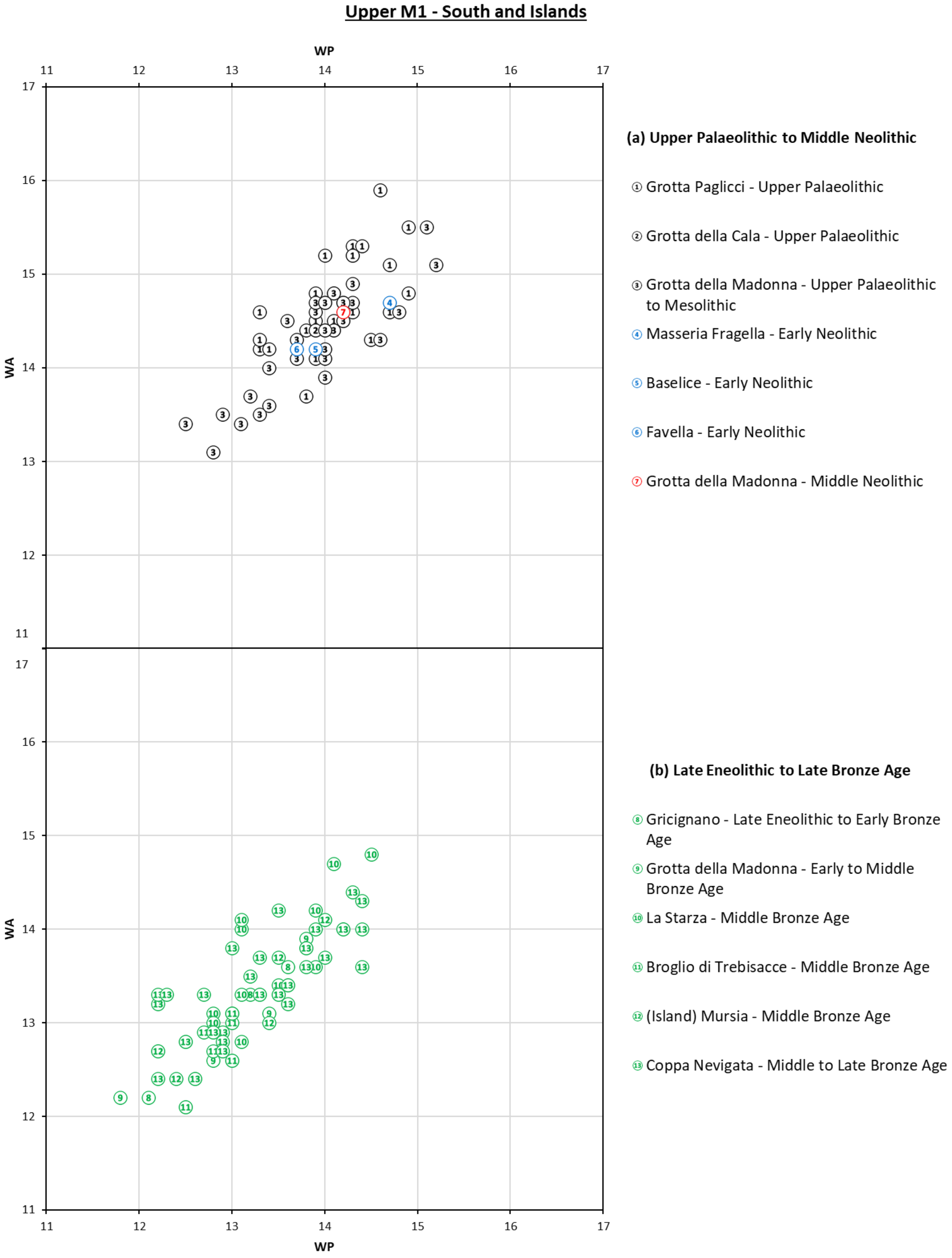


Figure 7.43. Upper M1 posterior and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

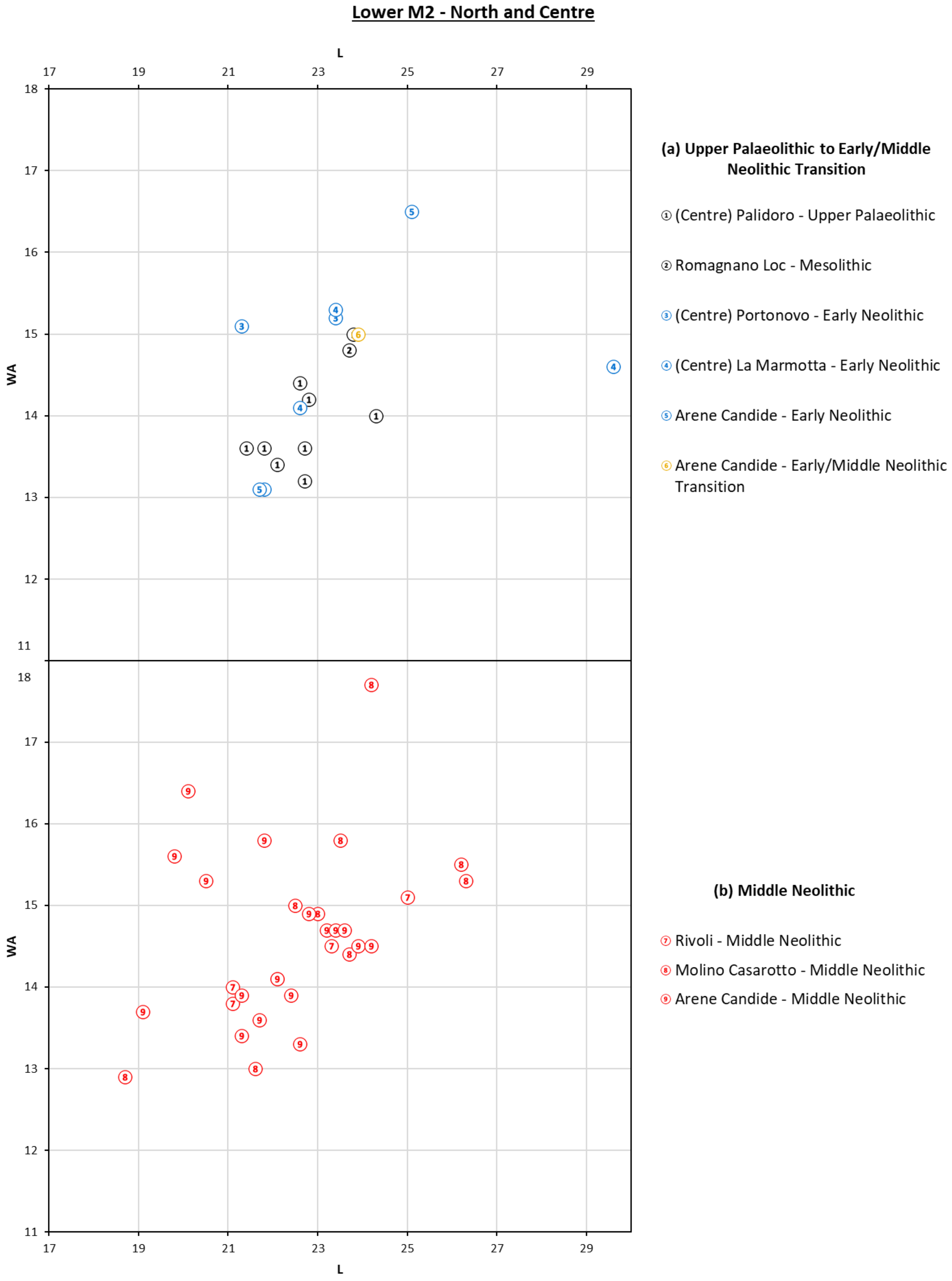


Figure 7.44. (1/2) Lower M2 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

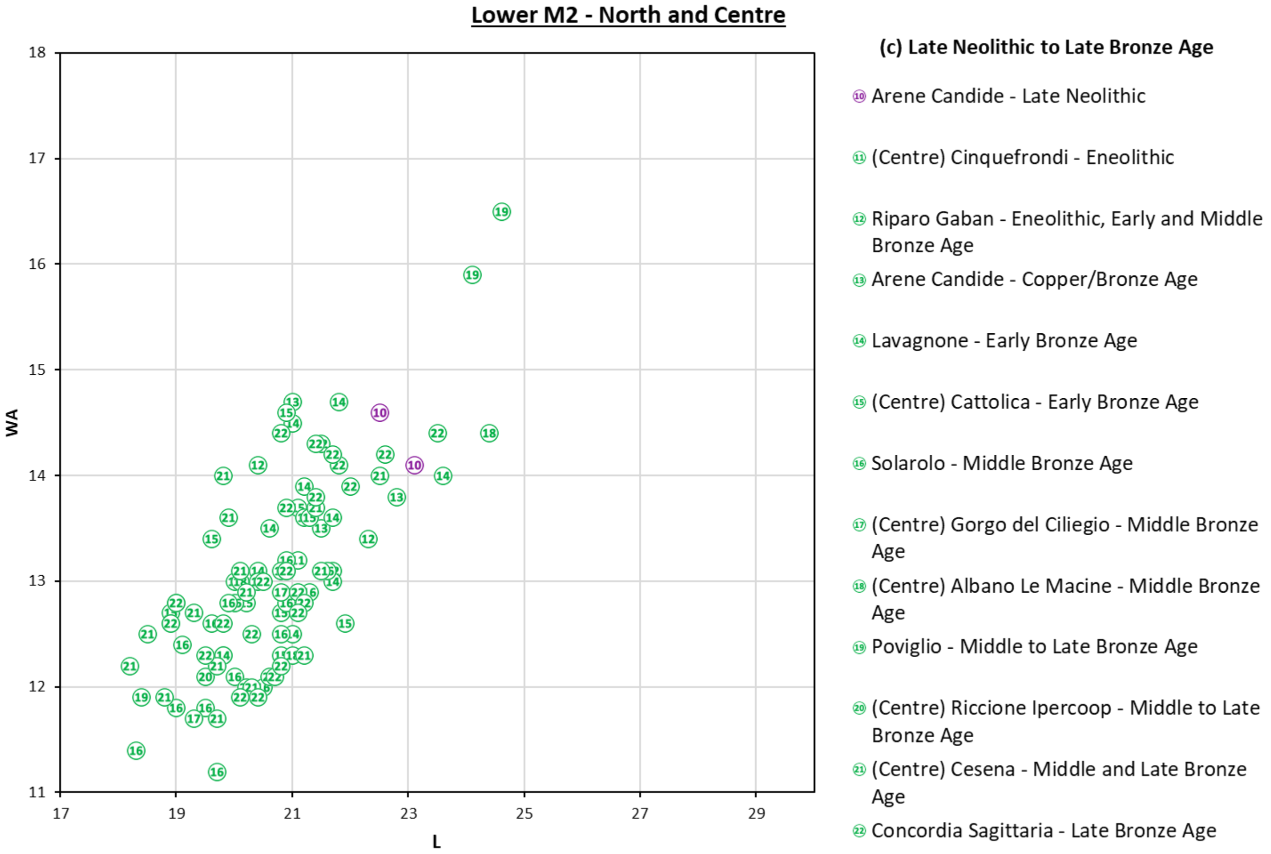


Figure 7.44. (2/2) Lower M2 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

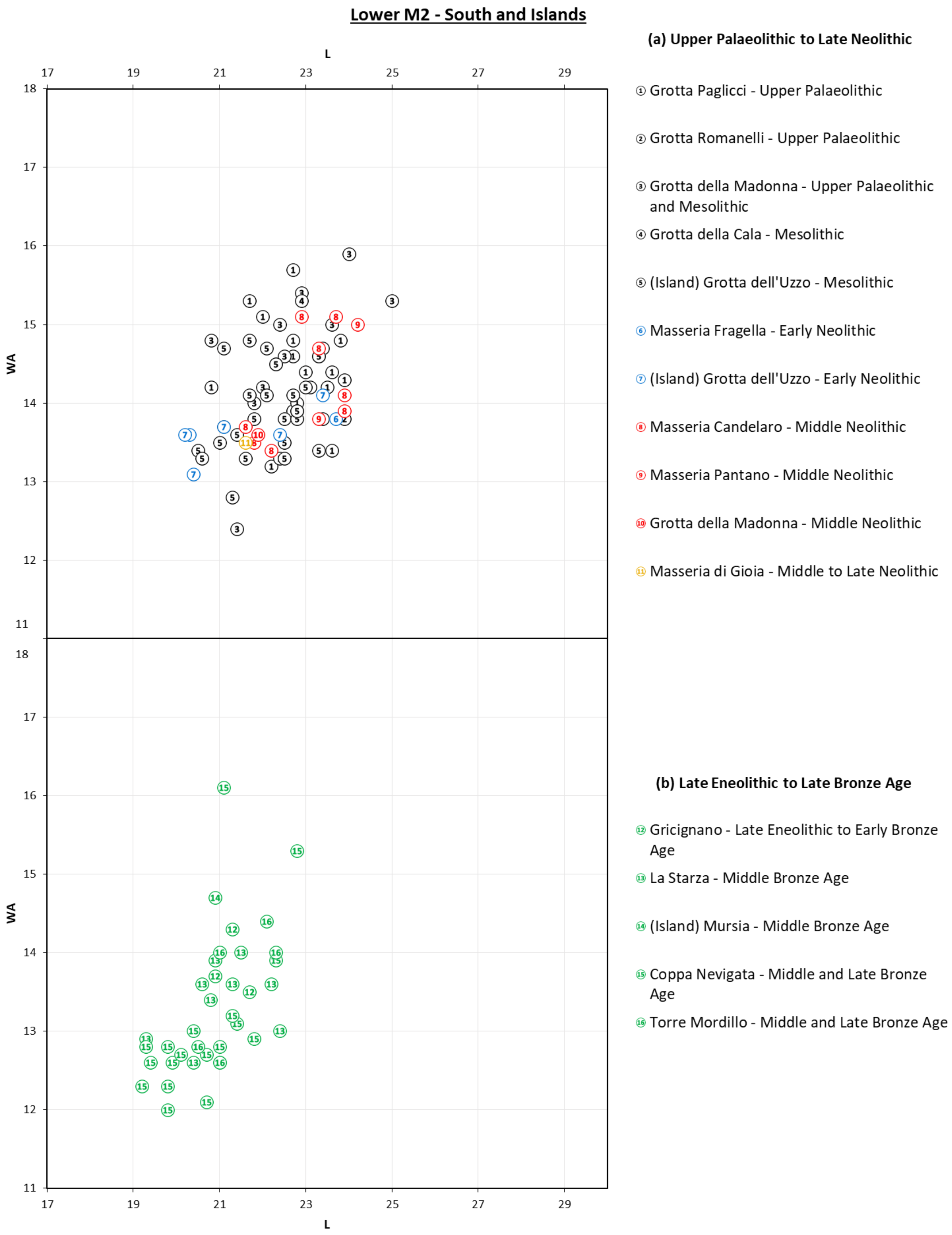


Figure 7.45. Lower M2 length and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Late Neolithic; (b) Late Eneolithic to Late Bronze Age.

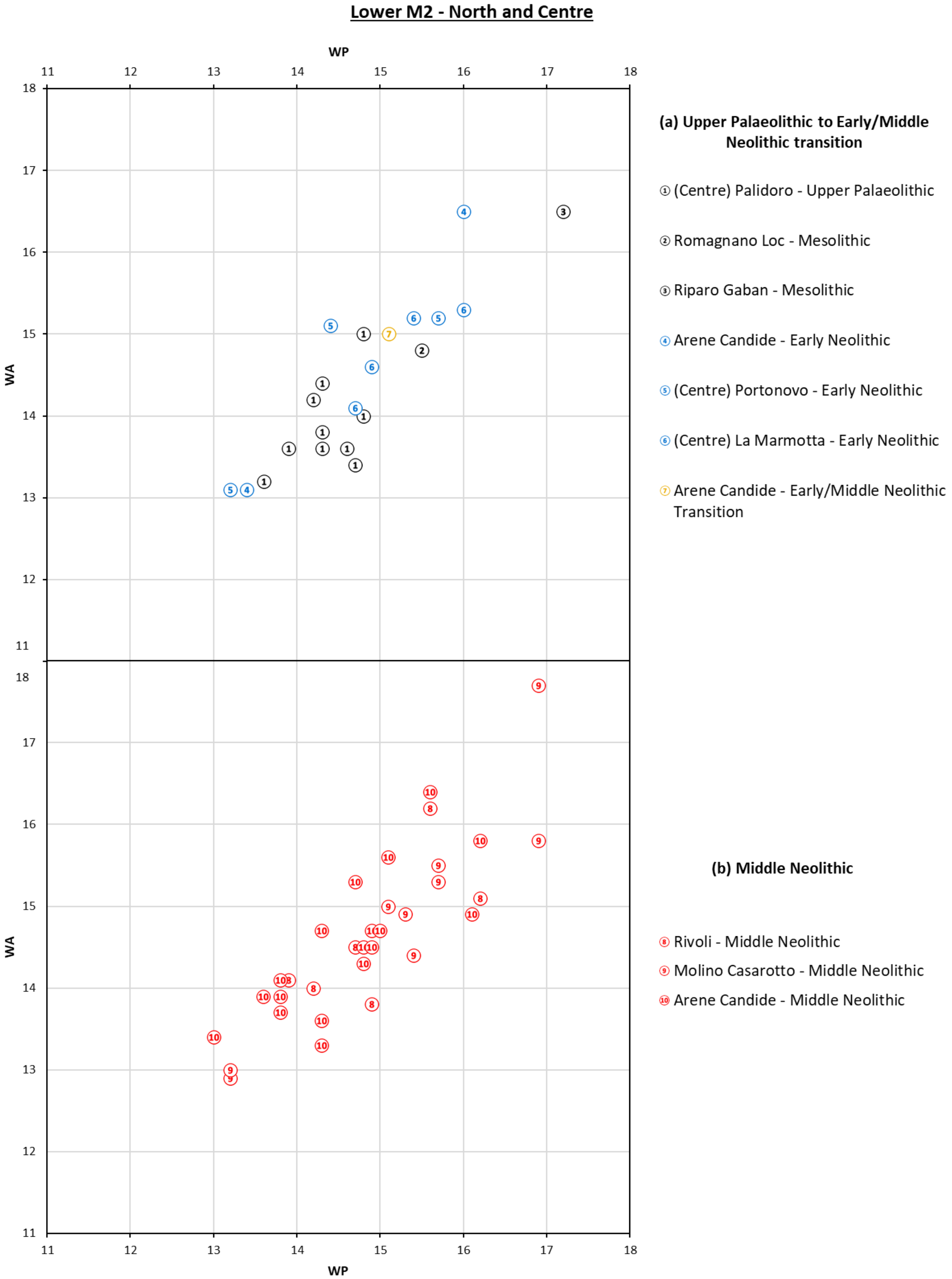


Figure 7.46. (1/2) Lower M2 posterior and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

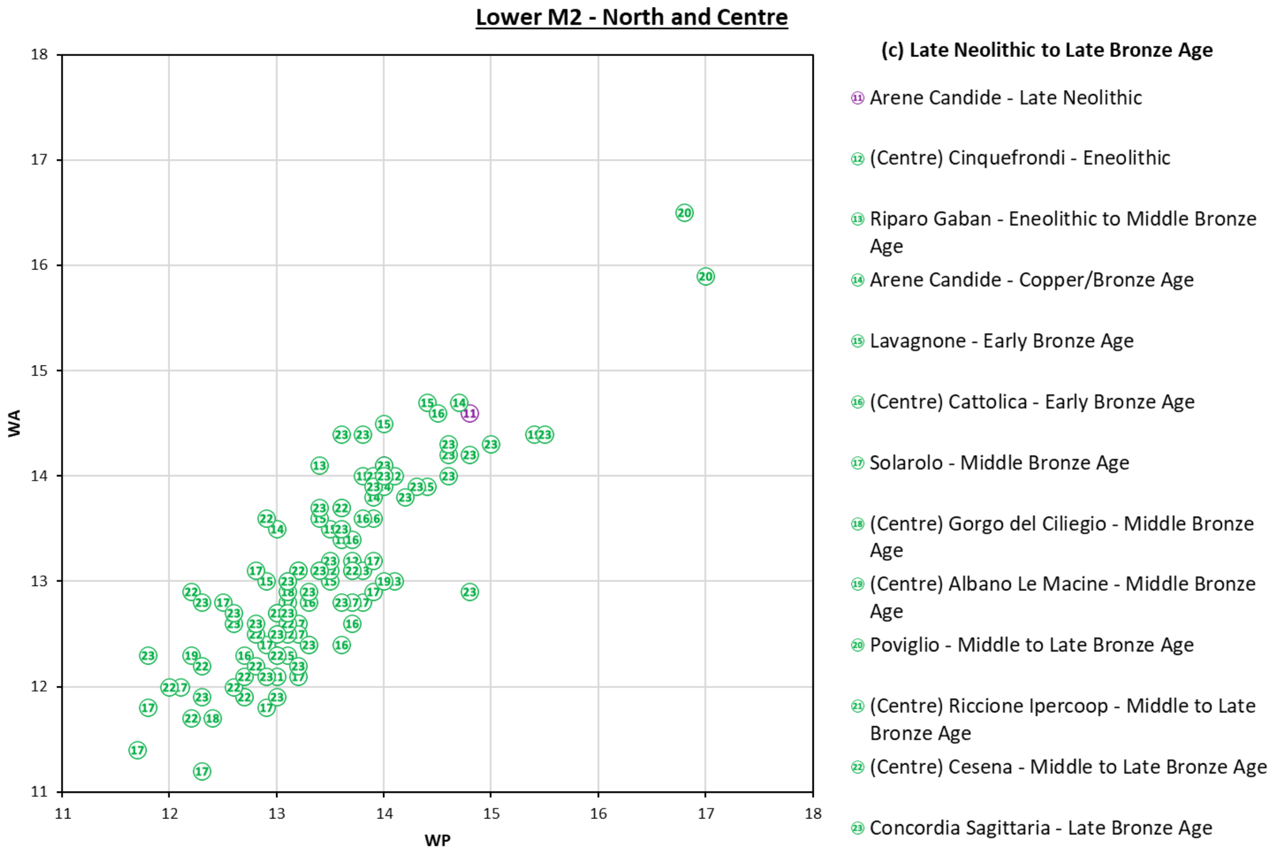


Figure 7.46. (2/2) Lower M2 posterior and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early/Middle Neolithic Transition; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

Figure 7.47. (1/2) Lower M2 posterior and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle to Late Neolithic; (c) Late Eneolithic to Late Bronze Age.

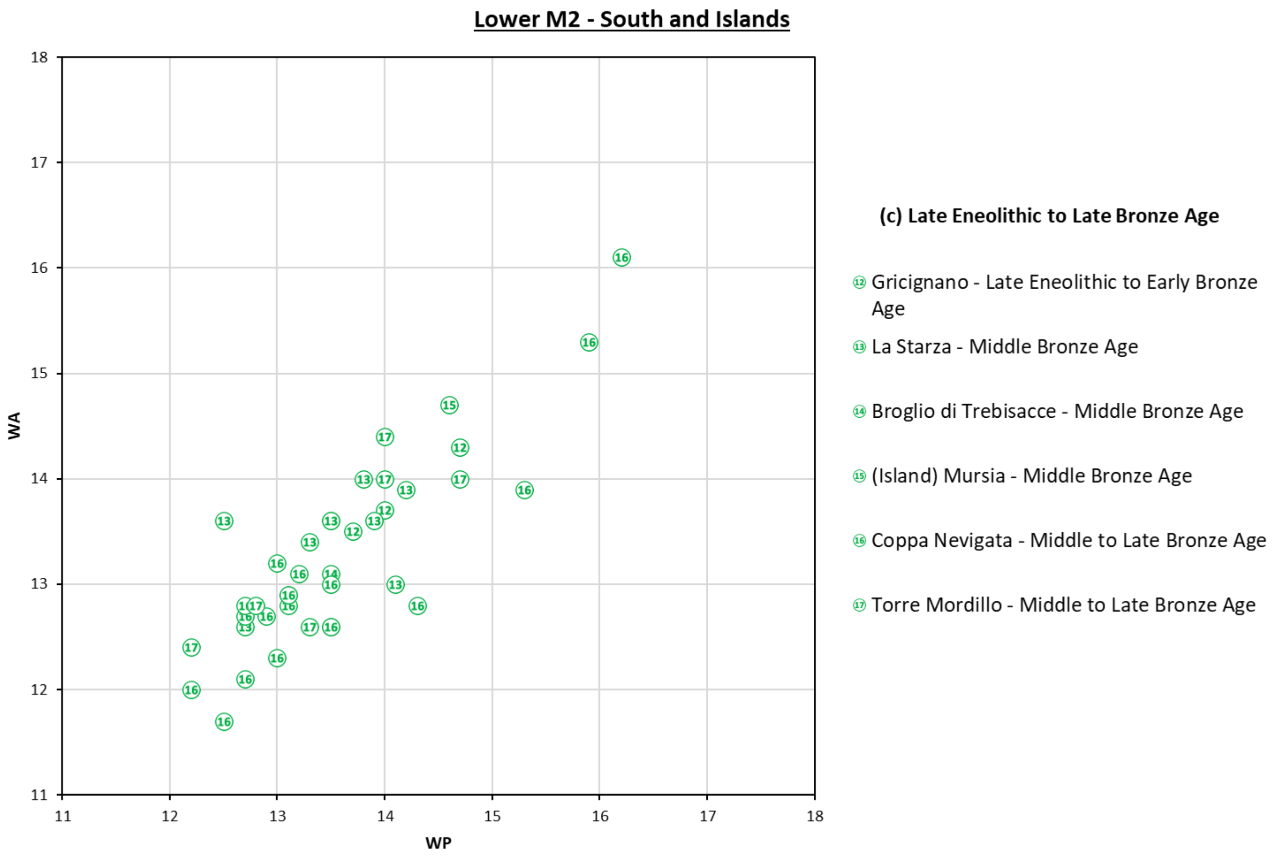


Figure 7.47. (2/2) Lower M2 posterior and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle to Late Neolithic; (c) Late Eneolithic to Late Bronze Age.

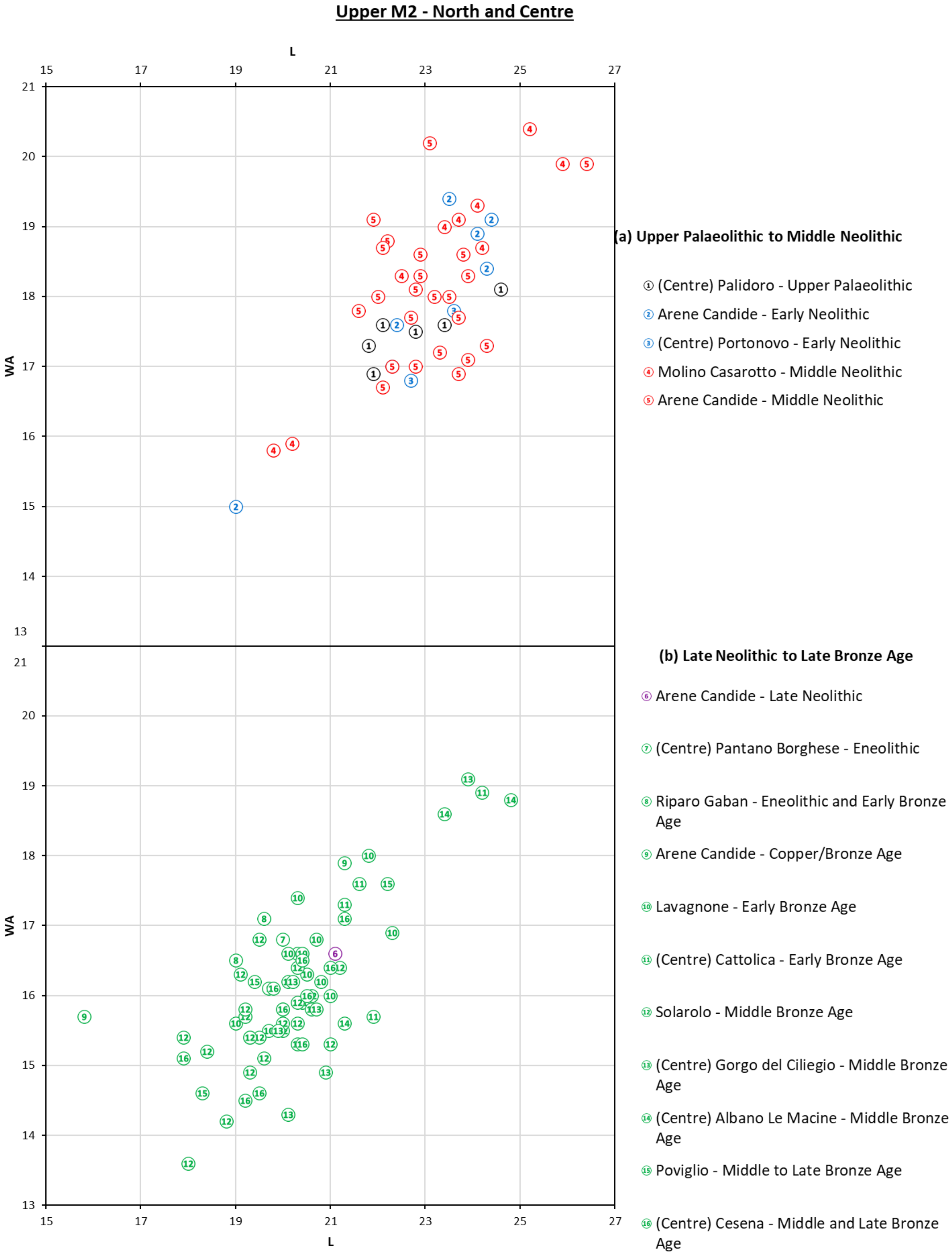


Figure 7.48. Upper M2 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

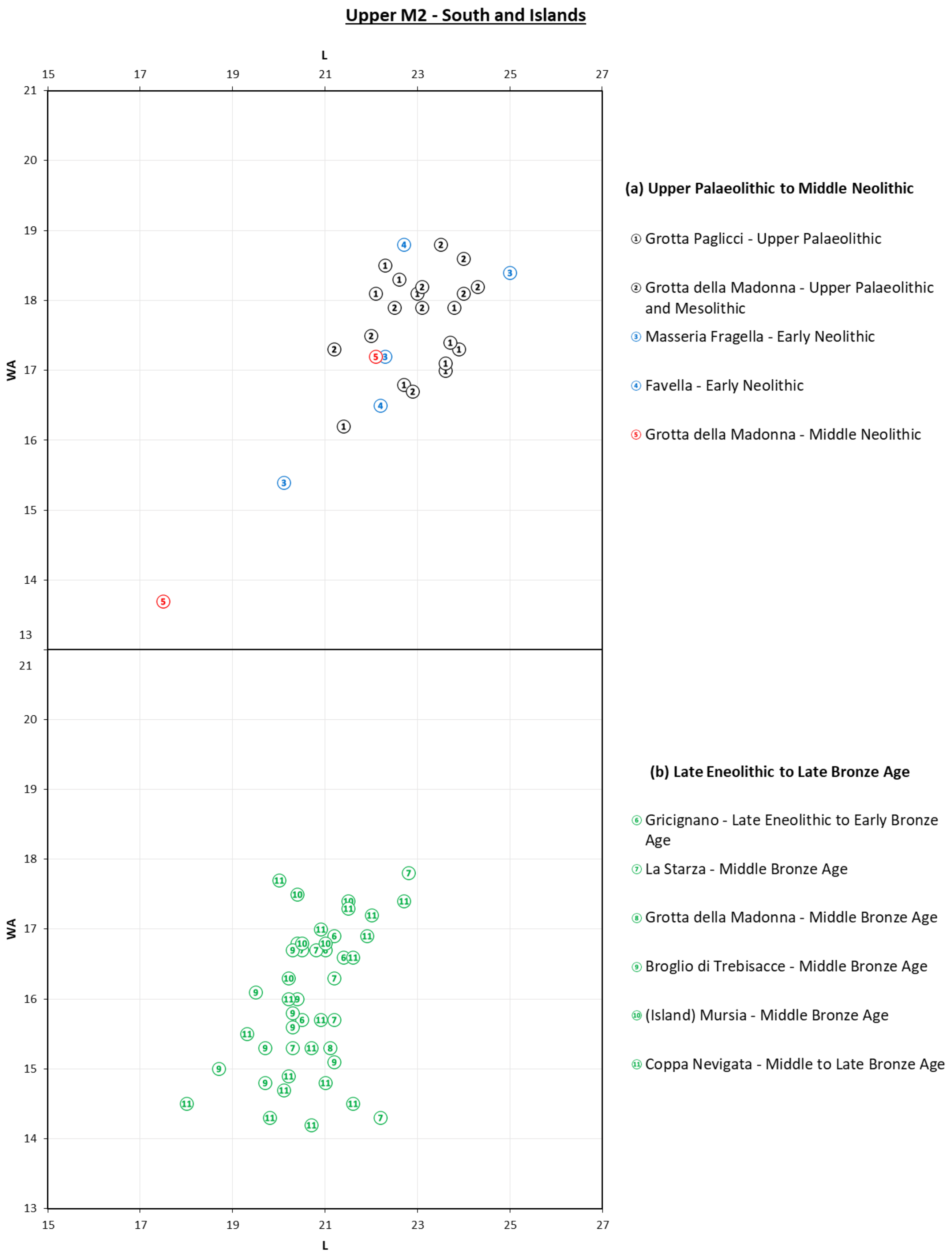


Figure 7.49. Upper M2 length and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

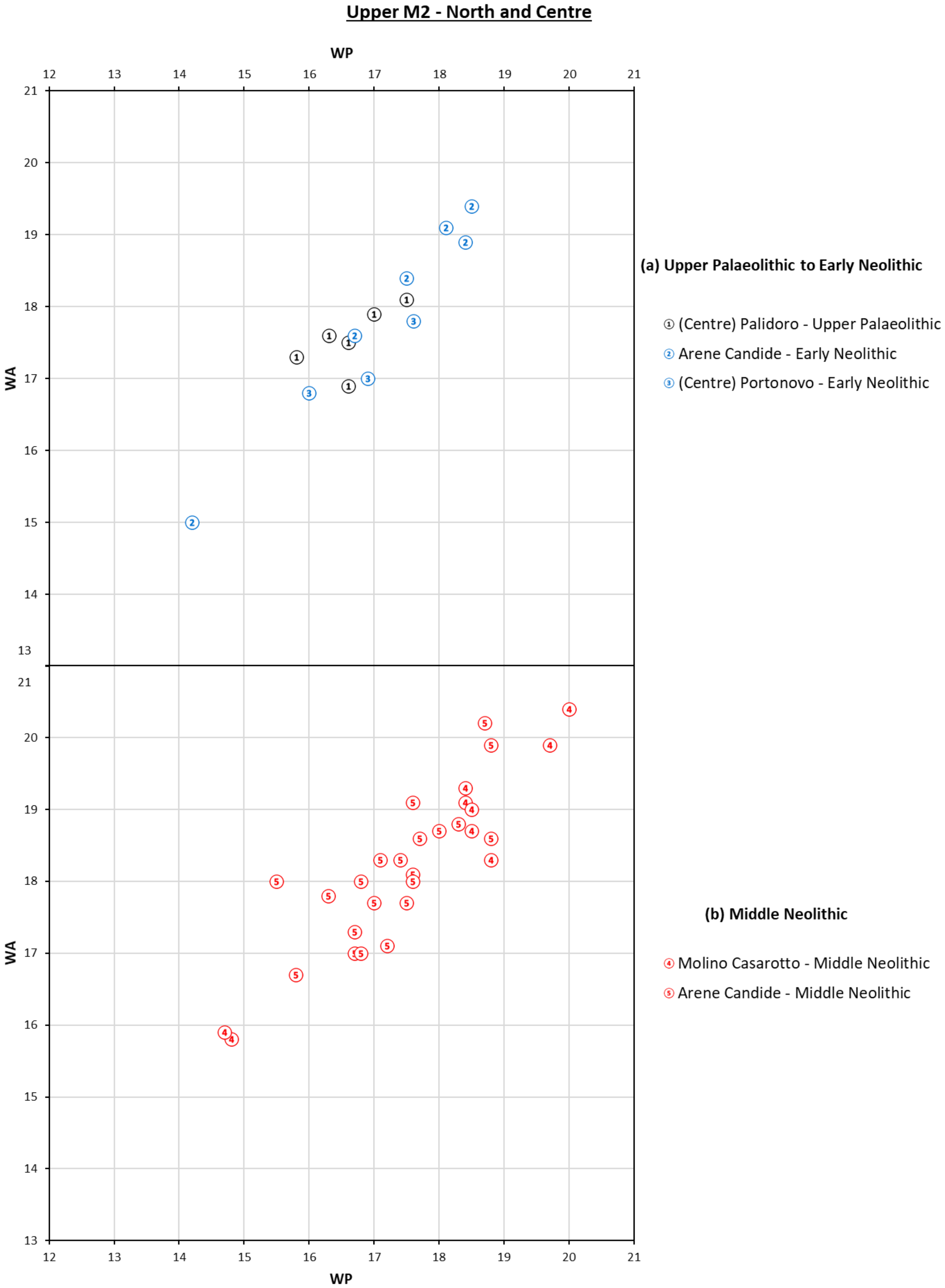


Figure 7.50. (1/2) Upper M2 posterior and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

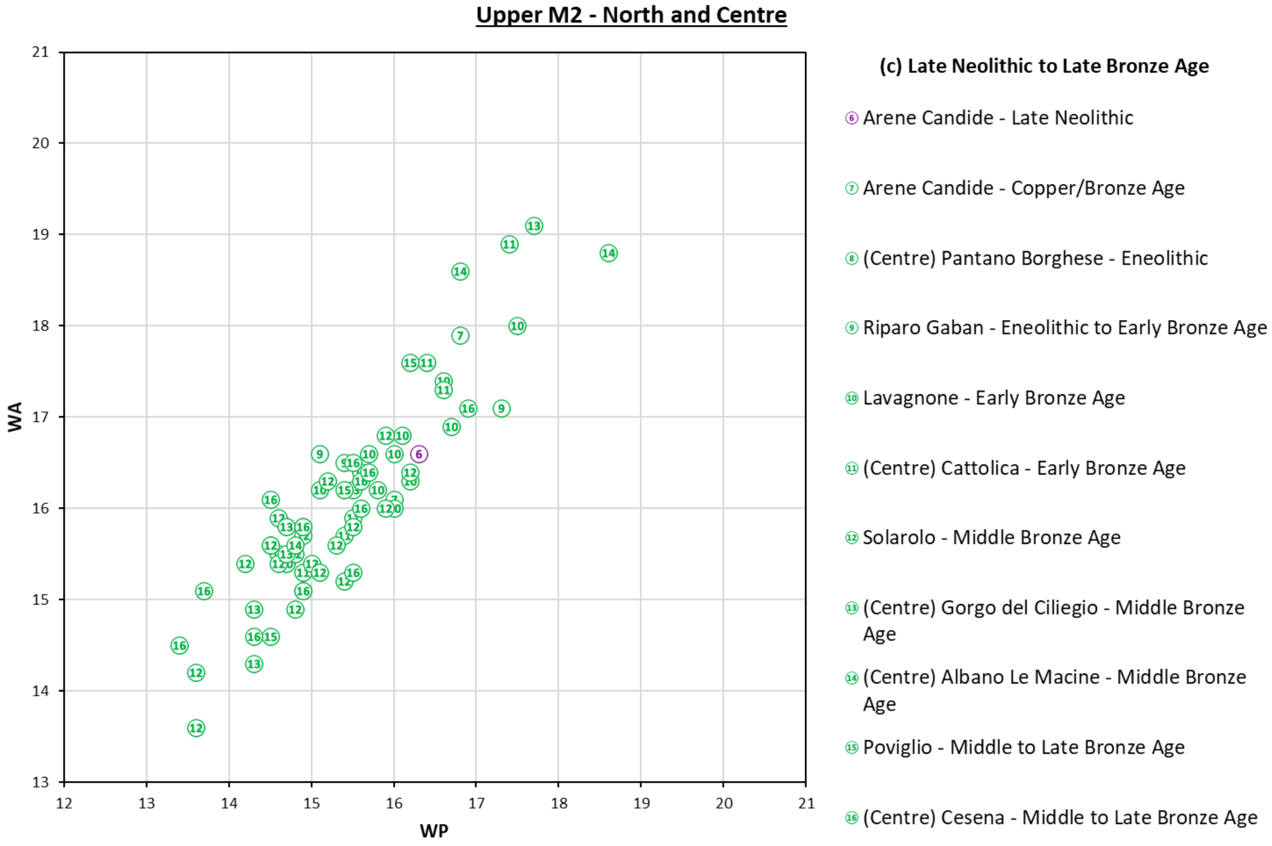


Figure 7.50. (2/2) Upper M2 posterior and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle Neolithic; (c) Late Neolithic to Late Bronze Age.

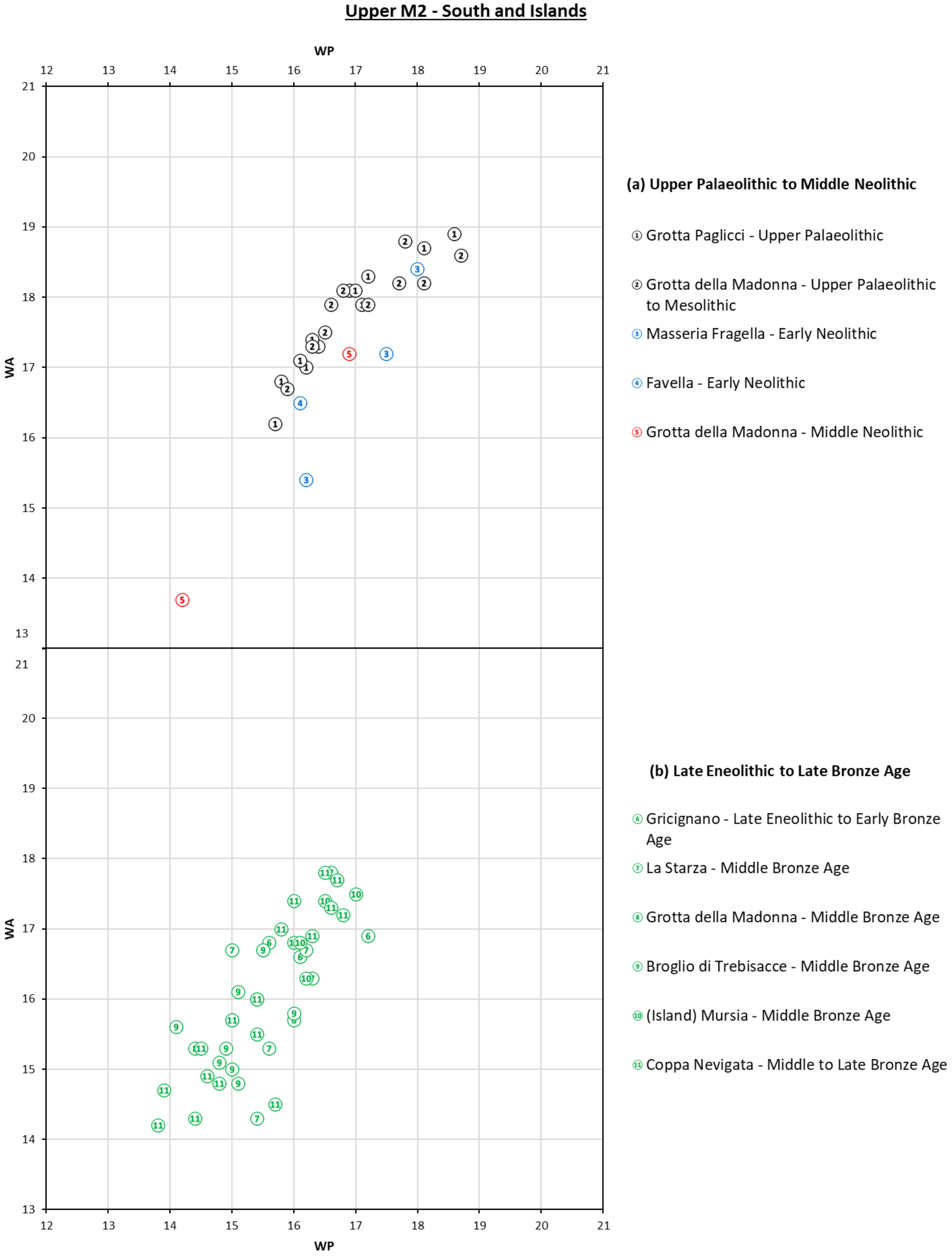


Figure 7.51. Upper M2 posterior and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

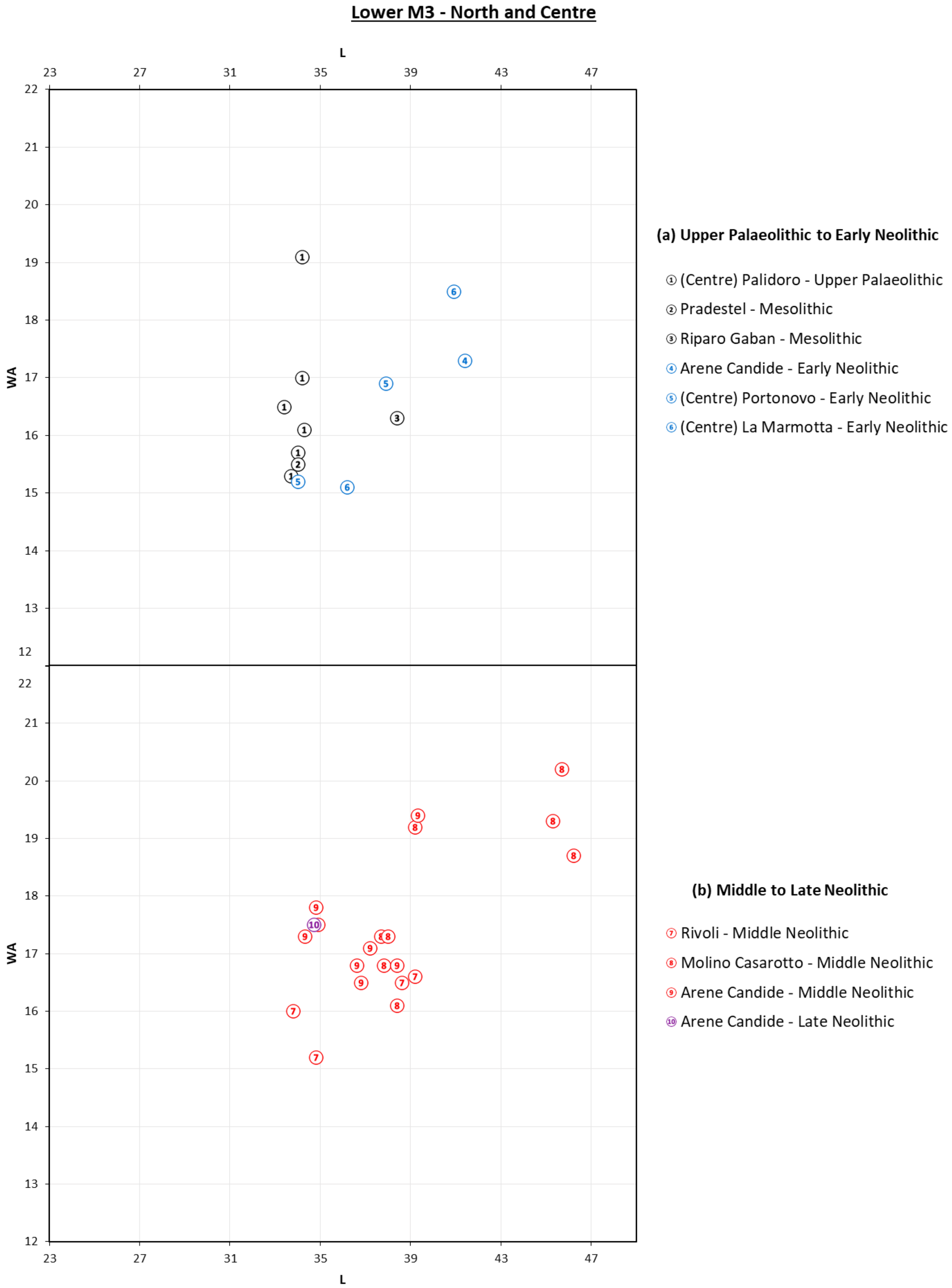


Figure 7.52. (1/2) Lower M3 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle to Late Neolithic; (c) Eneolithic to Late Bronze Age.

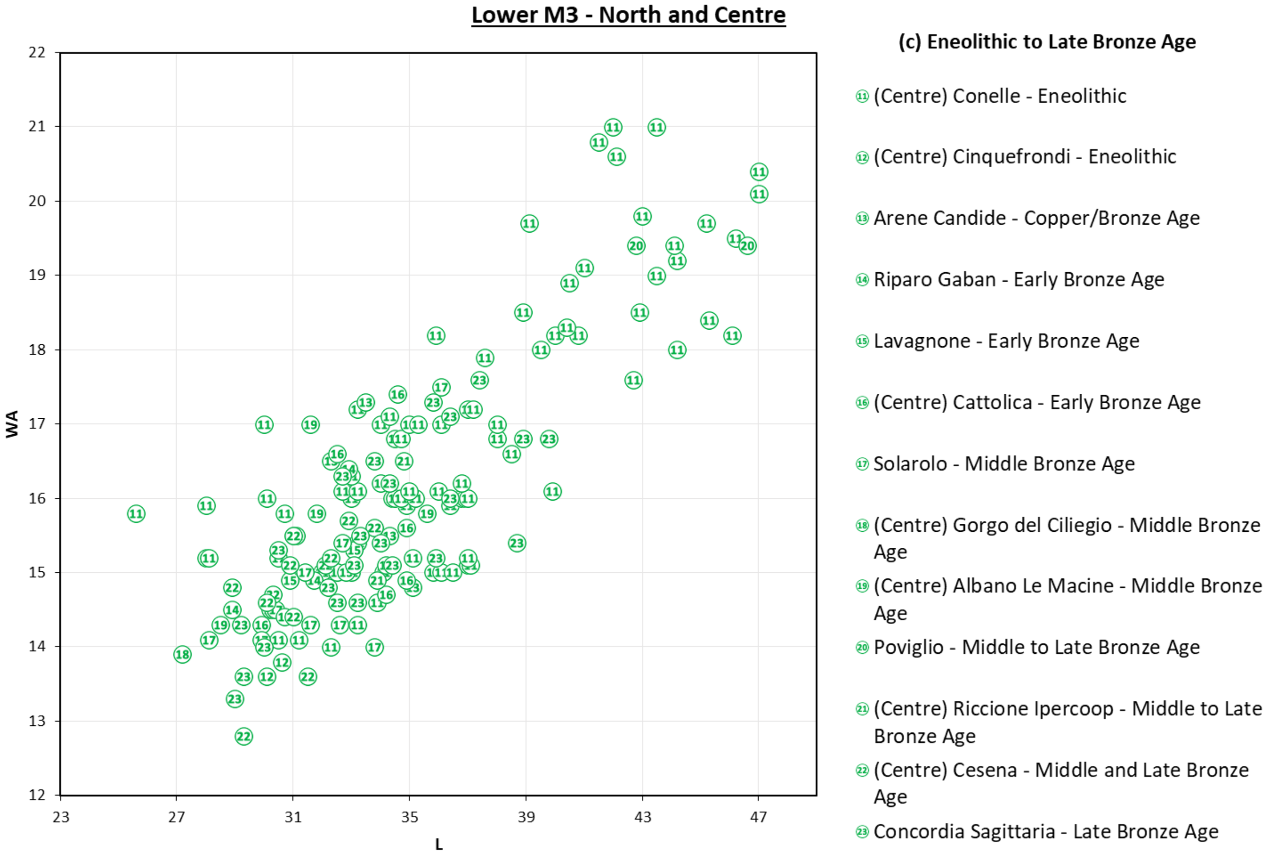


Figure 7.52. (2/2) Lower M3 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle to Late Neolithic; (c) Eneolithic to Late Bronze Age.

Figure 7.53. Lower M3 length and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

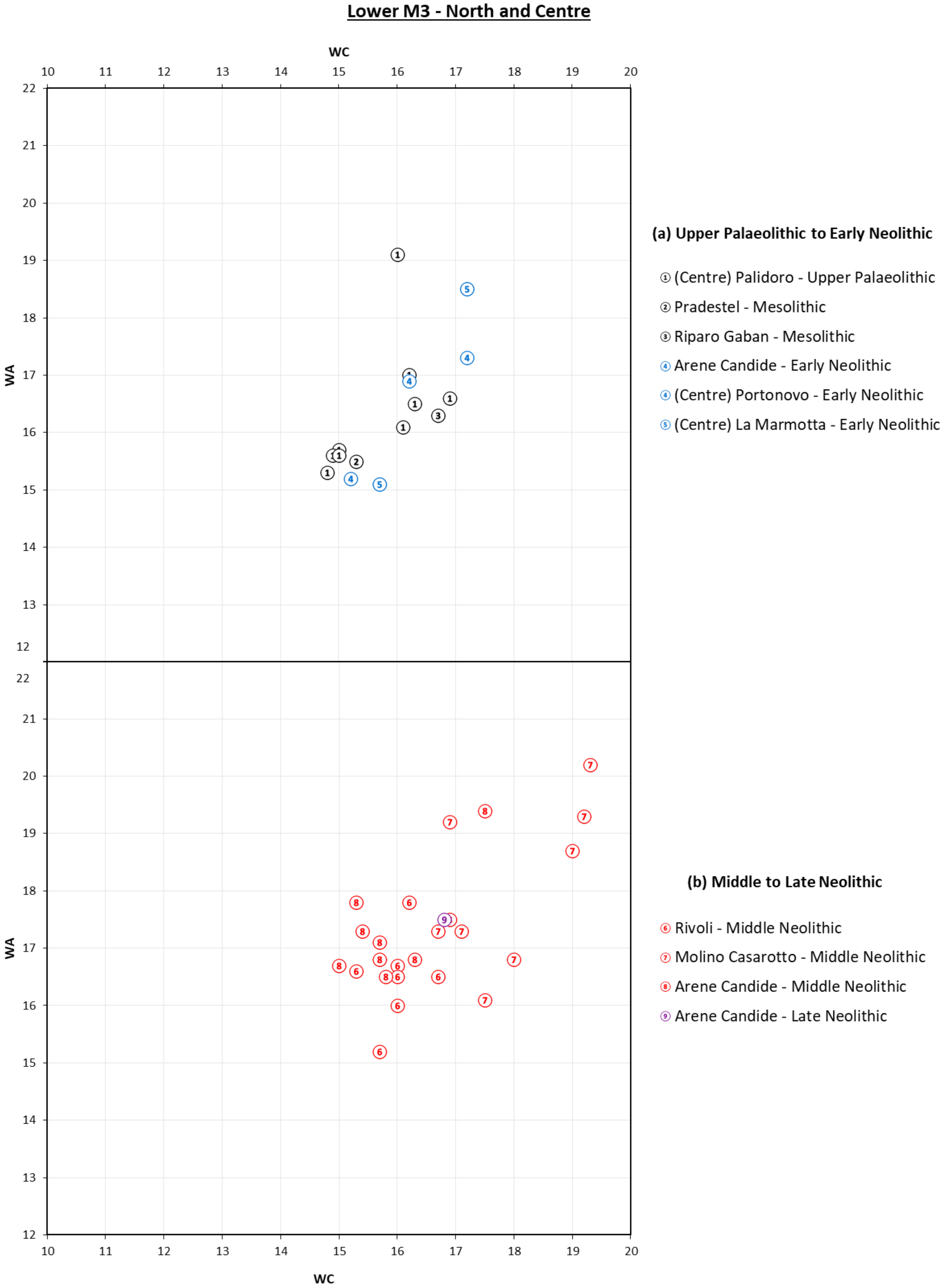


Figure 7.54. (1/2) Lower M3 central and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle to Late Neolithic; (c) Late Neolithic to Late Bronze Age.

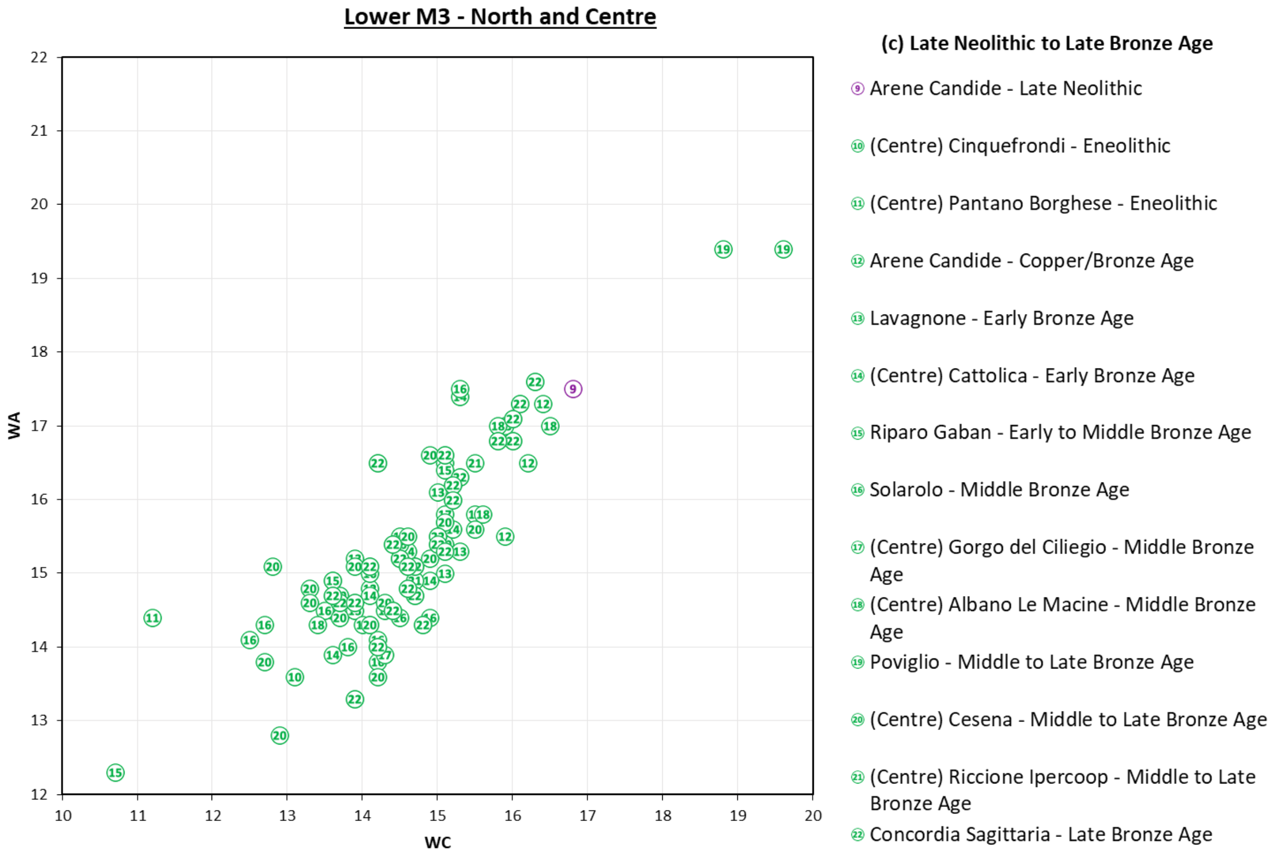


Figure 7.54. (2/2) Lower M3 central and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Early Neolithic; (b) Middle to Late Neolithic; (c) Late Neolithic to Late Bronze Age.

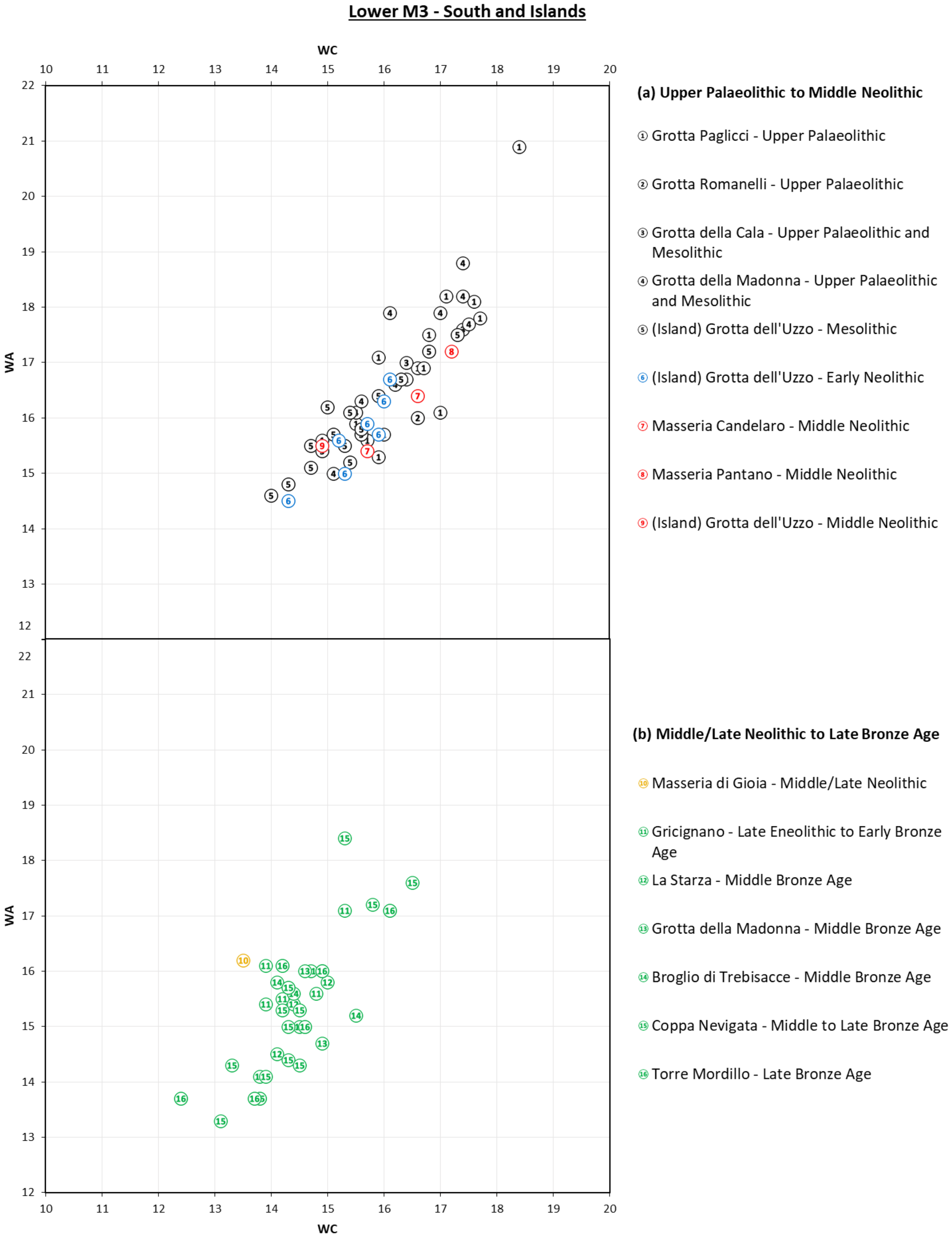


Figure 7.55. Lower M3 central and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Middle/Late Neolithic to Late Bronze Age.

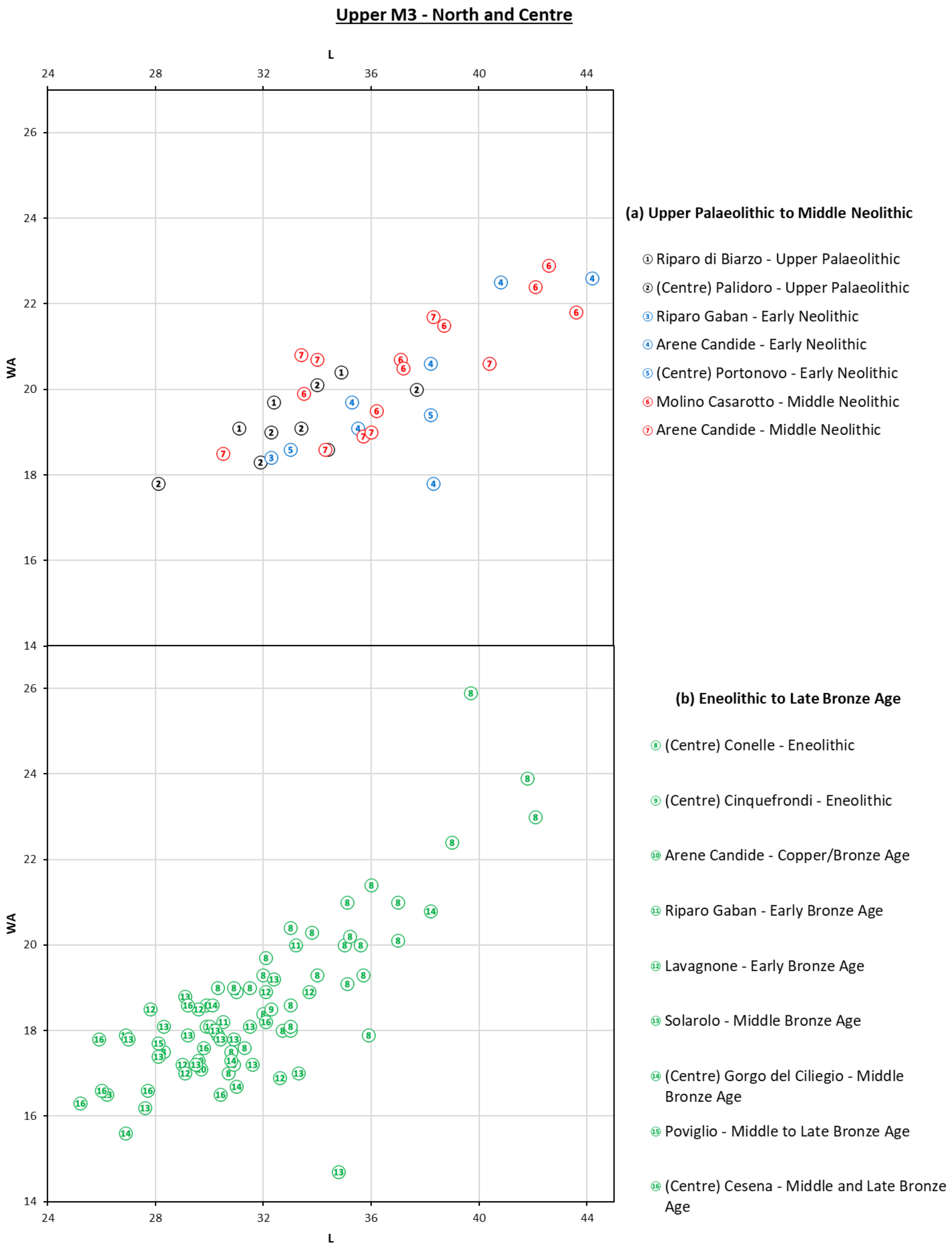


Figure 7.56. Upper M3 length and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Eneolithic to Late Bronze Age.

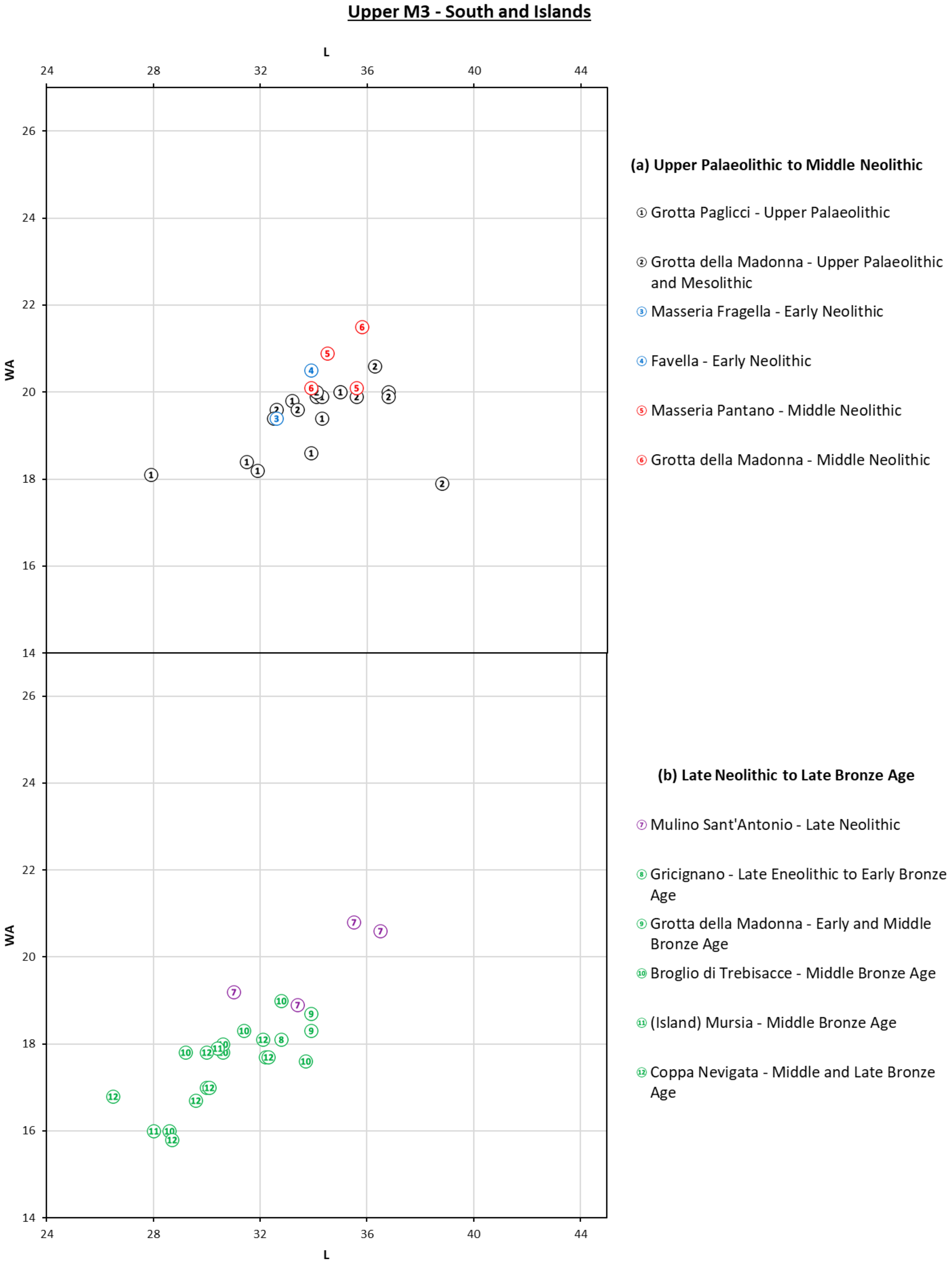


Figure 7.57. Upper M3 length and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

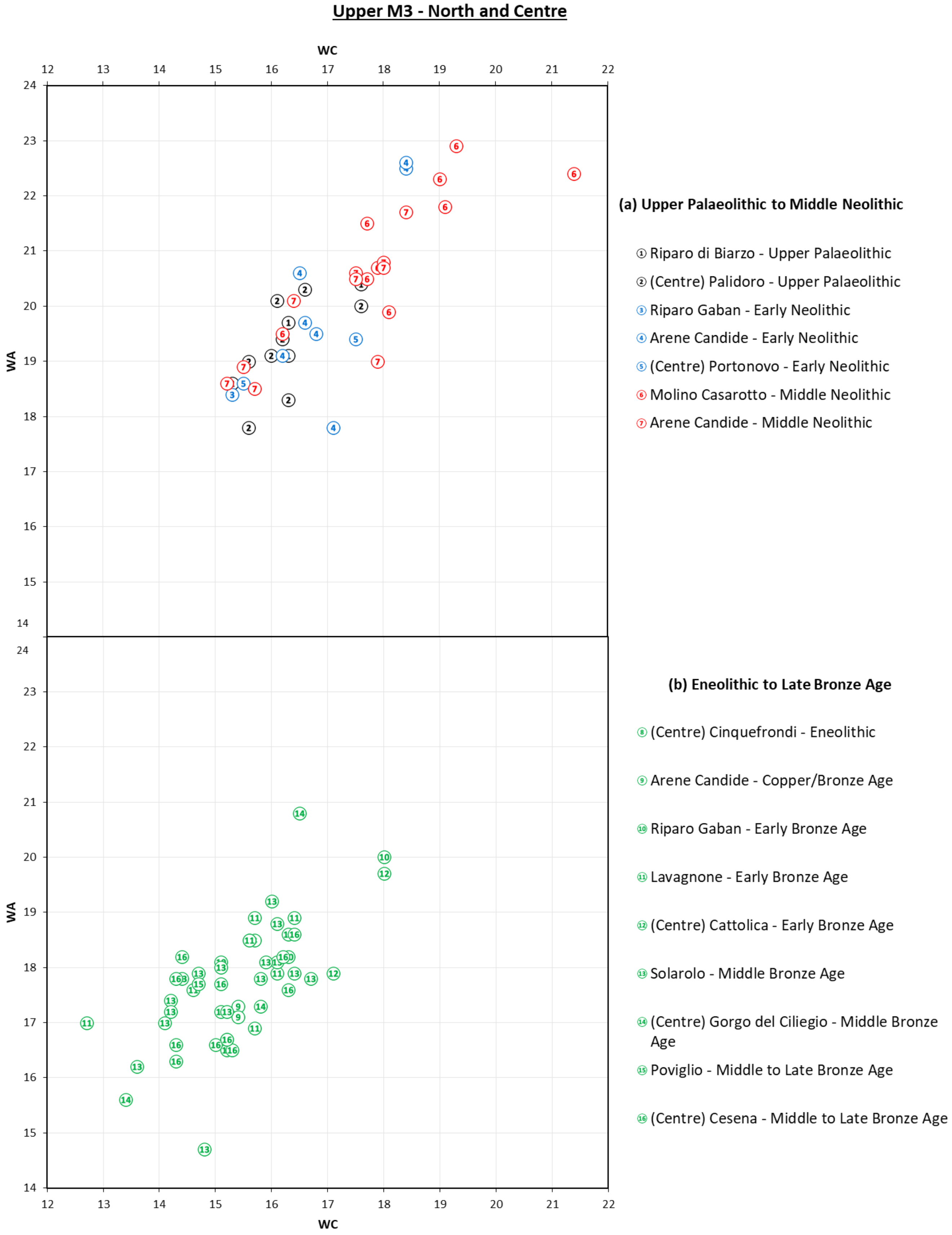


Figure 7.58. Upper M3 central and anterior width scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Eneolithic to Late Bronze Age.

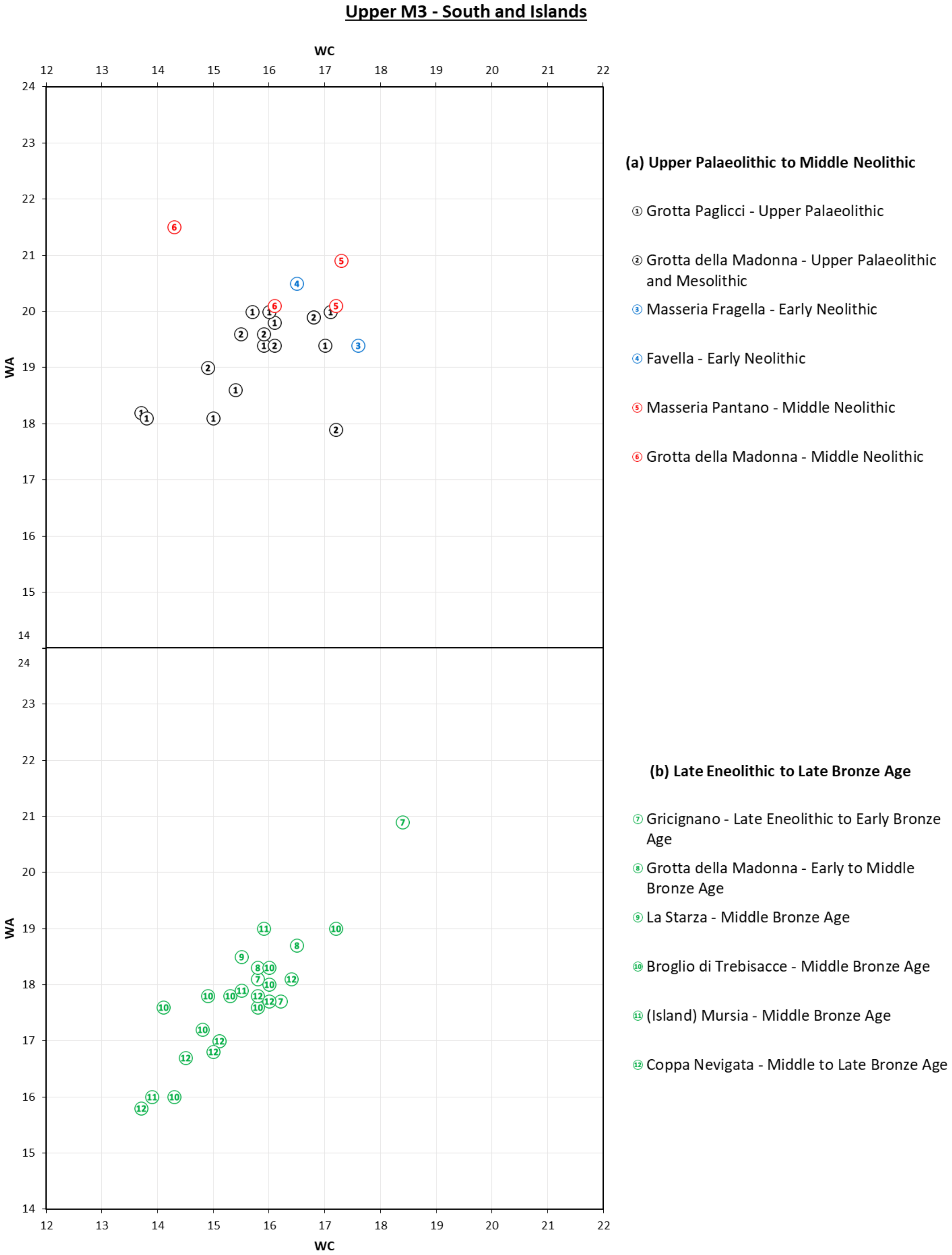


Figure 7.59. Upper M3 central and anterior width scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

The case of Arene Candide (Figures 7.60 to 7.69) serves as an example of the evolution of these patterns through time within one site. Indeed, in this site the postcranial evidence from the tibia and astragalus[26] (Figures 7.60 and 7.61) indicates a clear bimodality of the data from the Late Neolithic onwards. The Early and Middle Neolithic data is very similar, although the latter period evidence some smaller specimens. The tooth measurements (Figures 7.62 to 7.69) also show a decrease in size from the Late Neolithic, although a clear bimodality is not visible. Additionally, the Middle Neolithic teeth would seem to include smaller specimens than before, although unfortunately the sample size for the Early Neolithic is much smaller and it is therefore not possible to ascertain this with certainty.

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[26] The humerus data from Arene Candide is in this case excluded from the analysis, as the Early Neolithic, and Late Neolithic and Copper/Bronze Age periods have very small sample sizes.

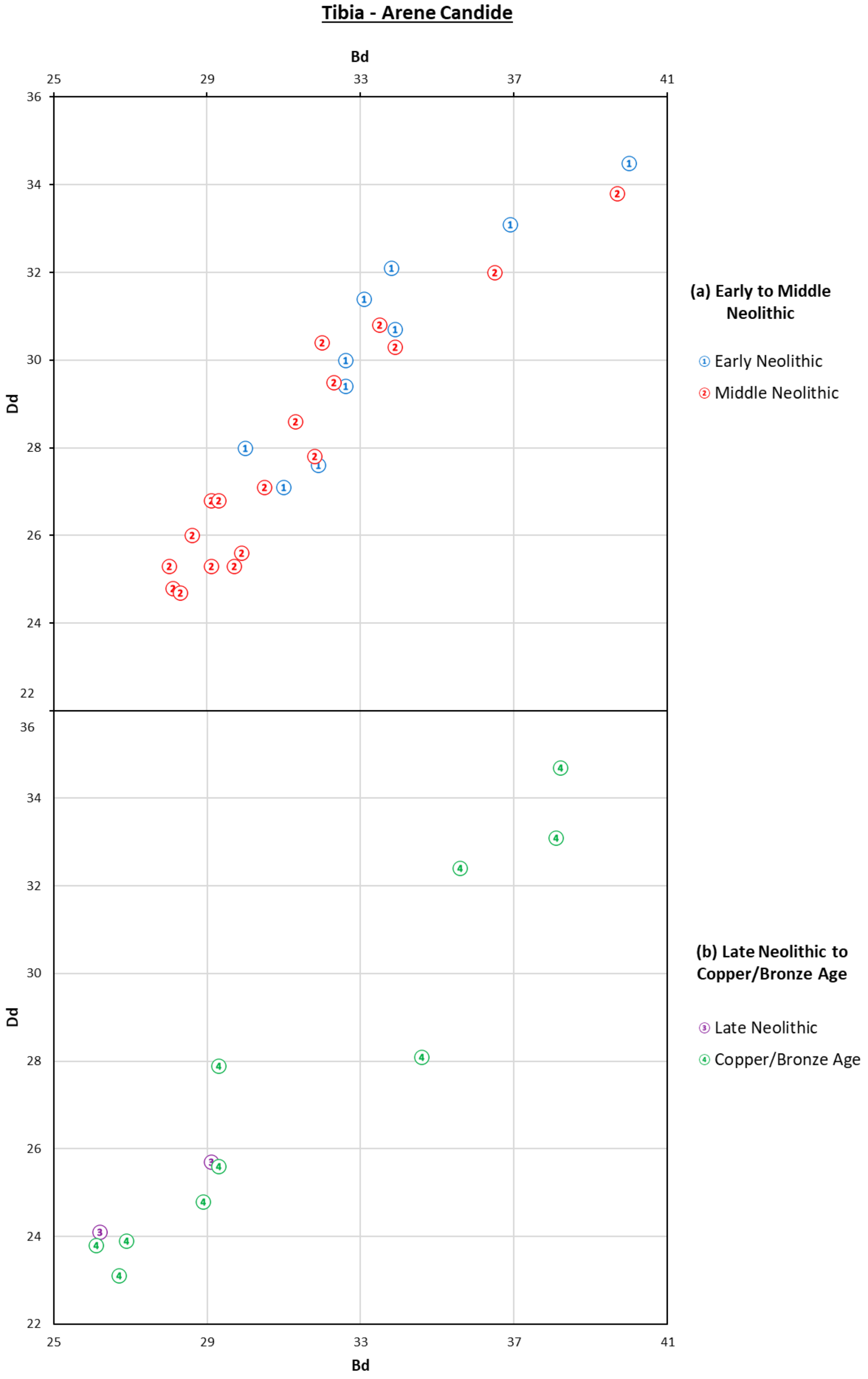


Figure 7.60. Tibia Bd and Dd scatterplots, for Arene Candide: (a) Early to Middle Neolithic; (b) Late Eneolithic to Copper/Bronze Age.

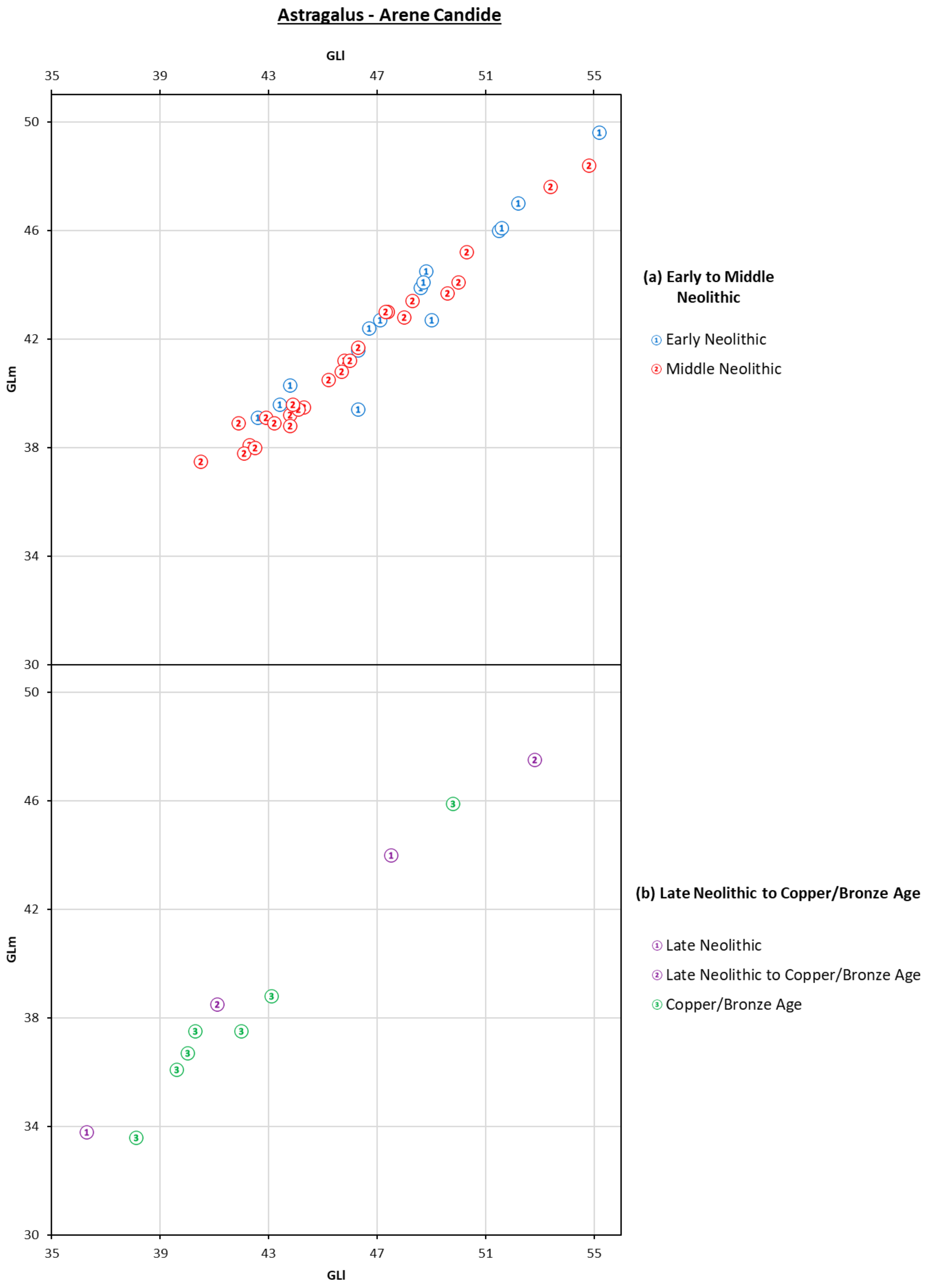
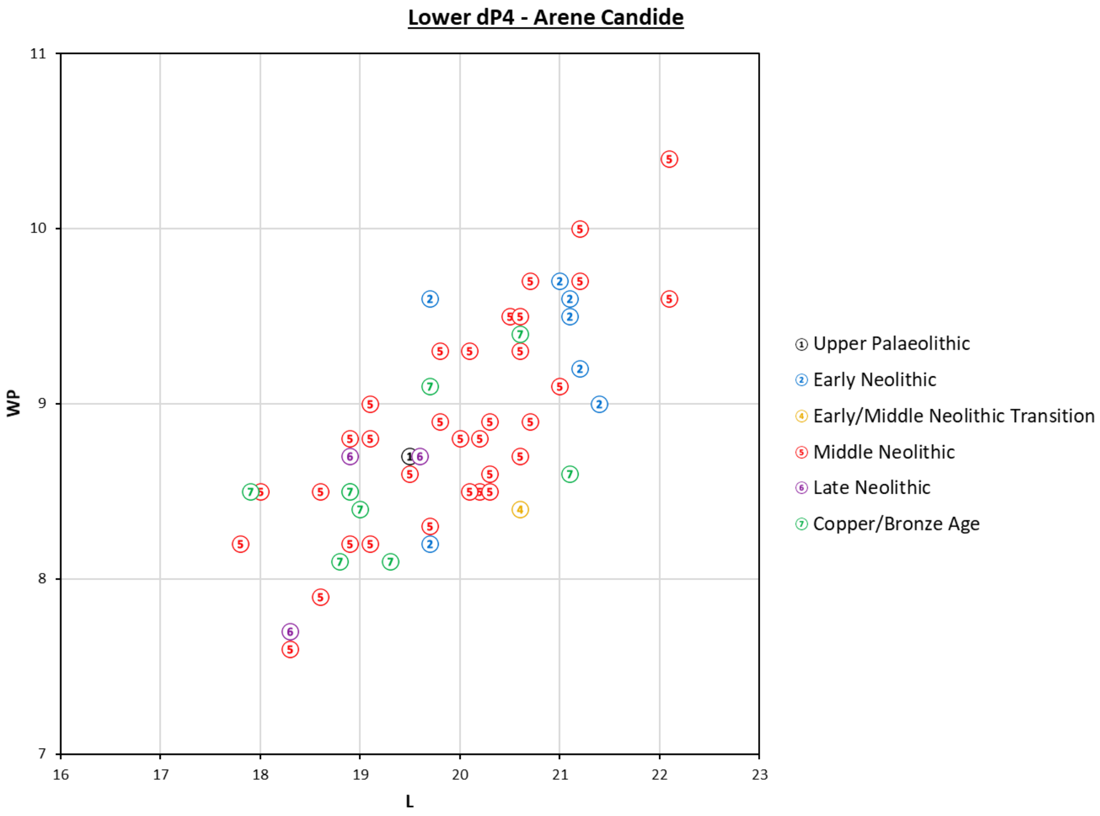


Figure 7.61. Astragalus GLl and GLm scatterplots, for Arene Candide: (a) Early to Middle Neolithic; (b) Late Eneolithic to Copper/Bronze Age.



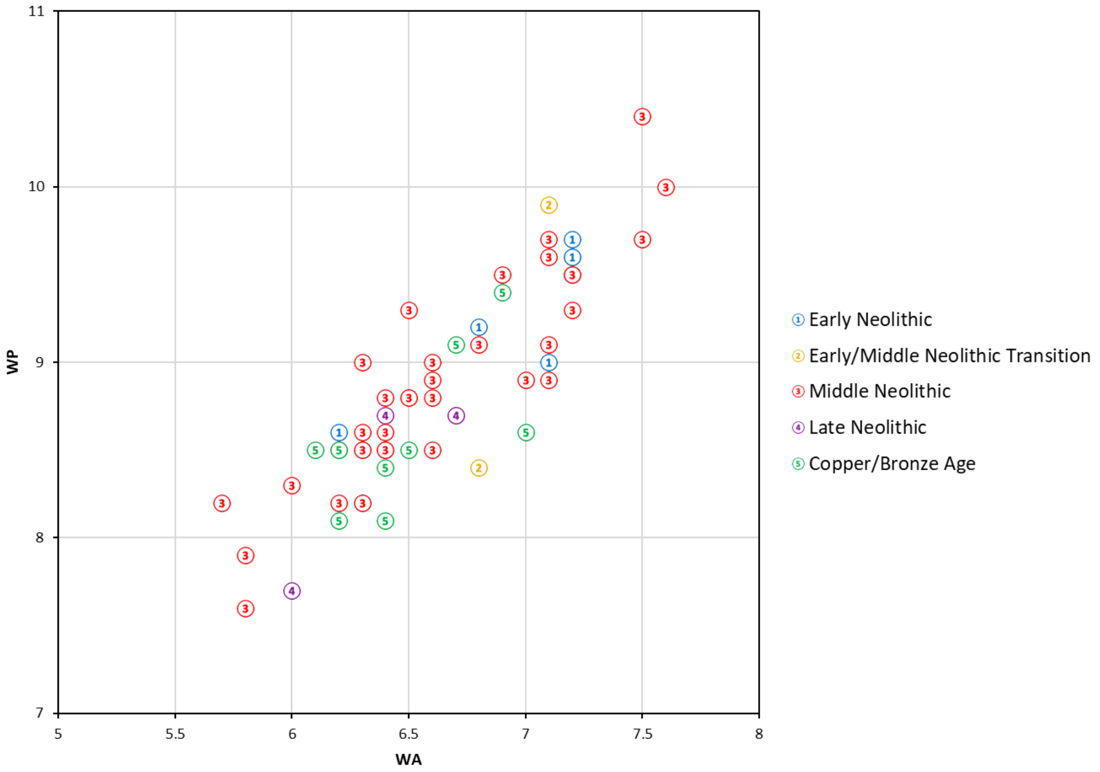


Figure 7.62. Lower dP4 length and posterior width, and anterior and posterior width scatterplots, for Arene Candide.

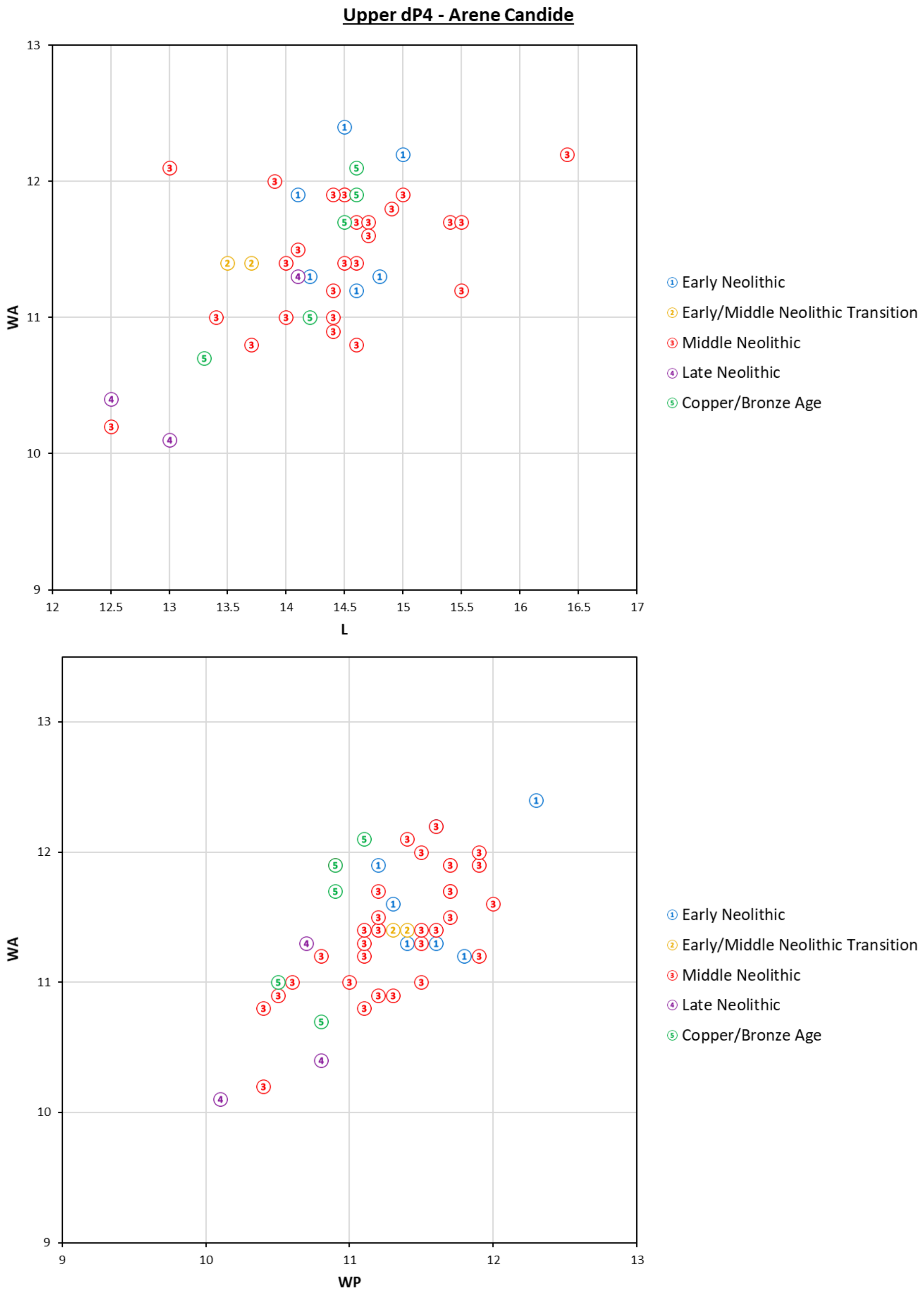


Figure 7.63. Upper dP4 length and anterior width, and posterior and anterior width scatterplots, for Arene Candide.

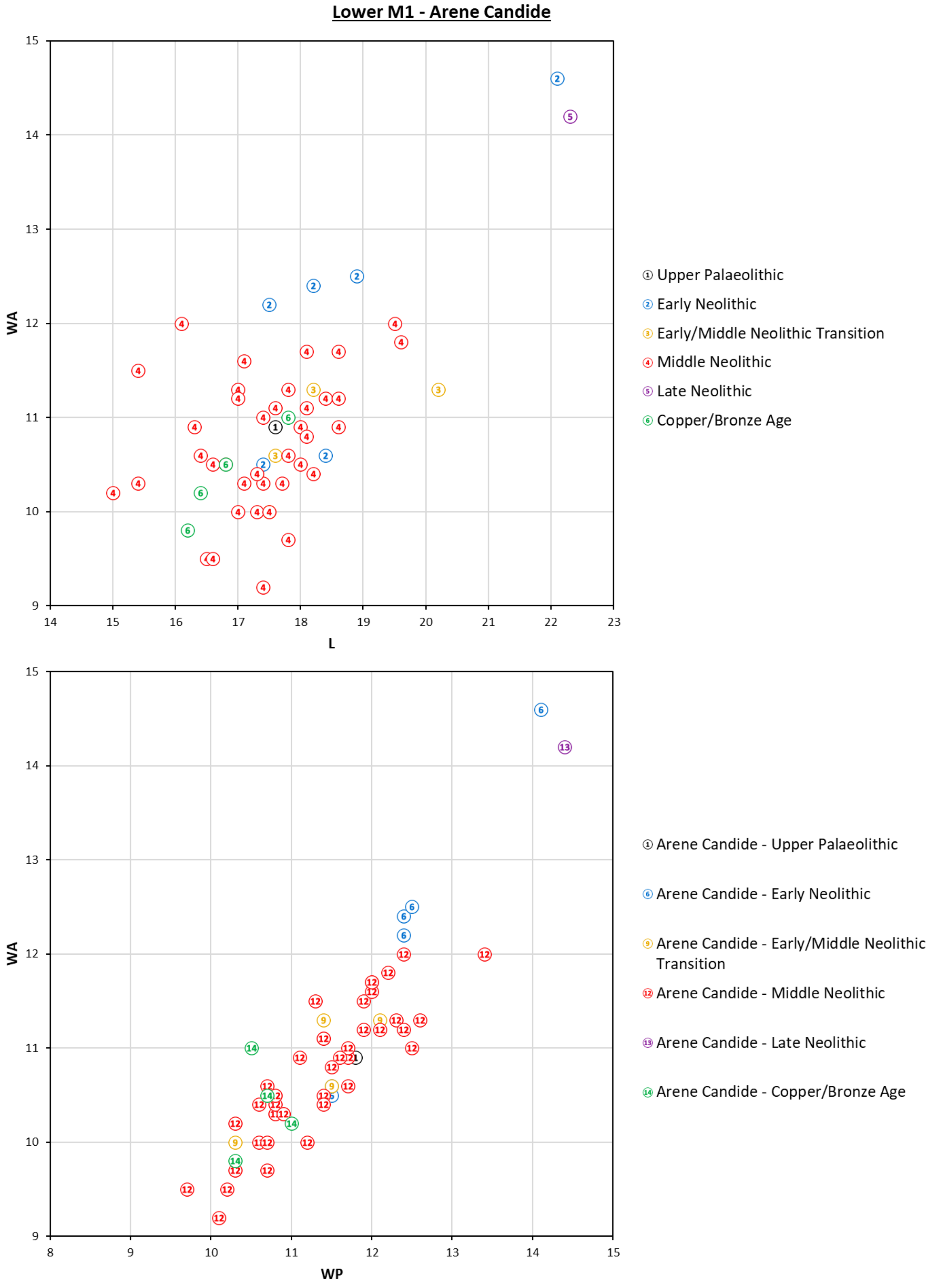


Figure 7.64. Lower M1 length and anterior width, and posterior and anterior width scatterplots, for Arene Candide.

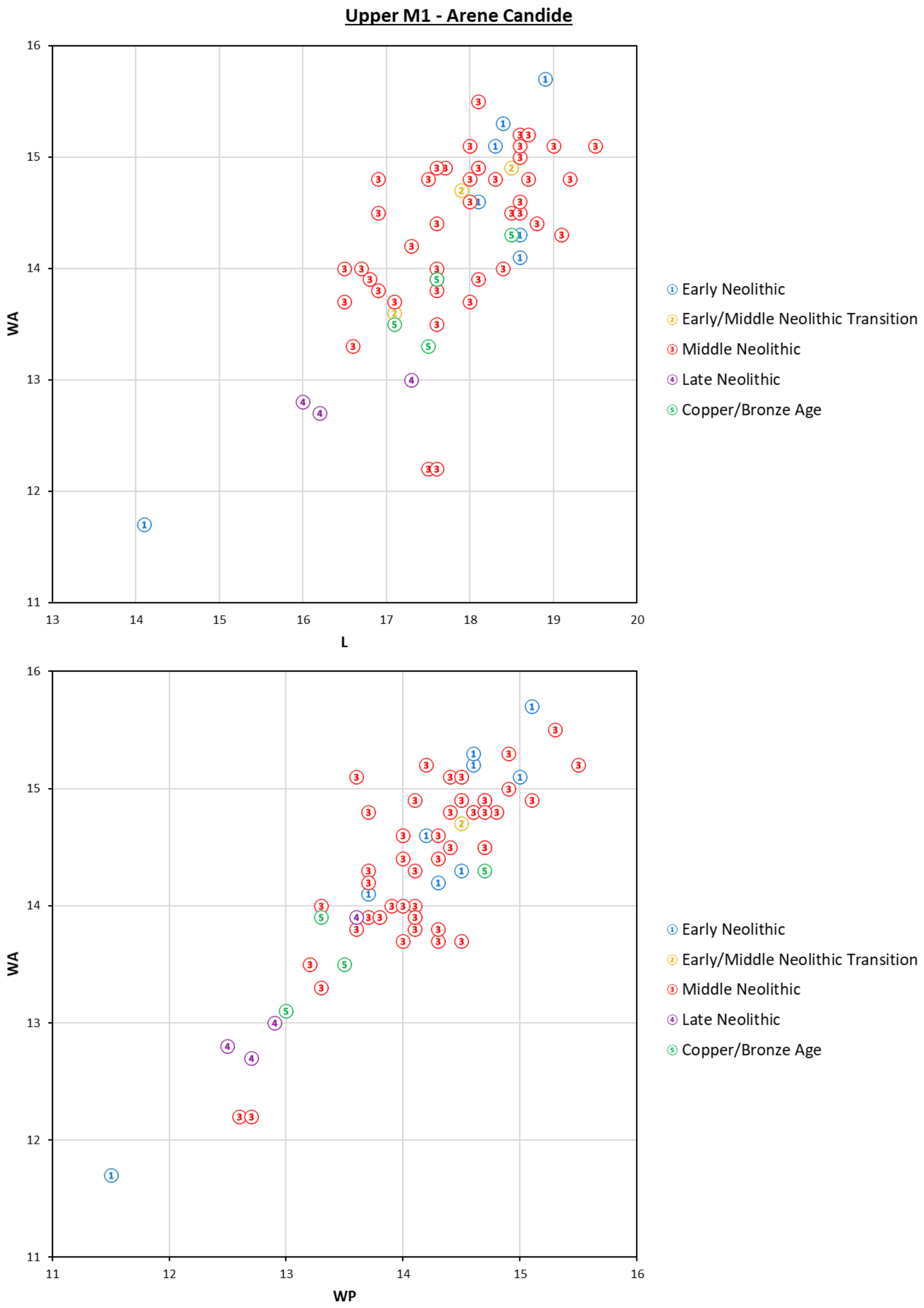


Figure 7.65. Upper M1 length and anterior width, and posterior and anterior width scatterplots, for Arene Candide.

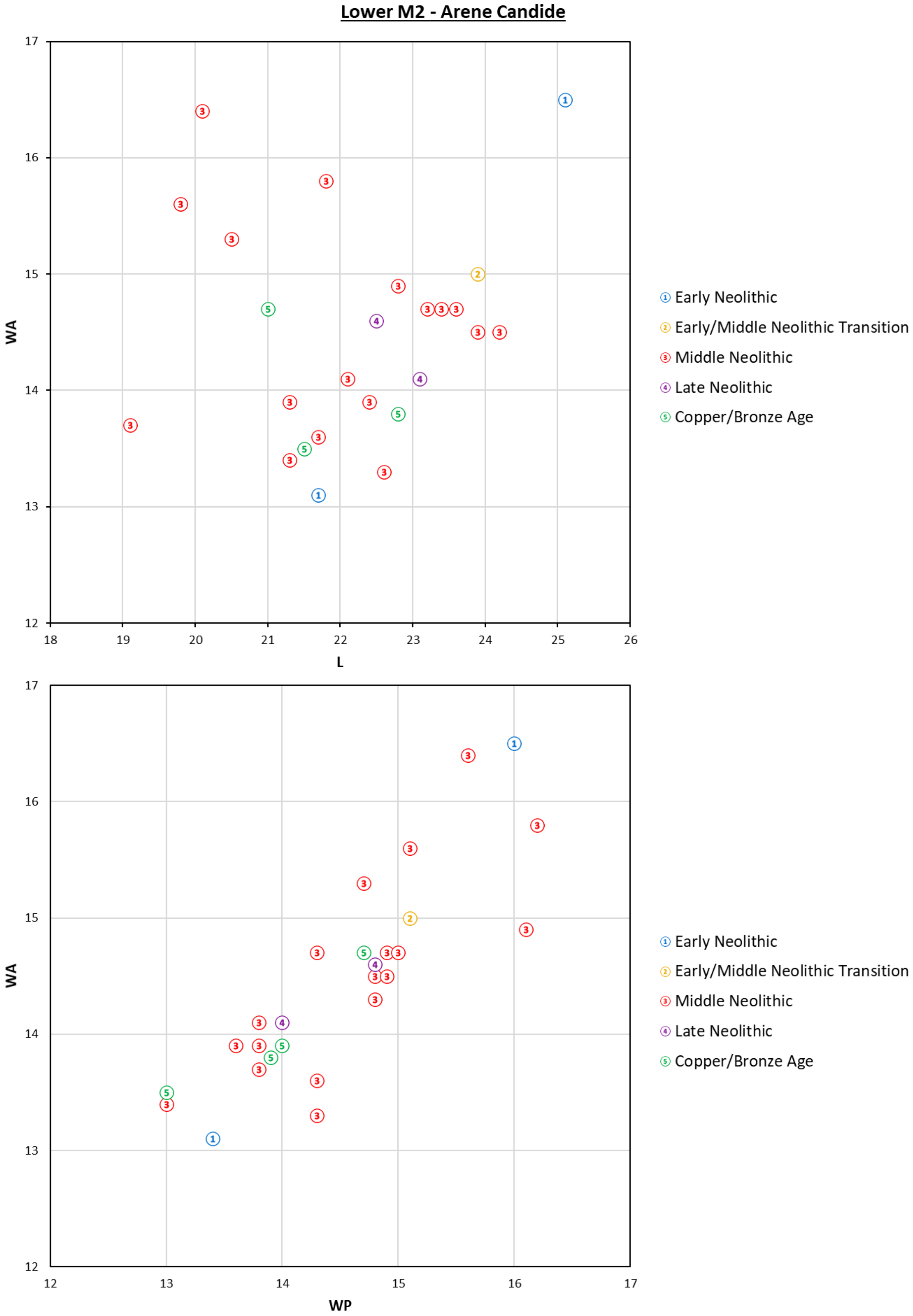


Figure 7.66. Lower M2 length and anterior width, and posterior and anterior width scatterplots, for Arene Candide.

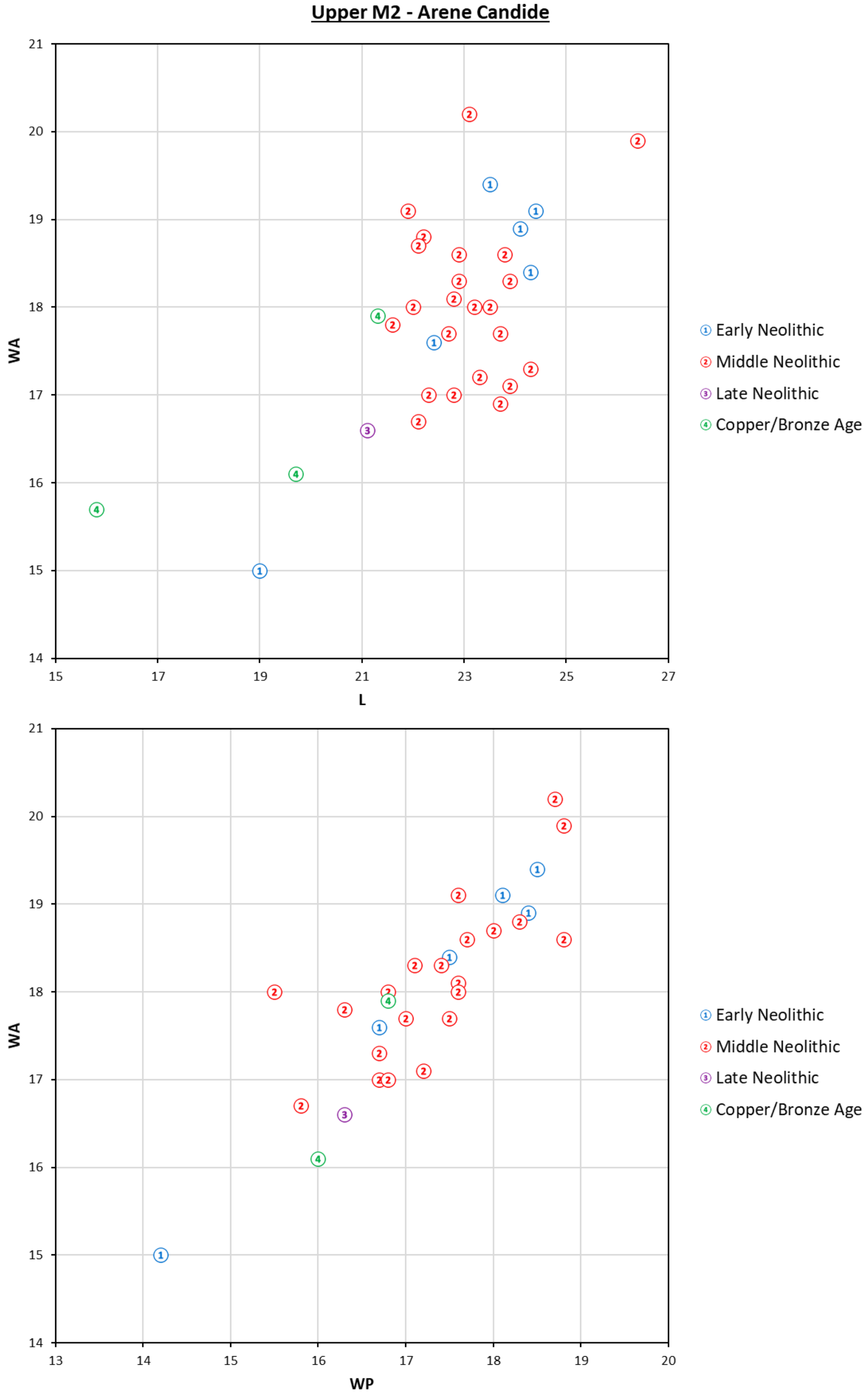


Figure 7.67. Upper M2 length and anterior width, and posterior and anterior width scatterplots, for Arene Candide.

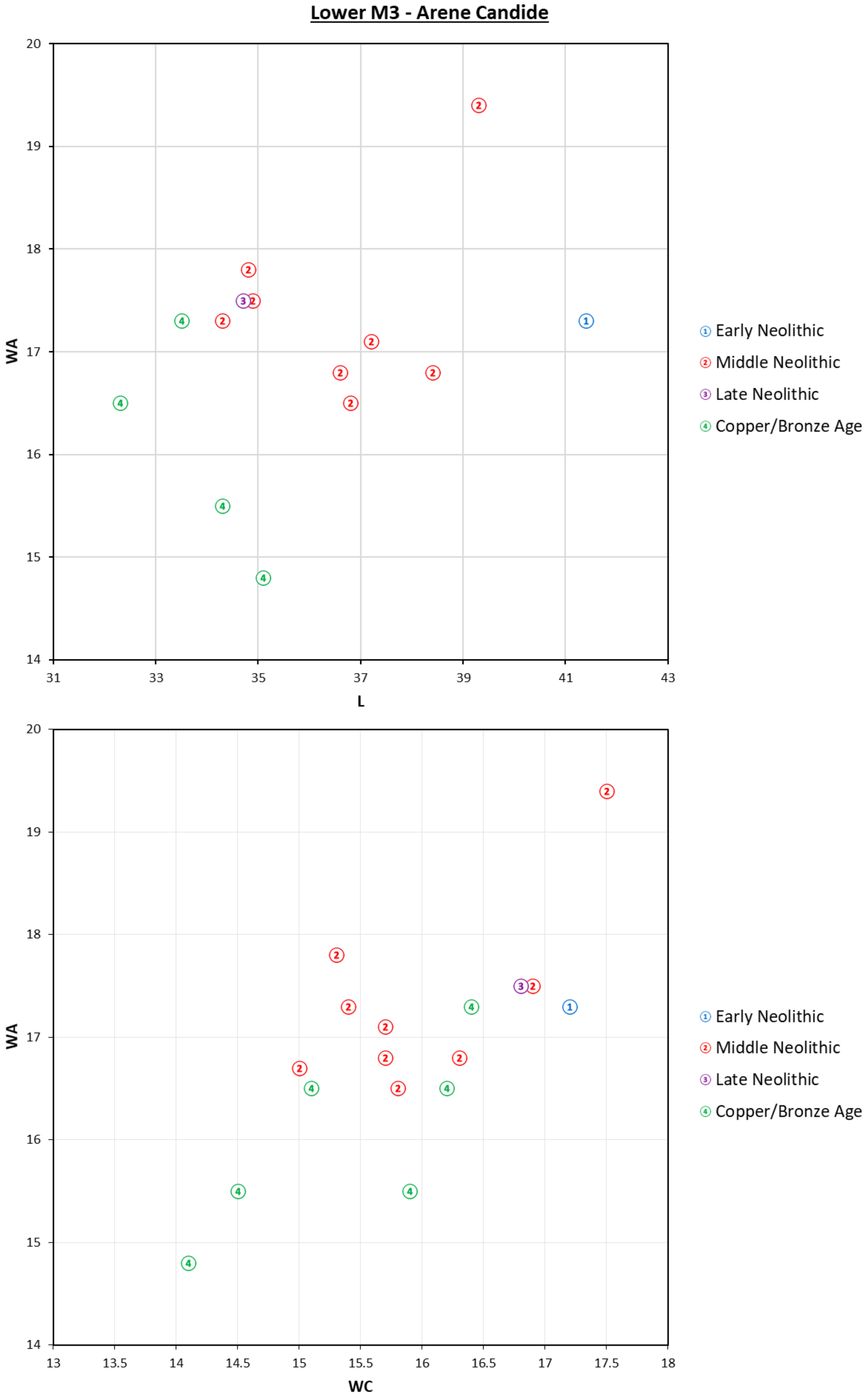


Figure 7.68. Lower M3 length and anterior width, and central and anterior width scatterplots, for Arene Candide.

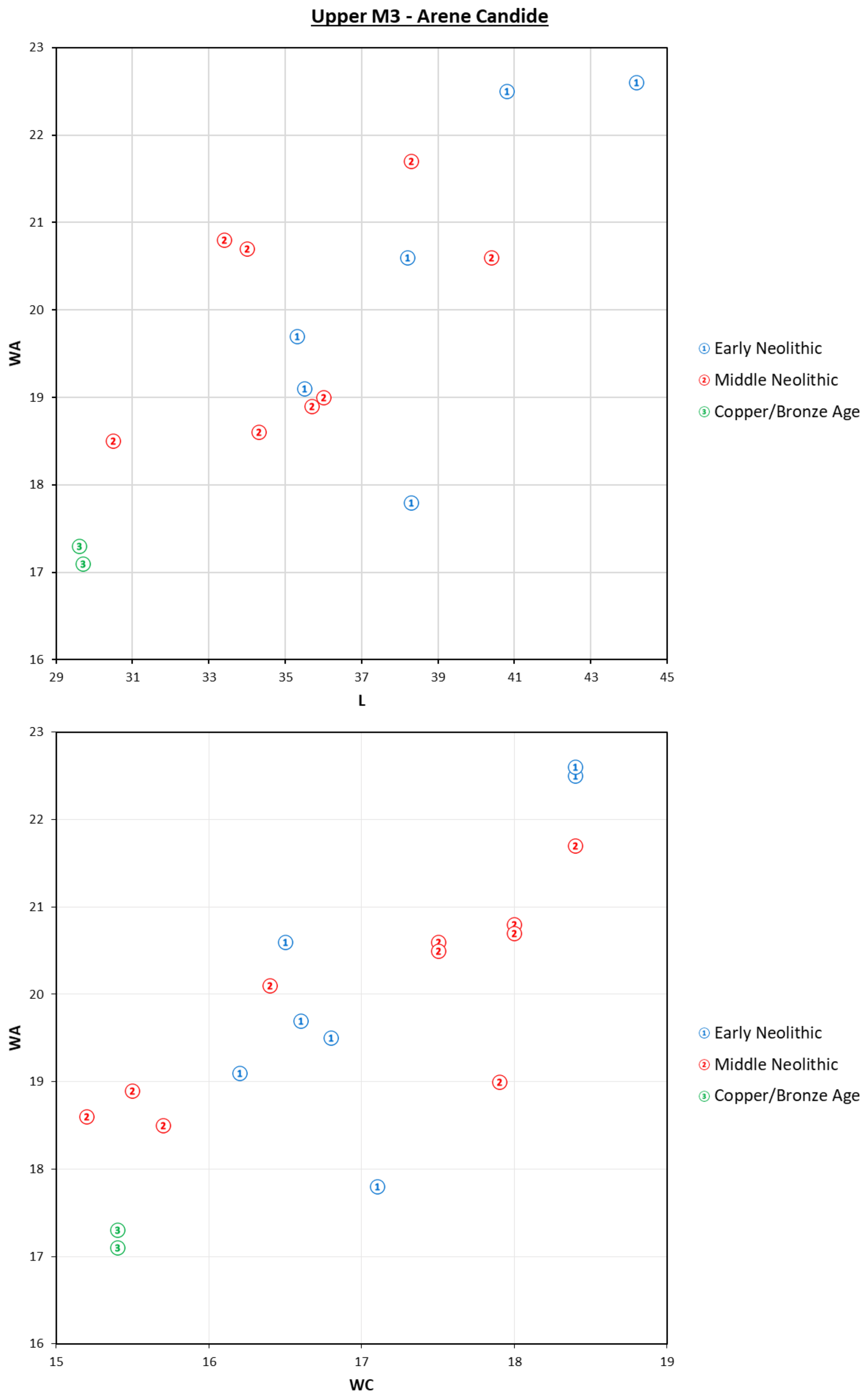


Figure 7.69. Upper M3 length and anterior width, and central and anterior width scatterplots, for Arene Candide.

It has been previously observed that the shape of the third molar can vary in different pig populations, and in domestic and wild animals (Albarella et al., 2009). An example of how different this tooth can look like in different pig individuals can be seen in Figure 7.70. To investigate possible shape changes of the lower and upper third molar through time, a shape analysis of these teeth was also conducted via scatterplots (Figures 7.71 to 7.79). Two different sets of analyses were conducted. In the first, the ratio of the upper and lower third molar anterior width and length was compared to the ratio of the central width and length, to observe possible shape changes through time independently of size (Figures 7.71 to 7.74). In all cases, no visible differences were observed between the Upper Palaeolithic/Mesolithic and Early/Middle Neolithic, although the sample sizes are small when considered individually. However, the results do indicate changes from the Late Neolithic/Eneolithic onwards. Indeed, in the case of the Northern and Central sites, the results of both the lower and upper third molar indicate a change at least from the Eneolithic onwards towards a tooth which is wider – mostly in the central cusp, but also slightly in the anterior – in comparison with the length. This could be a consequence of more intensive husbandry and genetic isolation. The Southern and Island sites evidence a different scenario, with the lower third molar showing a slight change from Late Eneolithic onwards, suggested by roughly half of the distribution decreasing in central width in relation to length. The upper third molar, however, evidences the opposing trend during the same time, with an increase in central width in relation to length.

In the second third molar shape analysis, the ratio of the anterior and central widths was compared with the length of the tooth, both for upper and lower teeth (Figures 7.75 to 7.78). In the case of the Northern and Central sites, the small sample size of the Upper Palaeolithic/Mesolithic and Early Neolithic material precludes any possible comparison between those periods. When comparing the combined Upper Palaeolithic to Middle Neolithic data with that of the Eneolithic onwards, however, it is possible to detect a trend towards a shorter tooth, roughly keeping the same anterior and central widths proportions. The data from the Southern and Island sites has a dearth of Early and Middle Neolithic data, once again not allowing any comparisons between these periods and the Upper Palaeolithic and Mesolithic data. It is possible, nonetheless, to compare these periods together to the Late Eneolithic to Late Bronze Age data. This comparison for the lower third molar evidences a slight shortening of the teeth, while retaining the width proportions. The sample sizes for the upper molar evidence a change from the Late Eneolithic onwards towards an increase in size of the central pillar in comparison to the anterior one plus once again a shortening of the tooth, although the sample size is in this case smaller than for the lower tooth. This evidence pointing to a shorter third molar could be related to the shortening of the snout, a phenomenon linked to domestication.

Figure 7.70. Photos showing different shapes of lower third molars in pig jaws. Left: Molino Casarotto (Middle Neolithic); Right: Coppa Nevigata (Middle to Late Bronze Age). Photos by S. Tecce.

Figure 7.71. Lower M3 shape (width-length ratios) scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

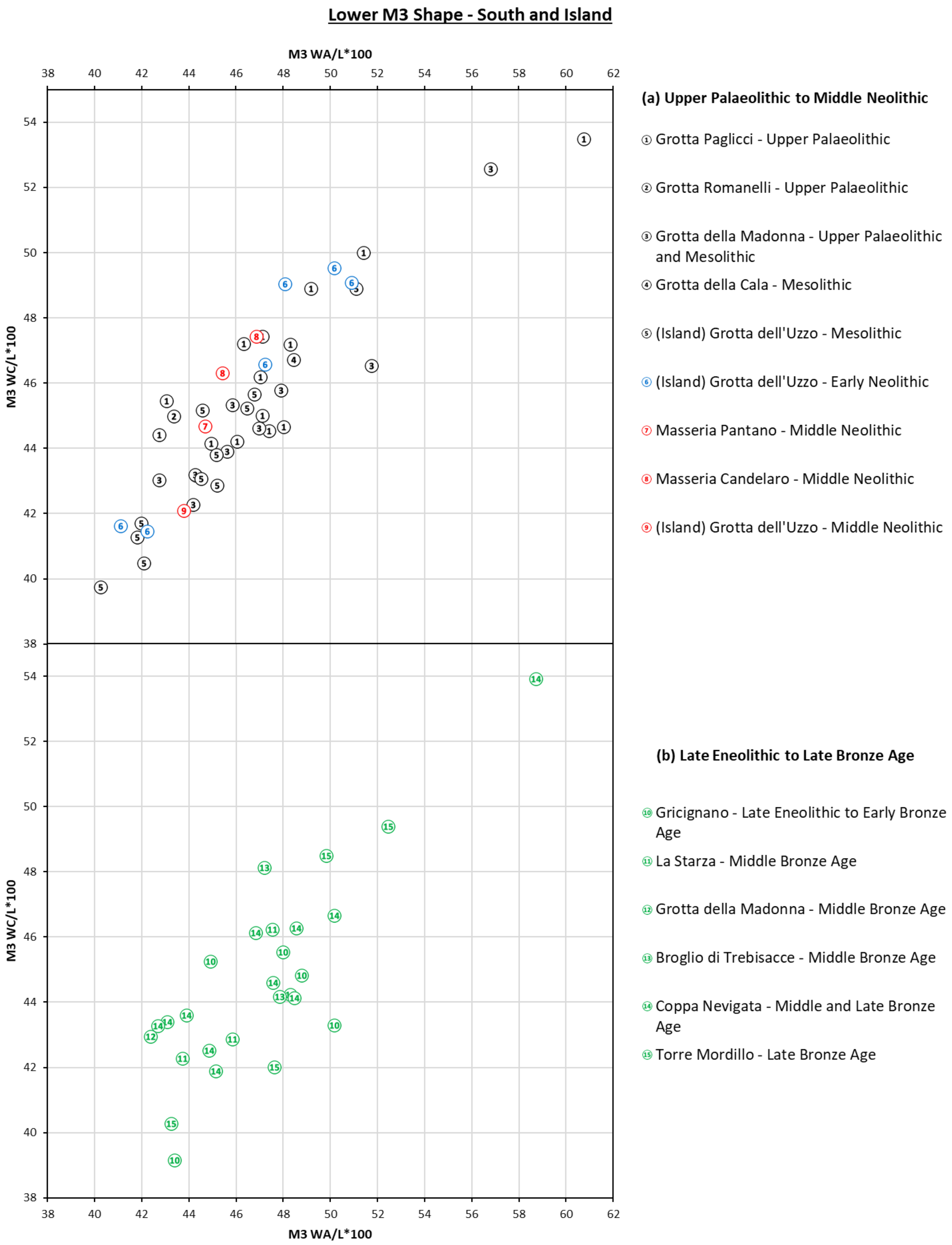


Figure 7.72. Lower M3 shape (width-length ratios) scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

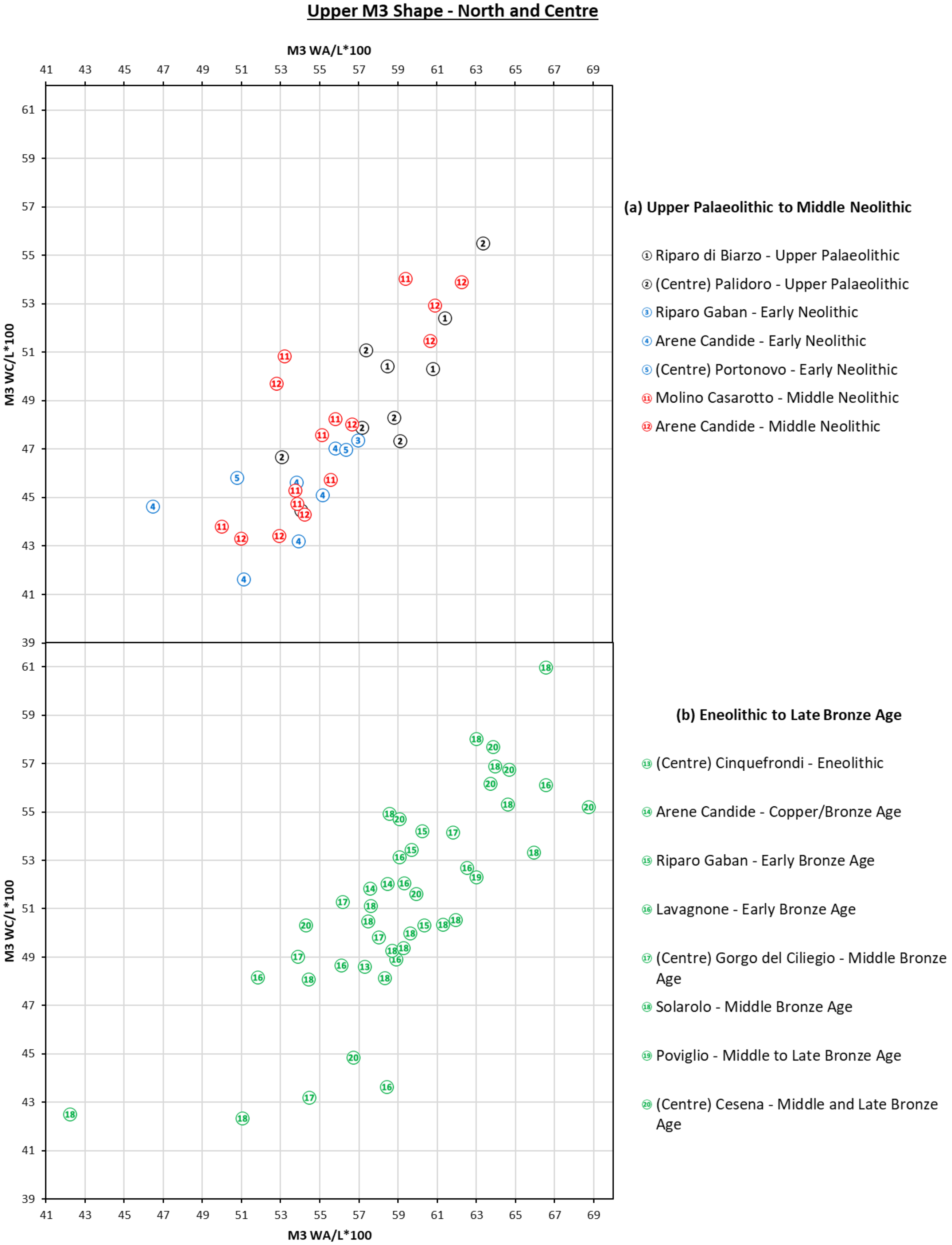


Figure 7.73. Upper M3 shape (width-length ratios) scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Eneolithic to Late Bronze Age.

Figure 7.74. Upper M3 shape (width-length ratios) scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

Figure 7.75. Lower M3 shape (widths ratio and length) scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Neolithic to Late Bronze Age.

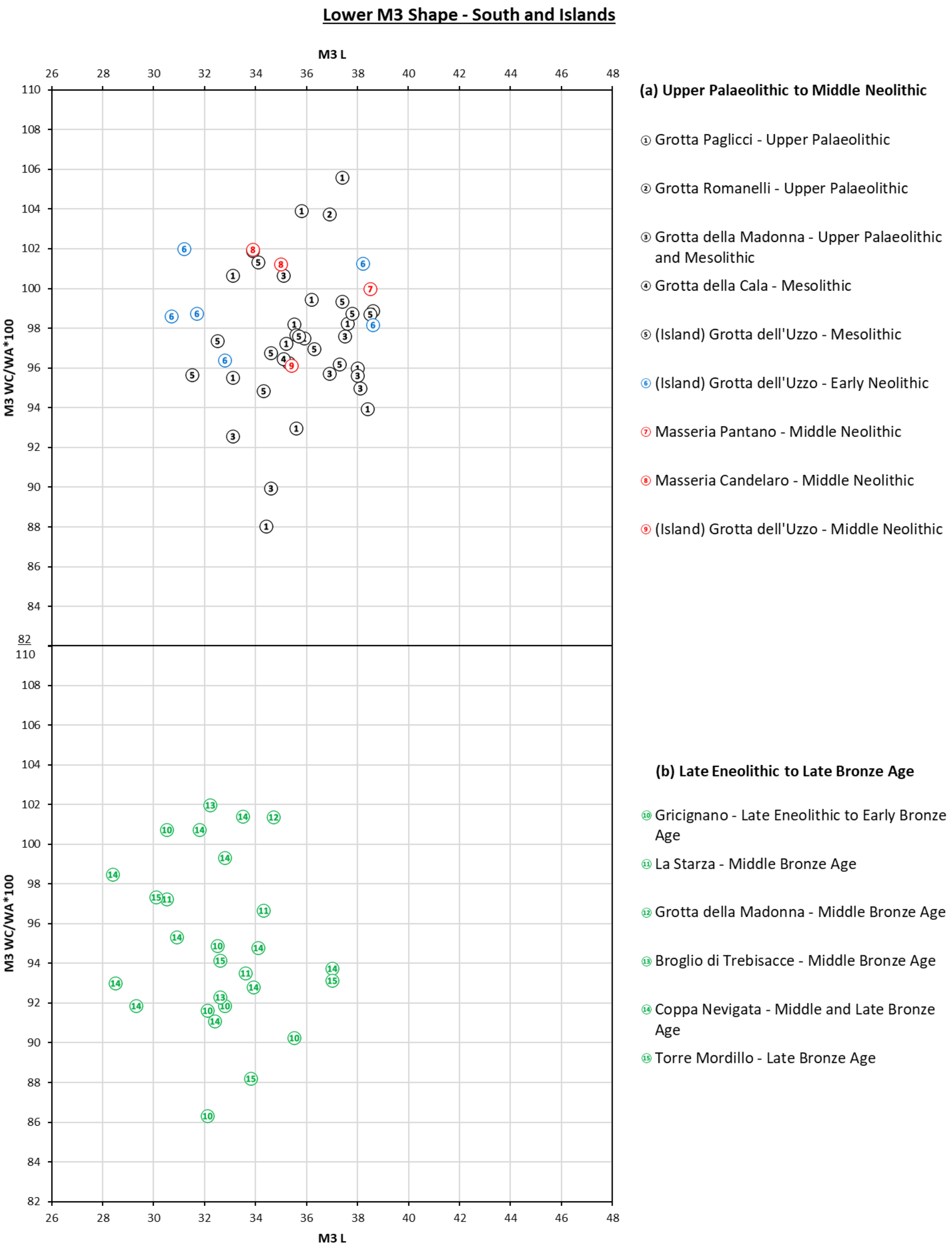


Figure 7.76. Lower M3 shape (widths ratio and length) scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

Figure 7.77. Upper M3 shape (widths ratio and length) scatterplots, for North and Central sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Eneolithic to Late Bronze Age.

Figure 7.78. Upper M3 shape (widths ratio and length) scatterplots, for South and Island sites: (a) Upper Palaeolithic to Middle Neolithic; (b) Late Eneolithic to Late Bronze Age.

In sum, all postcranial elements analysed provide a largely similar pattern: it is only after the Late Neolithic that a clear bimodality in the data, representing two pig populations, can be seen. The tooth data shows the same general pattern, but the clear bimodality observed for the postcranial bones during later prehistoric times is not echoed by this information. Although caution is warranted as some of the period/region combinations are not well represented, the fact that a similar trend is observed for all the different postcranial bones and teeth analysed guarantees greater confidence in the results. The data shows, so far, a different rate of size changes of postcranial bones and teeth, with the former changing at a faster rate than the latter, suggesting the possibility that a local domestication of pigs could have been taking place in the Italian peninsula, as teeth are more conservative. In a scenario where most of the domestic pigs were being introduced from other areas, we would expect the teeth to show changes simultaneously to postcranial bones, as a reflection of a different pig population being introduced, but that is not the case in this data. In terms of third molar shape, the evidence points towards a shape change from at least the Eneolithic onwards. A shortening of the third molars can also be detected during those periods, which could be related to a shortening of the snout, a fact usually linked to domestication.

7.3.b. Log ratios

The second part of this biometrical study concerns the analysis of the log ratios for selected individual sites with a minimum sample size of 10 across the Italian peninsula and Sicily. In terms of chronology, it is important to keep in mind that the sites of Rivoli, part of the Middle Neolithic assemblage of Arene Candide, Cornuda, and Mulino Sant'Antonio are all roughly contemporary, and have evidence of late Square Mouthed Pottery. However, and as mentioned in Chapter 6, in order to be consistent with previous zooarchaeological studies of these sites, Rivoli and Arene Candide are considered Middle Neolithic, while Cornuda and Mulino Sant'Antonio are classified as Late Neolithic.

Figures 7.79 to 7.80 and 7.84 to 7.85 show the log ratios of pig postcranial bones and teeth, respectively, for the Upper Palaeolithic, Mesolithic, and Early Neolithic periods. It can be observed that the teeth of wild boar are proportionally smaller than their postcranial bones in the Upper Palaeolithic and Mesolithic samples (in relation to the Durrington Walls standard), and this correlation continues through to the Early Neolithic, when the domestic/wild status of the pigs is of course unknown. This pattern had been previously observed by Albarella et al. (2006c), and it is here confirmed, using additional data. Significantly, all analysed sites follow the same trend.

Regarding the data for the Early Neolithic sites (Figures 7.80 and 7.85), when compared to the central Upper Palaeolithic site of Palidoro, the means for Arene Candide, La Marmotta, and Baselice pig postcranial bones are slightly larger, although more similar to the southern wild boar size of Upper Palaeolithic Grotta Paglicci and Upper Palaeolithic and Mesolithic Grotta della Madonna. The same observations can be put forward in the case of the tooth data from the Early Neolithic northern and central sites of Riparo Gaban, Arene Candide, Portonovo, and La Marmotta, which is more similar in size to the southern wild boar than to the smaller northern/central wild boar from the Upper Palaeolithic/Mesolithic. Conversely, the teeth from the Early Neolithic southern site of Favella are smaller than their southern wild boar counterparts from previous periods, but consistent instead with the earlier northern/central wild boars. In sum, the Early Neolithic pigs are by and large consistent in size with the Upper Palaeolithic and Mesolithic wild boar, although their log ratios show a slightly broader spread of measurements.

At the Sicilian site of Grotta dell'Uzzo (Figures 7.79 to 7.80 and 7.84 to 7.85), the Mesolithic wild boars are smaller in both postcranial bones and teeth than those of the southern site of Grotta della Madonna, and this difference is statistically significant in some of the t-test results (Tables 7.35 to 7.37). It has previously been suggested that these could be a result of insular dwarfism occurring in the Sicilian wild boar (Albarella et al., 2006c), and the smaller size of the Grotta dell'Uzzo animals in comparison with the peninsular ones has also been observed for red deer (Tagliacozzo, 1994a). At this site, a slight decrease in postcranial size can be observed between the Mesolithic and Early Neolithic-early Middle Neolithic periods, which is, in a few cases, statistically significant (Table 7.35). Changes is culling patters have also been observed (Tagliacozzo, 1994a; see also Chapter 7.1), suggesting, if not the beginnings of a domestication event, at least an increase in hunting pressure (see also Albarella et al., 2006c).

Figures 7.81 and 7.86 show the results of the log ratio analysis of postcranial bones and teeth, respectively, for the Middle Neolithic period in the northern sites of Rivoli, Molino Casarotto, and Arene Candide, and the southern site of Grotta della Madonna. At first glance, the correlation noted for the previous phases between postcranial bones and teeth – the former being smaller than the latter in comparison with the standard – continues on throughout the Middle Neolithic in the sites analysed. There is only a slight reduction in postcranial size between Early and Middle Neolithic. The southern site of Grotta della Madonna shows a slightly larger mean than the previous period site of Baselice, although the sample size is small. The teeth are consistent in size with those of previous periods, with the southern sites of Grotta della Madonna exhibiting some very small specimens, while Masseria Pantano has a slightly larger mean than before. All in all, the Middle Neolithic pigs do not show substantial size changes in comparison with previous periods.

The Middle Neolithic site of Molino Casarotto is unusual, due to the especially large size of the postcranial pig bones sampled, even when compared with earlier Mesolithic and Neolithic data. An increase in 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, as well as the likelihood that most of the Molino Casarotto pigs represent wild boar mixed (and probably interbred) with domestic pigs under loose management. A high presence 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 sustenance through the exploitation of the rich surrounding woodland environment (Boyle, 2014b,a).

The log ratios for postcranial bones and teeth for the Late Neolithic and Eneolithic and Copper/Bronze Age sites can be seen in Figures 7.82-7.83 and 7.87-7.88. Once again, it can be observed that the pattern of smaller teeth than postcranial bones in comparison with the standard continues in this period. However, the situation is here more complex, as there is more biometric variability, as for instance demonstrated by the increase in coefficient of variation values for the later periods at Arene Candide (see Chapter 7.3). 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; Figure 7.82). The

Late Neolithic to Early Bronze Age postcranial log ratios (Figures 7.82-7.83) 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 backed up by statistical testing (Table 7.35). The postcranial measurements tend, on the whole, towards bimodality, echoing the scatterplot results.

The Late Neolithic cases of Cornuda and Mulino Sant'Antonio are even more extreme than Molino Casarotto, as the pigs here are noticeably larger than in Middle and Late Neolithic Arene Candide. Like Molino Casarotto, at these sites the zooarchaeological evidence suggests that the hunting of wild fauna might have been the main means of meat procurement for the site's inhabitants (Albarella 1987-88; Riedel 1988). For Cornuda, Riedel noticed, while studying the pigs from the site, that, although only a limited amount of bones was suitable for measuring, other smaller specimens were also present, suggesting that domestic pigs were not altogether absent from the site (Riedel, 1988). The data from these sites indicates that the domestic and wild populations were undifferentiated on morphological terms, probably due to regular interbreeding and with likely a large wild component involved. A similar situation can be seen in Middle Neolithic Arene Candide and Rivoli, although in these cases the smaller overall pig size points at a greater domestic component. The case of the central Eneolithic site of Conelle is unique, as the bimodality is very evident, clearly showing two distinct populations of likely wild and domestic pigs. In a previous paper, the large size of the wild boars at this site has been highlighted, especially when comparing it with Mesolithic and Neolithic data (Albarella et al., 2006c), and is roughly consistent with the earlier Molino Casarotto and Cornuda pigs.

In the case of the tooth log ratios, it is during the Late Neolithic that the beginnings of a reduction in size can be seen (Figures 7.87-7.88). 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 postcranial bones (Payne and Bull, 1988). This evidence − combined with the occurrence of more noticeable differences in postcranial bones in these periods as opposed to earlier times, plus the preservation through time of the “smaller teeth in comparison with postcranial bones” relationship observed for the wild boar since the Upper Palaeolithic/Mesolithic – hint at the possibility that these domestic pigs derive from local domestication of native wild boar. During the Bronze Age, this pattern of mostly smaller pigs (likely domestic) accompanied with some larger specimens (possibly wild boar) continues on until the end of the chronological range analysed. Indeed, the progressive reduction in size can be seen in the postcranial log ratios for all sites sampled (Figures 7.82-7.83), and also in teeth, although with lower intensity (Figures 7.87-7.88). The data therefore suggests a continuation and consolidation of the pattern first identified in the Late Neolithic and Eneolithic sites.

The data from Arene Candide, spanning from Early Neolithic to Copper/Bronze Age (Figure 7.89), can serve as an example of the development of pig morphology through time in one site, thus shedding more light into the origins of the domestic pig in the area. The postcranial evidence indicates limited change from the Early to the Middle Neolithic, although during the latter period a larger spread of measurements can be seen. During the Late Neolithic, there is a clear shift towards smaller animals, with some elements still plotting on the larger side of the spectrum. Despite the limited sample size, the results for this period hint towards bimodality, probably indicating the presence of domestic pigs and a smaller component of wild boar. This trend continues during the Copper/Bronze Age period. For teeth too, there is little change between the Early and Middle Neolithic. The teeth from the Late Neolithic period are, in general terms, consistent with previous times, but they do show some diminution in size and bimodality. During the Copper/Bronze Age period, the teeth continue the trend towards smaller size. All in all, the pigs from the Late Neolithic onwards at Arene Candide are noticeably smaller than in any preceding periods, indicating a change in pig management practices on the site from this time.

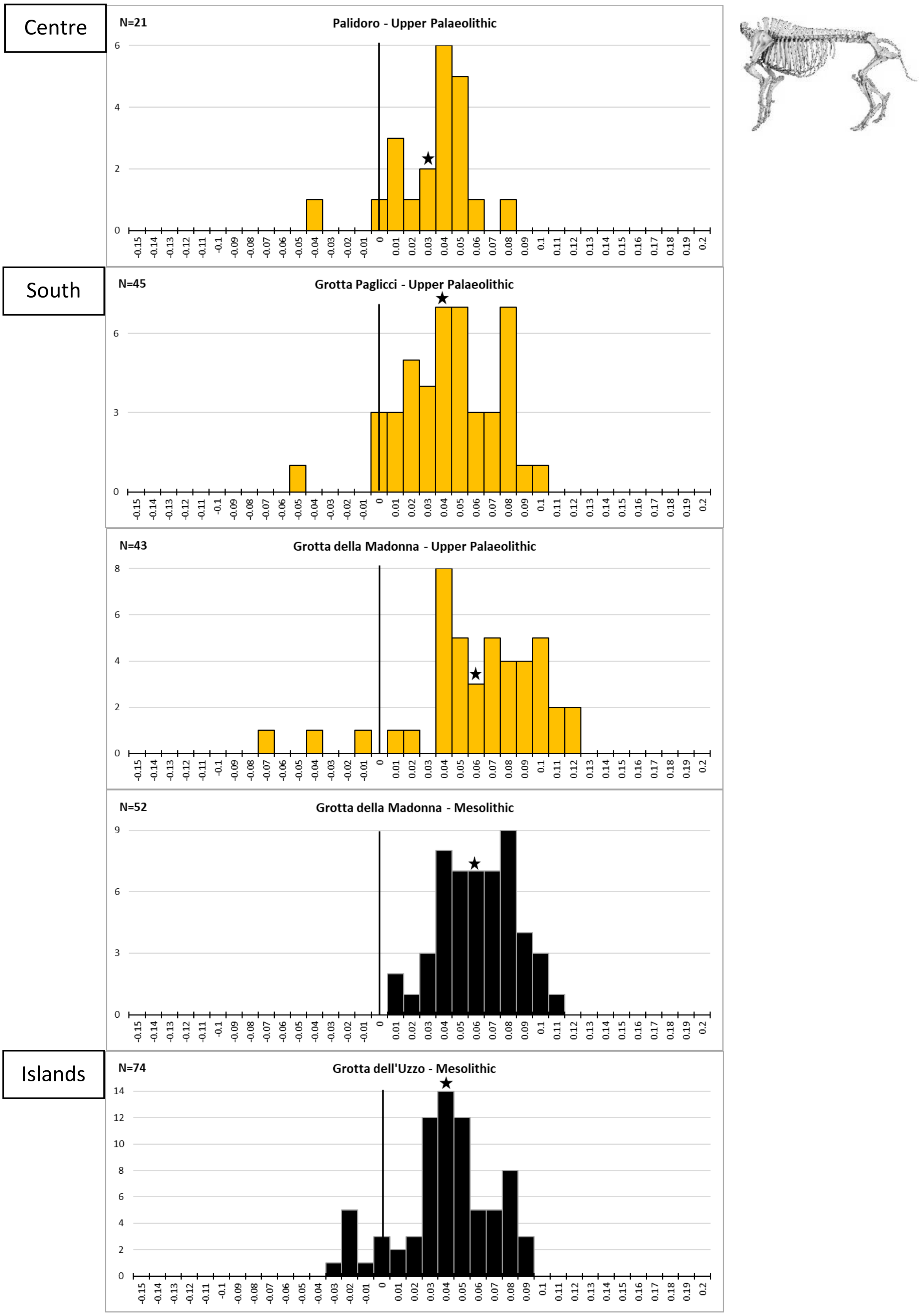
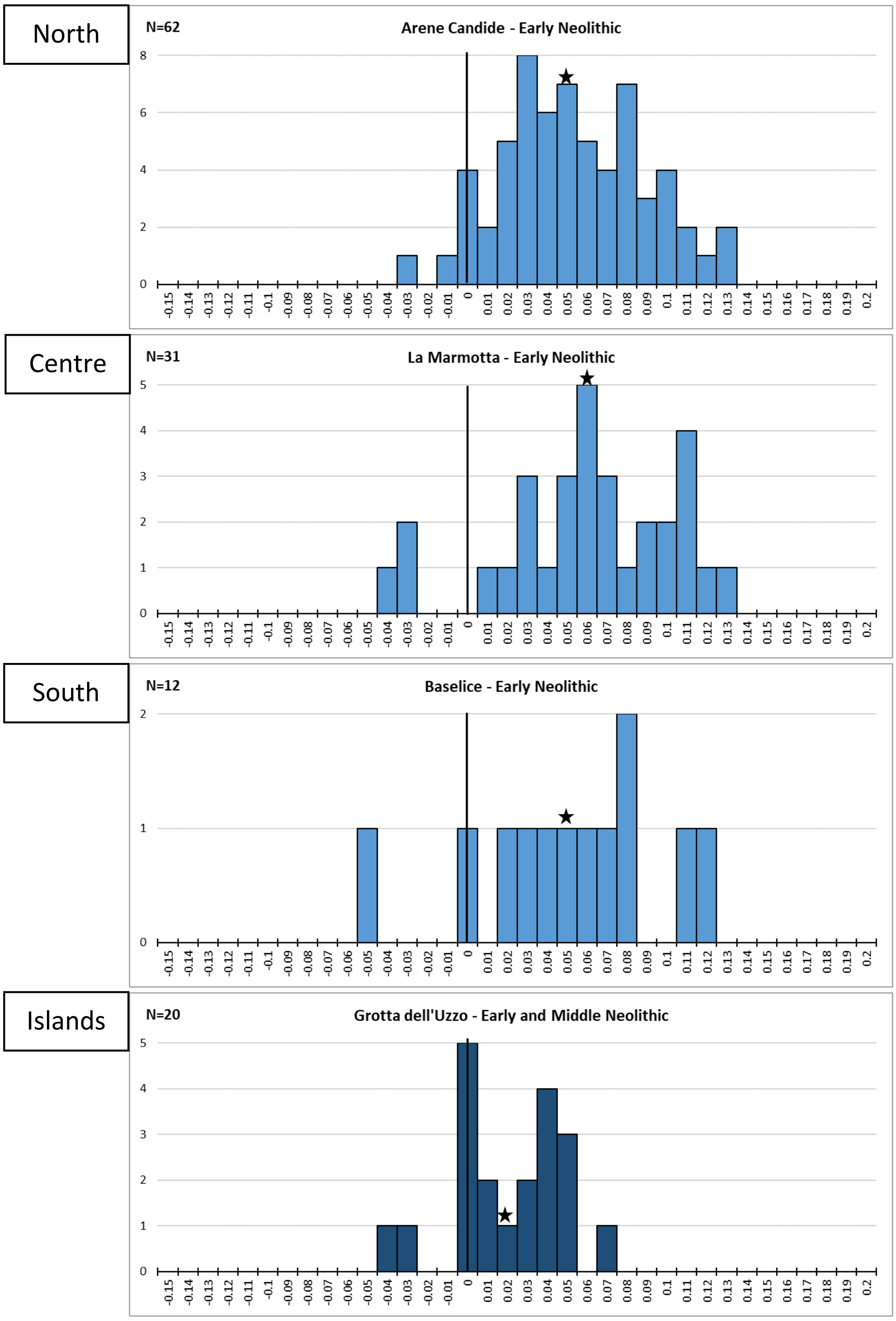


Figure 7.79. Postcranial bones log ratios for Upper Palaeolithic to Mesolithic sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.



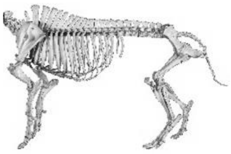
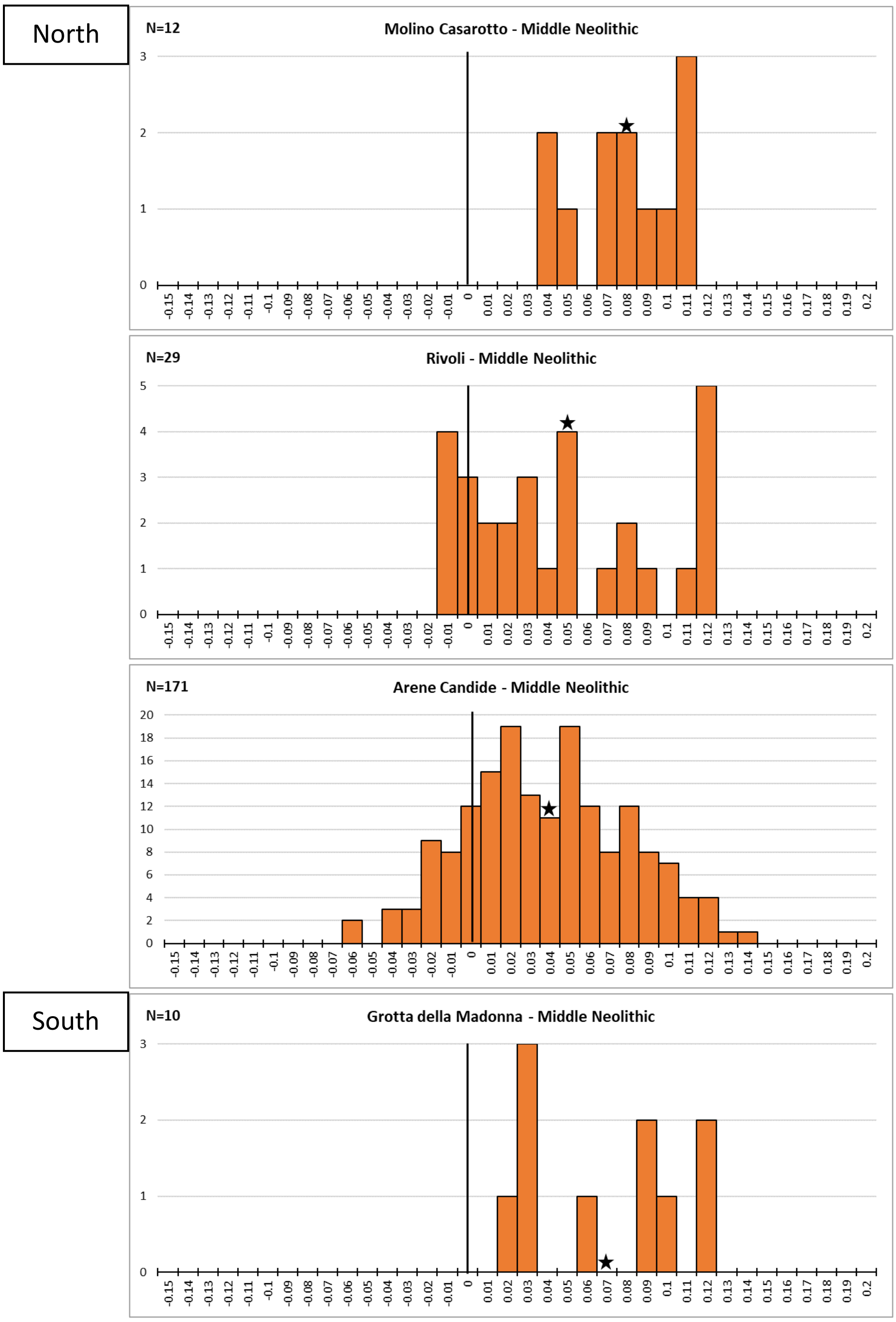


Figure 7.80. Postcranial bones log ratios for Early Neolithic sites and Early to Middle Neolithic Grotta dell'Uzzo, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.



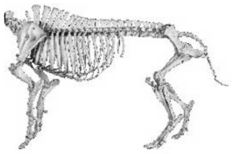


Figure 7.81. Postcranial bones log ratios for Middle Neolithic sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

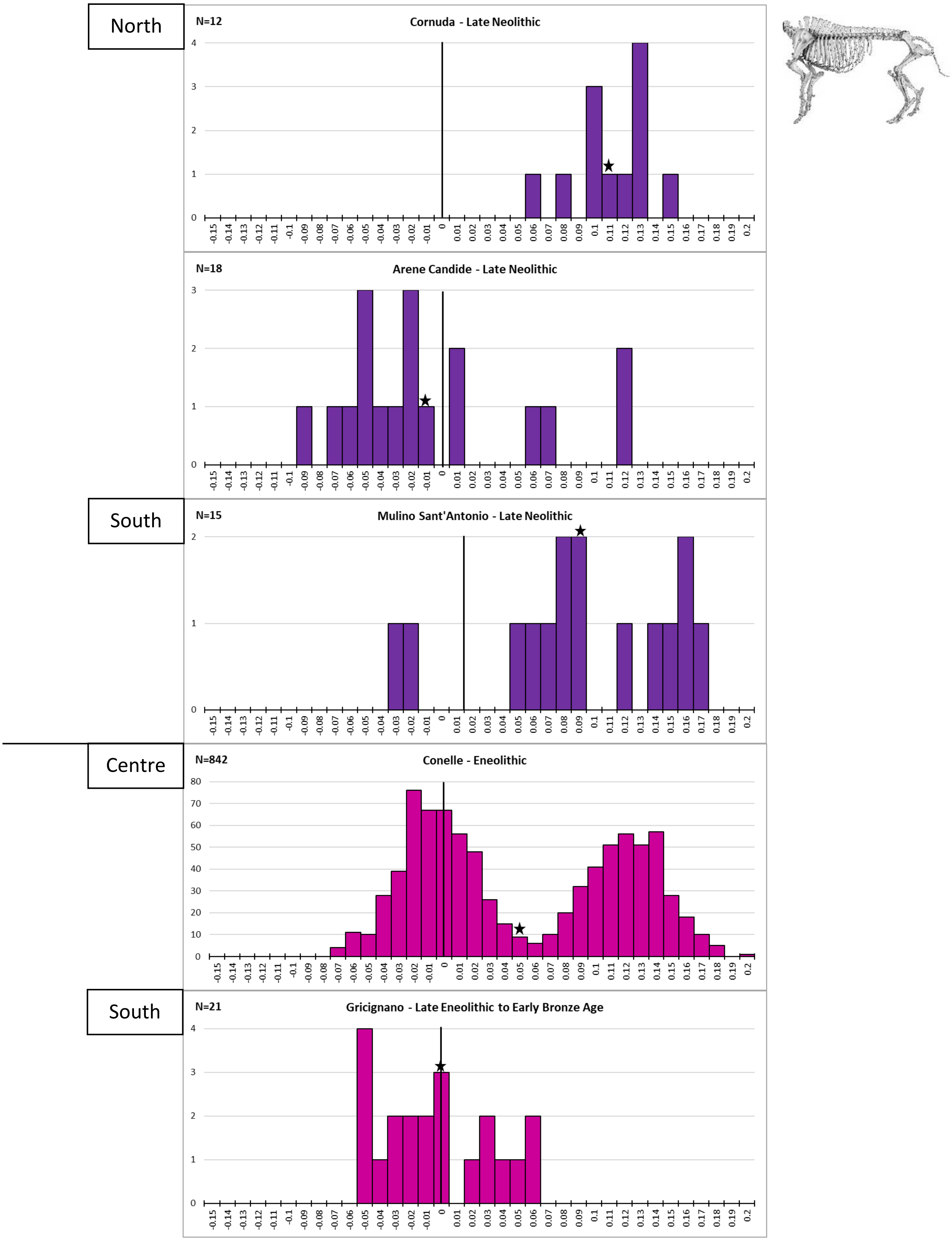
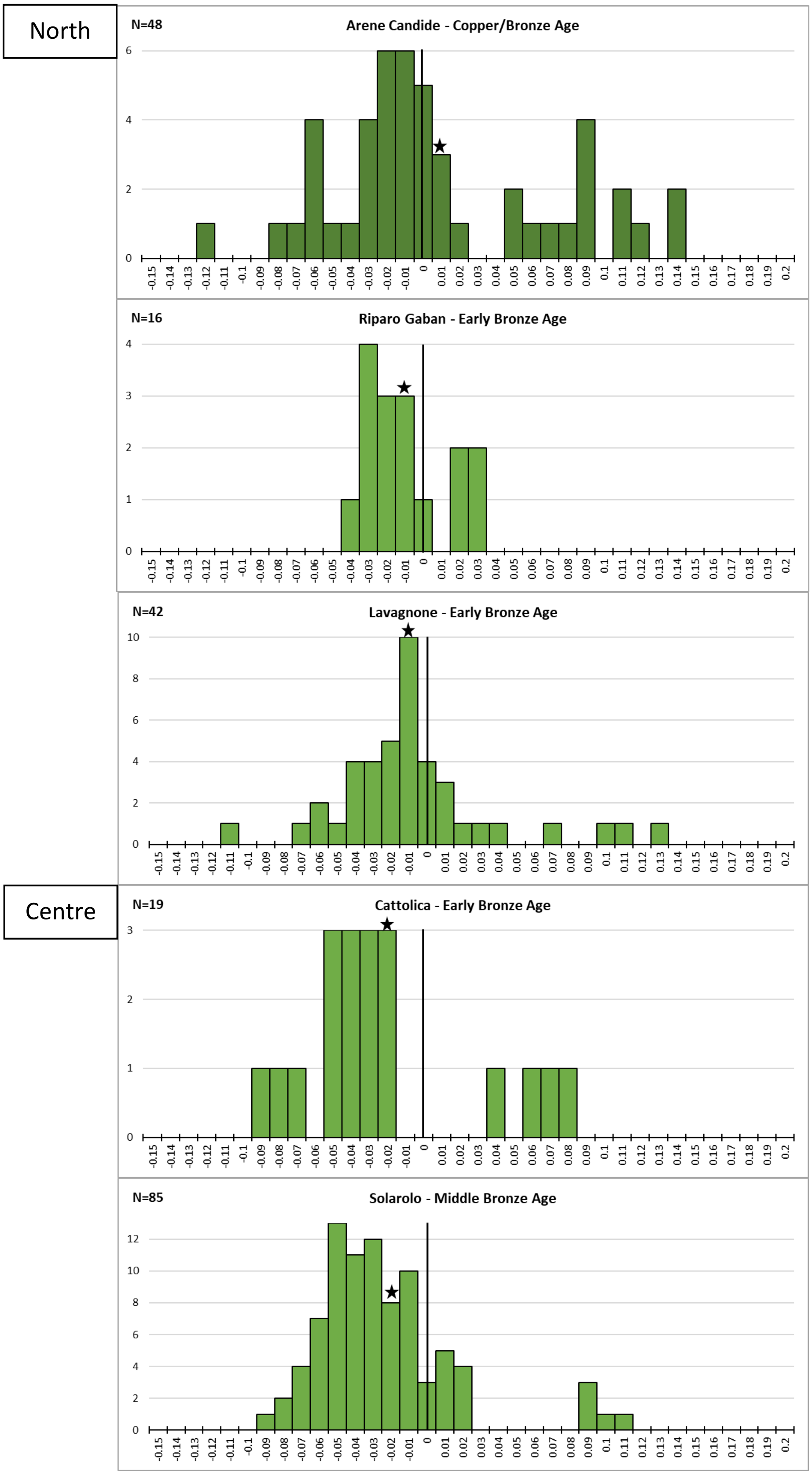


Figure 7.82. Postcranial bones log ratios for Late Neolithic to Eneolithic/Early Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.



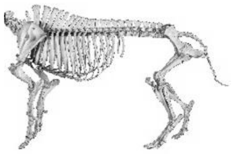


Figure 7.83. (1/4) Postcranial bones log ratios for Copper/Bronze Age and Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

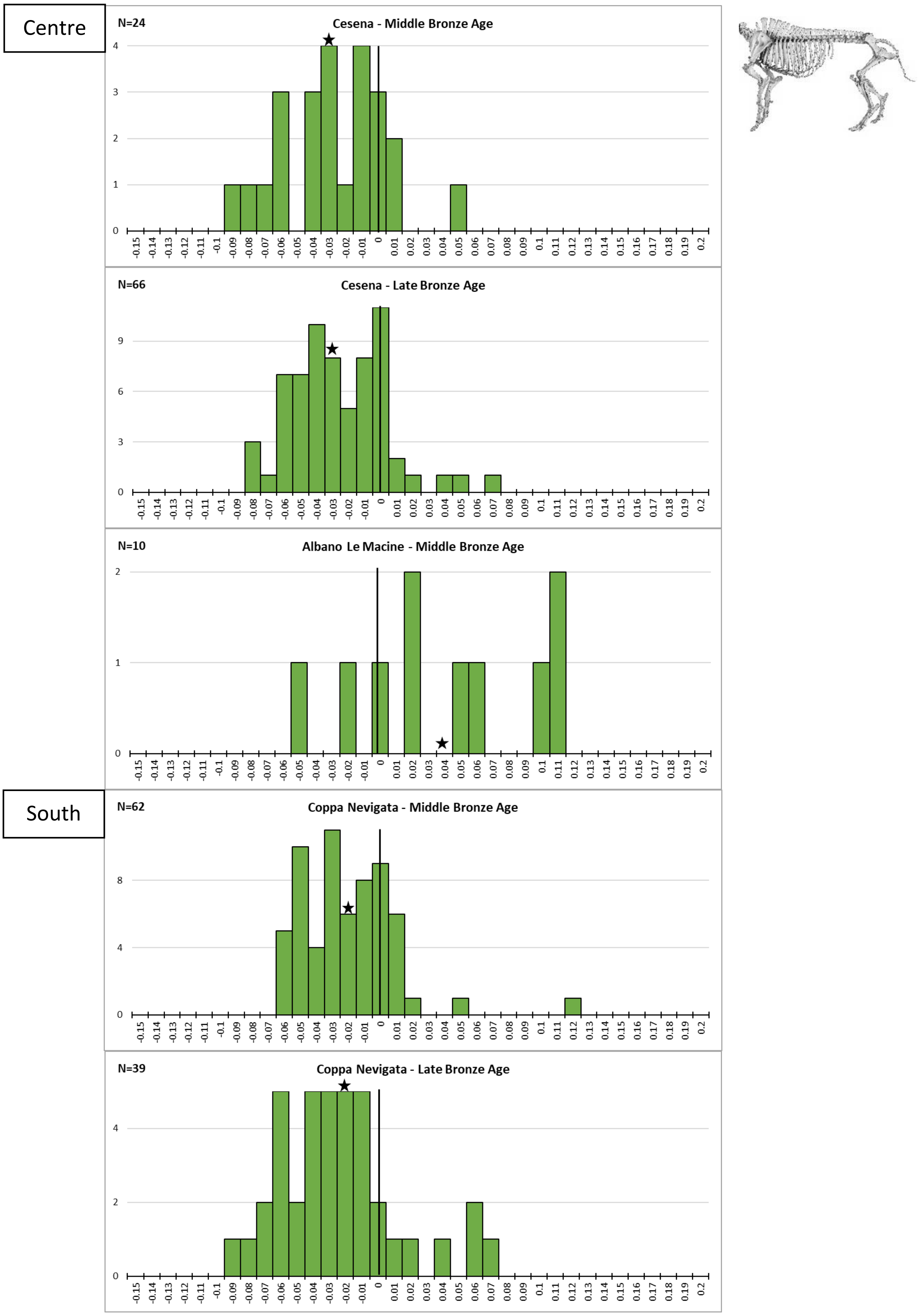
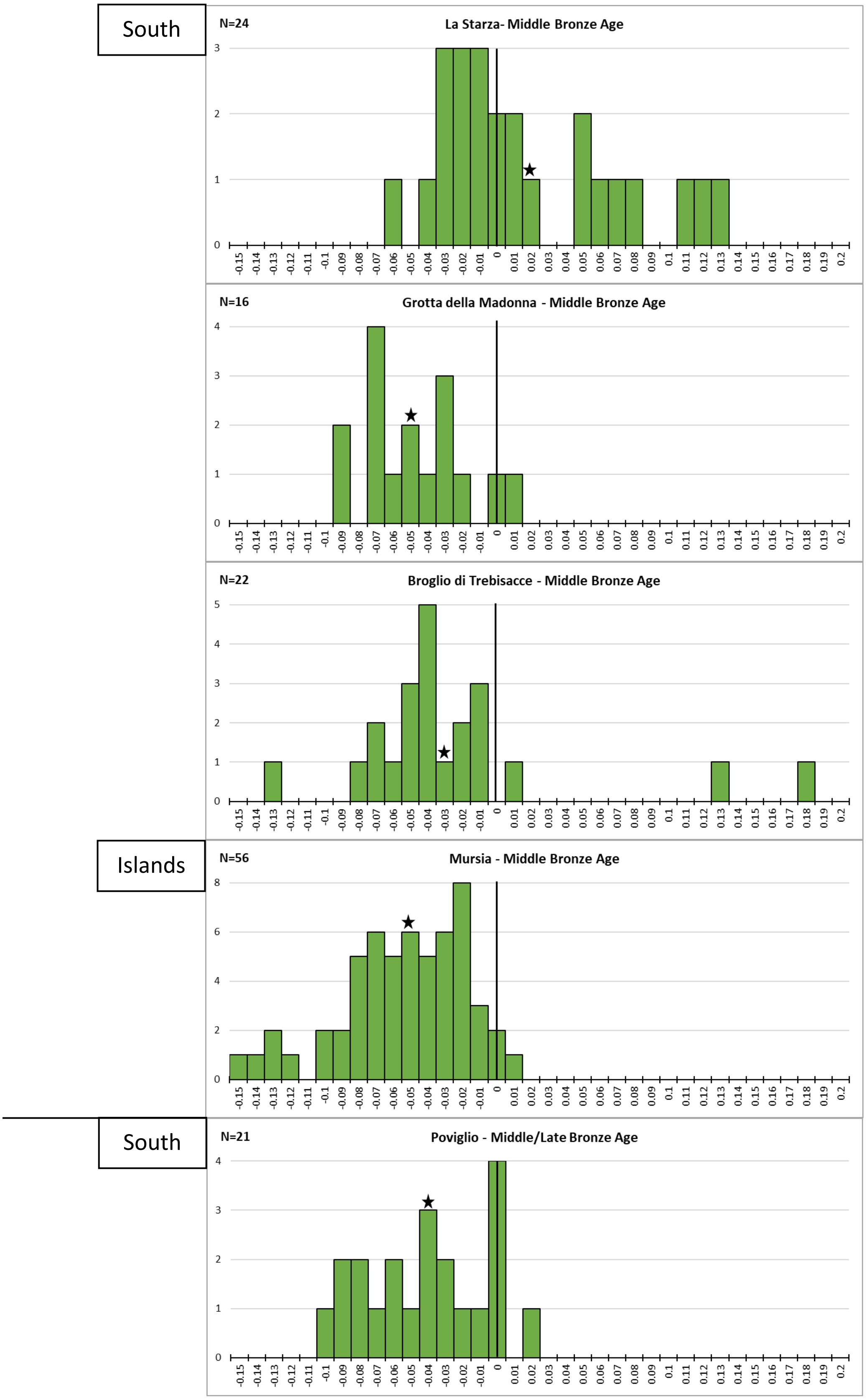


Figure 7.83. (2/4) Postcranial bones log ratios for Copper/Bronze Age and Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.



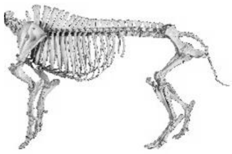
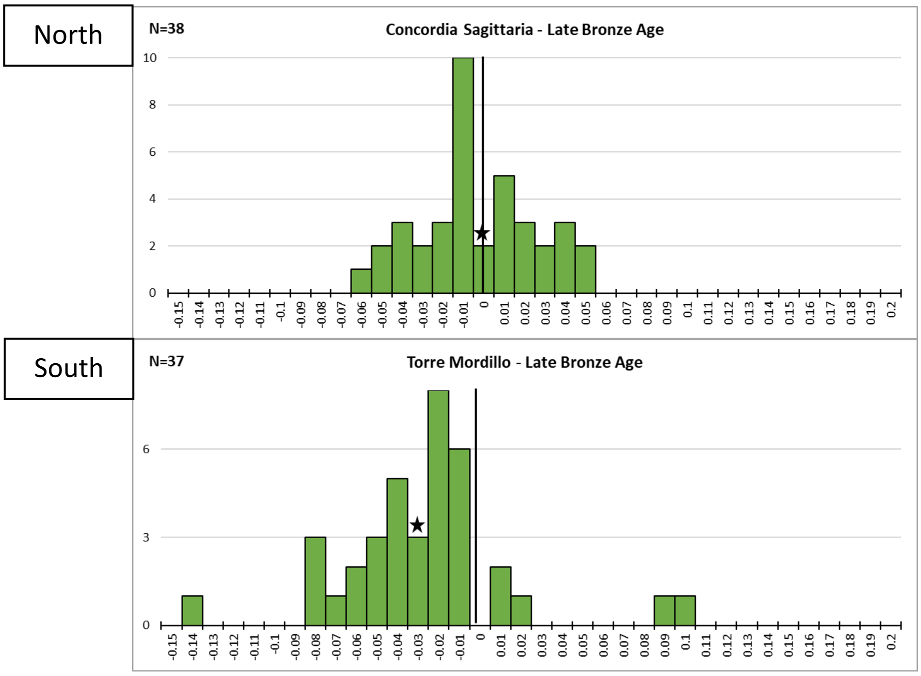


Figure 7.83. (3/4) Postcranial bones log ratios for Copper/Bronze Age and Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.



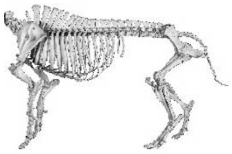


Figure 7.83. (4/4) Postcranial bones log ratios for Copper/Bronze Age and Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

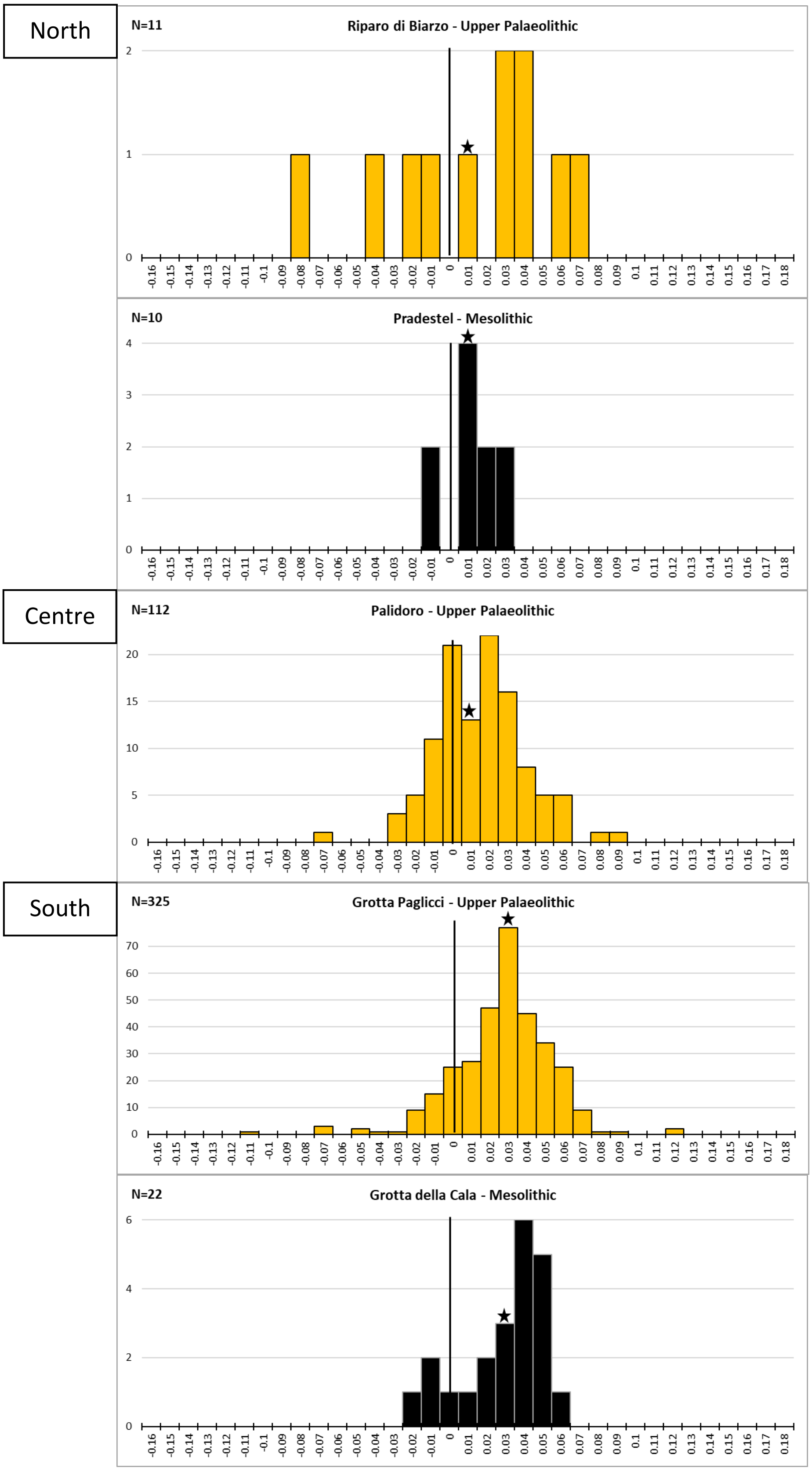


Figure 7.84. (1/2) Teeth log ratios for Upper Palaeolithic to Mesolithic sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

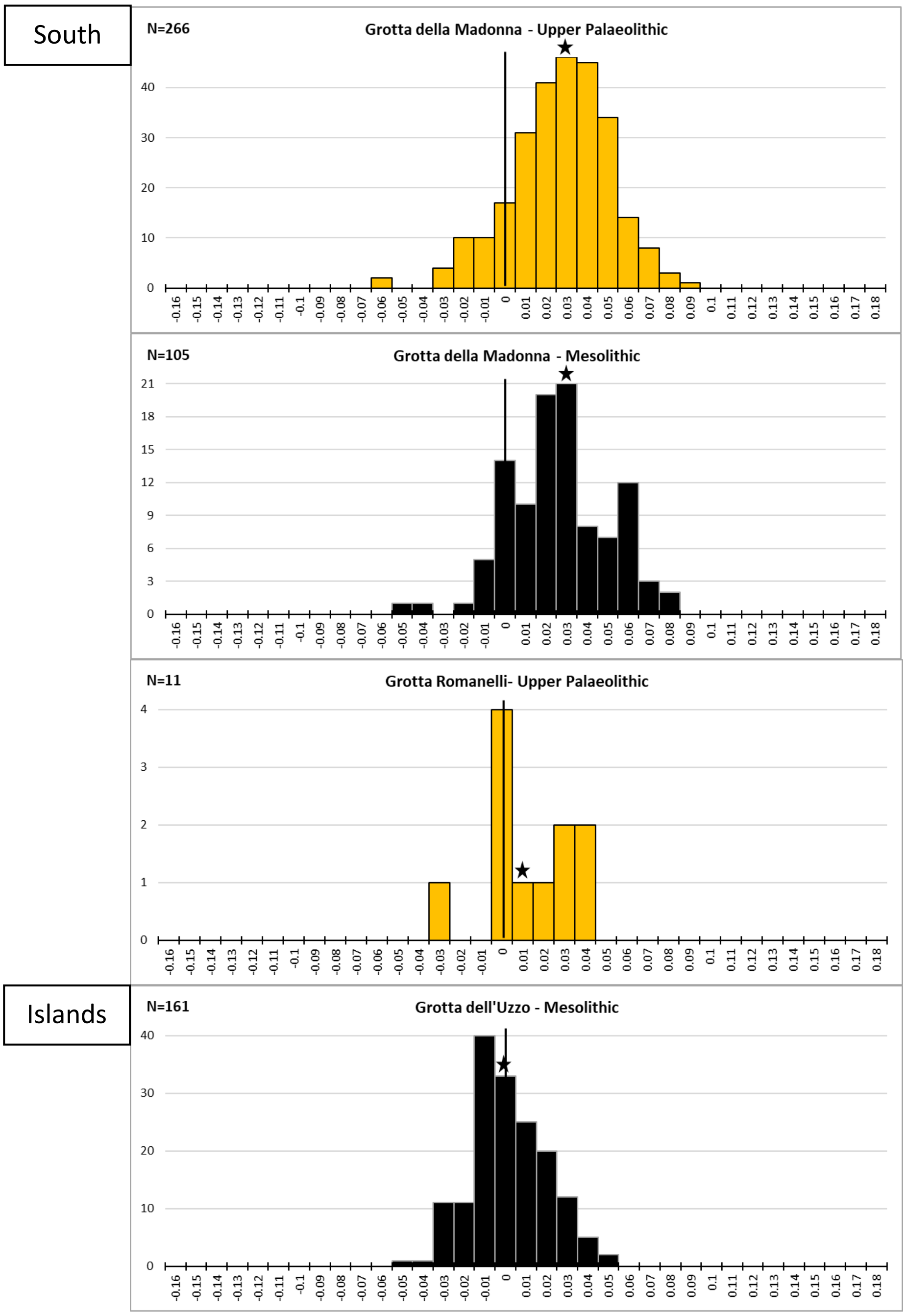


Figure 7.84. (2/2) Teeth log ratios for Upper Palaeolithic to Mesolithic sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

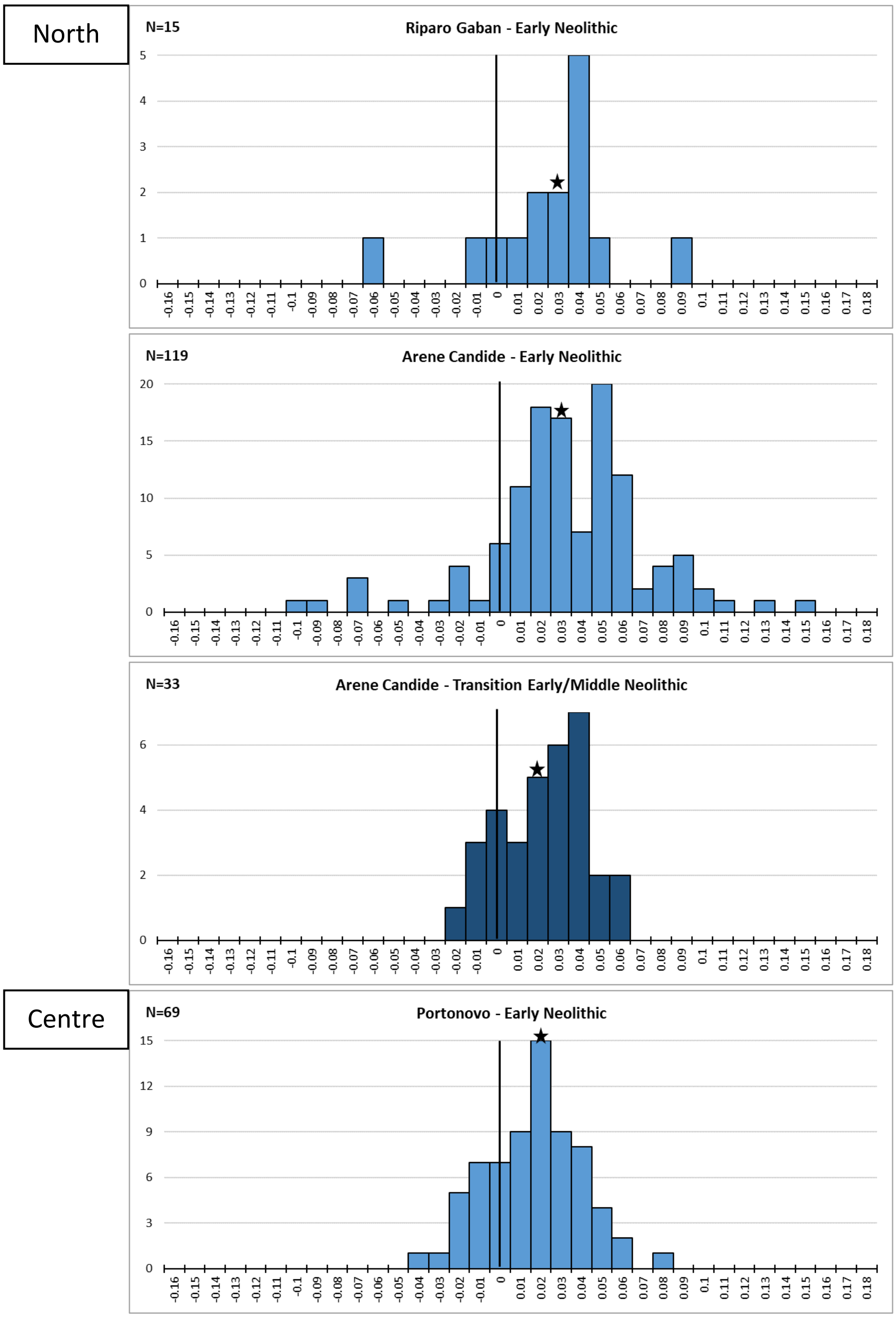


Figure 7.85. (1/2) Teeth log ratios for Early Neolithic sites, Arene Candide Early to Middle Neolithic Transition, and Early to Middle Neolithic Grotta dell'Uzzo for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

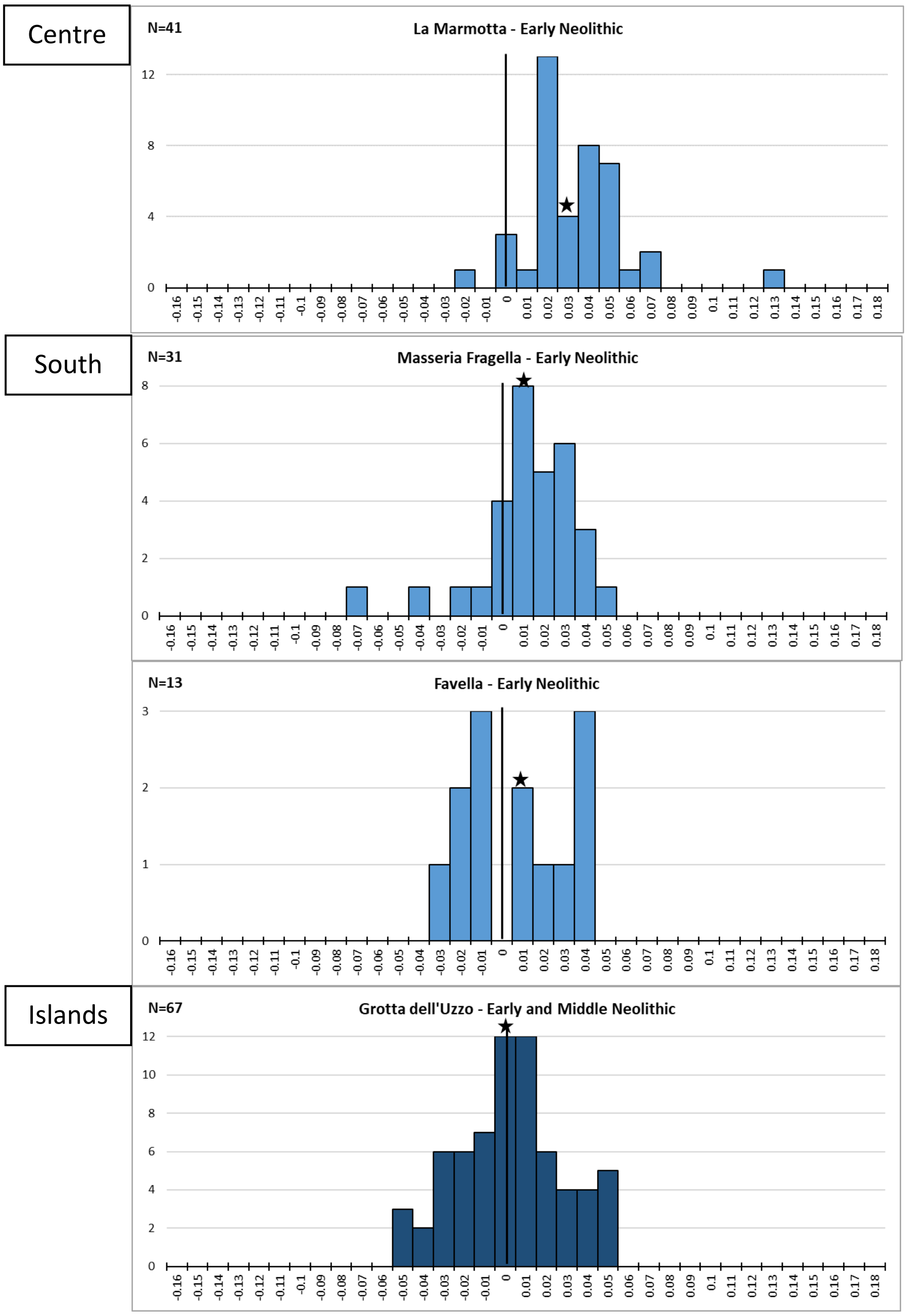


Figure 7.85. (2/2) Teeth log ratios for Early Neolithic sites, Arene Candide Early to Middle Neolithic Transition, and Early to Middle Neolithic Grotta dell'Uzzo, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

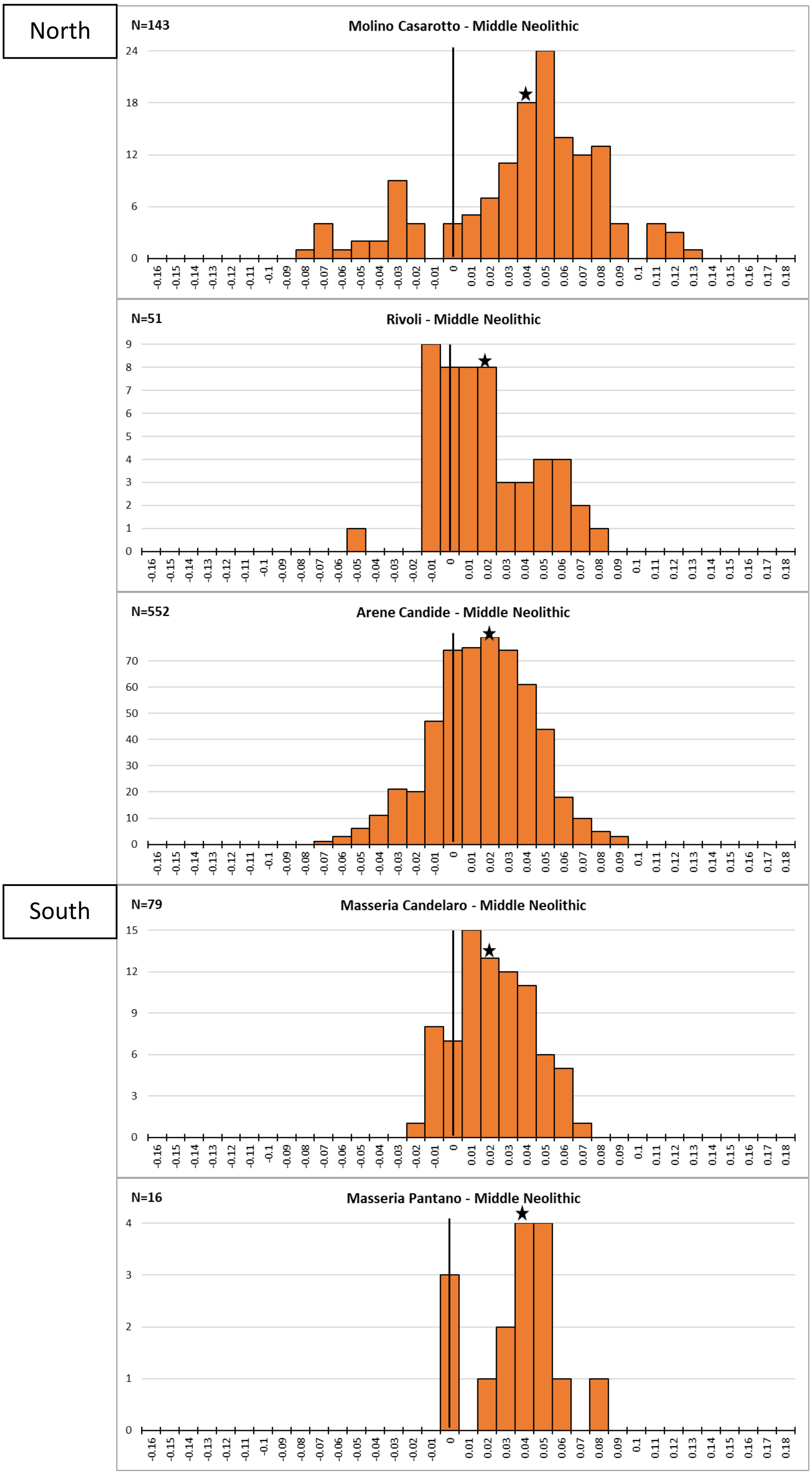


Figure 7.86. (1/2) Teeth log ratios for Middle Neolithic sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

South

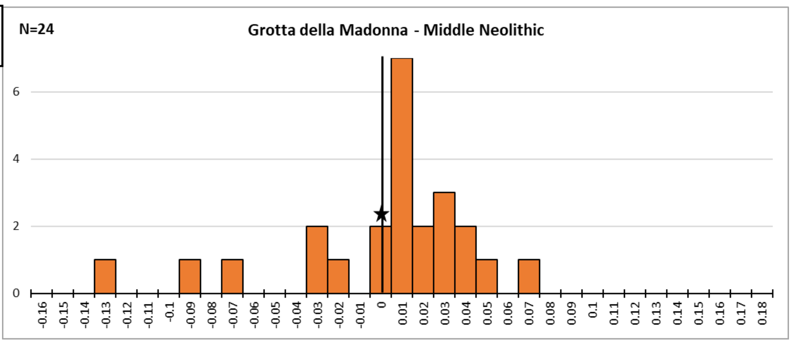


Figure 7.86. (2/2) Teeth log ratios for Middle Neolithic sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

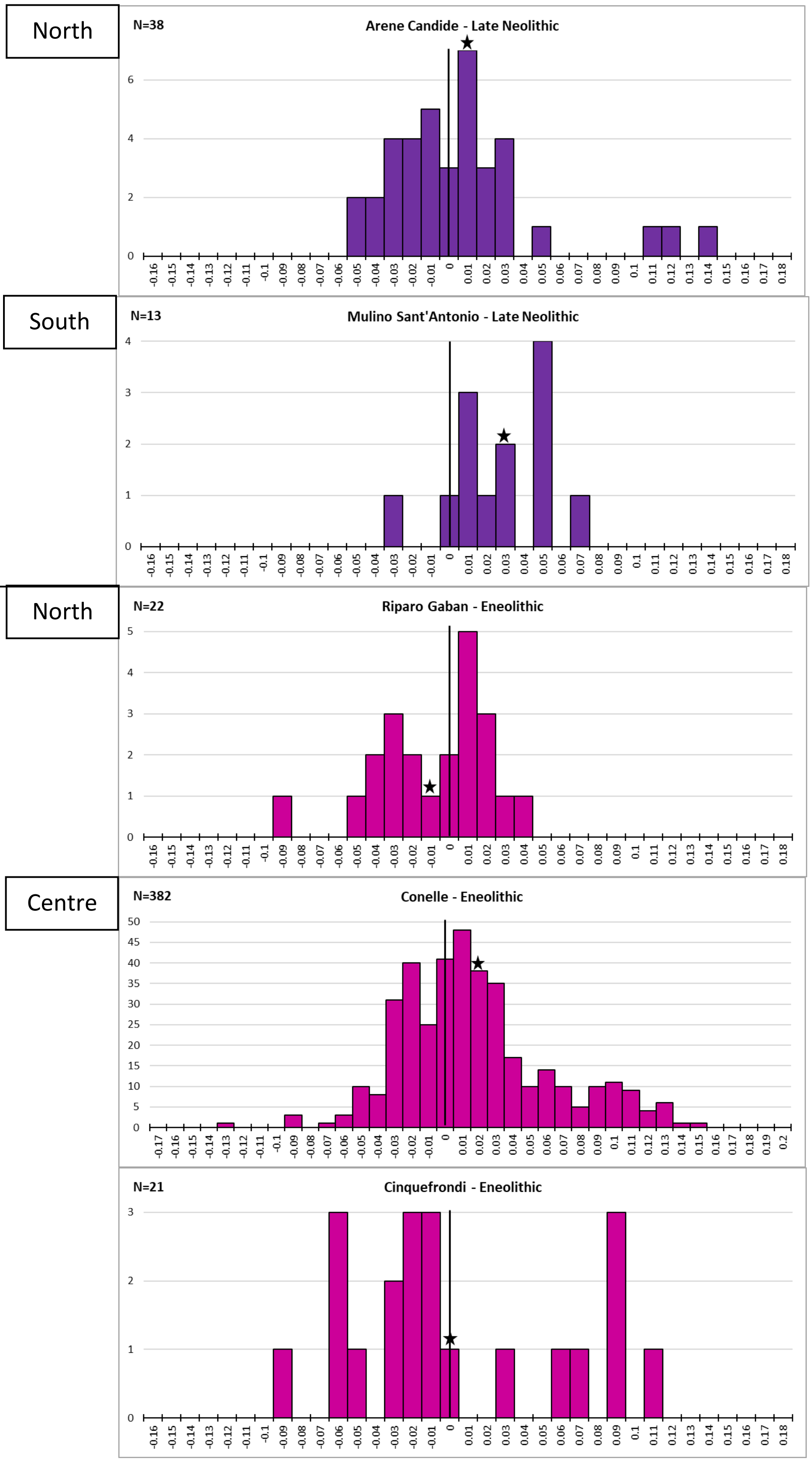


Figure 7.87. Teeth log ratios for Late Neolithic to Eneolithic sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

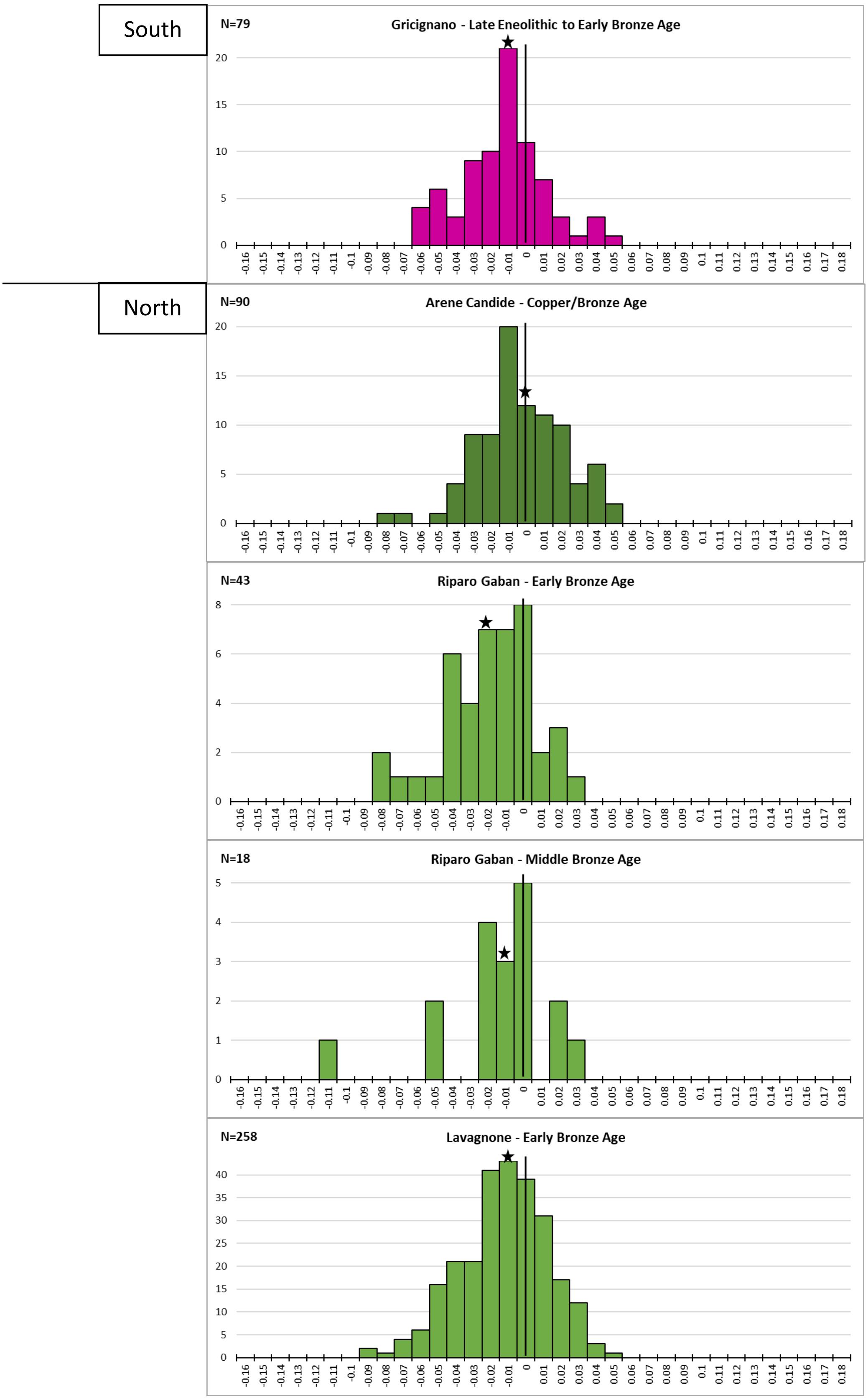


Figure 7.88. (1/5) Teeth log ratios for Copper/Bronze Age, and Late Eneolithic to Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

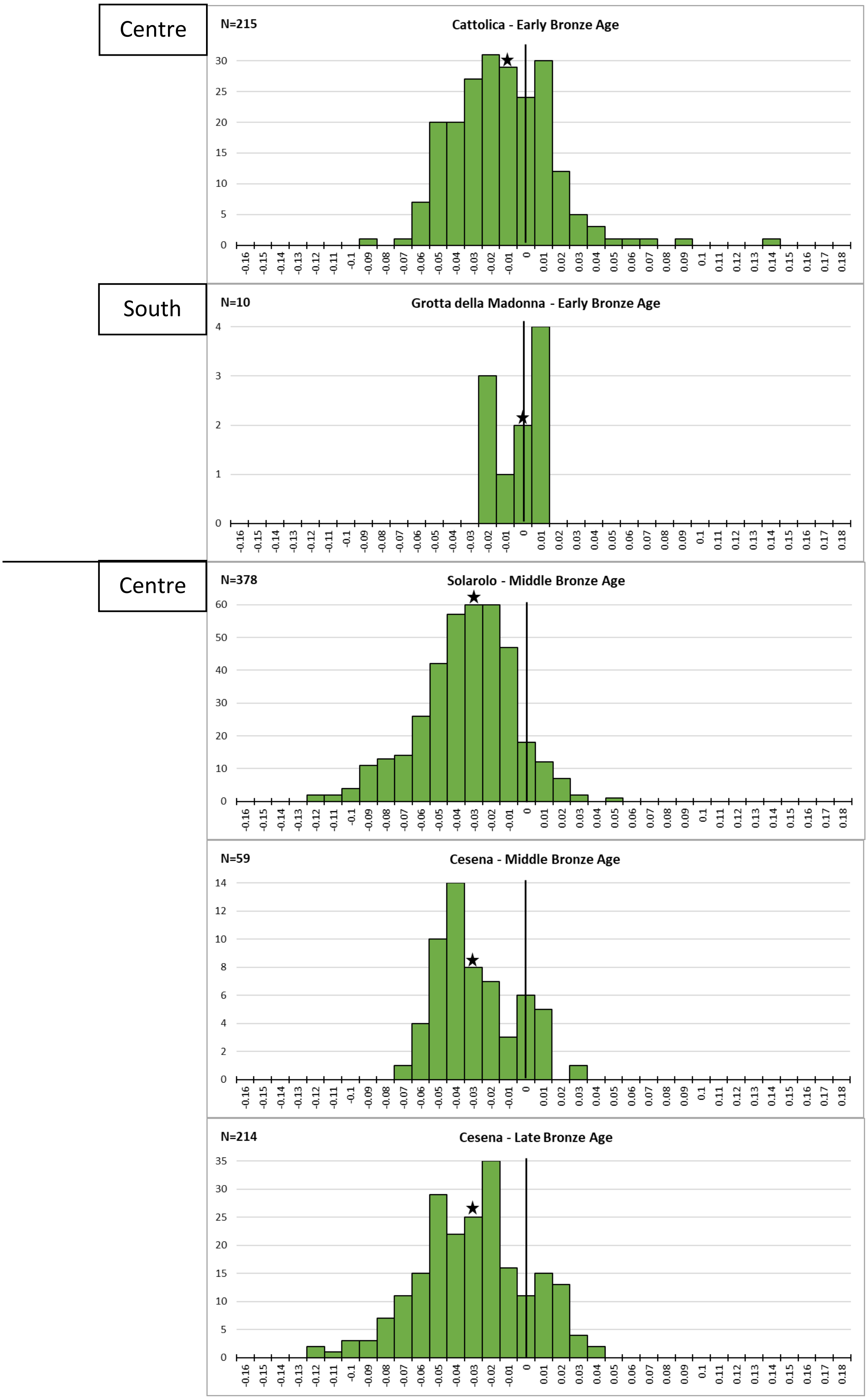


Figure 7.88. (2/5) Teeth log ratios for Copper/Bronze Age, and Late Eneolithic to Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

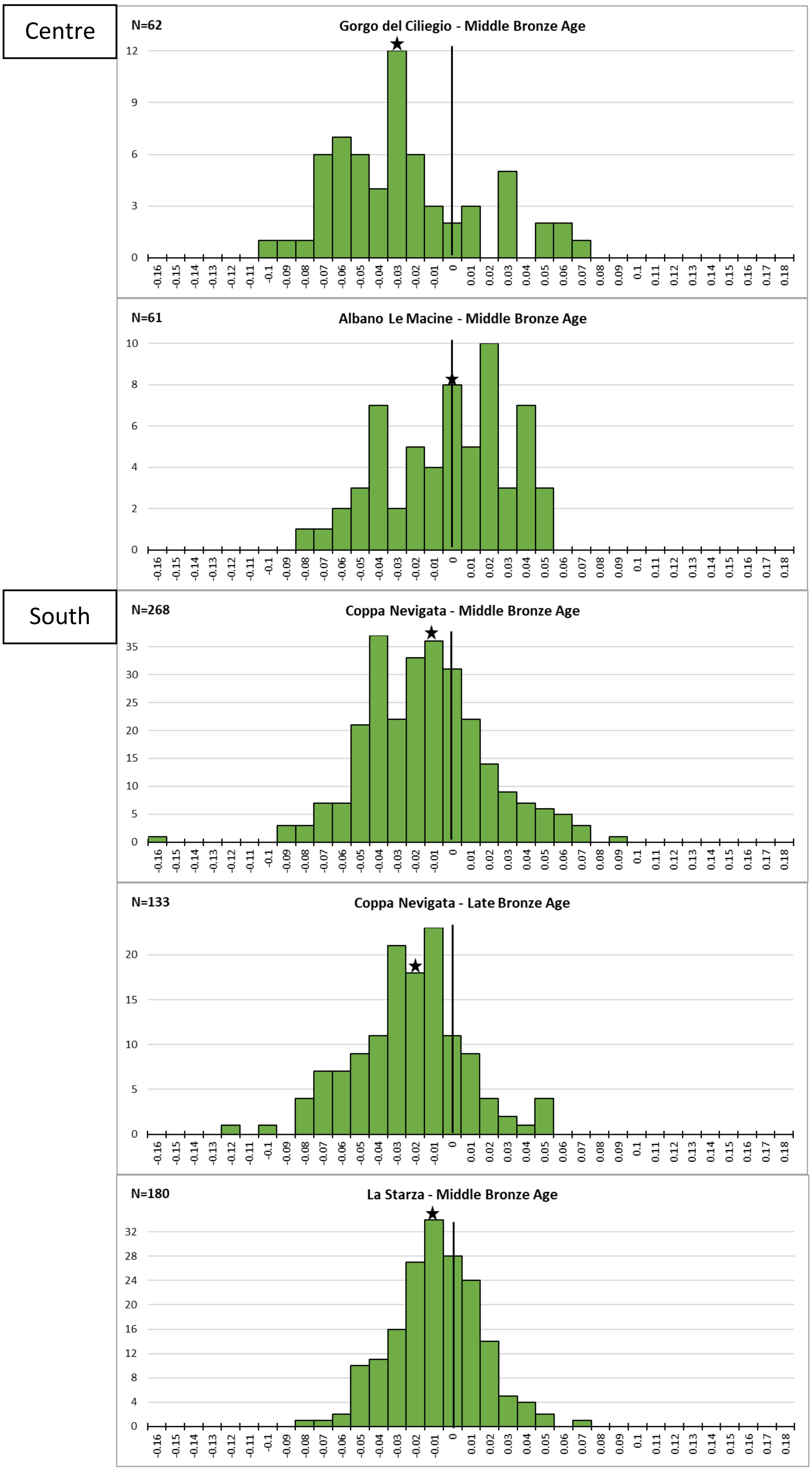


Figure 7.88. (3/5) Teeth log ratios for Copper/Bronze Age, and Late Eneolithic to Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

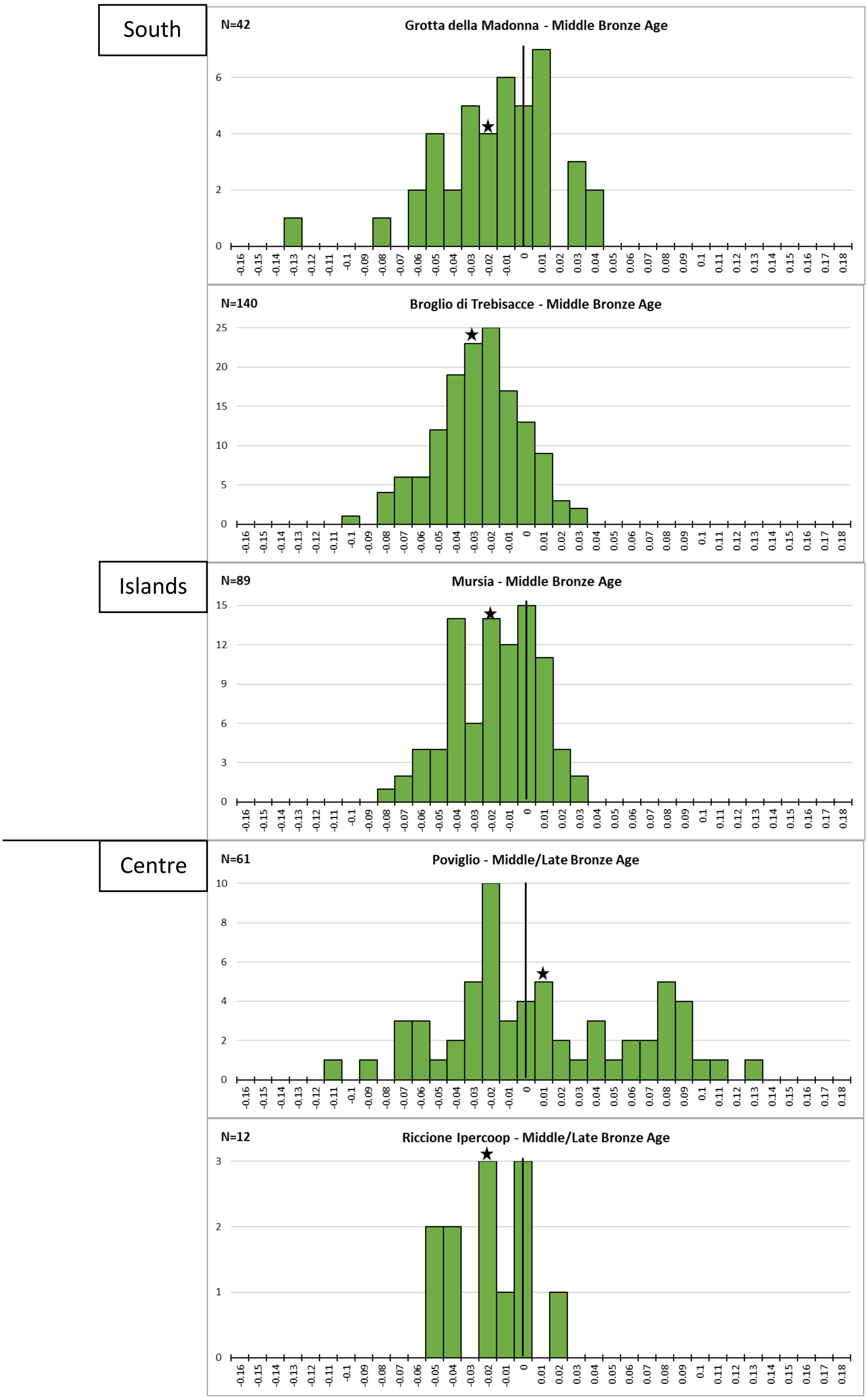


Figure 7.88. (4/5) Teeth log ratios for Copper/Bronze Age, and Late Eneolithic to Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

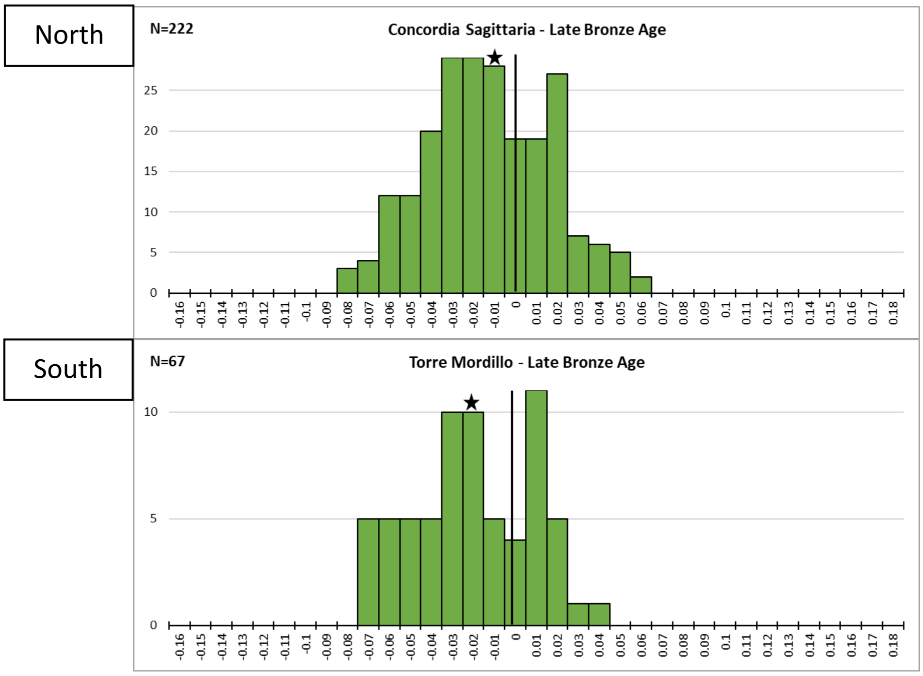
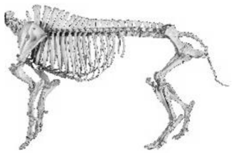


Figure 7.88. (5/5) Teeth log ratios for Copper/Bronze Age, and Late Eneolithic to Bronze Age sites, for samples of at least 10 measurements (by period, and north to south). Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.



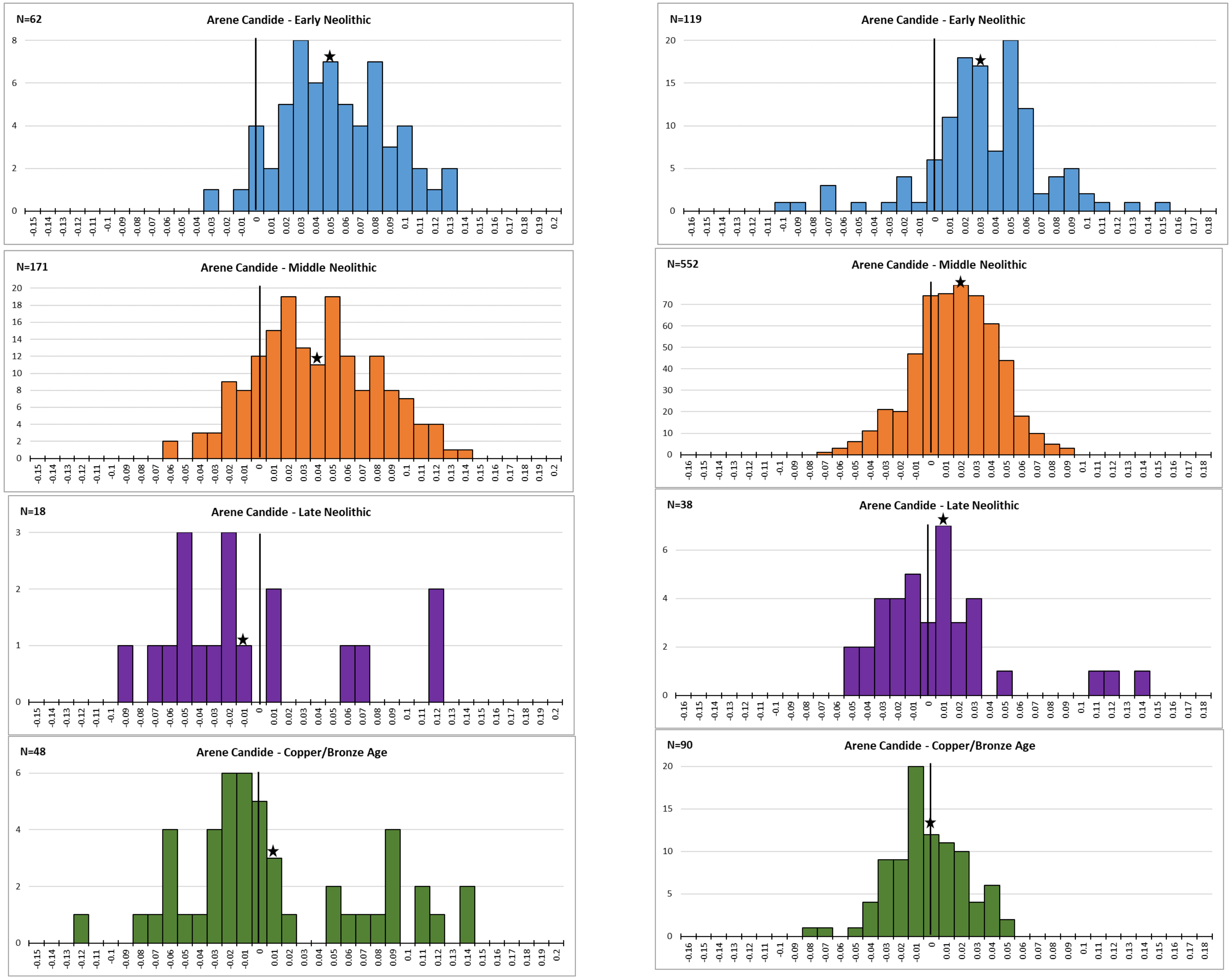


Figure 7.89. Arene Candide postcranial bones (left) and teeth (right) log ratios through time, for samples of at least 10 measurements. Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

7.4. Summary and Preliminary Discussion

From the evidence presented in this chapter, particularly the biometry, three main periods in the history of the Italian human-pig interactions can be identified: the hunting of wild boars during the Upper Palaeolithic and Mesolithic; the Early and Middle Neolithic pigs, of not clear-cut biometrical difference from the previous periods, and therefore unknown domestic or wild status; and the Late Neolithic to Late Bronze Age pigs, which can often easily be separated into two populations, presumably domestic and wild, on the basis of biometry. Table 7.39 offers a summary of the data presented in this chapter, while Figures 7.90 to 7.7.95 represent a log ratio summary by main areas. In the following paragraphs, the evidence pertaining each chronological group will be summarized.

PIG EVOLUTION IN PREHISTORIC ITALY			
PERIOD	AGE	SEX	BIOMETRY
Upper Palaeolithic to Mesolithic	▪ Generalised hunting strategy in terms of prey age, with some sites more focused on adult individuals while other sites evidence hunting of a broader range of ages.	▪ Indiscriminate hunting of both male and female wild boar.	▪ Southern pig bone specimens tend to be smaller than the Northern and Central ones (Bergmann's rule). ▪ Sicily: overall smaller size than the continental data (likely due to insular dwarfism). ▪ Teeth of wild boar are proportionally smaller than their post-cranial bones (in relation to the Durrington Walls standard). Correlation continues through all periods studied.
Early Neolithic	▪ Arene Candide and Grotta dell'Uzzo: increase in the number of immature and subadult pigs slaughtered in comparison with the Upper Palaeolithic and Mesolithic in other sites. ▪ Presence of neonatal bones in these locations. ▪ Arene Candide: shed tooth (dP4).	-	▪ Coefficient of variation: average larger postcranial values than during the previous periods. Teeth consistent with previous periods. ▪ Pigs are by and large consistent in size with the Upper Palaeolithic and Mesolithic wild boar, although their log ratios show a slightly broader spread of measurements. ▪ Grotta dell'Uzzo: At this site, a slight decrease in size can be observed between the Mesolithic and Early Neolithic-early Middle Neolithic periods. ▪ Wild boar size increase after the Mesolithic.
Middle Neolithic	▪ Arene Candide: continuation and perhaps intensification of a trend towards the killing of younger individuals and keeping of a small number of adults observed for the Early Neolithic. Shed tooth (dP4). ▪ Molino Casarotto: variable pig kill-off pattern. ▪ Presence of neonatal bones at Molino Casarotto and Arene Candide.	▪ Female dominance in the assemblages.	▪ Coefficient of variation: consistent with previous period. ▪ There is only a slight reduction in size between Early and Middle Neolithic. ▪ All in all, the Middle Neolithic pigs do not show substantial size changes in comparison with previous periods, except for a size increase in the wild boar range in comparison with the Mesolithic.
Late Neolithic	▪ Arene Candide: possible intensification of the trend towards the killing of younger animals already noted for the Early and Middle Neolithic, plus neonatal bones. ▪ Mulino Sant'Antonio: The assemblage was interpreted as being likely composed of mostly domestic animals being killed young for their meat, alongside the smaller presence of other age stages representing the combination of remains from domestic and wild animals (Albarella 1987-88).	-	▪ Clear overall reduction in size can be observed in all cases from the Late Neolithic onwards, with the presence of outliers more common in these latter periods as well. This change is more marked in the postcranial data (bimodality) but can also be seen in the tooth measurements. ▪ Third molar shape: change from at least the Eneolithic onwards towards. A shortening of these teeth can also be detected during those periods, which could be related to a shortening of the snout. ▪ The variability in the postcranial coefficient of variation values for these periods is greater than before, reflecting greater inter-site variability. Teeth values do not seem to evidence a greater variability than before.
Eneolithic to Late Bronze Age	▪ Kill-off patterns suggestive of an economy of animals killed young for the meat, with adult and older animals kept alive most likely for reproduction purposes. ▪ Presence of neonatal bones. ▪ Cattolica, Solarolo, Grotta della Madonna: evidence of shed teeth (dP4).	▪ Early to Late Bronze Age: variable proportions of males and females across different sites.	

Table 7.39. Summary of results by period.

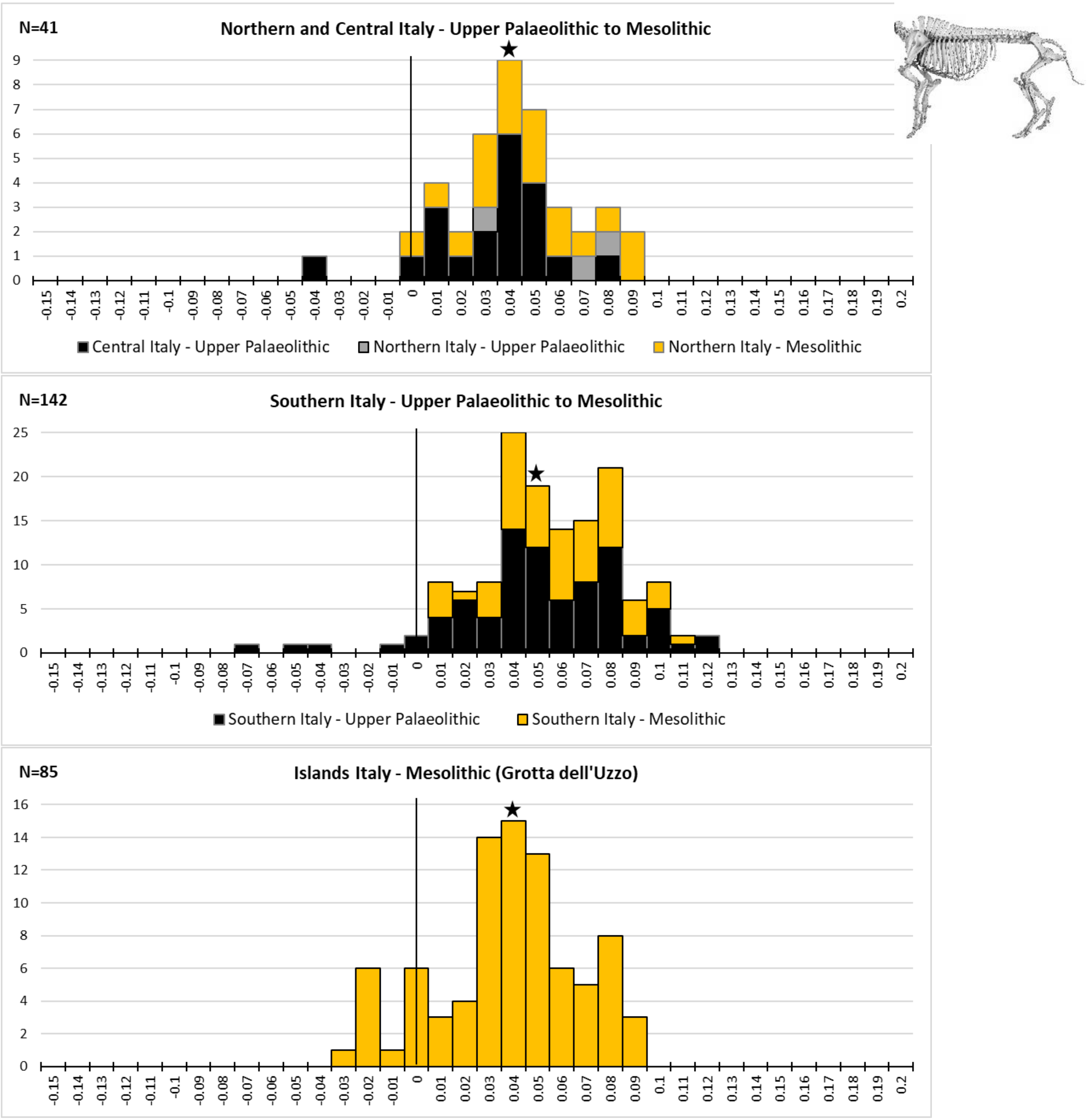
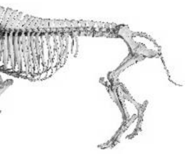


Figure 7.90. Upper Palaeolithic to Mesolithic postcranial bones log ratio summary by main areas. Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.



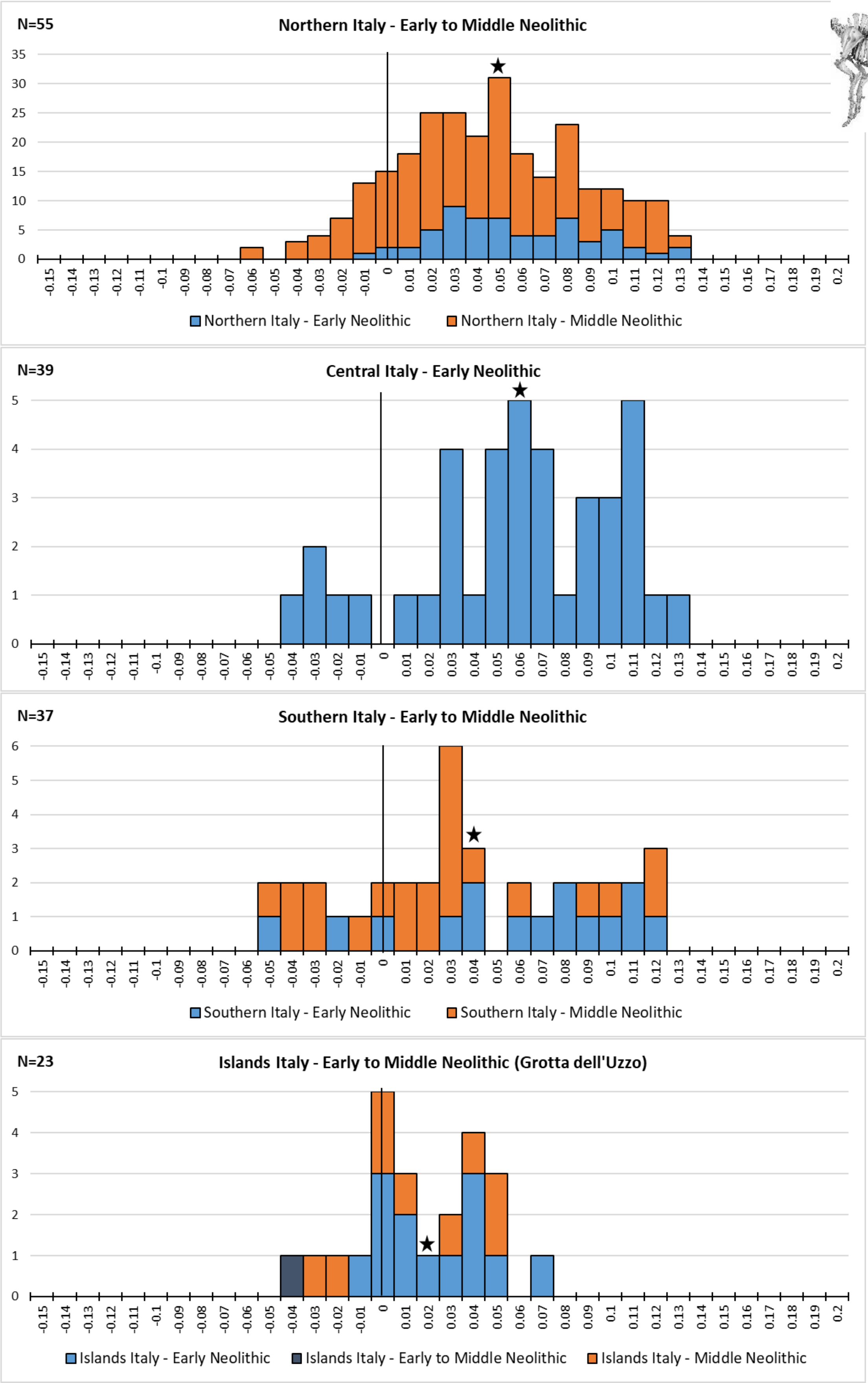


Figure 7.91. Early to Middle Neolithic postcranial bones log ratio summary by main areas. Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

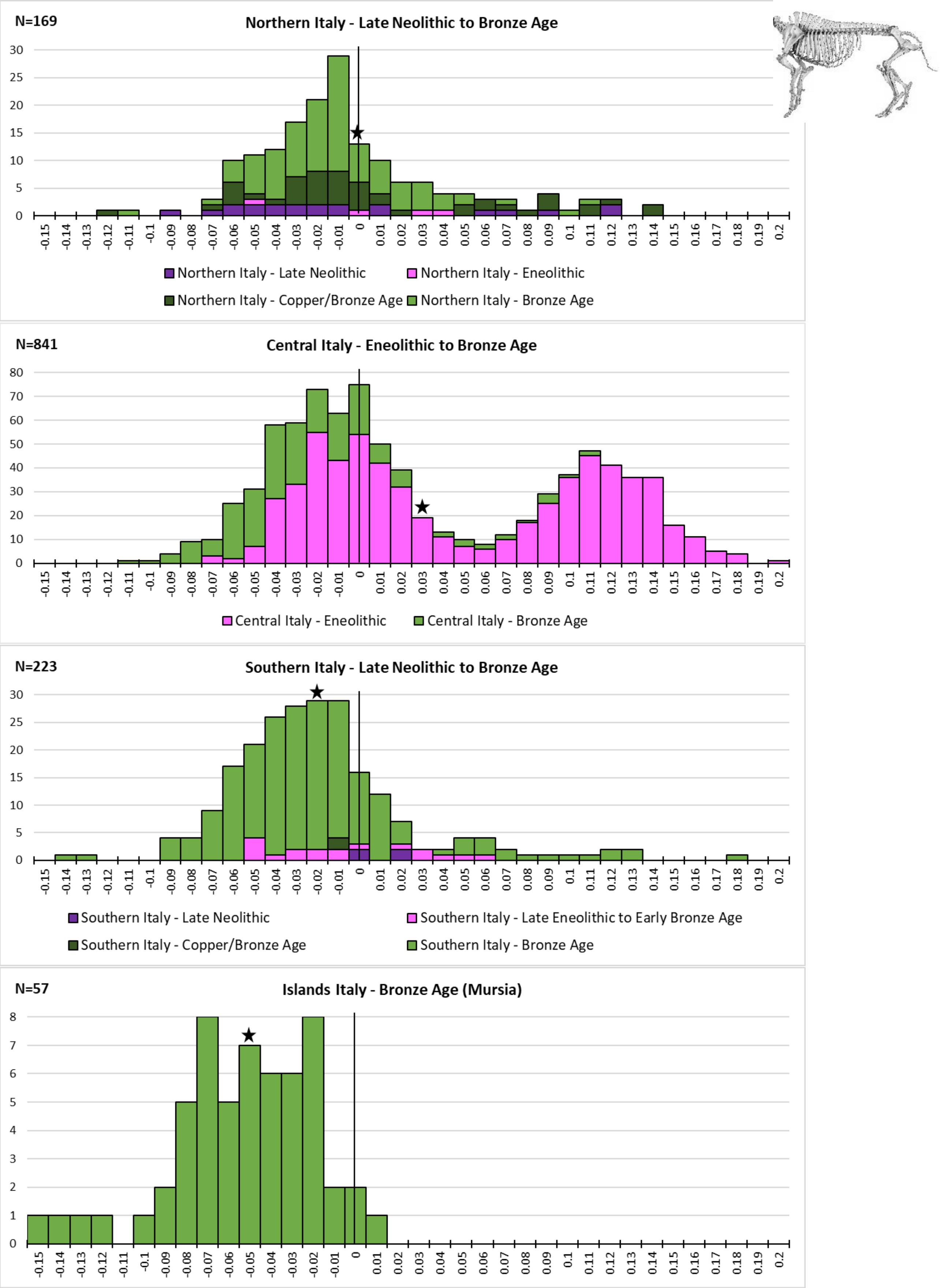


Figure 7.92. Late Neolithic to Late Bronze Age postcranial bones log ratio summary by main areas. Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

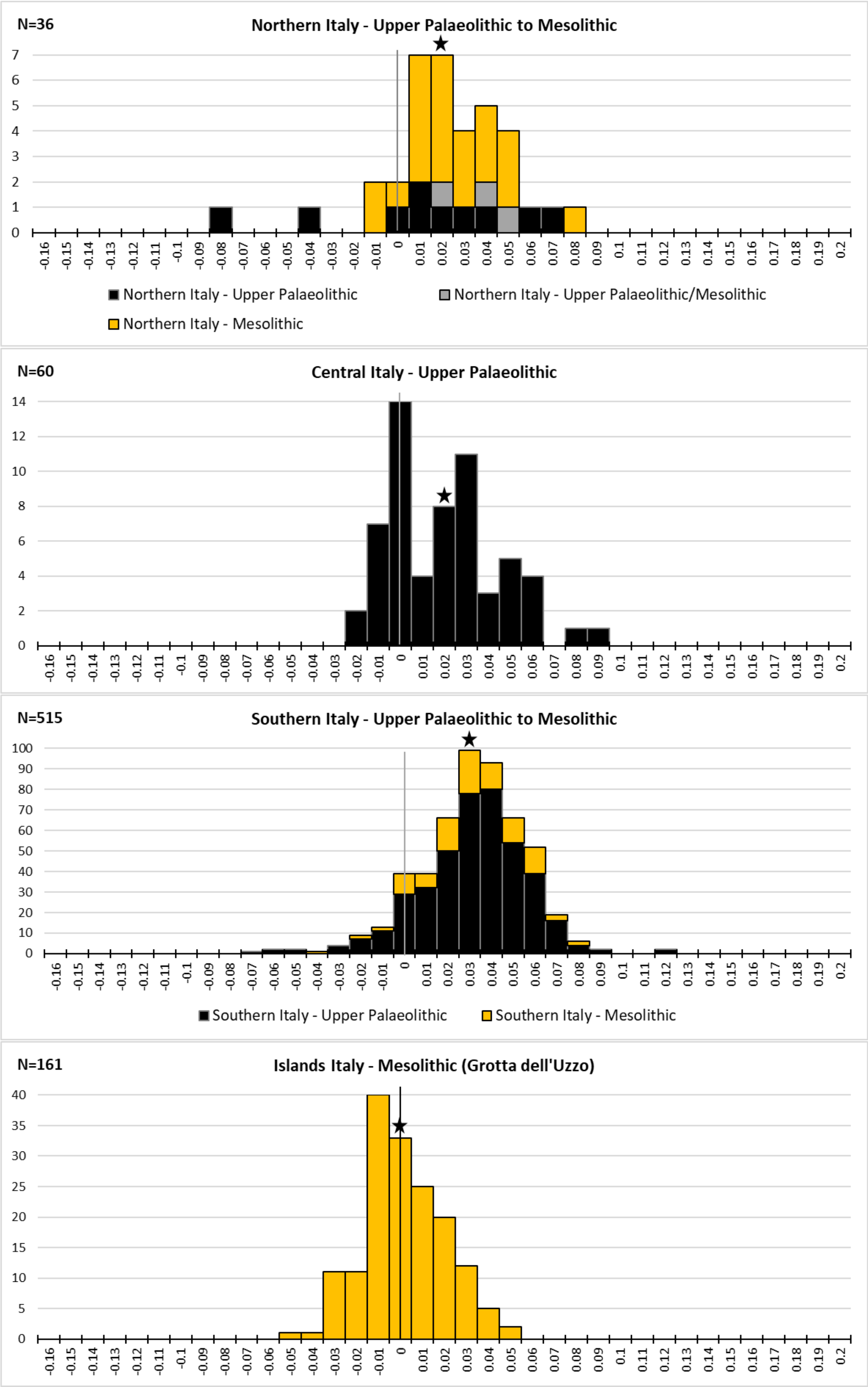


Figure 7.93. Upper Palaeolithic to Mesolithic teeth log ratio summary by main areas. Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

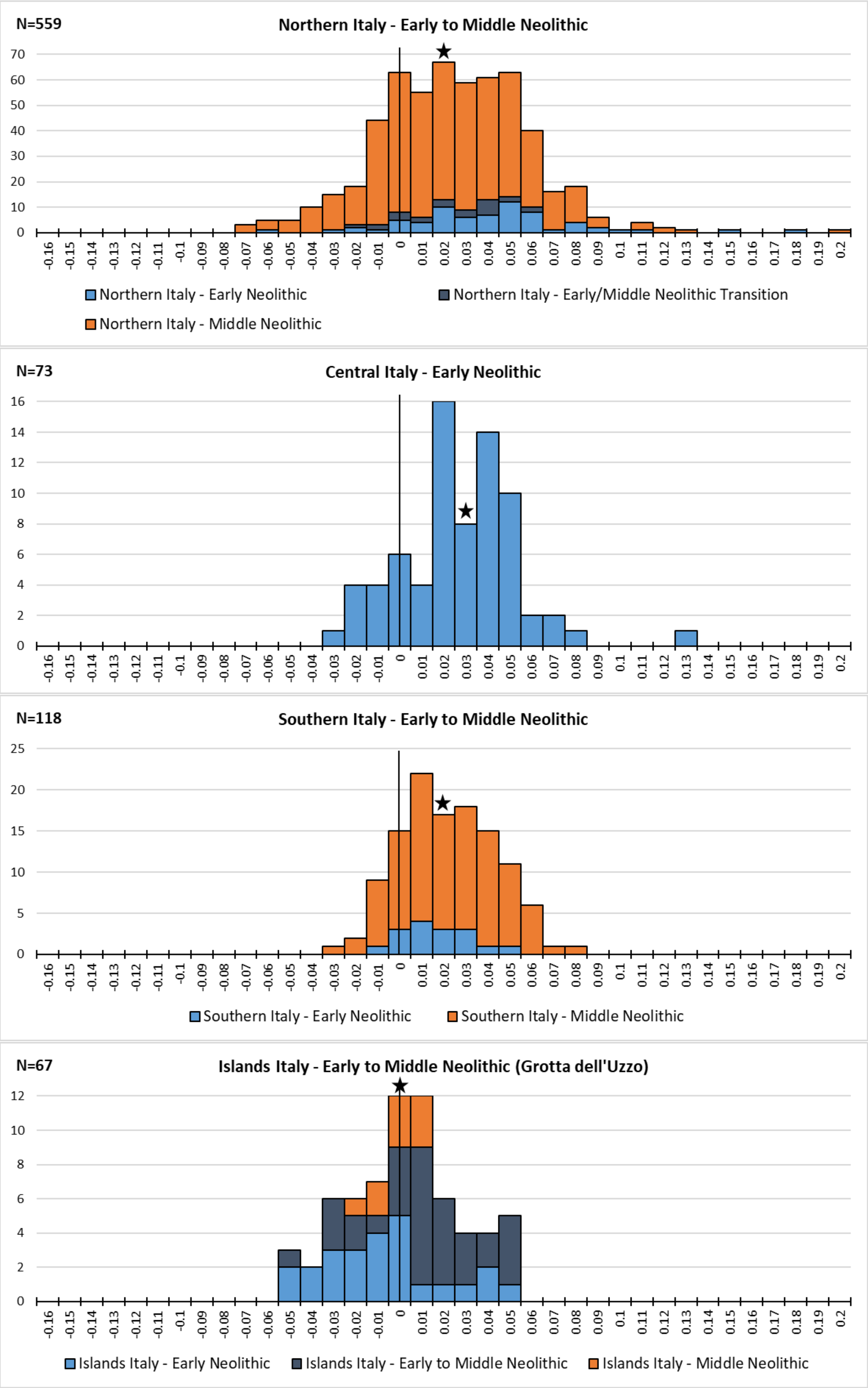


Figure 7.94. Early to Middle Neolithic teeth log ratio summary by main areas. Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

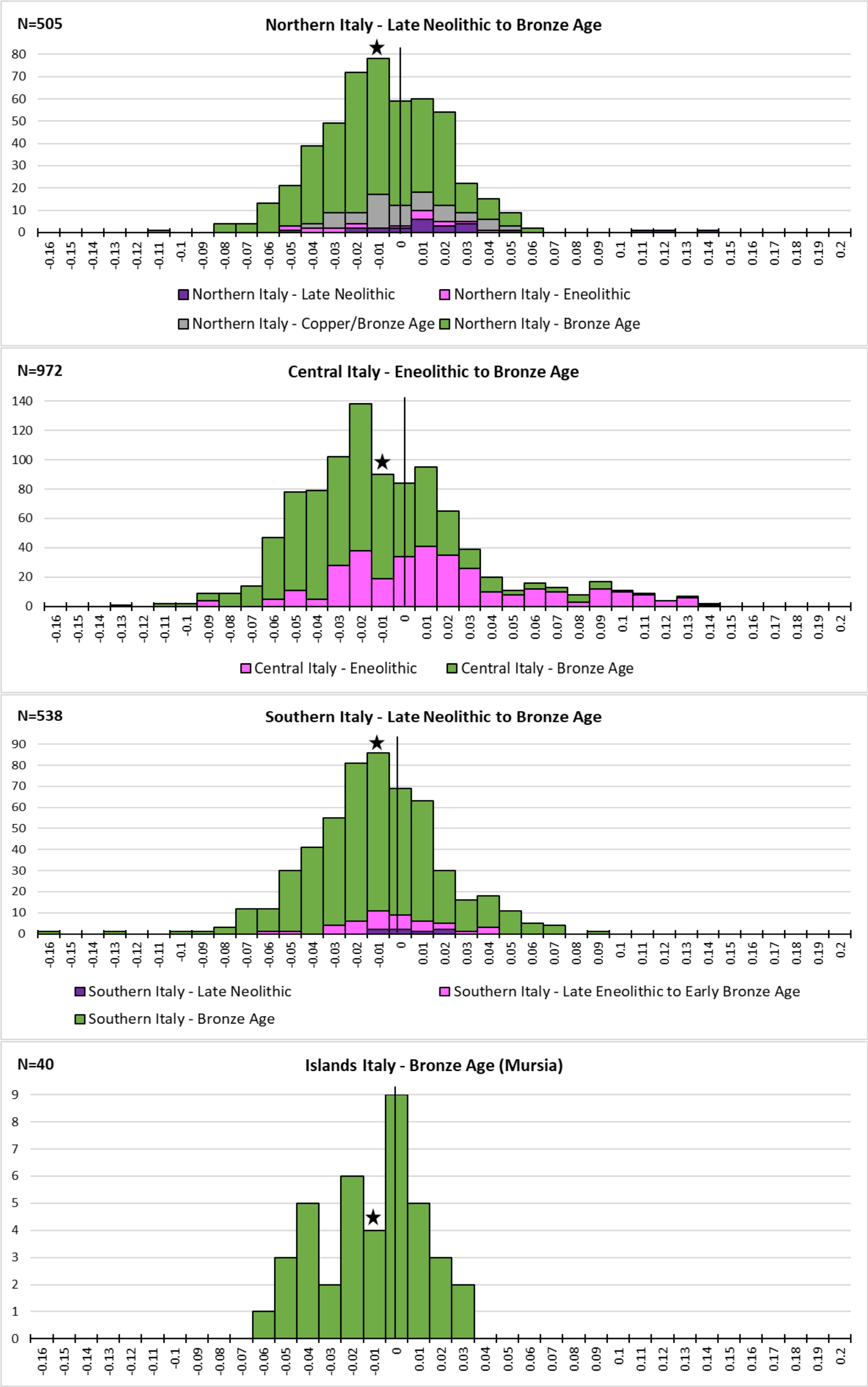


Figure 7.95. Late Neolithic to Late Bronze Age teeth log ratio summary by main areas. Line indicates the standard (Late Neolithic Durrington Walls, UK) and the star indicates the mean.

7.4.a. Upper Palaeolithic and Mesolithic

The Italian Upper Palaeolithic and Mesolithic wild boar can be characterised as having proportionally smaller teeth in comparison with their postcranial bones, in relation to the Durrington Walls standard. This fact, previously observed by Albarella et al. (2006c) and here confirmed through the analysis of a larger sample, seems to be a true characteristic of the Italian wild boar shared with other Mediterranean wild boar (see also Albarella et al., 2009; Hadjikoumis, 2010). In addition, the southern pigs tend to be smaller than the northern ones during these times, likely as a consequence of the climatic variability of the peninsula and in response to Bergmann's rule (Blackburn et al., 1999; Meiri and Dayan, 2003). Furthermore, the Sicilian wild boar, as observed in the site of Grotta dell'Uzzo, is smaller than in the southern continent. This relationship has been previously observed also for the red deer populations (Tagliacozzo, 1993a; 1994a), and it possibly due to the phenomenon of island dwarfism (Lomolino, 1985; 2005).

The evidence indicates that Upper Palaeolithic and Mesolithic populations had a generalized hunting strategy when it comes to the wild boar, with the different sites showing variable age at death profiles. These differences could be due to the sites being occupied during different seasons, different hunting strategies employed, and/or issues related to recovery procedures during the excavations. Regardless of these factors, the pig hunters did not seem to preferentially target one sex over the other, with both females and males roughly equally represented.

7.4.b. Early and Middle Neolithic

The first impression, in terms of size, of the Early and Middle Neolithic pigs is that they are in general terms consistent with the Upper Palaeolithic and Mesolithic wild boars, although a larger spread of measurements can be detected in the postcranial biometrical data and backed by statistical tests (coefficient of variation). This latter characteristic could be pointing at a larger variability in the Neolithic pig populations. Between the Early and Middle Neolithic, only a slight reduction in postcranial size can be seen in the data, while the teeth do not show any significant changes. Moreover, the relationship detected between wild boar postcranial bones and teeth during the previous periods – namely, the latter being proportionally smaller than the former – can still be observed in the Neolithic data.

During the Neolithic, however, an increase in size of the wild boar from the Mesolithic can be observed – both in postcranial bones and teeth – especially during the Middle Neolithic onwards. A wild boar size increase after the Mesolithic has previously been observed for Italy and other European areas (Albarella et al., 2005; 2006c; 2009), and the further evidence from the Neolithic onwards introduced here supports this statement. Under the light of that evidence, therefore, the similarity between the Upper Palaeolithic/Mesolithic and Early/Middle Neolithic patterns could be masking actual an overall decrease in postcranial size during the latter periods, as the expected size of the wild boar has increased.

The kill-off patterns of Rivoli, Arene Candide, and Grotta dell'Uzzo during the Early and Middle Neolithic show a trend towards the killing of younger animals than in previous periods, with the presence of neonatal bones. Other sites (Rivoli and La Marmotta) also show this pattern, although in a lesser extent when compared with data from previous times. This tendency towards the butchery of younger animals could be due to pig hunting during gestation/farrowing times and/or it could represent casualties of on-site breeding of domestic pigs. Whether these changes in the age at death profiles are related to an incipient process of domestication or not is not clear. However, the dominance of females in the assemblages (i.e. possibility of males being killed young, when their canines are under developed, while females are kept for reproduction), the presence in Arene Candide of shed deciduous teeth (i.e. suggestive of pigs living in the cave), and the previously mentioned likelihood of an overall decrease in size from the wild boar, offers additional support to the domestication hypothesis.

Lastly, a particular pattern is shown by the Middle Neolithic site of Molino Casarotto. In this site, the postcranial biometrical evidence displays a larger mean than in other contemporary sites, whereas that of the teeth is consistent with that of other sites. Also, the teeth ageing evidence younger animals than the postcranial bones fusion data. All this evidence, combined with previous knowledge of the site (i.e. large proportions of wild fauna in the assemblages — Boyle 2014b; Boyle 2014a), suggests the possibility that this site could be reflecting differential killing and processing patterns related to a combination of wild boar hunting and pig husbandry on site.

7.4.c. Late Neolithic, Eneolithic/Copper Age, and Bronze Age

The biometrical evidence for these periods is abundant, except for the case of the Late Neolithic, which is only represented by Arene Candide and Cornuda in the north and Mulino Sant'Antonio in the south of the peninsula (although Rivoli and part of the Middle Neolithic at Arene Candide are roughly contemporary). The combined biometrical analysis of postcranial bones indicates a clear separation between a smaller, likely domestic, pig and a larger, likely wild, animal. This evidence suggests that the wild and domestic pig populations had become by these times more genetically isolated, leading to a noticeable size reduction of the domestic forms. This bimodality in the data is clear from the Eneolithic onwards but is also reflected in the less abundant Late Neolithic data. In this respect, the site of Conelle is unique as it displays a clear bimodality in the postcranial data, most likely representing two distinct and roughly equally represented populations of wild and domestic pigs. Apart from Conelle, the pattern seen in the sites is one of a large population of mostly small animals (domestic pig) accompanied by larger outliers (wild boar). An increase in the coefficient of variation values for postcranial measurements during these times also points at an increased variability and bimodality of the data. The teeth, which up to these periods did not show clear changes since the Upper Palaeolithic/Mesolithic, start to show a consistent decrease in size for the first time, accompanied by changes in shape that could be linked to a shortening of the snout.

The increase in size of wild boar when compared to the earlier Mesolithic period is visible in the data also of these periods, especially in the cases of Cornuda, Conelle, and Mulino Sant'Antonio, and it maintains the relationship of proportionally smaller teeth than postcranial bones in comparison with the standard observed since early times. Indeed, the Late Neolithic cases of Cornuda and Mulino Sant'Antonio show a wild boar size even more extreme than Molino Casarotto. Like in this latter site, the hunting of wild fauna might have been the main means of meat procurement for these sites' inhabitants, as supported by the available zooarchaeological evidence (Albarella, 1987;

Riedel, 1988). The data for these sites, combined with what was observed for the ageing information, suggests a scenario in which the domestic and wild populations are undifferentiated, possibly due to regular interbreeding, but a very substantial wild component appears to be present, if only in the genes of the domesticated animals. Middle Neolithic Arene Candide and Rivoli present a similar situation, but the smaller overall size indicates that at these two sites the domestic component was greater.

With regards to the age at death profiles, the data from these periods suggests a focus on the killing of young animals for their meat, while keeping some adult individuals likely for reproduction purposes. This pattern is already visible by the Late Neolithic, with the site of Arene Candide showing what appears to be an intensification of the previously observed trend of butchery of younger animals. Some sites have a higher proportion of adult individuals, a fact that could be hinting at the primitiveness of the domestication process, as the pigs would take a long time to reach the desired weight for optimal meat returns in comparison with historical times. The presence of neonatal bones and deciduous teeth in some sites hint at the strong possibility that the pigs were being reared in those locations. The different sex proportions are variable according to the different sites, which alongside the variable age at death profiles of the different sites, suggests diverse pig management practices in the different sites (i.e. some sites dedicated to pig rearing, while others focused more on consumption, for example).

Taken together, the evidence from the Late Neolithic onwards would seem to suggest a primitive process of pig domestication full underway in the Italian peninsula. There is a strong indication that the main bulk of the domesticated stock could derive from local wild boar: faster reduction in size in postcranial bones over teeth and the conservation through time of the smaller teeth/larger postcranial bones in comparison with the standard relationship observed for the wild boar since the Upper Palaeolithic. Throughout the Bronze Age, the pattern of a large population of small pigs, likely domestic, complemented by some larger animals, likely wild boar, carries on until the end of the period, suggesting a continuation and consolidation of the pattern first identified in the Late Neolithic and Eneolithic.

Chapter 8

RESULTS: ITALY IN ITS BROADER CONTEXT

In this section, the results presented in the previous chapter will be compared with data from other European and Middle Eastern areas, in order to, firstly, put the Italian data in a wider geographical context, and secondly, to identify potential similarities and/or differences in the trajectories that the processes of pig domestication might have taken in the different regions. This comparative analysis will focus exclusively on postcranial and tooth biometrical data, presented in the form of scatterplots and log ratios. The sites chosen for comparison come from Portugal, Spain, France, Germany, the Netherlands, Greece, Turkey, and Syria, and cover a diverse chronological range, from Upper Palaeolithic to the Bronze Age. The European sites were selected from countries which, due to their geographic location, could have had a connection with Italy in the past; and the Middle Eastern data is included as well to inquire into whether they could have been the source of origin of potentially imported domesticated pigs during the Neolithic – their inclusion in the analysis is therefore focused only on sites contemporary with the Italian Neolithic. The focus of this chapter remains on the Italian peninsula, with the comparative analysis presented here ultimately aimed at understanding the process of pig domestication in our main area of study.

A comprehensive list of the sites included for comparison, their chronologies and their locations can be seen in Table 8.1 and Figures 8.1 and 8.2. In the analyses, the biometrical data will be combined and presented by periods and main geographical areas (i.e. modern countries), with the Italian data combined by periods and main regions (i.e. North, Centre, South, and Islands). The data from Portugal, originally published by Albarella et al. (2005), comes from sites dated to the Mesolithic, the Late Neolithic and the Chalcolithic, the latter period being contemporary to the Italian Eneolithic/Copper Age. The Spanish data, published by Hadjikoumis (2010; 2011), belongs to several sites dated from the Upper Palaeolithic/Mesolithic (Pre-Neolithic) to the Bronze Age. The Early Neolithic period in these assemblages refers to the 6th to 4th millennium BC and is contemporary to the Italian Early and Middle Neolithic; while the following period, Late/Final Neolithic, corresponds to the mid to end of 4th millennium BC, equivalent to the Italian Late Neolithic. Regarding the Early Neolithic period, the data has been classified as to whether it comes from inland sites in caves, or coastal sites, as the author of the original analysis detected a difference between the two. Indeed, the Early Neolithic inland cave sites had large pigs, compatible in size with Pre-Neolithic wild boar, whereas the coastal pigs were of a smaller size. It was therefore suggested that the coastal sites had introduced domestic pigs that had reached Iberia via a coastal route (Hadjikoumis, 2010).

The French material is represented by only one site, Rocadour, dated to the Middle Neolithic. This site is characterised by continuation of hunting practices, responsible for the majority of the caloric intake of its inhabitants; therefore, it is very likely that the Rocadour pigs were mostly, if not all, wild (Lesur et al., 2001). The data from Germany represents the Mesolithic and Early Neolithic (Linearbandkeramik) periods of the area. It has not been previously published but data has been kindly provided by U. Albarella. The same is the case for the Dutch data, which covers the Mesolithic to Chalcolithic periods (Hogestijn and Peeters, 2001; Louwe Kooijmans, 2001; Louwe Kooijmans et al., 2001; Zeiler, 1997). Data from Greece comes from the Early to Middle Neolithic site of Souloukia, not yet published but kindly provided by G. Kazantzis; the Late Neolithic site of Promachon (Kazantzis, 2018); and the Bronze Age site of Zarkos (Becker, 1991). Finally, data from the Turkish Anatolian site of Erbaba Höyük (Bordaz, 1973; Perkins, 1973) and the Syrian site of Tell Sabi Abyad (Akkermans and Le Mière, 1992; Russell, 2010) are also included. These sites are dated to the 6th millennium BC, which in the Middle East corresponds to the Chalcolithic cultural period, but it is roughly contemporary to the European Early Neolithic. It is not the intention of this discussion to offer a fully detailed description of the zooarchaeological information available for the comparative sites, which can be found in the original publications cited, where available.

COUNTRY	REGION	SITE	CHRONOLOGY	DATA COLLECTED BY
Netherlands	Flevoland	Hoge Vaart	Mesolithic/Early Neolithic Transition	U. Albarella
		Swifterbant S3 and S4	Middle Neolithic and Chalcolithic	
	South Holland	Hardinxveld-Giessendam Polderweg	Mesolithic	
		Hardinxveld-Giessendam De Bruin	Mesolithic to Early Neolithic	
		Hazendonk	Middle to Late Neolithic	
Germany	Mecklenburg-Vorpommern	Rothenklempenow	Mesolithic	U. Albarella
	Brandenburg	Friesack	Mesolithic	
	Saxony-Anhalt	Eilsleben	Mesolithic to Early Neolithic (Linearbandkeramik)	
		Gatersleben	Early Neolithic (Linearbandkeramik)	
		Halle-Trotha	Early Neolithic (Linearbandkeramik)	
		Zorbau	Early Neolithic (Linearbandkeramik)	
	Hesse	Allendorf	Upper Palaeolithic	
Portugal	Centro	Zambujal	Chalcolithic	U. Albarella and S. Davis
	Lisboa	Cabeço do Pez	Mesolithic	
		Leceia	Late Neolithic to Chalcolithic	
		Lapiás de Lameiras	Early Neolithic to Chalcolithic	Davis et al. 2018
	Alentejo	Cabeço da Arruda	Mesolithic	U. Albarella and S. Davis
		Moita do Sebastião	Mesolithic	
		Mercador	Chalcolithic	
Spain	Cantabria	Cueva de Cubio Redondo	Pre-Neolithic	A. Hadjikoumis
		Cueva del Mazo	Pre-Neolithic	
		Cueva del Otero	Pre-Neolithic	
		Cueva del Pendo	Pre-Neolithic	
	Basque Country	La Renke	Late Final Neolithic to Copper Age	
		Los Husos	Copper Age	
		Castillo de Henayo	Bronze Age	
		Castros de Lastra	Bronze Age	
		La Hoya	Bronze Age	
	Navarra	Aizpea	Pre-Neolithic	
		Cueva de Zatoia	Pre-Neolithic	
		Abrigo de la Peña	Pre-Neolithic, Late Final Neolithic to Copper Age	
		Cueva Abauntz	Copper Age	
		Castillar de Mendavía	Bronze Age	
		Monte Aguilar	Bronze Age	
	Aragon	Cueva Chaves	Early Neolithic	
		Cueva del Moro	Late Final Neolithic and Bronze Age	
	Catalonia	La Draga	Early Neolithic	
		Sant Pau del Pau	Early Neolithic	
	Castile and León	Cueva de la Vaquera	Early Neolithic, Late Final Neolithic to Copper Age	
		Cueva Rubia	Copper to Bronze Age	
		Las Pozas	Copper Age	
	Castilla-La Mancha	Acequión	Bronze Age	
		Morra de Quintanar	Bronze Age	
	Valencia	Cova Fosca	Early Neolithic	
	Murcia	Bastida de Totana	Bronze Age	
	Andalusia	Los Millares	Copper Age	
		Fuente Álamo	Bronze Age	
		Los Barruecos	Late Final Neolithic	
		Valencina de la Concepción	Copper Age	
		Los Castillejos	Late Final Neolithic to Copper Age	
		Cerro de la Encina	Bronze Age	
France	Thémines	Rocadour	Middle Neolithic	U. Albarella
Greece	West Macedonia	Souloukia	Early to Middle Neolithic	G. Kazantzis
	Central Macedonia	Promachon	Late Neolithic	
	Thessaly	Zarkos	Late Neolithic and Bronze Age	Becker 1991
Turkey	Lakes District	Erbaba Höyük	6th millennium	U. Albarella
Syria	Balikh River Valley	Tell Sabi Abyad	6th millennium	U. Albarella

Table 8.1. Geographical and chronological details of the sites included in the comparative analysis.

Figure 8.1. Location of the sites included in the comparative analysis (see also Figure 8.2 for sites in Spain). Larger circles indicate the presence of several sites within the same area.

Figure 8.2. Location of Spanish sites included in the comparative analysis. Larger circles indicate the presence of several sites within the same area.

All the data utilised here was kindly provided by the original researchers, except for the Greek site of Zarkos (Becker, 1991) and the Portuguese site of Lameiras (Davis et al., 2018). All measurements provided were taken following the same methods and recording protocol, which allows for a degree of consistency and comparability. One exception is the tooth length measurements from the Spanish data, which Hadjikoumis (2010) took differently and are therefore excluded from the analysis. Other exceptions are the data from the mentioned sites of Zarkos and Lameiras, which come from the bibliography; in these cases, care was taken to include measurements only taken following the same criteria as in this research.

8.1. Biometry of postcranial elements

In this section the comparison of the postcranial measurements between the different sites will be presented. The data presented in scatterplots will be discussed first (8.1.a), followed the log ratio analysis (8.1.b).

8.1.a. Postcranial Scatterplots Comparison

Figures 8.3 to 8.5 scatterplots show the biometrical data site's comparison for the humerus BT and HTC, tibia Bd and Dd, and astragalus GLl and GLm, respectively. The Upper Palaeolithic and Mesolithic data, as seen in Figures 8.3.a, 8.4.a, and 8.5.a, indicate that the German and Dutch wild boar plot at the larger end of the spectrum, while the Portuguese cluster around the smaller end. The Italian data covers most of the range but tends to be more similar to the Portuguese material. The data from the astragalus shows that the Spanish wild boar was of a similar size to the Italian. These results suggest the existence of a North-South cline in wild boar size. Unfortunately, no wild boar data from these periods is available for Greece or France.

The Early and Middle Neolithic data (Figures 8.3.b, 8.4.b, and 8.5.b) indicate for the Italian material a wide range, roughly consistent with the Spanish data, and similar in size to the Upper Palaeolithic and Mesolithic wild boar. The Greek pigs are quite small, plotting at the lower end of the scale alongside one Portuguese specimen, whereas the

Dutch data plots in the middle of the range. The German data offers an interesting bimodal pattern, with some very large elements plotting in the same range as the French pigs (which are presumed to be wild, as mentioned previously), and some very small specimens, which plot with the small Greek pigs. The larger German pigs are even larger than the wild boar of previous periods, which could be due to this animal's post-Mesolithic size increase, mentioned in previous chapters for the interpretation of the Italian data. This bimodality could be indicating the presence of two separate domestic and wild populations in Germany at this time, with the Greek data showing also potentially domestic pigs. If these pigs were introduced from the Near East, the Turkish data from 6th millennium Erbaba, which plots at the larger end of the Italian range, would seem to suggest that Anatolia was not their source of origin.

The Late Neolithic data, presented in separate scatterplots (Figures 8.3.c, 8.4.c, and 8.5.c), has unfortunately very scant Italian data, with no humerus measurements available at all. The Greek data shows in this instance a clear bimodality, echoing, in the case of the astragalus, the few Italian measurements available. The smaller group is consistent with the smaller specimens from the previous periods within their respective areas, and during the Late Neolithic it is possible to see a further reduction in size in some cases. This is probably indicating the presence of two separate wild and domestic populations. The Early and Middle Neolithic Greek data only show the smaller range of this spectrum, and when the larger Late Neolithic specimens (presumably wild boar) are compared to the earlier periods, they suggest a size comparable to the larger Italian and Spanish specimens. It is not possible, however, to safely assume the presence in Greece during the earlier Neolithic periods of a wild boar of comparable size, due to the lack of data. The Spanish and Portuguese data from the Late Neolithic do not show this clear bimodality, although the evidence is limited. They tend to plot towards the smaller of the two Italian and Greek size groups.

Lastly, the Eneolithic/Copper to Bronze Age data (Figures 8.3.d/e to 8.4.d/e and 8.5.d/e) indicate a clear overall reduction in size and bimodality in the Italian, Spanish and Greek areas. The overall size of the pigs in the three main areas seem to converge during this time as well, but with the Italian and Greek larger outliers – presumably wild boar – being larger than the Portuguese and Spanish ones. It seems clear, therefore, that the pattern already observed for the Italian peninsula during this time, i.e. the presence of two distinct domestic and wild populations, is echoed in other Mediterranean and Atlantic areas. The size ranges of the domestic pig populations also seem to converge during this time.

Figure 8.3. (1/3) Humerus BT and HTC scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age; (e) Eneolithic/Copper to Bronze Age periods without the Portuguese data, for clarity.

Figure 8.3. (2/3) Humerus BT and HTC scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age; (e) Eneolithic/Copper to Bronze Age periods without the Portuguese data, for clarity.

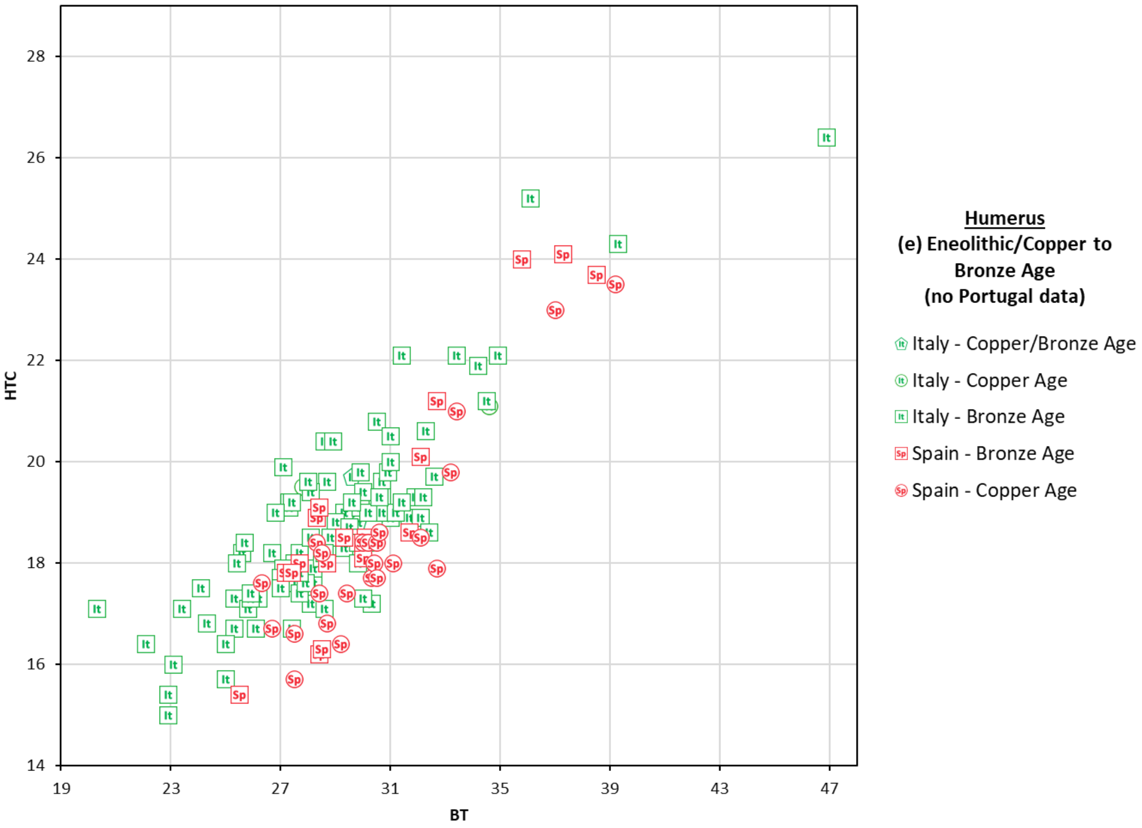


Figure 8.3. (3/3) Humerus BT and HTC scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age; (e) Eneolithic/Copper to Bronze Age periods without the Portuguese data, for clarity.

Figure 8.4. (1/3) Tibia Bd and Dd scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age; (e) Eneolithic/Copper to Bronze Age periods without the Portuguese data, for clarity.

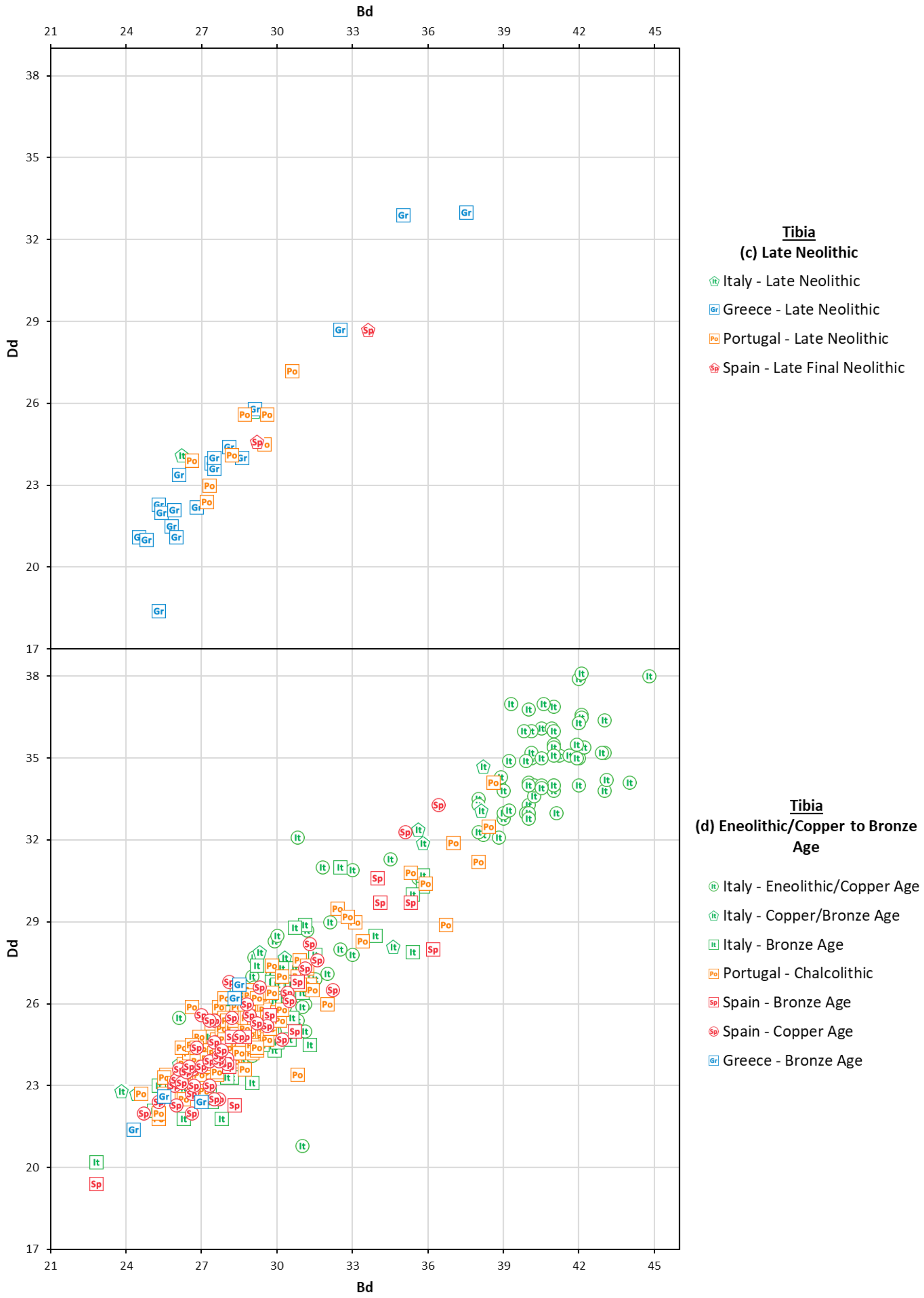


Figure 8.4. (2/3) Tibia Bd and Dd scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age; (e) Eneolithic/Copper to Bronze Age periods without the Portuguese data, for clarity.

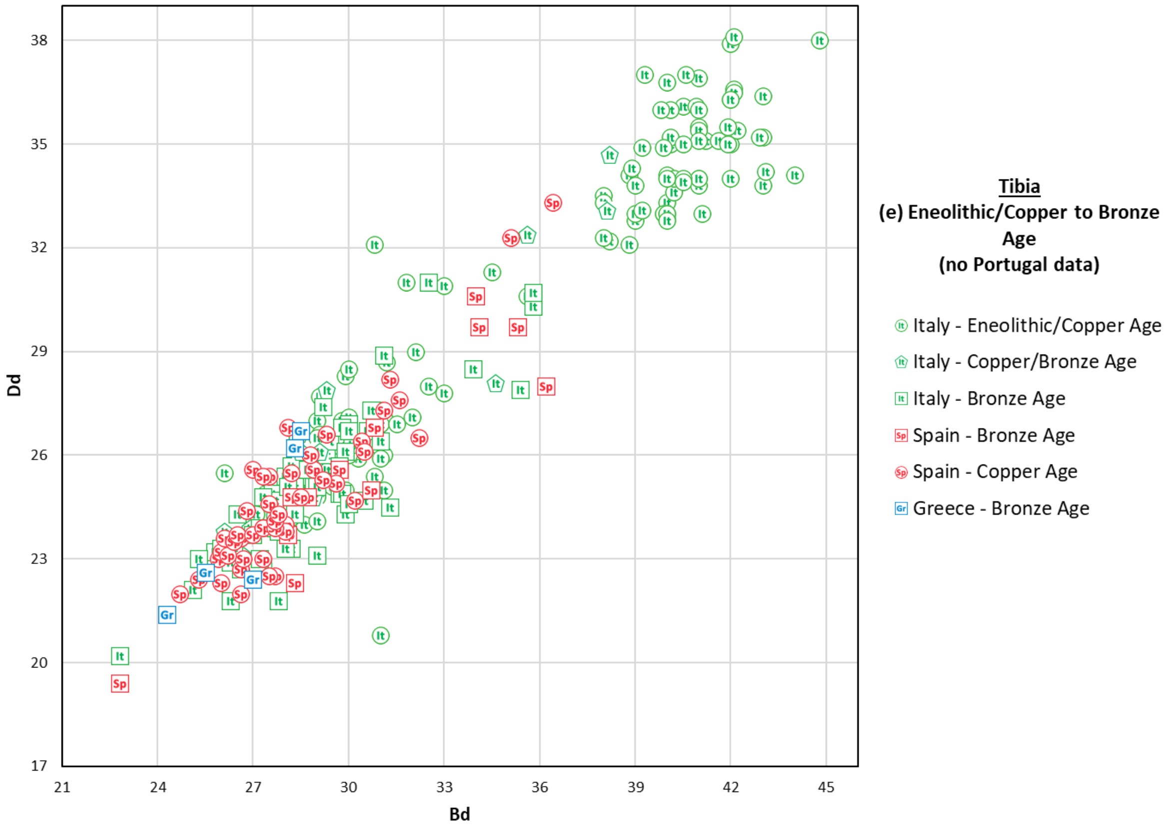


Figure 8.4. (3/3) Tibia Bd and Dd scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age; (e) Eneolithic/Copper to Bronze Age periods without the Portuguese data, for clarity.

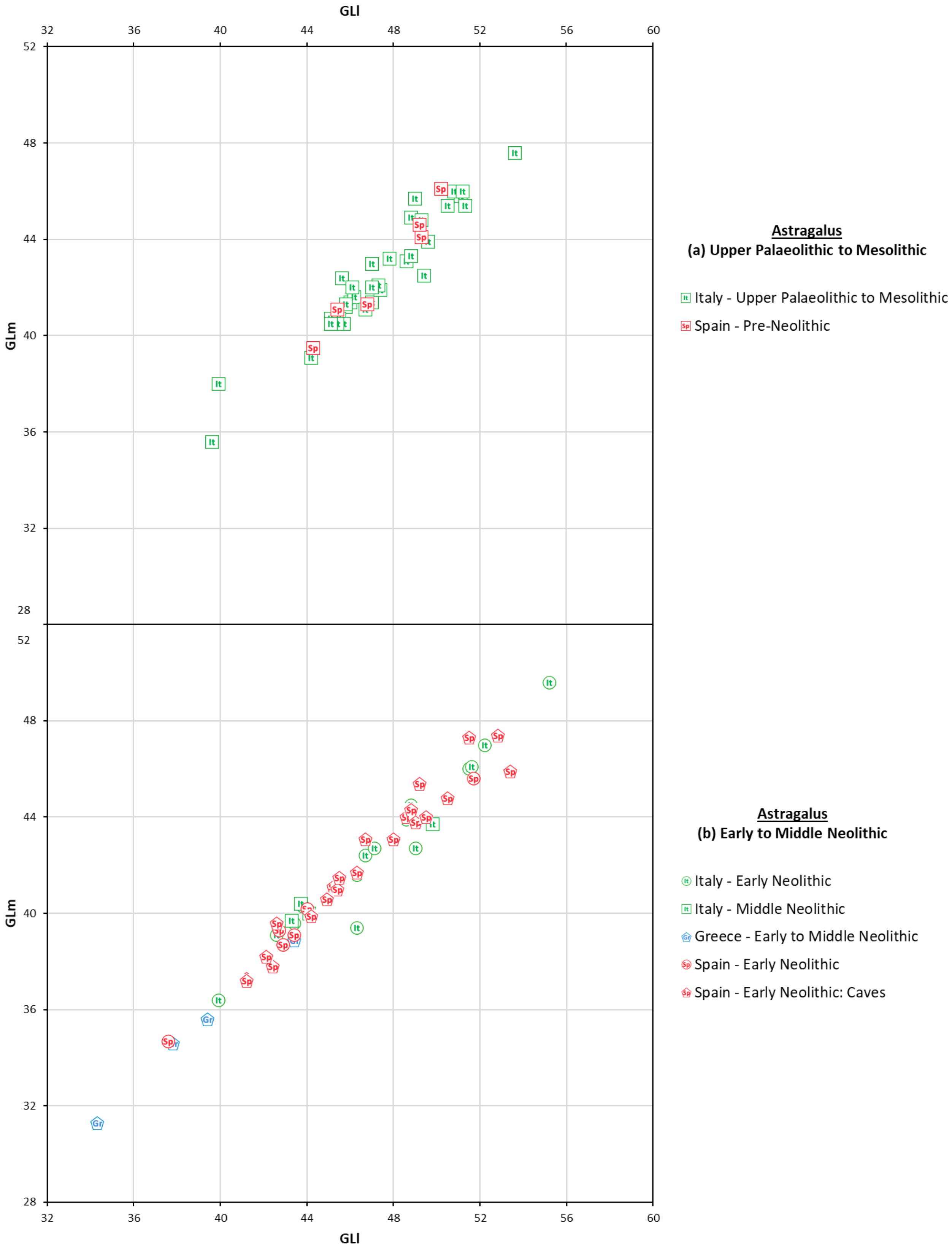


Figure 8.5. (1/2) Astragalus GLl and GLm scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

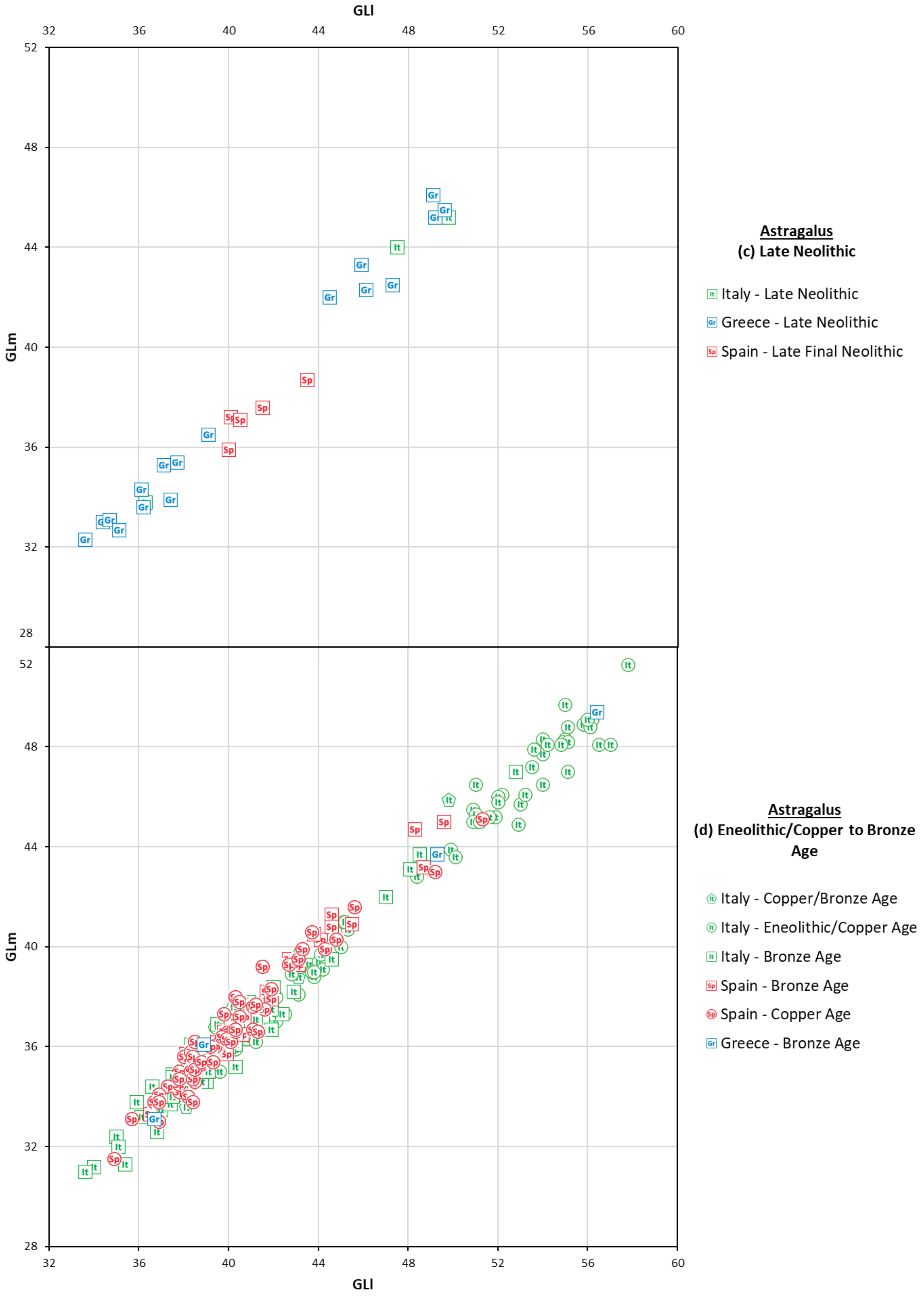


Figure 8.5. (2/2) Astragalus GLl and GLm scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

8.1.b. Postcranial Log Ratios Comparison

Figure 8.6 shows the results of the log ratio analysis of the postcranial data from Italy – North and Centre, South, and Islands (Grotta dell'Uzzo) –, Portugal, Spain, Germany, and the Netherlands, during the Upper Palaeolithic and Mesolithic periods. The data echoes the North-South size difference observed in the scatterplots, with the German and Dutch wild boar being considerably larger than their Southern counterparts. The Grotta dell'Uzzo wild boar are smaller than the other Southern data, confirming observations made in the previous chapter. The Spanish wild boar is slightly larger than the Italian, while the Portuguese is slightly smaller.

In Figure 8.7 the comparison between the log ratios of the Early and Middle Neolithic data from Italy, Portugal, Spain, France, Germany, the Netherlands, Greece, Syria, and Turkey is presented. In the case of the Italian data, as discussed in the previous chapter, no significant size change can be seen in relation to the previous periods, albeit a larger spread of measurements is detectable, and the smaller size of the Grotta dell'Uzzo in comparison with the nearby mainland can still be observed. The data from the Netherlands indicated pigs of a size consistent with the wild boar from previous periods, replicating the Italian scenario. The Middle Neolithic pigs from Rocadour are large, as expected given the large proportion of hunted animals in the assemblage. Their large size is consistent with the post-Mesolithic wild boar size observed in Italy and in other European areas during the Neolithic (see the discussion for Molino Casarotto and Cornuda in the previous chapter, for example).

The Spanish pigs during the Early Neolithic (which is equivalent to the Italian Early and Middle Neolithic periods) are very similar in size to the Italians, and, as observed originally by Hadjikoumis (2010), an incipient bimodality and reduction in size can be seen in the coastal sites, as opposed to the inland cave sites. The Portuguese data also sees a reduction in size in the Early and Evolved Early Neolithic from the previous periods, albeit from a smaller sample. The German data replicates what was observed in the scatterplots, namely, a noteworthy reduction in size of the pig populations and bimodality, not observed in the Italian data for these times. The Greek data indicates the presence of a population of largely small pigs and a roughly bimodal distribution. The smaller end of the spectrum of the German, Greek, Portuguese, and coastal Spanish data, which we could interpret as the domestic population, roughly overlap. These situations could be signifying the presence in these assemblages of a considerable proportion of domestic animals that, given their smaller size in comparison with their Upper Palaeolithic and Mesolithic counterparts (no data is available for these periods for Greece though), it may mean that they were imported from elsewhere. In order to look for the origin of these potential imports, the Turkish Erbaba and Syrian Sabi Abyad data is included. Regarding the former, the larger size of these pigs would seem to preclude this region where this site is located as the origin of those pigs. The case of Sabi Abyad is, however, different, as the pigs here are of a smaller size comparable to those of Germany, Spain, Portugal, and Greece. The possibility that this area could have been a source of origin of domestic pigs cannot therefore be excluded. The smaller pigs from Germany and/or Spain could have arrived via Greece through the Danubian and Mediterranean routes respectively.

This discussion brings us back to the Italian case. As discussed in the previous chapter, although no visible size decrease from the Upper Palaeolithic and Mesolithic can be observed in the data, when taking into consideration the post-Mesolithic size increase of the wild boar – as evidenced at sites such as Molino Casarotto, Cornuda, and Conelle – the smaller end of the postcranial measurements' range seems more likely to characterise a domestic rather than wild population. This observation seems is strengthened by comparison of the Italian data with the German, Spanish, and Greek areas, as the smaller Italian pigs are consistent with the likely domestic assemblages from those areas. Regardless of these observations, it is clear that areas such as the Italian peninsula, the Netherlands, and inland Spain saw a different trajectory of pig management than the German, Greek, Portuguese, and coastal Spain areas during the Early and Middle Neolithic. In the first set of countries, the pig data does not show clear bimodality, and is likely to reflect the regular inter-breeding between domestic and wild pig populations – in other words, a slow local process of pig domestication. The second set of countries, which do show bimodality or the presence of a considerably smaller pig population alongside larger animals, could be indicating instead the presence of introduced animals in larger numbers, and/or the lack of a regular inter-breeding between morphologically different domestic and wild populations.

Lastly, Figure 8.8 show the results of the log ratio analysis of the materials from the Late Neolithic to Bronze Age from Italy, Portugal, Spain, and Greece. As stated in the previous chapter, the Italian data from these times show a clear reduction in size of the pig populations, and a bimodal or ‘peak and tail’ distribution, likely representing the presence of a large domestic population accompanied by the occasional wild boar. The scenario depicted by the data from other the European areas included echoes the observations put forward for the scatterplot analysis, that is, a generalised uniformity of scenarios. Indeed, the Portuguese and Spanish data duplicate the Italian ‘peak and tail’ pattern, with similarly sized pigs. The Late Neolithic data from Greek Promachon also shows this type of distribution, and the pig sizes are now more in line with the data from the other Mediterranean areas. Unfortunately, no data from the Netherlands nor Germany is available for these times.

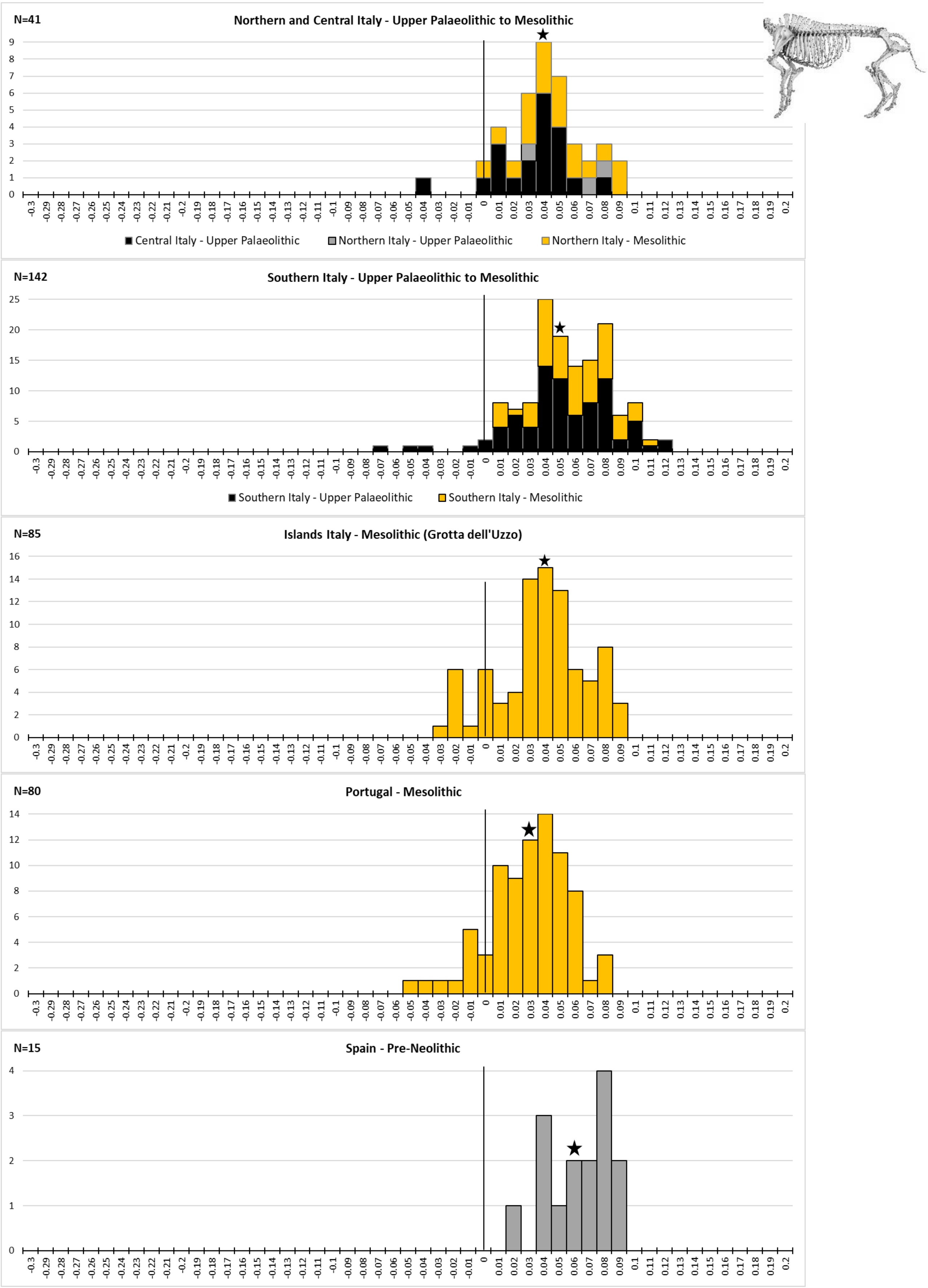
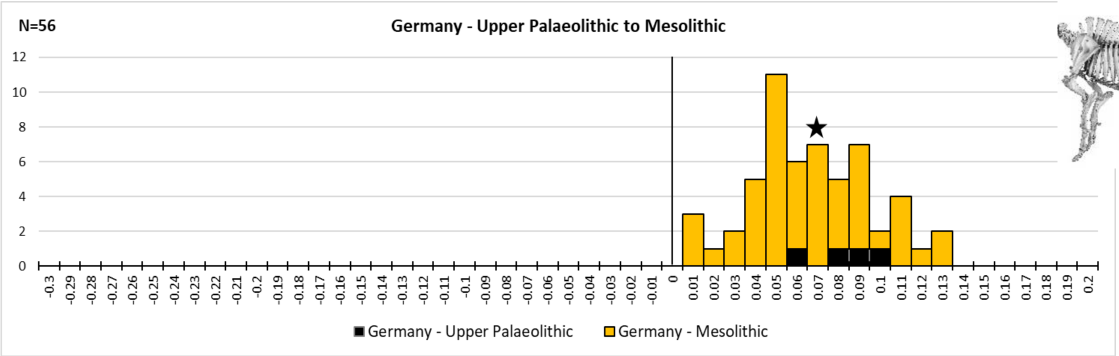


Figure 8.6. (1/2) Upper Palaeolithic to Mesolithic postcranial log ratios by countries.



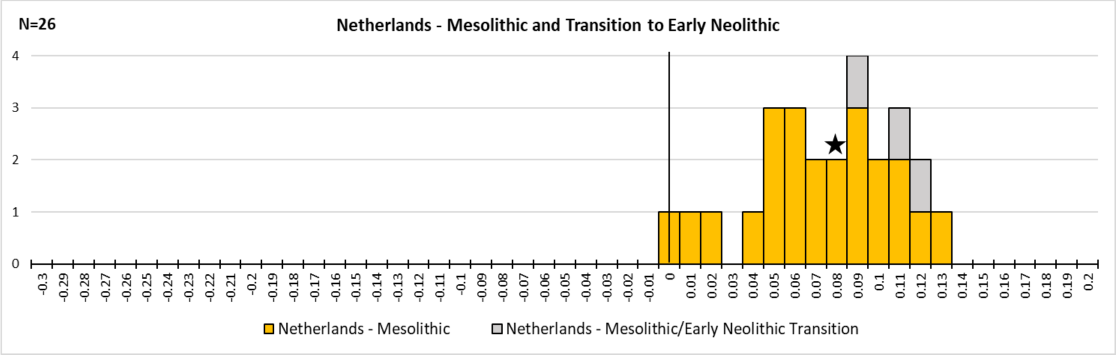


Figure 8.6. (2/2) Upper Palaeolithic to Mesolithic postcranial log ratios by countries.

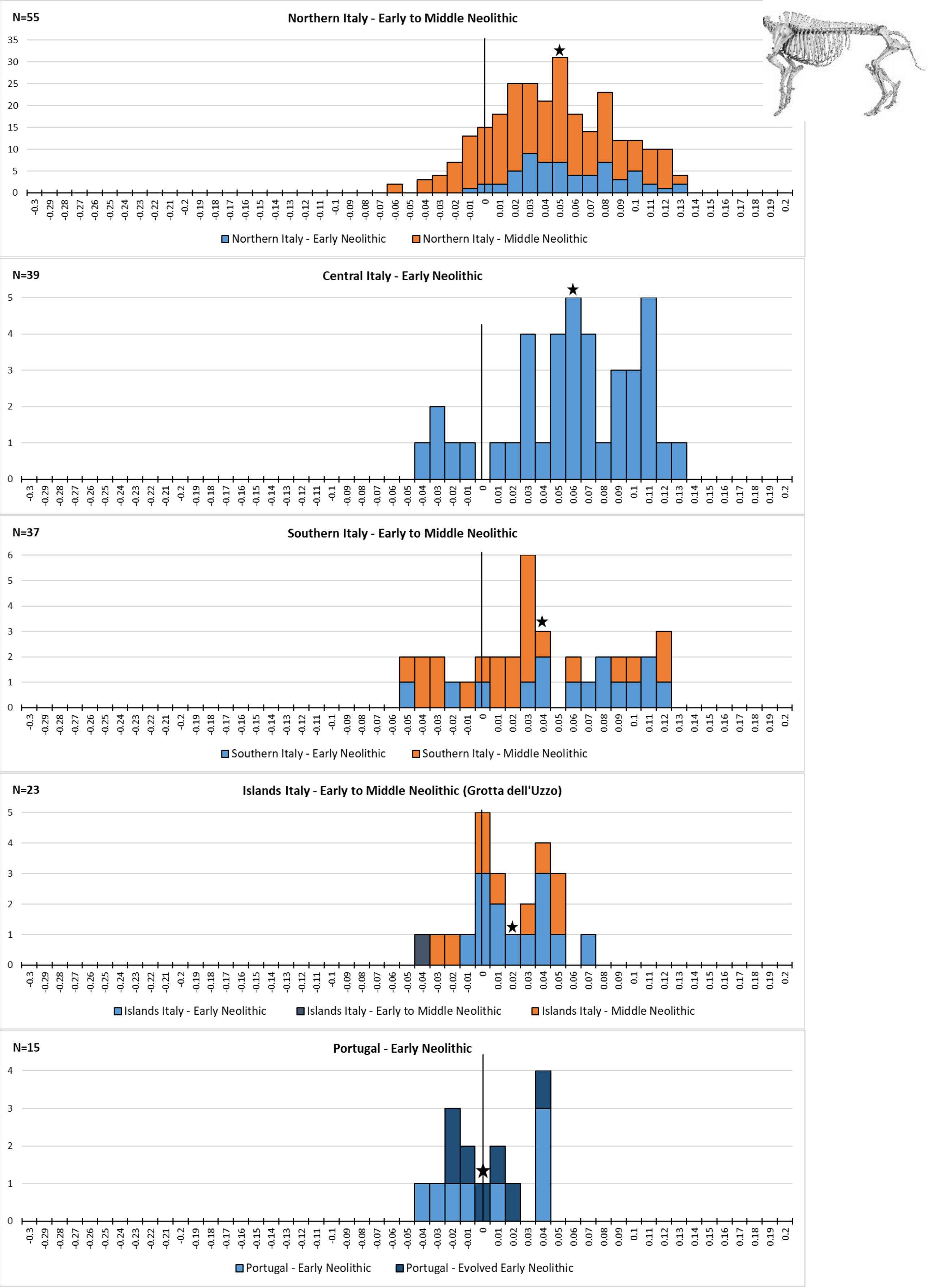


Figure 8.7. (1/3) Early to Middle Neolithic postcranial log ratios by countries.

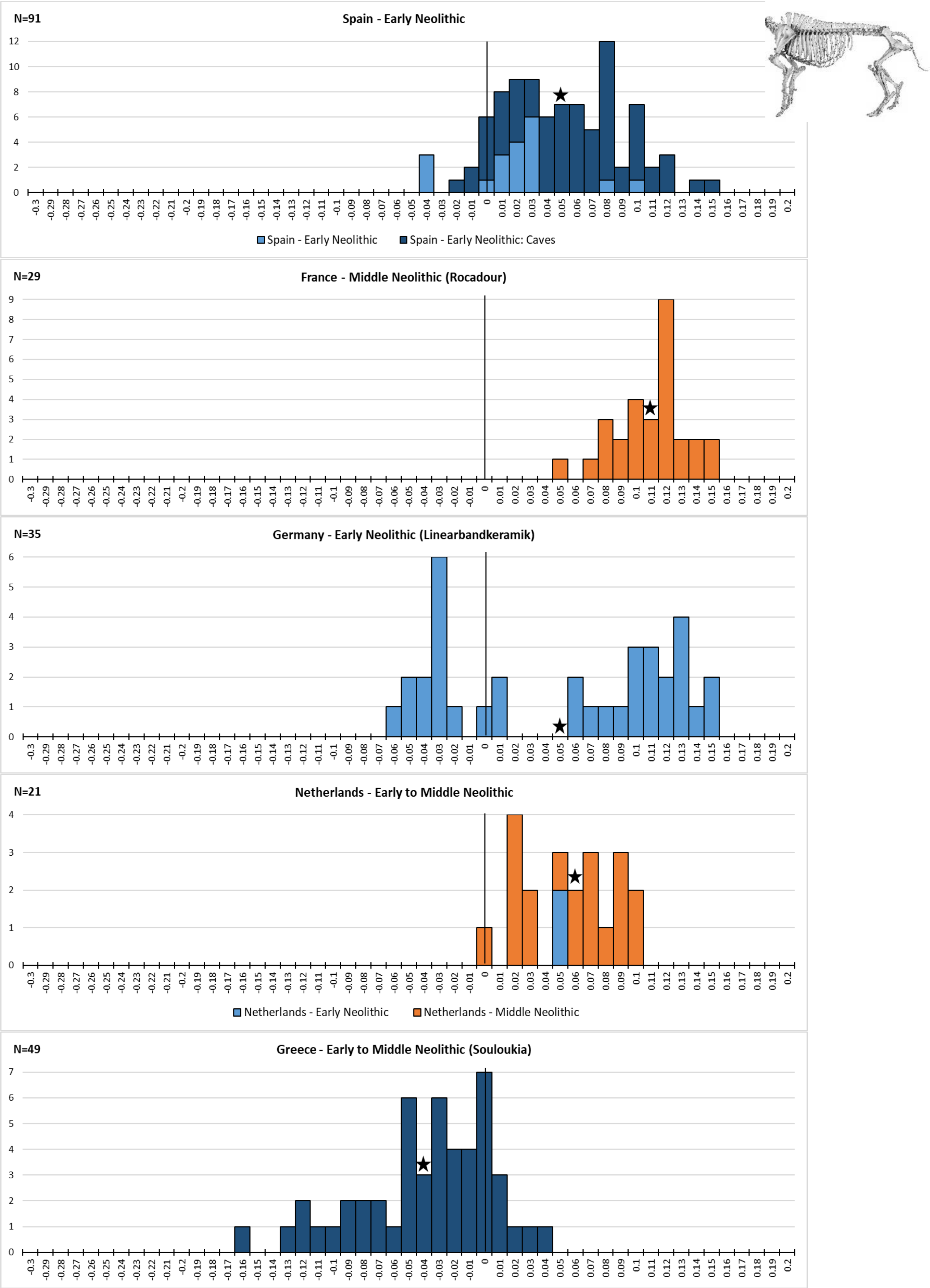


Figure 8.7. (2/3) Early to Middle Neolithic postcranial log ratios by countries.

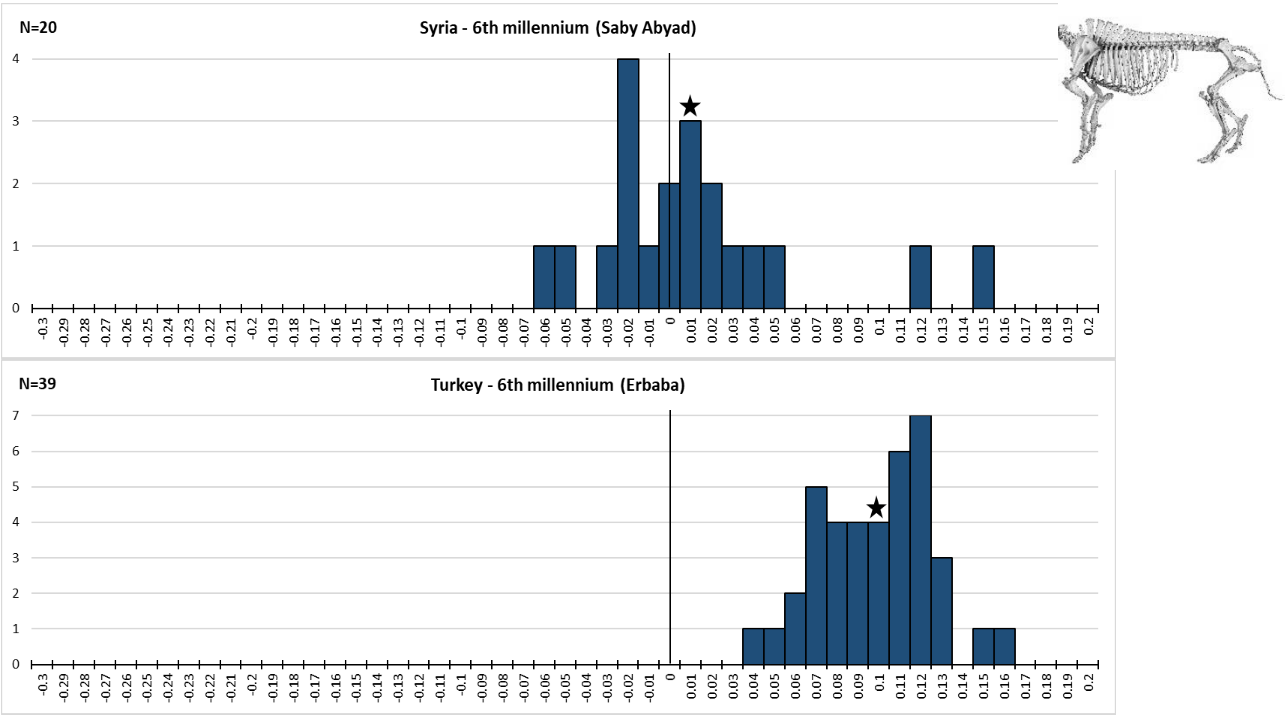


Figure 8.7. (3/3) Early to Middle Neolithic postcranial log ratios by countries.

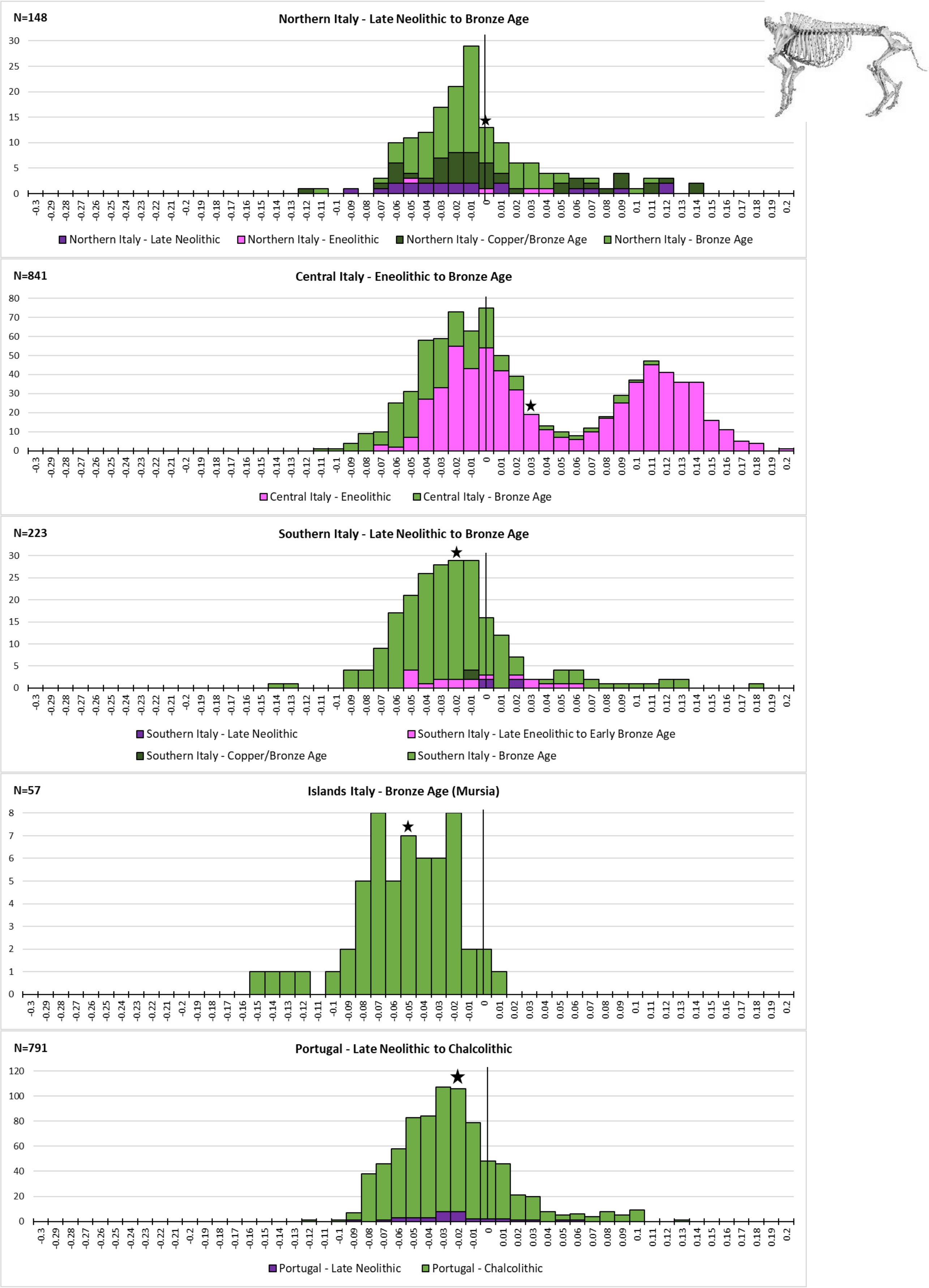


Figure 8.8. (1/2) Late Neolithic to Bronze Age postcranial log ratios by countries.

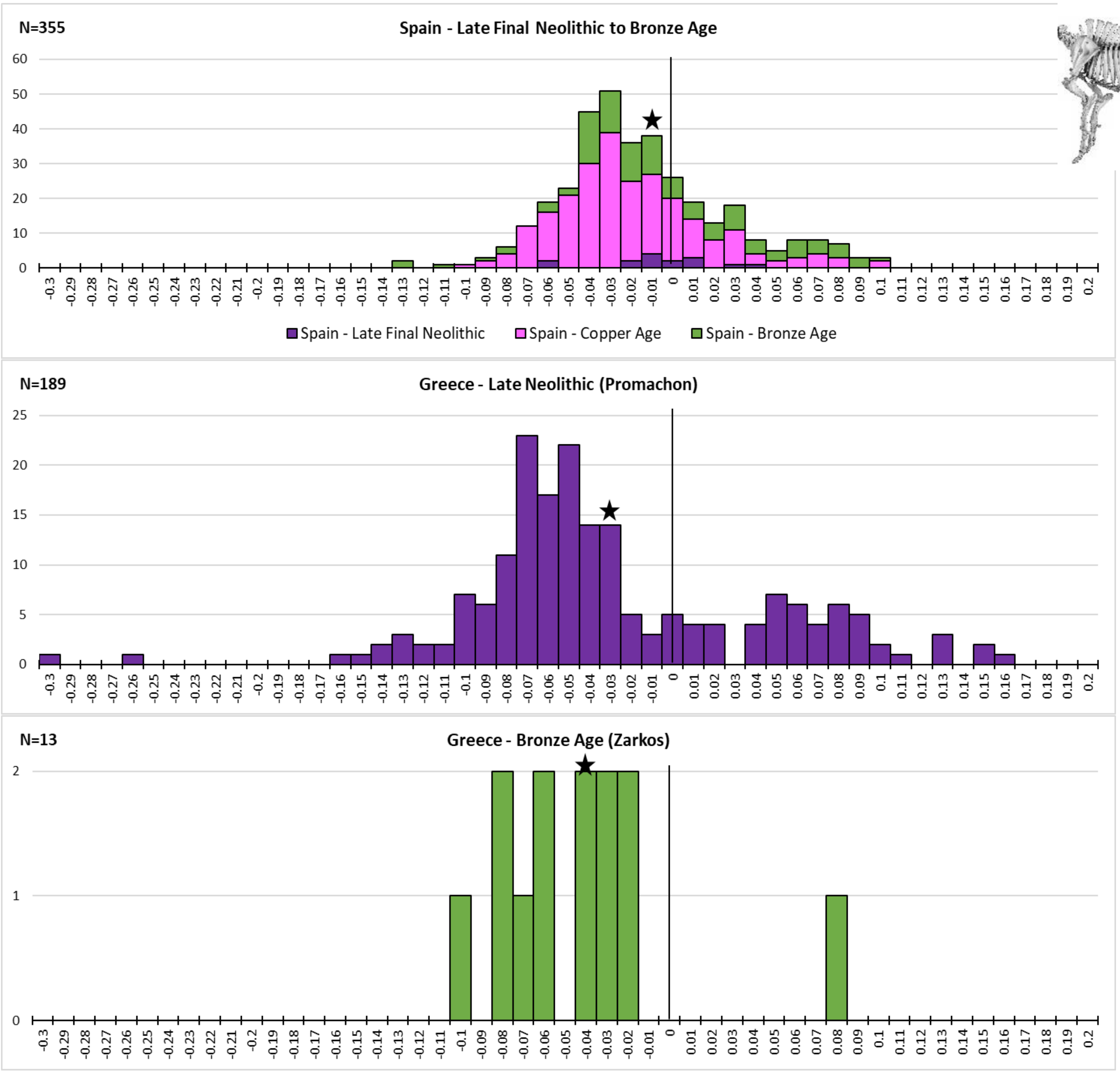


Figure 8.8. (2/2) Late Neolithic to Bronze Age postcranial log ratios by countries.

8.2. Tooth Biometry

In this sub-section, the analysis will be focused on the biometrical tooth data from the different countries included in the comparison (Figures 8.9 to 8.17). Once again, first the scatterplots will be discussed, and then the log ratios. As mentioned before, the lengths from the Spanish sites will be excluded, as they were taken by the original author in a different way (Hadjikoumis, 2010).

8.2.a. Tooth Scatterplots Comparison

Starting with the lower deciduous fourth premolar, and first, second, and third molar lengths and widths, and widths scatterplots for the Upper Palaeolithic and Mesolithic periods from Italy, Portugal, Spain, the Netherlands, Germany, and Turkey (Erbaba) (Figures 8.9.a, 8.10.a, 8.11.a, 8.12.a, 8.13.a, 8.14.a, 8.15.a), the data replicates the North-South size pattern observed in the postcranial bones, with the German and Dutch wild boars being overall larger than their Italian, Portuguese, and Spanish counterparts. Some German wild boar lower third molars show a remarkably smaller size, and this was observed as well by U. Albarella (pers. comm.) when studying the material.

The Early and Middle Neolithic data (Figures 8.9.b, 8.10.b, 8.11.b, 8.12.b, 8.13.b, 8.14.b, 8.15.b) once again echoes the patterns observed in the postcranial materials, with the German and Greek data showing bimodality also in teeth, while the Italian, Spanish, Dutch, and the scant Portuguese materials do not evidence significant size changes from the previous periods. Additionally, the German data includes specimens much smaller than in earlier times. The Greek teeth are in all cases the smallest, with some specimens showing smaller lengths in relation to widths, and therefore suggesting the possibility that they could be different pigs, perhaps imported domestic animals. The Dutch, French, Turkish, and larger German specimens plot at the larger end of the spectrum, overlapping with the larger Italian pigs and thus replicating the situation observed for the postcranial data. Regarding the data from Turkish Erbaba, if the smaller teeth from Greece and Germany do represent imported animals, Anatolia does not seem to have been their source of origin. The Spanish data seems to be more similar in general to the Italian, albeit tending to plot towards the smaller end of the range.

The Late Neolithic data (Figures 8.9.c, 8.10.c, 8.11.c, 8.12.c, 8.13.c, 8.14.c, 8.15.c) sees once again a dearth of Italian measurements. Other assemblages represented come from Greece, Portugal, Spain, and the Netherlands. The Greek data continues to represent the smaller pigs, albeit with some larger outliers, with the Spanish and Portuguese data overlapping with the smaller Greek group, but not reaching the smallest sizes. A trend towards a reduction in size from the previous periods can also be seen in the Greek data. The smaller length to width ratio observed for some Greek Early to Middle Neolithic specimens can also be seen in some cases during this period, potentially signifying the continued presence of differently shaped pigs. The scarce Italian and Dutch data plot towards the middle of the larger end of the Portuguese and Spanish data, although the very scant amount of measurements prevents us from drawing firm conclusions.

Lastly, the Eneolithic/Copper to Bronze Age data (Figures 8.9.d, 8.10.d, 8.11.d, 8.12.d, 8.13.d, 8.12.d, 8.15.d/e) from Italy, Portugal, and Spain, evidence only now a generalized trend towards a reduction in pig tooth size from the previous periods. The Greek data for this period is too negligible to provide any meaningful observations for this area. We have already commented in the previous chapter about how in the Italian case it is during these times that a visible reduction in pig tooth size can be seen accompanied with larger outliers, although not a marked bimodality as was seen in the postcranial bones. The presence of a domestic population in this region can therefore be safely asserted for this period on the basis of tooth biometry, and this pattern is seen replicated by the Spanish and Portuguese data. As we have seen for the postcranial comparison, a uniformity of the pig populations throughout the Mediterranean countries is detectable in these periods, blurring any differences observed between these regions in previous times.

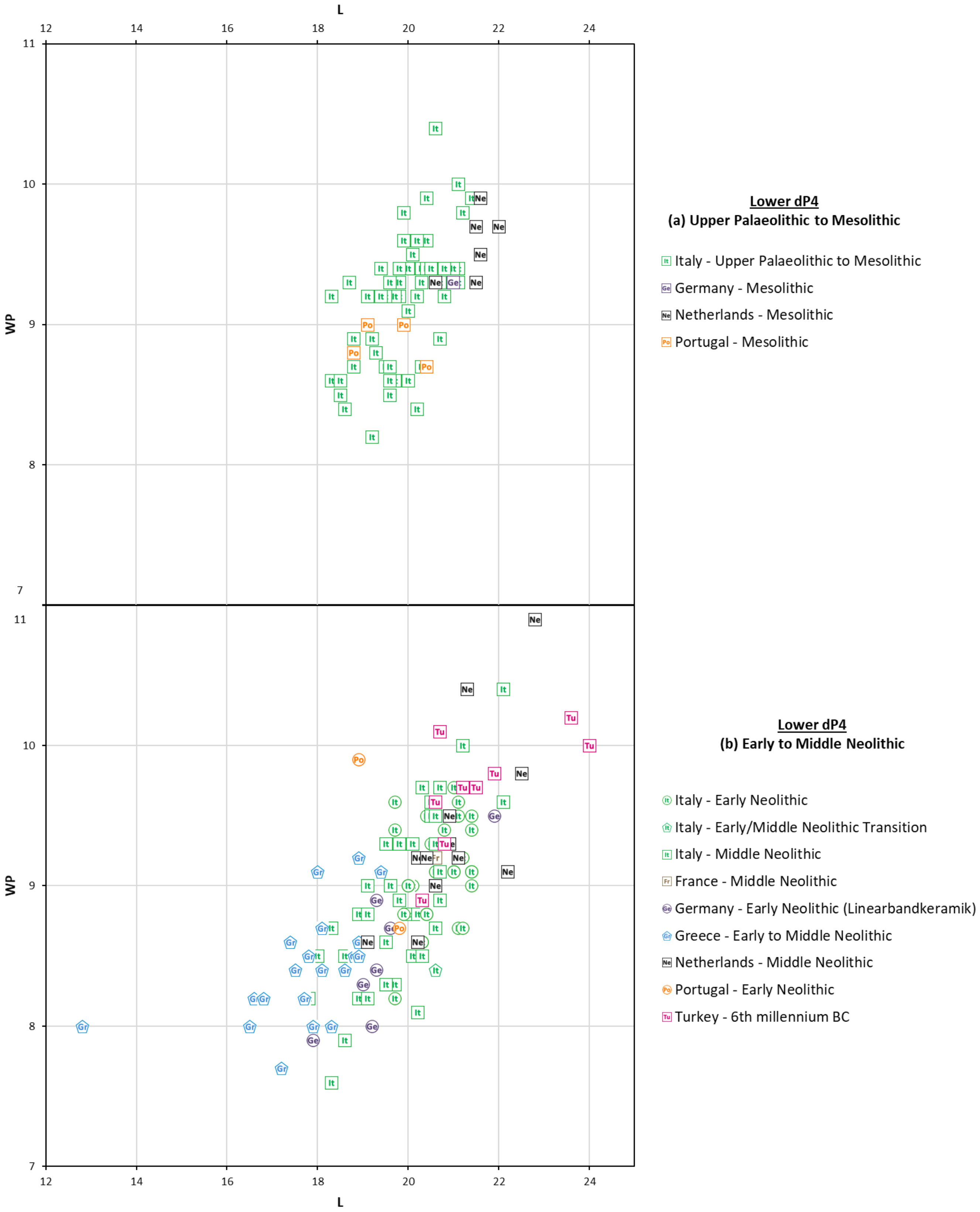


Figure 8.9. (1/2) Lower dP4 L and WP scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

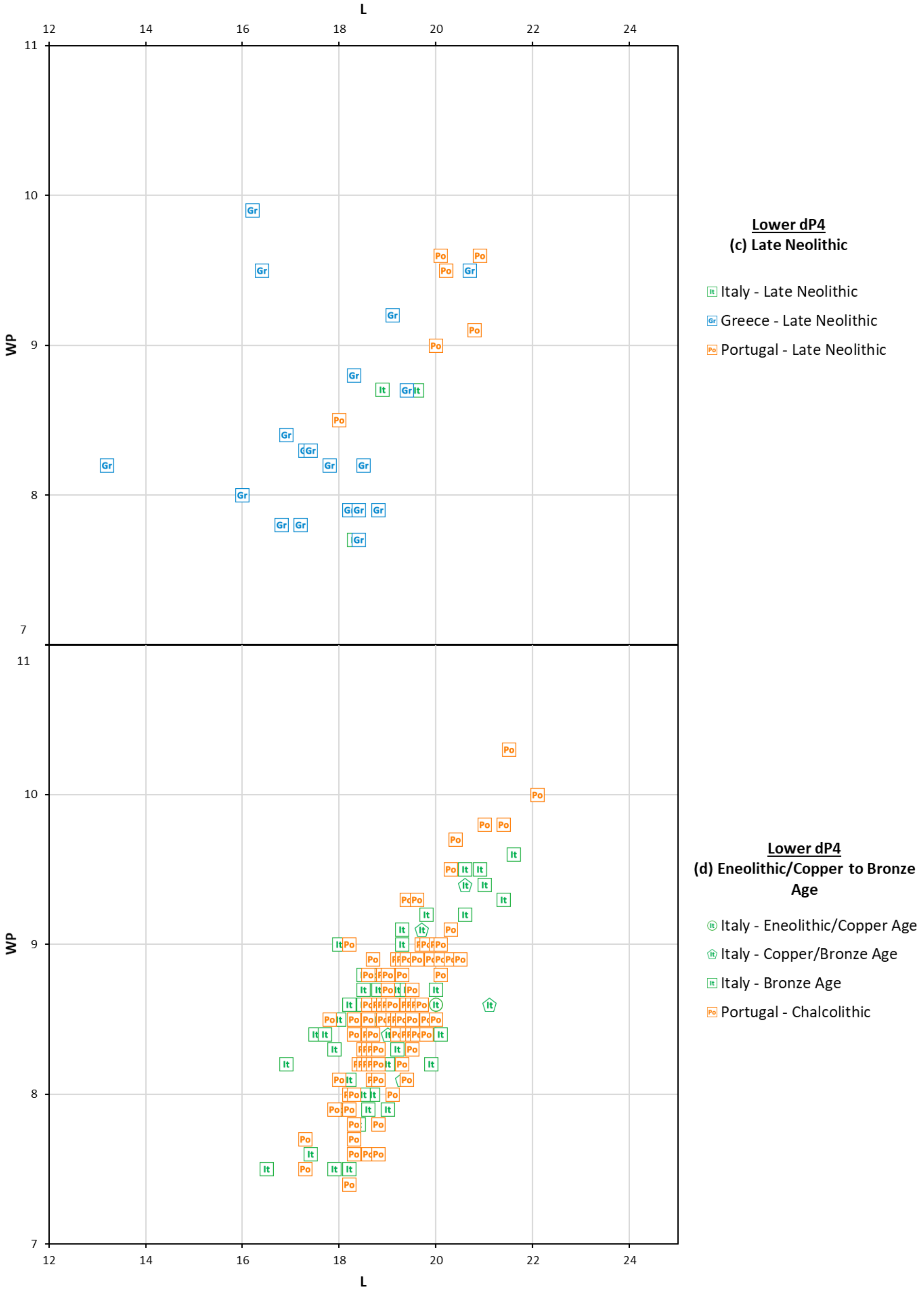


Figure 8.9. (2/2) Lower dP4 L and WP scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

Figure 8.10. (1/2) Lower M1 L and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

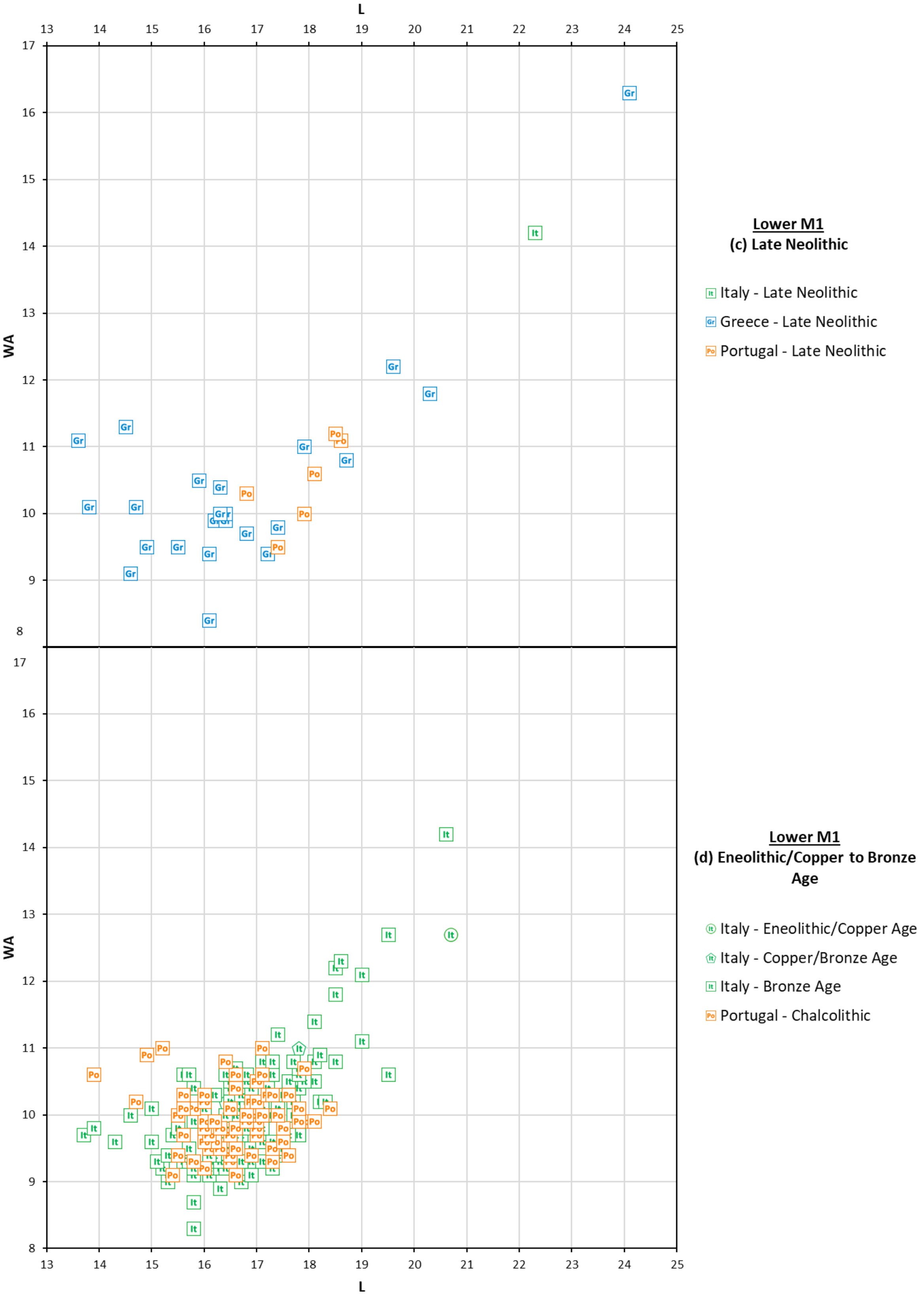


Figure 8.10. (2/2) Lower M1 L and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

Figure 8.11. (1/2) Lower M1 WP and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

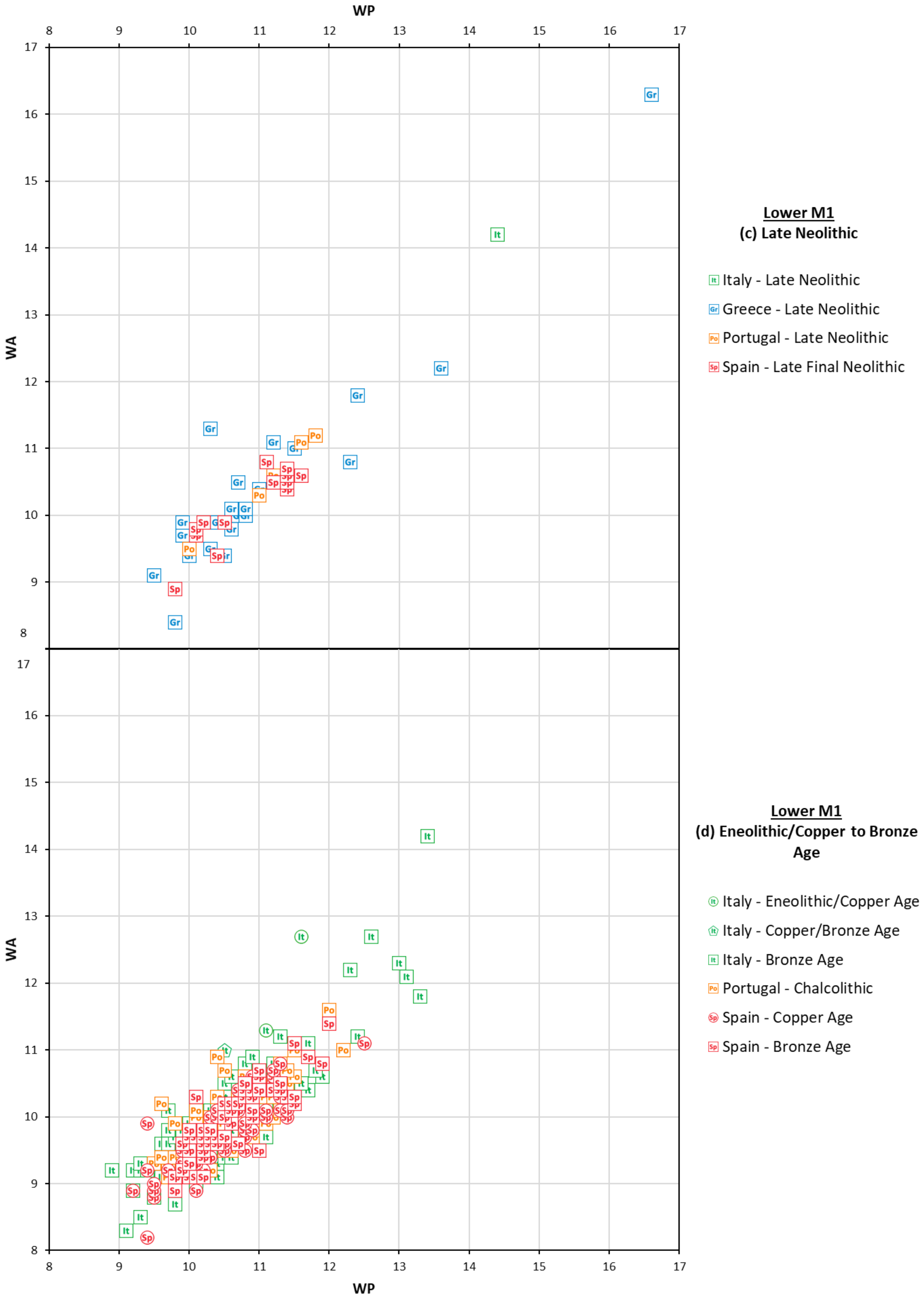


Figure 8.11. (2/2) Lower M1 WP and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

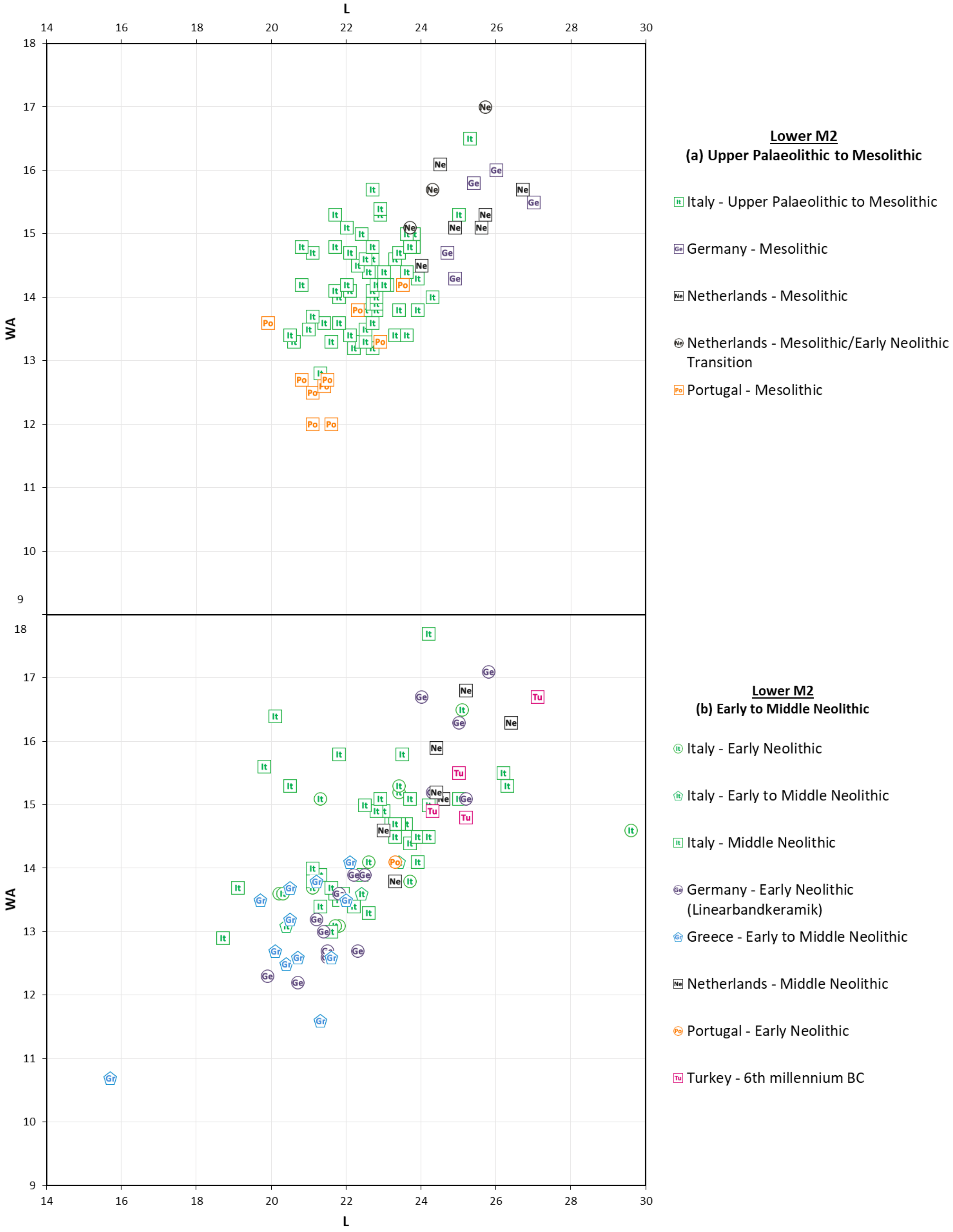


Figure 8.12. (1/2) Lower M2 L and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

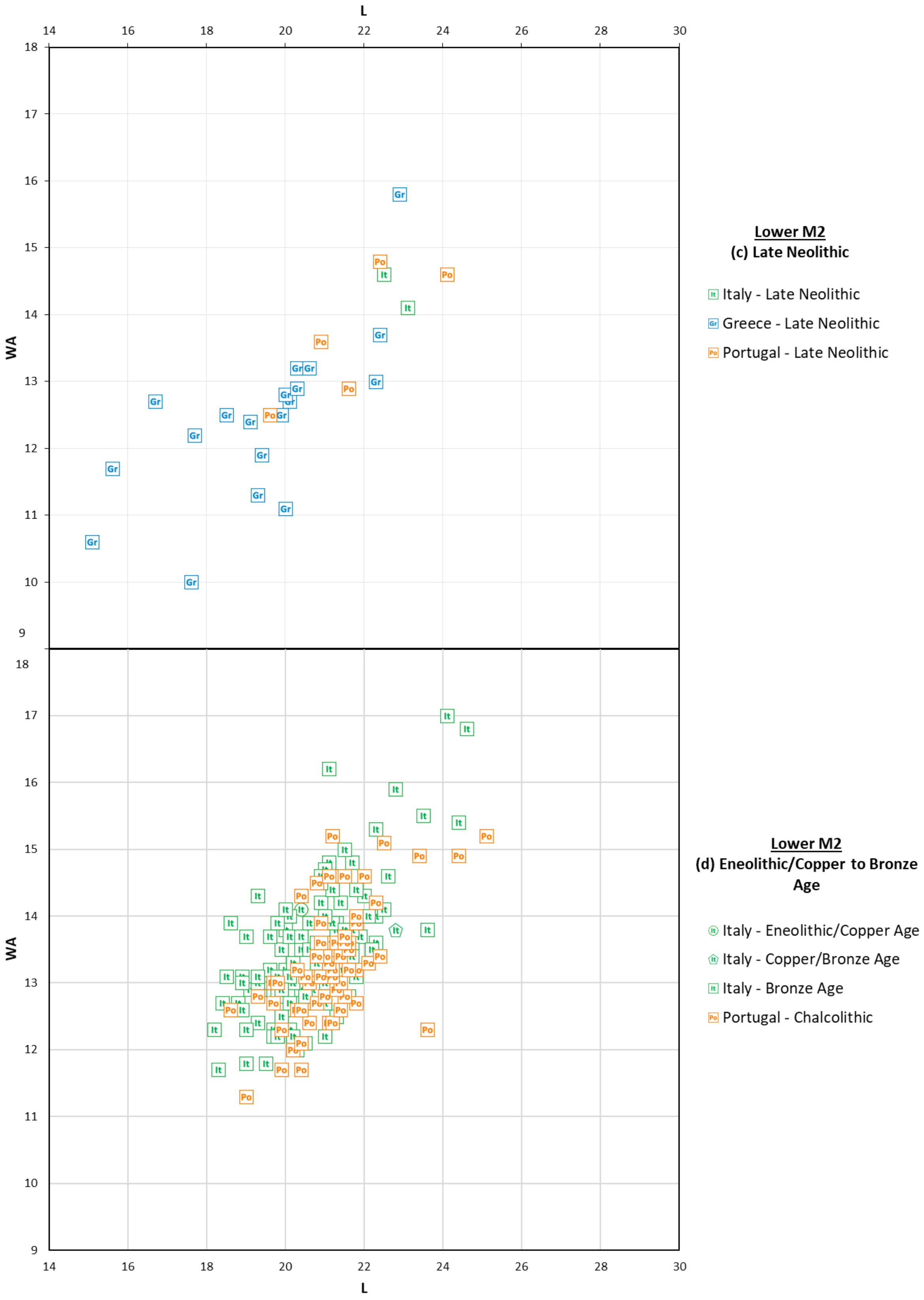


Figure 8.12. (2/2) Lower M2 L and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

Figure 8.13. (1/2) Lower M2 WP and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

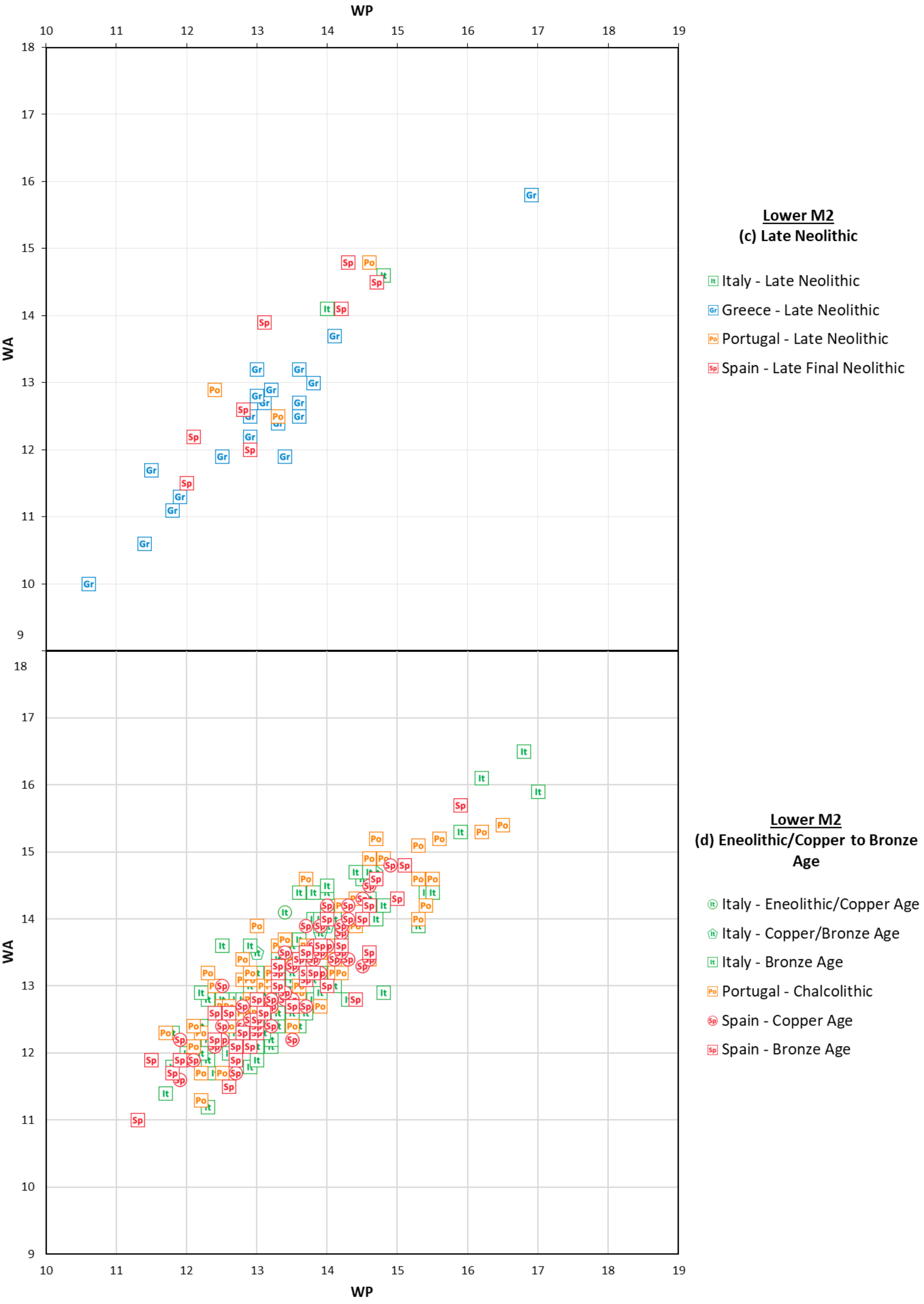


Figure 8.13. (2/2) Lower M2 WP and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

Figure 8.14. (1/2) Lower M3 L and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

Figure 8.14. (2/2) Lower M3 L and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

Figure 8.15. (1/3) Lower M3 WP and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age; (e) Eneolithic/Copper to Bronze Age periods without the Portuguese data, for clarity.

Figure 8.15. (2/3) Lower M3 WP and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age; (e) Eneolithic/Copper to Bronze Age periods without the Portuguese data, for clarity.

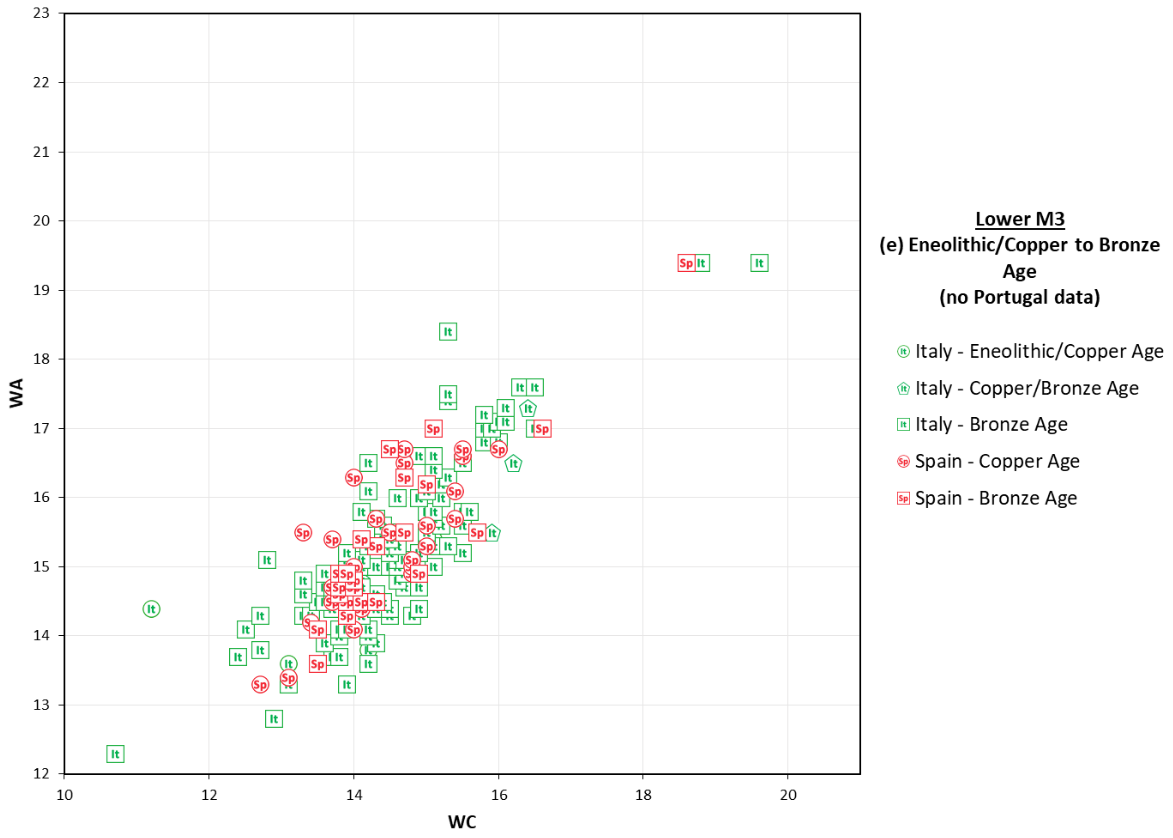


Figure 8.15. (3/3) Lower M3 WP and WA scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age; (e) Eneolithic/Copper to Bronze Age periods without the Portuguese data, for clarity.

A shape analysis of the lower third molar has also been performed via scatterplots. In the first analysis, the lengths were plotted against the anterior and central width ratio (Figure 8.16). Regarding the Upper Palaeolithic and Mesolithic data from Italy, Portugal (one data set only), Germany, and the Netherlands (Figure 8.16.a), the northern countries show a longer tooth in relation to the widths' ratio than the Mediterranean ones, with the addition of some smaller German outliers. The Early to Middle Neolithic (Figure 8.16.b) German and Dutch data do not show significant changes to the previous patterns. The same can be said about the Italian data for those periods, although a few teeth are as long as the German and Dutch. The Turkish data from Erbaba are very similar to this latter two areas, while the Greek teeth are amongst the shortest of all. The Late Neolithic data (Figure 8.16.c) from Greece, Italy, Portugal, and the Netherlands is very scant, and overall do not evidence much changes from previous periods. Finally, the Eneolithic/Copper to Bronze Age scatterplot (Figure 8.16.d) from Portugal and Italy, show no differences between the two countries. In sum, all differences observed between the countries through time seem to be due to size rather than shape changes.

The second shape analysis involved the plotting of both anterior and central widths with the lengths of the lower third molar (Figure 8.17), in order to obtain a size independent analysis. The Upper Palaeolithic to Mesolithic data (Figure 8.17.a) from Italy, Portugal, Germany, and the Netherlands do not show any clear patterns differentiating the countries, although the northern countries' data tend to have a greater length in comparison with the widths. The Early to Middle Neolithic analysis (Figure 8.17.b), including data from Italy, Germany, the Netherlands, Greece, and Turkey (Erbaba) sees the disappearance of the teeth which were wider in relation to the length. Additionally, the German, Dutch, and most of the Turkish data plot towards the lower end of the Italian group, while the Greek one does so towards the higher end. The Late Neolithic scatterplot (Figure 8.17.c) again consists of very scant datasets from Italy, Greece, Portugal, and the Netherlands, and it can only be mentioned that the Greek data sees the presence of some teeth which are wider in relation to their length. Lastly, the Eneolithic/Copper to Bronze Age data (Figure 8.17.d) from Italy and Portugal do not show any visible differences, mostly overlapping throughout. In sum, a hint of possible regional shape trends is suggested by the Early to Middle Neolithic data, but all in all the limited data available do not show consistent evidence of shape differences.

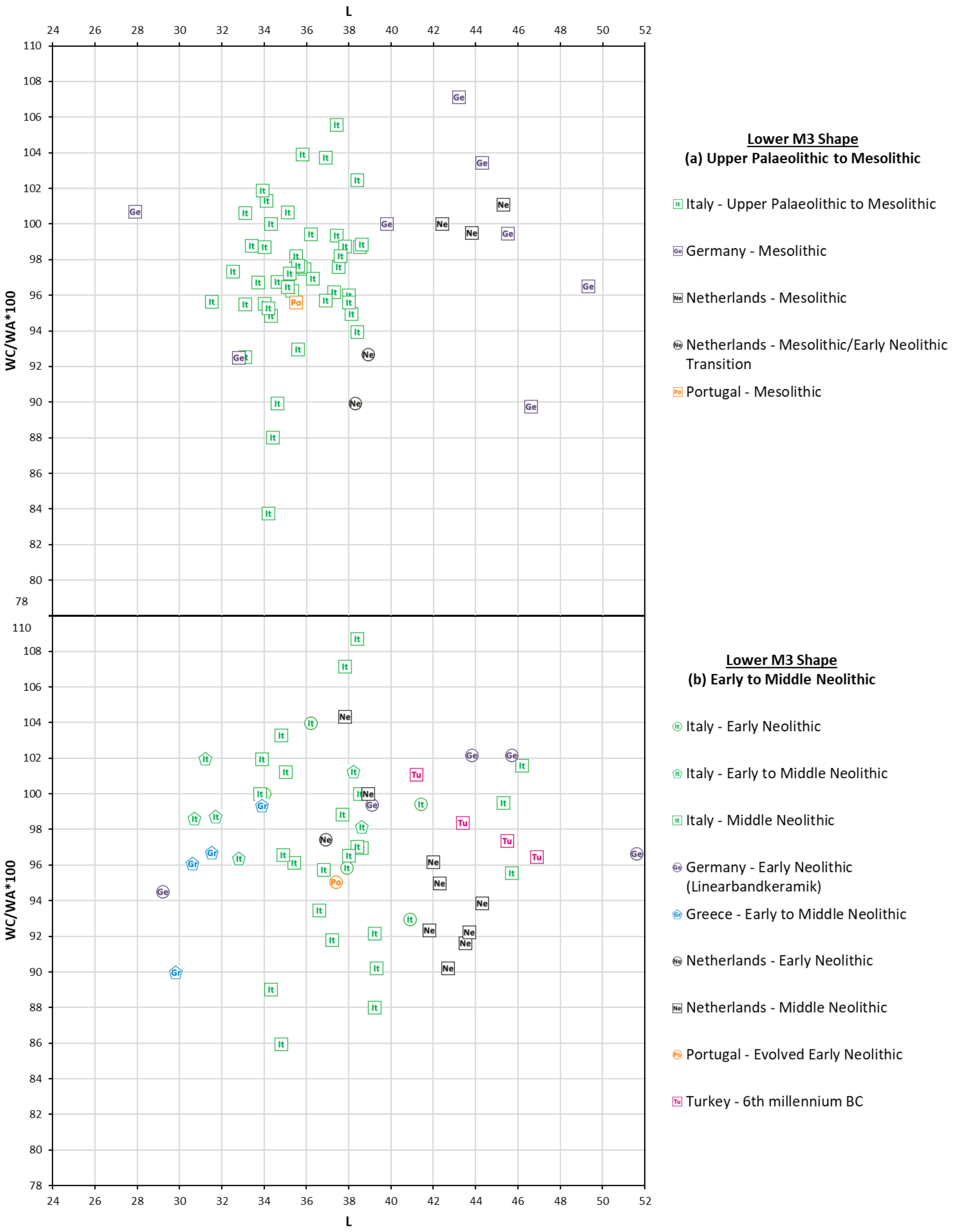


Figure 8.16. (1/2) Lower M3 L and WC/WA ratio shape scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

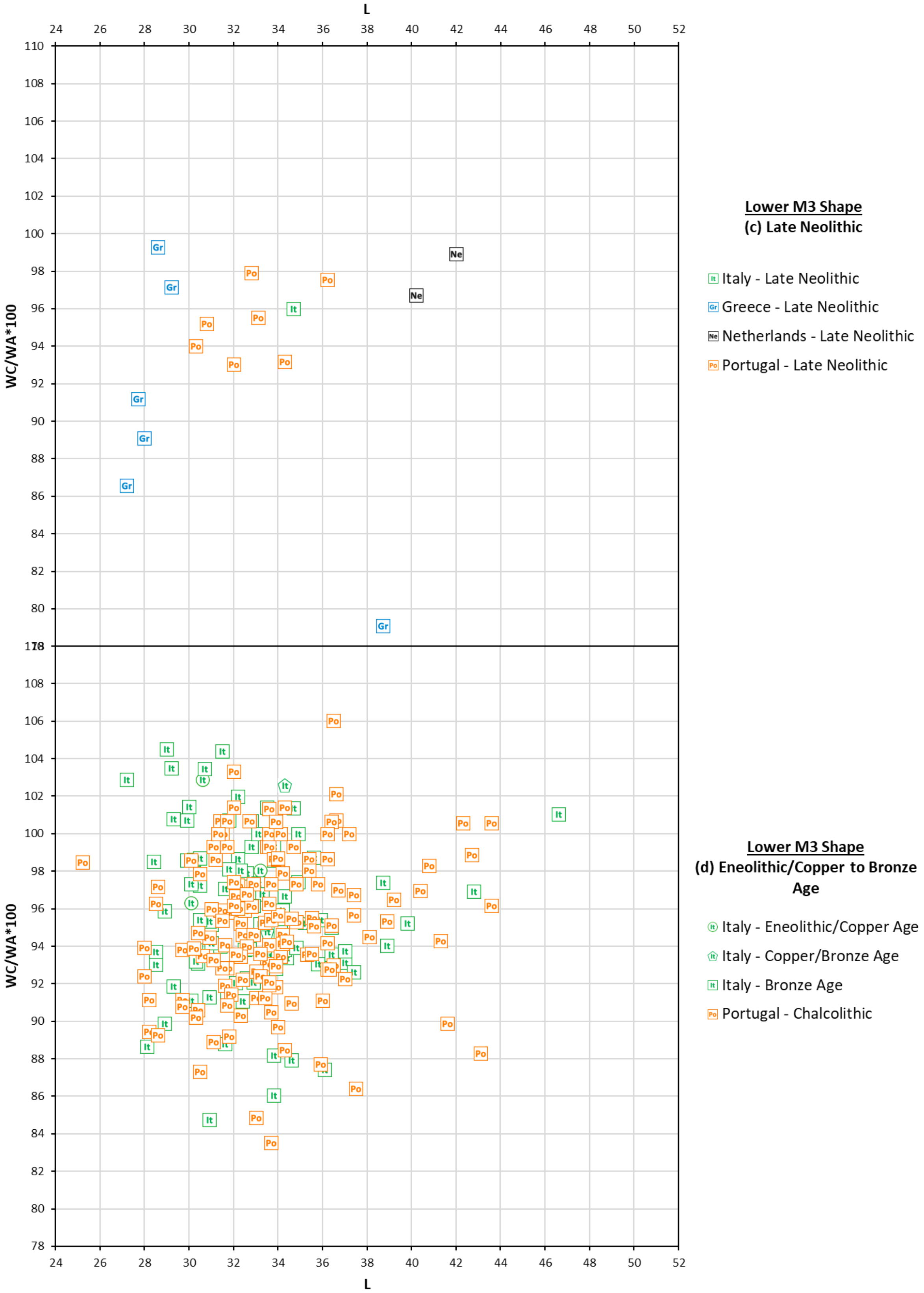


Figure 8.16. (2/2) Lower M3 L and WC/WA ratio shape scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

Figure 8.17. (1/2) Lower M3 WA/L ratio and WC/L ratio shape scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

Figure 8.17. (2/2) Lower M3 WA/L ratio and WC/L ratio shape scatterplots, sites grouped by countries: (a) Upper Palaeolithic to Mesolithic; (b) Early to Middle Neolithic; (c) Late Neolithic; (d) Eneolithic/Copper to Bronze Age.

8.2.b. Tooth Log Ratios Comparison

Figure 8.18 shows the results of the log ratio analysis for the Upper Palaeolithic and Mesolithic period in the areas considered. The North-South size cline is noticeable as well in these results, with the German and Dutch wild boars being larger than their Southern European counterparts. In Germany, some smaller wild boar teeth can be seen alongside the more common larger specimens, as it was observed also in the scatterplot analysis. Regarding the Italian data, and as mentioned in the previous chapter, the Sicilian wild boar is smaller than the Southern peninsular ones, in teeth as well as in postcranial bones, a fact likely related to insular dwarfism. The Portuguese and Spanish wild boars are slightly smaller than the Italian ones.

The Early to Middle Neolithic data comparison (Figure 8.19) indicates, in the Italian, Portuguese, Spanish, and Dutch cases, no significant tooth size changes from the previous periods. As remarked in the previous chapter, the Italian case shows a slight increase in the spread of measurements, particularly for the North and South of the peninsula. The Spanish situation indicates a trend towards smaller teeth in the coastal sites, although no clear-cut bimodality is visible. The German data, however, does show a noticeable decrease in size of teeth, displaying a peak and tail distribution. This fact, echoed by the postcranial evidence, would seem to suggest the introduction of domestic pigs in this region during this time. The Greek data is similar in size to the German during the Early and Middle Neolithic, like for the postcranial bones, although the peak and tail shape is inverted towards the smaller range. However, unfortunately the lack of Greek Upper Palaeolithic or Mesolithic data does not allow us to observe whether this signifies the introduction of new animals or a continuation of the wild boar trend. Finally, the data from Turkey (Erbaba) and Syria (Sabi Abyad), included here to assess their potential as source of domestic pigs imported to Europe, offer two different scenarios, with the former being larger than the latter. The similarity of the Syrian with the German and Greek data makes this area a potential source for these pigs, if imported; the larger Turkish data, however, does not fit the role.

Lastly, Figure 8.20 shows the results of the log ratio analysis of the different areas, from the Late Neolithic to Bronze Age periods. As observed in the scatterplots and previous chapter's analysis, it is during these periods that a clear reduction in size can be seen in the Italian data (i.e. clear domestic populations), accompanied by large outliers (i.e. wild boar). The Portuguese and Spanish patterns are remarkably similar to the Italian one, showing a consistency between the different countries' pig populations during this time, as also reflected by the postcranial data. Even the Greek case – which also shows a decrease in size from the earlier Neolithic periods – becomes more alike these other areas, unlike in preceding times, albeit with a larger spread of measurements.

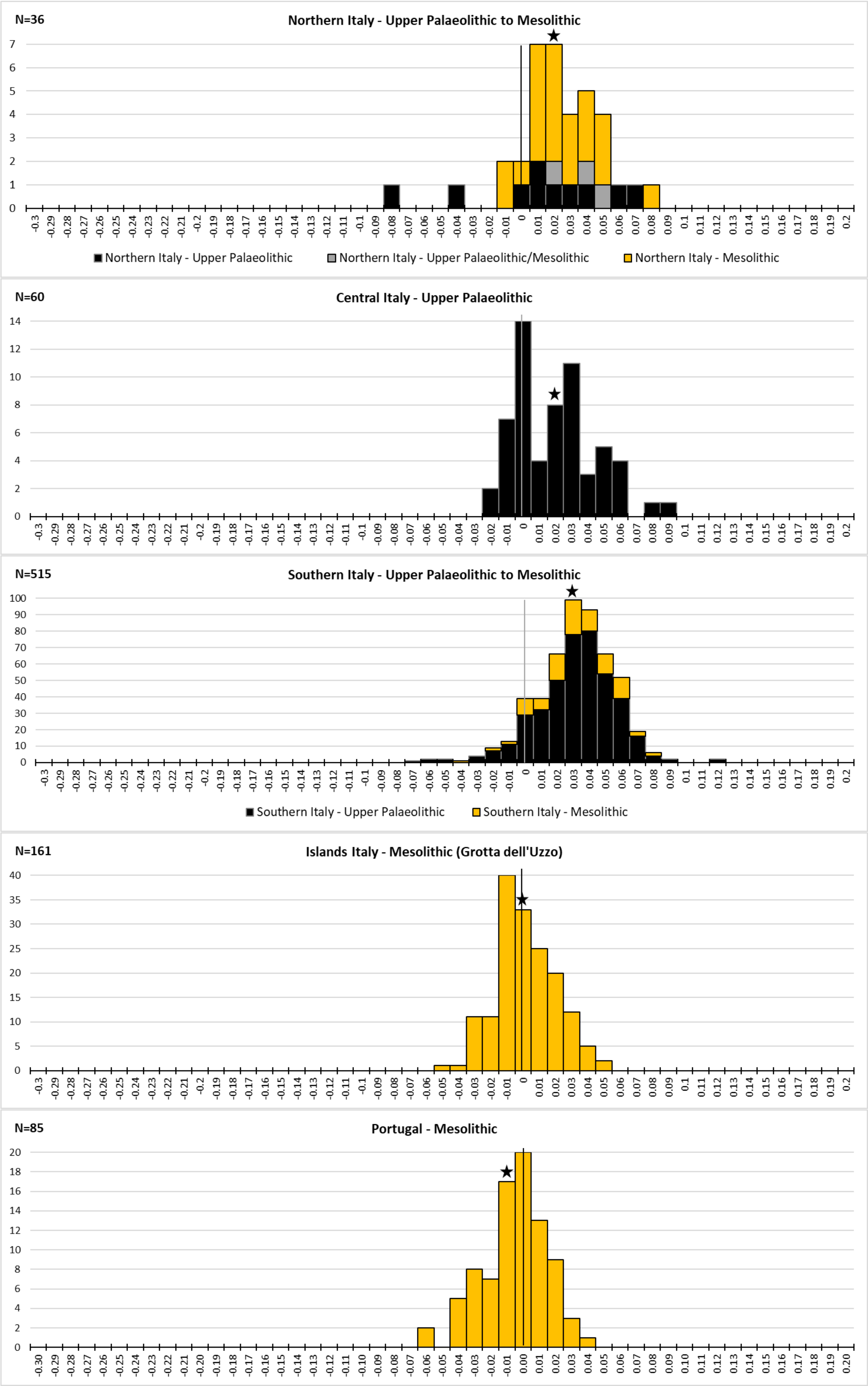


Figure 8.18. (1/2) Upper Palaeolithic to Mesolithic tooth log ratios by countries.

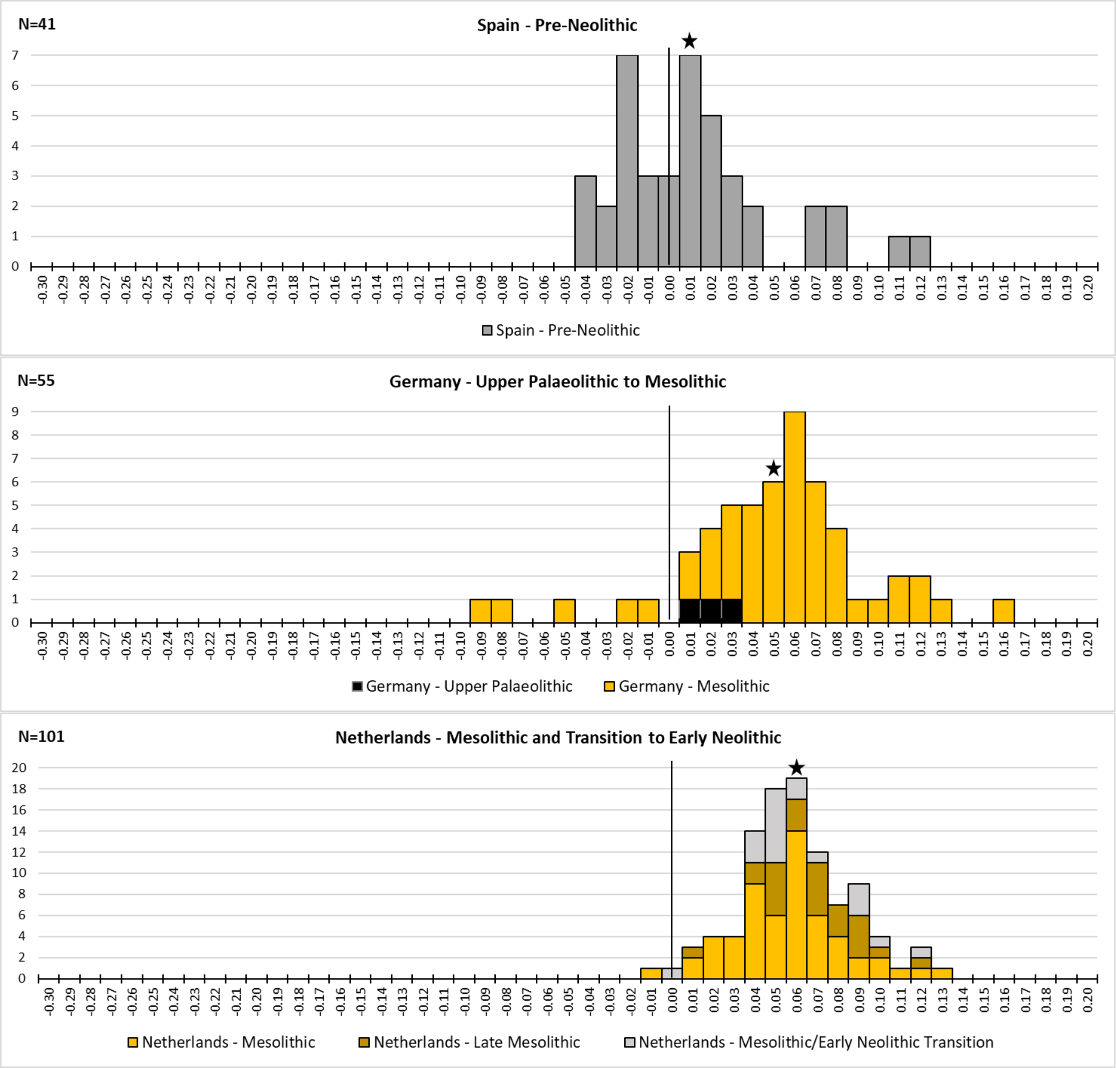


Figure 8.18. (2/2) Upper Palaeolithic to Mesolithic tooth log ratios by countries.

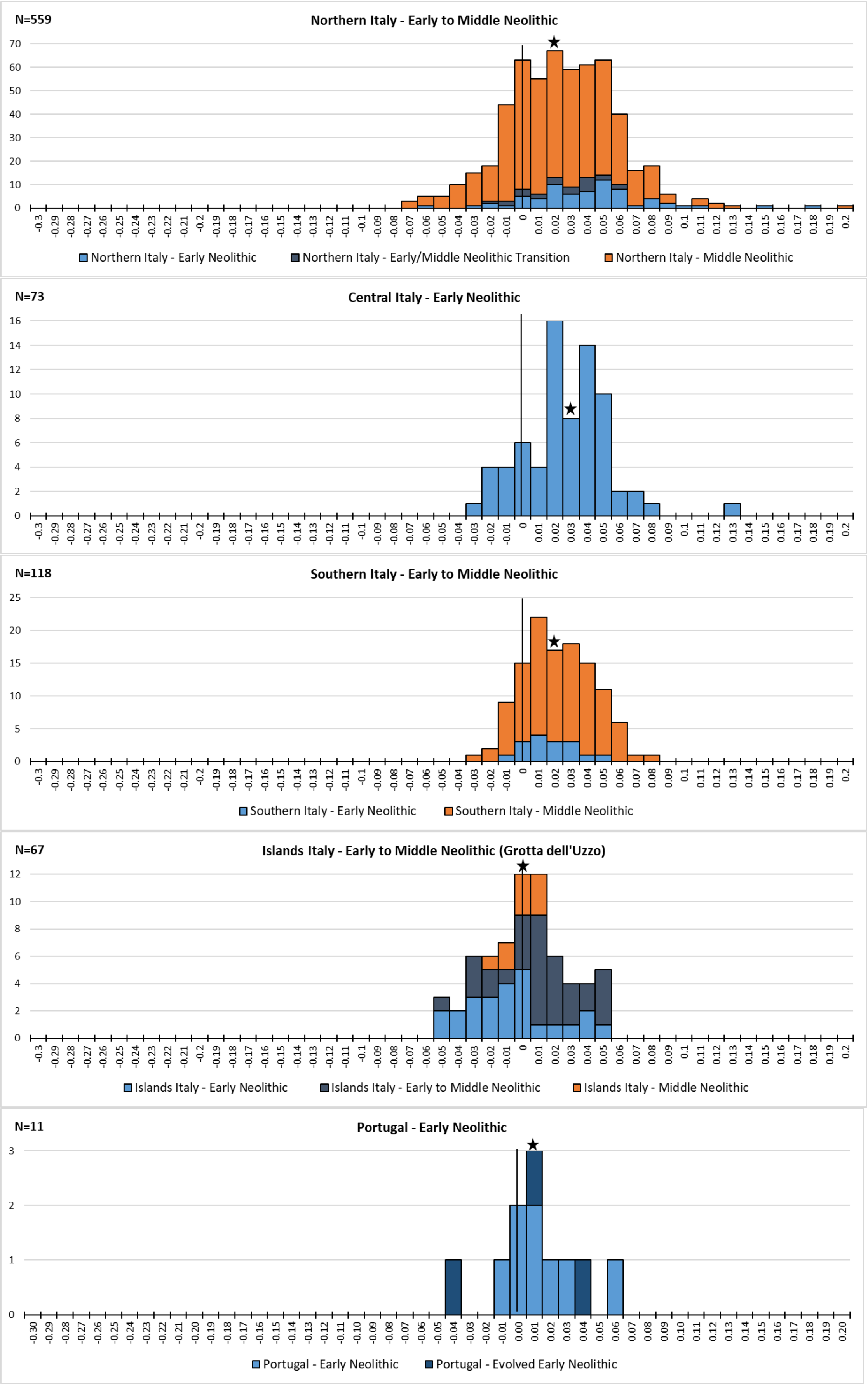


Figure 8.19. (1/3) Early to Middle Neolithic tooth log ratios by countries.

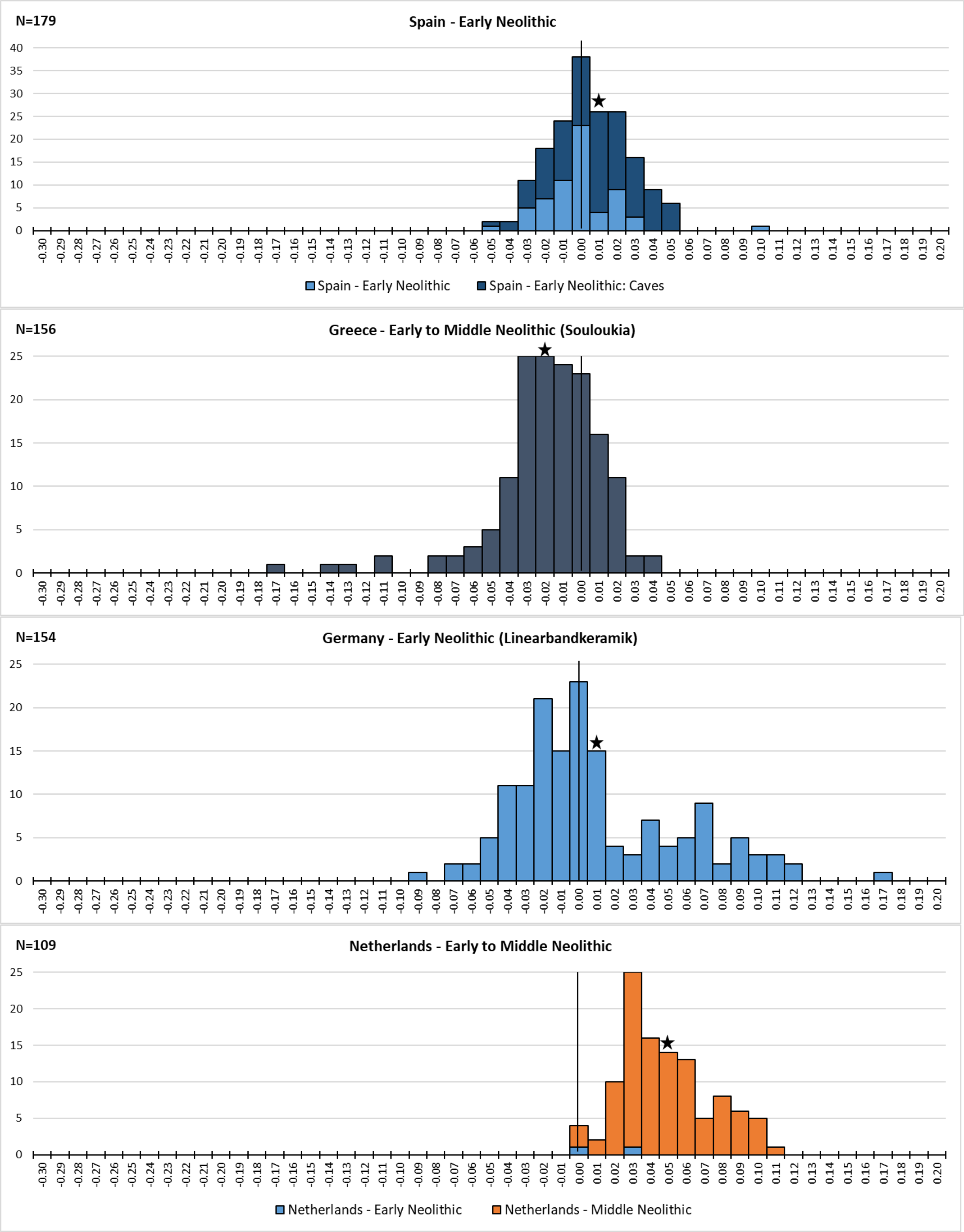


Figure 8.19. (2/3) Early to Middle Neolithic tooth log ratios by countries.

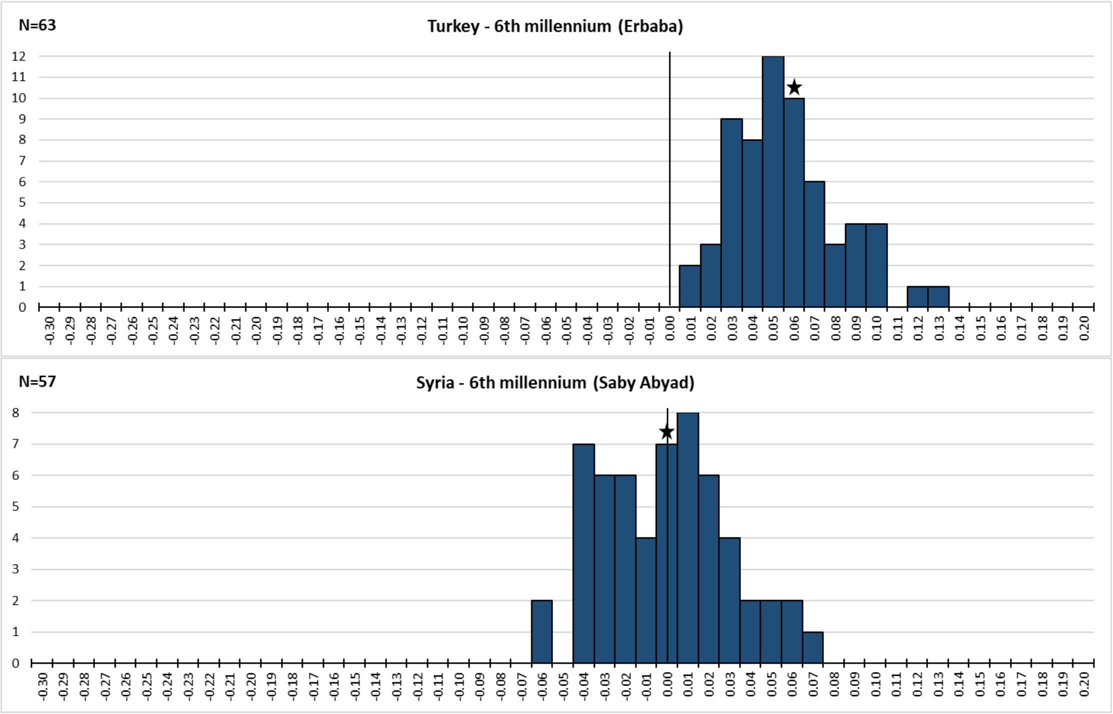


Figure 8.19. (3/3) Early to Middle Neolithic tooth log ratios by countries.

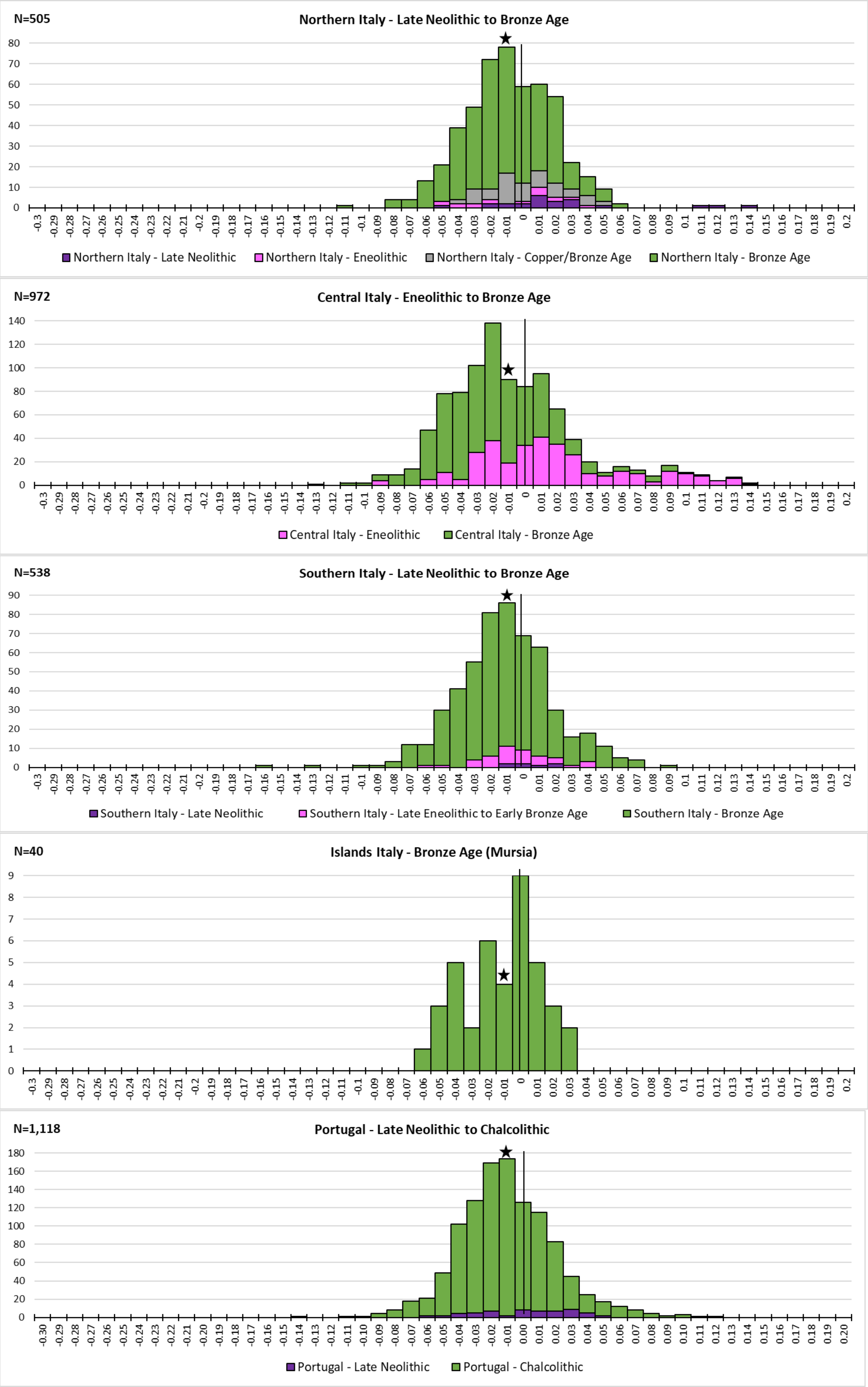


Figure 8.20. (1/2) Late Neolithic to Bronze Age tooth log ratios by countries.

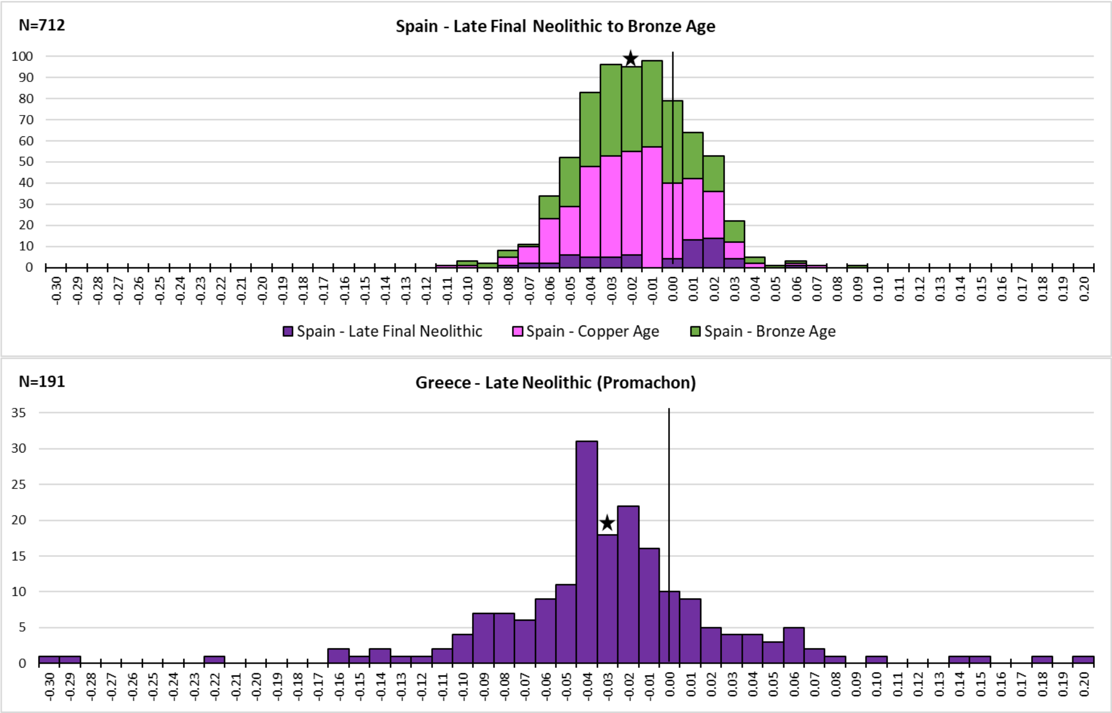


Figure 8.20. (2/2) Late Neolithic to Bronze Age tooth log ratios by countries.

8.3. Summary and Preliminary Discussion

From the preceding discussion, it appears that the process of pig domestication in the European areas examined took two different trajectories during the Neolithic. The postcranial evidence suggests that the case of Italy is akin to that of the Netherlands, and inland Spain, where no significant size difference can be seen in the Early to Middle Neolithic pigs compared to the Upper Palaeolithic and Mesolithic wild boar. The German data shows a different pattern, with a clear bimodality and reduction in size already visible in Early Neolithic times, indicating the presence of two separate populations of domestic and wild pigs. The coastal Spanish data also shows this pattern, though to a lesser degree. The scant Neolithic Portuguese data indicates a clear postcranial reduction in size, but not in teeth, suggesting an intermediate position between the two described scenarios. The Early to Middle Neolithic Greek case is similar to the German, but the lack of Upper Palaeolithic/Mesolithic data prevents us from observing any potential changes from the native wild boar. In the case of the first group of countries, which includes Italy, the bimodality and decrease in size in pigs can only be clearly seen from the Late Neolithic period onwards. Additionally, the French data from the Middle Neolithic site of Rocadour shows the presence of a large pig (presumably wild), when compared to Upper Palaeolithic/Mesolithic sites from other areas, which is consistent in size with the larger Italian animals from Molino Casarotto, Cornuda, Conelle, and Mulino Sant'Antonio. Rocadour offers further support to the idea of an increase in the size of wild boar in Europe after the Mesolithic.

The varied patterns identified in different European areas indicate different evolutionary histories for the domestic pig. On the one hand, the Italian, inland Spain, and Dutch data points to either the local domestication of wild boar, under a scenario of animal management involving regular interbreeding with wild boar; or the introduction of domestic pigs of a similar size to the local wild boar. However, the latter option seems unlikely as the Middle Eastern pigs are not comparable in size with the local wild boar. On the other hand, the German, coastal Spanish, and likely also Greek data, indicate the presence of a large number of imported domesticates, smaller than the local wild boar, already from the Early Neolithic. The Portuguese scenario seems to be intermediate between the two, with a decrease in postcranial size during the Early Neolithic and a further decrease in size during the Chalcolithic, possibly indicating a higher component of introduced domesticates (likely interbreeding with local wild boar, as there is no clear cut bimodality) in the first stages of pig domestication.

The fact that the bimodality observed for Early and Middle Neolithic German and Greek postcranial bones is seen replicated in the tooth biometrical analyses, strengthens the observation that these countries saw indeed a different trajectory than the Mediterranean and Dutch countries. This is especially the case for the German data, as the decrease in size from the Upper Palaeolithic to Mesolithic is evident, while coastal Spain sees also a decrease in tooth size from previous times, although not as marked as in the German case. Portugal does not evidence a diminution in tooth size during the Neolithic, although the evidence is small. The lack of Greek data from the Upper Palaeolithic and Mesolithic periods unfortunately precludes us from observing any size changes between the periods mentioned. As teeth are more impervious to morphological change than postcranial bones under the impact of domestication processes, it would be expected for them to take several millennia to register change in cases of local domestication of wild boar. On the contrary, if there were an introduction of different breeds of domesticated pigs, the change observed in the postcranial bones could be simultaneously reflected in the teeth. Since this latter scenario seems to have been the case at least for the German sites, if not also for Greece and coastal Spain, the pig domestication scenario for these areas do seem to have taken a different path than what we have seen for the case of Italy and the other European areas analysed. Indeed, in the Italian, Portuguese and German cases, the tooth size decrease is only noticeable from the Eneolithic/Copper Age onwards, supporting our previous interpretations of a high component of local wild boar domestication.

If there was indeed a large proportion of imported domesticated pigs in Germany, coastal Spain, and Greece during the Early to Middle Neolithic, these animals could have reached these areas through the routes in which the Neolithic package has been hypothesised to spread throughout Europe (see Chapter 4.2.c): to Germany via the Danube route, and to Greece and Spain via the Mediterranean. In terms of where these imported animals could have come from, the Middle Eastern data from the 6th millennium analysed would seem to suggest Syria as a possible origin, while the Turkish Anatolian appear to be too large to be a potential source.

During the Eneolithic/Copper and Bronze Age, these two trajectories described converge, and the patterns observed in all European countries become more similar, reflecting the natural evolution of pig husbandry strategies. This could also be related to the more connected cultural trends seen in Europe during these times, associated with the movement of people and ideas throughout Europe (Allentoft et al., 2015; Cavazzuti et al., 2019; Haak et al., 2015; Kristiansen et al., 2017; Olalde et al., 2018).

Chapter 9

DISCUSSION

The evidence presented in this study provides a strong basis from which to tackle the research questions presented in Chapter 1. The data analysed in Chapters 7 and 8 will be discussed with the aim of investigating what it tells us about the potential origins and evolution of the domestic pig in Italy. In the first part of the discussion, the particular case of the pig in the Italian peninsula through time will be investigated. Secondly, the Italian case will be interpreted within the general context of Europe and the Near East. In the third and final part, the research questions of this study will be more directly addressed, using the discussion presented in the previous two sections as support for the proposed answers.

9.1. Pig Domestication in Italy: The Story So Far

From the analysis of the biometrical, age, and sex data from the Italian sites studied, covering the whole of the Italian peninsula and Sicily, from the Upper Palaeolithic to the Late Bronze Age, it has been possible to identify three key phases in the evolution of the human-pig interactions, which will be discussed in the following sub-sections. These moments are:

a) The Upper Palaeolithic and Mesolithic periods, which are characterised by the hunting of wild boar by hunter-gatherer populations.

b) The Early and Middle Neolithic periods, where it is not possible to easily distinguish two different (wild vs. domestic) pig populations on the basis of biometry.

c) The Late Neolithic to Late Bronze Age, where a clear bimodality in the biometry of the postcranial bones and a clear reduction in tooth size allows for the distinction of two separate populations, wild and domestic.

9.1.a. Upper Palaeolithic and Mesolithic: Wild Boar Hunting in Italy

The data pertaining to the first phase, covering the Upper Palaeolithic and Mesolithic periods, characterises the natural Italian wild boar populations, and represents the 'starting point' to which the following pig populations, of unknown status, will be compared. This wild boar was characterized by small teeth in comparison to postcranial bones, when compared to a Late Neolithic British standard. In this sense, it is similar to other contemporary Mediterranean wild boars, such as those from Spain (Albarella et al., 2009; Hadjikoumis, 2010). This research proved that these relative proportions were maintained by the pigs in the Italian assemblages all the way through the Late Bronze Age, an observation previously made by Albarella et al. (2006c) using a smaller set of data.

Moreover, the wild boar size decreases along a North-South gradient, likely as a result of Bergmann's rule being in operation (Blackburn et al., 1999; Meiri and Dayan, 2003). Additionally, the analysis of the pig data from the Sicilian site of Grotta dell'Uzzo has shown that these animals were smaller than those from the contemporary levels of the continental site of Grotta della Madonna, in the south of the peninsula. Once again, this observation was put forward in the past by Albarella et al. (2006c) and Tagliacozzo (1994a), and it is here confirmed with the incorporation of more data. This phenomenon is likely a consequence of insular dwarfism (Lomolino, 1985; 2005), and is supported by an equivalent difference in red deer size (Tagliacozzo, 1993a; 1994a).

9.1.b. Early and Middle Neolithic: Wild Boar Hunting or the Beginning of Pig Domestication?

In the second phase of pig evolution in Italy, which covers the Early and Middle Neolithic periods, the wild/domestic status of the pigs becomes difficult to ascertain. The results from the biometrical analysis of *Sus* remains from Italian archaeological sites presented in this study indicate a consistency in these animals' size between pre-Neolithic and Early and Middle Neolithic times, as was also noted in previous studies (Albarella et al., 2006c). The true nature of these Neolithic animals thus remains elusive. To understand the status of these earlier suids, two main interpretations can be proposed:

A. Most, if not all, of the Early and Middle Neolithic pigs are wild, and pig husbandry did not develop at this time.
B. Domestic pigs were present during the Early and Middle Neolithic, but, due to regular interbreeding with wild boar, it is not possible to distinguish them on the basis of size and morphology.

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, 1997b; 2003; Rowley-Conwy et al., 2013; see also Chapter 3.3). However, a closer look at the evidence available indicates a more complex reality (cf. Albarella et al., 2006). There is convincing evidence that in Italy the wild boar increased in size after the Mesolithic, both in Italy (Albarella et al. 2006), and other European areas (Albarella et al., 2005; 2009; Hadjikoumis, 2010). Although this needs to be considered in our interpretation, the nature of the evidence is more complex, as discussed below.

When we compare the data from Early and Middle Neolithic assemblages with those of the later Neolithic, Eneolithic and Bronze Age, it becomes clear that the Early and Middle Neolithic pigs hardly ever reach the size of the very large wild boar identified in some Middle Neolithic and later sites[27], and, on average, they are definitely smaller than those. Even considering the suggested increase in wild boar size over time, some of the sites (e.g. Rivoli, Cornuda, and Middle Neolithic Arene Candide) are too close chronologically for a natural biological development to be the only explanation for the size difference. For example, the wild boar from Cornuda, as seen in the log ratios, 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. Taken all this evidence into consideration, the initial apparent similarity between the Upper Palaeolithic/ Mesolithic and Early and Middle Neolithic patterns takes on a new dimension, making the suggestion that no domestic pigs were present in the Early and Middle Neolithic in Italy as unlikely. Instead, the possibility of an incipient size

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[27] This is especially evident in the cases of Middle Neolithic Molino Casarotto and Rivoli; Late Neolithic Arene Candide, Cornuda, and Mulino Sant'Antonio (all roughly contemporary); and Eneolithic Conelle. This increase in size is more noticeable in the postcranial bones, but teeth also show larger measurements in some cases (Early and Late Neolithic Arene Candide, La Marmotta, Molino Casarotto, and Conelle).

decrease, hinting at the beginning of a process of domestication, seems to be a more viable alternative.

Conversely, 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, and on a similar vein as to what has been described to explain the beginnings of pig domestication in the Near East (see Chapter 3.1). The greater variability observed in Early Neolithic assemblages, when compared to Upper Palaeolithic and Mesolithic sites, and the particular case of Grotta dell'Uzzo, where some size reduction from the Mesolithic is apparent, also support the interpretation that early Neolithic farmers did own domestic pigs. Jarman (1976, 1971) 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.

However, the biometrical data alone cannot fully answer the question of the wild/domestic status of the Early and Middle Neolithic pigs. The age at death profiles offer further insight into this dilemma. The data for these periods point at a slight decrease in the mortality of the animals, in comparison with the Upper Palaeolithic and Mesolithic. The change is not extreme but could be indicating changes in culling patterns related to an incipient process of domestication. Additionally, the higher presence of females observed at Arene Candide and Molino Casarotto might also be hinting at the preferential butchery of very young males, while the females are kept alive longer for reproduction purposes, yet another indication of possible domestication taking place. A change towards the butchery of younger animals was observed previously for the case of Grotta dell'Uzzo (Tagliacozzo, 1993a; 1994a). It is possible that the early presence of domestic pigs in Sicily could be related to contacts with the East via a Mediterranean route, which is believed to have been one method for the spread of Neolithic ideas in Europe (see Chapter 4.2.c).

Not all Early and Middle Neolithic Italian sites seem to have developed the same systems of pig exploitation, or the same agricultural systems for that matter (see also Chapter 4.2.c). The sites of Molino Casarotto, Cornuda, and Mulino Sant'Antonio, roughly contemporary, indicate a large proportion of wild animals present in the assemblages. At all these sites, the general zooarchaeological evidence suggests that their inhabitants fulfilled most of their meat requirements through hunting in the surrounding woodland environments of mainly red deer but also, as our data suggests, wild boar, while also keeping other domestic stock such as sheep/goat and cattle (Albarella, 1987-88; Boyle, 2014a, 2014b; Jarman, 1976, 1971; Riedel, 1988). These types of sites have been considered to represent a 'survival' of some hunter-gatherer lifestyle within the context of newly introduced agricultural practices (Boyle, 2014a,b; Jarman, 1971; 1976a). Although at these sites the pigs include quite large individuals – supporting the previously made observation of a post-Mesolithic wild boar size increase –, the overall biometrical evidence[28] indicates that these sites could have represented a combination of use of domestic pigs and wild boar hunting. In these scenarios, the proximity of rich woodland areas could have been conducive to a strategy of loose pig management, where regular interbreeding with wild boar could be masking potential changes in pig morphology brought about by domestication.

At other contemporary sites, such as Arene Candide and Rivoli, the new agricultural way of life seems to have been fully embraced, not less so given the hypothesised foreign origin of the first agricultural populations (see Chapter 4.2.c). In these cases, the importance of wild game in the diet seems to have been lesser, albeit not entirely absent. The large proportion of pigs at these sites could therefore have consisted in a domestic population that could not have easily been distinguished from their fully wild counterparts, due to regular interbreeding with wild boar under a system of loose management.

The evidence for the Early and Middle Neolithic seems to favour the hypothesis of an incipient process of pig domestication, which was underway in these times, most likely under a system of loose management of domestic pigs. Within this system, domestic pigs would have been left to roam in the surrounding woodlands to feed and breed for themselves. It is highly likely that these animals were physically very similar to the native wild boar, but this would have not meant that their domestic status in the human societies was in question. If this hypothesis is correct, we are still left with the question of whether these first domesticates were introduced, locally domesticated, or a

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[28] Also combined with ageing and sexing data and previous observations made by the authors of the original zooarchaeological analyses regarding the presence of small pigs alongside considerably larger ones (Albarella, 1987-88; Riedel, 1988).

combination of both. However, to fully explore this question, the Italian data must be looked at within the context of Europe and the Near East. Therefore, this question will be explored in more detail in Chapter 9.2.a.

9.1.c. Late Neolithic to Late Bronze Age: Consolidation of the Domestic Pig

Later prehistory marks a change in the biometrical pattern of the pigs from previous times. Indeed, from this point on, a clear bimodality and overall reduction in size of pigs is visible in the postcranial data, while the tooth data indicate a clear reduction in size for the first time since the Upper Palaeolithic. The Late Neolithic data already shows this pattern, although the number of sites that correspond to this period is limited: Cornuda and Arene Candide in the North, and Mulino Sant'Antonio in the South. It is worth remembering, though, that part of the assemblages from Rivoli and Middle Neolithic Arene Candide are associated with late Square Mouthed Pottery, which is often attributed to the Late Neolithic (Bagolini, 1993; Cipolloni Sampò, 1993). Additionally, the site of Masseria di Gioia needs to be mentioned, as it has an assemblage dated to an undifferentiated Middle to Late Neolithic. The more abundant evidence from the Eneolithic and Bronze Age sites certainly fit the pattern observed for the Late Neolithic sites, indicating that the process likely initiated during this latter period continued on and was consolidated in the following centuries.

The biometrical evidence for these periods strongly suggests the presence in the assemblages of two distinct wild and domestic pig populations, marking a clear change from previous times. The strong bimodality of the postcranial samples and the tooth size decrease indicates that these populations are genetically isolated, at least in some measure. The data therefore points to a change in herd management during this time. While in the Early and Middle Neolithic domestic pigs would have been kept loose, from the Late Neolithic onwards, these animals would have been more rarely allowed to breed with wild boar, being kept instead on a system of closer domestic control. This results in an unconstrained evolution of the domestic pig morphology, which is clearly visible in the data. Moreover, shape changes in the third molars are also noted from these periods, indicating a shorter and stockier tooth, which could have resulted from a shortening of the snout, another trait of advanced domestication. These later prehistoric assemblages are generally dominated by domestic pigs, but the presence of a few large outliers indicates that some wild boar hunting was still being practiced.

The kill-off and sex patterns for the sites from these periods show great inter-site variability. The evidence suggests that some sites were more focused on pig breeding, thus showing higher proportions of animals killed younger than before and/or breeding casualties. In some cases, adult animals are still well represented, indicating not only their use in breeding but perhaps also the primitive stage of pig domestication, as the animals would have taken longer to reach the desired weight for slaughter than they did in historic times. Regardless of these inter-site discrepancies, the greater separation of wild and domestic forms appears to be a consistent feature of this period.

In sum, our evidence supports the view that domestic pig husbandry in Italy began during the early Neolithic. Changes that we see later during the Late Neolithic do not represent a transition from hunting to husbandry, but rather from an extensive (i.e. loose) to an intensive (i.e. close domestic control) management system, which is reflected in the bimodality of the later prehistoric data. This change is occurring within a context of social and economic changes which began during Late Neolithic times and intensified during the Bronze Age (see Chapter 4.2). This is a time of increasing social complexity, inequality and conflict, linked to a demographic increase and characterized by the emergence of high-status warrior castes which competed for control of regional resources (Barker, 1999; Cardarelli, 1993; Gilman, 1981; Guidi, 1993; Pellegrini, 1993). Many sites now occupy strategic defensive positions in the landscape, reflecting the new social dynamics of the times. It is also a period of general agricultural intensification which, aided by the introduction of the plough, involved the use of drier and less fertile soils, woodland clearance, and an increased importance in secondary products from ovicaprids and cattle. These economic changes would have certainly had an effect on pig husbandry systems, as the progressive clearing of the forests would have limited the availability of surrounding land for pig use. Also, the importance of cereal agriculture would have put the pigs in direct competition with humans, as if left to roam freely they could cause damage to crops (see Chapter 2). Consequently, a change to a close domestic control of the pigs during these times seems like an adequate response to the new social and economic context that characterised the Italian populations, beginning during the Late Neolithic and consolidating during the Bronze Age. In their new role, pigs could have acted as a protein 'insurance' in a context of high dependence on secondary products from other domesticates, and, as usual, a highly effective 'waste disposal system' (Grigson, 1982; Miller, 1990; Redding, 1988; 2015; Redding and Rosenberg, 1998b; Rosenberg and Redding, 1998).

9.1.d. A Case in Point: Arene Candide

The cave of Arene Candide (Liguria), with its continuous occupation from Early Neolithic to Bronze Age times and even beyond, provides the opportunity of observing the patterns described in the previous sections from the perspective of one location. However, the lack of substantial evidence from the Upper Palaeolithic and Mesolithic precluded us from drawing direct comparisons between those periods and the Early Neolithic in the cave. When the postcranial data from the Early and Middle Neolithic periods was compared with the Upper Palaeolithic and Mesolithic data from other sites, the evidence indicated no significant size changes, albeit a larger spread of measurements. However, when this same data was compared with the postcranial evidence from the partly contemporary northern sites of Rivoli, Molino Casarotto, Cornuda, the southern site of Mulino Sant'Antonio, and the later central site of Conelle, the larger size of wild boar demonstrated by these sites indicated that the size of the Arene Candide pigs was smaller than what we should expect for a genuine wild boar. The teeth, for their part, did not show significant size changes through time, although the Early Neolithic assemblage shows smaller and larger outliers which could perhaps represent introduced animals (see also Chapter 9.2). Interestingly, in both the Early and Middle Neolithic, shed deciduous fourth premolars were identified, suggesting that these animals were living in the cave, which was interpreted to have been used seasonally as an animal stable as well as, occasionally, a human habitation area.

All these variables, combined with the larger component of young individuals (including neonatal bones) in this site when compared with Upper Palaeolithic and Mesolithic times, and the higher occurrence of females during the Middle Neolithic, seem to offer support to the idea that an early form of pig domestication was already in place during the earlier Neolithic of Arene Candide. If this was indeed the case, the domestic pigs would have been interbreeding with wild boar, as expected on a loose management system, and that could be why it is not possible to isolate two different populations on the basis of biometry. This would have coincided with the colonization of the cave by possibly migrants that would have arrived via the Mediterranean, bringing with them domestic sheep and goats and, most likely, the know-how of pig domestication, if not the animals themselves (see Chapter 6.1.d).

The Late Neolithic in Arene Candide marks a change from previous times, as in this period and the next (Copper/Bronze Age) a clear bimodality can be seen in the postcranial biometry results, with the smaller group likely corresponding to domestic pigs and the larger to wild boar. A continuation of the kill-off patterns seen during previous Neolithic times, as well as the presence of neonatal teeth and shed deciduous teeth, offers support to the interpretation of a domestic status of the pigs and at the same time reinforces the suggestion that the pigs from the previous periods also included a domestic component. Unfortunately, no significant canine teeth sample was available for other periods to offer a comparison of sex patterns through time on the site. In sum, a change in the way domestic pigs were managed at the site seems to have occurred in the Late Neolithic, and it is possible that these animals were now being kept enclosed in the cave, without the possibility of interbreeding with the local wild boar, and therefore evolving into their unique smaller morphology. This change in management could have been related to the larger impact humans seem to have had in the surrounding environment from the Late Neolithic, an impact which could have seen a decrease in forest cover available for pig rearing (see Chapters 4.2.d-e and 6.1.d).

To sum up, the patterns of evolution of the pig described for the whole of the Italian peninsula are echoed by the data from Arene Candide. The evidence presented in this study would seem to suggest the beginning of a process of pig domestication at the site from the Early Neolithic. The change observed on a continental scale from the Late Neolithic onwards can be seen also in the Arene Candide data, and it could have been linked to the increasing human impact on the surrounding environment. It is no wonder that this site has been key in past studies of pig domestication (e.g. Albarella et al., 2006c; Rowley-Conwy, 1997b; 2003; Rowley-Conwy et al., 2013), and is likely to continue to be so.

9.2. The European and Near Eastern Context of Pig Domestication

From the comparison between different pig biometrical datasets from Italy with assemblages from Portugal, Spain, France (Rocadour), Germany, the Netherlands, Greece, Syria (Tell Sabi Abyad), and Turkey (Erbaba Höyük), two different trajectories of pig domestication were identified (see Chapter 8). On the one hand, the case discussed for Italy seems to have been very similar to the patterns observed for Portugal, inland Spain, and the Netherlands. Indeed, in all those areas, no marked size change can be seen between the Upper Palaeolithic and Mesolithic, and the Early to Middle Neolithic pigs. It is only from the Late Neolithic onwards that two pig populations can be distinguished on the basis of the postcranial bones, alongside a decrease in tooth size. On the other hand, the cases of Germany, Greece, and coastal Spain are quite different, as the postcranial data shows a clear bimodality accompanied by a considerable size decrease in tooth measurements as early as the Early Neolithic. Additionally, in the German and coastal Spanish assemblages, the smaller 'domestic' range from the Neolithic is significantly smaller than the wild boar observed in previous periods. Unfortunately, the lack of Greek data from the Upper Palaeolithic or Mesolithic precludes us from observing any such possible changes in the Neolithic of this area.

These two diverse patterns suggest different evolutionary histories for the domestic pigs in those two groups of countries. From previous studies on the origin of pig domestication in the Middle East, we know that under a scenario of loose management, it can take up to two millennia before a fully morphologically unique domestic pig can be identified in the assemblages. Therefore, and as previously discussed for the specific case of Italy, the lack of visible size changes in the Mediterranean and Dutch data until the Late Neolithic indicates either the absence of domestic pigs in the assemblages until the Late Neolithic or the presence of a domestic pig since the Early Neolithic which, due to regular interbreeding with wild boar, cannot be easily distinguished from the local wild boar. There is evidence in those areas and in France of a wild boar size increase after the Mesolithic, just as seems to have been the case for Italy. Indeed, the comparison of the Italian assemblages with the French data from the Middle Neolithic site of Rocadour, a site which has evidence of a large proportion of game, offers further support to the idea of an increase in the size of wild boar in Europe after the Mesolithic, as the Rocadour pigs are of a size comparable to the larger animals from the Italian sites of Molino Casarotto, Cornuda, Conelle, and Mulino Sant'Antonio. Therefore, the same conclusions drawn for the Italian case can be proposed here; namely, that a slight reduction in size can indeed be observed in the Neolithic assemblages from the Mediterranean and the Netherlands. This is indicative of the presence of a pig domestication process underway in the earlier Neolithic, but, due to loose pig management practices, any morphological changes in the domestic populations are limited. Indeed, it is only after the Late Neolithic that those changes become clear, indicating for these European countries a change in pig management in accord with what was seen in Italy: pigs are now being kept in close domestic control.

The German, coastal Spanish, and likely also Greek data, however, show a clear bimodality in both postcranial bones and teeth from the Early Neolithic, alongside a clear reduction in size of the smaller range of likely domestic animals in the first two regions in comparison with the Upper Palaeolithic and Mesolithic wild boar. The larger animals from those sites indicates that hunting of wild boar was still being practiced. Given the mentioned required time for a local domesticated pig to show morphological changes in the bones, especially in teeth, this clear-cut change suggests instead the presence of imported domesticates, smaller than the local wild boar, already in the Early Neolithic. The possible origin of these domesticates could have been Syria (or equivalent), as the Turkish pigs from Erbaba Höyük were much larger. These imported domesticates could have arrived in those areas via the routes in which the Neolithic package has been hypothesised to spread throughout Europe (see Chapter 4.2.c): to Germany via the Danube route, and to Greece and Spain via the Mediterranean.

In the Eneolithic/Copper and Bronze Age, the patterns from the two trajectories described become more similar, and the differences between countries observed during earlier Neolithic times fade. This could be related to the more connected cultural trends seen in Europe during these times, associated with the movement of people and ideas throughout Europe (Allentoft et al., 2015; Cavazzuti et al., 2019; Haak et al., 2015; Kristiansen et al., 2017; Olalde et al., 2018).

9.2.a. Domestic Pigs in Italy: Introduced or Locally Domesticated?

If the interpretation of the Early and Middle Neolithic evidence put forward is correct, and it represents the beginnings of a slow process of pig domestication in Italy from these times, much like in the case of Anatolia (Ervynck et al., 2001; Hongo and Meadow, 1998; Rosenberg and Redding, 1998); the question remains as to whether these early domestic pigs are from an imported stock or local domesticates from the native wild boar population, or perhaps 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 paleogenetically (Larson et al., 2007b), 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 postcranial bones that seem to be a genuine characteristic of the Italian wild boar, carry on through time, and the changes observed in postcranial bones from the Late Neolithic onwards (i.e. size reduction and bimodality) seem to take much longer to manifest in teeth, as would be expected in the case of a local domestication event.

Furthermore, when the Italian biometrical data is compared with two Near Eastern sites (Erbaba Höyük in Turkey and Tell Sabi Abyad in Syria, dated 6th millennium BC) which are located in an area from where imported domestic pigs could have originated, the Italian Neolithic pigs are more similar to the Mesolithic Italian wild boar than to either of the Asian assemblages. Moreover, the presence of the distinct Italian wild boar genetic signature in Sardinian pigs (Larson et al., 2005; 2007b), which are thought to originate from feralised domestic animals (Vigne, 1988), offers support to the idea of a local domestication event, as these pigs would have been descendants of the peninsular domesticates brought to the island (but see also Scandura et al., 2008 for an alternative interpretation).

The combined evidence, therefore, seems to support the local domestication of native wild boar in Italy. The situation could have been very similar in the cases of Portugal, inland Spain, and the Netherlands, which share many similarities with the Italian case, as discussed in the previous subsection. The case for a local domestication becomes more inviting when the Italian data is compared with that of Germany, Greece, and coastal Spain. Indeed, in those areas the biometrical evidence indicates the opposite picture, likely due to the presence of a large number of introduced pigs which were much smaller than the local wild boar populations. Nevertheless, the possibility that a certain element of imported domestic pigs contributed to the initial domestic stock in Italy during the Neolithic cannot be dismissed. The Early to early Middle Neolithic pigs from Grotta dell'Uzzo, for example, hint to a decrease in size and changes in culling patterns already in those early periods, opening the possibility that the people living in the cave could have acquired domestic pigs from trading through the Mediterranean Sea, one of the proposed routes of transmission of Neolithic ideas.

9.3. Research Questions Revisited

The combined biometrical, age, and sex data from the zooarchaeological pig assemblages from Italy studied and thus discussed, provides strong evidential support to answer the research questions proposed in Chapter 1. In this final section, we will attempt to answer each of these questions in turn.

1) *From previous research, the biometrical data seems to support the hypothesis of slow and gradual local pig domestication in the region, echoing the results of the biomolecular analysis. Particularly, previous research has revealed that during the Early and Middle Neolithic periods no clear distinction between wild boar and pig could be identified on the basis of biometry, suggesting loose management and interbreeding. From the Late Neolithic onwards there is a rather abrupt change, as a distinction between the two forms becomes evident* (Albarella et al., 2006c). *Genetic research has highlighted the existence of a unique Italian genotype, separating the history of these animals from those of the rest of Europe* (Larson et al., 2005; 2007b). *Thus, the current scenario suggests that the domestication of the pig in Italy has likely involved a mixture of introduced domestic animals and local domestication. Does the current hypothesis hold up to scrutiny in the analysis of a larger sample, both in terms of actual data and geographic/chronological coverage?*

This research supports, from a much larger set of data, the previous hypothesis suggested by Albarella et al. (2006c) of a likely scenario of local domestication of wild boar in Italy. The evidence presented here suggests that the Early and Middle Neolithic

Italian communities kept their first domestic pigs on a loose management system, allowing these animals to forage for themselves in the surrounding woodlands and interbreed with wild boar. Their domestic status is supported by an overall decrease and increased variability in the size of postcranial bones and changes in culling patterns. The evidence supports a local origin of these first domesticates, conserving characteristics of the native wild boar, alongside slow biometrical change, with a likely smaller component of introduced domestic pigs. This seems to have been largely the case for all the Italian sites throughout the peninsula.

2) *Unlike Spain, where a mixed scenario occurs* (Hadjikoumis, 2010)*, in Italy it has not been possible so far to identify any example of an abrupt change in pig management between the Mesolithic and the Neolithic – can this further work identify such cases?*

In the case of Spain, the coastal sites evidenced bimodality in the postcranial biometrical data and a tooth size decrease from the Early Neolithic, while the inland sites did not and did not evidence size changes from the previous periods. This difference was interpreted as the coastal sites acquiring imported domestic pigs via sea routes, while the inland sites kept a more traditional approach to pig keeping, perhaps even involving local domestication (Hadjikoumis, 2010). The case of Italy seems to have been different, as no clear postcranial bimodality or tooth size reduction can be seen in the Early nor Middle Neolithic sites. Indeed, the data does not support an abrupt change in pig management anywhere in the Italian peninsula. However, we cannot discard the possibility that a certain amount of imported domestic stock was introduced via the Mediterranean, as could have been the case for Grotta dell'Uzzo, although their impact in the pig populations would have been limited. It is possible that in the future Early Neolithic sites with a strong component of introduced domestic pigs from the East will be found, but, the rather extensive geographic analysis undertaken as part of this work has not revealed any. In this respect, the development of animal husbandry, and therefore the Neolithic, in Spain and Italy appears to have had some similarities, but it is certainly not identical in the two regions.

3) *Can the system of more intensive pig management suggested for the Late Neolithic be identified at other sites? Was it widespread and how does it compare with other European areas?*

Although unfortunately the evidence for the Italian Late Neolithic is not abundant, the pattern of bimodality in the postcranial biometry and tooth size reduction is confirmed by the analysis of larger number of sites than were available to previous research. This pattern is very evident in the Eneolithic and Bronze Age data, and becomes more marked through time, suggesting its continued evolution and consolidation. This evidence indicates a change in pig husbandry from a loose system of management to a more intensive close domestic control of the animals. This change can be seen in all sites from those periods studied, with perhaps the exception of Late Neolithic Cornuda and Mulino Sant'Antonio, whose inhabitants seem to have relied on the hunting of wild game to a greater extent than was typical for the period.

This move towards a more intensive system of pig management during late prehistoric times seems to have been in response to broader changes towards more intensive agricultural practices occurring throughout Italy. The European data for the Late Neolithic and Bronze Age echoes these patterns, which become quite similar in all countries analysed. The evidence therefore indicates that the Italian case did not develop in isolation and was indeed part of broader farming changes occurring all throughout western Europe during later prehistory.

4) *As a whole, does the pattern of pig domestication in Italy appear to be unique or is it similar to other European areas? How can it be integrated with our overall understanding of the beginning of farming in Europe?*

The pattern of pig domestication in Italy does not seem to be unique. Indeed, its similarity with the cases of Portugal, inland Spain, and the Netherlands suggests an analogous history of pig domestication in all those areas. On the other hand, the evidence from Germany, Greece, and coastal Spain shows that several trajectories of pig domestication took place in Europe during the Neolithic. These trajectories were probably linked to the routes in which the Neolithic package is believed to have spread into the continent, with some communities taking direct advantage of the introduced animals, while others would receive the transmission of Neolithic ideas which they could then apply to the local development of domestication of the native wild boar. The difficulty of herding pigs through long distances could have also discouraged the spread of imported populations further away from the main maritime routes. These two different approaches in the use of domestic pigs seem to have coexisted in Spain, with coastal and inland areas developing different approaches to pig management. However, this does not seem to have happened in Italy, or at least not to such an extent as to be reflected in the archaeological evidence; instead, a scenario of local domestication of wild boar is more strongly supported by the evidence. All in all, pig domestication in Italy appears to have developed in a way that bears both similarities and differences with other European regions.

In conclusion, the evidence presented and discussed in this research reveals that the history of the domestic pig in Europe was quite different from that of other domesticates, like sheep and goat. Indeed, the biological and behavioural particularities of the pig and the different ways in which it can be managed by the human communities, determined the trajectories of its domestication process in Europe. Whether the utilised domestic pigs where imported or locally domesticated, the spread of the Neolithic ideas and know-how of pig domestication had reached all areas of Italy, and likely the rest of Europe, by the earlier Neolithic period.

Finally, this research has proven once again the effectiveness of the biometrical method in tackling questions of animal domestication. In this research, biometry was used successfully to observe changes in size of postcranial bones and teeth, and in the shape of third molars trough time. However, the use of the biometrical method in isolation would not have been powerful enough to analyse the development of pig domestication in Italy. Indeed, the addition of ageing and sexing of pig bones was crucial to obtain a clearer picture of the process and its evolution through time. Unfortunately, since pigs were very rarely the most represented species in the assemblages, the sample sizes tend to be smaller than ideal in some cases. In this respect, the log ratio technique has been an essential tool to cope with this issue. Lastly, the possibility of comparing sets of biometrical data from different archaeological and modern assemblages worldwide is another potential of this method. Indeed, a comparison with biometrical data from other areas outside Italy was fundamental in understanding the results obtained in this study and how they articulate with and contribute to our wider knowledge of the spread of the Neolithic into Europe.

Chapter 10

CONCLUSIONS AND FUTURE PERSPECTIVES

This research has addressed the question of the beginnings and evolution of pig domestication in the Italian peninsula from mainly a biometrical perspective, but also considering other factors such as killing patterns and sex profiles. The evidence presented and discussed here favours the hypothesis of a gradual and partially local process of pig domestication in Italy from the Early Neolithic, accompanied by a free-range management system of pig-keeping. The contribution of imported domestic pig stock seems not to have been of primary importance in this process. The new Neolithic ideas which spread throughout Europe at this time could have included the necessary know-how of pig keeping and domestication, which in turn would have been applied by the Italian prehistoric societies to locally domesticate pigs from the native wild boar readily available in the surrounding areas. In this sense, the scenario of pig domestication in Italy would have been quite different from that of sheep and goat, which were necessarily introduced domesticated during this time, and of cattle, which was not particularly abundant by the arrival of the Neolithic. Within the context of a Neolithic animal economy mainly based on the use of introduced domesticated sheep and goat, the exploitation of domestic pigs could have represented an additional protein source. The widespread availability of wild boar in the surrounding environments, combined with the native communities' centuries long interaction with this animal, could have meant that there was little incentive to import large number of pigs, particularly given the potential difficulties of herding pigs through long distances. The domestication of the local wild boar, though, would have been a slow process, as it was in the Near East, taking millennia before an entirely morphologically distinct domestic form could be identified in the zooarchaeological record.

The early process of pig domestication in Italy was far from a simple process and it did not occur in isolation from the new European social and economic dynamics that came about with the introduction of the Neolithic package. The Italian approach towards early pig domestication seems to have been very similar to other European areas such as Portugal, parts of Spain, and the Netherlands. It differed, however, from other European regions such as Germany, coastal Spain, and perhaps also Greece, which saw a higher level of introduced animals into their economy. The difference between these two approaches to early pig domestication could be related to the proximity and contact of the early Neolithic communities to mobility routes coming from the Near East. Neolithic immigrants and native populations which adopted the Neolithic package could have also had very different relationships with their pigs. For example, there is evidence in Italy of certain sites keeping alive hunting traditions alongside the new Neolithic practices (e.g. Molino Casarotto, Cornuda, and Mulino Sant'Antonio).

The Late Neolithic, Eneolithic, and Bronze Age periods signified a change in how the Italian communities where managing their domestic pigs. From the Late Neolithic onwards, the domestic pigs became morphologically distinct, a phenomenon likely related to being now kept under an intensive system of management. This change, which can be seen in Italy but also in the other European areas considered in this study, did not occur in isolation but instead was part of a more general move towards more intensive agricultural practices occurring during these times.

10.1. Future Perspectives for the Study of Pig Domestication in Italy and Europe

The evidence presented here hopefully constitutes an important and positive contribution towards elucidating the complex process of pig domestication in Italy, but much more work can still be done. In particular, several lines of additional research would contribute greatly towards further understanding the phenomenon of pig domestication in Italy, such as:

- Geometric morphometrics. This relatively new approach complements the biometric studies by providing further insight into shape changes of teeth, which is genetically controlled and does not vary much in relation to environmental changes (Rowley-Conwy et al., 2012). Recent years have seen an increase in the number of studies utilising this methodology to the study of pig domestication (e.g. Evin et al., 2013; 2014a; 2015; Krause-Kyora et al., 2013; Ottoni et al., 2012). However, this technique as used in the study of domestication is still in its early stages, and there have been debates on how to interpret its results (e.g. Evin et al., 2014b; Krause-Kyora et al., 2013; Rowley-Conwy and Zeder, 2014b,a).

Therefore, more studies on its true explanatory power and on the factors that affect teeth shape need to be made (Rowley-Conwy et al., 2012; Rowley-Conwy and Zeder, 2014b). Regardless of these limitations, it would be very valuable to incorporate this method to investigate possible shape changes of pig teeth through time in the Italian assemblages, as it could help to answer the question of pig management and the possible introduced or imported status of the animals. This research, done not in isolation but as a complement to biometrical studies, would also serve as a way of further exploring the real potential of this technique, which is still unclear.

- DNA studies. The value of these kinds of studies has been clearly demonstrated in the past (e.g. Caliebe et al., 2017; Larson et al., 2005; 2007a,b; Ottoni et al., 2012; Vai et al., 2015), but there are still immense gaps in the evidence and a lot more work can and should be done on pig material. Previous genetic studies have been carried out on Italian *Sus* material, both archaeological and modern (Larson et al., 2005; e.g. 2007b; Vai et al., 2015), but it would be of great value to continue this type of research on Italian material on a larger number of samples. It would be very interesting to study in more detail how much the Italian, European, and Middle Eastern haplotypes have contributed to the first domesticated pigs in the peninsula, as this data would certainly help to elucidate the true nature of these animals (i.e. whether they derive from wild boar and/or imported animals, and to which degree). Additionally, it would be interesting to explore the true extent of the Middle Eastern haplotypes in Mesolithic Europe, as Vai et al. (2015) identified its presence in these contexts in the north eastern Italian site of Riparo di Biarzo (if these haplotypes were not restricted to the Near East in the past, as it is currently understood, then the current interpretations of mtDNA data would have to be revised). It is important to be careful on our interpretations of the genetic data, as they could be a response to very complex historical and biological processes. Once again, and much like in the case of geometric morphometrics, the genetic data must be complemented with other types of evidence to get a more complete picture of the possible processes responsible for the patterns observed in the DNA data, and be very careful of simplistic explanations based on small and localised samples of data that can end up being inflated in the news.

- Stable isotopes and tooth microwear. These types of studies provide information relative to the diet of the animals involved, and are therefore of key value in investigating the past animal management practices (Rowley-Conwy et al., 2012). Indeed, any methodology that can provide a clearer picture of the pigs' paleodiet have the potential to help answer complex domestication questions. Recent isotopic studies done on pig remains have provided valuable results (e.g. Eriksson, 2004; Fornander et al., 2008; Lösch et al., 2006; Matsui, 2005; Minagawa et al., 2005; Pechenkina et al., 2005). Furthermore, microwear studies on pig teeth have the potential to distinguish between free-ranging animals that are able to root, and stall-fed animals that are not (Rowley-Conwy et al., 2012), and the implications of this knowledge on the question of domestication can be vast. However, not many studies have been done following this approach as of yet (e.g. Vanpoucke et al., 2009; Ward and Mainland, 1999; Wilkie et al., 2007). In sum, there is no question that these avenues of research would provide key data towards the identification of the way the early and later pigs were being managed by the human populations (e.g. free-range vs. close domestic control), and their domestic and wild status. The fact that no such studies have been done yet on prehistoric Italian pig assemblages indicates a research vacuum that should be addressed.

- Comprehensive biometrical studies focused on other European countries and regions. One of the key benefits of the biometrical method is the possibility of comparing datasets from different assemblages, as proven by this research. Applying the biometrical approach used in this research on large *Sus* zooarchaeological assemblages from areas in Europe not yet indagated in this manner, using a wide chronological perspective, would therefore contribute to our understanding of how the case of Italy connects and articulates with the rest of the continent. Indeed, such studies would help understand the trajectories that the pig domestication process took in the different European areas, and whether these where similar or different to the Italian case. Ultimately, from the comparison of these major studies we would gain further understanding of the process of pig domestication in Europe as a whole.

- Other venues of research. The aforementioned areas of study of the process of pig domestication are only a sample of the potential of archaeology to tackle this question. Another type of study worth mentioning is organic residue analysis, which can identify the presence of porcine fats in ancient pottery (e.g. Dudd et al., 1999; Evershed et al., 1999; 2002b,a; Heron and Evershed, 1993; Mukherjee et al., 2007; 2008). Through these analyses it is possible to indagate whether different types of pottery were used preferentially for pigs or not, whether geographical variations in pig exploitation can be identified in the organic animals fats preserved in pottery vessels, whether certain vessel types were used selectively for processing pig materials, and/or whether porcine lipids in potsherds reflect the proportion of pigs observed in faunal assemblages (Mukherjee et al., 2007; 2008). So far, no study of this type has been done on Italian prehistoric ceramics, and it would certainly contribute to our understanding of the use of pigs by these past societies. Finally, studies of depictions of pigs and wild boars in material culture, iconography and art, can offer evidence of the cultural perception of these animals by ancient societies (e.g. Bonera, 1991; Dalix and Vila, 2007; Foster, 1977; MacKinnon, 2001; Phillips, 2007). These types of studies have been mostly focused on later historical periods, with the addition of literary evidence. More studies of this kind focussed on earlier periods would contribute to unravel the nature of the early relationship between pigs and humans, and help to decipher whether the animals depicted were considered wild or domestic.

In conclusion, the process of pig domestication in Italy is, unsurprisingly, a very complex one. I hope to have demonstrated with this research how valuable the biometrical approach is in answering questions relating to the origins and evolution of animal domestication, when combined with other types of zooarchaeological data. I believe this research represents a successful attempt at answering some of those questions for the Italian case, and I am looking forward to seeing the development of future studies on the subject and how they will contribute to our further understanding of the beginnings of husbandry and agriculture in Europe.

APPENDIX

Recording protocol

The recording system will basically follow Davis (1992), although there are a number of substantial changes and the system is also adapted for a computerized database. Further information about the recording system can be found in Albarella and Davis (1994).

The system is based on two main database structures, one for teeth and one for bones. Only pig bones will be recorded. The selection of recordable skeletal parts is based on the sex, age and biometrical information retrievable from the bones.

The criterion in the selection of recordable skeletal parts is that they provide ageing and/or biometrical information. The following parts of the skeleton are recorded when more than half of the specified area is present:

- Upper and lower teeth occlusal surface (deciduous fourth premolar, fourth premolar, first molar, second molar and third molar);
- Upper and lower canines (if complete section present);
- Atlas;
- Scapula, glenoid cavity (if coracoid process present);
- Humerus, distal;
- Humerus, proximal head;
- Radius, distal;
- Radius, proximal;
- Ulna, proximal articulation;
- III and IV metacarpals, distal (when proximal part is present and except unfused epiphyses)
- Pelvis, acetabulum from ischium (only if fusion data available or measurement possible);
- Femur, distal;
- Femur, proximal head;
- Tibia, distal;

- Tibia, proximal;
- Astragalus, lateral half;
- Calcaneum (only if it is possible to measure);
- III and IV metatarsals, distal (when proximal part is present and except unfused epiphyses);
- Phalanges 1 and 2, proximal (only from central digits).

For proximal and distal long bone ends is meant either the epiphysis or the unfused diaphysis, except when specified. If recordable elements of the radius and ulna are fused together, they will be recorded separately and then reference to each other will be made in comments. If a jaw has teeth on both the left and right side, as many different teeth as possible are recorded as they were on just one side, then the exact situation is explained in comments. Sex will be recorded for canine teeth.

"Non-countable" elements are those which are not used for any quantitative analysis and include bone specimens which are not included in the list of regularly recorded teeth and bones but are worth recording for any specific reason (e.g. anomalous size, interesting butchery marks or abnormalities). All “non-countable” elements will be recorded as “OTH” and the part of the body, if known, will be specified in comments.

Eruption and wear stages of teeth will be recorded following both Grant (1982) and Wright et al. (2014). Measurements are taken on teeth only when there is sufficient enamel preserved to be able to do so. Fused, fusing and unfused bones are all measured. For a description of how measurements are taken see Albarella and Davis (1994), Albarella and Payne (2005), Davis (1992), von den Driesch (1976) and Payne and Bull (1988). All measurements are taken in millimetres, one decimal point (i.e. approximated to the tenth of millimetre).

The following measurements are taken:

<u>Teeth and Jaws</u>:

- Lower fourth premolar: W (crown width);
- Upper and lower deciduous fourth premolar; first, second, and third molars: L (crown length), WA (anterior pillar width), WP (posterior pillar width);

- Lower deciduous fourth premolar, lower and upper third molar: L (crown length), WA (anterior pillar width), WC (central pillar width), WP (posterior pillar width)
- Complete hemi-mandible: H (height in front of M1 on buccal side).

Portcranial bones:

- Atlas: H (height), BFcr (width of cranial articular surface);
- Scapula: GLP (length of articular end), SLC (width of neck);
- Humerus: GLC (greatest length from head), GL (maximum length), Bd (distal width), BT (width of the trochlea), HTC (minimum diameter of trochlea), SD (smallest width of shaft);
- Radius: GL (maximum length), SD (smallest width of shaft), BpP (proximal width), Bd (distal width);
- Ulna: DPA (depth at the processus anconaeus), BPC (width across coronoid process);
- Pelvis: LAR (diameter of acetabulum);
- Femur: GLC (greatest length from head), GL (maximum length), SD (smallest width of shaft), DCP (diameter of caput);
- Tibia: GL (maximum length), Bd (distal width), Dd (distal depth), SDap (smallest antero-posterior width of shaft), SDml (smallest medio-lateral width of shaft);
- Astragalus: GLl (lateral length), GLm (medial length);
- Calcaneum: GL (greatest length), GD (greatest depth);
- Metapodials: GL (greatest length);
- For all foetal and neonatal bones: GL (maximum length), SD (smallest width of shaft).

List of the most represented macro mammalian taxa in the sites analysed

REGION	SITE	CHRONOLOGY	MOST REPRESENTED MACROMAMMALS (%NISP/MNI)					BIBLIOGRAPHY
NORTH								
Trentino-Alto Adige	Galgenbühel/ Dos de la Forca	Mesolithic	Castor fiber (89%/20)	Sus scrofa (43%/18)	Cervus elaphus (23%/11)	Felis silvestris (22%/9)	Rupicrapra sp. (20%/8)	(Wierer et al., 2016; Wierer and Boscato, 2006)
	Riparo Gaban	Mesolithic	Cervus elaphus (48%/14)	Capreolus capreolus (16%/14)	Sus scrofa (19%/10)	Castor fiber (1%/3)	Meles meles (1%/3)	(Thun Hohenstein et al., 2016)
Friuli-Venezia Giulia	Riparo di Biarzo	Upper Palaeolithic (Late Epigravettian)	Sus scrofa (36%/18)	Cervus elaphus (25%/4)	Rupicapra sp. (3%/4)	Ursus arctos (3%/3)	Capra Ibex (3%/2)	(Bertolini et al., 2016)
		Mesolithic (Sauveterrian)	Sus scrofa (38%/8)	Capreolus capreolus (10%/5)	Cervus elaphus (23%/3)	Alces alces (1%/2)	Capra ibex (2%/1)	
		Mesolithic (Castelnovian)	Cervus elaphus (28%/3)	Sus scrofa (28%/3)	Capreolus capreolus (17%/3)	Meles meles (6%/3)	Rupicapra sp. (2%/2)	
Liguria	Arene Candide	Upper Palaeolithic	Capra ibex (37%)	Mustela nivalis (10%)	Oryctolagus cuniculus (9%)	Lepus sp. (9%)	Cervus elaphus (8%)	(Cassoli and Tagliacozzo, 1994)[1,2]
CENTRE								
Latium	Palidoro	Upper Palaeolithic	Cervus elaphus (41%)	Bos primigenius (31%)	Equus hydruntinus (17%)	Sus scrofa (5%)	Equus ferus (4%)	(Ruiu and Tagliacozzo, 2016)[2]
SOUTH								
Apulia	Grotta Paglicci	Upper Palaeolithic (Aurignacean and Gravettian)	Bos primigenius (32%)	Capra ibex (17%)	Equus caballus (16%)	Equus hydruntinus (10%)	*Rupicapra* cf. *pyrenaica* (10%)	(Boscato, 2004)[1,2]
	Grotta Romanelli	Upper Palaeolithic (Late Epigravettian)	Cervus elaphus (26%/415)	Vulpes vulpes (25%/283)	Bos primigenius (19%/279)	Equus hydruntinus (22%/215)	Lepus europaeus (6%/125)	(Cassoli et al., 1997)[1]
Campania	Grotta della Cala	Upper Palaeolithic (Uluzzian, Aurignacean and Gravettian)	Cervus elaphus (75%)	Capreolus capreolus (12%)	Rupicapra sp. (7%)	Sus scrofa (3%)	Capra ibex (1%)	(Boscato et al., 1997)[2]
		Mesolithic	Sus scrofa (30%/8)	Cervus elaphus (36%/7)	Capreolus capreolus (14%/5)	Rupicapra sp. (1%/2)	Bos primigenius (0.4%/2)	(Moroni et al., 2016)
Calabria	Grotta della Madonna	Mesolithic	Sus scrofa (47%)	Cervus elaphus (17%)	Capreolus capreolus (14%)	Bos primigenius (1%)	Capra ibex (0.1%)	(Fiore et al., 2002)[2]
ISLANDS								
Sicily	Grotta dell'Uzzo	Mesolithic I	Cervus elaphus (86%)	Sus scrofa (5%)	Vulpes vulpes (7%)	Bos primigenius (0.4%)	-	(Tagliacozzo, 1993a)[2]
		Mesolithic II	Cervus elaphus (70%)	Sus scrofa (26%)	Vulpes vulpes (5%)	Bos primigenius (2%)	Felis silvestris	
		Mesolithic/Neolithic Transition	Cervus elaphus (67%)	Sus scrofa (26%)	Vulpes vulpes (5%)	Felis silvestris (2%)	Bos primigenius (0.1%)	

Table 11.1. List of the five most represented macro mammalian taxa for Upper Palaeolithic and Mesolithic sites included in this study. Taxa is sorted by MNI first and %NISP second; percentages have been rounded up or down accordingly, except in numbers of 0.5 or less. [1] The %NISP of Sus scrofa for Arene Candide is 1%, for Grotta Paglicci is 7%, and for Grotta Romanelli is 0.32%/MNI=15. [2] The authors have not provided raw MNI data.

REGION	SITE	CHRONOLOGY	MOST REPRESENTED MACROMAMMALS (%NISP/MNI)					BIBLIOGRAPHY
NORTH								
Veneto	Cornuda	Late Neolithic	Cervus elaphus (39%/17)	Sus domesticus (16%/8)	Sus scrofa (15%/6)	Ovis/Capra (10%/6)	Bos primigenius (7%/3)	(Riedel, 1988)
	Molino Casarotto	Middle Neolithic	Cervus elaphus (50%)	Sus scrofa (38%)	Capreolus capreolus (5%)	Bos taurus (1%)	Ovis/Capra (0.5%)	(Jarman, 1976a)[1]
	Rocca di Rivoli	Middle Neolithic	Sus scrofa (31%)	Bos taurus (23%)	Ovis/Capra (22%)	Cervus elaphus (7%)	Capreolus capreolus (2%)	
Liguria	Arene Candide	Early Neolithic	Ovis/Capra (61%/29)	Sus sp. (21%/13)	Cervus elaphus (14%/8)	Bos taurus (3%/4)	Capreolus capreolus (1%/2)	(Rowley-Conwy, 1997a)
		Middle Neolithic I	Ovis/Capra (77%/138)	Sus sp. (16%/35)	Bos taurus (4%/11)	Capreolus capreolus (0.8%/5)	Cervus elaphus (2%/3)	
		Middle Neolithic II	Ovis/Capra (90%/32)	Sus sp. (7%/3)	Bos taurus (2%/2)	Cervus elaphus (1%/2)	Capreolus capreolus (0.2%/1)	
		Late Neolithic	Ovis/Capra (77%/42)	Sus sp. (12%/5)	Bos taurus (7%/3)	Cervus elaphus (3%/1)	Capreolus capreolus (0.4%/1)	
CENTRE								
Latium	La Marmotta	Early Neolithic	Ovis/Capra (50%/84)	Sus domesticus (21%/49)	Bos taurus (10%/31)	Canis familiaris (6%/8)	Sus scrofa (2%/7)	(Tagliacozzo, 2005)

Table 11.2. (1/2) List of the five most represented macro mammalian taxa for Neolithic sites included in this study. Taxa is sorted by MNI first and %NISP second; percentages have been rounded up or down accordingly, except in numbers of 0.5 or less. Taxa is sorted by MNI first and %NISP second. [1] The authors have not provided raw MNI data.

REGION	SITE	CHRONOLOGY	MOST REPRESENTED MACROMAMMALS (%NISP/MNI)					BIBLIOGRAPHY
SOUTH								
Apulia	Masseria Candelaro	Middle Neolithic	Ovis/Capra (58%/145)	Bos taurus (22%/74)	Sus domesticus (17%/72)	Canis familiaris (2%/19)	Lepus europaeus (0.5%/7)	(Curci et al., 2005)
	Masseria Fragella	Early Neolithic	Ovis/Capra (54%/35)	Bos taurus (29%/18)	Sus domesticus (11%/16)	Canis familiaris (6%/9)	Vulpes vulpes (not specified)	(Maini, 2017)
	Masseria Pantano	Middle Neolithic	Ovis/Capra (38%/31)	Sus domesticus (30%/20)	Bos taurus (24%/14)	Canis familiaris (9%/7)	-	(Curci et al., 2016)
Campania	Baselice	Early Neolithic	Ovis/Capra (29%/14)	Bos taurus (34%/9)	Sus domesticus (18%/9)	Sus scrofa (7%/3)	Canis familiaris (5%/2)	(Curci and Langella, 2005)
	Masseria di Gioia	Middle/Late Neolithic	Ovis/Capra (58%/25)	Bos taurus (21%/13)	Sus domesticus (17%/10)	Lepus europaeus (1%/2)	Canis familiaris (3%/1)	(Curci and Langella, 2005)
	Mulino Sant' Antonio	Late Neolithic	Cervus elaphus (28%/9)	Sus scrofa (51%/7)	Ovis/Capra (7%/4)	Capreolus capreolus (8%/3)	Lepus sp. (2%/2)	(Albarella, 1987)
Calabria	Favella	Early Neolithic	Ovis/Capra (63%/27)	Sus domesticus (10%/15)	Bos taurus (20%/14)	Sus scrofa (1%/3)	Canis familiaris/Capreolus capreolus/Vulpes vulpes (0.5%/3)	(Tagliacozzo, 2005)
	Grotta della Madonna	Middle Neolithic	Ovis/Capra (70%/127)	Sus domesticus (14%/47)	Bos taurus (4%/22)	Cervus elaphus (3%/7)	Capreolus capreolus (2%/6)	(Tagliacozzo, 2000)
	Grotta della Madonna	Late Neolithic	Ovis/Capra (77%/37)	Sus domesticus (10%/10)	Bos taurus (3%/5)	Cervus elaphus/Mustela nivalis/Meles meles/ Lepus europaeus (0.4%/1)		
ISLANDS								
Sicily	Grotta dell'Uzzo	Early Neolithic	Cervus elaphus (40%)	Sus sp. (26%)	Ovis/Capra (12%)	Vulpes vulpes (11%)	Bos taurus (4%)	(Tagliacozzo, 1993a)[1]
		Early to Middle Neolithic	Ovis/Capra (54%)	Cervus elaphus (15%)	Sus sp. (18%)	Vulpes vulpes (11%)	Bos taurus (4%)	

Table 11.2. (2/2) List of the five most represented macro mammalian taxa for Neolithic sites included in this study. Taxa is sorted by MNI first and %NISP second; percentages have been rounded up or down accordingly, except in numbers of 0.5 or less. Taxa is sorted by MNI first and %NISP second. [1] The authors have not provided raw MNI data.

REGION	SITE	CHRONOLOGY	MOST REPRESENTED MACROMAMMALS (%NISP/MNI)					BIBLIOGRAPHY
NORTH								
Lombardia	Lavagnone	Early Bronze Age	Ovis/Capra (50%)	Sus domesticus (22%)	Bos taurus (20%)	Cervus elaphus (2%)	Canis familiaris (1%)	(Curci, 2013)[1]
Liguria	Arene Candide	Copper/Bronze Age	Ovis/Capra (54%/36)	Sus sp. (30%/14)	Bos taurus (9%/4)	Cervus elaphus (6%/3)	Capreolus capreolus (1%/1)	(Rowley-Conwy, 1997a)
CENTRE								
Emilia-Romagna	Cattolica	Early Bronze Age	Sus domesticus (38%/35)	Ovis/Capra (29%/8)	Bos taurus (21%/15)	Canis familiaris (2%/4)	Cervus elaphus (1%/2)	(Maini, 2013a)
	Cesena	Middle Bronze Age	Ovis/Capra (43%)	Sus domesticus (36%)	Bos taurus (19%)	Canis familiaris (1%)	Equus caballus (1%)	(Miari et al., 2014)[1]
		Late Bronze Age	Sus domesticus (37%)	Ovis/Capra (35%)	Bos taurus (24%)	Canis familiaris (2%)	Equus caballus (4%)	
	Poviglio	Middle to Late Bronze Age	Ovis/Capra (41%)	Bos taurus (28%)	Sus domesticus (26%)	Canis familiaris (3%)	Sus scrofa (1%)	(Maini, 2015)[1]
	Riccione Ipercoop	Middle and Late Bronze Age	Bos taurus (46%/5)	Sus domesticus (22%/5)	Ovis/Capra (19%/2)	Equus caballus (2%/2)	Cervus elaphus (3%/1)	(Maini, 2013b)
	Solarolo	Middle Bronze Age	Ovis/Capra (53%/95)	Sus domesticus (29%/67)	Bos taurus (13%/29)	Canis familiaris (3%/7)	Equus caballus (0.5%/2)	(Maini and Curci, 2013b)
Marche	Conelle	Eneolithic/Copper Age	Sus sp.[3] (53%/207)	Ovis/Capra (12%/73)	Bos taurus (18%/43)	Canis familiaris (4%/51)	Cervus elaphus (11%/23)	(Wilkens, 1999)
Tuscany	Gorgo del Ciliegio	Middle Bronze Age	Ovis/Capra (35%)	Sus domesticus (22%)	Bos taurus (17%)	Capreolus capreolus (9%)	Canis familiaris (7%)	(Arrighi et al., 2007)[1]
Latium	Albano Le Macine	Middle Bronze Age	Cervus elaphus (55%/19)	Ovis/Capra (15%/8)	Sus domesticus (7%/8)	Sus scrofa (3%/6)	Capreolus capreolus (4%/5)	(Tagliacozzo et al., 2012)
	Cinquefrondi	Eneolithic/Copper Age	Ovis/Capra (50%)	Bos taurus (38%)	Sus domesticus (9%)	Cervus elaphus (NISP=2)	-	(Angle et al., 2015)[1]
	Pantano Borghese	Eneolithic/Copper Age	Bos taurus (12%)	Ovis/Capra (11%)	Sus domesticus (6%)	Canis familiaris (1%)	Cervus elaphus (0.2%)	(Angle et al., 2012b)[1]

Table 11.3. (1/2) List of the five most represented macro mammalian taxa for Eneolithic/Copper and Bronze Age sites included in this study. Taxa is sorted by MNI first and %NISP second; percentages have been rounded up or down accordingly, except in numbers of 0.5 or less. sites included in this study. [1] The authors have not provided raw MNI data. [3] This calculation is a sum of remains identified by the authors as *Sus scrofa*, *Sus domesticus*, and *Sus* sp. [4] Raw data was only provided for the main domesticates.

REGION	SITE	CHRONOLOGY	MOST REPRESENTED MACROMAMMALS (%NISP/MNI)					BIBLIOGRAPHY
SOUTH								
Apulia	Coppa Nevigata	Middle to Final Bronze Age	Ovis/Capra (35%)	Testudo hermanni (21%)	Bos taurus (14%)	Sus domesticus (9%)	Cervus elaphus (7%)	(Siracusano, 2012)[1]
Campania	Gricignano	Late Eneolithic to Early Bronze Age Transition	Bos taurus (12%)	Ovis/Capra (9%)	Sus domesticus (8%)	Cervus elaphus (8%)	Canis familiaris (1%)	(Albertini et al., 2007)[1]
	La Starza	Middle Bronze Age	Ovis/Capra (45%/31)	Bos taurus (57%/17)	Sus sp. (29%/15)	-	-	(Albarella, 1999)[4]
Calabria	Broglio di Trebisacce	Middle Bronze Age	Ovis/Capra (32%)	Cervus elaphus (28%)	Sus domesticus (19%)	Bos taurus (15%)	Canis familiaris (1%)	(Tagliacozzo, 1994b)[1]
	Grotta della Madonna	Eneolithic/Copper Age	Ovis/Capra (57%/38)	Sus domesticus (17%/16)	Bos taurus (5%/4)	Canis lupus (3%/3)	Cervus elaphus (5%/2)	(Tagliacozzo, 2000)
		Early and Middle Bronze Age	Ovis/Capra (41%/77)	Sus domesticus (27%/44)	Bos taurus (16%/28)	Cervus elaphus (1%/6)	Canis familiaris (1%/6)	
	Torre Mordillo	Final Bronze Age	Sus domesticus (33%/60)	Ovis/Capra (29%/48)	Bos taurus (28%/41)	Cervus elaphus (8%/11)	Canis familiaris (2%/5)	(Arancio et al., 1995)
ISLANDS								
Sicily	Mursia	Middle Bronze Age	Ovis/Capra (65%/89)	Bos taurus (12%/37)	Sus domesticus (5%/16)	Monachus monachus (0.1%/1)	-	(Wilkens, 1987)

Table 11.3. (2/2) List of the five most represented macro mammalian taxa for Eneolithic/Copper and Bronze Age sites included in this study. Taxa is sorted by MNI first and %NISP second; percentages have been rounded up or down accordingly, except in numbers of 0.5 or less. sites included in this study. [1] The authors have not provided raw MNI data. [3] This calculation is a sum of remains identified by the authors as *Sus scrofa*, *Sus domesticus*, and *Sus* sp. [4] Raw data was only provided for the main domesticates.

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