# Animals and their roles in the medieval society of Sicily: from Byzantines to Arabs and from Arabs to Norman/Swabians

by
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*To all my friends out there,*
*looking for a land, sailing into the sea.*

*V.A.*

# *Abstract*

*In this project, a number of faunal samples recovered from different site-types and dated to the medieval period in Sicily are analysed and compared.*

*Zooarchaeological results reveal significant changes in the use of the main domesticates in the Byzantine-Arab and in the Arab-Norman/Swabian transitional periods.*

*In the Arab period, the socio-cultural effects of the Islamisation of the island are attested by an overall dearth of pigs at most urban sites. By contrast, similarly to the Byzantine period, pigs continue to be represented at contemporary rural settlements, thus suggesting a higher resilience of rural communities toward the newly imposed socio-cultural and religious rules. Sheep become larger in Arab times; such phenomenon was likely driven by an interest to maximise outputs from caprine husbandry, and can be seen as part of the 'Arab Green Revolution'.*

*During the Norman/Swabian rule, changes in dietary practices with the previous period are noticed. Although caprines maintain an important economic role, pigs are again present at urban and military sites; such result might be an indicator of an ongoing 'de-Islamisation' of the island. At the same time, a further improvement of sheep size indicates a continuity in the Norman/Swabian period of animal husbandry strategies initiated by the Arabs.*

*27th August 2018, Valguarnera (Enna, Sicily).*
The day I presumably met the Barbaresca sheep, before I even knew about them (Photo of the author).

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# Introduction

Sicily is the largest island in the Mediterranean Sea; it is located along the southern border of Europe and it is physically divided from the rest of Italy by the Strait of Messina. However, the proximity between Sicily and the Italian mainland to the north, and the African continent to the south has meant that the history of the island has been closely connected with both these territories. Its varied and productive landscapes and strategic position in the Mediterranean have invariably placed Sicily within the political interests of different powers, from the Phoenicians in the 7th century BC to the northern Italians in the 19th century AD. The island can be seen as a 'stretched arm' protruding in the sea, attracting different cultures that, over time, have affected and shaped the society and culture of the native population. As a result, the cultural identity of Sicily has always been difficult to define. On the one hand, different populations have conquered the island through time but, on the other, it is important to consider that the invaders always merged, to a greater or lesser extent, with the pre-existing population. This situation resulted in the creation of an intriguing, dynamic and complex society.

With this context in mind, the present project investigates the development of animal husbandry during the periods of transition between Byzantines, Arabs, Normans and Swabians in Sicily (6th-13th century AD).

The study of animal bones and teeth recovered from different medieval archaeological sites in Sicily has the potential to provide important indicators of dietary preferences and overall animal exploitation practices. It is well known that food production and consumption are crucial aspects of human communities. However, food does not only represent a vital biological need. Diet is a complex culturally-determined characteristic of human communities. Its role is central during celebrations, as it provides comfort beyond one's biological requirements and it offers opportunities to socialise and bond with colleagues, friends and relatives. For this reason, people's diet can provide essential information about their lives; for example their socio-economic standing, health and cultural background. The use of food in human culture has always represented a valuable source of information for researchers. However, the analysis of animal remains is not only about food; this class of archaeological material provides additional information about economic specialisation, social status, ethnic identity, ritual and religious practices characterising past societies, as well as environmental conditions.

## Aims and limitations of the research project

The project has the following aims:

- Contributing to our understanding of the nature and development of animal exploitation in Sicily during the Byzantine, Arab, Norman and Swabian periods. It is reasonable to assume that these four political entities, characterised by different cultural backgrounds, had different impacts on the use of animal resources.

- Investigating, for each historical period, the nature and main aims of husbandry practices, using available case studies. Imported cultural systems could have been imposed on the native population, or naturally adopted. To clarify these aspects, spatial and temporal patterns will need to be carefully considered.

- Investigating dietary preferences. These latter could have been influenced by a variety of factors, of both economic and non-economic nature. It is likely that non-economic variables, such as religion and cultural traditions, played an important role in food choices. This holds particularly true for the Muslim period, during which food taboos may have prohibited the consumption of specific animal products such as those derived from pig.

- Identifying degrees of specialisation in animal exploitation for each historical period. This latter will be analysed in terms of intensification of husbandry practices, focus on specific products, standardisation of animal management and carcass processing.

- Detecting the potential introduction of new breeds and/or any deliberate attempt of animal improvement through time. An interesting relevant example of animal improvement has been already attested for the Muslim period in Portugal (Davis 2008). My dissertation, therefore, will verify whether a similar scenario characterised Muslim Sicily as well.

- Analysing the degree of reliance on wild fauna and fishing during different periods and at different settlement types. Once again, this will provide information on cultural systems, from an economic and social viewpoint.

- Gaining more information about the environmental conditions surrounding archaeological sites, for which only sparse archaeobotanical evidence is currently available. Large domestic mammals are not ideal environmental indicators, yet the relative proportions of the main domesticates can still produce interesting information on available pastures. Smaller vertebrates may also contribute to clarify what kind of habitats were likely to surround relevant sites.

- Comparing and discussing zooarchaeological studies from different regions belonging to the same historical period. This comparison will allow re-evaluating the role of zooarchaeology in understanding the intertwined roles of religion, economy and society in the regional patterning of food production and consumption during the Middle Ages.

- Interpreting the results in light of the wider historical, socio-political and religious developments characterising the island. To this end, the integration of zooarchaeological results with other archaeological evidence (such as ceramic), as well as historical sources, will be essential.
- Raising awareness of the role that zooarchaeology can have for the reconstruction of socio-political and economic dynamics. Zooarchaeology is a rather undeveloped field in Sicily, at least for the medieval period; hitherto only a few reports on medieval faunal assemblages have been published, and much more needs to be done to recognise animal remains as one of the main sources of archaeological information.

It will be seen that this research project has broken new ground in more ways than one: firstly, it has set out to examine changes in animal husbandry in the central Mediterranean over a long and often turbulent period, 6th-13th centuries AD; secondly, due to the undeveloped nature of zooarchaeology on the island, the basic data for the study had largely to be collected and organised from scratch. Logistic challenges included the location and access of faunal assemblages from excavation projects, which were in some cases still unpublished. Additionally, in most cases the bones had to be cleaned for analysis - a time consuming job.

Having confronted these challenges, a substantial number of zooarchaeological remains from different medieval sites in Sicily have been analysed, producing a large dataset. This represents the first truly significant comparative study for the zooarchaeology of medieval Sicily, which contributes substantially to the characterisation and reconstruction of the economic and social history of Sicily during the Middle Ages.

## The White Rose Consortium network '*Faith in food and food in faith*'

This White Rose Consortium (WRoCAH) network was created in 2014 and aims at relating food production and dietary practices to social and ideological norms. A number of different methodological approaches are being deployed, such as molecular archaeology, zooarchaeology, nutritional epidemiology, history of medicine and artefactual archaeology.

The network, focusing on different fields and time periods, aims at exploring the relationships between food, health, religion, social status, migration and identity. This latter is composed of three scholarships, each one based at a different University of the White Rose Consortium. In addition to my research project, Alice Toso (University of York) has focused her doctoral research on the application of stable isotopic analysis to investigate human's diet in the Iberian Peninsula during the transitions between Muslim and Christian rules (11th-13th centuries AD, 15th-16th centuries AD). Holly Hunt-Watts (University of Leeds) has worked on food intake in low-income families in England during the 19th century AD. During the three years of studentship, as part of the network, the students have had the opportunities to collaborate in order to enhance inter-disciplinary.

To summarise, this doctoral thesis, funded by the White Rose Consortium, is the result of a collaboration between the University of Sheffield, the University of York and a number of archaeologists in Sicily, who were in charge of previously excavated assemblages of animal bones. Thanks to the scholarly interest and kindness of the latter, and the negotiations carried out by my supervisors, Prof. Alessandra Molinari (University of Roma Tor Vergata) and myself, it has been possible to conduct an in-depth zooarchaeological survey of a wide range of medieval sites in Sicily.

# Chapter 1

# An historical overview of medieval Sicily

"[. . . ] *Atlases show Sicily as an island, and this fact could be true since atlases are reliable books. However, we can doubt about this definition, especially when you see such concept relating an island to a defined set of racial and moral values. By contrast, in Sicily everything is ambiguous and mixed, as in the most hybrid of continents* [. . . ]. *The truth is that there are several Sicilies, and it would be impossible to count them all* [. . . ]. *Hence, why so many Sicilies? Because through the centuries Sicily was fortunate enough to become a hinge between the great western cultures and the temptations of the desert and the sun* [. . . ]"(Bufalino 2008) (translated by the author from the original Italian version).

In the following sub-chapters, an historical overview of the major social and political dynamics affecting Sicily from Byzantine to Norman/Swabian times is presented. Since most faunal assemblages analysed in this research is dated to the Arab period, much attention is paid to this chronological phase; at the same time, the Byzantine and the Norman/Swabian periods will be also described, although in a more concise way.

The centrality of Sicily within the economic and political dynamics of the Mediterranean during medieval times has been the subject of several recent studies (Molinari 2004; Arcifa 2008; Congiu *et al.* 2009; Molinari 2009; Arcifa *et al.* 2012; Nef and Ardizzone 2014; Mandalà 2016; Carver *et al.* 2018; Carver *et al.* 2019). Due to its geographical position, Sicily has always been considered a borderland, a gateway with the key potential of connecting the north with the south, as well as the east with the west of the Mediterranean (Tramontana 2014).

However, the centrality of a region does not only depend upon its geographical position. As Nef and Prigent (2010) pointed out, other variables should also be considered in order to define an area as ‘central’.

First, the role played by the region in the macro-political system to which it belongs has to be considered; in other words, it is important to characterise its economic and political capacity.

The second factor, which could be seen as a corollary of the first point, concerns the level of political control exercised on dominated lands. This latter point can be complemented by the degree of involvement of the analysed area within commercial exchanges.

Taking into consideration the political weight of the island in the central Mediterranean area, it could be affirmed that, from the Byzantine to the Arab periods, Sicily has occupied a rather peripheral position in relation to the main powers that ruled the island. However, from the 6th to the second ½ of the 13th century AD other interdependent variables, which include its strategic geographical position and economic and cultural developments, implied that Sicily was always considered central and of major interest to different political systems.

We will now try to investigate, from an historical point of view, the role played by Sicily from the Byzantine to the Norman/Swabian periods.

## 1.1. Sicily from the Romans to the Byzantines

"[...] *and for what concerns grain, honey, saffron, and certain other products, one might call Sicily even superior. There is, furthermore, its vicinity; for the island is a part of Italy, and readily and without great labour supplies Rome with everything it has, as though from the fields of Italy. And indeed it is called the storehouse of Rome.*" (Strabo VI.2.7) (translated by the author from the original Latin version).

The Romans conquered Sicily in 241 BC, during the final battle of the First Punic War against the Carthaginians. The island became the first *provincia* (the largest administrative unit under the Romans) of the Roman State (Cracco Ruggini 1980).

The strategic position occupied by the island in the Mediterranean basin was one of the main interests of the conquerors. In addition, the fertile and wealthy countryside characterising Sicily at that time would have represented another important economic resource for the Romans. As the Greek historian Strabo in his opera '*Geographica*' highlighted (see above), these latter aspects were well known by Roman authors, who often celebrated in their works the remarkable wheat production capacity of the Sicilian countryside (Cicero, II.2.2, Strabo, VI.2.7). Sicily, therefore, became a major supplier of grain for the capital and its armies. A governor and two magistrates (*quaestores*) administered the island and collected taxes, which were mainly in tithes of grain. The Romans did not alter the costumes of the local population, who continued to speak Greek throughout the entire period of Roman occupation (Wilson 1990; Congiu *et al.* 2009).

After the fall of the Roman Empire (AD 476) and even earlier, when the centre of power moved east to Constantinople, Sicily was left in a vulnerable condition. The economic wealth and the strategic position of the island started to attract the attention of various groups of people, such as the Vandals and the Goths. The Vandals, a Germanic tribe that had conquered North Africa in AD 429, started a series of incursions towards Sicily, occupying the island for almost eight years. Ultimately, the Vandals made a political agreement first with the Germanic king of Italy Odoacer and, later, with Theodoric (the Ostrogoth king of Italy) leaving the island in exchange of an annual payment (Cracco Ruggini 1980; Giuffrida and Cassia 2016). The Ostrogothic rule over Sicily (AD 489-535) was limited to some military expeditions, which did not result in any permanent establishment in the island. During this period, the administrative organisation of the territory set up by the Romans did not change: the *latifondium* (large estate owned by rich landlords) remained the most common system of land organisation. In addition, Sicily maintained important connections with Rome: the wealthy senatorial Roman families still played an important role in the Sicilian administration and they owned considerable properties in the island (Vera 1997-1998).

Within this historical scenario, the Byzantine conquest of Sicily did not just constitute a mere military occupation of the island, but an attempt to restore the power of the ancient Roman Empire. After the Roman Empire was divided in two parts in AD 395, Sicily was included in the Western Roman Empire, although the legacy of several centuries of Greek influence meant that it had a considerable amount of social and cultural elements in common with the Eastern part of the Empire. In order to reunite the Roman Empire, the Byzantine Emperor Justinian (AD 482-565) made several efforts to re-conquer Sicily as well as the rest of Italy. The Emperor was not able to pursue its dream of reuniting all the lands of the ancient Roman Empire; however, southern Italy (Sicily included) became Byzantine, while the Lombards conquered much of the rest of the peninsula shortly after the end of the Gothic War (AD 535-553).

AD 535 is the generally accepted starting date of the Byzantine period in Sicily, as in this year the Emperor Justinian sent his general Belisarius to conquer the island. From this point onwards, Sicily would have been a Byzantine province up until the arrival of the Arabs (Cracco Ruggini 1980) (Fig.1.1.1).

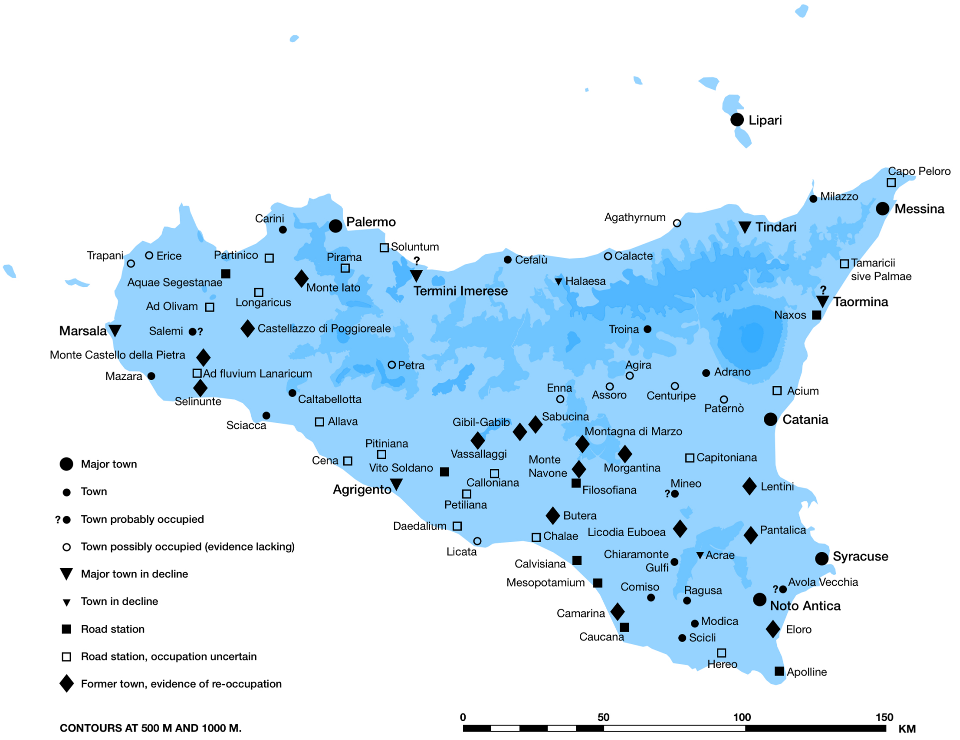

**Figure 1.1.1.** Map of Sicily showing the distribution of different settlements during the course of the 5th and 6th centuries AD (image created by the author from Wilson 1990).

After the Byzantine conquest, the administrative system of the island underwent several changes. Sicily received the status of private domain of the Emperor, and the typical Roman division between military and civil powers was reintroduced. A *praetor*, who was directly linked to Byzantium, was the responsible of the entire administrative system. In this way, Justinian managed to secure direct control over the island (Nef and Prigent 2010).

At the end of the 6th century AD, after the end of the war between Ostrogoths and Byzantines and, later, the Lombard invasion (this latter only affecting the northern and centre-southern parts of peninsular Italy), Sicily underwent a period of prosperity: indeed, the island continued to be considered the main granary of the Eastern Empire (Arcifa 2008; Molinari 2013). One of the most important historical sources dated to this period are the '*Epistoles of Saint Gregory the Great*', in which the economic situation of Sicily during the 6th and the early 7th centuries AD is described in detail. In his work, the pope highlights the prosperous agriculture characterising Sicily under the Byzantine rule; he also described the organisation of his properties in the island, referring to extensive agricultural units (*massae*) that were divided in smaller parts (*fondi*) (Cracco-Ruggini 1980). Without any doubt, the main economical income of the island was still represented by agriculture, although flourishing craft industries producing precious jewellery and silk, as well as wool fabrics, are also attested. Greek and Latin were the main languages spoken by the Sicilian population, already characterised by a high diversity of socio-cultural elements due to the continue immigration of people from different areas of the Mediterranean. Christianity represented the common denominator of social cohesion, although at the beginning of the Byzantine period pagan cults were still practiced in the island (Maurici 1995).

The economic prosperity characterising Sicily during these centuries might be one of the reasons why, in AD 663, the emperor Constant II decided to move the Byzantine capital and its court from Constantinople to Syracuse, shifting the centre of the Empire west. However, this was not to last and, after Constant II's assassination in AD 668, Constantinople regained again its status of capital of the Empire (Nef and Prigent 2010; Booms and Higgs 2016).

At the end of the 7th century AD, the Arabs started their first raids on the island. However, due to politico-military issues in the province of Ifrīqīya (northern Africa), the Byzantine army maintained control of the entire island (Chiarelli 2018; Ruta 2011).

In order to contrast the Arab military offence in Sicily, the Byzantines reorganised the island into *themata*. As a result of such administrative change, the military troops were no longer made of mercenaries, but soldiers who were provided fields to cultivate (Nef and Prigent 2010). In this way, the abandoned lands were reoccupied, and the troops were motivated to protect their properties against the new invaders. However, the Arab expeditions continued and, at the beginning of the 8th century AD, the island of Pantelleria was conquered. However, due to the Berbers threatening Ifrīqīya, a period of truce between the Byzantines and the Arabs followed. The Byzantine troops exploited this moment to reinforce their military presence in Sicily, fortifying several areas of the island. An Arab historian, An-Nuwayri, inform us in his encyclopaedic work '*Nihāyat al-arab fī funūn al-adab*' ('*The ultimate ambition in the arts of erudition*') that the island was entirely covered in fortifications and castles, and no one of the mountain peaks had been left without a fortress (Maurici 1995).

From this point onwards, a local fleet guarded the island and the territory was heavily fortified and defended by new garrisons. After this period of ostensible truce, in the 8th century AD the Arabs resumed their incursions against Sicily; in such difficult politico-military situation, the geographical distance of the island from Constantinople encouraged several rebellions and social riots against the Byzantine domain. During the 8th and 9th centuries AD, the political and social situation of Sicily was very far from the pacific description given by Saint Gregory the Great years before: the island had become a contested frontier, and as a consequence agricultural production and trade underwent a period of impasse (Chiarelli 2018).

In conclusion, if on one hand the period spanning from the 6th to the 7th centuries AD was a phase of relative wealth and peace for Sicily, due to its important trade with northern Africa, Constantinople, Rome and central Italy, on the other the 8th and 9th centuries represented a period of deep crisis. Such period would have culminated with the Arab invasion of Sicily.

## 1.2. Sicily from the Byzantines to the Arabs

"[...] *Sicily is an island, extensive and important. The Muslims have no island more splendid, more prosperous or with more cities* [...]. *Inhabitants of the island are continually engaged in jihad* [...]" (Al Muqaddasi as cited in Booms and Higgs 2016).

Since AD 642, the Arabs started conquering North Africa from the Byzantines and the Berbers, and by AD 709 they controlled all the territories from Egypt to Tangier, in modern Morocco (Hitti 1937; Ruta 2011).

As mentioned before, during the course of the 9th century AD, Sicily became a frontier of the Arab world (Chiarelli 2018). In this period the Arab Empire, with its capital placed in Baghdad, moved its political and economic interests eastwards, abandoning the Mediterranean basin. By contrast, the Arab states occupying northern Africa (modern Egypt, Libya, Tunisia, Algeria and Morocco), maintained and developed their influence in this geographical area. The region was called Ifrīqīya, and it corresponded to the former African provinces of the Roman Empire. At that time, the ruling dynasty of the Aghlabids started considering the conquest of Sicily as a mean to solve their own internal problems, aiming to make themselves more economically independent from Baghdad. Furthermore, the necessity of maintaining the slave supply and the memories of triumphs of previous Sicilian expeditions prompted further expansions (Hitti 1937; Tramontana 2014).

A consensus was reached among researchers in putting the beginning of the Arab conquest of Sicily at around AD 827. However, as mentioned above, the interest of the Arabs for the island dates back to the 8th century AD, by which time they had already developed a powerful fleet to prevent the military advance of the Byzantines in the Mediterranean basin. During this century, several attacks were organised from northern Africa, culminating with a first military assault to

Pantelleria in AD 700 and later to Syracuse in AD 739/40 (Hitti 1937; Chiarelli 2018).

At the beginning of the 9th century AD, Byzantines and Arabs were in ostensible truce due to their trade interests in the Mediterranean basin. In this period, insurrections taking place in Syracuse (the capital of the island under the Roman and Byzantine rules) represented a perfect excuse for the Muslim military advance in Sicily. Several are the explanations for these revolts.

The most famous one refers to a popular medieval story about the adventures of a Byzantine naval commander called Euphemius; apparently, after having broken the law by marring a nun against her will, the Byzantine Emperor ordered his arrest. For this reason, Euphemius organised a revolt against the imperial command on the island. After having killed the island's *strategos*, Euphemius proclaimed himself emperor of Syracuse, asserting his independency from Constantinople and claiming full powers (Nef and Prigent 2006). This situation led the Emperor of Constantinople to reinforce the military presence in the eastern part of the island. At that point the admiral Euphemius turned to the Muslim leader of Ifrīqīya, Ziyādat Allāh I, who supported the rebel and started organising troops composed of Berbers, Persians, Spanish and Slaves (Vanoli 2012; Booms and Higgs 2016). Another story claims that, when the Byzantine Emperor sent emissaries to Sicily in order to demand more taxes, such request fuelled a popular rebellion against the Byzantines (Maurici 1995; Chiarelli 2018).

However, none of these events can fully explain the increasing dissatisfaction of the local population towards the Byzantine Empire. As Nef and Prigent (2006) point out, other explanations are behind such phenomenon, and they are mostly linked to the loss of economic power of Sicily within the Byzantine Empire. In their article they referred to a famous archaeologist, Biagio Pace (1935), who points out in his work '*Arte e civiltà della Sicilia antica*' ('*Art and civilisation in ancient Sicily*') that:

"[. . . ] *the rebellion of Euphemius* [. . . ] *was linked to the fracture with the distant Imperial power, which was the main cause of the Sicilian discontent*" (translated by the author from the original Italian version).

The first reason for the decreased importance of Sicily during this period relates to the shift of political and economic interests of the Italian peninsula from the Tyrrhenian to the Adriatic Sea. The causes of such change of the political axes include the rise of the Francs, the development of the Venetian maritime trade, and the political stabilisation of the Balkans. A second political phenomenon contributed to decentralise Sicily from the economic dynamics of that time: the political and economic affirmation of the Balkans and of Anatolia. Indeed, two main agricultural areas located close to Constantinople, Bithynia and Thrace, gradually replaced the role played by Sicily, which until this time was considered the granary of the Empire. As a result, from the 9th century, Sicily, which for long represented for Constantinople a major gateway to the western part of the Mediterranean basin and a key economic player, lost its role and became more vulnerable to external invaders (Nef and Prigent 2006).

It is important to highlight that, at the time of the conquest of Sicily, the Arab military troops were very mixed in terms of ethnic composition, and few people were 'proper' Arabs (from an ethnic point of view). Indeed, apart from the Berbers, who were native from northern Africa, there were Slaves, Persians, Tartars, Andalusian and several Greeks. The majority of people were converted to Islam and, for this reason, the literary sources refer to them as 'Muslims' (adept to Islam) (Tramontana 2014).

After landing in Mazara del Vallo in AD 827, the Arabs, led by the Aghlabid Asad ibn al-Furat, marched on Syracuse. The siege of the city lasted one year, from the winter to the summer of AD 827-828. During this period, the invaders suffered from the scarcity of food supply, and an outbreak of epidemics caused the death of their commander. In addition, the Byzantine defence of the city was reinforced, forcing the new Arab leader, Muhammad ibn Abi'l-Jawari, to abandon the eastern part of the island and to retreat to south-western Sicily. The Val di Mazara was the first area to be conquered by the Arabs. After the capitulation of Palermo in AD 831 (from this point onwards this city started playing a major role in the political and economic dynamics of Arab Sicily), several urban and rural settlements fell under Muslim rule between AD 839-840 (Vanoli 2012; Chiarelli 2018).

Half a century after the Arab invasion, a mixed Muslim-Christian population inhabited the western part of Sicily, where natives were initiated to the Arab culture and Islamic religion (Metcalfe 2009).

Outside the Val di Mazara, Islamic successes were more sporadic. Muslims made quick incursions into the mountains, moving towards the north-eastern part of the island, the so-called Val Démone. The eastern third of the island, the Val di Noto, suffered a number of incursions that ended with the fall of Módica, Lentini and Ragusa (AD 845-849), while many strongholds in the east, such as Taormina, Catania and Syracuse, remained firmly under Byzantine control.

After the fall of Castrogiovanni (modern Enna) in AD 859, the Aghlabids gained complete control of central Sicily. This achievement allowed them to move south-east into the Val di Noto. The Byzantine defences, weakened by the loss of Castrogiovanni, attempted to protect their authority in the east, at the same time supporting insurgences in the southwest of the island (e.g. Agrigento, Caltabellotta and Platani) (Metcalfe 2009; Tramontana 2014; Chiarelli 2018).

However, Byzantine hopes were wiped out when the rebellions were put down and the Muslims continued their military expeditions eastwards (Metcalfe 2009).

The conquest of Syracuse was now perceived as impending and inevitable. After almost a year of conflict, in AD 878, the defences of the city fell and the inhabitants (mainly Christians and Jews) were moved to Palermo. If, on one hand, the native population was not massacred, on the other many buildings and infrastructures (e.g. defensive walls, houses and churches) were heavily damaged. It became soon clear that, although most of the island was now under Arab control, it was to remain culturally divided in two main sub-regions: the *dar al-Islam* (western and central-western part of the island), largely converted to Islam, and the *dar al-arb* (eastern part of the island), less prone to recognise the new doctrine (Metcalfe 2009; Vanoli 2012; Nef 2014) (Fig.1.2.1).

**Figure 1.2.1.** Map of the Arab conquest of Sicily, showing the conquests and sieges of the major cities (image created by the author from Booms and Higgs 2016).

Despite all the achievements of the Arab invasion, at the beginning of the 10th century AD the Muslim conquest of the island was far from complete. The resistance of Christian cities and fortresses, mostly located in the Val Démone, represented one of the main problems, though not the only one. Indeed, internal conflicts among the ruling elite, as well as within the army, undermined the stability of the Aghlabids (Metcalfe 2009; Vanoli 2012).

Since AD 909, the Fatimids replaced the Aghlabid dynasty, taking control of

Ifrīqīya as well as Sicily. During the Fatimid period, several rebellions were organised against the Fatimid caliphs. A sense of independence became strong among Sicilians, especially among those who retained the Sunni faith of the Aghlabids in contrast to the Shi'i Fatimids. A period of truce followed the expedition to Sicily in AD 948 of a descendent of the ancient dynasty of the Kalbids, Hassan al-Kalbi, who was elevated as Emir of Sicily. In 970 AD the Fatimids moved their capital from Ifrīqīya to Egypt. Theoretically, Sicily remained under Fatimid rule, but by now it had gained a large degree of independence. For this reason, this chronological period is generally known as the Kalbid rather than the Fatimid period (Vanoli 2012; Chiarelli 2018).

The Kalbid period is known as the economically and culturally richest one that Sicily experienced during the Middle Ages[1]. Whether such economic developments included the innovations in agriculture that elsewhere (e.g. Al-Andalus) go under the name of 'Green Arab Revolution' has been matter of speculations (Watson 1983; Masseti 2016); ongoing studies, including the present one, aim to assess this hypothesis.

The political stability of the Kalbid dynasty started to decline around the 11th century AD. The last Kalbid emir ruled until AD 1053, but during his rule the island fragmented into several autonomous entities under the control of local military leaders. One of these latter, in order to regain control of the entire island, asked for help to two Norman mercenaries, Robert Guiscard of Hauteville and his brother Roger. By that time, the Normans had already started conquering the regions of southern Italy (Booms and Higgs 2016).

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[1] These years also saw the conquest of two important Byzantine strongholds: Taormina (AD 962) and Rometta (AD 965) (Bramoullé 2014).

## 1.3. Sicily from the Arabs to the Normans/Swabians

Around the same time that the Arab conquered Sicily, the Normans settled in northern France in what became known as Normandy. The Normans were well-known as sly mercenaries at the service of local lords. Since the first years of the 11th century AD, the Normans started developing political and economic interests in the Italian peninsula; they focussed on the southern regions, including Sicily. As mercenaries, they hired themselves out as fighters, changing side at will and serving at different times the Byzantines and their enemies. The difficult political situation of southern Italy in this period represented a fertile ground for the Normans, who started to set up their first settlements in this area of the peninsula (Nef 2011).

Consequently, more Normans came to Italy and through alliances, marriages and clever political strategies, they quickly developed from mercenaries to conquerors, and then rulers. Menfi (Basilicata, Italy) was chosen as their political and administrative centre (Piccinni 1999).

The Norman immigrants of the Hauteville were the most powerful family in southern Italy. After the Treaty of Melfi in AD 1059 with Pope Nicholas II, Robert Guiscard was nominated Duke of Apulia (although the dukedom also included the modern regions of Molise and Calabria). In AD 1061 Robert Guiscard and the youngest of his brothers, Roger Hauteville, started the conquest of Sicily. They first raided the cities of Messina and Rometta. In AD 1072 Roger conquered Palermo, proclaiming himself Count of Sicily, therefore splitting the Norman reign in two: Sicily and the rest of southern Italy. In this period, the Hauteville were supported by the pope, who saw in the Normans an opportunity to finally extort southern Italy from both the Byzantines and the Arabs (Nef 2011). At the same time, Arab Sicily was weakened by an unstable political situation. Different families were trying to establish independent emirates at Girgenti (modern Agrigento), Mazara del Vallo (Trapani) and Syracuse, fostering the social and economic fragmentation of the island. Due to a series of logistical problems, such as insurrections in Calabria and Apulia against Robert and Roger Hauteville, the conquest of Sicily was relatively slow and took about thirty years to be completed (Abulafia 1994; Weltecke 2011). Although the Muslim capital of the island was soon conquered, there were other important cities that remained in Arab hands. After the capitulation of Palermo, Castronovo succumbed in AD 1077; Syracuse in AD 1085, Castrogiovanni and Agrigento in AD 1087, and the final Muslim resistance in Noto was put down in AD 1091 (Boom and Higgs 2016).

During the invasion, many Muslims joined the Norman army due to their dissatisfaction with the political and economic situation created by the last Kalbid emir (D'Alessandro and Spinnato 2000). For this reason, Roger Hauteville found himself in a difficult position; he was Christian by faith, sponsored by the Pope, and he knew that the conquest would have been considered as a Christian expedition. However, Roger perfectly understood the need for inclusion of and tolerance towards the Arab Sicilian population. As a consequence of this open-minded political view, the conversion of Muslims to Christianity was not imposed; several mosques were left intact, while others (such as the main one in Palermo) were converted into churches. This does not mean that the Norman Conquest of Sicily was not cruel and violent; however, there were also some important efforts of conciliation among different cultures put in place by the Norman administrators (Metcalfe 2013).

After the Norman arrival, the island became mainly Roman in religion, Latin in language and west European in culture. However, it is important to highlight that all the above-mentioned changes did not occur all of a sudden, but rather as part of a gradual process of assimilation. If, on one hand, the Normans enforced several reforms that affected the Arab/Muslim society, on the other they preserved some of its original aspects. As an example, the Arab system of land division was partly maintained (to a point that some modern Sicilian terms for land units derive from Arabic words), and the first coins were struck with Cufic inscriptions (an Arab calligraphic style) using the same types of the previous khalifs (Nef 2011; Booms and Higgs 2016; Mandalá 2016) (Fig.1.3.1).

**Figure 1.3.1.** Gold coin (tari) dated to the time of Count Roger (Roger I, AD 1071-1101). The coin was probably minted in Messina or Palermo and it is similar to those of the Arab khalifs (from Booms and Higgs 2016).

After Roger I's death, his nine-year-old brother, Roger II, became the sole ruler of the island in AD 1112. Unfortunately, little is known about Roger's childhood. However, the literature reports that he grew up in various southern Italian courts surrounded by Greek and Arab tutors. Due to his right of inheritance, he started claiming territories in southern Italy, proclaiming himself 'Duke of Apulia, Calabria and Sicily'. As mentioned before, the pope had great interests in this part of the Italian peninsula and, as a result, he excommunicated Roger, fearing he could be a threat to his own authority. In AD 1128, Roger marched against the pope, who decided to surrender without fighting. Two years later, in AD 1130, Roger II unified the two Norman reigns and he proclaimed himself King of Sicily, Calabria and Puglia (Tramontana 2003) (Fig.1.3.2).

**Figure 1.3.2.** The Norman Kingdom of Sicily with indication of some places mentioned in the text (image created by the author from Booms and Higgs 2016).

In addition, Roger conquered also some areas of Ifrīqīya, founding the Norman Kingdom of Africa, and he maintained contacts with Fatimid Egypt. During his reign in Sicily, Muslims still represented the majority of the population; they made up the middle and the lower classes and their support was essential for the king. Palermo became a major centre for humanistic studies and scientific research, where scholars from all over the world and of different religions could share and develop their knowledge. Roger's kingdom managed to survive under his two successors, his son William I, and his grandson, William II. In AD 1194 the Kingdom of Sicily passed to Henry IV Hohenstaufen (King of Germany from AD 1190 and then, since AD 1191, Emperor of the Holy Roman Empire) and to his wife Constance of Hauteville (Abulafia 1994; Raffaele *et al.* 2015).

After the death of her husband, the Empress Constance brought her son Frederick to Sicily, where in May AD 1198 he was crowned king of Sicily. Before her death, Constance managed to loosen the bonds between Sicily and the Empire, by appointing Pope Innocent III as her son's guardian and regent of the Kingdom of Sicily. In Germany, the core of the Empire, two rival princes were elected, Frederick's uncle Philip of Swabia and Otto of Brunswick (Otto IV). Between AD 1198 and 1208, Palermo became a battleground between the supporters of the pope, who wanted to keep Sicily within his domains, those of Constance (and of her son Frederick), and other internal and external pretenders such as the Pisans and the Genoese. In the end, Frederick was crowned King of the Romans in AD 1212, and Holy Roman Emperor in AD 1220. From this point onwards, Frederick became known as Frederick II, and after five years from his coronation he also became King of Jerusalem (Tramontana 2003).

Frederick II considered Palermo the eventual capital of his Empire; indeed, here he constructed a monumental tomb in the Cathedral of Palermo, where in AD 1215 he buried his brother and his father alongside his grandfather Roger II. In this period, the intolerance (already started under the Norman domain) towards Muslim and Jewish communities increased, leading to expulsions and, in some cases, to forced conversions to Christianity. As the Norman kings did before, Frederick II encouraged the Latin translation of the classical literature that only survived in Greek and Arabic versions. Frederick II also developed a strong interest in astrology, and at the same time he pursued scientific research through his court and personal involvement. These interests lie at the base of his masterpiece, the '*De Arte Venandi cum Avibus*' ('*About the art of hunting with birds*'), a treatise on ornithology and falconry. When Frederick II died in 1250, the pope saw again the opportunity to get his hands on Sicily (Abulafia 1994; Toubert and Paravicini Bagliani 1998; Abulafia 2007).

In the end, Manfredi, an illegitimate son of Frederick II, was crowned King of Sicily in AD 1258 in Palermo. After that, a series of events culminating with the Sicilian Vespers in AD 1282 led to the coronation of Peter III, King of Aragon (Abulafia 2007).

# Chapter 2

# An overview of medieval Palermo

"[. . . ] *in Palermo the Byzantines left the perfect architectural model of their basilicas. The Arabs, aqueducts and mosques. The Normans their churches with domes [...] Palermo resembles an onion and, for this reason, you must consider the information gathered about the city as layers; you can decide to stop at the first one but, if you are a good traveller, you should go ahead and try to peel off some more layers until you reach the bulb* [. . . ]" (Alajmo 2013) (translated by the author from the original Italian version).

This chapter is dedicated to the main changes that occurred in Palermo during the Arab, and the Norman/Swabian domains; such review provides a useful background to the four analysed faunal assemblages recovered from the city (i.e. Corso dei Mille, Sant'Antonino, Castello San Pietro and the Norman Palace) (*§Chapter 4: Sites and material*). None of these sites is dated to the Byzantine period, therefore this historical period is only briefly mentioned. After a geographical and historical introduction to Palermo, the urban transformations underwent by the city from Arab to Norman/Swabian times are discussed, taking into consideration the available historical and archaeological sources.

As Gallina (2012) pointed out, an urban analysis of the structural and functional changes in the *forma urbis* of Palermo through history is important in order to understand the different roles that different areas of the city held trough time, as well as the social-demographic developments the city underwent in historical times. This holds particularly true for the Middle Ages, since at that time multiple ethnicities with different social and cultural backgrounds inhabited the city (Gallina 2012).

## 2.1. A geographical and historical introduction to Palermo

Palermo is the capital of the autonomous region of Sicily (Italy) and is located on the north-western coast of the island (Fig.2.1.1). It lies beside a sheltered harbour (La Cala) and is encircled by mountains facing the Tyrrhenian Sea; of these, Monte Pellegrino is the highest peak (606 metres a.s.l.). Until the mid-20th century, the city was surrounded by the well-known '*Conca d'Oro*' (Golden Basin), a fertile area with fields and plantations (Maurici 2015).

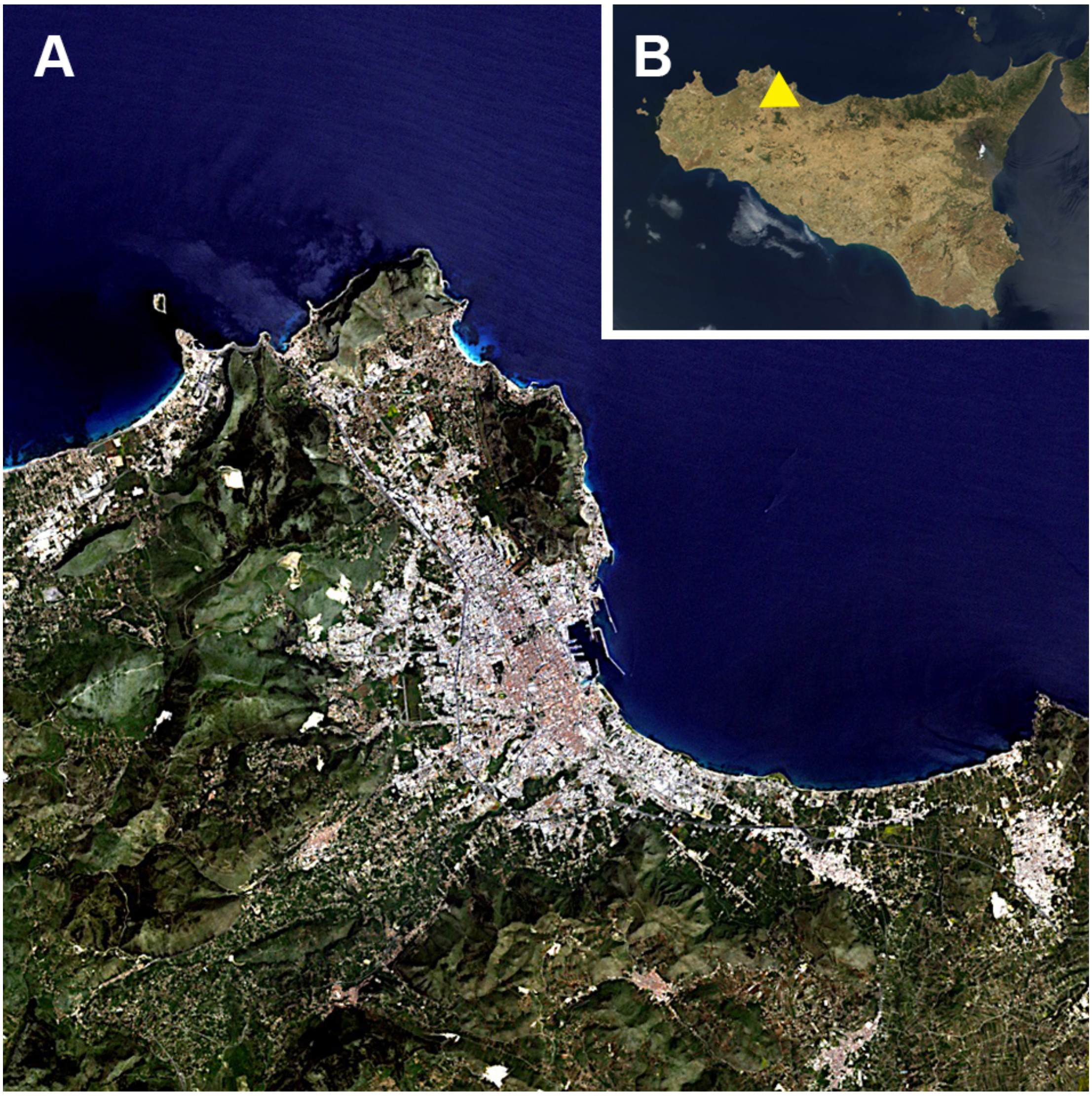

**Figure 2.1.1.** a) Satellite photo of the city of Palermo (from www.nasa.gov). b) Satellite photo of Sicily with Palermo indicated by a yellow triangle.

Apart from sporadic prehistoric sites, the Phoenicians were the first people to settle permanently in the area around the 7th century BC. Since the time of its foundation, two separate watercourses, the Papireto and the Kemonia, delimited the core of the settlement, which originally spread along a northeast-southwest axis. At that time, the topography of Palermo was that of a small peninsula surrounded by the rivers and the sea. For this reason, the Greek population called it $\Pi\acute{\alpha}\nu o\rho\mu o\varsigma$ (Panormos), literally translated as 'all harbour' (Spatafora 2005; Nef 2013). Later, the city became a Carthaginian settlement, until the Roman invasion in 254 BC. The final conquest of the island by the Romans (210 BC) led to the creation of the first Roman province. From this point onwards, Palermo was included by the Romans among the '*immunes ac liberae*' cities, which referred to large-sized settlements free from duties and with a certain degree of autonomy from Rome. During the early centuries of Roman occupation, Palermo was characterised by great economic prosperity. More generally, this economic vivacity characterised the so-called 'western triangle towns', which also included Termini, Carini and Lilibeo (Prigent 2013). Unfortunately, both from a historical and an archaeological point of view, little is known about Palermo in the latest years of the Roman Empire (Spatafora 2005).

In the 5th century AD, Palermo was invaded by the Vandals who, at the end of the same century, ceded Sicily to Odoacer and then to Theodoric (king of the Goths, AD 454-526). In AD 535, the Byzantine military troops led by Belisarius occupied the city, which was used as a military stronghold to conquer the rest of the island. During the Byzantine period, Palermo hosted the archbishop's residence, which highlights the important role of the city (Bonacasa Carra 2000). Like the late Roman Empire, this period is characterised by a dearth of archaeological evidence (Prigent 2013).

In AD 827, the Byzantines rule came to an end, when the troops of the Arab dynasty of the Aghlabids started invading Sicily. At the beginning of the 10th century AD, the Arab dynasty of the Fatimids and, later, the Khalbids, replaced the Aghlabids. This latter was a period of great prosperity for Palermo, which became one of the wealthiest and most populated cities in the Mediterranean. The 11th century AD, however, marked the beginning of a process of political destabilisation, which favoured the Norman conquest of the island (Vanoli 2012; Tramontana 2014).

In AD 1072 the Normans invaded Palermo, under the leadership of Robert Guiscard and his brother Roger I de Hauteville. The city was chosen as the capital of the new Christian kingdom. After having unified the dukedoms of Apulia and Sicily in AD 1130, Roger II maintained his court in Palermo (Vanoli 2012). The Norman dynasty came to an end in AD 1194, when Henry IV Hohenstaufen (husband of Constance de Hauteville, Roger II's daughter) was nominated successor to the Sicilian crown. Later, Frederick II (AD 1198-1250) was to be the greatest character of the Swabian period. During his reign, the city benefited greatly from sensible governance, which contributed to reinforce economic and cultural developments in the island. Frederick II held a rather ambiguous relation with the local Muslim (and Jewish) communities. If, on the one hand, because of his well-known interest in Islamic culture, he had frequent diplomatic and scholarly contacts with the Arabs, on the other, he also forced deportations of Muslim communities from Sicily to a new colony based in Lucera (Apulia, Italy) (Abulafia 2007). At the death of William II (AD 1153-1189), a decade before the coronation of Frederick II, the re-Christianisation of the island was almost complete, Muslims being still present in small isolated communities. In this period, the socio-political situation of Sicily became unstable, and several Muslim rebellions burst across the island. As a result, the deportation of Muslims was seen as an inevitable political decision to restore peace within the Sicilian kingdom (Abulafia 1994; Toubert and Paravicini Bagliani 1998; Tramontana 2003; Weltecke 2011). After Frederick II's death, the crown passed to his son, Manfred; in AD 1266, he was killed in Benevento by the Angevins, who took control of the island. Some years after this event, the so-called Sicilian Vespers (AD 1282) marked a period of revolt against the French dynasty. At the end of the 13th century AD, Peter III of Aragon took control of the island (Booms and Higgs 2016).

The history of Palermo has always represented an important topic for both historians and archaeologists (La Duca 2000). However, if the Norman/Swabian period (second ½ of the 11th-second ½ of the 13th centuries AD) has been thoroughly investigated by researchers, less attention has been paid to the previous centuries (6th-11th centuries AD). This is unfortunate, because only by looking at all the historical events affecting Palermo throughout the medieval period, it is possible to understand and correctly interpret the topographic and social developments of this Mediterranean city (Nef 2013). This holds particularly true when the Early Middle Ages are considered (i.e. when the Arabs started conquering the island). Indeed, during this latter period Palermo became the capital of the island, replacing Byzantine Syracuse (AD 831) (Vanoli 2012). Unfortunately, there are only limited contemporary documentary sources providing information on the urban characteristics of Palermo under the Arab domain. Furthermore, despite recent archaeological excavations carried out by the Soprintendenza dei Beni Culturali and Ambientali of Palermo (Spatafora 2005; Vassallo *et al.* 2016), the archaeological evidence is still insufficient to draw an exhaustive picture of Arab Palermo (D'Angelo and Zoric 2002). In particular, little is known about the 9th century AD, when Palermo was chosen as the seat of government of the Aghlabids (AD 831-909), and also about the first half of the 10th century AD, when the Fatimids replaced the Aghlabids. By contrast, a considerable amount of archaeological evidence dated to the following period (AD 948-1040) has shed light on the new urban organisation of Palermo. This has provided the rather biased impression that all the main topographic changes occurred during the government of the Khalbids, the last of the Arab dynasties (Bagnera 2013).

## 2.2. Palermo in the Aghlabid period

After landing in Mazara del Vallo in AD 827, the Ifrīqīyan troops moved towards Palermo and after four years (AD 831) they conquered the city (Vanoli 2012). *Balarm*, *Bulurm*, *Banarm*, other variants of *Panormus* (the Byzantine name of the city), *al-Madina* (the city) or *Siqiliyya* (Sicily) were the names used by the Aghlabids to refer to Palermo, the new seat of their government. However, it remains difficult to assess exactly when Palermo became the base of the new Arab emirate and the capital of Sicily (Bagnera 2013).

Information about this latter issue is reported in some Arab written sources[1]. However, most of these documents are dated to a later period (12th-14th centuries AD), and the majority state that Palermo became the capital of the *dar-al-Islam* immediately after the Arabs' arrival (9th-10th centuries AD). Sources dated to the end of the 10th century AD, such as those written by the chronicler Ibn Hawqal[2] (who visited Palermo around AD 973) and the geographer Al-Muqaddasi[3](who completed his geographical survey of Sicily in AD 988), inform us that during the Aghlabid period Palermo had already undergone some topographic changes that transformed the city from a marginal settlement into a political and administrative centre (De Simone 2000). However, in light of a rather slow and troubled Arab conquest, it seems more appropriate to envisage a gradual, rather than rapid,

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[1] Ali ibn al-Athir (AD 1160-1233) was an Arab historian. He is the author of the '*al-Kamil fit-Tarikh*' (The complete history) (AD 1231), an important book on Islamic history (Ali ibn al-Athir as cited in Nef 2013).

Ibn Idhari (late 13th-early 14th centuries AD) was an Arab historian. He is the author of a medieval text '*Al-Bayan al-Mughrib*' (AD 1312), which focuses on the history of Maghreb and Iberia. This opera is widely regarded among researchers as containing important information that cannot be found elsewhere, since most of the older works it relies on went lost (Ibn Idhari as cited in Nef 2013).

Ibn Khaldun (AD 1332-1406) was a North African historian. He is mainly famous for his work entitled '*Kitab al-Ibar*' (Book of Lessons), in which he describes the historical events behind the political rise of Arabs and Berbers in the Mediterranean (Ibn Khaldun as cited in Nef 2013).

[2] Ibn Hawqal (10th century AD) was an Arab geographer, chronicler and writer. He wrote an important book called '*Surat al-'Ard*' (The face of the Earth) (AD 977), in which he collected several information on his travels in Asia and Africa; his descriptions contain also detailed information of Spain and Sicily under the Arab rule (Ibn Hawqal as cited in Bagnera 2013).

transformation of Palermo into the centre of the new Arab government (Nef 2013; Boom and Higgs 2016).

Palermo was firstly chosen by the Arabs for its strategic position. The city was located at some distance from the eastern part of the island, which was still controlled by the Byzantines; at the same time, it was also not far from the front, which allowed the Arabs to conduct military operations in a more efficient way (Nef 2013). Once Palermo had been chosen as the political and military capital of the island, the Aghlabids established themselves within *Panormus*, the ancient Punic and then Romano-Byzantine fortified part of the city. The Arab written sources refer to this latter as *Balarm* or *Qasr al-qadim*, and later, during the Late Middle Ages, as Cassaro (Maurici 2015). From this point onwards, the Byzantine *Panormus* underwent several adaptations and modifications, in order to respond to the political requirements of its new role (Bagnera 2013).

The central axis of the city was called *simat* (Bagnera 2013). This was a street paved with flagstones, crossing the city from east to west; several shops were located on its sides (Nef 2013). Furthermore, according to the description of the monk Theodosius[4], who arrived in Palermo after the conquest of Syracuse in AD 878, the *simat* ran close to a great mosque (De Simone 2000). In Theodosius's letter, the city already appeared as a multi-cultural and densely populated city, in which the Arabs (and their followers) had already become well integrated with the local population. Furthermore, this document informs us that, during the Aghlabid period, the city had begun to extend beyond the ancient walled centre. Hence, considering the written sources, it seems that already in the 9th century AD Palermo had undergone some urban alterations and that peripheral suburbs were established (Bagnera 2013).

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[3] Al-Muqaddasi (AD 945/946-991) was an Arab geographer. He is the author of '*Ahsan at-Taqasim fi Ma'arifat Al-Aqalim*' (The best divisions in the knowledge of the Regions). This work is based on several years of personal experience travelling around the Arab territories, from the Atlantic to the Indian Ocean (Al-Muqaddasi as cited in Bagnera 2013).

[4] Theodosius (late 9th century AD) was a Greek monk who lived in Syracuse. He wrote a letter

Unfortunately, the above-mentioned topographic changes to the ancient Panormus are difficult to detect archaeologically. A lack of archaeological evidence also affects the identification of the *extra-moenia* suburbs supposedly established during this early phase of Arab Palermo's history. In addition to some archaeological structures discovered at Palazzo Bonagia and dated to the 9th-10th centuries AD, and some pottery fragments dated to an early Islamic phase and imported from North Africa found at the monastery of the Magione (Nef 2013; Sacco 2014), the most important finding is represented by the stratigraphic sequence of the archaeological excavation at Castello San Pietro. Here, archaeologists uncovered an Islamic cemetery that was probably in use during the 9th century AD; the exact extension of this site is still debated, and it is possible that other similar cemeteries were located along the seaside of the city (Di Stefano *et al.* 1989; Arcifa and Bagnera 2014).

Considered in its entirety, the archaeological evidence dated to the Aghlabid period is scarce in comparison to written texts, which still represent the most informative sources for the early Arab phase of Palermo.

To sum up, it appears that, during this first period of Arab occupation, Palermo had already undergone some structural modifications, although apparently limited to the ancient Byzantine fortified nucleus. The presence of *extra-moenia* occupation is sporadically documented, reinforcing the idea of a mainly '*intra-moenia*' early Arabic Palermo (Bagnera 2013; Maurici 2015).

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to Leo (an archdeacon of the Christian church) describing the Arab raids against Syracuse. Later, Theodosius was brought to Palermo as a slave and he described the city under the Arab rule. Researchers have used his work as an accurate source of information to reconstruct the *forma urbis* of Palermo in its early Arab phase (Theodosius as cited in Bagnera in Nef 2013).

## 2.3. Palermo in the Fatimid and Khalbid periods

After the arrival of the Shi'ite Fatimids (910 AD), Palermo underwent several important urban developments (Maurici 2015). The most relevant is represented by the foundation of the Khalisa (AD 937-938), the new fortified citadel. The Khalisa was located outside the ancient nucleus of Balarm; researchers have tentatively located it in an area close to the sea, near current Piazza Marina (Bagnera 2013; Nef 2013). This location, not yet fully supported by archaeological evidence, seems in line with the position indicated by the Arab historian Ali ibn al-Athir (AD 1160-1233), who located the Khalisa in the proximity of the city's harbour.

This new building was used as the seat of government of the new Fatimid administration. At that time, Palermo could have been described as 'a city of two cities', represented by the ancient fortified nucleus (Balarm) and the new detached centre of power (the Khalisa). After the foundation of the Khalisa, Balarm was partially deprived of its political and administrative role. Although this latter maintained its religious and social importance among the local population, its new functions were probably similar to those of typical urban Arab quarters, the so-called *harat-s*, characterised by the presence of markets, dwellings and mosques (Bagnera 2013).

The construction of the Khalisa needs to be analysed in light of a new approach to urban topography which characterised all the Fatimid capitals, such as Mahdiyya (AD 921) and Sabra al-Mansuriyya (AD 945) in Tunisia, and Cairo (AD 969) in Egypt. This new 'urban trend' reflects a deliberate policy, which aimed to enhance the socio-religious distinctions in Palermo between the Sunni elite (previously represented by the Aghlabid dynasty) and the new ruling class that was predominantly Shi'ite. Before the advent of the Khalbids, the foundation of the Khalisa represented without any doubt an important event for the city, which would have influenced its topographic organisation in the following period (Maurici 2015).

In addition to the Khalisa, a new area with specific military functions was established next to Balarm. The chronicler Ibn Hawqal (10th century AD) informs us about the existence of the Mu'askar (military encampment), which was located in the western part of the ancient fortified nucleus, in a fertile area surrounded by water and plantations. Archaeologists agree that this area was located just outside the modern Porta Nuova, although archaeological evidence is still lacking (Bagnera 2013).

During the Khalbid dynasty (second ½ of the 10th-first ½ of the 11th centuries AD), Palermo was radically transformed into a polynuclear city. The works by Ibn Hawqal in AD 973 and Al-Muqaddasi in AD 985 represent the best and most reliable written sources for Palermo in this period. In addition, important topographic information for Palermo and Sicily during the 11th century AD can be found in the '*Kitab Gharaib al-funun wa-mulah al-uyun*' (The Book of Curiosity, chapter 12), a contemporary Arabic manuscript (Johns 2004).

According to these historical sources, it appears that Palermo was divided into five districts (Fig.2.3.1). In the centre of the city the ancient fortified nucleus of Balarm (*'al qasr*) was still present, and was characterised by the presence of nine doors. In addition, the ancient fortification was surrounded by four suburbs, as listed below:

- the *'al halisah* (l'Eletta); this was the administrative centre and the Caliph's residence. This quarter was surrounded by a high timber wall with four main doors;

- the three *Harat-s*; these were larger quarters without walls and characterised by the presence of markets, dwellings, mosques, baths etc.:

- the *Harat 'as saqalibah* (Quarter of the Slaves). This quarter was the most populated area;

- the *Harat 'al masgid Ibn Saqlab* (Quarter of the mosque of Ibn Saqlab). This area was characterised by the presence of mills, as well as vegetable and ornamental gardens;

- the *Harat ‘al gadidah* (the New Quarter). This was a small section of the city located close to the Quarter of the mosque.

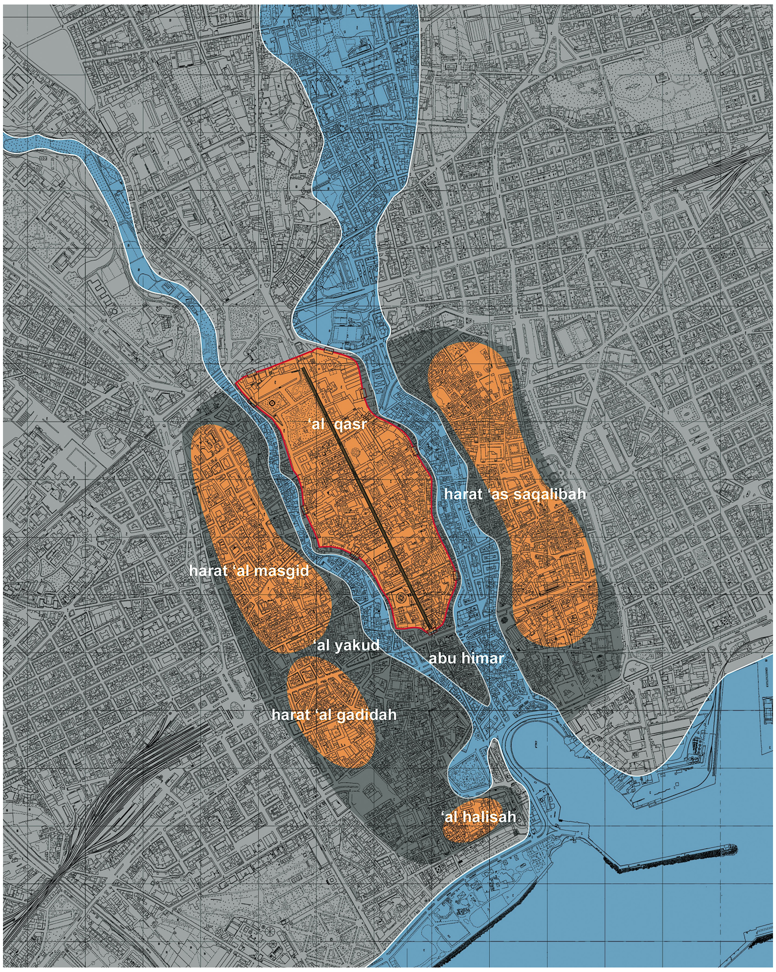

**Figure 2.3.1.** Map of Palermo during the Arab period with indication of the various quarters (orange areas) and of the simat (black line) according to the description of Ibn Hawqal (from Spatafora 2015).

The role of the *simat* as the main artery of trade and exchange increased, and two bridges were built at its extremities. The majority of the markets were situated between the Quarter of the mosque and the New quarter. Ibn Hawqal informs us about the presence of pharmacies, oil and grain shops, coppersmiths, cobblers etc. Several shops were also located within the ancient city of Balarm, and more than one hundred and fifty of them belonged to butchers (Nef 2013).

Archaeological evidence dated to the Khalbid period are particularly abundant in Palermo. Although we know little about the Khalisa and the structural modifications underwent by the ancient fortified area (Balarm), there is abundant archaeological evidence attesting the existence of *extra moenia* suburbs.

More specifically, the archaeology currently indicates the presence of well organised hydraulic and food storage systems. Some of these were uncovered in the area of the Archaeological Museum of Palermo and at San Domenico, where several silos and wells were discovered. An Islamic settlement was discovered by the monastery of the Magione (Nef 2013). In the same area, additional archaeological remains have been discovered during recent excavations carried out by the Soprintendenza dei Beni Archeologici e Ambientali of Palermo at Sant'Antonino (Aleo Nero 2015) and Corso dei Mille (Battaglia *et al.* 2016) (*§Chapter 4: Sites and material*). Concerning the latter site, large amounts of by-products (goat horns and metal slags) were found during the excavation, indicating the presence of craft activities. Similar archaeological finds were also recovered from Palazzo Bonagia, located in the Khalisa quarter (Tisseyre 1997).

To summarise, Palermo was conquered by the Arabs during the first ½ of the 9th century AD and, although written sources seem to indicate a sudden Islamisation of the city straight after the conquest, it seems more reasonable to suggest a more gradual process of transformation, culminating in the Khalbid period with a complete adaptation of the city to Islamic standards.

## 2.4. Palermo in the Norman/Swabian period

Since the late 1980s, the topography of Palermo from the Arab to the Norman/Swabian period has been stimulated much interest. Architectural studies of Norman/Swabian buildings and archaeological surveys have proliferated, providing an important insight into the urban organisation of the city in this period (D'Angelo and Zoric 2002; Spatafora 2005; Andaloro 2011; Di Liberto 2013; Pezzini 2013; Nef and Ardizzone 2014). Moreover, a series of civilian and religious structures and infrastructures dated to the Norman period (AD 1130-1198) and located in Palermo, Monreale and Cefalù have been recently included in the UNESCO World Heritage List (for further information see http://www.whc.unesco.org/en/list/1487).

A brief description of the developments undergone by Palermo under the Norman/Swabian period is provided below.

Until the early 1040s AD, the Khalbids administered Palermo, which at that time was the capital of Sicily (a province of the *dar-al-Islam*). The end of this Arab dynasty was followed by a deep political and economic crisis, leading to fragmentation into smaller territorial units which came under the control of local military leaders. This scenario inevitably led to a severe political instability for the whole island (Vanoli 2012). In the second ½ of the 11th century AD, such unstable political and economic conditions favoured the Norman invasion (AD 1061). After a long siege, in AD 1071, the Normans Robert Guiscard and Roger Hauteville conquered Palermo (Booms and Higgs 2016).

As far as the *forma urbis* of Palermo in the early Norman period is concerned, the city still appeared as an Arab polynuclear centre, characterised by different quarters which were organised hierarchically (Pezzini 2013). At that time, Palermo was a multicultural city: several communities of diverse cultural and religious backgrounds inhabited the urban centre (mainly Christians, Muslims and Jewish) (Bresc 1981; Abulafia 1994). Unfortunately, the early Norman phase in Palermo has produced no documentary sources nor surviving buildings, with very few exceptions (Pezzini 2013). According to the few available historical sources[5], it seems that the earliest Norman urban transformation of Palermo should be attributed to Robert Guiscard (AD 1020-1085). Such urban interventions aimed to provide a physical expression to the new rulers, as well as to reinforce military control over the city. The first architectural modification refers to the re-conversion of the ancient Byzantine basilica (which had become a mosque in the Arab period) into a Christian cathedral (Amato di Montecassino and Guglielmo di Puglia as cited in Pezzini 2013). This latter structural change was strategically designed to affirm the predominance of Christianity over Islam. At the same time, the new conquerors started consolidating their military control over the city. The chronicler 'Anonimo Vaticano' (late 11th-mid-12th centuries AD), in his opera '*Historia Sicula ab ingressu Normannorum in Apulia usque ad annum 1282*', informs us about the presence of two new fortified structures. These were the *castrum superior* or *novum* (which will be later known as the Norman Palace, the residence of Roger II), located on the highest part of the city, and the *castrum vetus*, a fortified structure located close to the harbour (Anonimo Vaticano as cited in Pezzini 2013). From this information, it appears that the new conquerors settled in the peripheral areas of the city.

Unfortunately, little is known about the social and cultural impact of the

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[5] Amato di Montecassino (11th century AD) was a historian. His opera '*Historia Normannorum*' (AD 1080) was one of the earliest descriptions of the Norman conquest of southern Italy. His original work was lost and all the information he reported are based on a later French version of the opera '*Ystoire de li Normant*' (Paris, National Library) (Amato di Montecassino as cited in Pezzini 2013).

Goffredo Malaterra (11th century AD) was a Benedictine monk and a historian. His opera '*De Rebus Gestis Rogerii Calabriae et Siciliae Comitis et Roberti Guiscardi Ducis fratris eius*'focuses on the history of the Normans in Italy, with special regards to the military campaigns undertaken by Robert Guiscard and Roger I of Sicily (Goffredo Malaterra as cited in Pezzini 2013).

Guglielmo di Puglia (11th century AD) was a chronicler. His opera '*Gesta Roberti Wiscardi*'(AD 1095- 1099) consisted of five books written in hexameters (Guglielmo di Puglia as cited in Pezzini 2013).

'Anonimo Vaticano'(13th century AD) was a historian; he wrote the '*Historia Sicula ab ingressu Normannorum in Apulia usque ad annum 1282*'(AD 1285) (Anonimo Vaticano as cited in Pezzini 2013).

Normans on the local inhabitants. It is reasonable to assume that, already in this early phase, the Muslim elite had moved elsewhere (Sciascia 1993; Pezzini 2013).

The city started to attract merchants from different parts of Italy, such as the Amalfitans, Venetians, Genoese, and Pisans (Bresc 1981). As Amari (1854) pointed out, it can safely be affirmed that during the early Norman phase the city of Palermo did not appear much different from that of the Arab period, despite a few urban alterations (mostly affecting military installations).

However, important changes in the urban fabric of the city occurred after AD 1122, when Palermo became the capital of a kingdom extending from southern Italy to Sicily, under the control of Roger II. During this period, the city underwent several changes that transformed it into the residence of the Norman court, around which a multitude of intellectuals of different social origins (e.g. Latins, Arabs and Greeks) gravitated (Pezzini 2013).

In particular, around AD 1140, the *castrum superior* was transformed into the *sacrum palacium* (the Norman Palace), a majestic building surrounded by gardens, still partly surviving (Bresc 1972; Andaloro 2011; Longo 2011). During the reign of Roger II (AD 1130-1154), other important buildings were constructed in Palermo (Di Liberto 2013); a brief list of the most remarkable ones is provided below:

- the Palatine Chapel. The church is dedicated to Saint Peter and is one of the most important artistic expressions of power of the Hauteville. Here, Roger was probably crowned king of Sicily in AD 1130. Unfortunately, it is impossible to chronologically assess the foundation of the church, although there is some evidence supporting the existence of a previous building dated to the beginning of the 12th century AD (D'Angelo and Zoric 2002; Dittelbach 2011);

- San Giovanni degli Eremiti. The monastery is located close to the Norman Palace and it was built under Roger II. Along with S. Maria Maddalena (AD 1184-1186), San Giovanni dei Lebbrosi (AD 1071), Santo Spirito o dei

Vespri (AD 1172-1178) and the SS. Trinità or the Magione (AD 1169-1174), this building represents an exemplary expression of Norman architecture in Palermo (Torregrossa 2013);

- Santa Maria dell'Ammiraglio or Martorana. This was the private chapel of George Antioch, the first minister of Roger II from AD 1126 (Longo 2014);
- Favara or Maredolce. This building, along with the Zisa (built under William I around AD 1165 and concluded later, under William II) and the Cuba (built under William II in AD 1180) is one of the so-called Arabo-Norman buildings. It is important to highlight that such definition does not suggest an Arab origin of these buildings, since all of them are dated to the Norman period. However, the architectonical schemes in vogue during the Norman period in Sicily clearly recall Arabic architecture. The name of Favara derives from a spring (*fawwara*), located close to the building. The site was one of the '*solatii regi*' of Roger II (Canzonieri and Vassallo 2014; Barbera *et al.* 2015).

All these urban developments need to be considered in the light of a *promotio* regia carried out by Roger II, which aimed to reinforce and legitimate his power and that of his dynasty (Pezzini 2013).

Useful information on new building projects developed during the later Norman period can be found in written sources[6]. Indeed, the period spanning from Roger II to the beginning of the Swabian phase benefits from a large number of written descriptions and representations of medieval Palermo (Pezzini 2013).

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[6] Al-Idrisi (AD 1100-1165) was an Arab geographer who lived in Palermo under Roger II. His opera '*Entertainment for those wanting to discover the world*' was generally known as '*The Book of Roger*' (Arabic: *Kitab Rujar*), and its maps as the '*Tabula Rogeriana*'. This opera represents one of the most accurate cartographic work and richest source of geographical information produced during the Middle Ages (Pezzini 2012, 210) (Al-Idrisi as cited in Pezzini 2013).

Ibn Jubayr (AD 1145-1217) was a geographer and poet from Al-Andalus (modern Andalucia, in southern Iberia). His opera, the '*Rihla*' ('*Travels*'), is a description of the pilgrimage he made

The *Book of Roger* (AD 1154), written by the geographer and chronicler Al-Idrisi (AD 1100-1165), represents one of the most useful historical sources about the new topography of Palermo (Nef and Prigent 2010).

According to Al-Idrisi's work, the previous Arab urban organisation of the city, as described by Ibn Hawqal in the 10th century AD, seems to have disappeared. Rather, the city is now divided into two main areas: the Cassaro and the Rabad (the suburb). This latter is perceived by the author as a single extensive area with scattered settlements. Several shops, houses, and markets characterised this part of the city, which was also surrounded by a wall. Indeed, until the 10th century AD, the defensive system of the city was limited to the walls surrounding '*Panormus*', the ancient Phoenician-Punic urban nucleus. Through history, this fortification had been repeatedly modified, until being partly dismantled at the beginning of the 10th century AD. In his work, Al-Idrisi informs us about the construction of a new and complex wall fortification system during the kingdom of Roger II; as mentioned before, this new defensive construction enclosed the entire urban area, which at the time included the Cassaro, the Arab Halisah quarter, and the suburb (Pezzini 1998).

Furthermore, Al-Idrisi reports that, in the 1130s, a new fortified area named '*Galka*' was established (its name probably derives from the Arabic word '*ghalqa*', which means 'enclosed place'). Although this has not yet been uncovered by archaeological investigations, there is no doubt that this new organisation of the city considerably altered the previous Arab urban fabric (Pezzini 2013). As Bresc (1989) pointed out, the construction of the Galka should not be considered a

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to Makkah in AD 1183-1185, in the years preceding the Third Crusade (Ibn Jubayr as cited in Cassarino 2013).

Peter of Eboli (AD 1150-1220) was an Italian chronicler and poet who lived under the Swabians. The writer dedicated an opera to Henry IV Hohenstaufen (AD 1165-1197), the '*Liber ad honorem Augusti*', in which he celebrates the conquest of Sicily by the 'Emperor' (Peter of Eboli as cited in Pezzini 2013).

Ibn Qalaqis (AD 1137-1172) was an Arab poet, who visited Sicily around AD 1168-1169. In his opera, the '*Zahr*' ('*Flower*'), he provides important and detailed descriptions of the island under the Norman rule (Ibn Qalaqis as cited in De Simone 1999).

Norman architectural innovation, as its descriptions rather remind us of a building that was already present in Arab Palermo: the Khalisa (see above). Similarly to this latter, the Galka was a royal citadel with a remarkable concentration of symbolic elements, such as churches and a palace (Bresc 1989). From the 12th century AD onwards, the Arab Khalisa lost its original functions and was absorbed within the Rabad. For this reason, Al-Idrisi refers to the Khalisa as the 'old city', while the Cassaro and the Galka were part of the 'new city'.

At the time of its construction, the Galka included the royal palace and some additional annexes (such as the Sala Verde and the Palace of the Slaves). Inside the Galka, with time, several religious buildings were erected, along with the residences of the Christian elite and of the canons of the Cappella Palatina. Outside the Galka, the area of the city more affected by the Normans was the Cassaro, where the members of the military aristocracy, as well as of the Greek and Latin clergy, had their own residences; in this area, the cathedral was connected to the Norman Palace by a road called *Via Coperta*.

It seems that, in this later phase, the Norman elite settled along the wall of the Cassaro, in order to have a better control over the city (Pezzini 2013). During the Arab period, several mosques had been built in this part of the urban centre; written sources attest that some of them survived into the Norman period, while others (especially those connected with private houses) were transformed into Christian churches (Pezzini 2013). The Cassaro was divided into three main quarters, in which bazars and taverns were side-by-side with sumptuous residential houses. Besides attesting a prosperous economic situation, the description given by Al-Idrisi highlights a close correlation between residential and commercial activities, which reminds us of the typical urban structure of other Arab cities (Scarlata 2004).

Another important Norman quarter in Palermo was that of the Seralcadi located on the northern side of the Cassaro. This latter area was close to the Papireto River and was crossed by a road called '*Platea publica Seralcadi*'. This area was important for the tannery industry: here was located the *Conceria*, which included storages for tanning materials (for example myrtle leaves), as well as for the leather itself (D'Angelo 2002). On the southern part of the Cassaro there was the quarter of the Albergaria, which was crossed by the *Platea magna Albergaria.* On the south-western extremity of this latter quarter was located the church of San Giovanni degli Eremiti, around which potters had their shops (Arcifa 1996) (Fig.2.4.1).

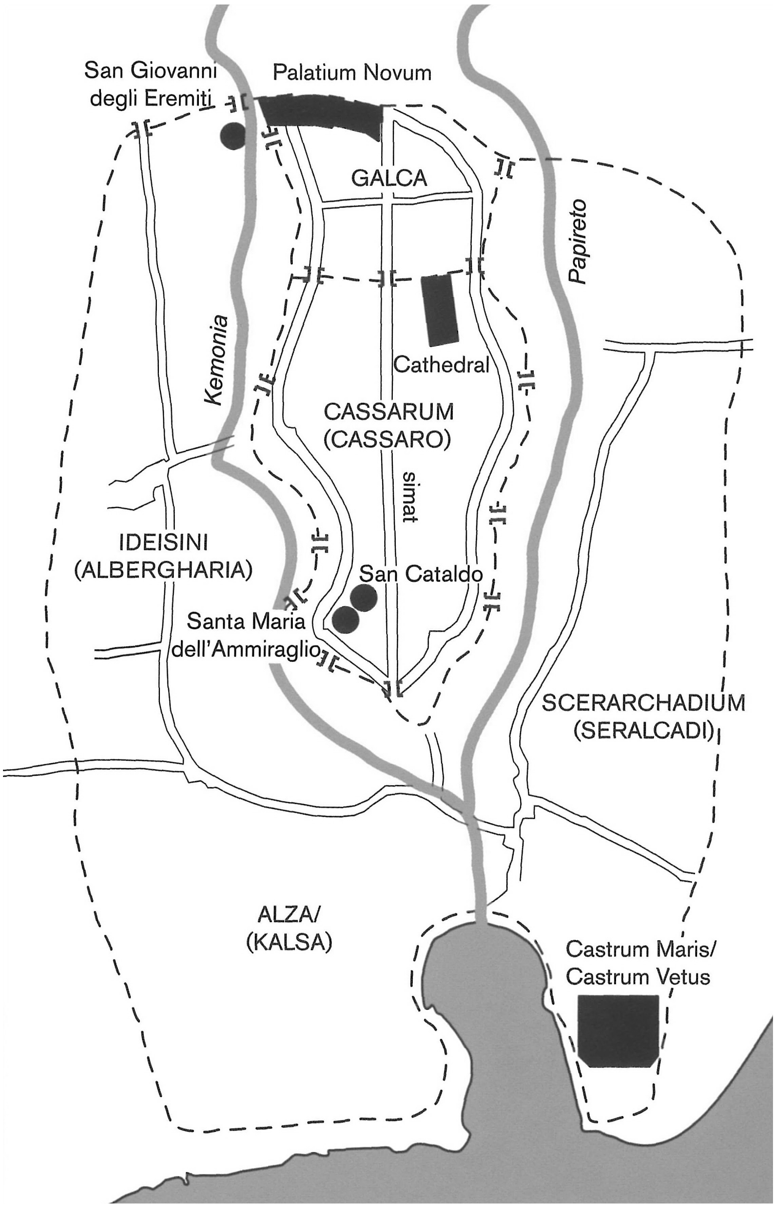

**Figure 2.4.1.** The picture shows the topography of Palermo under the Normans. Some of the churches mentioned in the text, such as San Cataldo, San Giovanni degli Eremiti and Santa Maria dell'Ammiraglio, are indicated along with the different quarters in which Palermo was divided (Cassaro, Galka, Kalsa, Seralcadi and the Albergaria) (from Booms and Higgs 2016).

Approximately 30 years after Al-Idrisi wrote his book, another Arab traveller native of Spain, Ibn Jubayr, visited Palermo (c. AD 1183). In his work, the chronicler informs us about similarities between the northern coast of Sicily and Spain. The syncretism highlighted by the Arab chronicler finds its highest expression when the city of Palermo is compared, from an architectural point of view, to Cordoba (Mandalà 2012). In Cordoba, in the 8th century AD, a new fortified area called the Alcazar (from the Arab '*qasr*', palace, from which the term Cassaro as well derives) was built. This latter incorporated the ancient Visigothic castle, which had been the political and administrative centre of the city (Murillo Redondo 2013). This urban reorganisation recalls what happened with the Cassaro and the Galka in Palermo.

In conclusion, as the Norman and the Swabian conquests proceeded and Palermo was chosen as the capital of Sicily, important urban alterations affected the topography of the city. Especially in the late Norman/early Swabian period, Palermo underwent several urban changes and, at the same time, disputes between Christians and Muslims culminated in social and cultural segregations. Consequently, it does not come as a surprise that, in the early Swabian period, the Christians settled close to the fortified areas, creating in this way culturally homogeneous neighbourhoods. As part of this process, the Muslims were expelled from the Cassaro and mostly confined to the Seralcadi quarter. However, it is reasonable to assume that, although a large proportion of the Muslim population was converted to Christianity, Islamic culture continued to influence the Norman/Swabian elite (Pezzini 2013).

# Chapter 3

# The archaeology of food and social identity

This section is presented in support of the archaeological questions underpinning this research project (*§Introduction*), as well as the interpretation of the zooarchaeological results (*§Chapter 6: Results*).

A brief introduction on the socio-cultural values of food in human societies will be followed by a description of different approaches adopted for the study of food. Furthermore, considering the different populations that inhabited Sicily during the analysed period (6th-second ½ of the 13th centuries AD), and the different religions to which they were devoted (Christianity, Islam and Judaism), a sub-chapter has been dedicated to the so-called ‘food taboos’, and to the possibilities of detecting them in the archaeological record. Two sub-chapters dedicated to Islamic and Judaic dietary laws follow, with a special section focusing on the origin of the exclusion of pork from the diet. The chapter ends with a section on Christian dietary laws.

## 3.1. The socio-cultural value of food and its study in archaeology

Food consists of nutrients supporting body growth and providing energy for metabolism (Twiss 2007). However, apart from its nutritional value, humans use food as a visible expression of the social and cultural background to which they belong (Montanari 2002; 2004). From this assumption derives the well-known and widespread saying "*you are what you eat*". This sentence was inspired by two earlier quotes: the first written by the lawyer Anthelme Brillat-Savarin (1755-1826) and the second by the German philosopher and anthropologist Ludwig Feuerbach (1804-1872):

"*Dis-moi ce que tu manges, je te dirai ce que tu es* [...]" (Anthelme Brillat-Savarin 1826, Aphorism IV, 26).

"*Tell me what you eat and I will tell you who you are* [. . . ]" (Translated by the author from the original French version).

"*Der mensch ist was er isst* [. . . ]" (Ludwig Feuerbach 1862, 26).

"*Man is what he eats* [. . . ]" (Translated by the author from the original German version).

What these authors suggest is that, if on the one hand food has important effects on humans' well-being, on the other it is not only a matter of calories, but it also represents a powerful symbol of human identity. The intake of food implies the expression of specific cultural behaviours, as specific products will bear a symbolic value (Twiss 2012). Food represents "*embodied material culture*" (Dietler 2006): as people habitually eats a specific type of food, this becomes part of their cultural roots. On this basis, and assuming that choices are available, it follows that humans symbolically consume and create identity through what they consume and avoid.

Moving away from a purely individual perspective, foodways have also the potential to work as important social discriminators among different populations (Montanari 1994). Several cultures (especially the principal world religions) have established a number of boundaries through the avoidance of certain food products, thus distinguishing themselves from others (Simoons 1994).

Food habits are also used to build intra-societal differentiations; the acquisition, preparation and consumption of food can be specific to some individuals within the same community, based on age, gender, social status and/or economic affluence. Therefore, at both inter- and intra- social levels, food can be used to mark and create relations of equality, intimacy and solidarity, or emphasise closeness as well as distance between groups and/or individuals (Mintz and Du Bois 2002).

The study of the social meaning of food and eating has a long history in anthropology (e.g. Mallery 1888; Smith 1889; Cushing 1920; Lévi-Strauss 1965; Douglas 1966), and has been important among archaeologists in the past few decades (e.g. Twiss 2012).

In the 70s, in the early years of the New Archaeology approach, the archaeological literature on food was oriented toward a nutritional and evolutionary approach (Binford 1964; 1965; 1983). This approach was inspired by nutritional science, which interprets food in terms of human's health and body growth (Winterhalder 1981; Keene 1985). Processual archaeologists approached the study of food mainly in light of human behavioural adaptation to a particular environment. For this reason, the majority of archaeological studies focused on the analysis of the different ways in which ancient communities acquired the primary nutritional sources that favoured their survival and development (Twiss 2007).

Since the 1980s, post-processual archaeologists started raising several critiques against the New Archaeology approach to food studies (Mintz and Du Bois 2002).

While the ecological approach remained an important element of archaeological studies on food, post-processualists developed a new perspective (Sherratt 1991). They raised the point that too many non-biological aspects of food were ignored in previous studies, and that food represented not only a mere nutritional resource, but also an integral component of human's cultural and social background (Hayden and Dietler 1996; Hamilakis 1999).

As a result, archaeological studies on foodways started adopting a broader approach, which aimed to analyse to what extent dietary practices intersected with different aspects of the socio-cultural background of societies, such as ethnicity, gender, status and religion.

Considering most of current archaeological studies on food, it appears that socio-cultural diversities have now become a key theme, with scholars investigating the modalities in which production, cooking and eating can reflect differences and/or similarities in past human cultures (Samuel 1996).

The fundamental assumption of these modern studies relies on this simple equation:

"*different food and/or diets = different ethnic and/or social groups*" (Twiss 2012).

However, this basic equation could be influenced by multiple factors, such as group and/or individual different strategies of food manipulation, available resources, politics, religion, gender and, of course, diachronic changes. At the same time, it is important to consider that differences in dietary practices may also reflect, to some extent, environmental change (Baroni *et al.* 2007).

Nowadays, in order to tackle such complex social variations, archaeologists adopt a wide range of different methodologies to approach the study of food remains (Metheny and Beaudry 2015); among these, zooarchaeology is a central one.

Although often highly fragmented and damaged, animal bones and teeth recovered from archaeological excavations provide a reliable insight on food production and consumption in past communities, as animals (wild and domestic) have always been of primary importance for humans. This remains valid also in modern times, in which the high demand for animal products has caused the exponential growth of intensive breeding. In addition to their food value, animals were also used in agricultural works, transport, craft activities, religion (e.g. ritual sacrifices), and as companions. In addition to provide the (zoo)archaeologist with precious insights into these aspects of human life, some animals can also be used to reconstruct past environmental conditions, and what role these might have had in shaping choices of food production (Reitz and Wing 2008). In sum, zooarchaeology bears great potentials for the investigation of the intertwined relation between food and social diversity (Crabtree 1990; Russell 2012; Sapir-Hen at al. 2014; Albarella 2017).

To conclude, the 'archaeology of food and social identity' is a broad and challenging research field, which is increasingly becoming of interest among archaeologists (Carroll 2005; Woolgar *et al.* 2006; Baker 2009; Fowles 2008; Insoll 2011; Hastorf 2017). Eating and drinking, especially in ancient populations, did not only represent mere instruments for biological sustenance. Rather, dietary habits were essential in the articulation of different cultural identities and social relations (Pitts 2015).

In more recent times, the archaeological investigation of the socio-cultural background of past societies has paid much attention to the study of food remains, and different methodologies have been developed through time to address such issue. Taking into consideration the topic of this research project and the chosen methodology, it is important to underline that the study of faunal remains has the potentials to shed light on how different communities in medieval Sicily produced and consumed their food, thus offering important insights into their diverse socio-cultural expressions.

## 3.2. Food taboos and their study in archaeology

Before addressing the details of potential dietary taboos characterising the populations settled in Sicily from the 7th to the second ½ of the 13th centuries AD, it is necessary to understand better the meaning of the word 'taboo', along with its impact on ancient and modern human societies.

The word 'taboo' was firstly introduced into the European world by James Cook (1728-1779 AD) in the 18th century AD, after he visited Polynesia in his third voyage around the world. During his travel, the British explorer analysed the modalities in which the word 'taboo' ('tapu' in Polynesian) was used among the Polynesian population, and he observed that this concept was always linked with the avoidance of specific things or behaviours. More specifically, he stated:

> "*This prohibition was always laid on them after they had assisted at any funeral, or touched a dead body, and also on other occasions. It is necessary to observe that, on these occasions, they apply the word taboo indifferently both to persons and things* [...]. *This word is also used to express anything sacred, or eminent or devoted*" (Cook in Steiner 1967).

From that point on, the word 'taboo' rapidly came into use among Europeans, and became a major study subject in anthropology and ethnography. From the late 19th century until modern times, studies on the meaning and the origin of the concept of taboo have multiplied (Milner 2011).

James Frazer, a Scottish anthropologist, was one of the first researchers who attempted to analyse the origin of taboos. In his essay, which was published in 1875 in the *Encyclopaedia Britannica*, the anthropologist explained that taboos were present only in those human societies that were still trapped in the so-called 'Age of Magic', a primordial stage of religion. According to Frazer, the premises, upon which 'magic' and taboos rely, are primitive, and they derive from an incorrect interpretation of the main concepts of holiness and uncleanliness (Frazer 1890).

A few years later, Robertson Smith (1889) made a clear distinction between religious and non-religious behaviours, using the term 'taboo' to describe these latter. He also stated that religious behaviours were intelligible, while taboos were primordial and typical of savages, as Frazer had previously affirmed (Douglas 1966). From these early studies, it is clear that the concept of taboo was considered to be a specific feature of underdeveloped societies.

Since the 1920s, new studies on taboos proliferated. Among them, the lectures in Social Anthropology at the University of Oxford (United Kingdom) given by the anthropologists Radcliffe-Brown (2014) and Franz Steiner (1967), represented important reviews of all previous studies on the topic.

Radcliffe-Brown criticised previous research, affirming that taboos were and are present in all human societies, and play a major role in them. He also claimed that human societies can only exist if people share some of the same social values, including taboos.

From this point on, the concept of taboo in anthropology was no longer associated with primitive cultures, but it was rather seen as representing the essential base for the definition and development of a society. Radcliffe-Brown (2014) also realised that the original Polynesian concept of taboo had a different meaning from the European interpretation of the word. The Polynesian word referred to a ritual/religious prohibition that always results in an "*undesirable change of ritual status*" (Radcliffe-Brown 2014) of the person who failed to follow the rule. People who have broken a taboo are considered to be ill and/or a danger to themselves as well as the community to which they belong. To purify their souls and restore their former ritual status, the sinners are requested to go through a specific ritual (Radcliffe-Brown 2014).

In western societies a taboo may also operate in a non-religious context. An example is represented by spilling salt, considered as a sign of bad luck, without affecting the religious status of the guilty party. Therefore, the European translation of the Polynesian word 'tapu' makes a distinction between those tabooed behaviours connected with the religious sphere, which are regarded as 'sacred', and those considered as non-religious, which are merely 'prohibited'. However, according to Radcliffe-Brown (2014) this double use of the concept of taboo is the consequence of a misinterpretation of the original concept.

Steiner (1967) took Radcliffe-Brown's ideas further to suggest that a universal definition of the word 'taboo' is unfeasible.

To circumvent the potential difficulties associated with the term, in this dissertation, for the sake of clarity, the definition of 'taboo' provided by the Oxford English Dictionary (2017) is adopted:

> "*A social or religious custom prohibiting or restricting a particular practice or forbidding association with a particular person, place, or thing*" (Oxford English Dictionary 2017).

If, on the one hand, the concept of taboo is one of the most discussed topics in anthropology, on the other, it still does not receive the attention it deserves in archaeological studies. This is most likely the consequence of the fact that a taboo may not leave visible traces in the archaeological record. For instance, the Polynesian prohibition of women and men eating together, the touching of dead bodies and the denied access for women to sacred places can be very difficult to detect archaeologically (Fowles 2008; Milner 2011).

However, one class of archaeological material is strictly connected with specific taboos, and bears great potential for archaeological studies - food remains. The prohibition against eating specific foods was and remains very common (Meyer-Rochow 2009).

Food taboos can be divided into 'temporary food taboos' and 'permanent food taboos'. The former tend to apply to selected human groups, such as women, during a specific moment of their life cycle (e.g. during pregnancy, menstruation, lactation periods), while the latter refer to food avoidances that are permanently in place for all. In addition, the strictness of a dietary taboo can be variable, ranging from the suggestion to avoid specific food products to food rules that needed to be strictly adhered to. Since permanent dietary taboos are more strictly and widely applied, they are also more easily visible in the archaeological record (Russell 2010).

Vegetables can be subjected to taboo, but meat products are more frequently prohibited. Such prohibitions may range from killing an animal, to touching it, consuming specific parts or eating its meat in general (Fessler and Navarrete 2003).

With the mixed socio-cultural backgrounds characterising Sicily during the Middle Ages, it is worth analysing to what extent different religions could have influenced food practices. Islam and Judaism are characterised by some permanent dietary taboos, and it is therefore reasonable to expect the absence of prohibited animals (for instance pig) in the analysed faunal remains, as well as traces of traditional butchery practices (e.g. the Jewish ritual slaughtering-*Shechita*) on the bones.

Although it is not always clear why specific animal foods have been prohibited, information about what is tabooed, along with the prescribed methods of animal slaughtering, can be found in religious texts. This evidence can be used by archaeologists to detect the presence of different traditions of food production and consumption (Milner 2011). However, the composition of an animal assemblage is not always the direct result of the culture which produced it. For this reason, before attempting any interpretations, some precautions need to be taken, and taphonomic processes analysed carefully (Klein and Cruz-Uribe 1984; Davis 1987; Lyman 1994).

## 3.3. Food taboos in Islam

Nowadays Islam is the second largest religion in the world, after Christianity. This faith is currently mostly spread in Asia and Africa; smaller Islamic groups are also present in America, Oceania and Europe (Insoll 2001).

Islam is a religion built upon the Judeo-Christian tradition. The world 'Islam' means 'total obedience to the will of God', the principal creator of the entire universe. According to Islamic precepts, after Adam, Abraham, Moses and Jesus, Muhammed was the last prophet to whom God revealed his will. The Muslim calendar begins in AD 622, but the main event leading to the rise of this religion occurred some years before, in AD 610, when prophet Muhammed received the first message from the archangel Gabriel at the Hira, a mountain close to the city of Mecca (western Saudi Arabia). The Quran is the principal religious text of Islam, in which all God's revelations received by the Prophet were collected during the Osman caliphate (AD 644-656) (Kocturk 2002).

Some scholars consider Islam to be a uniform religion, thus adopting a rather simplistic view of its real nature. The anthropologist Ernest Gellner (1981) affirms:

> "[...] *because Islam is the implementation of one book and its prescriptions, therefore Muslim civilisation is homogeneous*" (Gellner 1981).

However, Islam should not be considered as a monolithic religion, since heterodoxy exists, and is a substantial part of it. There are three main creeds within the Islam that are represented by Sufism, Sunni and Shi'ah (these last two represent the current dominant groups). Such groups slightly differ from each other in the interpretation and in the application of the Sharia, the Islam religious laws. Notwithstanding these differences, this religion is characterised by an underlying uniformity (Insoll 2001). Indeed, despite its socio-cultural complexity, this religion tends to be fairly easily detected in the archaeological record. In the majority of cases these religious-social codes result in specific cultural material manifestations. Food remains, particularly from animals, represent one of the most important indicators. Despite variation within Islamic traditions, a number of coherent food taboos do exist.

Food rules in Islam are generally contained within the concepts of *halal* and *haram*. The first term means lawful and permitted, while the second one refers to prohibition. Between these two terms is the concept of *mushbooh*, which means suspect, and it refers to all foods that are not as strictly forbidden as the *haram* (Tab.3.3.1) (Morales-Muñiz *et al.* 2011).

In Islam, animals, in order to be considered *halal*, need to have specific characteristics. These latter are reported in the Quran and they refer to the same food rules present also in the Genesis (1:29) and the Leviticus (11:3; 11:7 and 17:12-4). Permitted food derives from animals with cloven hooves and that are able to chew their cud[1](e.g. sheep, goat and cattle). Secondary animal products, such as dairy products, are allowed only if they come from *halal* animals (Morales-Muñiz *et al.* 2011).

Therefore, in Islam, the consumption of certain types of animal meat is prohibited. Several *hadith* (i.e. reports describing the words, habits and actions of prophet Muhammed) prohibit the intake of flesh from animals with fangs (carnivores, such as dog, cat, wolf and lion), animals that live on carrion (e.g. some insects) and animals without ears (e.g. reptiles). Animals that live both on land and in water, such as amphibians, should also not be consumed (Kocturk 2002).

Furthermore, it is well known that Muslims (as well as Jews) had, and still have, a strong aversion towards the consumption of pork, since this animal has split hoofs, but it does not chew its cud. The Quran states:

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[1] Such expression refers to a characteristic, typical of ruminants, to regurgitate a portion of semi-digested food in order to chew it again.

"[. . . ] *forbidden to you are: dead meat, blood, the flesh of swine* [. . . ]" (Quran 5:3).

*Mushbooh* products of domestic animals refer to horsemeat, which is consumable only under specific circumstances and also to lagomorphs (i.e. rabbit and hare), although in this latter case exceptions exists (for instance, Alevism, a branch of Shi'a Islam, strictly forbids the consumption of lagomorph meat).

Birds that do not use their claws to catch their food (e.g. chicken, duck, goose, turkey, pigeon, dove, ostrich) can be eaten. All fish were originally deemed to be consumable. However, in modern times some Islam groups (e.g. the Shiite Muslims) exclude some fish types from their diet (i.e. they are *haram*); these are the poisonous, scaleless and/or 'snake-shaped' fish (e.g. eel). The hunting of permitted wild animals (e.g. deer, pheasants etc.) is allowed if the animals are hunted for food, but not for the mere pleasure of catching them. Consuming domestic and wild animals is only allowed if they have been slaughtered according to Islamic laws (for further details see below) (Morales-Muñiz *et al.* 2011).

Additional forbidden animals are those that have been strangled and/or beaten to death, killed due to a fall, or attacked by beasts of prey, as well as animals sacrificed to idols other than Allah (Quran 2:173; 5:3; 16:114). Animal blood is forbidden. There are no restrictions on mixing milk and meat (Regenstein *et al.* 2003).

| **Animal groups** | ***Halal*** | ***Haram*** | ***Mushbooh*** |
|---|---|---|---|
| Domestic mammals | Sheep, goat, cattle, camel | Pig, carnivores | Horse, rabbit |
| Wild mammals | Ungulates | Carnivores | Lagomorphs |
| Domestic birds | All poultry | - | - |
| Wild birds | All with some exceptions | All birds of prey | - |
| Reptiles | - | All species | - |
| Insects | - | All species | - |
| Amphibians | - | All species | - |
| Fish | All fishes originally | - | Scaleless fishes,<br>Snake-shaped fishes,<br>Poisonous fishes |
| Other | Molluscs? | Worms | Molluscs, shellfish? |

**Table 3.3.1.** Categorisation of *halal*, *haram* and *mushbooh* animals according to Islam dietary laws (from Morales-Muñiz *et al.* 2011).

Despite their rigidity, Islam dietary laws have also some forms of flexibility, which are testified by a verse in the Quran:

"[...] *but whoever is forced* [by necessity], *neither desiring* [it] *nor transgressing* [its limit] - *then indeed, Allah is forgiving and merciful* [. . . ]" (Quran 16:115).

This verse has been repeatedly used to explain certain illicit practices (e.g. the consumption of camel blood in cases of extreme dehydration), as well as in the archaeological interpretation of certain forbidden animal species recovered from Muslim archaeological records (e.g. pig) (Morales-Muñiz *et al.* 2011).

An important point that needs to be made here is that, although pig is prohibited among Muslims and Jews, several authors have suggested that, at least for the former, the prohibition of eating the pig's wild relative (the wild boar, *Sus* *scrofa*) would have been less strictly followed, as it is nowadays (Simoons 1994; García-Moreno 2004).

Furthermore, in Islam, as in Judaism, there also exist some strict rules about animal culling. Usually, this consists in cutting the jugular vein and the oesophagus of the animal with a sharp knife, in order to interrupt the flow of blood to the brain, thus producing an immediate state of unconsciousness. However, the *halal* slaughter of animals is difficult to detect in both archaeological and modern animal carcasses, since the cut inflicted on the animal throat is unlikely to leave traces on the hyoid bone or the cervical vertebrae (Milner 2011).

## 3.4. Food taboo in Judaism

Jewish communities inhabited Sicily from at least Byzantine times; their presence in the island continued also under the Arab and the Norman domains, as attested in several documents of the Cairo Genizah, and also in some papers preserved in the Sicilian archives[2]. From these documents, it emerges that most Sicilian Jews, since Byzantine times, lived in cities (i.e. Mazara del Vallo, Ragusa, Syracuse and Trapani). A substantial number of Jews gravitated around Palermo also during the Arab period; here, at the end of the 10th century AD, they were established in an urban area known as *Harat Al-Yahud* (the Jewish quarter) and they were well integrated with the Muslim community (La Lumia 1984; Vanoli 2012).

Since most of the faunal assemblages analysed in this project and dated from the Arab to the Norman-Swabians domains originate from Palermo, a brief overview of Jewish dietary practices is relevant.

In Judaism, like in Islam, dietary habits include several permanent food taboos. Food rules in Judaism are generally contained within the concepts of *kosher* and *non-kosher*. *Kosher* refers to all food products that follow the rules of the *Kashrut* (the list of Jewish dietary laws reported in the Torah) and, in more detail, in Leviticus and Deuteronomy (Insoll 2001).

Concerning mammals, animals characterised by cloven hooves (e.g. artiodactyls) and that chew their cud (e.g. ruminants) are allowed to be consumed (Leviticus 11:3-8, Deuteronomy 14:4-8). Animal species that have only one *kosher* characteristic, but not both, such as hare, rock hyrax (they chew their cud, but they do not have split hoofs), and pig (it has split hoofs, but it does not chew its cud) are tabooed. In addition, the horse is also *non-kosher*, since it does not

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[2] The documents from the Cairo Genizah refer to a collection of manuscripts written in Jewish and found in 1890 in an ancient synagogue at Old Cairo (part of modern Cairo, Egypt). These are dated to the end of the 10th-first ½ of the 13th centuries AD, while the documents preserved in the Sicilian archives belong to the end of the 13th-first ½ of the 16th centuries AD (Mandalà 2013).

present any of the *kosher* traits. Carnivores are also banned, because they possess paws rather than hooves (Leviticus 11:27).

*Kosher* animals are listed in Deuteronomy (14:4-5) and are represented by cattle, sheep, and goat. However, the identification of additional allowed species remains ambiguous, as different translations and versions of the Bible include different species of bovids (e.g. antelope, gazelle, ibex, etc.) and cervids, generically defined as 'deer' (Amar *et al.* 2010).

Animal-derived products (e.g. milk, cheese, etc.) are only consumable if they come from *kosher* animals. However, *non-kosher* animals can be employed for activities other than consumption, for example as traction force (e.g. horses, asses) or for cleaning garbage through their scavenging (e.g. pigs, dogs). Bones that derive from tabooed species can be also used for making tools. Many wild species are considered *kosher* (e.g. aurochs, deer, gazelle, wild goat, ibex, chamois, etc., while others are not - e.g. wild boar) (Regenstein *et al.* 2003) (Tab.3.4.1).

However, the main problem with wild animals is not whether they have all the *kosher* characteristics, but how to butcher them (for details see below).

Unlike mammals, no identification rules for *kosher* birds exist. The bible only makes a list of all the tabooed bird species (e.g. birds of prey), hence permitted birds have been determined on the basis of other historical sources. These include: chicken, ducks, geese, doves, and quail. Concerning sea products, all fish with scales and fins may be eaten; this applies to the majority of fish, with the exclusion of the cartilaginous ones (e.g. sharks). Among sea food, oysters, crabs, lobsters, clams and shrimps are not allowed. Other animals, such as amphibians, reptiles and insects are tabooed, with the only exception of some forms of grasshoppers (Greenfield and Bouchnick 2011).

| **Animal groups** | ***Kosher*** | ***Non-kosher*** | **Additional information** |
|---|---|---|---|
| Domestic mammals | Sheep, goat, cattle | Pig, camel, horse, donkey | To be kosher all consumable animals need to be slaughtered according to *Shechita* rules |
| Wild mammals | Arabian oryx, aurochs, mouflon, wild goat, fallow deer, roe deer, red deer, hartebeest, mountain and dorcas gazelle and Nubian ibex, giraffe | Hare, rock hyrax | |
| Domestic birds | All poultry | - | |
| Wild birds | - | All birds of prey | |
| Reptiles | - | All species | |
| Insects | Locust, saltamontes, grasshopper, long-horned grasshopper | Almost all species | |
| Amphibians | - | All species | |
| Fish | Almost all fishes | - | |
| Other | - | Molluscs, worms | |

**Table 3.4.1.** Categorisation of the main *kosher* and *non-kosher* animals according to Jewish dietary laws (Kashrut).

For permitted animals (domestic and wild) to become *kosher* they need to be slaughtered following a defined set of rules (i.e. *Shechita*). Rules are applied to all phases of butchery, beginning with the slaughter. Animals that have been previously shot, impaled and/or poisoned are non- kosher, thus they cannot be butchered. This is the case also for animals with diseases and/or malformations. Usually, the jugular vein of the animal is cut by using a very sharp knife. Later, the trachea and the carotid arteries are cut, without ripping them. During this step, no bones of the animal carcass must be affected by butchery (Greenfield and Bouchnick 2011). After having slaughtered the animal, the butcher must inspect its body to look for any evidence of disease. If some are found, the animal cannot be considered to be kosher (Daróczi-Szabó 2004). After having lifted the animal, its neck is moved downwards, thus allowing the blood to come out. During this process, the animal sciatic nerve is removed; this anatomical part is considered forbidden since Jacob, one of Judaism's three patriarchs, injured this nerve while he fought against an angel (Genesis 32, 33). Because of the difficulties in removing this nerve, all the hind limbs are generally considered to be prohibited. However, some exceptions to this rule exist among different Judaic groups (Daróczi- Szabó 2004).

As only *kosher* animals are supposed to have been consumed, the presence of Jewish communities is potentially detectable. Butchery marks can provide additional evidence. Care needs, however, to be taken, in order to understand whether non culturally-related factors (for instance taphonomic processes) may have influenced the faunal composition.

## 3.5. The prohibited pork

One would expect a complete absence of pig remains in Muslim, as well as Jewish faunal records. However, the issue of the prohibited pig among Muslim and Jewish communities is complex and caution in interpretation is needed.

Nowadays, the pork taboo is mostly associated with Islam and Judaism (Lobban 1994), but there is evidence of its occurrence in other cultures. The avoidance of pork has, for instance, been attested in Egypt around the 5th century BC, and among other religious cults in Asia Minor, Mesopotamia and Syria. Currently, Christian and Pagan populations in Ethiopia, some non-Muslim communities inhabiting the eastern and southern areas of Africa, and Buddhists in Tibet also avoid pig meat (Simoons 1978).

It has been suggested that pork avoidance is associated with a view of the pig as an unclean animal (Diener *et al.* 1978). Historically, touching, or sometimes even seeing, a pig could be considered as bad omens: in other words, it was an interaction that people had to avoid, as it could have negative repercussions for their present and future lives.

At different times in history, attitudes towards this animal have varied in intensity in different cultures. However, in some specific cases, a high level of intolerance unquestionably existed. An example of such strong prejudice is reported by the Greek historian Herodotus in his Histories (440 BC), when he describes the attitude of the Egyptian population towards the pig. He writes that when Egyptians came into contact, even by accident, with a pig, they would immediately jump into the Nile, without any clothes on, to allow for a complete purification of their bodies (Herodotus 2:47- 48). However, the repulsion for pig in the past did not necessarily imply the avoidance of its meat; these two aspects, although often related, did not necessarily go together.

In ancient and modern times, pig-keeping has also been recognised as having a considerable number of advantages (Albarella *et al.* 2007). First of all, pig can provide fat-rich protein outputs, and almost all of its body can be used for different purposes. Secondly, pigs are omnivores, and can therefore be versatile; their long snout and sharp lower and upper canines allow them digging in the soil to find additional food sources (Albarella *et al.* 2007). For this reason, it is not strictly necessary to drive them to pasture (like sheep); indeed, they can easily rely on the food available around settlements. Free-range pasturing is a common way of raising pigs. In temperate climates, pigs are driven into woodlands during the autumn season, so that they can feed on acorns, chestnuts and other mast products (Wealleans 2012). On the other hand, although pigs can be very mobile, they are not driven over long distances as frequently as sheep and cattle; their presence therefore is more typically associated with sedentary communities (Grigson 2007). Pigs are also highly 'renewable' resources; they are very fertile and the sow gestation period is shorter than that of ewes and cows. This represents a key advantage, as it means that most pigs, if needed, can be killed at a young age, without putting at risk the herd survival (Kridder and Carroll 1971; MacKinnon 2001).

It is therefore even more remarkable that, despite the many advantages of keeping pigs, pork avoidance is so widespread. Our understanding of the phenomenon is made more difficult by the fact that its origins are still far from having been clarified (Simoons 1994). The majority of researchers, however, believe that pig prohibition started with the ancient Jews in the Near East.

One of the first hypotheses concerning the origins of the pig taboo suggests that ancient Jews rejected pork for hygienic reasons. The philosopher Moses Maimonides (AD 1135-1204) was one of the first scholars to advance the hygiene explanation. He claimed that, since pigs were considered dirty for their behavioural and feeding habits, if ancient Jews had allowed their consumption, their houses and markets would have become like latrines (Maimonides in Friedländer 1956). However, Simoons (1994) argues that in the Leviticus (the third book of the Torah) there are no mentions of behavioural and dietary habits of pig as the cause for the taboo on pork. In addition, it is not clear why ancient

Jews should have also banned the consumption of the flesh of other animals, such as hare, which feeds mainly on plants, or allowed that of the chicken, whose food habits bear some similarities with those of the pig (Simoons 1994). Another point is that in ancient and modern times, pig food habits were not always looked at negatively; indeed, as mentioned above, pig can consume many types of food that are usually discarded by other animals, including humans. Pigs could be seen as a formidable energy-conversion machines, as no other existing domesticates can convert such great diversity of food into meat (Grigson 2007). Furthermore, pig food habits played, and still play, an important function in public health, as this animal can also feed on humans' food waste, thus minimising the spread of parasites and diseases that can be harmful to human communities (Gerard 1952).

Another suggested explanation for the Jewish ban on pork is represented by the risk of contracting trichinosis, an infection caused by the roundworm *Trichinella spiralis.* In modern times, this parasite is also known as 'pork worm', because it is typically found in uncooked pig meat. The same roundworm can also be found in rodent, horse, bear and dog flesh (Kozar 1970; Yamashita 1970).

Additionally, it is not certain that this infection already existed at the time that the ancient Jews started banning pork, since no available information about the place of origin of this parasite, or about the exact time of its spread, is available.

Some studies suggest that this parasite arrived in Europe only around the 18th century AD as a consequence of the brown rat (*Rattus norvegicus*) introduction (Robinson and Olsen 1960). Another proposed theory is that the parasitic worm reached Europe at an even later stage, in the 19th century, with the introduction of Indochinese and Chinese pigs (Simoons 1994). However, earlier studies had already rejected both the above-mentioned hypotheses, affirming that *Trichinella spiralis* is not a host-specific parasite, but it is present in several mammal species, including wild animals (Kozar 1970; Yamashita 1970). As a result, it is incorrect to consider pigs and rats as the only potential agents for the transmission of the disease (Campbell 1991).

Another important critique that has been raised against the '*Trichinella hypothesis*' is that it is unlikely that ancient Jews were aware of Trichinella spiralis or of its association with the intake of pig meat. Indeed, the awareness of this relation only developed in Germany in 1836, as the result of a medical inspection of a human cadaver in which an encyst of *Trichinella* worms was found (Campbell 1983).

At the same time, it cannot be completely ruled out that ancient Jews started associating the first-stage symptoms of trichinosis (high fever, diarrhoea, vomiting, etc.) with the consumption of pork, though the incubation period of the parasite usually lasts for ten days (Gould 1970; Lobban 1994).

A third hypothesis for the origin of the pork banning was developed by Frazer (1935), who proposed a 'fall from grace' of the pig for religious reasons. In the $2^{nd}$ millennium BC, the populations inhabiting the Middle East considered the pig as a sacred animal. Because of this, some communities often sacrificed pigs to gods and consumed their meat. At a later time, the pig started being considered as a dirty animal. This new negative approach was possibly related to a loss of importance of the gods, perhaps Set, with whom the pig was associated (Frazer 1935).

Historical evidence seems to provide support to this hypothesis, as there is considerable documentary evidence from Egypt, dated to the $2^{nd}$ millennium BC, which indicates the importance of the pig in that period (Darby *et al.* 1977). However, by the time of Herodotus (484-425 BC), pigs had already started to be seen as unclean animals. From this point onwards, those Egyptians who continued to raise pigs were considered part of the lower class, and were no longer allowed to enter the temples. However, although at the time of Herodotus pork was banned, the historian notes that pig sacrifices still occurred during annual religious events (Frazer 1935). Frazer's argument shows how convinced he had become of the power of religious belief to raise up or condemn a species of animal, although this theory alone does not seem enough to fully explain the long-lasting avoidance of pork (Simoons 1978).

Another theory suggests that the pork prohibition has its roots in environmental factors (Coon 1951). The premise of such theory relies on the fact that, because of their inability to sweat, pig tend to die quickly when they are exposed to high temperature (>36º Celsius degrees), unless some water sources, mud or woodland areas are present in the vicinity (Diener *et al.* 1978).

According to Coon's view, at the beginning of the Neolithic, pig was widely distributed both in the southern and eastern regions of the Middle East. However, in later periods, the increase in human population caused a higher demand for food that resulted in an increment of planted crops (especially olive trees) at the expenses of oaks, thereby causing the destruction of the pig's ecological niche. As the environmental conditions became unfavourable for pig's husbandry, this animal started being difficult to raise, and this situation would have caused its disappearance (Coon 1951). Drawing on Coon's theory, Harris (2012) claimed that not only pig was climatically ill-adapted to the Near East environment, but it was also not well suited to the topography of this region in terms of both land cover (limited woodland) and scarce water resources (Harris 2012).

Several critiques were raised against the climatic and topographic hypotheses. The most substantial one argues that, since antiquity, the environmental conditions of the Middle East have not represented a real impediment for pigs, as three substantial 'oasis regions' (the Fertile Crescent, the Nile Valley and the Yemen-Oman) are present. Furthermore, considering microhabitat levels, several woodlands characterised this land, thus enabling the presence of both wild boars and pigs (Diener *et al.* 1978). From this evidence, it is clear that the simplistic stereotype of the Middle East as an arid dry land unfavourable for pig husbandry cannot be used to explain the origin of the taboo on pork.

However, before ruling out completely the environmental hypothesis, it is worth having a look at the zooarchaeological evidence at our disposal. Of course, it can be argued that the presence of pig remains in archaeological records does not directly mean that these animals were raised in the vicinity of the settlements; their entire carcasses or part of them could have also been brought from other places, in which better conditions for pig breeding existed. Nevertheless, given the challenging climatic conditions characterising large parts of the Middle East, it is very unlikely that pig carcasses, or even part of them, were transported through long distances, as pork goes off quite quickly. Curing of the meat would have represented a solution but this is a demanding process that was unlikely to be routinely used; moreover, most of the cured meat would have been transported off the bone (Grigson 2007).

Zooarchaeological data from several archaeological sites in the Middle East dated from the 5th until the 4th millennia BC show a strong correlation between the distribution of sites in which pig remains are present and environmental conditions. However, it also appears that during the 5th and 4th millennia pig played an important role in the economy of ancient populations. This result could be related with the fact that, although climatic conditions were much hotter and drier than today, palaeobotanical and pedological studies have revealed the presence of patches of woodland and water sources, which would have made pig breeding feasible.

Towards the end of the 3rd millennium BC, the Middle East was characterised by increasing aridity. In view of such climatic changes, one would expect a decrease in pig frequency in the analysed faunal assemblages. However, as a whole, this is not the case (Grigson 2007). The zooarchaeological results have shown that, even where climatic conditions were not perfectly suitable for pig husbandry, people were able to raise them.

In the modern world, pig husbandry in less than ideal environmental and climatic conditions for this species is far from uncommon. In China, for instance, pigs are more numerous in the wetter central and southern regions, but can also be found in the North, where climatic conditions are semi-arid. Not only has northern China a similar amount of annual precipitations to Palestine, but also more rigid winters, which could have represented an additional impediment for pig husbandry (Simoons 1994). On the basis of all the above-mentioned evidence, it seems that also the environmental hypothesis is not entirely convincing.

From the beginning of the Holocene onwards, Sicily started developing geographical, topographical and climatic features similar to those of modern times (Incarbona *et al.* 2010). Recent palynological and sedimentological reconstructions of climatic and landscape changes that occurred during the last seven millennia show a tendency to aridification and forest opening. These changes may have been caused by a reduction of precipitations, and a consequent increase in temperature, and/or by human clearance activities (mainly after the transition from hunter-gathering to farming and animal herding) or, more likely, by a combination of these factors. The anthropogenic impact is also attested by a reduction of numerous animal populations, which had previously inhabited the island. Hunter-gatherers decimated several large mammals (e.g. deer and wild boar) (Tagliacozzo 1993), while agriculturalists/herders would have also caused the extinction of some endemic species trough the introduction of domestic animals as well as with the alteration of the vegetation cover (Masini *et al.* 2008). During the Greek and Roman phases, the Sicilian landscape was considerably altered, and a significant loss of vegetation occurred. Pollen and stable isotope analyses from the Pergusa Lake (Enna, Sicily) have revealed the presence of two humid phases in post-classical times: in the early Byzantine period (AD 450-750) and in the late medieval-early modern phase (AD 1400-1800). By the Middle Ages most of the Sicilian arable territory was used for agriculture, which favoured a demographic increase, as well as substantial economic developments. By contrast, just before the Arab conquest (AD 750-800), Sicily experienced a rather long period of aridity, as revealed by a decrease of arboreal plants and synanthropic vegetation (Sadori *et al.* 2016). However, independently from these climatic changes, since the end of the Roman period, the vegetation cover would have still been more widespread than it is nowadays, with *Olea* sp. and *Quercus* sp. trees, as well as the Mediterranean maquis, restricted to specific areas (Incarbona *et al.* 2010). As a result, if, on the one hand, it is true that during historical times the reduced vegetation cover may have represented a limit to pig breeding, on the other, it is also important to bear in mind that some wooded and more humid areas survived, and these could have represented a refuge area in medieval times, favouring pig husbandry and the practice of free-range herding.

To conclude, the origin of pork taboo cannot be explained by focussing only on one of the above-mentioned hypotheses. On the contrary, this taboo should be considered the result of different factors, which may have varied in different cultures and environmental conditions.

Whatever the reasons behind the taboo on pork, it can definitely be affirmed that by the time the Arabs invaded Sicily in the 9th century AD, this prohibition was present and widespread among the invaders and the Jews, and that the environmental and topographic conditions of medieval Sicily would have not represented an insurmountable problem for pig breeding.

## 3.6. Food taboos in Christianity

Faunal assemblages dated to the Byzantine, Norman and Swabian periods are considered in this project and, for this reason, it is worth analysing also the food dietary taboos of the Christian tradition (Tab.3.6.1). Following the Bible, it seems that in Christianity no permanent taboos were originally imposed and that all animals were allowed to be eaten:

> "[. . . ] *for every creature of God is good, and nothing is to be refused*" (Timothy 4:4).

> "[. . . ] *what goes into someone's mouth does not define them, but what comes out of their mouth* [. . . ]" (Matthew 15:11)

However, in the 8th century AD, Popes Zachary and Gregory III banned permanently the intake of horse meat (Boniface 1940 in Simoons 1994). This food prohibition may have derived from the interpretation of horsemeat consumption as a pagan practice (Meens 2002). However, documentary sources and archaeological evidence have widely attested a strong aversion of ancient Romans towards the consumption of horsemeat, even well before their conversion to Christianity. In ancient Roman times, those people who were used to consume horsemeat were often labelled as 'others' and/or 'barbarians', since they did not fully embrace the political and cultural concepts by which the Romans usually identified themselves (the so-called *Romanitas*). Later, this food taboo was included in the teaching of the Catholic Church, and was used to identify those people who were not acting as good Christians (Simoons 1994; Lauwerier 1999).

However, butchery evidence on horse remains from archaeological contexts dated to after the 8th century AD is not uncommon in Christian settlements. A number of archaeological sources also report that, in case of need, the consumption of horseflesh was practised (Lauwerier 1999; Poole 2013). Butchery marks on horse bones, however, should not necessarily be interpreted as evidence of consumption. Carcasses of elderly horses may have been dismembered into smaller pieces to feed dogs and/or to facilitate their burial (Thomas and Locock 2000).

Christianity is also characterised by the presence of temporal food abstentions; these are generally followed by Catholic Christians, who avoid meat on Fridays and also during the Easter lent (during these periods fish products can be eaten). Also Eastern Orthodox communities generally avoid meat and other animal products (e.g. milk, cheese, etc.) on Wednesdays and Fridays and also during specific religious events (e.g. Lent and Advent). An exception to these mere temporary abstentions is represented by the Ethiopian Christian community. This group follows strict dietary laws that prohibit the consumption of camel, hare, and porcupine meat, since these animals chew their cud but do not have (visibly, in the case of the camel) split hoofs; also hyena and pig are prohibited, since they do not chew their cud (Guindeuil 2014). However, temporary abstentions from meat and other animal products during specific Christian events are unlikely to leave detectable changes in the faunal record and are therefore unlikely to be detected archaeologically.

| Animal groups | Allowed | Not-allowed | Additional information |
|---|---|---|---|
| Domestic mammals | Almost all species | Horse | In the 8th century AD, the consumption of horse meat was banned |
| Wild mammals | All species | - | |
| Domestic birds | All species | - | |
| Wild birds | All species | - | - |
| Reptiles | All species | - | - |
| Insects | All species | - | - |
| Amphibians | All species | - | - |
| Fish | All species | - | - |
| Other | All species | - | - |

**Table 3.6.1.** Categorisation of prohibited and allowed animal species according to Christian dietary laws.

## 3.7. Conclusion

Considering the different cultural identities characterising the Byzantines, Arabs, Normans and Swabians in Sicily during the medieval period, it would not be unreasonable to expect differences in the patterns of animal food production, distribution and consumption.

When these populations occupied the island, they did so alongside other ethnic groups, such as Berbers and Jews (Simonsohn 2011; Vanoli 2012; Mandalà 2013).

From both historical and archaeological evidence, it is clear that different ethnic groups did not merely replace one another through time in Sicily. On the contrary, they all left their marks in creating a melting pot of different traditions and beliefs. The religions professed (Christianity, Islam and Judaism) unquestionably represented one of the most important aspects of their 'diversity', which could have influenced their dietary habits. As discussed in the previous sub-chapters, Islam, Judaism and, to a lesser extent, also Christianity, were and still are characterised by the presence of strict dietary rules.

As a result, assemblages of animal remains have the potential to provide evidence of Muslim and Jewish religious traditions. This is due to the fact that, unlike Christianity, Islam and Judaism are characterised by strict and permanent dietary taboos that should have been universally followed. These latter refer not only to the allowed and/or forbidden animals, but also to the way in which they must be processed.

As concerns medieval Sicily, food remains have been insufficiently used in archaeology as markers to help the identification of ancient communities belonging to different religious traditions. Most archaeologists limit their investigation of the origin of Islam and Judaism, as well as the presence of their practitioners, to the analysis of settlement patterns, funerary practices, ceramic, religious items and historical sources. However, animal remains are obviously associated with food consumption, an important cultural identifier, and are usually recovered in large quantities from archaeological deposits. Other zooarchaeological studies in the Mediterranean region and in continental Europe have proved that the composition of faunal assemblages can be affected by Muslim and Jewish dietary laws (Morales-Muñiz *et al.* 2011; Arcoleo and Sineo 2014; García-García 2014; Grau-Sologestoa 2014; Valenzuela-Lamas 2014; Grau-Sologestoa 2016; García-García 2017; García-García 2019; Lisowski 2019).

For all these reasons, the zooarchaeological study of animal remains has a great potential in detecting the presence of dietary taboos, highlighting their wider implications within past communities, and informing the interpretation of the archaeological evidence. In Sicily such an approach can contribute to highlight the presence and nature of the dietary taboo on pork imposed by the Arabic administration in various parts of the island. In turn, this can have important implications regarding our understanding of the character, efficiency and impact of the Arabic administration of Sicily.

# Chapter 4

# Sites and materials

This chapter briefly introduces the archaeological sites whence the faunal assemblages here analysed were collected. For each site, the main archaeological features will be discussed according to the information available in the published reports. Detailed information on the archaeological contexts that produced the analysed faunal remains will follow. Attention will be mostly paid to the chronological range considered by this project, which spans from the 6th century AD until the second ½ of the 13th century AD.

This project analyses eight faunal assemblages collected from as many sites located in different parts of Sicily (Tab.4.0.1). As Fig.4.0.1 shows, the majority of sites concentrates in the western part of Sicily; only the site of Rocchicella (Mineo, Catania) is situated in the eastern part of the island. The analysed faunal assemblages were recovered from archaeological contexts dated from the Byzantine to the Norman-Swabian periods. All the archaeological sites have at least an Arab and/or a Norman-Swabian phase, with the exclusion of Rocchicella (Mineo, Catania), which has two separate Byzantine phases (i.e. the 1st Byzantine period and the 2nd Byzantine period). Apart from Rocchicella, a Byzantine phase is also present at Colmitella.

Most sites were discovered during rescue excavations (i.e. Corso dei Mille, Sant'Antonino, the Norman Palace, Mazara del Vallo and Colmitella), while only three are the result of planned archaeological projects (i.e. Casale San Pietro, Castello San Pietro and Rocchicella).

In all excavations, faunal remains were hand-collected; only at the site of Casale San Pietro (Castronovo di Sicilia, Palermo) sieving was occasionally implemented.

| **Archaeological site** | **Province** | **Chronology** | **Settlement type** | **Reference(s)** |
|---|---|---|---|---|
| **1. Corso dei Mille (Palermo)** | Palermo | 10th-11th c. AD<br>12th-13th c. AD | urban | Battaglia *et al.* 2016 Vassallo *et al.* 2016 |
| **2. Sant'Antonino (Palermo)** | Palermo | late 9th-11th c. AD | urban | Aleo Nero 2015 |
| **3. The Norman Palace (Palermo)** | Palermo | early 12th c. AD | urban/military? | Vassallo *et al.* 2018 |
| **4. Casale San Pietro (Castronovo di Sicilia)** | Palermo | 8th-9th c. AD | rural | Carver *et al.* 2017<br>Carver *et al.* 2018 |
| **5. Mazara del Vallo (Trapani)** | Trapani | 10th- 11th c. AD<br>12th-13th c. AD | urban | Cassai 2003<br>Molinari and Cassai 2006<br>Molinari *et al.* unpublished report |
| **6. Colmitella (Racalmuto)** | Agrigento | 7th/8th-9th c. AD<br>9th-11th c. AD | rural | Rizzo *et al.* 2012<br>Rizzo and Romano 2012<br>Rizzo *et al.* 2014<br>Rizzo *et al.* 2015 |
| **7. Rocchicella (Mineo)** | Catania | 6th-7th c. AD<br>9th c. AD | military<br>rural? | Arcifa 2007<br>Arcifa 2008(b)<br>Maniscalco 2008<br>Arcifa 2016 |
| **8. Castello San Pietro (Palermo)**[1] | Palermo | 9th c. AD | urban | Di Stefano *et al.* 1989<br>Arcifa and Lesnes 1997<br>Arcifa 1998<br>Arcifa and Bagnera 2014 |

**Table 4.0.1.** List of the archaeological sites that produced the faunal assemblages analysed in this project. Information about location, chronology, settlement type and references are provided for each site.

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[1] Castello San Pietro is the last site presented in this chapter and in the results (*§Chapter 6: Results*); this is due to the fact that, despite being located in Palermo like Corso dei Mille, Sant'Antonino and the Norman Palace, the dating of its archaeological contexts only became available in the very last stages of this PhD project.

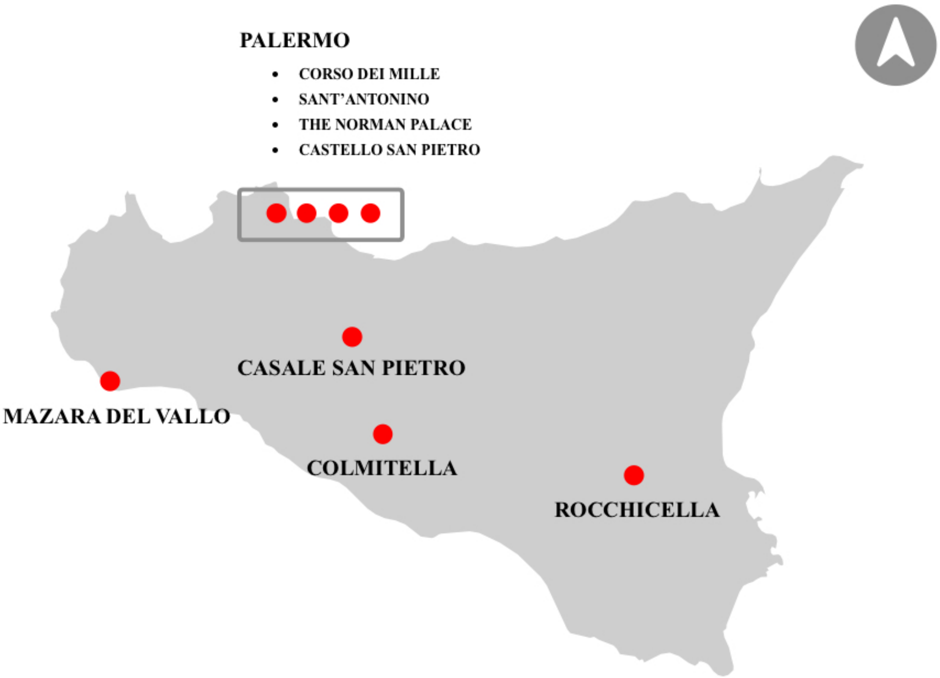
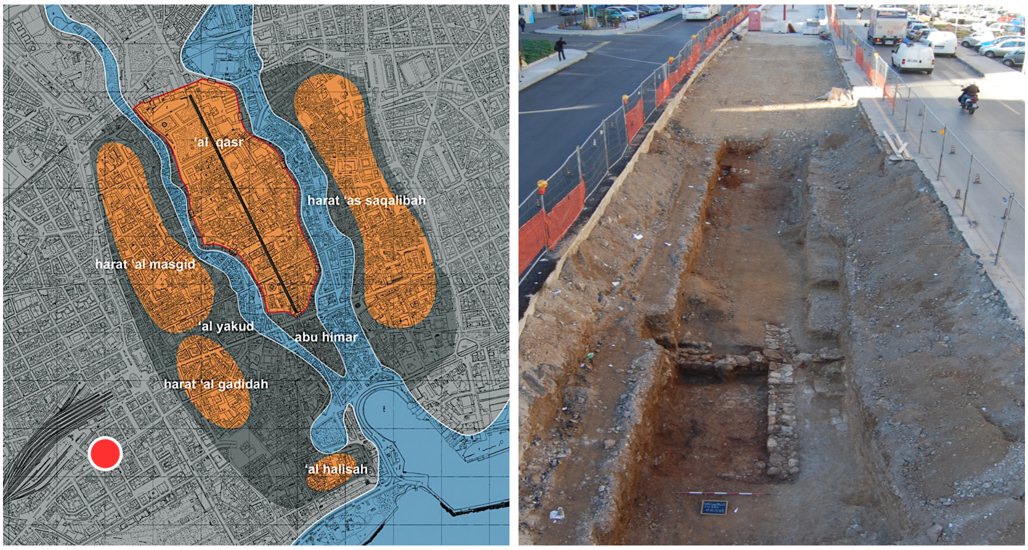


**Figure 4.0.1.** Map of Sicily with the locations of the archaeological sites whence the analysed faunal assemblages were recovered: Corso dei Mille, Sant'Antonino, the Norman Palace and Castello San Pietro (Palermo), Casale San Pietro (Castronovo di Sicilia, Palermo), Mazara del Vallo (Trapani), Colmitella (Racalmuto, Agrigento) and Rocchicella (Mineo, Catania).

## 4.1. Corso dei Mille (Palermo)

### 4.1.1. The site

In advance of the construction of a tramline track, rescue archaeological excavations were carried out in 2014 and 2015 by the Soprintendenza dei Beni Culturali e Ambientali of Palermo along Corso dei Mille (Palermo) and, more specifically, in the urban area delimited by the Antico Ponte to the south and the former Porta Termini to the north (scientific directors: S. Vassallo and G. Battaglia) (Vassallo *et al.* 2016) (Fig.4.1.1).



**(a)** Map of Palermo during the Arab period with the location of the archaeological site of Corso dei Mille (red dot), the Arab quarters (orange areas) and the simat (black line) according to the description of Ibn Hawqal (from Spatafora 2005).

**(b)** Archaeological trenches excavated along Corso dei Mille (from Battaglia *et al.* 2016).

**Figure 4.1.1.** Corso dei mille

In this area of the city, archaeological features dating from the 10th to the 13th centuries AD were uncovered. During the excavation, a number of trenches were opened along Corso dei Mille and divided into two main areas: Northern Area and Southern Area.

The earliest occupation phase in the Northern Area consisted of some layers and wall structures; these latter were directly built on the rock and mainly consisted of dry stone walls, with the exception of one made of mud bricks (Trench 144-US[2]22).

Ceramic material found in association with such evidence mainly includes closed shapes with rounded edges, cooking pot lids with horizontal brims, mill pots and red painted ceramics with vertical band decorations and/or oblique lines; such finds suggest a chronology spanning from the 10th to the beginning of the 11th centuries AD (Battaglia *et al.* 2016). This chronology was also confirmed by the recovery of two glass jetons (Trench 106-US 2007), one of which presented an inscription of Al-Azīz bi-lāh (AD 975-996) and is probably dated to the Fatimid period (De Luca personal comment). In addition, several pieces of iron slag and animal bones (in particular goat horn cores) were found. These were interpreted as by-products of craft activities related to the production of metal objects (*§Chapter 6: Results*).

In the Southern Area, close to the Istituto Alberghiero Pietro Piazza, archaeologists recovered a considerable amount of scrap pottery remains datable to the second ½ of the 10th-early 11th centuries AD; such evidence suggests the presence of a nearby ceramic workshop that could have exploited the clay quarries located along the right bank of the river Oreto. Among ceramic materials, different types of red painted amphorae produced in Palermo, fragments of circular-section pottery bars from vertical ceramic kilns, and a small group of 'overcooked' closed shapes were found (Battaglia *et al.* 2016) (Fig.4.1.2).

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[2] In Italian, the abbreviation 'US' stands for Unita Stratigrafica, which is translated into English with 'archaeological context' (literally, 'stratigraphic unit').

**Figure 4.1.2.** Circular-section ceramic bars (upper left) and overcooked' pottery remains (lower left and right) recovered from Corso dei Mille (from Battaglia *et al.* 2016).

In the second occupation phase of the site (11th-12th centuries AD), the previous structures were abandoned and new buildings and walls erected. A cemetery containing 30 aligned burials is dated to a later period (12th-13th centuries AD) (Trenches 120, 126, 134, 144). The burials include 23 human skeletons deposited in wooden coffins. The bodies were generally buried in a supine position, with the legs stretched out and the arms placed along the body or on the pubis. In addition, four burials contained skeletons laid on their right side with the head facing south-east, according to the traditional Muslim burial rite. Furthermore, two burials presented a more 'monumental' aspect; these were partly excavated into the rock and were partially covered with lithic slabs presenting, in some cases, traces of plaster. The majority of burials were characterised by the lack of grave goods. Only in one grave, archaeologists found an extremely rare perfume bottle made of white and blue glass; such object may have been produced in Egypt or Syria and was dated to the 12th-13th centuries AD (Norman/Swabian period) (Fig.4.1.3).

At the end of the 12th-early 13th centuries AD, the previous structures as well as the cemetery were abandoned, and replaced by new occupation layers, a clay-court road and a drainage ditch (Battaglia *et al.* 2016).

**Figure 4.1.3.** The perfume bottle recovered in a grave at the site of Corso dei Mille and dated to the 12th-13th centuries AD (from Battaglia *et al.* 2016).

### 4.1.2. The faunal assemblage

Animal bones and teeth recovered from the site of Corso dei Mille (Palermo) consist of 736 remains. These were mainly recovered from occupation and destruction layers dating to the earliest phase of the site (Trenches 106, 134, 144 and 192), which corresponds to the 10th-11th centuries AD (Arab period). By contrast, occupation layers dated to the 12th-13th centuries AD (Norman/Swabian periods) produced a smaller quantity of animal remains.

## 4.2. Sant’Antonino (Palermo)

### 4.2.1. The site

The archaeological site of Sant’Antonino is located within the urban core of Palermo, in the cloister of a former monastery with the same name built in the 17th century AD.

Since the restoration works started in 2013, rescue archaeological excavations are being carried out by the Soprintendenza dei Beni Culturali e Ambientali di Palermo (scientific directors: S. Vassallo and C. Aleo Nero). The excavations revealed the presence of parts of an urban quarter dated to the Arab period (late 9th-first ½ of the 11th centuries AD). Later, the site was abandoned and it was only reoccupied in the 17th century AD, when the monastery was built. Since the analyses of the archaeological evidence and materials recovered from the site are still on-going, the information provided here should be considered preliminary (Aleo Nero 2015).

In the Arab period, the site was located just outside the Arab quarters (Fig.4.2.1). The chronicler Ibn Hawqal reported that, in the Arab period, this southern area of the city was occupied by permanent and semi-permanent settlements (Bagnera 2013). The identification of a number of archaeological sites dated to the 10th century AD in the southern part of Palermo seems to support this claim (Arcifa and Ardizzone 1995; Pesez 1995; Spatafora and Canzonieri 2014; Battaglia *et al.* 2016).

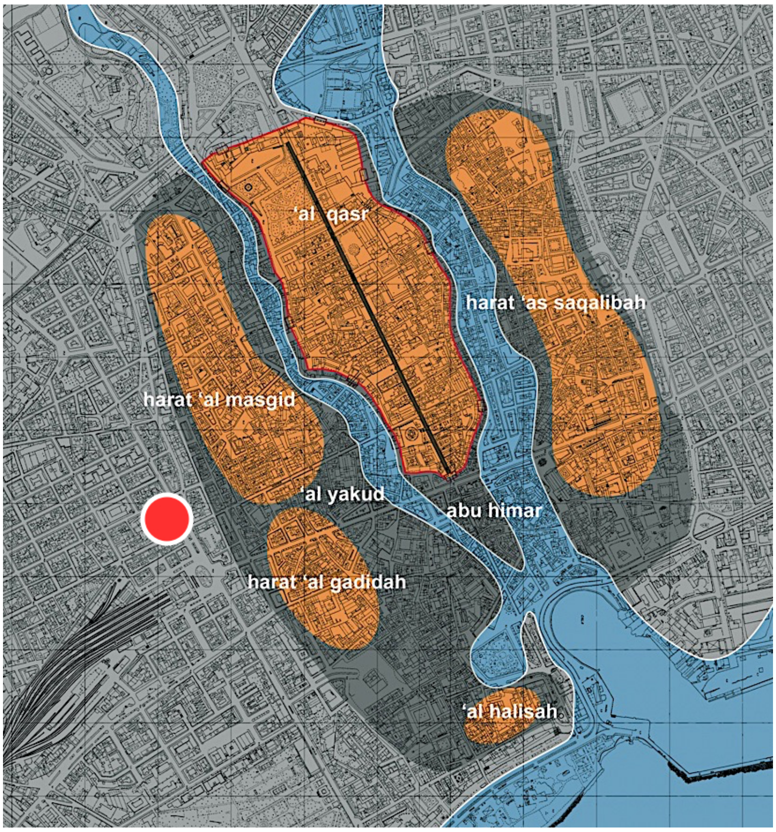
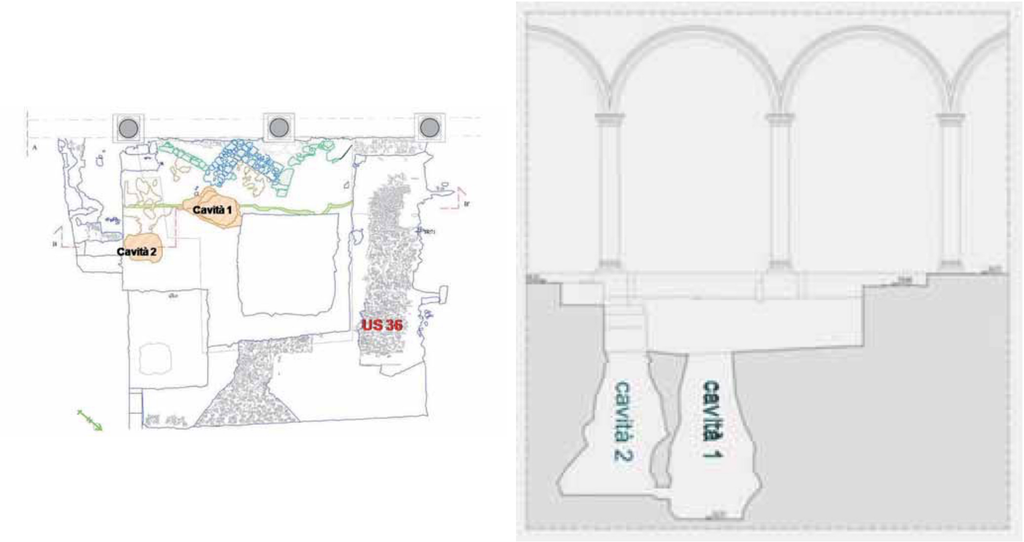


**Figure 4.2.1.** Map of Palermo during the Arab period with the location of the archaeological site of Sant'Antonino (red dot), the Arab quarters (orange areas) and the simat (black line) according to the description of Ibn Hawqal (from Spatafora 2005).

The archaeological excavation at the site of Sant'Antonino consisted of a square of 8x8 metres located along the western side of the former monastic cloister.

During the earliest occupation phase (late 9th century AD), the site included some dwellings and two medium-sized cavities connected to each other by a short tunnel (Cavity 1 and Cavity 2) (Fig.4.2.2). These had been cut directly into the rock and were probably used to extract building material, as suggested by similar evidence observed at nearby sites. At the beginning of the 10th century AD, the two cavities may have been used as storage pits, and later for waste disposal (mid-10th-first ½ of the 11th centuries AD) (Aleo Nero 2015).



**(a)** Excavation plan of the site of Sant'Antonino; the perimeter of a dwelling (US 36), wall structures (green and blue), and the two cavities (yellow; Cavities 1 and 2) are indicated.

**(b)** Archaeological section of the two cavities and of the tunnel connecting them (from Aleo Nero 2015).

**Figure 4.2.2.** Sant'Antonino

Ceramic analyses were carried out by C. Aleo Nero (Soprintendenza dei Beni Culturali e Ambientali di Palermo), with most of the material deriving from Cavity 1. The pottery remains from this context are dated to the late 9th-11th centuries AD. Among these, it is worth mentioning the presence of an amphora fragment with a decoration of repeated loops defined in the literature as 'cappi' (9th-10th centuries AD) and of glazed and unglazed lamps (10th-11th centuries AD) occasionally characterised by a long spout, which differs from earlier productions (8th-9th and 9th-10th centuries AD). In addition, a considerable amount of polychrome glazed ceramics was found; among them there were brown-green painted pottery fragments and a series of carinated basins with zoomorphic, phytomorphic and epigraphic decorations. Deserving special mention is a fragment of a carinated basin with a depiction of the 'bevitore' ('drinker'), a well-known topic in Islamic iconography. Pottery remains from Cavity 2 are typologically identical to those found in Cavity 1 and, therefore, it is reasonable to think that these two contexts were abandoned at about the same time (Aleo Nero personal comment).

### 4.2.2. The faunal assemblage

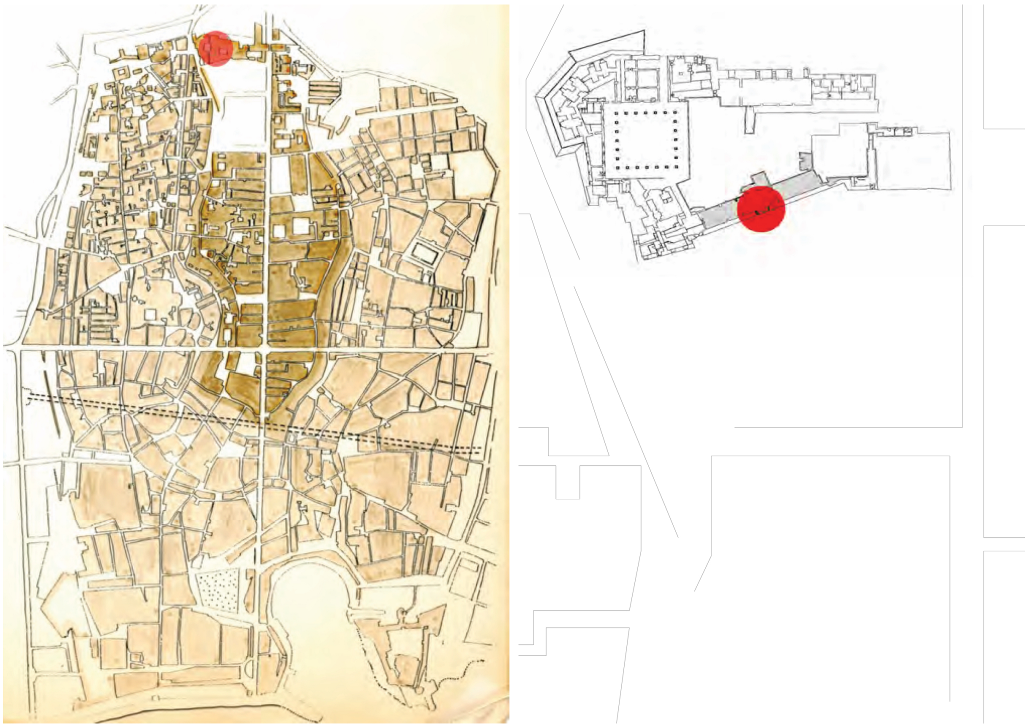
Animal bones and teeth recovered from the site of Sant'Antonino consist of 612 fragments. These were mainly found in the fills of Cavity 1 and Cavity 2, so they refer to a chronological period spanning from the late 9th to the first ½ of the 11th centuries AD (Arab period).

As mentioned before, the typological similarity of pottery remains present in Cavities 1 and 2 suggests that the two pits were abandoned at the same time. The homogeneity of ceramic typologies and the presence of articulated animal bones indicate that these contexts had not been disturbed, and therefore that their chronology is reliable.

## 4.3. The Norman Palace (Palermo)

### 4.3.1. The site

In 2016, in occasion of some works for the construction of a new tourist entrance to the Norman Palace (Palermo), the Soprintendenza dei Beni Culturali e Ambientali di Palermo (scientific directors: S. Vassallo and M. Chiovaro) carried out two small archaeological excavations in a large room of the Palace called 'Ala Maqueda', which stands at the same height as the 17th century door facing the modern Piazza del Parlamento (Fig.4.3.1) (Vassallo *et al.* 2018).



**(a)** Location of the Norman Palace in the urban core of Palermo. **(b)** Location of the archaeological excavation in the Ala Maqueda, within the Norman Palace (Palermo) (from Vassallo *et al.* 2018).

**Figure 4.3.1.** The Norman Palace

The first archaeological trench revealed the presence of a defensive wall made of sandstone blocks and arranged in regular rows. The structure, dated to the 12th century AD (Norman period), was preserved for a height of ca. 2 meters and presented a northwest-southeast orientation. Archaeologists interpreted this evidence as the northern front of the early Norman settlement; indeed, written sources indicate that, immediately after the Norman conquest of the city (AD 1072), Robert Guiscard (AD 1015-1085) and his youngest brother Roger (AD 1040-1101) fortified the highest point of Palermo with high walls and towers. During the early phase of the Norman conquest, this part of the city (the so-called *castrum superius*) looked like a large fortified enclosure and hosted the Norman military troops (*§Chapter 2: An overview of medieval Palermo*).

The defensive wall partly covered some earlier structures dated to the late 11th-early 12th centuries AD; these included some walls, a well and a series of deposits. Among the ceramic material associated with these contexts, it is worth mentioning the presence of a siliceous bowl with an arabesque motif covered by a yellow glaze, which may have been imported from Egypt or Syria. Another pottery fragment with the depiction of an aquatic bird could originate from the Middle East (possibly Iraq).

The second archaeological excavation revealed the presence of a wall structure built with sandstone blocks, and some layers dated approximately to the 12th century AD. Archaeologists interpreted this evidence as belonging to an additional Norman defensive structure, or the so-called Sala Verde (*§Chapter 2: An overview of medieval Palermo*); however, an interpretation of this context has not been finalised.

### 4.3.2. The faunal assemblage

During archaeological excavations carried out in 2016 by the Soprintendenza dei Beni Culturali e Ambientali di Palermo, some deposits containing animal remains and dated to the Norman period were excavated.

The faunal assemblage from the Norman Palace consists of 395 hand-collected remains. Animal bones and teeth originate from the second excavation and, in particular, from the occupation layers located in the proximity of the wall structure dated to the 12th century AD (Norman period).

## 4.4. Casale San Pietro (Castronovo di Sicilia, Palermo)

### 4.4.1. The site

The archaeological site of Casale San Pietro (Castronovo di Sicilia, Palermo) is located in central-western Sicily, along the modern road connecting Palermo and Agrigento (SS189).

The investigation of the site is part of the European Research Council (ERC) project 'Sicily in Transition' (SICTRANSIT, ERC scientific directors: M. Carver and A. Molinari). The project, which started in 2014, is run by the Department of Archaeology of the University of York (United Kingdom), the University of Rome 'Tor Vergata' (Italy) and the Department of Beni Culturali of the University of Lecce (Italy), in collaboration with the Soprintendenza dei Beni Culturali e Ambientali di Palermo and with the support of the Comune of Castronovo di Sicilia (Palermo).

The ERC project SICTRANSIT investigates changes in demography, agricultural production and trade in Sicily during the Byzantine, Arabic and Norman/Swabian transitions (6th to 13th centuries AD) (http//sicilyintransition.org) (Carver *et al.* 2017).

Since 2014, archaeological investigations, surface collections and geophysical surveys at Casale San Pietro have revealed a long and complex occupation sequence, with several archaeological features dated from the Late Antiquity to modern times (Fig.4.4.1). Phasing at the site has been divided into four periods (Period 1, 2, 3 and 4). A brief description of the main archaeological contexts identified during the 2014, 2015 and 2016 campaigns at the site of Casale San Pietro is provided below.

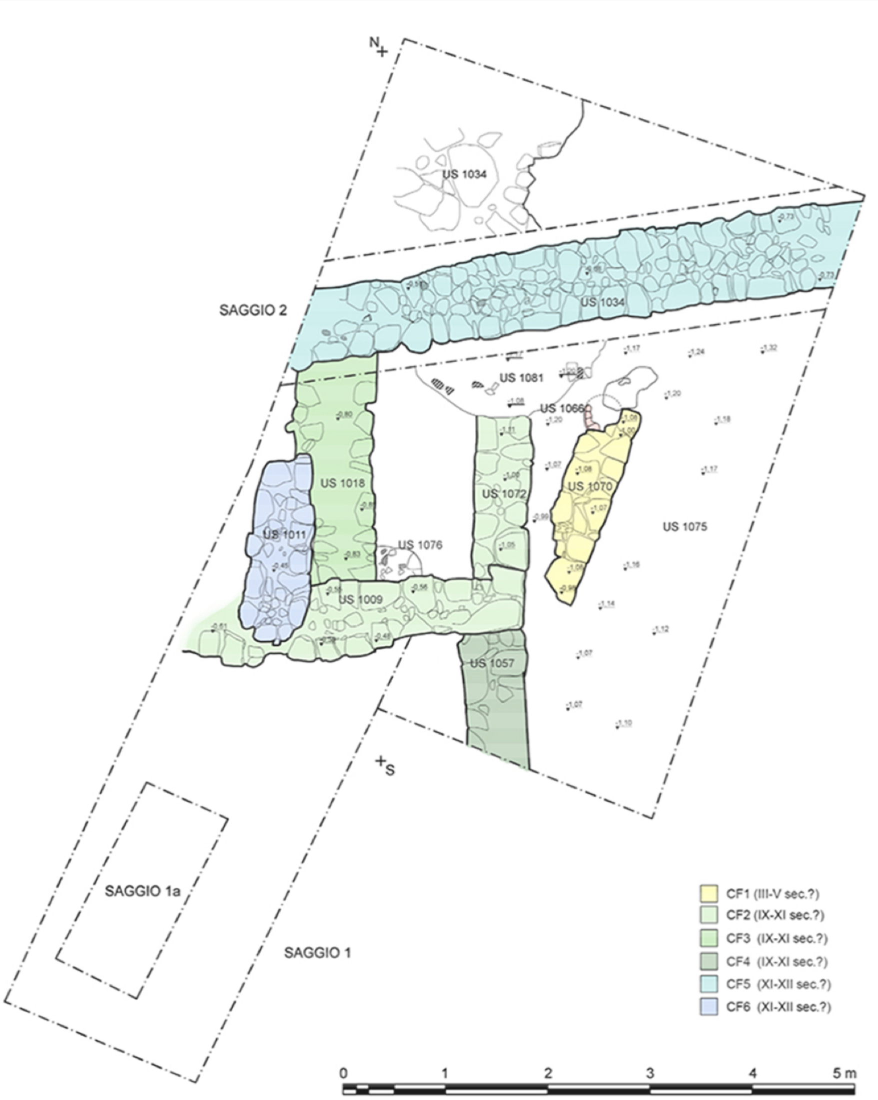


**Figure 4.4.1.** Archaeological plan of Casale San Pietro (Trench 5) with the indication of some wall structures belonging to different chronological periods (from Carver *et al.* 2018).

In Period 1, the archaeological evidence consists of several occupation layers and a building associated with highly-fragmented archaeological materials datable to the 3th-4th centuries AD.

From the second ½ of the 8th century AD to the first ½ the 9th century AD, the previous settlement was reorganised, and new structures built with irregular blocks of stone bonded with clay were erected (Period 2). This group of buildings was probably associated with a courtyard, as suggested by the identification of an oven, maybe a *tannur*/*tabun* (terracotta oven for baking flat bread), a typical element in Arabic households (Carver *et al.* 2018) (Fig.4.4.2).

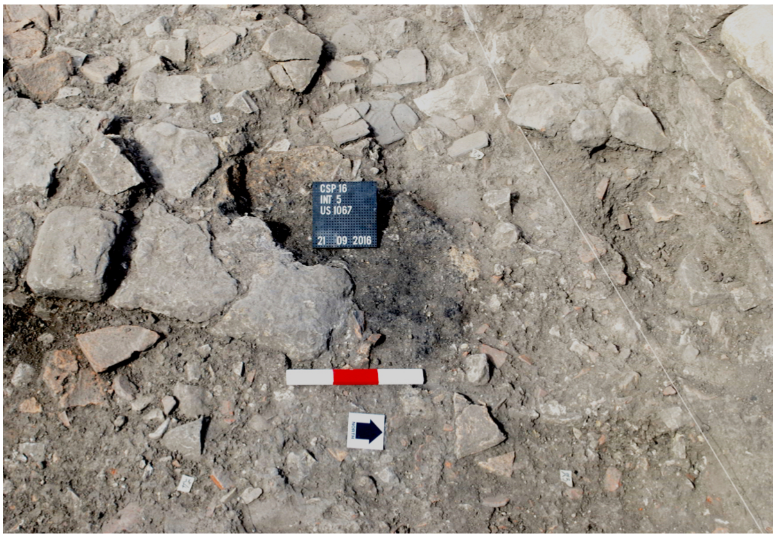


**Figure 4.4.2.** The oven identified at Casale San Pietro (Castronovo di Sicilia, Palermo) and interpreted as a a *tannur*/*tabun* (Trench 5, US 1067) (from Carver *et al.* 2018).

These structures were abandoned between the 10th and late 11th centuries AD. Layers accumulated above the destruction levels produced a substantial quantity of pottery datable to the Islamic period (10th-early 11th centuries AD); this mainly consisted of fine wares including a carinated bowl, water filter jugs, painted amphorae (mostly originating from Palermo), and globular vessels with the body decorated in green and brown below a transparent glaze (Carver *et al.* 2018).

The site was later reoccupied in the late 11th-12th centuries AD, when a large building was constructed (Period 3). After the late 12th century AD, this complex was demolished. From this point onwards sporadic archaeological evidence suggests an occupation of the area in the late Norman and Swabian periods (Period 4) (Carver *et al.* 2018).

### 4.4.2. The faunal assemblage

Animal bones and teeth from Casale San Pietro consist of 321 remains. These originate from the abandonment layers of the buildings dated to early Arab period (late 8th-9 century AD) (US 1014; 1015; 1016; 1037; 1055; 1060; 1061; 1068; 1072).

The archaeological campaigns carried out in 2017 and 2018 brought to light additional archaeological contexts containing animal remains. However, this became available too late in the course of this dissertation project and will therefore be part of future studies.

## 4.5. Mazara del Vallo (Trapani)

### 4.5.1. The site

The city of Mazara del Vallo (Trapani) is located in south-western Sicily. In 1997, in occasion of the construction of a car park, archaeological excavations were carried out by the Soprintendenza dei Beni Archeologici e Ambientali di Trapani and by the Cooperativa AR.CO. of Rome (scientific directors: S. De Fabrizio, A. Molinari, S. Pergola and C. Termini). The excavation area extended for ca. 1,500 square metres in Via Tenente Gaspare, located in the outskirts of the historical city centre.

Although part of the site had already been heavily compromised by the use of heavy machinery, archaeologists uncovered several archaeological features datable from the Arab to the Norman/Swabian periods ($9^{th}$/early $11^{th}$-late $12^{th}$/$13^{th}$ centuries AD) (Fig.4.5.1).

A final archaeological report of the site is currently in preparation. Interim studies of the material mostly focus on the later period of occupation of the site (Norman/Swabian) (Molinari and Cassai 2006), while only preliminary analyses are available for the earlier phases (Cassai 2003). However, considering the preliminary report and the information provided by A. Molinari (personal comment), it was possible to broadly reconstruct the history of the site.

The first occupation period at the site is represented by a limestone surface in which a number of cavities interpreted as silos, wells, and ditches were excavated. In association with these features, there were also some wall structures, interpreted as the perimeters of two dwellings (Room I and Room II). This early phase at the site of Mazara del Vallo was also characterised by several indicators for craft activities; most of these were linked to ceramic production, as attested by the recovery of a furnace and by several pottery scraps.

The pottery material associated with the above-mentioned contexts included several ceramic shapes related to water use. In addition, table ware and cooking pots, also suggesting a domestic use of the area, were recovered. On the basis of these finds, archaeologists dated this first phase to the Arab period. This chronology was also confirmed by the recovery of glass coin weights and of a *tarì* (golden coin of Islamic origin) datable to the 9th-early 11th centuries AD (Molinari *et al.* unpublished).

Later, the site was abandoned, to be reoccupied only in the Norman/Swabian period (late 12th-13th centuries AD). In this second phase, the previous wells started to be used for waste disposal; this evidence suggests a change in the use of the site. This later period is characterised by the recovery of a high number of glass and ceramic fragments, which were mostly found in the abandonment layers of the previous wells; among these latter, several spiral ware, proto-maioliche ‘brindisine’, ‘graffita arcaica tirrenica’ and pots of the ‘Messina type’ were found.

Some wells continued to be used for waste disposal until the 17th century AD, as attested by the recovery of glazed and maiolica pottery fragments (Molinari *et al.* unpublished).

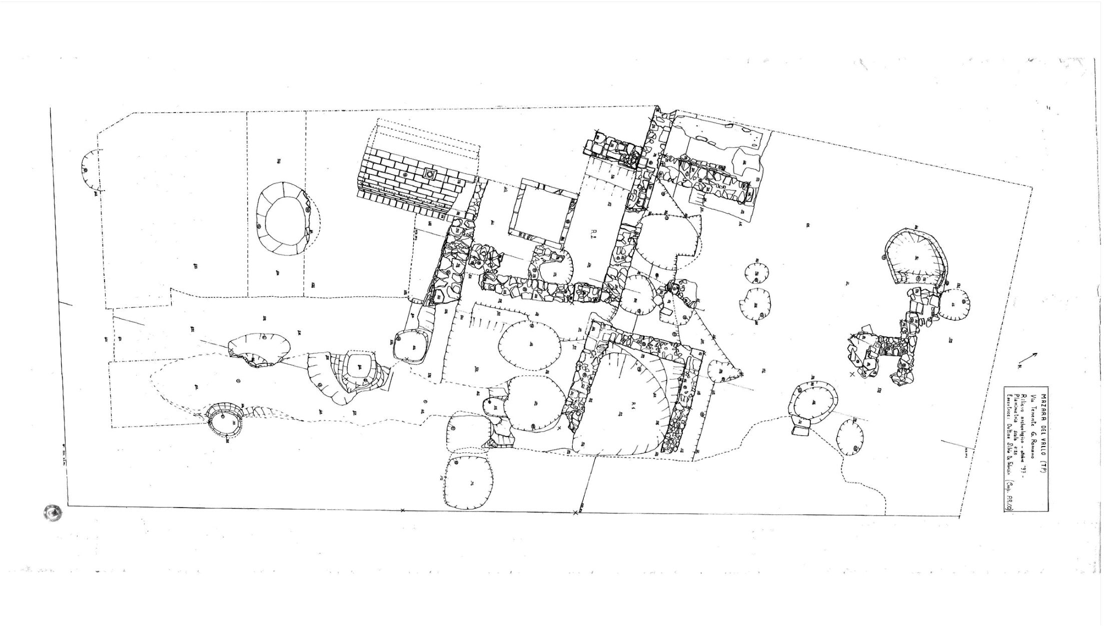


**Figure 4.5.1.** Archaeological plan of the excavations at the site of Mazara del Vallo (Via Tenente Gaspare), with wall structures, wells, silos and ditches from the two phases (from Molinari *et al.* unpublished).

### 4.5.2. The faunal assemblage

Animal bones and teeth recovered from the site of Mazara del Vallo (Via Tenente Gaspare) consist of 1398 hand-collected remains. These originated from several archaeological contexts dated to both the Arab and the Norman/Swabian phases.

The faunal remains from the Arab period (late 10th-early 11th centuries AD) derive from the occupation layers of Room 1 (US 83; 87; 89; 105, US and 106) and Room 2 (US 29; 47; 62; 64; 66; 72; 75; 80; 86; 96; 104; 107; 109; 122 and US 125), structure US 36, abandonment layers of well US 2 (US 3 and US 12), well US 18 (US 19; 27; 31; 45; 48 and US 55) and well US 90 (US 89).

The faunal assemblage collected from the Norman/Swabian contexts (late 12th-13th centuries AD) originates from the fills of well US 4 (US 8; 5 and US 11), well US 6 (US 7 and US 9), well US 32 (US 33; 34; 41; 46; 49; 53; 56; 57 and US 59), well US 51 (US 52; 63; 71 and US 74) and the abandonment layers of Room I (US 78) and Room II (US 85).

A small quantity of animal bones and teeth belonged to 14th-15th century AD contexts; however, these remains were excluded from analysis, as they are irrelevant to the aims of this project.

## 4.6. Colmitella (Racalmuto, Agrigento)

### 4.6.1. The site

The archaeological site of Colmitella (Racalmuto, Agrigento) was discovered during maintenance works on the Agrigento-Caltanissetta motorway (2011-2014). The site is located on the south-western coast of Sicily, at a distance of approximately 15 kilometres from the city of Agrigento (Rizzo *et al.* 2015).

In the 1970s road works were carried out in the entire area, severely compromising in some parts the stratigraphy of the site. As a consequence, archaeologists could not assess the original extension of the settlement, of which only small portions were investigated (Rizzo *et al.* 2012). Nevertheless, the archaeological excavation carried out by the Cooperativa Archeologica di Firenze and the Soprintendenza dei Beni Archeologici e Ambientali di Agrigento (scientific director: Maria Serena Rizzo) revealed a complex archaeological stratigraphy that provided important insights on settlement dynamics characterising this part of the island during the Middle Ages. Previously, information about this area and period exclusively derived from field surveys (Aprosio *et al.* 1997; Rizzo 2004).

Unfortunately, a complete study of the archaeological evidence and of the materials recovered from the site of Colmitella is not yet available. Hence, the majority of information reported here derives from an initial inventory made by archaeologists M. Scibona and D. Romano, who excavated the site, and also from some preliminary archaeological reports (Rizzo and Romano 2012; Rizzo *et al.* 2012; 2014; 2015). In addition, direct observations of the archaeological finds were made by the author and by Veronica Testolini, who carried out petrographic analyses on pottery remains from the site (Testolini 2019).

During the archaeological excavation, the investigated area was divided into two main sectors: A and B (Fig.4.6.1).

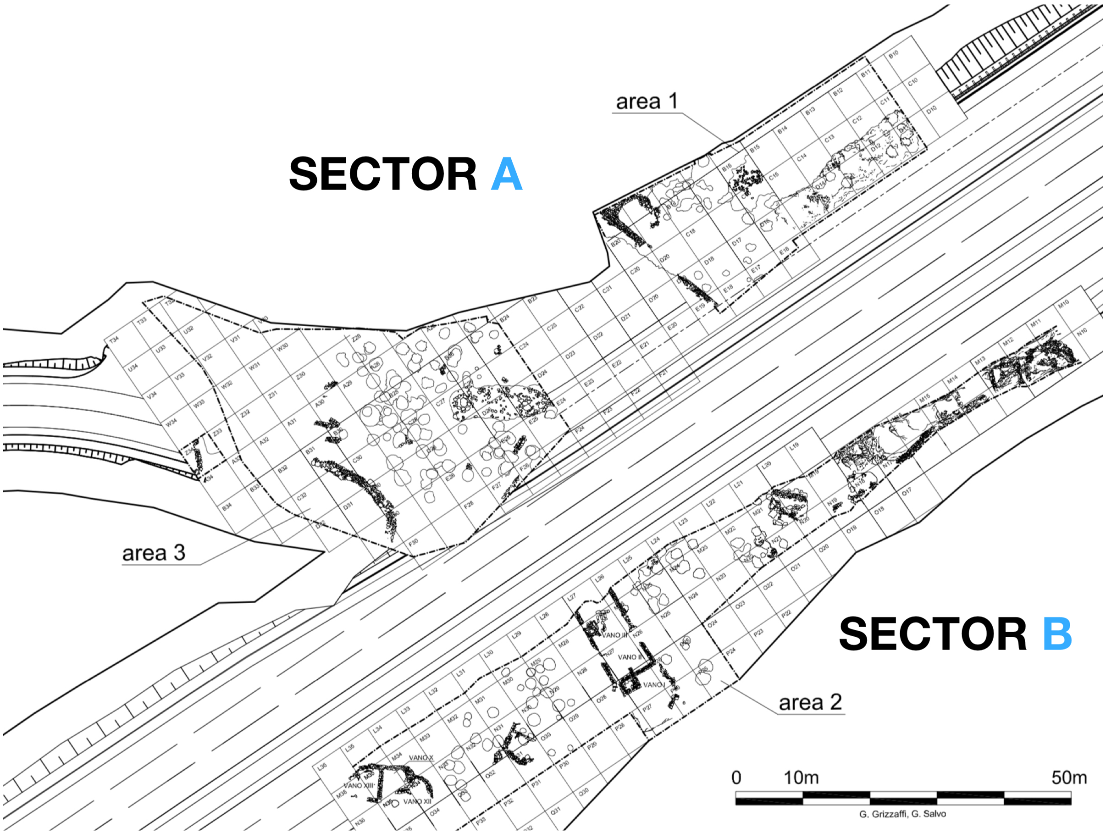


**Figure 4.6.1.** Archaeological plan of the site of Colmitella, divided into Sector A and Sector B (from Rizzo *et al.* 2015).

In Sector A, archaeologists revealed the presence of several storage pits, probably used for storing grain. Several fragments of '*dolia*' (large containers for storage or transportation) were found within the above-mentioned pits, suggesting that they could have been used as cereal containers. The preliminary study of ceramic fragments recovered from the fills of some pits revealed that these were abandoned in different periods, starting from the 7th and until the mid-12th centuries AD. In most cases, the fills consisted of a single stratigraphic unit containing homogenous ceramic materials; residual pottery fragments were rare (Rizzo *et al.* 2015). However, a complete archaeological report of Area A is not yet available, and further archaeological analyses on the structures and associated materials is needed (Rizzo and Romano 2012).

Sector B was interpreted by archaeologists as a living area; this was characterised by the presence of several buildings erected in three different construction phases spanning from 6th-7th to the late 12th centuries AD (Rizzo *et al.* 2014). The earliest layers (6th/7th-8th centuries AD) included one building (Room XIV) and a series of storage pits.

The later period of occupation (late 8th-early 9th centuries AD) is characterised by the presence of several dwellings (Rooms I-IV, IX-XIII and XV) and a series of storage pits with large *dolia* (Rizzo *et al.* 2015) (Fig.4.6.2). The suggested chronology is confirmed by the recovery in Room II of a lead seal dating to between AD 720 and 780 (with the name *Antiochos notarios*), and of a sword fragment typologically consistent with a Byzantine origin (Rizzo *et al.* 2014). The ceramic assemblage is very similar to the contemporary one from Rocchicella (Mineo, Catania), with the presence of many 'stuoia' cooking pots and globular amphorae fragments (Rizzo *et al.* 2015).

**Figure 4.6.2.** Part of a dolium found in a pit and dated to the late 8th- early 9th centuries AD (from Rizzo *et al.* 2015).

During the third occupation phase (10th-11th centuries AD), some dwellings were built in the area (Rooms VI-VIII). The archaeological material associated with some of these buildings suggested the presence of craft activities. The exact nature of such activities is still uncertain. Pottery remains associated with occupation layers of Rooms VI-VIII mainly consist of handmade cooking pots with vertical walls, basins with transparent lead glaze applied over brown manganese, and of a bronze handle with a small pomegranate on the top, which is common in Islamic contexts (Fig.4.6.3) (Rizzo *et al.* 2014). These finds might suggest the presence of an Arab community at the site; however, further analyses are needed to evaluate such hypothesis.

**Figure 4.6.3**. Handmande cooking pot with vertical walls (from Rizzo *et al.* 2014).

The later period of occupation sees the presence of some structures interpreted as bread ovens; these were typologically similar to the *tannur/tabun* (terracotta oven for baking bread) common in the Near East, Al-Andalus and Maghreb. In Sicily, similar structures were only found at the site of Piazza Armerina (Catania). The recovery of two coins dating back to the time of Roger II (AD 1095-1154) allowed to date this context to the 12th century AD. Contemporary to the bread kilns, there were also some cavities, probably used for waste disposal, from which a high quantity of ceramic and animal remains were recovered. However, a more precise interpretation of this later period was not possible, as maintenance road works had compromised the stratigraphy (Rizzo *et al.* 2014).

### 4.6.2. The faunal assemblage

Animal bone and teeth hand-collected from the site of Colmitella consist of 1517 recorded remains. These derive from different archaeological contexts from Sector B, which, until now, is the best documented and best studied area of the site.

In particular, the analysed faunal assemblage belongs to the 7th/8th-early 9th centuries AD (Byzantine period) and to the 9th-11th centuries AD (Arab period). The faunal sample from the Byzantine period represents the majority of the analysed animal remains; these originate from different occupation and destruction layers of Rooms III and II. It is worth mentioning the recovery of some animal carcasses; these were associated with the earliest fills of some pits (US 2476; 2477; 2547; 2548; 2648; 2732 and US 2733). In particular:

- US 2476 (pit: US 2460): partial red deer skeleton
- US 2477 (pit: US 2460): partial pig skeleton
- US 2547 and 2548 (pit: US 2546): partial cattle skeleton
- US 2648 (pit: US 2637): partial cattle skeleton
- US 2731 (pit: US 2720): partial cattle skeleton
- US 2732 (pit: US 2720): partial cattle skeleton

All these carcasses were found in primary deposition, as most of their elements were still in anatomical connection (*§Chapter 6: Results*).

Animal remains dated to the Arab period were recovered in occupation layers of Rooms VI-VIII.

## 4.7. Rocchicella (Mineo, Catania)

### 4.7.1. The site

The archaeological site of Rocchicella (Mineo, Catania) is located in eastern Sicily. It lies in the Margi plain, a large flat landform created by the alluvial deposition of the Margi river (Arcifa and Maniscalco 2016), at the foot of a basaltic hill plain, close to the modern village of Palagonia (Lentini) (Fig.4.7.1). The settlement, also known as Palikè, was originally founded by Ducetius in AD 459 (Maniscalco 2008).

Due to its vicinity to the urban centres of Catania and Syracuse, this area has always been densely settled and crossed by roads connecting the Ionian to the Mediterranean coast (Arcifa 2007).

**Figure 4.7.1.** Part of the archaeological site of Rocchicella (Mineo, Catania) located at the foot of a basaltic hilltop (from Testolini 2019).

Since 1995, archaeological investigations carried out by the Soprintendenza of Beni Archeologici and Ambientali di Catania have revealed a long and complex stratigraphy, with several archaeological features dated from the Palaeolithic to, at least, the late Islamic period ($11^{th}$ century AD); however, occupation at the site of Rocchicella was discontinuous, and several phases of abandonment and reoccupation are documented (Arcifa and Maniscalco 2016).

In the 7th-6th centuries BC the site was occupied by a sanctuary dedicated to two local gods: the so-called ‘Palici brothers’. This building controlled large portions of land in the surrounding area (Maniscalco 2008). During the first ½ of the 5th century BC, a *hestiaterion* (dining hall) and two *stoai* (walkways supported by columns) were erected. The use of these buildings seems to have continued into the early and mid-Roman Imperial period (1st century BC-3rd century AD), as attested by some restoration works (Maniscalco 2008).

Later, at the end of the 2nd-3rd centuries AD, the *hestiaterion* lost its original function; the recovery of a mill and a kiln suggests that this area was now used for craft activities. Unfortunately, the dearth of additional archaeological evidence did not allow more detailed interpretations of the specific nature of such activities. In this period, the settlement of Rocchicella was acquired by the owner of the Roman rural villa of Favarotta/Tenuta Grande, located 2 km from Rocchicella (Arcifa and Maniscalco 2016).

In the 4th and 5th centuries AD, the site was abandoned and it was only reoccupied in the early Byzantine period (6th-7th centuries AD), when a monastery and some dwellings were built. In this phase, a church with a semi-circular apse was erected, partially reusing some walls of the previous *hestiaterion* (Arcifa 2007; 2008b) (Fig.4.7.2).

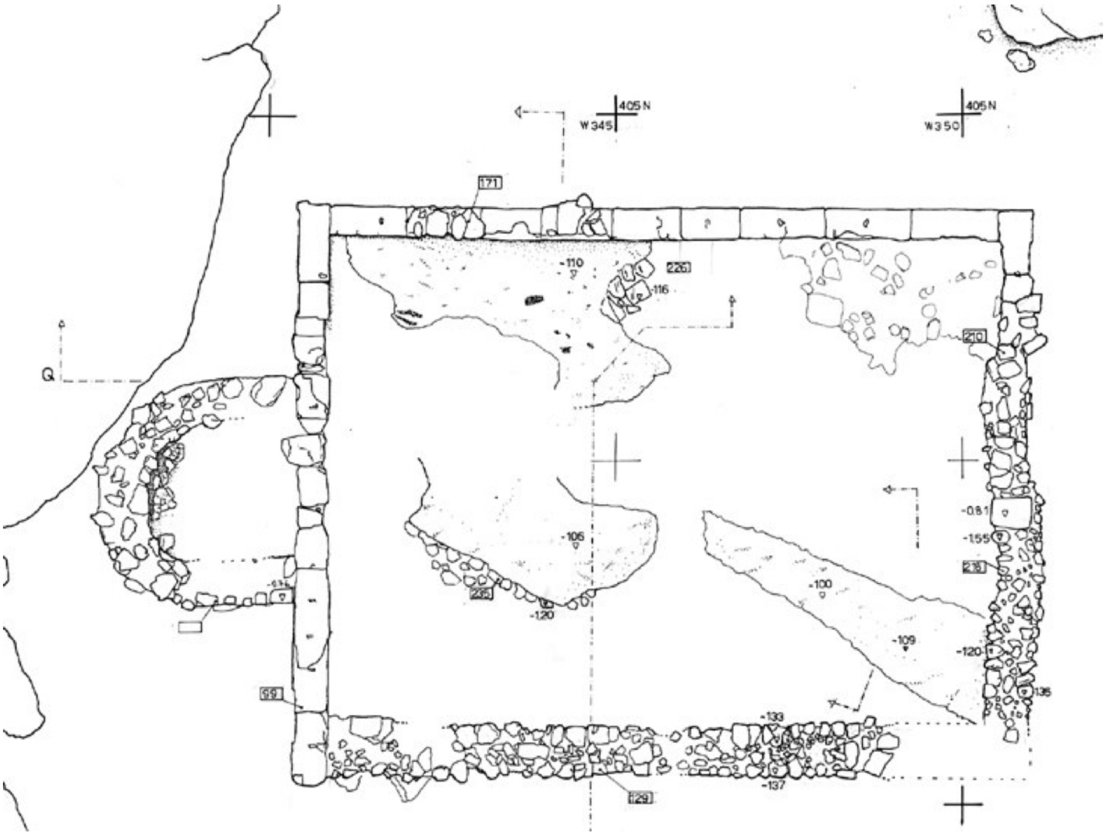


**Figure 4.7.2.** The early Byzantine church found at the site of Rocchicella (Mineo, Catania) (from Arcifa 2008b)

Among the dwellings mentioned above, four late Roman amphorae (Keay 61) were found, along with a considerable quantity of seeds, in particular legumes and cereals. These remains allowed archaeologists to interpreted this structure as a storage room (Arcifa and Maniscalco 2016). A coin scale, typologically similar to those found in other Byzantine and/or Romano-Byzantine sites dated to the 6th and 7th centuries AD (e.g Castel Trosino, Roma and Sardis), was also found (Arcifa 2008b). The 6th-7th centuries AD village shows the usual range of pottery types found in contemporary early Byzantine villages in Sicily.

At the end of the 7th century AD the church and the village were abandoned (Arcifa 2016).

Archaeological evidence dated to the first ½ of the 9th century AD attests the presence of a new settlement erected over the ruins of the previous early Byzantine village. Two circular huts located close to the storage room described above were identified; these were built with medium-large vulcanite blocks and had a housing function. The presence of circular huts dated to the high Middle Ages in Sicily is unusual; however, similar structures can also be found at the archaeological site of contrada Edera, between the villages of Bronte and Maletto (Arcifa and Maniscalco 2016).

The recovery of some Byzantine bronze coins (*folles*) dating back to the times of Costantine V (AD 741-775), Michael I (AD 811-813), Michael II (AD 820-829) and Theophilus (AD 829-842), as well as several 'stuoia' cooking pots, date this new village to the 9th century AD (Arcifa 2008b).

Excavations carried out by the University of Catania since 2012 have revealed the presence of a storage area (9th century AD), in which several globular amphorae were found *in situ*.

The recovery of metal slags and of a ceramic pot with an inscription dedicated to Sergio 'the blacksmith' (Fig.4.7.3) suggest that craft activities occurred in the vicinity and/or within the site. The productive function of this building is also confirmed by the presence of two kilns, which might have been used for firing ceramics (Arcifa and Maniscalco 2016).

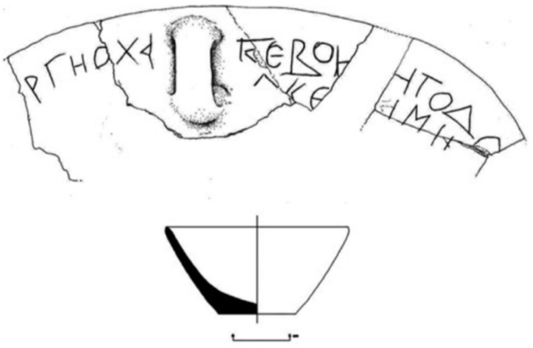


**Figure 4.7.3.** The pot with the inscription dedicated to the balcksmith Sergio found at the site of Rocchicella (from Arcifa and Maniscalco 2016).

Pottery remains dated to this chronological period are comparable to others recovered from contemporary sites in Sicily, although the number of globular amphorae found in the storeroom is remarkable (Testolini 2019).

Archaeological evidence dated to the Arab and the Norman periods has also been recorded; however, archaeological excavations carried out by the University of Catania are still ongoing, and the dating of material from these later phases is uncertain.

### 4.7.2. The faunal assemblage

Animal bones and teeth recovered from the site of Rocchicella (Mineo, Catania) consist of 785 fragments; these belong to the 1st Byzantine period (6th-7th centuries AD) and to the 2nd Byzantine period (9th century AD). Faunal remains from the former period were recovered from the occupation and destruction layers identified in some of the early Byzantine dwellings mentioned above; these were located in the proximity of the monastery (US 318; 412; 439; 441 and US 1069).

Animal remains from the 2nd Byzantine phase (9th century AD) were collected from the destruction layers of the two circular huts (US 1003; 1008; 1012; 1013; 1014; 1015; 1017; 1020; 1023; 1025; 1032; 1034; 1038; 1039; 1041; 1060 and US 1065).

The dearth of animal bones and teeth from later phases (post-9th century AD) did not make their analysis worthwhile. However, since archaeological excavations at the site will continue, additional zooarchaeological material recovered in the forthcoming campaigns will eventually contribute to a better understanding of the socio-economic and cultural dynamics characterising the site in Arab and Norman times.

## 4.8. Castello San Pietro (Palermo)

### 4.8.1. The site

The archaeological site of Castello San Pietro is located in the north-western part of the Cala harbour, within the urban core of Palermo (Di Stefano *et al.* 1989) (Fig.4.8.1).

In the 1980s, excavations at the site revealed the presence of several archaeological features dated to the late 9th-mid-10th centuries AD (Arcifa and Lesnes 1997). The investigated area (Area B) did not show any evidence of earlier occupations (Arcifa and Bagnera 2014). Additional archaeological features from later periods (Norman and Swabian), were also excavated; however, their interpretation is still debated, and a complete archaeological report has not yet been published (Arcifa personal comment).

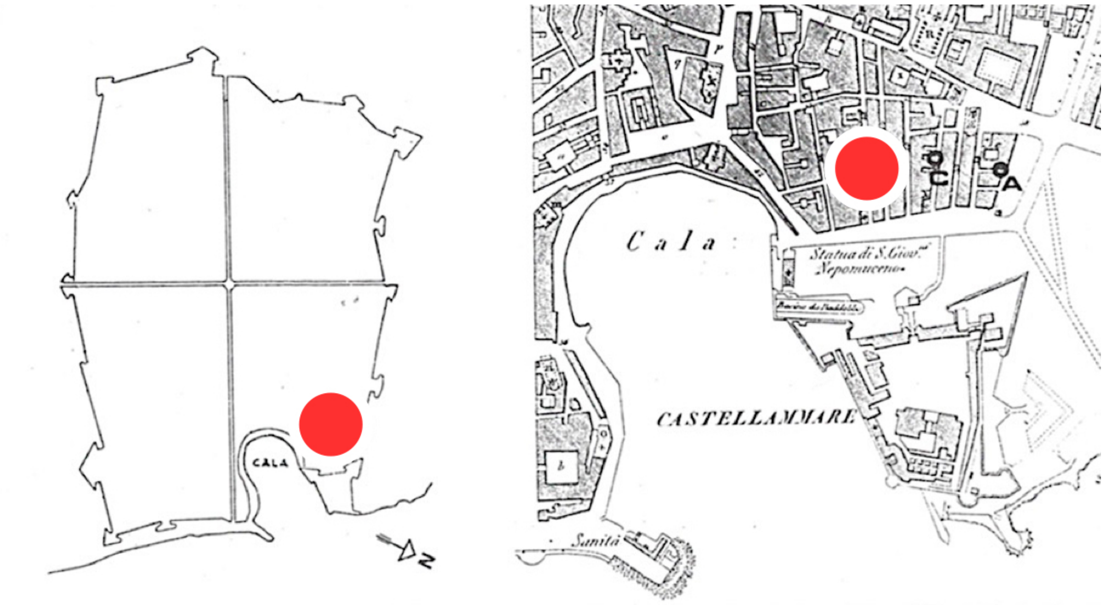


**Figure 4.8.1.** Location of the site of Castello San Pietro in a 1984 map of Palermo (from Di Stefano *et al.* 1989).

In these last few years, part of the ceramic material recovered from Area B at Castello San Pietro has been re-examined by L. Arcifa and A. Bagnera in light of the new chronological indicators identified for the early Arab period in Sicily.

Indeed, the material from some local archaeological sites was recently recognised to play a key role in outlining the ceramic sequence of Islamic Palermo (Arcifa and Bagnera 2014). Following these new results, a chronological sequence of the main archaeological evidence uncovered at Castello San Pietro (Area B) and dated from the $9^{th}$ to the $11^{th}$ centuries AD is summarised below.

The earliest phase of occupation at the site is characterised by the presence of some dwellings and an Islamic cemetery; this latter consisted of 12 burials buried in the Muslim manner, which were directly cut into the calcareous rock. Considering that the Arabs conquered the town of Palermo in 831 AD, the burials could be ascribed to the early $9^{th}$ century (Fig.4.8.2).

At a later period could be ascribed the abandoned layers of a water well (US 865), identified in Room VIII. Pottery remains found in the above-mentioned deposits suggest that the well was abandoned between the $9^{th}$ and the early $10^{th}$ centuries AD.

Following this, a wall was erected above the well; the ceramic material from associated contexts was dated to the first decades of the $10^{th}$ century AD. Contemporary to this evidence, there were also two layers (US 975 and US 977) associated to the levelling out of the rock for the construction of a road (US 973), and a series of new dwellings (Rooms IV-VI). The road and the houses covered all the previous evidence and they may have belonged to a better organised urban plan. It is possible that these constructions were part of the laying out of the Khalisa, the governmental seat established by the Fatimids in AD 937-8 (*§Chapter 2: An overview of medieval Palermo*). Two other levelling layers were identified in Room VI (US 970 and US 967), in direct stratigraphic succession with the road mentioned above. Ceramic material dated these contexts to the mid-$10^{th}$ century AD.

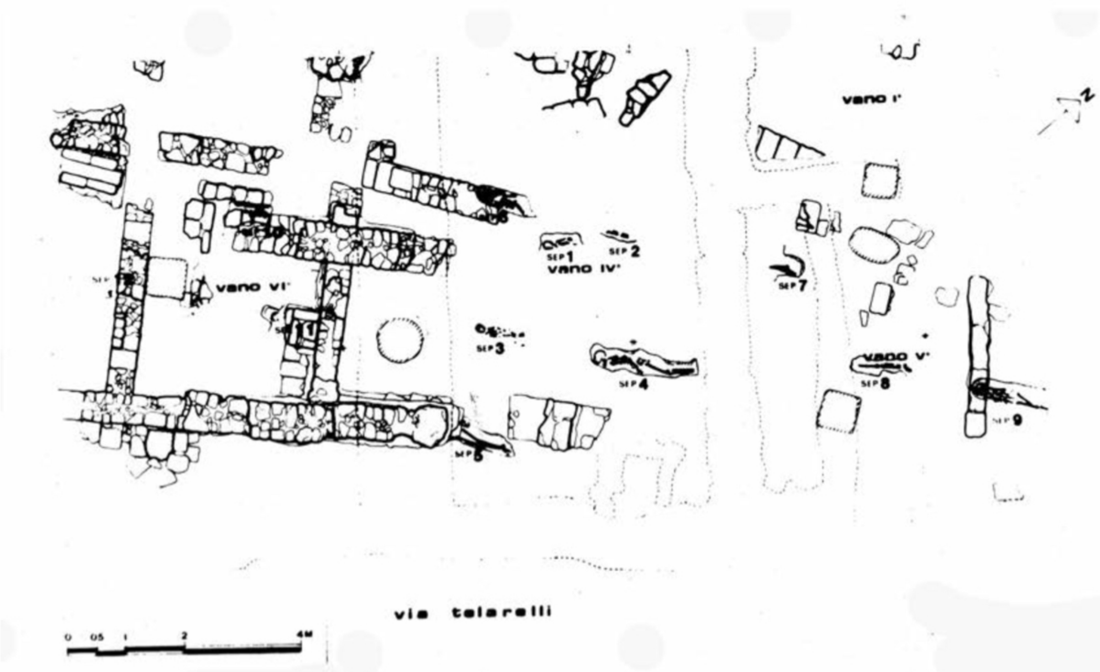


**Figure 4.8.2.** Archaeological plan of Area B at Castello San Pietro (Palermo), with the Islamic burials and the later structures (Rooms IV, V and VI) (from Arcifa and Bagnera 2014).

### 4.8.2. The faunal assemblage

The analysed animal bones and teeth from Castello San Pietro consist of 1338 remains. Among these, 497 animal fragments belong to early medieval contexts (9th century AD), while 841 refer to hitherto undated archaeological layers.

In detail, the animal remains from Castello San Pietro (Area B) mostly derive from the abandonment layer of the well US 865 (9th centuries AD); in addition, a smaller quantity of animal bones and teeth were also recovered from levelling layers US 975 and US 977 (first decades of the 10th century AD), layers US 970 and US 967, which were identified in Room VI (mid-10th century AD), and additional deposits from Room VIII (late 9th-early 10th centuries AD) and Rooms IV and V (first ½ of the 10th century AD).

# Chapter 5

# Methodology

This chapter introduces the methodology chosen to record the faunal assemblages analysed in this project.

Animal bones and teeth from archaeological sites can be recorded in a variety of ways. The choice of a certain procedure should be based on the nature of the assemblage and, more importantly, on the research questions that are being pursued.

Some zooarchaeologists are highly selective, while others tend to include all fragments; a number of middle-ground strategies are possible. The selective approach implies the recording of only a suite of pre-defined elements, and is known as the 'diagnostic zone' method (Watson 1979).

## 5.1. The diagnostic zone method

The potential of faunal assemblages to address archaeological questions has been widely recognised by the research community. The analysis of animal bones can complement the interpretation of other archaeological evidence and contribute to the investigation of local, regional or even international issues (O'Connor 2000; Reitz and Wing 2008).

However, several variables such as natural processes and/or human behaviour can bias and limit the range of information provided by animal bones and teeth. Taphonomy is the subject focused on the study of all such processes affecting living animals and their remains (Lyman 1994). As a consequence of taphonomic modification, zooarchaeologists generally deal with osteological samples that represent only a small portion of the original assemblage (De Grossi Mazzorin 2008).

The mammal skeleton is composed of about two hundred anatomical elements (and high skeletal complexity can also be encountered in other vertebrates); in addition, activities such as butchery, result in a variable degree of fragmentation of such elements. As a result of human-induced fragmentation and diagenetic processes, analyses of faunal assemblages that consider the recording of every single collected fragment can be problematic (Davis 1987). Many variables need to be taken into account in the formation of bone assemblages, and the recording of loosely defined 'fragments' or 'specimens' may lead to a situation in which they cannot be controlled.

With these fundamental problems in mind, during the 70s, a detailed, though flexible, method for recording fragmented bones was developed. Such method, initially proposed by Watson (1979), became known as the 'diagnostic zone method'. A few years later a similar system was used by Rackham (1986), while he analysed animal bones from a Roman fort at Piercerbridge (United Kingdom).

In recent years, this *modus operandi* has been used by several researchers, who have applied minor or major modifications to Watson's original recording protocol (e.g. Dobney and Rielly 1988; Serjeantson 1991; Davis 1992; Albarella and Davis 1994).

Diagnostic zones are morphologically distinctive anatomical parts that are defined prior to recording. Each diagnostic zone is chosen according to its level of differentiation between species and its survival potential in the archaeological record.

The aim of this method is to produce the highest amount of useful and reliable information, avoiding the collection of redundant, low quality and potentially misleading data. Several specific advantages in using this approach can be identified.

Firstly, this method enhances transparency concerning what is recorded, and therefore what represents a 'specimen'. Secondly, the fact that, with the protocol adopted by this study, a specimen is recorded only when more than the 50% of a diagnostic zone is present, allows for greater consistency of correct identifications across different taxa and body parts, as well as a higher control on specimen interdependence.

In addition, since all faunal assemblages analysed in this research were recorded with this method, the comparability of the recorded material is improved. Although this method leads to an apparently lower number of taxonomically identified specimens, it allows for the creation of more reliable datasets. Furthermore, the potential bias introduced by the lack of experience of relatively inexperienced researchers can be overcome through the selection of a number of diagnostic zones which can be easily identified. This also mitigates any problems resulting from the quality of available facilities (reference collections, atlases and the support of colleagues). Such approach suits perfectly this research project due to the different locations in which the faunal assemblages were stored in Sicily and the small size of the reference collection held at the Department of Animal Biology in Palermo, which could only sporadically be consulted.

### 5.1.1. The recording protocol

The starting point of the recording system adopted in this study are the principles outlined by Watson's (1979) diagnostic zone method; however, the recording method used in this research follows more closely the protocol created for the faunal assemblage of West Cotton (UK) by Albarella and Davis (1994), although some aspects were adapted to fit the nature of the analysed faunal assemblages.

Remains were recorded and then counted when more than half of the specified diagnostic zone was present. Any other fragment was recorded, but not used in quantifications, only in the presence of peculiar surface modifications, anomalous size, or when it originated from rare species. The 'non-countable' elements were recorded as 'OTH' (i.e. others). This abbreviation was used also for the proximal ends of the four main long bones that were recorded as OTHU (proximal end; head of humerus), OTHRA (proximal end), OTHFE (proximal end) and OTHTI (proximal end). In addition, loose teeth were also considered to be 'non-countable'.

Proximal epiphyses of the main long bones were not included in quantitative analyses (i.e. taxonomic quantification), but they were used in epiphyseal fusion data, in the distribution of anatomical elements as well as in taphonomic analyses (e.g. recovery bias, surface preservation, etc.).

Tab.5.1.1 and Tab.5.1.2 indicate the recorded diagnostic zones for mammals and birds, Tab.5.1.3 indicates the anatomical elements recorded for fish remains, while Tab.5.1.4 presents the remains recorded for Amphibians. Concerning the order Testudines, fragments from the carapax and plastron were considered only when sufficiently large to be assigned to one of the elements listed in Tab.5.1.5.

Data were recorded in a Microsoft Access database, using a three-database structure:

- bones
- teeth
- vertebrae and ribs

The use of a database allows pursuing a safer way of gathering data than using a normal spreadsheet program such as Excel, since defined parameters (i.e. ‘controls’) can be more easily embedded in the programme prior to recording.

The fields included in the bone database are: site name, archaeological context, anatomical element, taxon, side, state of preservation, fusion status, gnawing, burning, and pathology. These data were followed by two specific sections, the first dedicated to bone measurements and the second to comments.

The tooth database followed roughly the same structure, but additional fields were created to indicate whether a tooth was loose or within a jaw; the mandibular or maxillary positon of each tooth was also recorded, as well its eruption and/or wear stages (*§5.3 Ageing and sexing*). For Artiodactyls, no attempts were made, however, to separate first and second molars when isolated; these were recorded either as $M^{1/2}$ (maxillary) or as $M_{1/2}$ (mandibular).

When possible, the side (left/right) was recorded for all the elements, apart from phalanges and loose teeth.

The database for vertebrae and ribs presents less fields than those for teeth and bones; these mainly provide an indication of size classes (i.e. small/medium and large), presence of butchery, gnawing and burning marks, as well as pathological conditions.

| **MAMMALS: diagnostic zones** | |
|---|---|
| horncore (complete trasversal section) | vertebrae (present/absent) |
| upper teeth (occlusal surface) | ribs (present/absent) |
| **maxilla (with at least one tooth)** | **pelvis (ischial part of acetabulum)** |
| lower teeth (occlusal surface) | proximal femur (head) |
| **mandible (with at least one tooth)** | **distal femur** |
| **zygomaticus (cranium)** | proximal tibia |
| **atlas** | **distal tibia** |
| **axis** | **astragalus (lateral half)** |
| **scapula (glenoid cavity)** | **calcaneum (sustentaculum)** |
| proximal humerus (head) | **scafocuboid** |
| **distal humerus** | **distal metatarsal (pig and carnivores only III, IV)** |
| proximal radius | **distal metapodial (pig and carnivores only III, IV)** |
| **distal radius** | **proximal 1st phalanx** |
| proximal ulna (articulation) | **proximal 2nd phalanx** |
| **C3 or C2+3** | **proximal 3rd phalanx** |
| **distal metacarpal (pig and carnivores only III, IV)** | - |

**Table 5.1.1.** Diagnostic zones for mammals; countable elements in bold (after Albarella and Davis 1994).

| **BIRDS: diagnostic zones** | |
|---|---|
| **scapula (articular end)** | distal carpometacarpus |
| proximal coracoid | **sternum (coracoid articulation)** |
| **distal coracoid** | ribs (present/absent) |
| proximal humerus | vertebrae (present/absent) |
| **distal humerus** | proximal femur |
| proximal radius | **distal femur** |
| **distal radius** | proximal tibiotarsus |
| **proximal ulna** | **distal tibiotarsus** |
| distal ulna | proximal tarsometatarsus |
| **proximal carpometacarpus** | **distal tarsometatarsus** |

**Table 5.1.2.** Diagnostic zones for birds; countable elements in bold (after Albarella and Davis 1994).

| **FISH: anatomical elements** | **Region** |
|---|---|
| lepidotrich | fin skeleton |
| pterygiophore | |
| articular | oromandibular region |
| dentary | |
| maxilla | |
| premaxilla | |
| basipterygium | appendicular skeleton |
| cleithrum | |
| cerathoyal | hyoid region |
| epihyal | |
| hyomandibular | |
| subopercular | |
| urohyal | |
| branchiogestal ray | |
| ceratobranchial | branchial region |
| pharyngeal | |
| frontal | orbita region |
| neurocranium bone | neurocranium |
| otic bulla | otic region |
| postemporal | |
| parasphenoid | basicranial region |
| prevomer | olfactory region |
| scale | - |
| scute | |
| rib | vertebral column |
| vertebrae | |
| anterior abdominal vertebra | |
| posterior abdominal vertebra | |
| caudal vertebrae | |

**Table 5.1.3.** Recorded anatomical elements for fish (after Wheeler and Jones 2009).

| **AMPHIBIANS: diagnostic zones** | |
|---|---|
| **atlas** | **femur** |
| **scapula** | **tibiofibular** |
| **humerus** | **astragalus** |
| **radioulna** | **calcaneum** |
| **pelvis** | **metapodials** |
| **urostyle** | - |

**Table 5.1.4.** Diagnostic zones recorded for amphibians; countable elements in bold.

| **TESTUDINES: diagnostic zones** | |
|---|---|
| **carapax** | ribs (present/absent) |
| **plastron** | **pelvis** |
| **scapula** | **femur (proximal and distal)** |
| **coracoid** | **tibia (proximal and distal)** |
| **humerus (distal and proximal)** | **fibula (proximal and distal)** |
| **radius (distal and proximal)** | **astragalus** |
| **ulna** | **calcaneum** |
| **metacarpal** | **metatarsal** |
| vertebrae (present/absent) | - |

**Table 5.1.5.** Diagnostic zones recorded for Testudines; countable elements in bold.

### 5.1.2. Taxonomic identification

Taxonomic identification, when possible, was aided by comparison with the small reference collection held at the Department of Animal Biology in Palermo. Some difficult specimens were taken to the Department of Archaeology (University of Sheffield, UK) to allow comparison with the zooarchaeological reference collection hosted there.

The animal bone atlases by Schmid (1972) and Barone (1976) were also used for identification. Cohen and Serjeantson (1996)'s work further helped bird identification.

During the identification process, well-preserved archaeological specimens were regularly used for internal comparison; these tended to be very useful, as they bear the greatest similarity to other bones from the same assemblage.

*Caprines* - The distinction between sheep (*Ovis aries*) and goat (*Capra hircus*) was attempted on a pre-defined set of anatomical elements (largely following Albarella and Davis 1994) (Tab.5.1.6). The distinction was based on Boessneck (1969), Kratochvil (1969), Payne (1985), Zeder and Lapham (2010) for postcranial bones and Payne (1985), Halstead *et al.* (2002) and Zeder and Pilaar (2010) for mandibular premolars. Maxillae, mandibular teeth other than premolars, and unfused bones were generically classified as 'O' (i.e. *Ovis*/*Capra*). In addition, some caprine post-cranial measurements *sensu* Salvagno and Albarella (2017) were used to allow an estimation of the proportion of sheep and goat on the basis of biometrical analysis (*§5.4 Biometry*; *Chapter 6: Results*).

| **Sheep (*Ovis aries*)/goat (*Capra hircus*) distinction** | |
|---|---|
| **Anatomical elements** | |
| horncore | **distal metacarpal** |
| posterior cranium | **distal tibia** |
| **mandible (in the presence of at least one of these teeth: dP$_3$, dP$_4$, P$_3$, P$_4$)** | **astragalus** |
| **dP$_3$, dP$_4$, P$_3$, P$_4$ (loose teeth)** | **calcaneum** |
| proximal radius | **distal metatarsal** |
| **distal humerus** | **1st, 2nd and 3rd phalanges** |

**Table 5.1.6.** Anatomical elements on which separation between sheep and goat was attempted; countable elements in bold.

*Suids* - The wild boar (*Sus scrofa*), the ancestor of the domestic pig (*Sus domesticus*), was present in Sicily, as well as in most of Europe, during the early and late Middle Ages (Masseti 2016). In zooarchaeology, it is generally difficult to distinguish the remains of pig from those of its wild form. As a result, biometrical analyses were carried out in order to assess the incidence of pigs and wild boars in all the analysed faunal assemblages (*§5.4 Biometry; Chapter 6: Results*).

*Cervids and bovids* - Roe deer (*Capreolus capreolus*) and red deer (*Cervus elaphus*) were present in Sicily in the chronological periods considered for this project, while the occurrence of the fallow deer (*Dama dama*), at least in the Arab phase is debatable (Masseti 2016). The distinction between cervids and bovids can be problematic for certain elements; the main reference used in order to separate between sheep/goat and roe deer (*Capreolus capreolus*) was Helmer and Rocheteau (1994), while Prummel (1988) was consulted for the larger species (i.e. cattle - *Bos taurus* - and red deer - *Cervus elaphus*). Even though these references, along with internal comparisons, helped in identifying some taxa specifically, some had to be left undetermined as *Ovis/Capra/Capreolus* (OCC) and *Cervus/Bos* (CB). The distinction of different cervids (red deer and fallow deer) was mainly based on the criteria suggested by Lister (1996); in particular, the most useful morphological criteria for separating the two species were the proximal radius and the distal tibia. Some dubious post-cranial bones, which had preliminarily been identified as belonging to the fallow deer, were taken to Sheffield, UK, to be compared with material in the local reference collections, and for consultation with my supervisor and other colleagues.

*Lagomorphs* - Separation based on biometrical criteria could not be attempted due to the dearth of usable measurements. Callou's (1997) morphological parameters were used to separate rabbit (*Oryctolagus cuniculus*) from hare (*Lepus* sp.). In the majority of cases it was not possible to distinguish between the two species. For this reason, most faunal remains were registered as 'LAG' (i.e. Lagomorphs).

*Equids* - The taxonomic identification of the remains of horse (*Equus caballus*), donkey (*Equus asinus*) and their hybrids (mules and hinnies) is difficult. Nevertheless, attempts to biometrically separated 1st phalanges of horse from those belonging to closely-related taxa were made following Davis (1982) (*§Chapter 6: Results*). However, in the majority of cases remains of equids had merely to be registered as 'EQ' (i.e. Equids).

*Carnivores* - The distinction between dog (*Canis familiaris*), wolf (*Canis lupus*) and fox (*Vulpes vulpes*) has been attempted on the basis of biometrical data, although separating dog from wolf is rarely feasible. The same is also the case for the distinction between the domestic cat (*Felis catus*) and its wild form (*Felis silvestris*). In the majority of cases, the archaeological remains could not be assigned to species and had to be recorded as 'CAN' (*Canidae*) and 'FEL' (*Felidae*).

There was no need to differentiate the European pine marten (*Martes martes*) from the beech marten (*Martes foina*), since this latter was not present in Sicily during the Middle Ages, and is still absent today (Sarà 2008; Masseti 2016). Within the Mustelidae family, the ferret (*Mustela putorius furo*) was present in Sicily during the Middle Ages, as is today (Genovesi and De Marinis 2003). This animal was and still is commonly used in North Africa as well as in southern Europe to hunt rats and rabbits (Masseti 1992). The wild form of the ferret, the European polecat (*Mustela putorius*), was not present in Sicily in the analysed period and it remains absent today (Masseti 2016).

The distinction between the European pine marten and the ferret was mainly attempted on the basis of biometrical criteria, as the first species is substantially larger. In addition, the Sheffield reference collection was consulted, and Loy's *et al.* (2004), Ambros and Hilpert's (2005) and Baumann and Gornetzki's (2013) works were also used. Another mustelid present in medieval Sicily was the weasel (*Mustela nivalis*), which is characterised by a much smaller size in comparison to the pine marten and the ferret, hence it is unlikely to be confused with them. This animal is today widely distributed in Sicily (Sarà 2008).

As concerns larger mustelids, the Eurasian otter (*Lutra lutra*) was present in medieval Sicily, while the European badger (*Meles meles*) has never been documented on the island. The Eurasian otter became extinct on the island in the 1950s (Masseti 2016). Due to its larger size and distinct morphology, it is unlikely to be confused with any other mustelids.

Most anatomical remains belonging to the Mustelidae family were generally recorded as 'MUST' (Mustelidae); few attempts to attribute such remains to a species level were made on biometrical observations.

*Micromammals* - In this study, the identification of the few micromammal remains recorded in the analysed faunal samples was only attempted on teeth, and they mainly relied on comparisons with mandibles and/or loose teeth from individuals stored in the Sheffield reference collection. Pictures and morphological descriptions from Andrews (1990), Fernandez-Jalvo and Andrews (1992), Balčiauskienė *et al.* (2002) and Holmes and Wallace (2002) were also used.

*Galliformes* - It is usually difficult to separate, on the basis of bone morphology, chicken from some other species of the family Phasianidae.

Among the bird species belonging to the Phasianidae, the common pheasant (*Phasianus colchicus*) is rarely found in Sicilian medieval contexts (Hill and Robertson 1988; Masseti 2016). Bresc (1980) wrote, on the basis of historical evidence, that this species became more common on the island between the 12th and the 15th centuries AD; before this period, its distribution seems to have been limited to the eastern part of the island (Bresc 1980).

The helmeted guineafowl (*Numidia meleagris*), native to Africa, is osteologically similar to the chicken (Serjeantson 2009, 309). Its presence in Europe is attested since the Roman period in literary sources (e.g. Varro and Columella), as well as in iconographic reproductions (but in this latter case, we cannot be sure of the physical presence of the bird on European soil). In later periods, the presence of this species is attested by Frederick II (AD 1194-1250); however, it was considered a rarity until the 16th century AD, when Portuguese ships returning from West Africa introduced it in larger quantities to southern Europe (Serjeantson 2009). The osteological identification of this bird in medieval Italy is limited to only two sites, Calathamet (Sicily, 13th century AD; Sarà 2005) and Torre della Curia (Liguria, 12th-13th centuries AD; Serjeantson 2009).

Hence, and despite their likely rarity, both the common pheasant and the guineafowl could have been present in Sicily during the Middle Ages. Therefore, the majority of bones belonging to the *Galliformes* order has been cautiously assigned to the broader category ‘GNP’ (i.e. *Gallus/Numidia/Phasianus*), though the overwhelming majority is likely to derive from chicken. However, separation between chicken, pheasant and guinea fowl remains has been attempted on the most diagnostic elements (proximal coracoid, proximal scapula, distal humerus, ulna, proximal femur and tarsometatarsus). The atlas of Tomek and Bochenski (2009) was consulted to aid these identifications.

*Passeriformes* - Due to the lack of an extensive reference collection, it was impossible to assign the few passerine present in the assemblages to species level. For this reason, all remains belonging to this order were recorded as 'PSF' (i.e. Passeriformes).

*Amphibians* - The remains of frogs (*Rana* sp.) and toads (*Bufo* sp.) are usually very difficult to tell apart; the only exception is the pelvis, which can be identified to genus based on morphological criteria. All other elements were registered as 'AMP' (i.e. Amphibians).

*Testudines* – In the majority of cases, it was not possible to separate morphologically turtles from tortoises. As a result, most anatomical elements were generally recorded as 'TES' (i.e. Testudines).

*Fish* - All the fish remains were firstly recorded as 'FIS' (i.e. Fish) in the database. At a later stage, they were taken to Sheffield. Here, identification of fish bones and teeth relied on the help of my colleague Angela Maccarinelli (PhD candidate at the University of Sheffield), who deals with fish remains for her doctoral project, and also on direct comparisons with the Sheffield fish reference collection. In addition, Cannon's (1987) and Wheeler and Jones's (2009) manuals, as well as the digital website of the Archaeological fish resource of the University of Nottingham (2019) were consulted. The few measurements taken on fish remains follow Morales and Rosenlund (1979) (*§5.4 Biometry*).

## 5.2. Quantification

Quantification is a crucial part of the analysis of animal bone assemblages. Converting the amount of identified bones into numbers allows assessing the abundance of species in a given site-period, and therefore the examination of changing frequency patterns through time and in different archaeological contexts.

However, since the beginning of the discipline, different quantification methods have been subjected to intense debates, highlighting the pros and the cons of each system (Reitz and Wing 2008).

In this project, the frequency of animal species was calculated using the number of identified specimens (NISP) and the minimum number of individuals (MNI). The minimum number of anatomical units (MAU), which was obtained from the minimum number of elements (MNE), was used for the analysis of body part distributions.

### 5.2.1. Number of Identified Specimens (NISP)

In order to quantify the relative proportion of each taxon, the number of identified specimens (NISP) was calculated. This represents the raw count of all specimens classified as 'countable'.

However, the use of NISP as the basic measure of taxonomic abundance of a specific assemblage presents some drawbacks.

The first problem is that of interdependence (Grayson 1984; Lyman 1994). The use of this method implies that each recorded specimen represents an individual unit; however, different fragments attributed to the same species may have derived from the same animal. This problem is enhanced when the analysed assemblage presents a high degree of fragmentation.

In addition, NISP analysis does not consider the variability in the number of bones making up the skeleton of different species. As an example, the pig skeleton is characterised by a higher number of toes and teeth than that of sheep; this may result in an over-estimation of pig remains relative to caprines. However, this problem is partly overcome by the selection of diagnostic zones used in this study, and can also be adjusted by calculating the Minimum Number of Individuals (*§5.2.2 Minimum number of individuals (MNI)*).

Another drawback is that some species, such as sheep and goat, can be identified only on a limited number of bones (*§5.1.2 Taxonomic identification*), causing therefore an underrepresentation of these taxa. This problem has been overcome in this study by treating the two species together as part of the sub-family Caprinae, while species-level identifications were used only to investigate the proportions of sheep and goat.

The most serious problem of NISP is, however, that is highly subject to recovery bias, particularly when no sieving occurred on site. Specimens deriving from smaller body parts and smaller taxa will be more commonly overlooked during excavation, and will, therefore, end up being underrepresented.

### 5.2.2. Minimum number of individuals (MNI)

The minimum number of individuals (MNI) is another quantification method. It is based on the use of the most frequent anatomical element for each identified species as a predictor of its frequency (Lyman 1994, 100). The MNI represents the highest MAU obtained for each taxon (*§5.2.3 Minimum number of elements (MNE) and Minimum Number of Animal Units (MAU)*).

Although the MNI overcomes part of the problems affecting the NISP, it is also subjected to a number of limitations. Indeed, the use of this method tends to lead to an over-representation of rare species (particularly when sample size is small), since even a single recorded fragment equals one animal. Furthermore, the result varies according to the ways in which the archaeological contexts are combined (Grayson 1984). In addition, by using individual animals as the unit of analysis it is assumed that whole complete animal carcasses entered the analysed archaeological context. However, this was not necessarily the case.

Conversely, one advantage on the MNI in comparison to NISP is that is much less affected by recovery bias as it relies only on the most common anatomical element. The effect of small body parts in taxonomic quantification is, therefore, substantially mitigated.

In this research the calculation of the MNI was carried out by dividing the total number of each anatomical element of a given taxon by the number of the same element present in the skeleton of that species, and then choosing the highest value. Differences in age, sex and size of animals were not taken into account.

The results of the NISP and of the MNI were compared. Comparisons between these two methods can provide important insights on the nature of the faunal assemblage. Similarities between the NISP and the MNI results would suggest that the species frequency is not heavily compromised by taphonomic processes as well as by biases present in the two methods. At the same time, differences between the two systems can help us in understanding the taphonomic phenomena that led to the formation of the assemblage.

### 5.2.3. Minimum number of elements (MNE) and Minimum Number of Animal Units (MAU)

The MNE is the minimum number of anatomical elements represented by the remains recorded for each taxon. The calculation of the MNE varies according to the definition of the word ‘element’, the basic unit of analysis of this quantification method (Lyman 2008). In this study, the recording of a designed set of diagnostic zones, and the presence of only one countable zone per anatomical element make the estimation of the MNE straightforward. As an example, the presence of 20 sheep distal tibiae would give an MNE of 20 for sheep tibiae.

Once the MNE per skeletal part was determined, the values were later divided by the number of times that part occurs in the skeleton of each taxon (Lyman 2008). As an example, the above-mentioned 20 sheep tibiae would give a MAU of 10. In this study, the MNE and the MAU were calculated to establish any disproportions in the skeletal representation of individual taxa.

## 5.3. Ageing and sexing

The analysis of age at death represents the most important source of information to understand exploitation strategies of a given domestic species. Age data can reveal much about the economy and society of ancient communities (Davis 1987).

### 5.3.1. Epiphyseal fusion and bone ossification

Epiphyseal fusion is here used as a primary source of ageing information, as too few mandibles are present in most of the analysed faunal assemblages. However, this method presents several limitations.

For instance, small-size bones and very young individuals characterised by less ossified bones are less likely to survive. This aspect is very important when considering the issue of the prohibited pig for Muslim and Jewish communities (*§Chapter 3: The archaeology of food and social identity*). This species is only raised for its meat, implying that animals are usually culled as subadults, when they have reached their optimum weight; since the more porous bones from younger animals can be biased against, as they are less resilient to taphonomic damage, immature pigs can end up being underrepresented.

The method itself implies that it is not possible to distinguish between individuals of different ages once all their bones are fused. The animals that survive after the late fusing stage can either represent early adults, mid-adults or elderly individuals. According to the system adopted in this study, during the process of skeletal growth from birth to sub-adulthood, three age stages can be identified. A major issue related to this method, indeed, is the much lower degree of precision in comparison to the analysis of mandibular wear stages, as a result of a higher incidence of taphonomic biases and of resolution of the analyses.

In an animal skeleton, hence in most faunal assemblages, postcranial bones are much more abundant than mandibles, implying that it may be more often possible to reconstruct ageing through epiphyseal fusion than with the analysis of mandibular wear stages. However, it is also true that there is a higher risk of overrepresentation of the same individuals, namely that the larger amount of data we are dealing with actually originates from a very restricted number of animals.

The presence of castrated animals represents another inconvenience of this method, since the practice of castration can delay skeletal maturity.

In this study, fusion was recorded for both proximal and distal epiphyses. The stage of bone epiphyseal fusion was recorded as unfused, fused and/or fusing (when the fusion line was still visible). Fused and fusing diaphyses were considered together and, to avoid the overrepresentation of unfused elements, unfused diaphysis (but not epiphyses) were considered in the calculation of fused bone proportions.

To estimate the age of the main domestic species (cattle, sheep/goat and pig) and deer, post-cranial bones were grouped into three stages according to Silver (1969) (Tab.5.3.1); then, for each fusion group (i.e. early fusing, middle fusing and late fusing) the percentage of fused bones was calculated and plotted (*§Chapter 6: Results*).

| **Post-cranial bones** | **Pig** | **Deer** | **Cattle** | **Goat** | **Sheep** |
|---|---|---|---|---|---|
| **Early fusing:** | | | | | |
| **humerus, distal** | 12-18[1] | 18-20 | 12-18 | 11-13 | 3-10 |
| **scapula, distal** | 12 | - | 7-10 | 9-13 | 6-8 |
| **radius, proximal** | 12 | 5-8 | 12-18 | 4-9 | 3-10 |
| **acetabulum** | 12 | 8-11 | 6-10 | - | 6-10 |
| **metapodial, proximal** | (Fused before birth for many taxa) | | | | |
| **phalanx 1, proximal** | 24 | 17-20 | 18-24 | 11-15 | 6-16 |
| **phalanx 2, proximal** | 12 | 11-17 | 18-24 | 9-13 | 6-16 |
| **Middle fusing:** | | | | | |
| **tibia, distal** | 24 | 20-23 | 24-30 | 19-24 | 15-24 |
| **fibula, distal** | 30 | - | - | - | - |
| **calcaneus, proximal** | 24-30 | 26-29 | 36-42 | 23-60 | 30-36 |
| **metapodium, distal** | 24-27 | 26-29 | 24-36 | 23-36 | 18-28 |
| **Late fusing:** | | | | | |
| **humerus, proximal** | 42 | > 42 | 42-48 | 23-84 | 36-42 |
| **radius, distal** | 42 | - | 42-48 | 33-84 | 36-42 |
| **ulna, proximal** | 36-42 | 26-42 | 42-48 | 24-84 | 36-42 |
| **ulna, distal** | 36-42 | 26-35 | 42-48 | - | 42 |
| **femur, proximal** | 42 | 32-42 | 42 | 23-84 | 30-42 |
| **femur, distal** | 42 | 26-42 | 42-48 | 23-60 | 36-42 |
| **tibia, proximal** | 42 | 26-42 | 42-48 | 23-60 | 36-42 |
| **fibula, proximal** | 42 | - | - | - | - |
| **vertebral, centrum** | 48-84 | 35-42 | 84-108 | - | 48-60 |

**Table 5.3.1.** Age at epiphyseal fusion of postcranial bones for pig, deer, cattle, goat and sheep (after Silver 1969).

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[1] The numbers in the table refer to months (e.g. 12=12 months).

A limited set of measurements was taken on unfused bones to provide additional information on the age distribution of young individuals (Tab.5.3.2).

| **Measurement** | **Description** | **Bibliography** |
|---|---|---|
| **SLC** | smallest length of the collum scapulae (not in birds) | von den Driesch 1976 |
| **GLud** | greatest length of unfused diaphyses | von den Driesch 1976 |
| **SD** | smallest breadth of the diaphysis | von den Driesch 1976 |

**Table 5.3.2.** Measurements considered on unfused bones (after von den Driesch 1976).

In some cases, it was also possible to estimate an approximate age at death for cervids by observing their antler structure. Indeed, antlers increase in weight, size and complexity every growth year, with the exception of the very old individuals (Reitz and Wing 2008).

The age estimation of bird remains relied on observations of the degree of bone ossification (distinguishing between immature and mature), and for those few bones which present epiphyses, on the degree of fusion (unfused, fusing and fused).

### 5.3.2. Mandibular wear stage

In this research age at death is also based on dental development and wear.

Tooth eruption was recorded following Ewbank *et al.* 1964 (Tab.5.3.3).

In this study, the wear stage of each tooth was recorded following Grant (1982) for cattle and pig, while Payne (1973) was used for sheep and goat.

Mandibles were attributed to age stages only when at least two teeth with recordable wear in the $dP_4/P_4$-$M_3$ sequence were present. The mandibular wear stage of cattle and pig was recorded following O'Connor (1988) (Tab.5.3.4), while Payne's (1973) (Tab.5.3.5) method was used for sheep and goat.

When mandibles could not be directly attributed to a wear stage, the tables by Grant (1982) and Payne (1973) were consulted.

| **Abbreviations** | **Erupting stage** |
|---|---|
| **C** | Still in crypt |
| **V** | Visible |
| **E** | Erupting |
| **H** | Half-erupted |
| **U** | Fully erupted, yet unworn |

**Table 5.3.3.** Tooth eruption stages (after Ewbank *et al.* 1964).

| **Mandibular wear stage *sensu* O'Connor (1988)** | Tooth wear stages *sensu* Grant (1982) |
|---|---|
| **Neonate** | $dP_4$ not yet in wear |
| **Juvenile** | $M_1$ not yet in wear |
| **Immature** | $M_1$ in wear, $M_2$ not yet in wear |
| **Sub adult** | $M_2$ in wear, $M_2$ not yet in wear |
| **Adult** | $M_3$ in wear, not yet heavily word |
| **Elderly** | $M_3$ heavily worn (stage j or beyond *sensu* Grant 1982) |

**Table 5.3.4.** Mandible wear stages for cattle and pig (after O'Connor 1988). The 'Neonate' category has been added to O'Connor's original scheme.

| **Mandibular wear stage** | **Tooth wear stages** | **Estimated age** |
|---|---|---|
| **A** | $dP_4$ not yet in wear | 0-2 months |
| **B** | $dP_4$ in wear, $M_1$ not yet in wear | 2-6 months |
| **C** | $M_1$ in wear, $M_2$ not yet in wear | 6-12 months |
| **D** | $M_2$ in wear, $M_3$ not yet in wear | 1-2 years |
| **E** | $M_3$ in wear, posteriori cup still unworn (stages 1-8) | 2-3 years |
| **F** | posterior cusp of $M_3$ in wear (stage 9-10) | 3-4 years |
| **G** | $M_3$ stage 11, $M_2$ stage 9 | 4-6 years |
| **H** | $M_3$ stage 11, $M_2$ stage post-9 | 6-8 years |
| **I** | $M_3$ stage post-11 | 8-10 years |

**Table 5.3.5**. Mandible wear stages for caprines (after Payne 1973).

### 5.3.3. Sexing

The analysis of the sex ratio of domestic populations can provide important insights on husbandry strategies.

In addition to biometrical analyses, the relative proportion of females, males and castrates can be assessed on the basis of specific morphological and morphometric features, though this is rarely, if ever, straightforward.

In this project, a number of sex-dependent features were recorded.

Usually, the boar is characterised by larger and morphologically different canines in comparison to the sow. In this study, loose teeth were not considered from calculation of the proportion of male *versus* female pig canines. This is because, when isolated, the smaller female canines tend to be underrepresented in hand-collected assemblages. When pig canines were not present in the jaws, the alveoli could at times still be sexed and these data have been included in the analyses.

The presence or absence of the spur on domestic fowl tarsometatarsi was recorded in order to distinguish hens from cockerels (Sadler 1990). Cockerels are usually characterised by a distinctive spur which is located near the distal end of the tarsometatarsus. However, a number of limitations need to be considered, such as different environmental conditions and nutrition that, in some cases, can affect the fusion process of the spur (Serjentson 2009).

The process of castration (i.e. caponisation) usually results in the presence of a scar on the shaft of the tarsometatarsus, where the spur would have been present (West 1982); similar scars or reduced spurs have been also observed in hens from specific breeds (Sadler 1990; De Cupere *et al.* 2005).

Concerning cervids, the presence of antlers was used as a criterion to establish the occurrence of males.

For other taxa, any attempts to detect the sexual composition of the assemblage relied on metrical analysis (*§5.4 Biometry*).

## 5.4. Biometry

Biometry represents an important tool for zooarchaeological analysis. For instance, biometrical data can contribute to taxonomic identification; size and shape can be useful as criteria for distinguishing between species (Davis 1987), either in the absence of morphological criteria, or - better - in combination with them. Biometry can also be used to investigate sex ratios in sexually dimorphic taxa, as well as changes in size and/or shape through time as a result of environmental or human selective pressures (Albarella 2002). Biometry can be invaluable in analysing different strategies of animal husbandry and/or in investigating the introduction of new breeds, which may imply potential attempts of stock improvements. These latter analyses allow addressing research questions which are of primary importance for this project, such as the dynamics and conditions of animal improvement in the Arab period, and the development of animal management in the Byzantine and Norman/Swabian periods in Sicily.

In this study, measurements were taken after von den Driesch (1976), Payne and Bull (1988), Davis (1992), Albarella and Payne (2005) and Salvagno and Albarella (2017). The complete set of measurements considered for mammal bones is listed in Tab.5.4.1, while Tab.5.4.2 and Tab.5.4.3 present the measurements taken on bird and fish remains. Descriptions and references of measurements considered for each anatomical element of mammals, birds and fish are presented in Tab.5.4.4.

The complete list of measurements taken on mammal teeth is presented in Tab.5.4.5; detailed descriptions of each measurement considered for teeth and references are listed in Tab.5.4.6.

| **Post-cranial elements** | **Bovinae** | **Caprinae** | **Suidae** | **Cervidae** | **Equidae** | **Canidae, Felidae** | **Leporidae** |
|---|---|---|---|---|---|---|---|
| **horn cores** | L; W min W max | L; W min W max | - | - | - | - | - |
| **atlas** | H | H | BFcr | H | H | H | H |
| **scapula** | SLC | SLC | SLC | SLC | SLC | SLC | SLC |
| **humerus** | GLC; BT; HTC; SD | GLC; BT; HTC; SD | GLC; Bd; HTC; SD | GLC; BT; HTC; SD | GLC; BT; HTC; SD | GLC; BT; HTC; SD | GLC; BT; HTC; SD |
| **radius** | GL; SD | GL; SD | GL; SD | GL; SD | GL; SD | GL; SD | GL; SD |
| **metacarpal** | GL; SD; BatF; BD; a; b; 3; 6 | GL; SD; BD; a; b; 1; 2; 3; 4; 5; 6 | GL | GL | GL | GL | GL |
| **pelvis** | LAR | LAR | LAR | LAR | LAR | LAR | LAR |
| **femur** | GL; SD; DC | GL; SD; DC | GL; SD; DC | GL; SD; DC | GL; SD; DC | GL; SD; DC | GL; SD; DC |
| **tibia** | GL; Bd; Dd; SD | GL; Bd; Dd; SD | GL; Bd; Dd; SD | GL; Bd; Dd; SD | GL; Bd; Dd; SD | GL; Bd; Dd; SD | GL; Bd; Dd; SD |
| **astragalus** | GLl; GLm; Bd; Dl | GLl; GLm; Bd; Dl | GLl; GLm | GLl; GLm | GH; GB; BFd; Lmt | GLl; GLm | GLl; GLm |
| **calcaneum** | GL; GD | GL; GD | GL; GD | GL; GD | GL; GD | GL; GD | GL; GD |
| **metatarsal** | GL; SD; BatF; BD a; b; 3; 6 | GL; SD; BD; a; b; 1; 2; 3; 4; 5; 6 | GL | GL | GL | GL | GL |
| **1st and 2nd phalanges** | - | - | - | - | GL; Bp; Dp; SD; Bd; Dd | - | - |

**Table 5.4.1.** Complete list of measurements considered for mammal remains in this study (for additional information see the complete protocol in Appendix).

| **BIRDS Post-cranial elements** | **Measurements** |
|---|---|
| **coracoid** | GL; Lm |
| **humerus** | GL; SC; Bp; Bd |
| **ulna** | GL; SC; Bp; Bd |
| **carpometacarpus** | GL; Bp |
| **femur** | GL; Lm; SC; Bp; Dp; Bd; Dd |
| **tibiotarsus** | GL; La; SC; Dip; Bd; Dd |
| **tarsometatarsus** | SC; Bp; Bd |

**Table 5.4.2.** Complete list of measurements considered for bird remains in this study (for additional information see Tab.5.4.4).

| **FISH Anatomical elements** | **Measurements** |
|---|---|
| **vertebrae** | 1a; 2a; 2b |
| **dentary** | 4 |

**Table 5.4.3.** Complete list of measurements considered for fish remains in this study (for additional information see Tab.5.4.4).

| **Measurements** | **Description** | **Bibliography** |
|---|---|---|
| **W min** | Minimum basal diameter of the horn core | Driesch, von den (1976) |
| **W max** | Maximum basal diameter of the horn core | Driesch, von den (1976) |
| **H** | Height | Albarella and Payne (2005) |
| **BFcr** | Width of cranial articular surface | Driesch, von den (1976) |
| **SLC** | Width of neck | Driesch, von den (1976) |
| **BT** | Width of trochlea | Payne and Bull (1988) |
| **HTC** | Minimum diameter of the trochlea | Payne and Bull (1988) |
| **SD** | Smallest breadth of diaphysis | Driesch, von den (1976) |
| **GL** | Greatest length | Driesch, von den (1976) |
| **BatF** | Greatest width of distal end | Davis (1992) |
| **Bd** | Width of distal end | Driesch, von den (1976)) |
| **Bp** | Width of the proximal end | Driesch, von den (1976) |
| **a** | With of left distal condyle | Davis (1992) |
| **l** | Width of right dial condyle | Davis (1992) |
| **1** | Depth of left distal condyle | Davis (1992) |
| **2** | Diameter of the verticillus of the medial condyle | Davis (1992) |
| **3** | Diameter of the internal trochlea of the medial condyle | Davis (1992) |
| **4** | Depth of right distal condyle | Davis (1992) |
| **5** | Diameter of the verticillus of the lateral condyle | Davis (1992) |
| **6** | Diameter of the internal trochlea of the lateral condyle | Davis (1992) |
| **LA** | Length of the acetabulum including the lip | Driesch, von den (1976) |
| **LAR** (pig only) | Diameter of the acetabulum | Payne and Bull (1988) |
| **DC** | Depth of the caput femuris | Payne and Bull (1988) |
| **Dd** | Depth of the distal end | Driesch, von den (1976) |
| **Dp** | Depth of the proximal end | Driesch, von den (1976) |
| **GLl** | Greatest length of the lateral half | Driesch, von den (1976) |
| **GLm** | Greatest length of the medial half | Driesch, von den (1976) |
| **Dl** | Depth of lateral side | Driesch, von den (1976) |
| **GH** | Greatest height | Driesch, von den (1976) |
| **GB** | Greatest breadth | Driesch, von den (1976) |
| **BFd** | Breadth of the distal articular face | Driesch, von den (1976) |
| **LmT** | Length of the medial part of the trochlea tali | Driesch, von den (1976) |
| **GD** | Greatest depth of the calcaneum excluding the sustentaculum | Albarella and Payne (2005) |
| **1a** | Greatest dorso-ventral height of the centrum (vertebra) | Morales-Muñiz and Rosenlud (1979) |
| **2a** | Greatest medio-lateral breadth of the centrum (vertebra) | Morales-Muñiz and Rosenlud (1979) |
| **2b** | Greatest cranial-caudal length of the centrum (vertebra) | Morales-Muñiz and Rosenlud (1979) |
| **4** | Anterior height (dentary) | Morales-Muñiz and Rosenlud (1979) |

**Table 5.4.4.** The table provides descriptions and literature references for each measurement considered for anatomical elements referring to mammal, bird and fish species.

| **Teeth** | | **Bovidae** | **Caprinae** | **Suidae** | **Equidae** | **Cervidae** | **Carnivores** |
|---|---|---|---|---|---|---|---|
| **Maxillary** | dP$^{4}$ | - | - | L;WP | - | - | - |
| | $\mathbf{M^{1}}$ | - | - | L;WA;WP | - | - | - |
| | $\mathbf{M^{2}}$ | - | - | L;WA;WP | - | - | - |
| | $\mathbf{M^{1/2}}$ | - | - | L;WA;WP | - | - | - |
| | $\mathbf{M^{3}}$ | - | - | L;WA;WC | - | - | - |
| | $\mathbf{P_{1}}$ | - | - | - | - | - | L |
| **Mandibular** | $\mathbf{P_{2}}$ | - | - | - | - | - | L |
| | $\mathbf{P_{3}}$ | - | - | - | - | - | L |
| | $\mathbf{dP_{4}}$ | W | W | L;WP | L1;WA | W | L |
| | $\mathbf{P_{4}}$ | - | - | L;WA;WP | L1;WA | - | L;W |
| | $\mathbf{M_{1}}$ | W | W | L;WA;WP | L1;WA;WD | W | L;W |
| | $\mathbf{M_{2}}$ | W | W | L;WA;WP | L1;WA;WD | W | L |
| | $\mathbf{M_{1/2}}$ | L;W | L;W | L;WA;WP | L1;WA;WD | L;W | L |
| | $\mathbf{M_{3}}$ | L;W | L;W | L;WA;WP;WC | L1;WA;WD | L;W | L |

**Table 5.4.5.** Complete list of the measurements considered for each tooth.

| **Measurements** | **Description** | **Bibliography** |
|---|---|---|
| **L** | Crown length | Driesch, von den (1976); Davis (1982); Payne and Bull (1988) |
| **W** | Crown width | Driesch, von den (1976) |
| **WA** | Width of anterior cusp | Davis (1982); Payne and Bull (1988) |
| **WC** | Width of central cusp | Albarella *et al.* (2005) |
| **WD** | Width of distal cusp | Davis (1982) |
| **WP** | Width of posterior cusp | Payne and Bull (1988); Albarella *et al.* (2005) |

**Table 5.4.6.** The table provides descriptions of each measurement considered for teeth and literature references.

As mentioned before (*§5.3.1 Epiphyseal fusion and bone ossification*), only the greatest length (i.e. GLud), the smallest breadth (i.e. SD) and the greatest length of the collum scapulae (i.e. SLC) were taken on mammalian unfused diaphyses.

Light or 'porous' astragali (i.e. immature) and unfused bones were excluded from biometrical analyses.

Scatter plots from individual elements were preferred to log ratio histograms whenever possible. The preference derived from the fact that individual measurements allow a greater control of factors affecting variation (e.g. ageing, sex differences and/or external stimuli) (Payne and Bull 1988; Albarella 2002). However, in most cases, the sample size of individual measurements was too small. Therefore, measurements from different bones were merged by using a scaling index technique, calculated through log ratios. Simpson *et al.* (1941) first introduced this method that came to be more commonly used on archaeological material after Uerpmann's (1979) and Meadow's (1981) articles.

The log-ratio technique consists in calculating the decimal logarithm of the ratio between the archaeological data and a standard value of the same measurement (Meadow 1999):

$$\text{Plotted value} = \text{Log}_{10}\ (\text{archaeological measurement / standard measurement})$$

The standards used can be the measurements of a single specimen or the means of measurements from a group of specimens, either archaeological or modern. The standards employed in this study are listed in Tab.5.4.7:

| **Domestic species** | **Standards measurements** | **Reference** |
|---|---|---|
| **Caprines** | the mean of measurements of sheep bones from a sample of unimproved Shetland ewes | Davis 1996 |
| **Cattle** | the mean of measurements of cattle bones from the late Iron Age at the site of Heybridge, Essex (UK) | Albarella *et al.* 2008 |
| **Pigs** | the mean of measurements of pig teeth from the late Neolithic site of Durrington Walls (Wiltshire, UK) | Albarella and Payne 2005 |

**Table 5.4.7**. Standard used in this study for the production of log ratio histograms.

The use of scaling index techniques presents some limits, as environmental changes and the introduction of new genotypes can affect different anatomical elements at different degrees (Payne and Bull 1988). As a consequence, merging all the measurements on the same scale could obscure the causative factors affecting metric variation.

One possible solution is to select measurements according to the research question (Payne and Bull 1988).

In addition, it is also important to analyse teeth and bones separately, since they tend to respond differently to external variables (Albarella 2002). Teeth tend to be more conservative in term of size-changes within a population. As a result, variations in their size/shape generally suggests the introduction of a new genotype (Payne and Bull 1988).

However, in this study, log ratio histograms mainly focus on the analysis of post-cranial measurements, as very few biometrical values were taken on both mandibular and maxillary teeth (especially of caprines, which are the most representative species in most faunal assemblages analysed in this project); the only exception are suids, of which log ratio histograms exclusively rely on the analysis of teeth measurements.

As mentioned above, measurements lying on different axes should be analysed separately, as these can react differently to size change. However, due to the overall dearth of width/depth measurements, these had to be combined; length measurements, which were even scarcer, had to be excluded from log-ratio histograms. The combination of width and depth measurements was carried out to avoid an excessive reduction of the sample size. By plotting width/depths it was possible to verify the occurrence of size changes between two or more populations (Meadow 1999). The smallest breadth of the diaphysis of long bones (i.e. SD) as well as the smallest length of the collum scapulae (i.e. SLC) were excluded, since they tend to be heavily age-related.

In several cases (at the exception of Mazara del Vallo, *§Chapter 6: Results*), due to the small metric sample gathered from the analysed faunal assemblages, sex-dependent bones (e.g. metapodials) were not separated from those which are less affected by sexual dimorphism (e.g. astragali); this situation has produced log ratio histograms where the issue of changing sex-ratio and size increase could not be independently pursued. However, observations on the potential presence of male, female and castrate individuals have been made by analysing the data distribution (i.e. unimodal and/or bimodal, but also other aspects of the shape of the distribution).

The statistical significance of biometrical differences between the various groups of data was assessed according to Student's $t$-tests. Such test is commonly used when measurements are normally distributed (as is the case of most groups of measurements analysed in this project); however, being a robust test, it is only little affected by variance (Simpson *et al.* 1960), and therefore can be also used when data are non-normally distributed. For these tests, statistical significance was tested at the 95% confidence level – $p < 0.05$. However, higher or lower values of $p$ have been commented for each specific case when appropriate.

## 5.5. Taphonomy

### 5.5.1. Recovery

The majority of faunal assemblages analysed in this project were hand collected (*§Chapter 4: Sites and material*). As a result, it is reasonable to assume that they were all affected by a recovery bias, as it is likely that only those faunal remains more clearly visible in the archaeological record would have been recovered.

This scenario will have caused an underrepresentation of smaller taxa (e.g. small mammals, fish, birds, etc.) as well as the smaller elements of larger taxa. For this reason, it is very important to be aware of the impact that such recovery bias had on the integrity of each analysed faunal sample.

In order to assess the extent of the impact of the recovery bias, the proportions between anatomical 'correlated' elements, such as distal metapodials and phalanges of cattle, caprines and suids (these latters were included only in very few cases) were calculated. In details, it has been assumed that, since smaller anatomical elements belonging to smaller species such as caprines and/or suids are less likely to be collected, their underrepresentation would be linked with the presence of a recovery bias.

### 5.5.2. Surface preservation

Alterations of the bone surface can be important indicators of the natural and human factors involved in taphonomic processes (Lyman 1994).

Carcass treatments, different environments and burial conditions can alter bone preservation and compromise the identification of remains, at both anatomical and taxonomic level; in some cases, diagenetic processes can lead to complete dissolution. In addition to this, the differential preservation of remains from different animal species may affect conclusions regarding their relative frequency within a given assemblage (Von Endt and Ortner 1984).

The analysis of surface alterations provides information on how taphonomic factors affected the faunal assemblage. In this research, each surface modification was analysed under a bright lamp; when necessary, magnifying glasses were used. The degree of surface preservation of fragments was recorded using five different stages: excellent, good, medium, bad and awful (Tab.5.5.1).

| **Grade** | **Definition of surface preservation** |
|---|---|
| **E (excellent)** | clearly visible surface morphology, fresh appearance, no modification |
| **G (good)** | slight and local surface erosion |
| **M (medium)** | part of the surface eroded and some details masked by erosion |
| **B (bad)** | whole surface eroded but general bone profile maintained |
| **A (awful)** | heavy erosion across whole bone surface, bone profile heavily compromised |

**Table 5.5.1.** The table shows the different levels of surface preservation followed by a brief description.

### 5.5.3. Gnawing

Gnawing provides useful information on peri-depositional damage, implying the exposure of bones to certain conditions before final burial (Lyman 1994). It is well known that scavengers, such as dogs and rodents, are usually attracted by any edible residues still attached to the bone or to the bone marrow itself. By gnawing bones, scavengers can affect the degree of fragmentation of faunal samples, as well as the preservation of the bone surface, in some cases compromising the taxonomic identification of the specimen.

Gnawing evidence provides information on human practices of waste disposal. It seems reasonable to assume that animals that were not promptly buried were exposed for some time to several taphonomic alterations, including gnawing. However, it is also true that burial does not entirely preclude gnawing (e.g. burrowing rodents).

In this research, the identification of gnawing evidence is limited to post-neonatal bones, as the porous and fragile surface of neonatal specimens prevents any attempts of recognizing gnawing. Pig gnawing is problematic to identify and thus its identification was not attempted here; it must, however, be considered that, among the multitude of carnivore-chewed bones, some may have been affected by pigs. Conversely, carnivore and rodent gnawing are fairly distinctive (Lyman 1994) and were, therefore, systematically recorded.

### 5.5.4. Butchery

The process of butchery consists in a series of activities aimed at the dismemberment of an animal carcass. Although such evidences are often associated with the extraction of consumable resources, in the past butchery was also carried out to reduce the size of dead animals and, hence, to facilitate their transport or burial (Binford 1981; Lyman 1994). Butchery techniques imply the use of different tools such as knives and cleavers; these were used in the process of dismemberment, filleting or skinning of the carcass.

The preference for a tool instead of another may result in different marks on bones.

In this project, cut marks, chop marks and saw marks were all recorded and additional notes were made in the comment section concerning their position on the bone. In some cases, different traces, implying the use of various tools, were observed on the same specimen, and the recording reflected the combination of such different activities.

The term ‘cut mark’ is referred to thin lines, which were inflicted by light and sharp tools, such as knives, for dismemberment, filleting or skinning. Chop marks refer to traces inflicted by heavy tools (e.g. cleavers) to divide the animal carcass into a number of portions. Saw marks are self-explanatory and are more commonly associated with bone working than butchery. Saws were valuable tools and people would tend to use them only for specialised activities that required precision in the cut.

### 5.5.5. Worked bones

A few worked bones and cervid antlers were found in some of the analysed faunal samples. They were recorded in the database as 'W' (i.e. worked). Additional comments on bone modifications were included in the comment section.

### 5.5.6. Burning

Burnt animal bones are commonly found in archaeological sites; these may represent the remains of consumed food or cremated animals. In some cases, burnt bones provide direct evidence of the utilization of animals as food, for instance when burning occurred during cooking, However, burning can also result from other causes, such as the use of bone as fuel, or the accidental or deliberate disposal of bones in a fire.

Identifying burning incidence in the archaeological record is not always straightforward, as some bones may look like burned as a result of exposure to soil minerals and moisture (Lyman 1994).

In this research, discerning burnt from oxidized bones was not always feasible. Burning traces were therefore recorded only on specimens for which burning could be clearly identified with a high degree of reliability. Several experiments have proved that the duration of exposure to a heat source, as well as its temperature and size, will have different effects on the bone surface (Shipman *et al.* 1984; Nicholson 1993; Outram 2002).

In order to identify the nature of burning incidence on bones from the analysed contexts, three types of burning stages were recorded in this project:

- 'singed' suggests cases in which bones were only partially affected by heat.

- 'burned' refers to cases were the incidence of burning covered most or the whole surface of bones. In this case bones were usually characterized by a black surface, suggesting that they were exposed to a relatively low temperature. The black colour is the result of the partial carbonization of the bone organic components.

- ‘calcined’ indicates cases in which the bone surface appears white (in some cases violet or blue shades were also found). This colouration suggests that a complete oxidation of the organic components of the bone occurred, leaving only the mineral phase.

### 5.5.7. Distribution of anatomical elements

The distribution of anatomical elements has the potentials to provide important insights on waste disposal as well as on butchery practices. This analysis can reveal whatever primary (i.e. initial preparation of dressed animal carcasses) and/or secondary butchery (i.e. the process through which the carcass is cut into smaller portions) occurred at the analysed sites.

In this project, the analysis of the distribution of anatomical elements is based on the calculations of the minimum number of anatomical unit (MAU, previously obtained from the minim number of anatomical elements, MNE; *§5.2 Quantification*).

## 5.6. Pathologies and non-metric traits

Identifying pathologies may provide useful information on the way in which animals were managed in the past. Only a small portion of diseases leaves their mark on the skeleton, while the majority limit their damage to soft tissues.

In this research pathological conditions were recorded following Baker and Brothwell's (1980) parameters, and additional notes were made in the comments section of the dataset.

# Chapter 6

# Results

In this chapter the zooarchaeological results from the faunal assemblages considered for this project are presented. As mentioned in Chapter 4: Sites and materials, eight faunal assemblages collected from archaeological sites located in various areas of Sicily, and dated from the Byzantine until the Norman/Swabian periods (6th-12th/13th centuries AD), were analysed.

The chapter is divided into eight sub-chapters, corresponding to each analysed faunal assemblage; the results are then organised into fields of analysis (e.g. taphonomic alterations, species frequency, ageing, etc.).

## 6.1. Corso dei Mille (Palermo)

The faunal assemblage from Corso dei Mille (Palermo) includes 736 recorded specimens, of which 423 were also countable; of these, 177 date to the 10th-11th centuries AD, and 246 to the 12th-13th centuries AD. The earlier phase will be referred to as the ‘Arab period’ and the later one as the ‘Norman/Swabian period’ (Tab.6.1.1).

| **Chronology** | **Period** | **Countable** | **Non-countable** | **Total** |
|---|---|---|---|---|
| 10th-11th c. AD | Arab | 177 | 215 | 392 |
| 12th-13th c. AD | Norman/ Swabian | 246 | 98 | 344 |
| **Total** | | **423** | **313** | **736** |

**Table 6.1.1.** Corso dei Mille. Number of recorded countable and non-countable specimens for the Arab and the Norman/Swabian periods.

### 6.1.1. Taphonomic alteration

#### *6.1.1.1. Surface preservation*

On average, the degree of surface preservation was quite good at Corso dei Mille, both in the Arab and the Norman/Swabian periods, with a smaller proportion of medium to heavily damaged fragments (Fig.6.1.1 and Fig.6.1.2). These conditions facilitated taxonomic identification and the detection of marks on bone surfaces.

Other taphonomic alterations included red-brownish concretions and, to a lesser extent, weathering, shallow cracks from post-depositional disturbances (e.g. roots) and damages produced during excavation.

In the majority of cases, the alterations did not interfere with the anatomical and taxonomic identification of the specimens; heavy bone modifications were rare and the recording of measurements was prevented only in a very limited number of cases.

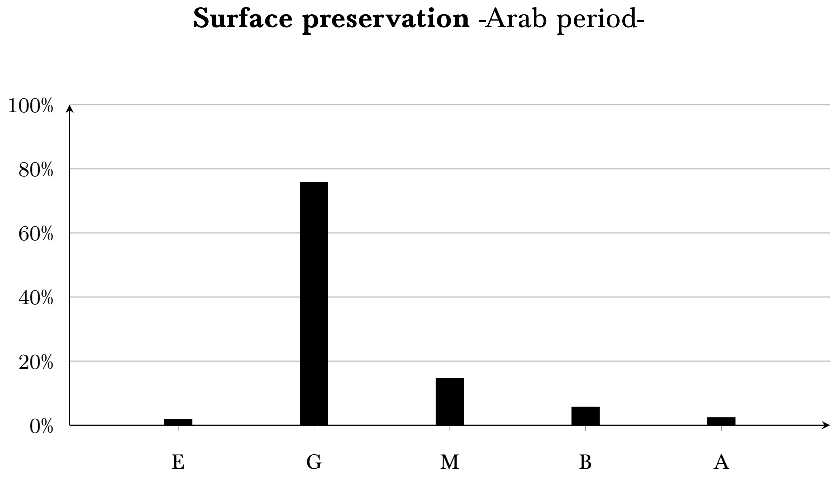


**Figure 6.1.1.** Corso dei Mille, Arab period. Surface preservation of anatomical elements (n:392). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

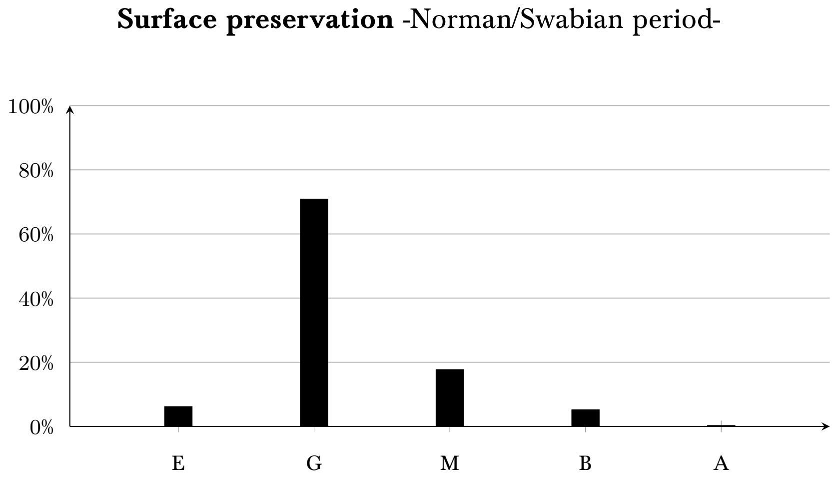


**Figure 6.1.2.** Corso dei Mille, Norman/Swabian period. Surface preservation of anatomical elements (n:344). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

#### *6.1.1.2. Gnawing*

Only two bones (i.e. a distal metacarpal and the proximal diaphysis of a femur), respectively belonging to sheep and cattle and dated to the Arab period, showed evidence of gnawing marks; these were produced by carnivores, most likely dogs.

### *6.1.1.3. Recovery bias*

The faunal assemblage from the archaeological site of Corso dei Mille was hand-collected during a rescue excavation (*§Chapter 4: Sites and material*) and is likely to be affected by recovery bias.

Analyses to assess the presence of recovery bias were only possible for the Arab period, due to the small sample size in the Norman/Swabian phase (*§Chapter 5: Methodology*).

The recovery bias was evaluated by considering differences in the proportion of distal metapodials and 1st phalanges for cattle (*Bos taurus*) and caprines (*Ovis aries*/*Capra hircus*) (*§Chapter 5: Methodology*).

Fig.6.1.3 shows that the metapodials from sheep and cattle do not outnumber the phalanges; actually, in both species the percentages of 1st phalanges exceed the natural 1:2 proportion. The higher frequency of cattle phalanges compared to sheep probably represents recovery bias, though this is not very pronounced.

All in all, recovery bias seems to affect this assemblage, but to a limited extent.

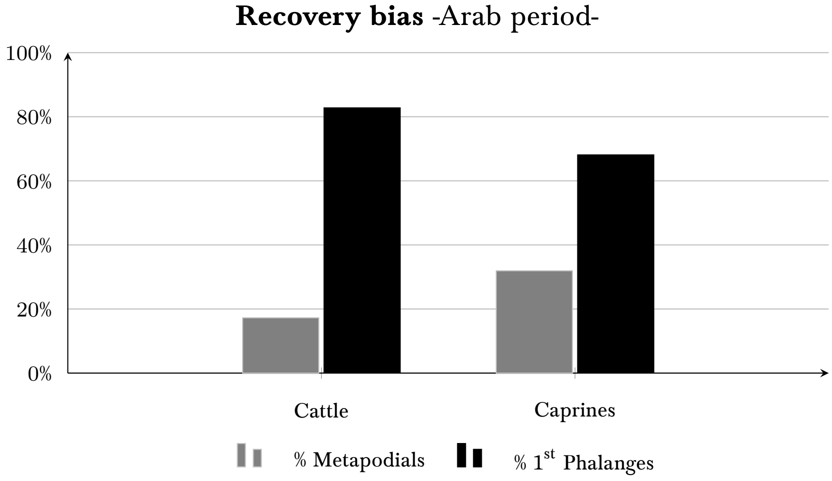


**Figure 6.1.3.** Corso dei Mille, Arab period. Proportions of metapodials and 1st phalanges for cattle (n:5;24) and caprines (n:15;32).

### 6.1.2. Species frequency: NISP and MNI

| **Corso dei Mille** | | |
|---|---|---|
| **Taxa** | **Arab period** | **Norman/Swabian period** |
| Cattle (*Bos taurus*) | 54 | 27 |
| Caprines (*Ovis aries*/*Capra hircus*) | 106 | 171 |
| Suids (*Sus* sp.) | 2 | 4 |
| Equids (*Equidae*) | 3 | 16 |
| Canids (*Canidae*) | - | 1 |
| Fallow deer (*Dama dama*) | - | 1 |
| Lagomorphs (*Lagomorpha*) | - | 1 |
| Galliforms (*Gallus*/*Numida*/*Phasianus*) | 7 | 10 |
| Tuna (*Thunnus* sp.) | 5 | 15 |
| **Total** | **177** | **246** |

**Table 6.1.2.** Corso dei Mille, Arab and Norman/Swabian periods. List of all the taxa. Non-countable elements are not included. In case a taxon is only present with non-countable fragment(s), this is indicated with a + (*§Chapter 5: Methodology*).

| **Corso dei Mille** | **Arab period** | | **Norman/Swabian period** | |
|---|---|---|---|---|
| | **Countable** | **Non-countable** | **Countable** | **Non-countable** |
| Sheep | 88 | 8 | 127 | 11 |
| Goat | 5 | 92 | 9 | 33 |
| Sheep/goat | 13 | 65 | 35 | 41 |
| **Total** | **106** | **165** | **171** | **85** |

**Table 6.1.3.** Corso dei Mille, Arab and Norman/Swabian periods. Recorded countable and non-countable elements identified as sheep (*Ovis aries*), goat (*Capra hircus*) and sheep/goat (*Ovis*/*Capra*).

As Tab.6.1.2 shows, the faunal assemblages from the Arab and the Norman/Swabian periods at Corso dei Mille are largely dominated by the three main domesticates, which together account for almost 98% of the countable bone fragments.

Among the main domesticated, caprines (*Ovis aries* and *Capra hircus*) are by far the best represented taxon in both periods (Fig.6.1.4 and Fig.6.1.5). Although raw counts from countable elements reveal that sheep are predominant in both periods, a large amounts of goat horncore (non-countable elements) have been recovered from specific archaeological contexts (*§6.1.4 Anatomical elements distribution*). (Tab.6.1.3).

Cattle is relatively well represented in the 10th-11th centuries AD, while its frequency decreases in the following period (12th-13th centuries AD).

Suids are barely represented in both periods (Tab.6.1.2, Fig.6.1.4 and Fig.6.1.5).

Equids were also present at Corso dei Mille, mostly in the later period. Although it was not possible to rule out the presence of donkey (*Equus asinus*) and/or equid hybrids (i.e. mules, hinnies), most specimens appeared to belong to horse (*Equus caballus*), on the basis of morphology and size (Tab.6.1.2).

Other potential domesticates recorded at Corso dei Mille are dogs (recorded as canids due to morphological similarities with closely-related taxa, fox and wolf). Only one remain was found from a Norman/Swabian archaeological context; this was characterised by a medium-large sized specimen, which rules out the fox as a possibility (Tab.6.1.2).

Wild animals are absent in the earlier phase, and they are barely represented in the Norman/Swabian period; these include a fallow deer (*Dama dama*) humerus and a hare (*Lepus* sp.) distal tibia.

Regarding birds, only a few bones were found in both periods, and these most likely belong to chickens (*Gallus gallus*), though, morphologically, the possibility that they represented imported species, such as pheasant (*Phasianus*) or guinea fowl (*Numida*) cannot be excluded (Tab.6.1.2).

Fish are also present in both phases, but with few remains. They are represented by abdominal and/or caudal vertebrae which, according to size and morphology, can be attributed to *Thunnus* sp. (Tab.6.1.2); unfortunately, here as well as in the other assemblages, it was not possible to distinguish between the Atlantic bluefin tuna (*Thunnus thynnus*) and the albacore or longfin tuna (*Thunnus alalunga*).

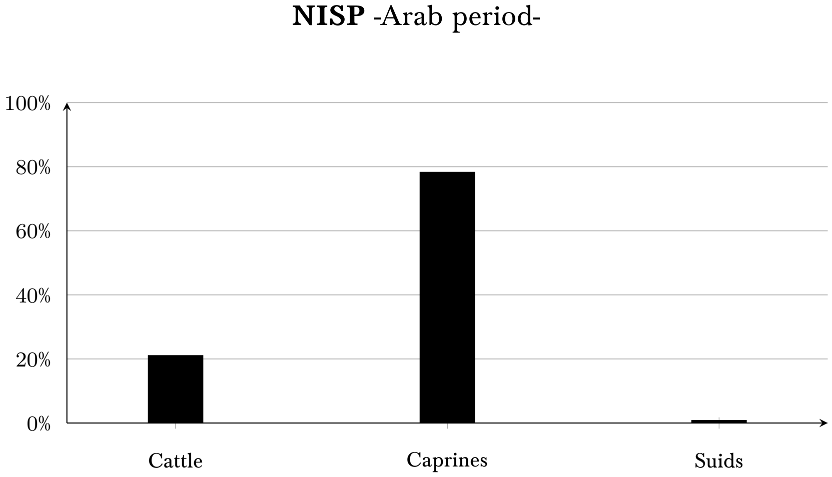


**Figure 6.1.4**. Corso dei Mille, Arab period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates in the Arab period (n:162).

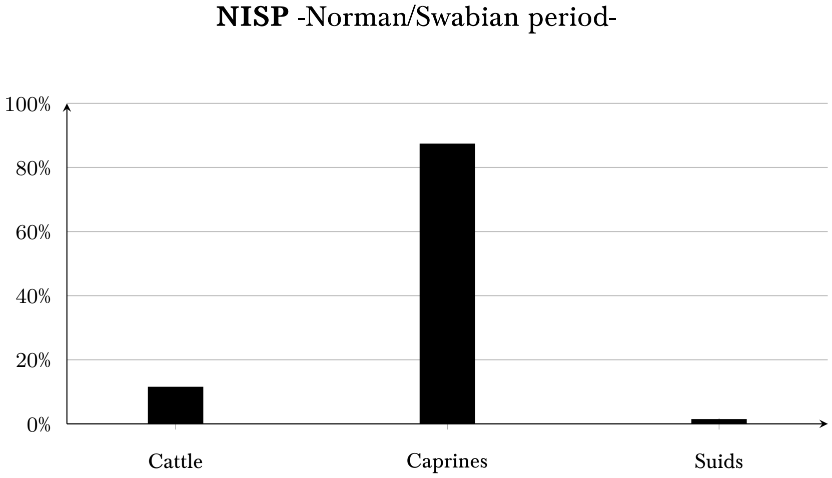


**Figure 6.1.5**. Corso dei Mille, Norman/Swabian period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates in the Norman/Swabian period (n:202).

The MNI analysis shows a very similar trend to the NISP and no substantial changes are evident (Fig.6.1.6 and Fig.6.1.7). The strong similarity of results between these two quantification methods gives us greater confidence in the reliability of the results (*§Chapter 5: Methodology*).

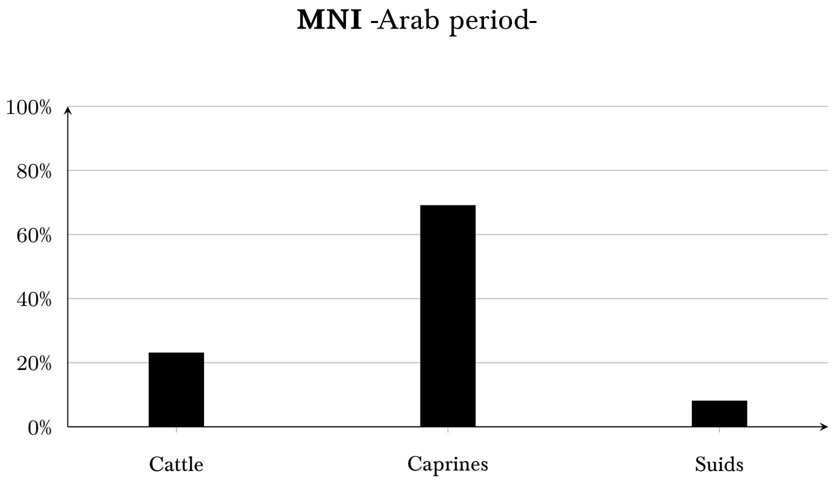


**Figure 6.1.6.** Corso dei Mille, Arab period. Percentage of the Minimum Number of Individuals (MNI) for the main three domesticates in the Arab period at Corso dei Mille (n:42).

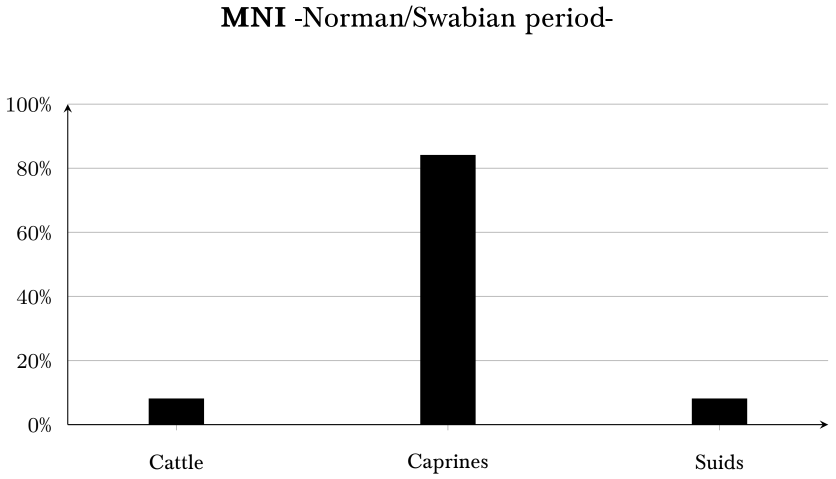


**Figure 6.1.7.** Corso dei Mille, Norman/Swabian period. Percentage of the Minimum Number of Individuals (MNI) for the main three domesticates in the Norman/Swabian period at Corso dei Mille (n:28).

*Sheep/goat separation* – The distinction between sheep and goat remains at Corso dei Mille mainly relied on specific morphological criteria characterising a defined set of anatomical elements. In addition, it was also possible to carry out some biometrical analyses following the biometrical criteria suggested by Salvagno and Albarella (2017) (*§Chapter 5: Methodology*).

It was decided to analyse measurements taken on the condyles and on the verticilli of caprine distal metacarpals; some of these could be identified to species level trough observation of morphological criteria, while others could not; biometrical analyses allowed to investigate this taxonomic distinction in a more objective way, as well as to attempt identification of metacarpals that could only be assigned to sub-family level.

Because of the dearth of measurements from metacarpals for both periods, it was decided to merge them in the same graph, in order to allow the identification of potential clusters; however, different marks were used to distinguish the values from the Arab period from those dated to the Norman/Swabian period.

As Fig.6.1.8 shows, the majority of specimens falls within the modern values of sheep (red oval), with one outlier probably representing a goat (blue oval). Three values are located at the edge of the two distributions of modern values of sheep and goat; although these specimens cannot be identified with certainty, they seem to cluster with the other archaeological sheep metacarpals, suggesting they might belong to this species. In any cases, it looks like the majority of caprine remains belong to sheep.

Fig.6.1.9, which employs different measurements from the same element (i.e. metacarpals), seems to confirm this result. In this case too, most specimens plot within the modern values of sheep, with only two values falling fully in the range of goats. One value has a more marginal position between the two modern groups and cannot be attributed with certainty to any of the two species. Another value plots towards the top right corner of the graph, and therefore has enhanced sheep characters, leaving little doubt about its attribution.

All in all, the joint analyses of the two graphs has allowed a more reliable identification of most specimens, highlighting a neat prevalence of sheep. While to some extent the morphological observations of specimens has been confirmed, the biometrical analyses allowed to identify to species level most of the metacarpals previously recorded as caprines (including the three specimens falling in between the modern ranges of sheep and goat in Fig.6.1.8).

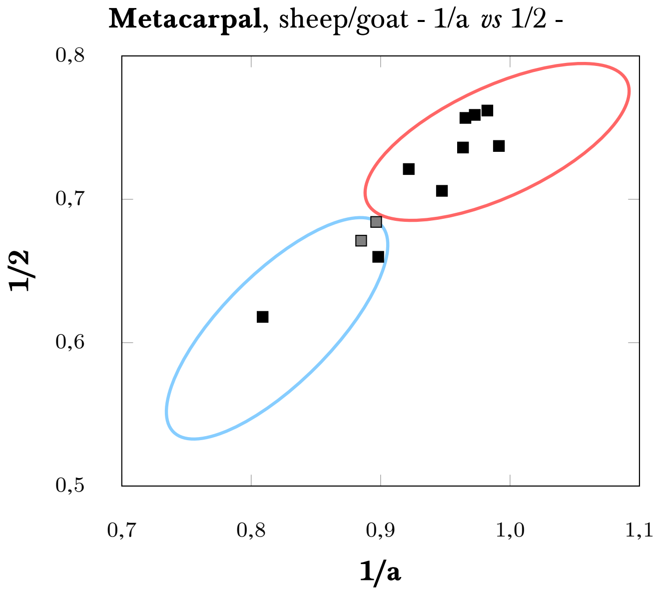


**Figure 6.1.8.** Corso dei Mille, Arab and Norman/Swabian periods. Sheep/goat, metacarpals, shape indices. Arab period (grey squares), Norman/Swabian period (black squares). Red oval: range of values attributed to sheep, blue oval: range of values attributed to goat according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). 1: depth of left distal condyle; a: width of the medial condyle; 2: diameter of the verticillus of the medial condyle.

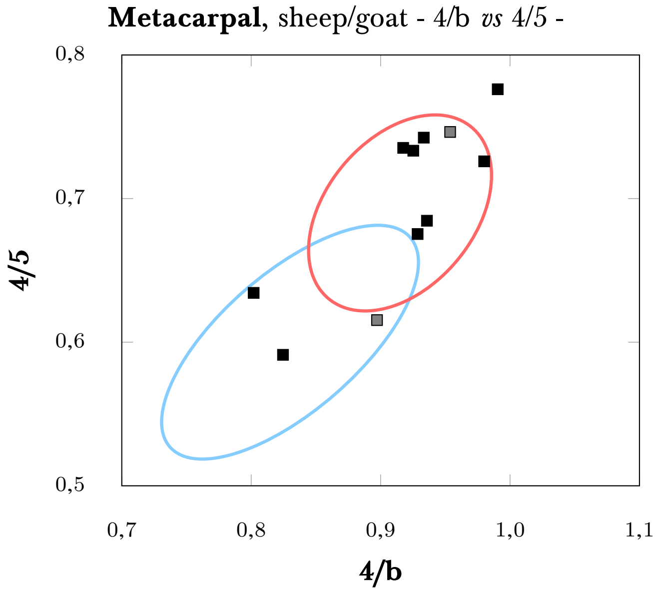
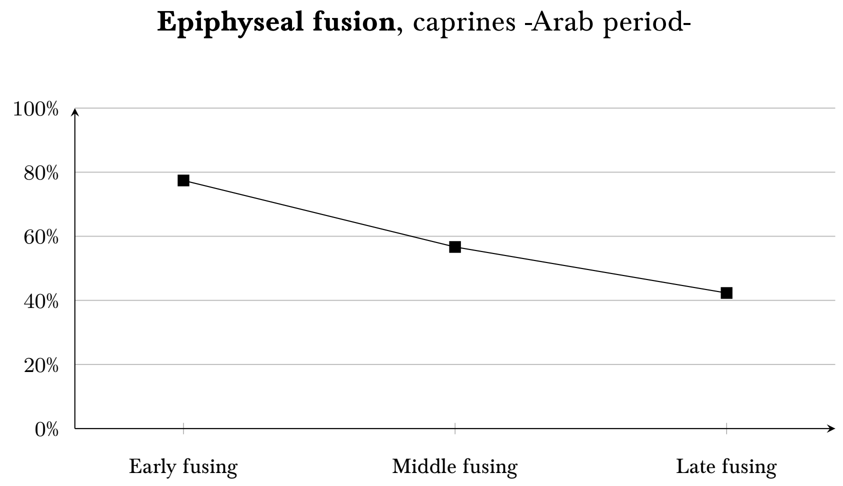


**Figure 6.1.9.** Corso dei Mille, Arab and Norman/Swabian periods. Sheep/goat, metacarpal shape indices. Arab period (grey squares), Norman/Swabian period (black squares). Red oval: range of values attributed to sheep, blue oval: range of values attributed to goat according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). 4: depth of the lateral condyle; b: width of the lateral condyle; 5: diameter of the verticillus of the lateral condyle.

### 6.1.3. Ageing

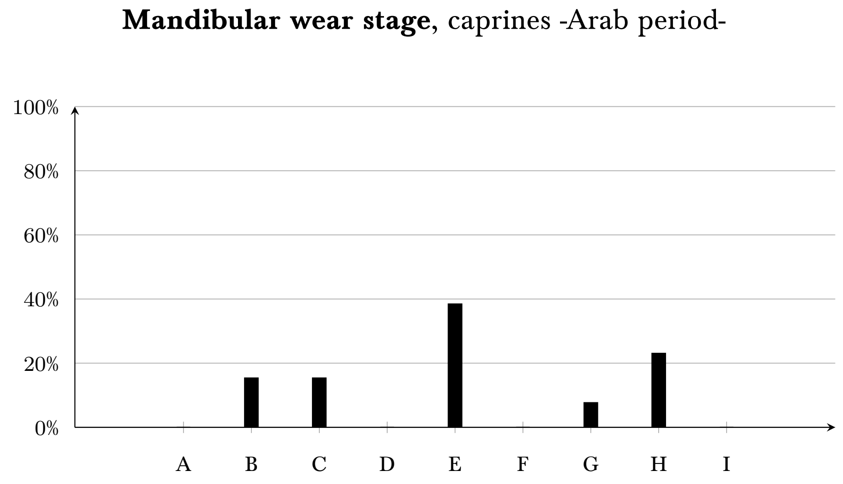
This section focuses on caprines and cattle, as insufficient ageing data were available for other species. Nonetheless, brief comments about equids and galliformes are also made.

*Caprines* – The proportion of caprine fused bones for the three age-stages (Silver 1969) was calculated for the Arab and Norman/Swabian periods respectively. In the Arab period (Fig.6.1.10), about 60% of the animals were culled before three and four years of age (late fusing stage). However, there is also evidence for earlier culling and, at the same time, a fair number of individuals survived into adulthood. Despite the low number of recovered caprine mandibles for this period, the kill-off pattern reconstructed from mandibular wear stages seems to confirm the results from the epiphyseal fusion analysis (Fig.6.1.11). Therefore, in this period, caprine husbandry did include meat production, although animals would have also been exploited for dairy and wool production. In the Norman/Swabian period (Fig.6.1.12) some changes in caprines husbandry are attested. Indeed, in this case a clearer majority of individuals were culled before reaching three/four years of age (late fusing stage). Caprine husbandry, thus, apparently focused on meat production. In addition, a small number of animals survived into later adulthood and very few individuals were slaughtered before one-two years (lambs, early fusing stage). In sum, the pattern from the Arab period at Corso dei Mille seems quite generalised, as the culling strategy did not focus around specific age groups. By contrast, the kill-off pattern for the Norman/Swabian period at Corso dei Mille appears to be more focused on meat production in comparison to the earlier period, with limited wool and dairy production.



**Epiphyseal fusion**, caprines -Arab period-

**Figure 6.1.10.** Corso dei Mille, Arab period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:77;57;42). Epiphyseal fusion stages follow Silver (1969)



**Mandibular wear stage**, caprines -Arab period-

**Figure 6.1.11.** Corso dei Mille, Arab period. Mandibular wear stages for caprines (n:13). Age stages follow Payne (1973). A: 0-2 months, B: 2-6 months, C: 6-12 months, D: 1-2 years, E: 2-3 years, F: 3-4 years, G: 4-6 years, H: 6-8 years, I: 8-10 years.

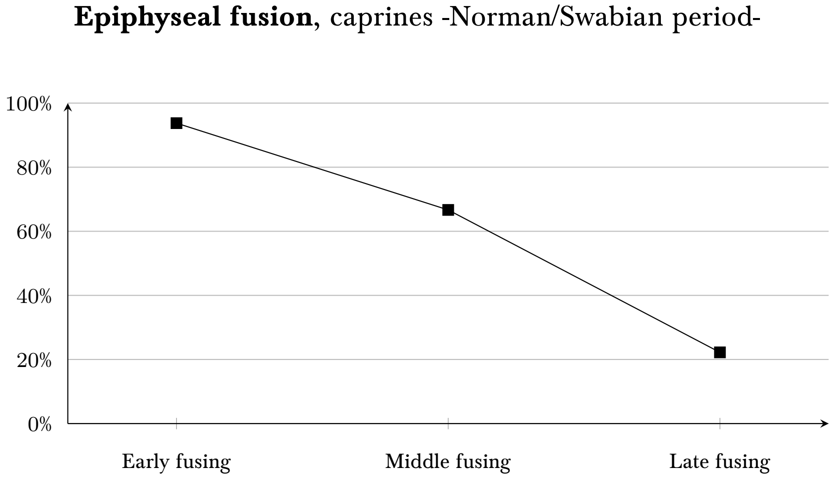


**Figure 6.1.12.** Corso dei Mille, Norman/Swabian period. Epiphyseal fusion stages for caprines. Percentage of fused bones within each fusion stage (n:94;67;22). Epiphyseal fusion stages follow Silver (1969).

*Cattle* – The mortality profile for cattle could only be analysed for the Arab period; some comments about the culling strategy of this animal in the Norman/Swabian period were cautiously made, despite the few available data. The analysis relies only on postcranial bones, as there were not enough dental sequences to investigate the kill-off pattern.

As Fig.6.1.13 shows, almost 20% of middle fusing elements were unfused, representing animals killed before two-three years of age, and therefore probably exploited for beef production. An additional ca. 25% of the animals were slaughtered during the following stage and were likely to have also been used for meat, but some animals survived also into later adulthood, suggesting their exploitation for secondary products (e.g. traction, dairy products).

It is reasonable to think that some cows could have also been exploited for milk. Indeed, the virtual absence of calves (early fusing anatomical elements) could be related to taphonomic processes; these may have prevented the preservation of the more porous and highly fragile elements characterising very young individuals, which we would expect to find as part of a dairy economy.

Twenty-seven cattle post-cranial elements were recorded for the Norman/Swabian period; all of them were fused indicating the presence of old animals (≥ three-four years of age). This result suggests a preference for old individuals, which were probably used as traction force in agricultural works and/or for milk production.

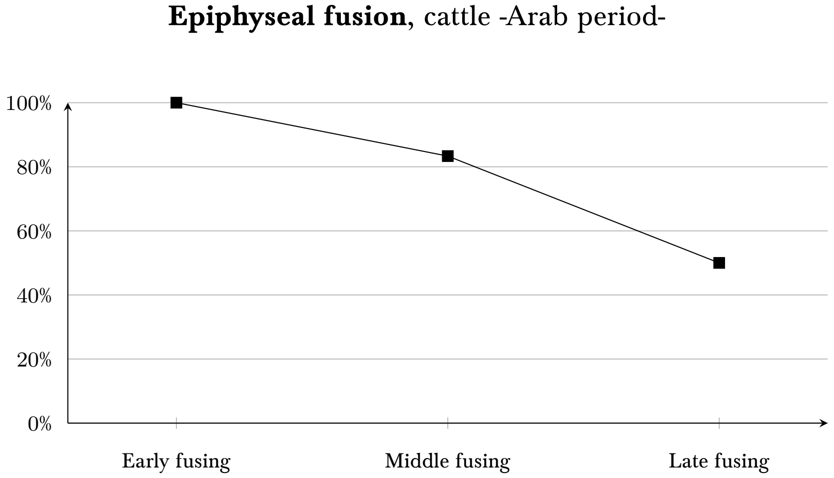


**Figure 6.1.13.** Corso dei Mille, Arab period. Epiphyseal fusion stages for cattle. Percentage of fused bones within each fusion stage (n:0;83;50). Epiphyseal fusion stages follow Silver (1969).

*Equids* – In the Arab period, three bones belonging to equids were recorded (one third phalanx, one calcaneum and one metacarpal); the calcaneum and metacarpal were fused. This and the presence of a heavily worn mandibular premolar or molar suggests the presence of mature individuals at the site. However, caution in the interpretation is needed due to the tiny sample.

In the Norman/Swabian period, thirteen post-cranial bones belonging to equids were recorded; all of them were fused, with the exception of two calcanea. In addition, two loose teeth (mandibular premolars or molars) belonged to elderly individuals. This evidence suggests the presence of predominantly mature equids at the site; the younger specimens may represent early adults being brought to the site, or the practice of horse breeding in the vicinities of the site.

*Galliformes* – Overall, few anatomical elements belonging to this order were recorded for the Arab and Norman/Swabian phases at Corso dei Mille. In the Arab period, out of ten bones, six were not fully ossified, while four were mature; the very small size of two of the porous bones (one coracoid and one humerus) is likely to indicate natural mortality and therefore on-site breeding.

A similar scenario characterised also the Norman/Swabian period, with three galliformes anatomical elements belonging to immature individuals, and seven to adults.

### 6.1.4. Anatomical element distribution

The distribution of anatomical elements could only be properly analysed for caprines while for other animals, due to the small sample size, only cursory observations could be made.

Given the higher than usual presence of goats (though mainly produced by horncores), it was preferred for this site to analyse the distribution of anatomical elements separately for sheep and goat; for the sake of comparison with other sites, a general analysis for caprines was also produced.

The analysis of anatomical element distributions for sheep and goat was carried out only considering the anatomical elements on which the taxonomic distinction between these two species was attempted, while all elements have been used for the general analysis of caprine body parts (*§Chapter 5: Methodology*).

*Sheep* – As Fig.6.1.14 shows, in Arab Corso dei Mille, the most represented body parts for sheep are mandibles; their high incidence may suggest the introduction of complete sheep carcasses at the site. In addition, both upper and lower limb bones are also present, suggesting that both primary and secondary butchery occurred on site. Smaller body parts, such as the astragalus, the calcaneum and 2nd and 3rd phalanges are less represented than other body parts; this result is likely the consequence of a recovery bias.

Some changes in the anatomical element distribution of sheep carcasses can be observed for the Norman/Swabian period (Fig.6.1.15); cranial elements (mainly mandibles) are now less represented, while upper and lower limbs (in particular the distal humerus and the distal tibia) are proportionally more numerous in comparison to cranial elements. This result may suggest that more secondary rather than primary butchery activities were carried out at the site. The low presence of smaller bones (carpals, tarsals and phalanges) could be symptomatic of a recovery bias, rather than of a lesser contribution of primary butchery to the assemblage. The prevalence of secondary butchery suggested above would lead to the discard of lower limb bones including small bones; however, the presence of distal metapodials suggests that recovery bias played a greater role in the representation of body parts.

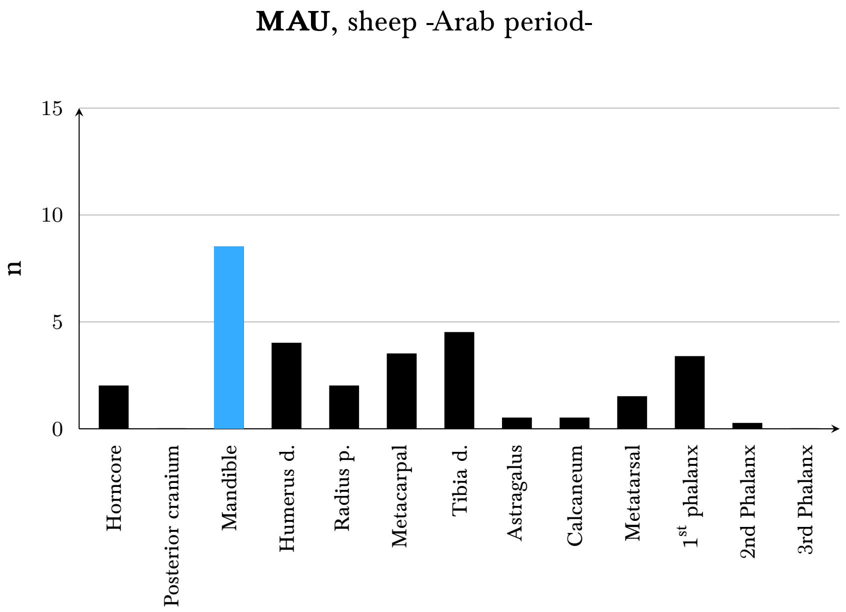


**Figure 6.1.14.** Corso dei Mille, Arab period. Distribution of the Minimum number of Animal Units (i.e. MAU) for sheep (n:31). Most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

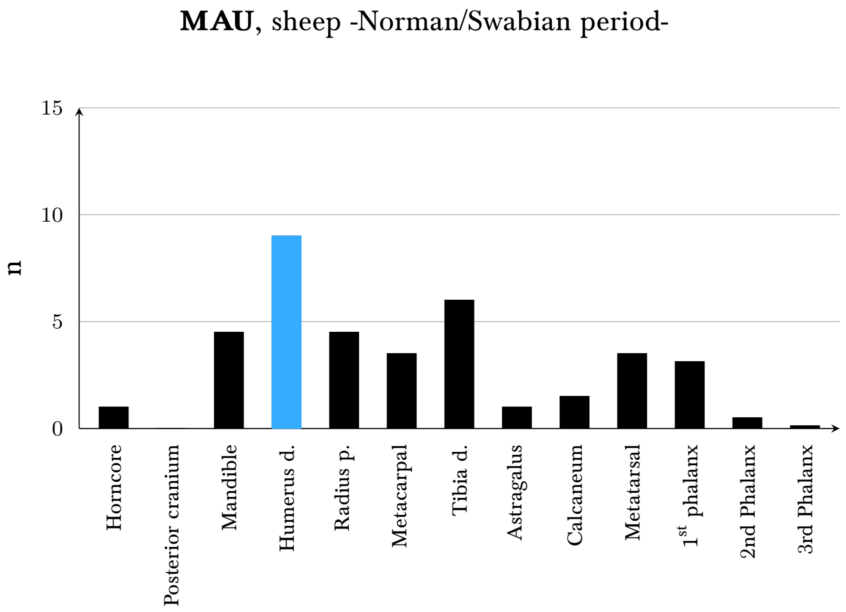


**Figure 6.1.15.** Corso dei Mille, Norman/Swabian period. Distribution of the Minimum number of Animal Units (i.e. MAU) for sheep (n:38). Most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Goat* – The distribution of goat anatomical elements in the Arab period at Corso dei Mille shows a different pattern from that of sheep (Fig.6.1.16). While in this period sheep is represented by almost all the diagnostic anatomical elements (see above), goat remains mostly belong to horncores, while mandibles are absent. Most horncores were chopped or cut at the base, suggesting that horns were removed for making objects (*§6.1.5 Butchery*).

The body part distribution indicates that complete goat carcasses were only occasionally introduced to the site.

Goat horncores were recovered in archaeological contexts characterised by the presence of iron slags and hearths. In some cases, metal slags were also found inside the horncore cavities. The association of goat horncores and iron slags is probably indicative of the presence of craft activities, where the horn was also employed.

The situation in the Norman/Swabian period is similar, with horn cores by far representing the most common elements, and mandibles, as well as upper and lower limbs poorly represented (Fig.6.1.17). However, in contrast to the Arab period, no iron slags were found in association with the goat horn cores; despite this, the high frequency of these cranial elements and the several chopping marks present at their base suggest that craft activities related with goat horn working continued at the site of Corso dei Mille also in this later phase.

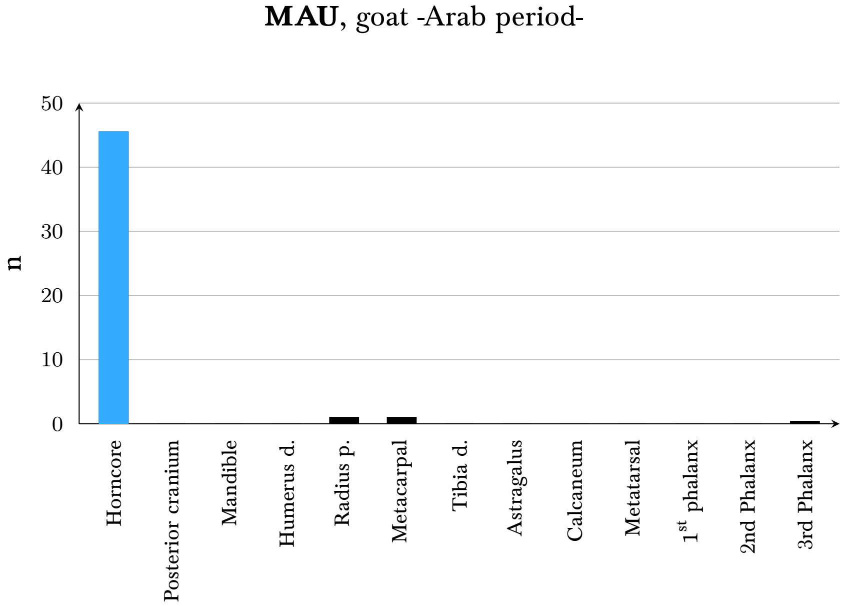


**Figure 6.1.16.** Corso dei Mille, Arab period. Distribution of the Minimum number of Animal Units (i.e. MAU) for goat (n:96). Most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

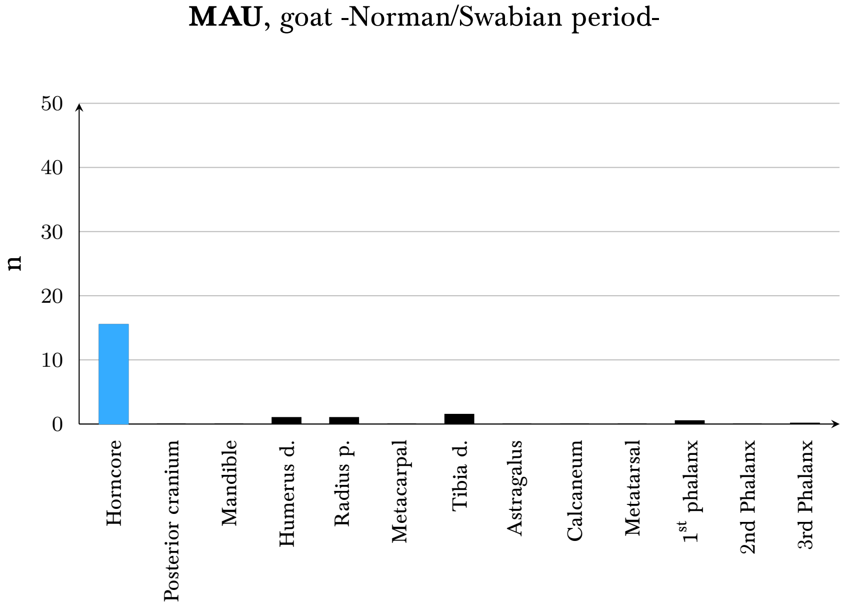


**Figure 6.1.17.** Corso dei Mille, Norman/Swabian period. Distribution of the Minimum number of Animal Units (i.e. MAU) for goat (n:20). Most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Caprines* – The analysis of the Minimum number of Anatomical Units (i.e. MAU) shows that both cranial and post-cranial anatomical elements of caprines are present in the Arab period at Corso dei Mille (Fig.6.1.18). Among them, mandibles are the best represented body parts; their high incidence may suggest the introduction of complete carcasses at the site. The high incidence of cranial elements, along with several post-cranial bones, suggests that both primary and secondary butchery occurred on site.

Small body parts (e.g. carpals and tarsals) are completely absent; this is likely a consequence of recovery bias.

Late fusing epiphyses, such as the proximal humerus, the proximal and distal femur and the proximal tibia are poorly represented; this is related to the differential destruction of more fragile body parts caused by taphonomic processes (Brain 1981).

In the Norman/Swabian period (Fig.6.1.19), caprine cranial elements are not as well represented as in the previous period, and upper limb bones such as the scapula and the distal humerus become the best represented body parts. In contrast to the previous period, lower limb bones (e.g. pelvis and distal tibia) are well represented. Variation between the two periods is probably a consequence of the combined effect of taphonomic processes and different strategies of waste disposal.

The prevalence of upper and, to a lesser extent, lower limb elements in comparison to cranial elements suggests that, differently from the Arab period, some of the primary butchery was carried out elsewhere.

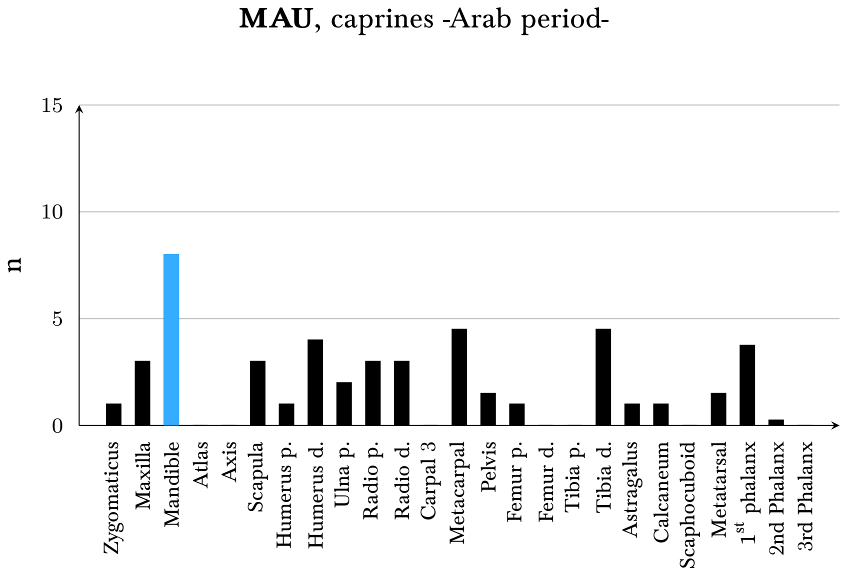


**Figure 6.1.18.** Corso dei Mille, Arab period. Distribution of the Minimum number of Animal Units (i.e. MAU) for caprines (n:95). Most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

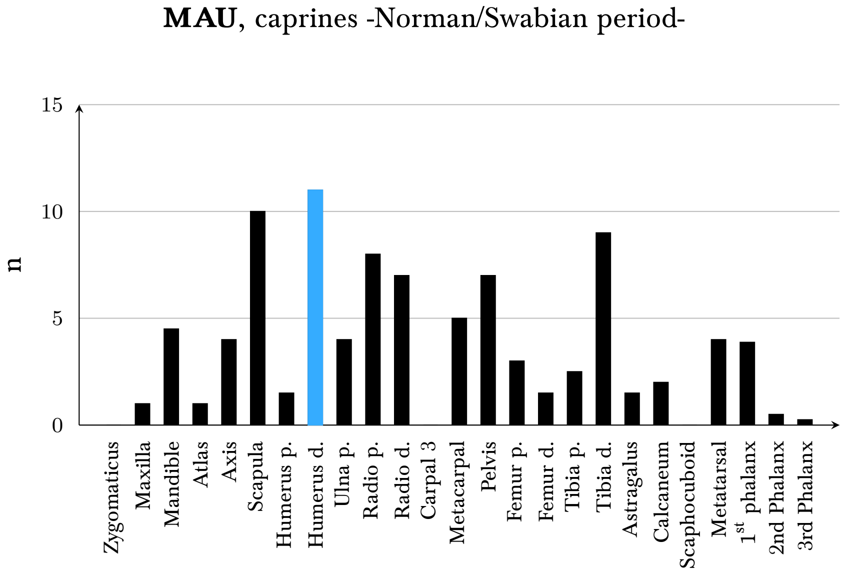


**Figure 6.1.19.** Distribution of the Minimum Number of Animal Units (i.e. MAU) for caprines (n:109). Most represented anatomical element/s in light blue. Mandibles and maxilla refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Cattle* – No substantial differences in the anatomical elements distribution of cattle remains can be observed between the two analysed periods. Cranial and axial ones, as well as lower and upper limbs, are equally represented, suggesting that entire carcasses were introduced to the site of Corso dei Mille. Hence, it is likely that both primary and secondary butchery were carried out on site.

Small body parts (e.g. carpals and tarsals) are missing; this is likely to be a consequence of recovery bias, despite the larger size of the cattle carcass in comparison to caprines.

*Equids* – Comments on the distribution of anatomical elements of equid remains are only possible for the Norman/Swabian period, since only three equid elements were recovered from Arab contexts. In general, bones from the lower and upper limbs are present; elements from the head and the axial skeleton are only represented by two loose teeth.

*Fish* – Fish remains are only represented by abdominal and caudal vertebrae in both periods; in the Norman/Swabian period, for which there are more *Thunnus* sp. remains in comparison to the Arab phase, abdominal vertebrae are more represented than caudal ones. In both periods, fish vertebrae are characterised by the presence of several cut and chop marks. No fish cranial elements are present, suggesting that partly processed fish carcasses were brought to the site of Corso dei Mille.

### 6.1.5. Butchery

For this site, the analysis of butchery marks focuses on goat in both periods. A few comments on sheep, cattle and fish carcass processing are made, despite the modest quantity of available data.

Goat – Several butchery marks on goat horn cores (Fig.6.1.20 and Fig.6.1.21), found in archaeological contexts dated to the Arab and the Norman/Swabian periods (Fig.6.1.22 and Fig.6.1.23) were recorded, while the few post-cranial bones belonging to this species did not show any traces of carcass processing.

As Fig.6.1.24 and Fig.6.1.25 show, half of the recorded goat horn cores presented several processing marks, most of them localised at the base; among them, saw marks were the most numerous, followed by chop and cut marks. At the same time, the pattern of marks varied substantially among specimens.

This pattern of carcass processing may suggest the existence of intensive and specialised practices, which included the removing of goat horns from the horn cores (and of these latter from the skull). As mentioned before, these horn cores may represent the discarded by-products of some sort of craft activities linked with the production of metal objects, due to the presence of iron slags in the same contexts and even within the horn cores themselves. However, these slags are not present in the Norman/Swabian period. This may suggest that the nature of the craft activity had changed between the two periods, though the area was still used as a workshop. It is also possible that in the later period the iron slags were disposed of elsewhere, in an area that was not archaeologically investigated. Either way, a continuity of not-yet-defined craft activities associated with goat horn working is attested between the two phases.

**Figure 6.1.20.** Corso dei Mille, Arab period: a goat horncore

**Figure 6.1.21.** Corso dei Mille, Arab period; evidence of saw marks on goat horncores.

**Figure 6.1.22.** Example of an archaeological context at Corso dei Mille dated to the Arab period from which several goat horncores were recovered.

**Figure 6.1.23.** Example of an archaeological context at Corso dei Mille dated to the Norman/Swabian period and characterised by the presence of several goat horncores.

**Butchery marks** on horn cores, goat -Arab period-

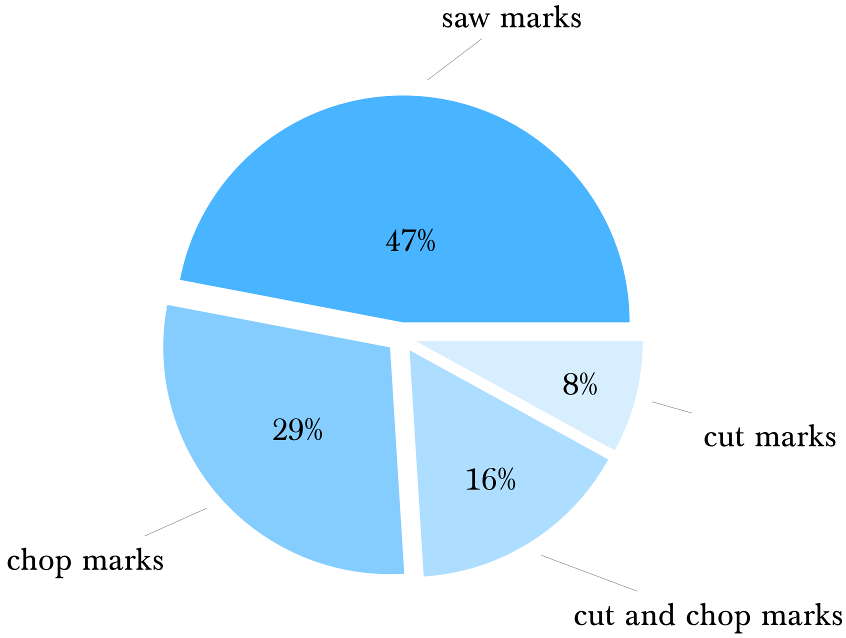


**Figure 6.1.24.** Corso dei Mille, Arab period. Butchered goat horn cores; proportions of cut marks, chop marks and saw marks (n:45).

**Butchery marks** on horn cores, goat -Norman/Swabian period-

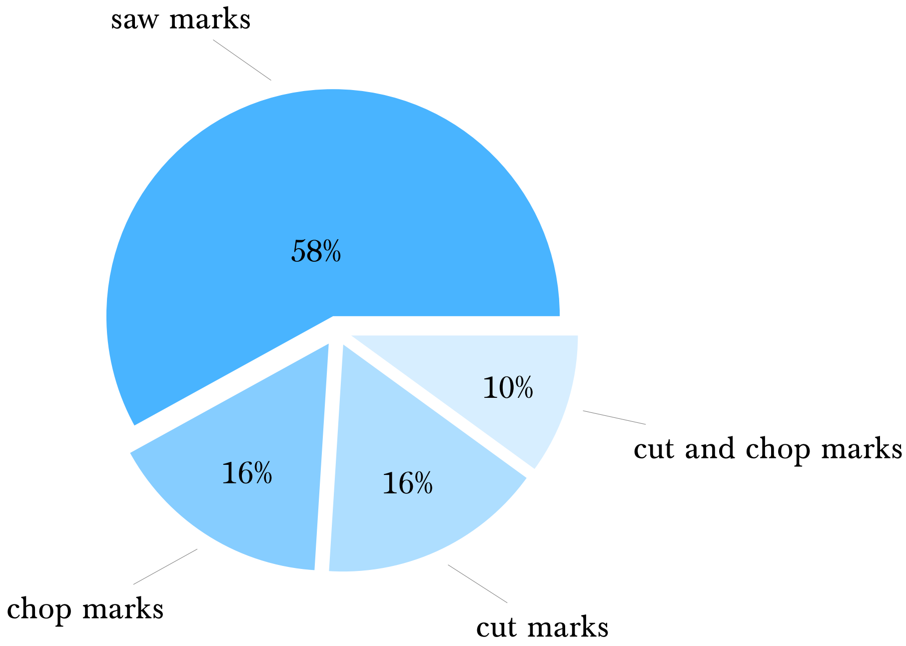


**Figure 6.1.25.** Corso dei Mille, Norman/Swabian period. Butchered goat horn cores; proportions of cut marks, chop marks and saw marks (n:18).

*Sheep* – Butchery marks on sheep bones were recorded on a small proportion of remains both in the Arab and the Norman/Swabian periods. In the earlier phase, out of 85 sheep remains, only seven (all long bones) presented evidence of butchery marks. Similarly, in the Norman/Swabian period, only 14 elements out of a total of 144 sheep remains were butchered. This result may suggest that non-intensive butchery practices were carried out at the site.

In both periods, cut marks from knives were more common, although a number of chop marks from heavier tools, such as cleavers, were also recorded.

*Cattle* – Similarly to sheep, butchery marks on cattle bones were recorded only on few elements. Chop marks were far more common than cut and saw marks; these were mainly located on the shaft of post-cranial bones. Heavier tools, such as cleavers, may have contributed to the dismemberment of cattle carcasses.

*Fish* – No evidence of butchery marks were recorded on *Thunnus* sp. vertebrae for the Arab period; for the Norman/Swabian period, out of 15 *Thunnus* sp. vertebrae, two presented cut marks, and only one chop marks. All the cut marks were located along the vertebral processes and were probably produced during filleting and/or in order to remove the flesh from bones; multiple chop marks were located along an abdominal vertebra and were probably aimed at dismembering the fish carcass into smaller pieces.

### 6.1.6. Size and shape

Overall, few measurements could be taken for the main domestic animals at Corso dei Mille, especially for suids that are almost absent in both analysed periods. Some biometrical analyses could be carried out for caprines, thanks to the good preservation of most anatomical elements.

However, due to the dearth of measurements from individual anatomical elements at Corso dei Mille and/or within each analysed period, only in a few cases it was possible to investigate the biometrical characters of caprines through scatter plots, and measurements from different elements had to be merged by use of a scaling index technique (log ratio). In order to allow a proper biometrical comparison of caprine size between Corso dei Mille and the other analysed sites, width/depth measurements of different post-cranial bones belonging to the Arab and Norman/Swabian periods were merged and plotted into two different log ratio histograms. The most age-dependent measurements were excluded; at the same time, due to the small sample, it was not possible to analyse separately sex-dependent bones (e.g. humeri) from those less affected by sexual dimorphism (e.g. astragali). Comments about the potential presence of males, females and castrates were made considering the distribution of values.

As mentioned before, biometrical differences between the various groups of data from Arab and Norman/Swabian Corso dei Mille were evaluated according to a Student's *t*-test (*§Chapter 5: Methodology*). Statistical comparisons of measurements from all the analysed assemblages are presented in Fig.6.8.27, Tab.6.8.6 and Tab.6.8.7).

*Caprines* – Measurements of the distal tibia from the Arab and Norman/Swabian periods at Corso dei Mille were plotted in the same graph to investigate changes in caprine size trough time.

As Fig.6.1.26 shows, the majority of values from the Arab period are localised at the bottom left of the graph, while those from the Norman/Swabian period are mostly distributed on the upper right part. This distribution suggests that caprines from the Arab period were smaller than those of the Norman/Swabian period, though the small sample size invites caution.

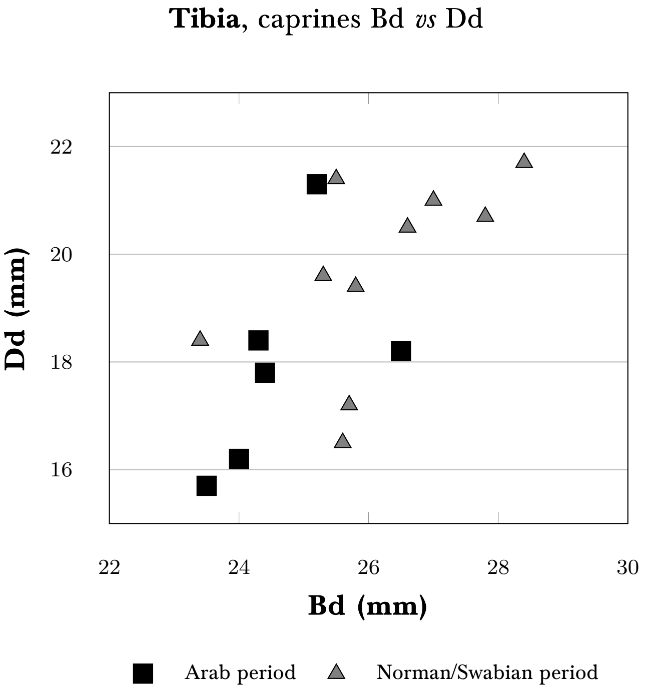


**Figure 6.1.26.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab (black squares) and the Norman/Swabian periods (grey triangles).

In order to further investigate this increase in caprine size, width and depth measurements from fused post-cranial anatomical elements dated to the Arab and to the Norman/Swabian periods were analysed together through the log ratio technique (*§Chapter 5: Methodology*).

In the Arab period (Fig.6.1.27), the histogram displays a unimodal distribution. In the following period (Fig.6.1.27), although the range of sheep measurements is similar to that of the Arab period, the mean is higher. This result supports the existence of an increase of caprine size during the Norman/Swabian period at Corso dei Mille. This potential increase is not confirmed by the Student's *t*-test (*p*: 0.3197), indicating that no statistically significant size change in caprines occurred between the two periods (Fig.6.8.27, Tab.6.8.6 and Tab.6.8.7). However, the small size of the available sample of width and depth measurements from caprines in both periods might lie behind the result of statistical tests.

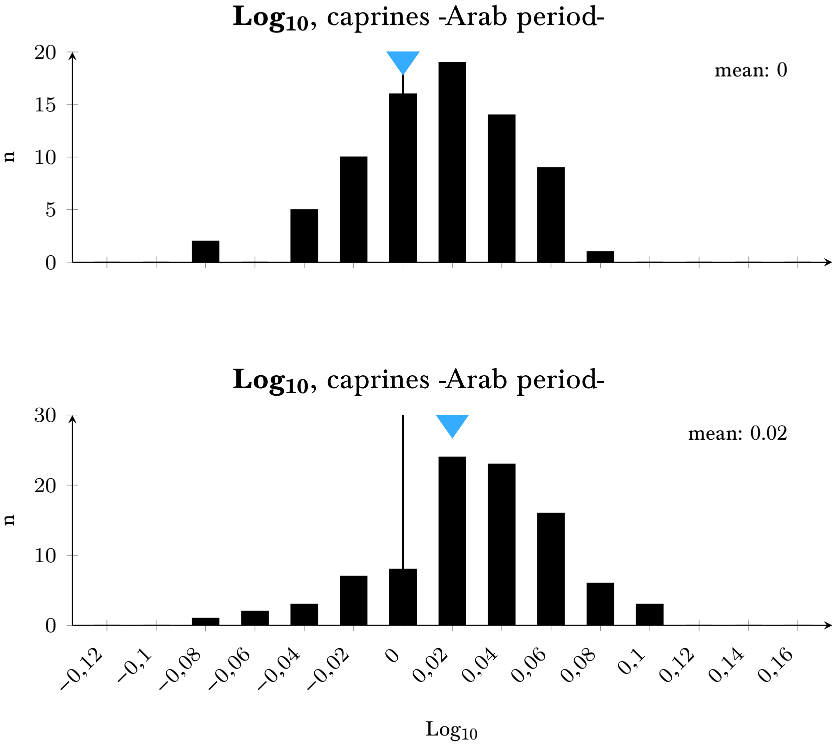


**Figure 6.1.27**. Corso dei Mille. Log ratio histogram for width/depth measurements of caprines from the Arab period (n:76) and from the Norman/Swabian period (n:92). The triangle indicates the logarithmic mean. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

## 6.2. Sant’Antonino (Palermo)

The faunal assemblage from Sant’Antonino (Palermo) includes 612 recorded specimens, of which 474 were also countable; these were recovered from archaeological contexts dated to the 11th-11th centuries AD, which will be referred to as the ‘Arab period’(Tab.6.2.1).

| **Chronology** | **Period** | **Countable** | **Non-countable** | **Total** |
|---|---|---|---|---|
| 10th-11th c. AD | Arab | 474 | 138 | 612 |

**Table 6.2.1.** Sant’Antonino, Arab period. Number of recorded countable and non-countable specimens.

### 6.2.1. Taphonomic alteration

#### *6.2.1.1. Surface preservation*

On average, the degree of surface preservation was good (Fig.6.2.1). A small proportion of animal bones and teeth presented a medium-bad level of preservation; these remains were usually characterised by iron concretions on their surface and, to a lesser extent, by weathering and shallow cracks caused by rooting. In a very limited number of cases, the poor state of preservation compromised the identification of a proper wear stage on mandibular teeth and the recording of measurements.

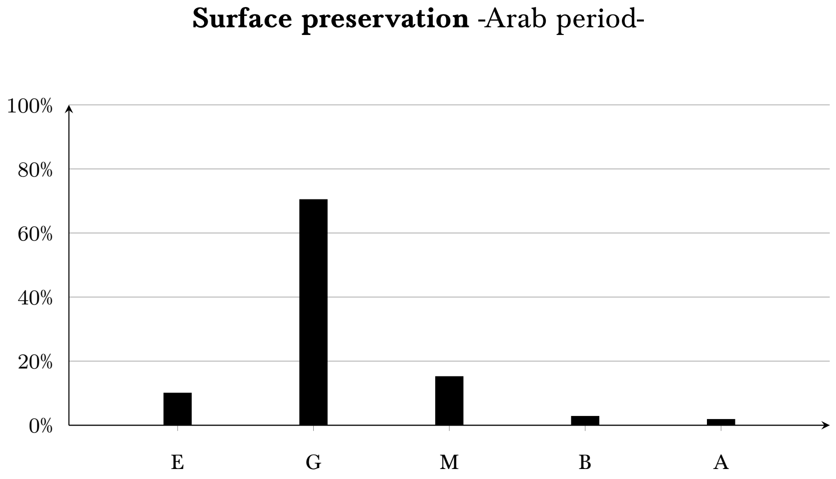


**Figure 6.2.1.** Sant'Antonino, Arab period. Surface preservation of recorded elements (n:612). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

### *6.2.1.2. Gnawing*

Five caprine bones (distal metacarpal, distal metatarsal, distal tibia, proximal radius and 1st phalanx) showed evidence of gnawing marks on their surface; in at least one case such marks (i.e. punctures) were produced by a carnivore, most likely a dog (Fig.6.2.2), while in the others by rodents. Some remains of canids were found in the assemblage, further supporting their presence at the site (*§6.2.2 Species frequency: NISP and MNI*); rodent remains were not found, probably due to the lack of sieving (*§6.2.1.3 Recovery bias*).

**(a)** Frontal side.

**(b)** Dorsal side.

**Figure 6.2.2**. Sant’Antonino, Arab period. Puncture marks on a caprine left distal tibia.

### *6.2.1.3. Recovery bias*

The faunal assemblage was recovered through hand-collection (*§Chapter 4: Sites and material*). The lack of sieving may have thus caused a recovery bias.

This was evaluated by considering differences in the proportions of metapodials and 1st phalanges of caprines; the dearth of data from the other main domesticates (i.e. cattle and suids) did not allow a comparison between large and medium-sized species, which would have been useful (*§Chapter 5: Methodology*).

Fig.6.2.3 shows that 1st phalanges are heavily underrepresented, their incidence being much lower than the natural proportion of metapodials/1st phalanges (1:2). As a result, a recovery bias seems to have considerably affected the analysed assemblage.

Despite this, small-sized bones from birds, fish and tortoises/turtles were recovered (*§6.2.2 Species frequency: NISP and MNI*). However, the considerable bias in the collection of faunal material shown by Fig.6.2.3 suggests that the majority of remains from these taxa could have been missed during the excavation.

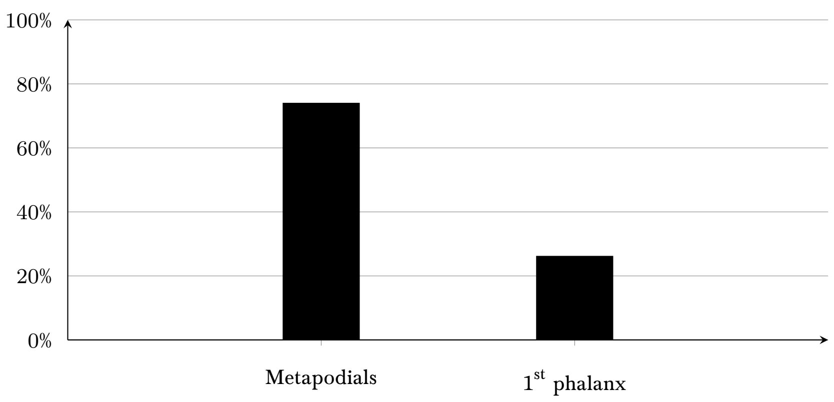


**Figure 6.2.3.** Sant'Antonino, Arab period. Proportions of metapodials and 1st phalanges (n:34;12) of caprines.

### 6.2.2. Species frequency: NISP and MNI

| Sant'Antonino | |
|---|---|
| **Taxa** | **Arab period** |
| Cattle (*Bos taurus*) | 27 |
| Caprines (*Ovis aries*/*Capra hircus*) | 358 |
| Suids (*Sus* sp.) | 3 |
| Equids (*Equidae*) | 5 |
| Canids (*Canidae*) | 7 |
| Felids (*Felidae*) | 16 |
| Mustelids (*Mustelidae*) | + |
| Lagomorphs (*Lagomorpha*) | 2 |
| Galliforms (*Gallus*/*Numida*/*Phasianus*) | 27 |
| Tortoises/turtles (*Testudines*) | 7 |
| Tuna (*Thunnus* sp.) | 22 |
| **Total** | **474** |

**Table 6.2.2.** Sant'Antonino, Arab period. List of all the taxa recorded. Non-countable elements are not included. In case a taxon is only present with non-countable fragment(s), this is indicated with a + (*§Chapter 5: Methodology*).

| **Sant'Antonino** | **Arab period** | |
|---|---|---|
| | **Countable** | **Non-countable** |
| *Ovis aries* | 170 | 17 |
| *Capra hircus* | 26 | 5 |
| *Ovis*/*Capra* | 162 | 141 |
| **Total** | **358** | **163** |

**Table 6.2.3.** Sant'Antonino, Arab period. Recorded countable and non-countable elements identified as sheep (*Ovis aries*), goat (*Capra hircus*) and sheep/goat (*Ovis*/*Capra*).

As Tab.6.2.2 shows, the faunal assemblage from the Arab period at Sant'Antonino is largely dominated by caprines, which represent almost 75% of countable remains. Most caprines that could be identified to species belonged to sheep (Tab.6.2.3).

Cattle is represented in low frequencies (less than 10%), and suids are even scarcer (Tab.6.2.2 and Fig.6.2.4). With such a small number of suid bones it was not possible to carry out any biometrical attempt to separate domestic pig from wild boar.

Equids are also uncommon and none of the remains bore diagnostic traits that allowed them to be assigned to species.

Other potential domesticates recorded at the site include canids; all remains were medium-large in size and visibly robust, which would exclude the possibility they belonged to foxes. The presence of cats (*Felis* sp.) was also attested; these remains could belong to either domestic (*Felis catus*) or wild cat (*Felis silvestris*).

The proximal femur (non-countable element) of a ferret (*Mustela putorius furo*) was also found; although the remain is also compatible with the European polecat (*Mustela putorius*), this species was not present in Sicily in the analysed period, and it still absent today (Masseti 2016).

Two unfused distal femurs could not be identified any more specifically than to the order Lagomorpha (Tab.6.2.2).

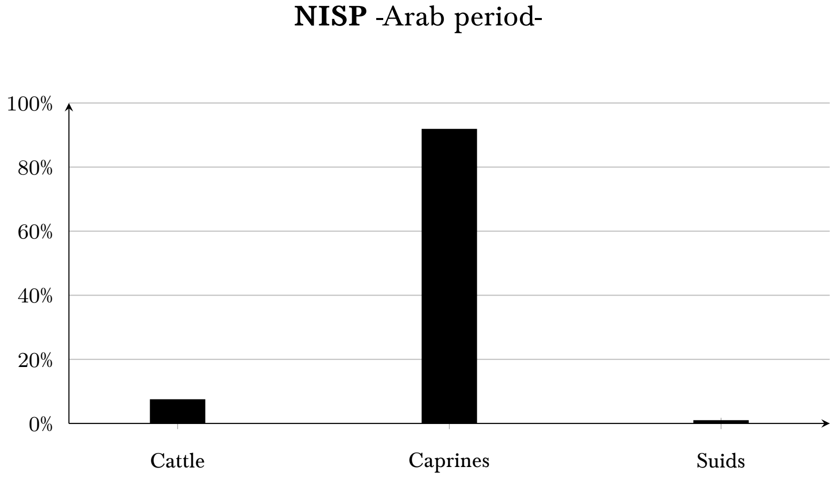


**Figure 6.2.4.** Sant'Antonino, Arab period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates in the Arab period (n:388).

Birds are represented by 27 remains, and these most likely belong to chicken (*Gallus gallus*) (Tab.6.2.2); however, their morphological similarities with closely-related taxa, such as the pheasant (*Phasianus colchicus*) and the helmeted guineafowl (*Numida meleagris*), do not allow to rule out with certainty the presence of such birds in the assemblage.

A few fish remains are also present and they consist of 22 remains, exclusively belonging to tuna (*Thunnus* sp.); these mainly belong to abdominal and caudal vertebrae, although a few cranial elements were also present (Tab.6.2.2).

Other animal species present in the assemblage included seven remains of tortoise/turtle (Tab.6.2.2). The taxonomic identification of Testudines species mainly relies on the different conformation of the carapax and plastron; however, since only non-diagnostic and fragmented parts of the plastron were found (Fig.6.2.5), it was not possible to distinguish between terrestrial and aquatic species.

**Figure 6.2.5**. Sant'Antonino, Arab period. Fragments of plastrons belonging to the order Testudines.

When the MNI of the three main domesticates is considered, the expected overestimation of rare species (in this case, suids and cattle), at the expenses of the most common ones (sheep/goat) is not apparent; this result is likely due to the disproportionate presence of caprine astragali (Fig.6.2.6) (*§6.2.4 Anatomical element distribution*). When astragali are not considered in the MNI count, the incidences of the less common species (cattle and suids in this case), as expected, slightly increase at the expenses of that of caprines (Fig.6.2.7).

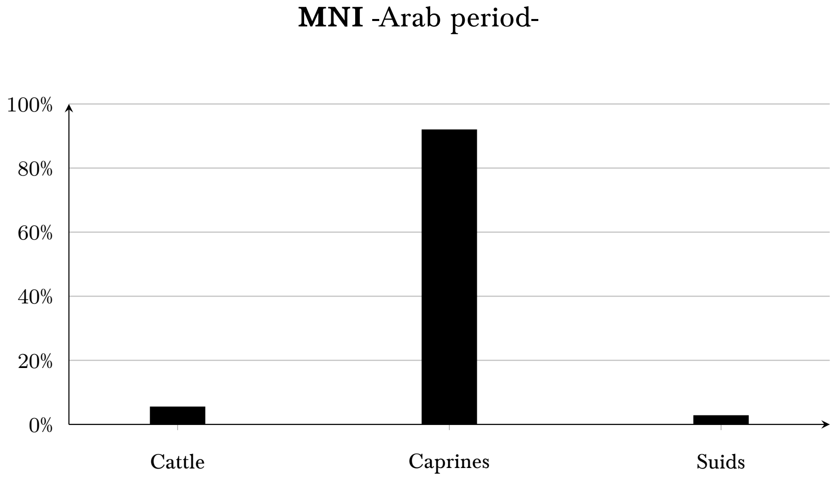


**Figure 6.2.6.** Sant'Antonino, Arab period. Percentage of the Minimum Number of Individuals (MNI) for the three main domesticates (n:42).

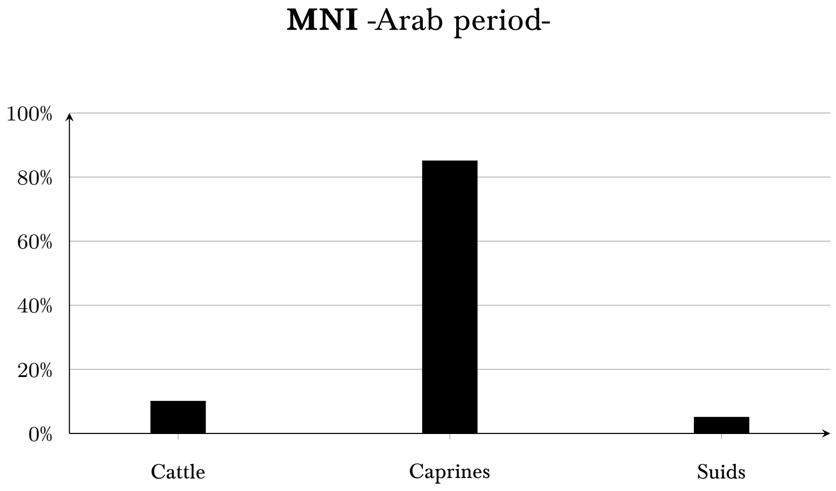


**Figure 6.2.7.** Sant'Antonino, Arab period. Percentage of the Minimum Number of Individuals (MNI) for the three main domesticates in the Arab period at Sant'Antonino (n:20). In this case, astragali were not considered.

*Sheep/goat separation* – Specific morphological criteria characterising a defined set of anatomical elements were systematically used to distinguish between sheep and goat remains at Sant'Antonino (*§Chapter 5: Methodology*).

To further investigate the sheep and goat ratio at the site, biometrical analyses on caprine astragali were carried out; the ratio between the breadth of the distal end (Bd) and the greatest depth of the lateral half (Dl), as well as the one between the greatest depth of the lateral half (Dl) and the greatest length of the lateral half (GLl) were calculated. The obtained values were then compared with those of the same element deriving from modern specimens as presented in Salvagno and Albarella (2017).

Overall, only few astragali from Sant'Antonino could be directly attributed to species level on morphological grounds, as in many cases polishing marks partly obscured the morphological traits on which criteria for taxonomic identification usually rely. At the same time, some astragali were too heavily polished or otherwise modified; for this reason, ten astragali out of 77 were also excluded from the biometrical analysis (*§6.2.6 Worked bones*).

As Fig.6.2.8 shows, most specimens fall within the modern values of sheep (red oval), while fewer in those of goat (blue oval). Some specimens lie in the overlap area between the two groups; hence, they cannot be attributed with certainty to either of the two species.

All in all, it seems that sheep were better represented than goat; this fits well with what was initially suggested by taxonomic identification based on morphological criteria.

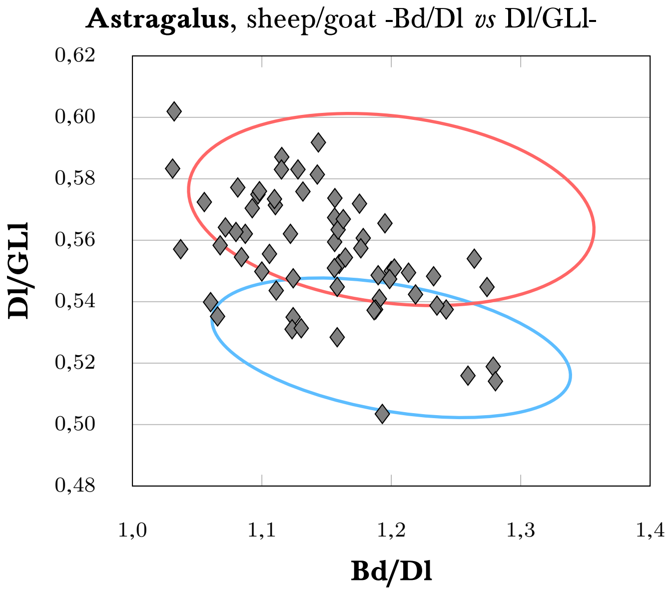


**Figure 6.2.8.** Sant'Antonino, Arab period. Sheep/goat, astragali, shape indices. Red oval: range of values attributed to sheep, blue oval: range of values attributed to goat according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). Bd: breadth of the distal end; Dl: greatest depth of the lateral half; GLl: greatest length of the lateral half.

### 6.2.3. Ageing

This section focuses on caprines (sheep/goat) and cattle, as sufficient ageing data were available only for these species; brief comments about the age-at-death of suids, equids, canids, felids and birds are made below.

*Caprines* – Ageing from sheep/goat epiphyseal fusion reveals that at Arab Sant'Antonino a fair number of animals (20%) were slaughtered before one-two years of age (early fusing stage), and ca. 50% of the animals were culled before they reached their second and third year of age (middle fusing stage); no cullings between the middle and the late fusing stage are present. In addition, ca. 30% of the individuals survived into late adulthood (≥ three to four years) (Fig.6.2.9). Some sheep perinatal bones were also recorded; these might represent natural losses.

A relatively large number of caprine mandibles were also recorded (Fig.6.2.10). The diagram seems to suggest the occurrence of two groups of animals, which may indicate that one part of the flock (the larger one) was kept for meat production, and another (the smallest one) for secondary products; such result seems to validate the epiphyseal fusion analysis.

In sum, the culling pattern for the Arab period at Sant'Antonino appears quite generalised, with a large part of caprines raised for meat, and fewer animals exploited for milk and wool production.

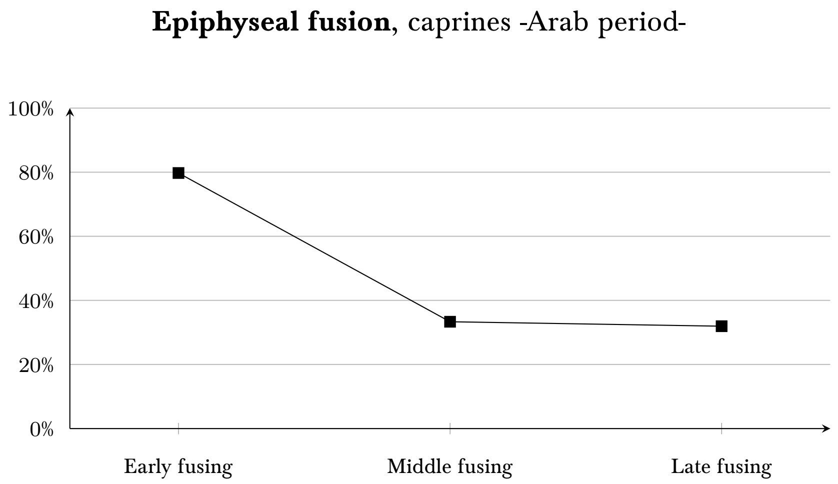


**Figure 6.2.9.** Sant'Antonino, Arab period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:80;34;32). Epiphyseal fusion stages follow Silver (1969).

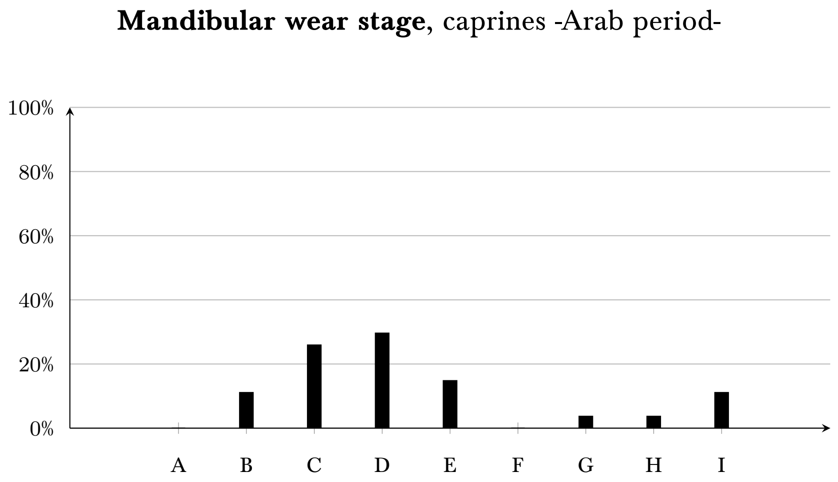


**Figure 6.2.10.** Sant'Antonino, Arab period. Mandibular wear stages for caprines (n:27). Age stages follow Payne (1973). A: 0-2 months, B: 2-6 months, C: 6-12 months, D: 1-2 years, E: 2-3 years, F: 3-4 years, G: 4-6 years, H: 6-8 years, I: 8-10 years.

*Cattle* – As Fig.6.2.11 shows, the majority of individuals survived into later adulthood (≥ three and four years), with less than ca. 20% of animals killed before two-three years of age (middle fusing stage).

This pattern might suggest that cattle were mainly exploited for secondary products (e.g. traction and/or dairy products), although a small amount of animals would have been raised for meat.

The absence of calves (early fusing elements) might be related with a husbandry strategy specifically focused on the use of cattle for traction; however, it is equally likely that taphonomic processes compromised the survival of the more fragile bones of very young individuals.

Due to the small size of the sample, caution in the interpretation of data is needed.

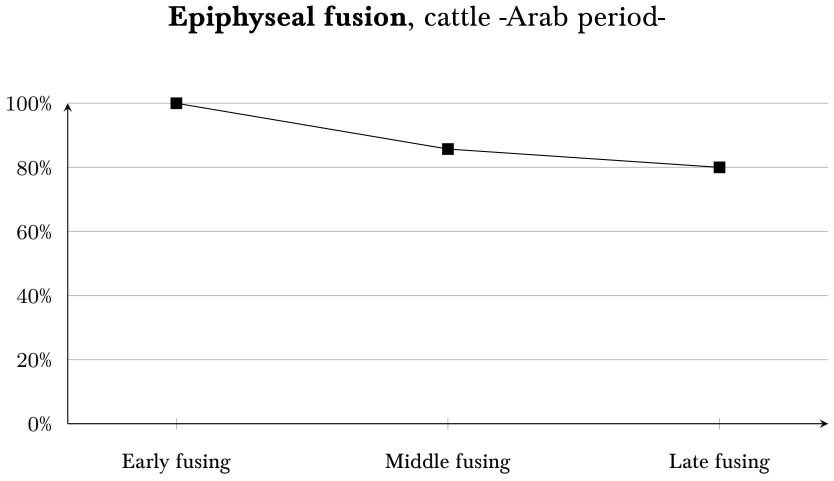


**Figure 6.2.11**. Sant'Antonino, Arab period. Epiphyseal fusion analysis for cattle. Percentage of fused bones within each fusion stage (n:100;86;80). Epiphyseal fusion stages follow Silver (1969).

*Suids* – Only three specimens were assigned to Sus sp. and were all unfused (one proximal ulna and two distal humeri).

*Equids* – Overall, a few specimens belonging to the Equidae were recovered; all the five recorded post-cranial bones were fused, suggesting the presence of mature individuals.

*Canids and Felids* – All the seven specimens belonging to canids were fused, thus suggesting the presence of adult individuals at the site. Conversely, adult and young individuals of cat were present; indeed, out of the 16 recorded anatomical elements, four were unfused diaphyses (two femurs, one humerus and one metatarsal IV) (Fig.6.2.12).

**Figure 6.2.12**. Sant'Antonino, Arab period; frontal view of an unfused left humerus of cat.

*Galliformes* – Out of 20 remains assigned to the order *Galliformes*, seven belonged to immature individuals and are particularly small in size; they may represent natural mortality and, therefore, on-site breeding.

### 6.2.4. Anatomical element distribution

The distribution of anatomical elements could only be properly analysed for caprines and fish. Due to the small sample size, only cursory observations were made for cattle.

*Caprines* – The analysis of the anatomical elements distribution for caprines shows an interesting pattern (Fig.6.2.13); indeed, both upper and lower limbs are almost equally represented, with the exception of the high and abnormal number of astragali (*§6.2.6 Worked bones*). Caprine carcasses are also represented by a considerable amount of cranial bones; this result might indicate that complete carcasses were brought to the site. The dearth, and in some cases the absence, of small-sized bones (i.e. carpals, tarsals and phalanges) is probably related with the lack of sieving during the collection of the material, and the resulting recovery bias.

Putting aside for a moment the unusual number of astragali, all in all, the distribution of caprine body parts at Sant'Antonino in the Arab period suggests that both primary and secondary butchery processes were carried out at the site.

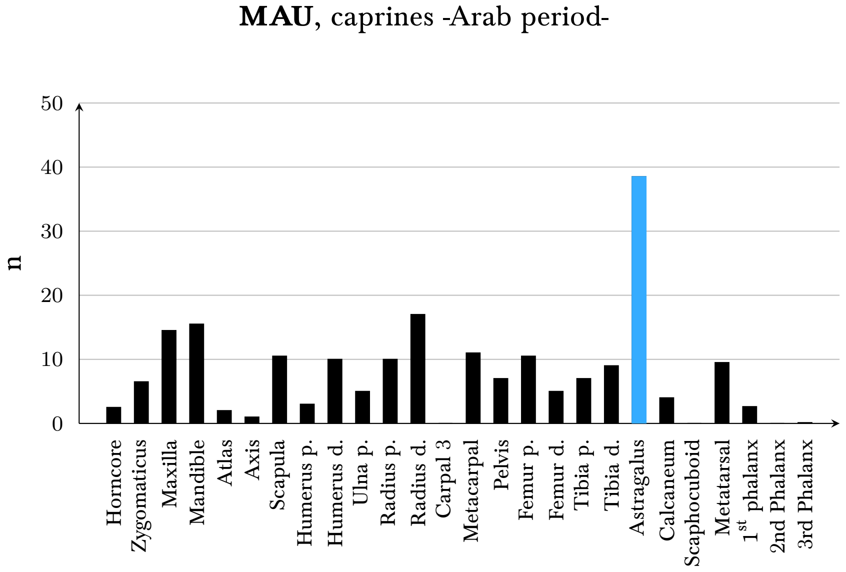


**Figure 6.2.13.** Sant'Antonino, Arab period. Distribution of the Minimum number of Animal Units (i.e. MAU) for caprines (n:201). Light blue: the most represented anatomical element/s. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (§*Chapter 5: Methodology*).

*Fish* – The anatomical element distribution for fish remains was calculated using the Minimum Number of Element (i.e. MNE) rather than the Minimum number of Animal Units (i.e. MAU), due to the sample size of sample and to the large number of vertebrae in fish.

Fish remains of *Thunnus* sp. are represented by ten abdominal vertebrae and two first vertebrae. Fish cranial elements, such as dentary, pre-maxilla, quadrate, vomer and cleithrum are also present (Fig.6.2.14). The majority of fish remains show evidence of cut and chop marks; this indicates that entire fish carcasses of tuna were brought to and processed at the site.

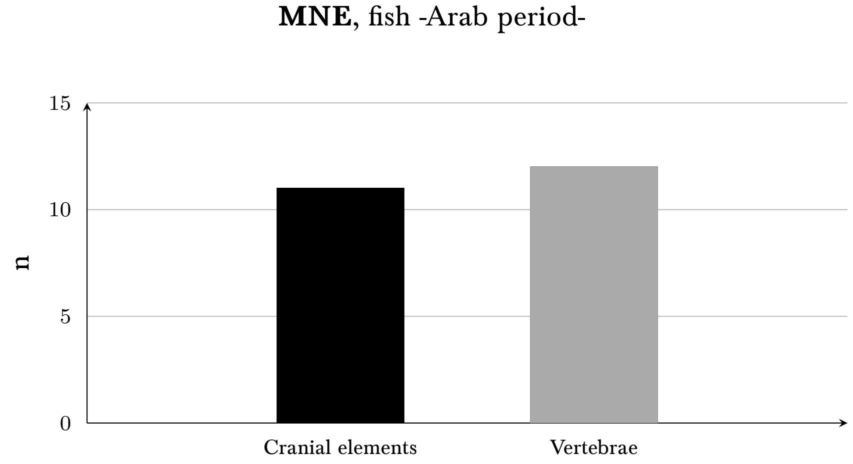


**Figure 6.2.14.** Sant'Antonino, Arab period. Distribution of the Minimum Number of Element (i.e. MNE) for *Thunnus* sp. remains (n:22).

*Cattle* – All the 27 cattle specimens belong to lower limbs, with the exception of a scapula and two distal femurs; metatarsals and phalanges are the most abundant body parts. Cranial elements are absent, while small sized bones (e.g. carpals, tarsals) are present but in low numbers. The absence of cattle cranial elements and upper limbs is probably a consequence of the combined effect of different strategies of waste disposal and taphonomic processes.

Despite the small sample size, which invites caution, it seems that primary butchery was largely responsible for the accumulation of the cattle assemblage identified at the site.

### 6.2.5. Butchery

For this site, the analysis of butchery marks focuses on caprines. Brief comments on cat and fish carcass processing are made, despite the modest quantity of available data.

*Caprines* – As Fig.6.2.15 indicates, evidence of butchery marks on caprine bones was recorded on a relatively small portion of the remains (considering their overall good preservation). Out of 311 remains, 47 (all long bones) presented butchery marks. Among the recorded butchery marks, cut were more common, although a fair number of chop marks was also present (Fig.6.2.16).

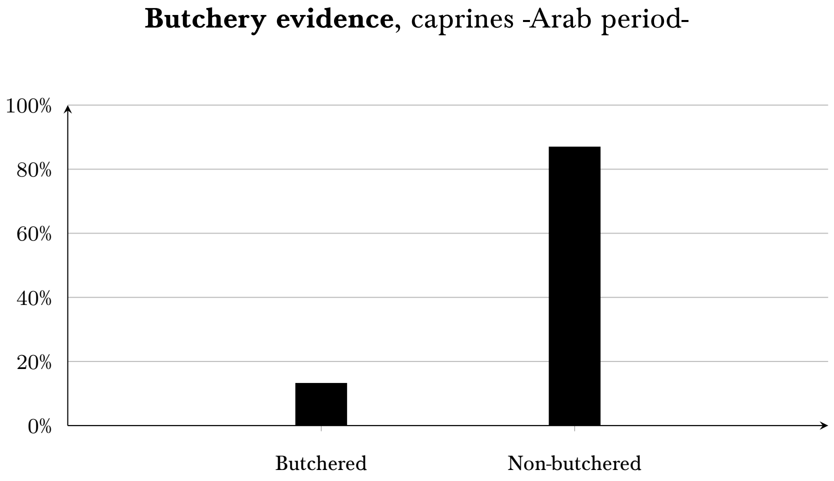


**Figure 6.2.15.** Sant'Antonino, Arab period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:47;264).

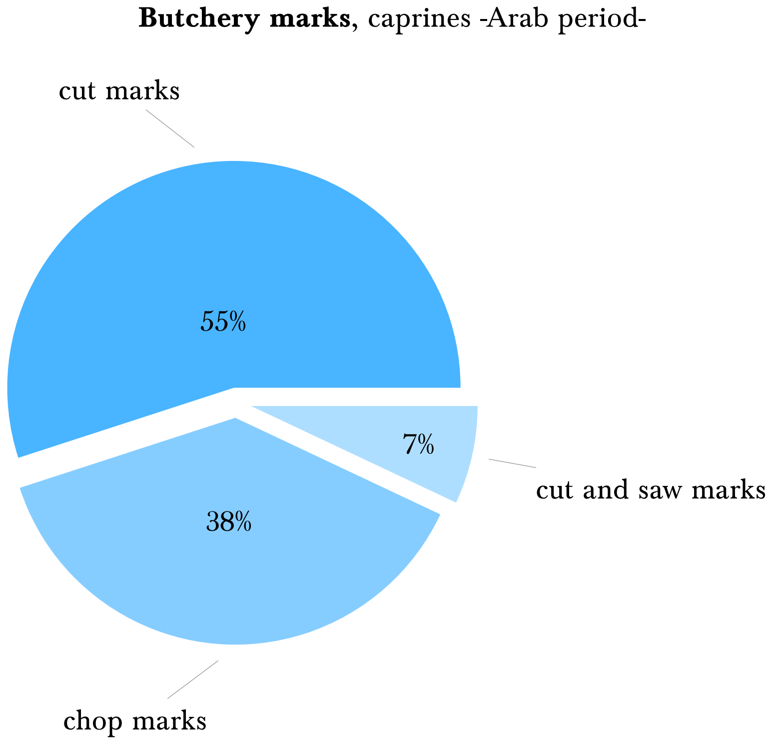


**Figure 6.2.16.** Sant'Antonino, Arab period. Butchered post-cranial bones of caprines; proportions of cut marks, chop marks, and cut and saw marks (n:47).

*Cat* – Three cat specimens showed evidence of butchery marks on their surface. These include two fused proximal femurs and one fused radius, which were characterised by the presence of cut marks located in the proximity of their articular ends (Fig.6.2.17). Such marks are likely to have been produced during skinning activities and/or to severe tendons.

**(a)** Cut mark on the proximal diaphysis of a cat radius.

**(b)** Cut marks on the proximal diaphysis of a cat femur.

**Figure 6.2.17**. Sant'Antonino, Arab period.

*Fish* – Out of 22 *Thunnus* sp. remains, seven presented butchery marks. Two fish first vertebrae were chopped along their vertebral processes, while cranial elements presented in some cases both chop and cut marks.

Considering the large-size of individuals belonging to *Thunnus* sp., chop marks from heavier tools (e.g. cleaver) were probably aimed to dismember the carcasses into smaller portions; cut marks from tools such as knives are more likely to be the result of filleting or other secondary butchery activities.

### 6.2.6. Worked bones

A considerable quantity of worked bones were recovered in contexts dated to the Arab period at the site of Sant'Antonino.

*Caprine astragali* – 77 caprine astragali were recovered at Sant'Antonino from archaeological contexts dated to the Arab period (Fig.6.2.18).

All the caprine astragali were characterised by human-derived modifications on their surfaces (mainly polishing). Such marks were usually located on both the medial and lateral sides of the bone (Fig.6.2.19), with less intensive polishing also present on the dorsal and palmar sides. In addition, some astragali had been perforated; only in some cases, however, the perforation went from side to side (Fig.6.2.20). Such evidence might suggest that the astragali had been collected and were being used as gaming pieces and/or, in the case of perforated ones, as ornaments.

**(a)** Anterior view.

**(b)** Posterior view.

**Figure 6.2.18**. Sant'Antonino, Arab period; polished caprine astragali.

**(a)** Lateral side.

**(b)** Medial side.

**Figure 6.2.19**. Sant'Antonino, Arab period; caprine polished astragali.

**Figure 6.2.20**. Two perforated caprine astragali.

*Swan flute* – Another example of worked bone is represented by a swan (*Cygnus* sp.) ulna which is made into a flute, with four tone holes locate on the frontal side of the bone, and a 'D'-shaped window close to the proximal end. In addition, decorative motifs consisting of squares and crosses along with other incised lines adorn the musical artefact (Fig.6.2.21)[1].

**Figure 6.2.21**. Sant'Antonino, Arab period; the flute made from a swan ulna.

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[1] The flute is currently being analysed by researchers of the Soprintendenza Archeologica dei Beni Ambientali e Culturali of Palermo, the University of Palermo and the University of Barcelona. aDNA analyses are being carried out to attribute the element to species-level.

*Worked caprine metatarsal* – Another example of worked bone is represented by a caprine metatarsal (Fig.6.2.22). The bone present five circular holes, distributed around the proximal and distal ends; a further circular perforation is made antero-posteriorly at the mid-shaft. In addition, several transversal incised lines characterise three of the bone four sides; such lines are more regularly spaced on the anterior side, while they are more irregularly distributed on the medial and lateral sides. No evidence for working is present on the posterior side of the element.

**(a)** anterior and posterior views;

**(b)** Medial view. **(c)** Later view.

**Figure 6.2.22**. Sant'Antonino, Arab period. Worked caprine metatarsal.

### 6.2.7. Burning

A small number of bones belonging to caprines and galliforms were either burnt or singed (n:10), while calcination was recorded only on one caprine bone.

### 6.2.8. Size and shape

In this section, biometrical analyses focus on caprines, as only a small number of measurements could be taken on the other animals.

Investigation about size and shape of caprines (mainly sheep) rely largely on the use of the scaling index tecnique, as only a few measurements from individual anatomical elements could be taken. Width/depth measurements of different caprine post-cranial bones dated to the Arab period of Sant'Antonino were merged and plotted into a log ratio histogram. Due to small sample size more and less sex-dependent bones could not be plotted separately, and the potential effect of this combination must be taken into account in the interpretation.

*Caprines* – Measurements of the distal tibia from the Arab period at Sant'Antonino and Corso dei Mille were plotted to investigate potential differences in caprine size between the two sites (Fig.6.2.23).

As Fig.6.2.23 shows, most values from the Arab Sant'Antonino are distributed on the upper right part of the graph, while those from Arab Corso dei Mille mainly cluster at the bottom left. This distribution suggests that caprines at Sant'Antonino were larger than those present at Corso dei Mille in the Arab period. However, the small sample size invites caution in the interpretation of these results.

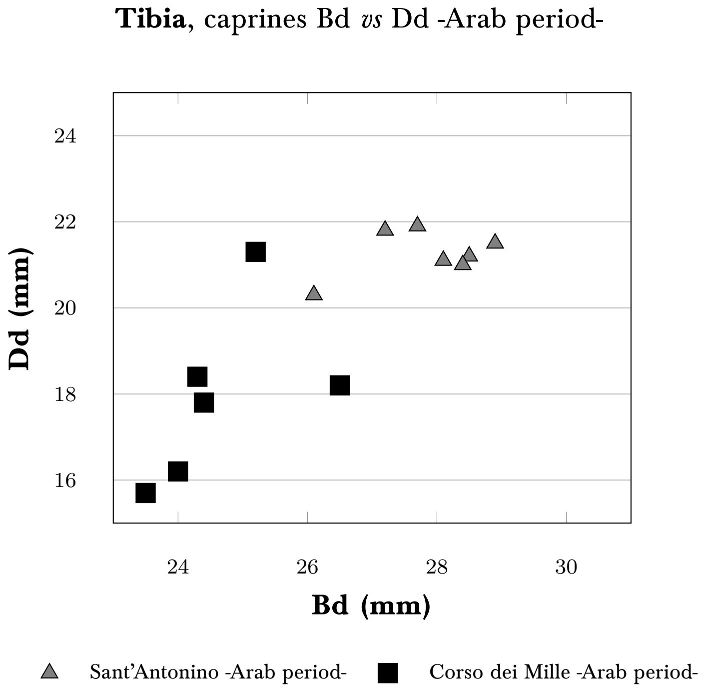


**Figure 6.2.23.** Measurements of the distal tibia (Bd and Dd) of caprines from Sant'Antonino (grey triangles) and Corso dei Mille (black squares) in the Arab period.

In order to further analyse differences in caprine size in the Arab period at Sant'Antonino, width and depth measurements from fused post-cranial anatomical elements were analysed (*§Chapter 5: Methodology*). A comparison with the results obtained through the same analysis for Corso dei Mille has been made.

At Sant'Antonino the histogram displays a largely unimodal distribution for the Arab period; the same result can also be observed for the site of Corso dei Mille (Fig.6.2.23). However, values from Sant'Antonino are more skewed to the right side of the graph in comparison to those from Corso dei Mille, suggesting the presence of larger sheep at the former site.

The result of the *t*-Student's test does not indicate that the difference between the group of values from Arab Corso dei Mille and Arab Sant'Antonino is statistically significant with a 0.05 threshold. However, the obtained p value is rather low (0.098); the tiny sample size of measurements available for Arab Corso dei Mille might have influenced such result. The results of all statistical tests are included in Fig.6.8.27, Tab.6.8.6 and Tab.6.8.7.

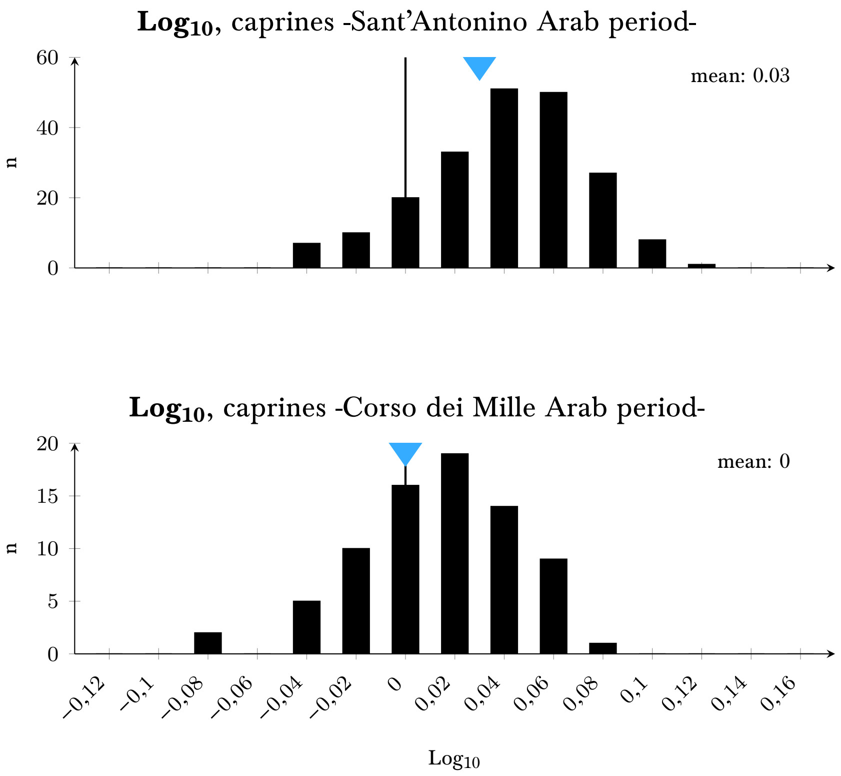


**Figure 6.2.24.** Comparison between Sant'Antonino and Corso dei Mille. Log ratio histogram for width/depth measurements of caprines from Sant'Antonino (n:215) and Corso dei Mille (n:76) in the Arab period. The triangle indicates the logarithmic mean. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (§*Chapter 5: Methodology*).

## 6.3. The Norman Palace (Palermo)

The faunal assemblage from the Norman Palace (Palermo) includes 395 recorded specimens, of which 286 were also countable; these were recovered from archaeological contexts dated to the 12th century AD, which will be referred to as the Norman period in the following analyses (Tab.6.3.1).

| Chronology | Period | Countable | Non-countable | Total |
|---|---|---|---|---|
| 12th c. AD | Norman | 286 | 109 | 395 |

**Table 6.3.1.** The Norman Palace, Norman period. Number of recorded countable and non-countable specimens.

### 6.3.1. Taphonomic alteration

#### *6.3.1.1. Surface preservation*

The degree of surface preservation was good (Fig.6.3.1), although only occasionally excellent.

A small proportion of animal bones and teeth presented a medium level of preservation; these remains were usually characterised by weathering cracks and fresh breaks produced during excavation. This result suggests that soil conditions did not severely affected the faunal assemblage; additional taphonomic processes did not substantially compromise taxonomic identification, detection of marks on bone surfaces, and recording of measurements.

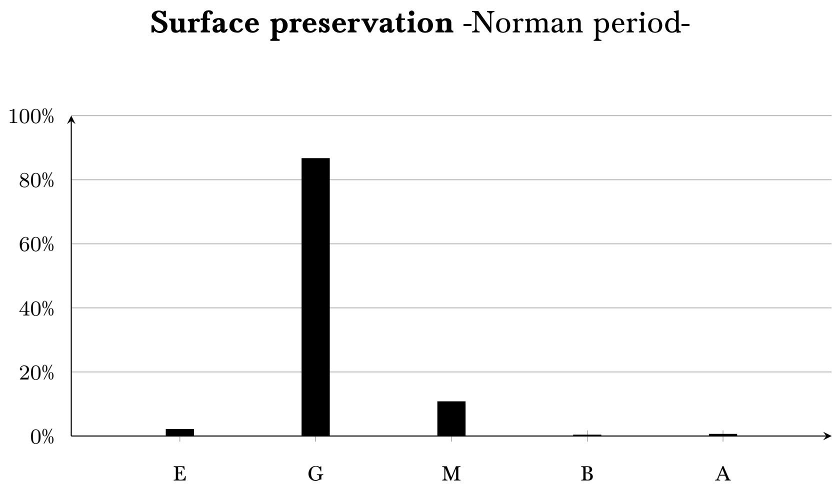


**Figure 6.3.1.** The Norman Palace, Norman period. Surface preservation of recorded elements (n:395). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

### *6.3.1.2. Gnawing*

Four bones (one distal humerus, two distal tibiae and one distal metacarpal), belonging to caprines, showed evidence of gnawing produced by rodents. In addition, three bones of suids (two distal humeri and one proximal ulna) had been heavily gnawed by carnivores, whose presence at the site is also supported by the recovery of 16 remains recorded as canids (most likely dogs); by contrast, no rodent remains were found, probably due to the lack of sieving, and the consequent recovery bias (*§6.3.1.3 Recovery bias* and *§6.3.2 Species frequency: NISP and MNI*).

### *6.3.1.3. Recovery bias*

The animal remains from the Norman Palace were recovered by hand during a rescue excavation; as a result, a substantial recovery bias must be expected.

The recovery bias was evaluated by considering differences in the proportions of metapodials and 1st phalanges of caprines and suids; the overall dearth of cattle remains did not allow a proper comparison between larger and medium sized species, which is usually desirable to better estimate the degree of a recovery bias in a faunal assemblage (*§Chapter 5: Methodology*).

Fig.6.3.2 shows that suid metapodials and 1st phalanges are not proportionally represented, although the ratio gets close to the natural proportion of 1:1. Similarly, caprine phalanges are only slightly more numerous than metapodials, being still far from their natural proportion of 1:2. Such discrepancy in the proportion of these elements is likely to represent a recovery bias, which might be the reason lying behind the almost complete absence of small-sized mammals, birds and fish from the assemblage (*§6.3.2 Species frequency: NISP and MNI*).

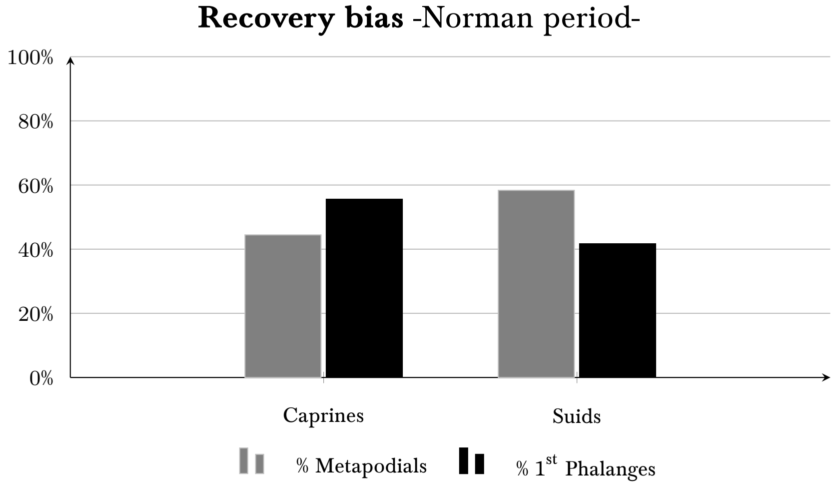


**Figure 6.3.2.** The Norman Palace, Norman period. Proportions of caprine and suid metapodials (n:12;14) and 1st phalanges (n:15;10) recovered.

## 6.3.2. Species frequency: NISP and MNI

| **The Norman Palace** | |
|---|---|
| **Taxa** | **Norman period** |
| Cattle (*Bos taurus*) | 11 |
| Caprines (*Ovis aries*/*Capra hircus*) | 95 |
| Suids (*Sus* sp.) | 147 |
| Equids (*Equidae*) | 4 |
| Canids (*Canidae*) | 16 |
| Cervids (*Cervidae*) | 3 |
| Hare (*Lepus* sp.) | 2 |
| Galliforms (*Gallus*/*Numida*/*Phasianus*) | 5 |
| Common crane (*Grus grus*) | 2 |
| Tortoises/turtles (*Testudines*) | 1 |
| **Total** | **286** |

**Table 6.3.2.** The Norman Palace, Norman period. List of all the taxa recorded at the site. Non-countable elements are not included. In case a taxon is only present with non-countable fragment(s), this is indicated with a + (*§Chapter 5: Methodology*).

| **The Norman Palace** | **Norman period** | |
|---|---|---|
| | **Countable** | **Non-countable** |
| *Ovis aries* | 58 | 2 |
| *Capra hircus* | 1 | 0 |
| *Ovis*/*Capra* | 36 | 6 |
| **Total** | **95** | **8** |

**Table 6.3.3.** The Norman Palace, Norman period. Recorded countable and non-countable specimens identified as sheep (*Ovis aries*), goat (*Capra hircus*) and sheep/goat (*Ovis*/*Capra*).

The faunal assemblage from the Norman period at the Norman Palace is largely dominated by the three main domesticates, which together account for almost 90% of the countable bone fragments (Tab.6.3.2). Suids make up the relative majority of the NISP (ca. 60%), while caprines are less represented (ca. 35%) (Tab.6.3.2 and Fig.6.3.3). The large majority of caprine remains were identified as sheep, although in some cases they could not be identified to species; only one remain (i.e. a distal tibia) was attributed to goat (Tab.6.3.3). The dearth of measurements prevented to further confirm the taxonomic identification of caprines with biometrical analyses.

Cattle is barely represented at the site (less than 5%) (Tab.6.3.2 and Fig.6.3.3); this holds also true for equids, for which only four anatomical elements were recorded (Tab.6.3.2). The lack of distinctive morphological features on the recorded equid remains and the impossibility of running biometrical analyses, due to the very limited sample size, did not allow to assign such remains to species level.

Other potential domesticates recorded at the Norman Palace are canids (Tab.6.3.2): all remains were quite robust and presented a medium-large size; these characteristics seem to indicate the presence of dogs and/or wolfs rather than foxes, which are generally more gracile in shape.

Wild medium-large sized animals are infrequent. These include two distal tibiae, one proximal tibia and one proximal femur belonging to red deer (*Cervus elaphus*) and/or to fallow deer (*Dama dama*). The absence of clear species-related morphological criteria on these elements did not allow to assign them with certainty to species level; for this reason, it was preferred to record them as 'Cervids' (Tab.6.3.2).

Wild small-sized mammals are represented by two mandibles attributed to hare (*Lepus europaeus*) (Tab.6.3.2).

Birds are represented by seven remains; five of these most likely belong to chicken (*Gallus gallus*), although the presence at the site of closely related taxa, such as the pheasant (*Phasianus colchicus*) and the helmeted guineafowl (*Numida meleagris*), cannot be ruled out with certainty. The other two bird remains, a distal femur and a distal tibia, belong to the common crane (*Grus grus*) (Tab.6.3.2).

In addition, the fragment of a carapax (*Testudines*) was recorded; this find did not present any species-specific morphological criteria, thus preventing the distinction between terrestrial and aquatic taxa (Tab.6.3.2).

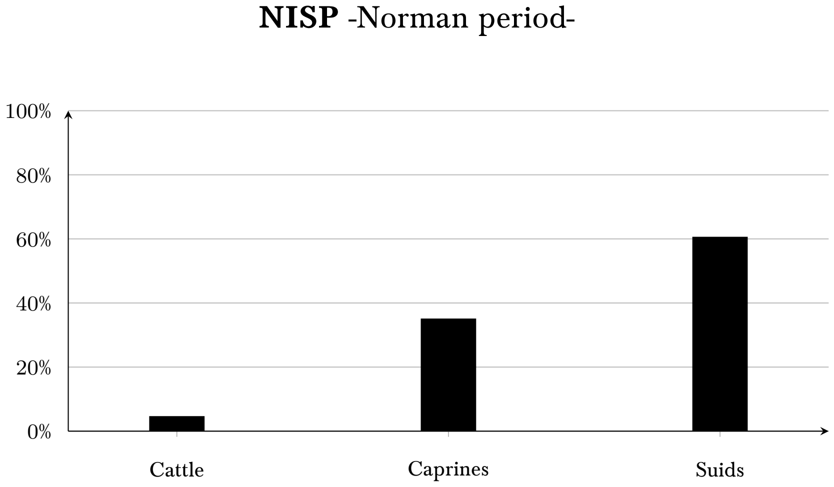


**Figure 6.3.3.** The Norman Palace, Norman period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates (n:253).

As Fig.6.3.4 shows, no substantial changes to the NISP trend are evident when the MNI is considered. The slightly better representation of cattle is likely due to the tendency of this quantification method to emphasise the rarer species, while the marginally higher representation of caprines may be a consequence of the fact that this method is less affected by recovery bias and therefore smaller taxa tend to be better represented. The similarity between NISP and MNI analyses provide a stronger confidence in the accuracy of the presented results (*§Chapter 5: Methodology*).

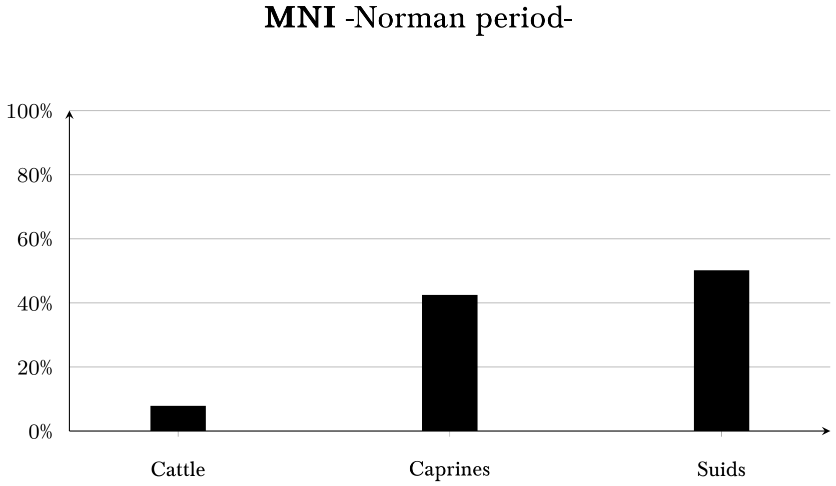


**Figure 6.3.4.** The Norman Palace, Norman period. Percentage of the Minimum Number of Individuals (MNI) for the three main domesticates (n:26).

### 6.3.3. Ageing

This section focuses on suids and caprines, as not enough ageing data were available for other species. Nonetheless, brief comments about the age-at-death of cattle and canids are made below.

*Suids* – As Fig.6.3.5 shows, ca. 50% of early fusing elements were unfused, representing suids killed before one-two years of age. This trend suggests the consumption of young pigs at the site. Some pig perinatal bones were also recorded; however, it was decided to excluded them from the ageing analysis, as they likely represent natural losses rather than deliberate slaughter. An additional ca. 20% of the animals were slaughtered before two-three years of age (middle fusing stage), once they had reached their optimum weight. The rest of animals were killed before their third-fourth year of age, with very few individuals surviving into adulthood; these latter probably represent sows and boars kept for reproduction.

Despite the small sample size, the kill-off pattern reconstructed from mandibular wear stages for suids seems to generally confirm the results obtained from the epiphyseal fusion analysis (Fig.6.3.6), with the majority of individuals culled as subadults (middle fusing stage) or at a younger age (neonatal, juvenile and immature, i.e. early fusing stage).

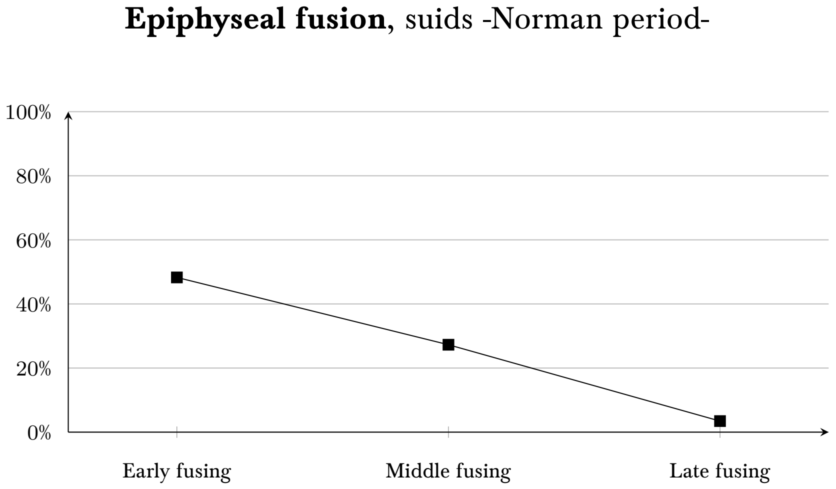


**Figure 6.3.5.** The Norman Palace, Norman period. Epiphyseal fusion analysis for suids. Percentage of fused bones within each fusion stage (n:48;27;3). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

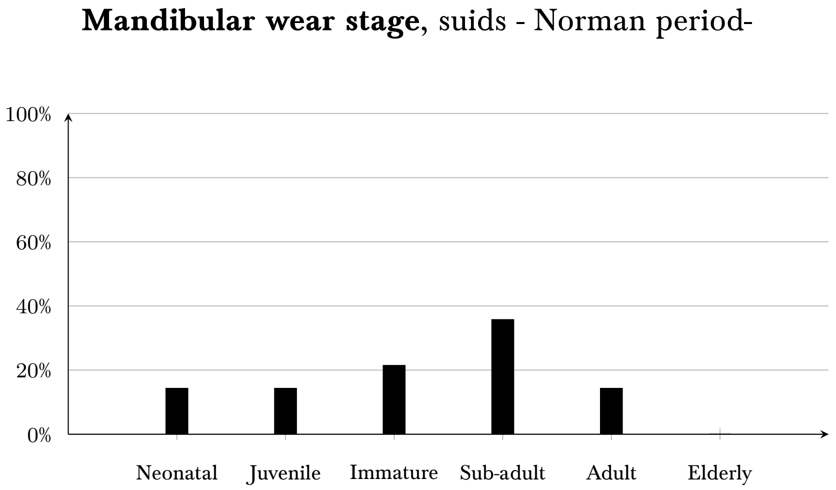


**Figure 6.3.6.** The Norman Palace, Norman period. Mandibular wear stages for suids (n:14). Age stages follow O'Connor (1998), with the Neonatal stage added.

*Caprines* – As Fig.6.3.7 indicates, ca. 30% of animals were culled before their second-third year of age (middle fusing stage), while a further ca. 40% of animals before reaching the three-four years of age (late fusing stage). A smaller proportion of individuals survived into later adulthood (≥ three-four years of age).

As a result, it seems that the major focus of caprine husbandry at the Norman Palace was upon meat production, with wool and dairy products playing a minor role. The virtual absence of early culling events may be a consequence of taphonomic processes, which could have prevented the preservation of the more fragile bones characterising very young individuals.

A number of caprine mandibles were also aged; as Fig.6.3.8 shows, the analysis of the mandibular wear stage does not contradict the epiphyseal fusion analysis, showing a clearer emphasis on meat production. The only discrepancy between the two ageing methods is represented by the presence of lambs corresponding to stage B (animals aged between 2-6 months) and stage C (animals between 6-12 months), which are not represented in the epiphyseal fusion analysis; such difference, as mentioned above, could be the result of taphonomic processes (bones from very young individuals tend to preserve less well than their teeth).

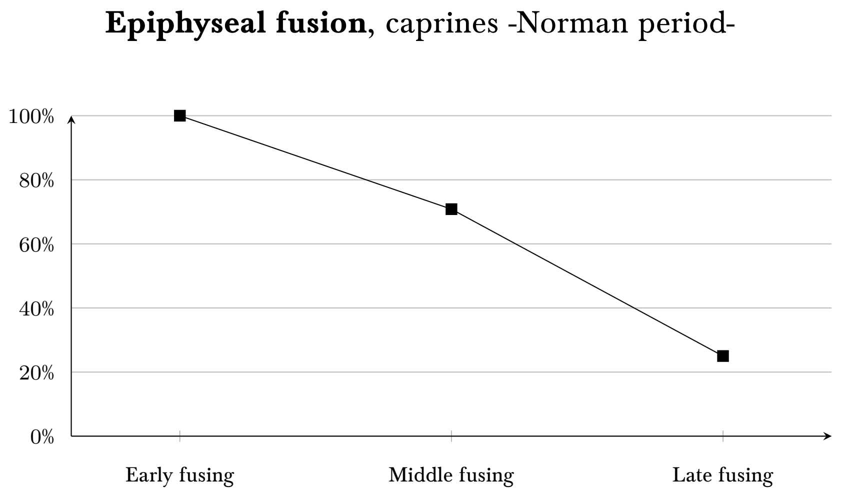


**Figure 6.3.7**. The Norman Palace, Norman period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:100;71;25). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

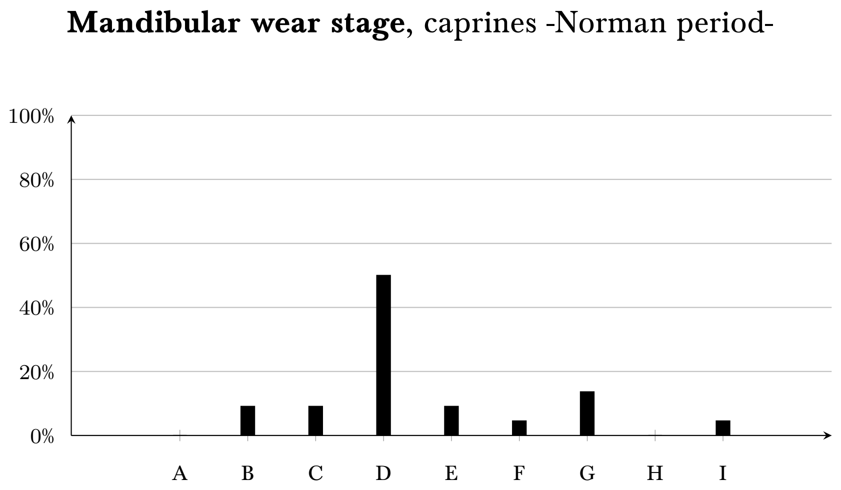


**Figure 6.3.8**. The Norman Palace, Norman period. Mandibular wear stages for caprines (n:17). Age stages follow Payne (1973). A: 0-2 months, B: 2-6 months, C: 6-12 months, D: 1-2 years, E: 2-3 years, F: 3-4 years, G: 4-6 years, H: 6-8 years, I: 8-10 years.

*Cattle* – Eleven cattle post-cranial elements were recorded; all of them were fused, suggesting the presence of adult/old animals (≥ three-four years of age). If this reflected a general trend at the site, the result suggests that cattle were mainly used as traction force and for dairy production. However, the small size of the sample invites caution in the interpretation of the results.

*Canids* – All the 16 anatomical elements identified as dogs and/or wolfs were fused, and thus belonged to adult individuals.

### 6.3.4. Anatomical element distribution

The distribution of anatomical elements could only be properly analysed for suids and caprines while, for other animals, due to the small sample size, only cursory comments can be made.

*Suids* – The anatomical elements distribution of suids reveals that most parts of the skeleton, including elements from the head (in particular mandibles), are almost equally represented at the site. The most abundant element is the distal humerus: this, apart from being a meat-bearing body part (along with other elements such as proximal radius, femur and proximal tibia), is also a dense and resistant element that tends to preserve well in the archaeological record (Brain 1981). The considerable incidence of suid mandibles confirms that entire carcasses entered the site. Smaller elements, such as carpals, tarsals, and phalanges are not surprisingly under-represented, as a consequence of recovery bias (Fig.6.3.9).

All in all, these results indicate that animals were slaughtered locally and that primary and secondary butchery occurred at the site.

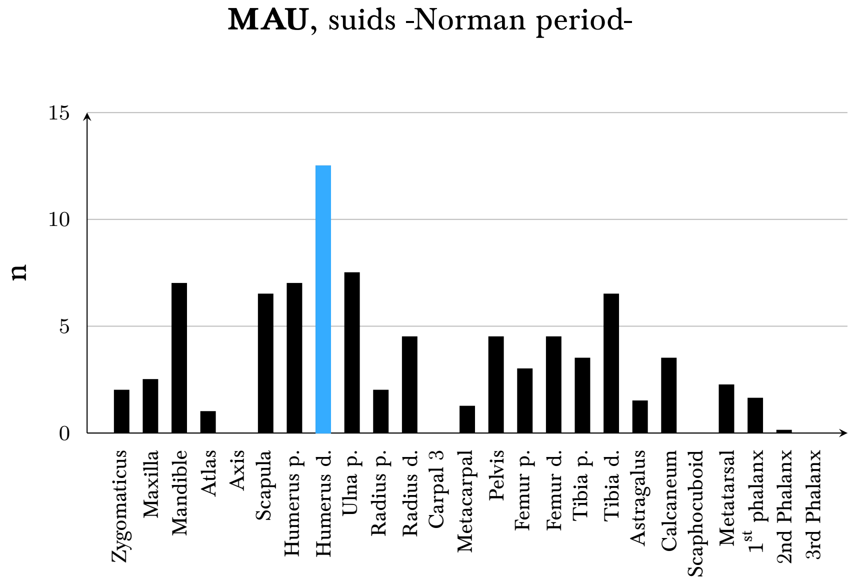


**Figure 6.3.9.** The Norman Palace, Norman period. Distribution of the Minimum number of Animal Units (i.e. MAU) for suids (n:85). Light blue: the most represented anatomical element/s. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Caprines* – The analysis of the Minimum number of Anatomical Units (MAU) for caprines seems strongly affected by recovery and taphonomic factors (Fig.6.3.10). Indeed, as in the case of suids, small body parts (e.g. carpals, tarsals and phalanges) are completely absent, and this is likely to be a consequence of the lack of sieving.

In addition, post-cranial bones are under-represented relatively to mandibles and, to a lesser extent, maxillae. Among post-cranial bones, distal humeri and distal tibiae are the most abundant body parts; this does not come as a surprise, as the distal ends of such elements are very dense, hence their rate of survival is high; other late fusing epiphyses, such as the proximal humerus, the proximal and distal femur and the proximal tibia, survive less well (Brain 1981).

Overall, it is likely that all parts of the skeleton were originally present at the site, and therefore caprine carcasses were being processed at the site.

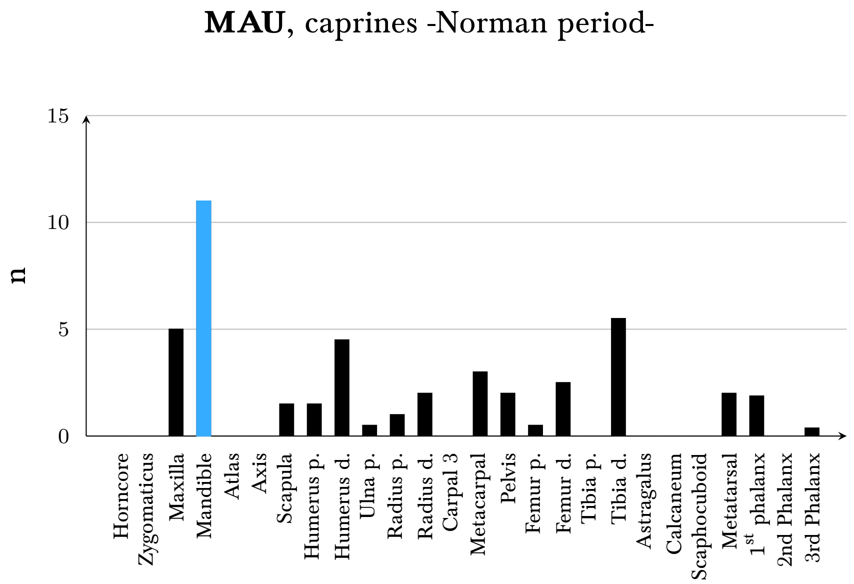


**Figure 6.3.10**. The Norman Palace, Norman period. Distribution of the Minimum number of Animal Units (i.e. MAU) for caprines (n:45). Light blue: the most represented anatomical element/s. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Cattle* – The 14 recorded anatomical elements of cattle include upper and lower limbs, with very few cranial elements. Hence, it is possible that more secondary rather than primary butchery was carried out on site. Carpals and tarsals are missing; this is likely to be a consequence of recovery bias, despite the large size of cattle bones. However, the small sample size invites caution in the interpretation of the results.

### 6.3.5. Butchery

For this site, the analyses of butchery marks focus exclusively on suids and caprines, as other recorded taxa did not show any evidence of carcass processing.

*Suids* – Evidence of butchery marks on suid bones was recorded on a considerable percentage of remains (Fig.6.3.11). Indeed, out of 159 post-cranial bones, 46 presented butchery marks; among these, chop marks were more common, although a fair number of cut and chop/cut marks was also recorded (Fig.6.3.12);

these marks were generally located at the extremities of long bones, while fewer were present along the shafts.

Considering these results, there can be little doubt that these remains derive from kitchen waste and butchery.

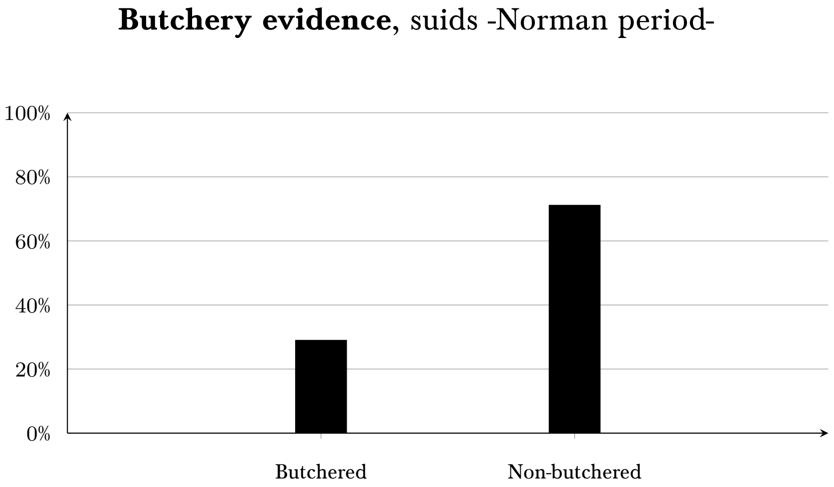


**Figure 6.3.11.** The Norman Palace, Norman period. Proportion of butchered and non-butchered post-cranial bones of suids (n:46;113).

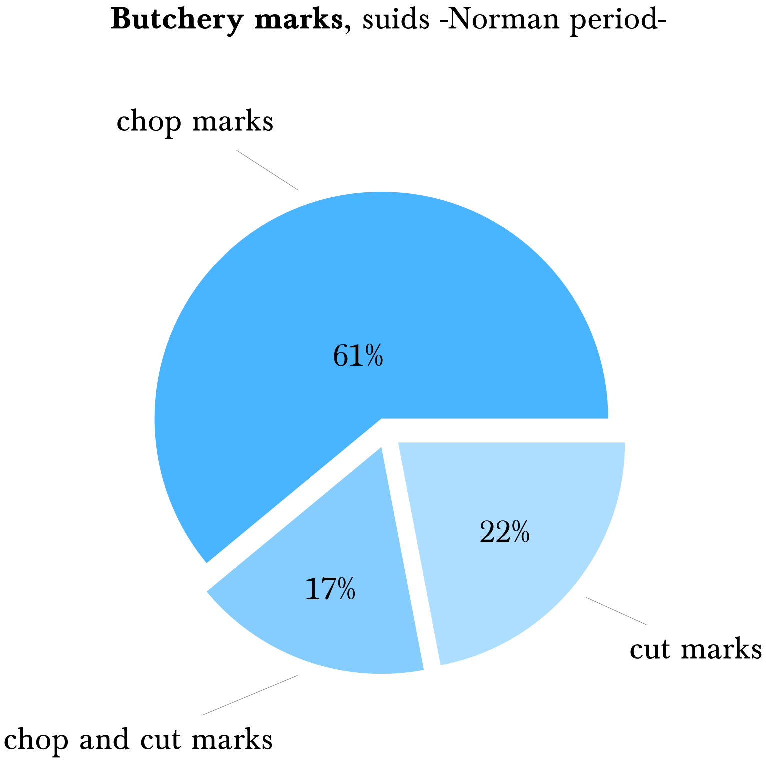


**Figure 6.3.12.** The Norman Palace, Norman period. Butchered post-cranial bones of suids; proportions of chop, cut and chop and cut marks (n:46).

*Caprines* – ca. 40% of caprine bones showed evidence of butchery (Fig.6.3.13); among these, more chop than cut marks were noticed (Fig.6.3.14). Chop marks were mostly located on the proximal diaphysis of metapodials, and they may have been the consequence of severing tendons and/or of skinning activities; some butchery marks were also located close to the proximal and to the distal ends of other long bones, and they were probably inflicted to divide the animal carcass into smaller pieces.

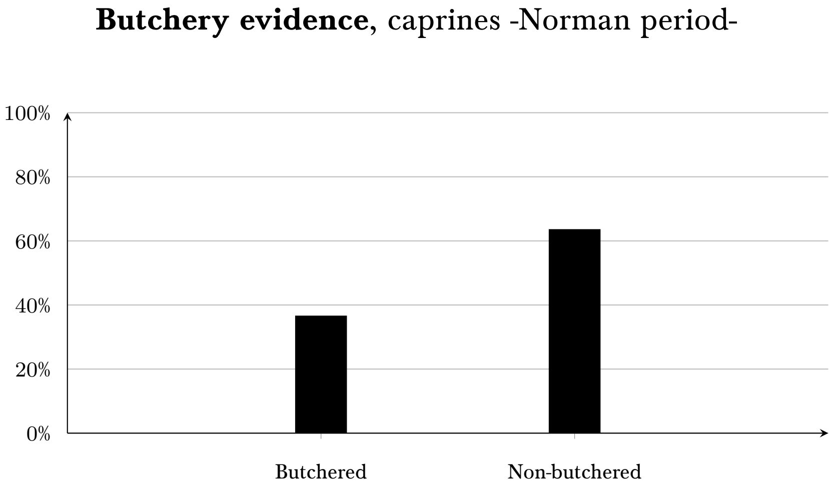


**Figure 6.3.13.** The Norman Palace, Norman period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:23;48).

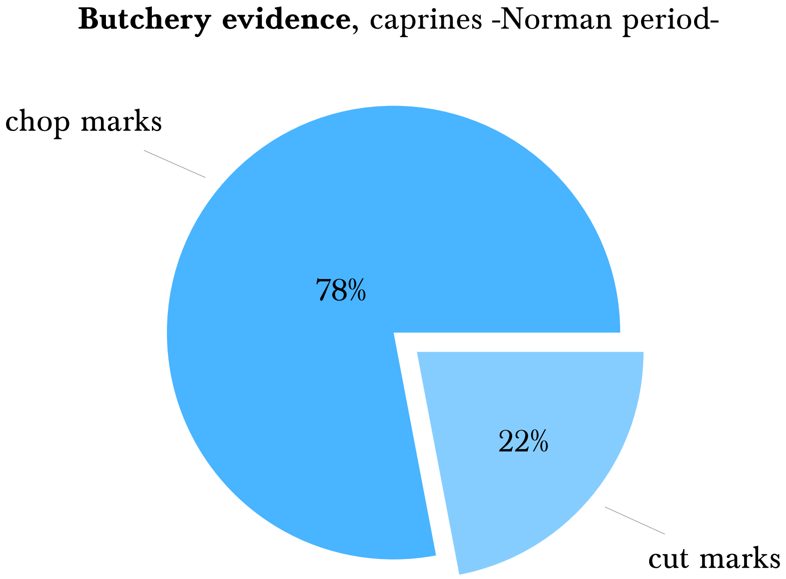


**Figure 6.3.14.** The Norman Palace, Norman period. Butchered post-cranial bones of caprines; proportions of cut marks and chop marks (n:23).

### 6.3.6. Size and shape

Overall, relatively few measurements could be taken on the main domestic animal remains from the Norman Palace; this holds especially true for suids, which were mainly represented by unfused anatomical elements. However, some biometrical analyses could be carried out for caprines (mainly represented by sheep - *§6.3.2 Species frequency: NISP and MNI*); it was possible to investigate their biometrical characters through a scatter plot, and to compare the results with those already discussed for other sites located in Palermo (i.e. Corso dei Mille and Sant'Antonino) and dated to the same period (i.e. Norman period) and/or to the earlier one (i.e. Arab period). For further comparisons and to improve the sample size, width/depth measurements of different post-cranial bones were merged by use of a scaling index technique (log ratio); also in this case, comparisons with other sites located in Palermo were made.

*Caprines* – Measurements of the distal tibia from the Norman period at the Norman Palace and from the Norman/Swabian period at Corso dei Mille were plotted together to investigate potential differences in caprine size between the two sites (Fig.6.3.15).

As Fig.6.3.15 shows, the majority of values from the Norman Palace are mostly distributed on the upper right part of the graph. Although this holds true for some values from Corso dei Mille, the majority of measurements from this site mainly cluster at the bottom left of the graph. This distribution suggests that caprines at the Norman Palace were larger than those from Corso dei Mille.

**Tibia**, caprines Bd *vs* Dd -the Norman Palace and Corso dei Mille-

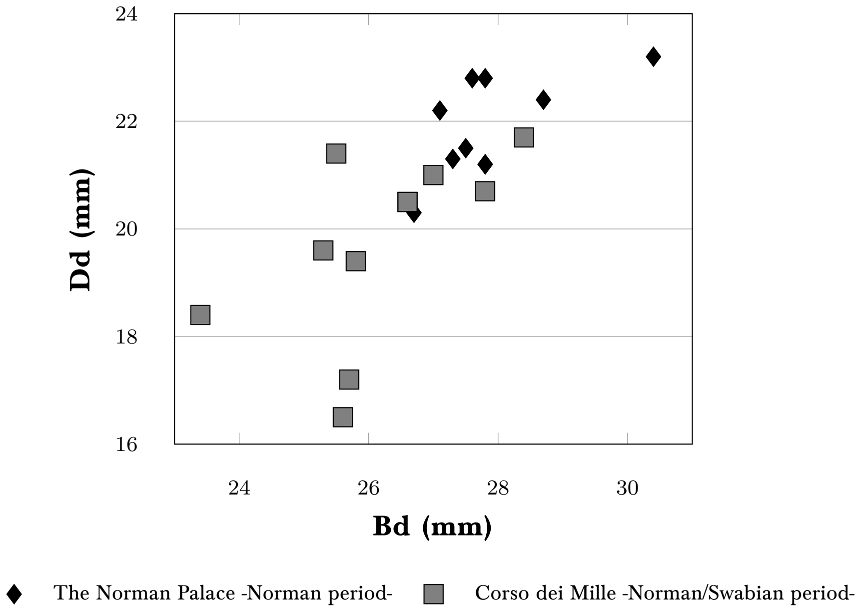


**Figure 6.3.15**. Measurements of the distal tibia (Bd and Dd) of caprines from the Norman Palace (black diamonds) and Corso dei Mille (grey squares) in the Norman and Norman/Swabian periods.

Another scatter plot compares the Norman Palace and Norman/Swabian Corso dei Mille with Arab Corso dei Mille and Arab Sant'Antonino (Fig.6.3.16). As Fig.6.3.16 shows, the values from Arab Sant'Antonino plot on the upper right part of the graph, within the range of measurements from the Norman Palace. At the same time, values from Arab Corso dei Mille are mostly located in the bottom left part of the graph, while those dated to the Norman period are widely distributed through the graph.

All in all, these result, seem to suggest that at the Norman Palace caprines are generally larger than those present at the other analysed sites both in the Norman and in the Arab periods (though with a considerable overlap with caprines from Arab Sant'Antonino).

**Tibia**, caprines Bd *vs* Dd -the Norman Palace, Corso dei Mille and Sant'Antonino-

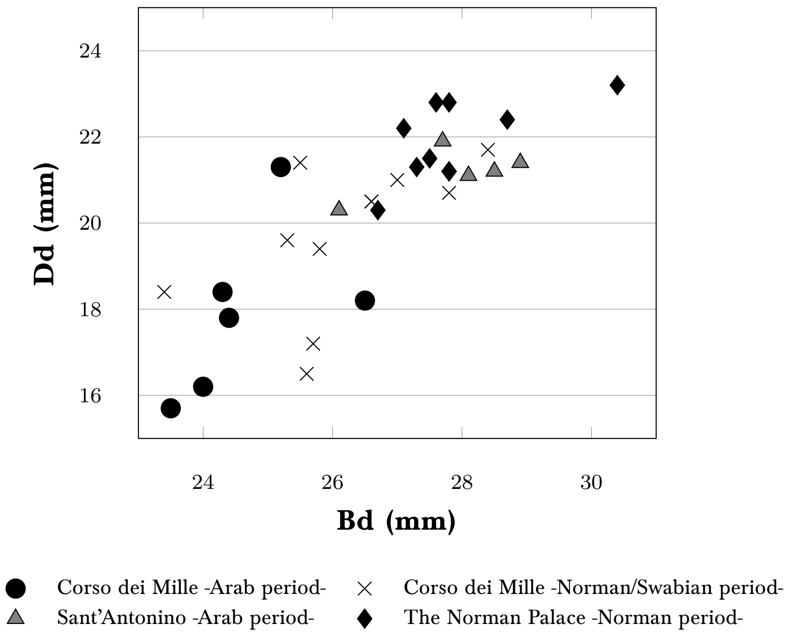


**Figure 6.3.16.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Corso dei Mille (black dots) and Sant'Antonino (light grey triangles) and from the Norman-Swabian period at Corso dei Mille (black crosses) and at the Norman Palace (black diamonds).

The large size of caprines at the Norman Palace was further analysed by merging width and depth measurements from fused post-cranial anatomical elements through the log ratio technique (*§Chapter 5: Methodology*). Comparisons with the results obtained through the same analysis for Arab and Norman/Swabian Corso dei Mille, and for Arab Sant'Antonino have been made.

At the Norman Palace the histogram displays a unimodal distribution; the same occurs at Norman/Swabian Corso dei Mille (Fig.6.3.17); however, at this latter site, there is a higher incidence of smaller individuals.

At Arab Corso dei Mille the histogram displays a unimodal distribution; the same result can also be observed for Arab Sant'Antonino (Fig.6.3.17); at this latter site, values are more distributed to the right side of the graph in comparison to those from Arab Corso dei Mille, displaying a similar distribution and mean to Norman/Swabian Corso dei Mille.

All in all, these results suggest that, in the Norman period, an increase in caprine size occurred. At the same time, in Arab Palermo (Corso dei Mille and Sant'Antonino), there seem to be a coexistence of caprine populations characterised by different sizes.

The Student's *t*-test indicates that a statistically significant difference exists in size of caprine remains from the Norman Palace and Arab Corso dei Mille (*p*: 0.0428); the same holds true when samples from the Norman Palace and Arab Sant'Antonino are compared (*p*: 0.038).

At the same time, the result of the Student's *t*-test does not indicate that the difference between the group of values from the Norman Palace and Norman/Swabian Corso dei Mille is statistically significant at 0.05; however, the obtained *p* value is rather low (*p*: 0.1054); the small available sample of width and depth measurements from caprines, especially for Norman/Swabian Corso dei Mille, might lie behind such statistical result (Fig.6.8.27, Tab.6.8.6 and Tab.6.8.7).

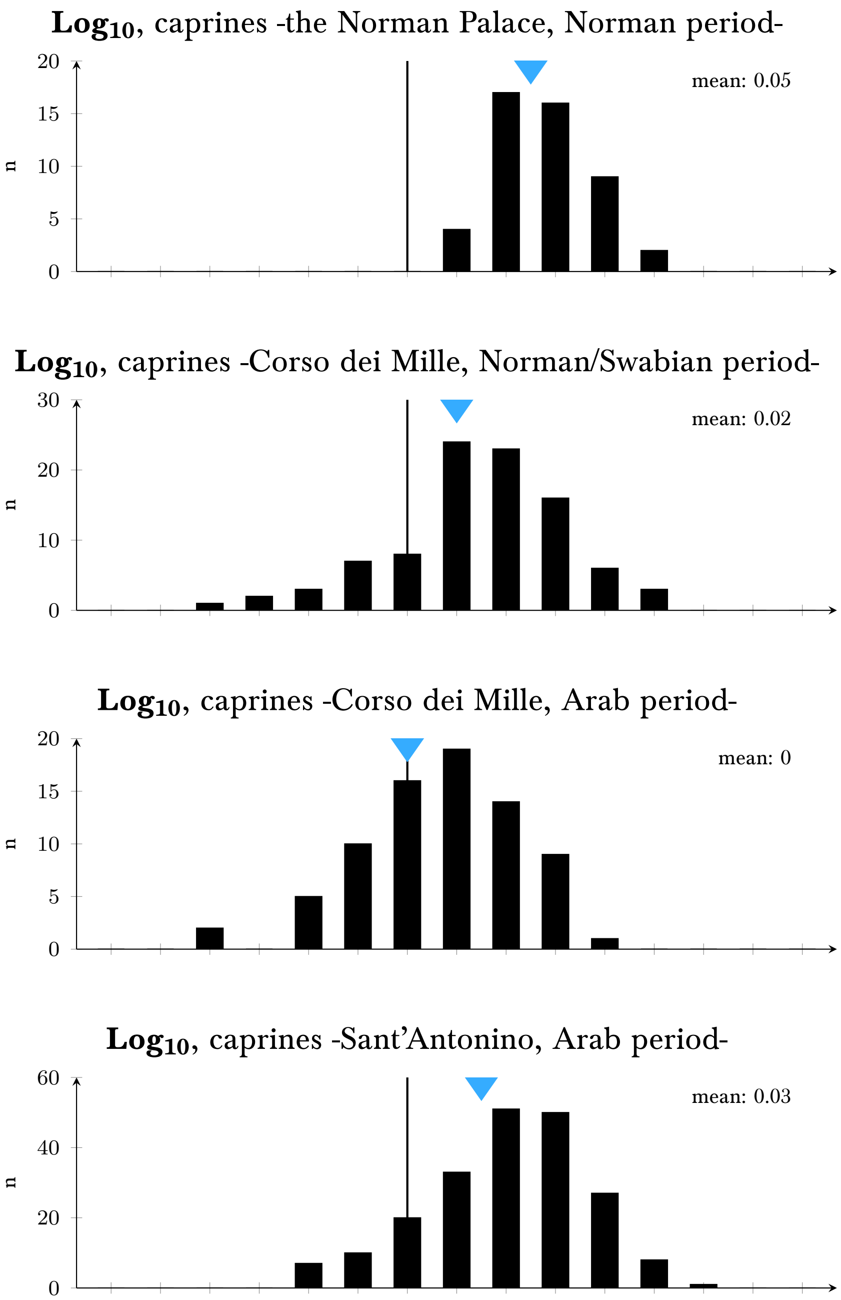


**Figure 6.3.17.** Comparison among the Norman Palace (Norman period) Corso dei Mille (Norman/Swabian and Arab periods) and Sant'Antonino (Arab period). Log ratio histogram for width/depth measurements of caprines from the Norman Palace (n:40) and from Corso dei Mille (Arab period n:76; Norman/Swabian period n:92) and Sant'Antonino (Arab period n:215). The triangles indicate the logarithmic mean. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

## 6.4. Casale San Pietro (Castronovo di Sicilia, Palermo)

The archaeological investigation at the site of Casale San Pietro is part of the European Research Council (ERC) project ‘Sicily in Transition’ (SICTRANSIT) (*§Chapter 4: Sites and material*). The archaeological excavations started in 2014, and they are still ongoing. For this reason, the study of the faunal remains from the site is not complete and must be regarded as preliminary. The results presented here refer to the 2015 and 2016 campaigns.

The assemblage includes 321 recorded specimens, of which 192 were also countable; these were recovered from archaeological contexts dated to the late 8th-9th centuries AD (Arab period) (Tab.6.4.1).

| **Chronology** | **Period** | **Countable** | **Non-countable** | **Total** |
|---|---|---|---|---|
| late 8th-9th century AD | Arab | 192 | 129 | 321 |

**Table 6.4.1.** Casale San Pietro, Arab period. Number of recorded countable and non-countable specimens.

### 6.4.1. Taphonomic alteration

#### *6.4.1.1. Surface preservation*

Most remains were well preserved, with a few presenting a medium-bad level of surface preservation (Fig.6.4.1). Taphonomic processes behind surface degradation included damages produced during recovery, rooting and weathering. In addition, some fragments presented dark-brown staining from the soil.

All in all, these conditions facilitated taxonomic identifications, the taking of measurements and the observation of the bone surface for butchery marks.

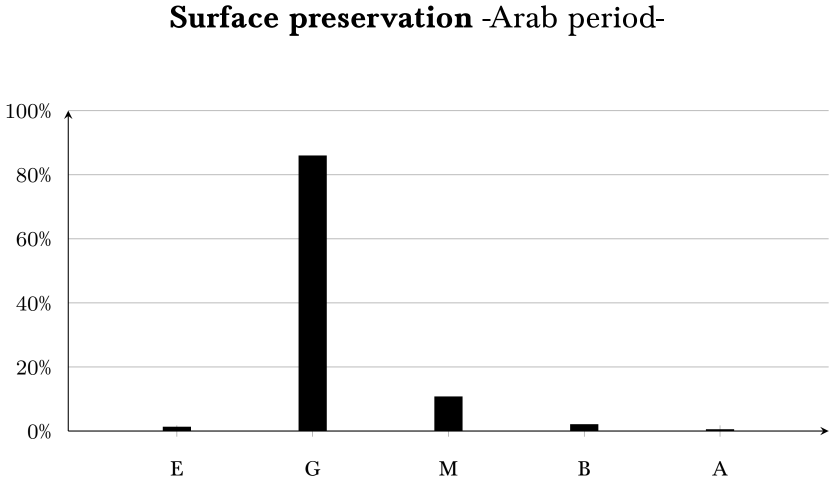


**Figure 6.4.1.** Casale San Pietro, Arab period. Surface preservation of anatomical elements (n:321). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

### *6.4.1.2. Gnawing*

Only five out of 321 bones from Casale San Pietro were gnawed. These included caprine distal tibia and distal metatarsal, equid distal tibia and suid atlas and a proximal ulna of suids, all probably chewed by carnivores. Remains of canids (most likely dogs) were found in the assemblage, making them likely agents of the gnawing marks seen on the bones (*§6.4.2 Species frequency: NISP and MNI*).

### *6.4.1.3. Recovery bias*

The faunal assemblage from Casale San Pietro was mostly hand-collected. A few samples were collected and sieved, but the material deriving from them is not included here. A recovery bias must therefore be expected.

Such bias was evaluated by calculating the proportions of metapodials and 1st phalanges of caprines and suids; comparisons between medium- and large-sized species could not be included due to the small sample size for cattle and equids.

Caprine metapodials and 1st phalanges are not proportionally represented (1:2). Suid phalanges are only slightly better represented than those of caprines, however, the ratio with metapodials is still far from their natural proportion of 1:1 (Fig.6.4.2).

As a result, the higher frequency of caprine and suid metapodials in proportion to their 1st phalanges is likely to represent a recovery bias; this may have led to an underrepresentation of smaller species as well as smaller anatomical elements. Despite this, small-sized fish bones were recovered (*§6.4.2 Species frequency: NISP and MNI*), indicating that at least some of the smaller specimens were indeed collected.

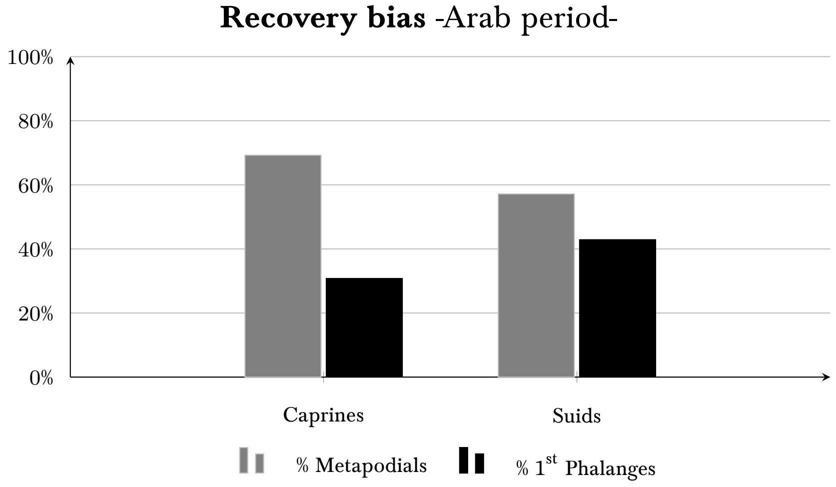


**Figure 6.4.2.** Casale San Pietro, Arab period. Proportions of caprine and suid metapodials (9;8) and 1st phalanges (n:4;6) recovered.

## 6.4.2. Species frequency: NISP and MNI

| **Casale San Pietro** | |
|---|---|
| **Taxa** | **Arab period** |
| Cattle (*Bos taurus*) | 23 |
| Caprines (*Ovis aries/Capra hircus*) | 69 |
| Suids (*Sus* sp.) | 62 |
| Equids (*Equidae*) | 14 |
| Cervids (*Cervidae*) | 8 |
| Fallow deer (*Dama dama*) | (2) |
| Canids (*Canidae*) | 5 |
| Galliforms (Gallus/Numida/Phasianus) | 3 |
| Domestic fowl (*Gallus gallus*) | (1) |
| Fish | 7 |
| Tuna (*Thunnus* sp.) | (4) |
| European seabass (*Dicentrarchus labrax*) | (1) |
| Carangids (*Carangidae*) | (1) |
| Rajids (*Rajidae*) | (1) |
| **Total** | **192** |

**Table 6.4.2.** Casale San Pietro, Arab period. List of all the taxa recorded. Non-countable elements are not included. In case a taxon is only present with non-countable fragment(s), this is indicated with a + (*§Chapter 5: Methodology*).

| **Casale San Pietro** | **Arab period** | |
|---|---|---|
| | **Countable** | **Non-countable** |
| *Ovis aries* | 38 | 10 |
| *Capra hircus* | 1 | 1 |
| *Ovis/Capra* | 30 | 48 |
| **Total** | **69** | **58** |

**Table 6.4.3.** Casale San Pietro, Arab period. Recorded countable and non-countable elements identified as sheep (*Ovis aries*), goat (*Capra hircus*) and sheep/goat (*Ovis/Capra*).

Faunal remains from the Arab period at Casale San Pietro mainly consisted of the three main domesticates, which together account for almost the 85% of countable fragments (Tab.6.4.2).

Among the main domesticated, caprines (*Ovis aries* and *Capra hircus*) are the best represented species (45%) (Fig.6.4.3). The majority of caprine remains were identified as sheep or were generally classified as sheep/goat; only one horn core (Fig.6.4.4) and a distal tibia could be directly attributed to the goat (Tab.6.4.3). Biometrical analyses to further confirm the taxonomic identification were prevented by the small sample of measurements from individual anatomical elements.

Suids (*Sus domesticus* and/or *Sus scrofa*) are well represented too, although slightly less than caprines (40%), while cattle (*Bos taurus*) accounts only for the 15% of the NISP total (Fig.6.4.3). In addition, 14 remains were attributed to equids which, on the basis of morphology and size, probably belong to horse (*Equus caballus*) rather than donkey (*Equus asinus*) and/or equid hybrids (i.e. mules, hinnies) (Tab.6.4.2). However, it was preferred to record them as 'Equids', due to the difficulty of separating equid species on the basis of bone morphology; one unfused element was also present.

Other potential domesticates recorded at Casale San Pietro are canids (Tab.6.4.2): the medium-large size and the robustness characterising all these remains seem to suggest the presence of dogs (*Canis familiaris*)/wolfs (*Canis lupus*) rather than foxes (*Vulpes vulpes*) at the site.

Cervids include seven long bone fragments attributed to red deer (*Cervus elaphus*) and/or to fallow deer (*Dama dama*); most of these were recorded as 'Cervids', at the exception of two distal tibiae that were attributed to the fallow deer on the basis of morphological criteria (Tab.6.4.2).

Bird remains are rare at the site and they exclusively belong to the *Gallus*/*Numidia*/*Phasianus* group of closely related Galliformes. The majority of bones of these three birds are difficult to separate, although in one case the presence of a spur lacking a continuous posterior keel on a tarsometatarsus allowed the attribution of this element to chicken (*Gallus gallus*) (Tab.6.4.2).

Fish are represented by seven remains; four vertebrae belonged to *Thunnus* sp. and one caudal vertebra to the European sea bass (*Dicentrarchus labrax*). In addition, two vertebrae were respectively attributed to Carangidae and Rajidae (Tab.6.4.2).

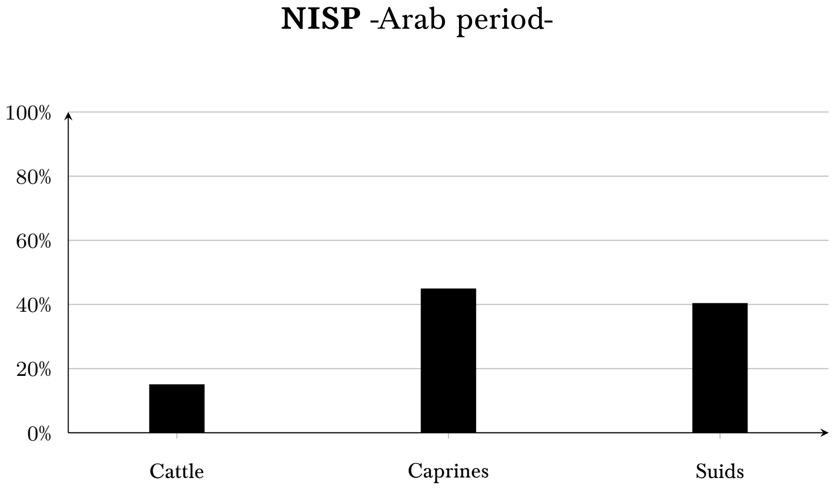


**Figure 6.4.3.** Casale San Pietro, Arab period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates (n:154).

**Figure 6.4.4.** Casale San Pietro, Arab period. Goat horn core.

When the MNI of the three main domesticated is considered, the overestimation of rarer species (in this case cattle) at the expenses of the most common ones (caprines and suids) is only slightly visible (Fig.6.4.5); as a result, no substantial changes between the MNI and the NISP trends are evident, providing more confidence about the accuracy of the results.

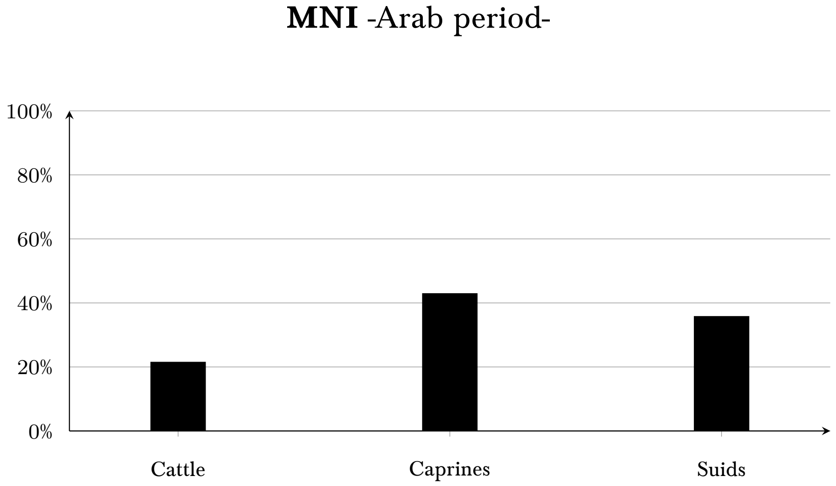


**Figure 6.4.5.** Casale San Pietro, Arab period. Percentage of the Minimum Number of Individuals (MNI) for the three main domesticates (n:14).

### 6.4.3. Ageing

This section focuses on caprines, suids and cattle; in addition, brief comments about the age-at-death of equids, cervids, canids and galliforms are made.

*Caprines* – Ageing from the epiphyseal fusion of sheep/goat bones indicates that ca. 40% of the animals were slaughtered before reaching their second and third years of age (middle fusing stage); an additional ca. 20% were culled before three-four years of age (late fusing stage), while ca. 40% survived into later adulthood (≥ three to four years). Evidence for earlier culling is also present (ca. 5%) (Fig.6.4.6).

Overall, the culling strategy for caprines from the Arab period at Casale San Pietro appears quite generalised, as it did not focus around specific age groups. Caprine husbandry did certainly involve meat production, although a good number of animals were probably also raised for dairy and wool production.

The dental evidence, however, suggests a higher degree of slaughtering in the fist year than indicated by the bone fusion (i.e. stage C) (Fig.6.4.7); such discrepancy may be the consequence of taphonomic processes, as porous bones characterising very young individuals are highly fragile and tend to preserve less well than teeth in the archaeological record.

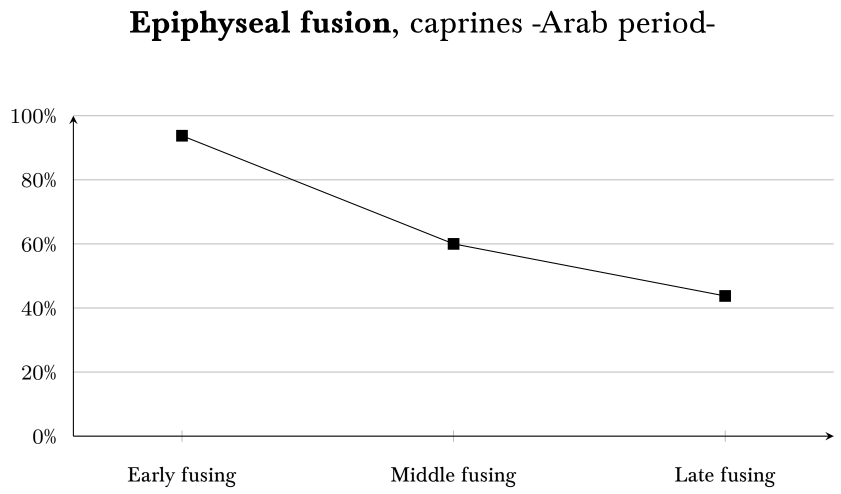


**Figure 6.4.6.** Casale San Pietro, Arab period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:94;60;44). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

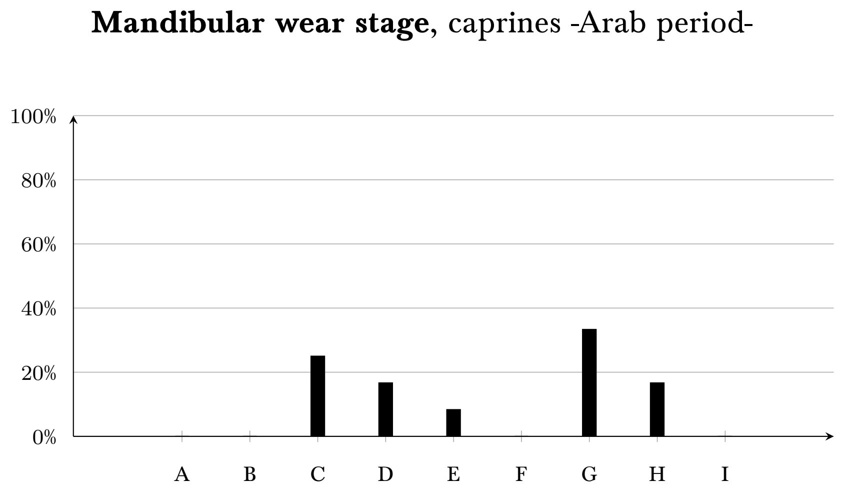


**Figure 6.4.7.** Casale San Pietro, Arab period. Mandibular wear stages for caprines (n:12). Age stages follow Payne (1973). A: 0-2 months, B: 2-6 months, C: 6-12 months, D: 1-2 years, E: 2-3 years, F: 3-4 years, G: 4-6 years, H: 6-8 years, I: 8-10 years.

*Suids* – ca. 40% of suids were culled before reaching their first-second year of age (early fusing stage), while a further ca. 10% of individuals were culled before the two-three years of age (middle fusing stage). Another ca. 40% of late fusing elements were unfused, reflecting another group of animals culled before three-four years of age (late fusing stage). Only a few pigs survived until older age, presumably representing animals kept for breeding or wild boars (Fig.6.4.8).

Pig husbandry obviously focused on the production of pork and fat; however, the high incidence of young individuals at Casale San Pietro is particularly interesting.

This result might suggest a domestic (i.e. pig –*Sus domesticus*) rather than a wild origin (i.e. wild boar –*Sus scrofa*), as domestic pigs are usually culled as soon as they reached their optimum weight, and the incidence of fully mature individuals is usually lower in domestic pigs and higher in hunted populations (Albarella *et al.* 2007).

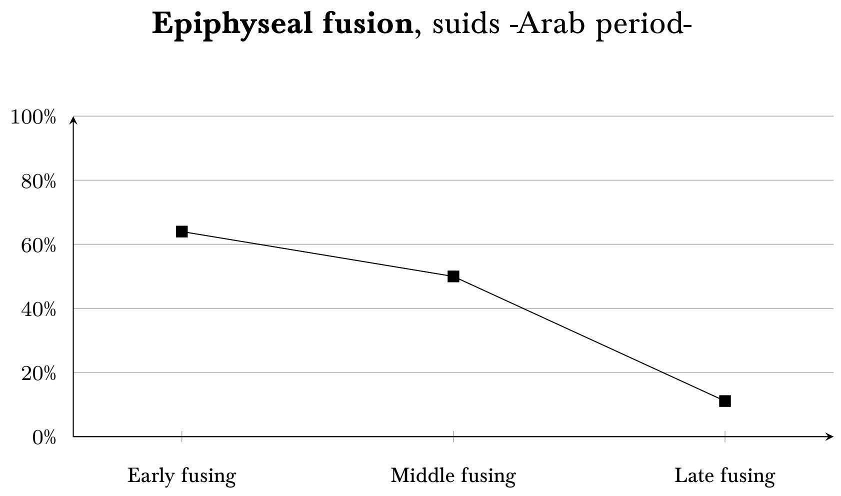


**Figure 6.4.8.** Casale San Pietro, Arab period. Epiphyseal fusion analysis for suids. Percentage of fused bones within each fusion stage (n:64;50;11). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Cattle* – The epiphyseal fusion analysis of cattle shows that ca. 80% of the animals survived into late adulthood (≥ three to four years), while ca. 20% were slaughtered before their second-third years of age. Earlier culling events are present, but in low percentages (Fig.6.4.9).

Overall, this result suggests the exploitation of cattle mainly as traction force, with few individuals culled younger for meat. Cow milk, as well as beef, was of secondary importance, as attested by the presence of very few calves and subadult individuals.

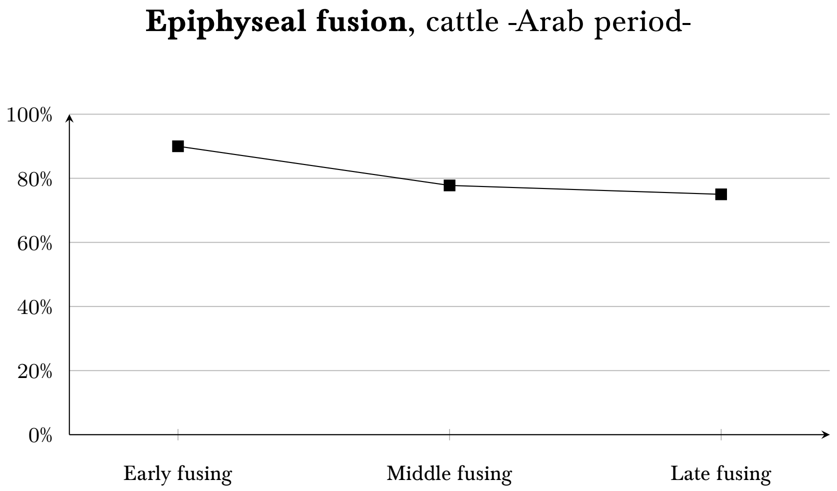


**Figure 6.4.9.** Casale San Pietro, Arab period. Epiphyseal fusion analysis for cattle. Percentage of fused bones within each fusion stage (n:90;78;75). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Equids* – 14 post-cranial bones belonging to equids were recorded; all of them were fused, with the exception of one distal tibia. In addition, one heavily worn mandibular premolar/molar tooth suggests the presence of at least one elderly individual. This result indicates the presence of predominantly mature equids at the site; the younger specimen may be indicative of an early adult individual being brought to the site, or of the practice of horse breeding in the proximity of the site. However, considering the sample size, this evidence has to be treated with caution.

*Cervids* – All the seven post-cranial bones attributed to red deer and/or to fallow deer were fused, suggesting the hunting of adult animals.

*Canids* – All the four anatomical elements identified as dogs and/or wolfs (i.e. two atlases, one scapula and one ulna) were fused, and thus belonged to adult individuals.

*Galliforms* – Overall, very few anatomical elements belonging to this order were collected for the Arab period at Casale San Pietro; among the four anatomical elements recorded, three belonged to mature individuals, and one (a not fully ossified distal femur) to an immature animal.

### 6.4.4. Sex

Information about the sex of animals from Casale San Pietro could be obtained for suid, cervid and galliform remains.

*Suids* – Only canines in jaws were considered to assess the ratio between sows and boars at the site; in addition, when pig canines were not present in the jaws, the mandibular and maxillary alveoli were sexed. This has been done to avoid potential problems caused by recovery bias (*§6.4.1.3 Recovery bias*), as male canines are larger and can preferentially be collected during excavation (*§Chapter 5: Methodology*).

As Table 6.4.4 indicates, both female and male pigs were present at the site, although sows appear to be more frequent than boars. However, caution is necessary because of the small sample size.

| **Casale San Pietro** | | |
|---|---|---|
| **Arab period** | **Sows** | **Boars** |
| Canines (in jaws) | 5 | 3 |
| Alveoli (mandibular and maxillary) | 4 | 2 |
| **Total** | **9** | **5** |

**Table 6.4.4.** Casale San Pietro, Arab period. Presence of male and female pigs based on canines in jaws and alveoli.

*Cervids* – One antler fragment of a male red deer or fallow deer was recovered from contexts dated to the Arab period at Casale San Pietro (Fig.6.4.10). The antler fragment was characterised by the presence of a pedicle, indicating that it had been shed; this evidence suggests the antler was collected rather than obtained from a hunted carcass.

**Figure 6.4.10**. Casale San Pietro, Arab period; red deer or fallow deer antler.

*Gallus gallus* – A spur on a tarsometatarsus, without a continuous posterior keel, could be indicative of the presence of a cockerel at the site, though hens occasionally also develop spurs (*§Chapter 5: Methodology*).

### 6.4.5. Anatomical element distribution

The distribution of anatomical elements could only be reliably analysed for caprines, suids and cattle, while for equids only minimal observations could be made.

*Caprines* – As Fig.6.4.11 indicates, the anatomical element distribution of caprines seems strongly determined by recovery and preservation factors. Indeed, small elements, such as phalanges, carpals and tarsals are underrepresented, if not completely absent; this result could be a consequence of the lack of systematic sieving. The best represented body parts are the distal humerus and the mandible. The high count of the distal humerus is more likely related to its higher density than preferential disposal of meatier body parts from the upper limbs (Brain 1981). Others elements, such as the proximal radius and the distal tibia, which carry less meat than the humerus, are also well represented; this supports the hypothesis that the anatomical element distribution of caprine bones is mainly determined by preservation factors.

On the other hand, the high incidence of caprine mandibles may suggest the introduction of complete carcasses at the site; this is further attested by the presence of other cranial elements, such as maxillae and horncores.

Overall, it is likely that whole animal carcasses were processed on site.

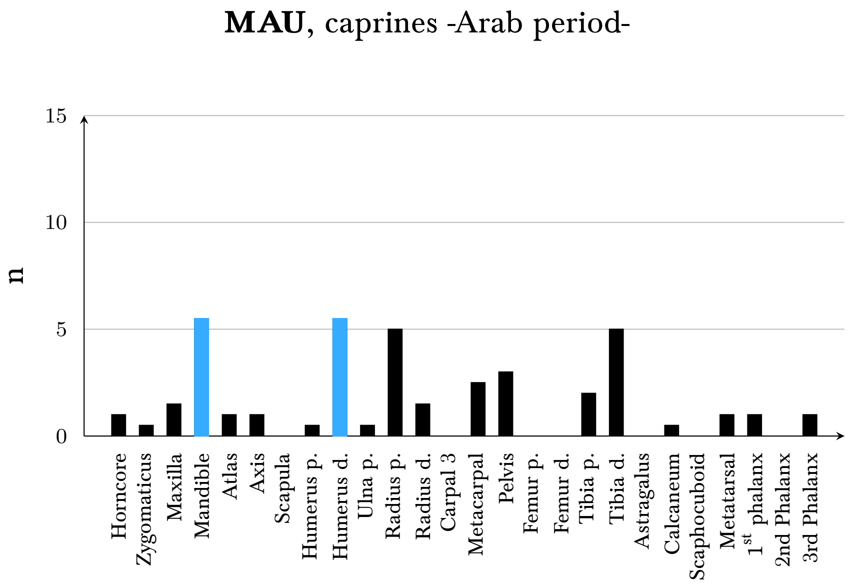


**Figure 6.4.11**. Casale San Pietro, Arab period. Distribution of the Minimum number of Animal Units (i.e. MAU) for caprines (n:40). Light blue: the most represented anatomical element/s Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Suids* – As for caprines, the anatomical element distribution of suids seems mostly affected by recovery and preservation factors (Fig.6.4.12). Small body parts (e.g. carpals, tarsals and phalanges) are completely absent, a likely consequence of hand collection bias. The most abundant elements are mandibles, which indicates the introduction of entire carcasses at the site. In addition, fore limbs are better represented than hind limbs; the scapula and the distal humerus are, respectively, the second and third most represented body parts. Such bones are known for their high bone density, implying higher survival chances in the archaeological record (Brain 1981). The same is valid also for the proximal ulna and the distal tibia, which are relatively well represented in comparison to other body parts. In addition, less dense elements, such as the proximal femur, the distal femur and the proximal tibia are completely absent, further validating the hypothesis that preservation processes have strongly affected the anatomical element distribution of suid remains.

All in all, as for caprines, complete suid carcasses were probably processed on site.

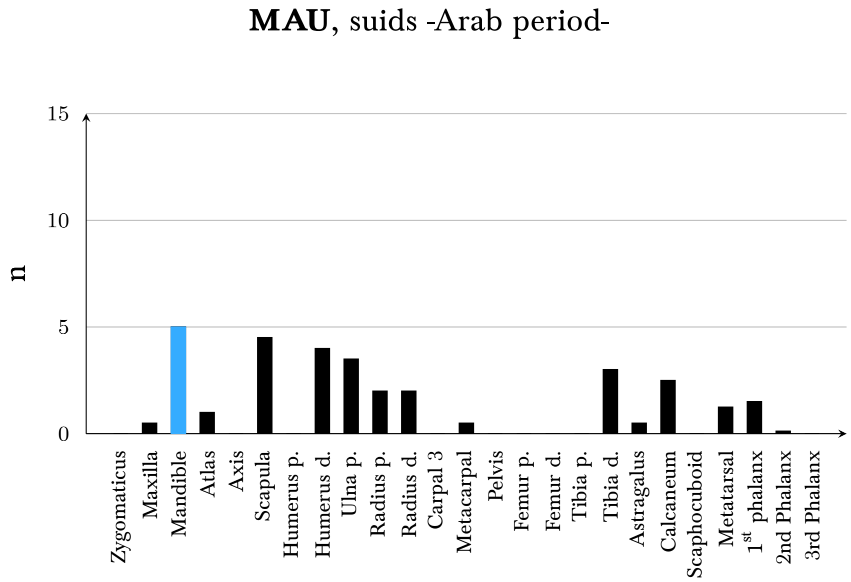


**Figure 6.4.12.** Casale San Pietro, Arab period. Distribution of the Minimum number of Animal Units (i.e. MAU) for suids (n:32). Light blue: the most represented anatomical element/s. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Cattle* – Due to the small sample size, little can be said about the anatomical element distribution of cattle. As Fig.6.4.13 shows, elements from the head as well as from the fore and hind limbs are almost equally represented. The best represented element is the distal tibia, which has a high bone density and, therefore, tends to preserve well in the archaeological record (Brain 1981).

Several large-sized vertebrae and ribs were also recorded and they are likely to belong largely to cattle; however, the possibility that some of these remains belong to equids cannot be ruled out.

Overall, it seems that cattle carcasses were, at least occasionally, brought to the site and that primary and secondary butchery processes were practiced. However, caution is needed due to the small sample size.

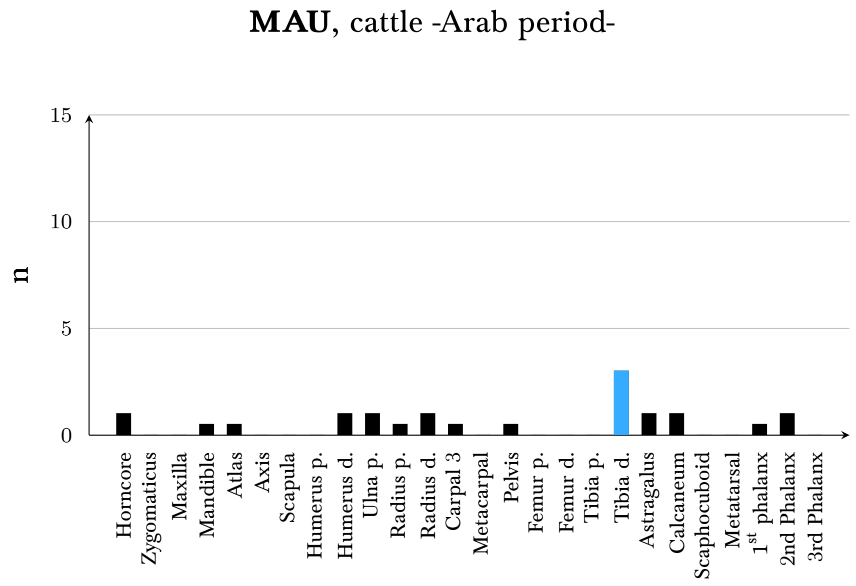


**Figure 6.4.13.** Casale San Pietro, Arab period. Distribution of the Minimum number of Animal Units (i.e. MAU) for cattle (n:13). Light blue: the most represented anatomical element/s. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Equids* – The 14 equid remains mainly derive from hind limbs, and in particular the distal tibia. Smaller elements, such as carpals and phalanges are also present.

Elements from the head are only represented by one mandibular molar/premolar tooth.

*Cervids* – Cervid remains mainly consist of fore limbs. Small bones (e.g. carpals, tarsals and phalanges) and elements from the head are missing, with the exception of an antler fragment (*§6.4.4 Sex*), which is, however, shed.

*Fish* – Fish remains are exclusively represented by vertebrae; in some cases, it was possible to identify them as caudal or abdominal. No fish cranial elements are present, suggesting that partly processed fish carcasses were present at the site of Casale San Pietro; however, the tiny sample size does not allow drawing any accurate conclusions. No evidence of chop and/or cut marks were observed on fish remains.

### 6.4.6. Butchery

The analyses of butchery evidence mainly focus on caprines, suids and cattle. In addition, brief comments for equids and cervids are included.

*Caprines* – As Fig.6.4.14 shows, many of the caprine remains bore evidence of butchery (ca. 50%); cut marks from knives were particularly common, although a number of chop marks from heavier tools, such as cleavers, was also recorded (Fig.6.4.15). Cut marks were mainly located at the extremities of long bones, such as the proximal ulna, the proximal and distal humerus, and the proximal and distal tibia, and they were probably aimed at disarticulation; the same holds true for cut marks recorded on some caprine calcanea. The few cut marks recorded on phalanges and metapodials are almost certainly due to skinning. Chop marks were mainly distributed along the shaft of long bones, and they were probably aimed to divide the animal carcass into smaller pieces. Medium-sized vertebrae and ribs (many of which likely belonging to caprines) also had cut and chop marks.

In sum, the anatomical element distribution and the analysis of the butchery evidence suggest that the caprine remains from Casale San Pietro represent butchery and food waste.

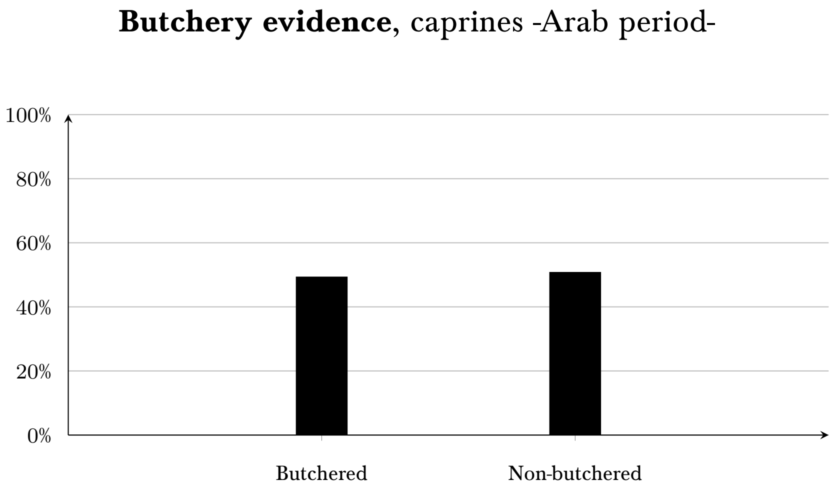


**Figure 6.4.14**. Casale San Pietro, Arab period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:34;35).

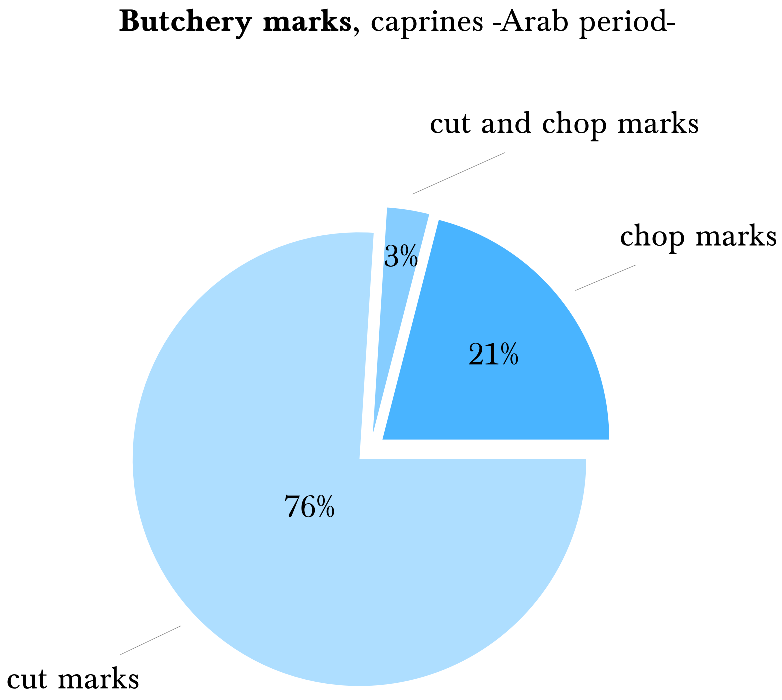


**Figure 6.4.15**. Casale San Pietro, Arab period. Butchered post-cranial bones of caprines; proportions of cut marks, chop marks and cut/chop marks (n:34).

*Suids* – As Fig.6.4.16 indicates, the frequency of butchery marks on suid bones is a little lower than for caprines. ca. 35% of suid remains presented butchery marks on their surface; these mainly consisted of cut marks, while very few chop marks were recorded (Fig.6.4.17). As in the case of caprines, cut marks were mainly located at the proximal and/or distal ends of long bones. Chop marks were mainly distributed along the shaft of long bones, especially humeri, and around the glenoid cavity of scapulae, suggesting again that chopping was aimed to divide the carcass into smaller units, while mainly cutting implements were used for disarticulation.

In sum, the results suggest that suid remains derive from butchery and food waste disposal.

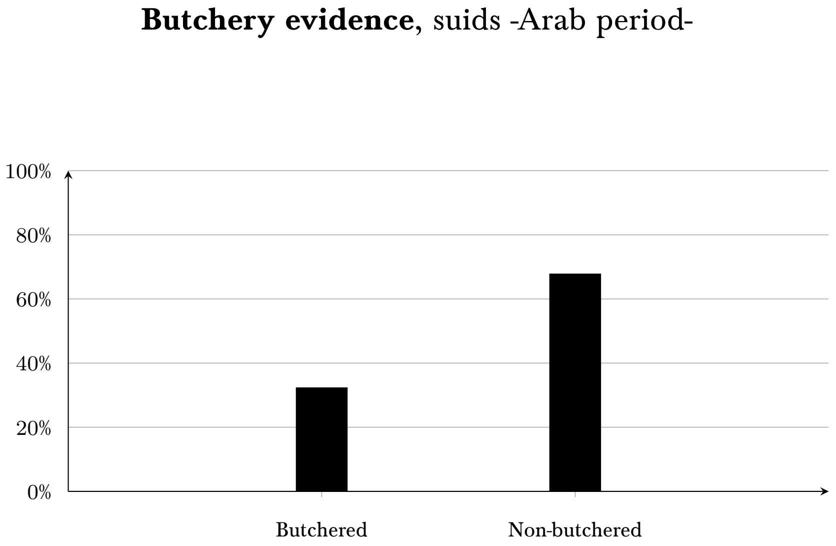


**Figure 6.4.16.** Casale San Pietro, Arab period. Proportion of butchered and non-butchered post-cranial bones of suids (n:20;42).

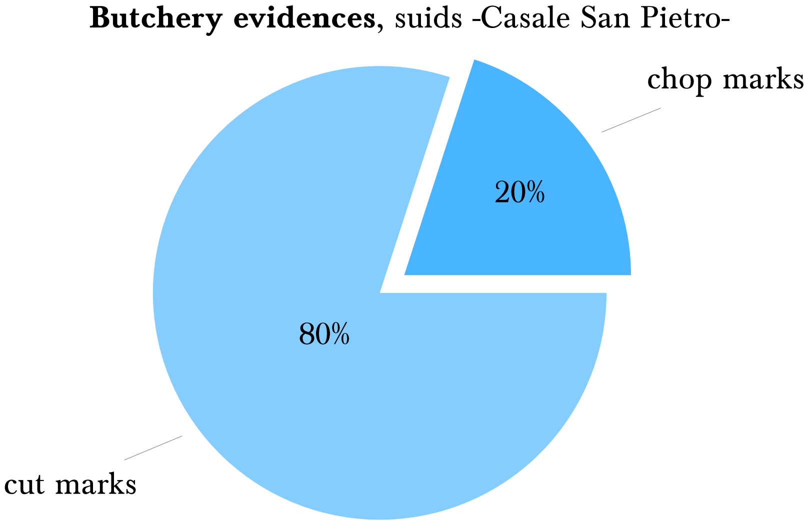


**Figure 6.4.17.** Casale San Pietro, Arab period. Butchered post-cranial bones of suids; proportions of cut marks, chop marks and cut/chop marks (n:20).

*Cattle* – Because of the very small size of the cattle post-cranial assemblage, limited butchery evidence was available for this animal; however, out of 27 remains, seven bones showed signs of butchery (Fig.6.4.18). Unlike caprines and suids, many more chop than cut marks were recorded; heavier tools, such as cleavers, may have contributed to the dismemberment of larger animal carcasses, as would be the case for cattle. However, caution in the interpretation is needed due to the small sample size.

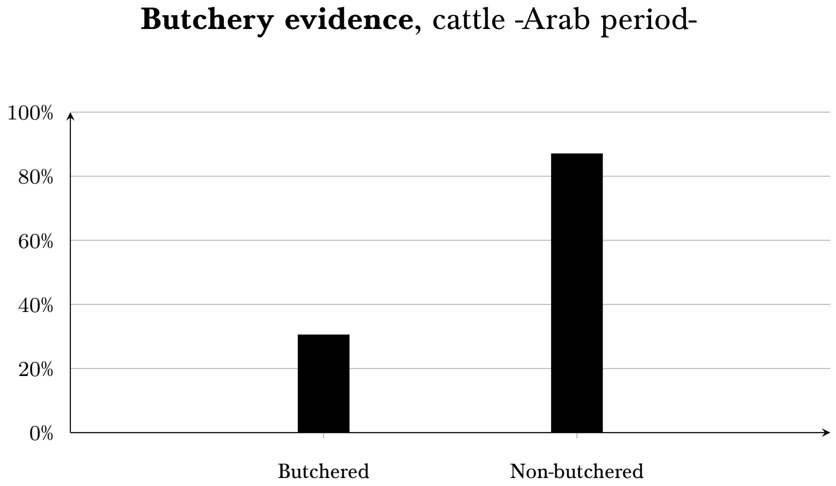


**Figure 6.4.18**. Casale San Pietro, Arab period. Proportion of butchered and non-butchered post-cranial bones of cattle (n:7;20).

*Cervids* – One cervid (red deer/fallow deer) left distal tibia (Fig.6.4.19) and one distal humerus presented several chop marks on their medial side. This evidence could result from the severing of tendons.

**Figure 6.4.19**. Casale San Pietro, Arab period. Red deer/fallow deer distal tibia with cut marks.

### 6.4.7. Size and shape

The following biometrical analyses mainly focus on caprines; only few measurements were taken on suid remains, which were mainly represented by unfused or fusing anatomical elements.

Only for the tibia it was possible to investigate caprine biometrical characters using absolute measurements. Comparisons with urban sites, such as Sant'Antonino and Corso dei Mille, were made to investigate differences in sheep size between different site types (i.e. rural and urban) in the Arab period.

Biometrical analyses mainly relied on log ratio histograms, in which width/depth measurements from fused post-cranial bones of caprines (mainly represented by sheep) were merged to allow comparisons and increase the sample size. Due to the small sample size, it was not possible to analyse the more sex-dependent anatomical elements independently; however, comments about the incidence of ewes, wethers and/or rams were made considering the distribution of values.

A log ratio histogram was made also for suid measurements, using lengths and widths from mandibular and maxillary teeth (post-cranial bones were mainly represented by unfused anatomical elements). The dearth of measurements did not allow to analyse separately widths/depths and lengths.

This analysis aimed to investigate the nature, either domestic and/or wild, of the suid populations present at Arab Casale San Pietro and to detect potential changes in the size of suids trough time. To allow comparisons with other sites, such analysis will be presented and discussed in the sub-chapter on the assemblage from Colmitella (*§6.6 Colmitella (Agrigento) – 6.6.10 Size and shape*).

*Caprines* – Measurements of the distal tibia from Casale San Pietro, Sant'Antonino and Corso dei Mille were plotted to investigate potential differences in caprine size among the three sites in the Arab period (Fig.6.4.20) (*§Chapter 5: Methodology*).

As Fig.6.4.20 indicates, the majority of values from Casale San Pietro plot close to the range of measurements from Sant'Antonino, which are mostly distributed on the upper right part of the graph. Only two measurements from Casale San Pietro are in the same range of values as those from Corso dei Mille, which mainly cluster at the bottom left of the graph.

All in all, it seems that caprine tibiae from Arab Casale San Pietro are intermediate in size between those from Arab Sant'Antonino and Arab Corso dei Mille. However, the small size of samples from the three sites invites caution in the interpretation of results.

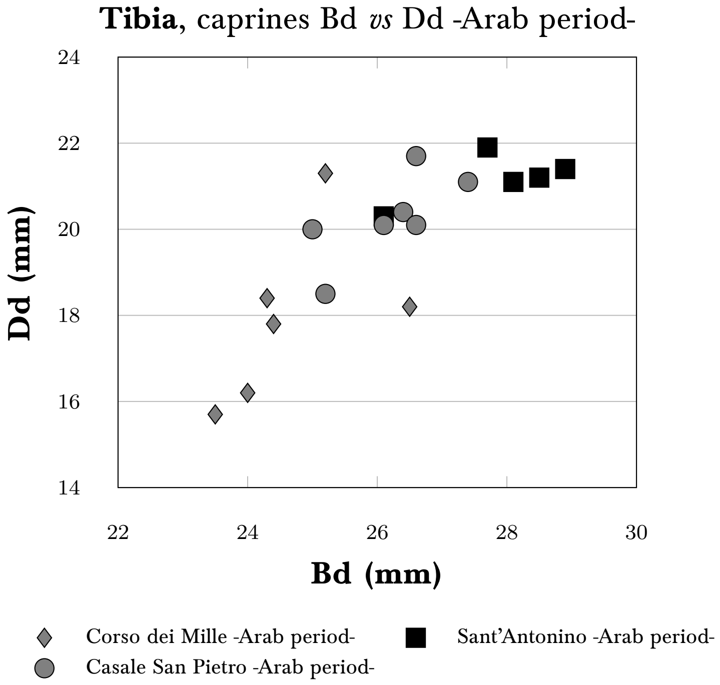


**Figure 6.4.20.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Casale San Pietro (light grey dots), Sant'Antonino (black squares) and Corso dei Mille (grey diamonds).

The size of caprines at the site of Casale San Pietro was further analysed by merging width/depth measurements from sheep fused post-cranial anatomical elements in a log ratio histogram (*§Chapter 5: Methodology*). Comparisons with the results obtained from Arab Sant'Antonino and Corso dei Mille have been carried out.

In the Arab period at Casale San Pietro the histogram displays a unimodal distribution; the same holds true for Sant'Antonino and Corso dei Mille.

(Fig.6.4.21). Although the range of caprine measurements is more or less similar in the three analysed sites, values from Casale San Pietro and Sant'Antonino are skewed to the right side of the graph in comparison to those from Corso dei Mille. These results further validate the biometrical analysis of the distal tibia, indicating that sheep from Casale San Pietro are similar in size to those present at Sant'Antonino; this similarity is also supported by the mean, which is the same at both sites. In addition, caprines from Casale San Pietro and Sant'Antonino are larger than those present at Corso dei Mille in the Arab period, the mean being higher in the former sites.

A potential higher presence of castrated and/or rams at Casale San Pietro and Sant'Antonino in comparison to Corso dei Mille lying behind such difference in sheep size is difficult to assess, as the three histograms display a unimodal distribution, hindering the detection of sex groups.

Future zooarchaeological analyses on the faunal assemblage from Casale San Pietro will increase the sample size of sheep post-cranial bones, thus providing a larger dataset of measurements on which to test the results obtained so far.

The result of the Student's *t*-test does not indicate that the difference between the group of values from Arab Casale San Pietro and that from Arab Sant'Antonino and Arab Corso dei Mille is statistically significant at 0.05; however, the obtained $p$ values are rather low (0.105 and 0.113); the tiny sample size of measurements available for Arab Corso dei Mille and Arab Casale San Pietro might have influenced such result (Fig.6.8.27, Tab.6.8.6 and Tab.6.8.7).

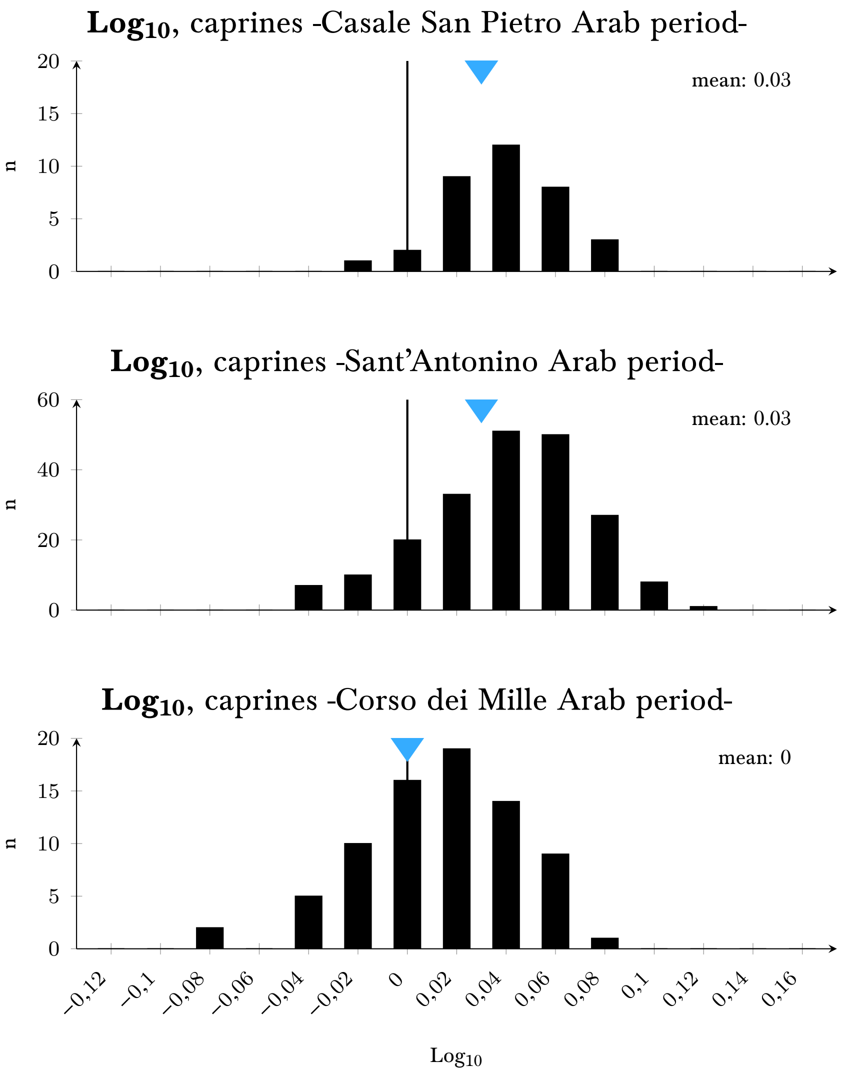


**Figure 6.4.21.** Comparison among Casale San Pietro, Sant'Antonino and Corso dei Mille in the Arab period. Log ratio histogram for width/depth measurements of caprines from Casale San Pietro (n:35), Sant'Antonino (Arab period n:215) and Corso dei Mille (Arab period n:76). The triangles indicate the logarithmic mean. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

## 6.5. Mazara del Vallo (Trapani)

The faunal assemblage from Mazara del Vallo (Trapani) includes 1398 recorded specimens, of which 1063 were also countable; of these, 633 date to the late 10th-11th centuries AD, and 430 to the late 12th-13th centuries AD. The earlier phase will be referred to as the 'Arab period' and the later one as the 'Norman/Swabian period' (6.5.1).

| **Chronology** | **Period** | **Countable** | **Non-countable** | **Total** |
|---|---|---|---|---|
| late 10th-11th c. AD | Arab | 633 | 190 | 823 |
| late 12th-13th c. AD | Norman/Swabian | 430 | 145 | 575 |
| **Total** | | **1063** | **335** | **1398** |

**Table 6.5.1.** Mazara del Vallo. Number of recorded countable and non-countable specimens by period.

## 6.5.1. Taphonomic alteration

### *6.5.1.1. Surface preservation*

On average, the degree of surface preservation at Mazara del Vallo in the Arab and in the Norman/Swabian periods was good (Fig.6.5.1 and Fig.6.5.2). A smaller proportion of remains presented a medium to bad/awful level of surface preservation; taphonomic processes included weathering, cracks from post-depositional disturbances (e.g. roots) and fresh breaks produced during excavations. In addition, evidences of green staining were recorded on a number of fragments from both periods (Fig.6.5.3 and Fig.6.5.4); such evidence usually occur when bones come into contact with metals, especially with copper and copper alloys (e.g. bronze and brass) (Dupras and Schultz 2013).

The alterations did not severely interfere with the anatomical and taxonomic identification of the specimens, nor with the detection of marks on the bone surface. The recording of measurements was prevented only in a very limited number of cases.

All in all, the faunal assemblage from the two periods did not heavily suffer from post-depositional disturbance.

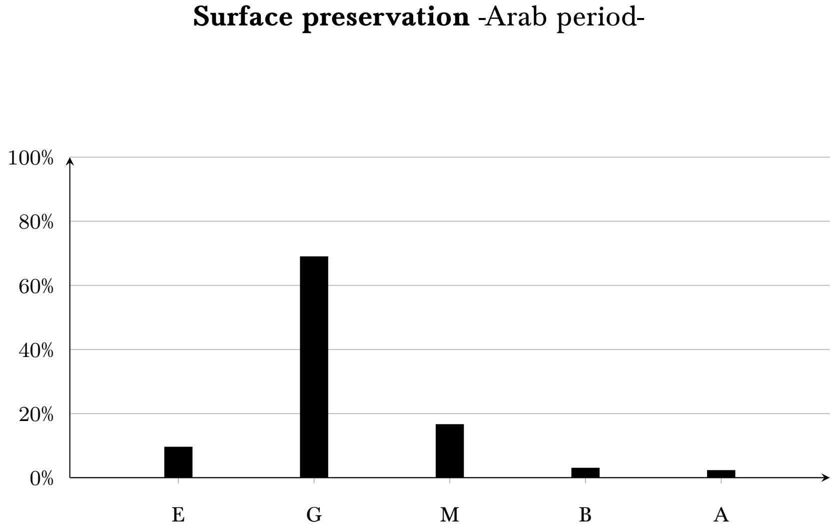


**Figure 6.5.1.** Mazara del Vallo, Arab period. Surface preservation of anatomical elements (n:823). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

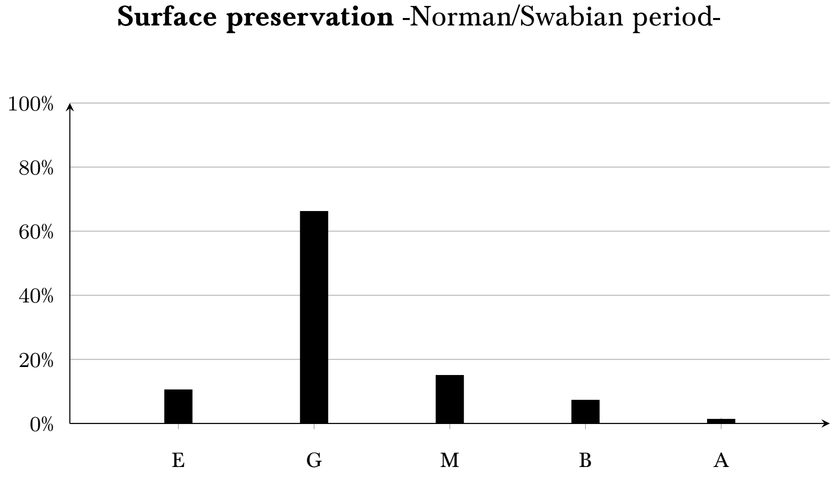


**Figure 6.5.2.** Mazara del Vallo, Norman/Swabian period. Surface preservation of anatomical elements (n:575). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

**Figure 6.5.3.** Mazara del Vallo, Arab period. Evidence of green staining on rib fragments.

**Figure 6.5.4.** Mazara del Vallo, Norman/Swabian period. Evidence of green staining on a caprine metapodial (probably a goat).

### *6.5.1.2. Gnawing*

Gnawing marks were uncommon; only three bones dated to the Arab period and nine dated to the Norman/Swabian period showed evidence of gnawing marks produced by carnivores (most likely dogs and cats). This result is further validated by the recovery of felid and, to a lesser extent, of canid remains at both periods (*§6.5.2 Species frequency: NISP and MNI*).

All gnawed bones belong to suids, most of them unfused diaphyses. This result does not come as a surprise, as suid bones are usually very porous and greasy, hence they tend to be preferred by carnivores (Albarella and Davis 1994); also, as most of them come from juvenile individuals, they are softer and easy to be chewed on.

Such low incidence of gnawed remains in both periods could be the result of prompt disposal through burial of most animal remains.

### *6.5.1.3. Recovery bias*

The faunal assemblage from the archaeological site of Mazara del Vallo was hand-collected during a rescue excavation and is likely to be affected by recovery bias (*§Chapter 4: Sites and material*).

Analyses to assess the presence of recovery bias in the two periods considered differences in the proportion of distal metapodials and 1st phalanges for caprines (sheep/goat) and cattle.

In the Arab period, the 1st phalanges from caprines are largely outnumbered by the metapodials, while in the case of cattle the percentages of the two anatomical elements are slightly closer to the natural 1:2 proportion (Fig.6.5.5).

In the Norman/Swabian period, the number of phalanges of caprines and cattle slightly exceed the metapodials, although the percentages in both species is quite far from to their natural proportion (Fig.6.5.6).

In the Arab period, the higher frequency of cattle phalanges in proportion to distal metapodials, compared to sheep/goat, is likely to represent recovery bias.

Despite the slightly higher incidence of cattle and caprine 1st phalanges in comparison to metapodials, a recovery bias is likely to affect also the faunal assemblage dated to the Norman/Swabian period, as the two elements in both species are not proportionally represented.

All in all, recovery biases seem to have affected the assemblages from both periods; however, the faunal assemblage from the earliest phase suffered a higher recovery bias in comparison to the Norman/Swabian assemblage.

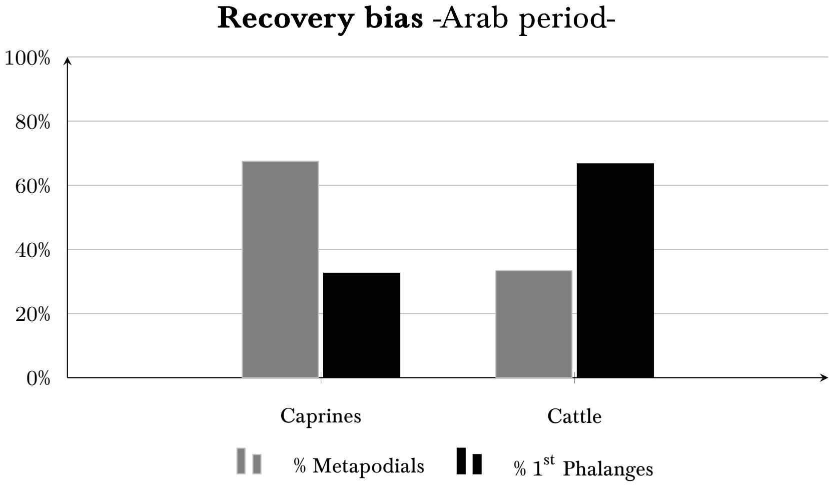


**Figure 6.5.5**. Mazara del Vallo, Arab period. Proportions of metapodials and 1st phalanges for caprines (n:29;14) and cattle (n:6;12).

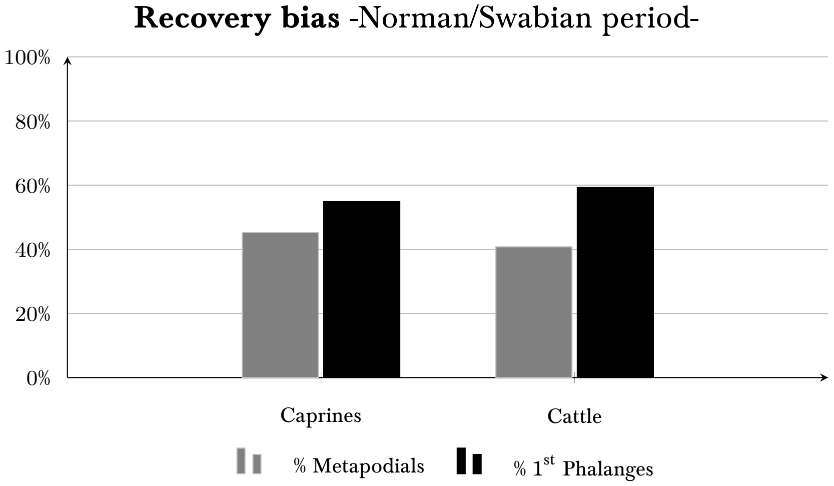


**Figure 6.5.6**. Mazara del Vallo, Norman/Swabian period. Proportions of metapodials and 1st phalanges for caprines (n:14;17) and cattle (n:11;16).

## 6.5.2. Species frequency: NISP and MNI

| **Mazara del Vallo** | | |
|---|---|---|
| **Taxa** | **Arab period** | **Norman/Swabian period** |
| Cattle (*Bos taurus*) | 105 | 64 |
| Caprines (*Ovis aries*/*Capra hircus*) | 410 | 166 |
| Suids (*Sus* sp.) | 13 | 41 |
| Equids (*Equidae*) | 17 | - |
| Cervids (*Cervidae*) | 5 | 10 |
| Fallow deer (*Dama dama*) | (1) | (1) |
| Felids (*Felidae*) | 19 | 39 |
| Canids (*Canidae*) | 1 | + |
| Lagomorphs (*Lagomorpha*) | - | 8 |
| Hare (*Lepus* sp.) | - | (3) |
| Large rodents (*Rattus*/*Arvicola*) | 4 | 2 |
| *Rattus rattus* | - | (1) |
| Galliformes (*Gallus*/*Numidia*/*Phasianus*) | 42 | 77 |
| Domestic fowl (*Gallus gallus*) | (29) | (52) |
| Tortoises/turtles (*Testudines*) | 9 | 9 |
| Hermann's tortoise (*Testudo hermanni*) | (1) | - |
| Amphibians | 3 | 6 |
| Tuna (*Thunnus* sp.) | 5 | 8 |
| **Total** | **633** | **430** |

**Table 6.5.2.** Mazara del Vallo, Arab and Norman/Swabian periods. List of all the taxa recorded. Non-countable elements are not included. In case a taxon is only present with non-countable fragment(s), this is indicated with a + (*§Chapter 5: Methodology*).

| Mazara del Vallo | Arab period | | Norman/Swabian period | |
|---|---|---|---|---|
| | **Countable** | **Non-countable** | **Countable** | **Non-countable** |
| Sheep | 197 | 15 | 70 | 14 |
| Goat | 17 | 12 | 7 | 6 |
| Sheep/goat | 196 | 77 | 89 | 57 |
| **Total** | **410** | **104** | **166** | **50** |

**Table 6.5.3.** Mazara del Vallo, Arab and Norman/Swabian periods. Recorded countable and non-countable elements identified as sheep (*Ovis aries*), goat (*Capra hircus*) and sheep/goat (*Ovis*/*Capra*).

As Table 6.5.2 shows, the faunal assemblages from the Arab and Norman/Swabian periods at Mazara del Vallo are largely dominated by the three main domesticates, which respectively account for almost the 85% and the 65% of countable fragments; such incidences are even higher when remains from domestic fowl (*Gallus gallus*) are considered (Arab period – 87 % and Norman/Swabian period – 76%).

On the basis of NISP, sheep/goat (*Ovis aries* and *Capra hircus*) are the most numerous of the main domestic species in both periods (6.5.2, Fig.6.5.7 and Fig.6.5.8). The majority of caprine remains were identified as sheep, or were generally classified as sheep/goat; some remains could be directly attributed to goat (6.5.3). In addition, in both periods, a number of sheep and goat horncores (non-countable elements) were recorded; these usually presented butchery marks at their bases (*§6.5.6 Butchery*). Attempts to metrically separate sheep from goat metacarpals and astragali were made (see subchapter Sheep/goat below).

Cattle (*Bos taurus*) is relatively well represented in the Arab period, and its frequency very slightly increases in the Norman/Swabian period (Fig.6.5.7 and Fig.6.5.8).

Suids (*Sus domesticus* and/or *Sus scrofa*) are barely represented in the Arab period, while their incidence is higher in the Norman/Swabian assemblage (Fig.6.5.7 and Fig.6.5.7).

Equids only occurred in the Arab period. Although it was not possible to rule out the presence of the donkey (*Equus asinus*) and/or equid hybrids (i.e. mules, hinnies), most specimens are likely to belong to the horse (*Equus caballus*), on the basis of morphology and size (see subchapter – Equids below) (Tab.6.5.2).

Other potential domesticates recorded at Mazara del Vallo are dogs (*Canis familiaris*) and cats (*Felis catus*). The formers (recorded as 'Canids' due to morphological similarities with closely-related taxa, such as fox – *Vulpes vulpes* – and wolf – *Canis lupus* –) are represented by a mandible dated to the Arab period, and two loose mandibular teeth (a premolar and a 1st molar) from Norman/Swabian contexts. The mandible is of a medium-large size, which rules out the possibility that it belonged to a fox. Felid remains (recorded as 'Felids' due to morphological similarities between the domestic cat –*Felis catus* and the European wild cat –*Felis silvestris*) were by far better represented than canids in both periods (Tab.6.5.2); in the majority of cases, it was impossible to distinguish between the domestic cat and its wild form, as most bones were unfused; however, an attempt to investigate the nature, either domestic or wild, of the felid populations present in the two analysed periods was made by comparing the measurements to domestic and wild cat standards (*§6.5.10 Size and shape*).

Cervids are barely represented at both periods. They include four and nine long bones dated to the Arab and the Norman/Swabian periods respectively, and attributed to red deer (*Cervus elaphus*) and/or to fallow deer (*Dama dama*); these were recorded as 'Cervids', as no reliable enough morphological criteria were present to attribute such remains to species level. However, a distal radius from the Arab period, as well as a proximal radius (non-countable element) and a distal tibia from the Norman/Swabian period could be attributed to the fallow deer on morphological grounds (Tab.6.5.2).

Lagomorphs were only identified for the Norman/Swabian period, and are represented by a mandible, a distal humerus and a distal femur attributed to the hare (*Lepus* sp.), and to two proximal femurs, three proximal tibiae (non-countable elements) and two calcanei (countable elements) which could only be recorded as 'Lagomorphs' (Tab.6.5.2).

Rodents, i.e. rats (*Rattus* sp.) and water voles (*Arvicola* sp.), are represented by four post-cranial bones in the Arab period and by one remain in the following period; in addition, the recovery of one whole cranium in the later period allowed to attribute this specimen to the black rat (*Rattus rattus*) (Tab.6.5.2). Bird remains are well represented at the site in both periods, although they exclusively belong to the *Gallus/Numidia/Phasianus* group of closely related Galliforms; despite the well-known difficulty in separating bones of these three birds, in some cases it was possible to attribute them to the domestic fowl (*Gallus gallus*) (Tab.6.5.2) (*§Chapter 5: Methodology*).

Other animal species present in the assemblage from Mazara del Vallo include nine remains of turtle/tortoise recorded for each of the analysed periods; most of these belonged to the plastron and the carapax and did not present any diagnostic features, thus preventing the distinction between terrestrial and aquatic species. However, the presence of one entire carapax dated to the Arab period allowed to assign such remain to the Hermann's tortoise (*Testudo hermanni*) (Tab.6.5.2 and Fig.6.5.9).

Amphibians are represented by nine remains, all post-cranial bones (no pelvises, on which the frog/toad distinction can be attempted, were recorded); of these, three are dated to Arab period, while six to the Norman/Swabian one (Tab.6.5.2).

Fish are also present in both phases, but with few remains. They are represented by cranial elements as well as abdominal and caudal vertebrae, assigned to *Thunnus* sp. (Tab.6.5.2).

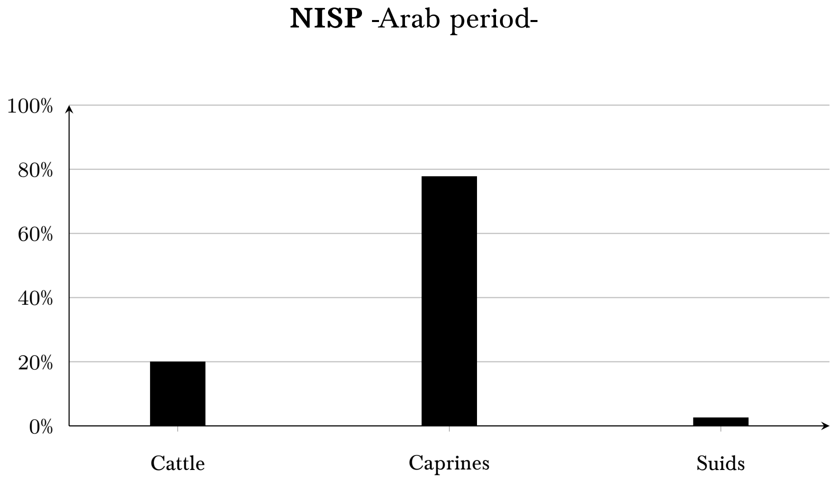


**Figure 6.5.7**. Mazara del Vallo, Arab period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates (n:528).

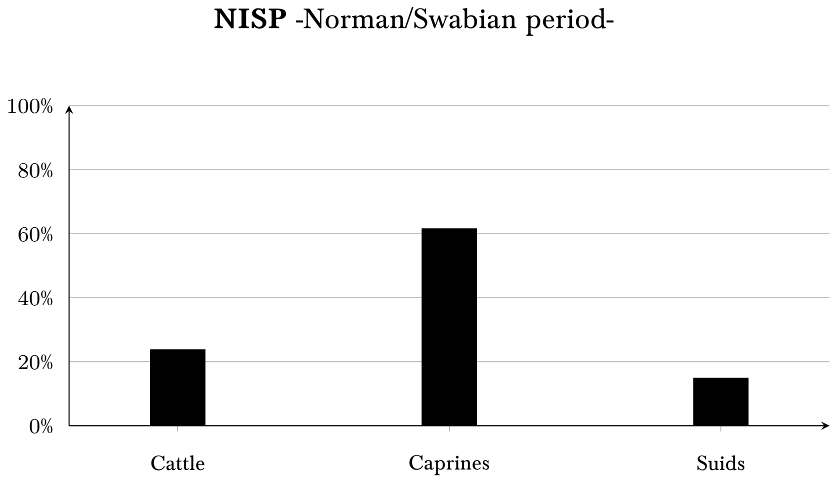


**Figure 6.5.8**. Mazara del Vallo, Norman/Swabian period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates (n:271).

**Figure 6.5.9**. Mazara del Vallo, Arab period. Entire carapax of a Hermann's tortoise.

The MNI analysis shows a very similar trend to the NISP, and no substantial differences are evident between the two periods (Fig.6.5.10 and Fig.6.5.11). The strong similarity of results between the two quantification methods gives us confidence about the degree of reliability of the results (*§Chapter 5: Methodology*).

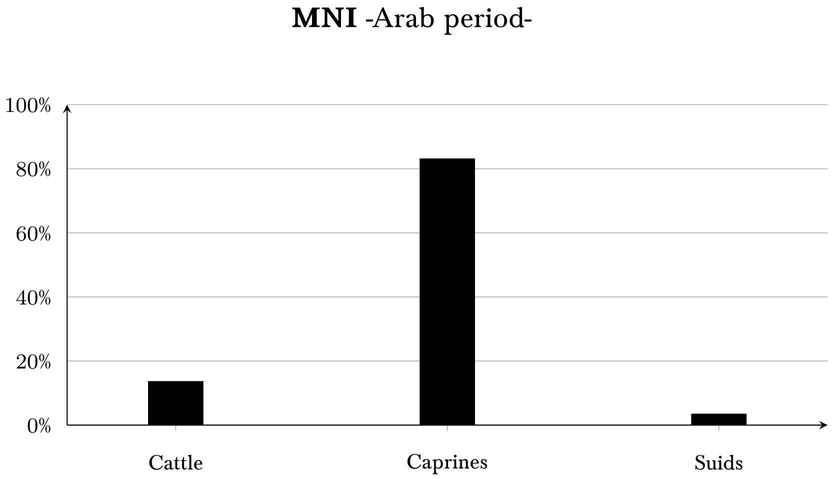


**Figure 6.5.10.** Mazara del Vallo, Arab period. Percentage of the Minimum Number of Individuals (MNI) for the three main domesticates (n:59).

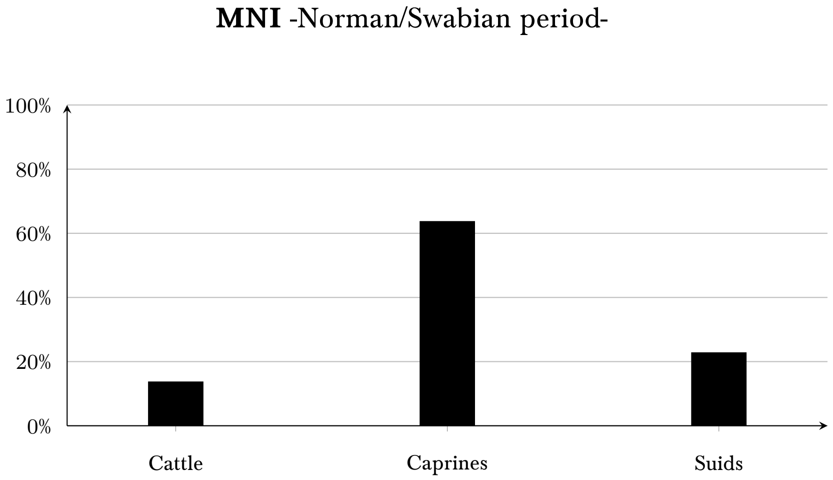


**Figure 6.5.11.** Mazara del Vallo, Norman/Swabian period. Percentage of the Minimum Number of Individuals (MNI) for the three main domesticates (n:22).

*Sheep/goat separation* - The distinction between sheep and goat remains at Mazara del Vallo was mainly carried out by looking at distinctive morphological criteria present on a defined set of anatomical elements. In addition to this, it was also possible to carry out some biometrical analyses following the biometrical parameters suggested by Salvagno and Albarella (2017) (*§Chapter 5: Methodology*).

Measurements of the condyles and of the *verticilli* of caprine distal metacarpals were analysed; based on morphological criteria, most of these elements had been initially attributed to sheep.

As Fig.6.5.12 shows, the majority of specimens falls within the modern values of sheep (red oval), with three values located at the edge of the two distributions of modern values of sheep and goat (blue oval); although these specimens cannot be identified to species level through biometrical analyses, they were previously identified as belonging to sheep on the basis of morphological criteria. At the same time, two metacarpals generically attributed to sheep/goat fully plot within the range of modern sheep.

Fig.6.5.13 employs different measurements from the same element (i.e. metacarpals). As in the previous case, most individuals plot within the range of sheep measurements. Two values are located on the left of the modern values of sheep, leaving little doubt about their attribution; these metacarpals were previously attributed to sheep on the basis of distinctive morphological criteria. As in the previous graph, also in this case, the metacarpals registered as 'sheep/goat' fully plotted within the range of modern sheep.

In sum, only sheep appears to be represented by the metacarpals.

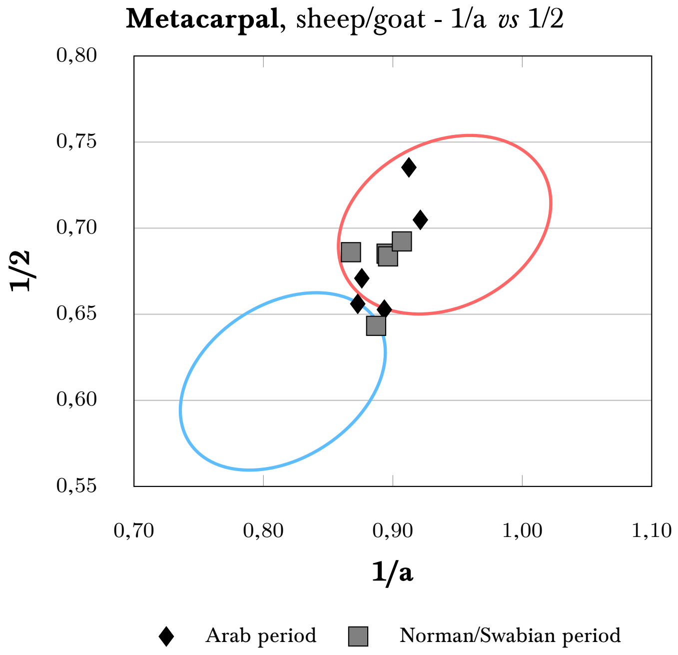


**Figure 6.5.12**. Mazara del Vallo. Arab and Norman/Swabian periods. Sheep/goat, metacarpals, shape indices. Arab period (black diamonds), Norman/Swabian period (grey squares). Red oval: range of modern sheep values, blue oval: range of modern goat values according to Salvagno and Albarella (2017) (§*Chapter 5: Methodology*). 1: depth of left distal condyle; a: width of the medial condyle; 2: diameter of the verticillus of the medial condyle.

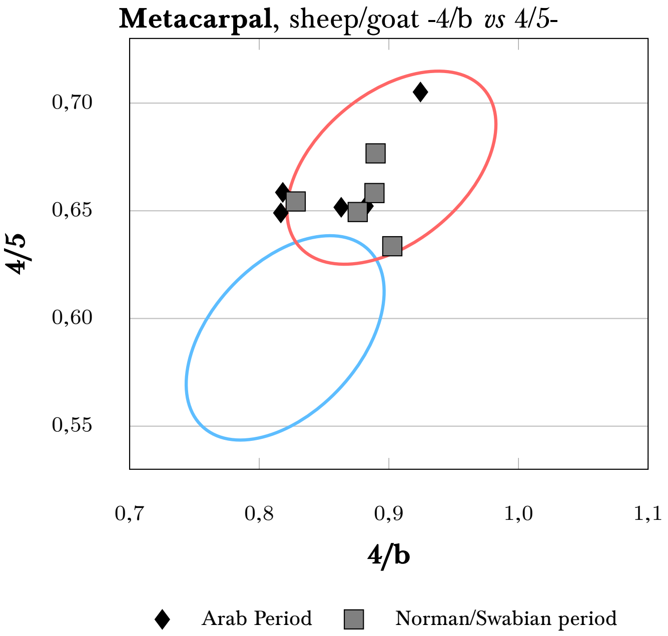


**Figure 6.5.13.** Mazara del Vallo, Arab and Norman/Swabian periods. Sheep/goat, metacarpals, shape indices. Arab period (black diamonds), Norman/Swabian period (grey squares). Red oval: range of modern sheep values, blue oval: range of modern goat values according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). 4: depth of the lateral condyle; b: width of the lateral condyle; 5: diameter of the verticillus of the lateral condyle.

To further investigate the sheep to goat ratio at Mazara del Vallo in the analysed periods, shape indices from the astragalus have been plotted. The obtained values were then compared with those from modern specimens as presented in Salvagno and Albarella (2017) (Fig.6.5.14).

During the recording of the faunal assemblage, all the astragali were taxonomically attributed to sheep, with the exception of two goat astragali dated to the Norman/Swabian period.

As Fig.6.5.14 shows, the majority of specimens falls within the modern values of sheep (red oval), while only one in those of goat (blue oval). Another value, morphologically attributed to goat, plots in between the modern values of sheep and goat.

To sum up the morphometric analyses, these fully validate the morphological identification, confirming that sheep were far better represented than goats at Mazara del Vallo in both periods.

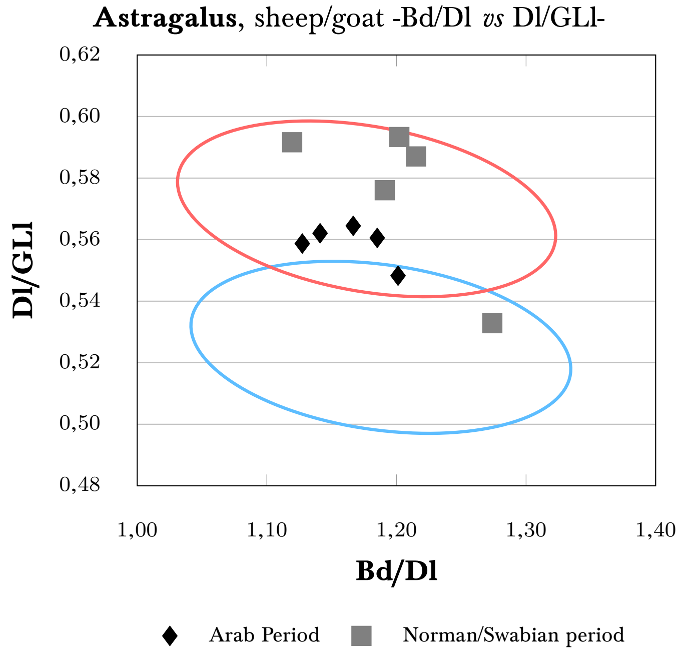


**Figure 6.5.14**. Mazara del Vallo, Arab and Norman/Swabian periods. Sheep/goat, astragali, shape indices. Arab period (black diamonds), Norman/Swabian period (grey squares). Red oval: range of modern sheep values, blue oval: range of modern goat values according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). Bd: breadth of the distal end; Dl: greatest depth of the lateral half; GLl: greatest length of the lateral half.

*Equids* – Equid remains were exclusively recorded in the Arab period, and they consist of 17 post-cranial bones; as mentioned before, most specimens appear to belong to horse (*§6.5.2 Species frequency: NISP and MNI*).

An attempt to separate horses, donkeys and/or equid hybrids was made by investigating the shape of equid 1st phalanges; this has been done by calculating the ratio between the greatest length (GL) and the breadth of the distal end (Bd), which was plotted against the greatest length (GL). The assumption laying behind such analysis is that donkeys and equid hybrids tend to be slenderer than horses (Johnstone 2004). Hence, differences in robustness could help in identifying the presence of different equid species (Davis *et al.* 2008).

As Fig.6.5.15 indicates, most values plots in the upper right part of the graph, representing more robust animals (i.e. horses); one slenderer outlier at the bottom of the graph may represent a donkey or an equid hybrid. Although the sample size is very small, it is likely that during the Arab period horses were more common than donkeys/equid hybrids at Mazara del Vallo, though the latter would have also been present.

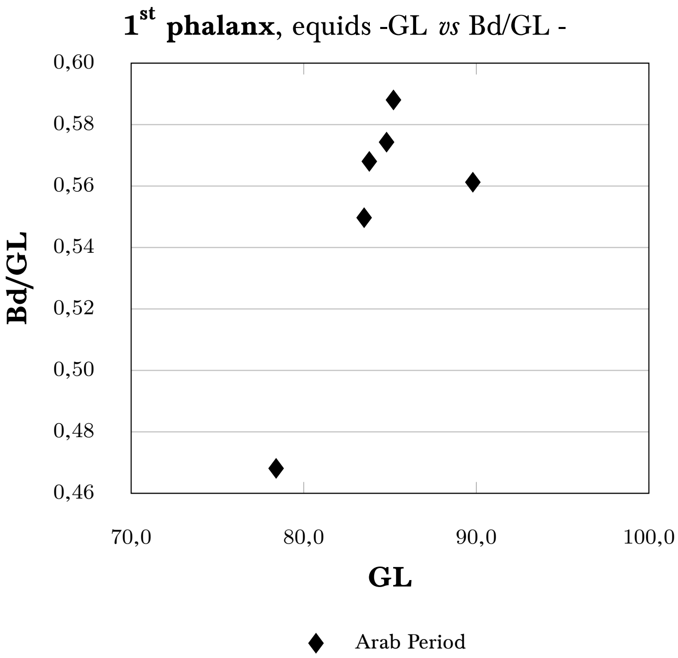


**Figure 6.5.15.** Mazara del Vallo, Arab period. Equids, 1st phalanges, shape indices. GL: greatest length; Bd: breadth of the distal end (§*Chapter 5: Methodology*)

### 6.5.3. Ageing

The analysis of age-at-death could only be carried out for caprines and cattle for both periods, as insufficient ageing data were available for other species. Nonetheless, desultory comments on suids, equids, felids and galliforms were also made.

*Caprines* – The proportions of caprine fused bones for the three age-stages (Silver 1969) were calculated for the Arab and Norman/Swabian periods.

In the Arab period (Fig.6.5.16), ca. 30% of caprines were culled before their first-second year of age (lambs, early fusing stage), while few individuals (ca. 10%) were slaughtered in their second-third year of age (middle fusing stage). ca. 20% of the animals were culled before reaching their third-fourth years of age (late fusing stage), with ca. 40% of individuals surviving into adulthood.

Mandibular wear stages were estimated for seventy-eight mandibles; the obtained kill-off pattern seems to confirm the results from the epiphyseal fusion analysis (Fig.6.5.17).

Therefore, a good number of mature caprines were kept for their wool, milk and for breeding before they were eventually killed; however, several individuals were also raised for their meat.

In the Norman/Swabian period (Fig.6.5.18) a clear majority of individuals survived into late adulthood (ca. 70%), while ca. 30% were culled before reaching their third-fourth year of age (late fusing stage), the second-third year of age (middle fusing stage), and the first-second year of age (early fusing stage). As for the Arab period, early culling events are also attested for the Norman/Swabian period, although with a lower incidence. Caprine husbandry, thus, mainly focused on wool and, to a much lesser extent, on milk and meat production.

The kill-off pattern reconstructed from caprine mandibular wear stages supports the evidence shown by the epiphyseal fusion data (Fig.6.5.19), though we must consider that the sample size is fairly small.

In sum, the pattern from the Arab period at Mazara del Vallo appears to be quite generalised, as the culling strategy did not coalesce around specific age groups. Changes are attested in the Norman/Swabian period, when caprine husbandry appears to be much more focused on wool production in comparison to the earlier period, with limited milk and meat production.

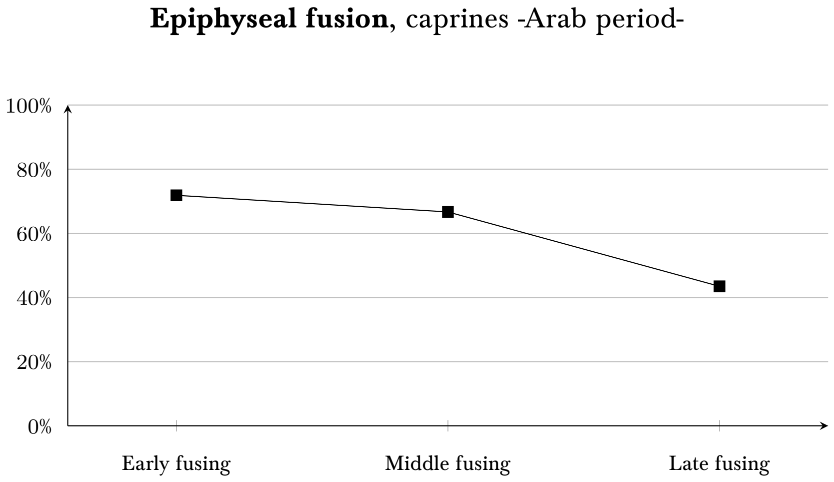


**Figure 6.5.16.** Mazara del Vallo, Arab period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:72;67;43). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

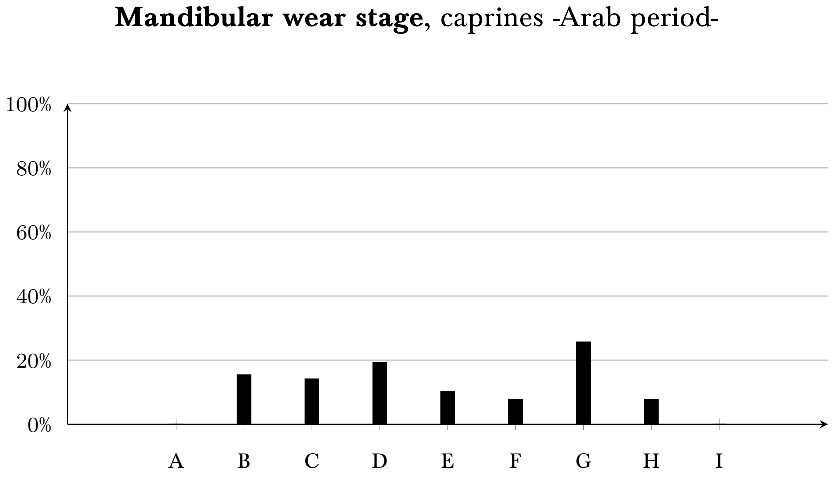


**Figure 6.5.17.** Mazara del Vallo, Arab period. Mandibular wear stages for caprines (n:78). Age stages follow Payne (1973). A: 0-2 months, B: 2-6 months, C: 6-12 months, D: 1-2 years, E: 2-3 years, F: 3-4 years, G: 4-6 years, H: 6-8 years, I: 8-10 years.

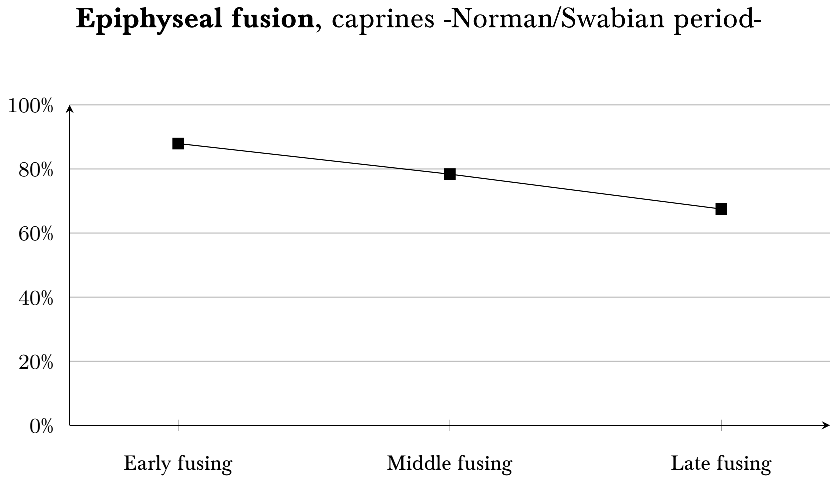


**Figure 6.5.18.** Mazara del Vallo, Norman/Swabian period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:88;78;68). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

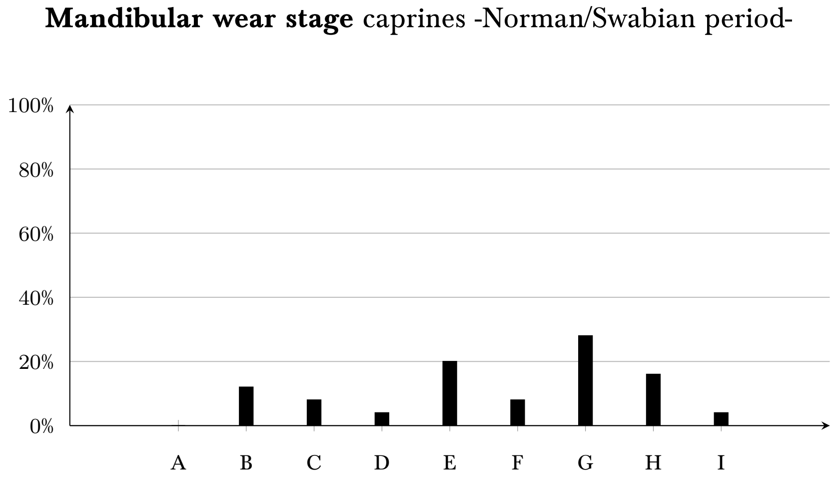


**Figure 6.5.19.** Mazara del Vallo, Norma/Swabian period. Mandibular wear stages for caprines (n:23). Age stages follow Payne (1973). A: 0-2 months, B: 2-6 months, C: 6-12 months, D: 1-2 years, E: 2-3 years, F: 3-4 years, G: 4-6 years, H: 6-8 years, I: 8-10 years.

*Cattle* – The analysis of the mortality profile for cattle in Arab and in the Norman/Swabian periods relies only on post-cranial bones, as not enough mandibular sequences were recorded.

As Fig.6.5.20 shows, in the Arab period, ca. 20% of individuals were killed before their second-third years of age (middle fusing stage), while another ca. 20% were slaughtered before reaching their third-fourth year of age (late fusing stage); ca. 60% of the individuals survived into late adulthood.

This pattern suggests that cattle were mainly exploited as a traction force, with few individuals raised specifically for beef production. However, it is reasonable to think that some cows could have also been exploited for milk; the virtual absence of early culling events (calves, early fusing stage) might be a consequence of taphonomic processes, which prevented the preservation of the more porous elements of very young individuals, which we would expect to find as part of a dairy economy.

In the Norman/Swabian period, no substantial changes are noticed; indeed, as Fig. 6.5.21 shows, most cattle survived into late adulthood (>60%), while fewer individuals were slaughtered before the three-four years of age (late fusing stage) and before the two-three years of age (middle fusing stage) (ca. 20% and 15% respectively).

As already discussed for the Arab period, the absence of early fusing elements of very young individuals (i.e. calves), could be a consequence of taphonomic processes rather than of a complete absence of dairy production.

Overall, in the Arab and in the Norman/Swabian periods, most cattle were kept to an old age and, therefore, were probably exploited mostly for their secondary products, such as traction force, milk and manure, rather than for meat production.

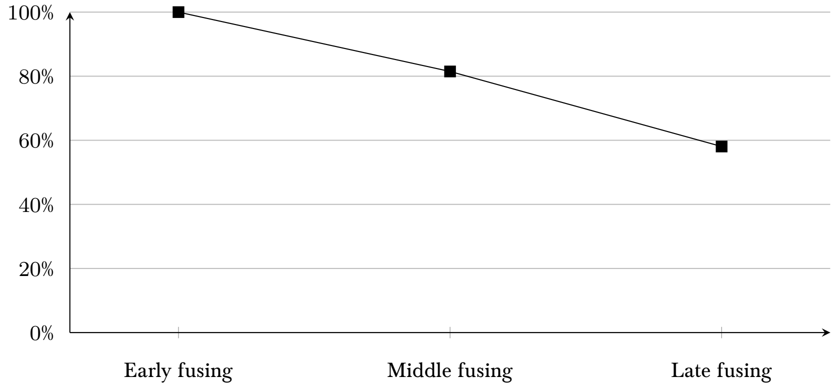

**Epiphyseal fusion**, cattle -Arab period-

**Figure 6.5.20.** Mazara del Vallo, Arab period. Epiphyseal fusion analysis for cattle. Percentage of fused bones within each fusion stage (n:100;81;58). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

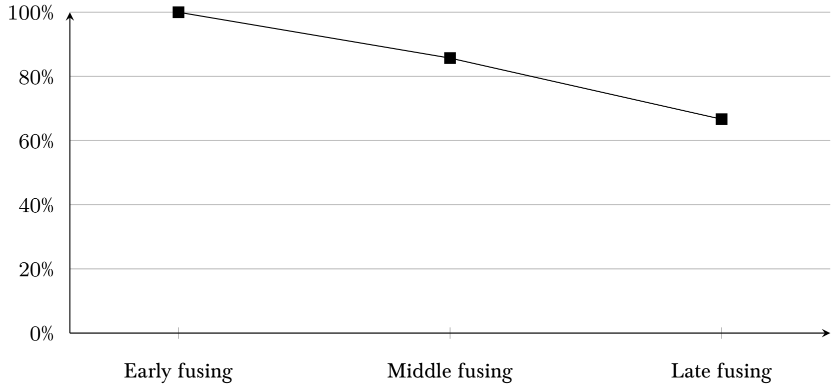

**Epiphyseal fusion**, cattle -Norman/Swabian period-

**Figure 6.5.21.** Mazara del Vallo, Norman/Swabian period. Epiphyseal fusion analysis for cattle. Percentage of fused bones within each fusion stage (n:100;86;67). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Suids* – In the Arab period, due the small sample size, it is not possible to assess the age at death of suids.

In the Norman/Swabian period, ca. 20% of early fusing elements of suids were unfused, representing animals killed before one-two years of age. This result may suggest the consumption of very young pigs at the site. An additional ca. 30% of the animals were slaughtered, cumulatively, before two-three years and three-fours years of age, with ca. 25% of the individuals surviving into adulthood.

As pig husbandry only aims at the production of meat and fat, this pattern is not highly unusual for suids; the high incidence of both very young and mature individuals, however, is rather intriguing.

*Equids* – Equid remains were only recorded for the Arab period at Mazara del Vallo; these exclusively belong to post-cranial bones. All bones were fused, therefore suggesting the presence of predominantly mature equids at the site.

*Felids* – For the Arab period, 23 post-cranial bones belonging to felids were recorded; all of them were fused, with the exception of one unfused distal femur and two proximal humeri, whose diaphyses were fusing. As a result, it seems that adults were better represented than young individuals in this period.

In the Norman/Swabian period, out of 35 post-cranial elements, 20 were fully fused, 17 had their proximal and/or distal diaphyses unfused, and two proximal humeri were fusing. In addition, a mandible and two maxillae, all with permanent teeth, were also recorded (Fig.6.5.22).

This result suggests that, in the assemblage from the Norman/Swabian period, young and sub-adult felids are by far more represented than in the Arab period, although adults are equally represented.

**(a)** Cranium of a felid (probably domestic cat) with permanent teeth (C, $P^3$ and $P^4$);

**(b)** Mandible of a felid (probably domestic cat) with permanent teeth ($P_3$, $P_4$ and $M_1$).

**Figure 6.5.22.** Mazara del Vallo, Norman/Swabian period. Felid remains.

*Cervids* – In the Arab as well as in the Norman/Swabian periods, all cervid anatomical elements belonging to the red deer or to the fallow deer were fused, at the exception of one metacarpal with the distal diaphysis unfused. Mandibles and maxillae were absent. In addition, a distal radius (Arab period) and a proximal radius and a distal tibia (Norman/Swabian period) attributed to the fallow deer were also fused. These results indicate the introduction of predominantly mature cervids at the site in both periods.

*Galliforms* – In the Arab period, out of 42 recorded bones (i.e. countable and uncountable), eight were not fully ossified, with some being particularly small.

In the Norman/Swabian period, out of 88 anatomical elements (i.e. countable and uncountable), 27 had the proximal and/or the distal diaphyses non-fully ossified, suggesting the presence of immature individuals, while 61 were fully ossified; of these, 52 were attributed to domestic fowl. Among the not-fully ossified bones, some were particularly small in size.

The presence in both periods of very small-sized porous bones is likely to indicate natural mortality, therefore on-site breeding.

### 6.5.4. Sex

Information about the sex of animals from Mazara del Vallo could be obtained for suid, cervid and domestic fowl remains.

*Suids* – In order to assess the ratio between sows and boars, canines in jaws were considered; in addition, the mandibular and maxillary alveoli were also sexed when canines were not present and considered in the calculations (*§Chapter 5: Methodology*).

As Table 6.5.4 indicates, the few suid canines and alveoli recorded for the Arab period show that boars are slightly better represented than sows. By contrast, in the Norman/Swabian period, the pattern is reversed; indeed, in this period, more sows than boars are present. However, caution in the interpretation is necessary because of the small sample size, especially for the Arab period.

| **Mazara del Vallo** | **Arab period** | | **Norman/Swabian period** | |
|---|---|---|---|---|
| ***Sus* sp.** | **Sows** | **Boars** | **Sows** | **Boars** |
| Canines (in jaws) | 1 | 4 | 8 | 3 |
| Alveoli (mandibular and maxillary) | 1 | 0 | 3 | 2 |
| **Total** | **2** | **4** | **11** | **5** |

**Table 6.5.4.** Mazara del Vallo, Arab and Norman/Swabian periods. Presence of male and female pigs based on canines in jaws and alveoli (n:6,16).

*Cervids* – Two antler fragments of male red deer or fallow deer were recovered from contexts dated to the Arab period; in one case the antler presented polishing marks on its surface.

One antler fragment of a male red deer or fallow deer was also recorded in an archaeological context dated to the Norman/Swabian period; the fragment had been worked, and polishing marks were detected on its surface (*§6.5.8 Worked antlers*).

*Domestic fowl* – In the Arab period, out of six mature tarsometatarsi, three presented a spur; in all cases these anatomical elements lack a continuous posterior keel, which is more typical of pheasants. As a result, the three spurred tarsometatarsi were securely identified as domestic fowl, and they indicate the presence of cockerels/capons.

In the Norman/Swabian period, out of seven mature tarsometatarsi, only one was spurred; also in this case a continuous posterior keel was missing, thus confirming its taxonomical attribution to a male domestic fowl.

Tarsometatarsi characterised by the presence of a spur scar and/or of a reduced spur were not detected in either period (Tab.6.5.5).

However, sexing based on the presence and/or absence of the spur may not always be reliable, as exceptions occur (*§Chapter 5: Methodology*).

| **Mazara del Vallo** | **Unspurred tarsometatarsi** | **Spurred tarsometatarsi** |
|---|---|---|
| Arab period | 3 | 3 |
| Norman/Swabian period | 6 | 1 |
| **Total** | **9** | **4** |

**Table 6.5.5.** Mazara del Vallo, Arab and Norman/Swabian period. Number of unspurred (most likely female) and spurred (most likely male) tarsometatarsi of domestic fowl.

### 6.5.5. Anatomical element distribution

The distribution of anatomical elements could only be properly analysed for caprines and cattle in both periods. Comments about the anatomical element distribution of suids were only possible for the Norman/Swabian period, as not enough data were available for the Arab phase. In addition, brief comments on equids, cervids, felids, domestic fowls and fish were also made.

*Caprines* – The anatomical element distribution of caprines reveals that, in the Arab period, mandibles are the most represented body parts (Fig.6.5.23); their high incidence may suggest the introduction of whole carcasses at the site, as those are elements that would tend to be discarded during primary butchery. Upper and lower limb bones are equally represented, confirming that primary and secondary butchery both occurred on site. Smaller anatomical elements, such as tarsals and phalanges, are less represented than other body parts, while carpals are completely absent; this result is likely the consequence of a recovery bias.

Scapula, distal humerus, distal radius and distal tibia are also well represented, probably as a consequence of their high density (Brain 1971). The situation in the Norman/Swabian period is similar, with mandibles being by far the most common element, and both upper and lower limbs similarly represented (Fig.6.5.24).

Overall, it is likely that caprines in the Arab and in the Norman/Swabian periods were slaughtered locally and that both primary and secondary butchery occurred at the site.

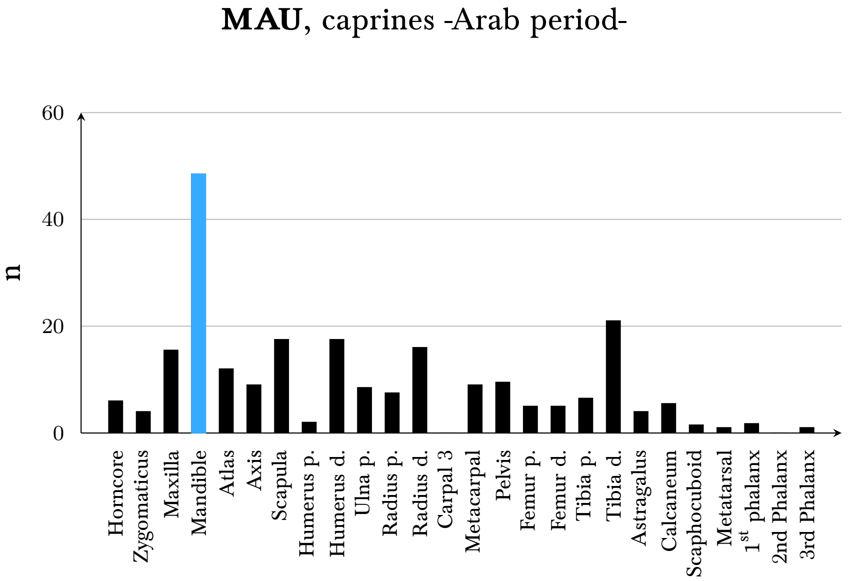


**Figure 6.5.23**. Mazara del Vallo, Arab period. Distribution of the Minimum number of Animal Units (MAU) for caprines (n:235). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

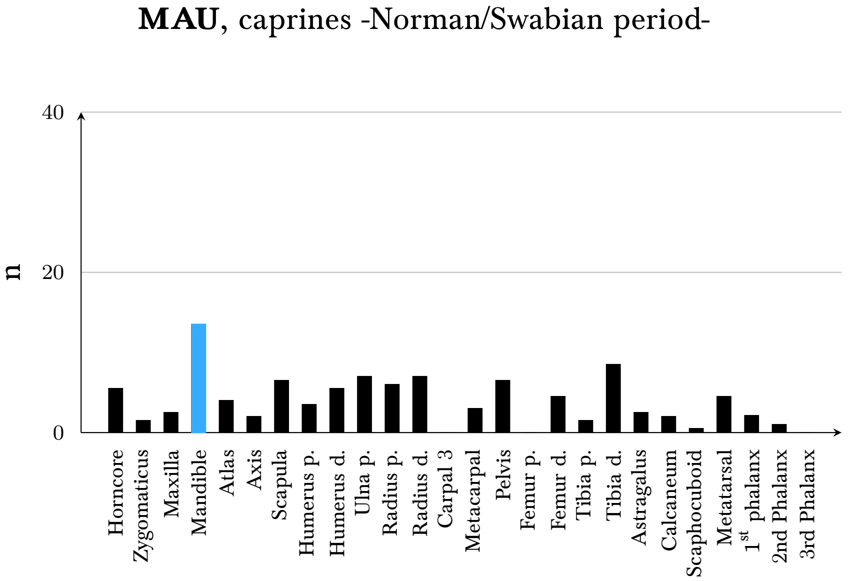


**Figure 6.5.24**. Mazara del Vallo, Norman/Swabian period. Distribution of the Minimum number of Animal Units (MAU) for caprines (n:101). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Cattle* – The anatomical element distribution of cattle in the Arab period suggests that lower limbs are better represented than upper limbs (Fig.6.5.25).

The most abundant element is the distal tibia, followed by the proximal tibia and the proximal femur. Cranial elements are less represented in comparison to other body parts, with mandibles completely absent. Among the small bones, tarsals are better represented than carpals, and few phalanges are present.

The high density characterising the distal tibia might lie behind its high incidence in the cattle anatomical distribution, as this histological feature would have allowed such element to preserve well in the archaeological record (Brain 1981). However, a similar consideration is unlikely to lie behind the high incidences of the proximal tibia and of the proximal femur; indeed, these body parts present a lower density in comparison to other elements, such as the scapula and the distal humerus, that are only scarcely represented in this period. As a result, there seem to be a higher incidence of cattle hind limbs, which might be related to a preferential disposal of this part of the cattle carcass.

In Norman/Swabian Mazara del Vallo the cattle anatomical element distribution shows a similar pattern to that of the Arab period (Fig.6.5.26). Indeed, also in this period, cattle is mostly represented by hind limbs, the distal tibia being the most represented body part. Cranial elements are even less present than in the Arab period, and are represented only by one horncore and one mandible. Since the head is among the body parts most likely to be excluded from cattle dressed carcasses, their underrepresentation might suggest the prevalent presence of partly processed carcasses at the site.

It can thus be concluded that, in each period, at Mazara del Vallo cattle hind limbs (although in different percentages) were the best represented body parts. Similarly, cranial elements are barely represented, if not completely absent at both periods. As a result, it seems that in the Arab and in the Norman/Swabian periods more secondary than primary butchery processes occurred at the site, and that whole cattle carcasses entered the site only occasionally.

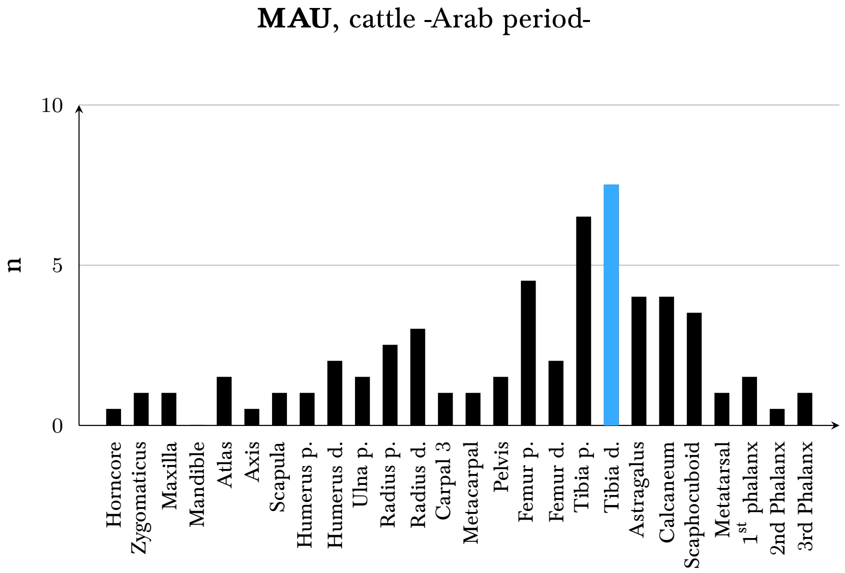


**Figure 6.5.25.** Mazara del Vallo, Arab period. Distribution of the Minimum number of Animal Units (MAU) for cattle (n:55). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

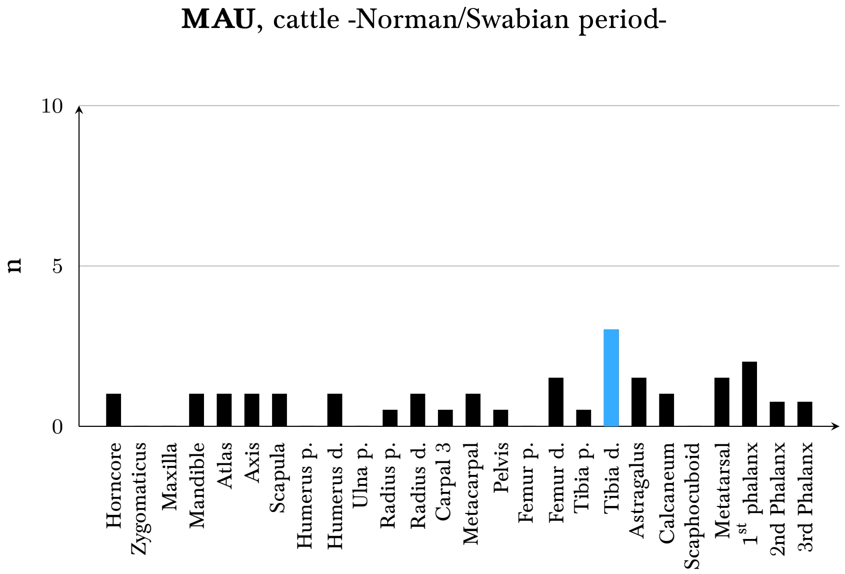


**Figure 6.5.26.** Mazara del Vallo, Norman/Swabian period. Distribution of the Minimum number of Animal Units (MAU) for cattle (n:22). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Suids* – The anatomical distribution of suids can only be properly analysed for the Norman/Swabian period, as not enough suid remains were recovered from Arab contexts.

As Fig.6.5.27 indicates, the pattern of representation of suid body parts can almost entirely be explained by recovery biases and differential preservation. Indeed, small elements, such as phalanges, carpals and tarsals are underrepresented, if not completely absent; this result might be the consequence of the lack of sieving of the archaeological deposits. The most represented body parts are mandibles, followed by the distal tibia; these elements are known to have better chances to preserve in the archaeological record, as they present a high bone density; although to a lesser extent, this consideration is also valid for the distal radius. However, the high incidence of mandibles along with other cranial elements, such as the zygomaticus and the maxilla, indicates the introduction of whole suid carcasses at the site.

Overall, it is likely that all parts of the skeleton were originally present at the site in the Norman/Swabian period and, therefore, that entire animal carcasses were processed locally.

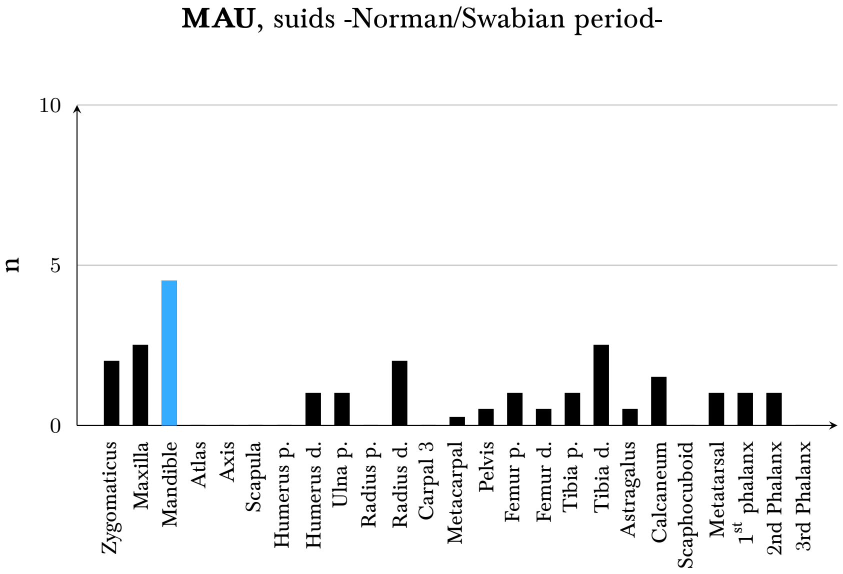


**Figure 6.5.27**. Mazara del Vallo, Norman/Swabian period. Distribution of the Minimum number of Animal Units (MAU) for suids (n:23). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Domestic fowl* – As Fig.6.5.28 indicates, chicken leg bones are the most abundant elements at both periods. As taphonomic processes are unlikely to lie behind such pattern, a higher incidence of leg bones in comparison to wings might suggest a preferential consumption of such meatier body parts (Corbino *et al.* 2017). The ageing data reveal that some small-sized and porous elements, probably belonging to domestic fowl, were recovered for both periods, thus suggesting that breeding occurred at the site (*§6.5.3 Ageing – Galliforms*).

This consideration would suggest that, in addition to specific food preferences, both butchery processes and/or different strategies of waste disposal might have played a role in the distribution of domestic fowl anatomical elements.

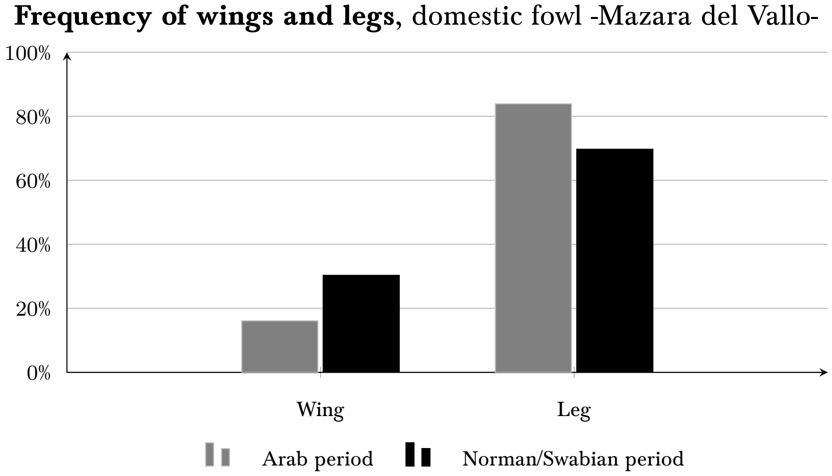


**Figure 6.5.28.** Mazara del Vallo, Arab and Norman/Swabian periods. Frequency of wing and leg bones of domestic fowl based on the Minimum number of Animal Units (MAU) in the Arab period (n:3;12) and in the Norman/Swabian period (n:10;23). Wing bones: humerus, ulna and carpometarcapus; leg bones: femur, tibiotarsus and tarsometatarsus.

*Equids* – In the Arab period, bones from both the lower and upper limbs are present, while elementsof the head are absent.

*Cervids* – In the Arab as well as in the Norman/Swabian periods cervid remains mainly consist of hind limbs, with fore limbs less represented. Small bones (e.g.

carpals, tarsals and phalanges) and elements from the head are missing, with the exception of antler fragments (*§6.5.4 Sex*).

*Felids* – In the Arab period, felids are mostly represented by upper limbs; small bones, such as carpals and tarsals are completely absent, and only two 1st phalanges were recorded. Cranial elements are attested by two mandibles, while axial elements were absent.

In the Norman/Swabian period, both upper and lower limbs were equally represented. As in the Arab period, small bones are completely missing and no phalanges were recorded. Axial elements are represented by only one atlas. Felid cranial elements are slightly better represented in comparison to the earlier period, and tare represented by two entire crania, two maxillae and one mandible.

*Fish* – In the Arab period, *Thunnus* sp. remains consist of two abdominal vertebrae, one caudal vertebra, one ceratohyal and one epihyal; this latter presented one cut mark on its surface.

*Thunnus* sp. remains dated to the Norman/Swabian period consist of four abdominal vertebrae, one maxilla, one premaxilla, one angular and one dentary; the dentary presented two cut marks on its surface (*§6.5.6. Butchery*).

All in all, cranial and axial elements are represented in both periods, suggesting that entire fish carcasses were introduced to the site.

### 6.5.6. Butchery

For this site, the analysis of butchery marks focuses on caprines and cattle in both periods. A few comments on suid, domestic fowl and fish carcass processing are made, despite the modest quantity of available data.

*Caprines* – In the Arab period, ca. 15% of caprine remains showed evidence of butchery (Fig.6.5.29); among these, cut marks were more frequent than chop marks, while a few specimens presented both chop and cut marks on their surface (Fig.6.5.30). Cut marks were mostly located on the ends of post-cranial bones, and they might have aimed at the severing of tendons. A number of cut marks were also recorded at the base of four horncores, of which two belong to sheep and two others to goat (Fig.6.5.31); such marks were presumably made to separate the horncores from the skull and/or remove the horn sheath from the bony core. This evidence might be indicative of craft activities carried out at the site in this period.

Chop marks were mostly distributed on elements of the axial skeleton (i.e. atlas, axis, other vertebrae and pelvis), and were probably inflicted to dismember the carcass; a few chop marks were also recorded along the shaft of long bones, and they might be linked with the extraction of marrow and/or with further reduction of the carcasses into smaller units.

In the Norman/Swabian period, ca. 10% of caprine bones were butchered (Fig.6.5.32). Similarly to the Arab period, cut marks were better represented than chop marks (Fig.6.5.33), and were mostly located on the articular ends of long bones; few chop marks were recorded on the shaft of long bones, especially along the humerus and the tibia. In addition, two goat horncores presented cut marks at their bases and, as in the Arab period, they probably suggest the existence of craft activities where the horn was employed.

All in all, in both analysed periods, butchery evidence on caprines was mainly represented by cut marks; this preference might be related with the medium size of caprine carcasses, which do not require the extensive use of heavy tools, such as cleavers.

In addition, the abundance of butchery marks suggests that most caprine remains derive from food waste disposal in both periods. The recovery of a high incidence of burnt animal remains further confirms this hypothesis (*§6.5.7 Burning*).

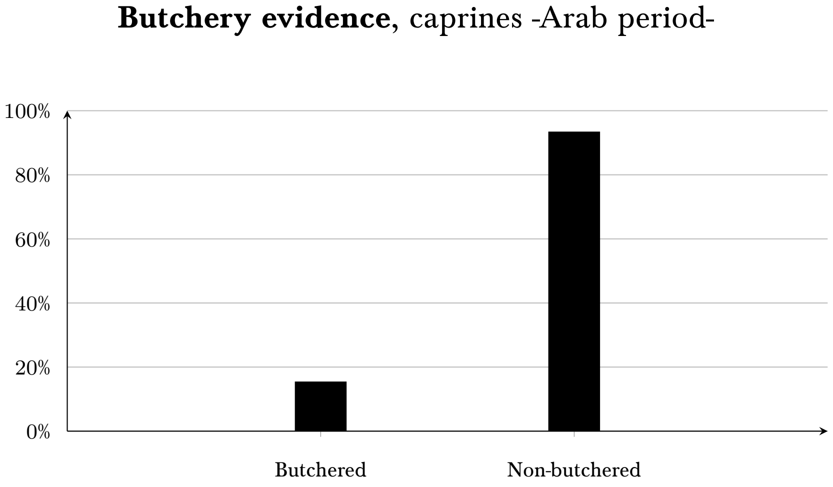


**Figure 6.5.29.** Mazara del Vallo, Arab period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:55;335).

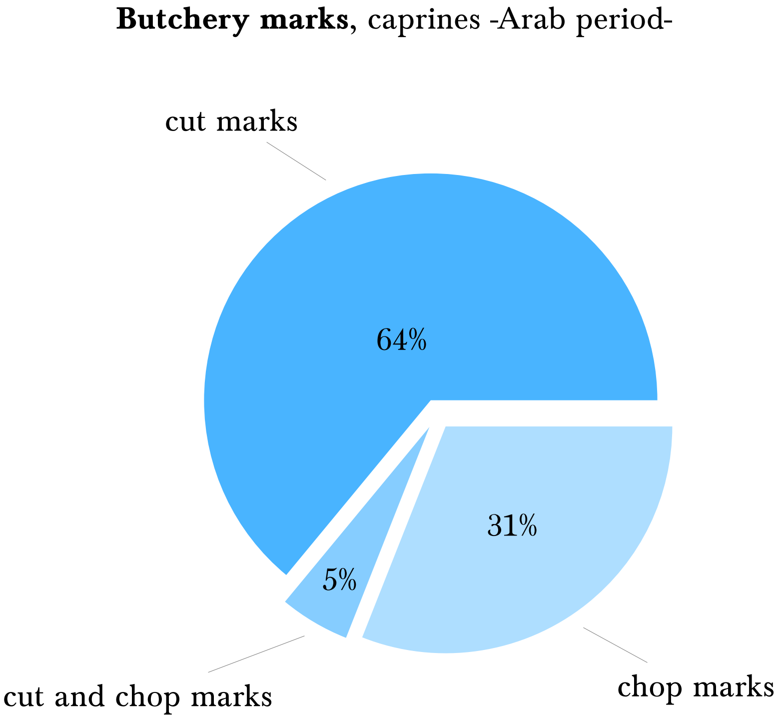


**Figure 6.5.30.** Mazara del Vallo, Arab period. Butchered post-cranial bones of caprines; proportions of cut marks, chop marks and cut and chop marks (n:55).

**Figure 6.5.31**. Mazara del Vallo, Arab period. Goat horncore with a cut mark at the base.

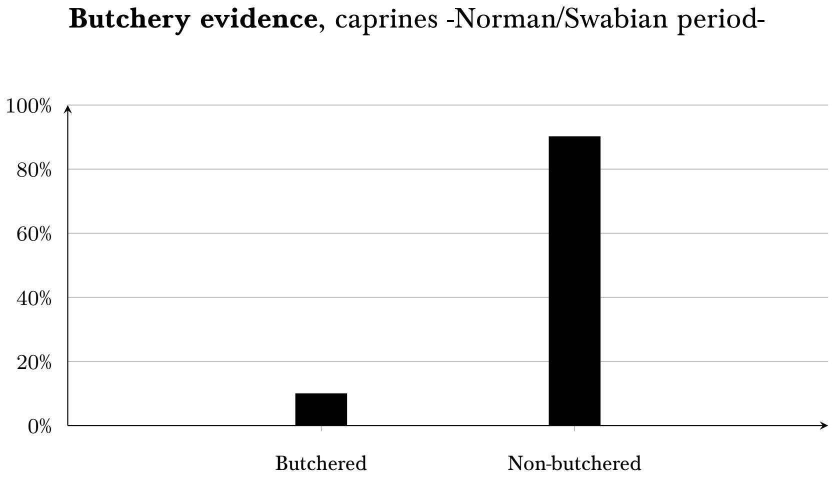


**Figure 6.5.32.** Mazara del Vallo, Norman/Swabian period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:33;341).

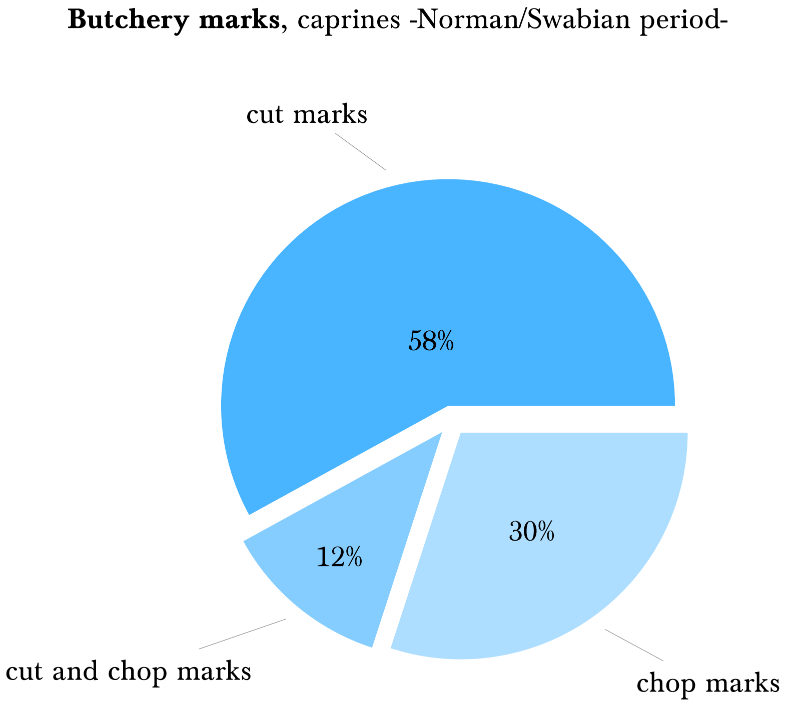


**Figure 6.5.33.** Mazara del Vallo, Norman/Swabian period. Butchered post-cranial bones of caprines; proportions of cut marks, chop marks and cut and chop marks (n:33).

*Cattle* – In the Arab period, butchery marks were recorded on ca. 25% of cattle post-cranial remains (Fig.6.5.34). Chop marks were far more common than cut marks; in addition, 30% of the bones presented both cut and chop marks (Fig.6.5.35).

Chop marks were mainly located on the shaft of post-cranial bones; heavy tools, such as cleavers, contributed to the dismemberment of cattle carcasses and/or the extraction of bone marrow. In addition, one metatarsal and three 1st phalanges presented cut marks on their surface, as a consequence of skinning.

Butchery evidence on cattle remains from the Norman/Swabian period show a similar pattern to that of the Arab period (Fig.6.5.36); ca. 25% of butchery marks consist of chopping, mostly located along the shaft of long bones (Fig.6.5.37). Like in the Arab period, cut marks were recorded on cattle phalanges, indicating skinning.

In both periods cattle carcasses were more intensively butchered than caprines', and chopping marks were more common than cut marks; such evidence is related to the large size of cattle carcasses, which needs to be divided into a higher number of portions than those of caprines.

In sum, the analyses of the butchery evidence suggest that cattle remains from Mazara del Vallo mainly represent butchery and food waste, and that butchery activities took place on site in both periods. In addition, skinning activities are attested for both periods, highlighting the exploitation of cattle hides.

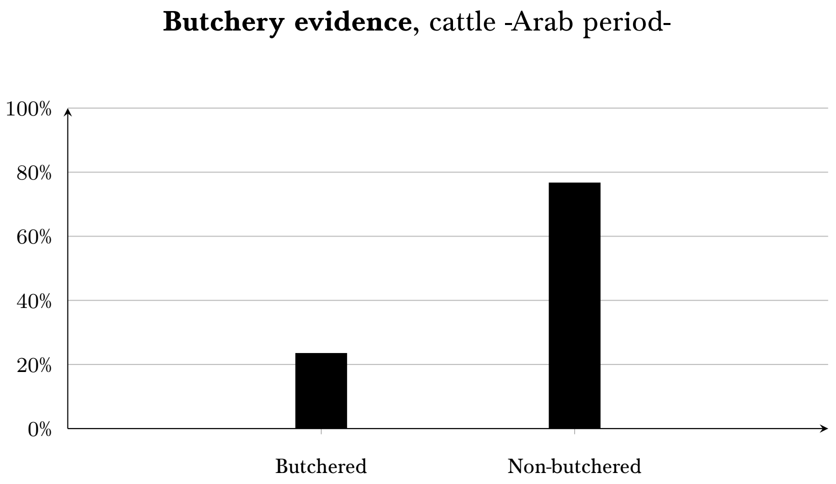


**Figure 6.5.34**. Mazara del Vallo, Arab period. Proportion of butchered and non-butchered post-cranial bones of cattle (n:33;108).

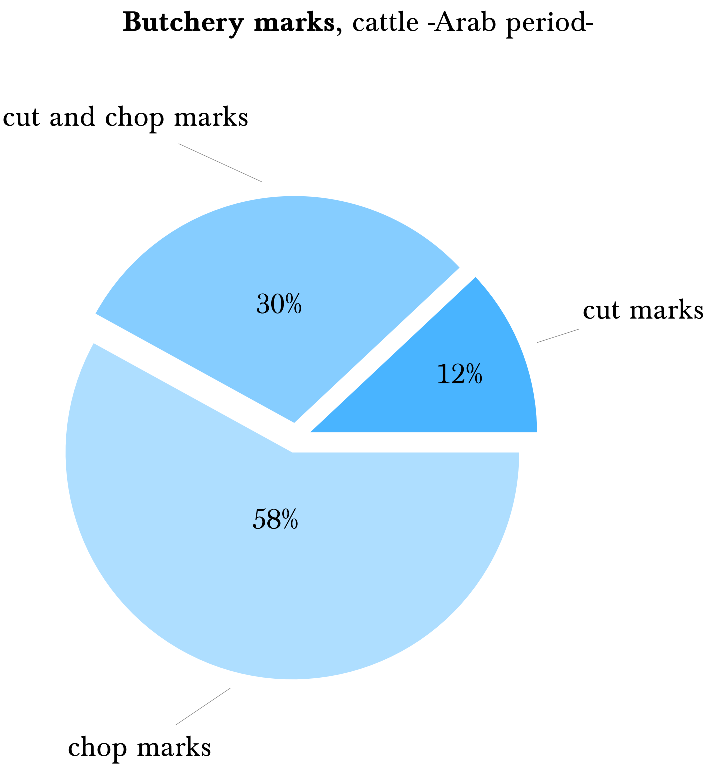


**Figure 6.5.35**. Mazara del Vallo, Arab period. Butchered post-cranial bones of caprines; proportions of cut marks, chop marks and cut and chop marks (n:33).

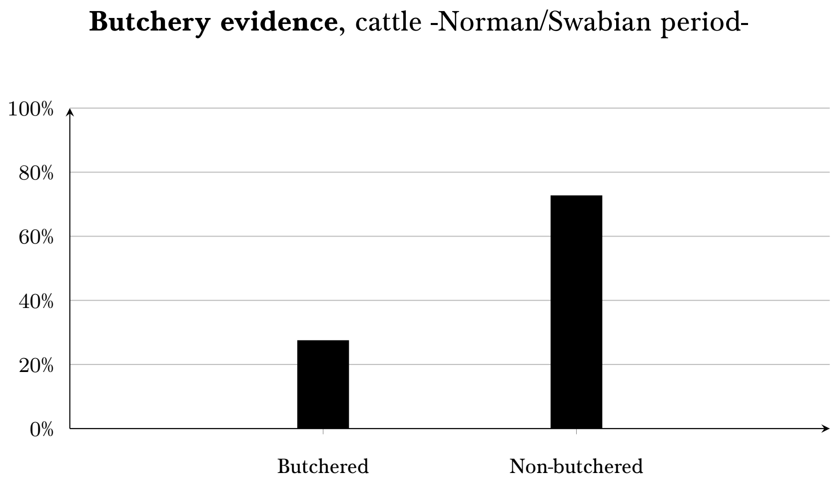


**Figure 6.5.36**. Mazara del Vallo, Norman/Swabian period. Proportion of butchered and non-butchered post-cranial bones of cattle (n:20;53).

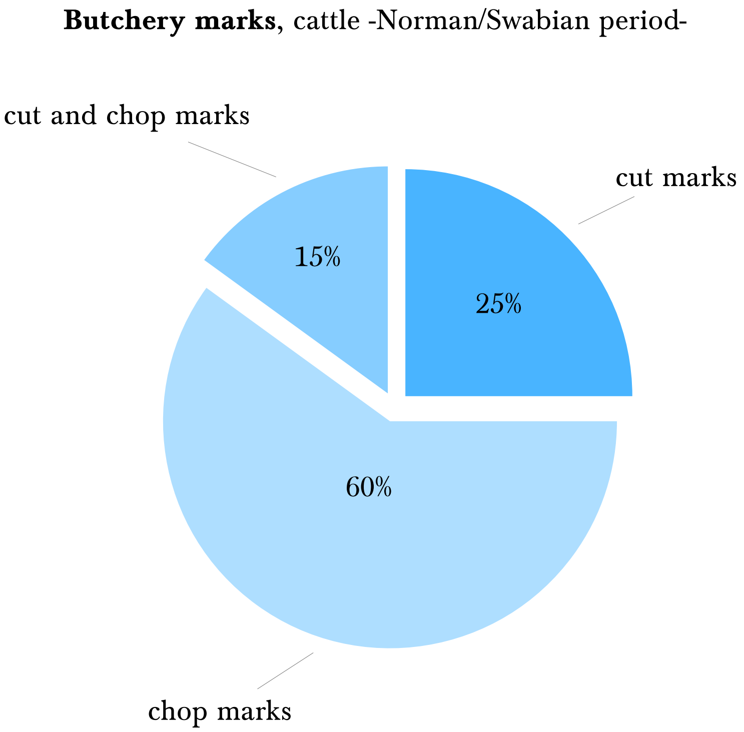


**Figure 6.5.37**. Mazara del Vallo, Norman/Swabian period. Butchered post-cranial bones of cattle; proportions of cut marks, chop marks and cut and chop marks (n:20).

*Suids* – Only two suid bones (both calcanei), dated to the Norman/Swabian period, presented cut marks on their surface; these are probably associated to the severance of tendons.

*Domestic fowl* – In the Arab period, two distal humeri were cut, while in the Norman/Swabian periods one distal humerus and five distal tibiotarsi presented parallel cut marks on their surfaces.

In both periods, such marks can be interpreted as direct evidence for the consumption of chicken. (*§6.5.7 Burning*).

*Testudines* – In the Arab period, two carapax fragments presented chop marks on their surfaces; in addition, an entire carapax attributed to the Hermann's tortoise also presented chop marks (Fig.6.5.38). This evidence could be related with the removal of the keratinous scutes covering the carapax of tortoises/turtles for manufacturing.

**Figure 6.5.38**. Mazara del Vallo, Arab period. Hermann’s tortoise carapax with chop mark on one of the sides.

*Fish* – In the Arab period, an epihyal attributed to *Thunnus* sp. presented an oblique cut mark (Fig.6.5.39). A *Thunnus* sp. dentary dated to the Norman/Swabian period presented two oblique cut marks (Fig.6.5.40).

This evidence suggests that fish carcasses were processed.

**Figure 6.5.39**. Mazara del Vallo, Arab period. *Thunnus* sp. epihyal with cut marks.

**Figure 6.5.40**. Mazara del Vallo, Norman/Swabian period. *Thunnus* sp. dentary with cut marks.

### 6.5.7. Burning

In the Arab period, out of 803 recorded fragments, 41 bones (ca. 20%) showed evidence of burning; 29 remains were burnt, eight were singed, while calcination was recorded only on three bones. These remains mainly belonged to caprines, while a few were from cattle and galliforms (Fig.6.5.41).

In the Norman/Swabian period, out of 575 recorded fragments, 49 post-cranial elements and one mandible (ca. 12%) were characterised by contact with a source of heat; among these, the majority were burnt (29 remains), 15 were singed, while only five remains presented evidence of calcination. As for the previous period, these burnt remains mainly belonged to caprines (Fig.6.5.42), and a few to cattle and galliforms. In addition, a distal femur of a hare was also burnt.

**Figure 6.5.41**. Mazara del Vallo, Arab period; singed tarsometatarsus of domestic fowl.

**Figure 6.5.42**. Mazara del Vallo, Norman/Swabian period; singed metapodial of caprine.

### 6.5.8. Worked antlers

Two worked cervid antlers, attributed to the red deer or to the fallow deer, were recovered from Arab and Norman/Swabian contexts.

The first antler (Fig.6.5.43) presented clear polishing on the mean beam and on the brow tine; in addition, also the coronet looked polished.

The second fragment showed clear evidence of polishing on the mean beam, and a saw mark on the coronet surface (Fig.6.5.44).

In both cases, the antlers had been shed, suggesting that they were collected for craft purposes.

**Figure 6.5.43.** Mazara del Vallo, Arab period. Polished antler fragment of a red deer or a fallow deer.

**Figure 6.5.44.** Mazara del Vallo, Norman/Swabian period. Polished antler fragment of a red deer or a fallow deer.

### 6.5.9. Pathology

Only one fragment, a caprine maxilla dated to the Arab period, showed a pathological condition. This consists of irregular wear of the 1st maxillary permanent molar, which was in part much less worn than the other maxillary teeth (Fig.6.5.45). Such condition could have been caused by the breakage, loss and/or congenital absence of the corresponding mandibular 1st permanent molar; this could have contributed to an abnormal/reduced wear of the maxillary one. All the other maxillary teeth did not present any abnormality, and the degree of wear suggests this was an adult rather than an elderly individual. This condition is known to cause gum inflammation and serious problems in chewing (Maxie and Jubb 2016).

**(a)** Buccal side.

**(b)** Lingual side.

**Figure 6.5.45.** Mazara del Vallo, Arab period. Caprine maxilla with abnormal wear on 1st molar. a) buccal side; b) lingual side.

### 6.5.10. Size and shape

The good preservation of most anatomical elements recorded from Mazara del Vallo allowed to take a considerable amount of measurements for the main domestic animals for both periods; in this section the biometrical characteristics of caprines, cattle, suids, domestic fowls and felids have been analysed.

Biometrical analyses of suid remains were only possible for the Norman/Swabian period, as not enough remains were recorded for the earlier phase.

Only in the case of caprines and domestic fowl it was possible to investigate biometrical characters and differences using measurements from individual elements.

In the case of caprines, in order to allow a proper biometrical comparison of sheep size between Mazara del Vallo and the other analysed sites, width/depth measurements of all post-cranial bones belonging to the Arab and Norman/Swabian periods were merged and plotted into two log ratio histograms; in addition, it was also possible to make histograms in which the less sex-dependent post-cranial bones were analysed separately. In all cases, the most age-dependent measurements were excluded (*§Chapter 5: Methodology*). Moreover, as mentioned before, biometrical differences between the various groups of data from Arab and Norman/Swabian Mazara del Vallo were evaluated according to a Student's t-test (*§Chapter 5: Methodology*).

Furthermore, in order to investigate changes in cattle size at Mazara del Vallo in the Arab and in the Norman/Swabian periods, a log ratio histogram was made; as with caprines, widths and depths of post-cranial bones were plotted together. However, due to the dearth of measurements, it was not possible to analyse the less and the more sex-dependent elements separately. As for caprines, the more age-dependent measurements were excluded. The potential presence of cows, oxen and bulls have been discussed considering the distribution of values.

A log ratio histogram was made also for suid measurements, using lengths and widths from mandibular and maxillary teeth. The dearth of measurements did not allow to analyse separately widths/depths from lengths. This analysis aimed to investigate the nature, either domestic and/or wild, of the suid populations present at Mazara del Vallo during the analysed periods. To allow comparisons with other sites, such analysis will be presented and discussed in the sub-chapter on the assemblage from Colmitella (*§6.6 Colmitella (Agrigento) – 6.6.10 Size and shape).*

In addition to scatter-plots, differences in the size of domestic fowl in the two periods were further analysed through the log ratio technique; in this case only widths of post-cranial elements were included.

A final log ratio histogram was made for felid remains, in order to investigate their domestic and/or wild nature; in this case, length, widths and depths of post-cranial bones from both the Arab and the Norman/Swabian periods were merged together into a log ratio histogram, due to the dearth of available measurements.

*Caprines* – Measurements of the distal tibia from the Arab and the Norman/Swabian periods were plotted in a scatter plot to investigate changes in caprine size trough time.

As Fig.6.5.46 shows, the majority of specimens from the Arab period clusters at the bottom left of the graph, while those from the Norman/Swabian period are mostly distributed on the upper right side, though some overlap between the two periods is visible.

This result indicates that caprines from the Arab period were smaller than those of the Norman/Swabian period, though the small size of the sample invites caution in the interpretation.

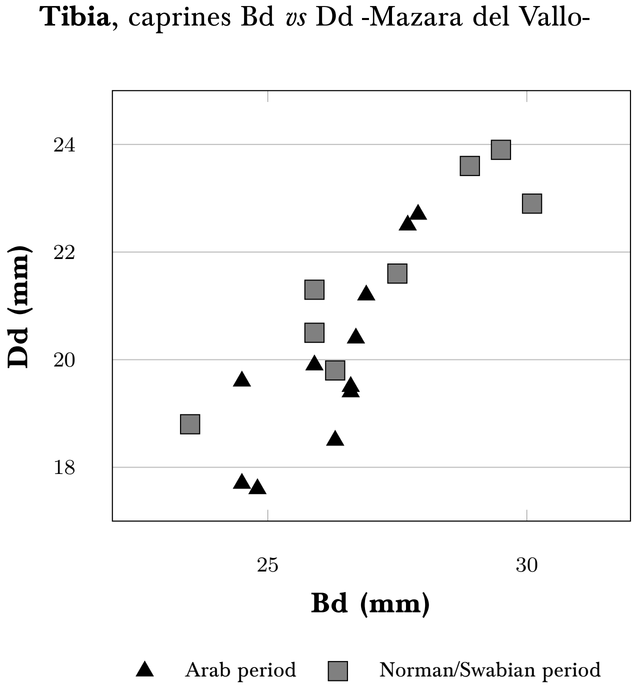


**Figure 6.5.46.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period (black triangles) and the Norman/Swabian period (grey squares) at Mazara del Vallo (*§Chapter 5: Methodology*).

A second scatter plot comparing measurements from the distal humerus was made. The humerus, contrary to the tibia, is highly sexually dimorphic and its measurements more closely reflect variations in the sex ratio of different populations.

As Fig.6.5.47 indicates, two groups of values can be noticed for each period. In the Arab period, most specimens cluster at the bottom left of the graph, with two larger outliers located at the top right; most likely, the formers refer to ewes and/or castrated individuals, and the latters to rams.

In the Norman/Swabian period, two specimens plot in the upper right part of the graph, being slightly larger than the individuals interpreted as rams in the Arab period. The main group of values plots close to the range of smaller individuals interpreted as ewes/wethers in the Arab period, though the Norman/Swabian specimens are characterised by a slightly larger size.

As a result, the composition of the two caprine populations at both periods seem to be mostly composed of females and/or castrated, with few rams present. At the same time, it is also clear that caprines from Norman/Swabian Mazara are larger in size to those present in the Arab period.

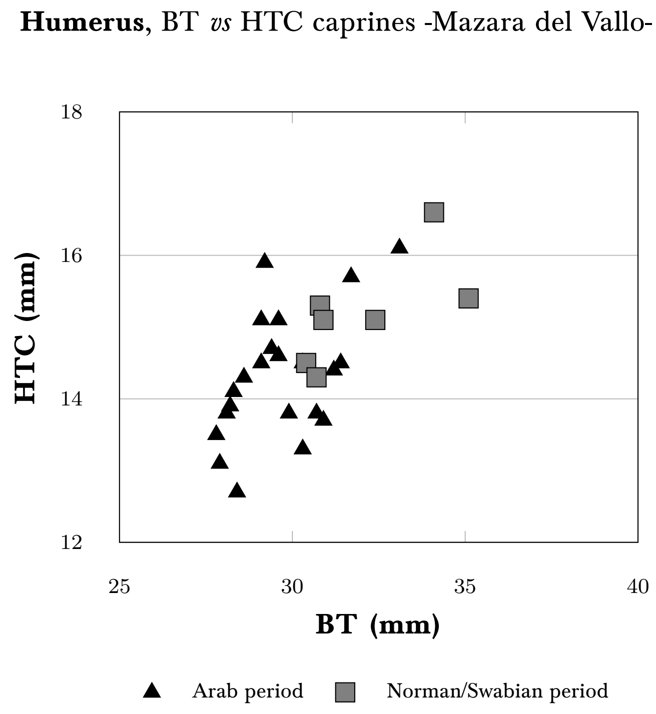


**Figure 6.5.47**. Measurements of the distal humerus (BT and HTC) of caprines from the Arab period (black triangles) and the Norman/Swabian period (grey squares) at Mazara del Vallo (*§Chapter 5: Methodology*).

Despite the small size of the sample, it was decided to analyse the length and the width of caprine astragali, as these are among the least sex-dependent bone measurements (Higham 1969; Albarella 1997).

As Fig.6.5.48 shows, all the values from Norman/Swabian Mazara cluster at the top right of the graph; by contrast, those from the earlier period are all located at the bottom left, with a specimen presenting a particularly small size.

This graph confirms the results obtained for the distal tibia and the distal humerus, further suggesting an increase in caprine size in the Norman/Swabian period at Mazara del Vallo.

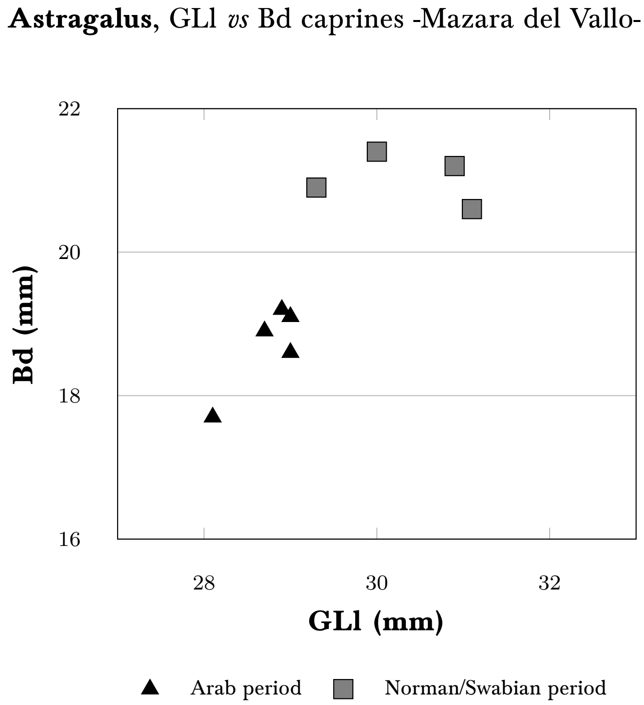


**Figure 6.5.48**. Measurements of the astragalus (GLl and Bd) of caprines from the Arab period (black triangles) and the Norman/Swabian period (grey squares) at Mazara del Vallo (*§Chapter 5: Methodology*).

In addition to size changes, potential morphological differences of caprine remains from Mazara del Vallo in the two analysed periods were also investigated.

In order to produce a shape index, independent from size, the ratio between BT (width of trochlea) and SD (smallest breadth of diaphysis) and the ratio of HTC (minimum diameter of the trochlea) to SD (smallest breadth of diaphysis) of the humerus were calculated.

In the Arab period, as Figure 6.5.49 indicates, three distinctive groups of values can be recognised, possibly referring to ewes, castrated and rams.

In the Norman/Swabian period (Fig.6.5.49), the situation is similar, apart from the lack of particularly slender animals.

All in all, these results suggest the presence in the Arab period of a rather heterogeneous population characterised by the presence of ewes, rams and wethers; these seem fairly represented also in the Norman/Swabian period, for which the smaller sample size might have made female sheep (the slenderest ones) invisible.

However, the overall small sample size, especially that of Norman/Swabian Mazara, invites caution in the interpretation of results.

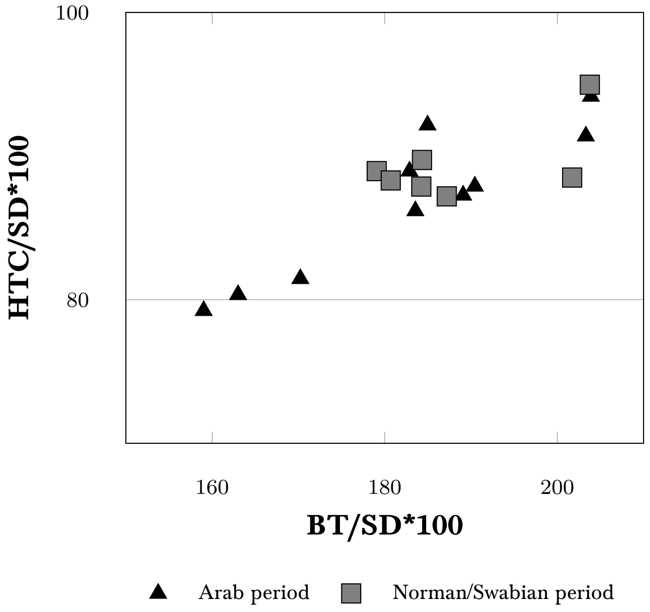

**Humerus**, BT/SD*100 *vs* HTC/SD*100 caprines -Mazara del Vallo-

**Figure 6.5.49.** Shape indices of the humerus (BT/SD*100 and HTC/SD*100) from the Arab period (black triangles) and the Norman/Swabian period (grey squares) (*§Chapter 5: Methodology*).

To investigate further caprine shape changes, it was decided to plot the Bd (maximum width of the distal end) expressed as a percentage of the GL (greatest length) versus SD (minimum width of the shaft), also expressed as a percentage of GL (greatest length), of sheep matacarpals (Fig.6.5.50).

Metacarpals are known to be highly sexually dimorphic anatomical elements hence, they can provide important information on the sex ratio of sheep populations from Arab and Norman/Swabian Mazara del Vallo. However, it is important to stress the fact that, apart from sex, the potential presence of different clusters in the shape distribution of metapodials might also be linked to the presence of different types of sheep (Albarella 1997; Albarella 2002).

Bearing in mind such considerations, two groups can clearly be distinguished within each analysed period. Overall, caprine metacarpals from Norman/Swabian Mazara del Vallo appear to be more robust than those from the Arab period.

In the earlier phase, most values cluster at the bottom left side of the graph, probably representing slenderer ewes and/or wethers; at the same time, a very well-separated and more robust specimen plots as an outlier at the top right of the graph, most likely representing a ram.

In the Norman/Swabian period, one individual presents a slenderer shape in comparison to the other specimens plotting at the upper right side of the graph; such value might represent a female sheep, while the others could be wethers and/or rams. The possibility that the more robust individuals present at the Norman/Swabian period represent rams rather than wethers seems quite unlikely, as caprine husbandry strategies focus on females and castrates, with very few males kept for breeding. Due to the small size of the sample, additional biometrical analyses are needed to investigate whether different sex ratios characterised the two analysed populations, thus affecting differences in size and shape in the Arab and in the Norman/Swabian periods. However, the size difference shown by less sexually dimorphic anatomical elements would support a genuine difference in size.

Having said this, the possibility that the presence of two different breeds of sheep respectively belonging to the Arab and to the Norman/Swabian periods might lie behind the already discussed size and shape changes of these animals cannot be completely ruled out.

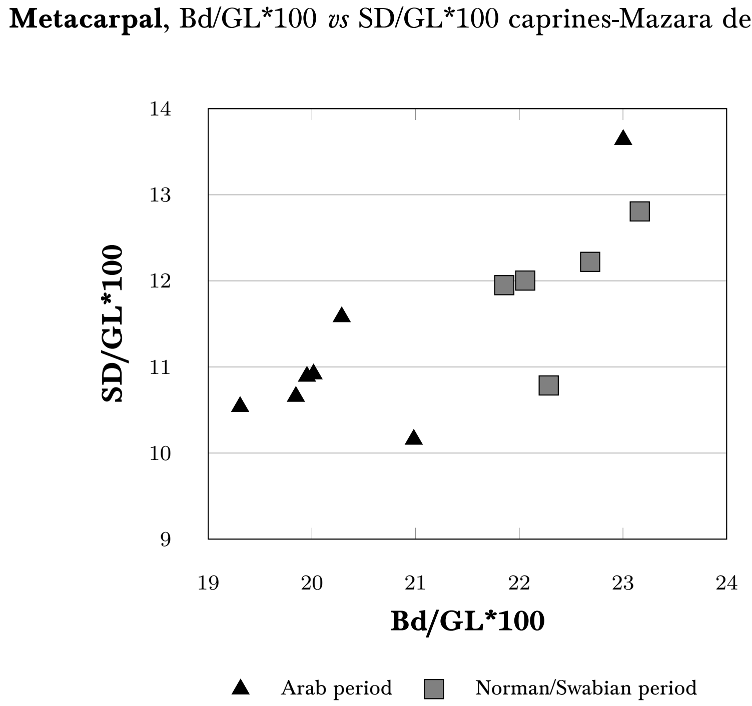


**Figure 6.5.50.** Shape indices of caprine metacarpal (Bd/GL*100 and SD/GL*100) from the Arab period (black triangles) and the Norman/Swabian period (grey squares) (*§Chapter 5: Methodology*).

Potential differences in sheep size among different site-types in Sicily (i.e. urban and rural) were investigated by comparing measurements of the distal tibia (Bd: width of distal end and Dd: depth of the distal end) from the Arab period at Mazara del Vallo, Casale San Pietro, Sant'Antonino and Corso dei Mille (Fig.6.5.51).

As Fig.6.5.51 shows, most values from the Arab period at Mazara del Vallo are distributed on the upper right part of the graph, within the same range of measurements from Sant'Antonino and Casale San Pietro, while those from Corso dei Mille mainly cluster at the bottom left, despite some overlap with values from the other sites.

All in all, it seems that sheep from Mazara del Vallo (urban site) were more similar in size to those from Sant'Antonino (urban site) and Casale San Pietro (rural site), their size being larger than animals from Corso dei Mille (urban site) in the Arab period. However, the small sample size invites caution in the interpretation of these results.

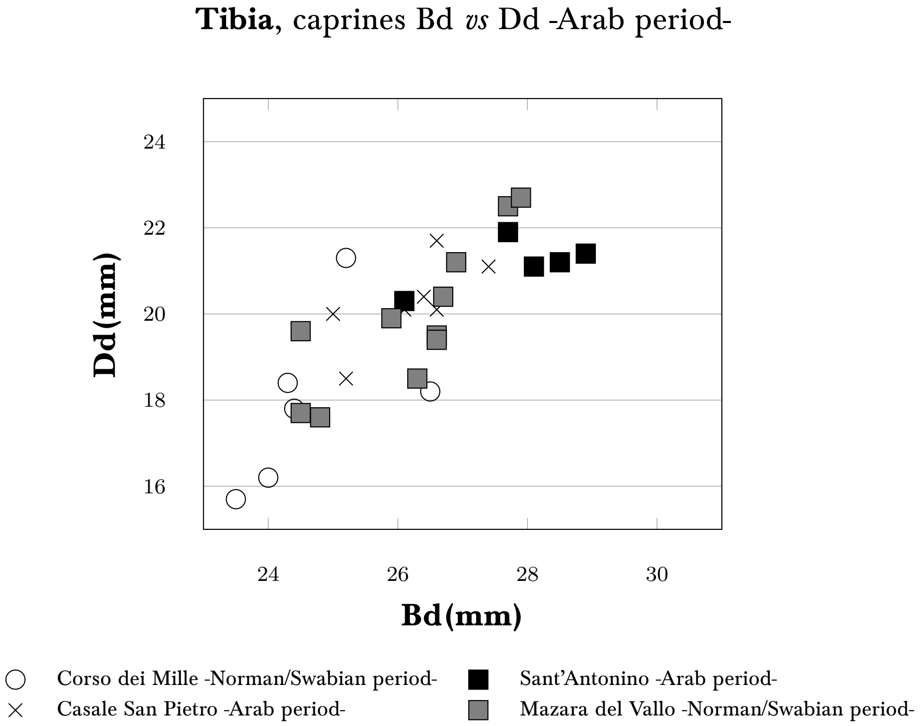


**Figure 6.5.51.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Corso dei Mille (black empty circles), Casale San Pietro (black crosses), Sant'Antonino (black squares) and Mazara del Vallo (grey squares) (*§Chapter 5: Methodology*).

Comparisons among different urban sites located in different areas of Sicily and dated to the Norman and Norman/Swabian period, such as Mazara del Vallo, the Norman Palace and Corso dei Mille, were made by analysing measurements of the distal tibia (Fig.6.5.52).

As Fig.6.5.52 shows, most of the values from the Norman/Swabian period at Mazara del Vallo are located on the upper right part of the graph, largely plotting within the same range of measurements of caprines from the Norman Palace. By contrast, values from Corso dei Mille in the Norman/Swabian period are mostly distributed at bottom left side of the graph, though with some overlap with sheep from Mazara del Vallo and the Norman Palace.

All in all, these results seem to indicate that caprines from Mazara del Vallo were generally larger than those from Corso dei Mille in the same period, their size being more similar with animals from the Norman Palace in the Norman period.

**Tibia**, caprines Bd *vs* Dd -Norman and Norman/Swabian periods-

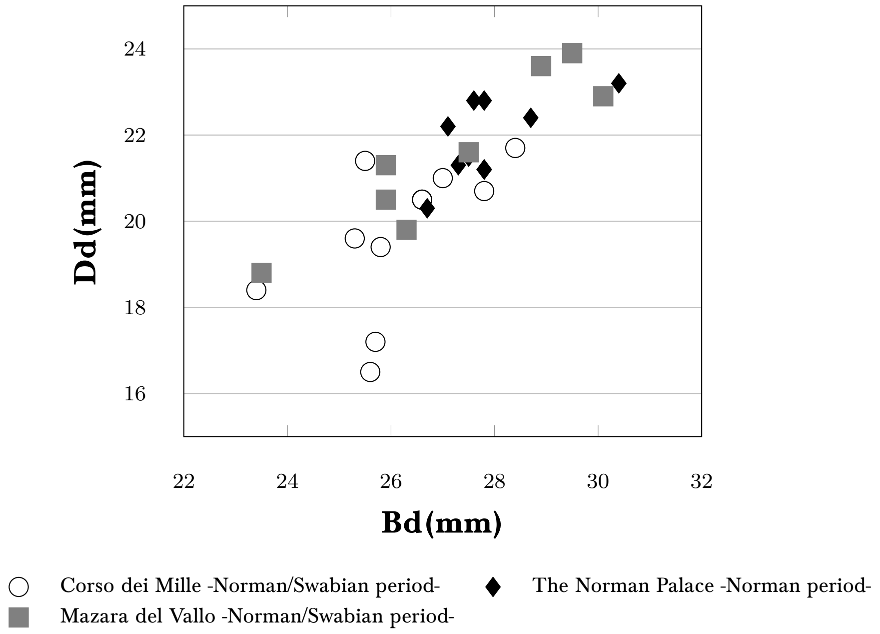


**Figure 6.5.52.** Measurements of the distal tibia (Bd and Dd) of caprines from the Norman/Swabian period at Mazara del Vallo (grey squares) and Corso dei Mille (black empty circles), and from the Norman period at the Norman Palace (black diamonds) (*§Chapter 5: Methodology*).

The size of caprines at the site of Mazara del Vallo was further investigated by merging width/depth measurements from fused post-cranial anatomical elements in a log ratio histogram (*§Chapter 5: Methodology*). Comparisons with the results obtained from other analysed sites both from the Arab and the Norman/Swabian periods were made (Fig.6.5.53).

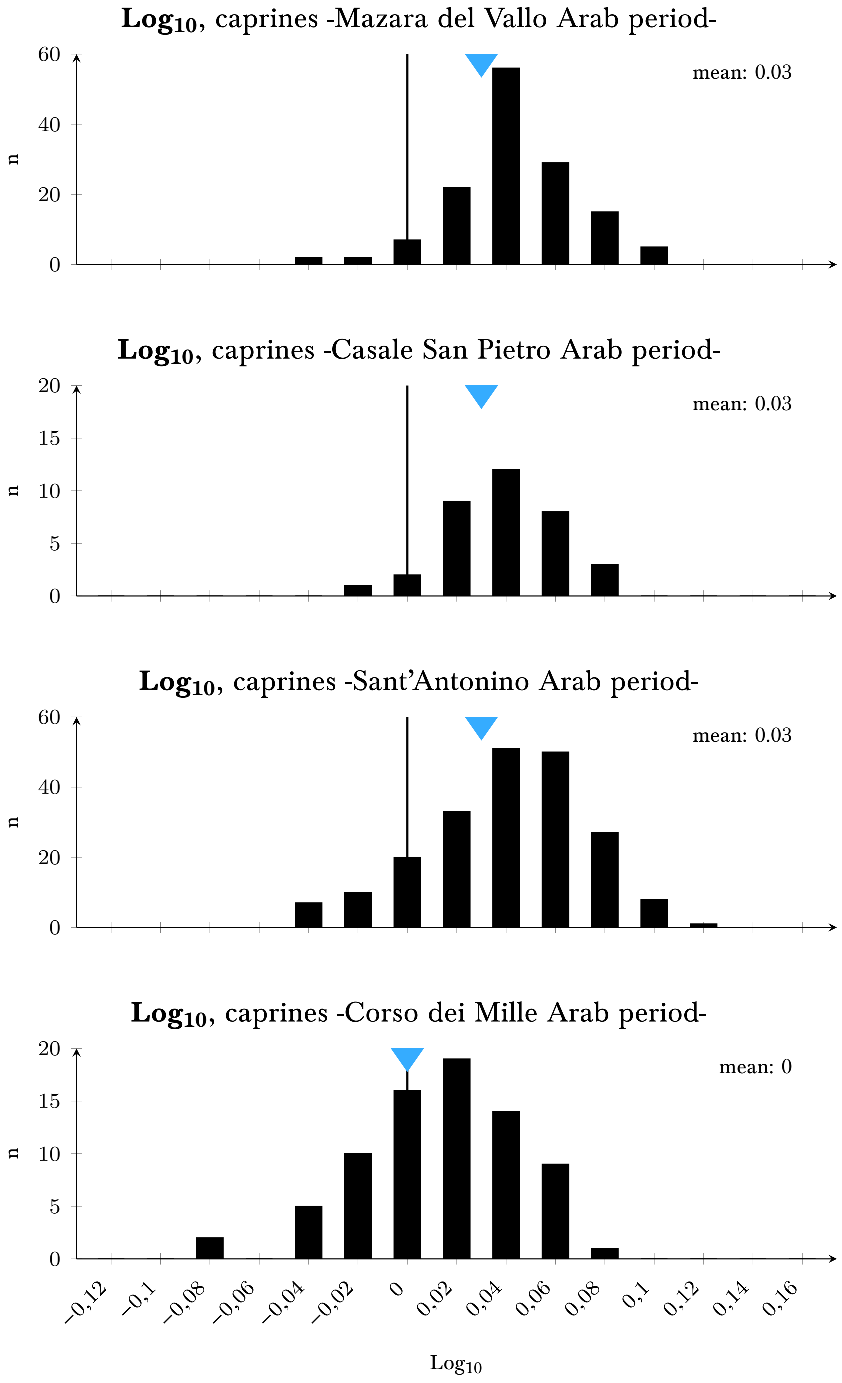
In the Arab period at Mazara del Vallo the histogram displays a unimodal distribution; the same is true for Casale San Pietro, Sant'Antonino and Corso dei Mille. Although the range of caprine measurements is more or less similar in the four analysed sites, values from Mazara del Vallo, Casale San Pietro and Sant'Antonino are on average larger in comparison to those from Corso dei Mille.

These results further validate the biometrical analysis of the distal tibia, indicating that caprines from Mazara del Vallo are more similar in size to those present at Casale San Pietro and Sant'Antonino; this similarity is also supported by the mean, which is the same at the three sites.

In the Norman/Swabian period, at Mazara del Vallo the histogram displays a unimodal distribution; the same occurs at the site of the Norman Palace in the Norman period and at Corso dei Mille in the Norman/Swabian period (Fig.6.5.54). The range of measurements is higher at Corso dei Mille, and more values are present on the left side of the graph in comparison to Mazara del Vallo and the Norman Palace, indicating the higher incidence of smaller animals. This difference in caprine size is also supported by the mean, which is higher at the Mazara del Vallo and at the Norman Palace.

For Mazara del Vallo, the slightly higher mean in comparison to the Norman Palace, as well as the higher incidence of larger animals, highlight a potential difference in the average size of caprines between these two populations.

The Student's $t$-test indicates that a statistically significant difference exists between groups of values from caprine post-cranial bones from Arab and Norman/Swabian Mazara ($p$: <0.001) (Fig.6.8.27, Tab.6.8.6 and Tab.6.8.7).



**$Log_{10}$**, caprines -Mazara del Vallo Arab period-

**$Log_{10}$**, caprines -Casale San Pietro Arab period-

**$Log_{10}$**, caprines -Sant'Antonino Arab period-

**$Log_{10}$**, caprines -Corso dei Mille Arab period-

**Figure 6.5.53.** Comparisons of caprine post-cranial measurements from Mazara del Vallo, Casale San Pietro, Sant'Antonino and Corso dei Mille in the Arab period. Log ratio histogram for width/depth measurements from Mazara del Vallo (n:140) Casale San Pietro (n:35), Sant'Antonino (Arab period n:215) and Corso dei Mille (Arab period n:76). The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (§*Chapter 5: Methodology*).

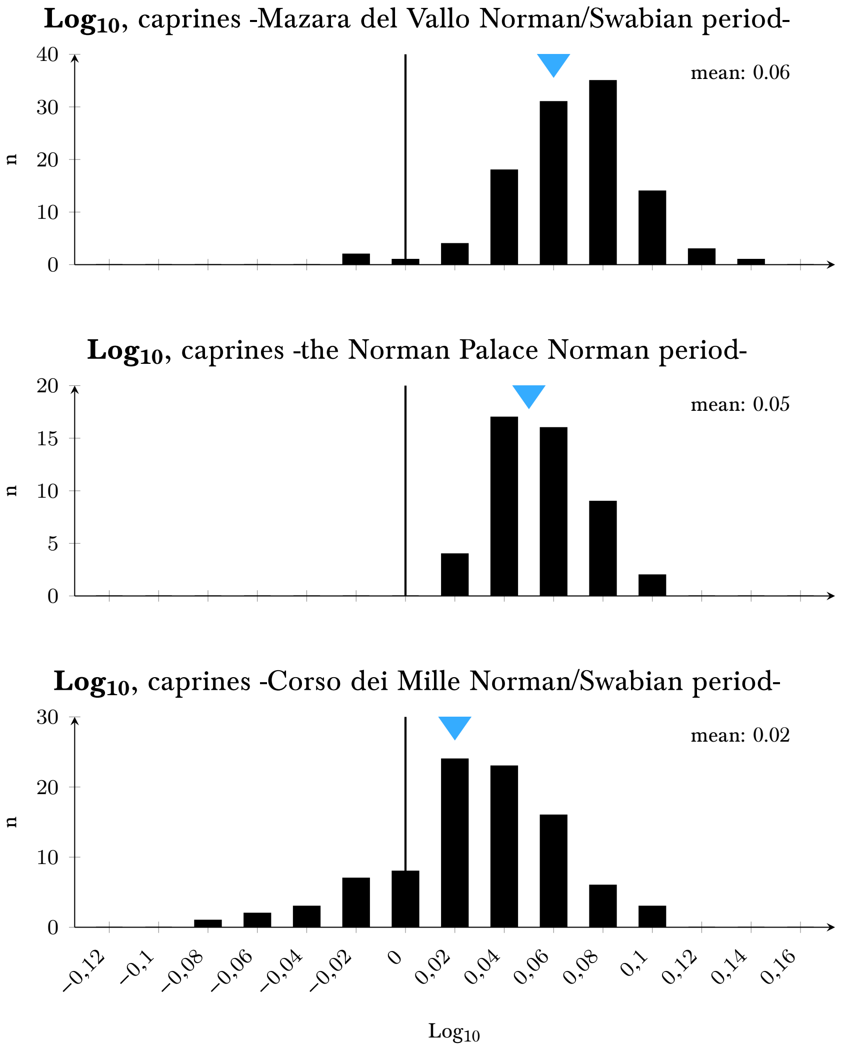


**Figure 6.5.54**. Comparison of caprine post-cranial measurements from Mazara del Vallo, the Norman Palace and Corso dei Mille in the Norman and Norman/Swabian period. Log ratio histogram for width/depth measurements from Mazara del Vallo (n:108), the Norman Palace (n:48), Corso dei Mille (n:92). The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

The morphometric results obtained from caprine highly sexually dimorphic anatomical elements, such as humerus and metacarpal, showed partly contrasting results; indeed, if on the one hand results from the humerus revealed the presence of rather homogenous caprine populations in terms of sex ratio in the Arab and the Norman/Swabian periods, on the other hand values from caprine metapodials revealed the presence of different clusters, which might correspond to different proportion of females, castrated and males; at the same time, the results may be partly biased by the small sample size.

The good amount of recorded measurements from caprine elements allowed to make additional log ratio histograms in which widths and depths from only the less sex-depended bones could be analysed (Fig.6.5.55). This has been done in order to further investigate whether a different proportion of caprine females, males and castrated could lie behind the increase in sheep size attested for the Norman/Swabian period at Mazara del Vallo.

As Fig.6.5.55 indicates, the range of values is similar in both periods. However, a higher incidence of larger measurement characterises Norman/Swabian Mazara in comparison to the Arab period, thus suggesting an increase in sheep size. This result is further validated by the mean, which is higher in the Norman/Swabian period.

All in all, it is possible to affirm that a genuine increase in sheep size occurred from the Arab to the Norman/Swabian periods at Mazara, and that differences in the proportion of ewes, wethers and rams are unlikely to lie behind such differences in size.

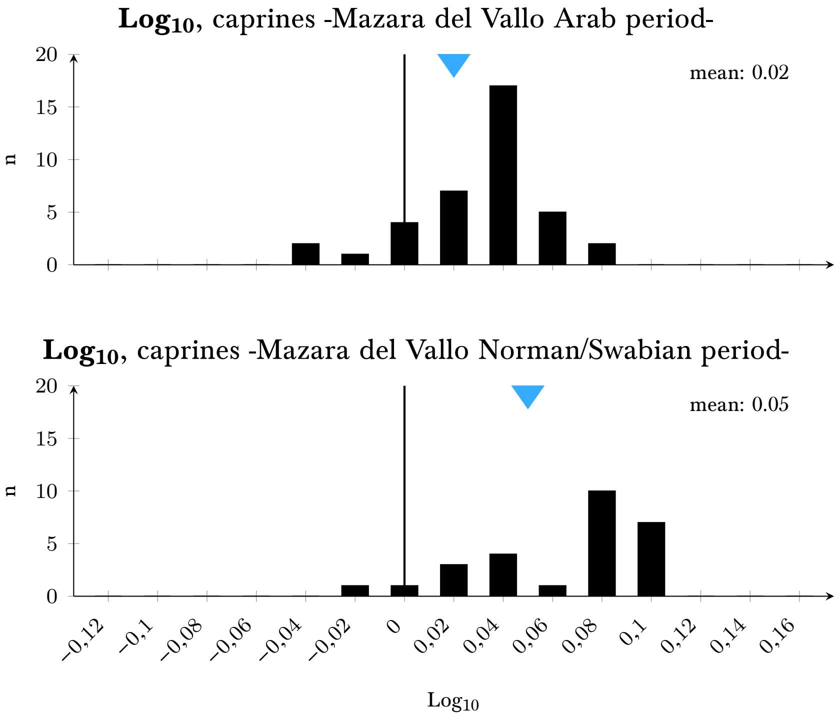


**Figure 6.5.55.** Mazara del Vallo, comparison between the Arab and the Norman/Swabian periods. Log ratio histogram for width/depth measurements of the less sex-dependent elements of caprines from the Arab period (n:38) and the Norman/Swabian period (n:30). The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

*Cattle* – As mentioned above, width and depth measurements of cattle post-cranial bones from the Arab and the Norman/Swabian periods at Mazara del Vallo were merged together and plotted into two log ratio histograms (Fig.6.5.56).

In the Arab period, the histogram displays a bimodal distribution, with a group of larger animals (probably oxen and a few breeding bulls) distributed at the very right end of the graph, and a larger concentration of smaller individuals (probably cows and oxen), located closer to the standard.

By contrast, in the Norman/Swabian period the histogram shows a unimodal distribution, as well as a narrower range of values in comparison to the earlier period.

The overall distribution relatively to the standard and to the logarithmic mean suggests that cattle from the Arab period were larger in size than individuals from the Norman/Swabian period at Mazara del Vallo; alternatively, the group of larger males/oxen might be missing from the Norman/Swabian assemblage. However, the lower number of available values and the lack of a bimodal distribution for the Norman/Swabian period prevent to draw definite conclusions on a decrease in cattle size in this later phase.

The Student *t*-test indicates that no statistically significant difference exists between groups of values from cattle post-cranial bones from Arab and Norman/Swabian Mazara (*p*: 0.1080); however, the tiny sample size, especially that from Norman/Swabian Mazara, might have affected such result.

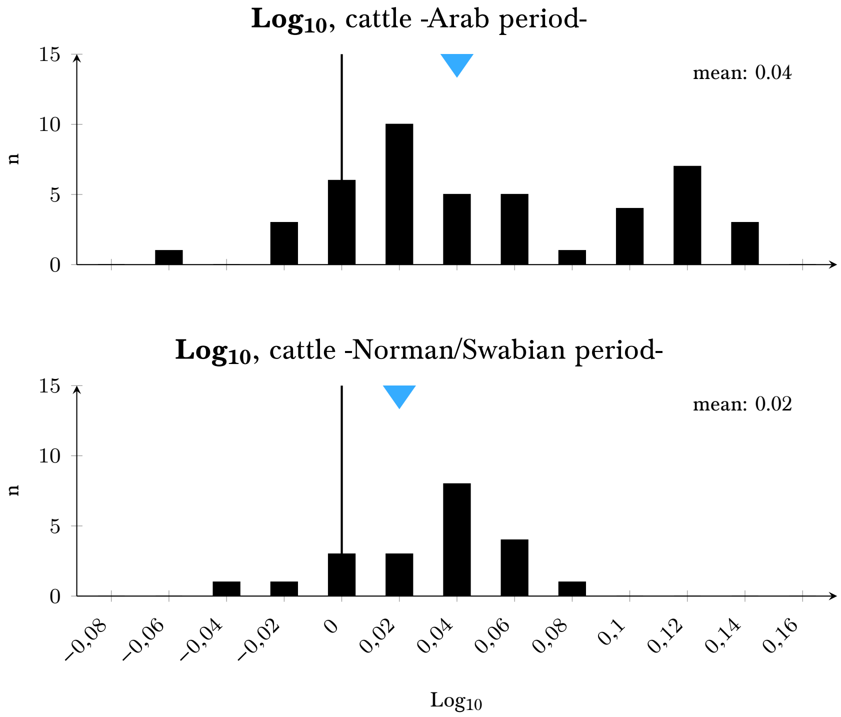


**Figure 6.5.56.** Mazara del Vallo, comparison between the Arab and the Norman/Swabian period. Log ratio histogram for width/depth measurements of cattle from the Arab period (n:44) and from the Norman/Swabian period (n:27). The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements of cattle bones from the late Iron Age at the site of Heybridge, Essex (UK) (Albarella *et al.* 2008) (§*Chapter 5: Methodology*).

*Domestic fowl* – Measurements of the tibiotarsus from the Arab and Norman/Swabian periods at Mazara del Vallo were plotted to investigate changes in domestic fowl size trough time (Fig.6.5.57).

In the Arab period, two groups of values can be noticed; the first one is composed by smaller individuals plotting at the bottom left of the graph (possibly female domestic fowls), while the second one includes three larger specimens locating at the upper right side (possibly cockerels and/or capons).

Most values from the Norman/Swabian period plot within the range of smaller individuals from the Arab period, whit only one larger individual located at the upper right side of the graph.

All in all, it seems that the domestic fowl included both smaller and larger individuals in the Arab period; these latters are by far less represented in the Norman/Swabian period, for which a clear majority of smaller-sized individuals is visible.

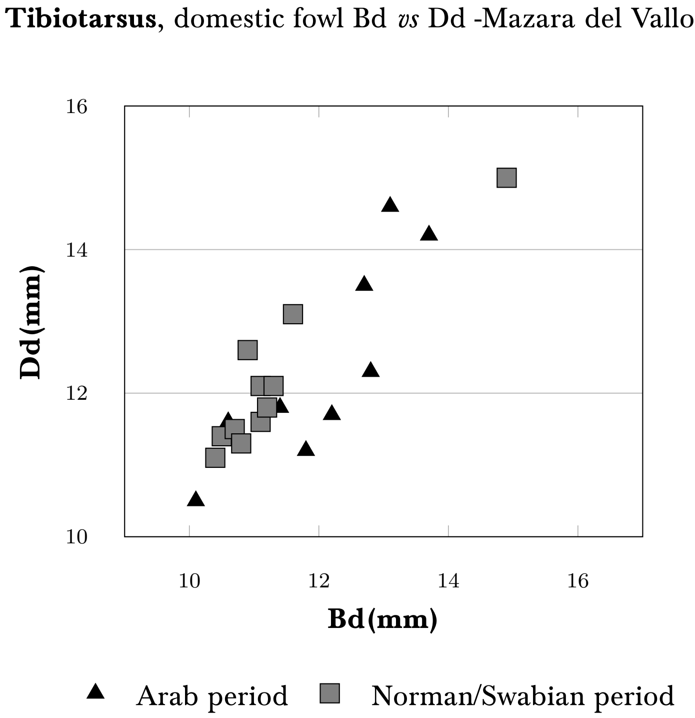


**Figure 6.5.57**. Measurements from the distal tibia (Bd and Dd) of domestic fowl from the Arab period (black triangles) and the Norman/Swabian period (grey squares) at Mazara del Vallo (*§Chapter 5: Methodology*).

A second scatter plot comparing measurements of the femur from the Arab and the Norman/Swabian periods at Mazara del Vallo was made to further investigate changes in domestic fowl size trough time (Fig.6.5.58).

As Fig.6.5.58 indicates, in the Arab period two larger specimens (possibly cockerels/capons) plot at the top right of the graph, and four smaller sized individuals (possibly hens) cluster at the bottom left of the graph. Measurements from the Norman/Swabian period are located within the same range of smaller individuals from the Arab period, and might belong to female domestic fowl.

As a result, it seems that measurements from the femur confirm the biometrical analysis of the tibiotarsus, for which differences in domestic fowl size between the two periods were better visible.

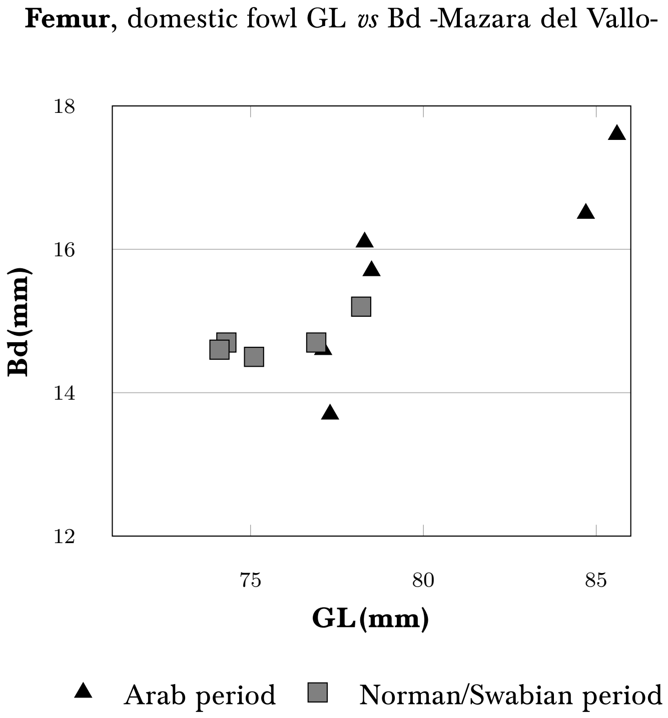


**Figure 6.5.58.** Measurements from the femur (GL and Bd) of domestic fowl from the Arab period (black triangles) and the Norman/Swabian period (grey squares) at Mazara del Vallo (*§Chapter 5: Methodology*).

A third scatter plot comparing measurements from the domestic fowl tarsometatarsus from the Arab and the Norman/Swabian periods at Mazara del Vallo was made to investigate the ratio of females and males and/or castrated, as well as changes in domestic fowl size trough time (Fig.6.5.59).

As Fig.6.5.59 indicates, despite the small sample size, the two groups of values display some differences. In Arab Mazara, three spurred tarsometatarsi plot at the top right of the graph, living little doubt about their attribution to cockerels and/or capons. The two smaller values are more likely to belong to to hens.

In the Norman/Swabian period, the only spurred tarsometatarsus plots quite far from the majority of smaller specimens, which are distributed on the left side of the graph.

The biometrical analysis from tarsometatarsi confirm the results obtained from the other elements, despite the small size of the sample.

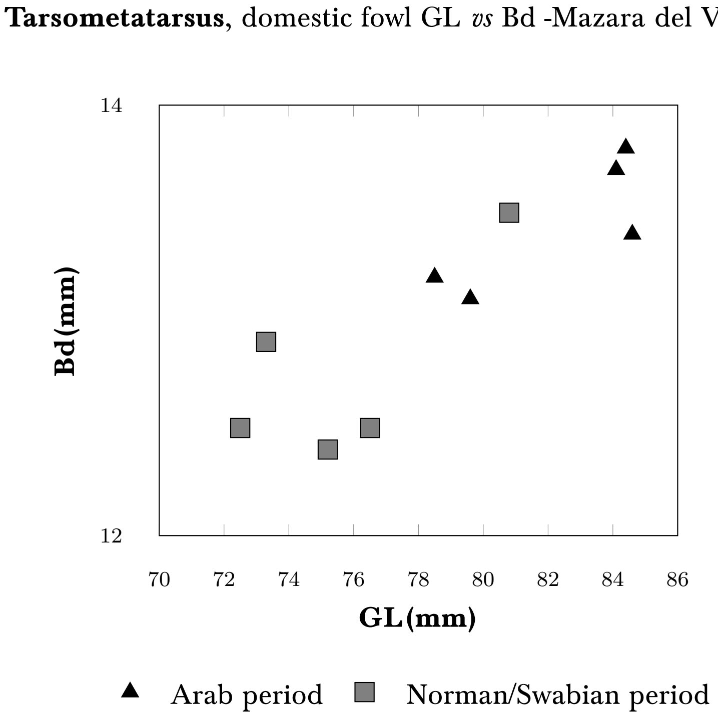


**Figure 6.5.59.** Measurements from the tarsometatarsus (GL and Bd) of domestic fowl from the Arab period (black triangles) and the Norman/Swabian period (grey squares) at Mazara del Vallo (*§Chapter 5: Methodology*).

The size of domestic fowl at the site of Mazara del Vallo was further analysed by merging width/depth measurements from mature post-cranial anatomical elements in two log ratio histograms (*§Chapter 5: Methodology*) (Fig.6.5.60).

In the Arab period, the histogram displays a bimodal distribution, with a larger group of medium-sized animals on the centre of the graph, and a concentration of smaller specimens located to its left; four particularly large outliers plot closer to the standard.

By contrast, in the Norman/Swabian period, the histogram shows a more unimodal distribution, with values more homogeneously distributed within a slightly narrower range in comparison to the earlier period; most specimens are in the same range of smaller and medium-sized values from the Arab period, and no outliers are visible. The smaller specimens could represent hens, while larger ones could include cockerels and/or capons.

The overall distribution relatively to the standard and to the logarithmic mean suggests that domestic fowl from the Arab period were larger in size than individuals from the Norman/Swabian period at Mazara del Vallo. However, this result seems mainly caused by the presence of very large individuals in the Arab period.

As a result, one cannot exclude the possibility of the presence of different breeds in the Arab period; if this would be the case, the ‘larger-sized breed’ of domestic fowl seems to have disappeared by Norman/Swabian times.

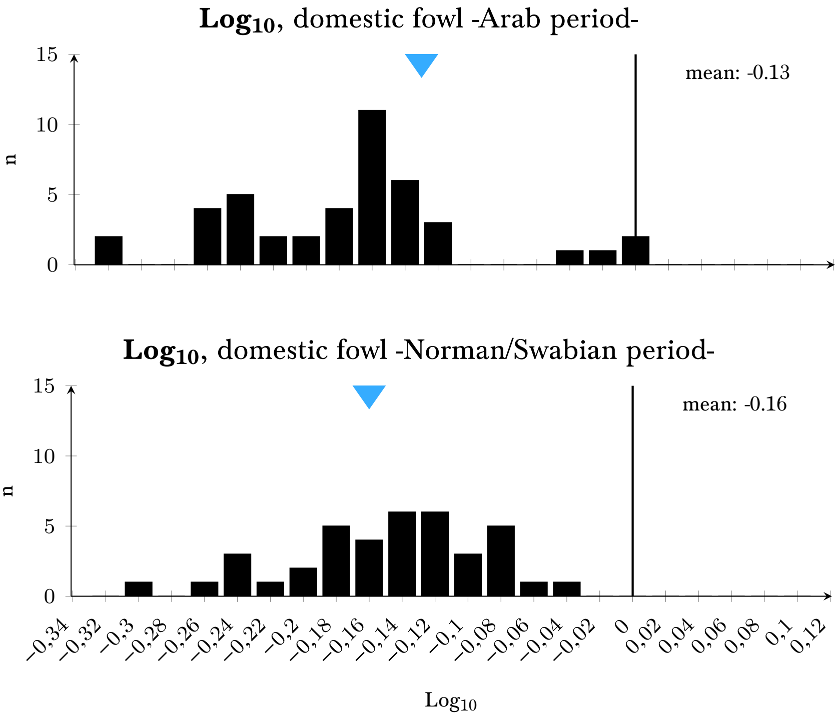


**Figure 6.5.60.** Mazara del Vallo, comparisons between the Arab and the Norman/Swabian periods. Log ratio histograms for width/depth measurements of domestic fowl from the Arab period (n:23) and from the Norman/Swabian period (n:31). The triangles indicate the logarithmic means. The standard used (black line) was the measurements of bones from a modern hen from Tursi (Matera, Basilicata, Italy) (Corbino *et al.* forthcoming) (*§Chapter 5: Methodology*).

*Felids* – In order to investigate the domestic and/or wild origin of the felid populations present at Mazara del Vallo in the Arab and in the Norman/Swabian periods, all post-cranial measurements (lengths, widths and depths) were analysed together in a log ratio histogram (Fig.6.5.61). The small number of fully fused bones recorded at both periods prevented to analyse the Arab and the Norman/Swabian periods separately.

Figure 6.5.61 shows that most values are in the same range of measurements of the standard, with a few skewed towards the left side of the histogram (Brno, Czech Republic) (Kratochvil and Kratochvil 1976); this result suggests that the populations of felids from Mazara del Vallo in both periods were most likely composed by domestic cats.

Given the rather negligible sexual dimorphism in the post-cranial elements of domestic cat (Kratochvil, 1976), the incidence of larger and smaller values at Mazara del Vallo might suggest the presence of difference domestic cat breeds. However, caution is needed due to the small sample size.

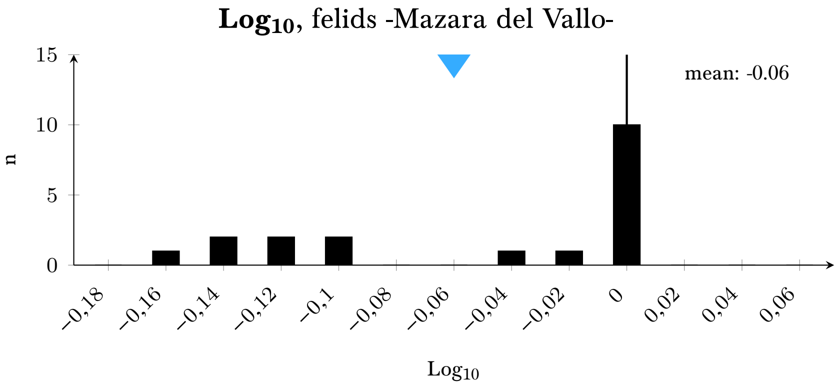


**Figure 6.5.61.** Mazara del Vallo, Arab and Norman/Swabian periods. Log ratio histogram for all post-cranial measurements of felids (n:21). The triangle indicates the logarithmic mean. The standard used (black line) was the mean of measurements of domestic cat post-cranial bones from Brno (Czech Republic) (Kratochvil and Kratochvil 1976) (§*Chapter 5: Methodology*).

## 6.6. Colmitella (Agrigento)

The faunal assemblage from Colmitella (Agrigento) includes 1517 recorded specimens, of which 1171 were also countable; 871 date to the late 7th/8th- early 9th centuries AD, and 300 to the mid-late 9th-11th centuries AD. The earlier phase will be referred to as the 'Byzantine period', and the later one as the 'Arab period' (Tab.6.6.1).

In addition, six Associated Bone Groups (ABGs) (Morris 2011) were recorded from contexts dated to the Byzantine period. Since these represent archaeological contexts with different meaning and function, it was decided to discuss them separately (*§6.6.11 Associated animal bone groups*).

| **Chronology** | **Period** | **Countable** | **Non-countable** | **Total** |
|---|---|---|---|---|
| 7th/8th- early 9th c. AD | Byzantine | 871 | 154 | 1025 |
| 10th-11th c. AD | Arab | 300 | 192 | 492 |
| **Total** | | **1171** | **346** | **1517** |

**Table 6.6.1.** Colmitella. Number of recorded countable and non-countable specimens by period.

### 6.6.1. Taphonomic alteration

#### *6.6.1.1. Surface preservation*

The degree of surface preservation in the Byzantine and in the Arab periods was generally good, with a considerable number of animal bones and teeth showing an excellent level of preservation in the earlier phase (ca. 25%) (Fig.6.6.1 and Fig.6.6.2).

A smaller proportion of remains presented a medium-bad level of surface preservation; taphonomic alterations included weathering and breakages caused by post-depositional disturbances (e.g. rooting etc.). In addition, a number of bones presented reddish concretions on their surface; these are probably associated with the deposition of minerals on the bone surface.

Generally, such modifications did not severely hamper anatomical and taxonomic identification, as well as the possibility to take measurements on the bones.

All in all, it seems that the faunal assemblages from the two periods at the site were not heavily affected by post-depositional processes.

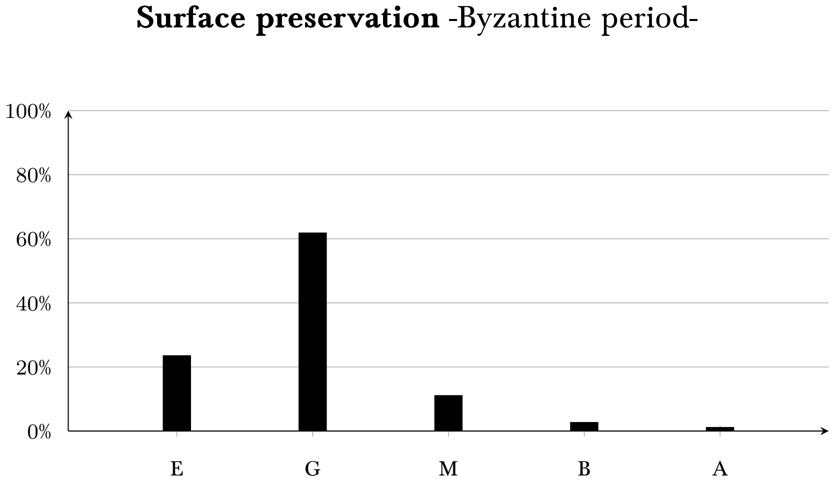


**Figure 6.6.1.** Colmitella, Byzantine period. Surface preservation of anatomical elements (n:871). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

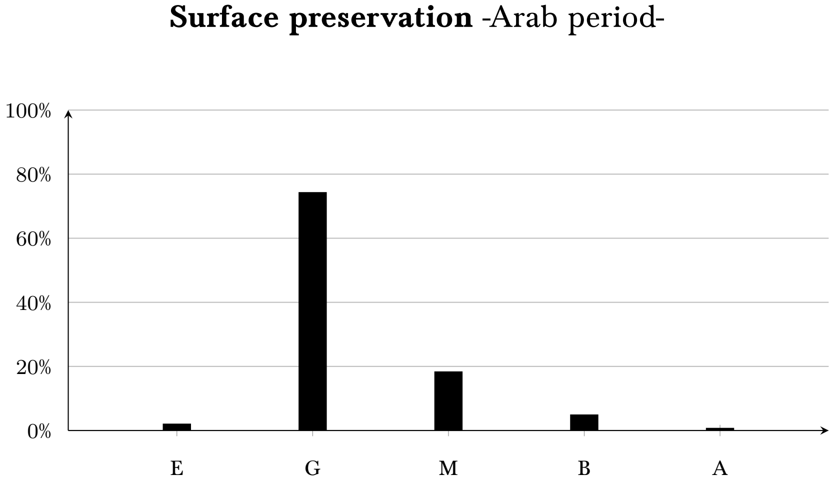


**Figure 6.6.2.** Colmitella, Arab period. Surface preservation of anatomical elements (n:300). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

#### *6.6.1.2. Gnawing*

Gnawing marks were rare at Colmitella. Only 15 bones from the Byzantine period and five from the Arab period showed evidence of gnawing marks on their surfaces; these were exclusively produced by carnivores (most likely dogs and cats). This hypothesis is further validated by the recovery of a number of felid and canid remains from both periods, suggesting these species were the main responsible agents for the gnawing marks detected on the bones (*§6.6.2 Species frequency: NISP and MNI*).

The majority of gnawed bones belonged to suids, most of them presenting their proximal and/or distal diaphyses unfused; a few gnawing marks were also recorded on caprine and cattle bone remains.

### *6.6.1.3. Recovery bias*

The faunal assemblage from Colmitella was hand-collected during a rescue excavation; a recovery bias must therefore be expected (*§Chapter 4: Sites and material*).

Analyses to assess the presence of recovery bias were carried out for the two analysed periods; the proportion of distal metapodials and 1st phalanges for cattle, caprines and suids was calculated. Suids were only included for the Byzantine period, as not enough metapodials and 1st phalanges were present in the Arab phase.

In the Byzantine period, the 1st phalanges of caprines and suids are largely outnumbered by metapodials, while in the case of cattle the percentages of the two anatomical elements are slightly closer to the natural 1:2 proportion (Fig.6.6.3).

Similar results have been obtained for the Arab period; in this phase too, caprine metapodials and 1st phalanges are not proportionally represented, while cattle phalanges are slightly more numerous than metapodials; however, for cattle too there is an under-representation of phalanges, which should be twice as common as metapodials (Fig.6.6.4).

In both periods, the higher frequency of cattle phalanges in proportion to distal metapodials, compared to those recorded for caprines and, for the Byzantine period, suids, is likely to represent a recovery bias. Such disparity in the collection of the faunal material may be the reason lying behind the overall low incidence of small-sized mammals and birds recorded, and could have resulted in an underrepresentation of the smaller domestic mammals (*§6.6.2 Species frequency: NISP and MNI*).

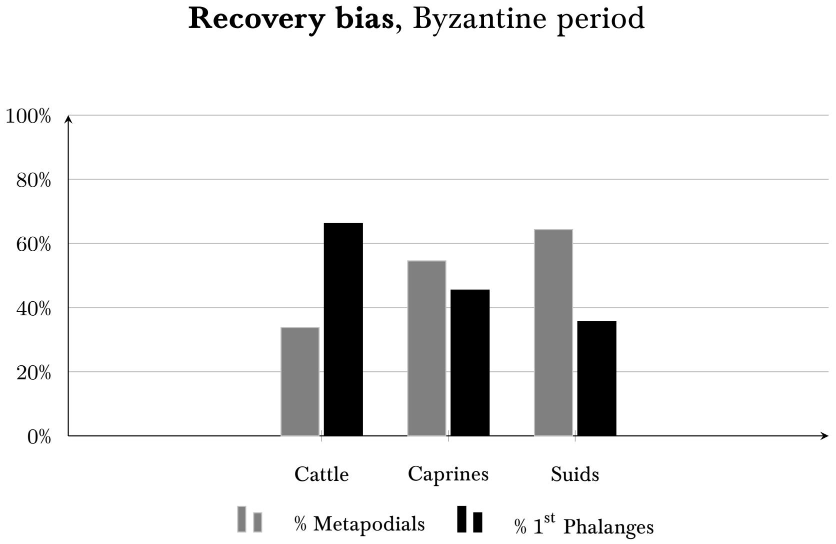


**Figure 6.6.3**. Colmitella, Byzantine period. Proportions of metapodials and 1$^{st}$ phalanges for cattle (n:25;49), caprines (24;20) and suids (n:36;20).

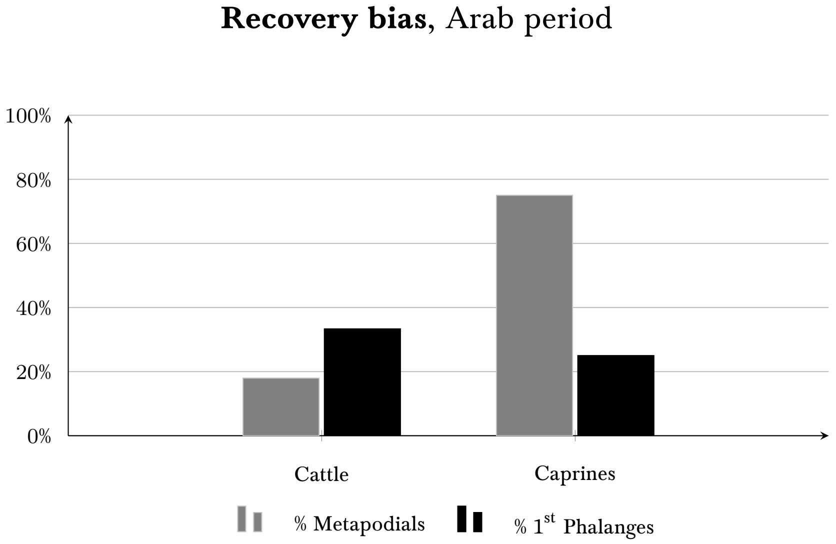


**Figure 6.6.4**. Colmitella, Arab period. Proportions of metapodials and 1$^{st}$ phalanges for cattle (n:7;13) and caprines (6;2).

### 6.6.2. Species frequency: NISP and MNI

| **Colmitella** | | |
|---|---|---|
| Taxa | Byzantine period | Arab period |
| Cattle (*Bos taurus*) | 176 | 95 |
| Caprines (*Ovis aries/Capra hircus*) | 265 | 97 |
| Suids (*Sus* sp.) | 256 | 47 |
| Equids (*Equidae*) | 18 | 7 |
| Cervids (*Cervidae*) | 23 | 6 |
| Red deer (*Cervus elaphus*) | (9) | (3) |
| Fallow deer (*Dama dama*) | (3) | (2) |
| Felids (*Felidae*) | 21 | 1 |
| Canids (*Canidae*) | 79 | 25 |
| Lagomorphs (*Lagomorpha*) | 5 | 1 |
| Hare (*Lepus* sp.) | (4) | (1) |
| Hedgehog (*Erinaceus europaeus*) | 2 | - |
| Galliformes (*Gallus/Numidia/Phasianus*) | 26 | 14 |
| Domestic fowl (*Gallus gallus*) | (11) | (5) |
| Anatids | - | 6 |
| Testudines | - | 1 |
| **Total** | **871** | **300** |

**Table 6.6.2.** Colmitella, Byzantine and Arab periods. List of all the taxa recorded. Non-countable elements are not included. In case a taxon is only present with non-countable fragment(s), this is indicated with a + (§*Chapter 5: Methodology*).

| **Colmitella** | **Byzantine period** | | **Arab period** | |
|---|---|---|---|---|
| | **Countable** | **Non-countable** | **Countable** | **Non-countable** |
| Sheep | 149 | 35 | 69 | 9 |
| Goat | 23 | 2 | 1 | 5 |
| Sheep/goat | 93 | 30 | 27 | 47 |
| **Total** | **265** | **77** | **97** | **61** |

**Table 6.6.3.** Colmitella, Byzantine and Arab periods. Recorded countable and non-countable elements identified as sheep (*Ovis aries*), goat (*Capra hircus*) and sheep/goat (*Ovis*/*Capra*).

The faunal assemblages from the Byzantine and the Arab periods are dominated by the three main domestic taxa, which respectively account for almost the 70% and the 80% of countable fragments (Tab.6.6.2).

On the basis of NISP, sheep/goat (*Ovis aries* and *Capra hircus*) are the most numerous of the main domestic species in both periods (Tab.6.6.2, Fig.6.6.5 and Fig.6.6.6). Most caprine remains were identified as sheep or were generally recorded as sheep/goat. In the Byzantine period caprine non-countable elements are mostly represented by horncores; such remains were usually characterised by the presence of cut and chop marks at their base (*§6.6.6 Butchery*). Only a few remains were directly attributed to the goat (Tab.6.6.3); these seem to be much better represented in the Byzantine period rather than in the Arab period, for which only six remains were recorded (including countable and non-countable elements). In order to refine the taxonomic proportions of caprine remains, attempts to metrically separate sheep from goat astragali and metacarpals were made (see subchapter Sheep/goat below).

In the Byzantine period, suids (*Sus domesticus* and/or *Sus scrofa*) are the second most represented species, their frequency being lower in the Arab phase (Fig.6.6.5 and Fig.6.6.6).

Cattle (*Bos taurus*) is well represented in the Byzantine period, and its frequency clearly increased in the Arab period, when it reaches a similar incidence to that of caprines (Fig.6.6.5 and Fig.6.6.6).

Equids were present in both periods at Colmitella, although their frequency is much higher in the Byzantine period (Tab.6.6.2). On the basis of morphology and size it is likely that most of the recorded specimens belong to horse (*Equus caballus*); however, the potential presence of donkey (*Equus asinus*) and/or equid hybrids (i.e. mules, hinnies) cannot be excluded.

Other potential domesticates recorded at Colmitella are dogs (*Canis familiaris*) and cats (*Felis catus*). The formers are well represented in both periods; most of fused canid remains were quite robust, which would potentially exclude the fox (*Vulpes vulpes*) as a possible identification, but not the wolf (*Canis lupus*).

Felid remains (recorded as 'Felids' due to morphological similarities between the domestic cat – *Felis catus*, and the European wild cat – *Felis silvestris*) were by far better represented in the Byzantine period in comparison to the Arab period, for which only one mandible was recorded (Tab.6.6.2).

Cervids are well represented in the Byzantine period, while their incidence strongly decreases in the following phase. In both periods, the majority of cervid remains were attributed to the red deer (*Cervus elaphus*), while fewer were assigned to the fallow deer (*Dama dama*). In addition, 11 remains from the Byzantine period, and one from the Arab period had to be more generally recorded as 'Cervids', as not clear enough morphological criteria were detected. 18 antler fragments (i.e. non-countable elements) were also recorded from contexts dated to the Byzantine period; among these, one presented polishing marks on its surface (*§6.6.8 Worked antlers and bones*).

A few lagomorphs were present; in the Byzantine period these are represented by one mandible, two distal humeri and one distal tibia attributed to the hare (*Lepus* sp.), and to one proximal ulna and one proximal tibia (i.e. non-countable element) which could only be recorded as 'Lagomorphs'. For the Arab period, only a distal humerus of a hare was present (Tab.6.6.2).

Small-sized mammals were represented by two remains (i.e. one scapula and one pelvis) attributed to the hedgehog (*Erinaceus europaeus*).

Bird remains are uncommon in both periods. They almost exclusively belong to the *Gallus/Numidia/Phasianus* group of closely related galliforms; among these, some anatomical elements could be directly attributed to the domestic fowl (*Gallus gallus*) (Tab.6.6.2) (*§Chapter 5: Methodology*).

Anatids were exclusively recorded for the Arab period, and they are represented by six countable remains.

Other animal species present at Colmitella include a turtle/tortoise (plastron fragment) recorded from an Arab context; this did not present any diagnostic features, thus hindering a distinction between terrestrial and freshwater species (Tab.6.6.2).

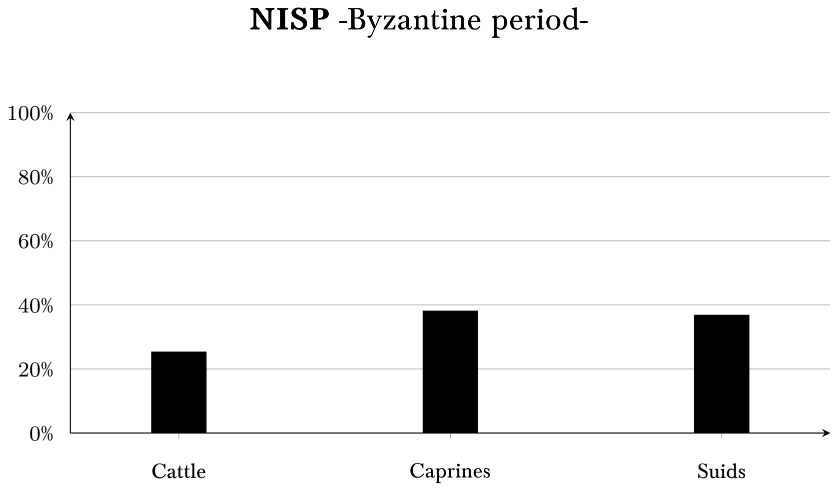


**Figure 6.6.5.** Colmitella, Byzantine period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates (n:697).

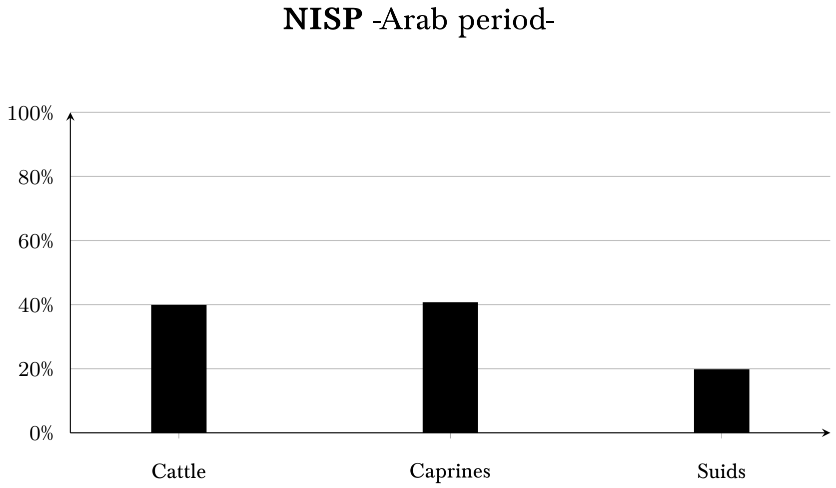


**Figure 6.6.6.** Colmitella, Arab period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates (n:239).

The MNI of the three main domestic taxa for the Byzantine period shows a similar trend to that of the NISP, and no substantial changes are visible between the results of the two quantitative methods (Fig.6.6.7).

In the Arab period, the MNI shows a slightly better representation of caprines and suids in comparison to the NISP (Fig.6.6.8). As this method is less affected by recovery bias, smaller taxa (such as suids and caprines in this case) tend to be better represented.

All in all, the similar patterns shown by the NISP and the MNI at both periods provide us with a high level of confidence about the reliability of the zooarchaeological data.

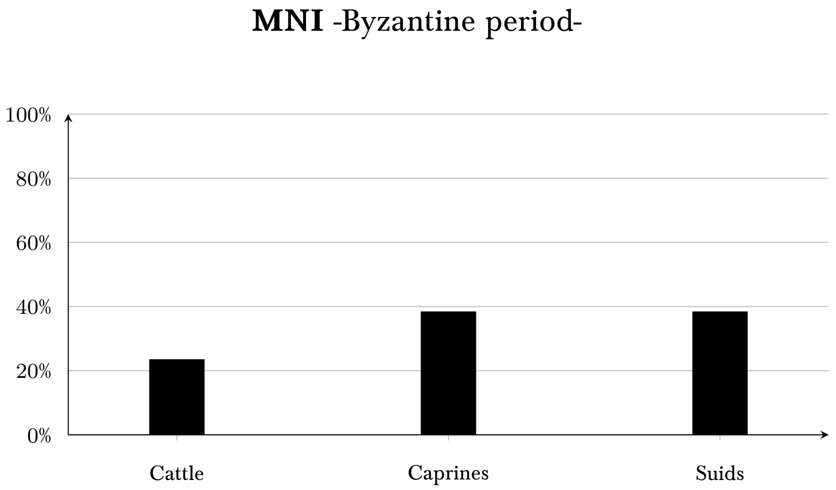


**Figure 6.6.7.** Colmitella , Byzantine period. Percentage of the Minimum Number of Individuals (MNI) for the three main domesticates (n:47).

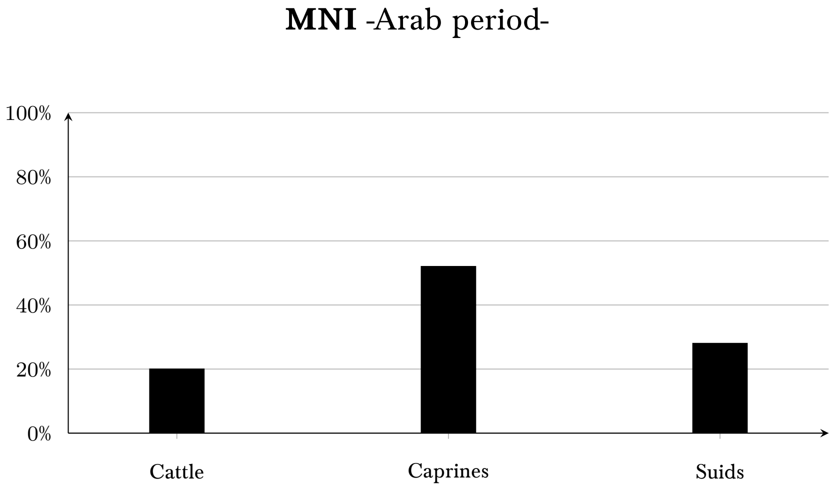


**Figure 6.6.8.** Colmitella, Arab period. Percentage of the Minimum Number of Individuals (MNI) for the three main domesticates (n:27).

*Sheep/goat separation* – In addition to the detection of distinctive morphological features on a defined set of caprine bones, the sheep/goat ratio at the site of Colmitella was also investigated trough biometrical analyses. The ratio between the breadth of the distal end (Bd) and the greatest depth of the lateral half (Dl), and the one between the depth of the lateral half (Dl) and the greatest length of the lateral half (GLl) of caprine astragali were calculated and plotted. The obtained values were then compared with those of astragali deriving from modern caprines as discussed in Salvagno and Albarella (2017).

Morphologically, out of 15 recorded astragali (11 from the Byzantine period; four from the Arab period), 10 were directly attributed to sheep, while three to goat (all Byzantine).

As Fig.6.6.9 shows, most specimens fall within the range of modern values of sheep (red oval), while only three individuals fully plot in that of goat (blue oval). Four measurements, previously attributed to sheep, plot in between the modern values of sheep and goat.

All in all, it seems that biometrical analyses further confirm the results previously obtained through the observation of morphological criteria, for which sheep were much better represented than goat at both periods. The presence of (a few) goats in the Byzantine period has also been confirmed by biometrical analyses, which undoubtedly play an important role in the assessment and refinement of the taxonomic attribution of caprine remains.

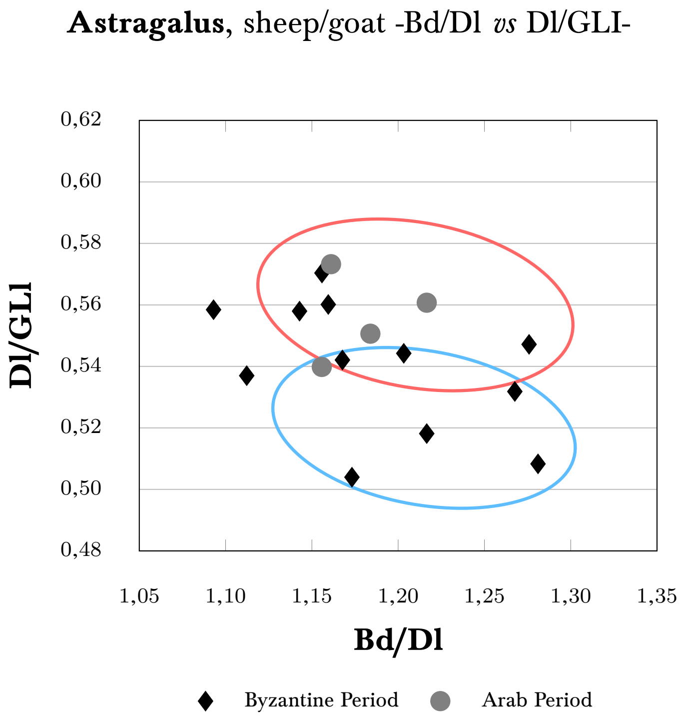


**Figure 6.6.9**. Colmitella, Byzantine and Arab periods. Sheep/goat, astragali, shape indices. Byzantine period (black diamonds), Arab period (grey circles). Red oval: range of modern sheep values, blue oval: range of modern goat values according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). Bd: breadth of the distal end; Dl: depth of the lateral half; GLl: greatest length of the lateral half.

Despite the small sample size, measurements of the condyles and of the verticilli of caprine distal metacarpals were analysed (Fig.6.6.10 and Fig.6.6.11).

On the basis of morphological criteria, most of these elements had been previously attributed to sheep, while two were generally recorded as sheep/goat; these latter were from contexts dated to the Byzantine period.

As Fig.6.6.10 shows, most specimens fall within the modern values of sheep (red oval), with one value plotting within the range of modern goats (blue oval); this specimen had been previously attributed to sheep/goat, as not enough distinctive morphological criteria were present. In addition, two outliers are visible: the first one, previously recorded as sheep/goat, is located close to the modern values of goat, while the second value is much closer to that of modern sheep; this latter had been previously identified as sheep on the basis of morphological criteria.

Fig.6.6.11 employs different measurements from metacarpals. As in the previous case, most individuals plot within the modern values of sheep, while two are fully located within the range of modern goats; these latter had been previously identified as ‘sheep/goat’.

All in all, these results further suggest that sheep were better represented than goats at both periods. Biometrical analyses have allowed to attribute the two ‘sheep/goat’ metacarpals to goat.

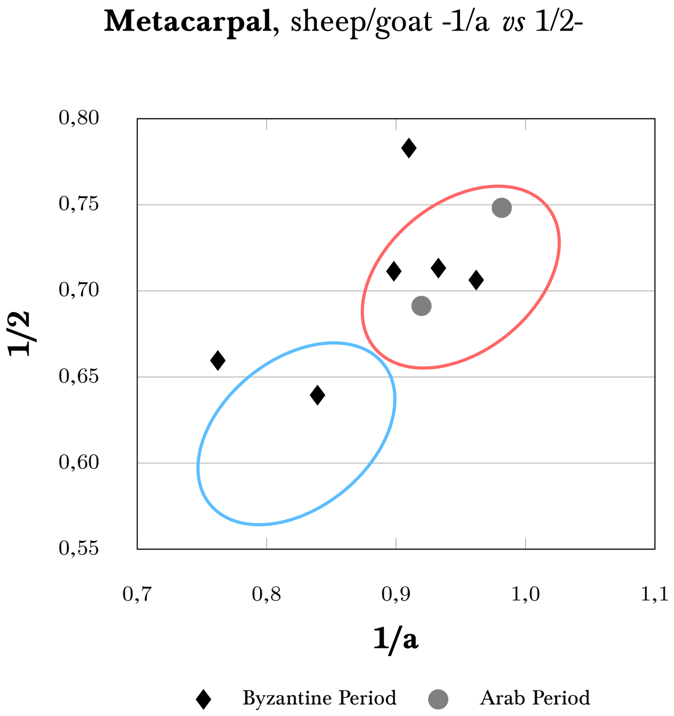


**Figure 6.6.10.** Colmitella, Byzantine and Arab periods. Sheep/goat, metacarpals, shape indices. Byzantine period (black diamonds), Arab period (grey circles). Red oval: range of modern sheep values, blue oval: range of modern goat values according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). 1: depth of left distal condyle; a: width of the medial condyle; 2: diameter of the *verticillus* of the medial condyle.

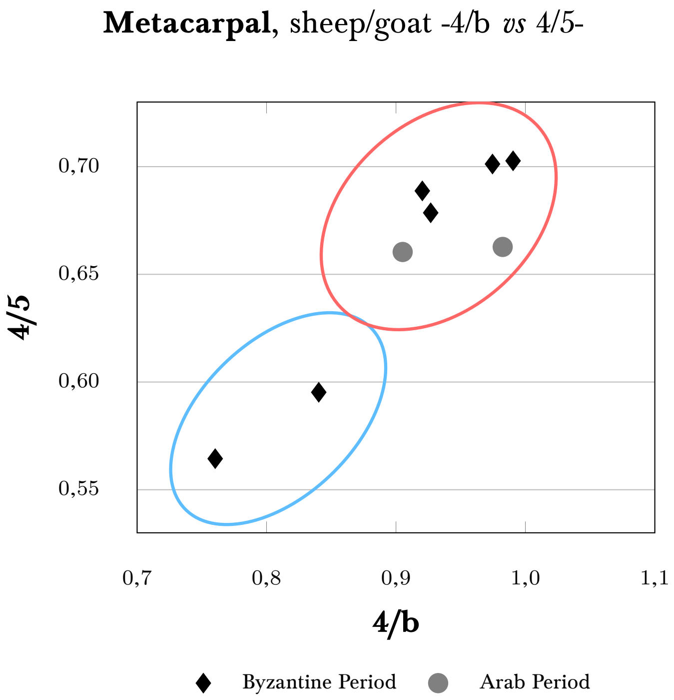


**Figure 6.6.11**. Colmitella. Byzantine and Arab periods. Sheep/goat, metacarpals, shape indices. Byzantine period (black diamonds), Arab period (grey circles). Red oval: range of modern sheep values, blue oval: range of modern goat values according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). 4: depth of the lateral condyle; b: width of the lateral condyle; 5: diameter of the *verticillus* of the lateral condyle.

## 6.6.3. Ageing

The analysis of age-at-death was carried out for caprines, cattle and suids for both periods. Brief comments about the age of equids, canids, felids, cervids and galliforms are also made according to the available data.

*Caprines* – The proportions of caprine fused bones for the three age-stages (Silver 1969) were calculated for the Byzantine and the Arab periods.

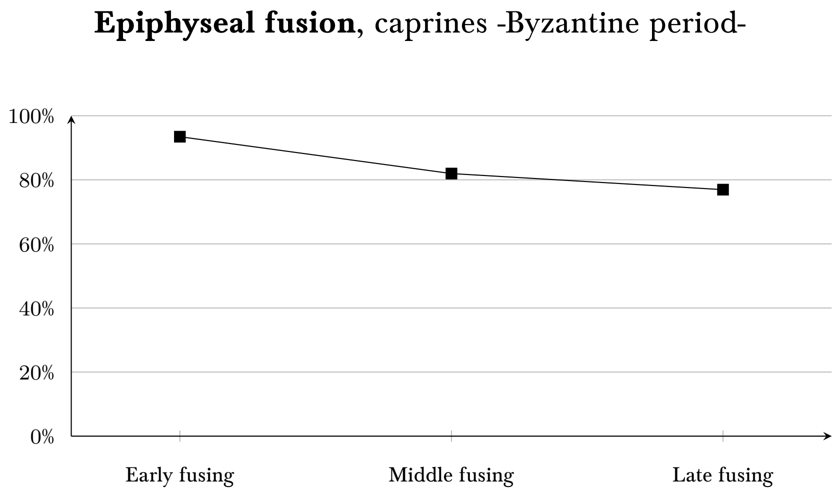
In the Byzantine period (Fig.6.6.12), ca. 15% of the individuals were slaughtered by their second-third year of age (middle fusing stage), with few caprines culled before their third-fourth year (late fusing stage). Most caprines survived into late adulthood (≥ three-four years of age). Early culling events (early fusing stage), representing animals culled before their first-second year of age (i.e. lambs) are only sparsely present.

Mandibular wear stages were estimated for 33 mandibles; the resulting kill-off pattern validate the results of the epiphyseal fusion analysis (Fig.6.6.13).

In the Arab period (Fig.6.6.14) a larger number of individuals (ca. 20%) were killed before reaching their third-fourth year of age (late fusing stage), with another ca. 20% culled before the second-third year of age (middle fusing stage). Similarly to the earliest phase, in the Arab period the majority of individuals (ca. 60%) survived into late adulthood (≥ three-four years of age). Early culling events are rarer; this virtual absence could be a consequence of taphonomic processes, which could explain the complete lack of the more fragile bones characterising very young individuals.

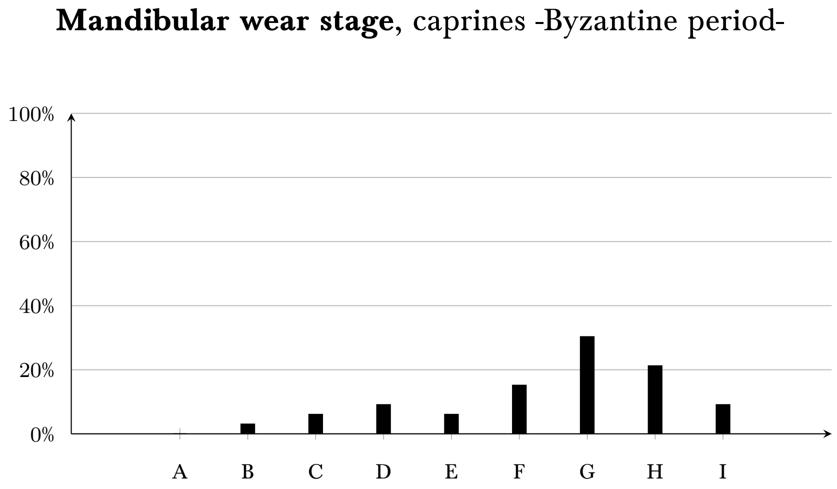
The kill-off pattern reconstructed from caprine mandibular wear stages in the Arab period fully supports the result obtained from the epiphyseal fusion analysis (Fig.6.6.15).

In sum, caprine husbandry practices in the Byzantine period appear to be focused on the production of secondary products. Mature caprines were largely kept until old age for their wool, milk and for breeding purposes, with fewer individuals also raised for meat and culled as subadults. Slight changes in caprine husbandry are attested for the Arab period; indeed, a higher number of animals were culled for their meat once they reached their optimum weight. However, a major focus on secondary outputs was clearly maintained in this period.



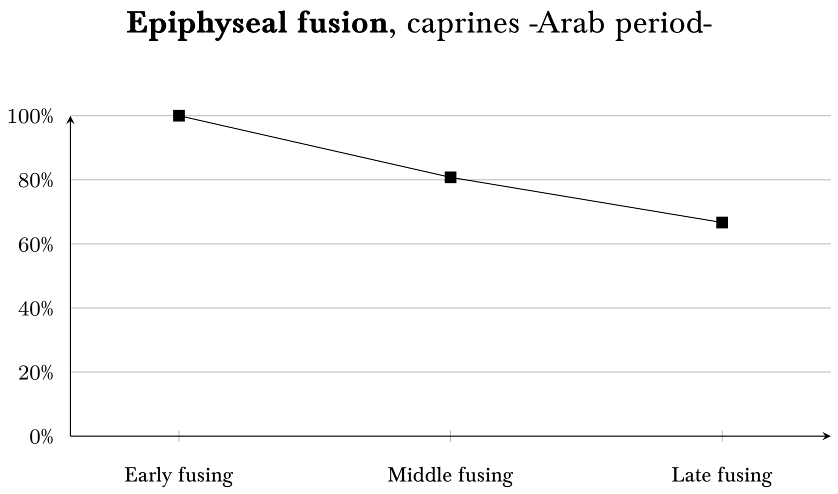
**Epiphyseal fusion**, caprines -Byzantine period-

**Figure 6.6.12**. Colmitella, Byzantine period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:93;82;77). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.



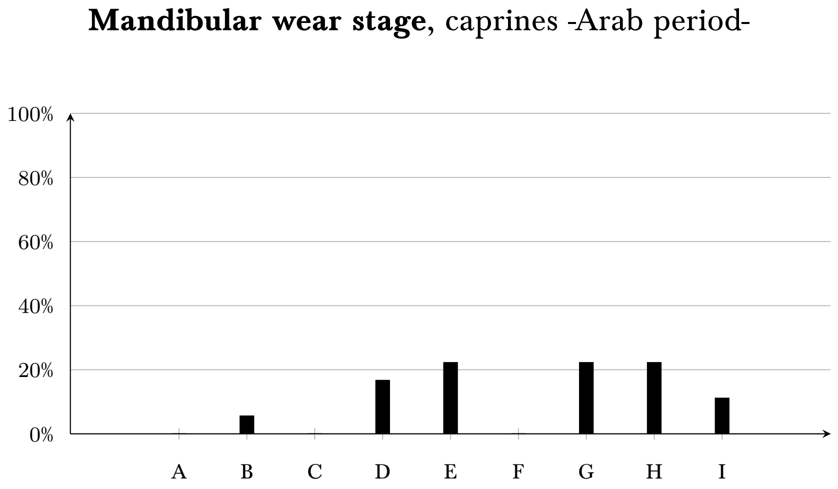
**Mandibular wear stage**, caprines -Byzantine period-

**Figure 6.6.13**. Colmitella, Byzantine period. Mandibular wear stages for caprines (n:33). Age stages follow Payne (1973). A: 0-2 months, B: 2-6 months, C: 6-12 months, D: 1-2 years, E: 2-3 years, F: 3-4 years, G: 4-6 years, H: 6-8 years, I: 8-10 years.



**Epiphyseal fusion**, caprines -Arab period-

**Figure 6.6.14**. Colmitella, Arab period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:100;81;77). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.



**Mandibular wear stage**, caprines -Arab period-

**Figure 6.6.15**. Colmitella, Arab period. Mandibular wear stages for caprines (n:18). Age stages follow Payne (1973). A: 0-2 months, B: 2-6 months, C: 6-12 months, D: 1-2 years, E: 2-3 years, F: 3-4 years, G: 4-6 years, H: 6-8 years, I: 8-10 years.

*Cattle* – The mortality profile for cattle in the Byzantine period could be reconstructed by analysing both the fusion stage of post-cranial bones and mandibular dental sequences. For the Arab period, ageing exclusively relies on the analysis of the epiphyseal fusion stages of post-cranial bones, as not enough mandibular sequences were recorded.

In the Byzantine period, ca. 20% of individuals were culled before their second-third year of age (middle fusing stage), while almost none between this stage and the third-fourth year of age (late fusing stage); more than ca. 70% of the individuals survived into late adulthood. Earlier culling events are present but in low percentages (i.e. calves– early fusing stage) (Fig.6.6.16).

The kill-off pattern from the mandibular wear stages recorded on 14 mandibles of cattle seems to confirm the results obtained from the epiphyseal fusion analysis (Fig.6.6.17).

In the Arab period, slight changes in cattle husbandry can be noticed; indeed, in this period, more individuals (ca. 40%) were culled before their second-third year of age (middle fusing stage), with another ca. 10% of cattle slaughtered between this stage and when they reached three-four years (late fusing stage). ca. 50% of cattle survived into later adulthood (≥ three-four years of age, late fusing stage). Like for the Byzantine period, in the Arab phase earlier culling events are represented, although in lower numbers (i.e. calves – early fusing stage) (Fig.6.6.18).

Overall, in the Byzantine period, most cattle were kept to old ages; this result suggests that these animals were mostly exploited for their secondary products, such as traction force, milk, and manure, as well as for breeding purposes, while fewer individuals were culled for beef production as soon as they reached their optimum weight.

In the Arab period, cattle husbandry is visibly more generalised, with a higher incidence of individuals raised for their meat as well as for secondary products.

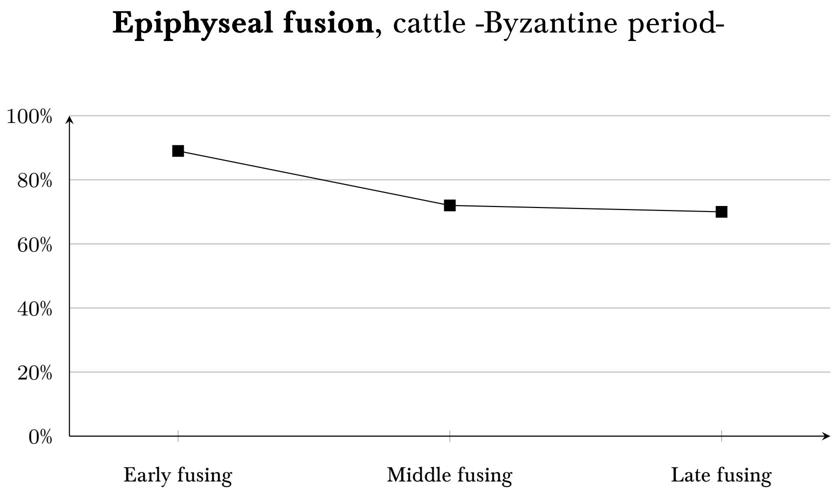


**Figure 6.6.16**. Colmitella, Byzantine period. Epiphyseal fusion analysis for cattle. Percentage of fused bones within each fusion stage (n:82;72;70). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

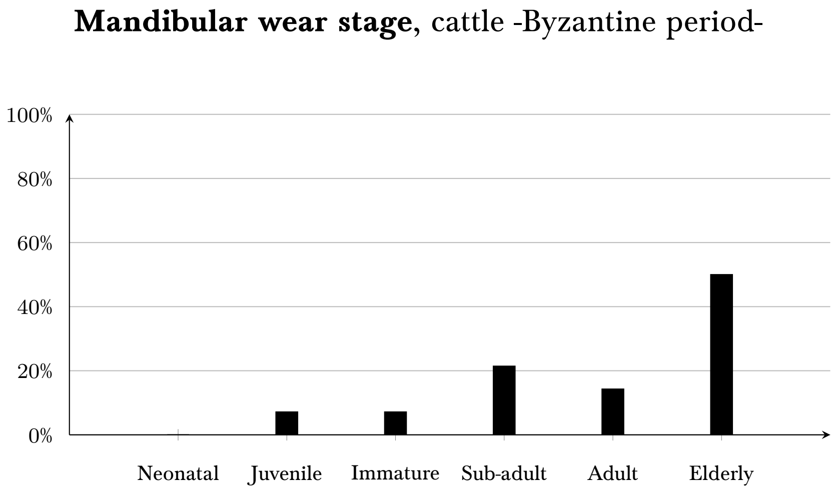


**Figure 6.6.17**. Colmitella, Byzantine period. Mandibular wear stages for cattle (n:14). Age stages follow O'Connor (1988), with the Neonatal stage added.

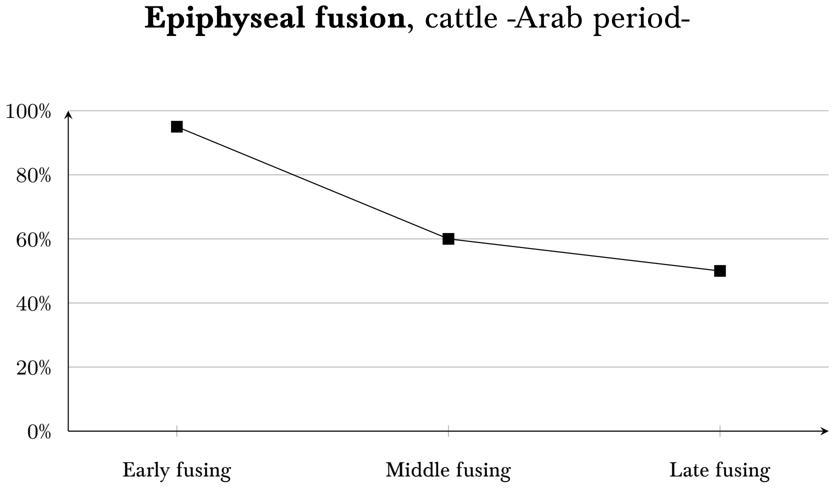


**Figure 6.6.18**. Colmitella, Arab period. Epiphyseal fusion analysis for cattle. Percentage of fused bones within each fusion stage (n:95;60;50). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Suids* – The comparison of the age-at-death of suids between the two analysed periods could only be undertaken on epiphyseal fusion, as not enough mandibles were present in the Arab period. However, a substantial mandibular sample exists for the Byzantine phase.

In the Byzantine period, ca. 50% of early fusing elements were unfused, representing suids killed before one-two years of age; this pattern may suggest the consumption of young pigs and piglets at the site (Fig.6.6.19). A number of pig perinatal bones were also recorded (Fig.6.6.20); however, these were not included in the ageing analysis, as they might represent natural losses rather than deliberate slaughter. An additional ca. 30% of suids were culled before their second-third year of age (middle fusing stage), once animals had reached their optimum weight. Most of the rest of the animals were culled before their third-fourth year of age, with very few individuals surviving into adulthood; these latter may represent sows and boars kept for reproduction.

The pattern from mandibular dental sequences corroborates the result from the epiphyseal fusion analysis (Fig.6.6.21).

Minor differences in suid husbandry practices can be noticed in the Arab period; these consist in a slightly lower incidence of piglets (early fusing stage), and in a higher number of individuals kept until older age (≥ three-four years of age, late fusing stage) (Fig.6.6.22); in addition, the absence of perinatal remains, is likely the result of taphonomic processes.

All in all, the patterns obtained for the Byzantine and the Arab periods do not come as surprise, as it is known that pig husbandry specifically aims at the production of meat and fat; however, the high incidence of suckling piglets both in the Byzantine and, though to a lesser extent, the Arab periods is rather interesting.

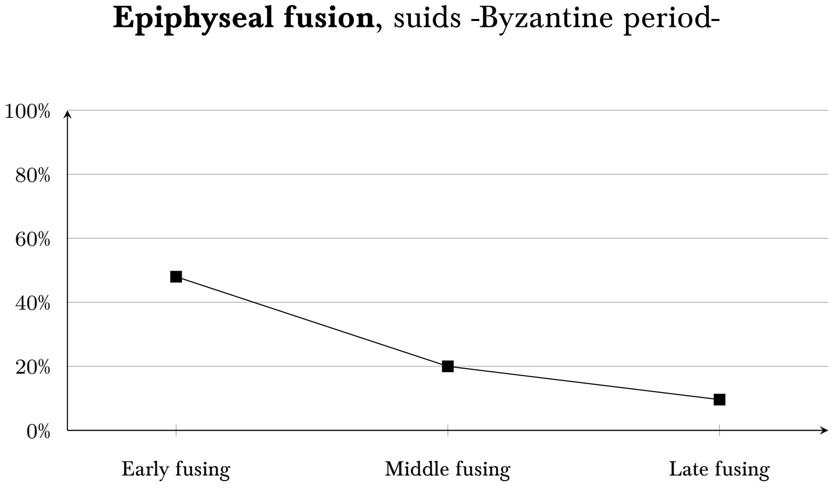


**Figure 6.6.19.** Colmitella, Byzantine period. Epiphyseal fusion analysis for suids. Percentage of fused bones within each fusion stage (n:53;20;10). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

**(a)** Skulls.

**(b)** Humeri.

**Figure 6.6.20.** Colmitella, Byzantine period. Remains of perinatal suids.

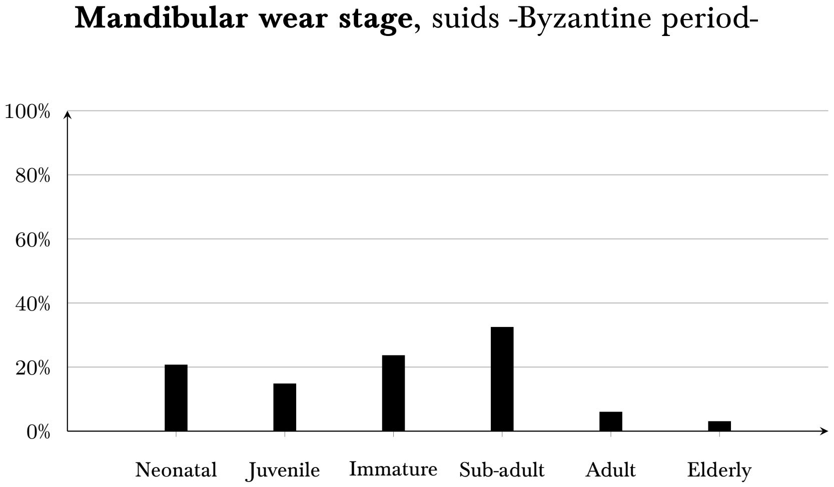


**Figure 6.6.21.** Colmitella, Byzantine period. Mandibular wear stages for suids (n:34). Age stages follow O'Connor (1988), with the Neonatal stage added.

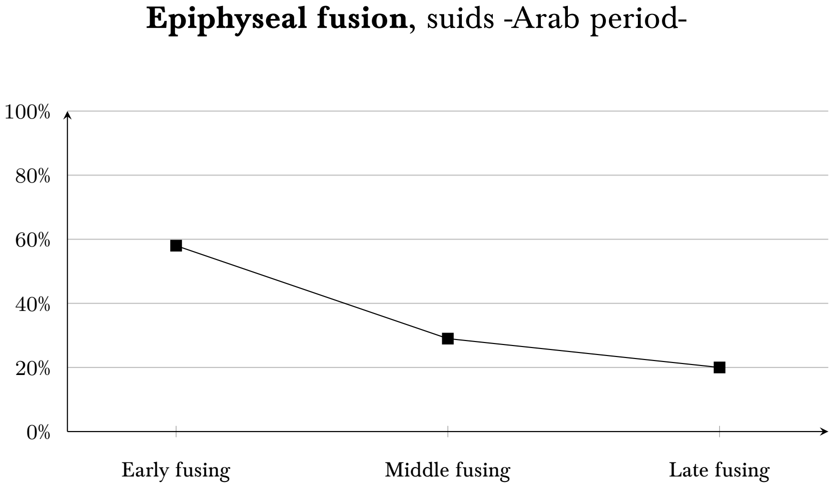


**Figure 6.6.22.** Colmitella, Byzantine period. Epiphyseal fusion analysis for suids. Percentage of fused bones within each fusion stage (n:58;29;20). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Equids* – In the Byzantine period, 18 post-cranial bones belonging to equids were recorded. All of them were fused, suggesting the prevalence of mature individuals in this period. This result seems to be further validated by the presence of heavily worn mandibular premolars or molars (loose teeth).

In the Arab period, seven post-cranial bones of equids were recorded; all of them were fused. In addition, one heavily worn loose tooth (maxillary premolar or molar) of an elderly individual was present.

All in all, these results suggest the presence of predominantly mature equids at the site for both periods. However, caution in the interpretation is needed due to the small sample size.

*Felids* – Felid remains were exclusively recorded for the Byzantine period. Of 18 post-cranial bones, all of them were fused, with the exception of two unfused distal femurs. In addition, two mandibles and one maxilla, all with permanent molars, were also recorded.

Therefore, adults are far better represented than young individuals in the Byzantine assemblage.

*Canids* – In the Byzantine period, out of 79 post-cranial canid bones, 11 were fused, while 68 were unfused. In addition, nine jaws were also recorded (eight mandibles and one maxilla); among these, three mandibles were characterised by the presence of deciduous teeth, while the others belonged to adult individuals.

In the Arab period, 17 post-cranial bones of canids were recorded; among these, four were fused, while the 13 were unfused. Furthermore, three mandibles were also recorded; one had the first molar still in crypt.

These results suggest that, unlike felids, young canids were far better represented than adult individuals at the site in both periods.

*Cervids* – In the Byzantine period, all cervid anatomical elements (n:49) belonging to the red deer and/or to the fallow deer were fused, with the exception of one proximal tibia. In addition, two mandibles and four maxillae were recorded; these were all characterised by the presence of rather worn teeth. Considering cervid loose teeth, only one unworn dP4 has been recorded, while the rest are all permanent mandibular and maxillary premolars and molars with rather worn occlusal surfaces.

In the Arab period, out of seven cervid post-cranial bones , six were fused, and only one proximal humerus was unfused. Unlike the Byzantine period, mandibles, maxillae and loose teeth were absent.

These results indicate that fully adult (larger) individuals were being targeted in hunting activities. However, in the Byzantine period, the presence of a few younger cervids has been also attested.

*Galliforms* – In the Byzantine period, out of 27 recorded bones (including countable and non-countable elements), eight were not fully ossified, while 19 belonged to mature individuals; among these, 11 could be identified as domestic fowl. The presence of two particularly small-sized and porous elements (one humerus and one tibiotarsus) has been noticed; this is likely to indicate natural mortality and, therefore, on-site breeding.

In the Arab period, out of 15 anatomical elements (including countable and non-countable elements), four had the proximal and/or the distal diaphyses not ossified yet, suggesting the presence of immature individuals, while 11 were fully ossified (i.e. adults); of these, five belonged to domestic fowl. No particularly small-sized and porous elements were recorded for this period.

### 6.6.4. Sex

Information about the sex of animals could be obtained for suids, cervids and domestic fowl. *Suids* – The ratio between sows and boars has been assessed by considering canines in jaws; in addition, when canines were not present in the jaws, mandibular and maxillary alveoli were also sexed (*§Chapter 5: Methodology*).

In the Byzantine period sows are far better represented than boars. This pattern is also valid for the Arab period, although a higher incidence of boars in comparison to the Byzantine period is visible (Tab.6.6.4). The unusual high incidence of mandibular and maxillary alveoli in comparison to canines in jaws may be related with the young age at which most suids were slaughtered, thus implying teeth could more easily drop off.

| **Colmitella** | **Byzantine period** | | **Arab period** | |
|---|---|---|---|---|
| *Sus* **sp.** | **Sows** | **Boars** | **Sows** | **Boars** |
| Canines (in jaws) | 21 | 5 | 13 | 11 |
| Alveoli (mandibular and maxillary) | 1 | 2 | 8 | 2 |
| **Total** | **22** | **7** | **21** | **13** |

**Table 6.6.4.** Colmitella, Byzantine and Arab periods. Presence of male and female pigs based on canines in jaws and alveoli (n:29;34).

*Cervids* – 18 red and/or fallow deer antler fragments were recovered from contexts dated to the Byzantine period; in one case an antler presented polishing marks on its surface (*§6.6.8 Worked bones*). Another antler had been shed, suggesting that this had been collected for craft purposes (Fig.6.6.23). All these specimens indicate the occurrence of males as female deer do not have antlers. However, they tell us nothing about sex ratios as they cannot be compared to equivalent female specimens.

**Figure 6.6.23.** Colmitella, Byzantine period. Shed antler fragment of a male red deer or a male fallow deer.

*Domestic fowl* – None of the four tarsometatarsi recorded in the Byzantine period was spurred.

In the Arab period, out of five mature tarsometatarsi, three were spurred; in all cases the bones lacked the presence of a continuous posterior keel, thus confirming its taxonomical attribution to the domestic fowl (Tab.6.6.5).

Tarsometatarsi characterised by the presence of a spur scar and/or of a reduced spur were not detected in any of the two periods.

All in all, it seems that for domestic fowl females were better represented than males at both periods; however, the tiny sample size invites caution in the interpretation of data. Additionally, younger males may have not yet have developed a spur.

| **Colmitella** | **Unspurred tarsometatarsi** | **Spurred tarsometatarsi** |
|---|---|---|
| Byzantine period | 4 | 0 |
| Arab period | 2 | 3 |
| **Total** | **6** | **3** |

**Table 6.6.5.** Colmitella, Byzantine period. Number of unspurred (most likely female) and spurred (most likely male) tarsometatarsi of domestic fowl.

### 6.6.5. Anatomical element distribution

The distribution of anatomical elements could only be properly analysed for caprines, cattle and suids for both periods. In addition, brief comments on equids, felids, canids, and cervids have been made.

*Caprines* – In the Byzantine period, mandibles are the most represented body parts (Fig.6.6.24); their high incidence may suggest the processing of whole carcasses at the site. Upper and lower limb bones are almost equally represented, supporting the fact that both primary and secondary butchery occurred on site. Smaller anatomical elements, such as carpals and phalanges, are less represented than other body parts (if not completely absent – e.g. carpal 3 and scaphocuboid); as discussed before, this is likely the consequence of a recovery bias.

Distal humerus and tibia are also well represented; this is probably the result of their high bone density (Brain 1971).

The situation in the Arab period is similar, with mandibles being by far the most common element; however, in this case, upper limbs are better represented than lower ones (Fig.6.6.25). Also in this period, the dearth of small sized anatomical elements is likely to be the consequence of a recovery bias.

Overall, it is likely that caprine carcasses in the Byzantine and in the Arab periods were processed on site, and that both primary and secondary butchery occurred locally.

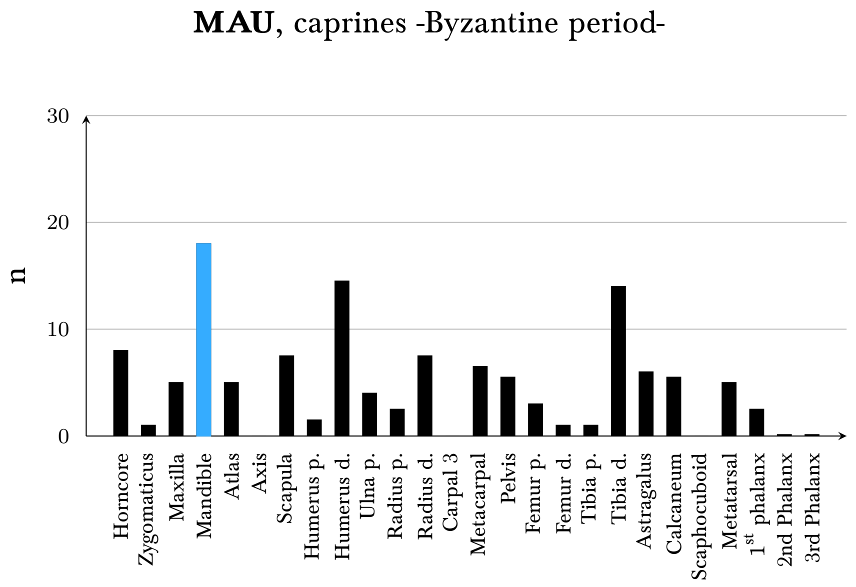


**Figure 6.6.24.** Colmitella, Byzantine period. Distribution of the Minimum number of Animal Units (MAU) for caprines (n:125). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

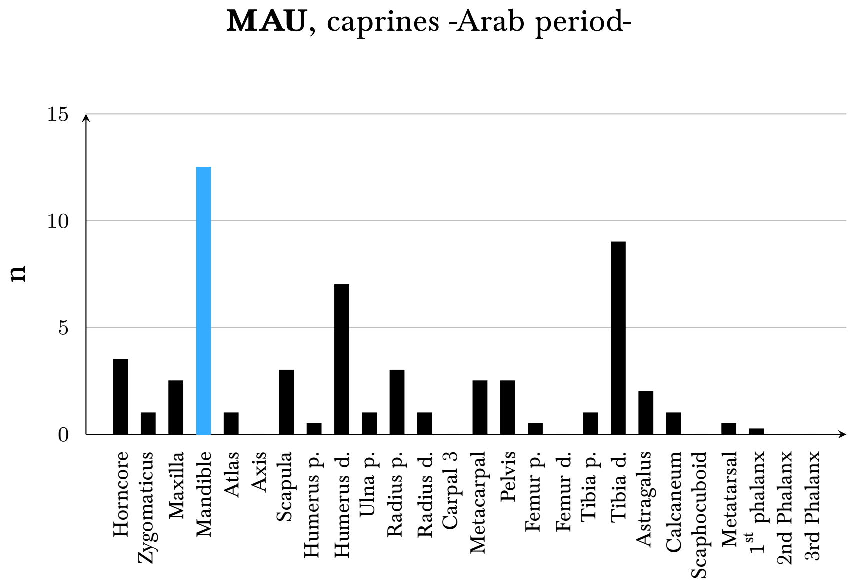


**Figure 6.6.25.** Colmitella, Arab period. Distribution of the Minimum number of Animal Units (MAU) for caprines (n:55). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Cattle* – The anatomical element distribution of cattle in the Byzantine period indicates that both upper and lower limbs are almost equally represented, the astragalus being the most abundant anatomical element (Fig.6.6.26). Smaller body parts (i.e. carpals, tarsals and phalanges) are well represented too, thus suggesting that, as expected, the lack of systematic sieving did not affect the recovery of remains from large-sized animals (*§6.6.1.3 Recovery bias*).

Cranial elements such as horncores, maxillae, mandibles and the zygomaticus are present; this could suggest the introduction of whole cattle carcasses to the site.

No substantial changes in the anatomical element distribution of cattle can be noticed for the Arab period (Fig.6.6.27); the only exception is represented by a slightly higher incidence of lower limbs in comparison to upper ones. Like in the previous period, the astragalus is one of the most abundant elements. Cranial elements are present, but in lower frequency than in the Byzantine period; however, their recovery indicates the processing of entire cattle carcasses at the site. Smaller sized bones, such as tarsals and phalanges, are well represented, although carpals are absent.

All in all, the results obtained from the analysis of cattle anatomical element distribution indicate that, like for caprines, both primary and secondary butchery activities were carried out at the site. The incidence of cranial elements, however, seems lower in comparison to that of caprines; this is especially true for the Arab period, suggesting that processed beef entered the site more frequently than processed caprine carcasses.

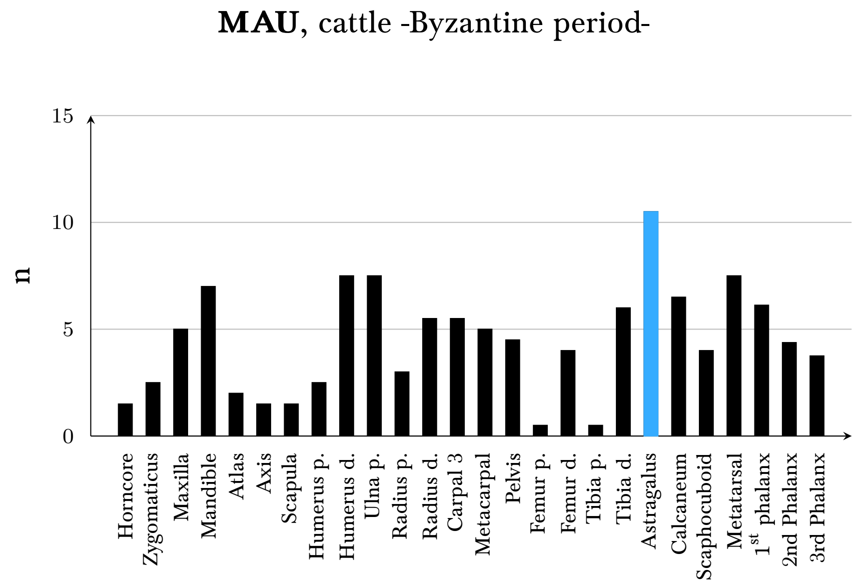


**Figure 6.6.26**. Colmitella, Byzantine period. Distribution of the Minimum number of Animal Units (MAU) for cattle (n:116). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

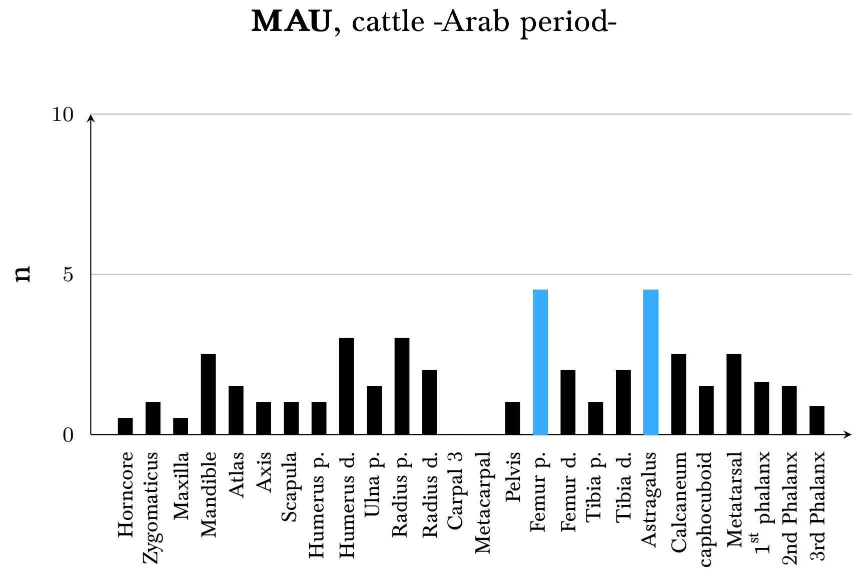


**Figure 6.6.27**. Colmitella, Arab period. Distribution of the Minimum number of Animal Units (MAU) for cattle (n:44). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Suids* – The anatomical element distribution for suids in both periods can almost entirely be explained with a recovery bias and differential levels of preservation (Fig.6.6.28 and Fig.6.6.29). Indeed, small elements, such as phalanges, carpals and tarsals, are underrepresented, if not completely absent; this result might be the consequence of the lack of sieving of the archaeological deposits. In the Byzantine period, the most represented body parts are the maxilla and the distal humerus, while in the Arab period, mandibles are the most abundant elements. All these body parts present a high bone density, thus having better chances to preserve in the archaeological record.

The high incidence of cranial elements (i.e. maxillae and mandibles) at both periods, alongside the presence of almost all other parts of the suid skeleton, suggest the introduction and processing of entire suid carcasses at the site.

However, this hypothesis needs to be treated with caution, especially in the case of suids from Arab Colmitella, for which a tiny sample size was available.

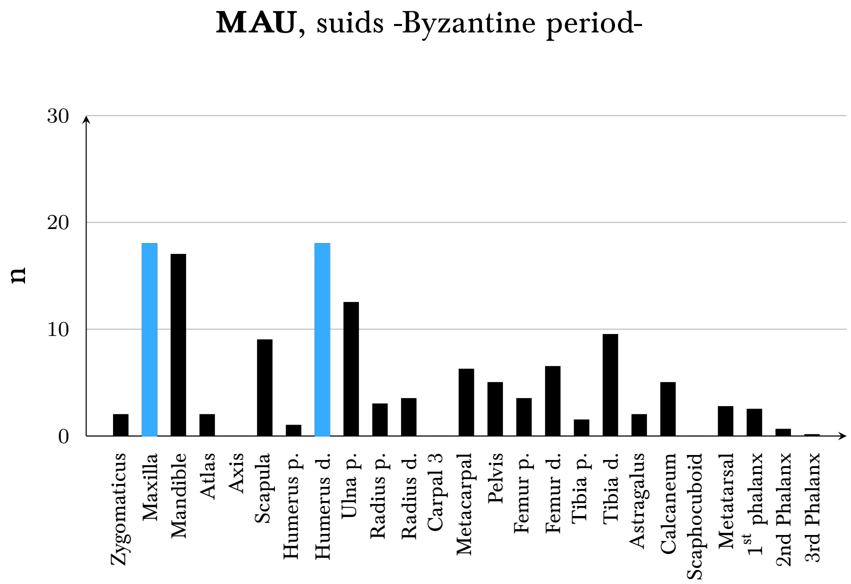


**Figure 6.6.28**. Colmitella, Byzantine period. Distribution of the Minimum number of Animal Units (MAU) for suids (n:131). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

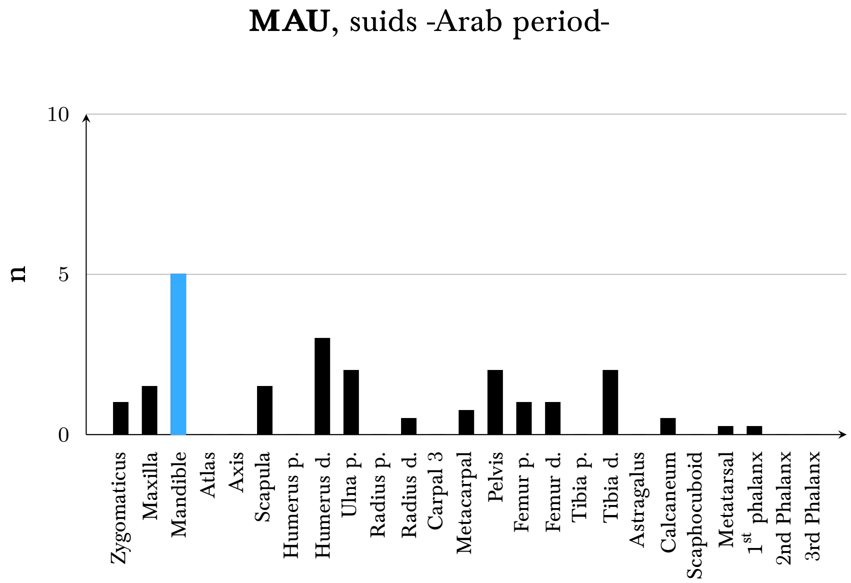


**Figure 6.6.29**. Colmitella, Arab period. Distribution of the Minimum number of Animal Units (MAU) for suids (n:22). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Equids* – In general, bones from both lower and upper limbs are present, the former being slightly more abundant. Elements from the head were recorded for the Byzantine period, while none were present in the Arab phase.

*Felids* – Felid remains were exclusively recorded from contexts dated to the Byzantine period; these include upper and lower limbs almost equally. Small bones, such as carpals and tarsals, are absent, and only one 1st phalanx was recorded; the dearth of such elements might be the result of a recovery bias. Cranial elements are attested by one zygomaticus, two mandibles and one maxilla.

*Canids* – Canid remains were recorded at the two analysed periods, their incidence being higher in the Byzantine period. No differences in the anatomical element distribution of canids were detected for the two periods.

Overall, lower limbs are better represented than upper limbs, metapodials being the most abundant anatomical element. Cranial elements, such as mandibles and maxillae, are well represented; by contrast, small-sized anatomical elements are almost absent, this probably being the result of the lack of systematic sieving of the faunal material.

*Cervids* – In the two periods, upper and lower limbs are both represented. Small bones (e.g. carpals, tarsals and phalanges) are almost completely missing. Cranial elements were only recorded for the Byzantine period, these being especially represented by mandibles and maxillae; antler fragments were also present (*§6.6.4 Sex*).

### 6.6.6. Butchery

For this site, the analysis of butchery marks focuses on caprines for both periods, while for cattle it could only be carried out for the Byzantine period. Desultory comments on suid and cervid remains have also been made, despite the modest quantity of data.

*Caprines* – In the Byzantine period, ca. 20% of caprine remains was butchered (Fig.6.6.30); among these, cut marks were more frequent than chop marks (Fig.6.6.31). The formers were mostly located on the ends of post-cranial bones, and were probably aimed at the severing of tendons. Chop marks were mainly located on vertebrae and ribs, of a size compatible with caprines; they are from the consequence of the reduction of the carcass into smaller pieces. Chop marks on the shafts of long bones would have had a similar role, but could also be related to marrow extraction. In addition, a number of sheep horncores presented cut and chop marks located close to their base (Fig.6.6.32); such marks were probably made to separate the horncores from the skull, and to obtain the horns from the horncores to use them for craft activities.

No changes in butchery practices have been detected for the Arab period, with the exception of the lack of butchered caprine horncores (Fig.6.6.33 and Fig.6.6.34).

All in all, cut marks were more common than chopping marks, though the latter were also present. Such pattern is likely to be related with the medium size of caprine carcasses, which do not usually require the intensive use of heavy tools. The types and locations of butchery marks reflect all steps of carcass processing, from initial dismemberment to reduction into sizeable portions.

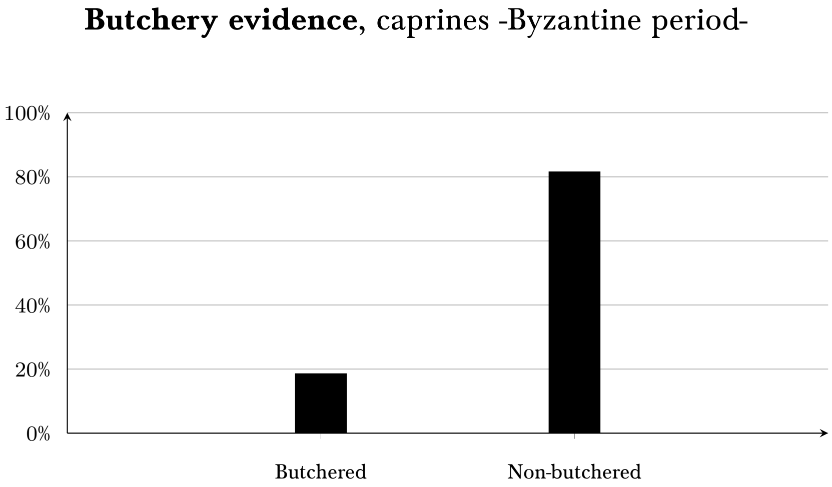


**Figure 6.6.30**. Colmitella, Byzantine period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:54;238).

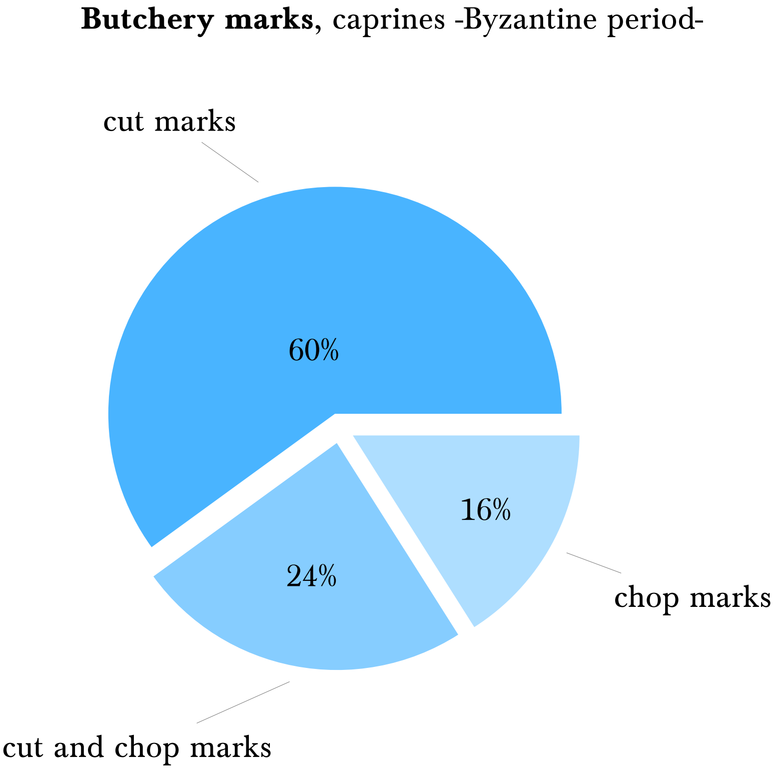


**Figure 6.6.31**. Colmitella, Byzantine period. Butchered post-cranial bones of caprines; proportions of cut marks, chop marks and cut and chop marks (n:56).

**Figure 6.6.32**. Colmitella, Byzantine period. cut and chop marks recorded on a sheep horncore.

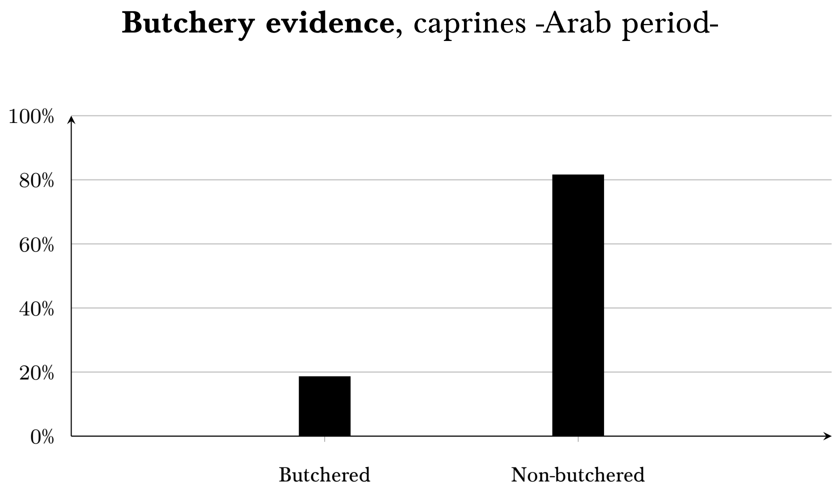


**Figure 6.6.33**. Colmitella, Arab period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:20;88).

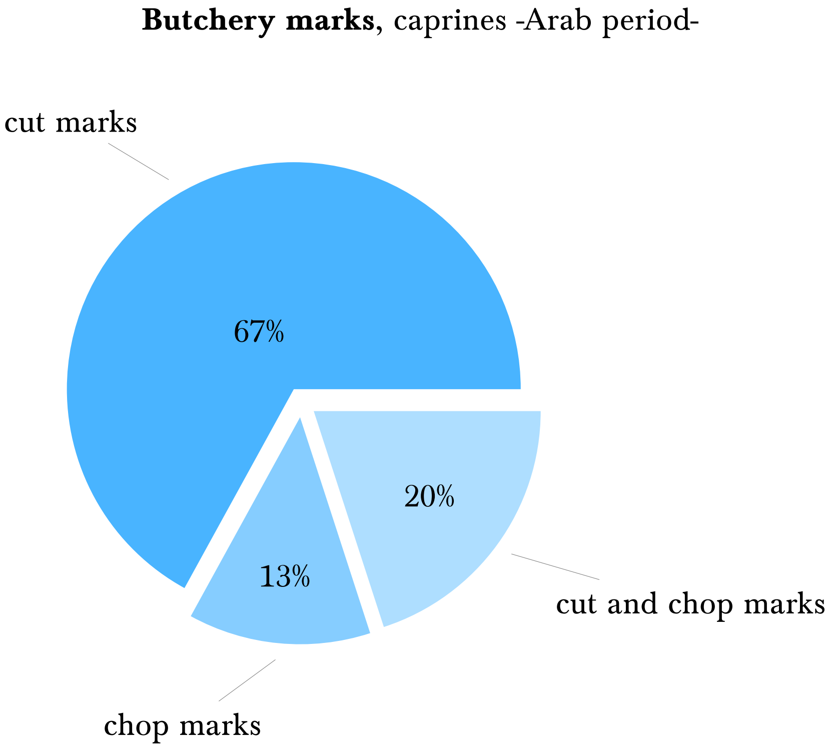


**Figure 6.6.34**. Colmitella, Arab period. Butchered post-cranial bones of caprines; proportions of cut marks, chop marks and cut and chop marks (n:20).

*Cattle* – The analysis of butchery evidence on cattle remains was only conducted for the Byzantine period, as not enough butchered bones were recorded for the Arab period (i.e. only one distal radius, one proximal femur and six large-sized vertebrae had any evidence of butchery).

In the Byzantine period, butchery marks were recorded on ca. 15% of cattle post-cranial remains (Fig.6.6.35). Chop marks were more common than cut marks (Fig.6.6.36); the higher proportion of chops than in caprines is a consequence of the larger size of cattle carcasses, which need to be dismembered into a higher number of portions than caprines. In general, chop marks were mainly located on the shaft of post-cranial bones; they might have contributed to the defleshing of specific body parts and/or to the extraction of bone marrow. In addition, a number of phalanges (mainly 1st and 2nd phalanges) presented cut marks on their surfaces, which are almost certainly associated with skinning.

Along with the distribution of anatomical elements, the evidence suggests that cattle remains from the Byzantine period at Colmitella are likely to represent butchery and food waste, and that primary and secondary butchery took place on site in both periods. In addition, skinning activities have been attested, suggesting the use of cattle hides and the full exploitation of carcasses.

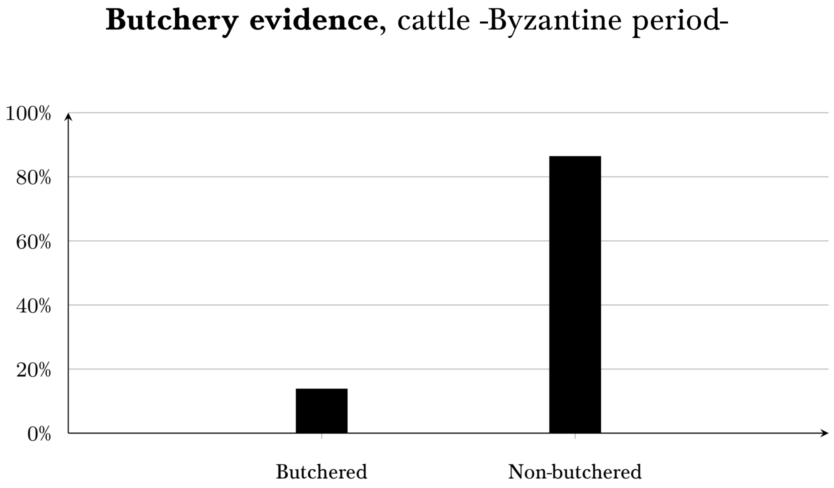


**Figure 6.6.35.** Colmitella, Byzantine period. Proportion of butchered and non-butchered post-cranial bones of cattle (n:48;302).

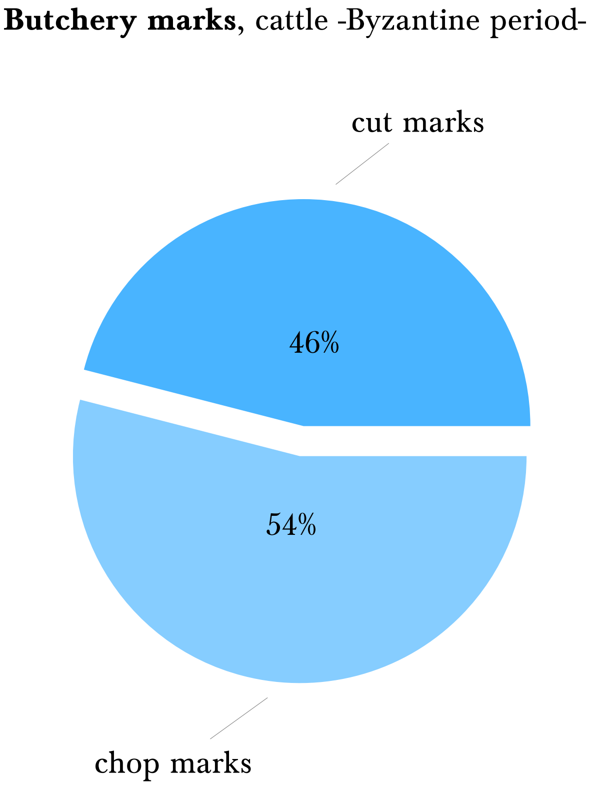


**Figure 6.6.36.** Colmitella, Byzantine period. Butchered post-cranial bones of cattle; proportions of cut marks, chop marks and cut and chop marks (n:48).

*Suids* – 12 post-cranial bones of suids from the Byzantine period (mainly metapodials and distal humeri), and one from the Arab period (a third metacarpal) presented cut and/or chop marks on their surfaces. The overall low incidence of butchered remains could be related to the young age in which many animals were slaughtered, and with their consequently smaller size; this would have not required the separation of the carcass into many small portions, as whole, or partially whole, piglets could have been cooked and consumed as such. The higher porosity and fragility of young suid bones could have also led to a lower visibility of butchery marks.

*Cervids* – Four antler fragments presented cut and chop marks located close to the pedicle. Such marks were probably inflicted to divide the antlers from the skulls.

### 6.6.7. Burning

In the Byzantine period, out of 871 recorded fragments, 20 bones showed evidence of burning, though two of them were only singed (Fig.6.6.37). No calcined remains have been recorded. Burnt remains mainly belonged to caprines and suids, while fewer were attributed to cattle and galliforms.

In the Arab period, out of 300 recorded fragments, 18 post-cranial elements presented burning evidence (with two being singed). As for the previous period, calcined bones were not present. Burnt remains mainly belonged to caprines and suids, and a smaller number to cattle, galliforms, and anatids.

In both periods, the type and location of burning marks, as well as the taxonomic attribution of the burnt remains to domestic food mammals, seem to support the interpretation of the faunal assemblage as ordinary food waste.

**Figure 6.6.37.** Colmitella, Byzantine period. Singed medium-sized rib and one burnt medium-sized rib.

### 6.6.8. Worked antler and bones

One worked red deer antler was recovered from a Byzantine context; this presented clear polishing marks on the brow tine, and cut and chop marks located just below the coronet (Fig.6.6.38).

**Figure 6.6.38**. Colmitella, Byzantine period. The arrow indicates the area of the red deer antler presenting polishing evidence.

Two worked bones, a caprine metacarpal and a metatarsal, were also recovered from contexts dated to the Byzantine period (Fig.6.6.39 and Fig.6.6.40); each of them presented symmetrical drilled perforations on the anterior-posterior sides, on the proximal and distal ends.

**(a)** Anterior view. **(b)** Posterior view.

**Figure 6.6.39**. Colmitella, Byzantine period. Worked caprine metacarpal.

**Figure 6.6.40**. Colmitella, Byzantine period. Worked caprine metatarsal, anterior view.

### 6.6.9. Size and shape

The overall good preservation of the Colmitella assemblage allowed to take a considerable amount of measurements on caprine, cattle and suid remains from both periods.

Scatter-plots were only made for caprines, for which it was possible to investigate potential size changes trough time using absolute measurements from individual anatomical elements (i.e. tibia, humerus and astragalus).

In addition, in order to allow an appropriate biometrical comparison of caprine size between Colmitella and the other analysed sites, width/depth measurements of a selection of post-cranial bones from the Byzantine and the Arab periods were merged and plotted into two log ratio histograms; however, it was not possible to separately analyse the more and the less sex-dependent post-cranial bones, as done for Mazara del Vallo (in this chapter: *§6.5 Mazara del Vallo*). In all the log ratio analyses, the most age-dependent measurements were excluded.

Moreover, potential differences in cattle size between Byzantine and Arab Colmitella were investigated by merging widths and depths of post-cranial bones into two log ratio histograms; as for caprines, it was not possible to analyse separately the less and the more sex-dependent elements, while the more age-dependent measurements were excluded. Biometrical comparisons of cattle size from Colmitella and Mazara del Vallo were also carried out.

Investigations about potential changes in suid size in Byzantine and Arab Colmitella, as well as about the domestic and/or the wild nature of the suid populations, were made by combining lengths, widths and depths of mandibular and maxillary teeth into two log ratio histograms. The use of measurements from post-cranial bones was prevented by the predominance of unfused suid bones. As in the cases of caprines and cattle, biometrical comparisons with other sites were carried out.

*Caprines* – Measurements of the distal tibia from the Byzantine and the Arab periods were plotted to investigate potential changes in caprine size trough time.

The scatter plot shows a clear size increase in the Arab period (Fig.6.6.41).

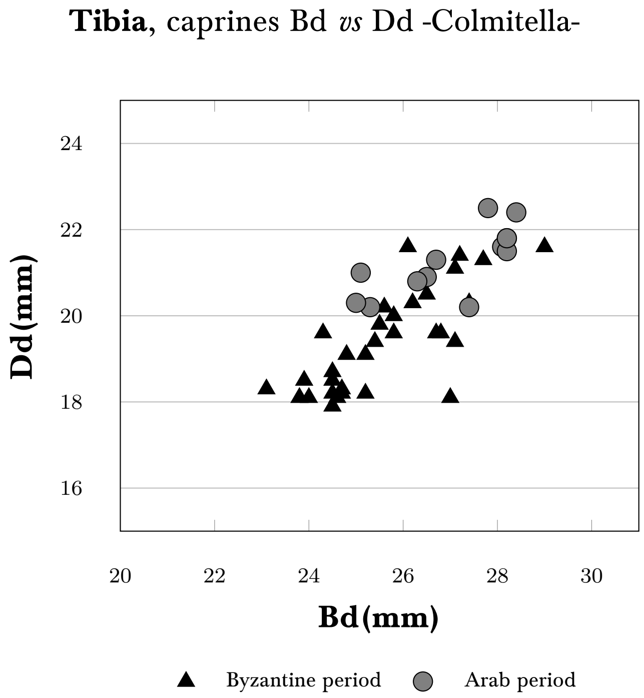


**Figure 6.6.41.** Measurements of the distal tibia (Bd and Dd) of caprines from the Byzantine period (black triangles) and from the Arab period (grey circles) from Colmitella (*§Chapter 5: Methodology*).

Potential differences in caprine size with a different site-type in Sicily were investigated by comparing measurements of the distal tibia from the Byzantine period at Colmitella with those from the 1st Byzantine period at Rocchicella (Fig.6.6.42).

The analysis indicates that no substantial differences in sheep size exist between the two sites, as there is a considerable overlap and no distinctive clusters can be noticed.

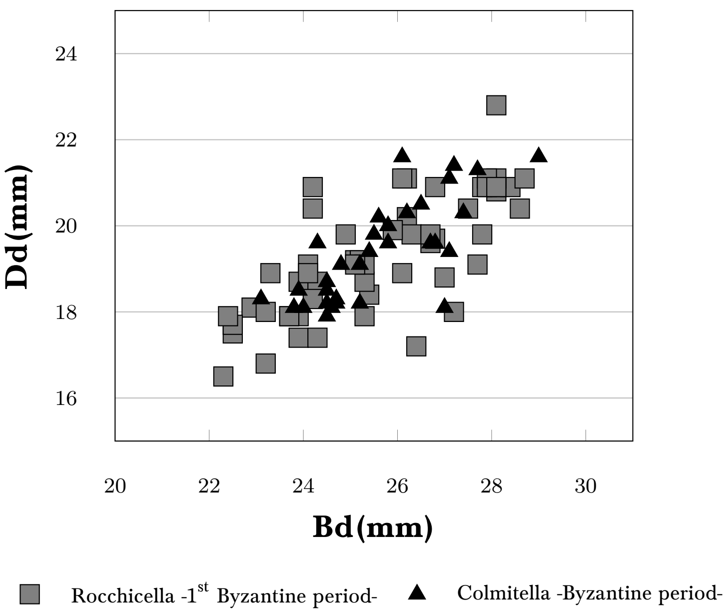

**Tibia**, caprine Bd *vs* Dd -Bazantyne period-

**Figure 6.6.42.** Measurements of the distal tibia (Bd and Dd) of caprines from the 1st Byzantine period at Rocchicella (grey squares) and from the Byzantine period at Colmitella (black triangles) (*§Chapter 5: Methodology*)

Measurements of the distal tibia from the Arab period at Colmitella were then compared with those from the Arab period at Casale San Pietro, and with the 2nd Byzantine period at Rocchicella (this latter being chronologically close to the Arab phases at the other two sites).

Despite some overlaps, most values from Rocchicella are smaller than those from Arab Colmitella and Casale San Pietro, with no evidence of a size change between the two Byzantine phases at Rocchicella (Fig.6.6.43).

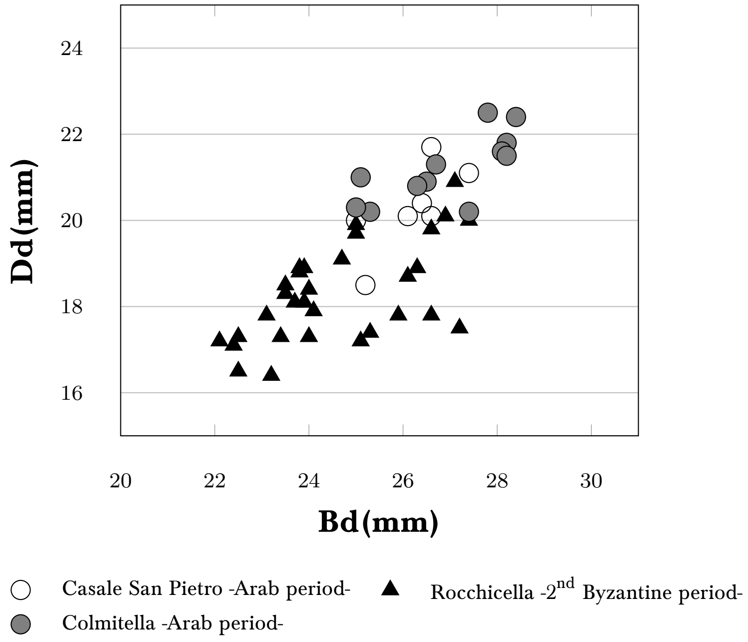

**Tibia**, caprines Bd *vs* Dd -Arab period-

**Figure 6.6.43.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Casale San Pietro (empty circles) and Colmitella (grey circles) and from the 2nd Byzantine period at Rocchicella (black triangles) (*§Chapter 5: Methodology*).

Fig.6.6.44 compares measurements of the distal tibia of caprines from Arab Colmitella with those from the contemporary urban sites of Corso dei Mille, Sant'Antonino and Mazara del Vallo. The values from Arab Colmitella are mostly distributed within the same range of measurements of Sant'Antonino and Mazara del Vallo, but are larger than the caprines from Corso dei Mille.

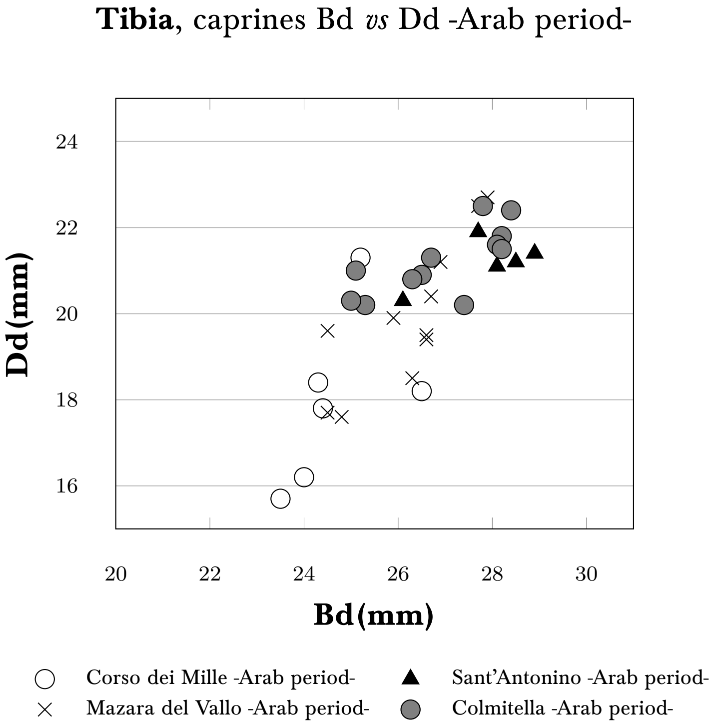


**Figure 6.6.44.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Corso dei Mille (empty circles), Mazara del Vallo (black crosses), Sant'Antonino (black triangles) and Colmitella (grey circles) (*§Chapter 5: Methodology*).

In Fig.6.6.45 caprine astragali from the Byzantine and the Arab periods at Colmitella the site are compared with those from Mazara del Vallo (Arab and Norman/Swabian periods).

Despite the small sample size, a clear chronological trend can be identified. The Byzantine data are the smallest, the Norman-Swabian are the largest, and those from the two Arab sites plot in-between.

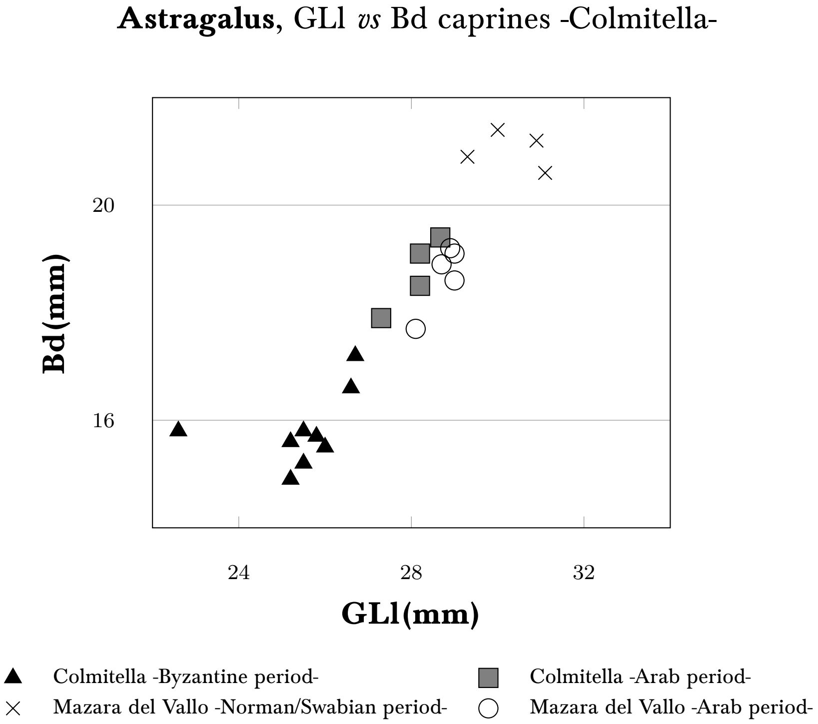


**Figure 6.6.45.** Measurements of the astragalus (GLl and Bd) of caprines from the Byzantine period (black triangles) and the Arab period (grey squares) at Colmitella, and from the Arab period (empty circles) and the Norman/Swabian period (black crosses) at Mazara del Vallo (*§Chapter 5: Methodology*).

To investigate potential changes in the sex ratio of caprines at Colmitella, a scatter plot comparing measurements from the distal humerus was made (Fig.6.6.46).

Consistently with previous analysis, the Byzantine specimens are smaller, but there are two larger outliers, probably males.

In the Arab period, the animals are larger, but there are, again two larger outliers (males?), those these are not as distinct as those from the Byzantine period.

All in all, it seems that in both periods the bulk of specimens is from ewes (and, potentially, wethers), though a few rams may have also been present, presumably for reproductive purposes.

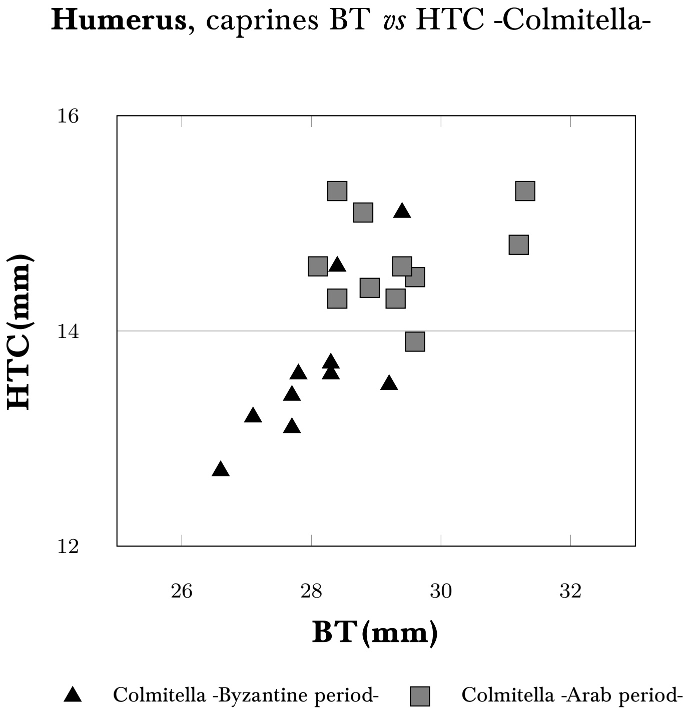


**Figure 6.6.46.** Measurements of the distal humerus (BT and HTC) of caprines from the Byzantine period (black triangles) and the Arab period (grey squares) at Colmitella (*§Chapter 5: Methodology*).

Width and depth measurements from caprine fused post-cranial anatomical elements dated to the Byzantine and the Arab periods at Colmitella were analysed together through the log ratio technique; this has been done to further investigate the sheep increase in size suggested by measurements of individual body parts.

The log ratio histograms display a unimodal distribution in both periods but with a size increase in the Arab period (Fig.6.6.47).

The result of the Student's *t*-test confirms such difference in caprine size with a *p*-values of 0.011 (Fig.6.8.27, Tab.6.8.6 and Tab.6.8.7).

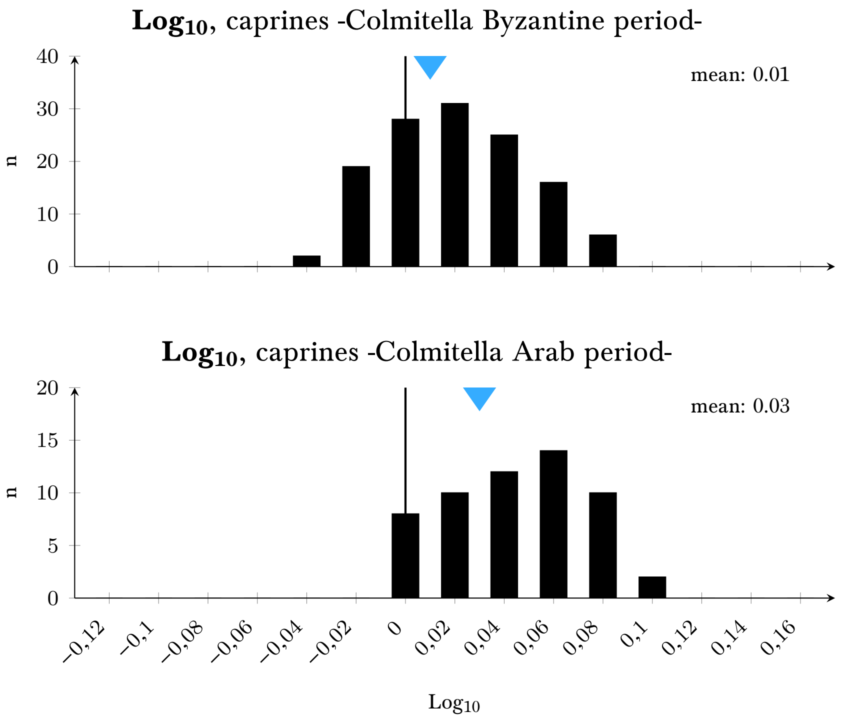


**Figure 6.6.47.** Comparisons of caprine post-cranial measurements from the Byzantine period and the Arab period at Colmitella. Log ratio histogram for width/depth measurements from the Byzantine period (n:132) and for the Arab period (n:56). The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

The size of caprines in the Byzantine period in Sicily was analysed by comparing post-cranial measurements (widths and depths) from Colmitella and Rocchicella (1st Byzantine period). Fig.6.6.48 confirms the evidence presented above, suggesting that sheep at Colmitella and Rocchicella (1st Byzantine period) were of a similar size.

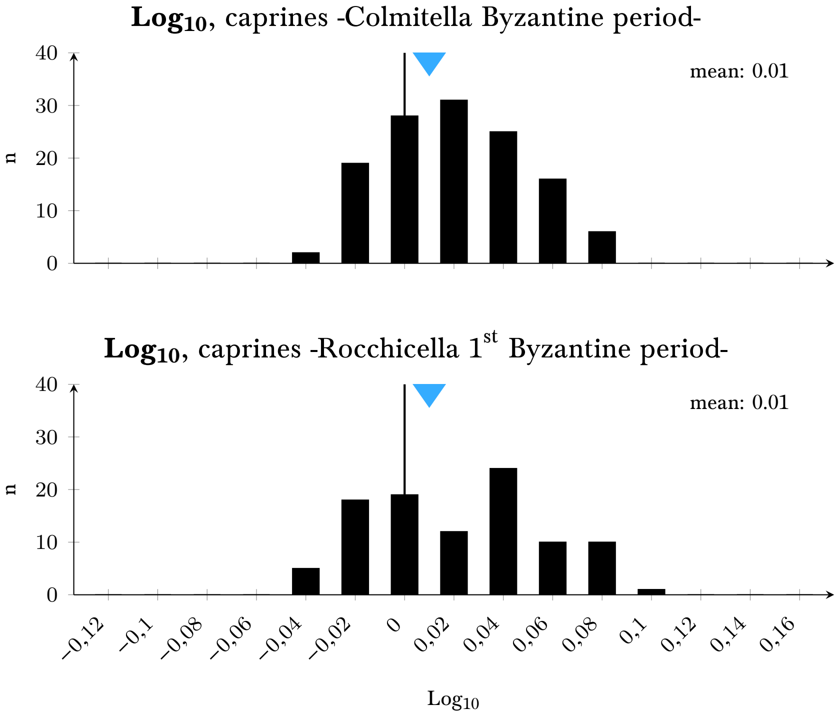
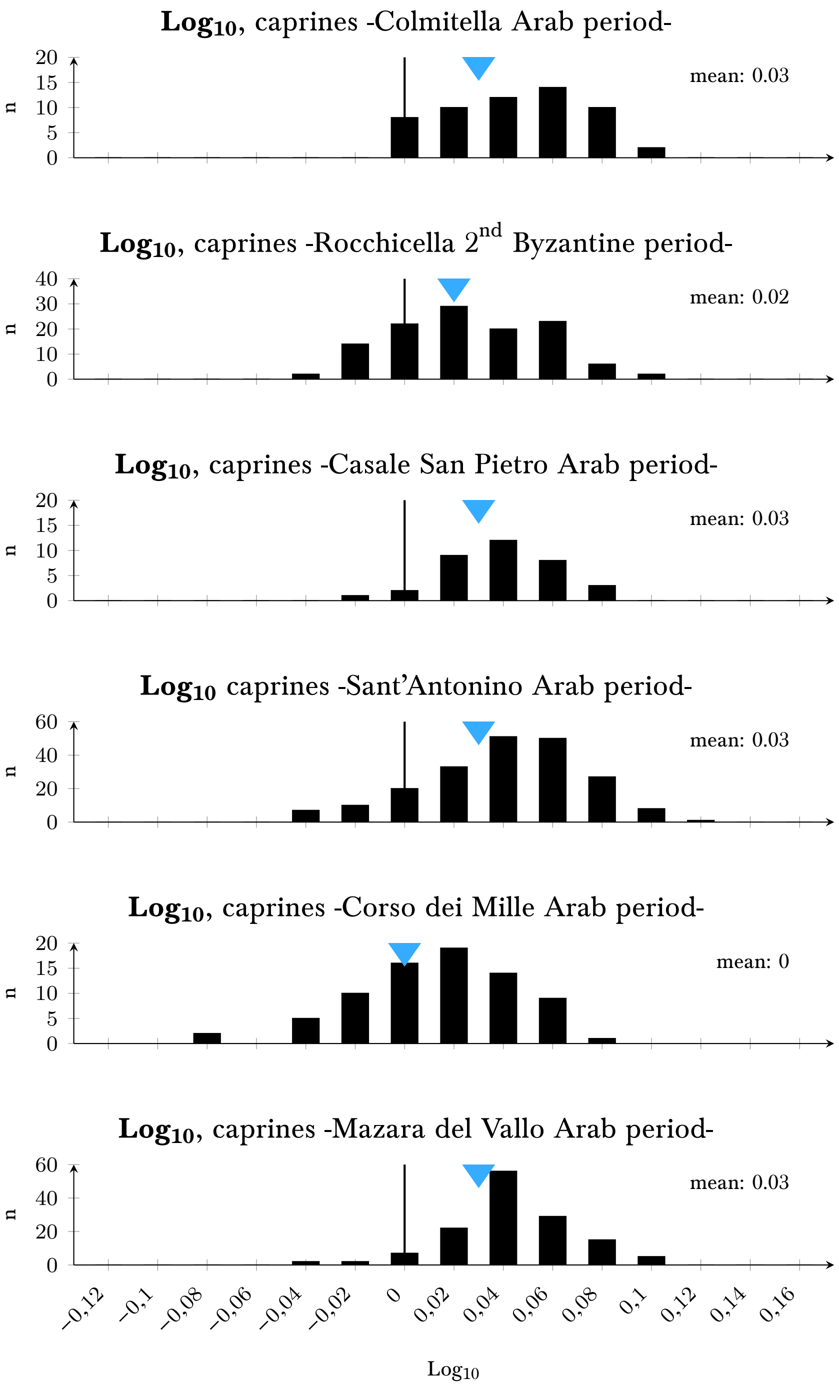


**Figure 6.6.48.** Comparisons of caprine post-cranial measurements from the Byzantine period at Colmitella (n:132) and from the 1st Byzantine period at Rocchicella (n:117). The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

To further investigate caprine size in the Arab period, a comparison of log ratio histograms (caprine post-cranial widths and depths) from different site-types was made (Fig.6.6.49). Overall, caprines from the sites Arab sites (Colmitella, Casale San Pietro, Sant'Antonino and Mazara del Vallo) appear to very consistent in size, with the exception of Arab Corso dei Mille, where the animals are clearly smaller. $2^{nd}$ Byzantine Rocchicella is intermediate between these two size groups.



**Log$_{10}$**, caprines -Colmitella Arab period-

**Log$_{10}$**, caprines -Rocchicella 2$^{nd}$ Byzantine period-

**Log$_{10}$**, caprines -Casale San Pietro Arab period-

**Log$_{10}$** caprines -Sant'Antonino Arab period-

**Log$_{10}$**, caprines -Corso dei Mille Arab period-

**Log$_{10}$**, caprines -Mazara del Vallo Arab period-

**Figure 6.6.49.** Comparisons of log ratio histograms for width/depth measurements of sheep post-cranial elements from Colmitella (n:56), Rocchicella (n:117), Casale San Pietro (n:35), Sant'Antonino (n:215), Corso dei Mille (n;76) and Mazara del Vallo (n:140) in the Arab period (Rocchicella, 2$^{nd}$ Byzantine period). The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

*Cattle* – As mentioned at the beginning of this subchapter, width and depth measurements of cattle post-cranial bones from the Byzantine and the Arab periods at Colmitella had to be plotted together into two log ratio histograms, due to the dearth of biometrical data (Fig.6.6.50).

In the Byzantine period, the histogram displays a bimodal distribution, possibly related to sexual dimorphism. This is not evident for the Arab period. A slight increase in size between the two periods is detectable, but whether this is due to a genuine average increase in the size of the animals, or a slightly higher incidence of castrates, is hard to establish.

This potential increase in cattle size is confirmed by the Student's *t*-test (*p*: 0.032), indicating that statistically significant size change in cattle occurred between the two periods.

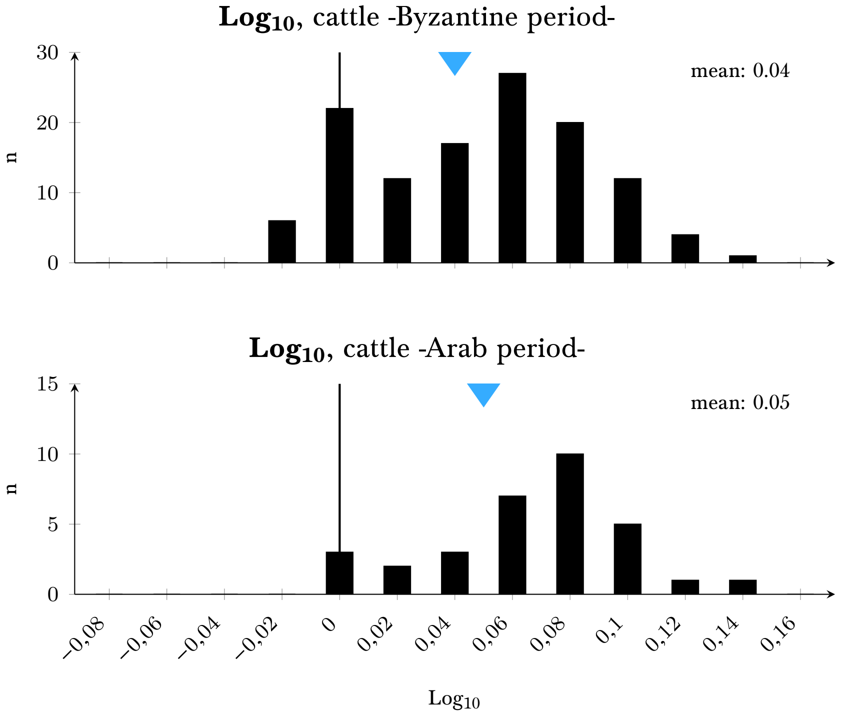


**Figure 6.6.50.** Comparison of cattle post-cranial measurements from the Byzantine period and the Arab period at Colmitella. Log ratio histogram for width and depth measurements of cattle from the Byzantine period (n:121) and from the Arab period (n:32). The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements of cattle bones from the Late Iron Age at the site of Heybridge, Essex (UK) (Albarella *et al.* 2008) (*§Chapter 5: Methodology*).

Measurements of cattle post-cranial elements from the Byzantine and the Arab periods at Colmitella were then compared with those from the Arab and the Norman/Swabian periods at Mazara del Vallo (Fig.6.6.51).

It is difficult to fully support an increase in cattle size between Byzantine and Arab Colmitella; at the same time, a decrease between Arab and Norman/Swabian Mazara could be affected by a lower incidence of males in the latter period, as the group of larger males could be underrepresented or absent.

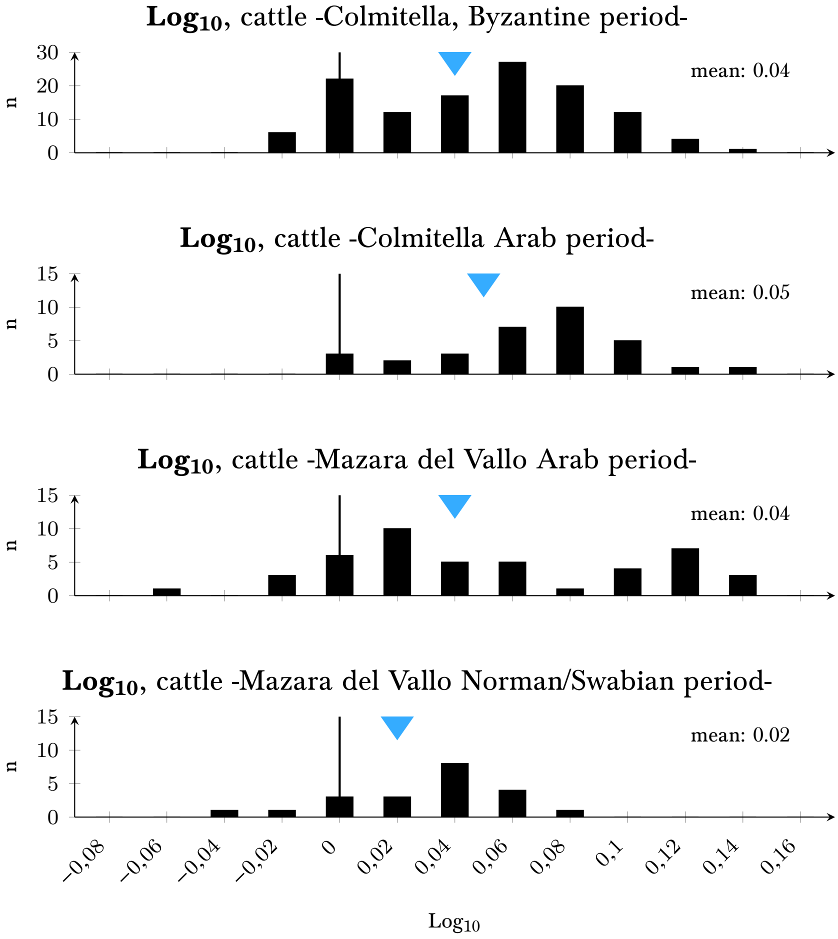


**Figure 6.6.51.** Comparisons of cattle post-cranial measurements from the Byzantine and the Arab periods at Colmitella, and from the Arab and the Norman/Swabian periods at Mazara del Vallo. Log ratio histograms for width and depth measurements of cattle from the Byzantine period (n:121) and from the Arab period (n:32) at Colmitella, and from the Arab period (n:44) and the Norman/Swabian period at Mazara del Vallo (n:27). The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements of cattle bones from the Late Iron Age at the site of Heybridge, Essex (UK) (Albarella *et al.* 2008) (*§Chapter 5: Methodology*).

*Suids* – The nature, either domestic and/or wild, of the suid populations present in the Byzantine and in the Arab periods at Colmitella has been investigated by analysing measurements from mandibular and maxillary teeth (i.e. crown lengths, anterior and poster crown widths); these were merged together into two log ratio histograms (Fig.6.6.52). There does not seem to be much difference in size between the two periods, and in both the measurements plot roughly uni-modally, with the occurrence in each of very few larger outliers. The most parsimonious explanation is that the bulk of animals belongs to the domestic form and that the outliers represent wild boar.

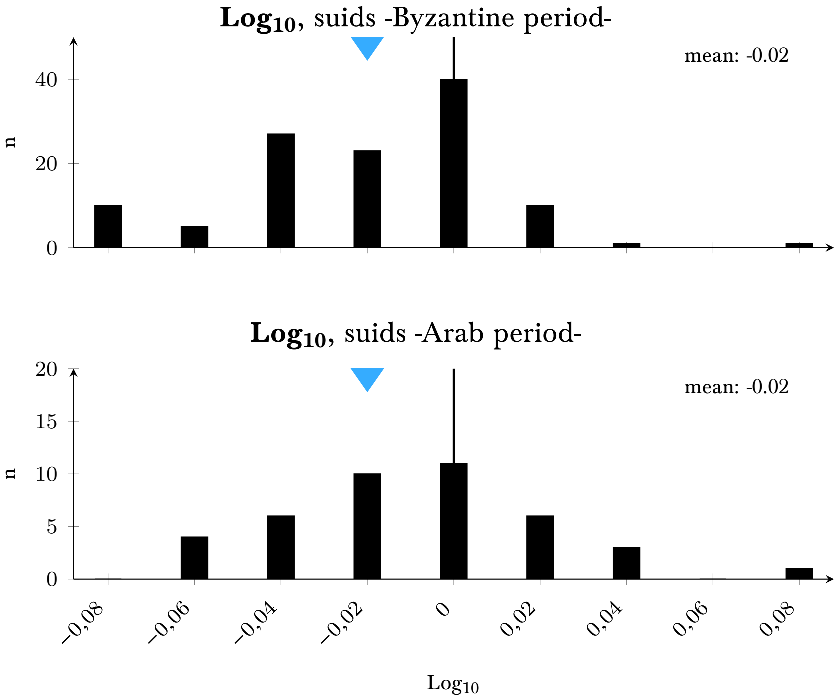
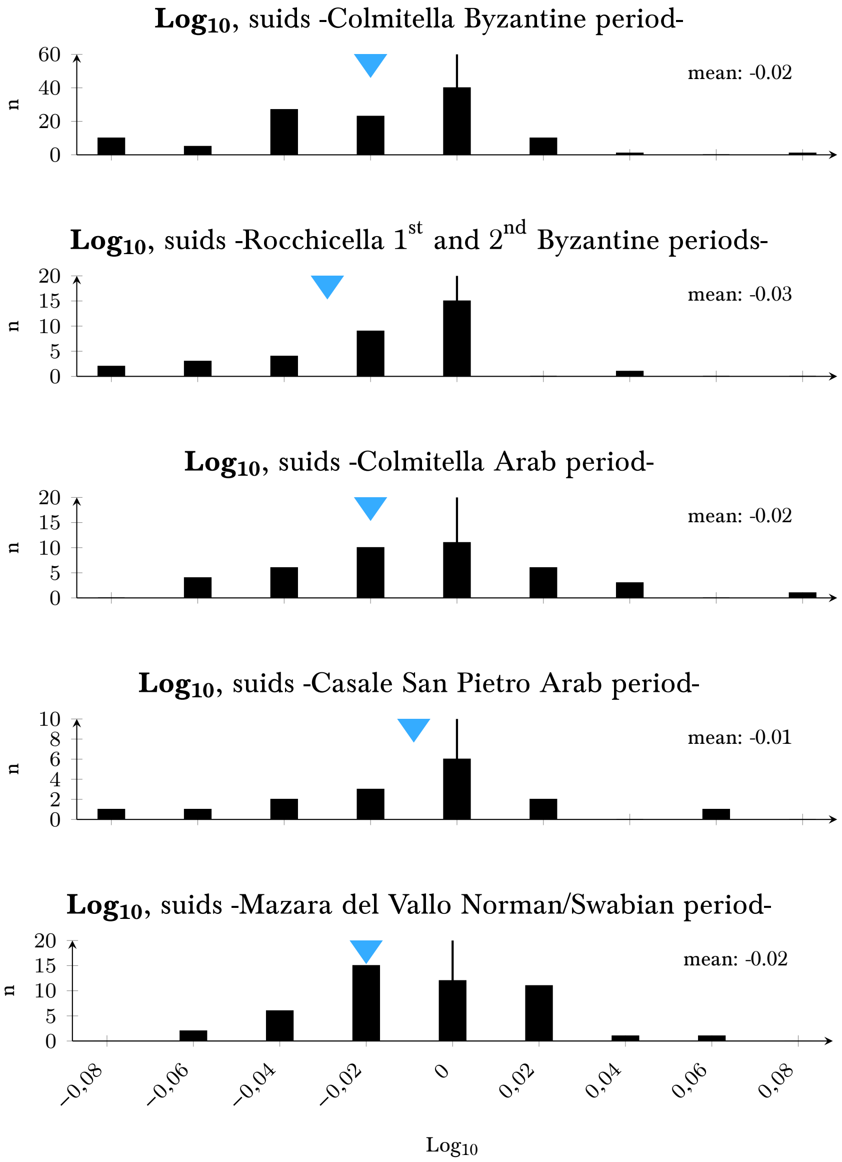


**Figure 6.6.52.** Comparisons of suid teeth measurements from the Byzantine period and the Arab period at Colmitella. Log ratio histogram for crown lengths and anterior and posterior crown widths of mandibular and maxillary molars of suids from the Byzantine period (n:117) and for the Arab period (n:41) The triangle indicates the logarithmic mean. The standard used (black line) was the mean of measurements of pig mandibular and maxillary teeth from the Neolithic site of Durrington Walls (UK) (Albarella and Payne 2005) (*§Chapter 5: Methodology*).

Measurements of suid teeth from Byzantine and Arab Colmitella were then compared with those from Rocchicella (2nd Byzantine period), Casale San Pietro (Arab period) and from Mazara del Vallo (Norman/Swabian period) (Fig.6.6.53). Although there is some variation in size between sites and phases, this is not substantial and does not follow a clear chronological trend. Odd large outliers (wild boar?), such as those recorded for Colmitella, are also found at other sites. It therefore seems that most pigs are domestic and that wild boar hunting was widespread but did not contribute substantially to the diet.



**Log$_{10}$**, suids -Colmitella Byzantine period-

**Log$_{10}$**, suids -Rocchicella 1st and 2nd Byzantine periods-

**Log$_{10}$**, suids -Colmitella Arab period-

**Log$_{10}$**, suids -Casale San Pietro Arab period-

**Log$_{10}$**, suids -Mazara del Vallo Norman/Swabian period-

**Figure 6.6.53.** Comparisons of suid teeth measurements from Colmitella, Rocchicella, Casale San Pietro and Mazara del Vallo. Log ratio histograms for crown lengths and anterior and posterior crown widths of mandibular and maxillary molars of suids from Colmitella (n:117) and Rocchicella (n:33) in the Byzantine period, from Colmitella (n:41) and Casale San Pietro (n:15) in the Arab period, and from Mazara del Vallo (n:47) in the Norman/Swabian period. The triangles indicate the logarithmic means. The standard used (black line) is the mean of measurements of pig mandibular and maxillary teeth from the Neolithic site of Durrington Walls (UK) (Albarella and Payne 2005) (*§Chapter 5: Methodology*).

### 6.6.10. Associated animal bone groups (ABGs)

During archaeological excavations at the site of Colmitella, a number of associated animal bone groups (ABGs) (Morris 2011) were hand-collected from different pits (US 2460, 2546, 2637 and US 2720); these included six partial skeletons, one of which belonged to a red deer, four to cattle, and one to a suid.

Most of these animal skeletons were placed at the top and/or at the bottom of the pit fills; the anatomical elements composing the animal carcasses were still found in anatomical connection, thus suggesting that post-depositional processes had only partially disturbed their primary deposition.

Associated archaeological materials (mainly pottery remains) found within the above-mentioned archaeological contexts were preliminary dated to the Byzantine period; however, the presence of a few (probably intrusive) pottery fragments from the Arab period has also been attested (Domenico Romano personal comment, October 2015). The study of pottery remains recovered from the pits is still ongoing; additional analyses will be carried out in the near future to validate or disprove the chronology suggested so far.

#### *6.6.10.1. Red deer skeleton (US 2476)*

A red deer carcass (US 2476) was found in primary deposition in pit US 2460, which was located along some building structures; the animal laid on its right side, with the head presumably facing south[2] (Fig.6.6.54). The skeleton lied on a layer of tiles and, to a lesser extent, of other types of ceramic remains and medium-sized stones (Fig.6.6.55).

The majority of body parts were found in anatomical connection (Fig.6.6.56), while a few were not (i.e. ribs and small-sized bones, such as carpals and tarsals); the position of these latters is likely to be the result of post-depositional processes

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[2] As few cranial bones were present, the orientation of the head is suggested by the general position of the skeleton and by the few cranial fragments recovered *in situ*.

that may have partially disturbed the archaeological context in which the red deer had been deposited.

Ageing data from the epiphyseal fusion analysis indicate that the individual was about two-three years old (26-29 months) (Tab.6.6.6). The presence of an antler indicates that the red deer was a male.

All the anatomical elements were present, with the exception of some parts of the cranium (i.e. one antler, maxillae and one zygomaticus) and one 3rd phalanx (Fig.6.6.57); the lack of such elements could be a combination of both taphonomic processes and recovery bias. The missing antler could have been deliberately removed before deposition. Rodents and/or carnivores did not have access to the buried red deer, as no bones had been gnawed. Evidence of root etchings was rather uncommon. No recorded elements showed butchery marks and/or burning evidence, suggesting that the animal had not been processed prior to final deposition; hence, its meat was not consumed. In addition, no pathological evidence was recorded.

**Figure 6.6.54**. Colmitella, Byzantine period. Red deer skeleton US 2476 recovered within pit US 2460.

**Figure 6.6.55.** Colmitella, Byzantine period. Details of the red deer skeleton US 2476, surrounded by tiles, other types of pottery and small-medium-sized stones.

**Figure 6.6.56.** Colmitella, Byzantine period. Limbs of the red deer carcass US 2476 recovered in anatomical connection.

| Red deer skeleton (US 2476) -Byzantine period- | | | | |
|---|---|---|---|---|
| **Anatomical element** | **Fused** | **Fusing** | **Unfused** | **Comments** |
| Antler | - | - | - | n:1 present; well developed beam, several tines present |
| Mandible | - | - | - | $P_2$, $P_3$, $P_4$, $M_1$ $M_2$ and $M_3$, not heavily worn (left and right) |
| Atlas | - | - | - | vertebral body fused |
| Axis | - | - | - | vertebral body fused |
| Scapula | X | | | |
| Humerus p. | | | X | proximal unfused epiphyses also present |
| Humerus d. | X | | | |
| Ulna p. | | | X | proximal unfused epiphyses present |
| Radius p. | X | | | |
| Radius d. | | | X | distal unfused epiphyses also present |
| Carpal 3 | - | - | - | ossified |
| Metacarpal | | X | | |
| Pelvis | X | | | |
| Femur p. | | | X | proximal unfused epiphyses also present |
| Femur d. | | | X | distal unfused epiphyses also present |
| Tibia p. | | | X | proximal unfused epiphyses also present |
| Tibia d. | | | X | distal unfused epiphyses also present |
| Astragalus | - | - | - | ossified |
| Calcaneum | | X | | |
| Scaphocuboid | - | - | - | ossified |
| Metatarsal | | X | | |
| 1st phalanx | X | | | |
| 2nd phalanx | X | | | |
| 3rd phalanx | X | | | n:7 present |

**Table 6.6.6.** Colmitella, Byzantine period. Red deer skeleton US 2476. Complete list of recorded anatomical elements and their epiphyseal fusion stages. Additional comments on the right column. The age has been estimated according to Silver's work (1969) (*§Chapter 5: Methodology*).

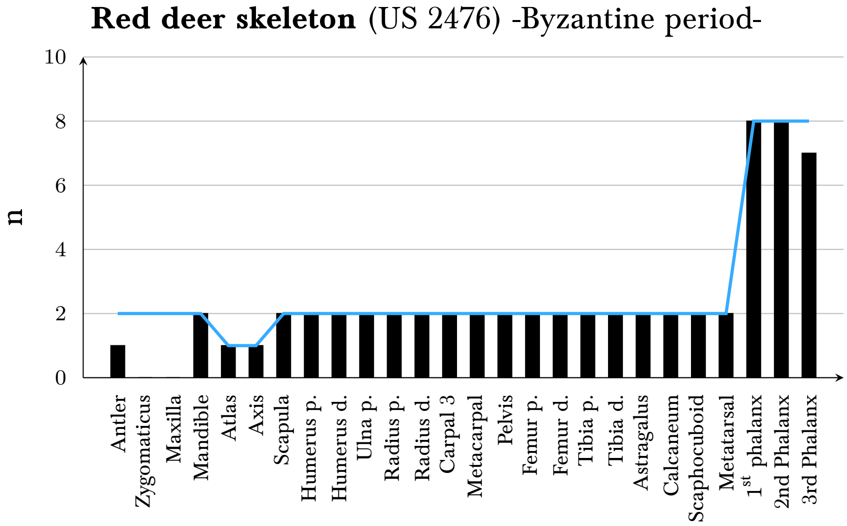

**Figure 6.6.57**. Colmitella, Byzantine period. Recorded (black columns) and expected (blue line) anatomical elements of the red deer skeleton US 2476 found in pit US 2460.

### *6.6.10.2. Suid skeleton (US 2477)*

In addition to the red deer skeleton, a second group of bones and teeth attributed to a suid (US 2477) was recovered in the same pit (US 2460); this was located west of the red deer carcass (Fig.6.6.58).

With the exception of some cervical and lumbar vertebrae, most bones composing the skeleton were not found in anatomical connection; considering the very young age of the buried animal (see below), this result is likely to be a consequence of taphonomic processes, which are likely to have affected the preservation and position of the more fragile and highly porous elements characterising very young animals.

The epiphyseal fusion and the mandibular wear stage data suggest that this individual was juvenile (<ca. 12 months) (Tab.6.6.7 and Tab.6.6.8). Most bones of the post-cranial skeleton were missing, (small-sized bones, such as tarsals, carpals and phalanges, were completely absent), while some cranial elements were present (zygomaticus, mandibles and one maxilla). Most upper and lower limbs elements survived only as fragments (Fig.6.6.59).

Butchery and burning marks were not present on any recorded anatomical elements, thus suggesting that, similarly to the red deer, the meat from this individual had not been consumed. In addition, no gnawing marks nor pathological evidence were recorded.

**Figure 6.6.58.** Colmitella, Byzantine period. The red oval indicates the position of the suid partial skeleton US 2477 recovered within pit US 2460.

| **Suid skeleton (US 2477) -Byzantine period-** | | | | |
|---|---|---|---|---|
| **Anatomical element** | **Fused** | **Fusing** | **Unfused** | **Comments** |
| Zygomaticus | - | - | - | fragments of other parts of the cranium present (e.g. temporal) |
| Maxilla | - | - | - | $dI^1$, $dI^2$, $dI^3$, C (in crypt), $dP^1$, $dP^4$ (only left side present) |
| Mandible | - | - | - | $dI_1$, $dI_2$, $dI_3$, C (in crypt), $dP_4$, $M_1$ (left and right sides present) |
| Scapula | | | X | perinatal |
| Humerus d. | | | X | perinatal |
| Metacarpal | | | X | perinatal |
| Pelvis | | | X | perinatal |
| Tibia p. | | | X | perinatal |
| Tibia d. | | | X | perinatal |
| Calcaneum | | | X | perinatal |
| Metatarsal | | | X | perinatal |

**Table 6.6.7.** Colmitella, Byzantine period. Suid skeleton US 2477. Complete list of recorded anatomical elements and their epiphyseal fusion stages. Additional comments on the right column. The age has been estimated according to Silver's work (1969) (*§Chapter 5: Methodology*).

| **Suid skeleton (US 2477) -Byzantine period-** | |
|---|---|
| **Mandibular teeth** | **Tooth eruption/wear stage** |
| $dP_4$ | d |
| $M_1$ | H |
| **Estimated age**: 'juvenile' (according to O'Connor 1988) | |

**Table 6.6.8.** Colmitella, Byzantine period. Suid skeleton US 2477. List of mandibular teeth present and their eruption/wear stages (according to O'Connor 1988 and Ewbank 1967) (*§Chapter 5: Methodology*). When the side of the analysed tooth is not specified, the stage refers to both the right and the left sides.

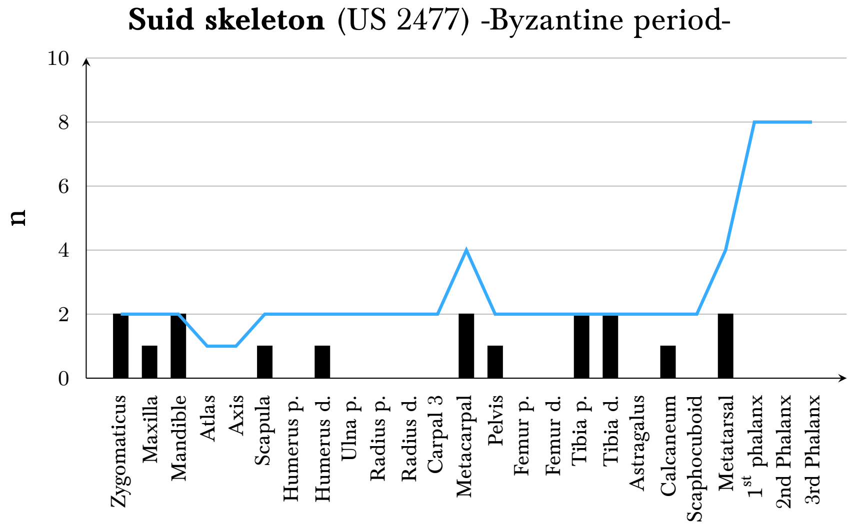

**Figure 6.6.59**. Colmitella, Byzantine period. Recorded (black columns) and expected (blue line) anatomical elements of the suid carcass US 2477 found in pit US 2460.

### *6.6.10.3. Cattle skeleton (US 2547 and US 2548)*

A third associated group of bones and teeth referring to a partial cattle skeleton (US 2547 and US 2548) was found in pit US 2546. During the excavation, it was decided to regard the archaeological context in which the cattle carcass was found as part of two separated stratigraphic units (US 2547 and US 2548), as the animal carcass seemed to have been deliberately divided into two different parts separated from each other by small and medium-sized stones.

Most body parts were still in anatomical connection, while a few were not; this was most likely the result of post-depositional processes which disturbed their original anatomical position (Fig.6.6.60). The animal presumably laid on its right side, with the head facing south; however, as all parts composing the skull survived only as fragments, it was impossible to reconstruct its original position fully.

Data from the epiphyseal fusion and the mandibular wear stage analyses suggest that the individual was a juvenile (ca.12-18 months) (Tab.6.6.9 and Tab.6.6.10). The anatomical element distribution analysis reveals that almost all anatomical body parts were present, with the exception of some cranial elements (e.g. zygomaticus, one maxilla, and the potential presence of horncores) and one 2nd phalanx (Fig.6.6.61); the absence of such elements could be a combination of both post-depositional disturbance and recovery bias.

Neither pathologies nor gnawing marks on the bone surface have been detected. In addition, as no recorded elements of the cattle carcass showed butchery marks and/or burning evidence, it is likely that the animal was buried whole.

**Figure 6.6.60.** Colmitella, Byzantine period. Cattle skeleton US 2547 and US 2548 recovered within pit US 2546.

| **Cattle burial (US 2547 and US 2548) -Byzantine period-** | | | | |
|---|---|---|---|---|
| **Anatomical element** | **F** | **G** | **UD** | **Comments** |
| Maxilla | - | - | - | $\mathrm{dP}_3$-$\mathrm{dP}_4$-$\mathrm{M}_1$-$\mathrm{M}_2$ (right side present) |
| Mandible | - | - | - | $\mathrm{dP}_3$-$\mathrm{dP}_4$-$\mathrm{M}_1$-$\mathrm{M}_2$ |
| Atlas | - | - | - | vertebral body fused |
| Axis | - | - | - | vertebral body fused |
| Scapula | X | | | |
| Humerus p. | | | X | proximal unfused epiphyses also present |
| Humerus d. | | X | | |
| Ulna p. | | | X | proximal unfused epiphyses present |
| Radius p. | | X | | |
| Radius d. | | | X | distal unfused epiphyses also present |
| Carpal 3 | - | - | - | not fully ossified |
| Metacarpal | | | X | proximal unfused epiphyses also present |
| Pelvis | X | | | |
| Femur p. | | | X | proximal unfused epiphyses also present |
| Femur d. | | | X | distal unfused epiphyses also present |
| Tibia p. | | | X | proximal unfused epiphyses also present |
| Tibia d. | | | X | distal unfused epiphyses also present |
| Astragalus | X | - | - | not ossified |
| Calcaneum | | | X | unfused epiphyses also present |
| Scaphocuboid | - | - | - | not fully ossified |
| Metatarsal | | | X | proximal unfused epiphyses also present |
| 1st phalanx | X | | | |
| 2nd phalanx | X | | | n:7 present |
| 3rd phalanx | X | | | |

**Table 6.6.9**. Colmitella, Byzantine period. Cattle skeleton US 2547 and US 2548. Complete list of recorded anatomical elements and their epiphyseal fusion stages (i.e. F: fused, G: fusing; UD: unfused). Additional comments on the right column. The age has been estimated according to Silver's work (1969) (*§Chapter 5: Methodology*).

| **Cattle burial (US 2547 and US 2548) -Byzantine period-** | |
|---|---|
| **Mandibular teeth** | **Tooth eruption/wear stage** |
| dP4 | k |
| M1 | H |
| M2 | C |
| **Estimated age**: ‘juvenile’ (according to O’Connor) | |

**Table 6.6.10.** Colmitella, Byzantine period. Cattle skeleton (US 2547 and US 2548). List of mandibular teeth present and their eruption/wear stages (according to O’Connor 1988 and Ewbank 1967) (§*Chapter 5: Methodology*). When the side of the analysed tooth is not specified, the stage refers to both the right and the left sides.

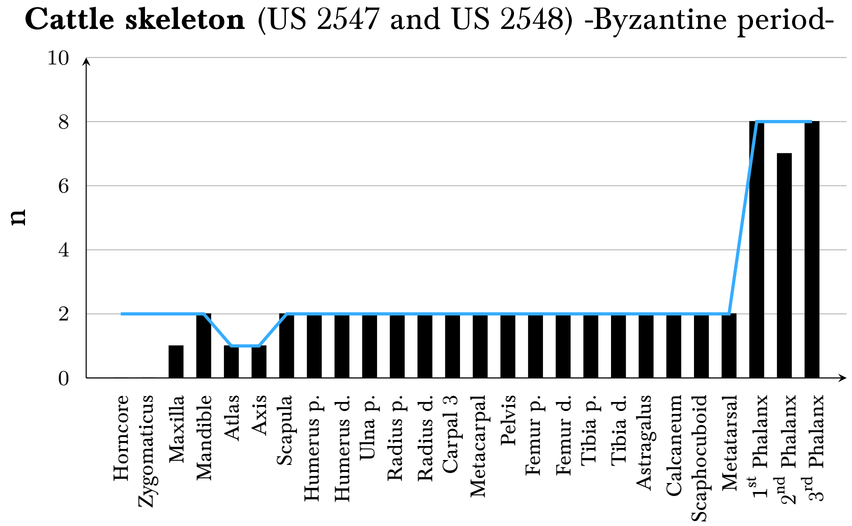

**Figure 6.6.61.** Colmitella, Byzantine period. Recorded (black columns) and expected (blue line) anatomical elements of the cattle skeleton (US 2547 and US 2548).

### *6.6.10.4. Cattle skeleton (US 2648)*

A fourth associated group of bones and teeth belonging to a partial cattle skeleton (US 2648) was found at Colmitella in pit US 2637. The individual was laid on its left side, with the head facing south; it was partially surrounded by medium and large-sized stones, which seemed to have been disposed by way of a small fence. Most anatomical elements were still in anatomical connection, while others were not, as they had been affected by post-depositional processes that compromised their original position (Fig.6.6.62).

The epiphyseal fusion analysis of post-cranial bones reveals that the animal was aged between 42-48 months (3 ½ - 4 years) (Tab.6.6.11). The mandibular wear stage analysis validated this result, confirming the presence of an adult cattle (Tab.6.6.12).

The anatomical elements distribution analysis (Fig.6.6.63) shows that most cranial elements (with the exception of the potential presence of horncores) and forelimbs (both right and left sides) were present, while the pelvis and most hindlimbs were absent. In addition, phalanges were present, although not all sets were complete; this suggests that some of them were recovered during the archaeological excavation and/or some feet were disposed of elsewhere at the site; these two hypotheses could also be valid for the near completely missing lower limbs and horncores (although we cannot assume that these latter were present).

Butchery marks have been detected on four 1st phalanges; these consist of parallel cuts inferred on the frontal side of the bone (Fig.6.6.64). Such marks are likely to be associated with skinning. Neither gnawing and/or burning marks nor pathologies evidence were noted on any of the bones.

**Figure 6.6.62.** Colmitella, Byzantine period. Cattle skeleton US 2648 recovered within pit US 2637.

| **Cattle skeleton (US 2648) -Byzantine period-** | | | | |
|---|---|---|---|---|
| **Anatomical element** | **Fused** | **Fusing** | **Unfused** | **Comments** |
| Maxilla | - | - | - | $P^2$, $P^3$, $P^4$, $M^1$, $M^2$, $M^3$ (left and right sides present) |
| Mandible | - | - | - | $P_2$, $P_3$, $P_4$, $M_1$, $M_2$, $M_3$ (left and right sides present) |
| Atlas | - | - | - | vertebral body fused |
| Axis | - | - | - | vertebral body fused |
| Scapula | X | | | |
| Humerus p. | | X | | |
| Humerus d. | X | | | |
| Ulna p. | | X | | |
| Radius p. | X | | | |
| Radius d. | | X | | |
| Carpal 3 | - | - | - | ossified |
| Metacarpal | X | | | |
| 1st phalanx | X | | | n:4 present; butchery marks on ventral side |
| 2nd phalanx | X | | | n:4 present |
| 3rd phalanx | X | | | n:4 present |

**Table 6.6.11.** Colmitella, Byzantine period. Cattle skeleton US 2648. Complete list of recorded anatomical elements and their epiphyseal fusion stages (i.e. F: fused, G: fusing; UD: not-fused). Additional comments on the right column. The age has been estimated according to Silver's work (1969).

| **Cattle skeleton (US 2648) -Byzantine period-** | |
|---|---|
| **Mandibular teeth** | **Tooth eruption/wear stage** |
| P4 | f (left); g (right) |
| M1 | k |
| M2 | j |
| M3 | g |
| **Estimated age**: 'adult' (according to O'Connor) | |

**Table 6.6.12.** Colmitella, Byzantine period. Cattle skeleton (US 2648). List of mandibular teeth present and their eruption/wear stages (according to O'Connor 1988 and Ewbank) (*§Chapter 5: Methodology*). When the side of the analysed tooth is not specified, the stage refers to both the right and the left sides.

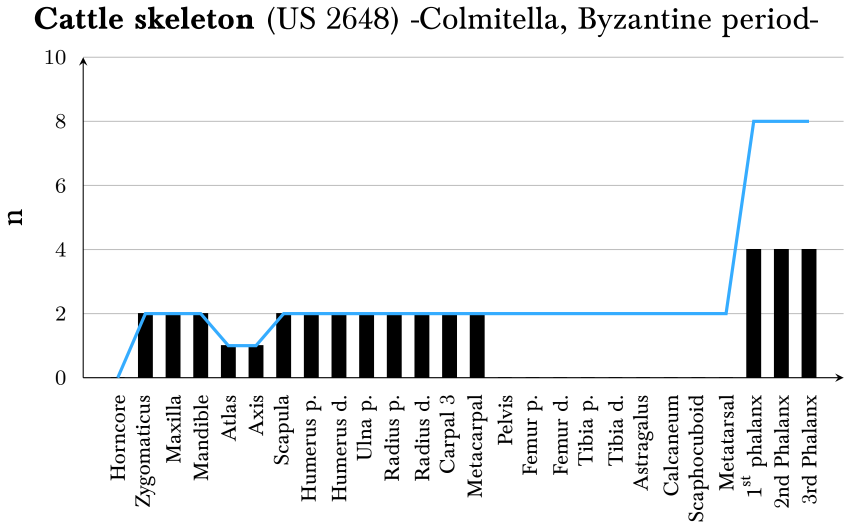

**Figure 6.6.63**. Colmitella, Byzantine period. Recorded (black columns) and expected (blue line) anatomical elements of the cattle skeleton, US 2648.

**Figure 6.6.64**. $1^{st}$ phalanges of the partial cattle skeleton US 2648 with cut marks on their frontal side.

### *6.6.10.5. Cattle skeleton (US 2731)*

Another cattle skeleton (US 2731) was found in pit US 2720. The animal was surrounded by small and medium-sized stones, which clearly defined its perimeter (Fig.6.6.65). It laid on its right side, with the head facing north. Most anatomical elements (including small-sized bones such as carpals, tarsals and phalanges) were found in anatomical connection, suggesting that post-depositional processes had not severely compromised the archaeological context in which the animal was originally buried (Fig.6.6.66).

Ageing data from the epiphyseal fusion analysis reveal that the individual was less then 6-10 months old (Tab.6.6.13), possibly neonatal, as the proximal ends of its metapodials had not yet ossified. The mandibular wear stage analysis was prevented by the absence of mandibles.

Most anatomical elements were present, with the exception of cranial elements (i.e. mandibles and maxillae), one $1^{st}$ phalanx, two $2^{nd}$ phalanges and one $3^{rd}$ phalanx (Fig.6.6.67). Such absences could be the consequence of the lack of systematic sieving as well as of taphonomic processes; these are likely to have affected the preservation of the more fragile and highly porous elements characterising very young animals.

No butchery, burning evidence or pathologies were detected on the bones. The condition of the skeleton suggests that the neonatal cattle was buried whole.

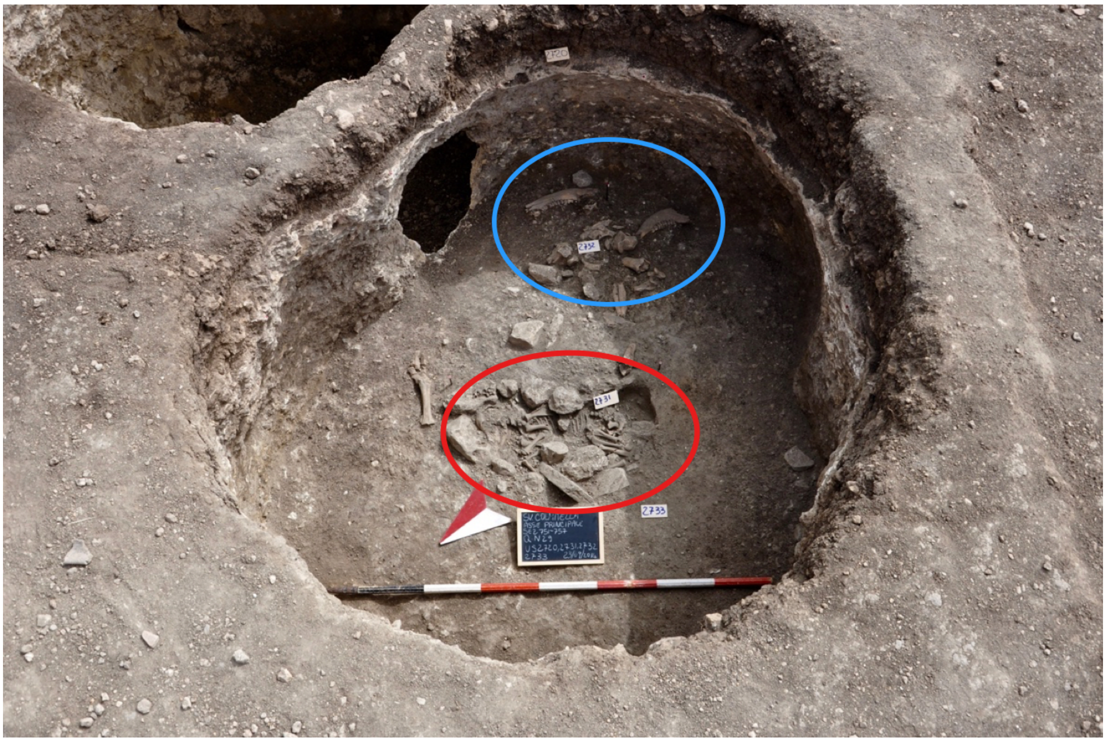

**Figure 6.6.65**. Colmitella, Byzantine period. The red oval indicates the position of the cattle skeleton (US 2731) recovered within pit US 2720.

**Figure 6.6.66.** Colmitella, Byzantine period. Body parts of the cattle carcass (US 2731) found in anatomical connection.

| **Cattle skeleton (US 2731) –Byzantine period-** | | | | |
|---|---|---|---|---|
| **Anatomical element** | **Fused** | **Fusing** | **Unfused** | **Comments** |
| Zygomaticus | - | - | - | |
| Atlas | - | - | - | vertebral body unfused |
| Axis | - | - | - | vertebral body unfused |
| Scapula | | | X | |
| Humerus p. | | | X | proximal unfused epiphyses also present |
| Humerus d. | | | X | distal unfused epiphyses also present |
| Ulna p. | | | X | proximal unfused epiphyses present |
| Radius p. | | | X | Proximal unfused epiphyses present |
| Radius d. | | | X | distal unfused epiphyses also present |
| Carpal 3 | - | - | - | not fully ossified |
| Metacarpal | | | X | distal unfused epiphyses also present |
| Pelvis (acetabulum) | | | X | |
| Femur p. | | | X | proximal unfused epiphyses also present |
| Femur d. | | | X | distal unfused epiphyses also present |
| Tibia p. | | | X | proximal unfused epiphyses also present |
| Tibia d. | | | X | distal unfused epiphyses also present |
| Astragalus | - | - | - | not fully ossified |
| Calcaneum | | | X | unfused epiphyses also present |
| Scaphocuboid | - | - | - | not fully ossified |
| Metatarsal | | | X | distal unfused epiphyses also present |
| 1st phalanx | | | X | n:7 present. Proximal unfused epiphyses also present |
| 2nd phalanx | | | X | n:6 present |
| 3rd phalanx | | | X | n:7 present |

**Table 6.6.13.** Colmitella, Byzantine period. Cattle skeleton US 2731. Complete list of recorder anatomical elements and their epiphyseal fusion stages. Additional comments on the right column. The age has been estimated according to Silver's Work (1969).

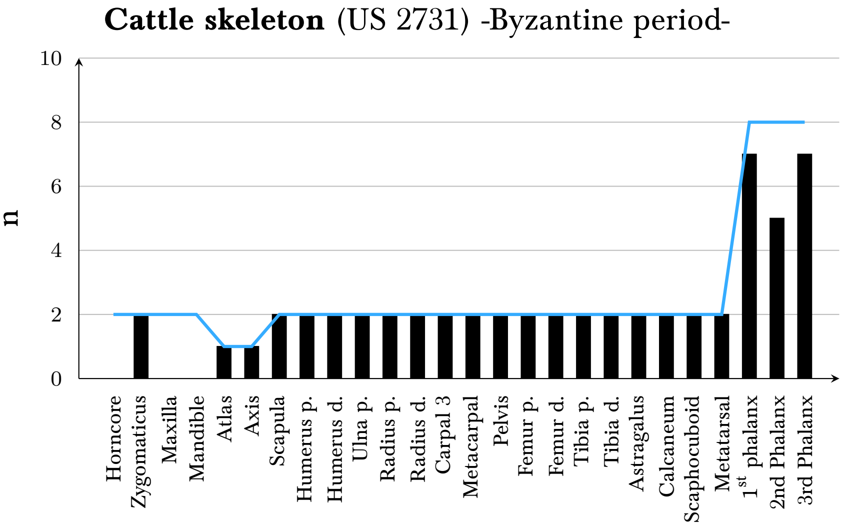

**Figure 6.6.67**. Colmitella, Byzantine period. Recorded (black columns) and expected (blue line) anatomical elements of the cattle skeleton, US 2731.

#### *6.6.10.6. Cattle skeleton (US 2732)*

A second partial cattle carcass (US 2732) was recovered from the same pit (US 2720). Most anatomical elements were not found in anatomical connection, suggesting that post-depositional processes had strongly compromised the archaeological context in which the animal was buried (Fig.6.6.68). Such conditions and the high fragmentation characterising most of the recorded elements did not allow drawing any potential conclusions about the original position of the skeleton. It is also possible that the carcass had originally been disposed into pieces.

Ageing data from the epiphyseal fusion stage of post-cranial bones and mandibular wear stage analyses indicate that the individual was an adult (>42-48 months) (Tab.6.6.14 and Tab.6.6.15).

The anatomical element distribution analysis shows that lower limbs were present, while some upper limbs, vertebrae and ribs, as well as smaller anatomical elements (i.e. carpals, tarsals and phalanges), were scarcely represented, if not completed absent. Cranial elements were present, with the exception of maxillae and horncores (although these might have been absent) Fig.6.6.69. No butchery, burning evidence or pathologies were detected on the bones, suggesting that this animal was not processed prior to its burial.

**Figure 6.6.68**. Colmitella, Byzantine period. The blue oval indicates the position in which the cattle skeleton US 2732 was found, while the red oval indicates the location of cattle skeleton US 2731. Both cattle skeletons were recovered within pit US 2720.

| **Cattle skeleton (US 2732) -Byzantine period-** | | | | |
|---|---|---|---|---|
| **Anatomical element** | **Fused** | **Fusing** | **Unfused** | **Comments** |
| Zygomaticus | - | - | - | |
| Mandible | - | - | - | $P_2$, $P_3$, $P_4$, $M_1$, $M_2$, $M_3$ (left and right sides) |
| Metacarpal | X | | | |
| Femur d. | X | | | |
| Tibia d. | X | | | |
| Astragalus | - | - | - | not fully ossified |
| Calcaneum | X | | | |
| Scaphocuboid | - | - | - | not fully ossified |
| 1st phalanx | X | | | n:2 present |
| 2nd phalanx | X | | | n:2 present |
| 3rd phalanx | X | | | n:2 present |

**Table 6.6.14.** Colmitella, Byzantine period. Cattle skeleton US 2732. Complete list of recorded anatomical elements and their epiphyseal fusion stages (i.e. F: fused, G: fusing; UD: not-fused). Additional comments on the right column. The age has been estimated according to Silver's work (1969).

| **Cattle skeleton (US 2732) -Byzantine period-** | |
|---|---|
| **Mandibular teeth** | **Tooth eruption/wear stage** |
| $P_4$ | g |
| $M_1$ | k |
| $M_2$ | k |
| $M_3$ | g |
| **Estimated age**: 'adult' (according to O'Connor) | |

**Table 6.6.15.** Colmitella, Byzantine period. Cattle skeleton US 2732. List of mandibular teeth present and their eruption/wear stages (according to O'Connor 1988 and Ewbank) (*§Chapter 5: Methodology*). When the side of the analysed tooth is not specified, the stage refers to both the right and the left sides.

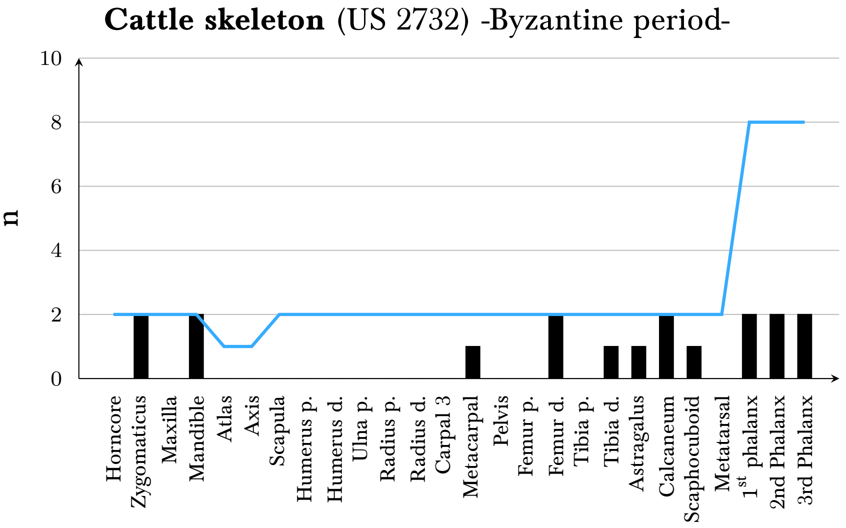

**Figure 6.6.69**. Colmitella, Byzantine period. Recorded (black columns) and expected (blue line) anatomical elements of the cattle skeleton, US 2732.

All in all, considering the archaeological contexts in which the animals were buried, as well as the recovered material culture, there is little doubt that all these associated animal bone groups (ABGs) are the result of human activities.

Despite the intriguing ritual and/or functional natures of these burials (Morris 2011), their interpretation is still ongoing and unlikely to contribute substantially to the research questions of this study. This evidence will be part of a future research project.

## 6.7. Rocchicella

The faunal assemblage from Rocchicella (Mineo, Catania) includes 785 recorded specimens, of which 634 were also countable; of these, 263 date to the 6th-7th centuries AD, and 371 to the 9th century AD. The earlier phase will be referred to as the '1st Byzantine period', and the later one as the '2nd Byzantine period' (Tab.6.7.1).

| **Chronology** | **Period** | **Countable** | **Non-countable** | **Total** |
|---|---|---|---|---|
| 6th-7th c. AD | 1st Byzantine | 263 | 58 | 321 |
| 9th c. AD | 2nd Byzantine | 371 | 93 | 464 |
| **Total** | | **634** | **151** | **785** |

**Table 6.7.1.** Rocchicella. Number of recorded countable and non-countable specimens by period.

### 6.7.1. Taphonomic alteration

#### *6.7.1.1. Surface preservation*

Overall, animal bones and teeth from the archaeological site of Rocchicella were well preserved; in both periods animal remains showed a good level of surface preservation, although rarely excellent (Fig.6.7.1 and Fig.6.7.2). On the other hand, some remains were badly preserved, with only a few bones presenting an awful state of surface preservation.

Taphonomic processes causing surface degradation included reddish concretions, weathering and root etchings.

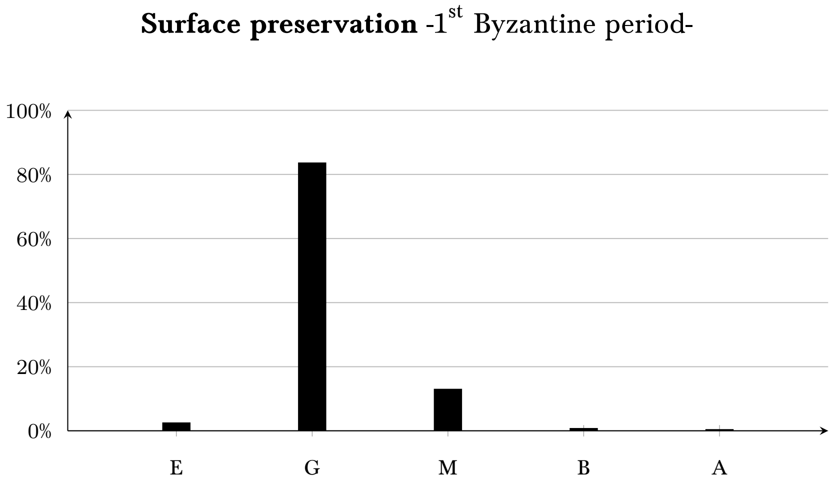

**Figure 6.7.1.** Rocchicella, 1st Byzantine period. Surface preservation of anatomical elements (n:321). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

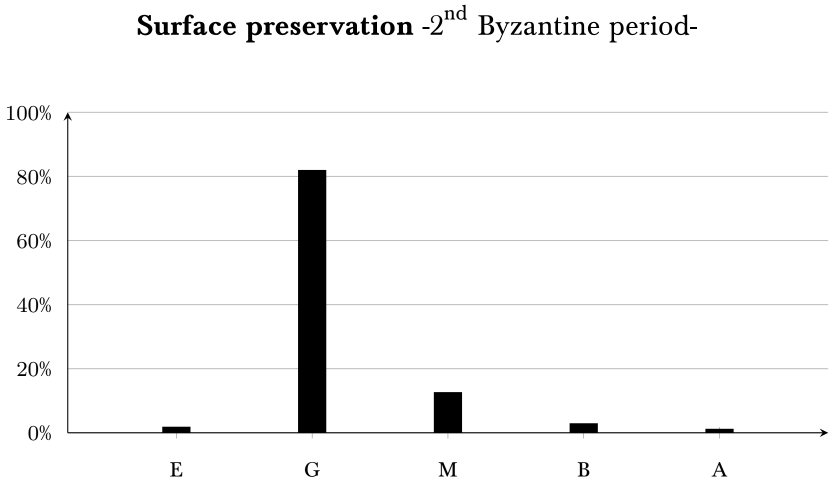

**Figure 6.7.2.** Rocchicella, 2nd Byzantine period. Surface preservation of anatomical elements (n:464). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

#### *6.7.1.2. Gnawing*

Gnawing was observed for both periods on a few postcranial bones of caprines, suids and cattle (i.e. 1st Byzantine period: 14 gnawed bones; 2nd Byzantine period: 26 gnawed bones). Most of the gnawing traces were suggestive of gnawing by carnivores, canids (most likely dog) and felids (most likely cat) being the species responsible for most of the chewing. Felid and canid remains are indeed present in the assemblage from the 2nd Byzantine period, though none occur in the earlier period (*§6.7.2 Species frequency: NISP and MNI*).

Traces of rodent gnawing are present on only three bone fragments dated to the 2nd Byzantine period (a suid proximal ulna, and a caprine distal tibia and astragalus). However, no rodent bones were found, though this may be a consequence of the lack of sieving.

#### *6.7.1.3. Recovery bias*

The faunal material from Rocchicella was hand-collected (*§Chapter 4: Sites and material*), which is likely to imply a recovery bias.

This was evaluated by considering the ratio between the first and the second phalanges of cattle, caprines and suids. This analysis allowed to assess the efficiency of recovery in both periods, as well as make comparisons between large (i.e. cattle) and small-medium sized species (i.e. caprines and suids).

Figure 6.7.3 and Figure 6.7.4 show that in both periods small anatomical parts such as caprine and suid second phalanges are underrepresented when compared to the proportions of the larger 1st phalanges. This holds especially true for caprines. In contrast, cattle 1st phalanges are only slightly better represented in comparison to second phalanges; this suggests that, as expected, the recovery bias applies mainly to the smaller animals.

Small-sized bones from birds, fish, reptiles and amphibians, as well as those from small-mammals (i.e. rodents) are scarcely represented, if not completely absent, from the assemblage. This result does not come as a surprise, as it is well known that un-sieved faunal materials are usually affected by an underrepresentation of small anatomical parts as well as small sized animals.

As a result, in the following analyses it must be borne in mind that the recovery bias is likely to have affected the faunal assemblage to a considerable extent.

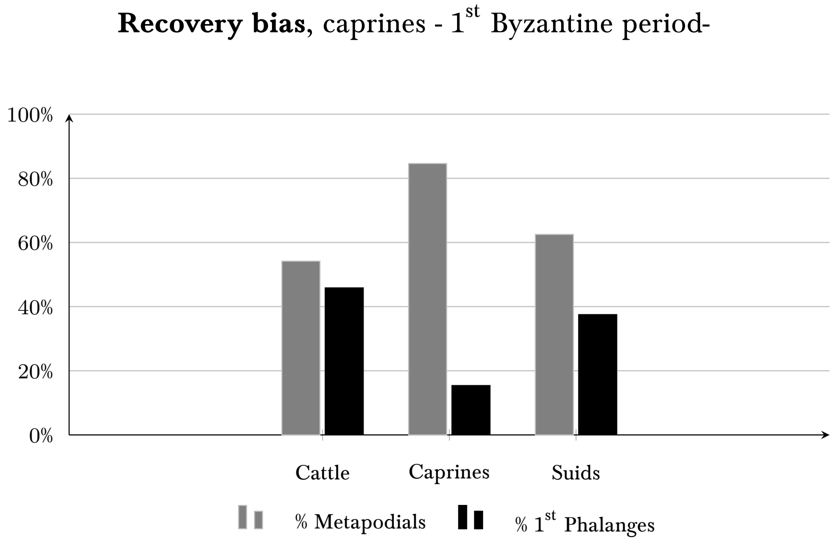

**Figure 6.7.3**. Rocchicella, 1st Byzantine period. Proportions of 1st and 2nd phalanges of cattle (13;11), caprines (22;4) and suids (10;6).

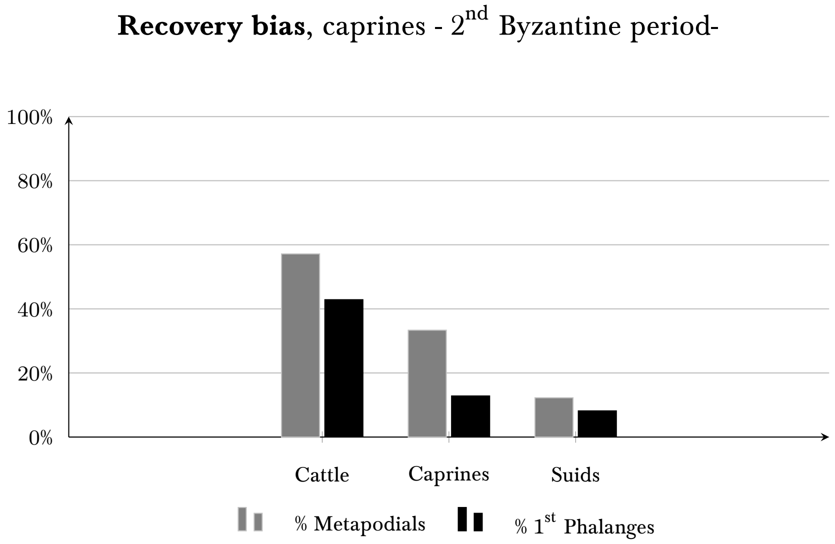

**Figure 6.7.4**. Rocchicella, 2nd Byzantine period. Proportions of 1st and 2nd phalanges of cattle (12;9), caprines (11;3) and suids (6;4).

## 6.7.2. Species frequency: NISP and MNI

| Rocchicella | | |
|---|---|---|
| **Taxa** | **1st Byzantine period** | **2nd Byzantine period** |
| Cattle (*Bos taurus*) | 33 | 44 |
| Caprines (*Ovis aries*/*Capra hircus*) | 149 | 181 |
| Suids (*Sus* sp.) | 71 | 119 |
| Equids (*Equidae*) | 2 | 4 |
| Felids (*Felidae*) | - | 9 |
| Canids (*Canidae*) | - | 3 |
| Cervids (*Cervidae*) | 1 | 1 |
| Lagomorphs (*Lagomorpha*) | 1 | + |
| Hare (*Lepus* sp.) | (+) | (+) |
| Galliforms (*Gallus*/*Numidia*/*Phasianus*) | 4 | 10 |
| Domestic fowl (*Gallus gallus*) | (2) | (7) |
| Anatids (*Anatidae*) | + | - |
| Passeriforms | 2 | - |
| **Total** | **263** | **371** |

**Table 6.7.2.** Rocchicella, 1st and 2nd Byzantine periods. List of all the taxa recorded. Non-countable elements are not included. In case a taxon is only present with non-countable fragment(s), this is indicated with a + (*§Chapter 5: Methodology*).

| **Rocchicella** | **1st Byzantine period** | | **2nd Byzantine period** | |
|---|---|---|---|---|
| | **Countable** | **Non-countable** | **Countable** | **Non-countable** |
| Sheep | 96 | 7 | 172 | 19 |
| Goat | 4 | 0 | 7 | 0 |
| Sheep/goat | 49 | 7 | 2 | 3 |
| **Total** | **149** | **14** | **181** | **22** |

**Table 6.7.3.** Rocchicella, 1st and 2nd Byzantine periods. Recorded countable and non-countable elements identified as sheep (*Ovis aries*), goat (*Capra hircus*) and sheep/goat (*Ovis*/*Capra*).

In both periods, the faunal assemblage from Rocchicella is largely dominated by the three main domesticates, (NISP for the 1st Byzantine period 94%; 2nd Byzantine period 92%) (Tab.6.7.2).

Within the three main domesticates, caprines (*Ovis aries* and *Capra hircus*) are the most represented taxa, respectively accounting for ca. 55% (1st Byzantine period) and ca. 50% (2nd Byzantine period) of countable remains (Fig.6.7.5 and Fig.6.7.6). The distinction between sheep and goat was made by considering distinctive morphological features present on a specific set of post-cranial bones. Biometrical analyses to separate sheep from goat were also carried out (see subchapter – Sheep/goat below). The vast majority of caprine remains which could be identified to species belonged to sheep.

Suids (*Sus domesticus* and/or *Sus scrofa*) are well represented in both periods, their incidence being slightly higher in the 2nd Byzantine period. A biometrical attempt to separate domestic pig from wild boar was made by using the log ratio technique (*§6.7.9 Size and shape*).

Cattle is represented in low frequencies in both periods (less than ca. 15%) (Tab.6.7.2, Fig.6.7.5 and Fig.6.7.6).

Equids are also uncommon in both periods; most remains are likely to belong to the horse (*Equus caballus*), on the basis of morphology and size; however, none of the remains presented diagnostic traits that allowed a more detailed taxonomic attribution. For this reason, the remains were cautiously assigned to the 'Equid' family (Tab.6.7.2).

Red deer and/or fallow deer (*Cervus elaphus* and/or *Dama dama*) are only represented by a proximal femur (non-countable element) and a distal tibia in the 1st Byzantine period, and by an antler fragment (non-countable element) and a 1st phalanx in the 2nd Byzantine period. No distinctive morphological traits could be used for these specimens to attempt species level identification (Tab.6.7.2).

Other potential domesticates recorded for the 2nd Byzantine period include cats

(*Felis* sp.); these remains could belong to either domestic (*Felis catus*) or wild cat (*Felis silvestris*). Canids (*Canis familiaris* and/or *Canis lupus*) were also attested for this period, although their incidence is lower than that of felids; all the four remains (two ulnae, one proximal radius –non-countable element– and one III metacarpal) were medium-large in size and visibly robust, excluding the possibility they belong to fox (*Vulpes vulpes*) (Tab.6.7.2).

Lagomorphs are represented by two remains in the 1st Byzantine period (one calcaneum and one proximal tibia); the proximal tibia (non-countable element) was attributed to the hare (*Lepus* sp.); an additional proximal tibia of a hare was recovered from contexts dated to the 2nd Byzantine period (Tab.6.7.2).

Concerning birds, in the 1st Byzantine period, galliforms (Gallus/*Numidia*/*Phasianus*) are represented by five remains; among them, two remains were attributed to the domestic fowl (*Gallus gallus*). The incidence of these birds slightly increases in the 2nd Byzantine period, for which 11 remains were recorded; seven of them were identified as belonging to the domestic fowl.

Anatids (*Anatidae*) are represented by a proximal humerus (non-countable element) in the 1st Byzantine phase.

In the same period, one distal femur and one distal humerus were generally attributed to the Passeriform order (Tab.6.7.2).

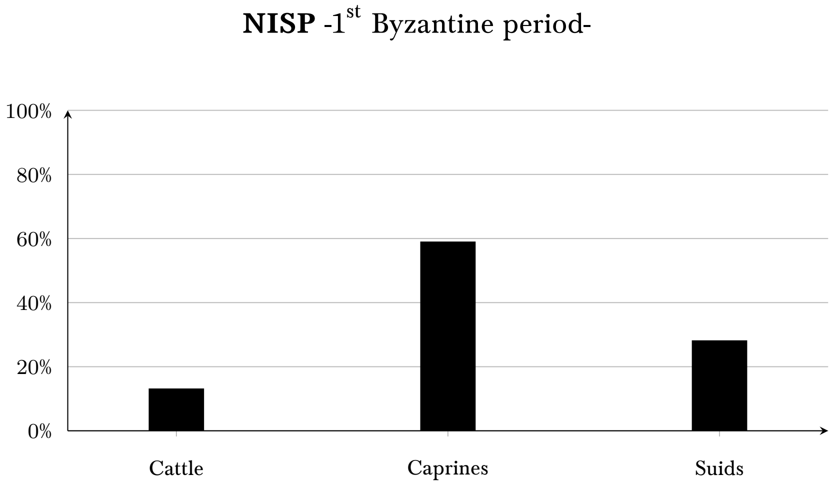

**Figure 6.7.5.** Rocchicella, 1st Byzantine period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates (n:253).

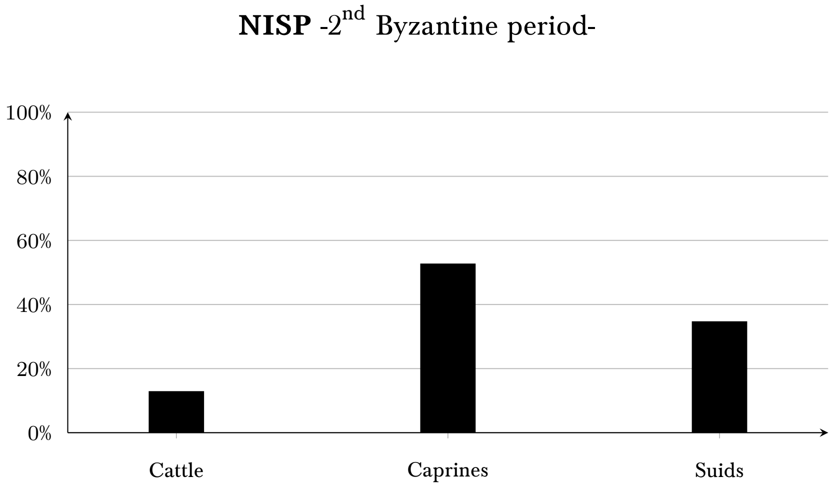

**Figure 6.7.6.** Rocchicella, 2nd Byzantine period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates (n:344).

The MNI counts are apparently inconsistent with the results provided by NISP (Fig.6.7.7 and Fig.6.7.8). This result is likely related to the high incidence of caprine distal humeri and distal tibiae present in both periods (*§6.7.4 Anatomical element distribution*), which produced a minimum number of 19 and 28 individuals respectively. When the distal tibiae and the distal humeri of caprines are not considered in the MNI counts, a similar trend to that obtained for the NISP is visible (Fig.6.7.9 and Fig.6.7.10). In addition, differences between the NISP and the MNI could be the result of the lower impact of a recovery bias on MNI estimations.

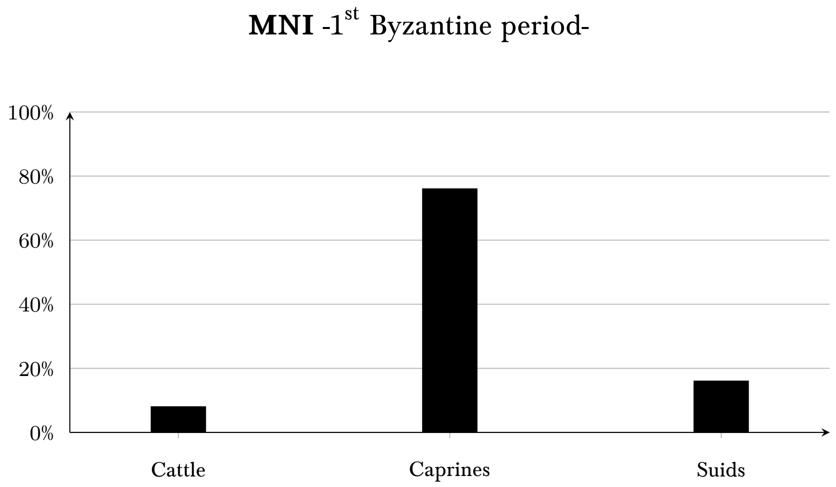

**Figure 6.7.7.** Rocchicella, 1st Byzantine period. Percentage of the Minimum Number of Individuals (MNI) for the main three domesticates (n:25).

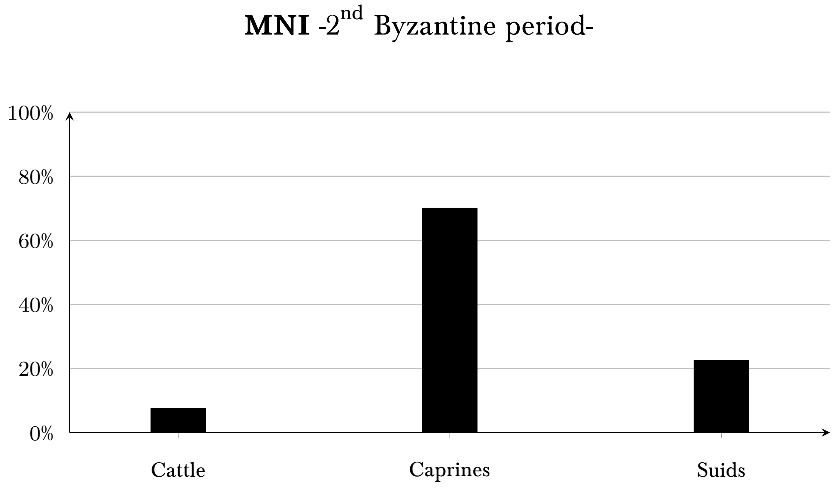

**Figure 6.7.8.** Rocchicella, 2nd Byzantine period. Percentage of the Minimum Number of Individuals (MNI) for the main three domesticates (n:40).

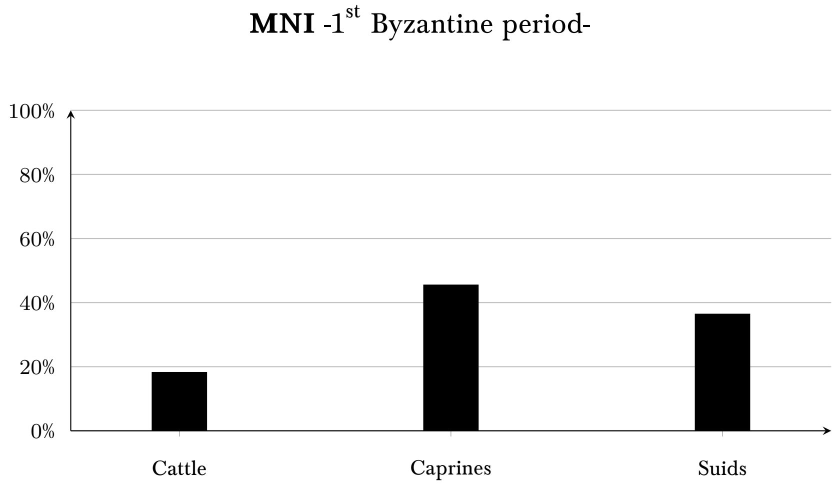

**Figure 6.7.9.** Rocchicella, 1st Byzantine period. Percentage of the Minimum Number of Individuals (MNI) for the main three domesticates (n:11). Distal humeri and distal tibiae of caprines not included.

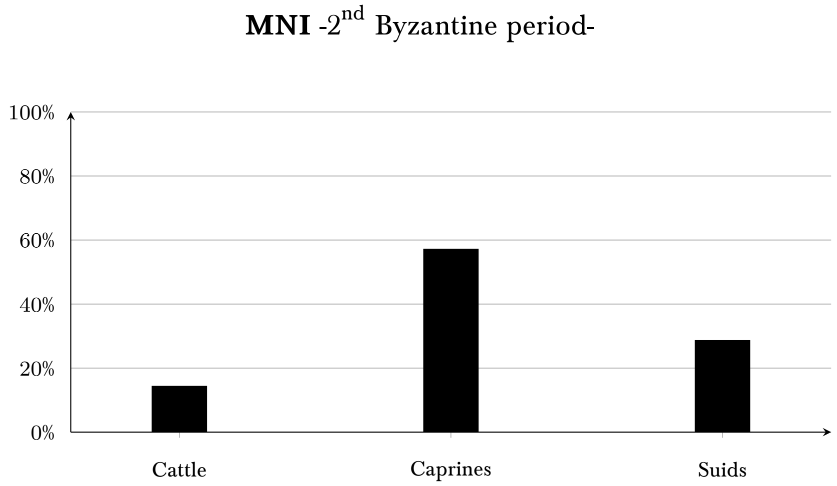

**Figure 6.7.10.** Rocchicella, 2nd Byzantine period. Percentage of the Minimum Number of Individuals (MNI) for the main three domesticates (n:14). Distal humeri and distal tibiae of caprines not included.

*Sheep/goat separation* – To investigate the sheep to goat ratio, shape indices from the astragalus were produced. The obtained values were then compared with those from modern specimens as presented in Salvagno and Albarella (2017) (Fig.6.7.11).

During the recording of the faunal assemblage, the majority of astragali were taxonomically attributed to sheep, with the exception of two for the 1st Byzantine period and four for 2nd Byzantine period, which were attributed to goat.

As Fig.6.7.11 shows, a large group of specimens falls between the modern values of sheep and goat; considering that these elements were all identified as sheep on the basis of distinctive morphological criteria, it is more likely that the values in between the two modern groups represent sheep, while the few values at bottom right of the graph would be the only certain goats. These specimens had already been identified as goat on the basis of morphological criteria. Another group of specimens, locating on the upper left of the graph, plot within the modern values of sheep; these were taxonomically attributed to this taxon during recording. As a result, morphometric analyses partially validate the morphological identifications of these anatomical elements.

In sum, in both periods the ratio between sheep and goat seems to suggest that the formers were much better represented.

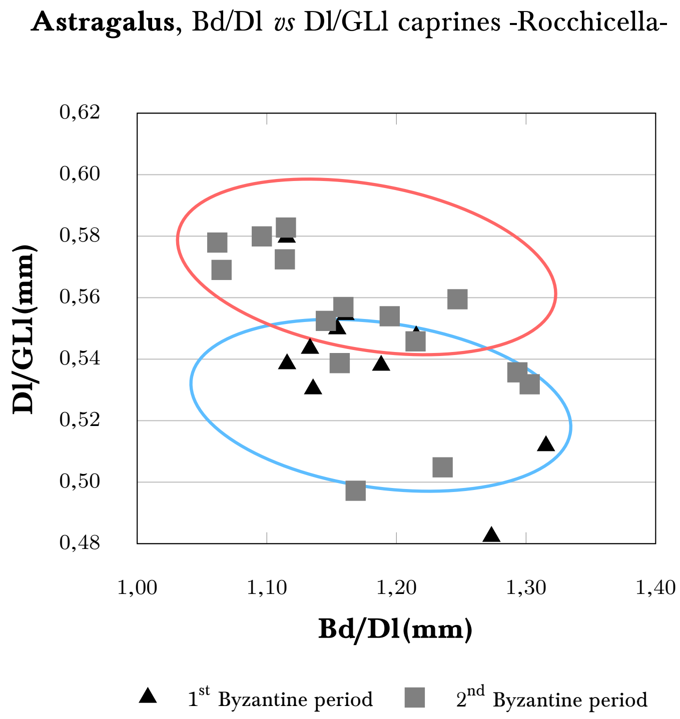

**Figure 6.7.11**. Rocchicella, 1st and 2nd Byzantine periods. Sheep/goat, astragali, shape indices. 1st Byzantine period (black triangles), 2nd Byzantine period (grey squares). Red oval: range of modern sheep values, blue oval: range of modern goat values according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). Bd: breadth of the distal end; Dl: greatest depth of the lateral half; GLl: greatest length of the lateral half.

A second scatter plot, comparing measurements taken on the condyles and on the verticilli of caprine distal metacarpals was made to further investigate the sheep/goat ratio at Rocchicella during the analysed Byzantine periods; the majority of metacarpals were previously identified as belonging to sheep, while two elements, respectively dated to the 1st and to the 2nd Byzantine periods, were recorded as ‘sheep/goat’.

As Fig.6.7.12 shows, the majority of specimens falls within the modern values of sheep (red oval), with only two values falling fully in the range of goats; these had been previously recorded as ‘sheep/goat’. One outlier plots outside the modern values of sheep; this is likely to represent a sheep.

All in all, in both periods the ratio between sheep and goat seems to suggest that the former were much better represented; this fits well with the biometrical analysis of the astragalus and with what was initially suggested by the morphological identification.

**Metacarpal**, sheep/goat - 1/a *vs* 1/2

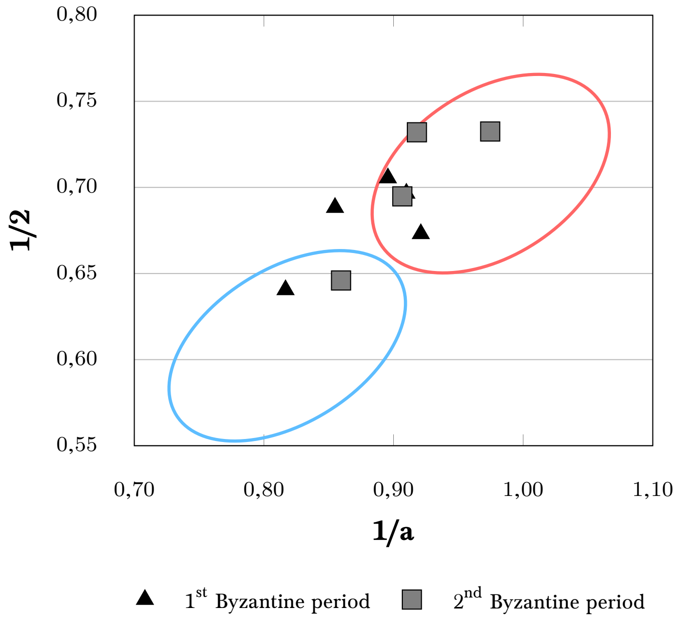

**Figure 6.7.12.** Rocchicella, 1st and 2nd Byzantine periods. Sheep/goat, metacarpals, shape indices. 1st Byzantine period (black triangles), 2nd Byzantine period (grey squares). Red oval: range of values attributed to sheep, blue oval: range of values attributed to goat according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). 1: depth of left distal condyle; a: width of the medial condyle; 2: diameter of the verticillus of the medial condyle.

### 6.7.3. Ageing

The age at death analyses were carried out for caprines and suids for both periods; the kill-off pattern analysis of cattle was only possible for the 2nd Byzantine period, as not enough remains were available from the 1st Byzantine phase.

All analyses rely only on postcranial bones, as there were not enough dental sequences to investigate the kill-off pattern of the above-mentioned taxa. Brief comments about the age-at-death of equids, cervids, felids and galliforms are also made.

*Caprines* – In the 1st Byzantine period, epiphyseal fusion evidence for caprines shows that ca. 99% of the early fusing bones (≤ one-two years) were fused; the frequency of fused middle fusing bones (≤ two-three years) slightly drops to ca. 96%, while in the late fusing stage (≥ three-four years), ca. 54% of bones were fused (Fig.6.7.13). One perinatal bone was recorded (a humerus); this could represent a natural loss and might suggest the presence of on-site breeding.

No substantial changes in caprine husbandry practices are attested for the 2nd Byzantine period. Indeed, also in this case, earlier culling events are rare, with very few individuals culled before their second-third years of age (middle fusing stage). As in the previous period, a large number of sheep and goat individuals were killed before reaching their third-fourth years of age (late fusing stage); at the same time an almost equal number survived until adulthood (Fig.6.7.14). No perinatal bones were recorded for this period.

In sum, the culling patterns from the 1st and the 2nd Byzantine periods at Rocchicella seems quite generalised, with caprines almost equally raised for their meat as well as for dairy products and wool. The very low incidence of lambs (early fusing elements) might suggest a husbandry strategy focusing more on the use of caprines for wool; however, it is equally likely that taphonomic processes compromised the survival of the more fragile bones of very young individuals, which we would expect to find as part of a dairy economy.

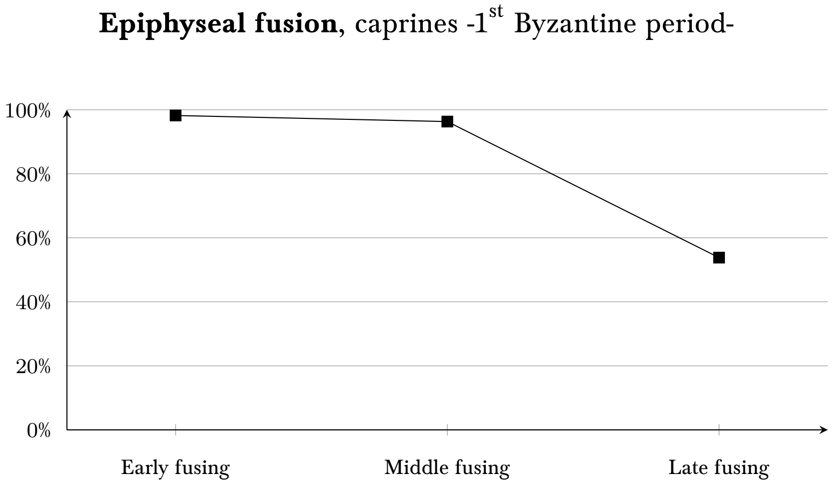

**Figure 6.7.13**. Rocchicella, 1st Byzantine period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:98;96;54). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

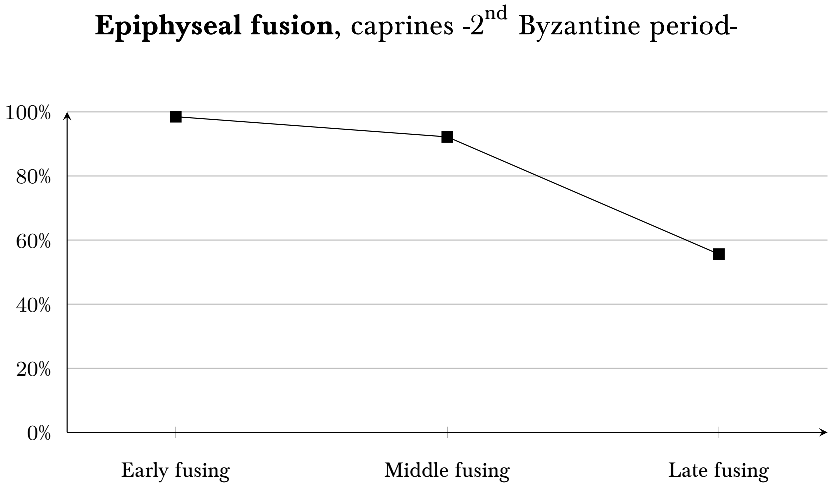

**Figure 6.7.14**. Rocchicella, 2nd Byzantine period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:98;92;56). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Suids* – In the 1st Byzantine period, epiphyseal fusion data indicate that the majority of suids were slaughtered before they reached their skeletal maturity (≤ three-four years). ca. 70% of the early fusing (one-two years) postcranial bones were fused; the frequency of fused bones in the middle fusing stage (two-three years) drops to ca. 45%, while in the late fusing stage (three-four years) only ca. 11% of the postcranial bones were fused (Fig.6.7.15).

This result suggests that a substantial number of pigs were killed between the first and third years of age, and that the majority of the pig population did not survive their third-fourth years of age. No perinatal bones were recorded for this period.

When data from the epiphyseal fusion of suids from the 2nd Byzantine period are considered, only slight changes with the previous period are visible. In this case, a larger number of suids were killed before reaching their first-second years of age (early fusing stage) and their second-third years (middle fusing stage). As in the previous period, few suids survived into adulthood, suggesting the presence of a few animals kept for breeding purposes (Fig.6.7.16).

Unlike the earliest phase, in the 2nd Byzantine period, ten perinatal bones of suids were recorded; these might suggest that pig breeding occurred at the site.

All in all, mortality profiles for suids in both periods at Rocchicella indicate that, unsurprisingly, these animals were culled for their meat and fat as soon as they approached their optimum weight or slightly earlier. In both periods, the consumption of very young pigs is attested (animals culled before reaching their 1st-2nd years of age – early fusing stage). In addition, some of the adult and subadult individuals were probably used for breeding purposes.

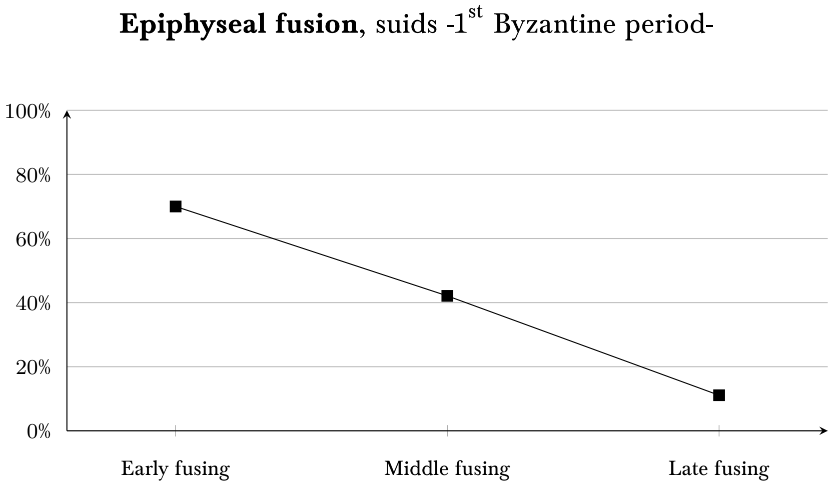

**Figure 6.7.15.** Rocchicella, 1st Byzantine period. Epiphyseal fusion analysis for suids. Percentage of fused bones within each fusion stage (n:70;42;11). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

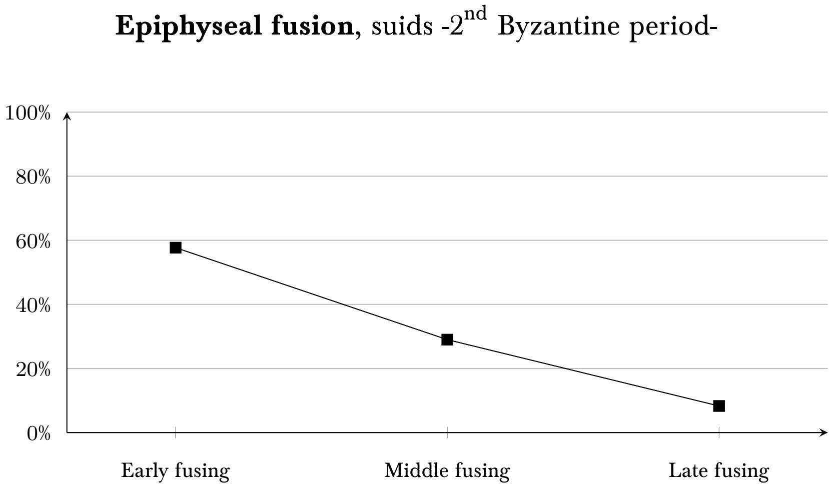

**Figure 6.7.16.** Rocchicella, 2nd Byzantine period. Epiphyseal fusion analysis for suids. Percentage of fused bones within each fusion stage (n:58;29;8). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Cattle* – As mentioned before, the analysis of the epiphyseal fusion of cattle post-cranial bones was only possible for the 2nd Byzantine period.

As Figure 6.7.17 shows, a considerable number of animals were slaughtered before reaching their third-fourth years of age (late fusing stage), with another ca. 20% of individuals killed before reaching their second-third years of age (middle fusing stage). A considerable part of the cattle population did survive beyond the fourth year (late fusing stage). Early culling events are not attested; however, the absence of unfused early fusing elements might be also related to the preferential destruction of such bones.

In sum, in the 2nd Byzantine period at Rocchicella, cattle husbandry appears to be quite generalised, with individuals equally raised for their meat and traction force. It is also likely that some adult cows were exploited for their milk, taphonomic processes being the main responsible for the virtual absence of calves.

**Epiphyseal fusion**, cattle - 2nd Byzantine period-

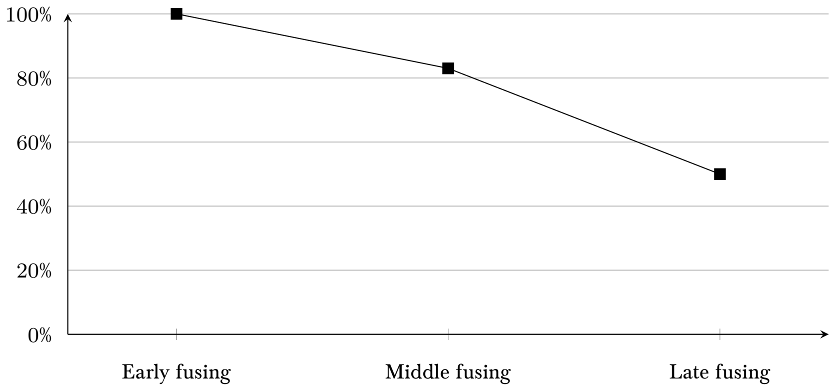

**Figure 6.7.17**. Rocchicella, 2nd Byzantine period. Epiphyseal fusion analysis for cattle. Percentage of fused bones within each fusion stage (n:100;83;50). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Equids* – Few equid remains were recorded for the two periods. In the 1st Byzantine period, two distal humeri and one proximal humerus were fused.

In the 2nd Byzantine period, all the four recorded anatomical elements (one distal radius, one distal humerus, one distal metapodial and one 2nd phalanx) were fused.

This evidence suggests the presence of predominantly mature equids at the site in both periods. However, caution is needed due to the tiny sample size.

*Cervids* – In the 1st Byzantine period, one proximal femur and one distal tibia attributed to the red deer and/or to the fallow deer were fused. Two cervid remains were also recorded from 2nd Byzantine period contexts; these refer to an antler fragment and to a 1st fused phalanx. Despite the small sample, the evidence indicates the introduction of adult cervids to the site in both periods.

*Carnivores* – All the remains attributed to felids and canids and dated to the 2nd Byzantine period were fused, thus suggesting the prevalence of adult individuals at the site.

*Galliforms* – In the 1st Byzantine period, three bones (one distal femur, one pelvis and one proximal tibiotarsus) attributed to the *Gallus/Numidia/Phasianus* group were fully ossified. The same holds true for the three remains (one proximal tarsometatarsus, one distal femur and one pelvic girdle) dated the later Byzantine period.

Among the galliform remains directly attributed to the domestic fowl, one proximal coracoid and one distal tibiotarsus from the 1st Byzantine period were from mature individuals; in the 2nd Byzantine period, out of seven recorded elements, all of them were ossified, thus suggesting the presence of mature individuals.

The results suggest the prevalence of mature individuals at the site in both periods. However, the lack of immature individuals could be the consequence of preservation factors, which may have prevented the survival of the more porous and fragile bones of younger individuals.

### 6.7.4. Sex

Information about sex were provided by morphological characteristics present in suids, cervids and galliforms.

*Suids* – The ratio between sows and boars at Rocchicella for the two Byzantine periods was calculated by considering canines in jaws and their alveoli (when canines were missing), as the proportion of male and female loose teeth would be biased by the preferential recovery of male canines. As not enough data were available from the 1st Byzantine period, the analysis of ratio between female and male suids was only possible for the 2nd Byzantine period.

In this period, a higher frequency of sows in comparison to boars is attested; this result probably reflects the common practice of keeping more mature sows for breeding. If this was the case, then we should assume that a high number of suids culled at a young age for their meat were mainly males (Tab.6.7.4) (*§6.7.3 Ageing*).

| **Rocchicella** | **2nd Byzantine period** | |
|---|---|---|
| ***Sus* sp.** | **Sows** | **Boars** |
| Canines (in jaws) | 7 | 4 |
| Alveoli (mandibular and maxillary) | 2 | 1 |
| **Total** | **9** | **5** |

**Table 6.7.4.** Rocchicella, 2nd Byzantine periods. Presence of male and female pigs based on canines in jaws and alveoli.

*Cervids* – An antler fragment suggesting the presence of a male cervid (red deer and/or fallow deer) was recovered from contexts dated to the 2nd Byzantine period.

*Galliforms* – One tarsometatarsus dated to the 2nd Byzantine period was characterised by the presence of a spur. The bone did not present a continuous posterior keel, which excludes its identification as a pheasant. As a result, this remain was securely identified as belonging to the domestic fowl.

### 6.7.5. Anatomical element distribution

The analysis of the anatomical element distribution was carried out for caprines and suids for both periods, while for cattle it was only possible for the 2nd Byzantine period. Nonetheless, desultory comments about the distribution of anatomical elements of equids, felids and domestic fowl are also made.

*Caprines* – The analysis of the anatomical element distribution of caprines in the 1st Byzantine period shows that the distal humerus is the most common element, followed by the distal tibia (Fig.6.7.18). At a first glance, this distribution seems to be mainly the result of preservation and recovery. Indeed, the overrepresentation of the distal humerus and the distal tibia may be attributed to their high chances to preserve in the archaeological context, their distal ends being compact and highly dense. Elements that are poorly represented are those that do not easily survive in the archaeological record (i.e. cranium, proximal humerus, proximal and distal femur, proximal tibia etc.) and/or are less frequently recovered when sieving is not implemented (i.e. carpals, tarsals and phalanges) (Brain 1971).

However, the very high incidence of the distal humerus in particular cannot be fully explained in term of differences in preservation; indeed, if taphonomic processes were the only the factors lying behind such patterns, one would have also expected a high representation of other body parts, such as the proximal radius, the ulna, distal metatarsals, the scapula and the pelvis; indeed, these elements are highly dense, thus they tend to preserve better than others in the archaeological record (Brain 1971).

As a result, in addition to preservation factors, it is likely that the use and disposal of specific body parts with high meat utility, such as the humerus, would have played a role in the anatomical element distribution of caprines; these would have also included the proximal and the distal femur that, due to low bone density, do not preserve well in the archaeological deposit.

A similar scenario is valid for the anatomical element distribution of caprines in the 2nd Byzantine period; in this case, the most representative body part is the distal tibia, followed by the distal humerus (Fig.6.7.19). As in the previous period, smaller body parts (i.e. carpals, tarsals and phalanges) and cranial elements are barely represented.

Overall, the pattern of body part distribution for caprines appears to be mainly the result of preservation and recovery biases. However, specific disposal practices and/or consumption preferences for specific body parts might have also contributed to such distributions. For example, the dearth of cranial and axial elements for both periods might suggest that already partly processed caprine carcasses entered the site, with whole carcasses brought in only occasionally. Consequently, it seems that more secondary rather than primary butchery was carried out on site.

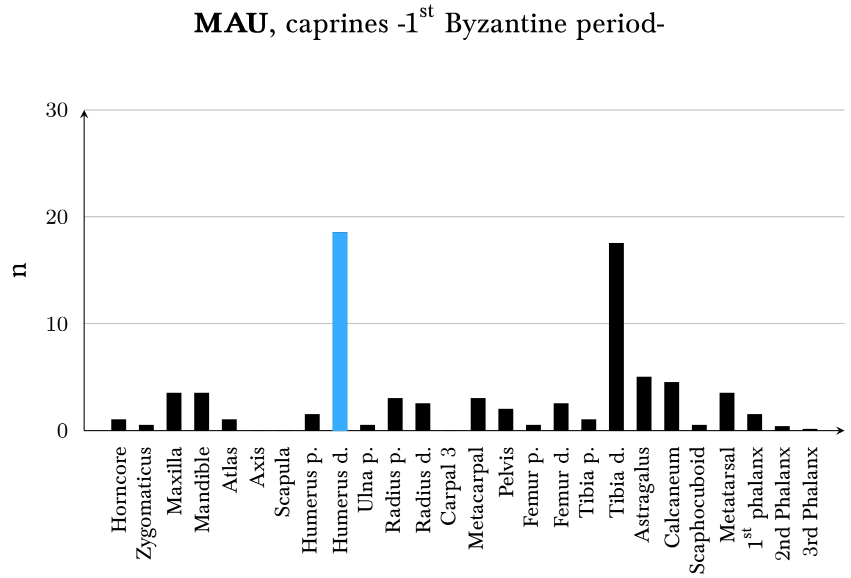

**Figure 6.7.18.** Rocchicella, 1<sup>st</sup> Byzantine period. Distribution of the Minimum number of Animal Units (MAU) for caprines (n:78). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

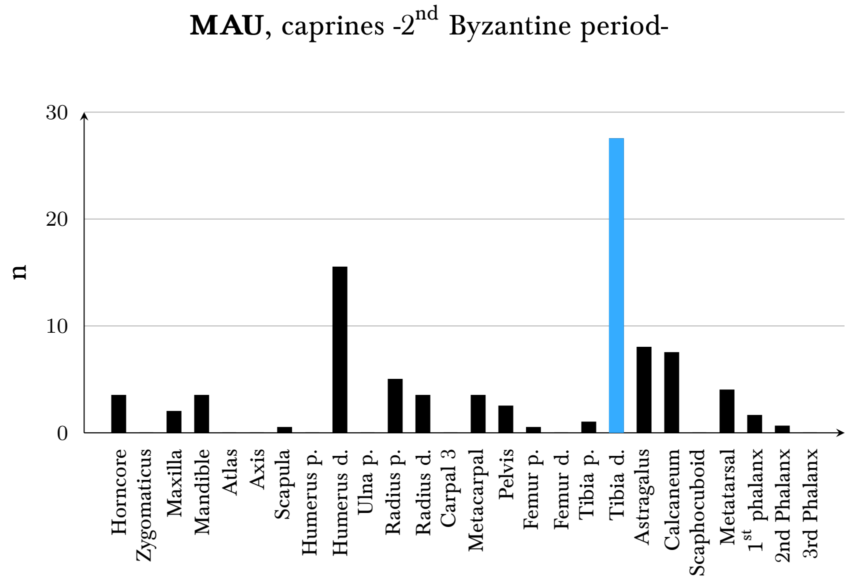

**Figure 6.7.19.** Rocchicella, 2<sup>nd</sup> Byzantine period. Distribution of the Minimum number of Animal Units (i.e. MAU) for caprines (n:90). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Suids* – In the 1st Byzantine period, the analysis of the anatomical element distribution of suid remains shows that the distal humerus is the best represented body part. In addition, upper limbs appear to be slightly better represented than lower limbs. Cranial elements are present, although in low numbers; this result might suggest that entire animal carcasses entered the site occasionally. Smaller body parts, such as carpals, tarsals and phalanges are barely represented, if not completely absent; this result is likely to be a consequence of recovery bias (Fig.6.7.20).

Similarly to the 1st Byzantine period, also in the 2nd Byzantine period the distal humerus is the best represented body part. As in the previous period, upper limbs appear to be better represented than lower limbs. Cranial elements are also present, their incidence being higher in comparison to the previous period. Smaller body parts, such as phalanges, are scarcely represented, with carpals and tarsals completely missing (Fig.6.7.21).

Overall, the pattern for suids in both periods appears to be mainly the result of preservation and recovery biases, rather than of specialized waste disposal practices. It is likely that all suid body parts were equally represented at the site before discard, and that both primary and secondary butcheries occurred on site.

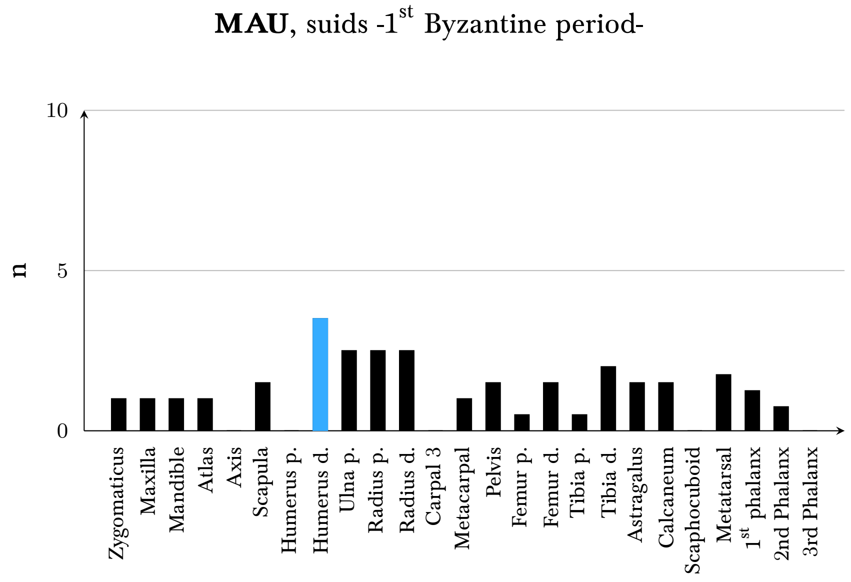

**Figure 6.7.20.** Rocchicella, 1st Byzantine period. Distribution of the Minimum number of Animal Units (i.e. MAU) for suids (n:30). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

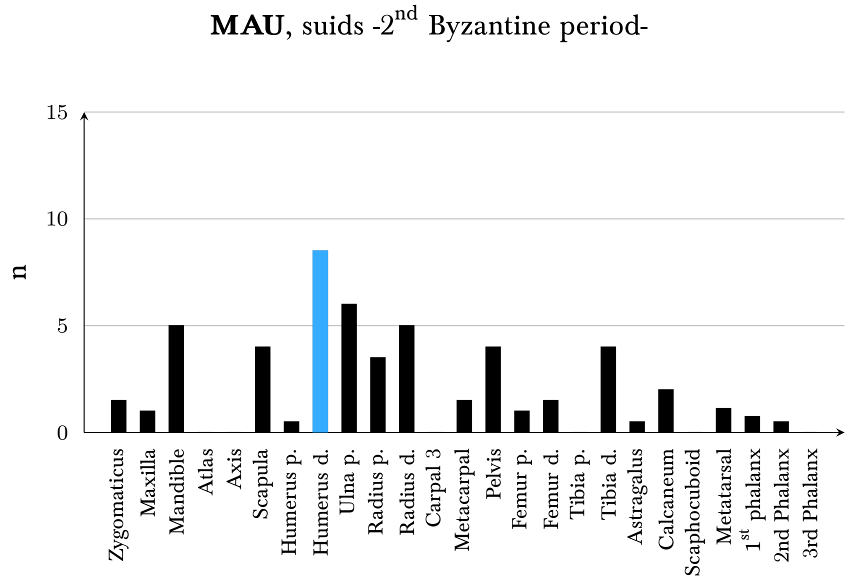

**Figure 6.7.21.** Rocchicella, 2nd Byzantine period. Distribution of the Minimum number of Animal Units (i.e. MAU) for suids (n:52). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Cattle* – Considerations on cattle body part distribution for the 2nd Byzantine period are rather difficult due to the tiny sample size. Nevertheless, a number of trends can still be detected.

In this period, the atlas is the most abundant body part; a good number of large-sized vertebrae (that might belong to cattle and/or equids) were also recorded. Hind limbs are better represented than fore limbs, and cranial elements are also represented (Fig.6.7.22).

It seems that cattle anatomical distribution for the 2nd Byzantine period is mainly represented by those body parts bearing a smaller quantity of meat, thus suggesting specialised waste disposal practices. However, the tiny sample size does not allow drawing any conclusions.

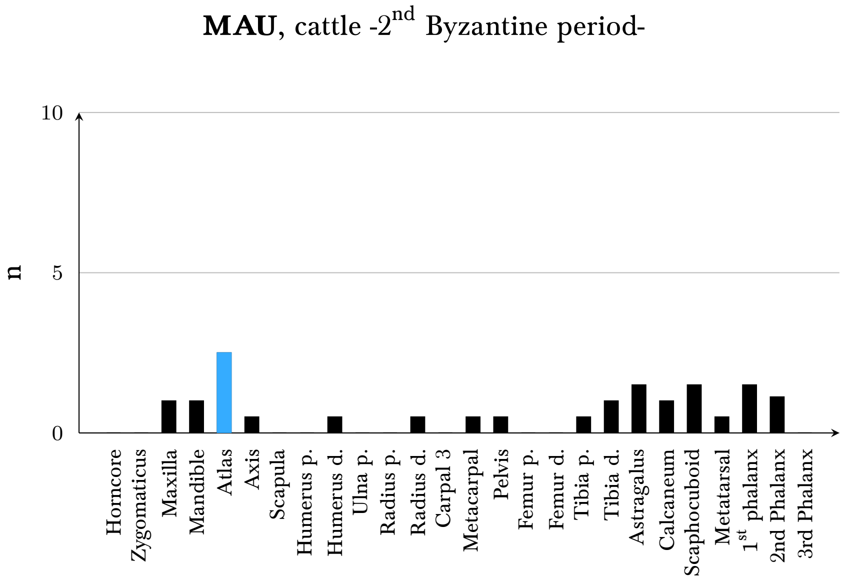

**Figure 6.7.22.** Rocchicella, 2nd Byzantine period. Distribution of the Minimum number of Animal Units (i.e. MAU) for cattle (n:15). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Equids* – In both periods, equid remains mainly consist of upper limb bones, while cranial elements are absent.

*Felids* – Felid remains were only recorded from the 2nd Byzantine period, and they include most body parts. All in all, it seems that entire carcasses of felids were present at the site.

*Galliforms* – Comments about the anatomical element distribution of galliforms could only made for the 2nd Byzantine period, as not enough remains were recovered from the earliest phase. The majority of bones from the latest period were attributed to the domestic fowl; these exclusively refer to lower limbs. A similar pattern is valid for the bones assigned to the *Gallus/Numidia/Phasianus* group.

### 6.7.6. Butchery

For this site, the analysis of butchery marks focuses on caprines and suids in both periods. Desultory comments on cattle and galliform carcass processing are made, despite the modest quantity of available data.

*Caprines* – In the 1st Byzantine period, ca. 31% of caprine remains showed evidence of butchery (Fig.6.7.23); among these, cut marks were far more represented than chop marks (Fig.6.7.24), the distal humerus and the distal tibia being the anatomical elements presenting the higher percentages of cut marks. This latter evidence possibly indicates the practice of separating the upper from the lower limb through the severing of tendons. A smaller quantity of cut marks was also recorded on small-sized vertebrae and ribs, part of which probably belonged to caprines; this evidence reflects the reduction of the carcass into smaller pieces. Chop marks are likely to have had a similar purpose. Five astragali and two calcanei showed some parallel cut marks, probably the result of skinning.

In the 2nd Byzantine period, ca. 20% of caprine bones were butchered (Fig.6.7.25). Like in the 1st Byzantine period, cut marks were better represented than chop marks; in addition, some remains were also characterised by the presence of both cut and chop marks (Fig.6.7.26). Concerning the position of cut and chop marks on caprine remains, no differences with the previous period have been detected. In addition, also for this period, skinning activities are attested by the recovery of five calcanei and eight astragali presenting cut marks on their surfaces. All in all, in both analysed periods, the butchery evidence on caprine remains is mainly represented by cut marks; as already discussed for other sites, this reflects the medium size of caprine carcasses, which do not require the extensive use of heavy tools.

In addition, the high incidence of butchery marks suggests that most of caprine remains derive from food waste disposal in both periods.

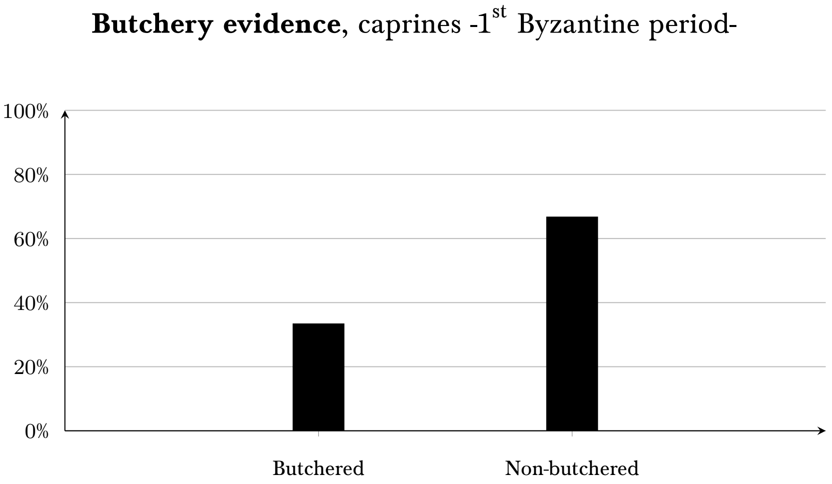

**Figure 6.7.23.** Rocchicella, 1st Byzantine period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:50;113).

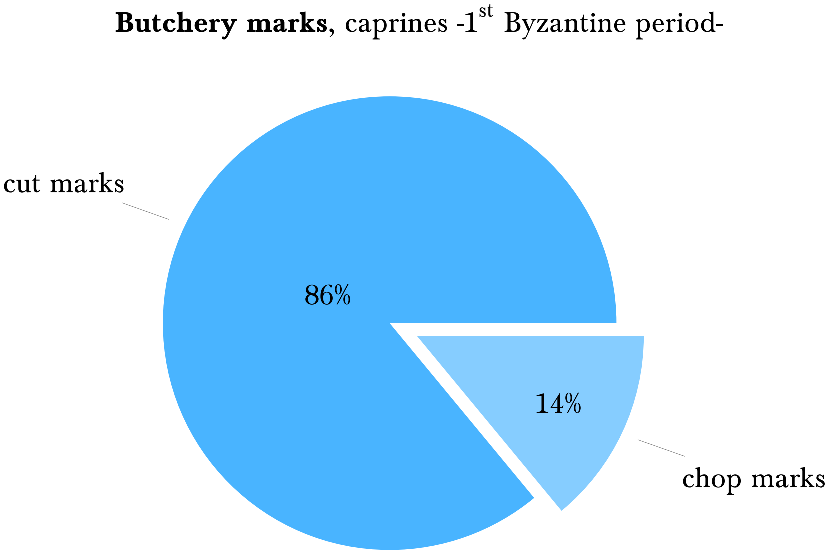

**Figure 6.7.24.** Rocchicella, 1st Byzantine period. Butchered post-cranial bones of caprines; proportion of cut and chop marks (n:50).

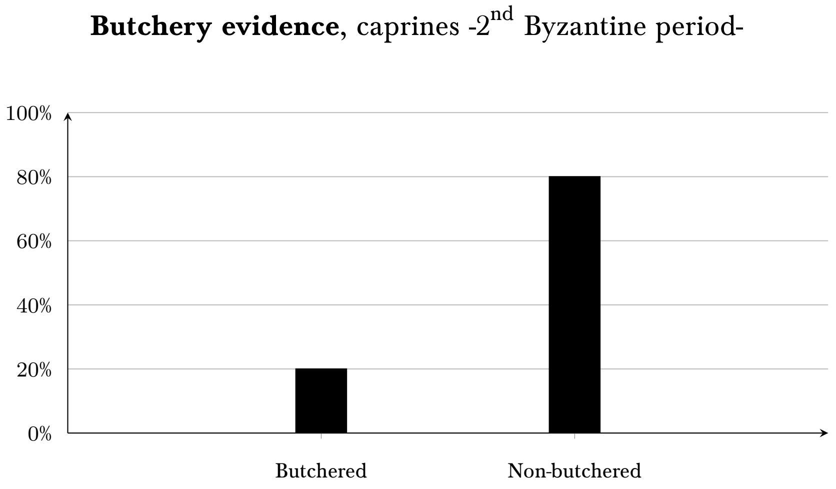

**Figure 6.7.25**. Rocchicella, 2nd Byzantine period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:37;148).

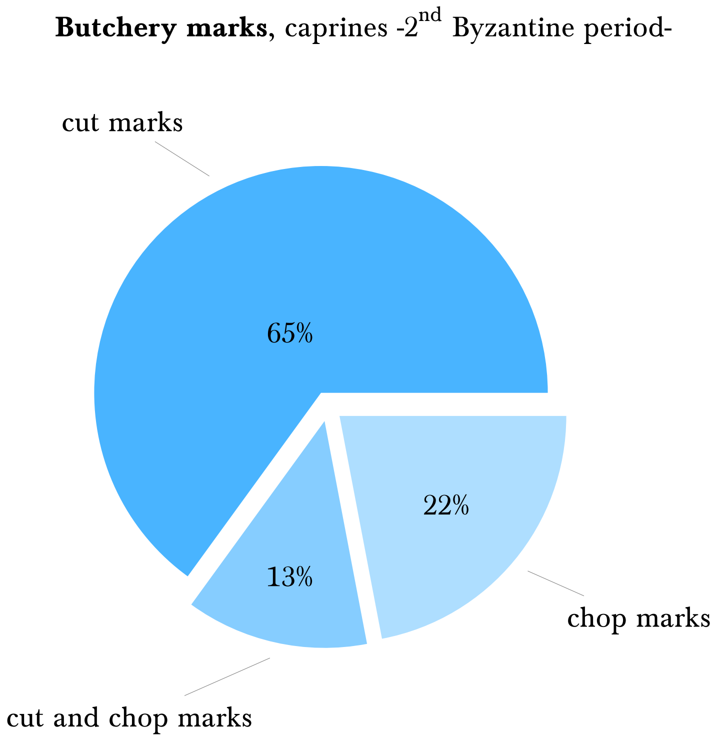

**Figure 6.7.26**. Rocchicella, 2nd Byzantine period. Butchered post-cranial bones of caprines; proportion of cut, chop, and cut and chop marks (n:37).

*Suids* – In comparison to caprines, a lower incidence of suid remains displayed butchery marks in both periods (ca. 16% and 10% respectively) (Fig.6.7.27 and Fig.6.7.29).

Overall, cut marks were better represented than chop marks; some remains dated to the 2nd Byzantine period were characterised by the presence of both cut and chop marks (Fig.6.7.28 and Fig.6.7.30). As for caprines, this pattern may reflect the medium size characterising these animals.

In both periods, most of the cut marks were located at the distal ends of the humerus and radius and, to a lesser extent, of the femur and tibia. Like for caprines, such evidence possibly indicates the separation of upper from lower limbs through the severing of tendons. Chop marks on two atlases from the 1st Byzantine period are likely to result from the removal of the head.

The young age profile of suids is likely to lie behind the overall lower incidence of recorded butchery marks on suids in comparison to caprines, as butchered immature elements are less likely to survive in the archaeological record (*§6.7.3 Ageing*); all in all, there is little doubt that the suid remains from Rocchicella mainly represent food waste.

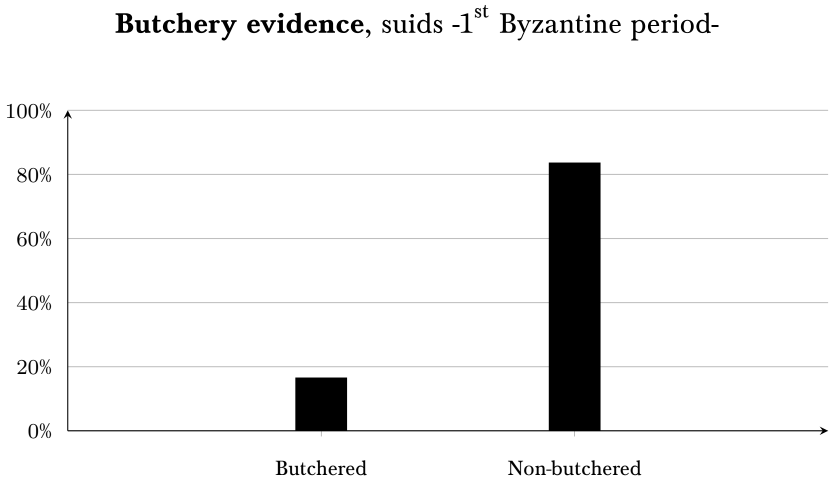

**Figure 6.7.27.** Rocchicella, 1st Byzantine period. Proportion of butchered and non-butchered post-cranial bones of suids (n:13;66).

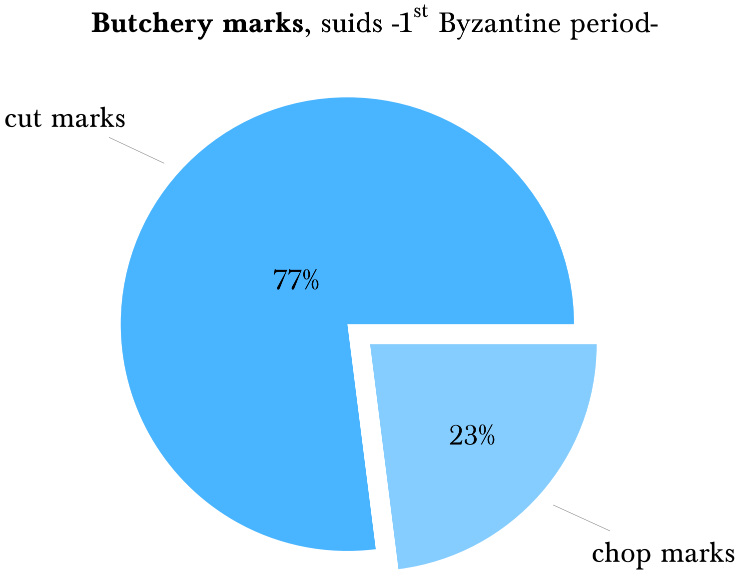

**Figure 6.7.28.** Rocchicella, 1st Byzantine period. Butchered post-cranial bones of suids; proportion of cut and chop marks (n:13).

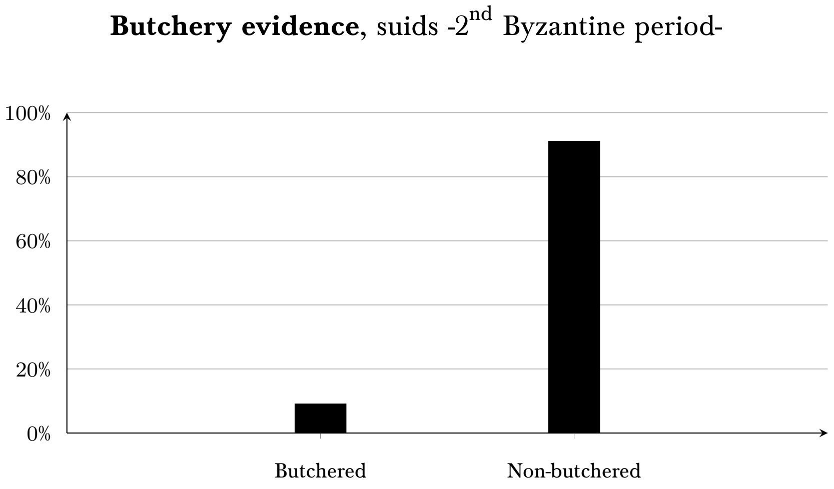

**Figure 6.7.29**. Rocchicella, 2nd Byzantine period. Proportion of butchered and non-butchered post-cranial bones of suids (n:12;121).

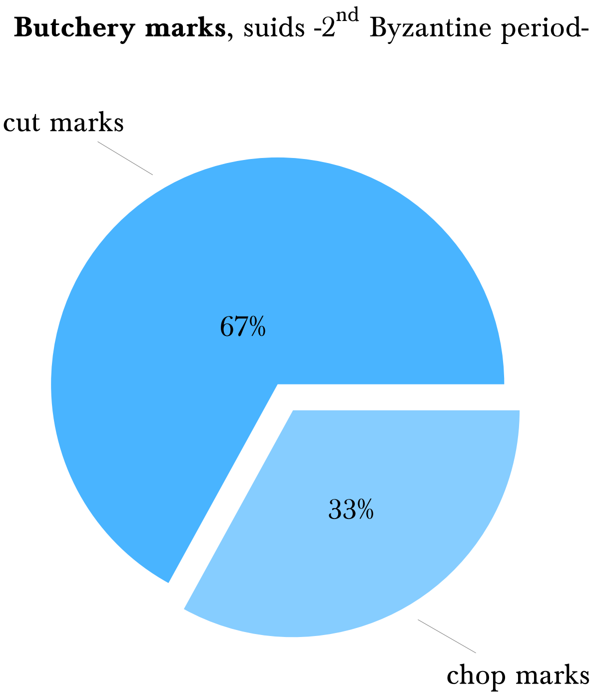

**Figure 6.7.30**. Rocchicella, 2nd Byzantine period. Butchered post-cranial bones of suids; proportion of cut and chop and cut marks (n:12).

### 6.7.7. Burning

Burning traces were observed on postcranial bones of cattle and suids, with fewer traces recorded on caprine remains. One fragment from the 1st Byzantine period and 18 remains from the 2nd Byzantine period were burnt; in this latter period, four bones were singed and, only in a few cases, calcinated.

### 6.7.8. Worked antler

One cervid antler fragment (red deer/fallow deer) was recorded from a 2nd Byzantine period context; this showed clear evidence of polishing and several cut marks were present. It is likely that it was used for craft purpouses.

### 6.7.9. Size and shape

Biometrical analyses for the site of Rocchicella mainly focus on caprines and suids, as not enough measurements were taken on other taxa.

It was possible to investigate caprine biometrical characters in the 1st and 2nd Byzantine periods using absolute measurements from specific anatomical elements (i.e. distal tibia and distal humerus); comparisons with urban sites, such as Corso dei Mille, Sant'Antonino and Mazara del Vallo, as well as with the rural site of Casale San Pietro, were made to investigate differences in sheep size among different site-types in Sicily in the Byzantine and Arab periods.

However, analyses mainly relied on the use of the log ratio technique, in which width/depth measurements from fused post-cranial bones were merged together to allow further comparisons and to increase the sample size. The sample size in both periods did not allow to analyse separately the more and the less sex-dependent anatomical elements; however, the proportion of ewes, wethers and/or rams was discussed taking into account the distribution of values in the histograms.

A log ratio histogram was made also for suid measurements, using lengths and widths from mandibular and maxillary teeth (post-cranial bones were mainly represented by unfused anatomical elements). To allow comparisons with other sites, such analysis has been presented and discussed in the sub-chapter on the assemblage from Colmitella (*§6.6 Colmitella (Agrigento) – 6.6.10 Size and shape*).

*Caprines* – Measurements of the distal tibia from the 1st and the 2nd Byzantine periods were plotted to investigate changes in caprine size trough time.

As Fig.6.7.31 shows, values from the two periods clearly overlap substantially; despite a slightly higher incidence of larger values in the 1st Byzantine period.

**Tibia**, caprines Bd *vs* Dd -1st Byzantine and 2nd Byzantine periods-

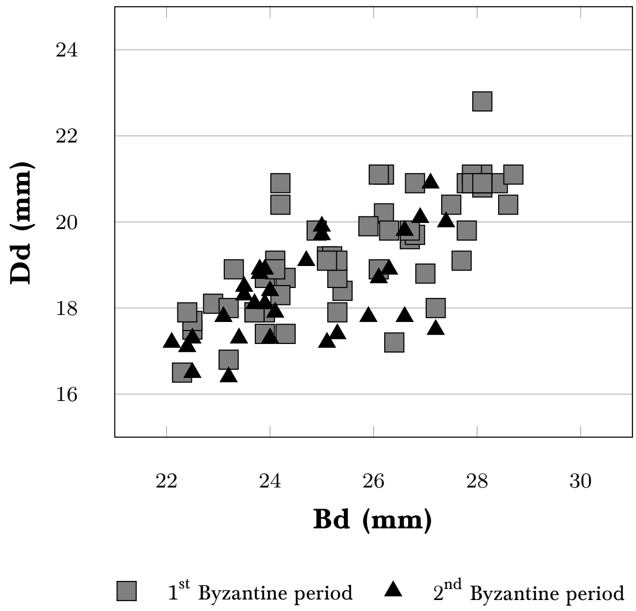

**Figure 6.7.31**. Measurements of the distal tibia (Bd and Dd) of caprines from the 1st Byzantine period (grey squares) and the 2nd Byzantine period (black triangles) at Rocchicella (*§Chapter 5: Methodology*).

Fig.6.7.32 and Fig.6.7.33 plot the 2nd Byzantine Rocchicella tibia data in comparison with Arab sites. Fig.6.7.32 deals with urban sites and shows that the sheep from Rocchicella tend to plot in the lower part of the diagram, together with those from Corso dei Mille. Fig.6.7.33 shows that the sheep from Casale San Pietro are also larger than those from Rocchicella (2nd Byzantine period).

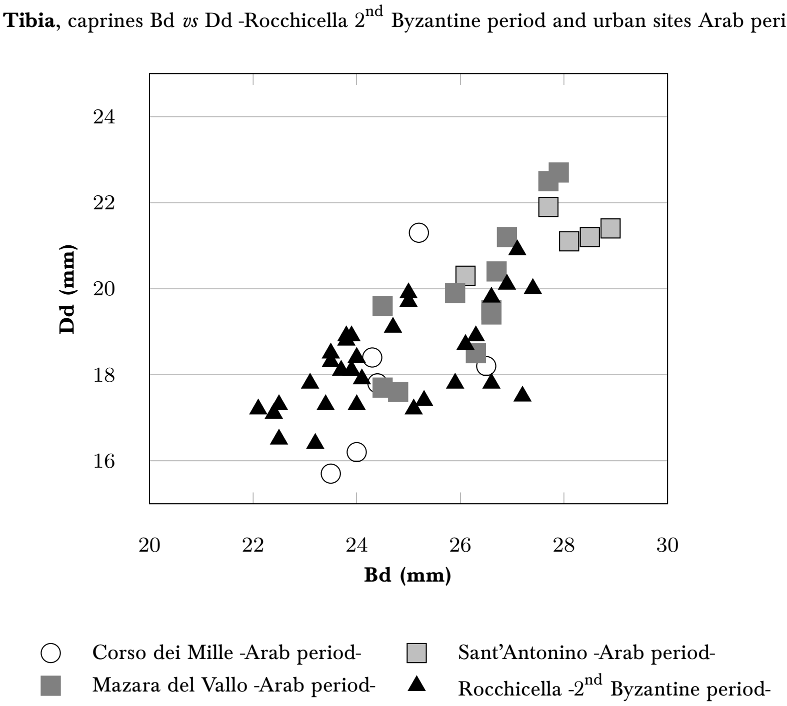

**Figure 6.7.32.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Corso dei Mille (black empty circles), Mazara del Vallo (grey squares), Sant'Antonino (grey squares with black border) and from the 2nd Byzantine period at Rocchicella (black triangles) (*§Chapter 5: Methodology*).

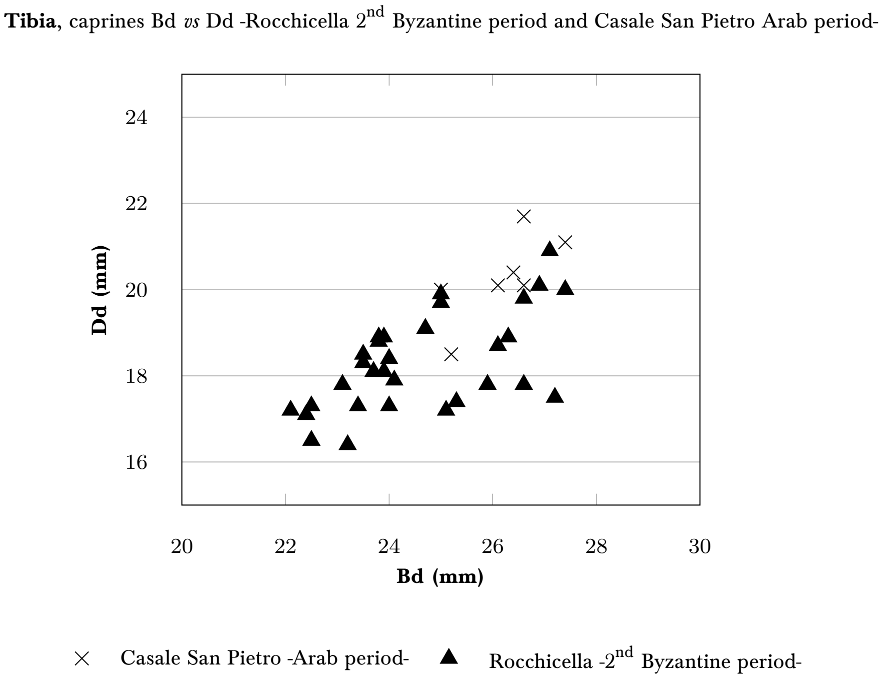
**Tibia**, caprines Bd *vs* Dd -Rocchicella 2nd Byzantine period and Casale San Pietro Arab period-

**Figure 6.7.33.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Casale San Pietro (black crosses) and from the 2nd Byzantine period at Rocchicella (black triangles) (*§Chapter 5: Methodology*)

Another scatter plot comparing measurements from the distal humerus was made. This biometrical analysis was carried out to investigate size change, as well as the sex ratio of sheep populations present in both the analysed periods.

As Fig.6.7.34 indicates, no substantial changes in the distribution of values are visible; indeed, most specimens largely plot within a single large cluster, similarly to the tibia.

All in all, the composition of the two sheep populations in both Byzantine periods at Rocchicella appears to include mostly females and/or castrated, with few rams present. This was expected, as few males are needed for breeding; unfortunately, it was not possible to estimate the proportions of females and castrates, which would have provided an insight in sheep management in the two periods at Rocchicella.

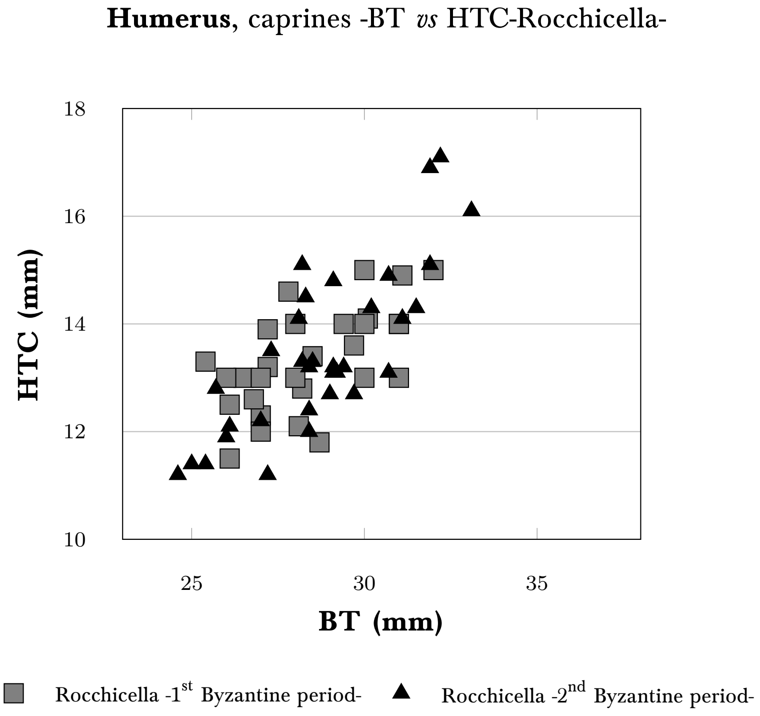

**Figure 6.7.34**. Measurements of the distal humerus (BT and HTC) of caprines from the 1st Byzantine period (grey squares) and the 2nd Byzantine period (black triangles) at Rocchicella (*§Chapter 5: Methodology*).

In order to further investigate sheep size in the two analysed periods, width and depth measurements from fused post-cranial anatomical elements dated to the 1st Byzantine and to the 2nd Byzantine periods were analysed together through the log ratio technique (*§Chapter 5: Methodology*). This has been done to further investigate the potential increase in sheep size suggested by biometrical analyses of the distal tibia.

In both periods (Fig.6.7.35), the histograms display a roughly unimodal distribution and a similar range of measurements. All in all, there is very little evidence of size change and the suggestion solely based on the tibia of a possible size decrease cannot be confirmed.

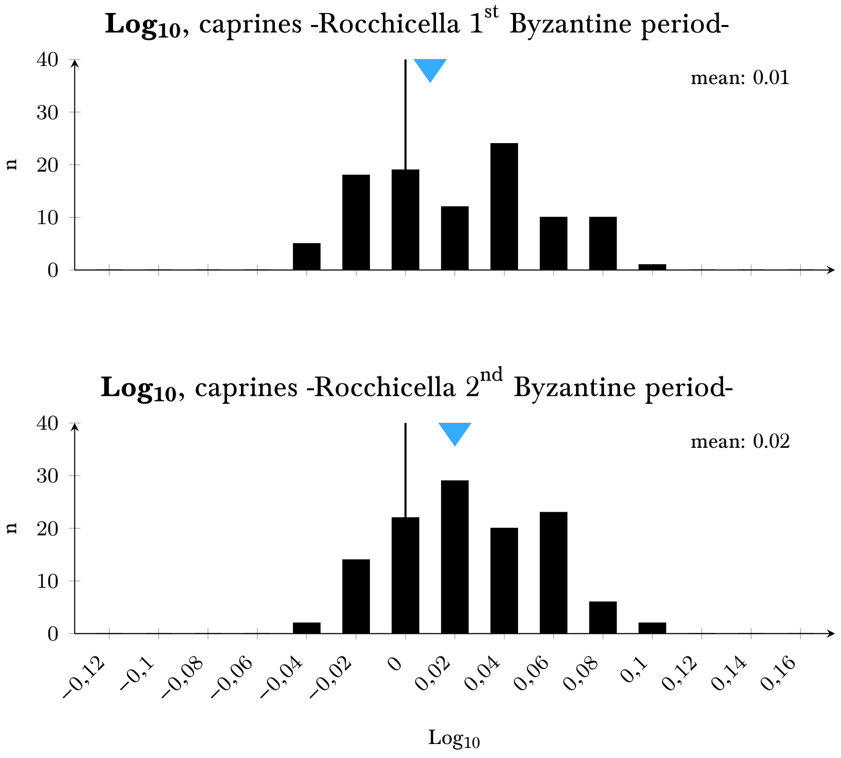

**Figure 6.7.35.** Comparisons of caprine post-cranial measurements from the 1st Byzantine period (n:98) and the 2ndByzantine period (n:117) at Rocchicella. The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

Log ratio comparisons with other sites (Fig.6.7.36) confirms the large size overlap between the values from Rocchicella and those from the other sites, and that the smallest sheep are found at Arab Corso dei Mille (especially) and Rocchicella itself ($2^{nd}$ Byzantine period).

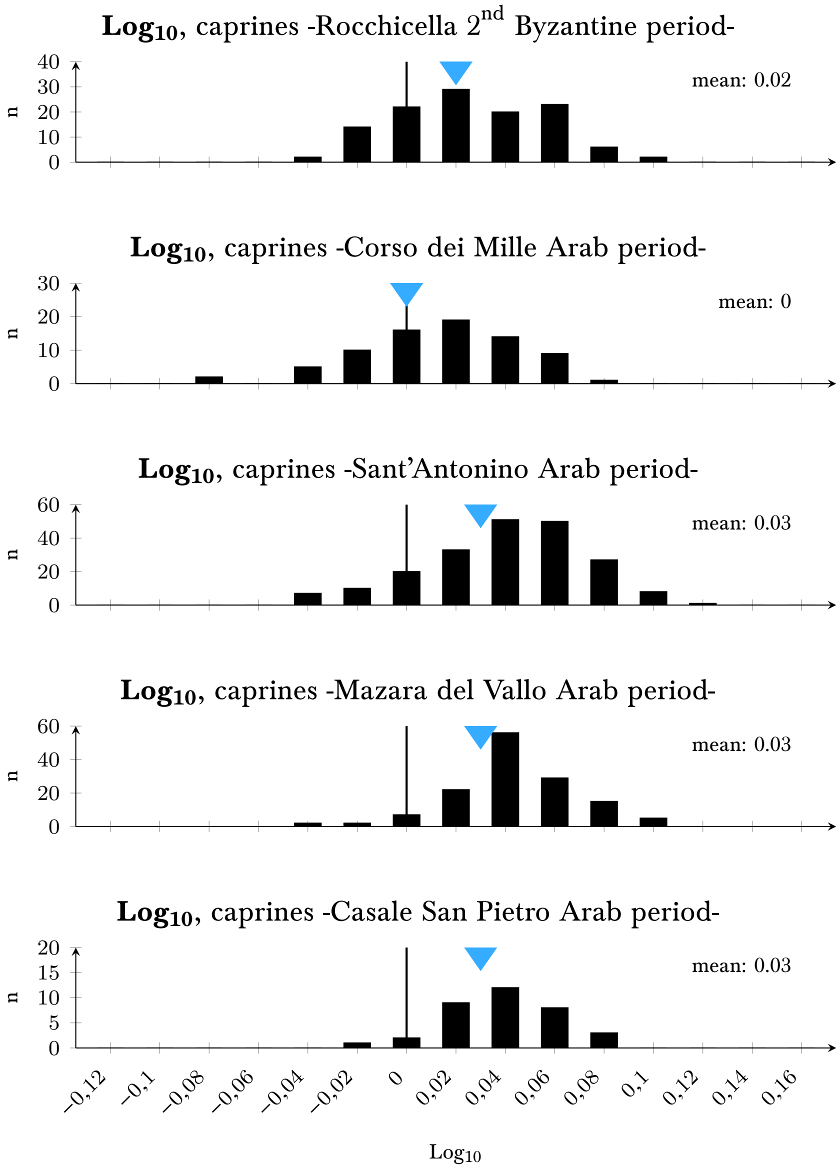

**Figure 6.7.36.** Comparison of caprine post-cranial measurements from Rocchicella, Corso dei Mille, Sant'Antonino and Mazara del Vallo, Casale San Pietro, and in the Arab period, Log ratio histogram for width/depth measurements from the $2^{nd}$ Byzantine period.

## 6.8. Castello San Pietro (Palermo)

A complete study of the archaeological stratigraphic sequence of Castello San Pietro has never been carried out (Arcifa personal comment[3]), and only a limited number of archaeological contexts could be dated; all these belong to the early Arab period (9th century AD)[4]. As a result, only a small portion of the studied faunal assemblage can be reported on here. Unphased contexts, have been excluded as those may belong to the Late Middle Ages and/or to the post-medieval period. Future archaeological studies on the site stratigraphy, as well as on the related material culture, will allow a more accurate study of animal remains dated to the later periods (Norman/Swabian and post-medieval period).

The faunal assemblage includes 1338 recorded specimens, of which 1047 were also countable; of these, 382 date to the 9th century AD, while 665 were not assigned to a specific chronology. The dated material from the site belongs to the Arab period, and as such will be referred to in the following analyses (Tab.6.8.1).

| **Chronology** | **Period** | **Countable** | **Non-countable** | **Total** |
|---|---|---|---|---|
| 9th c. AD | Arab | 382 | 115 | 497 |
| N/A | N/A | 665 | 176 | 841 |
| **Total** | | **1047** | **291** | **1338** |

**Table 6.8.1.** Castello San Pietro. Number of recorded countable and non-countable specimens for the Arab period and for the undated archaeological contexts.

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[3] Professor Lucia Arcifa (University of Catania) was the director of the archaeological excavations carried out at Castello San Pietro in the 1980s (Palermo).

[4] As this assemblage could only partly be analysed, and the study of the excavation is still on going, it was decided to leave this sub-chapter at the end of (*Chapter 6: Results.*)

## 6.8.1. Taphonomic alteration

### *6.8.1.1. Surface preservation*

The degree of bone surface preservation at Castello San Pietro was generally good (Fig.6.8.1). However, some remains were not very well preserved; among these, most presented a poor preservation of the cortical bone and reddish/brownish concretions on their surfaces, likely to be the result of mineral depositions. Additional taphonomic alterations included weathering and cracks from post-depositional disturbance (e.g. rooting).

Overall, the faunal assemblage was not severely compromised by post-depositional activities; in the majority of cases taphonomic processes did not hinder the taxonomic attribution of animal remains, the detection of marks on the bone surface (e.g. gnawing, butchery etc.), and the recording of measurements.

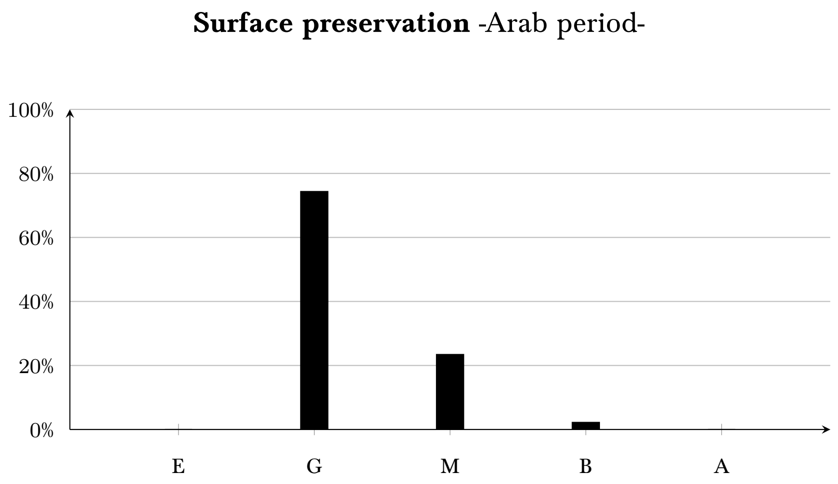


**Figure 6.8.1.** Castello San Pietro, Arab period. Surface preservation of anatomical elements (n:497). E: excellent, G: good, M: medium, B: bad, A: awful (*§Chapter 5: Methodology*).

#### *6.8.1.2. Gnawing*

An overall low level of scavenger gnawing was detected on animal remains from this site; only ten postcranial bones (mostly suid remains) bore gnawing marks. These were mainly caused by carnivores, and in only three cases by rodents. Felid and canid remains were also found in the assemblage, confirming the presence of these animals on or around the site. On the other hand, no rodent remains were found; the lack of systematic sieving during the collection of the material might lie behind the complete absence of such small-sized animals (*§6.8.2 Species frequency: NISP and MNI*).

### *6.8.1.3. Recovery bias*

All animal remains were hand-collected, which means that a recovery bias should be expected (*§Chapter 4: Sites and material*).

To assess it, differences in the proportions of distal metapodials and 1st phalanges for cattle, caprines (sheep/goat) and suids were investigated.

The proportions of caprine and suid metapodials exceed those of 1st phalanges; by contrast, cattle phalanges are slightly more numerous than metapodials, although not to the level expected for their natural proportion (1:2) (Fig.6.8.2).

As a result, there is little doubt that the higher frequency of cattle phalanges in proportion to distal metapodials, compared to the frequencies recorded for caprines and suids, indicates that a recovery bias occurred and was more pronounced for the smaller species. Such deficiency in the collection of the faunal material could have resulted in an overestimation of large-sized animals (e.g. cattle); at the same time, the recovery bias probably lies behind the almost complete absence of small-sized mammals - birds and fishes.

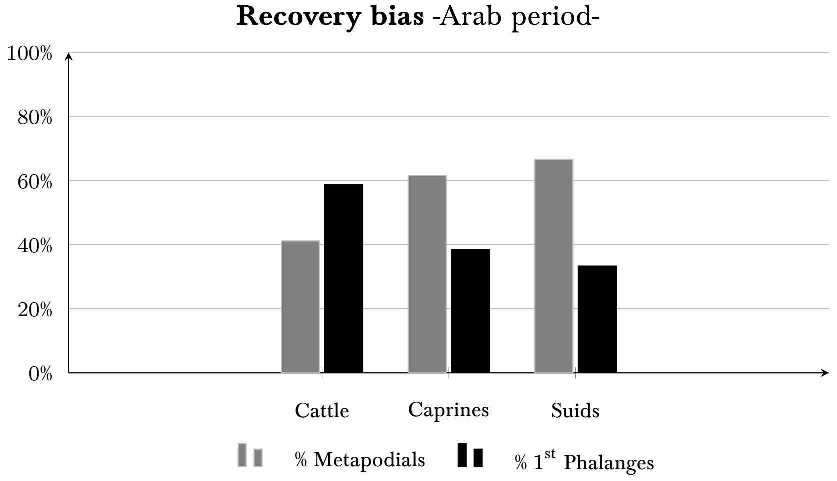


**Figure 6.8.2.** Castello San Pietro, Arab period. Proportions of metapodials and 1st phalanges for cattle (n:7;20), caprines (n:32;20) and suids (n:8;4).

## 6.8.2. Species frequency: NISP and MNI

| **Castello San Pietro** | |
|---|---|
| **Taxa** | **Arab period** |
| Cattle (*Bos taurus*) | 47 |
| Caprines (*Ovis aries*/*Capra hircus*) | 231 |
| Suids (*Sus* sp.) | 56 |
| Equids (*Equidae*) | 1 |
| Felids (*Felidae*) | 3 |
| Canids (*Canidae*) | 2 |
| Lagomorphs (*Lagomorpha*) | 3 |
| Hare (*Lepus* sp.) | (2) |
| Galliformes (*Gallus*/*Numidia*/*Phasianus*) | 26 |
| Domestic fowl (*Gallus gallus*) | (18) |
| Fish | 13 |
| Tuna (*Thunnus* sp.) | (10) |
| Total | **382** |

**Table 6.8.2.** Castello San Pietro, Arab period. List of all the taxa recorded. Non-countable elements are not included. When a taxon is only present with non-countable fragment(s), this is indicated with a + (*§Chapter 5: Methodology*).

| **Castello San Pietro** | **Arab period** | |
|---|---|---|
| | **Countable** | **Non-countable** |
| Sheep | 82 | 13 |
| Goat | 9 | 6 |
| Sheep/goat | 140 | 51 |
| **Total** | **231** | **70** |

**Table 6.8.3.** Castello San Pietro, Arab period. Recorded countable and non-countable elements identified as sheep (*Ovis aries*), goat (*Capra hircus*) and sheep/goat (*Ovis*/*Capra*).

Like other faunal assemblages analysed in this project, the animal remains from Castello San Pietro are mainly represented by the three main domesticates (caprines, cattle and suids), which represent almost 92% of countable remains (Tab.6.8.2). Caprines (*Ovis aries*/*Capra hircus*) dominate, followed by suids (*Sus domesticus* and/or *Sus scrofa*) and cattle (*Bos taurus*); suids and cattle are almost equally represented in the assemblage (Tab.6.8.2, Fig.6.8.3 and Fig.6.8.4).

On the basis of distinctive morphological criteria present on a defined set of anatomical elements, 95 caprine remains (countable and non-countable) were attributed to sheep, while the majority (n:161) could not be identified to species level, these being generally recorded as 'sheep/goat'. Very few remains were directly attributed to goat (Tab.6.8.3). Biometrical analyses to separate sheep from goat metacarpals were also attempted (see subchapter *Sheep*/*goat* below).

Equids are only represented by one distal metacarpal; this could belong to horse (*Equus caballus*), donkey (*Equus asinus*) or an equid hybrid (i.e. mules, hinnies).

In addition, canid and felid remains were also present, but in low numbers. The formers were represented by two medium-sized maxillae potentially belonging to the domestic dog (*Canis familiaris*) and/or to the wolf (*Canis lupus*), but most likely not to the fox (*Vulpes vulpes*), the maxillae and mandibles of this latter species usually being slenderer. Felid remains consisted of two mandibles and one distal femur; these remains could belong to either the domestic (*Felis catus*) or the wild cat (*Felis silvestris*).

Unlike the other analysed sites, large-sized wild mammals (i.e. cervids) were completely absent from the assemblage.

Very few small-sized wild mammal remains were recorded; these include a distal humerus, a distal femur and a proximal tibia attributed to the hare (*Lepus* sp.), and a pelvis, which could only be assigned to the order Lagomorpha (Tab.6.8.2).

Birds are represented by 26 remains, the majority being attributed to the domestic fowl (*Gallus gallus*); however, morphological similarities with closely-related taxa, such as the pheasant (*Phasianus colchicus*) and the helmeted guineafowl (*Numida meleagris*), did not allow to rule out with certainty the presence of such birds in the assemblage (Tab.6.8.2).

A few fish remains were also present, consisting of 13 elements; among these, ten remains belonged to tuna (*Thunnus* sp.), while the other three bones could not be identified due to their high degree of fragmentation and surface erosion. *Thunnus* sp. remains mainly consist of caudal vertebrae, although a few cranial elements were also present (i.e. one dentary, one quadrate and one preopercular) (Tab.6.8.2).

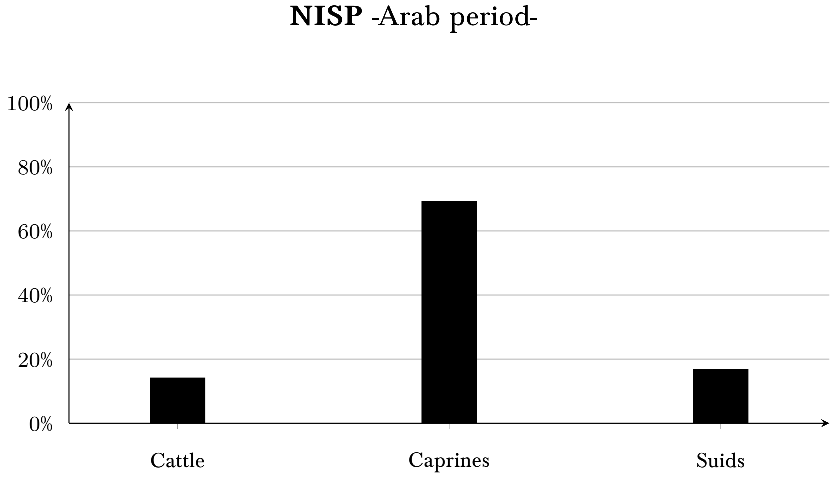


**Figure 6.8.3.** Castello San Pietro, Arab period. Percentage of the Number of Identified Specimens (NISP) for the three main domesticates (n:334).

The MNI analysis shows a very similar trend to the NISP, with no substantial differences (Fig.6.8.3 and Fig.6.8.4). The strong similarity of results between these two quantification methods provide us with greater confidence over the accuracy of the analyses (*§Chapter 5: Methodology*).

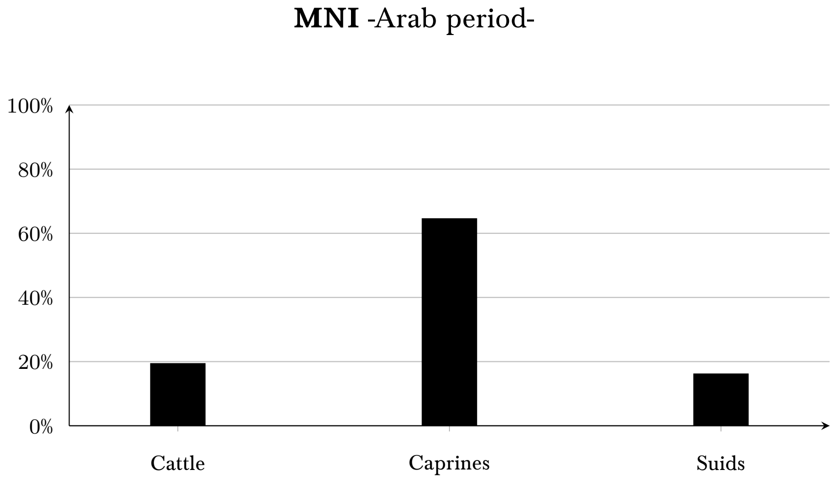


**Figure 6.8.4.** Castello San Pietro, Arab period. Percentage of the Minimum Number of Individuals (MNI) for the three main domesticates (n:30).

*Sheep/goat separation* – Biometrical analyses were carried out on caprine metacarpals to investigate the sheep/goat ratio further. Shape indices were produced by comparing measurements of the condyles and of the *verticilli* of caprine distal metacarpals; comparisons between the obtained values and those from modern specimens (Salvagno and Albarella 2017) were made (Fig.6.8.5).

During the recording of the faunal material, out of seven fused metacarpals, five had been identified as belonging to sheep, while the other two had been attributed one each to ‘sheep/goat’ and goat.

As Fig.6.8.5 shows, four specimens fall within the modern values of sheep, with one outlier almost certainly represents another sheep; these elements had all been identified as sheep on the basis of distinctive morphological criteria. In addition, one specimen plots at the bottom left of the graph, and is likely to represent a goat; another specimen, within the range of modern goats but not as detached from that of sheep had been previously recorded as ‘sheep/goat’, and remains unidentified.

Fig.6.8.6, which employs different measurements from the same element (i.e. metacarpals), seems to confirm this result. In this case five specimens plot within the modern values of sheep, with only one value falling fully within the range of goats.

In sum, the ratio between sheep and goats seems to suggest that the formers were better represented at the site in this period. As a result, morphometric analyses corroborated the results from morphological identifications of these anatomical elements. However, the sample size is rather small, thus inviting caution in the interpretation of the results.

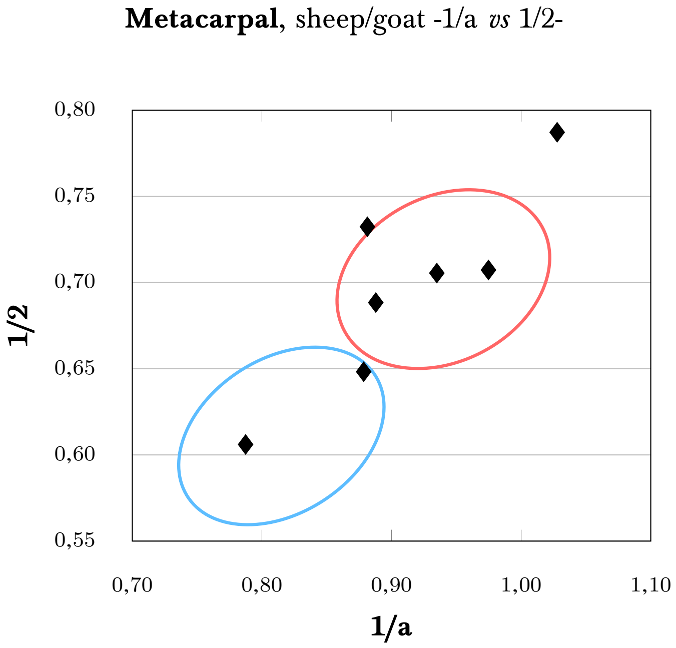


**Figure 6.8.5.** Castello San Pietro, Arab period. Sheep/goat, metacarpals, shape indices. Red oval: range of modern sheep values, blue oval: range of modern goat values according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). 1: depth of left distal condyle; a: width of the medial condyle; 2: diameter of the verticillus of the medial condyle.

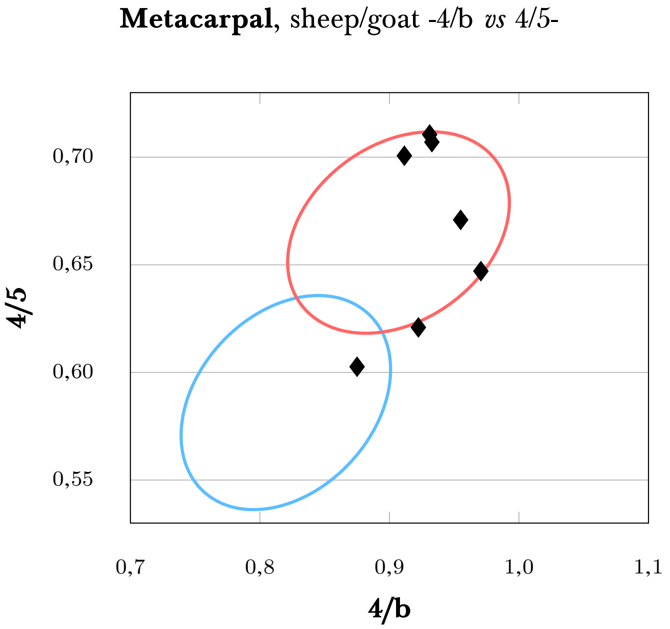


**Figure 6.8.6.** Castello San Pietro, Arab period. Sheep/goat, metacarpals, shape indices. Red oval: range of values attributed to sheep, blue oval: range of values attributed to goat according to Salvagno and Albarella (2017) (*§Chapter 5: Methodology*). 4: depth of the lateral condyle; b: width of the lateral condyle; 5: diameter of the verticillus of the lateral condyle.

### 6.8.3. Ageing

Comments about the age-at-death of caprines, cattle and suids mostly rely on the analysis of the epiphyseal fusion of post-cranial bones; in the case of sheep/goat, the relatively high number of ageable mandibular sequences allowed to make a comparison between these two ageing methods. Brief comments about the age-at-death of galliforms are also made.

*Caprines* – In the Arab period (Fig.6.8.7), ca. 7% of caprine early fusing post-cranial elements were unfused, thus suggesting the presence of animals culled before their first-second year of age (lambs). Ca. 40% of caprines were culled in their second-third year of age (middle fusing stage), and another ca. 20% were slaughtered before reaching their third-fourth year of age (late fusing stage). In addition, ca. 40% of individuals survived into adulthood (≥ three-four years of age), probably being kept for the exploitation of secondary products (e.g. milk and wool). Five perinatal bones of sheep/goat were also recorded; these were not included in the analysis, as they are likely to represent natural losses rather than deliberate culling. The presence of such remains might be an indicator of caprine on-site breeding.

Mandibular wear stages were estimated for 31 caprine mandibles. The obtained kill-off pattern fully supports the results from the epiphyseal fusion analysis (Fig.6.8.8), suggesting on overall lack of specialisation.

In sum, the culling pattern from the Arab period at Castello San Pietro suggests that caprines were exploited for meat as well as for dairy products and wool production.

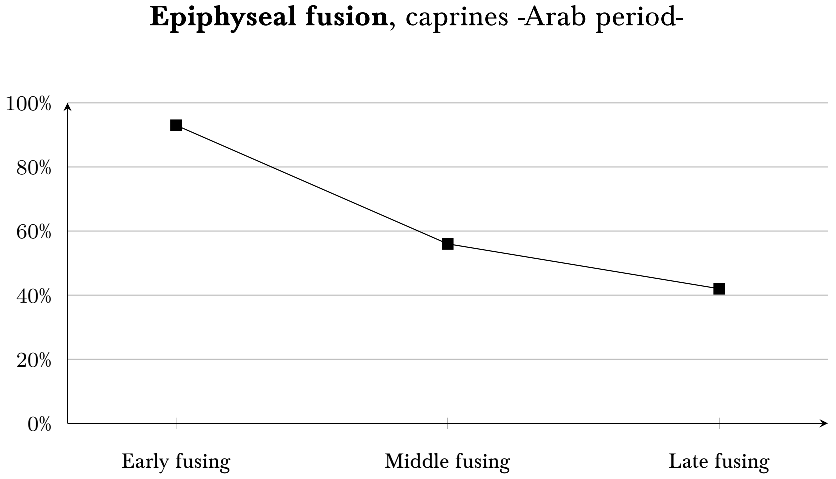


**Figure 6.8.7.** Castello San Pietro, Arab period. Epiphyseal fusion analysis for caprines. Percentage of fused bones within each fusion stage (n:93;56;42). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

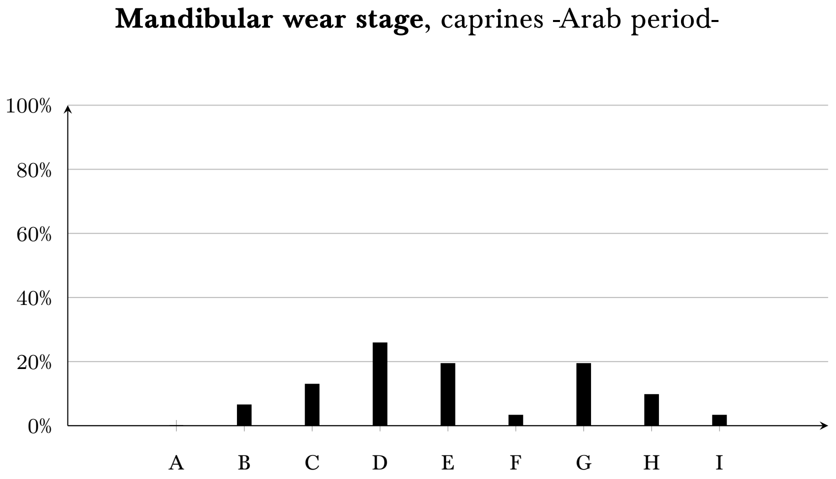


**Figure 6.8.8.** Castello San Pietro, Arab period. Mandibular wear stages for caprines (n:31). Age stages follow Payne (1973). A: 0-2 months, B: 2-6 months, C: 6-12 months, D: 1-2 years, E: 2-3 years, F: 3-4 years, G: 4-6 years, H: 6-8 years, I: 8-10 years.

*Cattle* – Ageing data suggest that ca. 50% of cattle survived into late adulthood (late fusing stage; ≥ three-four years); such individuals are likely to have been slaughtered once they became too weak for being used for traction, and/or once they stopped producing dairy products. A number of individuals were slaughtered before the third-fourth year of age (late fusing stage) and the second-third year of age (middle fusing stage) (ca. 20% in both stages). The dearth of unfused early fusing elements (ca. 5%), corresponding to very young individuals (i.e. calves), is likely the result of taphonomic processes rather than of a genuine disinterest in milk production (Fig.6.8.9).

Overall, as it was the case for caprines, cattle husbandry in the Arab period at the site seems quite generalised, with a number of individuals raised for their meat, and a similar proportion of animals being exploited for their secondary products, such as traction force, milk and manure.

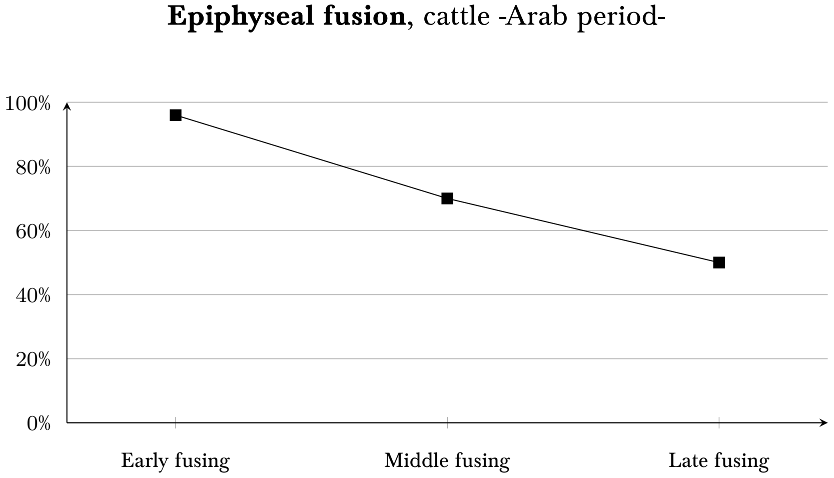


**Figure 6.8.9**. Castello San Pietro, Arab period. Epiphyseal fusion analysis for cattle. Percentage of fused bones within each fusion stage (n:96;70;50). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Suids* – In the Arab period, ca. 10% of early fusing elements were unfused, representing suids culled before their first-second year of age; this pattern may suggest the consumption of very young pigs at the site (Fig.6.8.10). No pig perinatal bones were recorded. An additional ca. 40% of suids were culled before their second-third year of age (middle fusing stage), once they had reached their optimum weight, with another ca. 20% of animals culled before their third-fourth year of age (late fusing stage). ca. 30% of the individuals survived into adulthood; these latter may represent sows and boars kept for reproduction, as well as pigs kept to be culled at a later stage.

This kill-off pattern obtained for suids is similar to that from other Sicilian assemblages analysed in this project, reflecting the fact that suids are obviously reared exclusively for their meat.

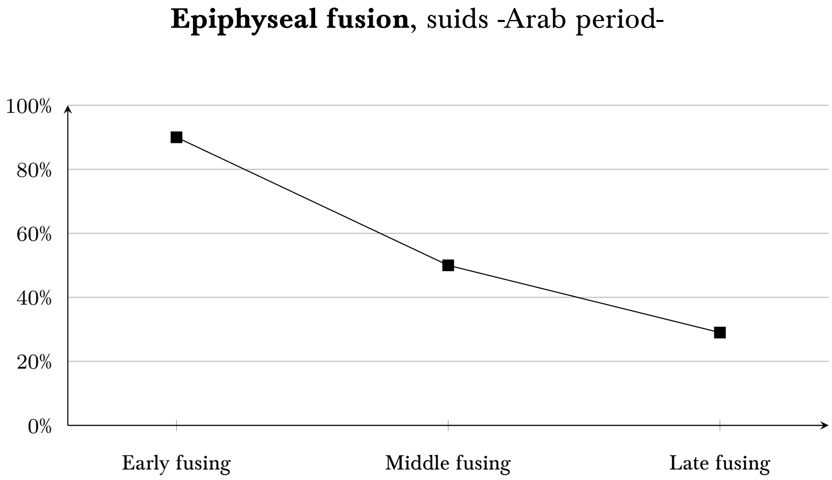


**Figure 6.8.10.** Castello San Pietro, Arab period. Epiphyseal fusion analysis for suids. Percentage of fused bones within each fusion stage (n:90;50;29). Epiphyseal fusion stages follow Silver (1969). Early fusing stage: 12-24 months; Middle fusing stage: 24-36 months; Late fusing stage: 36-48 months.

*Galliforms* – Out of 34 recorded bones (countable and uncountable elements), four were not fully ossified, while 30 belonged to fully ossified individuals; among these, 26 were directly attributed to the domestic fowl. Despite the small sample, it can be assumed that mature individuals were not especially young when slaughtered.

### 6.8.4. Sex

Information about the sex of animals from Castello San Pietro could only be obtained for suids and domestic fowl.

*Suids* – The ratio between sows and boars was calculated by considering canines in jaws; in addition, the mandibular and maxillary alveoli were also sexed when canines were not present in the jaws (*§Chapter 5: Methodology*).

As Table 6.8.4 indicates, the few suid canines and alveoli recorded show that sows are better represented than boars at the site.

This pattern is most likely related to the fact that males (mainly castrated) were more frequently culled at a younger age for meat consumption (in many cases, before permanent canines had fully developed), while more females were kept for breeding. This is supported by the fact that the majority of suids were culled at a young age (*§6.8.3 Ageing*).

| **Castello San Pietro** | **Arab period** | |
|---|---|---|
| *Sus* sp. | **Sows** | **Boars** |
| Canines (in jaws) | 7 | 2 |
| Alveoli (mandibular and maxillary) | 3 | 2 |
| **Total** | **9** | **4** |

**Table 6.8.4.** Castello San Pietro, Arab period. Presence of male and female suids based on canines in jaws and alveoli (n:9;4).

*Domestic fowl* – Out of 11 mature tarsometatarsi, only one bore a spur; this latter specimen did not present a continuous posterior keel, thus allowing a certain taxonomic attribution to the domestic fowl (therefore a cockerel or a capon).

Despite the small sample size and the methodological issues related to sexing based on the presence/absence of the spur in galliforms, it seems that hens were better represented than males at the site (Tab.6.8.5).

| **Castello San Pietro** | **Unspurred tarsometatarsi** | **Spurred tarsometatarsi** |
|---|---|---|
| Arab period | 10 | 1 |

**Table 6.8.5**. Castello San Pietro, Arab period. Number of unspurred (most likely female) and spurred (most likely male) tarsometatarsi of galliforms

### 6.8.5. Anatomical element distribution

The distribution of anatomical elements could be properly analysed for caprines, cattle and suids; in addition, cursory observations on fish body parts were also made.

*Caprines* – The distribution of caprine body parts in the Arab period can probably be explained entirely on the basis of differential recovery and preservation processes. The most common element is the distal tibia, followed by mandibles and distal humeri (Fig.6.8.11); such body parts are those which tend to preserve better in the archaeological record (they present a high bone density), and are large enough to be noticed during the process of recovery (Brain 1981).

Small elements are underrepresented (e.g. phalanges and tarsals), if not completely absent (e.g. carpals); the recovery bias against smaller body parts is likely the main reason behind this result (*§6.8.1.3 Recovery bias*).

The high incidence of cranial elements (e.g. mandibles), alongside the presence of almost all other parts of the caprine skeleton, suggest the introduction and processing (primary and secondary butchery) of entire caprine carcasses at the site.

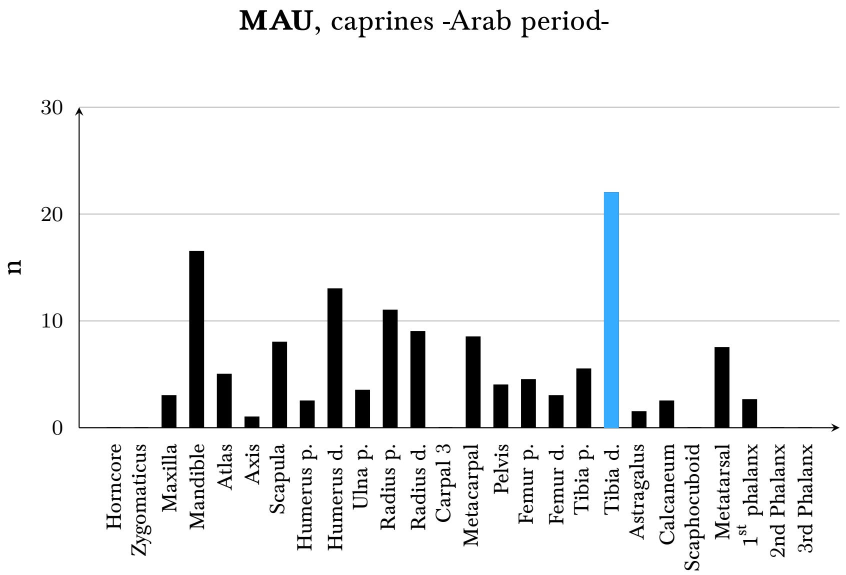


**Figure 6.8.11**. Castello San Pietro, Arab period. Distribution of the Minimum number of Animal Units (MAU) for caprines (n:134). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Suids* – Similarly to caprines, the recovery bias and differential preservation are likely to have substantially influenced the pattern of representation of suid body parts. Denser anatomical elements, such as the distal humerus and the scapula, are the most abundant body parts; on the other hand, the most fragile body parts, such as the proximal ends of most long bones (e.g. humerus and femur) are scarcely represented, if not completely missing (the only exception being the proximal tibia, that shows an equal incidence to that of the distal tibia). Like in caprines, smaller elements, such as carpals, tarsals and phalanges, are poorly represented (in some cases they are totally absent – i.e. carpal 3, astragalus, scaphocuboid, $3^{rd}$ phalanges); this pattern is likely to be the result of the recovery bias (*§6.8.1.3 Recovery bias*). Cranial elements (maxillae and mandibles) are present, but in low numbers (Fig.6.8.12).

Overall, it is likely that all suid body parts were equally represented at the site before being discarded, and that both primary and secondary butcheries occurred on site. However, this hypothesis needs to be treated with caution due to the small sample size.

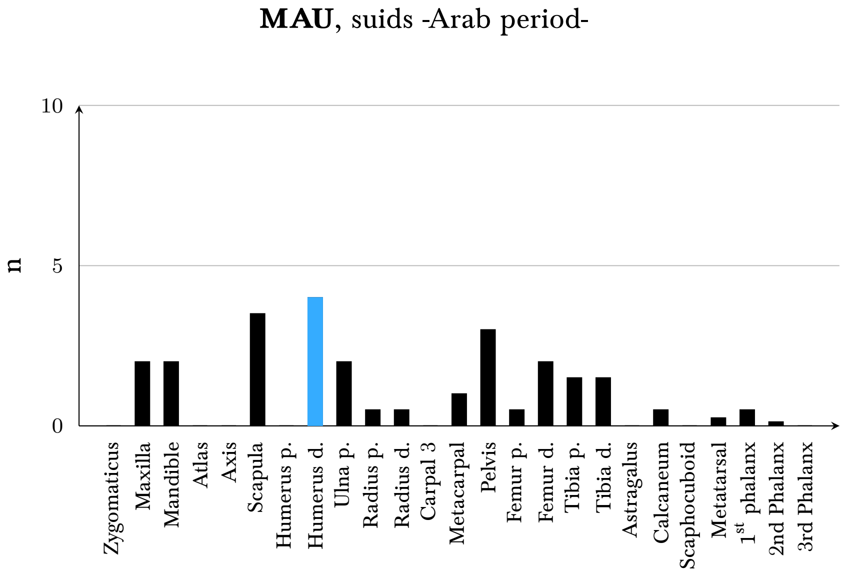


**Figure 6.8.12.** Castello San Pietro, Arab period. Distribution of the Minimum number of Animal Units (MAU) for suids (n:25). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Cattle* – Hind limb bones, such as astragali, (distal) tibiae and calcanea, are the most abundant anatomical elements; this probably reflects the fact that they tend to survive better in the archaeological record due to their higher level of bone density in comparison to other body parts (i.e. proximal humerus, proximal femur and proximal tibia). The similar number of metacarpals and metatarsals, which present almost the same chances of survival in archaeological deposits, suggests that the incidence of cattle fore and hind limbs at the site was originally the same. Unlike caprines and suids, smaller anatomical elements are present (the only exception being represented by carpals); their larger size (and consequently, their higher visibility during excavation) in comparison to those of caprines and suids, almost certainly lies behind such pattern (Fig.6.8.13) (*§6.8.1.3 Recovery bias*). A very low incidence of cranial elements is attested, suggesting that entire carcasses entered the site only occasionally.

Therefore, while the major incidence of hind limb bones could be taphonomic, on the other hand the abundance of lower limb bones suggests that primary rather than secondary butchery activities occurred at the site.

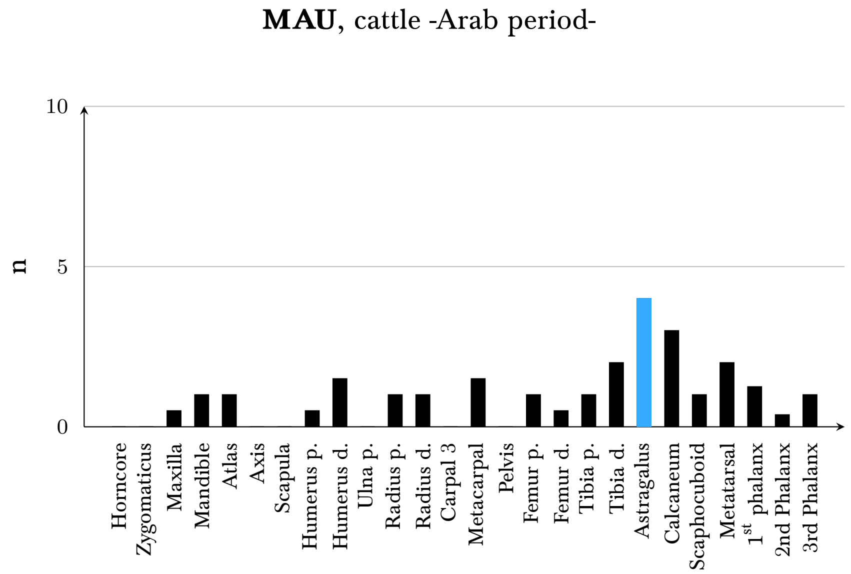


**Figure 6.8.13.** Castello San Pietro, Arab period. Distribution of the Minimum number of Animal Units (MAU) for cattle (n:24). The most represented anatomical element/s in light blue. Mandibles and maxillae refer to jaws with at least one tooth; loose teeth are not considered (*§Chapter 5: Methodology*).

*Fish* – Remains of *Thunnus* sp. are represented by seven caudal vertebrae and three cranial elements (i.e. one dentary, one quadrate and one preopercular); among these, three remains presented cut and chop marks (*§6.8.6 Butchery*).

### 6.8.6. Butchery

For this site, the analysis of butchery marks focuses on caprines and cattle. Brief comments about suid and fish carcass processing are also made, despite the small quantity of available data.

*Caprines* – Butchery marks were recorded on about 15% of caprine post-cranial bones, and were mainly caused by knives (i.e. cut marks) (Fig.6.8.14 and Fig.6.8.15). In most cases, such marks were located near the articular ends of long bones (especially the tibia and the humerus); such evidence could be related to the severing of tendons. Some chop marks were also detected, these having been likely produced by cleavers and/or axes; such marks were recorded on the articulations of post-cranial bones as well as on the axial skeleton (i.e. small/medium-sized vertebrae and ribs), and they are probably associated with the dismembering of the carcass into smaller pieces. No evidence potentially related with marrow extraction (i.e. chops along long bone shafts) and/or with skinning activities (i.e. cut marks on mandibles, maxillae, metapodials, and phalanges) was detected.

In sum, the analyses of the butchery evidence and of the anatomical element distribution suggest that most caprine remains recorded from Castello San Pietro likely represent food waste, and that both primary and secondary butchery occurred on site.

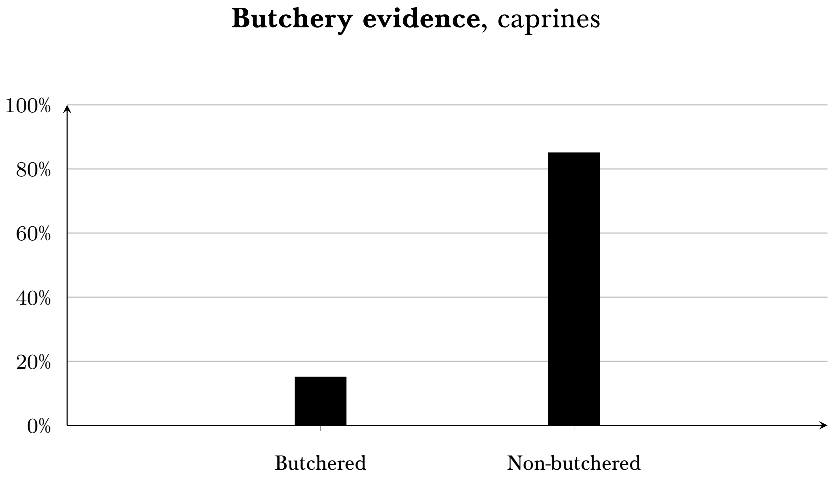


**Figure 6.8.14**. Castello San Pietro, Arab period. Proportion of butchered and non-butchered post-cranial bones of caprines (n:59;241).

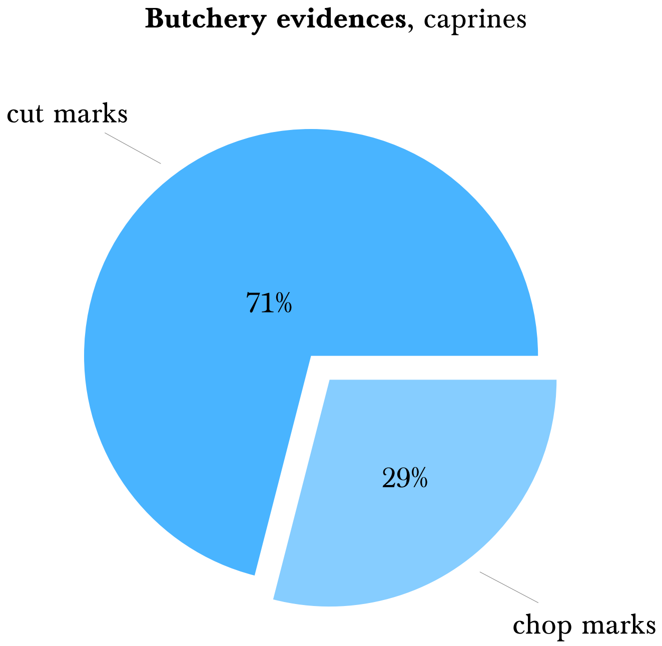


**Figure 6.8.15**. Castello San Pietro, Arab period. Butchered post-cranial bones of caprines; proportions of cut marks and chop marks (n:59).

*Cattle* – Butchery marks were more common in cattle than in caprines and suids. This pattern is likely a consequence of the larger size of cattle carcasses, which need to be dismembered into a greater number of portions. Butchery marks were recorded on about 25% of cattle post-cranial bones (Fig.6.8.16); chop marks, inflicted by heavier tools (i.e. cleavers and/or axes), were by far better represented than cut marks (Fig.6.8.17). In addition, a few metapodials were sawn close to their distal ends.

Most of the chopping marks were located near the articular ends of long bones, while fewer were detected along the shafts; the formers may indicate the reduction of carcasses into smaller piece, while the latters the extraction of bone marrow. In addition, few large-sized vertebrae and ribs, which are largely likely to be cattle, presented chop marks. No butchery marks were detected on the very few cranial elements.

Cut marks were mainly detected on hind limb bones, and especially on the astragalus and the calcaneum; such evidence was probably inflicted to severe tendons and/or for skinning.

In view of the anatomical element distribution and the butchery evidence, it can be argued that cattle carcasses were being butchered on site, although part of the process could have continued elsewhere.

**Butchery evidence**, cattle

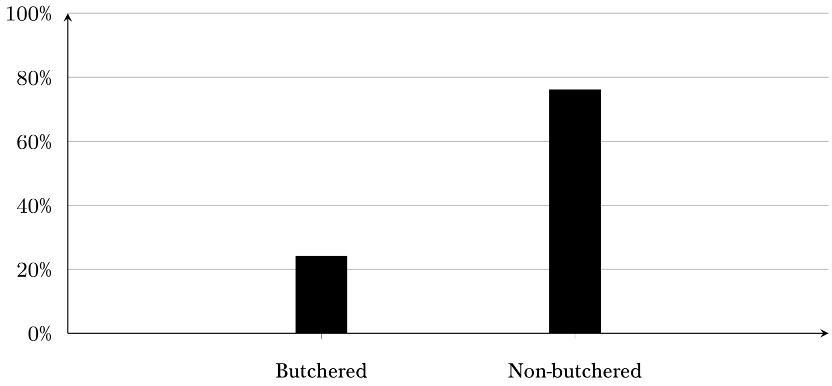


**Figure 6.8.16**. Castello San Pietro, Arab period. Proportion of butchered and non-butchered post-cranial bones of cattle (n:15;48).

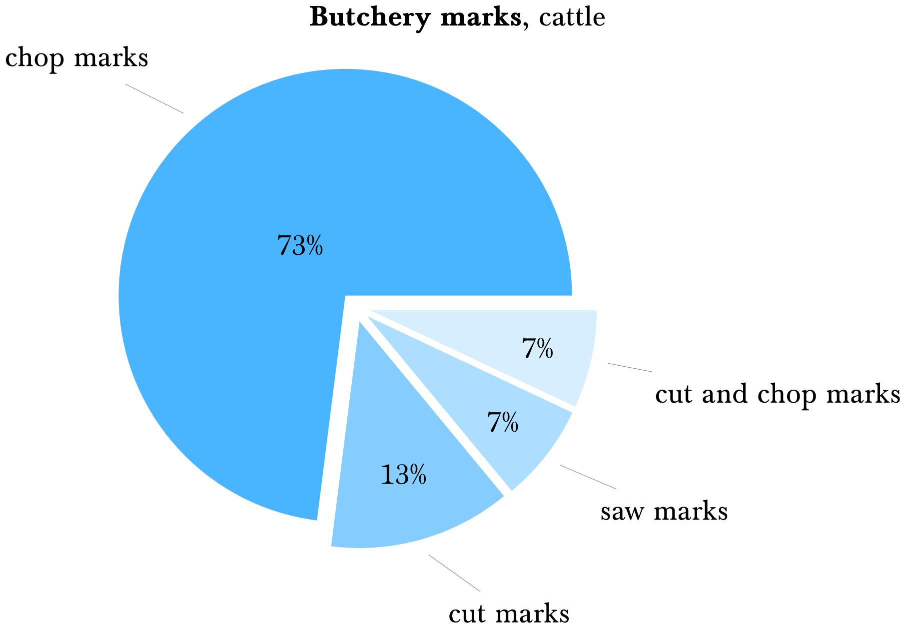


**Figure 6.8.17.** Castello San Pietro, Arab period. Butchered post-cranial bones of cattle; proportions of cut marks, chop marks, saw marks and cut and chop marks (n:15).

*Suids* – A much lower incidence of suid remains bore butchery marks (i.e. ten post-cranial bones). Chop marks and cut marks were both represented.

cut and chop marks were manly detected near the articular ends of long bones (e.g. femur, tibia and humerus), while fewer were also present on scapulae (n:2). The well-known fragile and porous consistency of suid bones, (especially for immature individuals), and their tendency to break up more easily, could be enhanced when intensively butchered, leading to an overall underrepresentation of butchered suid remains (*§6.8.3 Ageing*).

*Fish* – Chop and cut marks were detected on two caudal vertebrae and on one preopercular; this evidence may indicate that entire fish carcasses of *Thunnus* sp. were brought to and processed on site, as the head of this animal is usually removed in the early stages of butchery. However, these data need to be treated with caution due to the small sample size.

### 6.8.7. Burning

Out of 497 recorded fragments, 31 bones (ca.10%) bore evidence of burning; 21 remains were burnt, nine were singed, while calcination was recorded only on one bone. These remains mainly belonged to caprines, while a few belonged to cattle and suids. The location and type of burning evidence, as well as the identification of burnt material with domestic food mammals, might suggest most of the animal remains from the site are the result of food waste disposal.

### 6.8.8. Pathology

Fusion of vertebral bodies was detected on two caudal vertebrae attributed to *Thunnus* sp. (Fig.6.8.18); this pathology could have appeared during the embryonic or post-embryonic periods of the fish life, and it could has affected its movements, growth and morphology. The origin and the development of such skeletal deformity is likely a combination of environmental, nutritional and genetic factors (Witten *et al.* 2005).

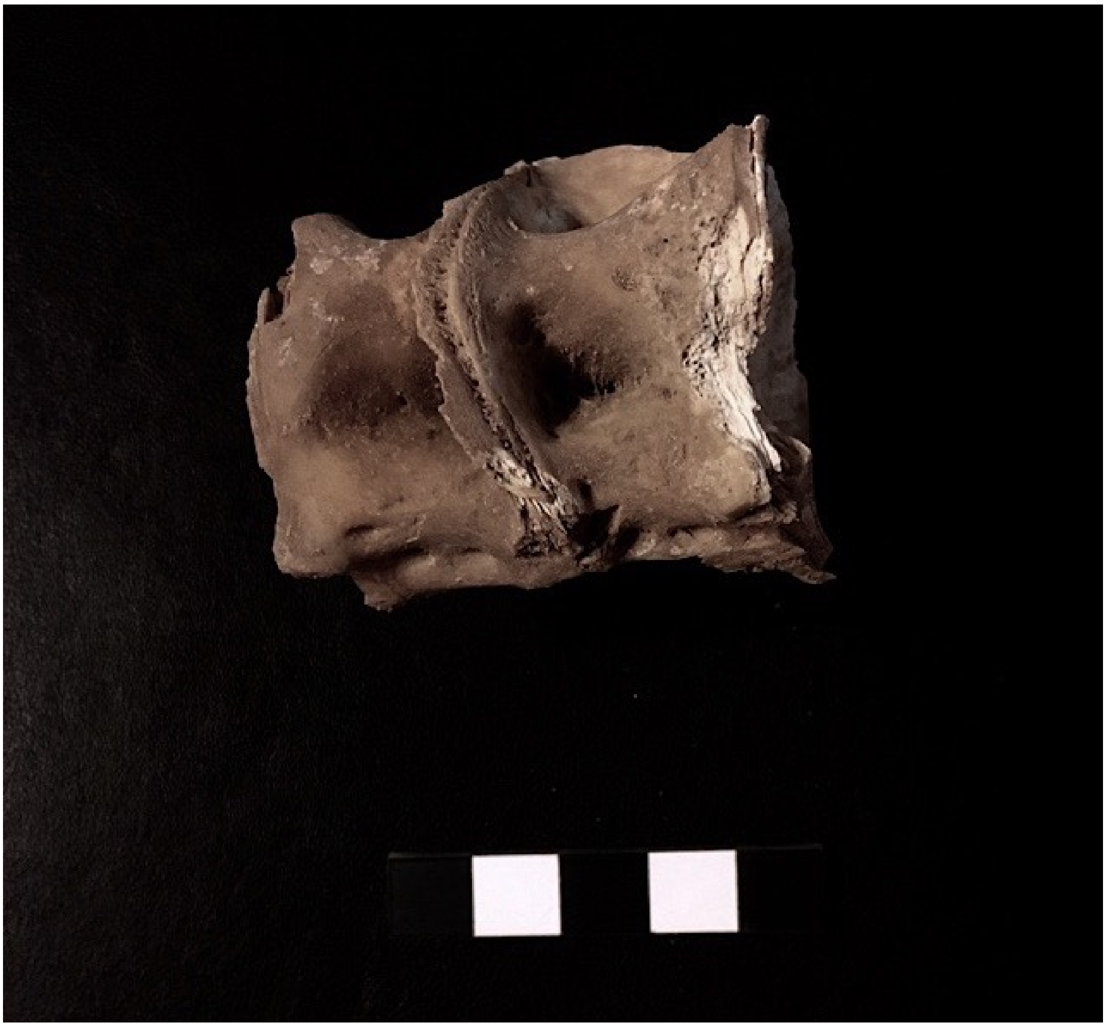


**Figure 6.8.18**. Castello San Pietro, Arab period. Two fused vertebral bodies of Thunnus sp.

### 6.8.9. Size and shape

Biometrical analyses were specifically carried out for caprines, as the overall good preservation of their remains recorded from Castello San Pietro allowed to take a considerable amount of measurements.

Potential size differences of caprines (i.e. sheep) from this and other sites were investigated by using absolute measurements from the same anatomical elements (i.e. tibia and humerus), and by plotting a selection of width/depth measurements of post-cranial bones into a log ratio histogram; however, it was not possible to analyse separately the more and the less sex-dependent post-cranial bones. In all the log ratio analyses, the most age-dependent measurements were excluded. Comparisons with different site-types analysed in this project and dated to the Byzantine, Arab and the Norman/Swabian periods were made.

In addition, widths/depths of post-cranial elements of domestic fowl were analysed through the log ratio technique; these were directly compared with biometrical data from Arab and Norman/Swabian Mazara del Vallo.

*Caprines* – Measurements of the distal tibia of caprines from Castello San Pietro, Corso dei Mille and Sant'Antonino were plotted in the same graph to investigate potential differences in caprine size among sites located in Arab Palermo (Fig.6.8.19). The evidence shows that the sheep from Castello San Pietro are similar in size to those from Sant'Antonino but larger than those from Corso dei Mille.

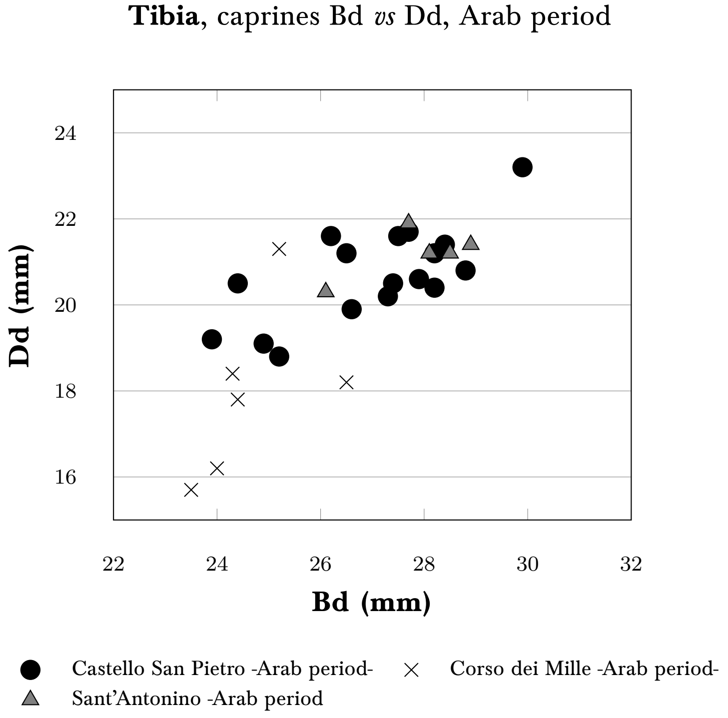


**Figure 6.8.19.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Castello San Pietro (black circles), Corso dei Mille (black crosses) and Sant'Antonino (grey triangles) (*§Chapter 5: Methodology*).

Comparison with urban Mazara del Vallo (Fig.6.8.20) suggests a slightly larger size of caprines from Castello San Pietro.

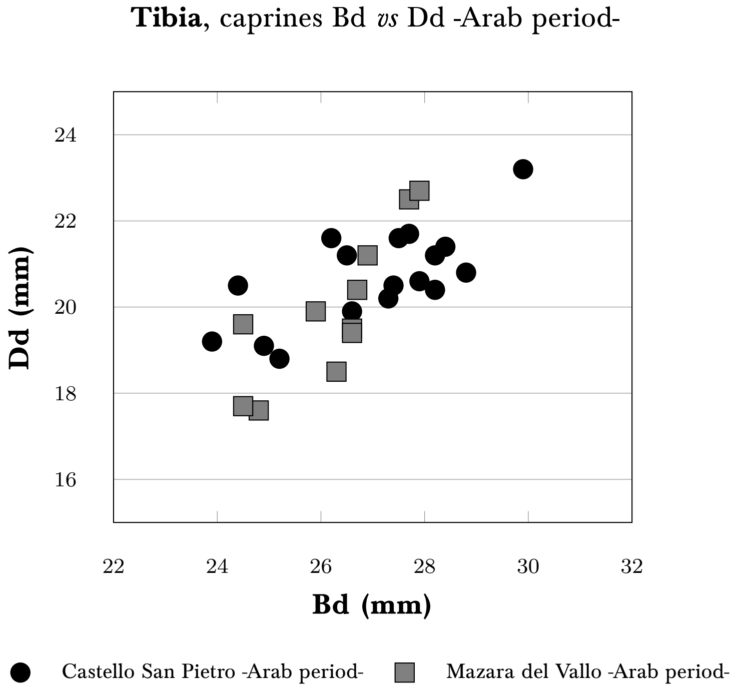


**Figure 6.8.20.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Castello San Pietro (black circles) and Mazara del Vallo (grey squares) (*§Chapter 5: Methodology*).

A third scatterplot comparing measurements of the distal tibia from Castello San Pietro, Colmitella, Casale San Pietro and Rocchicella ($2^{nd}$ Byzantine period) was made to detect potential differences in caprine size in the Arab period among different site-types (Fig.6.8.21). While Castello San Pietro, Colmitella and Casale San Pietro are largely similar, the sheep from the rural site of Rocchicella, the only one located in the eastern part of Sicily, appear to be generally smaller.

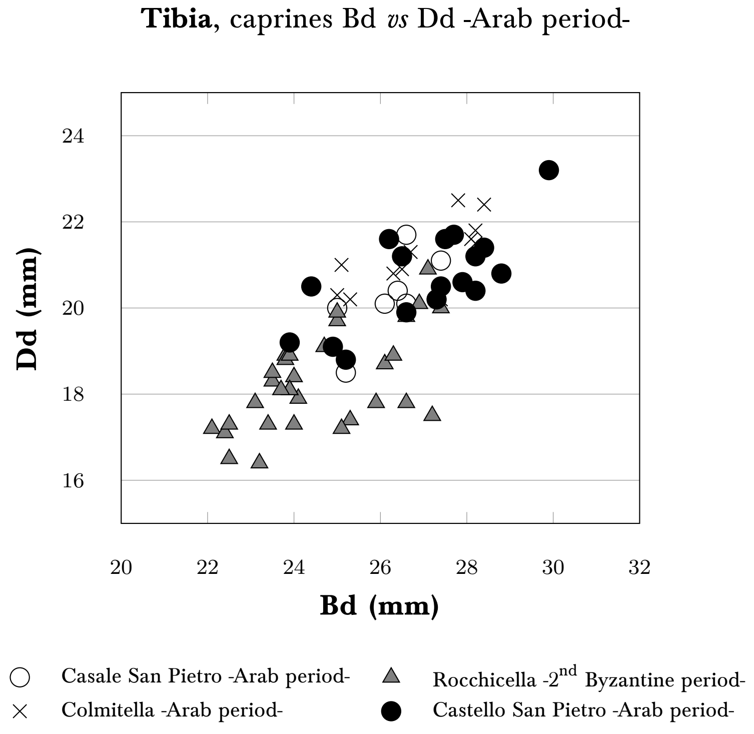


**Figure 6.8.21.** Measurements of the distal tibia (Bd and Dd) of caprines from the Arab period at Castello San Pietro (black circles), Casale San Pietro (empty circles), Colmitella (black crosses) and Rocchicella (grey triangles) (*§Chapter 5: Methodology*).

In order to investigate potential changes in the sex ratio of the caprine population present at the site in the Arab period, a fourth scatter plot comparing measurements from the distal humerus was made; the evidence from this bone also complemented the analyses of differences in caprine size.

In Fig.6.8.22 three loose groups of values can be noticed. The first one refers to two smaller specimens clustering at the bottom left of the graph, while the second one to two larger outliers located at the top right (most likely, the formers refer to ewes, and the latters to rams); the third, more numerous group is located in between these two clusters (most likely castrated and/or larger females).

As a result, the composition of the sheep population present at Castello San Pietro in the Arab period seems to be mostly composed of castrated and/or females, with few rams present. However, these results need to be treated with caution due to the small sample size.

**Humerus**, caprines BT *vs* HTC -Castello San Pietro-

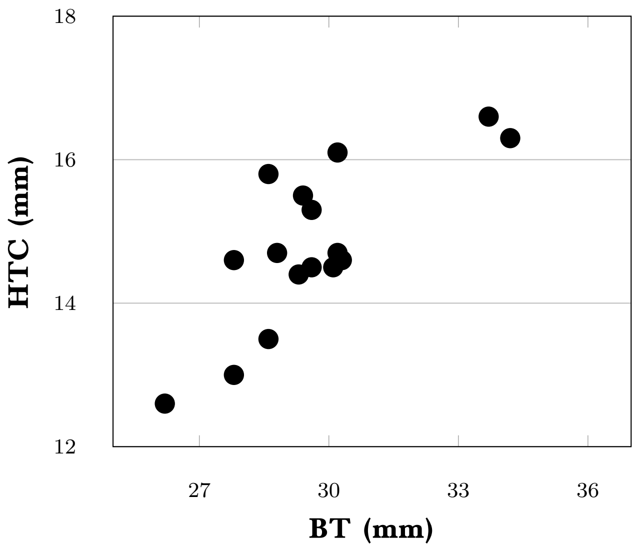


**Figure 6.8.22.** Measurements of the distal humerus (BT and HTC) of sheep from the Arab period at Castello San Pietro (*§Chapter 5: Methodology*).

As mentioned above, width and depth measurements from post-cranial caprine bones were also analysed trough the log ratio technique; comparisons with other site-types (urban and rural) with Arab phases discussed in this project were made. (Fig.6.8.23). Castello San Pietro shows a roughly unimodal distribution and has the highest mean of all compared sites, though its sheep are largely in line with those from other sites. Exceptions are represented by Rocchicella ($2^{nd}$ Byzantine period) and (especially) Corso dei Mille, which have distinctively smaller sheep. Results from the Student's *t*-test support the observed differences in caprine size (Castello San Pietro *vs* Arab Corso dei Mille, *p*: 0.042; Castello San Pietro *vs* Rocchicella ($2^{nd}$ Byzantine period), *p*: 0.002). For further comparisons see Fig.6.8.27, Tab.6.8.6 and Tab.6.8.7).

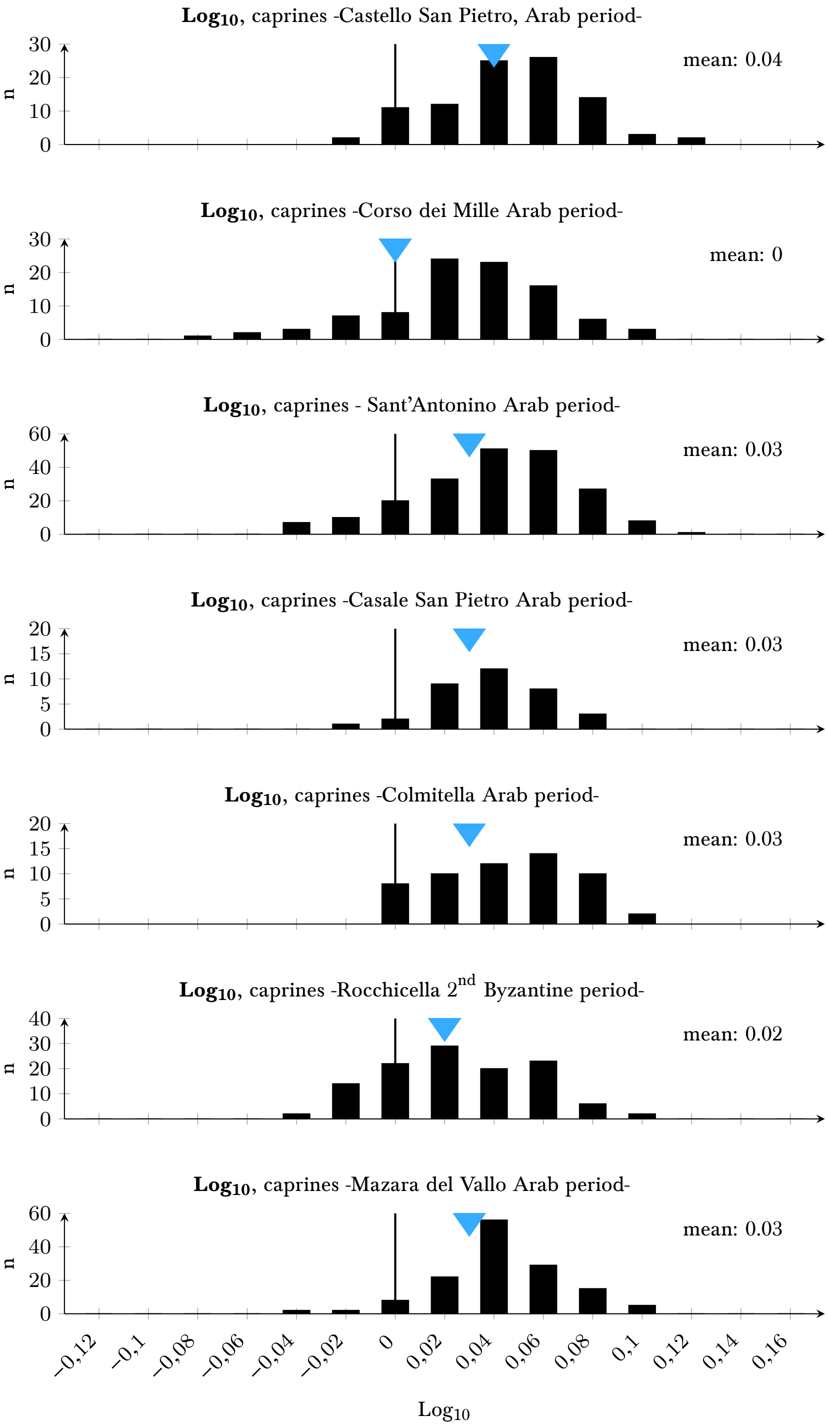
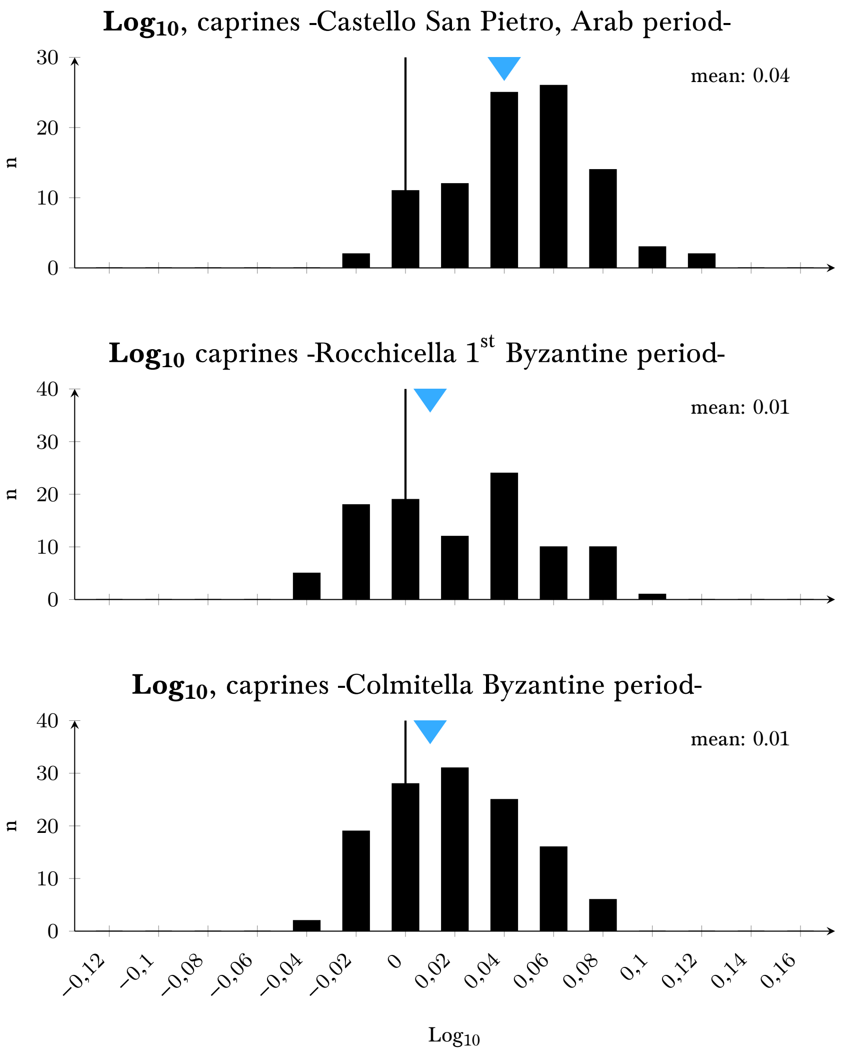


**Figure 6.8.23.** Comparisons of log ratio histograms for width/depth measurements of caprine post-cranial elements from Castello San Pietro (n:115), Corso dei Mille (n:76), Sant'Antonino (n:215), Casale San Pietro (n:35), Colmitella (n:56), Rocchicella (i.e. 2nd Byzantine period) (n:117) and Mazara del Vallo (n:140) in the Arab period. The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

To investigate potential chronological changes, the data from Castello San Pietro have also been compared with earlier Byzantine sites (Fig.6.8.24) and later Norman and Norman-Swabian sites (Fig.6.8.25). The results indicate a size increase between the Byzantine and Arab periods, with further increase in the Norman and Norman/Swabian periods. With the exception of Corso dei Mille, which has smaller sheep.

Results from the Student's *t*-test support the observed differences in sheep size (Castello San Pietro *vs* Byzantine Colmitella, *p*: 0.003; Castello San Pietro *vs* Rocchicella (1st Byzantine period), *p*: 0.033; Castello San Pietro *vs* Norman/Swabian Corso dei Mille *p*: 0.08; Castello San Pietro *vs* Norman/Swabian Mazara *p*: 0.001; Castello San Pietro *vs* the Norman Palace *p*: 0.188 – this represents the only exception, although the *p* value remains quite low). For further comparisons see Fig.6.8.27, Tab.6.8.6 and Tab.6.8.7).



Log10, caprines -Castello San Pietro, Arab period-

Log10 caprines -Rocchicella 1st Byzantine period-

Log10, caprines -Colmitella Byzantine period-

**Figure 6.8.24.** Comparisons of log ratio histograms for width/depth measurements of caprines post-cranial elements from Castello San Pietro (n:115) in the Arab period, and from Rocchicella (1st Byzantine period) (n:117) and Colmitella (n:132) in the Byzantine period. The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

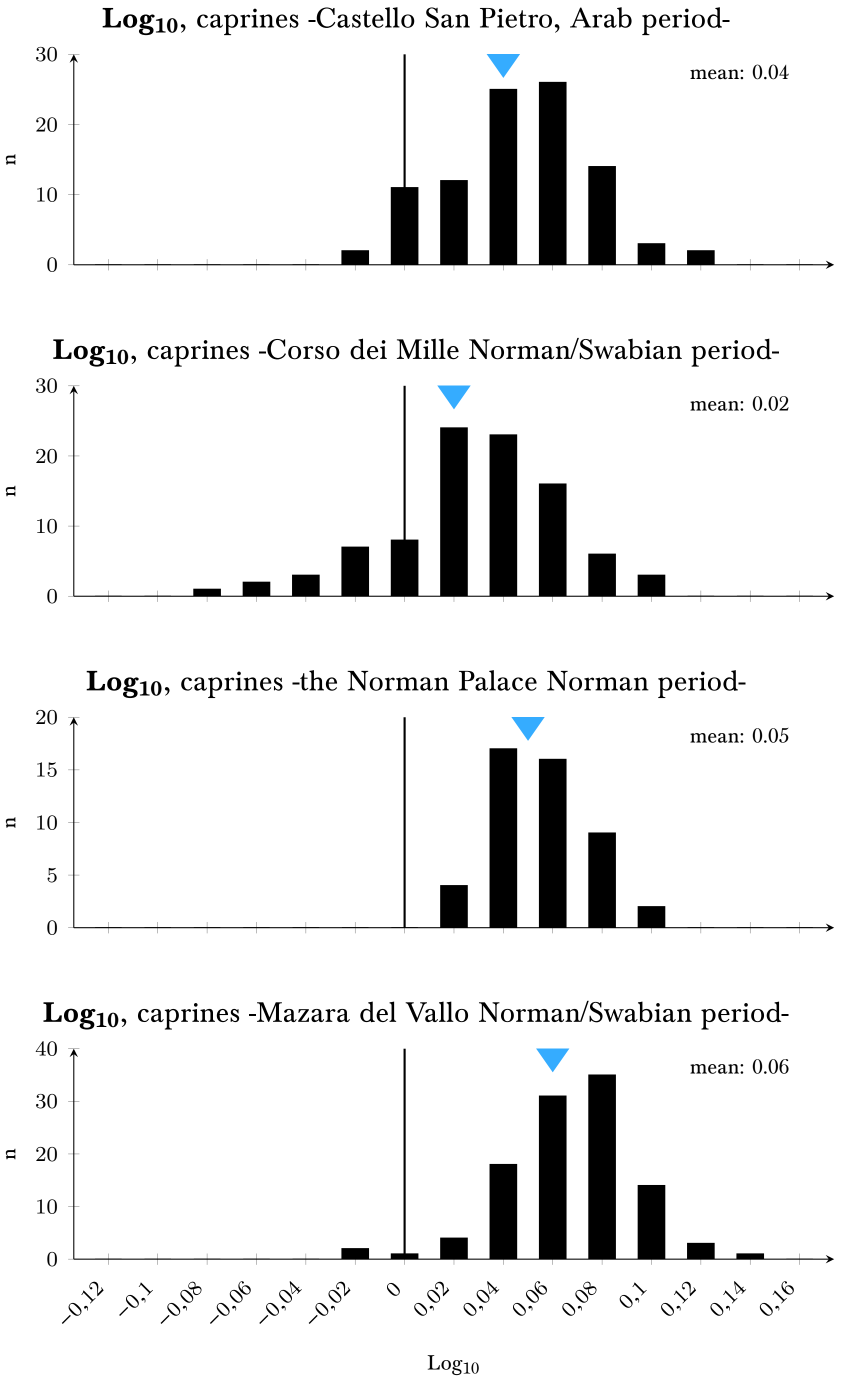
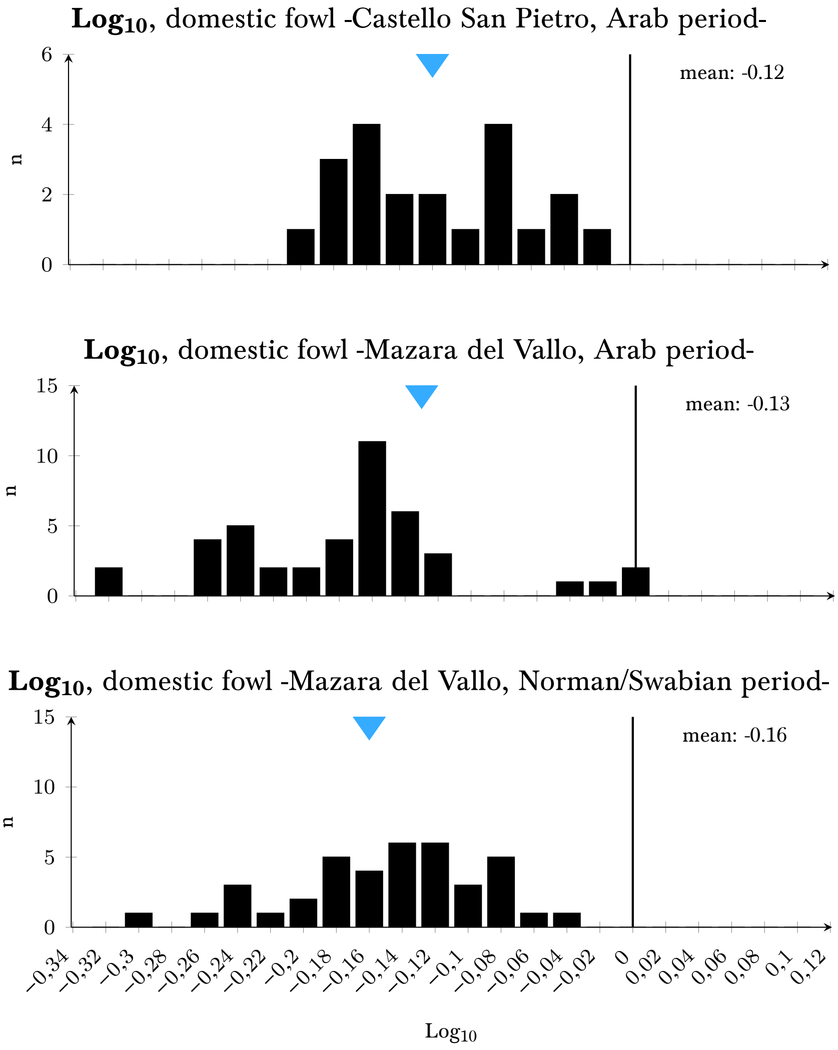


**Figure 6.8.25.** Comparisons of log ratio histograms for width/depth measurements of caprine post-cranial elements from Castello San Pietro (n:115) in the Arab period, and from Corso dei Mille (n:92), the Norman Palace (n:48), and Mazara del Vallo (n:108) in the Norman/Swabian period. The triangles indicate the logarithmic means. The standard used (black line) was the mean of measurements from a sample of unimproved Shetland ewes (Davis 1996) (*§Chapter 5: Methodology*).

*Domestic fowl* – At Arab Castello San Pietro, the histogram displays a bimodal distribution, with a larger group of medium-sized animals located on the right of the graph, and another concentration of smaller specimens located to the left; the smaller specimens could represent hens, while larger ones could include cockerels and/or capons. A polymodal distribution characterises the log ratio histogram from Arab Mazara; in this case, a lower incidence of larger individuals is visible, with chicken from Norman/Swabian Mazara presenting a similar pattern (Fig.6.8.26).

As a result, it seems that chicken from Castello San Pietro was slightly larger in size than that from Arab Mazara del Vallo; however, this result might also reflect a higher presence of cockerels/capons in the former site. Overall, no substantial differences in domestic fowl size among the analysed sites can be hypothesised.

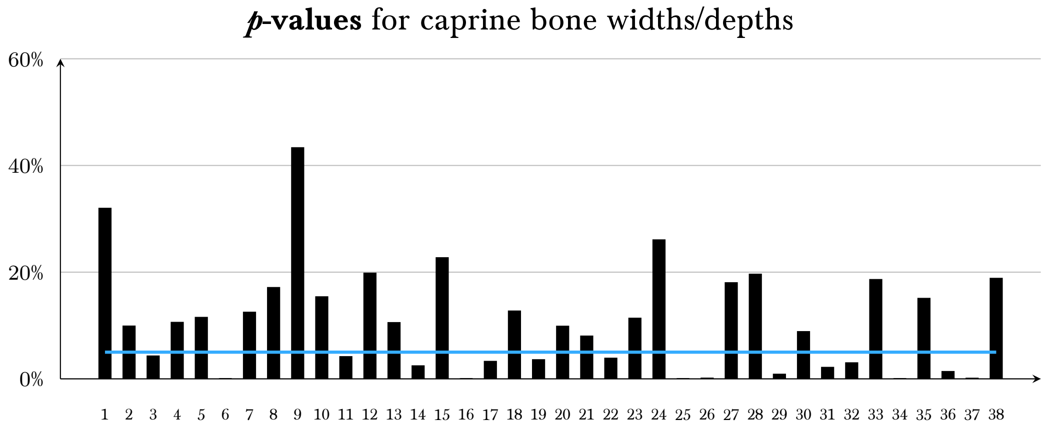


**Log$_{10}$**, domestic fowl -Castello San Pietro, Arab period-

**Log$_{10}$**, domestic fowl -Mazara del Vallo, Arab period-

**Log$_{10}$**, domestic fowl -Mazara del Vallo, Norman/Swabian period-

**Figure 6.8.26.** Comparisons of log ratio histograms for width/depth measurements of domestic fowl post-cranial elements from the Arab period at Castello San Pietro (n:20), and from the Arab (n:23) and the Norman/Swabian periods (n:31) at Mazara del Vallo. The triangles indicate the logarithmic means. The standard used (black line) was the measurements of bones from a modern hen from Tursi (Matera, Basilicata, Italy) (Corbino *et al.* forthcoming.) ()§*Chapter 5: Methodology*).



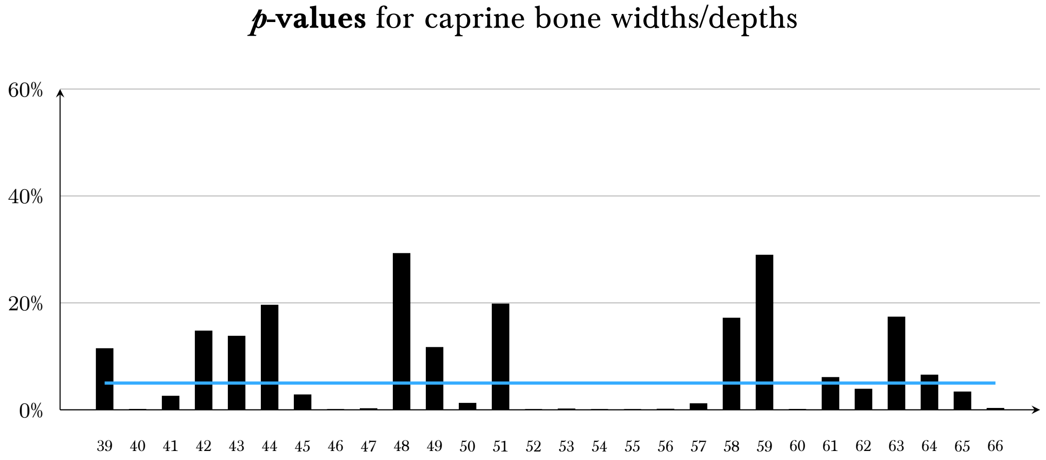


**Figure 6.8.27.** *p*-values for caprine post-cranial bone widths/depths obtained with the parametric test Student's *t*-test. *p*-values assess the probability that the two groups of values being compared are statistically similar. Therefore, low *p*-values suggest that the difference between the two groups is statistically significant; the threshold usually applied is $p<0.05$ (blue line). The numbers listed in the X axis of the graph refer to comparisons as shown in Tab.6.8.6.

| **References** | **CDM** -AR | **CDM** -N/S | **SANT** -AR | **NP** -N/S | **CSP** -AR | **MZ** -AR | **MZ** -N/S | **CO** -BY | **CO** -AR | **RO** -1BY | **RO** -2BY | **CASP** -AR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CDM** -AR | - | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **CDM** -N/S | 1 | - | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| **SANT** -AR | 2 | 12 | - | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| **NP** -N/S | 3 | 13 | 22 | - | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
| **CSP** -AR | 4 | 14 | 23 | 31 | - | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| **MZ** -AR | 5 | 15 | 24 | 32 | 39 | - | 45 | 47 | 48 | 49 | 50 | 51 |
| **MZ** -N/S | 6 | 16 | 25 | 33 | 40 | 46 | - | 52 | 53 | 54 | 55 | 56 |
| **CO** -BY | 7 | 17 | 26 | 34 | 41 | 47 | 52 | - | 57 | 58 | 59 | 60 |
| **CO** -AR | 8 | 18 | 27 | 35 | 42 | 48 | 53 | 57 | - | 61 | 62 | 63 |
| **RO** -1BY | 9 | 19 | 28 | 36 | 43 | 49 | 54 | 58 | 61 | - | 64 | 65 |
| **RO** -2BY | 10 | 20 | 29 | 37 | 44 | 50 | 55 | 59 | 62 | 64 | - | 66 |
| **CASP** -AR | 11 | 21 | 30 | 38 | 45 | 51 | 56 | 60 | 63 | 65 | 66 | - |

**Table 6.8.6.** Reference numbers for the statistical test presented in Figure 6.8.27. **AR**: Arab period; **N/S**: Norman/Swabian period. **CDM**: Corso dei Mille; **SANT**: Sant'Antonino; **NP**: the Norman Palace; **CSP**: Casale San Pietro; **MZ**: Mazara del Vallo; **CO**: Colmitella; **RO**: Rocchicella; **CASP**: Castello San Pietro.

| % *p*-values | **CDM** -AR | **CDM** -N/S | **SANT** -AR | **NP** -N/S | **CSP** -AR | **MZ** -AR | **MZ** -N/S | **CO** -BY | **CO** -AR | **RO** -1BY | **RO** -2BY | **CASP** -AR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CDM** -AR | - | 31.97% | 9.89% | 4.28% | 10.58% | 11.52% | 0.01% | 12.49% | 17.11% | 43.32% | 15.38% | 4.16% |
| **CDM** -N/S | 31.97% | - | 19.80% | 10.54% | 2.44% | 22.70% | 0.01% | 3.27% | 12.71% | 3.58% | 9.86% | 8.02% |
| **SANT** -AR | 9.89% | 19.80% | - | 3.87% | 11.36% | 26.05% | 0.01% | 0.13% | 18.02% | 19.62% | 0.86% | 8.85% |
| **NP** -N/S | 4.28% | 10.54% | 3.87% | - | 2.15% | 3.00% | 18.61% | 0.01% | 15.08% | 1.37% | 0.11% | 18.84% |
| **CSP** -AR | 10.58% | 2.44% | 11.36% | 2.15% | - | 11.42% | 0.03% | 2.52% | 14.71% | 13.74% | 19.55% | 2.77% |
| **MZ** -AR | 11.52% | 22.70% | 26.05% | 3.00% | 11.42% | - | 0.01% | 0.19% | 29.21% | 11.64% | 1.20% | 19.77% |
| **MZ** -N/S | 0.01% | 0.01% | 0.01% | 18.61% | 0.03% | 0.01% | - | 0.01% | 0.14% | 0.01% | 0.01% | 0.09% |
| **CO** -BY | 12.49% | 3.27% | 0.13% | 0.01% | 2.52% | 0.19% | 0.01% | - | 1.12% | 17.12% | 28.90% | 0.03% |
| **CO** -AR | 17.11% | 12.71% | 18.02% | 15.08% | 14.71% | 29.21% | 0.14% | 1.12% | - | 6.02% | 3.84% | 17.33% |
| **RO** -1BY | 43.32% | 3.58% | 19.62% | 1.37% | 13.74% | 11.64% | 0.01% | 17.12% | 6.02% | - | 6.47% | 3.31% |
| **RO** -2BY | 15.38% | 9.86% | 0.86% | 0.11% | 19.55% | 1.20% | 0.01% | 28.90% | 3.84% | 6.47% | - | 0.24% |
| **CASP** -AR | 4.16% | 8.02% | 8.85% | 18.84% | 2.77% | 19.77% | 0.09% | 0.03% | 17.33% | 3.31% | 0.24% | - |

**Table 6.8.7.** Complete list of all *p*-values (parametric test: Student's *t*-test) from all the analysed sites. **BY**: Byzantine period (1: first Byzantine phase; 2: second Byzantine phase); **AR**: Arab period; *N/S*: Norman/Swabian period. **CDM**: Corso dei Mille; **SANT**: Sant'Antonino; **NP**: the Norman Palace; **CSP**: Casale San Pietro; **MZ**: Mazara del Vallo; **CO**: Colmitella; **RO**: Rocchicella; **CASP**: Castello San Pietro.

# Chapter 7

# Discussion

The zooarchaeological results presented in the previous chapter have contributed new insights on the use of animal resources in medieval Sicily.

In this chapter, the most relevant results from the project are summarised and discussed in the light of the major socio-political and economic processes that shaped the history of the island from the Byzantine until the Norman/Swabian periods (6th-second ½ of the 13th centuries AD).

For better clarity, it was decided to organise the chapter into three main chronological sections; these follow a brief introduction which explains how the discussion has been organised:

- **7.1 Introduction**
- **7.2 Byzantine Sicily: the starting point**
- **7.3 The arrival of the Arabs: taboos, introductions and improvements**
- **7.4 Eagles over Sicily: the Norman/Swabian period**

## 7.1. Introduction

As mentioned in the Introduction chapter (*§Introduction*), medieval zooarchaeology in Sicily (as in most regions of southern Italy) is still a rather uncharted research field, and a specific interest in the study of animal remains from medieval contexts has only recently started (Scavone 2016). This has obviously limited zooarchaeological comparisons within the island across all the analysed periods, but has, at the same time, provided the opportunity to break relatively new ground in our investigation of medieval Sicily.

In the first section, a discussion of the zooarchaeological results from Byzantine Colmitella and Byzantine Rocchicella is presented; these sites are then compared with other contemporary faunal assemblages from Sicily. The overall dearth of faunal data from Sicilian Byzantine contexts implied the use, as comparative sites, of assemblages more generally dated to the late Roman - Byzantine period (late 5th-6th/7th centuries AD).[1]

In addition, zooarchaeological data from Byzantine Sicily were also compared with those available for Byzantine Apulia[2] and for late Roman/Vandal/Byzantine North Africa[3], in order to provide a wider bases against which comparing data from the Arab period.

Considering this geographical framework, general trends in the use of animal

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[1] At most sites, the lack of a systematic study of the stratigraphic sequence, as well as of the recovered archaeological materials, did not allow to separate late Roman and the early Byzantine contexts, nor to detect different phases within the Byzantine period (i.e. early, mid-, and late Byzantine periods).

[2] This region was conquered by the Byzantines during the Gothic War (AD 535-553). Despite the arrival of the Lombards in the early 7th century AD, some cities (especially those located along the coast, such as Gallipoli and Otranto), remained under the Byzantine domain. In the 9th century AD, a second 're-Byzantinisation process' started, which aimed to limit the Arab and Lombard military advances in southern Italy (Bari and Taranto were reconquered by the Byzantines in AD 875 and AD 880 respectively) (Cosentino 2008; Ostrogorsky 2014).

[3] Comparisons between Sicily and North Africa were made in view of the strong socio-cultural and economic relations linking these two geographic areas during the Byzantine period and beyond (e.g. North Africa table wares were commonly used in Sicily during the Late Antiquity; Molinari 2013).

resources are proposed, though the limitation of the current available evidence means that these need to be regarded as working hypotheses.

In the second sub-chapter, zooarchaeological results from urban sites dated to the Arab period and analysed by this project, namely Corso dei Mille, Sant'Antonino, Castello San Pietro (Palermo) and Mazara del Vallo (Trapani) are compared with those of the contemporary rural sites of Casale San Pietro (Palermo) and Colmitella (Agrigento), as well as with the site of Rocchicella (Catania). Differences and similarities in animal exploitation with the previous Byzantine period are highlighted. This section aims to detect and interpret the presence of new dietary habits and different animal management practices introduced by the Islamic incomers in the island since the early 9th century AD. Previous faunal reports from other contemporary urban sites located in Palermo were also considered, but these were scanty. The lack of published zooarchaeological studies from other southern Italian regions invaded by the Arab forces, such as Apulia and Calabria, means that a comparison with mainland contemporary sites, which would have been most interesting, has not been possible.

Comparisons with other Mediterranean regions have mainly relied on zooarchaeological studies from Al-Andalus[4]and North Africa.

In the third subchapter, the zooarchaeological results from Norman (AD 1061-1198) and Swabian contexts (AD 1198-1266) are discussed; these consist of urban sites in Palermo, namely Corso dei Mille and the Norman Palace, and urban contexts in Mazara del Vallo (Trapani). In addition, comparisons with other contemporary faunal assemblages from Sicilian sites, such as Calathamet (Trapani), Segesta (Trapani) and Rocca di Entella (Palermo) were made.

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[4] 'Al-Andalus' is the name given by the Arabs to some areas of the Iberian Peninsula and Septimania (western part of the former Roman province of *Gallia Narbonensis* – modern southern France); this latter was under Arab rule from the early to the mid-8th century AD, while most of Iberia remained under the Arabs for much longer time (early 8th-late 15th centuries AD) (Hitti 1937).

As most of the analysed faunal assemblages did not provide a clear distinction between Norman and Swabian phases, it was decided to use a more general 'Norman/Swabian' period (late 11th century AD-second ½ of the 13th century AD). Such unavoidable decision is likely to have affected the resolution of the faunal data here discussed, blurring or emphasising some aspects and trends in the use of animal resources.

However, the aim of this research is not that of developing any general overviews of husbandry practices in Norman/Swabian Sicily, but rather to detect aspects of continuity and discontinuity in dietary habits and animal management with the previous period dominated by Islamic governance.

The same consideration lies behind the decision not to include, as comparative studies, the zooarchaeological reports from Norman/Swabian mainland Italy. Since no published faunal reports from mainland Islamic contexts were available, a potential comparison between Norman/Swabian Sicily and mainland southern Italy would have not served the aim of detecting zooarchaeological similarities and differences with the previous period. Although this consideration may apply to the Byzantine period as well, the inclusion of southern Italian and North African Byzantine sites aimed to complement the dearth of data from Sicilian assemblages, as most of these latter are generally dated to the late Roman-Byzantine period; on the other hand, the good number of Norman/Swabian Sicilian sites allowed to focus on developments specific to this island.

## 7.2. Byzantine Sicily: the starting point

The two Byzantine faunal assemblages analysed in this project are the rural site of Colmitella (Agrigento, 7th/8th-9th centuries AD, south-western Sicily), and the military site of Rocchicella (Catania, eastern Sicily) (1st Byzantine phases, 6th-7th centuries AD) (*§Chapter 4: Sites and material*).

At both sites, caprines (mostly represented by sheep) were the most abundant species among the domesticates; these were followed by suids and cattle. A similar incidence of the main domestic taxa was observed at other late Roman – Byzantine rural sites in Sicily, such as Contrada Pistunina and Ganzirri (Messina; 5th-6th centuries AD, eastern Sicily) (Mangano 2001), Castagna (Agrigento; 5th-6th centuries AD, south-western Sicily) (Johnstone 1997) and Kaukana (Ragusa; 5th-6th AD, south-eastern Sicily) (MacKinnon forthcoming).

In comparison to the previous Roman period, a higher incidence of caprines was attested at the rural sites of Byzantine Apulia (e.g. Supersano, Apigliano, Masseria Quattro Macine and Herdonia); here, similarly to Byzantine Sicily, sheep and goat were followed by suids and cattle, the only exception being Herdonia in which cattle continued to represent the most abundant species (Albarella *et al.* 1996; Buglione 2003; Abatino 2011; De Grossi Mazzorin 2011; De Grossi Mazzorin and De Venuto 2015).

In addition to the rural sites, an increase in the incidence of caprines was also detected at the Byzantine urban contexts of Otranto (Apulia) (Cartledge *et al.* 1992) and Carminiello ai Mannesi (Naples, Campania) (King 1994).

Changes in caprine husbandry were also observed in Late Antique/Vandal/ Byzantine North African sites. Most urban sites located in Algeria, Tunisia (i.e. Carthage), Libya (coastal and inland sites), and Egypt (sites located in the Nile delta as well as in the western and eastern desert areas) show a drastic decrease of cattle (well represented in Roman times), a slight decrease of pig (these being often the first or second most represented species in the Roman period), and a consequently higher incidence of caprines. The only exception to such trend is represented by settlements located in Morocco, in which cattle continued to be the most common species (MacKinnon 2017).

Unlike the Roman period, in which caprine husbandry was mainly focused on meat production, different husbandry strategies are attested for Byzantine Apulia and Sicily. If, on the one hand, continuity in caprine culling strategies has been documented for the rural sites of Supersano, Apigliano and Masseria Quattro Macine (in which meat was indeed the main output), on the other, a rather unspecialised raising policy was observed at Byzantine Rocchicella (Sicily), Herdonia (Apulia), and Otranto (Apulia), as well as at most Byzantine North African sites. The fact that the culling strategies of sheep and goat did not focus on specific age-groups suggests that some flocks were kept throughout the year in the immediate vicinities of the sites: strong seasonality on caprine husbandry practices usually results in a neater focus on juveniles, culled before the beginning of transhumance. On the contrary, these were most likely short-distance transhumant flocks, herded in pasture areas around the site.

However, caprine husbandry at Byzantine Colmitella appeared to be specifically focused on wool production; a similar trend was also suggested for the late Roman - Byzantine rural site of Kaukana. Such specialised husbandry policy seems perfectly in line with a renewed interest in wool production, which starts to be attested in central and southern Italy since the Late Antiquity/early Byzantine period. This phenomenon could be a response to the decline in linen imports, which was highly popular in the textile market of the late Roman period. Political and military troubles faced by the Roman provinces in the Late Antiquity possibly compromised the flow of imports into Italy and, among these, those of linen. This scenario would have gradually resulted in a renewed interest in wool production, with a consequential conversion of cultivated fields into pastures (MacKinnon 2002).

In comparison to Roman times, suids slightly decreased in frequency in the Byzantine period, although they remain the second most common domesticate at most analysed sites. These animals were generally culled at a young age (before reaching their $1^{st}$-$2^{nd}$ years of age), thus suggesting a preference for the consumption of young pigs. As these latters, and especially suckling piglets, were considered a delicacy in the Roman period (MacKinnon 2004), their numerous early culling events detected at most Byzantine sites might indicate some sort of continuity with Roman dietary practices. At the same time, fewer individuals were culled at about 2 years of age, that could have been the age at which they reached their optimum weight, with fewer animals kept until late adulthood for breeding purposes.

In line with faunal data provided by MacKinnon for Roman sites in Italy (2004), cattle continued to be scarcely represented in Byzantine southern Italy, although some exceptions exist.

At rural sites, no substantial changes with the Roman period in cattle culling strategies were detected. Most animals were killed at an old age at Byzantine Colmitella, Supersano, Herdonia and Apigliano, thus suggesting that these animals were mainly exploited to plough the fields, for transport and manuring. At Colmitella, this hypothesis is further validated by the recovery of a considerable number of containers for storage and transportation of cereals (i.e. dolia). This zooarchaeological evidence fits well with the data provided by historical sources and other archaeological studies, which suggested the survival and thriving of wheat production in Byzantine Sicily[5] (Arcifa 2008a).

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[5] For example, Procopius of Caesarea (AD 490 - 565) affirmed that during Gothic War (535 - 553 AD), wheat supplies from Sicily (and Calabria) were shipped to cities such as Ancona (Marche – central Italy) and Naples (south-western Italy), thus suggesting a continuity of the central role of Sicily as a ‘wheat producer’ also in the Byzantine period (Arcifa 2008a).

In the Byzantine period, wild animals are rather infrequent across the Sicilian faunal samples here considered. A similar incidence is also attested for Apulian rural and urban settlements. Cervids were the most hunted targets; among them, red deer was the most represented species, followed by fallow deer and roe deer. Cervid worked antler fragments were often found in Sicilian and Apulian sites in this period. Wild boars were rare but present; biometrical results on suid tooth measurements from Colmitella and Rocchicella revealed that the suid populations were mainly composed of domestic pigs, and that particularly large suids, which probably represent wild boar and/or hybrids, were scarce.

At all the Byzantine sites here considered, domestic fowl was the most common of the farmyard birds; this was probably exploited for both meat and eggs. However, its overall low frequency across all the sites might indicate the minor role played by this species as a source of animal protein in Byzantine communities. Nevertheless, we should not forget that this species is certainly underrepresented due to a widespread recovery bias.

The consumption of fishes and molluscs is attested in some Apulian and North African sites, especially in coastal and riverine settlements. By contrast, no fish remains were found at Rocchicella and Colmitella; considering their proximity to the sea (especially Colmitella), the lack of these animals is more likely the result of a recovery bias rather than representing a genuine aversion for fish consumption.

## 7.3. The arrival of the Arabs: taboos, introductions and improvements

Zooarchaeological results from Islamic-period Palermo (i.e. Corso dei Mille, Sant'Antonino and Castello San Pietro) and Mazara del Vallo (Trapani) have highlighted the main role of caprines, and in particular of sheep, in the economy of Arab Sicily. A similar trend had been observed in previous zooarchaeological studies of contemporary urban sites from Palermo: Via Imera, Santa Maria degli Angeli alla Gancia, and Palazzo Bonagia (Arcoleo and Sineo 2014; Arcoleo 2015).

In most assemblages, the exploitation of caprines was fairly unspecialised, with animals culled at a variety of age stages. Such high level of flexibility in caprine husbandry schemes finds a direct comparison with modern pastoral managements practiced in North Africa and the Middle East. Nowadays, in these areas owning a flock and exploiting it for generalised purposes represent an invaluable economic investment; the exploitation of caprines is highly versatile, and can be adapted to economic changes and different demands (Abu-Rabia 1994; MacKinnon 2017). Considering the overall lower incidence of goat in comparison to sheep at the urban sites here considered (with the only exception of Corso dei Mille[6]), it is likely that the few goats were herded together with sheep in mixed local flocks.

When Arab urban sites in Sicily are compared with those from Al-Andalus[7], a strong similarity in the frequency of the three main domesticates is apparent, especially in the high incidence of caprines; the central role of these latter has been further confirmed by recent zooarchaeological analyses of three urban sites in southern Iberia: Madīnat Ilbīra (Granada), Šaqunda (Cordoba) and Cercadilla (Cordoba) (García-García 2019). However, unlike Sicily, most urban sites from

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[6] In Arab Corso dei Mille, a number of goat horncores were found in association with iron slags and hearths. Such evidence is here interpreted as the by-product of craft activities, where the horns of goat were also employed (*§Chapter 6: Results*).

Al-Andalus showed more specialised caprine husbandry practices focusing on the production and consumption of meat (Morales-Muñiz *et al.* 2011).

Exceptions to this trend do exist. A more generalised exploitation of caprines was recently suggested, for example, for the Muslim site of Šaqunda (García-García 2019); although more assemblages need be studied before drawing any firm conclusions, this result could be indicative of the existence of different pastoral strategies in Al-Andalus (Davis *et al.* 2008; Moreno-García 2013).

Similarly to Sicily and to Al-Andalus, Arab North African urban sites (e.g. Lepcis Magna, Libyan Valleys, Setif, Chercel, Volubilis, and Quseir al-Qadim) were also dominated by caprines; however, in this case, goats seem to prevail over sheep (Hamilton-Dyer 2011; Mackinnon 2017; King 2018).

Considering the ratio between sheep and goat in all these areas, it seems that the former species was much better represented in Sicilian and Al-Andalusian contexts, while goats were more common in North Africa. Different environmental and climatic conditions could explain such discrepancies, due to the different physical characters of the two species (Salvagno 2014; Salvagno and Albarella 2018). Goats tend to better adapted to severe climatic and environmental conditions, such as semi-desertic or desertic environments, which are more typical of North African regions. In addition, different social demands could have also contributed to a different incidence of sheep and goat; indeed, the former species is a well-known source of wool, while goats are better milk producers (Mackinnon 2017).

In Arab Palermo and Mazara, cattle represented the second most abundant species, despite its incidence being much lower than that of caprines. Cattle ageing data from Palermo (i.e. Sant'Antonino, Santa Maria degli Angeli alla

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[7] For a complete list of the sites here considered see García-García (2019).

Gancia, Via Imera and Palazzo Bonagia) showed that cattle were mainly used as draught animals in agricultural works as well as for their milk. A similar pattern was attested in Andalusian sites, such as Madīnat Ilbīra (Granada), Šaqunda (Cordoba) and Cercadilla (Cordoba) (García-García 2019), as well as at a number of Portuguese settlements (Davis 2006; Davis *et al.* 2008).

Such ageing pattern for cattle seems to find a direct comparison with the information provided by historical sources for the Arab period, which attest a major exploitation of cows for milk production, and of oxen as draft animals in agriculture (Rosenberger 1999). However, this does not necessarily mean that beef was not consumed by Muslims, despite some indications in the Quran that this was not common practice. Beef was considered 'halal' (i.e. permitted to be consumed), and there are several mentions of its dietary contribution in the Quran:

> "[..] *He says: 'It is a cow neither trained to plough the earth nor to irrigate the field, one free from fault with no spot upon her'. They said: 'Now you have come with the truth'. So they slaughtered her, but they could hardly do it* [. . . ]" (Quran 2:71)

> "[. . . ] *And the Budn* [cows, oxen, or camels driven to be offered as sacrifice animals at the sanctuary of Makkah] [. . . ] *so mention the name of Allah over them when they are drawn up in lines* [for sacrifice]. *Then, when they are down on their sides* [after being slaughtered], *eat them, and feed the beggar who does not ask* [men], *and the beggar who asks. Thus have we made them subject to you that you may be grateful.*" (Quran 22:36)

According to a more recent anthropological research on food dietary habits in medieval Cairo, beef usually represented the second meat choice at the urban markets. Not surprisingly, mutton was by far the most expensive and the most requested meat. By contrast, beef and goat meat were not as expensive, these being often bought and consumed by people who could not afford mutton (Lewicka 2011). In agreement with this trend, limited beef consumption was attested at Arab Corso dei Mille, Castello San Pietro, and Mazara del Vallo; at all these sites, apart from meat, cattle was also exploited for its secondary products. Beef was also consumed in the Arab urban sites of North Africa; other products, such as leather for clothing and tents, were also of great importance in the economy of these settlements (Mackinnon 2017).

Giving the well-known Muslim prohibition of pork consumption, the presence/absence of suids in Sicilian assemblages is likely to provide important insights on the socio-cultural effects of the Islamisation process of the island, and therefore represents one of the main topics of this research.

Most faunal assemblages from urban sites (i.e. Corso dei Mille, Sant'Antonino, and Mazara del Vallo) showed a scarce presence (if not a complete absence) of suid remains, their incidence being generally lower than the 5% of the total NISP of the three main domesticates. A similar pattern was observed in other contemporary urban contexts in Palermo, such as Via Imera, Palazzo Bonagia, Santa Maria degli Angeli alla Gancia (Arcoleo and Sineo 2014), and Palazzo Steri[8] (Di Patti and Lupo 2012).

An analogous scarcity or absence of suids was also detected at most Arab urban settlements in Spain and Portugal[9] (García-García 2019 and references therein; Moreno and Davis 2001 and references therein; Morales-Muñiz *et al.* 2011; Moreno-García 2013 and references therein). In line with the zooarchaeological data from urban Sicilian and Al-Andalusian sites, North African urban contexts dated to the Arab period (e.g. Carthage-Bir Ftouha, Carthage-Byrsa, Setif, Libyan Valleys, Abu Telis, Quseir al-Qadim and Volubilis; early 9th-16th centuries AD)

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[8] For this site, the tiny sample size recovered for Arab contexts invites caution in the interpretation of the results.

show an overall scarcity or absence of suids (Hamilton-Dyer 2011; King 2015; MacKinnon 2017).

As the consumption of pork is considered '*haram*' (i.e. prohibited) in Muslim faith, such overall dearth of suids is likely to be the result of an on-going or already well-established Islamisation of urban communities in all the analysed geographic areas.

However, variations in the presence of suids in Arab-period urban contexts of Palermo do exist. A relatively higher incidence of suids in comparison to those observed at the above-mentioned urban sites was found at 9th century AD Castello San Pietro (ca. 16% of the NISP of the three main domesticates). A comparable incidence of suids was also detected at the urban site of Cercadilla (Cordoba) in both the *emiral* period and the late *andalusi* one (mid-8th-first half 10th centuries AD; 12th century AD), as well as in other urban settlements, such as Torre Vedras (Lisbon; Gabriel 2003) and Tavira (Faro; Covaneiro and Cavaco 2012) in southern Portugal. Concerning Al-Andalus, such unusual presence of suids has been interpreted, along with other archaeological evidence, as an indicator of the presence of Christian communities, who had not (yet?) been influenced by the Islamisation process (Davis *et al.* 2008; García-García 2019). An analogous interpretation may also apply to Castello San Pietro.

The consumption of pork by a restricted group of Christian communities inhabiting Islamic areas is not uncommon, and it finds a direct comparison in modern Egypt: here, ca. 90% of the population is Muslim, and ca. 9% is Christian. Within this minority, the Coptic Christian community of the *Zabaleen* considers pigs an essential source of protein, making use of them also for getting rid of food waste. Christian communities, such as that in Castello San Pietro, could have been incorporated in the Islamic state after having paid the *jizya*, namely a taxation levied on non-Muslim subjects (Levy 2002).

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[9] For a complete list of the sites, see García-García (2019).

Another potential explanation to the relative high incidence of suids at Castello San Pietro is that most suid remains could belong to wild boars rather than domestic pigs[10]. In modern times, the consumption of wild boar meat by Muslim communities has been attested in several areas in which Islam is the major religion, for example in Syria, Sudan, Iran and Maghreb (Coon 1931; Simoons 1994; Benkheira 1995; Moreno-García 2004; Redding 2015). In modern Morocco, wild boar liver is consumed in order to acquire the animal's strength or as a medical remedy for syphilis (Simoons 1994; Moreno-García 2004). Considering these ethnographic examples, the consumption of meat from the wild ancestor of pigs does not seem to carry out the same 'haram' status as that of domestic pig (Davis *et al.* 2008). However, the consumption of wild boar by Muslims is an occasional practice, and it should be considered an exception rather than the norm (García-García 2019).

The consumption of domestic and/or wild suids by Muslims could also be the result of radical political actions aimed to socially separate a restricted number of individuals from the rest of the population. Indeed, in modern Maghreb, the meat of pig and/or wild boar is mostly consumed by marginalised communities of rebels, who display their political position against the Islam orthopraxy (from the ancient Greek ὀρθοπραξία meaning 'correct ethical and liturgical practices') by breaking dietary rules (Benkheira 1997; 2000).

Although the presence of wild boar at Arab Castello San Pietro cannot be ruled out with certainty, the exclusive presence of unfused bones highlights the presence of young suids; this is more likely to indicate a domestic rather than wild origin of such specimens, given the unlikelihood of targeting young wild boar on a regular basis, and, on the contrary, the common slaughtering of immature domestic pigs (Albarella *et al.* 2007). Such hypothesis is further validated by the overall low

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[10] At this site, most anatomical elements attributed to suids were unfused; such condition did not allow to carry out biometrical analyses in order to attempt a separation between the domestic pig and wild boar.

incidence of wild mammals in the assemblage, which attests to the minor role played by hunting activities.

In addition, Muslims are allowed to occasionally consume pork when they face a particular 'state of necessity'. However, "*necessity does not exist if the society possesses excess food*" (Faraouk *et al.* 2015). However, a 'state of necessity' does not seem in line with the information provided by archaeological and documentary sources for Sicily, which deny a dramatic collapse of commercial and productive activities in the island after the Arab conquest. This holds particularly true for Palermo; here, since the 9th century AD, important economic investments made by the Arab administration transformed drastically the city from a marginal settlement into a political and administrative centre (Bagnera 2013; *§Chapter 2: An overview of medieval Palermo*).

Additional data provided by anthropological and petrographic analyses on pottery remains have been of invaluable importance to better contextualise and interpret the 'unusual' high incidence of suids at Arab Castello San Pietro in Palermo. Archaeological investigations at the site have revealed the presence of 9th century AD cemetery area with a number of skeletons buried according to the Muslim ritual (i.e. the skeletons were laid on their lateral side -*decubitus lateralis*- with the face pointing towards Mecca). Such evidence suggests that at least some of the inhabitants of Castello San Pietro had an Islamic cultural and religious background (Bagnera and Pezzini 2004; Ardizzone *et al.* 2014). Recent petrographic analyses on pottery remains from 9th century AD contexts at Castello San Pietro have revealed the co-existence of traditional Byzantine ceramic typologies (e.g. amphorae) and new shapes of tableware (e.g. jugs with filter, glazed lamps etc.). Moreover, a considerable number of glazed wares, scarcely represented in the previous Byzantine period, was also found.

Such an increase in the presence of glazed pottery is interpreted as an indicator of new people coming from different geographic areas, where the use of glazed pottery was more common than in Sicily. Overall, petrographic analyses suggest that new potters (most likely of Islamic background?) and local potters (most likely of Byzantine background?) were both active at Castello San Pietro in the 9th century AD (Testolini 2019).

As a result, it seems that the zooarchaeological, anthropological and petrographic data all reflect a transitional chronological period at Castello San Pietro, namely the 9th century AD, in which the local population had only recently started becoming accustomed to the new socio-cultural parameters brought to the city by the Arab forces.

All in all, the socio-political, cultural, and religious effects of the Islamisation process of Sicily, as seen through the prohibition of pork detectable by zooarchaeological analyses, seem to have spread successfully in most of the urban sites of Palermo and Mazara del Vallo. At the same time, the archaeological data from Castello San Pietro suggest that the spread of Muslim dietary rules among the Sicilian native population would have been a gradual process.

When zooarchaeological results from the rural sites of Arab Colmitella (Agrigento) and Casale San Pietro (Palermo) are considered, differences and similarities in animal exploitation strategies with contemporary urban sites emerge. A similar consideration can be made for the site of Rocchicella (Catania), which lost its military function in the 9th century AD (2nd Byzantine period)[11].

At the rural sites, in line with faunal data from urban sites, caprines (mostly represented by sheep) were the most abundant animals; however, their incidence was not as high as in urban contexts, as suids and, to a lesser extent, cattle were well represented too. This more even representation of the main domesticates,

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[11] Considering the structural changes underwent by this site in the 9th century AD and the associated material culture (i.e. pottery remains (Testolini 2019)), it seems more appropriate to consider this site in the 2nd Byzantine period as a rural settlement rather than a military one.

and in particular the presence of suids, represents the most visible difference with Arab Palermo and Mazara del Vallo.

Suids were the second most abundant species at Arab Casale San Pietro and Rocchicella, their incidence recalling that of Sicilian late Roman-Byzantine faunal assemblages. A slightly different situation was detected at Colmitella; here, suids were the third species, and a decrease in their incidence was observed from the Byzantine to the Arab periods.

At the analysed rural sites, the culling strategy of caprines fully recalls that observed at most urban sites; at Rocchicella and Casale San Pietro sheep were raised for their meat, wool and milk, within a generalised management which did not focus on a specific output. A slightly more specialised raising policy of caprines was observed at Arab Colmitella, where the previous Byzantine interest in wool and dairy products was definitely maintained also in the following phase.

Similarly to Arab Corso dei Mille, Castello San Pietro and Mazara del Vallo, cattle was generally exploited for multiple purposes at Arab Colmitella and Rocchicella, i.e. for their traction, manuring, meat, and dairy products.

As mentioned above, the relatively high incidence of suids at Colmitella, Casale San Pietro and Rocchicella in the Arab period is different from that observed at most contemporary urban sites. Biometrical analyses suggest the suid remains from these rural sites mainly belonged to domestic pig, although a few wild boars and/or hybrids were probably present.

Following the recent zooarchaeological review presented by García-García (2019), an 'unusual' high incidence of suids was also observed in some Spanish rural sites dated to the early-mid Arab period (8th-10th centuries AD): Humanejos, La Gavia III, and Los Hitos. In the mid-late Arab period (11th-14th centuries AD), suids were still documented at La Gavia III and at Los Hitos, as well as at the rural sites of Villajos and Alcaria de Arge (García-García 2019 and references therein). Similarly to some urban settlements, the presence of suids at these rural sites has been interpreted as an indicator of a lower degree of Islamisation characterising the countryside[12] (García-García 2019).

A similar interpretation could also apply to Rocchicella, Casale San Pietro and, to a lesser extent, Colmitella. Among the pottery remains recovered from 8th-9th centuries AD contexts at Rocchicella and Colmitella, Sicilian amphorae with Greek inscriptions were present; additional archaeological materials included a few Byzantine seals and coins. Such archaeological finds suggest the presence of Greek-speaking inhabitants, who were probably still using Byzantine coinage (Testolini 2019), and who may have not yet been fully influenced by the 'Islamisation' process. In the case of Arab Casale San Pietro, the hypothesis of the presence of inhabitants with a Byzantine cultural background cannot yet be confirmed, as the excavation of the site and the analysis of the archaeological materials (including animal remains) are still ongoing.

Despite the presence at Colmitella of a more homogenous scenario in the representation of the main domesticates, a rather intriguing decrease of pig characterised the transitional phase from the Byzantine to the Arab periods; such change could be symptomatic of a cultural influence at the site, namely that of the Arabs and their Islamisation process. This hypothesis is supported by recent petrographic analyses on pottery remains. If, on the one hand, a number of ceramic fabrics were similar to those present in the previous period (8th-9th century AD), on the other, new forming and finishing techniques started to appear in the 9th century AD[13] (Testolini 2019). In addition to a decrease in

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[12] Such hypothesis was developed integrating the evidence from faunal remains with that from other archaeological materials.

[13] For example, thinner calcite tempered cooking pots with parallel incisions instead of criss-cross decorations, as well as painted jugs and small jars; similar fabrics and innovations have been observed in the ceramic material of Vega de Granada in the early Arab period (Testolini 2019).

pork consumption and to the appearance of new pottery shapes and techniques, biometrical analyses suggest that an increase in sheep size occurred at Colmitella between the Byzantine and the Arab periods ($9^{th}$-$11^{th}$ centuries AD)[14].

Zooarchaeological evidence for larger sheep in other regions conquered by the Arabs had already been detected in previous studies: an increase in sheep size has been attested in $12^{th}$-$13^{th}$ centuries AD contexts in Portugal (Davis 2008); more recently, an increase in sheep size was observed in the $8^{th}$-$10^{th}$ centuries AD levels of a number of southern Spanish sites (García-García 2019). As higher meat yield is correlated with larger bones in sheep (Hammond 1960), it is likely that the need and will of the Arab administration to replace meat production from the fast-growing and highly productive (but now prohibited) pig, was the trigger behind this increase in sheep size, along with the renowned passion for mutton of the Arab invaders (Davis 2008).

At this point, a useful question to raise would be whether the Arabs improved the sheep locally, for example by improving animal management and/or through selective breeding, or whether they imported a 'larger' breed from North Africa and/or the Middle East, in order to improve the size of local populations through interbreeding.

If, on the one hand, the effects of the so-called 'Arab Green Revolution' in terms of imported plant species[15], as well as new techniques aimed to improve production (such as irrigation – e.g. the *qanat*[16] and the noria[17]), in the regions

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[14] *p*-values obtained from the parametric Student's *t*-test suggest that the difference between the two groups of measurements from caprine post-cranial remains from the Byzantine and Arab periods is highly significant (*§Chapter 6: Results*).

[15] According to Watson (1983), the Arabs were responsible for the introduction in the territories they conquered of a great number of exotic (and economically important) plants such as sorghum, rice, sugar cane, cotton, orange, lemon, lime, banana, coconut palm, watermelon, spinach, artichoke, aubergine etc.

[16] The *qanat* is a method for supplying groundwater. It consists of a series of interconnected horizontals tunnels which bring groundwater from higher altitudes to lower areas (Beaumont 1971; Barceló 1983).

[17] Water-raising machines.

conquered by the Arabs are rather well-known topics (e.g. Glick 1979; Araújo 1983; Watson 1983; Guichard 2000; Carver *et al.* 2019), on the other hand, little is known about the impact of the Green Revolution on animal husbandry. Similarly to the many imported vegetable and fruit species, for example, new animal breeds and/or 'exotic' species[18]could have been introduced from North Africa and/or the Middle East for a variety of purposes.

Historical information from the Cairo Genizah indicates that, during the 11th-12th centuries AD, the Mediterranean Sea was perceived as a large, shared market (Goitein 1967; Goldberg 2012). Following Klein (1920), the establishment and development of important trade networks among different areas of the Mediterranean would have led to the introduction of new breeds of sheep from northern Morocco into Arab territories; the Merinos is likely (one of?) the breed(s) imported to the Iberian Peninsula. There are several theories about the origins of the Merino sheep (Laguna Sanz 1986; Sánchez Belda and Sánchez Trujillano 1987); among these, the one proposed by Riu (1983) suggests that this breed originated in the course of the 14th century AD as a result of the cross-breeding of coarse-woolled ewes with fine-woolled rams from North Africa.

The hypothesis of the movement of sheep flocks between North Africa and the Iberian Peninsula was proved by genetic studies which, on samples from seven modern Portuguese breeds, highlighted a strong correlation of maternal lineages with those of Middle Eastern and Asian sheep (Pereira *et al.* 2006).

Unlike modern Spain and Portugal, where Merinos are well-established, very few Merino sheep flocks are present nowadays in Sicily. Here, another breed, partly of North African origins, is commonly raised (especially in the areas around Caltanissetta, in central Sicily): the ''Barbaresca Siciliana. The individuals belonging to this breed are very well-suited to a generalised mode of

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[18] The exotic species potentially imported by the Arabs include the genet (*Genetta genetta*), of which the earliest archaeological evidence in Europe comes from Arab contexts at Mértola (Beja, Portugal) (Morales-Muñiz 1994), the Egyptian mongoose (*Herpestes ichneumon*) (Riquelme-Cantal *et al.* 2008), and the North African hedgehog (*Atelerix algirus*) (Morales-Muñiz and Rofes 2007).

exploitation, being rather prolific in terms of meat, milk and wool production, and are usually kept in small flocks. The Barbaresca Siciliana derives from the cross-breeding of the indigenous Pinzirita sheep with the fat-tailed Barbaresca (or Berberine/Berbera) sheep, which is native of North Africa (especially of the area from Egypt to Tunisia). Interestingly, among the autochthonous modern sheep breeds of Sicily, the Barbaresca is one of the largest; therefore, in addition to fitting very well generalised exploitation practices, it also provides a larger amount of meat (Bigi and Zanon 2008). The origin of the Barbaresca breed is still unknown. However, it is highly tempting to date back the cross-breeding between the autochthonous smaller Pinzirita sheep and larger imported individuals of the North African Barbaresca breed to Arab Sicily; this would have indeed led to an increase in sheep size. In addition to the introduction of new plants and agricultural techniques, sheep were brought by the Arabs into the island, as part of an improvement of animal management - a phenomenon that the zooarchaeological evidence is contributing to clarify.

The ‘Arab Green Revolution’, therefore, was not limited to the introduction of fruits, vegetables, and agricultural techniques, but embraced animal husbandry as well, aiming at a more comprehensive exploitation of the countryside. At the same time, improved agricultural production and irrigation could have led to a betterment of animal nutrition which, independently from potential introductions from abroad, would have contributed to an improvement of the Sicilian local sheep.

The presence in Arab Palermo and Mazara of sheep populations presenting different size and shape[19]suggests some degree of variability and the co-existence of different breeds; major urban sites such as Palermo and Mazara would have been most likely supplied from different sources, hence the presence of different size groups. Such hypothesis informs us about the extent of contribution of new husbandry (including breeding) practices introduced by the Arabs, thus reinforcing the theory, mentioned above, of a gradual Islamisation process of the island.

In the Arab period, no differences in butchery marks with the previous Byzantine period were observed. This is probably related to the well-known difficulties in detecting the '*halal* slaughtering' of animals in both archaeological and modern animal carcasses; indeed, the cuts inflicted on the animal throat are unlikely to leave distinctive traces on the hyoid bone or the cervical vertebrae (Milner 2011). Unlike other evidence discussed so far, therefore, butchery cannot be used to inform on the extent and nature of Islamisation of food consumption practices in Arab Sicily.

In most areas of the *dar-al-Islam*, fish was not considered of great value; such low gastronomic consideration is likely one of the reasons for the overall scarcity of fish recipes in most Arab cookbooks. However, in some areas (e.g. Maghreb and Al-Andalus[20]), fish was a rather basic staple; fatty fishes, such as tuna and sardines, were among the most consumed fish species (Rosenberg 1999).

Fishing activities are attested in Arab Sicily, although most of the evidence concerns tuna remains; such a result is likely to reflect recovery bias. Tuna remains are almost exclusively present at coastal sites (i.e. Palermo and Mazara del Vallo), while they are almost absent at inland settlements (i.e. Colmitella and Rocchicella); the only exception is the inland site of Casale San Pietro. Considering the distribution of fish remains among the analysed sites, it seems

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[19] In detail, sheep from the urban sites of Arab Sant'Antonino and Castello San Pietro (Palermo) were characterised by a similar size to those from Arab Mazara del Vallo; however, smaller sheep were present at Arab Corso dei Mille (Palermo).

[20] Fish were commonly sold in the urban markets of Cairo and Seville (Rosenberg 1999).

reasonable to think that fresh fish would have been more regularly consumed at coastal settlements, while inland areas, such as Casale San Pietro, were likely provided with processed fish products (e.g. salted fish) (Van Neer 1997; 2010).

As pointed out in the Results (*§Chapter 6: Results*), it was not possible to distinguish between the Atlantic bluefin tuna (*Thunnus thynnus*) and the albacore, also known as longfin tuna (*Thunnus alalunga*). However, historical and archaeological sources inform us that, since the Neolithic, the fishing of Atlantic bluefin tuna was a common activity in Sicily, as it is still nowadays. Such a high interest in bluefin tuna fishing is explained by the specific geographic position of the island within the Mediterranean Sea, which represents one of the well-known spawning areas of this species (Longo and Clark 2012).

Several techniques of tuna fishing have been developed in Sicily through time; among these, the method of the '*tonnara*' (a rather complex system consisting of a set of specifically disposed fishing nets) was likely developed in the island just before or during the Roman period[21]. However, it was only when the Arabs arrived that most of the key features of the '*tonnara*' were refined and established, spreading this fishing technique throughout the island (Sarà 1998; Doumenge 1999; García-Vargas and Florido Del Corral 2007).

Regarding the butchery evidence on tuna remains, interesting oblique chop and cut marks were observed on a number of vertebrae. Such evidence could be indicative of the presence of specialised butchery practices; in addition, this specific way of processing tuna may be culturally driven, as the portioning of the fish body by inferring oblique rather than transversal cuts has been recognised as a typical practice of Muslim butchers:

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[21] The earliest mention of a systematic fishing of Atlantic bluefin tuna is attributed to the Greek poet Oppian of Cilicia (2nd century AD). In his opera, called '*Halieutica*', he included a rather detailed description of a fishing technique consisting of nets and gates, which seems to recall the '*tonnara*' system. However, at that time, tuna fishing techniques were much more rudimentary and not as well structured as they will become in early medieval times (Longo and Clark 2012).

"[...] *This procedure was different from that documented in Muslim contexts* [at the site of Plaza de Oriente, Madrid], *where fish pieces were obtained with chop marks which were oblique to the longitudinal axis of the fish carcass; such chopping affected the vertebral centrum, but only rarely its apophysis* [...]" (Morales-Muñiz *et al.* 2011) (translated into English by the author).

Among birds, domestic fowl was found at all the analysed sites, but not in such numbers to suggest that it represented an important source of animal proteins. As for the Byzantine period, the overall dearth of this animal is likely to be a consequence of recovery bias, as almost all faunal assemblages were hand-collected. Chicken was exploited for both meat and eggs: the majority of the animals were culled when osteologically mature, with hens probably being kept for longer, to allow egg production as well as for breeding purposes.

Due to the potential presence of a recovery bias, it has been not possible to assess the importance of chicken in Arab Sicily. However, we know that this animal was of great economic value in Al-Andalus: here, eggs were often consumed by all social classes, and they were also recommended as an important source of proteins. Recent biometrical data from Arab sites have suggested an increase in chicken size in the Arab period. Such result has been interpreted as a direct consequence of the prohibition of pork consumption, as this would have led to increased pressure on finding alternative sources of animal proteins (e.g. increased consumption of mutton and chicken) (García-García 2019).

Possibly in line with this evidence from Al-Andalus, biometrical analyses of domestic fowl post-cranial bones from Arab Mazara indicate that these birds were larger than those of the following Norman/Swabian period; however, different management strategies (e.g. a greater focus on egg production in the Norman/Swabian period - hence, a predominance of females) may also lie behind the differences in size between the two periods.

Based on the analysed assemblages, hunting would have been rarely practised in Arab period sites; game targets mainly included red deer, fallow deer, and wild boars. Fallow deer remains have been recorded in several Sicilian assemblages dating from the Neolithic onwards; however, the presence and distribution of this species in the island before Norman/Swabian times has been widely debated (Masseti 2016). This project has contributed to highlight the presence of fallow deers in Byzantine and Arab contexts as well.

No substantial differences in the incidence of wild animals has been detected between rural and urban sites, confirming the widespread minor role played by hunting in the economy of the region.

Overall, the zooarchaeological analyses from different site-types in Sicily have provided important information about the use of animal resources in the Arab period; these data and their interpretation are fundamental to assess the socio-cultural and political effects of the so-called 'Islamisation' of the island. The concept of Islamisation has been largely debated within the academic world, and different hypothesis about its meaning are still being developed. In this research, the term Islamisation is used to refer to:

"[. . . ] *the set of practices, norms and expressions that determine a particular way* [that of the Islamic model] *of organising and discipline the human experience*" (Manzano 2006).

Considering the high incidence of suids in Byzantine Sicily and their very low incidence or complete absence in Palermo and Mazara del Vallo in the Arab period (with the exception of Castello San Pietro), there is little doubt that substantial changes in dietary practises, and consequently in animal husbandry strategies, were the results of the Islamisation of the island. New religious rules and cultural traditions undoubtedly played an important role in food choices; these became a key mode of expression, which contributed to shape the socio-cultural fabric of urban populations.

The restriction on pork consumption seems far more widely spread and more successfully established in urban sites rather than in the countryside, where suids continued to be raised and consumed. Indeed, for the site of Rocchicella and Casale San Pietro the arrival of the Arabs in the 9th century AD did not imply any strong influence on food production and consumption; here, animal husbandry strategies seem to have almost fully retained their Byzantine character. Similar considerations were made on the basis of recent petrographic analyses on pottery remains, which detected a similarity in shapes and production techniques between ‘eastern’ and ‘western’ sites (Testolini 2019). Such results might contribute to undermine the theory of a clear-cut border separating a ‘Byzantine east’ from an ‘Arab west’: ever more archaeological and historical data suggest that similarities in the economy and culture of the two sides certainly endured well beyond the Arab conquest, as well as differences among areas within these two macroregions.

In addition, zooarchaeological data and petrographic analyses on pottery remains from Colmitella show a partial continuity into the Arab period of some features typical of the previous Byzantine period. At the same time, some elements of innovation and change in pottery use and dietary habits were also detected, such as a decrease in pig frequency, an increase in sheep size and the introduction of new ceramic forms. Such results may reflect a slow reorganisation of the local ‘Byzantine’ population, who only gradually became accustomed to the new social and cultural parameters of the Islamic populations.

## 7.4. Eagles over Sicily: the Norman/Swabian period

In this project, three faunal assemblages dated to the Norman/Swabian period were analysed: Corso dei Mille (Palermo, 12th-13th centuries AD), the Norman Palace (Palermo, 12th century AD), and Mazara del Vallo (Trapani, 12th-13th century AD) (*§Chapter 4: Sites and material*).

Caprines (mostly represented by sheep) were still the most represented domesticates at Norman/Swabian Corso dei Mille and Mazara del Vallo. However, differences in the incidence of the main domestic taxa with the previous period were detected, especially at the Norman Palace. At this site pig remains made up the majority of domesticates, although caprines were still well represented; a similar trend was observed at the military site of Calathamet (13th century AD, Trapani) (Sarà 2005; Di Patti *et al.* 2013). Pigs were also present in good numbers in Norman/Swabian Mazara del Vallo; such evidence is clearly in contrast with the pattern observed for the Arab period, in which suids were almost absent.

As far as the Norman Palace, Mazara del Vallo and Calathamet are concerned, it seems that the arrival to the island of the Normans, and later of the Swabians, coincides with a renewed interest in pig husbandry and pork consumption. Such change is indicative of an ongoing ‘de-Islamisation’ process of the island, which finds parallels in the information provided by other archaeological evidence and by written sources (Abulafia 1994; Abulafia 1995; Molinari 1997; Abulafia 2007; Pezzini 2013; Chiarelli 2018).

However, exceptions in the incidence of pigs in Norman/Swabian Sicily do exist. Similarly to the Arab period, pigs were still barely represented at Norman/Swabian Corso dei Mille; this result may indicate the persistence of an Islamised community inhabiting this area of the city. Such hypothesis is further validated by the discovery at the site of a contemporary cemetery containing four individuals disposed according to the traditional Muslim burial rite (Battaglia *et al.* 2016); the latest Muslim burial was carbon dated to AD 1214-1235, 150-250 years after the Norman conquest of Palermo (Martin Carver personal comment).

A low incidence of pigs was also observed at Rocca di Entella (12th- ½ of the 13th centuries AD, Palermo) (Corretti *et al.* 2004). At this site, archaeological excavations revealed the presence of a Muslim community inhabiting the site possible until the arrival of Frederick II (AD 1246). The composition of the faunal assemblage from Norman/Swabian Rocca di Entella recalls that of Norman/Swabian Corso dei Mille, with caprines (mainly represented by sheep) being the most abundant animal, and pig being scarcely represented (ca. 6%) (Bedini 1999).

A dearth of suids and a high presence of caprines characterised also 12th century AD contexts at Segesta (Trapani) (Molinari 1997); here, the recovery of a contemporary mosque and the presence of a cemetery area with Muslim burials leave few doubts about the presence of an Islamised community living under the Norman rule. Later, in the Swabian period, the site underwent radical structural changes; the Arab mosque was destroyed and a castle, a church and a cemetery area with 56 Christian burials were established. This evidence indicates that, after Frederick II's repression of Muslim communities, Swabian Segesta was mostly inhabited by Christians. The high incidence of suids detected from late 12th century - early 13th century AD contexts at Segesta reflects the process of 're-Christianisation' underwent by the site in this period (Di Martino 1997).

In addition to the observed differences in the incidence of pigs, changes in the culling strategies of caprines were also detected. At all the analysed and comparative sites, an overall shift from a more generalised (typical of the Arab period) to more specialised caprine husbandry is noticeable.

In the Norman/Swabian period, most caprines were specifically exploited for meat production, as demonstrated by culling largely occurring when the animals had reached their optimum weight. This specific focus on meat consumption, which partially recalls the 'passion for mutton' of the Arabs (Davis 2008), seems fully supported by biometrical analyses on caprine post-cranial bones. These have revealed some interesting developments in sheep management; indeed, an analysis of the less sex-dependent measurements (which minimised the effects of different sex-ratios in the biometrical comparison) indicates a genuine increase in sheep size in the Norman/Swabian period of Mazara del Vallo. A similar increase in size is also attested at Norman/Swabian Corso dei Mille; however, in this case it was not possible to assess whether a different proportion of females, males and castrated lied behind such difference. No diachronic comparisons were possible for the Norman Palace; here, however, sheep are similar in size to those from Norman/Swabian Mazara del Vallo. As is the case for the Arab period, it would be interesting to assess whether this size increase of sheep is the result of local improvement and/or of the introduction of larger breeds.

In line with the previous Arab period, cattle still played a minor role in the Norman/Swabian phase. No changes in the culling strategies of cattle are attested; these animals continued to be mainly exploited for milk production and as traction force in agricultural works.

In Norman/Swabian contexts, no substantial differences in the incidence of wild mammals (mainly represented by cervids and, to lesser extent, hares) were noticed in the Arab period; this evidence suggests that hunting continued to play a marginal role in the economy. However, historical and iconographic sources highlight the importance of hunting activities during the Norman and Swabian periods in Sicily. Under Norman rule, most of the areas surrounding the main residences and administrative buildings were gradually transformed into parks; these mainly consisted of large forested areas in which hunting was performed

(Bresc 1980; Masseti 2009)[22]. In the Swabian period, Frederick II maintained and enlarged these areas, within which, since the Norman period, hunting rights were the sole prerogative of the upper class (Bresc 1980). In the light of this, the opera *De Arte venandi cum avibus*, written by Frederick II himself, perfectly shows how falconry (and, by extension, hunting in general) represented one of the favourite pastimes of the contemporary upper class. In sum, hunting (and the promotion of pork consumption) seems to have represented a new way for the ruling élite to display and impose a new cultural background, adapting similar developments from Continental Europe to the specific case of Sicily.

As a result, the overall low incidence of wild mammals more likely reflects the low social status of the analysed sites, rather than a general trend affecting all levels of the society. Hunting was probably important, but more as an indicator of status than an economic practice.

Tuna fishing continued to be practised in Norman/Swabian Sicily. According to written sources, fishing was one of Palermo's great industries in the 12th century AD, and ships regularly came there to buy salted tuna products[23](Smit 2009).

All in all, zooarchaeological data from Norman/Swabian contexts suggest both continuity and discontinuity with the previous Arab period. The 'rising again' of pigs at urban and military sites undoubtedly attests to a great administrative efficiency of the newly settled Christian rulers in shaping and changing some well

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[22] In Palermo, under William II's rule (second ½ of the 12th century AD), a hunting park and other courtly delights were established; this area was called 'the Genoard', or 'Gennoardo' (from the Arabic *Jannat al-ard*, meaning 'earthly paradise') (Masseti 2009).

[23] This information is provided by the Jewish traveller Benjamin of Tudela; in his work '*The travels of Benjamin*' (AD 1130 - 1173), important ethnographic and geographic information about the places the traveller visited during the 12th century AD are collected and discussed.

rooted aspects of the Arab culture, such as the prohibition of pork consumption. The remarkable incidence of pigs at Calathamet and the Norman Palace[24]could also be partially influenced by the specific military nature of these sites, as pigs would have more easily fulfilled the high request for meat typical of these site-types.

On the other hand, the absence or dearth of pigs characterising some Norman/Swabian sites indicate that some Islamised communities were still inhabiting the island under Christian rule, and that they were still living according to their own dietary rules.

According to historical sources, this latter scenario would not have been so unexpected for the Norman period, while it would have been more unlikely under the Swabians (Abulafia 1987). Although a great number of Muslim communities emigrated to North Africa and Spain, they would have still made up the majority of Sicily's population under the Normans; in particular, Muslims would have still represented an important and influential ethnic group operating in the island with a good level of administrative autonomy within their own communities.

However, in the 1190s, harsher economic regimes and the imposition of the archbishops of Monreale resulted in violent Muslim revolts. By the time Frederick II was in power, most Muslim rebellions had been violently suppressed. Frederick II saw himself as a pure Christian, and exterminations and deportations of a large number of Muslim communities were considered by the emperor as the only possible solutions to restore a Christian royal authority in the island. In line with this political regime, historical sources indicate that the agricultural techniques introduced to Sicily by the 'Arab Green revolution' were partly abandoned by the early 13th century AD; this may suggest an overall lack of interest in maintaining some of the innovations introduced by the Arabs (Abulafia 1994). Although

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[24] At the time the Normans arrived to Palermo, two areas of the city were fortified to gain greater military control over the urban population; these are the *castrum superior* or *novum* (which will be later known as the Norman Palace), and the *castrum vetus* (*§Chapter 2: An overview of medieval Palermo*).

not enough archaeological evidence exists to date to corroborate or deny such hypothesis, the further increase in sheep size led by the Normans/Swabians suggests that some Arab improvements to animal husbandry were inherited and adopted by the new Christian rulers. What we could be seeing is a long-term process of improvement of sheep size, reflecting a shared economic interest on part of both the Arabs and Normans to achieve better results from caprine husbandry. Larger sheep, along with pork consumption, could indeed be one of the many aspects of the troubled process of acceptance, rejection, adaptation, and resilience of cultural, religious, and economic elements from the old Arab administration to the new one.

# Conclusions and future research

> *"I learned that just beneath the surface there's another world,*
> *and still different worlds as you dig deeper.*
> *I knew it as a kid, but I couldn't find the proof."*
>
> *David Lynch*

This project represents the first substantial insight into the zooarchaeology of medieval Sicily. As the study of animal remains from medieval contexts in the island is in its early stages, the available zooarchaeological data are still too sparse to generate a fully comprehensive review of the use of animal resources in the analysed periods. However, due to its pioneering nature, this research has broken new ground, producing new insights on the socio-cultural and economic dynamics defining medieval Sicily. This holds especially true for the Arab period, which represents the core of this investigation and has produced the largest amount of evidence. This project also made an important contribution to the ERC project SICTRANSIT, which favoured its own existence.

In medieval Sicily, the characterisation of the socio-cultural backgrounds of past communities, and in particular that of the Arabs, has often been based on the study of buildings, funerary practices, and ceramics; by contrast, animal remains have been rarely used. Although the archaeological significance of pottery and human remains, as well as architectures and art styles, is undisputable, this project has highlighted how and why faunal remains are and should be considered invaluable archaeological indicators to assess the effects and the degree of cultural identity and transmission in medieval Sicily.

Zooarchaeological results highlighted important changes in animal husbandry practices with the arrival of the Arabs into Byzantine Sicily. Such changes were particularly evident in the urban centres of Palermo and Mazara del Vallo: here, the Muslim dietary prohibition on pork seems better established than in rural settlements, where a stronger continuity with previous animal husbandry strategies has been detected. Such persistence of previous practices in rural areas suggests that more time was needed for the Arab administration to bring and impose their new socio-cultural, religious and economic parameters in places located further from the main urban administrative centres; alternatively, or in combination with this, it could have been in the interest of the Islamic regime to allow the coexistence of Christian and Islamic communities involved in agricultural production. Nevertheless, change, also occurred in the countryside, as indicated by the slight decrease in pig frequency and the presence of improved larger sheep in Arab Colmitella. This was, however, delayed and less pronounced than in the urban centres.

The evidence indicates that the Islamisation of the island was a piecemeal and complex process, which affected different socio-cultural aspects of the native population at different levels and at different paces. Nevertheless, the cultural innovations introduced by the Arabs should not be used to hypothesise a rigid separation between Muslim and Christian communities. Conversely, a strong cultural osmosis, also driven by political and economic interests, characterised Arab Sicily since the beginning, thus allowing the formation of a multi-ethnic society where different communities co-existed in the same geographic area. In many cases, new cultural influences were fully or partly adopted and adapted by the local population.

The zooarchaeological evidence attesting the presence of larger sheep in Arab Sicily and Al-Andalus clearly indicates that the ‘Green Arab Revolution’ did not only maximise production by introducing new plants and farming techniques, but it also improved husbandry practices to increase the quantity and quality of animal yield.

According to current archaeological knowledge, by the 1240s Muslim communities had completely disappeared from Sicily; several factors such as emigration, extermination and conversion to Christianity marked the transformation of Sicily from an Islamised island into a Christian one. Zooarchaeological data, along with other lines of archaeological evidence, suggest that, as in the case of its Islamisation, the de-Islamisation of the island was not an abrupt process, and it took time for this new Christian and politically centralised reality to become fully established. In light of this, the renewed increase of pig frequencies at urban and military centres represented a clear discontinuity in dietary habits with the Arab period. Yet, some innovations in husbandry practices introduced by the Arabs were inherited by the Norman/Swabians; the further increase in sheep size being the clearest evidence of this legacy.

More can and has to be done on the zooarchaeology of medieval Sicily. Beside the desire and need to include more faunal samples from different site-types and regions within the island, several are the zooarchaeological analyses that could be carried out in the near future.

As the potential increase in sheep tooth size could be indicative of the presence of a 'new' genetic pool, possibly from imported larger animals, biometrical analyses on sheep teeth will undoubtedly contribute to shed light on the causative factors and logistics that led to an increase in sheep size in Arab and Norman/Swabian times.

The analyses of stable isotopes, such as oxygen ($\delta^{18}O$), carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and strontium ($\delta^{87}Sr$), may also provide some important insights on sheep management, for example on the practice of seasonal transhumance, as well as on animal feeding strategies and species biogeography. In addition, genetic studies (DNA) on modern and ancient sheep could contribute to assess the origin of sheep populations, including that of specific breeds.

At the same time, an analysis of pig diet could help in clarifying the husbandry regimes of these animals in medieval Sicily (e.g. free-range husbandry *vs* more controlled regimes); this can be pursued by measuring the stable isotope ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) from pig bones and teeth.

Comparisons of zooarchaeological data with information provided by stable isotopes analyses on human remains would certainly contribute to a better understanding of foods consumption dynamics.

Moreover, the consultation of ancient written sources with references to food production and consumption in medieval Sicily would represent an interesting and complementary source of information to set against the zooarchaeological data.

To conclude, future research on animal remains, as well as on other types of organic and inorganic archaeological materials, will definitely help us to reach a more mature state of research on medieval Sicily. The hope is that this 'launch pad' of medieval zooarchaeology in Sicily will represent a key framework of reference for whoever will want to study the use of animals in the island. Clearly, we are still far from a detailed zooarchaeological map of medieval Sicily; hence we must pursue our efforts in this direction.

Notwithstanding the project's limits, this research has provided the platform we needed for an understanding of the role of animals in medieval Sicily. Our analysis of the the Arab cultural phenomenon, in particular, has hopefully benefitted from the collection of evidence, which was previously far too sparse. The present research has shown how zooarchaeology can contribute to our understanding of the medieval history of Sicily and how this can also help in gaining a better insight of the broader mechanisms of cultural exchange, transmission and replacement, as well as the co-existence of different ethnic identities.

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