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Changes in animal husbandry, diet and animal trade in Tunisia from the Iron Age to the Roman period: an archeozoological approach

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MOHAMED AZAZA

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International Doctorate in Quaternary and Prehistory

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DEPARTAMENTO DE HISTORIA E HISTORIA DEL ARTE

INTERNATIONAL DOCTORATE IN QUATERNARY AND PREHISTORY (IDQP)

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TO THE MEMORY OF MY FATHER

TO MY MOTHER,

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ABSTRACT

The broad aim of this thesis is to use an archeozoological approach to further understand the changes that the Roman colonization of Tunisia brought about in animal husbandry practices, diet patterns and the animal trade.

To achieve this aim, we have undertaken a comparative study of faunal assemblages. We have analyzed the faunal remains from Ghizen and Zama, and the results have been contextualized with all the archaeozoological information available from Tunisia.

We developed a specific methodology for comparing published faunal data. Our analyses concentrated on the taxonomical quantification of the main domestic species (cattle, sheep, goat and pig) in order to establish the economic importance of each taxon. The skeletal elements were examined in order to determine the effects of taphonomic and human alteration on each assemblage. Age at death was estimated in order to shed light on animal use and exploitation.

Our results provide greater insight into changes in animal husbandry practices, meat diet and animal trade in Tunisia from the Iron Age to the Roman period. We have documented that during the Roman period animal husbandry was more specialized. More specifically, the economic importance of sheep and pigs increased: the former were largely exploited for their wool while the latter became a major source of meat.

At the same time, such species as cat, black rat, house mouse, rabbit, hare and fallow deer were introduced into Tunisia during the Roman period, which shows that animals were another commodity traded in North African ports. The animal trade was an important economic activity for Tunisia, not only for the exportation of wild beasts but also for the importation of wild and domestic animals.

The meat diet was also modified, particularly in the northern provinces of Tunisia, where there was an increase in pork consumption. So, we propose that the meat dietary pattern documented in Tunisia during the Roman period was influenced not only by cultural factors, but also by economic and maybe environmental factors, all of which were interconnected.

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Chapter 1:

INTRODUCTION

1. INTRODUCTION

Archaeozoology, with an emphasis on animal and human behavior, focuses on the study of animal remains associated with archaeological materials to address questions of the human-animal-environmental relationship (Steele, 2015). Archaeozoological analyses address topics ranging from diet, economy, resource use, domestication processes, herd management, breed development, economic and social exchange networks, colonization, adaptation, environment, climate, and site formation (Steele, 2015).

Despite the richness of archaeological sites with abundant archaeobiological remains, North Africa has been poorly investigated in terms of the socio-economic development of the ancient Mediterranean populations. Many Tunisian sites (Utica, Carthage, Althiburos, Meninx, Ghizen, Zama, etc.) now provide a good opportunity for understanding the development of pre-Roman and Roman communities using an integrated archaeozoological approach.

The present study provides valuable environmental, socio-economic and cultural information of past populations from Tunisia through the study of faunal remains. Archaeozoological analysis is particularly suited to investigate animal production and consumption, the animal trade and animal husbandry, and how these were transformed as part of a progressively more complex and specialized economic system. These will be the three main topics investigated in this PhD.

The conquest of North Africa, and more specifically of Tunisia, by the Roman Empire brought changes to the socio-political and socio-economic organization of the indigenous communities settled in this area. However, there is little information on how the conquest affected animal husbandry, trade and dietary patterns, even though important changes took place in these aspects in other areas of the Mediterranean basin (Lepetz, 1996; Mackinnon, 2010; Colominas, 2013, Valenzuela et al., 2013).

Two main cultures existed in North Africa before the Roman occupation: the Berber tribes (or the Numidians) and the Phoenician colonizers who had been settled there at least since the 8th century BC (De Marre, 2002). The Numidians and the Phoenicians are two societies that characterised the pre-conquest of North Africa (Fentress, 2006). They were a distinctive and independent civilisation from their homeland in the Levant

that dominated the Mediterranean Sea during the 1st millennium BC, when they established numerous colonies and trading posts (Zalloua et al., 2008). Their maritime expertise allowed them to establish a trading empire all over the Mediterranean and beyond (Stieglitz, 1990; Harden, 1971).

The indigenous Numidians were Berber people who farmed the land (Fentress, 2006). Pliny the Elder said that the Numidians were nomads (Nat. Hist., book V, pp. 3-11 in Cruz-Floch, Valenzuela-Lamas, 2018). Recent archaeological research at Althiburos (Kallala, Sanmarti, 2011; Sanmarti et al., 2012) and the study of bioarchaeological remains (Lopez-Reyes, Cantero, 2016; Valenzuela-Lamas, 2016) suggest that these tribes were sedentary in the 10th-9th centuries BC, and that the economy was based on intensive agriculture of cereals and mixed animal husbandry focused on cattle, sheep/goat and pigs (Cruz-Folch, Valenzuela-Lamas, 2018). Some epigraphic traces show that Numidian aristocrats became Roman citizens (Brett, Fentress, 1996). The emergence of Numidian families who controlled important resources may have been one of the effects of the Italian *negotiatores* in their search for wheat (Fentress, 2006). The incorporation of auxiliary units of Numidian cavalry into the Roman army also gave a new role to this important part of African society, one which brought status and a road to Roman citizenship (Brett, Fretness, 1996). Numidian soldiers and acquisitive merchants may have moved the society away from its economic isolation (Fentress, 2006).

1.1. Aims of the PhD research

This study investigates animal exploitation and the Roman colonization of North Africa, and specifically of Tunisia. It focuses on three aspects: animal husbandry, animal trade and the meat diet. Therefore, the specific objectives are:

1. To describe the general characteristics of animal husbandry in pre-Roman and Roman times in Tunisia and assess whether any changes occurred after the Roman conquest.

The Romans instigated changes in livestock practices in the territories that they occupied and after the Roman conquest the North-African communities underwent a social and political transformation. Therefore, this study aims to determine if the changes in animal husbandry documented in other countries were also produced in Tunisia, and, if so, the reasons for them.

2. To examine which species were introduced and exported during the Roman period in Tunisia using archaeozoological data and to contextualize them with written and iconographic sources.

Regional, inter-regional and international trade was a common feature of the Roman world. North Africa was a platform from which Rome was supplied with such products as cereals, olive oil, wine, fruit, legumes and animals. This study investigates which species were exported from and imported to North Africa in general and Tunisia in particular.

3. To document the general characteristics of the meat diet in Tunisia before and after the Roman conquest.

Diet, especially meat consumption, is a cultural trait that tends to persist for generations as an element of cultural identity (Harris, 1985; Scholliers, 2001). Much of our knowledge of diet in Classical Antiquity has been derived from ancient literary texts. The present study sets out the evidence for regional dietary patterns during the Roman period. It explores the notions of Romanization, inter-regional influence and diachronic change.

Therefore, this study acts as a basis on which ancient Tunisia can be comprehensively analysed from an archaeozoological perspective, studying some socio-economic aspects of the communities living there, and providing an overall approach that allow root Tunisia in its Mediterranean context during Antiquity.

1.2. Structure

This work is structured around three texts that focus on animal exploitation in Tunisia during the Roman period: one book chapter, one published paper, and another submitted paper on animal husbandry, the animal trade and the meat diet.

Chapter One is a general introduction that explains the main objectives of our research and the structure of the thesis.

Chapter Two describes the material studied and the methods used to carry out the investigation.

Chapter 3 discusses aspects of animal husbandry in pre-Roman and Roman times in Tunisia and assesses any changes that may have occurred after the Roman conquest on the basis of the book chapter “Romanization and Animal husbandry in Tunisia: demand for wool?”

Chapter 4 discusses the animal trade during the Roman period, and describes which species were exported from North Africa and which were introduced by the Romans, into Tunisia. The chapter includes the original scientific article of “The Roman introduction and exploitation of animals into Tunisia: Linking archaeozoology with textual and iconographic evidence”.

Chapter 5 discusses aspects of meat consumption in Tunisia during the pre-Roman to Roman period and describes the main food species which contributed to the Tunisian diet. It includes the original scientific article of “Roman Tunisian dietary patterns as a feature of *Romanitas*: an archaeozoological approach”.

Chapter 6 summarizes the conclusions of the study.

Scientific articles

Chapter 3: Animal husbandry

Azaza M., Colominas L. 2019. Romanization and animal husbandry in Tunisia: demand for wool? in Gourichon, L.; Daujeard, C.; Brugal, J.-P. (eds.), *Hommes et Caprinés: De la montagne à la steppe, de la chasse à l'élevage* (Antibes, France, 16–18 October 2018), Éditions APDCA, Antibes, p. 243-254.

Chapter 4: Animal trade

Azaza M., Colominas L. 2020. The Roman introduction and exploitation of animals into Tunisia: Linking archaeozoology with textual and iconographic evidence. *Journal of Archaeological Science*: Reports 29 (2020) 102076.
https://doi.org/10.1016/j.jasrep.2019.102076

Chapter 5: Meat diet

Azaza M., Colominas L., submitted. Roman Tunisian dietary patterns as a feature of Romanitas: an archaeozoological approach. *International Journal of Osteoarchaeology*. (Submitted on 28 January 2020).

Chapter 2:

MATERIAL AND METHODS OF ANALYSIS

2. MATERIAL AND METHODS OF ANALYSIS

2.1 Material

In this PhD we have analyzed the faunal remains from two sites unstudied until now: Ghizen (south-east of Tunisia, Djerba Island), and Zama (north-west of Tunisia, Siliana).

We have selected these two sites because they both have Iron Age and Roman occupations to compare the data between periods. At the same time, they are geographically separate, so data from different areas of Tunisia can be compared.

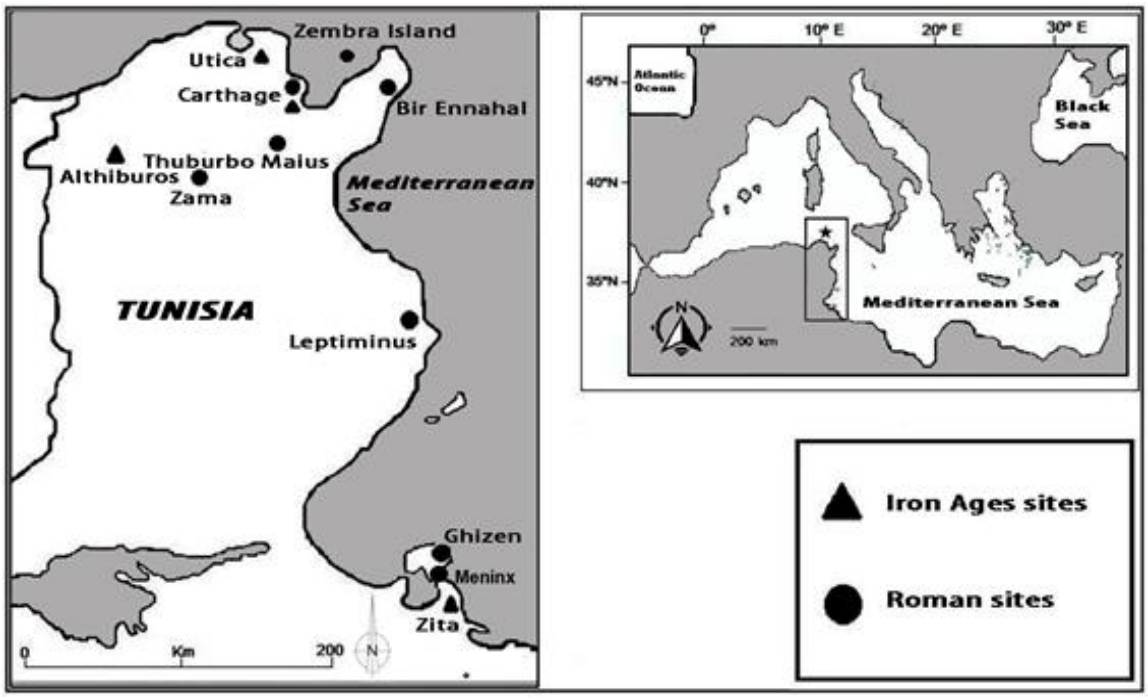


Figure 1: Map of location of the different site mentioned in the text.

Finding faunal assemblages to study in Tunisia was not an easy task because of the absence of systematic and programmed excavation campaigns organized by the Tunisian authorities. Most of the archaeozoological studies undertaken about Tunisia were the result of partnerships between the Institut National de Patrimoine de Tunis and international institutions.

The site in Ghizen consists of a quadrangular space parallel to the shoreline made up of three rooms of similar sizes oriented east-west (Bentaher, 2014). These three rooms presented three levels of occupation from between the Punic and the Roman periods, although anthropogenic activities have been documented on the site since the 6th century BC. The presence of fishing nets, weights and hooks indicate that these rooms are fishermen's houses (Bentaher, Sternberg, 2011). The current state of the excavations does not show whether these rooms are isolated fishermen's facilities or part of a large production structure associated with fish processing (Bentaher, Sternberg, 2011). In total, 929 faunal remains were recovered from these fishermen's houses from the Punic (first and second levels) and Roman period (third level).

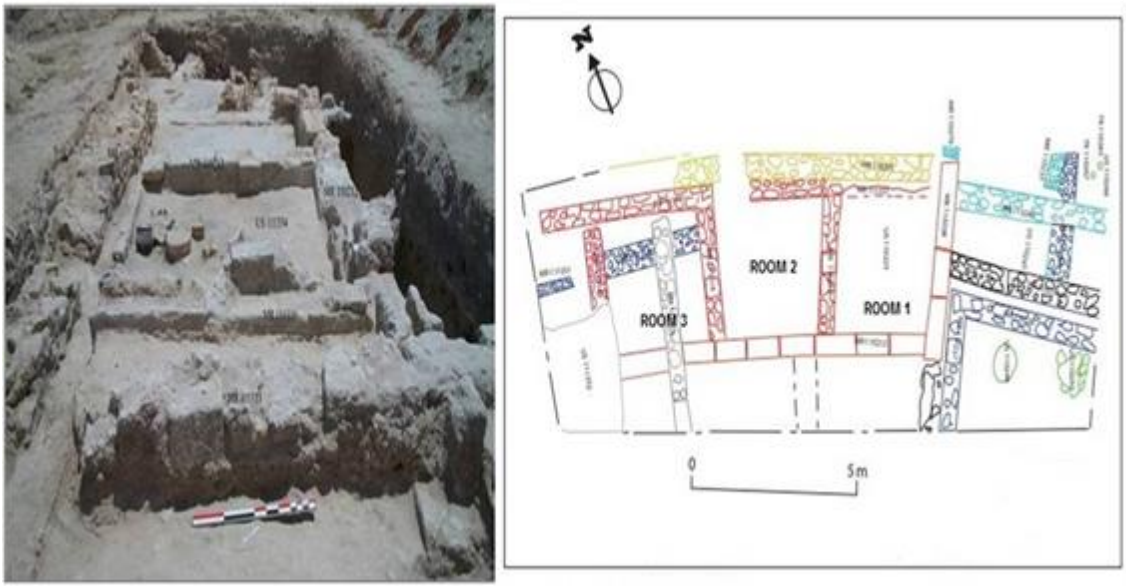


Figure 2: Plan of the excavation and photo of the archaeological structure of Ghizen site (Plan of Bentaher).

Zama is on the plain of Siliana (north-west of Tunisia), probably in the vicinity of the famous battle of Zama. Written sources show that Zama was an important Roman city. Since 1995, numerous surveys have been carried out at the site (Ferjaoui, 2001). A Tunisian-Italian mission was undertaken by the University of Sassari (Italy) and the National Heritage Institute of Tunisia, who in 2002 excavated the thermal structures dating from the 2nd-3rd centuries AD (Bartoloni et al., 2010). A total of 2,272 faunal remains were studied from these thermal structures and 1,682 faunal remains were recovered from the pre-Roman levels (temple zone) dating from 125-25 BC (Sebai, 2018).

Figure 3: Plan of the excavation and photo of the thermal structure of Zama site (Plan, Bartoloni et al., 2010).

To complement and contextualize the information obtained by the archaeozoological study of the sites at Ghizen and Zama, we used faunal data reported from other Tunisian sites at Utica, Carthage, Bir Messaouda, Magon Quarter, Ilôt de L'Amirauté, Yasmina, Kobbat Bent El Rey, Althiburos, Thuburbo Maius, Zembra Island, Bir Ennahal, Leptiminus, Zita, and Meninx (Figure 1).

2.2. Methods of Analysis

In this study, we intend to use faunal remains from Ghizen, Zama and other Tunisian sites, for which results have already been reported, to investigate the use of animals in Tunisia during the pre-Roman and Roman periods. The study analyses animal bones using a variety of techniques for identification, taxonomic determination and comparison.

Species, age, body-part representation and taphonomical characteristics, both diagenetic preservation and anthropic marks (fire, cut and chop marks), were recorded for each item.

The anatomic and taxonomic identifications were made by comparing the morphology of archaeological specimens with diagnostic criteria described in various atlases (Clarence et al., 1970; Schmid, 1972; Diane, 2009; Zeder, Pilaar, 2010; Zeder, Lapham, 2010). Distinguishing between sheep and goat remains in archaeological faunal assemblages is a recurring difficulty as the skeletons of small ruminant ungulates have similar morphological characteristics. Several papers have been published to facilitate this task. Nevertheless, sheep and goat were differentiated following Boessneck (1980), Payne (1985), and Prummel and Frisch (1986). Remains of birds, amphibians, mollusks and fish were counted but not taxonomically determined. The mammal remains that were not taxonomically determined because of fragmentation were classified in terms of size: large mammal (which includes cattle, horse and red deer), medium mammal (sheep/goat, pig, dog and roe deer) and small mammal (cat, hare and rabbit).

The anatomy was identified in terms of the fragment, the element and the body part. Here, five distinct body-part categories (head, forelimb, hind limb, feet, and trunk) were used.

The quantification units used were the number of remains (NR), the number of identified faunal remains (NRD or NISP), and the minimum number of individuals (MNI).

Mortality profiles are important to our understanding of breeding and production strategies, and they are more accurate when based on teeth age estimation. Age-at-death was estimated using two main methods: fusion of the eruption and wear of mandibular

teeth. For cattle and pig, tooth wear stages follow Grant (1982), and these were grouped into the age stages suggested by O'Connor (1988). For caprines, both tooth wear stages and age stages follow Payne (1973). We also estimated the age at death of individuals from the epiphyseal fusion (Silver, 1969).

Many factors (anthropic and natural) determine the preservation of bones on an archaeological site and there is no doubt that the bones recovered are only a very small percentage of the original representation (Davis 1995). The processes of recovery may be controlled to some extent by the archaeologist and it should be stressed that even a 100% recovery from the site is still only a small sample of the original amount. Due to the variable sizes and robustness of animal bones, taphonomic factors may favor the preservation of some species and not others. In some cases larger bones survive better although, if subject to trampling, smaller bones may remain more intact.

So different features may provide different information even though the assemblage is the same (Lyman 1994). The state of bone preservation made it possible to analyse butchering marks, in the form of cut and chop marks, which may be evidence of the removal of hides and the segmentation of carcasses.

The taphonomic traces that need also to be mentioned are traces of burning. When meat is prepared still attached to the bone, the bone often gets burnt. When they burn at low temperatures, bones turn brown or black. Calcination takes place at high temperatures and gives the bones a white color (Slopsma et al., 2009).

Metric analysis of mammal remains was performed mostly following von den Driesch (1976). All values are in millimeters.

3. ARCHAEOZOOLOGICAL DATA

3. ARCHAEOZOOLOGICAL DATA

3.1. Ghizen

A total of 929 faunal remains were recovered from the Punic and Roman levels of the Ghizen site. Of these, 183 were attributed to species, 98 were considered to be medium-sized mammals, 25 large mammals, and 6 small mammals. 436 were indeterminate.

TAXA	**Punic period**	**Roman period**	**Total**
Bos Taurus (cattle)	43	0	43
Ovis aries (sheep)/*Capra hircus* (goat)	46	33	79
Ovis aries (sheep)	14	20	34
Capra hircus (goat)	10	4	14
Sus domesticus (pig)	3	6	9
Equus sp.(equid)	1	1	2
Canis familiaris (dog)	1	0	1
Oryctolagus cuniculus (rabbit)	0	1	1
Large mammals	19	6	25
Medium mammals	31	67	98
Small mammals	1	5	6
Unidentified	200	236	436
Aves (birds)	1	2	3
Osteichthyes (fishes)	13	5	18
Mollusca (mollusks)	73	84	157
Herpetiles (amphibians + reptiles)	0	1	1
Crustacean	1	0	2
NISP	118	65	183
NR	457	472	929

Table 1: Taxonomic identification at Ghizen site by periods.

Taxonomical representation

Taxonomic identification shows the presence of domestic species, mainly cattle, sheep/goat and pigs. Horse, dog and rabbit are present but very rare. Remains of birds, amphibians, mollusks and fish are counted but not determined (Table 1).

A total of 457 faunal remains were recovered from the Punic levels. We recorded the presence of cattle, sheep, goat and pig. Equid and dog are present but very rare (one element for each taxon). The faunal spectrum also contains birds, fish and molluscs. A total of 118 elements were attributed as identified species. 19 remains were large mammals, 31 elements are medium-sized mammals, and just one was a small mammal. Almost 200 remains are unidentified.

A total of 472 faunal remains were recovered from the Roman levels. 65 elements were attributed as identified species. 6 remains were considered to be large mammals, 67 medium-sized mammals and 5 small mammals. During the Roman period, we documented the omnipresence of sheep, goat and pig. Equid and rabbit were present, but there was just one element for each species. Birds, fishes and mollusks were also present in the assemblage. One amphibian element (frog) was recorded.

Body part representation

The body part representation documented in the assemblage shows that during the Punic period, almost all portions of the skeleton were present for cattle and caprines, with the meat-rich upper-limb elements and trunk more represented than the head (Figure 4). We also recorded a high frequency of caprine foot remains. At the same time, pig remains were limited to phalanges. Caprine representation did not substantially vary for the Roman period, and all portions of the skeleton were present. Nevertheless, the trunk was less represented than in the previous period, and there was a high representation of tibias. Pig remains were limited to phalanges and mandibles, and cattle remains were absent.

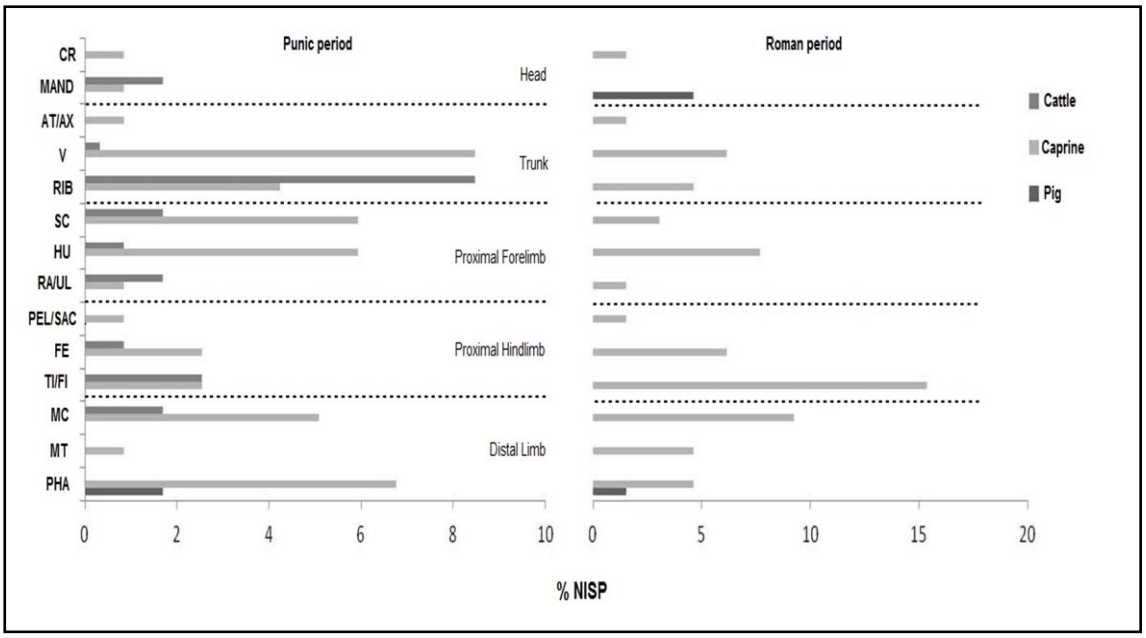


Figure 4: Body part representation of cattle, caprines and pig by periods at Ghizen.

Age-at-death

At Ghizen, the calculation of the minimum number of individuals (MNI) for the Punic period shows the presence of 1 adult goat, 1 juvenile sheep and 1 adult sheep. Cattle were present with 3 individuals (1 juvenile and 2 adult) and only 1 adult pig was documented (Table 2). In contrast, the calculation of MNI for the Roman period shows the presence of 1 juvenile goat, 1 adult goat, 1 juvenile sheep, 2 adult sheep, and 1 juvenile pig (Table 2).

Elements/Taxa	**Punic period**		**Roman period**		**Age at fusion**
Cattle	*Unfused*	*Fused*	*Unfused*	*Fused*	
Radius, p	-	-	-	-	12-15 months
Humerus, d	-	-	-	-	15-20 months
Phalanx I	-	-	-	-	20-24 months
Tibia, d	-	1	-	-	24-30 months
Metapodial, d	-	1	-	-	24-30 months
Femur, p	-	1	-	-	36-42 months
Humerus, p	-	-	-	-	42-48 months
Radius, d	-	-	-	-	42-48 months
Ulna, p	-	-	-	-	42-48months
Femur, d	-	-	-	-	42-48 months
Tibia, p	-	-	-	-	42-48 months
Sheep/Goat	*Unfused*	*Fused*	*Unfused*	*Fused*	***Age at fusion***
Humerus, d	-	2	-	3	3-4 months
Radius, p	-	-	-	-	3-4 months
Phalanx I	-	1	1	1	7-10 months
Tibia, d	1	-	-	3	15-20 months
Metapodial, d	1	-	-	-	20-24 months
Femur, p	-	-	-	-	36-42 months
Humerus, p	-	-	-	-	42 months
Radius, d	-	-	-	-	42 months
Ulna, p	-	-	1	-	42 months
Femur, d	-	-	-	1	42 months
Tibia, p	-	-	-	-	42 months
Pig	*Unfused*	*Fused*	*Unfused*	*Fused*	***Age at fusion***
Humerus, d	-	-	-	-	12 months
Radius, p	-	-	-	-	12 months
Phalanx I	-	1	1	-	12 months
Tibia, d	-	-	-	-	24 months
Metapodial, d	-	-	-	-	24 months
Ulna, p	-	-	-	-	36-42 months
Femur, p	-	-	-	-	36-42 months
Hemrus, p	-	-	-	-	42 months
Radius, d	-	-	-	-	42 months
Femur, d	-	-	-	-	42 months
Tibia, p	-	-	-	-	42 months

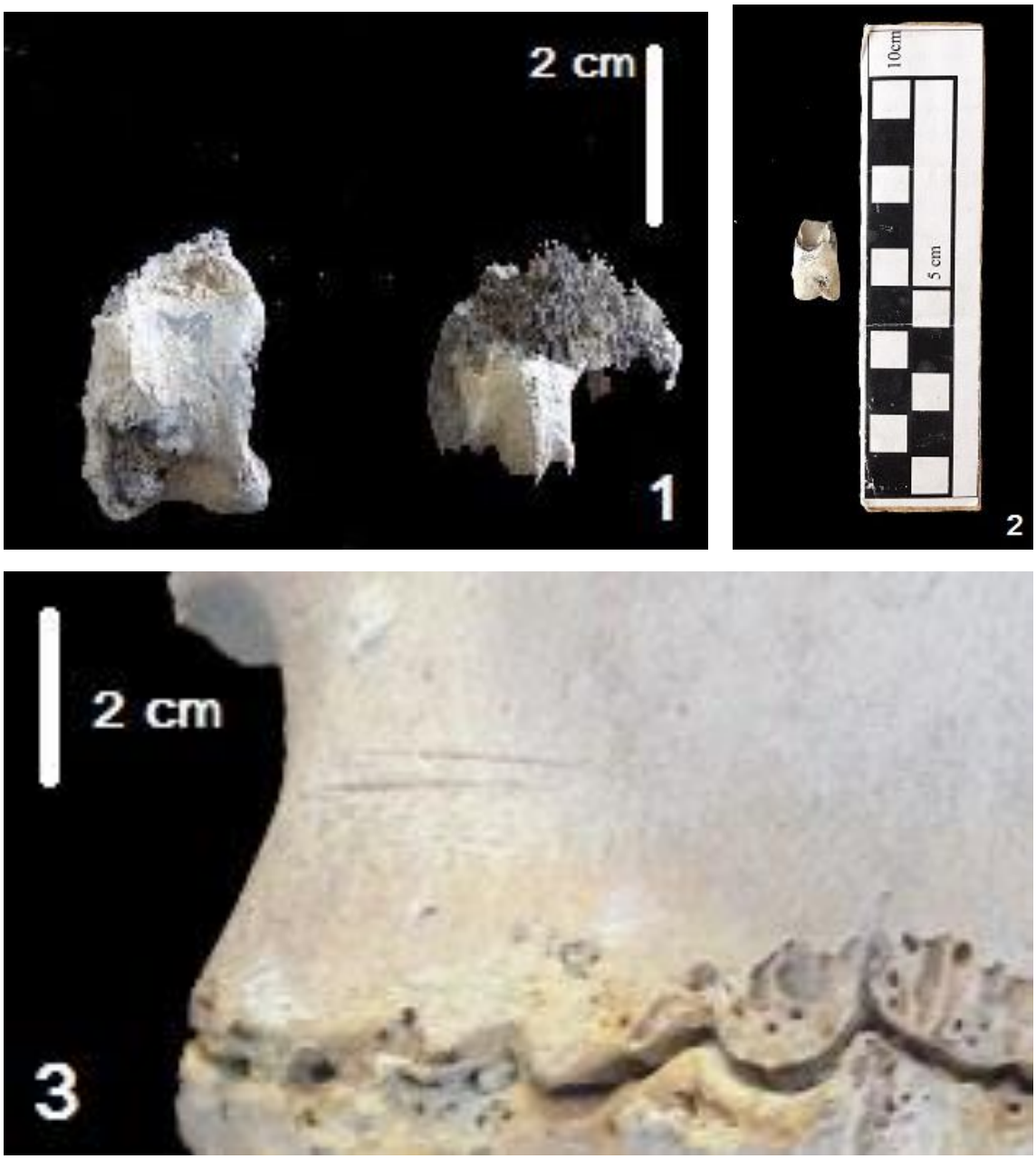
Table 2: Fusion and age-at-death estimation at Ghizen site by periods.

Anthropic marks

Almost all bones were broken by the excavation work. We documented some cut and chop marks on the surface of bones from unidentified remains which also had traces of burning. Two large-mammal remains and 14 unidentified bones were burnt. Also, 2 cut marks were recorded on the surface of young cattle vertebra and 5 sheep/goat remains were burnt (Table 3).

Taxon	**Ghizen site**					
	Punic period			*Roman period*		
	Cut	*Chop*	*Burnt*	*Cut*	*Chop*	*Burnt*
Cattle	2	-	-	-	-	-
Sheep/goat	-	-	5	-	-	-
Pig	-	-	-	-	-	-
Total	2	-	5	-	-	-

Table 3: Anthropic marks at Ghizen site by periods.



Board 1: 1) Astragalus and metapodial of sheep/goat burnt (US 180112; Punic period); 2) Phalanx II of sheep/goat burnt (US 180112; Punic period); 3) Vertebra of cattle showing cut marks (US 180183; Punic period).

3.2. Zama

A total of 3,954 faunal remains were recovered from the pre-Roman and Roman levels at the site in Zama. Of these, 2,521 were identified and attributed to species. 250 remains were large mammals, 463 were medium-sized mammals, and only 8 were small mammals. 657 remains were unidentified, 46 were birds, 6 were mollusks and 3 were herptiles.

TAXA	**Iron age**	**Roman period**	**Total**
Bos taurus (cattle)	350	486	836
Ovis aries (sheep)/*Capra hircus* (goat)	510	547	1057
Ovis aries (sheep)	140	217	357
Capra hircus (goat)	23	90	113
Sus domesticus (pig)	1	105	106
Equus sp.(equid)	2	6	8
Camelus (camel)	2	3	5
Canis familiaris (dog)	22	14	63
Felis catus (chat)	-	1	1
Deer (cervid)	-	2	2
Large mammals	60	190	250
Medium mammals	205	258	463
Small mammals	1	7	8
Unidentified	345	312	657
Aves (birds)	21	25	46
Osteichthyes (fishes)	-	-	-
Mollusca (mollusks)	-	6	6
Herpetiles (amphibians + reptiles)	-	3	3
NISP	1050	1471	2521
NR	1682	2272	3954

Table 4: Taxonomic identification at Zama by periods.

Body part representation

The body part representation documented in the assemblage at Zama shows that during the Iron Age almost all the skeleton was present for cattle and caprines, with the meat-rich upper-limb elements and trunk better represented than the head (Figure 5). We also recorded frequent cattle and caprine food elements. On the other hand only one pig remain was recorded. During the Roman period, we also documented practically all the body parts of the skeleton for cattle and caprines, with the meat-rich upper-limb elements and trunk better represented than the head. High frequencies of distal limb elements of cattle and caprines were also recorded. Likewise, almost all the portions of the pig skeleton were present, with the meat-rich upper-limb elements and head better represented than the trunk.

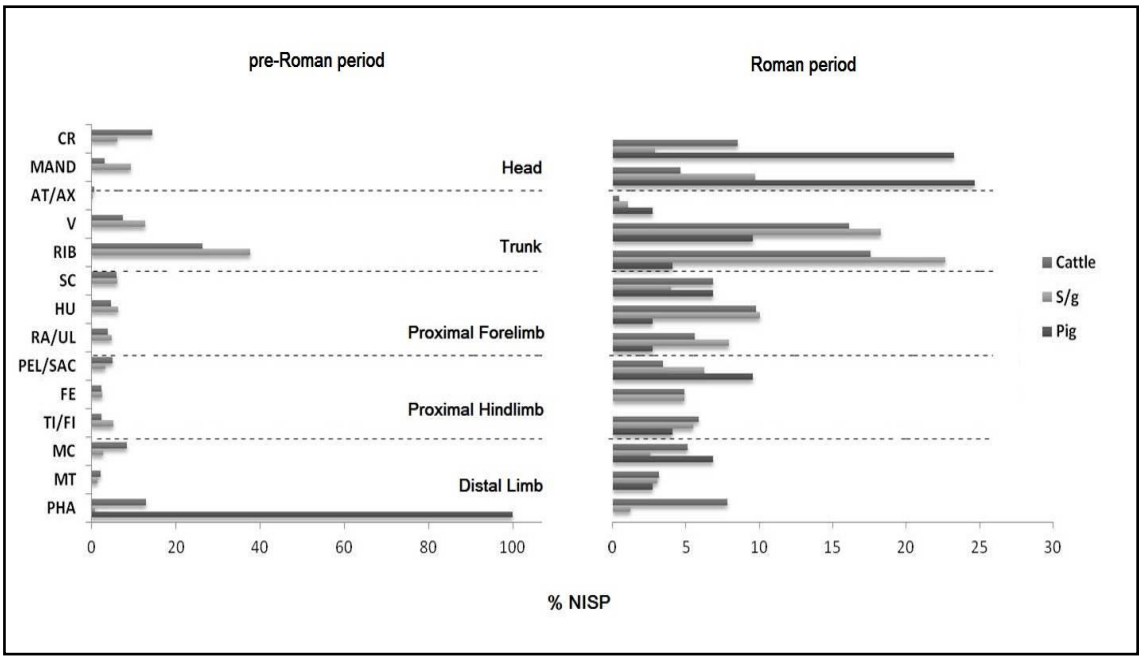


Figure 5: Body part representation of cattle, caprines and pig by periods at Zama.

Age-at-death

The calculation the Minimum Number of Individuals (MNI) shows the presence of 1 juvenile goat, 1 adult goat, 1 juvenile sheep, and 2 adult sheep during the Iron Age (Table 5). Cattle were present with 10 individuals (4 juveniles and 6 adults) and one pig was documented.

Elements/Taxa	**Iron Age**		**Roman period**		**Age at fusion**
Cattle	*Unfused*	*Fused*	*Unfused*	*Fused*	
Radius, p	-	1	-	-	12-15 months
Humerus, d	-	1	-	-	15-20 months
Phalanx I	2	8	-	-	20-24 months
Tibia, d	-	2	-	-	24-30 months
Metapodial, d	-	5	-	-	24-30 months
Femur, p	-	-	-	-	36-42 months
Humerus, p	1	-	-	1	42-48 months
Radius, d	1	5	-	-	42-48 months
Ulna, p	1	-	-	-	42-48months
Femur, d	-	-	-	-	42-48 months
Tibia, p	1	-	1	-	42-48 months
Sheep/Goat	*Unfused*	*Fused*	*Unfused*	*Fused*	***Age at fusion***
Humerus, d	-	5	3	12	3-4 months
Radius, p	-	-	-	2	3-4 months
Phalanx I	-	1	-	-	7-10 months
Tibia, d	1	4	-	1	15-20 months
Metapodial, d	-	-	-	-	20-24 months
Femur, p	5	-	-	1	36-42 months
Humerus, p	1	-	-	1	42 months
Radius, d	-	2	-	-	42 months
Ulna, p	-	1	-	2	42 months
Femur, d	2	-	-	2	42 months
Tibia, p	1	-	-	-	42 months
Pig	*Unfused*	*Fused*	*Unfused*	*Fused*	***Age at fusion***
Humerus, d	-	-	-	1	12 months
Radius, p	-	-	-	-	12 months
Phalanx I	-	-	-	-	12 months
Tibia, d	-	-	-	-	24 months
Metapodial, d	-	-	2	-	24 months
Ulna, p	-	-	1	-	36-42 months
Femur, p	-	-	-	-	36-42 months
Hemrus, p	-	-	-	-	42 months
Radius, d	-	-	-	-	42 months
Femur, d	-	-	-	-	42 months
Tibia, p	-	-	1	-	42 months

Table 5: Fusion and age-at-death estimation at Zama site by periods.

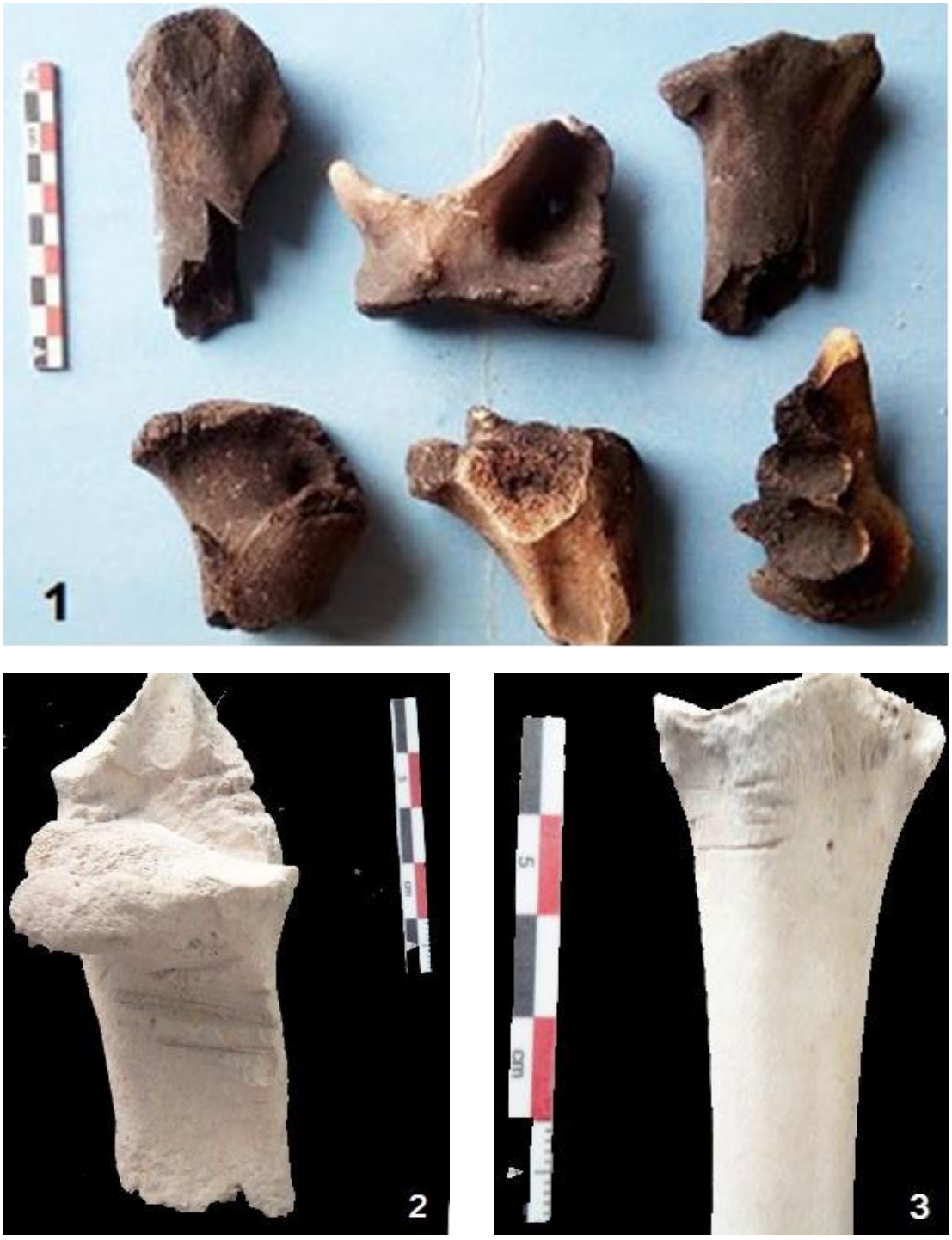
During the Roman period, the calculation of (MNI) shows the presence of 1 juvenile of goat, 1 adult of goat, 4 juveniles of sheep, and 8 adults of sheep. Cattle were present with 7 individuals (2 juveniles, 5 adults). Pig was present with 3 individuals (2 juveniles and 1 adult) (Table 5).

Anthropic marks

We documented many anthropic marks (Table 6). During the Iron Age, 1 cut mark, 14 chop marks, and 16 burnt elements were recorded. During the Roman period, we recovered many remains with anthropic modifications: 39 cut marks, 15 chop marks, and 18 burnt remains were recorded (Table 6).

Zama site						
Taxon	*Iron Age*			*Roman period*		
	Cut	*Chop*	*Burnt*	*cut*	*Chop*	*Burnt*
Cattle	-	11	14	21	11	10
Sheep/goat	1	3	2	12	4	8
Pig	-	-	-	6	-	-
Total	1	14	16	39	15	18

Table 6: Anthropic marks at Zama site by periods.



Board 2: 1) Atlas, radius, femur of cattle burnt (US 068; Roman period); 2) Chop marks on the surface cattle calcaneum (US 5080; Roman period); 3) Cut marks on the surface of sheep metatarsal (US 5080; Roman period).

CHAPTER 4: ROMANIZATION AND ANIMAL HUSBANDRY

4.1. ROMANIZATION AND ANIMAL HUSBANDRY IN TUNISIA: DEMAND FOR WOOL?

MOHAMED AZAZA, LÍDIA COLOMINAS

Hommes et Caprinés : de la montagne à la steppe, de la chasse à l'élevage
Humans and Caprines : from mountain to steppe, from hunting to husbandry
XXXIXe rencontres internationales d'archéologie et d'histoire d'Antibes
Sous la direction de Lionel Gourichon, Camille Daujeard, Jean-Philip Brugal
Éditions APDCA, Antibes, 2019

Romanization and Animal husbandry in Tunisia : demand for wool ?

Mohamed Azaza[a], *Lídia Colominas*[b]

Résumé
La conquête de l'Afrique du Nord, et plus concrètement de la Tunisie, par l'Empire Romain, a engendré des changements dans l'organisation socio-politique et socio-économique des communautés installées dans cette région. Cependant, peu d'informations sont disponibles sur la manière dont la conquête a affecté l'élevage, malgré les changements qui sont survenus dans d'autres zones du bassin méditerranéen. L'étude des restes fauniques récoltés sur le site de Ghizen (île de Djerba) et sa comparaison avec des données archéozoologiques déjà existantes depuis d'autres sites tunisiens ont permis de mettre en lumière cette problématique. Une augmentation de l'importance économique des caprinés, et plus concrètement du mouton, a été enregistrée. Nous émettons l'hypothèse que ce changement pourrait vraisemblablement être lié à une demande accrue de laine.
Mots clés : archéozoologie, caprinés, économie de subsistance, Tunisie, romanisation

Abstract
The conquest of North Africa, and more concretely of Tunisia, by the Roman Empire brought changes to the socio-political and socio-economic organization of the communities settled in this area. However, little information is available about how the conquest affected animal husbandry, despite important changes that took place in other areas of the Mediterranean basin. The study of the faunal remains recovered at Ghizen site (Djerba Island) and its comparison to the existing Tunisian archaeozoological data has enabled us to shed light on this issue. An increase in the economic importance of caprines, and more concretely of sheep, has been documented. We hypothesize that this change could be related with an increased demand for wool.
Keywords : Archaeozoology, Caprines, Animal Husbandry, Tunisia, Romanization

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Introduction

The Roman conquest of the Mediterranean territories led changes in livestock practices. Much information exists about these changes in present day Europe (cf. for example, Mackinnon, 2004a; Oueslati, 2006; Gudea, 2007; Albarella, *et al.* 2008; Colominas, 2013; Colominas, 2017; Valenzuela-Lamas, Albarella, 2017). However, little information is available about how the Roman conquest affected North African animal husbandry, and more concretely, the Tunisian husbandry. Two main cultures existed in North Africa before the Roman occupation: the Berber tribes and the Phoenician colonizers who had been settled there at least since the 8th century BC (Agnès De Marre, 2002). The history of Roman Africa starts at the end of the second Punic war (201 BC) (Graham, 1902). This date is considered the beginning of deep socio-political transformations in North Africa that took place gradually. Romanization was a slow process in which Roman models were adapted to African conditions and traditions (Picard, 1959); it was a gradual fusion of Roman, Carthaginian and indigenous influences. The Romanization of African provinces was in fact a two-way process of exchange between Roman and African elements which resulted in a uniquely Romano-African civilization (Brett, Fentress, 1996).

The beginning of the Roman occupation of Africa yields very little material since the process of Romanization did not accelerate until the Principate of Augustus (27 BC-14 AD) (Agnès De Marre, 2002). The principal instrument of Roman control in Africa until the 3rd century AD was the third Augustan legion of the Roman army, which manned the frontiers between Tripolitania and Numidia (Brett, Fentress, 1996). The policy of Rome appears to have been to co-opt the Berber tribal leaders, and through them to control the tribes, thus maintaining traditional forms of domination. Some epigraphic traces show that during the middle of the 2nd century AD, Numidian aristocrats turned to Roman citizens (Brett, Fentress, 1996). By the 3rd century AD *Africa Proconsularis* adopted Roman laws and customs, becoming a highly 'Romanized' province. At the same time, African communities employed *tabulae patronatus* to document the patronal contract since the 4th century AD (Peter I. Wilkins, 1989). The settlement's patterns in various parts of North Africa also show the gradual loosening of strength of Berber tribal groups (Brett, Fentress, 1996).

Despite the richness in archaeological sites with abundant archaeobiological remains, the North African region has been poorly investigated in terms of understanding the socio-economic development and cultural change of ancient communities through the study of this record. Bearing all this in mind, the aim of this paper is to shed light on the effects of Romanization on animal husbandry in North Africa, applying an archaeozoological approach. More concretely, we focus on the role of caprines in the subsistence economy of these ancient populations before and after the Roman conquest of Tunisia (by the end of second Punic war) (Graham, 1902). We have selected these animals (sheep and goats) because the importance in pastoralism in the region throughout history has been pointed out (Slopsma *et al.*, 2009; Mackinnon, 2010). To do that, we will focus on the Ghizen

site, as a case of study. The data obtained will be compared to published data for the region to document whether or not a general change in caprine exploitation took place with the Roman conquest of Tunisia.

Material and Methods

The archaeological site of Ghizen is 37°63'N and 9°55'E with an altitude between 14 and 24 m (Akkari, 1995: 51-76). It is located in the North-East of Djerba Island (South of Tunisia) (fig. 1). First excavations in the region were performed by Pierre Quoniam, who investigated several Punic Necropolises during the 50s on Ghizen region (Akkari, 1995: 51-76). The recent archaeological excavations on Ghizen site were performed between 2008 and 2011 under the heading of the National Heritage Institute of Tunisia (Bentaher, 2014: 19-35). These excavations documented a quadrangular space parallel to the shoreline constituted by three rooms of similar dimensions oriented East-West

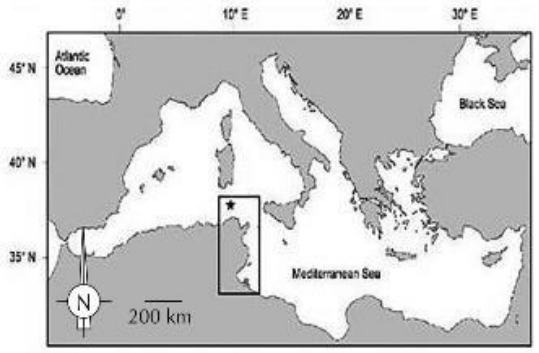

Fig. 1. *Location of Ghizen site and the other sites mentioned in the text.*

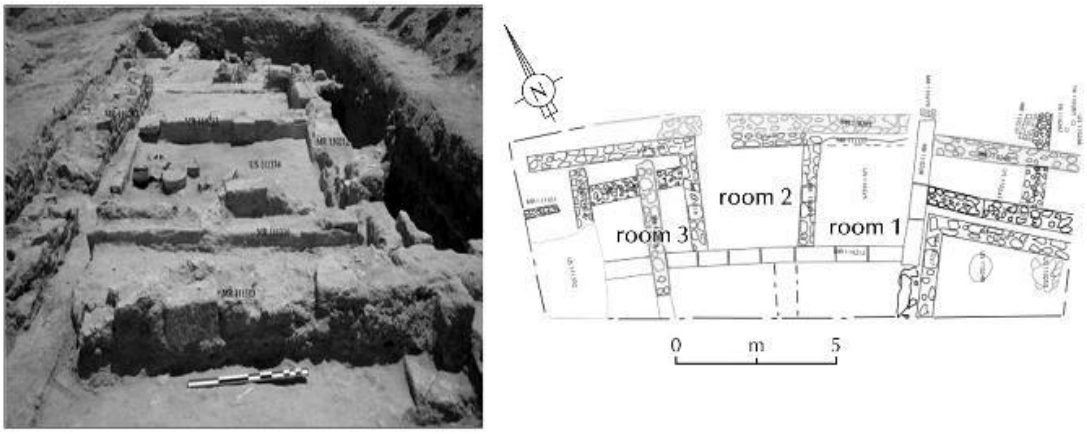

Fig. 2. *Plan of the excavation and photo of the archaeological structures (fishermen's houses) (drawing by Bentaher).*

(Bentaher, 2014: 19-35) (fig. 2). These three rooms presented three levels of occupation dated between the Punic and the Roman periods, although anthropogenic activities on the site since the 6th century BC have been documented. The first level was dated between the 4th-3rd century BC, the second level during the first part of the 2nd century BC and the third level between the 2nd and the beginning of the 3rd century AD) (Bentaher, 2014: 19-35). The presence of several fishing net, *pondera,* and hooks have allowed to interpret these rooms as fishermen's houses (Bentaher, Sternberg, 2011: 103-119). The current state of the excavations does not allow to know if these rooms are isolated fishermen's facilities or they are part of a large production structure linked with fish processing (Bentaher, Sternberg, 2011:117).

Faunal remains were recovered from these fishermen's houses. 929 faunal remains from the Punic (first and second levels) and Roman period (third level) compose the assemblage presented here (tab. 1). The archaeozoological analysis has focused on the study of taxonomic and anatomic representation frequencies and age-at-death estimations of the main domestic animals (*Ovis aries, Capra hircus, Sus domesticus, Bos taurus*). The anatomic and taxonomic identification was based on morphological comparison of archaeological specimen with diagnostic criteria described in different atlas (Clarence *et al.*, 1970; Schmid, 1972; Diane, 2009; Zeder, Pilaar, 2010; Zeder, Lapham, 2010). Sheep and goat differentiation was carried out following Boessneck (1980), Payne (1985) and Prummel, Frisch (1986). Remains of birds, amphibians, molluscs and fish were counted but not determined. The mammal remains that were not taxonomically determined were classified according to the size: Large, Medium and Small size. The quantification

Taxa	Punic period	Roman period	TOTAL
Sheep/Goat	70	57	127
Pig	3	6	9
Cattle	43	0	43
Horse	1	1	2
Dog	1	0	1
Rabbit	0	1	1
Bird	1	2	3
Fish	13	5	18
Shell Amphibian Crustacean Cephalopod	1	1	1 1
NISP	**118**	**65**	**183**
NR	**457**	**472**	**929**

Tab. 1. *Archaeozoological data from Ghizen site.*

units that have been used are the number of remains (NR), the number of identified faunal remains (NRD or NISP), and the Minimum Number of Individuals (MNI). Age-at-death was recorded on the basis of fusion of the eruption and wear of mandibular teeth. For cattle and pig, tooth wear stages follow GRANT (1982), and these were grouped into the age stages suggested by O'CONNOR (1988). For caprines both tooth wear stage and age stages follow PAYNE (1973). In the absence of dental material, we estimated the age at death of the individuals according to the epiphyseal fusion (SILVER, 1969).

Results

The Ghizen site

Mammals are the most represented animals in the total assemblage (tab. 1), but other groups such as molluscs, fishes, birds and amphibians have also been documented. In relation to mammal remains, we have documented cattle, caprines, equids, dogs, rabbits and pigs (tab. 1). Caprines are the most abundant taxa with 69 % of total mammal remains identified, followed by cattle (23 %). The other species are testimonial (tab. 1).

If we break down the results by period and we focus on mammal remains, caprines predominate (59.8 %), followed by cattle (36.7 %) during the Punic period (tab. 1). An equal representation of sheep and goats is documented during this period, as we pointed out; 10 remains of goat and 14 of sheep. The calculation of the Minimum Number of Individuals (MNI) for the Punic period shows the presence of 1 adult goat, 1 juvenile sheep and 1 adult sheep. Cattle were present with 3 individuals (1 juvenile and 2 adults) and only 1 adult pig was documented.

During the Roman period no cattle remains had been registered and 89.1 % of the faunal remains were attributed to caprines (tab. 1). Goat frequency decreases to 4 remains and we registered an increase of sheep remains: up to 20 during this period. The calculation of the MNI shows the presence of 1 juvenile goat, 1 adult goat, 1 juvenile sheep, 2 adult sheep and 1 juvenile pig.

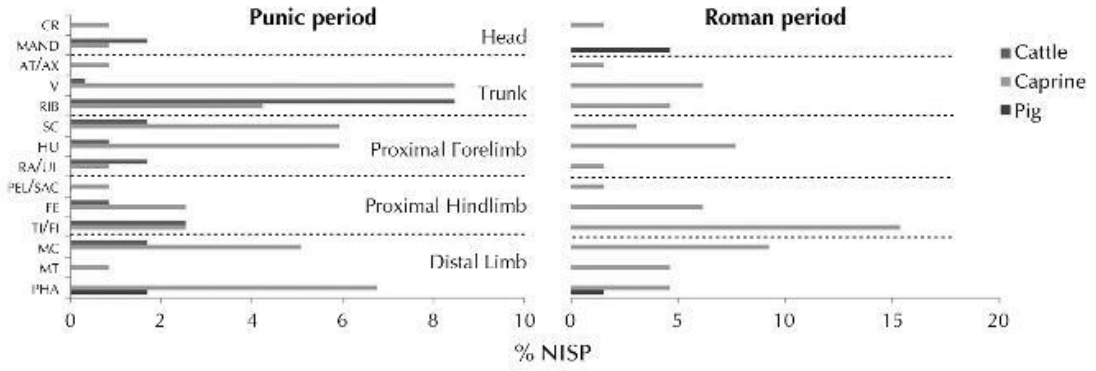

Fig. 3. *Body part representation of Ghizen site by periods. Key: CR cranium; MAND mandible; AT/AX atlas/axis; V vertebra; RIB rib; Sc scapula; HU humerus; RA/UL radius/ulna; PEL/SAC pelvis/sacrum; FE femur; TI/FI tibia/fibula; MC metacarpal; MT metatarsal; PHA phalanx).*

The body part representation documented in the assemblage shows that during the Punic period, almost all portions of the skeleton are present for cattle and caprines, with the meat-rich upper limb elements and trunk better represented than the head (fig. 3). We also register a high frequency of caprine foot remains. At the same time, pig remains only refer to phalanges. Caprine representation do not substantially vary for the Roman period (fig. 3), with the presence of all portions of the skeleton. Nevertheless, trunk representation is lower than in the previous period, and there is a high representation of tibias. Pig remains only refer to phalanges and mandibles during that period.

The Tunisian context

We applied for a comparison with other Tunisian sites with the aim to complement the information obtained through our archaeozoological study and contextualize the data presented thus far. It allowed us to evaluate if the changes documented were part of a general, Tunisian dynamic or whether they were the result of more specific, local-level changes.

Despite the large number of sites excavated in this region for this time period, few archaeozoological studies have been carried out on their recovered faunal material that encompass the two periods in the same site. Another issue worth highlighting is how difficult it is to undertake these comparative studies given that many of the studies involve 'unusual' assemblages or just present NISP information. Bearing these limitations in mind, data from 4 sites was only possible to use in order to carry out this contextualization, focused on NISP representation and age-at -death. The ancient Carthage sites (North-East of Tunisia) of Ilôt de l'Amirauté (Mackinnon, 2010), Bir Messaouda (Slopsma *et al.*, 2009) and Magon Quarter (Nobis, 2000) and the Althiburos site (North-West of Tunisia) (Valenzuela-Lamas, 2016: 421-448) allowed us to make this comparison and shed light on Tunisian animal husbandry before and after its Roman conquest.

Domestic mammals predominate in all assemblages at Carthage. Figure 4 depicts the percentages of the most represented species of the faunal spectrum of the Carthage sites during the Punic Period. At the site of Ilôt de l'Amirauté the following proportions of domestic mammals had been documented: 25.2 % of cattle, 64.9 % of sheep and goats and 9.9 % of pigs. We can observe the same representation at Bir Massaouda site, with 23.3 % of cattle, 62.6 % of sheep and goats and only 10 % of pigs. In contrast, a more equal distribution is recorded at Magon Quarter site, with the presence of 48.1 % of cattle, 38.3 % of caprines and 13.5 % of pigs.

On the contrary, livestock is dominated by caprines and pigs during the Roman period (fig. 5). The frequencies for cattle drop progressively from 25.2 % to 21 % at Ilôt de l'Amirauté site and from 48.1 % to 14.1 % at Magon Quarter site. Sheep/goat predominates at Magon Quarter and reaches 44.7 % and 38.0 % of the total NISP at Ilôt de l'Amirauté and Bir Messaouda sites respectively. At the same time, the frequency of pigs increases significantly up to 41.0 % at Ilôt site and to 41.2 % at Magon Quarter. A predominance of pigs (38.3 %) is also registered at Bir

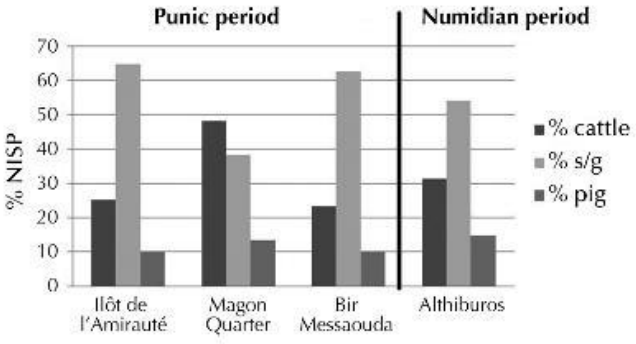

Fig. 4. *Percentage of main species from Tunisian sites during the pre-Roman period.*

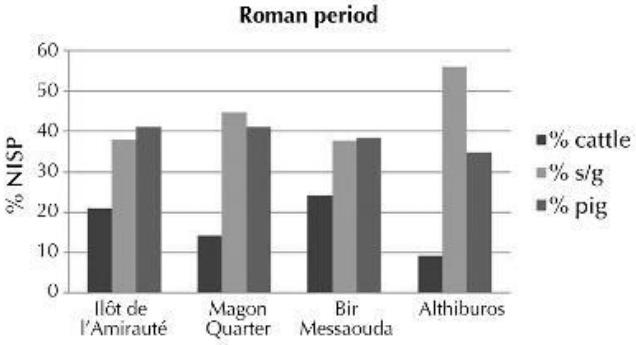

Fig. 5. *Percentage of main species from Tunisian sites during the Roman period.*

Messaouda. Information about the number of sheep versus goats in those sites is not available.

At Althiburos, 31.4 % cattle, 53.98 % sheep and goats and 14.64 % pigs during the Numidian period have been documented. The large majority of caprine specimens belong to sheep (13.1 % of the NISP are identified as sheep and 5.2 % as goats). On the contrary, a decrease of cattle (9.25 %) and a predominance of caprines (55.95 %) and pigs (34.8 %) have been documented during the Roman period. The number of sheep remains is also superior during this period, with the presence of 35 remains (% NISP = 5.2) and only 7 goats (% NISP = 1.3).

Caprine's kill-off-patterns also show interesting results. Most of the caprines were slaughtered at juvenile and subadult ages at Bir Messaouda during the Punic Period. The authors suggest a population primarily kept for meat, in which tender meat of juvenile and immature individuals was preferred for consumption (Slopsma *et al.*, 2009 : 21-63). For the Roman period, one individual reached the age of about 2 years. The authors suggest that sheep and goats may not have been kept only for meat production but also for secondary products such as milk and wool (Slopsma *et al.*, 2009 : 21-63). Available data from Ilôt de L'Amirauté and Magon Quarter suggest an importance of pastoralism of sheep and goat throughout these periods. During the Punic period, the ages separated by 12 month intervals may indicate that the animals were primarily kept to provide meat (Mackinnon, 2010 : 168-177). In contrast, an increase demand for wool, in addition to the requirement for lamb and mutton is documented during the Roman period (Mackinnon, 2010 : 168-177).

At Althiburos, there was a predominance of caprines killed between 6-12 months because of the production of meat during the early Numidian period (Valenzuela-Lamas, 2016 : 421-448). During the Roman period, a delay in the age of sacrifices has been documented (between 12 and 24 months), but the author also suggests that they were primarily killed for their meat (Valenzuela-Lamas, 2016 : 421-448). Kill-off-patterns differentiating between sheep and goats are not available for this site.

Discussion

The end of the second Punic War (in 201 BC) is considered the beginning of deep socio-political transformations of the communities in North Africa, which led them to be incorporated into the Roman political and social system. This study has demonstrated that these transformations also brought significant changes to animal husbandry and livestock management practices in Tunisia.

The analysis of the faunal assemblage of Ghizen shows an increase in the economic importance of caprines and a decrease of cattle during the Roman period, in comparison with the Punic period. At the same time, sheep clearly predominate over goats among the Roman levels. On the other hand, kill-off-patterns show that sheep were kept for meat but also for wool or as breeding animals during the Roman period, with an increase of the presence of sheep remains from adult individuals at the site. On the contrary, goats were kept for milk but also for meat during the Roman period, with an increase of goat remains from juvenile individuals at the site, in comparison with the Punic period.

These results fit well with the data documented in the other sites presented here, which suggest a general decrease of the economic importance of cattle from the Punic to the Roman period, replaced by a predominance of sheep mainly exploited for their wool. This predominance of cattle remains during the Punic period is also documented at the sanctuary of Kerkouane (area of Cap Bon, North-East Tunisia), in which their presence reaches up to 48 % of the total NISP (Nobis, 1999). At the same time, caprine remains predominate at the late Roman site of Leptiminus (North of Tunisia) (Burke, 2001), to point out other sites in which faunal studies are available for one of the periods investigated here.

It has been suggested that the decline in cattle consumption in *Africa Proconsularis* could be the consequence of the degradation of vegetation cover during the Roman period that would make cattle husbandry less suitable for the region (Cantero, Pique, 2016: 491-515). The palaeoenvironmental studies from Carthage have also documented that the vegetation cover of the city's surrounding lands was dry and was seriously degraded as a result of grazing, not only in the Roman period but also in the Punic period (Van Zeist *et al.*, 2001).

Therefore, the deterioration and the dry up of the quality pasture lands could facilitate the establishment of pastoral herding practices of sheep and goats. If it was the reason of caprine increase, the expected pattern would be a specific increase of goats, as they survive better in rougher pastures (Mackinnon, 2010: 168-177). This is not what is documented here. Therefore, we suggest that caprine increase should be related with economic factors and not only with changes in the environmental conditions of the area.

Wool was well demanded during Roman times. In fact, wool dominated the textile market during Republican and Early Imperial times and was the main textile fiber of the Roman Empire (Mackinnon, 2004b). At the same time, Latin authors described many breeds according to their fleece characteristics. As an example, *Columella* reported that during the 1st century BC, fine-wool sheep from Apulia were introduced in the southern part of Hispania and they were mated with coarse-wool

rams from Africa. He also explains how his paternal uncle *Marcus Columella*, brought several African wild sheep at Cadiz in order to breed them with local sheep, thereby achieving wool of a different colour (VII, 2 [4]). Therefore, we propose that a demand for wool could be considered as one of the reasons of the increase in Roman sheep pastoralism in Tunisia. Through caprine body part representation documented at Ghizen we can suggest in relation to this aspect, that caprines were bred at the site both in the Punic and the Roman period. Another change documented is the increase of pork. The frequency of pigs at Ghizen increases from 2.58 % to 9.52 % from the Punic to the Roman period. This pattern is consistent among all Roman sites presented here and appears to be culturally motivated, as would result from dietary changes (Mackinnon, 2010:168-177). The production of pork was not a central element of husbandry practices during the Punic period, probably because of the dietary cultural tradition of this Phoenician-Punic community with Semitic origin that considered pig impure. Their entrance was forbidden to the Punic sanctuary of Melkart in Cadis (*Silius Italicus III*: 22-23 in Cruz-Floch, Valenzuela-Lamas, 2018:175-189). On the contrary, it is a central animal for the Romans. The predominance of pig has been considered a characteristic feature of Romanitas (Mackinnon, 2001 : 649-673), leading to suggestions that pork may had been higher-status food or particularly associated with military domain (Cool, 2006), yet pigs are the most profitable species for meat production since they reproduce quickly, their diet is omnivorous, and they require little maintenance (Thurmond, 2006). In that sense, pig body part representation from Ghizen would be suggesting that this animal did not be bred in the site. Only some elements, maybe preserved, would arrive to the island by trade to be consumed.

Therefore, the comparison of the available data from Ghizen site with other Tunisian areas hints at changes in dietary and husbandry schemes through the-Punic to the Roman period. We propose that these changes were a consequence of the extension of the Roman Empire and the establishment of a new political and economic model that brought new forms of production into the local communities. In that sense, we would also like to point out the presence of rabbit at Ghizen during the Roman phase of the site as an example of another consequence of the Roman conquest. Its presence suggests the conscious introduction of this animal into the island at this time (Azaza, Colominas, in prep.). Certainly "Romanization" acted in exposing cultures to different behaviours, traits, and goods (Mackinnon, 2010:168-177) in Tunisia and more specifically at Ghizen.

Conclusion

No important architectural changes have been documented at the Ghizen site from the Punic to the Roman period (Bentaher, 2014:19-35). Therefore, through the architectural evidence we could interpret that no important changes were produced at Ghizen with the Roman conquest, as it continued to be a fishermen's site with the presence of the same fishermen's houses. With this study we have shown that, in contrast, some changes were produced in livestock practices.

We have documented an increase of the economic importance of sheep that would be principally exploited to obtain wool. These animals could have been bred on-site. We have also observed an increase in pork consumption. Preserved portions could have arrived at the site via trade. We suggest that these changes may be related with the Roman conquest, as the changes documented at Ghizen, a small site in a small island, are the same changes documented in other areas of Tunisia and of the Mediterranean basin under the Roman control.

An increase in the sample under study here, and deeper research are needed to conclusively test the hypothesis developed here. A systematic study of the archaeozoological remains from the different sites excavated in Tunisia would also help to improve knowledge about the Roman conquest in Tunisia, as demonstrated in this paper.

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CHAPTER 5: ROMANIZATION AND ANIMAL TRADE

5.1. THE ROMAN INTRODUCTION AND EXPORTATION OF ANIMALS INTO TUNISIA: LINKING ARCHAEOZOOLOGY WITH TEXTUAL AND ICONOGRAPHIC EVIDENCE

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The Roman introduction and exportation of animals into Tunisia: Linking archaeozoology with textual and iconographic evidence

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ABSTRACT

The Mediterranean basin was the core of the Roman Empire. Large communication networks were constructed and maintained that enabled the trade and distribution of large number of products between distant territories. North Africa, and more specifically Tunisia, was an important trading area. However, little information is available about the animal trade. To characterize this activity and evaluate its economic importance, in this study we examine which species were introduced and exported during the Roman era in Tunisia using archaeozoological data and contextualizing them with written and iconographic sources. This combined approach shows that the Romans were responsible for introducing and exporting numerous animals. We have documented the introduction of commensal animals, such as black rat (*Rattus rattus*) and house mouse (*Mus* sp.), wild animals such as fallow deer (*Dama dama*) and hare (*Lepus* sp.), and domestic animals such as rabbit (*Oryctolagus cuniculus*) and cat (*Felis catus*). At the same time, North Africa supplied Rome with wild beasts such as lions, tigers, bears and camels. We suggest that the animal trade was an important economic activity for Tunisia not only for the export of wild animals but also for the import of animals that were mainly used for social purposes.

1. Introduction

Archaeological and historical data have shown that since early times people played a fundamental role in the migration of animals in various locations around the world. One of the most active periods began with the creation of the Roman Empire, which promoted connectivity around the Mediterranean Sea as a unique geographical space. This connectivity encouraged the movement and spread of animals that colonized new areas by travelling on human means of transport. Mobility and trade flourished across the Roman provinces and massive quantities of goods were shipped over thousands of kilometres by sea, river and road (Campillo et al., 2018). Archaeological evidence reveals the interconnectivity of the Roman world, as indicated by traded goods such as ceramics, marble and bricks (Rice, 2008). Oil and grain were also traded in large quantities and transported over long distances (Dark, 2007).

During the Roman period, North Africa was one of the main productive areas and a fundamental source of goods for the Empire. The Romans exploited North Africa to maximize the production of agricultural products and supply them to Rome (Bomgardner, 1992). The introduction of wide-spread olive plantations and cereal cultivations increased prosperity in North Africa after its incorporation into the Mediterranean-wide economic system (Mackendrick, 1980; Raven, 1984). North Africa supplied Rome with products such as corn, oil, wine, legumes, salt-preserved fish, *garum*, pepper and other spices, herbs, vinegar and honey (Schwartz, 2004; Carandini, 1983; Rice, 2008). Other imported African products included fruits such as gourds and melons, lemons, figs, dates and fumé grapes (Schwartz, 2004). At the same time, many products were recorded at North African ports, thus providing evidence of trade imports during the Imperial period. In Carthage, numerous italic fine wares, Italian *Sigillata*, bricks, pumice and Spanish *amphorae* were present during the 2nd century CE (Rice, 2008). North Africa, and more specifically Tunisia, was an important economic trading area in the Mediterranean basin.

In view of the above, in this paper we aim to shed light on another commodity that was traded in Tunisia but that has been scarcely investigated: animals.

We know that a trade in wild animals existed between North Africa and Rome (Keller, 1913; Toynbee, 1973; Bomgardner, 1992; Epplett, 2001; Mackinnon, 2006, 2010; Pigière and Henrotay, 2012). However, little information is available about the importation of animals to North Africa.

In this study, we identify which species were introduced to Tunisia during the Roman period using an archaeozoological approach and

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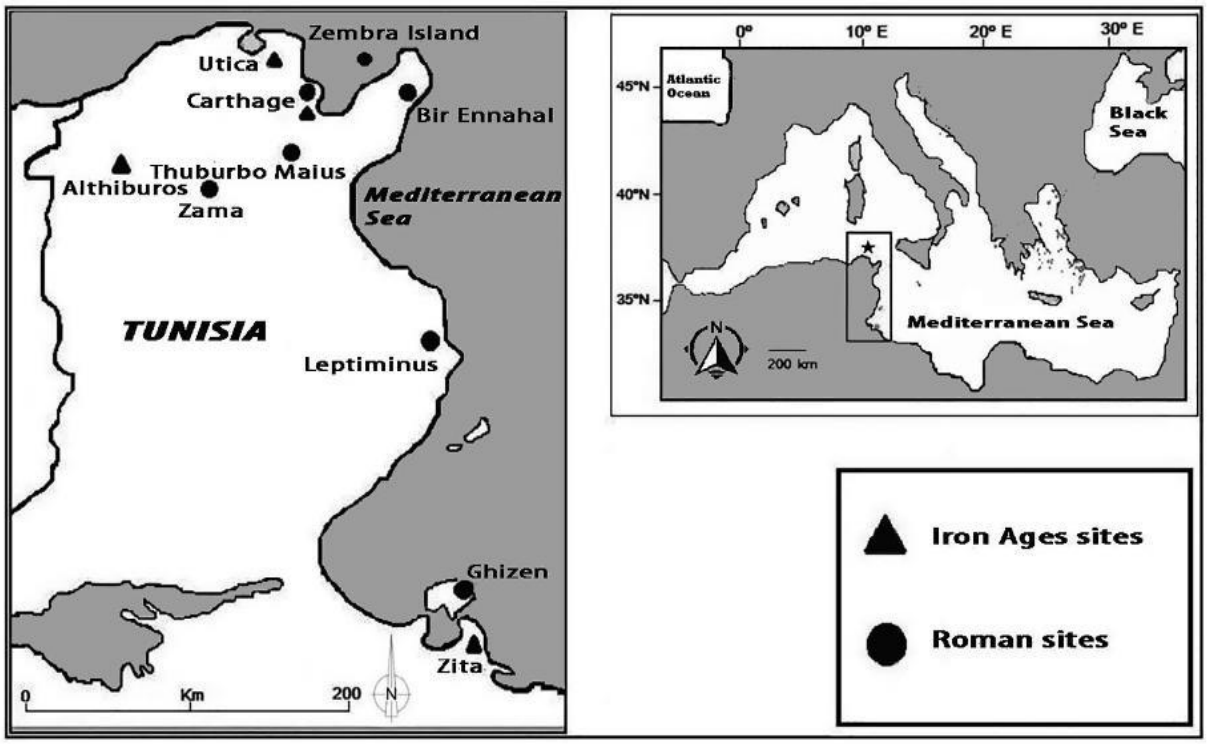

Fig. 1. Location of the Iron Age and Roman Tunisian sites mentioned in the text. For complementary information see Table 1.

compare this information with written and iconographic sources. We also analyse evidence available on the trade of animals from Tunisia to other locations. A review of all the information available on the introduction and exportation of animals is essential to understand the impact and importance of this economic activity in Tunisia during the Roman period.

2. Material and methods

To carry out this investigation we have focused on the Roman period but also on the Iron Age. Faunal remains from Iron Age sites will give us an idea about the faunal spectrum before the Roman conquest and it will allow us to contrast the absence/presence of the documented animals in each period. Therefore, our study has centered on the analyses of taxonomic representation of all the species documented (NISP frequency) and in their presence/absence. The available archaeozoological information comes from six Iron Age sites and eight Roman sites (Fig. 1, Table 1).

2.1. The Iron Age sites

The Iron Age sites under study here are Utica, Bir Messaouda, Ilot de l'Aumirauté, Magon quarter, Althiburos, and Zita (Fig. 1, Table 1).

The archaeological site of Utica, located in the North of Tunisia (modern day Bizerte), was one of the oldest Tyrian settlements in the Western Mediterranean (Ps. Aristotle, Mir Ausc 134, Flavius Josephus Against Apion I, 18; Velleius Patrerculus I, 2, 3, Plin, Nat. His. XVI, 216 in Cardoso et al., 2016). The Tunisian-Spanish campaigns performed in Utica in 2012–2015 uncovered a very ancient Phoenician architectural complex, C^{14} dated from the last quarter of the 10th century BCE to the middle of the 9th century BCE (Cardoso et al., 2016). The faunal set recovered in an abandoned water pit was composed by 536 fragments. J. L. Cardoso undertook the study of the faunal material in 2016.

Bir Messaouda site is located in the centre of modern day Carthage. It was an uncultivatable plot appropriated for the construction of the National Court of Cassation. In 1998, an excavation undertaken by the Institut National du Patrimoine de Tunis, and guided by F. Chelbi documented Roman, Late Punic and Archaic structures (Docter, 2002). A project launched by the University of Amsterdam and the Tunisian

Table 1
Archaeological information of Iron Age and Roman sites mentioned in the text. NR = Number of Remains. For complementary information see Fig. 1.

Site	Location	Chronology of the samples	Context of the samples	NR	Reference
Utica	Bizerte	10th–9th c. BC	A water pit	536	Cardoso et al., 2016
Bir Messaouda	Carthage	Archaic and Punic periods	buildings	911	Slopsma et al. 2009
Ilot de l'Amirauté		4th-2th c. BC	Circular Harbour	131	Mackinnon, 2010
Magon Quarter		Second half of the 7th c. BC	Urban structure	1159	Nobis, 2000
Althiburos	El Kef	6th–2th c. BC	Urban structure	5798	Valenzuela-Lamas, 2016
Zita	Zarzis	2nd c. BC-1st c. AD	Urban structure	1198	Moses et al. 2019
Z2	Zembra Island	5th–6th c. AD	Terrace of a riverbed	283	Vigne, 1988
Z7 *«Abri de Casino»*		2nd/3rd–5th/6th c. AD	Shelter	352	Vigne, 1988
Bir Ennahal	Kélibia	5th c. AD	House (*domus*)	766	Oueslati and Ennaifer, in press
Yasmina	Carthage	2nd–3rd c. AD	Necropolis	2303	Mackinnon and Belanger 2006
Kobbat Bent el Rey		3rd–5th c. AD	Underground building	664	Baumgartner, 1996
Tuburbo Maius	Tunis	Roman period	Courtyard Garden of the House of Bacchus and Ariadne	34	Jashemski et al., 1995
Althiburos	El Kef	1st c. BC- 6th $^{c.}$ AD	Capitolium	1987	Valenzuela-Lamas, 2016
Ghizen	Djerba Island	Roman period	Fishermen's houses	472	Azaza and Colominas, 2019
Zama	Siliana	2nd–3rd c. AD	Thermal structure	367	Present paper

authorities in 2000 continued with the excavations (Docter, 2002). The stratigraphy of the site was divided into nine archaeologically datable periods: two Archaic, two Punic, two Roman, one Vandal, one Byzantine, and one Medieval (Docter, 2002). J. Slopsma was responsible for the processing of the faunal remains, W.Van Neer of the Royal Belgium Institute of Natural Sciences (Belgium) identified fish remains, and L. Karali-Yannacopoulos of the University of Athens studied molluscs (Slopsma et al., 2009). 4850 mammal remains were recovered, and 911 remains were attributed to the Iron Age (Archaic and Punic periods).

Magon Quarter is located on the street of Septime Sévère in modern day Carthage, very close to the sea. It was excavated by the German Archaeological Institute of Rome between 1980 and 1984 directed by F. Rakob. The team documented many different Punic and Roman urban structures, such as the city wall, a handicraft and merchant and housing buildings (Rakob, 1983; Docter, 2002). Faunal remains were studied by G. Nobis (2000).

The Ilôt de l'Amirauté site is a small island inside the Circular Harbour, on modern Carthage. Three periods of occupation have been established on the site by British Archaeologists: an early Punic period, a late Punic period and a Roman period (Hurst, 2008). Trenches and postholes belonged to the 4th century BCE. Ship sheds were built on the island during the early Punic period. The late Punic period can be clearly identified by several buildings (Kruschen, 1978). In Roman times, the Ilot de l'Amirauté became a monumental colonnaded piazza with a temple and octagonal building at its centre (Hurst, 2008). The faunal assemblage comes from the excavations done by the British mission on the site (Mackinnon, 2010).

Althiburos (modern day El Médiena and the ancient *Sicca Veneria)* is a Numidian and Roman site, located on the Western-North of Tunisia, 215 km S-O from Tunis, and 45 km S from el Kef (Kallala et al., 2008). A Tunisian-Spanish project was launched in 2006 between the University of Barcelona and the Institut National du Patrimoine de Tunis, and directed by N. Kallala and J. Sanmarti. 10,379 faunal remains were studied from the excavations carried out between 2006 and 2012 by S. Valenzuela-Lamas. 5798 remains were attributed to the Numidian period (Valenzuela-Lamas, 2016).

The site of Zita, located in South East of Tunisia (modern Zarzis) is an urban site of approximately 34 ha occupied from 500 BCE to 300 CE (Kaufman et al., 2015). An American-Tunisian research project was undertaken by the University of Arizona between 2013 and 2015. The faunal assemblage comes from Area III, Square 1, which corresponds to a domestic area (Moses et al., 2019). 5837 faunal remains were recovered from these campaigns, in which 1198 remains were attributed to the pre-Roman period (Moses et al., 2019).

2.2. The Roman sites

The Roman archaeozoological information comes from eight sites: Z2 and Z7 in Zembra Island, Bir Ennahal, Yasmina, Kobbat Bent El Rey, Thuburbo Maius, Leptimus, Althiburos, Zama and Ghizen (Fig. 1, Table 1).

Zembra is an island in the Gulf of Tunis with an area of roughly 340 ha. The outstanding geographic situation, in the entrance of Carthage's golf, and on the road to Sicilia, led to Zembra Island a strategic importance through the history (Chelbi, 2013). Two archaeological campaigns were undertaken by the Centre National de Recherche Scientifique (CNRS) and the Direction Générale de la Santé Tunis (DRST). They were directed by J.D. Vigne in 1986 and 1987 that excavated two trenches: Z2 and Z7 (*«Abri de Casino»*) (Vigne, 1988). Z2 has two layers sealed under the ruins of an ancient building. The oldest layer dates from late antiquity (5th-6th century CE). Z7 produced two layers, from which faunal remains were recovered, dating from the 2nd-3rd century CE and the 5th-6th century CE respectively. The faunal remains from these two sites were studied by J.D. Vigne (1988), who determined 17 faunal remains from Z2 and 26 from Z7.

Bir Ennahal is located in the centre of *Old Clipea* in modern-day Kélibia in the area of Cap Bon (north east of Tunisia). The site was first excavated in 1977, while other investigations were carried out between 1998 and 2000 (Ennaïfer, 2002). A large house decorated with many mosaic and hunting scenes was documented. The house was constructed around the middle of the 5th century CE to replace a salt fish factory with tanks for *garum* dating from the end of the 2nd century or first part of the 3rd century CE (Oueslati and Ennaifer, in press) and it was inhabited until the 7th century CE. The 766 faunal remains recovered from a sewer located under the street along the house were analysed by Oueslati and Ennaifer (in press).

Yasmina, in the southwestern quadrant of the ancient city of Carthage (northern Tunisia), is an early Roman necropolis located in the modern community of Yasmina. It was discovered in 1981 during bulldozing operations for a road that was intended to mark the boundaries of the archaeological zone (Norman and Haeckl, 1993). Five years of excavations were carried out by the University of Georgia with the support of the Tunisian authorities. Inhumation burials from the 2nd century CE, funerary monuments from the early 3rd century CE and cremation burials from the 5th century CE were documented at this necropolis. Little activity has been registered after this date (Norman and Haeckl, 1993). The excavated burial sites yielded various goods and accoutrements, including charred pig remains. One inhumation burial of a young adolescent dated from around the 3rd century CE contained the skeleton of a dog in a relatively complete state (Mackinnon and Belanger, 2006). M. Mackinnon examined the faunal material from Yasmina between 1998 and 1999, while K. Belanger carried out further analyses of the canid remains in 2001(Mackinnon and Belanger, 2006).

Kobbat Bent El Rey, or *Baths of Dido*, is located in the province of Carthage on Bordj Djdid hill. A vaulted underground building dating from the early 4th century CE, it is considered to be among the best-preserved residential houses in Carthage. The monument was reconstructed between 1978 and 1989 during UNESCO's international campaigns. The animal bones recovered from excavations of the underground external area were assigned to late antiquity (294–439 CE), Vandal (439–533 CE) and early Byzantine eras (533–695 CE) (Baumgartner, 1996). I. Baungartner conducted her PhD on the study of the Kobbat Bent el Rey assemblage, in which 10.468 faunal remains from at least 122 species were recovered. From this assemblage, 664 faunal remains were attributed to late antiquity (3rd–5th centuries AD) (Baumgartner, 1996).

Thuburbo Maius is located 53 Km southwest of Tunis in the fertile Miliana Valley, which has been famous for its production of grains, olives and fruit since antiquity. Under Hadrian, *Thuburbo Maius* was a *municipium* and it became a colony under Commodus (Jashemski et al., 1995). Excavations were undertaken in 1990 by W. F. Jashemski from the Archaeological Institute of America. A total of 34 animal bones were recovered from the Courtyard Garden of the House of Bacchus and Ariadne dated from the 3rd-4th centuries AD and were identified by H. Setzer (Smithsonian Institution) between 1990 and 1995 (Jashemski et al., 1995).

Leptiminus is an ancient Roman city located on the Mediterranean coast of Tunisia in the modern-day town of Lamta, which is 16Km from Monastir. Excavations were undertaken in the area 304 between 2004 and 2006 by L. Stirling of the University of Manitoba (Canada) and N. ben Lazreg of the Institute National du Patrimoine (Tunisia). The site dates from the 2nd to the 5th century CE (Keenleyside et al., 2009). Faunal remains recovered from the area of the necropolis were studied by M. Mackinnon in 2006. The author did not indicate the total Number of Identified Specimens but identified fish, sheep, goat, hare, cattle, dog, and equid (Keenleyside et al., 2009).

Althiburos site played also a fundamental role as an interconnected city during the Roman period, with an occupation dated to the 1st century BCE until the 6th century CE (Ben Moussa and Calvo, 2016). 1987 faunal remains were recovered from the Roman layers and studied

by Valenzuela-Lamas (2016).

Zama is located in the plain of Siliana (North West of Tunisia) in the vicinity of the famous battle of Zama. Written sources show that Zama was an important Roman city. Since 1995, numerous surveys have been carried out at the site (Ferjaoui, 2001). A Tunisian-Italian mission was undertaken by the University of Sassari (Italy) and the National Heritage Institute of Tunisia, who in 2002 excavated the thermal structures dating from the 2nd-3rd centuries AD (Bartoloni et al., 2010). The 367 faunal remains from this thermal structure studied so far by M. Azaza are presented in this paper.

Ghizen is located in the northeast of Djerba Island (southern Tunisia). Archaeological excavations on this site led by the National Heritage Institute of Tunisia were conducted between 2008 and 2011 (Bentaher, 2014). These excavations documented a quadrangular space made up of three rooms of similar dimensions (Bentaher, 2014). These rooms presented three levels of occupation dating from the Punic and the Roman periods, although anthropogenic activities since the 6th century BCE have been documented. The presence of several fishing net *pondera* and hooks indicate that these rooms were fishermen's houses (Bentaher and Sternberg, 2011). A total of 472 faunal remains from the Roman occupation of these fishermen's houses have been studied by M. Azaza (Azaza and Colominas, 2019).

3. Results

In this study, animal bones from the Pre-Roman period are from excavations carried out in Utica, Carthage, Althiburos, and Zita. From the Roman period the remains come from Zembra Island, Bir Ennahal, Carthage, Thuburbo Maius, Ghizen and Zama (Table 1).

The faunal remains recovered are mainly mammalian species, in which the majority were domestic animals (Table 2). In this sense, the most common faunal remains in all the sites under study here are those of caprines, cattle, and pigs, as wastes of food. Other domestic animals are also present in the two periods, although their presence is not uniform in all sites. These are equid and dogs. Furthermore, there are other domestic animals only and/or mainly present in the Roman record. These are cats and rabbits. Cat remains have been documented at the Roman sites of Bir Ennahal, Tuburbo Maius and Zama and possibly at Zembra Island (Table 2, Fig. 2). Rabbit remains have been documented at the Roman sites of Zembra Island, Tuburbo Maius, Althiburos and Ghizen (Table 2, Fig. 2). It should be highlighted that 4 rabbit remains were also recovered at the Iron Age phase of Althiburos (Valenzuela-Lamas, 2016).

In relation to wild mammals, their presence is scarce in all sites, but we also document some species present in both periods and others only present in the Roman phase of the sites. The wild mammals present during the Iron Age and Roman period are Barbary lions, foxes, elephants and hares (Table 2). On the contrary, the wild mammals only present during the Roman period are fallow deer, red deer, hedgehog, hare, black rat and house mouse (Table 2, Fig. 3). Fallow deer remains have been documented at the Roman sites of Bir Ennahal and Kobbat Bent El Rey, and red deer at Bir Ennahal. Hedhehog is present at Kobbat Bent El Rey site. Black rat has been documented at the Roman sites of Zembra Island and at Bir Ennahal, and house mouse probably at Zembra Island.

4. Discussion

Before starting the discussion, some considerations are important to highlight in relation to methodological issues. First of all, we must point out that although the archaeozoological evidence has been increased in the last years, it remains scarce. For that reason, in this section we discuss the faunal data taking into account the textual and the iconographic evidence as far as possible. Another point to note is that we have accepted as correct the taxonomical identifications of the authors, although in most of the papers (specially the earlier reports), any explanation exists about the criteria used in their determination. We have encountered the same lack of information in relation to taphonomic issues or aspects related to the context of recovery of the samples. In this sense, we cannot be totally sure that none of the faunal remains presented here is intrusive, especially concerning the microfauna, because most of them are faunal reports in which this data is not reported. Although these deficiencies, we think that some general considerations are possible to make, if the data is conjointly evaluated.

4.1. Introduced animals

Taking into account the data presented in this study, we propose that the cat, the rabbit and the hare, the house mouse, the black rat and the fallow deer were introduced into Tunisia during the Roman period. Numerous studies have analysed the dispersion of these animals throughout Europe and their place of origin (see for example Vigne, 1988; Hardy et al., 1994; Dobney and Harwood, 1999; Lepetz and Yvinec, 2002; Albarella, 2007; Sykes et al., 2011; Valenzuela et al., 2016), showing that their spread was probably due to the Roman trade. This scenario fits well with the archaeozoological data presented here, in which these animals are only present in some of the Roman sites. Therefore, they were also probably introduced to North Africa in this period.

The dispersal of fallow deer to Europe is attributed to the Romans (Lever, 1977; Whitehead, 1972; Pascal et al., 2006; Sykes et al., 2011; Valenzuela et al., 2016). We suggest that these animals must have also been introduced to western North Africa during this period since live wild fallow deer did not exist in that area before (Kowalski and Rzebik-Kowalska, 1991; Baumgartner, 1996) and five remains have been documented at Bir Ennahal and one remain at Kobbat Bent El Rey. Nevertheless, we should also bear in mind that a trade in fallow deer antlers and metapodials as raw materials for craft activities existed in antiquity (Sykes, 2010). Roman texts also intimate that they were mostly traded for their medicinal properties. According to Pliny the Elder's Natural History, powdered deer antlers could be used to cure a range of disorders from tooth ache to epilepsy (see book XXVII, Trans. Jones 1963 in Madgwick et al., 2013). In Tunisia, fallow deer probably were introduced for hunting purposes linked with a high status activity, as the few identified remains were recovered in residential houses. A hunting mosaic from Le Kef in western Tunisia, dating from the late 2nd century CE should be pointed out, as it depicts a group of ostriches and deer herded into an enclosure by huntsmen (Lavin, 1963).

It has been suggested that the black rat and the house mouse were unwittingly introduced during the Roman period by human movements through maritime shipping routes (Vigne, 1994; Vigne and Villié, 1995; Albarella, 2007). Some recent studies however, show that, at least, the spread of house mouse in the western Mediterranean could be dated to the early 1st millennium cal BC and linked to both Greek and Phoenician maritime activities (Cucchi et al., 2005). The current available data for Tunisia, with the documentation of house mouse at the Roman site of Zembra Island and of black rat at Zembra Island and at Bir Ennahal and not before, could suggest their timid introduction during that period and not before. The introduction of these commensal animals must have been accidental in the wake of human habitation as these animals found refuge in grain depots that would have provided them with ideal habitats. Their introduction, however, was not without cost since it brought concomitant implications for foodstuff storage, hygiene and human health (Dobney and Harwood, 1999).

Domestic cats have been transported all over the world and have invaded mainland and insular systems (Nogales et al., 1996; Vigne et al., 2004; Cross, 2016). It has been suggested that they were introduced to Europe by Greek and Phoenician traders and later by the Romans. The spread of the black rat and the house mouse along sea routes probably encouraged cat dispersal, since this animal is important to human societies as a pest-control agent (Ottoni et al., 2017). Cat remains have been recovered in Roman North African contexts at Bir

Table 2
Archaeozoological information from Iron Age and Roman Tunisian sites mentioned in the text. NISP = Number of Identified Specimens.

Period	Iron Ages						Roman period								
SITES / TAXA	Utica	Bir Messaouda	Ilot de l'Amirauté	Magon Quarter	Althiburos	Zita	Z2	Z7	Bir Ennahal	Yasmina	Kobbat Bent El Rey	Tuburbo Maius	Althiburos	Ghizen	Zama
Ovis aries (sheep)/*Capra hircus* (goat)	142	134	85	448	1007	39		3	62	1073	85	8	351	57	75
Bos taurus (cattle)	265	75	33	556	523	2			67	221	8		55		34
Sus sp. (pig)	88	20	13	155	352		1	2	104	1008	72	5	238	6	11
Equus sp. (equid)	24	1			60				11		6		11	1	2
Felis catus (cat)								1?	1			1			1
Canis familiaris (dog)	12	7			53				3	1	5		2		1
Panthera leo (barbary lion)		1													
Vulpes sp.(fox)						1			1						
Dama dama (fallow deer)									5		1				
Cervus elaphus (red deer)									1						
Erinaceus algirus (hedgehog)											2				
Oryctolagus cuniculus (rabbit)					4		2	12				1	4	1	
Lepus sp. (hare)					3	2			5				1		
Rattus rattus (black rat)								4	1						
Mus sp. (house mouse)								1?							
Sciurus sp. (squirrel)		1													
Hystrix cristata (porcupine)						1									
Loxodonta africana (elephant)	3												1		
Testudo sp. (tortoise)	2														
Aves (birds)					23	8	12	4	143		66		46	2	2
Osteichthyes (fishes)						42			67		13			5	
Mollusca (mollusk)					7	21			26		241		13	1	1
Herpetiles (amphibians + reptiles)					44	1					7		1		
NISP	536	239	131	1159	2002	45	17	26	261	2303	174	15	662	65	124

Ennahal, Tuburbo Maius, Zama and probably at Zembra Island. Through our analysis, it seems that its arrival was also during the Roman period, being present on the coastal sites and on islands of Tunisia and not before, and being more common than its preys. This fact could have been showing that the scarce presence of rat and mouse in the archaeozoological record is due to taphonomic biases.

Rabbits and hares were important sources of hunting game and were not introduced as a supply of meat in antiquity (Baumgartner, 1996). It has been suggested that the Romans introduced the rabbit from the Iberian Peninsula to many territories (Rogers et al., 1994; Dobney and Harwood, 1999), among which we could include North Africa. Several rabbit and hare remains have been documented at Zembra Island, Bir Ennahal, Tuburbo Maius, Ghizen, Althiburos and Leptiminus, which could indicate their introduction and dispersal across the territory. They are also common animals depicted in African mosaics, although their appearance in them is not clearly indicative of their physical presence in the territory. Some examples are the mosaic of Lord Julius of Carthage, dated from the late 4th to the early 5th century CE that depicts a dog as well as a labourer carrying a basket of grapes and holding a rabbit (Parrish, 1979); the mosaic from Althiburos that shows a hare being picked up by its forelegs (Parrish, 1979); the "Satyrs and the Bacchantes" mosaic that depicts a hare (Balmelle et al., 1990); or the pavement found at El-Jem (Mahdia) and attributed to the 3rd century CE that depicts a rabbit hunting scene with hunters and dogs (Lavin, 1963). If we take into account that North-African mosaicists and patrons were less bound to traditional iconography and composition, which resulted in greater variety, innovative designs and a remarkable realism (Dunbabin, 1978), we could speculate that African pavements could be showing that rabbits and hares were, at least, known animals in North Africa during the Roman period. Nevertheless, four rabbit remains and five of hare were identified in the Numidia phase of Althiburos (Valenzuela-Lamas, 2016) and in Zita (Moses et al., 2019). Any information related to the archaeological context of these findings and about taphonomy is provided. If we take into account these punctual findings, we can point out that, at least, their spread across the territory was during the Roman period and not before.

4.2. Exported animals

North Africa was an outstanding platform from which to export African wild animals. The North African provinces of Mauretania, Numidia, and *Africanus Proconsularis* offered closer sources than Ethiopia for the acquisition of exotic African animals for Rome (Mackinnon, 2006). It has been suggested that the development of this

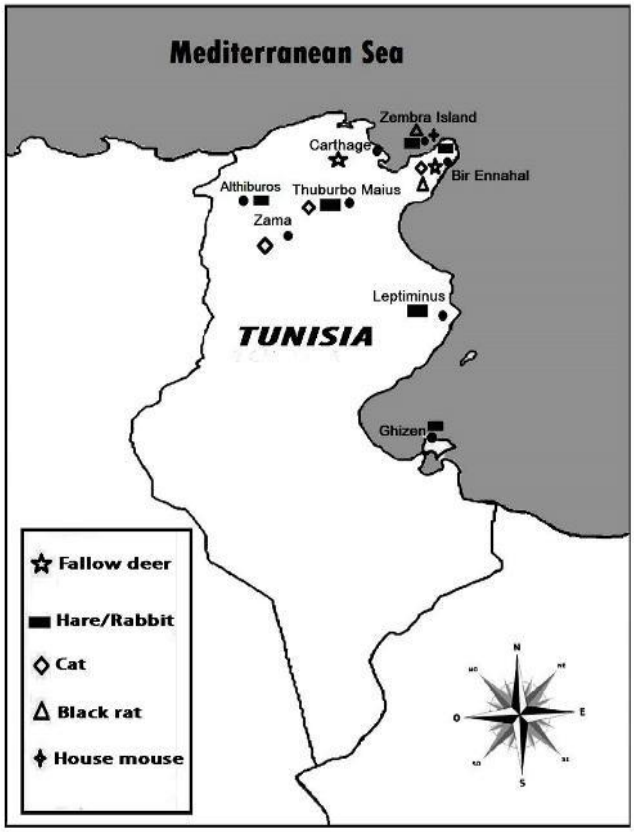

Fig. 2. Distribution of the introduced animals to Tunisia by sites during the Roman period (archaeozoological record).

wild animal trade during the Roman period was due to an increased demand for exotic beasts for entertainment and spectacles (Toynbee, 1973; Mackinnon, 2006). The successful outcome of the Punic wars gave Rome access to a large number of *Africanae bestiae*. In fact, after the Second Punic war, Rome obtained a secure source of wild animals from North Africa that were destined for the games. As Roman power and influence expanded throughout the Mediterranean, beast-hunts also became popular and spread quickly to other cities. Hundreds of animals from North Africa, including elephants, antelopes, lions, leopards, cheetahs, camels, ostriches, rhinoceros, bears, and giraffes, were used for spectacles (Epplett, 2001). Zebras, tigers, snakes and lynxes are also included in the list of animals collected for these games. Romans, therefore, captured and transported large numbers of North African animals for events staged throughout the Empire.

Potentially exported animals are sporadically represented in the faunal spectrum of Tunisia, but we have documented the local presence of Barbary lions, elephants, foxes and red deer (Table 2, Fig. 3). Archaeozoological evidence for exotic beasts in Roman cities outside North Africa is also scarce but some examples do exist (Fig. 3). Excavations conducted during the 19th and early 20th centuries around the Colosseum in Rome documented the remains of lions, tigers and other exotic animals (Lanciani, 1979: 373, 385; Ghini, 1988). The excavation of a 5th-7th century CE drain at the Meta Sudans site, located roughly 50 m southwest of the Colosseum, documented 16 bear bones, 2 leopard bones, an ostrich fragment and the remains of several red deer, roe deer, wild boar and foxes (De Grossi Mazzorin, 1995: 309–318).

Mosaics and other art forms described and depicted the capture, transportation and maintenance of these animals before their exhibition. Some examples are the mosaic from Carthage-Dermech dating from the early 4th century CE that depicts the capture of a lioness and caged bear before they were shipped to their ultimate destinations (Epplett, 2001); a cippus found in Tunisia that shows a bull-baiting *venator* in the air (Epplett, 2001); an early 3rd century mosaic from Radez (Tunisia) that depicts the scene of a boar hunt (Epplett, 2001); a mosaic from Utica (Tunisia) that depicts the capture of a Berber stag (Keller, 1913); a hunting mosaic from *Hippo Regius* (Algeria) that shows hunters in pursuit of antelopes (Loisel, 1912; Jennison, 1937); a mosaic from the "Maison de la chasse" in Utica that shows two hunters driving gazelles into a waiting net (Dunbabin, 1978); mosaics found in Carthage and *Hippo Regius* that illustrate the capture of wild equine (Toynbee, 1996; Dunbabin, 1978; Anderson, 1985); or the "Magerius mosaic" in Smirat (Tunisia) that represents the performance of four leopards and four venatores (Sparreboom, 2016) among others. Mosaics should not always reflect the reality, but the prominence of venatorial themes and the absence of gladiators in African mosaics suggest that in North African Roman period, beast fights attained greater cultural importance than gladiators (Sparreboom, 2016).

Written sources also provide information about the trade of wild North African animals. Pliny the Elder records that elephants could still be obtained in North Africa in the 1st century CE (Nat.His.VII, 11, 32 in Cardoso et al., 2016). Appian records that Scipio Africanus exhibited elephants during his triumphal ceremony for his victory at Zama in 202 BCE (Sparreboom, 2016). Large numbers of Barbary lions (*Panthera leo leo*) were also caught in North Africa and transported to Rome to be used in the Arena (Slopsma, et al., 2009; Barnett et al., 2008). In the games given by *Sella*, a Roman *patronus*, 100 lions supplied by King *Bocchus* of Mauretania were hunted (Bomgardner, 1992). King *Massinissa* of Numidia (203–148 BCE) may have supplied many of the animals used in early Roman spectacles (Epplett, 2001). *Athenæus* tells the story of the Roman gastronome *Apicius*, who approached the Libyan coast for North African products to supply the city of Rome. Prized birds such as the ostrich and the African chicken (*Guinea fowl*) were hunted from the desert and transported to Rome (Schwartz, 2004).

The importation of dromedary (*Camelus dromedarus*) and bactrian (*Camelus bacterianus*) camels to several provinces of the Roman Empire has also been documented (Fig. 3). Camel bones were found at the Colosseum in Rome (De Grossi Mazzorin et al., 2005), the Roman amphitheatre in Cartago Nova in Spain (Morales Muñiz et al., 1995) and the Roman amphitheatre in Serdica in Bulgaria (Velichkov, 2009: 125). Camels were also imported to the northern provinces of the Roman Empire, such as Austria, England, France, Belgium, Germany, Hungary and Switzerland (Pigière and Henrotay, 2012: 1531–1539; Benecke, 1994, 328; De Grossi Mazzorin, 2006, 234). At Ajdovscina-Casta (Slovenia), four camel teeth were identified in a deposit dated to 270 CE. Three camel bones were documented from the site at Hrusica-Ad Pirum (Slovenia) dating from the 3rd century CE, and three elements of camel hindlimbs were found at Vranj (northern Serbia) dating from the 3rd-4th century CE (Tomczyk, 2016:1–13).

They were traded from Africa to be used as pack animals linked with both military and civilian traffic (Toynbee, 1973; Pigière and Henrotay, 2012). Pliny the Elder also indicates other uses, writing that camel products, such as the brain, the tail and dung were used in medical and beauty treatments (Vuković-Bogdanović and Blažić, 2014). Meat, milk, fat, hair, wool and leather are other products from dromedaries and bactrian camels that were also used since ancient times (Köller-Rollefson, 1991; Potts, 2004). Moreover, camels can produce large quantities of meat and fat. In this context, fragmentation and butchering marks on long bones from the Roman city of Viminacium (Serbia) suggest that camel meat may also have been consumed (Vuković-Bogdanović and Blažić, 2014). Therefore, these animals could be exported from Tunisia for very different purposes, starting for their power as pack animal but also for the products that could be obtained from them once sacrificed. We also know from historical sources that Emperor Claudius (Dio. LX, 7,3) organized camel fights and that Emperor Nero (Suetonius Nero III) introduced camel races to the Circus Maximus (Toynbee, 1996).

The animal trade between Italy and Africa was organized predominantly by shipping routes. Improved transport mechanisms in relatively peaceful social and political circumstances may have promoted

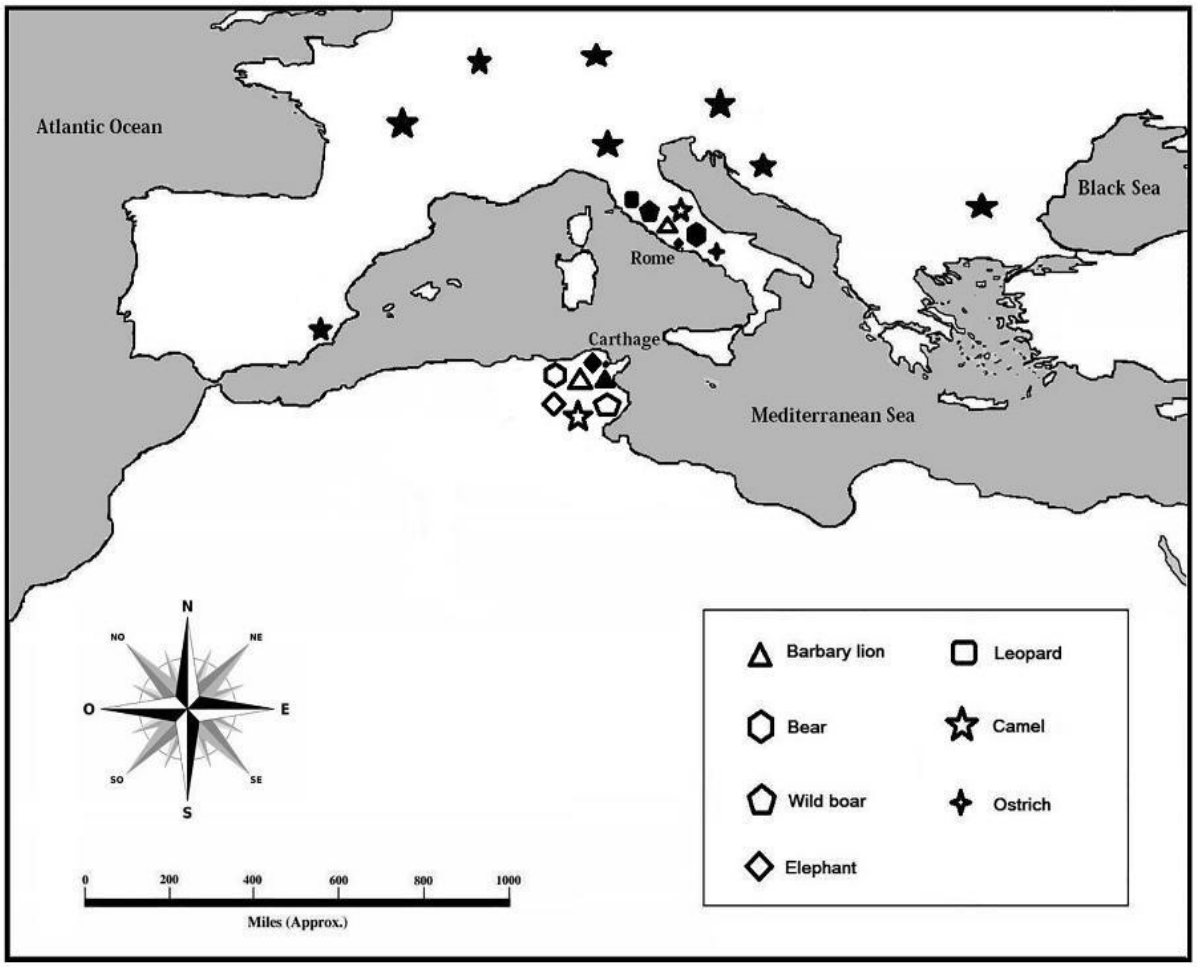

Fig. 3. Location of the exported animals from Tunisia during the Roman period (archaeozoological record = filled symbols; textual and iconographic record = empty symbols).

trading ties to outlying areas (Mackinnon, 2010). In this sense, an Ostian inscription dating from roughly 180–200 CE records shippers from *Hippo Diarrytus* in Tunisia, while two other inscriptions from the same site mention exporters from Carthage (Epplett, 2001). Despite the Roman trade, large numbers of lions and leopards survived in Algeria and Morocco until at least the 19th century. Large numbers of ostriches also survived in those countries until the beginning of the 20th century.

5. Conclusion

This study presents the first compendium of archaeozoological data about animal Roman trade in Tunisia. We have found some obstacles, such as the, still, scarcity of data, the complicated taxonomical identification of some species and some taphonomic biases. However, current evidence suggests that the Romans were responsible for introducing several animals to Tunisia. We have documented the introduction of commensal animals (black rat, house mouse) as well as the conscious introduction of wild (fallow deer, and hare) and domestic (rabbit and cat) animals.

The introduction of commensal animals such as the black rat and the house mouse must have been accidental. Whereas the conscious introduction of animals indicates their economic and social importance, which were brought to North Africa for specific purposes. In this paper we have demonstrated that most consciously introduced animals (fallow deer, rabbit and hare) were related to hunting activities. The translocation of these animals therefore shows the importance of this activity as a symbol of social status for the population living in North Africa that acquired a Roman lifestyle. At the same time, it shows another cultural connection between Tunisia and Italy.

In this paper we have also presented an update about iconographic and textual data about animal Roman trade. This evidence suggests that the Romans played a fundamental role in the exportation of wild animals despite being rarely found in archaeological Tunisian sites. North Africa, and more specifically Tunisia, was a platform for exporting wild beasts to other Roman territories. The increased demand for wild African animals for exhibition and the entertainment of Roman aristocracy encouraged their trade and exportation to Rome.

Therefore, this paper has demonstrated that animals were another commodity traded in North African ports. The evidence presented here suggests that this trade was an important economic activity for Tunisia, not only for the exportation of wild beasts but also for the importation of wild and domestic animals.

This paper has also shown that multidisciplinarity is an indispensable tool for studying animal trade, a topic too complex to be addressed from only one discipline. Archaeozoological evidence accompanied by written and iconographic sources have allowed us to present a more complete view of this phenomenon. However, further research is needed. More archaeozoological data is required to try to answer important questions related to animals' arrival and spread across Tunisia, such as the reasons behind the presence/absence of some species in some Roman sites. Is this due to social, economical or environmental conditions or is it an archaeological bias? We hope that this paper will help to answer some of these complicated questions in the future.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2019.102076.

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CHAPTER 6: ROMANIZATION AND MEAT DIET

6.1. ROMAN TUNISIAN DIETARY PATTERNS AS A FEATURE OF ROMANITAS: AN ARCHAEOZOOLOGICAL APPROACH

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Roman Tunisian dietary patterns as a feature of Romanitas: an archaeozoological approach

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Roman Tunisian dietary patterns as a feature of Romanitas: an archaeozoological approach

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Abstract

It has been said that the Romans were the greatest colonizers of antiquity. At its height, the Empire spanned the entire Mediterranean basin, from the Iberian Peninsula to the Near East, each territory contributing with its customs and specificities. In this melting pot, dietary preferences were modified, diversified and, sometimes, replaced. With this paper, we aim to study Roman dietary patterns in Tunisia, an area that has been the object of little academic scrutiny and for which only a few studies are available. We investigate this topic with an archaeozoological approach. The the relative frequency of taxa, body part representation and kill-off-patterns of faunal remains from 16 pre-Roman and Roman Tunisian sites shows that, in Tunisia, dietary patterns were modified as a result of the Roman conquest.

Keywords: *meat diet, faunal remains, Iron Age, Roman period, Tunisia*

1. Introduction

The current concept of 'Mediterranean diet' has can be traced back to the food and dietary patterns of the numerous populations that surroundeded the Mediterranean Sea in antiquity (Radd-Vagenas, et al., 2017). The region was a melting pot of influences from such civilizations as the Minoan (7000 BC-2000 BC), Phoenician (1200 BC- 332 BC), Greek (479 BC-323 BC), and Roman (31 BC- 476 AD) (Bispham, and Harrison, 2006; Mellersh, and Williams, 1999), each of which made a contribution with their customs and specificities.

This topic is commonly studied by using the information provided by written and iconographic sources, which provide evidence on the products in the diet, and butchery and cooking methods. However, most of these sources reflect an elite diet or an archetype diet, which sheds no light on the every-day diet and every-day food preferences. Therefore, a different approach is required if we are to gain greater insight into the dietary patterns in antiquity.

The study of faunal and seed remains from archaeological contexts can be a chance.

Archaeozoological studies can reveal what species were raised for meat consumption, how old the animals were when slaughtered, how carcasses were processed, and which body parts were most consumed. Archaeozoology can find all this information for different civilizations (Ashby, 2002; Woolgar, 2010), for different settlements of the same civilization (Closes et al., 2019; Grau-Sologestoa et al., 2016) and even for different occupants of a single settlement (Ervynck et al., 2003; Mackinnon, 2010; Mc Cornick, 2002; Van der Veen, 2003). It therefore reveals more than simply which animals were consumed, as studying human meat dietary variations through meat processing, preparation and consumption can shed light on social identities and cultural choices. Variety in food choice can reveal differences in social position, economic class, and even political status (Curet and Pestle, 2010; Crabtree, 1990; Holmes, 2014; Thomas, 2007).

These studies, however, have mainly focused on the dietary habits of the populations located at the north of the Mediterranean basin, showing how they took part in creating what is now known as the 'Mediterranean diet'. Few studies are available from North Africa.

Taking all the above into account, this paper aims to fill this research gap and study the meat consumption of inhabitants from the present-day territory of Tunisia during the transition from the Iron Age to the Roman period. In the 1st century BC, North Africa was occupied by the Romans and far-reaching socio-political transformations took place (Graham, 1902; Picard, 1959). Therefore, this study will allow us to determine if the Roman conquest affected North African dietary preferences for meat, or if the existing culinary traditions continued mostly unchanged despite the changing colonial powers.

To achieve these objectives, we adopt an archaeozoological approach. We analyzed relative frequency of taxa, body part representation and kill-off-patterns of faunal remains from pre-Roman and Roman Tunisian sites.

2. Materials and Methods

Our study focuses on a chronological period that stretches from the Iron Age to the Roman period. The study of faunal remains from the Iron Age sites will give us an idea about the diet and meat consumption preferences before the Roman conquest, and this data will then be compared with the information obtained from the Roman period.

Data were gathered from all available published studies and here we present the results from Zama for the first time. The Iron Age studied here are Utica, Carthage city, Althiburos, Zita, and

Ghizen, (Fig. 1, Table 1). The Roman archaeozoological information comes from nine sites: Bir Ennahal, Carthage city, Thuburbo Maius, Althiburos, Zita, Meninx, Ghizen, and Zama (Fig. 1, Table 1). We include all these studies, in an attempt to be as exhaustive as possible and, to present the most reliable portrayal of the meat diet in Tunisia during this time period.

The sites studied are from several areas of Tunisia. They are located on the north coast (Utica, Carthage, Bir Ennahal), on the south- east coast (Zita, Ghizen, Meninx), and inland (Thuburbo Maius, Althiburos, Zama), (Fig. 1), so the study covers the whole of the region. In this regard, and for purposes of comparison, all the sites from pre-Roman Carthage (Bir Messaouda, Ilôt de l'Amirauté, Magon Quarter, and Byrsa), and Roman period Carthage (Bir Messaouda, Ilôt de l'Amirauté, Magon Quarter, Circular harbour [harbourside], and the House of the Greek charioteers) will be presented together as the Carthage city site, and compared with the other sites in the region.

The investigation analyzed both the taxonomic representation of the species documented (NISP frequency) and body part representation and kill-off-patterns, when this information was available. This revealed the species used for their meat, what parts were processed and what kind of meat was eaten in each period.

It was not easy to compare the kill-off patterns of the main domesticates in the various faunal assemblages from Tunisia, partly because different archaeozoologists use different ageing methods, and partly because some of the assemblages were small. Moreover, raw ageing data are rarely published,so our analysis was based on a comparison of the published data. Ageing observations made by different authors were re-ordered into several age categories (infant, juvenile, subadult, adult).

The same difficulties were found for body-part representation. The observations made by different authors were re-ordered into five distinct body-part categories (head, forelimb, hind limb, feet, and trunk).

3. Results

3.1. Taxonomic frequencies

The following figures, present the results of the analysis of the taxonomic frequencies. Figure 2 shows the proportion of the main taxa by combining NISP from all pre-Roman and Roman

sites. Figures 3 (and Table 2) and 4 (and Table 3) present the relative taxonomic frequencies for the individual sites from the pre-Roman and Roman periods, respectively.

Figure 2 shows that the faunal remains recovered at all the sites were mainly mammalian species, of which the majority were domestic animals. The most common faunal remains found as food waste were sheep/goat, cattle, and pig, as food waste. It can also be seen that the proportion of cattle decreaseds drastically during the Roman period. In contrast, the proportion of sheep/goat and especially pig increaseds. There was also an increase in bird remains. Nevertheless, sheep and goat were the predominant taxa during pre-Roman and Roman times, with more than 40% of the specimens attributed to these animals in both periods.

Focusing only on the most common species (caprines, cattle and pigs) by sites, we can see that the general predominance of sheep and goat is documented during the pre-Roman period at all sites studied here except at Utica, where there is a clear predominance of cattle remains (Fig. 3). Cattle also have a considerable presence in Carthage city (42.51% of NISP). It should also be pointed out that pig remains are absent or nearly absent from Zita and Ghizen. Some patterns seem to be exclusive to particular areas. In the two northern sites, cattle were important. On the other hand, in the two south-eastern sites, sheep, and goats were predominant. Therefore, a more detailed analysis shows some differences between areas , despite the general predominance of caprine remains.

As far as caprines are concerned, at Althiburos there are more sheep (6,26% NISP) than goats (0.91% NISP). Results are similar for Carthage (MacKinnon, 2010) and Ghizen, where 10,52% of the remains are identified as sheep and 8,54% as goats (Azaza and Colominas, 2019). In contrast, at Zita, the authors documented a predominance of goat remains (0.85 % NISP are sheep and 1.7% NISP are goat). We do not have this information for Utica.

During the Roman period, cattle were clearly less important at all sites (Fig. 4) and sheep and goat were still the most represented taxa. The proportion of pigs increased, principally at Carthage city, Tuburbo Maius and Althiburos, where they were 30% of the sample. And at Bir Ennahal pig was the most represented species. This increase in pig remains is mainly documented at northern and inland sites, whereas at south-eastern coastal sites, there was a clear predominance of caprine remains, following the pattern documented in the previous period.

Information is also available on the proportion of sheep and goat during the Roman period. At Althiburos, sheep were still more predominant than goats, although the proportion of sheep

decreased to 3.21%, and goat to 0.35%. Similar proportions have been documented at Zama, where we registered 14.46% of remains as sheep, and 6% as goats. At Zita, the proportion of sheep remains increaseds to 1,44% NISP, and the frequency of goat decreased to 1,.44%, so these two species were equally represented. At Ghizen, the proportion of sheep remains increased to 27.39% NISP, and of goat decreased to 5.37% NISP, so the proportion of sheep to goats increased. At Meninx site, the authors also documented a predominance of sheep remains (11.2% sheep and 0.98% goats) during the Roman period. Sheep largely predominate over goats in the Roman levels at Carthage (MacKinnon, 2010).

3.2. Kill-off patterns

Table 4 shows the presence and predominance of sacrificed age categories of caprines, cattle and pigs documented at each site during the pre-Roman and Roman periods.

During the pre-Roman period, cattle meat was consumed from juvenile and adult individuals at Utica, Althiburos, Carthage and Ghizen, although meat from adult individuals predominated. In contrast, at Zita, only adult individuals were consumed. Sheep and goat meat was consumed from both juvenile and adult individuals at all sites during this period. However, at Althiburos, there was a predominance of caprine killed between 6-12 months (Valenzuela-Lamas, 2016) and most caprine were slaughtered at juvenile and subadult ages at Carthage city (Slopsma et al., 2009; Mackinnon, 2010). Similar was obtained from Zita, where most sheep and goat remains were from young animals, usually less than 1 year and often less than 3 months old (Moses et al., 2019). On the other hand, the meat consumed at Ghizen and Utica was predominantly from adult caprine. The pork consumed was mainly from adult individuals, although tender meat was also consumed at Utica and Althiburos.

During the Roman period cattle meat was consumed from juvenile but also from adult individuals at Carthage city, Zita, Meninx and Zama (Table 4). Data from Zita, Meninx and Ghizen reveals that sheep and goat meat was also consumed from juvenile and adult individuals (Azaza, Colominas, 2019; Burke, 2001; Fabis, King, 2009; Moses et al., 2019). For Carthage, Zama, Ghizen and Althiburos, the data show that sheep and goat meat was predominantly consumed from adult individuals, suggesting that these animals may have been kept mainly for secondary products such as milk and wool (Mackinnon, 2010; Slopsma et al., 2009; Valenzuela-Lamas, 2016; Azaza, Colominas, 2019). Meninx (and probably Zita) is the only site in which caprine exploitation is more oriented towards meat production. As far as pork is concerned, data from Carthage reveals that most pigs were killed around 2-3 years of age,

presumably when they had attained maximum weights (Mackinnon, 2010). On the other hand, data from Althiburos, Zita, Meninx, Ghizen, and Zama show that pork was mainly consumed from juvenile individuals (Azaza, Colominas, 2019; Burke, 2001; Fabis, King, 2009; Moses et al., 2019; Valenzuela-Lamas, 2016).

3.3. Body part frequencies

Information about body part frequencies in the Iron Age from Althiburos and Ghizen (Figure 5). Most body parts appear to be present at both sites, although the frequencies of representation are very different. At Althiburos, the predominant cattle parts are from the head, forelimb, and feet. At Ghizen, trunk elements are well represented. For sheep and goat, the most represented body parts are head, forelimb, hind limb, and feet at Althiburos. In contrast, there is a predominance of parts from the trunk, forelimb and feet at Ghizen (Figure 5). At Althiburos most body parts of the pig are present but at low frequencies (<30%). At Ghizen site, the only three pig bones documented are phalanges.

Slightly more data is available for the Roman period from Bir Messaouda, Althiburos, Ghizen and Zama (Figure 6). Most cattle body parts are present at Bir Messaouda, Althiburos, and Zama. At Ghizen, there are no cattle remains. At Bir Messaouda, forelimb parts are the most represented (40%). In contrast at Althiburos, more than 50% of the elements are from the feet. At Zama, the most represented elements are from the trunk and forelimb. As far as sheep and goats are concerned, most body parts are present at Bir Messaouda, Althiburos, Ghizen, and Zama, although at each site different body parts predominate. The frequency of head parts is also lower at Ghizen than at other sites. For pigs, most body parts are present at Althiburos and Zama. At Bir Messaouda, the trunk parts is absent. At Ghizen, only mandibles and feet elements are present among the six remains recovered.

4. Discussion

Now that we have presented the data, we can move on to explore different aspects of meat consumption in Tunisia, between the Iron Age and the Roman period. Since the Iron Age, most faunal remains as resulting from food waste can be attributed to four domestic species (cattle, sheep, goat, and pig), which is the diversified model of pastoral production of sedentary or semi-sedentary populations (Halstead 1996). In addition to these preponderant taxa, which make up a large part of the meat diet, we observe the presence of birds, fishes and mollusks in

the faunal spectrum, especially during the Roman period. Therefore, although meat consumption was generally focused on four species, it was also rich and varied. On the other hand, wild mammals are practically absent, which shows that hunting would have had little importance in the supply of meat and meat products.

From a diachronic point of view, we observe significant variations in the frequency of species, the proportion of different body parts and their mortality profiles, which show changes in the meat diet.

During the Iron Age, the most common animals were caprine and cattle. Age at death analyses show that cattle were mainly killed at adult ages at most of the sites and especially where they were the most common animal, showing that they were mainly exploited for traction and/or milk and not for meat producer, although their meat was consumed after sacrifice. This pattern is different if we focus on caprines, which were reared for wool and milk but also for meat. The data on body parts for this period shows that the sites produced and consumed meat products, as all anatomical parts are represented. We have not documented either a predominance of rich meat elements, which would characterize a consumer centre, or a predominance of poor meat elements, which would characterize a producer centre (Hambleton, 1999). Therefore, all these data seem to suggest that during the Iron Age, there was no specialization in terms of meat production and consumption. Some caprines were exploited as meat producers but their meat was consumed only after their capacities for traction, reproduction or wool and milk production started to decline.

After the Roman conquest of the area, the the relative frequency of cattle decreased and the relative frequency of pig increased, while the importance of sheep and goat remained stable over time. The most important changes in the relative frequencies are in the north area, whereas few changes are documented in the south-east. These changes were accompanied by a general shift in kill-off-patterns. Now, pigs were reared as meat producers, caprines were used mainly to produce milk and wool, and cattle were still exploited for their traction. The fact that most of the animals consumed were adults suggests the little importance given to meat in the diet, and that the products which were obtained during the animal's life were of greater value. The only animal reared excusively for its meat was the pig. Body part representation also shows interesting results, especially for caprines. Most of these parts were associated with rich meat elements, such as the trunk, forelimbs and hind limbs, which suggests that for the first time most of the population of these sites were consumers of meat products.

Therefore, a general comparison between the pre-Roman and Roman data shows a consistency in diet over time because caprines are the most commonly consumed domestic animals in terms of NISP in these two periods. However, the changes in kill-off-patterns reveal a more specialised livestock exploitation than in the previous period that must be linked with changes in diet and the pig becoming the primary meat producer.

High levels of pork (especially young pork) in the ancient diet have been considered a characteristic feature of Romanitas (King, 1999; Mackinnon, 2001), and it has been suggested that pork may have been a high status food or associated with the military. Pigs are the most profitable species for meat production since they reproduce quickly, they are omnivores, and they require little maintenance (Thurmond, 2006), so they are ideal for supplying urban agglomerations. So, for either cultural (adoption of new consumption habits) or practical reasons (an increase in the consumer population), Rome influenced the Iron Age Tunisian diet. This influence was more pronounced in these sites located on the northern coast and inland, whereas on the south-eastern coast the preferences continued to be for sheep and goat meat.

We believe that the continuity of pre-Roman dietary patterns in some settlements and not in others is related to a variety of factors and not only to the extent of the Roman influence in the territory. Taking into account that meat was fundamentally consumed from adult individuals (with the exception of pigs), we believe that the animal husbandry practised in each settlement (or territory) was key to the meat diet. So, we propose that the meat dietary pattern documented in Tunisia during the Roman period was influenced not only by cultural factors, but also by economic and maybe environmental constraints, all of which were interconnected.

5. Conclusions

This study sheds light on Roman Tunisian meat dietary patterns, a topic that has been subject to little investigation to date due to the lack of archaeozoological studies.

The study of the frequency of species, body-part representation and mortality profiles of 16 faunal assemblages from the Iron Age and Roman period shows that some changes in dietary habits came about as a consequence of the Roman conquest of Tunisia. These changes were a specialization in meat production and an increase in pork consumption, in particular in northern and inland Tunisia.

We suggest that the changes that this pre-Roman dietary pattern underwent are due to several inter-connected factors (such as environment and livestock practices) and not just the influence of Rome in the territory. We must bear in mind that most of the meat consumed during the Iron Age and the Roman period (with the exception of pork), was from adult individuals, and that meat consumption would have been unusual in the schemes of the 'Mediterranean diet'.

To gain greater insight into the dietary habits of ancient Tunisia and find answers to questions of social identities and cultural choices, further research is needed. Firstly, it would be of prime interest to make more archaeozoological studies so that the data and hypotheses presented here can be confirmed. Secondly, an integrated study of faunal remains and vessels, focusing on aspects that have not been discussed here, such as butchery practices and cooking techniques, would be an attractive prospect.

Figure captions:

Fig. 1- Location of the sites mentioned in the text. Additional information on each site in table 1.

Fig. 2- Relative frequencies of faunal remains recovered in pre-Roman and Roman Tunisian sites.

Fig. 3- Relative frequencies of main species (cattle=Bos taurus, caprines=Ovis/Capra and pigs=Sus sp.) by sites during the pre-Roman period. Additional information on each site in table 2.

Fig. 4- Relative frequencies (cattle=Bos taurus, caprines=Ovis/Capra and pigs=Sus sp.) by sites during the Roman period. Additional information on each site in table 3.

Fig. 5.- Body part representation of cattle, sheep/goat and pig documented in pre-Roman Tunisian sites.

Fig. 6- Body part representation of cattle, sheep/goat and pig documented in Roman Tunisian sites.

Table captions:

Table 1. Archaeological information on the sites mentioned in the text.

Table 2. Archaeozoological information on the pre-Roman sites mentioned in the text (Bos taurus=cattle; Ovis/Capra=caprine; Sus sp.=pig; Equus sp.=equid).

Table 3. Archaeozoological information onf the Roman sites mentioned in the text (Bos taurus=cattle; Ovis/Capra=caprine; Sus sp.=pig; Equus sp.=equid).

Table 4. Presence (*) and predominance (**) of sacrificed age categories of cattle (Bota), caprine (O/C) and pig (Sus) documented at each site during the pre-Roman and Roman periods. Juv=juvenile; ad. =adult.

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Site	Location	Chronology of the sample	Context of the sample	Type of the site	NR	Reference
Utica	Bizerte	10th-9th c. BC	A water pit	Tyrian settlement	536	Cardoso et al., 2016
Bir Messaouda	Carthage	Archaïc and Punic Period	Buildings	City	911	Slopsma et al., 2009
Ilot de l'Amirauté		4th.2th c. BC	Circular Harbour	Military site	131	Mackinnon, 2010
Magon Quarter		Second half of the 7th c. BC	Urban structure	City	1159	Nobis, 2000
Byrsa		Punic period	Urban structure		156	Poulain, 1982
Magon		Punic period	Urban structure		1504	Weinstock, 1996
Althiburos	El Kef	6th-2th c. BC	Urban structure	Numidian City	5798	Valenzuela-Lamas, 2016
Zita	Zarzis	2nd c. BC-1st c. AD	Urban structure	Carthaginian colony	1198	Moses et al., 2019
Ghizen	Djerba Island	Punic period	Fishermen's houses	Fishermen's Village	457	Azaza and Colominas, 2019
Bir Ennahal	Kélibia	5th c. AD	House	City of ancient *Clipea*	766	Oueslati and Ennaïfer, in press
Bir Messadouda	Carthage	Roman period	Buildings	City	479	Slopsma et al., 2009
Kobbat Bent El rey		3rd–5th c. AD	Underground building		664	Baumgartner, 1996
Ilot de L'Amirauté		Roman period	Circular harbour	Military site	167	Mackinnon, 2010
Magon Quarter		1st-4th c. AD	Urban structure	City	3727	Nobis, 2000
Magon		Roman period	Urban strcuture		96	Weinstock, 1996
Circular Harbour-harbourside		Roman period	Circular harbour	Military site	155	Levine and Wheeler 1994
House of the Greek Charioteers		Roman period	House	City	294	Reese, 1977
Thuburbo Mauis	Tunis	Roman period	Courtyard	Roman colony	34	Jashemski et al., 1995
Althiburos	El kef	Early Roman	Capitolum	Roman City	1568	Valenzuela-Lamas, 2016
Zita	Zarzis	Roman period	Urban structure	Indistrual Roman colony	4648	Moses et al., 2019
Meninx	Djerba Island	Roman period	Garbage pit	Roman city	983	Fabis and King, 2009
Ghizen		Roman period	Fishermen's houses	Fishermen's Village	472	Azaza and Colominas, 2019
Zama	Siliana	2nd-3rd c. AD	Thermal structures	City	2272	Present paper

Pre-Roman sites	Utica	Carthage City	Althiburos	Zita	Ghizen
Bos taurus	265	1364	523	2	43
Ovis/Capra	142	1453	1007	39	70
Sus sp.	88	382	352	0	3
Equus sp.	24	1	60	0	1
Canis familiaris	12	7	53	0	1
Wild mammals	3	2	4	4	0
Birds	0	0	23	8	1
Fishes	0	0	0	42	13
Mollusk	0	0	7	21	1
Herpetiles	2	0	44	1	0
NISP	536	3208	2076	117	133

Roman sites	Bir Ennahal	Carthage City	Thuburbo Maius	Althiburos	Zita	Meninx	Ghizen	Zama
Bos taurus	67	716	0	41	3	8	0	486
Ovis/Capra	62	2124	8	272	235	304	57	851
Sus sp.	104	1895	5	196	17	50	6	105
Equus sp.	11	6	0	6	0	1	1	6
Canis familiaris	3	1	0	1	0	107	0	14
Wild mammals	12	0	0	3	4	6	0	0
Birds	143	0	0	28	77	88	2	25
Fishes	67	0	0	0	313	239	5	0
Mollusks	26	0	0	9	174	0	0	6
Herpetiles	0	0	0	0	8	0	1	3
NISP	498	4742	15	560	831	910	73	1500

Period	Sites	*Bota* juv.	*Bota* ad.	*O/C* juv.	*O/C* ad.	*Sus* juv.	*Sus* ad.
Pre-roman	Utica	*	**	*	**	*	**
	Carthage City	*	**	*	*	-	*
	Althiburos	*	*	**	*	*	*
	Zita	-	*	**	*	-	-
	Ghizen	*	**	*	**	-	*
Roman	Carthage City	*	**	*	**	-	*
	Althiburos	-	-	*	**	**	*
	Zita	*	*	?	?	**	*
	Meninx	*	*	*	*	*	*
	Ghizen	-	-	*	**	**	*
	Zama	*	**	*	**	**	*

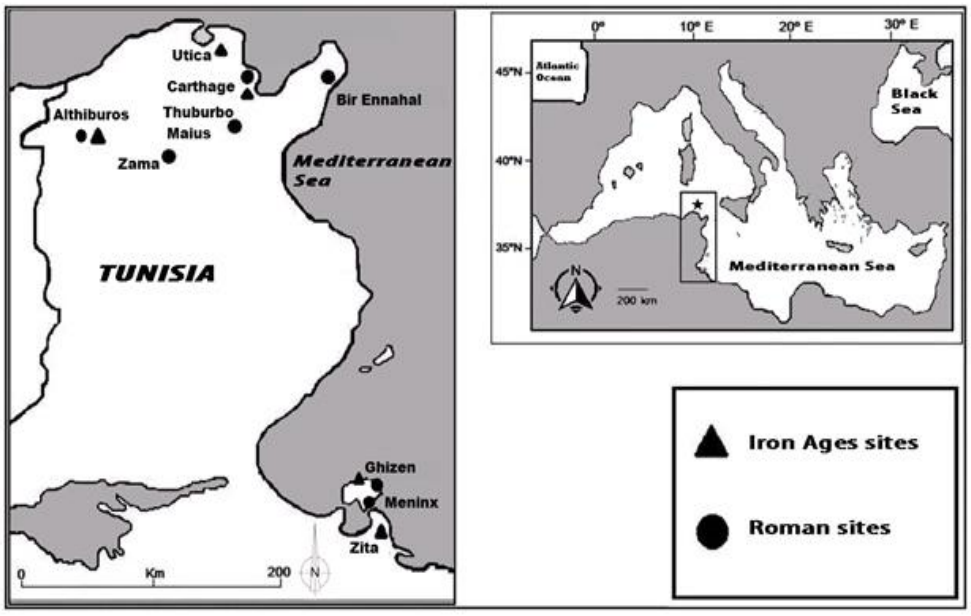

Fig. 1- Location of the sites mentioned in the text. Additional information on each site in table 1.

230x132mm (150 x 150 DPI)

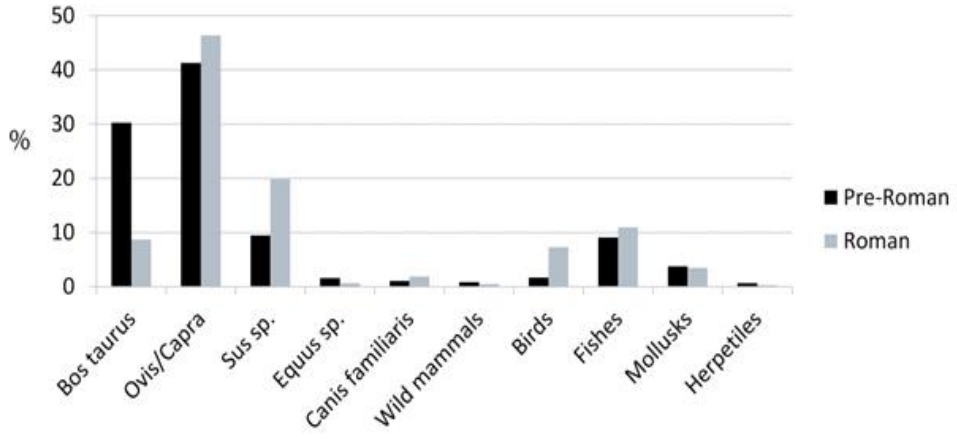

Fig. 2- Relative frequencies of faunal remains recovered in pre-Roman and Roman Tunisian sites.

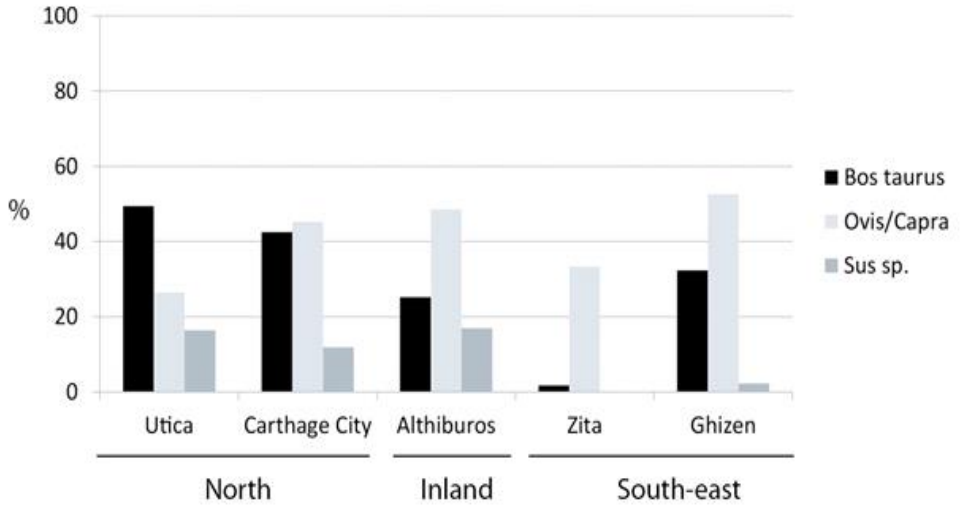

Fig. 3- Relative frequencies of main species (cattle=Bos taurus, caprines=Ovis/Capra and pigs=Sus sp.) by sites during the pre-Roman period. Additional information on each site in table 2.

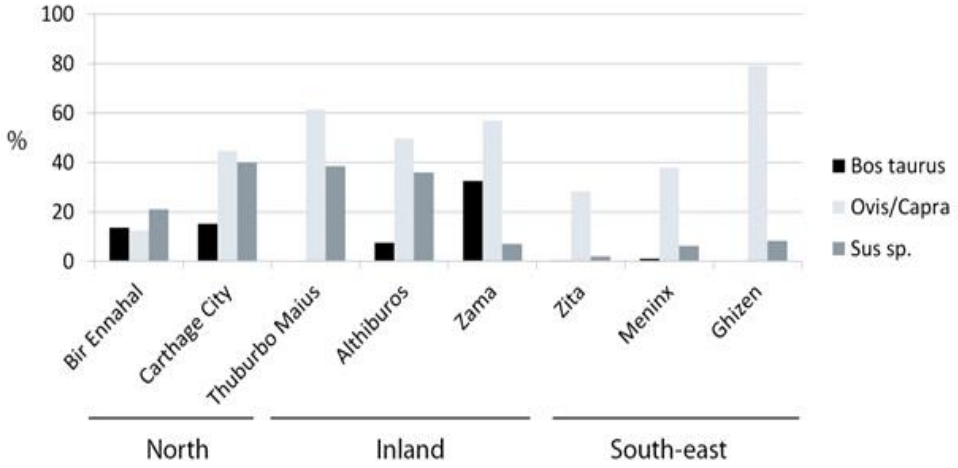

Fig. 4- Relative frequencies (cattle=Bos taurus, caprines=Ovis/Capra and pigs=Sus sp.) by sites during the Roman period. Additional information on each site in table 3.

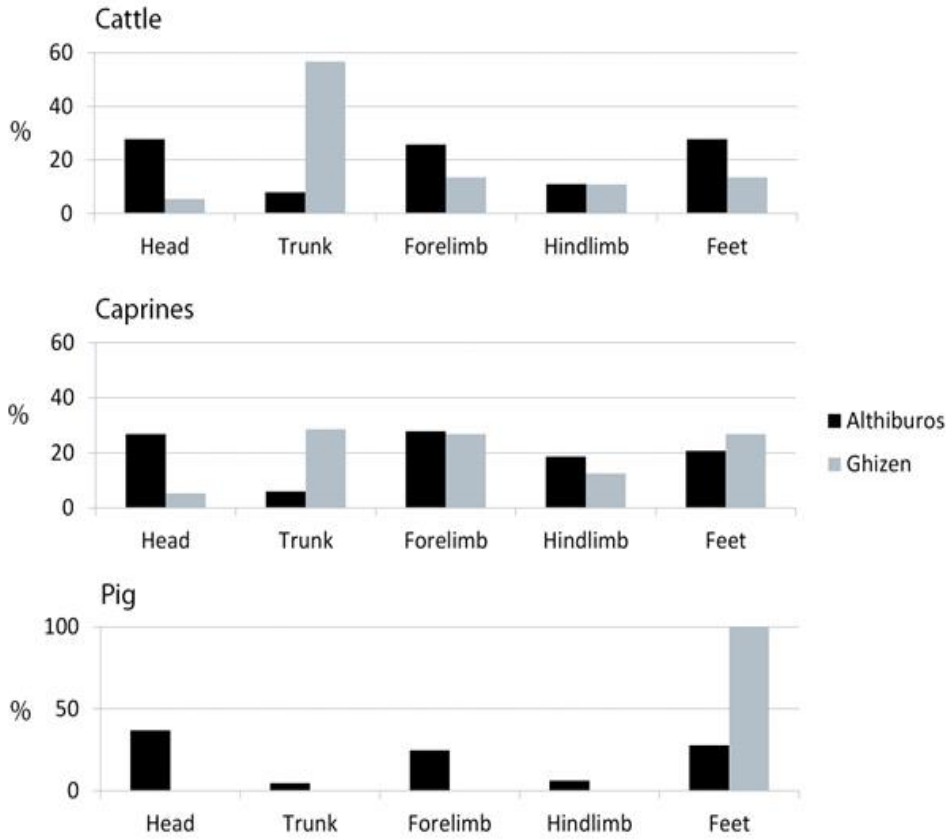

Fig. 5.- Body part representation of cattle, sheep/goat and pig documented in pre-Roman Tunisian sites.

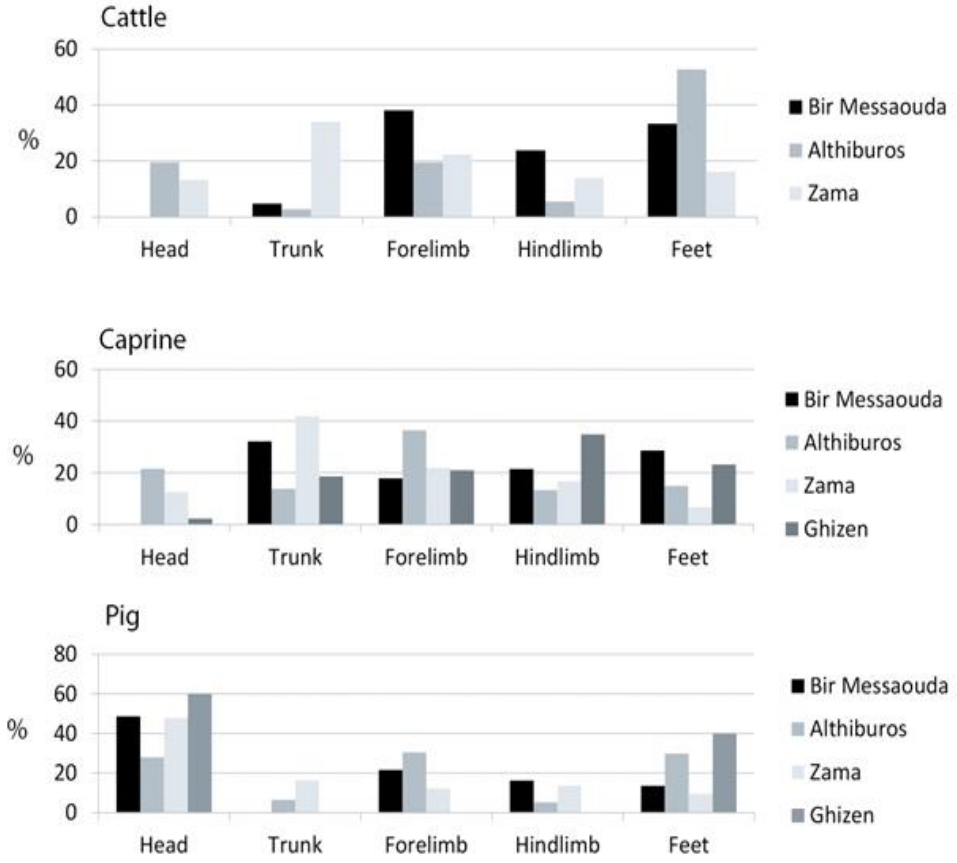

Fig. 6- Body part representation of cattle, sheep/goat and pig documented in Roman Tunisian sites.

CHAPTER 7: CONCLUSIONS

7. CONCLUSIONS

The present study has documented the changes (and the reasons for these changes) that were produced in animal husbandry, diet and the animal trade in Tunisia before and after the Roman conquest. The sites of Ghizen and Zama, and their comparison with other available data, had allowed to study this area of the Western Mediterranean and to locate Tunisia on the map of the Roman Empire in terms of animal exploitation.

7.1. Animal husbandry

Wool was in high demand in Roman times. In fact, wool dominated the textile market during the Republican and Early Imperial times and was the major textile fiber of the Roman Empire. Therefore, we propose that this demand is one of the reasons for the increase in sheep pastoralism in Tunisia at this time. We have demonstrated that caprine increase should be related with economic factors and not only with changes in the environmental conditions of the area, as previously suggested.

Another change was in pig production. Pigs were not central to husbandry practices during the Punic period, probably because of the dietary cultural tradition of the Phoenician-Punic community of Semitic origin, which considered pig impure. However, during the Roman period, the economic importance of the animal increased and became a meat producer. We have proposed that this change must be related not only with dietary habits (adoption of new consumption habits) but also with practical reasons (an increase in the consumer population).

We suggest that these changes are related to the Roman conquest, as the changes documented in animal husbandry in this study are the same changes documented in other areas of the Mediterranean basin under Roman control: animal husbandry became more specialized and there was an increased demand for wool.

7.2. Animal trade

North Africa, and specifically Tunisia, played a major role as a place of trade. We have demonstrated that the Romans were responsible for introducing several animals into Tunisia. We have documented the introduction of commensal animals (black rat, house

mouse) and wild and domestic animals (fallow deer and hare, and rabbit and cat). The introduction of commensal animals such as the black rat and the house mouse must have been accidental, whereas the deliberate introduction of the other animals, which were brought to North Africa for specific purposes, indicates their economic and social importance. In this paper, we have demonstrated that most of the animals introduced deliberately (fallow deer, rabbit and hare) were related to hunting activities. The translocation of these animals therefore shows the importance of this activity as a symbol of social status for the population living in North Africa who acquired a Roman lifestyle. At the same time, it shows another cultural connection between Tunisia and Italy.

The Romans also played a fundamental role in the exportation of wild animals even though they were rarely found in Tunisian archaeological sites. North Africa, and more specifically Tunisia, was a platform for exporting and trading wild beasts to other Roman territories.

Therefore, we have demonstrated that animals were another commodity traded in North African ports. Animal trade was an important economic activity for Tunisia, not only for the exportation of wild beasts but also for the importation of wild and domestic animals.

7.3. Meat diet

The study performed on meat patterns indicates that the Roman occupation of Tunisia led to some changes in the dietary habits of the pre-Roman populations. We have documented that the meat consumed was generally from four species (cattle, sheep, goat and pig). In addition to these preponderant taxa, which make up a large part of the meat diet, we observe the presence of birds, fishes and mollusks, especially during the Roman period. Therefore, the diet was rich and varied, although hunting would have had little importance in the supply of meat and meat products.

A general comparison between the pre-Roman and Roman data shows a consistency in diet over time because caprines are the most commonly consumed domestic animals in terms of NISP in these two periods. However, the changes in kill-off-patterns reveal that livestock exploitation was more specialized than in the previous period and that this

must have been linked to changes in diet and the pig becoming the primary meat producer.

We propose that the continuity of pre-Roman dietary patterns in some settlements and not in others is related to a variety of factors and not only to the extent of the Roman influence in the territory. Taking into account that meat was fundamentally consumed from adult individuals (with the exception of pigs), we propose that the animal husbandry practiced in each settlement (or territory) was key to the meat diet. So, the meat dietary pattern documented in Tunisia during the Roman period was influenced not only by cultural factors, but also by economic and maybe environmental constraints, all of which were interconnected.

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Index of tables and figures

Annex: Index of Biometry (Zama site)

Measurements are in mm. Code belong to Von den Driesch (1976)

In the Tables, Bota= cattle; OC= caprine; Ovis= sheep; Capra= goat; Sus=pig

Iron Age

Scapula

US	Square	Specie	Chrono	GLP	LG	BG	SLC
6106	X2	OVIS	Pre-Rom	30,9	24,6	23,5	22,5
6106	X2	OC	Pre-Rom				18,7
6106	X2	OC	Pre-Rom				12,4
404	X2	OVIS	Pre-Rom				20,6
6139	X2	OVIS	Pre-Rom	31,1	25,7		22,1
6139	X2	OVIS	Pre-Rom	29,8	26,8		
6102	X2	OVIS	Pre-Rom				16,4
6102	X2	OVIS	Pre-Rom	32,4	28,9	21,1	18,8
6102	X2	OVIS	Pre-Rom	26,8	24,3	19,1	16,6

Humerus

US	Square	Specie	Chrono	GL	GLp	Bp	Dp	SD	Bd	Dd	HTC	BT
6106	X2	BOTA	Pre-Rom					37,4				
404	X2	BOTA	Pre-Rom						68,5	35,5		64,9
404	X2	OC	Pre-Rom					17,3		19,1		
404	X2	OC	Pre-Rom							15,8		
6139	X2	OC	Pre-Rom						28,6	25,4		
6107	X2	BOTA	Pre-Rom			73,4	66,8					66,3
5057	X2	OVIS	Pre-Rom						33,9	29		
5057	X2	OVIS	Pre-Rom						34,5	29,8		
6114	X2	OC	Pre-Rom						29,3	23,1		
6114	X2	BOTA	Pre-Rom						76,8	48		
5109	X2	CAPRA	Pre-Rom					17,1	31,8	26,4		30,1
5109	X2	CAPRA	Pre-Rom						28,5	24		27,8
5109	X2	OVIS	Pre-Rom						31,2	24		29,5

Radius

US	Square	Specie	Chrono	GL	Bp	Dp	SD	DD	Bd	Dd
404	X2	BOTA	Pre-Rom					41,1	76,7	44,3
404	X2	OC	Pre-Rom				18,5			
404	X2	OC	Pre-Rom				15,1			
6139	X2	OC	Pre-Rom				17			
6139	X2	CAPRA	Pre-Rom		32,2	16,5				
6139	X2	CAFA	Pre-Rom	83,1	6,1	5,2	5	2,5	11,1	5,5
5057	X2	BOTA	Pre-Rom		61	36,3		28,1		
5057	X2	OVIS	Pre-Rom		34,7	19		12,9		
6114	X2	EQUUS	Pre-Rom						73,9	45,1
6102	X2	BOTA	Pre-Rom					29	62,6	36,6
5109	X2	OC	Pre-Rom				19,7			

Tibia

US	Square	Specie	Chrono	GL	Bp	Dp	SD	Bd	Dd
6106	X2	OC	Pre-Rom		33,1	33,7	14,8		
6106	X2	OC	Pre-Rom				12,3		
6106	X2	OC	Pre-Rom				12,7		
6106	X2	OC	Pre-Rom				12,4		
404	X2	BOTA	Pre-Rom				32,9		
404	X2	OC	Pre-Rom				17,5		
6105	X2	OVIS	Pre-Rom					24,7	19,8
6105	X2	OC	Pre-Rom		23,2	19,5	9,8		
5057	X2	BOTA	Pre-Rom					62,7	48
5057	X2	BOTA	Pre-Rom					59,7	42,2
6114	X2	OC	Pre-Rom				15,4	25,5	17,8
6114	X2	OC	Pre-Rom				13	22,4	17,6
6114	X2	OC	Pre-Rom		30,6	22,7	10,4	21,2	15,9
6114	X2	OC	Pre-Rom				15		
6114	X2	OC	Pre-Rom				12,7		
6114	X2	OC	Pre-Rom				12,1		

Calcaneum

US	Square	Specie	Chrono	GL	GB
7116	17	BOTA	Pre-Rom		41,7
6114	X2	BOTA	Pre-Rom		35,7
6114	X2	BOTA	Pre-Rom	109,8	30,3
6139	X2	BOTA	Pre-Rom	119,1	35,5

Metacarpal

US	Square	Specie	Chrono	GL	Bp	Dp	SD	DD	Bd	Dd
6106	X2	OVIS	Pre-Rom	120,2	24,6	16,4	12,6	8,7	25,9	16,3
6106	X2	OC	Pre-Rom				13,9			
6106	X2	BOTA	Pre-Rom					21,1	61,1	28,1
404	X2	BOTA	Pre-Rom				32	23,2		
6105	X2	OC	Pre-Rom		24,2	17,9				
6139	X2	BOTA	Pre-Rom				28	23,8	55,8	34
6107	X2	BOTA	Pre-Rom		60,3	37,3				
6107	X2	BOTA	Pre-Rom				24,6	22	49,6	26,6
5204	X2	BOTA	Pre-Rom					20,1	63,1	31
7108	17	OVIS	Pre-Rom	121,9	22,5	16	15,8	10,7	28,2	15,3
7116	17	OVIS	Pre-Rom	113	21,9	16,1	13,8	9		14
7116	17	OC	Pre-Rom		21,4	15,8	10,8			
6114	X2	BOTA	Pre-Rom	177,8	56,5	35,1	31	21	58,7	29,3
6114	X2	BOTA	Pre-Rom		50,7	32				
6114	X2	BOTA	Pre-Rom					26,2	56,2	31,4
6114	X2	BOTA	Pre-Rom						63,2	28,5
6102	X2	BOTA	Pre-Rom		49,5	30,8	34,6	21,8	53,9	28
5019	X2	BOTA	Pre-Rom		52,9	31,9	27,5			
5019	X2	BOTA	Pre-Rom					28,6	59,6	30,3

Metatarsal

US	Square	Specie	Chrono	GL	Bp	Dp	SD	DD
6106	X2	BOTA	Pre-Rom		49,3		26,6	
404	X2	BOTA	Pre-Rom		42,3	41,1		24
404	X2	BOTA	Pre-Rom		51,9	42,6	30,4	
5057	X2	BOTA	Pre-Rom		53,3	52,9		
6139	X2	BOTA	Pre-Rom		49,8	29,3		20,8

Roman period

Scapula

US	Specie	Chrono	GLP	LG	BG	SLC
5018	CAPRA	2-3 AD	35,2	24		
5010	OVIS	2-3 AD	34,3	31		
5004	BOTA	2-3 AD	58,2		47,8	
5083	OVIS	2-3 AD	34,9	25,6	23,7	
5083	OVIS	2-3 AD	31,5	26	21	17,5
5083	OVIS	2-3 AD	32,1	22,7	21,5	17,7
5083	OC	2-3 AD				17,7
5062	OC	2-3 AD				15,7
5062	OVIS	2-3 AD	31,6	26,8	22,3	21,8
5062	SUS	2-3 AD		13,6	9,5	10
5043	BOTA	2-3 AD		72,7	62,4	56,7
5043	OVIS	2-3 AD		27,1	23,4	19,2
5024	OVIS	2-3 AD	35,9	26,2		21,6
5019	OVIS	2-3 AD	26,3	23		18
5032	OVIS	2-3 AD	28,2	23,6		19,9
5054	BOTA	2-3 AD		76,5	51	55,7

Humerus

US	Specie	Chrono	GL	GLp	Bp	Dp	SD	Bd	Dd	HTC	BT
5018	CAPRA	2-3 AD									30
5018	OVIS	2-3 AD						34			
5018	BOTA	2-3 AD									61,4
5083	OVIS	2-3 AD						32,4			29,1
5083	OVIS	2-3 AD						33,5			31,3
5083	OC	2-3 AD						29,6			
5083	OVIS	2-3 AD						31,2	27,2		30,6
5083	OC	2-3 AD					13,7				
5083	BOTA	2-3 AD						66,1			
5067	BOTA	2-3 AD						78,7	54,2		72,1
5067	BOTA	2-3 AD					42,9				
5067	OVIS	2-3 AD					14,8	30,8	26,9		29,2
5067	CAPRA	2-3 AD						29,8	21,1		28,7
5067	OC	2-3 AD					12,2				
5067	BOTA	2-3 AD						64,2	63,5		
5067	OVIS	2-3 AD						26,5	25		26,3
5067	OVIS	2-3 AD						28	23,7		27,3
5067	OVIS	2-3 AD						31,9	21,7		30,4
5062	OC	2-3 AD					16				
5062	OC	2-3 AD			26,1	47,9	14,8				
5062	OC	2-3 AD			29,3	40,7					
5062	AVIS	2-3 AD	78,8		23,1			16			
5062	AVIS	2-3 AD	79		23,2			15,6			
5043	OVIS	2-3 AD						29,4	25,1		
5043	SUS	2-3 AD						37,5	29,8		
5084	BOTA	2-3 AD	198,6		50,8	79,3	33,1	78	71,1		
5080	OVIS	2-3 AD						34	30,5		33,2
5080	OC	2-3 AD						28,6	22,6		27,6
5080	OC	2-3 AD					13,6				
5080	OC	2-3 AD					13				
5089	BOTA	2-3 AD			63	81,1					

5089	OC	2-3 AD					12				
5092	OC	2-3 AD			30,5	20					
5057	CAPRA	2-3 AD			32	28,7					
5024	CANIS	2-3 AD					13,4	36,2	25,8		
5032	CAPRA	2-3 AD					20,2	34	27,8		
5018	SUS	2-3 AD						32,6	33,7		
5037	BOTA	2-3 AD						79,6	51,6		77
5016	BOTA	2-3 AD						82,6	52,6		74,9
5016	OC	2-3 AD						29,3	19,5		26,8
5036	OVIS	2-3 AD						27,6	25,4		27,1

Radius

US	Specie	Chrono	GL	Bp	Dp	SD	DD	Bd	Dd
5018	OVIS	2-3 AD	189,8						
5018	O/C	2-3 AD		36,1					
5083	OC	2-3 AD				13,6			
5083	OVIS	2-3 AD		31,5	15,4				
5083	BOTA	2-3 AD						74,9	38,5
5067	BOTA	2-3 AD						64,9	40,5
5067	BOTA	2-3 AD					26,9	52,1	42,7
5067	OC	2-3 AD				15,5			
5067	OC	2-3 AD				17,2		26,8	19,3
5067	OC	2-3 AD					11,7	28,3	19,6
5062	OC	2-3 AD					12,4	24,1	18,3
5062	OC	2-3 AD					13,9	26,4	19,8
5043	OVIS	2-3 AD		34,2	17,4	20,6	16		
5043	OC	2-3 AD					12,9	28,1	19,3
5043	OC	2-3 AD				20			
5084	BOTA	2-3 AD		79,2	36,7	42,5	26,7	66	39,5
5084	OVIS	2-3 AD		32	15,9	16,6			
5084	OC	2-3 AD				15,7			
5089	OVIS	2-3 AD		31	16	16,3			
5089	OC	2-3 AD		25,9	15,3	14,2			
5089	BOTA	2-3 AD		86,2	45,9				
5089	BOTA	2-3 AD						76,6	43
5085	OVIS	2-3 AD				15,1	12,3	30,4	22
5024	OVIS	2-3 AD	155	30,7	16,5	16,5	12,6	29,5	19
68	BOTA	2-3 AD					28,4	59	39,1

Femur

US	Specie	Chrono	GL	GLp	Bp	DC	SD	Bd	Dd
5083	OVIS	2-3 AD					15	35,5	27,6
5083	OC	2-3 AD					15,4		
5083	BOTA	2-3 AD			88,7		37,9		
5067	BOTA	2-3 AD	279,6		92,7		32,4	76,4	
5067	BOTA	2-3 AD					29		
5062	OC	2-3 AD	124,3		23,7		12	22	21,8
5062	OC	2-3 AD						31,8	39
5062	OC	2-3 AD	110		24,8			21,8	24,8
5062	OC	2-3 AD	96,9		26,2		9,1	19,6	20,5
5062	AVIS	2-3 AD	90		16,8			15,2	
5080	CANIS	2-3 AD			30,8		10		
5089	OC	2-3 AD	104,3		25,7			17,3	23,4
5085	CANIS	2-3 AD			31,1		11,3		
5032	CANIS	2-3 AD			43	22,2			

Tibia

US	Specie	Chrono	GL	Bp	Dp	SD	Bd	Dd
5083	OC	2-3 AD		34,9	26,5	12,1		
5083	OC	2-3 AD				11,8		
5083	OVIS	2-3 AD				13,7	25,6	17,5
5083	OVIS	2-3 AD					30,4	23,5
5067	OC	2-3 AD				13,2		
5067	OC	2-3 AD				9,9		
5067	OC	2-3 AD				13,7	25,9	18,7
5067	BOTA	2-3 AD					56,9	40,8
5067	BOTA	2-3 AD					56,6	38,6
5062	OVIS	2-3 AD					29	20,6
5062	OC	2-3 AD				14,1		
5062	OVIS	2-3 AD	185,6	32,5	26,7	13,7	23,4	17,4
5062	SUS	2-3 AD	138,2	33,1	28,2	16,3	22	20,5
5084	BOTA	2-3 AD					90,5	48,1
5084	BOTA	2-3 AD					50,3	33,5
5084	BOTA	2-3 AD					52,3	36,5
5089	BOTA	2-3 AD				30,1	53,6	41,8
5089	OC	2-3 AD		37,1	34,9	16,9		
5089	OC	2-3 AD				12,6		
5019	CANIS	2-3 AD				14,3		
5019	OC	2-3 AD		34,4	31,6			
5018	OC	2-3 AD				14,5	26,5	20
5016	OC	2-3 AD		51,9	36,8	18,9	35,7	23

Calcaneum

US	Specie	Chrono	GL	GB
5083	OVIS	2-3 AD	57,8	18,5
5067	OVIS	2-3 AD	43,6	15
5067	OVIS	2-3 AD	43,5	15,8
5067	BOTA	2-3 AD	111,5	36,1
5062	OVIS	2-3 AD	52,4	18,8
5062	OVIS	2-3 AD	46,2	17,7
5062	OVIS	2-3 AD	51,3	18,7
5062	BOTA	2-3 AD	106,4	36,4
5043	OVIS	2-3 AD	54,2	18,6
5080	BOTA	2-3 AD		35,4
5089	BOTA	2-3 AD		38
5019	SUS	2-3 AD	67,1	19,1
5054	BOTA	2-3 AD	133,5	39,6

Metacarpal

US	Specie	Chrono	GL	Bp	Dp	SD	DD	Bd	Dd
5004	BOTA	2-3 AD	154,4	55,9					
5067	BOTA	2-3 AD		59,9				61,9	
5083	OVIS	2-3 AD		23,5	16,3	14,1	10,1	29,6	
5083	OVIS	2-3 AD		23,2	16,2	13,7			
5083	OVIS	2-3 AD					10,6	26,9	15,4
5083	BOTA	2-3 AD	191,7	62,3	38,5	33,2	22,4	68,2	30,5
5067	BOTA	2-3 AD					18,5	49,1	26,4
5067	EQUUS	2-3 AD	242,4	50,7	36,2	34,1	25	48,1	37,6
5067	AVIS	2-3 AD	82,4	12,3		6,1		13,3	
5062	BOTA	2-3 AD		52,1	32,8	30,8			
5062	OVIS	2-3 AD		24,3	17,5	15	11,3	29,9	17,8
5062	OVIS	2-3 AD		24,1	17,5	11,5	8,9	24,4	14,5
5062	OVIS	2-3 AD		20,3	14,6	12,3	8,8	24,8	13,3
5043	BOTA	2-3 AD					21	62,9	30,4
5084	BOTA	2-3 AD		54,7	32,9				
5084	OVIS	2-3 AD		24,6	18,6	13,2			
5021	BOTA	2-3 AD					23	56,4	28,7
5019	EQUUS	2-3 AD	191,3	38	26,5	25,1	17		25,1
5018	OVIS	2-3 AD		23,8	17	16	12,1	31,2	17
5037	BOTA	2-3 AD						54,5	27
5054	OC	2-3 AD						24,7	18,3

Metatarsal

US	Specie	Chrono	GL	Bp	Dp	SD	DD	Bd	Dd
5083	OVIS	2-3 AD	125,1	21,8	21,3	13,1	10,9	26,2	
5083	OVIS	2-3 AD		22,3	21,8	10,7	9,2	24,6	
5083	OVIS	2-3 AD		21,4	20,9	11,8	11,3	25,7	
5083	OVIS	2-3 AD		22	21,3	11,4	10,9		
5083	OC	2-3 AD				10,9			
5083	BOTA	2-3 AD		41,8	40,7	25,6			
5083	BOTA	2-3 AD					24,5	55	28,8
5083	BOTA	2-3 AD					24,6	49,5	28,4
5083	BOTA	2-3 AD		41	32,1	21,4			
5062	BOTA	2-3 AD				25,3	21,9	55,2	25,2
5062	BOTA	2-3 AD		34,9	32,3	18,8	19,5	42,6	25
5062	BOTA	2-3 AD				24	23,4	48	26,8
5062	AVIS	2-3 AD	89,2	14,4				13,5	
5062	AVIS	2-3 AD	86,4					13,4	
5043	OVIS	2-3 AD	144,7	22	22,8	11,8	11,6	26,4	17
5043	OVIS	2-3 AD		22,2	22	12	10,8		
5084	BOTA	2-3 AD					22,4	46	26
5080	OVIS	2-3 AD		19,8	18,8	11			
5089	BOTA	2-3 AD		43,1	41,6	21,7			
5089	BOTA	2-3 AD					23	46,1	29,2
5089	OVIS	2-3 AD		23,3	24,1	13	10,8	24,6	15,7
5045	BOTA	2-3 AD	188,1	46,7	43	28,6	25,2		28,7
5006	BOTA	2-3 AD		47,7	46,1	30,6			
5054	OVIS	2-3 AD		20,3	20,1	14			
5071	BOTA	2-3 AD		56,5	51,3	35			

Astragalus

US	Specie	Chrono	GLI	GLm	GB	GH
5004	BOTA	2-3 AD	59,2	53,3		
5018	CAPRA	2-3 AD	32,6	30,9		
5018	CAPRA	2-3 AD	30,1	27,7		
5018	CAPRA	2-3 AD	30,7	28,4		
5018	CAPRA	2-3 AD	32,4	29,3		
5018	CAPRA	2-3 AD	30,1	28,2		
5018	CAPRA	2-3 AD	31,3	30,4		
5018	CAPRA	2-3 AD	31,1	30,9		
5083	BOTA	2-3 AD	54,2			
5067	BOTA	2-3 AD	64,3	60,8	35,9	29,3
5067	OVIS	2-3 AD	30,3	27,9	19,7	16,5
5062	SUS	2-3 AD	38,8	35,9	23,4	23,6
5062	OVIS	2-3 AD	29,3	27,7	19,1	21,4
5092	OVIS	2-3 AD	32	29,2		
5024	OVIS	2-3 AD	27,9	26,1		

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