The territory and its resources

STUDIES ON THE RURAL WORLD IN THE ROMAN PERIOD 4

Animal husbandry in the North-East of Catalonia from the 1ST to the 5TH Century AD: improvement and importation

Lídia Colominas, Maria Saña
GRLA (Grup de Recerca del Laboratori d'Arqueozoologia), Archaeozoology Laboratory,
Prehistory Department, Universitat Autònoma de Barcelona (UAB)

ABSTRACT
This paper presents an approach to the study of livestock management developed from the 1st century AD. until the 5th century AD. in the area of actual north-eastern Catalonia. The aim of this paper is determine whether the process of Romanization in this area affected and determined the livestock strategies, and in the case of document changes, characterize them and establish its causes.
The diachronically analysis of mortality profiles and of biometrical analysis to characterize the size and shape of animals, has revealed important changes in the livestock strategies implemented among the 3rt century BC. - 5th century AD. But these changes are not homogeneous nor affect equally to all domestic species involved. It is worth noting in this way, the increased size documented on cattle from the 1st century AD., raising the possibility that this increase was the result of animal's importation from other geographical areas.

KEYWORDS: archaeozoology, biometrical analysis, 1st-5th century AD., animal's improvement, animal's importation, north-eastern of Catalonia.

RESUM
En aquest treball es presenta una primera aproximació a l'estudi de la gestió ramadera desenvolupada a partir del segle I dC. i fins el segle V dC. a l'àrea del nord-est de l'actual Catalunya. Es pretén determinar si realment el procés de romanització en aquesta zona va afectar i condicionar les estratègies ramaderes, i, en el cas de documentar-se canvis, caracteritzar-los i establir-ne les causes.
L'anàlisi diacrònica dels perfils de mortalitat i de la caracterització de la talla i forma dels animals a partir de l'anàlisi biomètrica de les restes, ha permès evidenciar canvis importants en les estratègies ramaderes implementades entre els segles III aC. i V dC. Aquests canvis no són però homogenis ni afecten per igual a totes les espècies domèstiques implicades. S'ha de destacar en aquest sentit, l'augment de talla documentat en els bovins a partir del segle I dC., plantejant-se la possibilitat de que aquest augment fos el resultat d'una importació d'animals provinents d'altres zones geogràfiques.

PARAULES CLAU: arqueozoologia, biometria, segles I-V dC., tècniques ramaderes, importació d'animals, nord-est de Catalunya.

I. INTRODUCTION

Various studies confirm that animal husbandry was already well established in the north-east of the Iberian peninsula during the Iberian period, and that an economic system based on breeding domestic animals for different purposes was in place, with hunting and fishing playing a secondary role in food provision (Franquesa et al. 2000; Andugar/Saña 2004; Colominas 2005). Husbandry was based on diverse herding strategies. Sheep were the most widely exploited domestic animal, but cattle, pigs and goats also played an important role. Animal husbandry during this time was based on the specialised exploitation of animal resources to obtain different products.

Pigs were the main meat providers, but in some sites cattle and goats were also butchered for this purpose once they were no longer useful for breeding, milk production or traction. The main milk providers were goats and to a lesser degree cows and sheep were reared for their wool. Cattle and horses were used for traction to assist in the task of deforestation, for agricultural work, as a means of transport and for carrying loads. Generally, it seems that bovines were more suited to agricultural work and horses were used more for transport and carrying loads. Livestock at this time was based on an integrated system of managing and exploiting various domestic animals to obtain different animal products, which at the same time was a specialised system as each animal was reared for specific uses.

As the Romans consolidated their position in the north-east of the Iberian Peninsula their influence brought significant territorial, social and political changes. Within this new framework the husbandry practices characteristic of the Iberian period also underwent significant changes.

In this paper we present[1] an initial study of animal husbandry in the north-east of the Iberian Peninsula from the 1st to the 5th century AD. The aim is to determine whether or not romanisation in this area affected and conditioned livestock rearing practices and, in the event that changes can be documented, describe them and establish their causes.

2. MATERIAL

In order to carry out this study on animal husbandry in Roman times it was considered appropriate to compare the livestock rearing practices implemented at that time with those of previous period. Therefore, this study includes information about two sites occupied during the late Iberian period and the late Republican era. These sites (Mas Castellar and Bosc del Congost) are placed in the north-east of Catalonia and provide us with an insight into animal husbandry during these periods.

Material obtained from four Roman sites – *Vilauba*, *Ermedàs*, *Collet de Sant Antoni* and *Vil·la dels Ametllers* – was studied. As most of these sites were occupied for a long time, it was decided to differentiate between the early Roman period and the late Roman period. This distinction helps to define Roman animal husbandry more precisely and to determine whether there were any differences in the livestock rearing practices implemented during these two periods, as has been documented from the study of other archaeological materials.

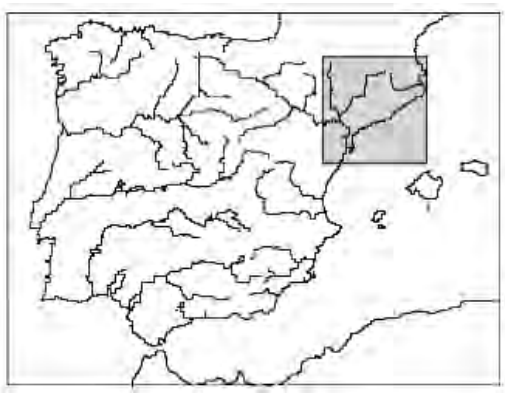

Figure 1. Geographical area analysed in this study.

1. This paper was carried out as part of the project HUM2007-65016/HIST, Ministry of Education and Science.

2.1. Mas Castellar de Pontós

The site of *Mas Castellar de Pontós* is a farmstead located in the municipality of Pontós in the district of Alt Empordà (Girona). An area of 2000 square metres has been excavated. The settlement is organised around a central street along which different domestic units were distributed. Three complex houses and two one-family houses have been documented. These establishments date from between 225 and 175 BC (Pons et al. 2005).
Both a land use study and the analysis of the different archaeological materials recovered during excavation suggest that the farmstead was occupied by rural aristocracy whose main function was to manage surplus cereal production and distribution, making this both an important commercial centre for cereal production and an important reserve centre for the entire Empúries area (Bouso et al. 2002).

2.2. Bosc del Congost

The site of *Bosc del Congost* is a silo field located on the eastern edge of Puig de Sant Julià de Ramis, in the district of Gironès, a few metres above the river Ter and some 400 metres from the Iberian village located on the upper part of the hill. Excavations carried out here have uncovered a total of 119 silos dating from between the 4th and the 1st century BC (Burch et al. 1995).
These silos are oval in shape and vary in depth, some as deep as two and a half metres. Smaller numbers of other types of silos have also been unearthed. Some of these are tubular shaped with straight walls, some are cone shaped with sloping walls and others are balloon-shaped. The widths of the mouths of these silos have hardly ever been determined although several circular flagstones, mostly made of slate, have been found which could have been lids and which would indicate that the approximate diameter was between 50 and 70 centimetres. An important amount of archaeological material including faunal remains, bronze, iron and a lot of ceramic has been recovered from these silos (Agustí et al. 1995).

2.3. Vilauba

The site of Vilauba is a Roman villa located in the municipality of Camós in the district of Pla de l'Estany (Girona), on the south side of a small valley. This villa was occupied during a long time period which can be divided into four shorter periods from the last quarter of the 2nd century BC to the first decades of the 7th century AD. This study is only concerned with the early Roman period (from the second half of the 1st century to the end of the 3rd century AD) and the late Roman period (from the end of the 3rd century to the end of the 5th century AD).
During the early Roman period the villa consisted of a residential area and work facilities. Architecturally, the residential part is made up of a central courtyard surrounded on the north, east and west by a gallery giving access to the different rooms. The work facilities were separated from the residential area and consisted of various large rectangular shaped structures which appear to be either where the animals were stabled or where the different activities related to agricultural work took place. A fire in the end of the 3rd century marked the beginning of a series of structural changes characteristic of a Late Roman period villa. These changes included two new wings located to the east and the south of the courtyard and, on the north side of the site, a series of new outbuildings which appear to have been various cisterns and different facilities related to agricultural work, and which were positioned around a press. These additional facilities increased the number of outbuildings used for agricultural work and meant that the residential and working areas were no longer so clearly separated

(Castanyer/Tremoleda 1999).

2.4. Ermedàs

The site of Ermedàs is a brick kiln located in the district Pla de l'Estany (Girona) to the south of the village of Ermedàs. Currently the site occupies an area of almost 3000 m^2 and provides us with a general, but not complete, picture of the facilities, which consisted of ten kilns – three very large and seven smaller – with different rooms and annexes.

Available data suggests that this brick kiln was in use from the 1st century to the end of the 2nd century AD. Only one small kiln has been documented from the first phase, dating from the middle of the 1st century AD. The most important period was the second phase when the facility was made bigger and systematised. Excavation has uncovered two large structures running from north to south and separated by a circulation area. Little is known about the third phase, evidence of which consists only of some covered structures from the previous phase (Tremoleda et al. 2002).

This brick kiln produced building materials, ceramic for cookery and kitchen utensils, imitations of imported products (the Spanish *terra sigillata* and imitations of African ceramics), large recipients for storing crops and amphoras for keeping wine (Castanyer et al. 2000).

2.5. Villa of Ametllers

The Roman villa of Ametllers is located in the village of Tossa de Mar in the district of Selva (Girona) on the eastern side of a small hill. During the Early Roman period the residence was built on a terrace halfway up the hill. Initially, the villa centred around two large courtyards which ran from north to south with the main façade facing east and presided over by a large portico. The industrial facilities, which consisted of several presses and storeroom annexes, were located on the lower part of the hill separate from the residential area.

The Roman villas of the 4th century AD were very different in design. Most sumptuous elements disappeared, the north courtyard became a work area and the ornamental swimming pool became a rubbish dump. The rooms on the north side of the building completely disappeared, and the lower part of the hill was used as a cemetery in the late antiquity and early medieval periods.

2.6. Collet de Sant Antoni

The site of Collet de Sant Antoni (Calonge) is located on an elongated hill that rises above the eastern and western alluvial planes and overlooks the sea (Nolla et al. 2004). On this site there is a large Roman villa with various related constructions located to the north and east. The most important structure is the aqueduct which covered an area of at least 5000 square metres when fully operational.

The land use characteristics of this villa and the archaeological materials found there suggest that the site was occupied sporadically from 200 BC to 500 AD and was used during this time for maritime commercial activities. The site was occupied permanently from the first half of the 1st century BC, and it became an important villa during the reign of Augustus. The main economic activity was cultivating grapes and producing and selling wine.

3. METHOD

To carry out this study we focused on the analysis of the mortality profiles based on an estimation of animal age at time of death, and on the definition of their shape and size based on biometrical analysis. The studies of Grant (1982) and Payne (1973) were used to estimate the age of the different

animals from the eruption and wear of teeth. The work of Barone (1976) was used to estimate the age of the animals on the basis of the fusion of bone epiphyses.

Measurements follow von den Driesch (1976). The *log ratio* technique was used with the measurements obtained. This technique is based on the assumption that the different parts of the skeleton of an individual are harmoniously proportioned. Although this technique is widely used, the results obtained must be interpreted with caution. One of the most important points to bear in mind is that certain selection processes can alter the original proportions of the individual. However, this technique is considered useful as a way to identify general changes over time: it allows us to combine the measurements of different skeletal parts on the same graph using the size index scaling method (Meadow 1999). In this way the size range of the animals can be determined from few individual measurements (Simpson et al. 1960), as is frequently the case with archaeological fauna remains.

The standard used for the calculation of cattle, sheep and goat *log ratios* is that suggested by Daniel Helmer (unpublished study). The standard measurements for cattle and sheep correspond to a modern cow from the Camargue in France and a modern Mouflon sheep from Corsica respectively. The standard used for the calculation of pigs log ratios is based on the assemblage obtained from the Neolithic site of Durrington Walls (Albarella/ Payne, 2005). These standards were considered to be the most appropriate in terms of the geographic area and the period under study, even though current standards are applied more widely and systematically.

4. RESULTS

The results of the comparison of the percentages of each taxon from the different sites show clear fluctuations in the proportions of the four main domestic species (sheep, goat, cow and pig) over the time period studied (Figure 2). From the 3rd to the 1st century BC sheep and goats remains are the predominant, followed by cattle and pigs remains. From the 1st century AD there is a substantial change, with both cattle and pigs becoming as numerous as sheep and goats. This tendency was fully established from the 3rd century AD, from which time cattle took on an increasingly important role and the proportion of goats decreased.

In order to determine whether these changes in the percentages of the main domestic species were linked to new livestock practices in this geographical area and, more specifically, to a change in livestock production, mortality profiles for sheep, goats, pigs and cattle were compiled and analysed.

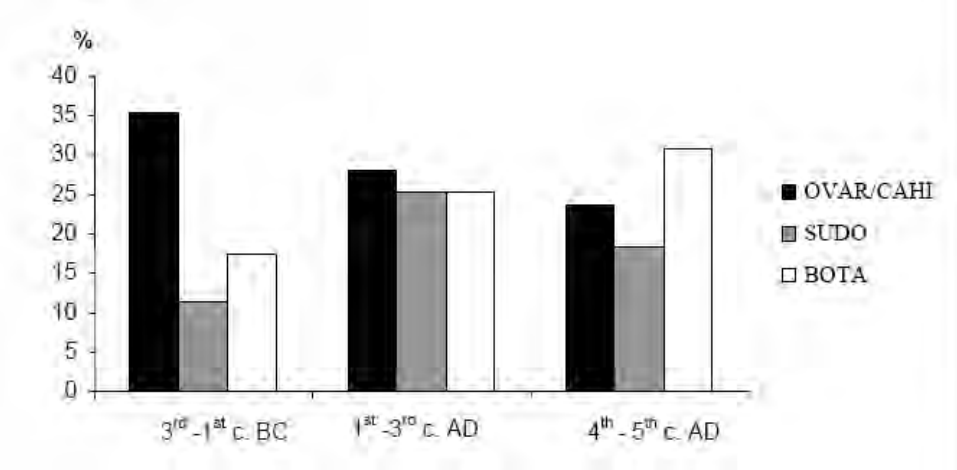

Figure 2. Percentages of sheep/goats, pigs and cattle in the different eras (NISP: 5494).

OVAR= *Ovis aries*
CAHI= *Capra hircus*
SUDO= *Sus domesticus*
BOTA= *Bos taurus*

4.1. Study of the mortality profiles

The results of the analysis of sheep and goats mortality profiles demonstrate the same general tendency throughout the three time periods studied regarding the age at which these animals were slaughtered. The results show that most of these animals were slaughtered over four years old. The slaughtering of animals before they reach maturity is normally related to either milk production for human consumption or to the provision of high quality tender meat. From one year, which is when animals reach their optimum meat value, the number of animals slaughtered increases progressively. Therefore, maintaining animals after the age of three or four is justifiable only when they have a use other than to provide meat, as after this age the animal's weight stabilizes and meat quality decreases (Oueslati 2006).

Therefore, this would suggest that sheep and goats were used to provide wool and milk (Figure 3). From the 4th century AD there was a slight increase in the number of animals slaughtered from six months old, which suggests that sheep and goats were increasingly exploited for their meat.

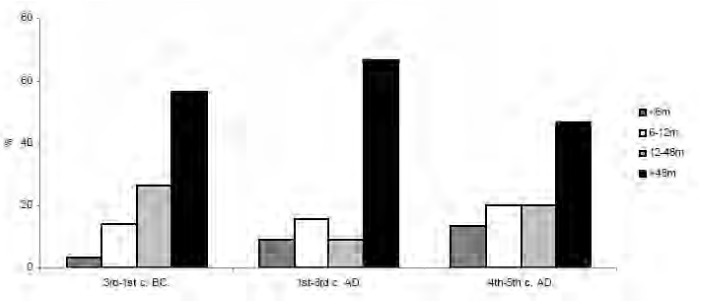

Figure 3. Histogram of sheep and goats frequencies class age in the different periods (NISP:182).

The age at which pigs were slaughtered is even more homogenous and consistent throughout the three time periods studied. Most of these animals were over five years old when they were slaughtered. If we consider that the ponderal growth of pigs begins at around six months of age, that they gain an average of 2.9 kilograms per month (Mauget 1982) and that this growth rate remains consistent until two years of age, we can conclude that the progressive increase in the number of animals slaughtered from six months onwards was related to meat production (Figure 4).

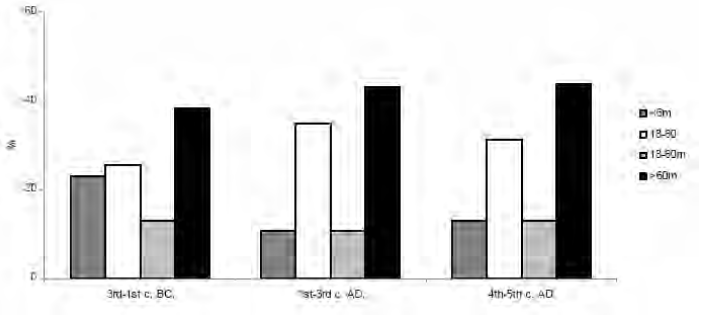

Figure 4. Histogram of pigs frequencies class ages in the different periods (NISP:92).

The number of animals slaughtered decreases from 18 months old and increases again at five years old. This is the age at which reproductive capacity begins to decline and when animals used for breeding would have been slaughtered. Overall, the average age for females was seven years old and for males three years old.

When the information of the estimated age is correlated with the data related to the sex of the animals, our initial hypothesis is corroborated.

In all three time periods the juvenile animals slaughtered were mainly males that were slaughtered for meat. A relatively small number of juvenile females also were sacrificed (Figure 5). On the other hand, a higher number of mature females were slaughtered than mature males, these being related to reproduction. It's important to remark that should be enough to keep as just one stud pig per 20 or 30 females (Burjachs et al. 1999).

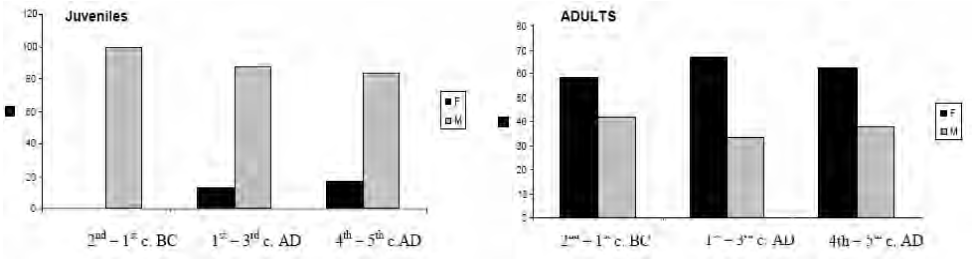

Figure 5. Proportions of young (NISP: 15) and adult male and female pigs (NISP: 44).

Cattle age however, varied throughout the time period studied, with a significant inflection point particularly from the 1st century AD.
Ponderal growth curves for cattle show that the weight of these animals stabilises at around two and a half to three years old (Oueslati 2006). Therefore, these animals would not be slaughtered before this age if they were to be used for meat. Cattle, however, can also be exploited for milk and traction and they could justifiably be kept alive after maturity and slaughtered only when their reproductive capacity (at around 12 years old for males and 10 years old for females), their milk producing capacity or their strength and stamina started to decline.
Taking these factors into account, during the late Iberian period and late Republican era cattle were probably reared mainly for traction and meat. However, from the Early Roman era there was a considerable increase in the number of animals slaughtered after five years old, which would indicate that these animals were used more for traction and probably also for milk production. This tendency was even more pronounced in the late Roman era (Figure 6).

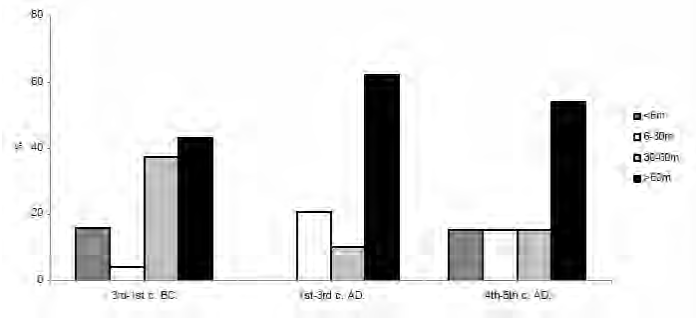

Figure 6. Histogram of cattle frequencies class age in the different periods (NISP:93).

Having described the different uses and productions of the main domestic species exploited and the most significant inflection points in animal husbandry practices during the time period studied, the next step is a biometrical analysis of the main domestic animals with the aim of establishing inter-specific variability and of determining if the changes described above were linked to an intensive selection process that could have altered the physical characteristics of the animal species in question. By studying the size and shape of these animals we can determine the possible presence of imported animals and also describe how livestock practices changed and how significant these changes were.

4.2. CHARACTERIZATION OF ANIMALS USING BIOMETRIC ANALYSIS

The results of the biometric analysis from sheep and goat remains using the *log ratio* technique demonstrate significant differences between the two. Sheep from the 1st century AD were clearly bigger than the sheep found at the end of the late Iberian period and the late Republican era. This increase in size coincides with an increase in the variability of the population, as evidence shows that in the study area there were also still some relatively small sheep like those documented in the Iberian era (Figure 7; N=133). From the 4th century AD onwards the size of sheep diminished slightly, and again the interval of variability decreases. Despite this slight size decrease these animals were not as small as those found during the Iberian era. Both the increase in size and the increase in variability documented for sheep population are statistically significant (Table 1).

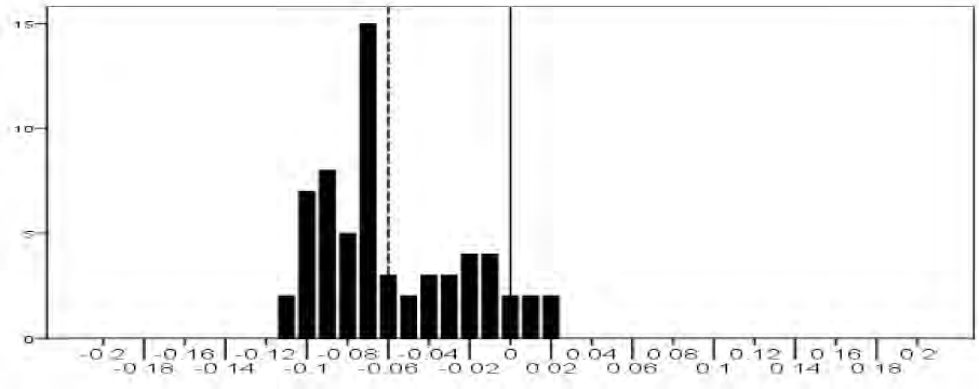

Figure 7a. *Log ratio* diagram of *Ovis aries* measurements (2nd - 1st century BC) n: 68.

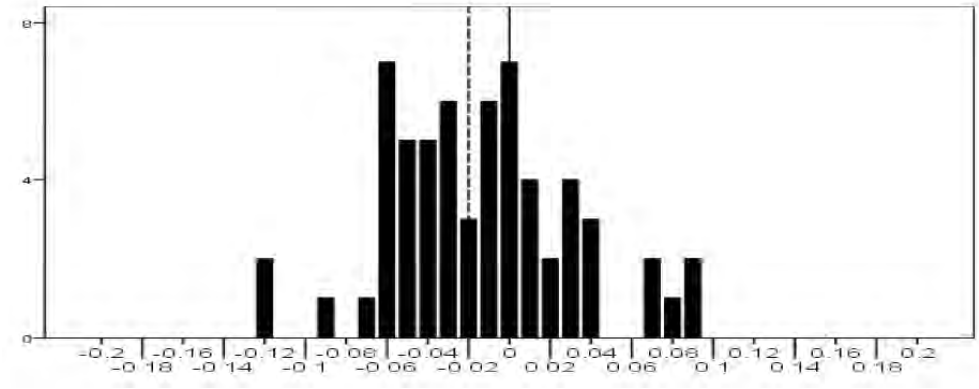

Figure 7b. *Log ratio* diagram of *Ovis aries* measurements (1st - 3rd century AD) n: 40.

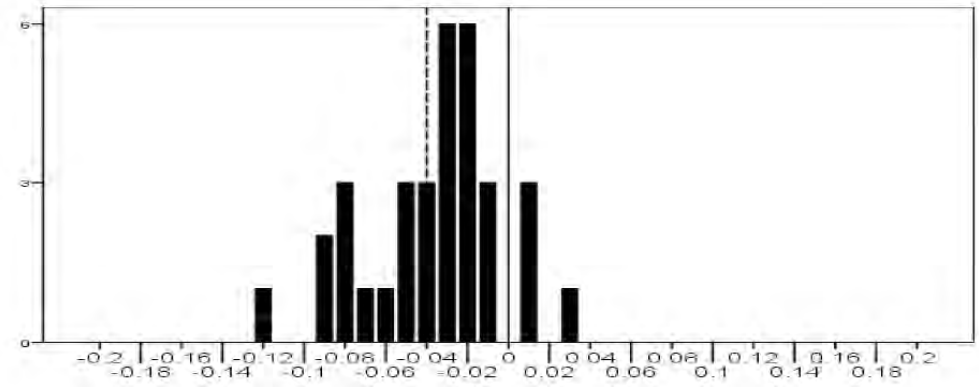

Figure 7c. *Log ratio* diagram of *Ovis aries* measurements (4th - 5th century AD) n: 25.

A *log ratio* diagram for goats could not be created as the number of measurements available was so few (NR=47). However, there is no evidence to suggest a significant alteration in the size of these animals over the time period studied. Therefore, it would seem that after Romanisation goat and sheep husbandry practices were quite distinct, and that sheep were subject to a marked selection process while goats were not.
A study of measurements of the first posterior phalanges of the sheep from the 1st to the 3rd century AD suggests, despite the few measurements available, that this increase in size was not caused by a change in the proportion of males and females (Figure 8). When we compare the measurements of sheep population from this period with those of modern male and female Soay sheep (Clutton-Brock et al. 1990) (sheep population most similar to that analysed here of which are presented separately for males from females), the results show that the sheep remains from the 1st to the 3rd century AD are those of both males and females.

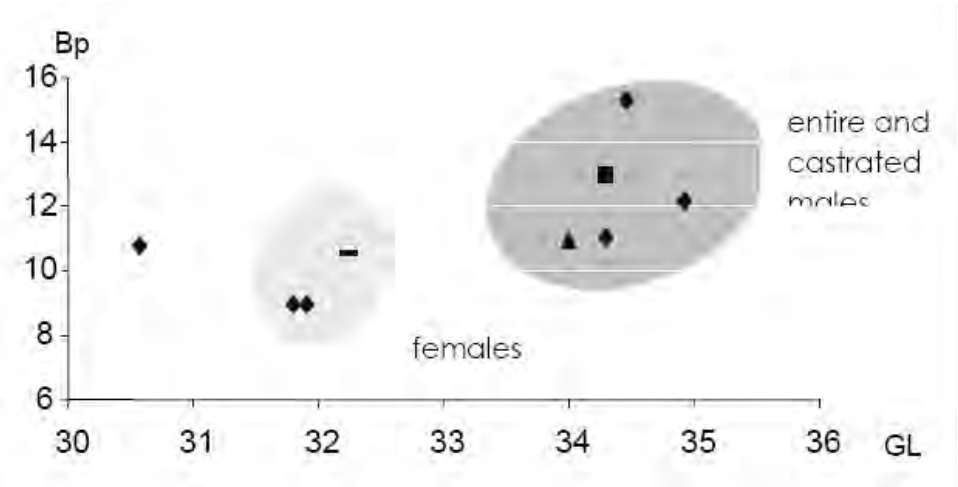

Figure 8. Dispersion diagram of Bp (proximal width) and GL (maximum length) of the first posterior phalanges of ovines from the 1st – 3rd century AD (rhombus) in relation to the average measurements of the first posterior phalanges of female Soay sheep (line), the average measurements of the first posterior phalanges of male Soay sheep (triangle) and the average measurements of the first posterior phalanges of castrated Soay sheep (square).

Only molar measurements were used for pig biometric analysis because no appendicular skeleton measurements corresponding to these animals were available, as most of this taxon was slaughtered before reaching maturity. This may seem to be a limitation, but any changes in size resulting from either natural selection or improvements in nutrition are reflected more slowly in the teeth than in the appendicular skeleton. Therefore, a marked change in molar size could indicate the introduction of a new genotype or the evolution of the genotype in question (Albarella et al. 2007).
The biometrical results obtained (N=163) indicate that there was a slight decrease in size from the 1st century AD, and that this decrease was maintained over the following centuries. What is most interesting, however, is the notable increase in the variability of the population starting from around the 1st century AD and becoming more marked from the 4th century AD (Figure 9). The decrease in size and the increase in the variability are statistically significant (Table 1).

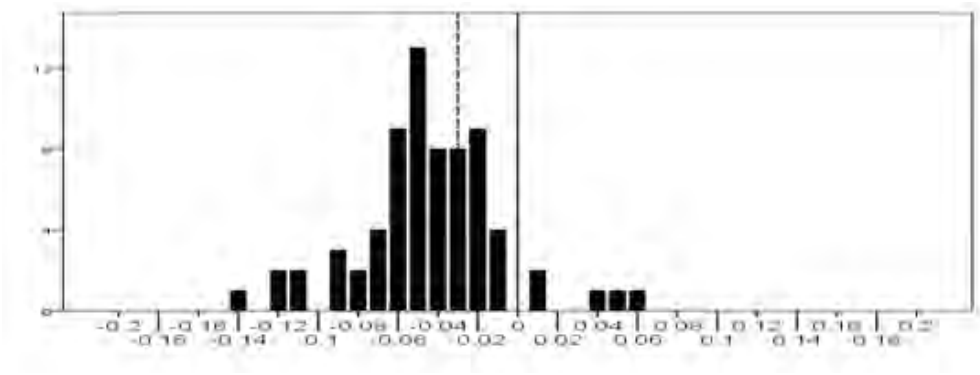

Figure 9a. *Log ratio* diagram of the molar measurements of the suids (3rd - 1st century BC) n: 47.

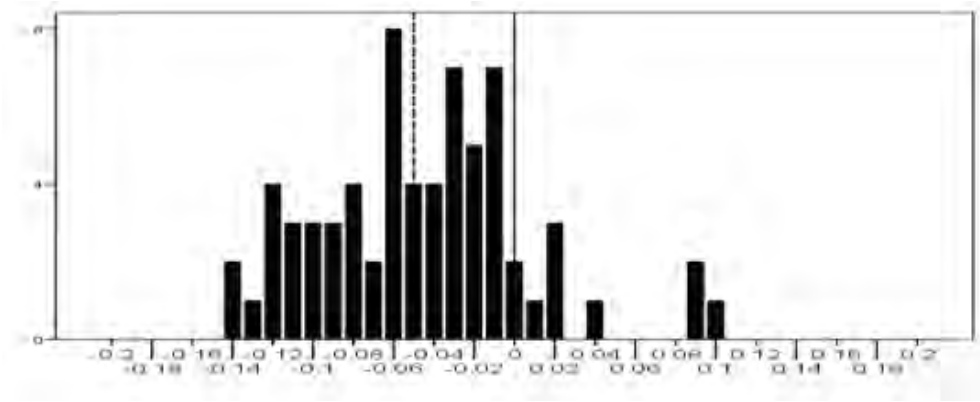

Figure 9b. *Log ratio* diagram of the molar measurements of the suids (1st - 3rd century AD) n: 66.

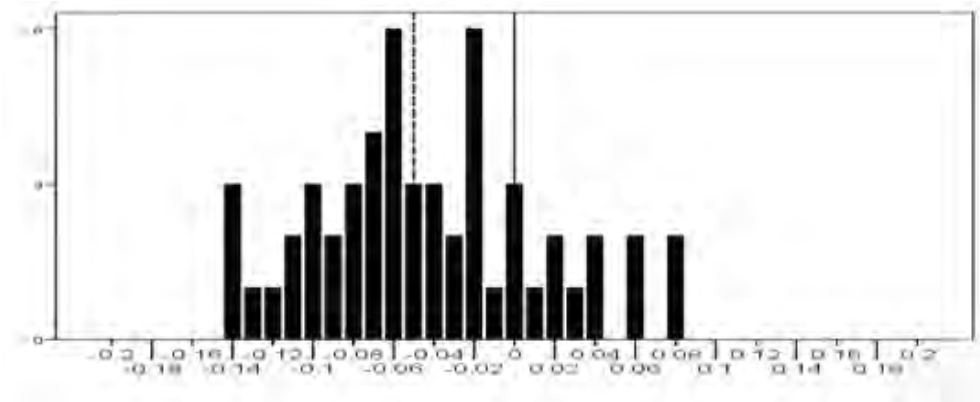

Figure 9c. *Log ratio* diagram of the molar measurements of the suids (4th - 5th century AD) n: 50.

Although there were few appendicular skeleton measurements available for pigs (N=54), those corroborate the results obtained from the biometric analysis of the molars, confirming both the reduction in size and the significant increase in the variability of the population (Figure 10).

The results of the biometric analysis for cattle (N=160) demonstrate a marked increase in the size of these animals from the 1st century AD. This size increase was proportionally greater even than that of the sheep. During the Iberian and late Republican period cattle had been relatively small, but rather suddenly this population became larger and the smaller animals almost disappeared (Figure 11). From the 4th century AD there was also an increase in the variability of the population. This bimodal dispersion demonstrates that the overall decrease in the size of the population was due to the presence, once again, of smaller individuals, although there is evidence of the continued presence of the larger animals documented since the 1st century AD. Both the increase in size and the increase in the variability are statistically significant (Table 1).

The biometric analysis of the few available measurements of cattle

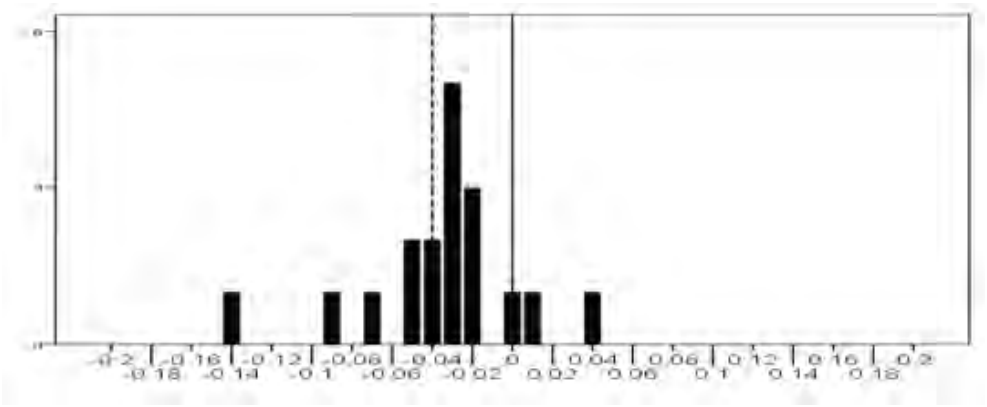

Figure 10a. *Log ratio* diagram of the measurements of the appendicular skeleton of the suids (3rd - 1st century BC) n: 19.

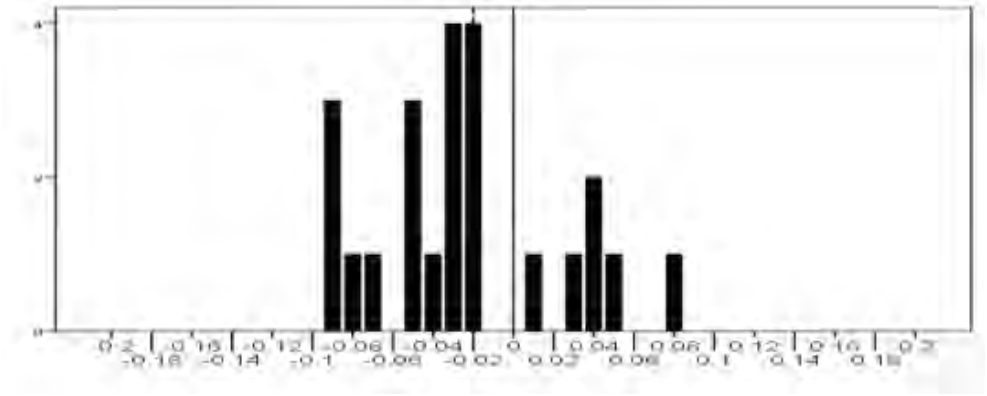

Figure 10b. *Log ratio* diagram of the measurements of the appendicular skeleton of the suids (1st - 3rd century AD) n: 23.

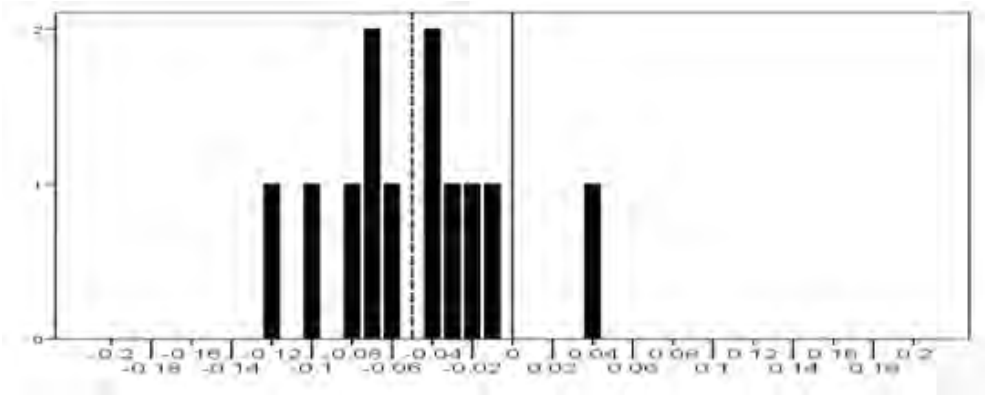

Figure 10c. *Log ratio* diagram of the measurements of the appendicular skeleton of the suids (4th - 5th century AD) n: 12.

metacarpals from the 1st to the 3rd century AD suggests that both male and female animals are represented in this group (Figure 12). The results obtained from comparing these measurements with those of three cows and an ox from the Camargue and three bulls from Madrid (Tekkouk/Guintard 2007), selected for their geographic proximity to our group and reliably sexed, confirm that the changes observed was not caused by potential differences in the proportion of males and females.

5. DISCUSSION

The results obtained from the analysis of the representation percentages of the four main domestic species exploited, the mortality profiles and the biometric analysis show important changes in animal husbandry practices in the north-east of Catalonia between the 1st and the 5th century AD.

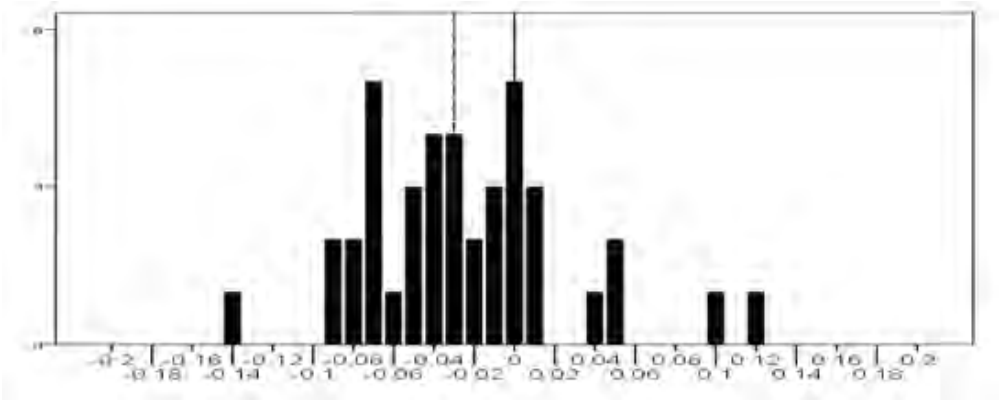

Figure 11a. *Log ratio* diagram of the measurements of *Bos taurus* (3rd - 1st century BC) n: 35.

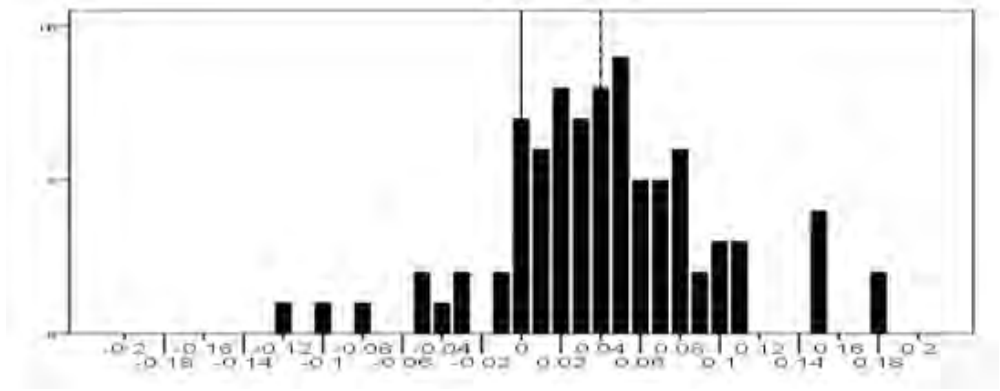

Figure 11b. *Log ratio* diagram of the measurements of *Bos taurus* (1st - 3rd century AD) n: 77.

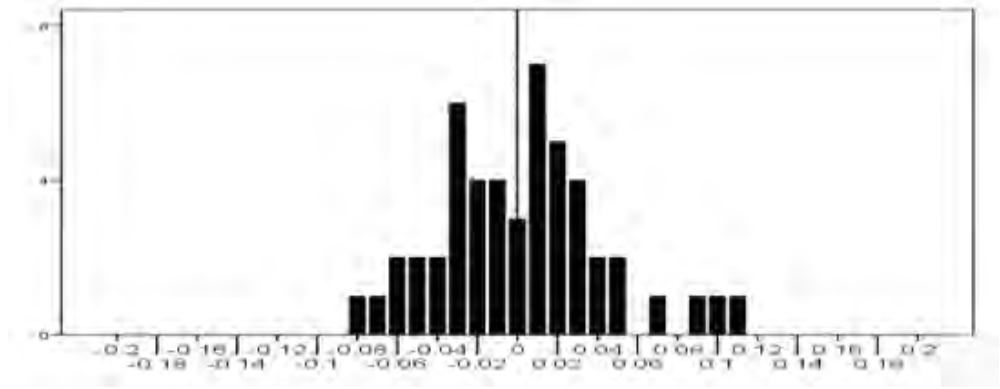

Figure 11c. *Log ratio* diagram of the measurements of *Bos taurus* (4th - 5th century AD) n: 48.

The most notable change was a significant increase in the size of cattle. The positive correlation between this size increase, the increasingly slaughter in adult age related with a specialised exploitation of cattle for traction, and the increase in the representation frequency in relation to the other domestic animals, could indicate that the larger and stronger cattle were subject to an intensive selection process. The increase in size of cattle was the result of either the improvement of local herds or the importation of animals with higher dimensions or improved in the country of origin. That bigger animals could be used to increase agricultural production through rotation farming, one of the intensive farming methods practiced in this era (Casas et al. 1995).

The evolution of the *log ratio* diagrams for cattle demonstrate that from the 1st century AD this species increased significantly in size and that later, around the 4th century AD, there was a bimodal distribution of the measurements**.** These results leave open the possibility that individual animals or herds of larger cattle were imported to this area from elsewhere,

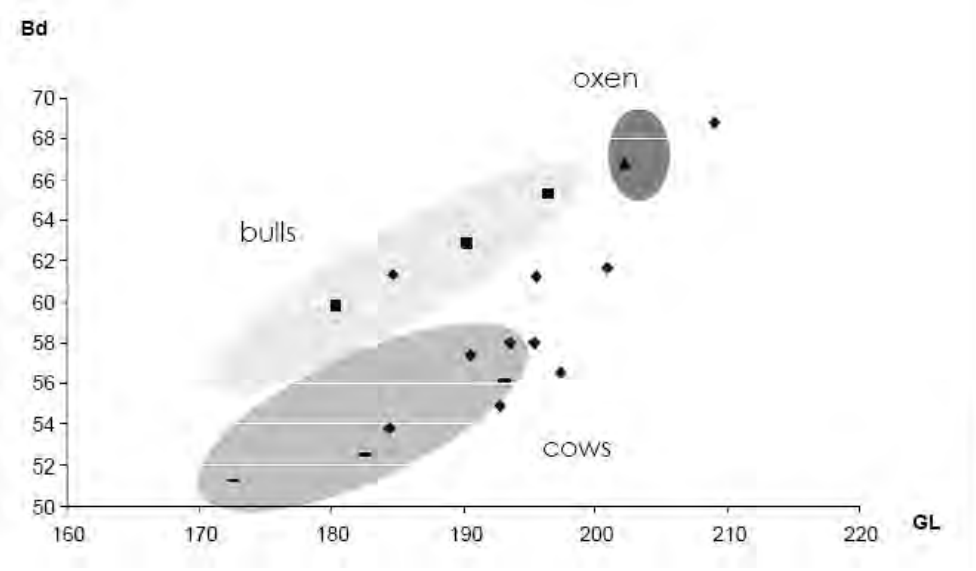

Figure 12. Distribution diagram of GL and Bd measurements of cattle metacarpals from the 1st to the 3rd century AD (rhombus), cows from the Camargue (lines), oxen from the Camargue (triangle) and bulls from Madrid (square).

and that these animals almost replaced local herds. If local herds had been improved this change would have probably been more progressive and less abrupt. The bimodality documented around the 4th century could indicate that animals imported from elsewhere were bred with local cattle, thereby increasing the size variability of this population.

This size increase in cattle has also been documented in other areas of the Roman Empire. In Holland there is evidence of two groups of cattle of different sizes, indicating that there were two distinct populations. The group of larger cattle would have been an imported population and the smaller animals would have formed part of the local population (Lauwerier 1988). Evidence collected from different sites in Great Britain, for example Lincoln (Dobney et al. 1996) and Great Holts Farm (Murphy et al. 2000), documents a population of cattle which were larger than those previously existent, their presence attributed to the importation of bigger animals. It seems that cattle were also imported to Roman Germany (Teichert 1984) as there is no evidence of larger cattle in the parts of the country which were not Romanised. Evidence of larger animals has also been found in the more Romanised settlements in France, such as Gournay-sur-Aronde and Fresnes-les-Mountauban, indicating that a new breed could have been introduced there (Lepetz 1995). However, it has also been suggested that this size increase in cattle recorded at many sites in France was due to zootechnical practices which were applied to local herds in the first 100-150 years after the Roman conquest and which resulted in the larger, and probably stronger, cattle recorded from the 1st century AD (Forest/Rodet-Belarbi 2002).

Evidence collected from across northern Europe suggests a general bimodal distribution of cattle population, with one group of animals measuring between 105-120 centimetres tall and the other between 130-140 centimetres. The first group would have been a local population and the second group an imported one (Audion-Rouzeau, 1995).

The imported animals may have come from Italy where cattle had presumably already been improved (Driesch 1992). It has also been suggested that these larger bovines were imported from other continents, for example the Near East or Africa (Schlumbaum et al. 2006). In Portugal there is no documented evidence of this size increase in either cattle or sheep during these eras (Davis 2008).

With reference to the Iberian peninsular, some Basque Country sites have yielded evidence of a size increase in cattle, for example Arellano, but there is no evidence of these larger animals in the more mountainous settlement of Cueva de Amalda (Mariezkurrena 2004). The author suggests that the bigger animals recorded at the Arellano site were either imported or that autochthonous herds had been improved.

The same hypothesis can be applied to sheeps as the results obtained from the biometric study show similar trends. The evidence suggests a marked size increase from the 1st century AD and a subsequent size decrease from the 4th century onwards. The only difference between sheeps and catlle is that during this second period the variability of the measurements of sheeps also decreases and the presence of fairly small sheep is documented throughout the time period studied. This could mean that while sheep may have been imported to improve local herds this process was possibly more sporadic and not as large scale as for cattle.

When we compare this data with the mortality profiles for the two Roman periods studied it can be seen that from the 4th century AD there was a decrease in the number of adult sheep and goats butchered. The positive correlation between the size decrease and the reduced number of adult animals slaughtered could be related to a decrease in wool production, as wool would have been less important than during the first centuries of the Roman Empire. Individual animals or herds would have been imported to improve the quantity and quality of the wool.

In other parts that were part of the Roman Empire, like England, France and Italy, there is documented evidence of a size increase in sheep. Unlike for cattle, however, opinion is divided as to why, as this tendency was neither as widespread nor as accentuated. At some sites in England it is proposed that the size increase in sheep was the result of importing animals from the continent (Albarella et al. 2007), while at some sites in France (Lepetz, 1996) and Italy (Mackinon 2004) this change in size is attributed to an improvement in local herds.

The results obtained for pigs show the least important changes. There was no evidence of a size increase in this specie throughout the time period studied. This tendency has also been documented in other parts of the former Roman Empire, registering a higher margin of variability between different regions. However, data collected from the area under study is significant in that it documents an increase in the biometric variability of pig population and a corresponding slight decrease in size in the general population. Regarding the mortality profiles, it was observed that there was no substantial change over the time periods studied being an animal that were exploited for their meat.

The positive correlation between these characteristics over the time period studied could be the result of an increasingly important selection process which was linked to a more intensive practice of rearing pigs for meat, and which over time resulted in a slight size reduction. As a result, certain stud animals may have been selected or some animals imported to improve the quality and/or quantity of meat production, causing an increased variability in the size of the population.

OVAR	N	MEAN	ST. DEV.
3rd-1st c. BC.	68	-0,0664	0,0598
1st-3rd c. AD.	40	-0,0216	0,05252
4th-5th c. AD.	25	-0,0368	0,03423
SUDO	N	MEAN	ST. DEV.
3rd-1st c. BC.	47	-0,0377	0,03744
1st-3rd c. AD.	66	-0,0491	0,05597
4th-5th c. AD.	50	-0,0463	0,05515
BOTA	N	MEAN	ST. DEV.
3rd-1st c. BC.	35	-0,0255	0,04543
1st-3rd c. AD.	77	0,0401	0,0529
4th-5th c. AD.	48	0,0043	0,05203

Table 1. Statistical results (number, average, standard deviation) obtained for the three taxa analysed in the different eras.

6. CONCLUSIONS

The results obtained from the analysis of faunal assemblages recovered from the four Roman sites, and the results of the comparative analysis of the data obtained from the Iberian site of Mas Castellar and from the late Republican phase of the site of Bosc del Congost, give us a first approximation of animal husbandry practices in the north-east of Catalonia between the 1st and the 5th century AD and allow us to establish and describe the main inflection points. Important changes were observed in animal husbandry practices over this period, especially from the 1st to the 5th century AD. However, these changes were not homogenous and they did not affect all the domestic species involved in this study in the same way.

Cattle played a more important role after Romanisation as a result of the need to increase the number of suitable animals to assist with agricultural work and maybe for transport. To this end certain animals may have been imported from elsewhere to improve the quality of local herds. It appears that sheep may also have been imported, or local herds improved, during the Early Roman era to increase wool production, and that male pigs intended for reproduction were subject to an intensive selection process, or certain animals were imported, to maximise meat production.

Significant changes in animal husbandry were observed over the time period studied. Until the 1st century BC livestock rearing practices in the north-east of the peninsula had remained unchanged since the 3rd century BC. While the study of other archaeological materials has documented changes during this time as a result of Roman influence, there was no evidence in this study to suggest this. However, from the 1st century AD significant changes took place. Therefore, the Early Roman era marked the beginning of new livestock rearing practices in the area implemented as a response to the new socio-political situation. The reorganisation of the territory brought about a series of changes in animal husbandry, including the introduction of new techniques and an increase in the types of animal production and distribution. By the Late Roman era these new practices were fully established and consolidated giving local animal husbandry a new impulse.

ACKNOWLEDGEMENTS

We would like to thank Umberto Albarella and Vianney Forest for their useful advice about being prudent when interpreting results obtained from using the *log ratio* technique.

BIBLIOGRAPHY

- AGUSTÍ, B., BURCH, J., MERINO, J. 1995, *Tombes, sitges i muralles (excavacions arqueològiques a Sant Julià de Ramis, 1991-1993)*. Museu Arqueològic de Girona.

- ALBARELLA, U., PAYNE, S. 2005, Neolithic pigs from Durrington Walls, Wiltshire, England: a biometrical database. *Journal of Archaeological Science* 32, 589-599.

- ALBARELLA, U., JOHNSTONE, C., VICKERS, K. 2007, The development of animal husbandry from the Late Iron Age to the end of the Roman period: a case study from South-East Britain. *Journal of Archaeological Science* XX, 1-21.

- ANDUGAR, L, SAÑA, M. 2004, La gestió ramadera durant el II mil·lenni, *Cypsela* 15, 209-228.

- AUDION-ROUZEAU, F. 1995, La taille des animaux d'élevage a l'époque romaine et leur exportation, *Home et animal dans l'antiquité romaine*. Actes du Colloque de Nantes, Université de Tours, 1991, 79-100.

- BARONE, R. 1976, *Anatomie comparée des mammifères domestiques. Tome I Osteologie* (2 fascicules), Vigot Frères Editeurs, Paris.

- BOUSO, M., BUXÓ, R., FERNÀNDEZ, M., FUERTES, M., GARCIA, M., GONZALO C., LÓPEZ, A., PONS, E., ROVIRA, N., VARGAS, A. 2002, Reflexions. In PONS, E. *Mas Castellar de Pontós (Alt Empordà). Un complex arqueològic d'època ibèrica (Excavacions 1990-1998)*, Sèrie Monogràfica 21, Girona, 587-596.

- BURCH, J., CARRASCAL, C., MERINO, J., NAVARRO, N. 1995, L'emmagatzematge en sitges al pla de Girona. L'exemple del Bosc del Congost. In AGUSTÍ, B., BURCH J., MERINO, J. (ed.), *Excavacions d'urgència a Sant Julià de Ramis. Anys 1991-1993*, Centre d'Investigacions Arqueològiques. Sèrie Monogràfica, 16, Girona, 71-84.

- BURJACHS, F., BUXÓ, R., CASELLAS, S., FÈLIX, J., GARCIA, Ll., JUAN-MUNS, N., ROS, M., VILLATE, E. 1999, La gestió econòmica dels recursos biòtics, *Excavacions arqueològiques a l'Illa d'en Reixac. Monografies d'Ullastret* 1, 327-338.

- CASAS, J., CASTANYER, P., NOLLA, J. M., TREMOLEDA, J. 1995, *El món rural d'època romana a Catalunya,* Centre d'Investigacions Arqueològiques, Sèrie Monogràfica 15, Girona.

- CASTANYER, P., TREMOLEDA, J. 1999, *La vil·la romana de Vilauba. Un exemple de l'ocupació i explotació romana del territori a la comarca del Pla de l'Estany*, Girona.

- CASTANYER, P., DEHESA, R., ESTEBA, Q., TREMOLEDA, J. 2002, La bòbila romana d'Ermedàs (Cornellà de Terri, Pla de l'Estany), *Cinquenes Jornades d'Arqueologia de les Comarques de Girona*, Olot, 132-135.

- CLUTTON/BROCK, J., DENNIS-BRYAN, K., ARMITAGE, P. 1990, Osteology of the Soay sheep, *Bulletin British Museum Natural History Zoology Series* 56, 1-56.

- COLOMINAS, L. 2005, La gestió ramadera durant la segona meitat del primer mil·lenni al Llevant Occidental Peninsular: model general o especialització entre assentaments?, *Quaderns de Prehistòria i Arqueologia de Castelló* 24, 213-226.

- DAVIS, S. 2008, Zooarchaeological evidence for Moslem and Christian improvements of sheep and cattle in Portugal, *Journal of Archaeological Science* 35, 991-1010.

- DOBNEY, K., JAQUES, D., IRVING, B. 1996, *Of Butchers and Breeds. Report on vertebrate remains from various sites in the city of Lincoln*, Lincoln Archaeological Studies 5, Lincoln.

- DRIESCH, A.V.D. 1976, *A guide to the measurement of animal bones from archaeological sites*. Cambridge, Peabody Museum, Harvard University.

- DRIESCH, A.V.D. 1992, L'elevage des animaux domestiques dans les cultures européennes pré-et protohistoriques, *Revue de médicine vétérinaire* 143, 113-137.

- FRANQUESA, D., OLTRA, J., PIÑA, A., PONS, E., SAÑA, M., VERDÚM, E. 2000, La ramaderia en les societats ibèriques del N-E de la Península Ibèrica: diversificació i especialització, *Saguntum*, Extra-3, 153-161.

- FOREST, V., RODET-BELARBI, I. 2002, À propos de la corpulence des bovins en France durant les périodes historiques, *Gallia* 59, 273-306.

- GRANT, A. 1982, The use of toothwear as a guide to the age of domestic ungulates. *Ageing and sexing animals from archaeological sites*, BAR, British Series 109, 91-108.

- LAUWERIER, M. 1988. *Animals in Roman times in the Dutch Eastern river area*. Amersfoort, ROB.

- LEPETZ, S. 1995, L'amélioration des races a l'époque gallo-romaine: l'exemple du boeuf, *Home et animal dans l'antiquité romaine*. Actes du Colloque de Nantes, Université de Tours, 1991, 67-78.

- LEPETZ, S. 1996, L'amélioration des espèces animales domestiques à la période romaine en France du Nord. MEEKS, D., GARCIA, D. (ed.), *Techniques et économie antiques et médiévales: le temps de l'innovation*. Errance, 157-165.

- MACKINON, M. 2004, Production and consumption of animals in Roman Italy: integrating the zooarchaeological and textual evidence, *Journal of Roman Archaeology*, supplementary series n. 54, Rhode Island.

- MARIEZKURRENA, K. 2004, Talla del bovino en el País Vasco durante la Edad del Hierro y las épocas romana y medieval, *Munibe* 56, 79-86.

- MAUGET, R. 1982, Seasonality of reproduction in the wild boar. COLE, D. FOXCROFT, G. (ed.), *Control of pig reproduction*, London, Butterworth, 509-526.

- MEADOW, R. 1999, The use of size index scaling techniques for research on archaeozoological collections from the Middle East. BECKER, G et al. (ed.), *Animalium Ex Ossibus*, 285-300.

- MURPHY, P., ALBARELLA, U., GERMANY, M., LOCKER, A. 2000, Production, imports and status: biological remains from a Late Roman farm at Great Holts Farm, Boreham, Essex, UK, *Environmental Archaeology* 5, 35-48.

- OUESLATI, T. 2006, *Approche archéozoologique des modes d'acquisition, de transformation et de consommation des ressources animales dans le contexte urbain gallo-romain de Lutèce (Paris, France)*, BAR International Series 1479.

- PAYNE, S. 1973, Kill-off patterns in sheep and goats. The mandibles from Asvan Kale, *Anatolian Studies* 23, 281- 303.

- PONS, E., ASENSIO, D., BOUSO, M., FUERTES, M. 2005, Noves aportacions sobre la periodització del jaciment de Mas Castellar, *Món Ibèric als Països Catalans, XIII Col·loqui Internacional d'Arqueologia a Puigcerdà*, 361-377.

- SCHLUMBAUM, A., TURGAY, M., SCHIBLER, J. 2006, Near East mtDNA haplotype variants in Roman cattle from Augusta Raurica, Switzerland, and in the Swiss Evolene breed, *Animal Genetics* 37, 373-375.

- SIMPSON, G., ROE, A., LEWONTIN, R. 1960, *Quantitative Zoology*. Harcourt Brace, New York.

- TEICHERT, M. 1984, Size variation in cattle from Germania Romana and Germania Libera. GRIGSON, C., CLUTTON-BROCK, J. (ed.), *Animals and Archaeology 4. Husbandry in Europe*, BAR International Series 227, Oxford.

- TEKKOUK, F., GUINTARD, G. 2007, Approche ostéométrique de la variabilité des métacarpes de bovins et recherche de modèles applicables pour l'archéozoologie: cas de races rustiques françaises, algériennes et espagnole, *Revue de Médecine Vétérinaire* 158, vol. 7, 388-396.

- TREMOLEDA, J., CASTANYER, P.; PUIGDEVALL, I. 2002, Resultats de les darreres campanyes d'excavacions arqueològiques a la bòbila romana d'Ermedàs, Cornellà de Terri, *Sisenes Jornades d'Arqueologia de Girona,* Sant Joan de les Abadesses, 179-183.