A study of a prehistoric population of sheep (*Ovis aries* L.) from Kerma (Sudan)

Archaeozoological and archaeological implications

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RÉSUMÉ

Les auteurs présentent les premiers résultats d'une étude consacrée à une population de moutons du site préhistorique de Kerma (Soudan) daté de 2 400 à 1 400 B.C.

La présence de nombreux moutons entiers déposés dans les tombes et momifiés naturellement, permet une étude détaillée de ces animaux, complétée par celle des nombreux ossements de cette espèce mis au jour dans la ville antique.

Pour les anciens habitants de Kerma, éleveurs et agriculteurs avant tout, le mouton occupe une place importante aussi bien dans le cheptel que dans les rites funéraires.

L'étude morphologique de ces moutons montre qu'il s'agit d'animaux de haute taille (environ 80 cm au garrot), et le plus souvent armés ; leurs membres sont allongés et leur squelette gracile. La longueur de leur queue (15 vertèbres en moyenne) les rapproche des formes primitives.

Leur pelage est non laineux, la majorité des individus étant blancs ou noirs, avec quelques exemples d'animaux bicolores. L'étude des âges montre un très forte dominance des animaux juvéniles. La relation entre éruption dentaire et fusion des épiphyses permet d'intéressantes observations. L'ordre de fusion diffère nettement de celui énoncé par certains auteurs. Ce fait incite à un emploi prudent des données de la littérature pour l'établissement des courbes de mortalité.

L'étude des sexes, encore peu avancée, montre la prédominance très forte des mâles (env. 90 %) alors que la castration ne peut être démontrée.

La distribution des âges entre les populations trouvées dans la ville et celle provenant du cimetière montre des similitudes nettes. Cette répartition indique un système d'élevage centré essentiellement sur la production de viande.

ABSTRACT

This paper presents the preliminary results of studies of a prehistoric population of sheep found in a cemetery and an ancient town at Kerma (Sudan). Metrical and morphological analyses show them to be a primitive long-legged breed. A study of their age at death throws light on the burial rituals and suggests that the contemporary

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sheep husbandry was focussed towards the production of meat. The wider archaeozoological implications of the study of the age of the animals is discussed.

Key words : Africa, Sudan, Kerma, sheep, sheep morphology, sheep withers heights, funerary rituals, age analysis, bone fusion, tooth eruption, tooth wear, analysis of sex, animal husbandry.

I- INTRODUCTION

The site of Kerma is situated in the north of the Sudan, approximately 600 km from Khartoum, close to the left bank of the Nile and about 12 km upstream from the third cataract.

An archaeological mission from the University of Geneva has been excavating here since 1977 (Bonnet 1983, 1984).

Two principal sites have been the focus of detailed research :

a. The ancient town, centered around a massive mud-brick temple which is called a "deffufa" by the Nubian population.

b. The cemetery belonging to this town, which is situated several kilometres to the east in a desert area, which is now gradually being reclaimed by the local population.

The modern environment in this area of Sudan is desertic, except along banks of the Nile and where there are natural oases, or artificial oases created by deep pumping. Recent palynological analyses of sheep coprolites from the tombs (David Taylor, unpublished report) indicated an arid environment 4000 years ago. The vegetation would have consisted of scrub and scrubland, and the pollen of Urticaceæ and Gramineæ was dominant in the coprolites.

The Kerma civilization developed in Nubia, along the Nile, over a territory whose precise boundaries are still unknown. However, some more northerly sites are known such as Sai (Gratien 1978), and others, such a Bugdumbush, are found much further to the south. The earliest phases are dated at around 2 400 B.C., while the end of the Kerma civilization occured at approximately 1 500 B.C., when the Egyptians took over control.

II- THE ANIMAL ECONOMY AT KERMA

A considerable number of animal bones have been recovered during the excavations of the ancient town and have indicated the animals utilized for food by the inhabitants of Kerma.

This picture is supplemented by the study of the many animals placed in the tombs which, due to natural mummification, are in an excellent state of preservation. The animal economy at Kerma is essentially based on husbandry, and hunting plays only a very minor role. Approximately 50 percent of the livestock appear to have been cattle (*Bos taurus* L.) and 45 percent ovicaprines, amongst which sheep (*Ovis aries* L.) predominate. A small percentage of dogs and a very few donkeys make up the rest of the domestic

livestock (Chaix 1980, 1982, 1984, 1986a). It is worth noting that in this area today, cattle only form 19 percent of the domestic livestock, while sheep and goats form over 70 percent (McLeroy 1961). This seems to be due to the increasing desertification in this region which has caused a major reduction in grazing areas.

In the cemetery, animals played a very important role in the funerary rituals. In the earliest phases, animals are represented by deposits of cattle or ovicaprine horns. Later, whole animals were placed in the tombs, to the west and the south of the inhumation. These animals were almost always ovicaprines, and in fact were mostly sheep. Outside the graves were placed cattle frontal bones with the horns still attached ("bucrania") ; they were positioned on the south side of the tomb, looking towards the burial. The significance of this positioning has been discussed elsewhere (Chaix 1985).

Even later, in addition to whole animals, joints of sheep were placed in the tombs, to the north of the inhumation, together with other offerings.

It is thus clear that sheep played an important role not only in the economy of the Kerma populations but also in the funerary rituals. This importance is accentuated by the discovery of several animals wearing decorative elements of unknown significance. The main ornament was an ostrich feather disc placed between the two horns and held there by leather thongs which passed through the horn sheath and ended in sewn bead pendants (fig. 1). This ornament bears an uncanny resemblance to that shown on engravings of rams from the Sahara, known as "béliers à sphéroïde" (Camps 1980).

III- THE SHEEP

3.1. Morphological description

This study is based on 55 complete sheep and 62 bones that were deposited as food offerings. The remarks that follow are preliminary observations that serve as an introduction to a much more detailed study currently being undertaken. The sample studied has certain biases. In the tombs, the majority of the sheep were males and were predominantly juvenile. Thus certain cranial elements, such as the horns and the forehead had not yet attained their definitive morphologies. The various estimations of size (Teichert 1975) showed that the sheep were tall animals, with a mean withers height of approximately 80 cm. This is shown clearly when the Kerma sheep are compared to several other prehistoric and modern sheep populations (fig. 2).

This tall stature is essentially due to the particular development of the radius and the metapodials. Figure 3 shows the characteristic morphology of the lower limb bones which have long, narrow shafts. It is a characteristic that is common to many modern african sheep but also to ancient Egyptian forms described by writers under the name "longipes" (Duerst and Gaillard 1902).

The majority of the animals are horned, but because so many are juvenile it is unfortunately not possible to give a description of the horn shape. Some rare individuals had atrophied horns.

On some skulls that were well preserved and not deformed, it was not

possible to see the "roman nose" that is characteristic of modern desert animals (Epstein 1971). In some modern cases the bulging of the profile terminated in a wrinkle across the nasal bones. Here again we are prevented from giving a complete description by the scarcity of adult animals.

The skeleton as a whole is characterized by the slenderness of the bones, with indices of robustness giving much lower values than those calculated for European sheep for example. The exceptional conservation of the skeletons has allowed a study of the tail vertebrae. The number of caudal vertebrae is a good indication of the degree of primitiveness of sheep. Wild forms have 12 to 13 vertebrae, while in domestic sheep this number can rise to 35 (Zeuner 1963 ; Bökönyi 1974). The mean number of tail vertebrae in the 30 individuals that were studied from Kerma was 15, while in the modern sheep from this region it is 20. The ancient animals thus have a characteristic that can be classed as primitive, and can be placed among the "thin-tailed" sheep breeds.

As we have already mentioned above, due to the natural mummification of these animals, elements that are rarely preserved have survived, including the hair and the skin. Several individuals had coats of a single colour, black or white, but there were also some black and white piebald individuals. A micromorphological examination of hair undertaken by Ryder showed that these animals were "hairy" sheep (Ryder 1984).

According to Ryder, the sheep whose hair he studied had all been killed at the end of the summer, a fact that if confirmed would pose important archaeological problems. Only a relatively small number of animals were studied by Ryder and further analyses of a much larger sample must be undertaken before the implications of this surprising result can be assessed.

Briefly, the morphological and metrical analysis of the Kerma sheep puts them amongst the long-legged breeds. Since the majority of the individuals studied were young, it was not possible to describe their adult form to compare them fully with the sheep found at Egyptian sites and described as "*Ovis longipes paleoaegyptiacus*" or "*Ovis platyura aegyptiaca*" (Thilenius 1900 ; Gaillard 1901, 1934 ; Lortet and Gaillard 1903, 1907, 1909).

3.2. Age and sex

This section presents the preliminary results of a study that is presently being undertaken on the age and sex of the Kerma sheep. The study is of importance not only for an understanding of the nature of the sheep husbandry at Kerma, and of the burial rituals, but also has wider implications for the methodology of age and sex analysis.

The study of the age of the Kerma sheep was based on an assessment of tooth eruption and wear and of bone fusion. Figure 4 gives the result of the analysis of the eruption and wear of the mandibular teeth of the sheep from the cemetery site, using Grant's method (1975a, 1982). This method assigns a relative age to the animals and shows the general age profile of the population. Assigning absolute ages is more problematic, but we can *suggest* that sheep with mandible wear stages (MWS) 10 - 14, and 22 - 26 may have been around one year and two years of age respectively. Animals at stages 34 - 35 are unlikely to be much older than three and a half to four

years of age. The most striking feature of this age distribution is very high proportion of young and juvenile animals — four of the sheep were very young and there are very few mature and no elderly animals. The bone fusion data confirm this picture — 17 percent of the animals had no fused bones, and only six percent (three sheep) had limb bones that were fully fused (table 1). Within the relatively short lifespan represented by these animals there was a fairly wide distribution of ages, but there was a small group of animals that seem to have been of similar age at death, shown by the peak at MWS 25 in figure 4.

Since the analysis of age was carried out on a large number of complete, or nearly complete skeletons it was possible to correlate evidence for age using different methods of age estimation and to establish a bone fusion sequence. Table 1 shows the fusion sequence and the number of animals from which each stage was determined. "Unfused" bones are defined as bones were the diaphysis and the epiphysis are completely separate. Only the main fusion zones for each bone are given. The results show that there was a very consistent fusion order, particularly for those bones that fuse relatively early in the animal's life. In three animals only, slight variations were seen and these are indicated in the table. It should however be noted that while the relative fusion order of some bones, for example the second and first phalanges, was given by several individuals, for other bones there were too few animals of appropriate age to establish the sequence with certainty. For example, the fusion of the distal end of the metacarpal bone before the distal end of the metatarsal bone was demonstrated in only one individual. There was in fact a higher proportion of animals with unfused metatarsals than with unfused metacarpals. This anomaly has occured as a result of the incomplete state of some of the sheep skeletons - in some tombs the animal skeletons had been disturbed when the tomb was plundered for objects placed with the human burial. Information from the study of bone fusion alone cannot be expected to indicate the actual timing of the fusion events, but this can be suggested by correlating bone fusion with tooth eruption and wear. Table 1 gives the range of mandible wear stages that could have coincided with each fusion event for the animals studied, and also indicates the points in the sequence when tooth eruption must have occured. The eruption of the first permanent molar (M1) to the point when it is likely to have perforated the gum (i.e. half erupted) took place before epiphyseal union at any of the fusion centres listed. The eruption of M2 occured between the fusion of the second and first phalanges. There was not a consistent relationship between the eruption of M3 and bone fusion - half erupted M3s were found in individuals were the last bone to fuse was the first phalange and the distal tibia, and in one individual, the M3 was only erupting through the jaw, but the calcaneum was partly fused. Correlation with mandible wear stages does however show that the distal tibia, the distal metapodials and the calcaneum are all likely to have fused within a relatively short time of each other. Similarly, the distal humerus, scapula and pelvis form an early fusing group of bones, and the proximal ulna, proximal and distal femur, distal radius, proximal tibia and proximal humerus a late fusing group, A small number of variants of the fusion sequences for this latter group have already been observed, and it is possible that when more skeletons have been found there may

prove to have been variation within other groups, particularly as has already been suggested, in respect of the metapodials.

The fusion sequence demonstrated for this ancient Sudanese sheep population is compared with that given by several authors whose work is widely used by archaeozoologists in table 2. For the early fusing bone elements, up to the fusion of the distal tibia, most authors are consistent, and give an order that is in broad agreement with the Kerma sequence. Some authors group several bones together as fusing at approximately the same time, and where this is the case the groupings are generally also in agreement with those suggested for Kerma. Only one author, Silver (1969), gives a fusion sequence for these early fusing bones that differs significantly from the rest.

The Kerma sequence for these bones has also been observed in sheep skeletons found at Boury-en-Vexin (see Méniel 1982), in Neolitic contexts, in the wild Soay population of North Ronaldsay, Scotland and in medieval sheep from Oxford and Aylesbury (Bob Wilson pers. comm ; Gill Jones pers. comm.). However, at the Iron Age sited at Danebury, England (Grant 1984), the fusion sequence for the earliest fusing bones seems to have varied. In two skeletons bone fusion was compatible with the Kerma sequence, but in one skeleton the distal humerus and scapula had both fused while the proximal radius was still unfused.

There is much less agreement for the later fusing bones. Duerst's (1926), Curgy's (1965) and Tschirvinsky's (1889) figures are compatible with Kerma, but Rajtova (1974), Barone (1976), Smith (1956) and to a lesser extent Silver (1969) give sequences that are in some details very different from that observed in the Sudanese material. Important conclusions can be drawn from this analysis. It has been shown that there is a broad agreement between the sequence of bone fusion in this ancient Sudanese sheep population and some of the modern sheep populations whose bone fusion has been studied, but it has also shown that there may be minor differences in fusion sequences which could have important implications where fusion evidence is being used to established age at death and mortality profiles. Fusion sequences given by some modern writers, particularly those, such as Rajtova (1974) and Smith (1956), who have studied modern specialized breeds, are very different from those established at Kerma and also seen in other ancient, or primitive modern populations. It is suggested that the information given by these authors should not be directly applied to ancient sheep populations.

Assigning absolute, rather than relative ages to bone fusion is much more problematic, and modern authors have given ages that can differ by as much as three years for the same event. The same problem exists for the timing of tooth eruption (see Silver 1969, 298 ; Payne 1984) and it is still not clear by how much eruption and bone fusion have been accelerated in the modern improved breeds on which many of the studies of the timing of these events have been carried out. This problem is an important one and will be discussed further in relation to future work on the sheep from Kerma.

There is not the space in this paper to present all the results of the work so far completed on the sexing of the sheep, and indeed at the time of writing this work is still continuing. Briefly the approach has been to compare a range of morphological and metrical criteria for each individual skeleton, and, using data from sheep of known sex, to look for consistency in the pos-

sible sexual groupings that emerge. Preliminary analyses of pelvis morphology and measurements, using a range of multivariate statistics demonstrated the predominance of males among the Kerma sheep burials - only six were found to be female. The analysis completed so far has not provided any clear evidence for the presence of castrates among the male sheep.

IV- BURIAL TRADITIONS AND SHEEP HUSBANDRY

The results of the analyses of age and sex are of vital importance when attempting to understand not only the burial traditions but also the nature of the sheep husbandry.

The marked sexual imbalance amongst the sheep found in the tombs suggests very strongly that these sheep were not just a random selection from the live herds, but that males were preferentially selected for sacrifice. A collection of mummified sheep currently housed in the Natural History Museum at Lyon, but originally found in Egyptian tombs of the Ptolemaic period were examined by the authors, and were found to be similar to the Kerma sheep in that they were all male, but unlike the Kerma sheep they were all mature or even quite elderly. In most economic animal management strategies, males are never, or only very rarely kept until they are old, and it seems very likely that these Egyptian sheep may have been especially reared for sacrifice. There is a much less convincing arguement for this having been the case at Kerma, and to test the hypothesis that the male animals placed in tombs may have been ordinary members of the sheep herd, the age distribution of the animals found in the tombs was compared with the age distribution of the sheep found in contemporary deposits in the town.

This comparison is by no means straightforward for several reasons. Firstly, conditions of preservation in the town were quite poor in relation to those that existed in the cemetery. While in the tombs, the bones were from a known number of individuals and all bone elements were fairly equally represented, this was not the case in the town. The number of individuals whose bones were recovered is not known, and some skeletal elements were very underrepresented (figure 5). Unfortunately, mandibles were very rarely recovered and so any assessment of age had to be based on bone fusion rather than tooth eruption or wear.

Secondly, the town deposits are likely to have included both male and female sheep, while the tombs contained mainly male animals. No analysis of the sex of the bones found in the town has yet been possible because of the poor preservation of the bones.

Thirdly, while the sheep could easily be separated from the goats in the tombs, this separation was only possible for some of the bones from the town deposits. Using one of Boessneck's (1969, p. 353) criteria for sheep/goat separation on the calcaneum, a bone that was reasonably well preserved, it was possible to show that approximately one third of the caprovines in the town deposits were goats. The proportions of unfused sheep and goat calcanei were not the same — a higher proportion of goat than of sheep calcanei were

unfused, suggesting that there may have been some differences in the management of the two species. In contrast, the very small number of goats that were found in the tombs, were among the oldest animals found, using both bone fusion and tooth wear criteria. Incidentally, the correlation of these two methods of ageing for goats suggested the possibility of either a more rapid rate of tooth wear or a later bone fusion than was usual for sheep. The goats from the tombs were not included in the main analyses of age and sex already discussed.

Clearly, we are comparing two rather different populations when we compare the age structure of the animals from the tombs with that of the animals whose remain were found in the town. However, if we allow for preservational factors, which are likely to have caused a bias against the recovery of unfused bone elements in the town deposits, the two distributions are remarkably similar (figure 6). It is rather suprising that there is so little evidence for the presence of fully mature animals in the town — one would expect that females might to have been kept beyond maturity. Despite the problems and limitations of the comparison between the tombs and the town, it seems that we are not unjustified in supposing that the age distribution of the sheep in the tombs may, at least in a broad sense reflect the general animal management strategy, rather than just a particular funerary ritual. The absence of female animals may reflect their importance as breeding animals which made them too valuable to the community to be readily sacrificied. Those females that were found in the tombs may have been barren animals. The female sheep were among the oldest of the animals from the cemetery, and were of an age when their fertility may have already been tested. Modern sheep of the Kerma region of Sudan reach sexual maturity at the end of their first year, although if they are underfed, maturity may be delayed a further year.

The age distribution of both the sheep from the cemetery and the sheep and goats from the town suggest a husbandry system that seems to have been focused on the production of meat, rather than on any of the so-called secondary products. Information is available on modern sheep husbandry in the area around Kerma from questioning of the local vet and of farmers by one of us (LC) and on the Kababish area in general from the study by McLeroy (1961). There are some local variations, but in most areas male lambs are raised for meat and females kept for breeding purposes. In some regions ewes are milked, but even where this is the practice, the male lambs are not killed at birth, but left with their mothers for one or two months and then weaned. In the area around Kerma itself, milk and milk products seem little used. The Kerma sheep were and are hairy rather than woolly animals, and today, the hair, although plucked and clipped from the sheep, is not intensively exploited and is bartered only locally, if at all. In some regions of this area of modern Sudan, male sheep are commonly castrated, but in other areas this practice is rare although some animals may be castrated prior to fattening for slaughter.

The age structure of the ancient Kerma sheep from the tombs and the town is compatible with a husbandry system that is similar to the modern one and suggests that meat was the most important animal product. The mortality profile constructed from tooth wear data is very different from that

from Portchester Castle (Grant 1975b), a Saxon site in Britain, where wool seems to be a very important product and a large proportion of the sheep were mature at death (see figure 4).

There is though, in the tombs, a higher proportion of deaths of young animals than would be expected today. Nowadays, infant mortality is claimed to be very low, as the flocks are generally healthy, despite their rather poor nutritional status, and male animals are not usually killed until they are two years of age. We do not know whether the very young sheep found in the tombs were deliberately killed or were natural mortalities, but there is certainly evidence for a significant proportion of young animals, probably under two years of age, in the tombs. There is a rather smaller proportion of very young animals in the town deposits, but such animals are likely to be under-represented here because of the poor preservation. The peak age at death of these animals seems to have occured at around two years, which is when most modern male animals are killed.

This paper presents only the preliminary results of our study of this unique collection of animals. Further seasons of excavation at Kerma will increase the size of the sample available for study and thus the validity of our results.

AKNOWLEDGEMENTS

We would like to thank Don Brothwell and Patrice Méniel for allowing the examination of sheep skeletons from North Ronaldsay and Boury-en-Vexin, Bob Wilson and Gillian Jones for providing information on sheep bone fusion, and David Taylor for his report on the pollen from the sheep coprolites.

Financial support was provided by the University of Reading and the Muséum d'Histoire Naturelle, Genève.

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Figure 1 :

Reconstruction of the sheep with head ornaments from grave no. 81 (drawing G. Deuber).

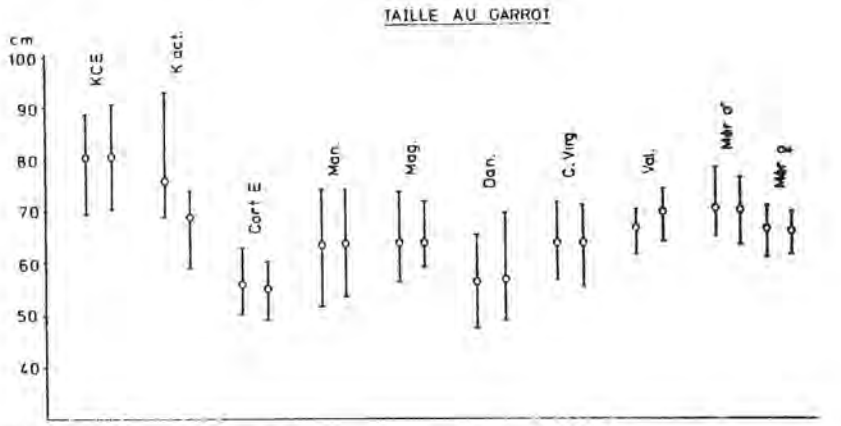


Figure 2 :

Estimation of withers' height in different sheep populations. (For each population, heights estimated from the metacarpal are given on the left, and from the metatarsal on the right).

KCE : Kerma - Eastern cemetery
Kact : Kerma - modern sheep
Cort. E. : Cortaillod - Est (Switzerland), Late Bronze Age (Chaix 1986b)
Man. : Manching (Germany), Iron Age (Boessneck *et al.* 1971)
Mag. : Magdalensberg (Austria), Iron Age (Hornberger 1970)
Dan. : Danebury (Great Britain), Iron Age (Grant 1984)
C. Virg. : Cerro de la Virgen (Spain), 2000-1200 B.C. (von den Driesch 1972)
Val. : Valencia de la Concepcion (Spain), Chalcolithic (Hain 1982)
Mér. : Merinos, modern (Teichert)

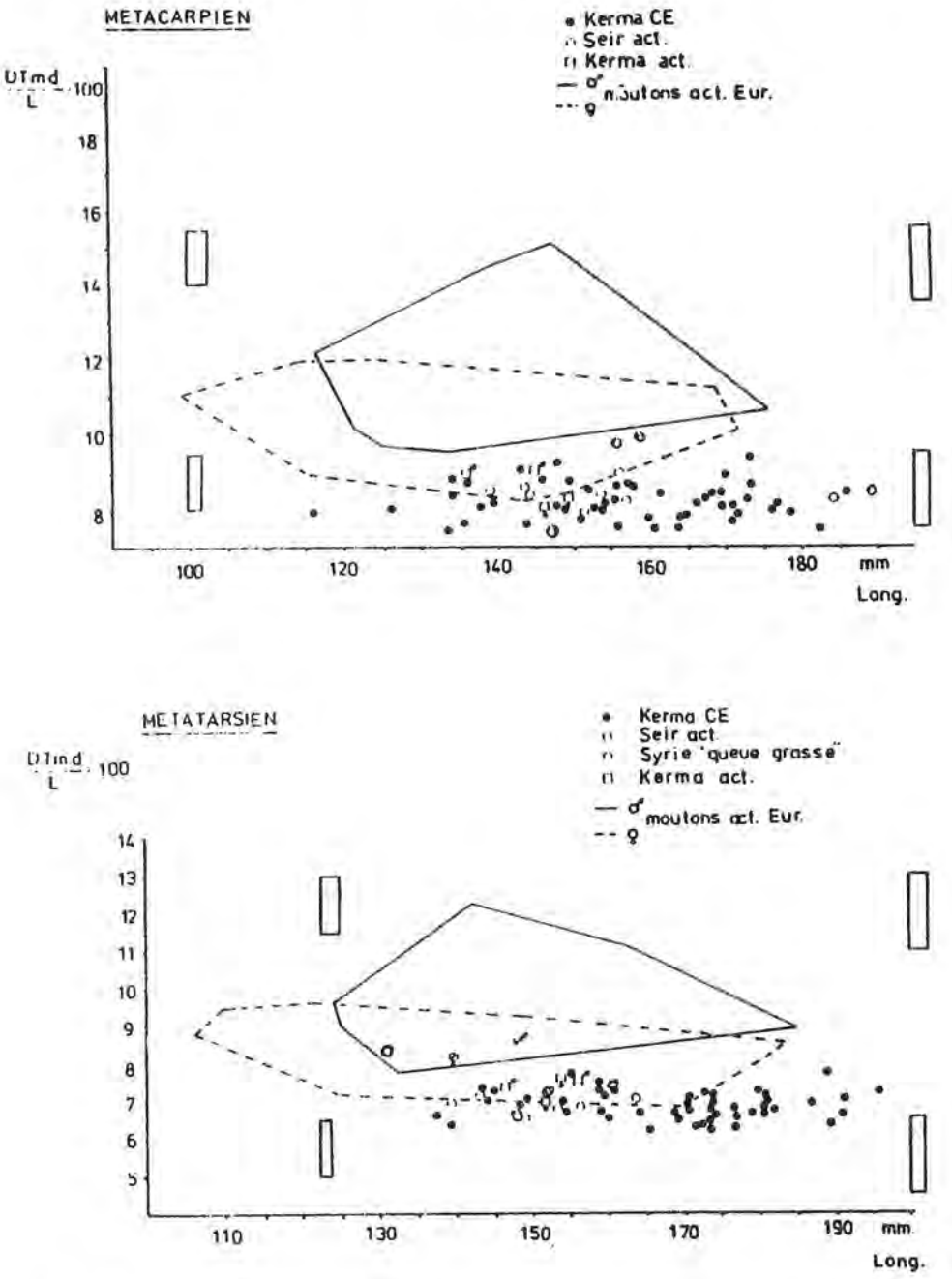
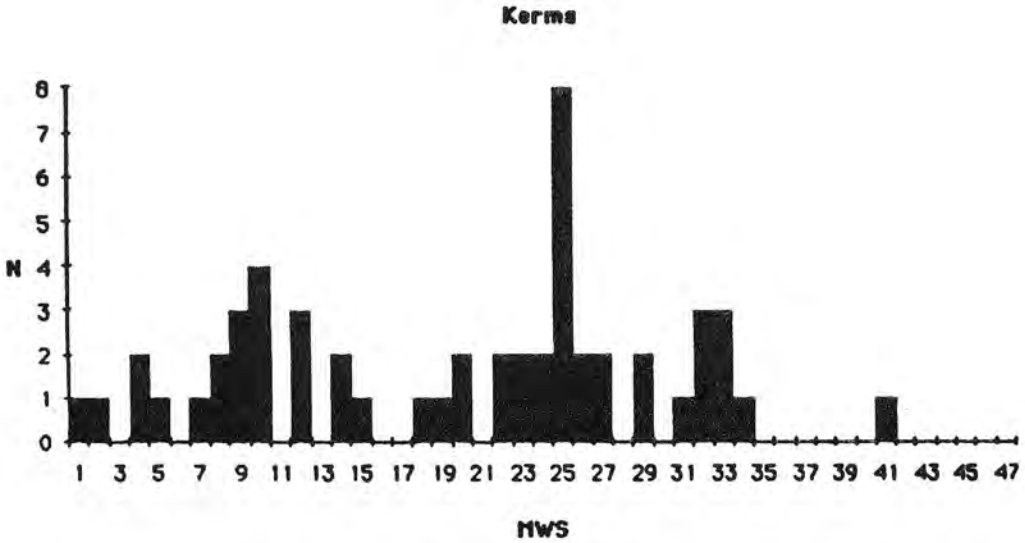


Figure 3 :

Metapodial shape. Comparisons of the ancient sheep from Kerma (Kerma CE) and modern sheep from Seir, Kerma, Syria and Europe.
X axis : length : Y axis : mid-shaft index.



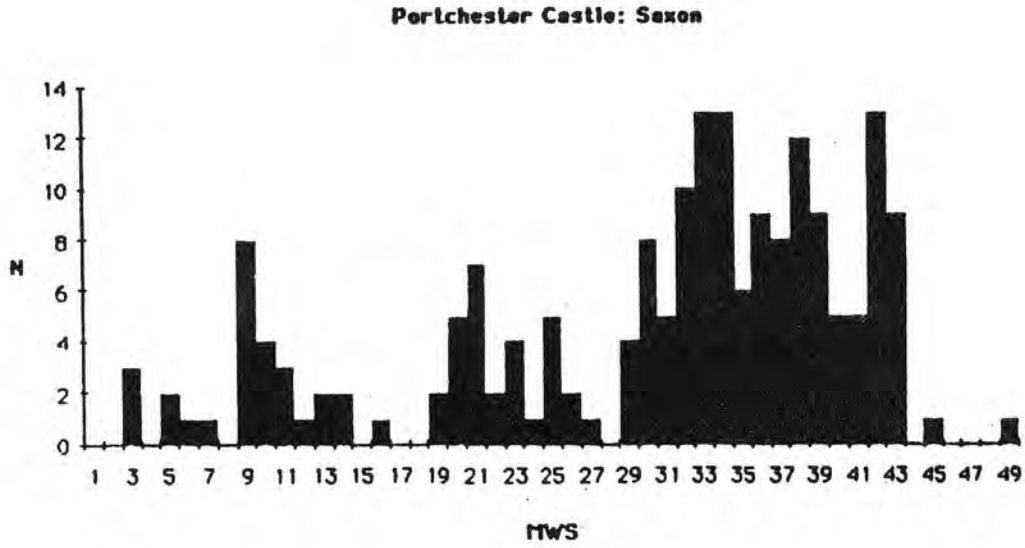


Figure 4 :
Histograms of sheep mandible wear stages (MWS) from Kerma and Portchester Castle (Saxon period) (see Grant 1975a, 1975b, 1982).

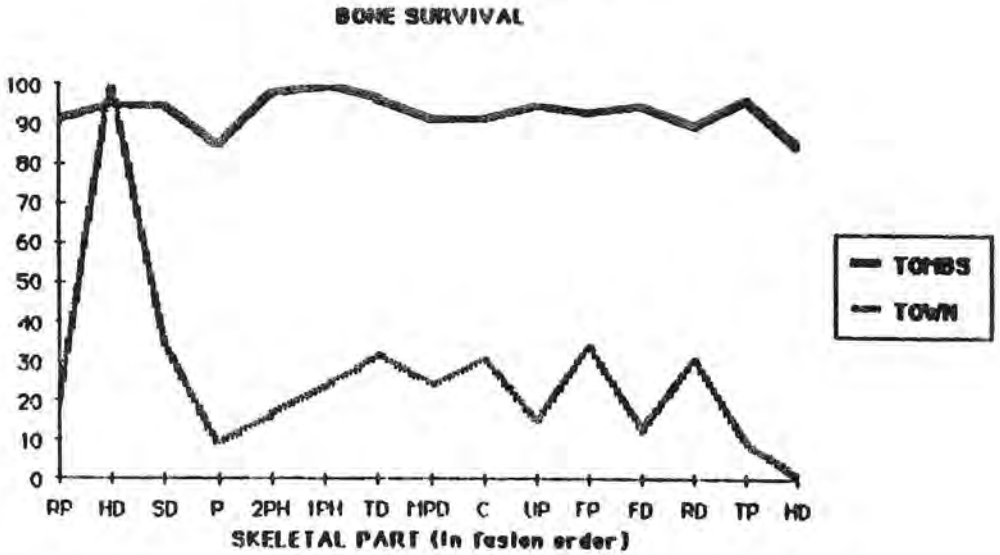


Figure 5 :

Bone element representation in the tombs and the ancient town at Kerma. Bone elements are those given in table 1.
% = % of greatest number.

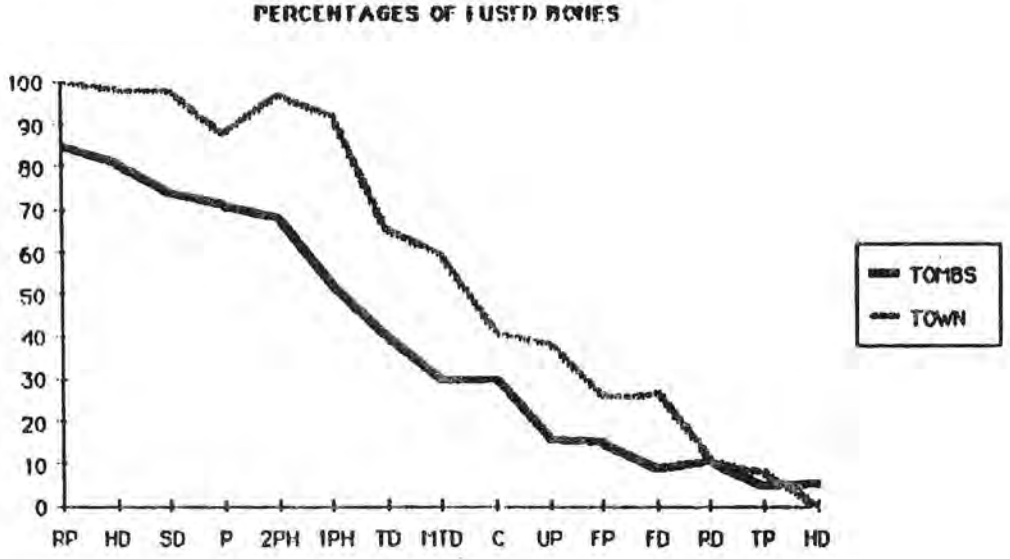


Figure 6 :

Percentages of fused bones in the tombs and the ancient town at Kerma. Bone elements are those given in table 1.
% = % of fused bones.

	No. fused	No. unfused	% fused	No. showing sequence	MWS at fusion	Tooth eruption (half erupted)
Radius P	45	9	83	6	6 - 9	M1
Humerus D	44	9	83	3	7 - 10	
Scapula D	38	14	73	7	9 - 10	
Pelvis	33	16	69	5	9 - 10	
2nd Phalange	39	19	67	12	12 - 16	M2
1st Phalange	30	29	51	13	14 - 20	M3 P4
Tibia D	22	35	39	7	20 - 26	M3 P4
Metacarpal D	13	40	25	1	22 - 26	M3 P4
Metatarsal D	17	35	33	2	22 - 26	M3 P4
Calcaneum	16	38	30	6	22 - 26	M3 P4
Ulna P	9	46	16	6*	31 - 33	
Femur P	7	47	13	3*	32 - 34	
Femur D	5	51	9	7	33 - 34	
Radius D	6	47	10	3	32 - 33	
Tibia P	3	54	5	3	33 - 34	
Humerus D	3	46	6		34 - 36	

* in 2 sheep Femur P has fused before Ulna P
* in 1 sheep Radius D has fused before Femur D

Table 1 :

Bone fusion, tooth eruption and tooth wear in the Kerma sheep

KERMA	DUERST	RAJTOVA (MERINOS)	BARONE	SILVER	SMITH (Clun Females)	CURGY	TSCHIRVINSKY
Radius P	Rad P	Rad P	Hum D	Scap D	Hum D	Hum D	Hum D
Humerus D	Hum D	Hum D	Rad D	Pelv	Rad P	Rad D	Rad P
		Scap P					
		Pelv					
Scapula D	Scap P		Scap D	Hum D	Scap D	Scap D	
	Pelv		Pelv	Rad P			
Pelvis						Pelvis	
2nd Phalange	2nd Phal		2nd Phal	2nd Phal	2nd Phal	2nd Phal	
				1st Phal			
1st Phalange	1st Phal		1st Phal		1st Phal	1st Phal	
Tibia D	Tib D	Ulna P	Tib D	Tib D	Tib D	Tib D	Tib D
Metacarpal D		Metat D	Metac D	Metac D	Calc	Metac D	Metac D
			Metat D		Metat D	Metat D	Metat D
Metatarsal D	Metat D	Fem P		Metat D			
		Calc P					
Calcaneum	Calc	Hum P	Fem D	Calc	Metac D	Calc	
				Fem P			
Ulna P	Ulna P		Tib P		Hum P	Ulna P	
	Fem P		Fem P		Fem P		
Femur P		Tib D		Ulna P		Fem P	Fem P
		Metac D		Rad D		Fem D	
Femur D	Fem D		Rad D		Fem D	Rad D	Hum P
	Rad D						Rad D
Radius D	Tib P	Fem D	Ulna P	Fem D	Ulna P		Fem D
	Hum P		Hum P	Tib P	Radius D		Tib P
Tibia P		Rad D		Hum D		Tib P	
						Hum P	
Humerus P		Tib P	Calc P		Tib P		

Table 2 :

Fusion sequences at Kerma compared with those given by Duerst (1926), Rajtova (1972), Barone (1976), Silver (1969), Smith (1956), Curgy (1965) and Tschirvinsky (1899). Bone elements on consecutive lines are given as fusing at approximately the same age. Bold type indicates significant departures from the Kerma sequence.