

ARCHAEOZOOLOGICAL EVIDENCE FOR EQUID USE, SEX STRUCTURE AND MORTALITY IN A ROMAN AUXILIARY FORT (CARNUNTUM-PETRONELL, LOWER AUSTRIA)

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Abstract - A series of skeletons and cranial remains of horses and mules from the Roman auxiliary fort Carnuntum (Lower Austria, Roman province of Pannonia) allows a detailed investigation of metrical traits, age and sex structure and pathological phenomena. This rather unique situation is due to opportunistic human behaviour, as ditches and pits in the foreland of the fort were used for the dumping of animal carcasses. The bone sample exhibits a high degree of selectivity regarding sex and size for both horses and mules: only male specimens are present, and the size range covers the upper part of the known variability for the period and region given. As for the age structure, the majority of the horses belongs to the age group of young adults (5-9 years), a situation known from other Roman military contexts. The skeletons and other equid bones are interpreted as the remains of "normal" losses, probably due to all kinds of diseases or injuries, which occurred during their use as ride or pack animals. Some pathological features are evidenced by the bone remains themselves. The scarcity of aged horses can be explained either by quick turnover or by the disposal of the animals into different economic circumstances.

Résumé - Témoignages archéozoologique de l'utilisation, de la structure sexuelle et de la mortalité des Équidés dans un fort auxiliaire romain (Carnuntum-Petronell, Basse Autriche). Une série squelettes et de restes crâniens de chevaux et de mulets du fort auxiliaire romain Carnuntum (Basse Autriche, Province romaine de Pannonie) permet une étude détaillée de la morphométrie, de l'âge, de la structure sexuelle et des phénomènes pathologiques. Cette situation assez rare est due à un comportement humain opportuniste, les fossés et fosses autour du fort ayant été utilisés pour rejeter les carcasses animales. L'échantillon montre une forte sélection du sexe et de la taille à la fois des chevaux et des mulets : seuls des individus mâles sont présents, et l'éventail de taille correspond à la partie supérieure de la variabilité connue pour cette période et cette région. En ce qui concerne la structure d'âge, la majorité des chevaux est représentée par des jeunes adultes (5/9 ans), une situation connue dans d'autres contextes militaires romains. Ces restes d'Équidés ont été interprétés comme le résultat de pertes "normales", probablement liées à toutes sortes de maladies ou de traumatismes qui se produisent lors de l'utilisation des animaux pour la monte ou le trait. Le faible nombre de chevaux âgés peut s'expliquer par un remplacement rapide ou par l'utilisation des animaux dans différents contextes économiques.

Key-words: Equid remains, Roman Period, Lower Austria, Auxiliary fort, Age structure.
Mots clés: Restes d'Équidés, Période romaine, Basse Autriche, Fort auxiliaire, Structure d'âge.

IBEX J. Mt. Ecol. 5: 109-118
ANTHROPOZOOLOGICA 31: 109-118

1. Introduction

Long term rescue excavations in the Roman auxiliary fort of Carnuntum/Petronell (Lower Austria) are carried out by the Austrian Archaeological Institute. Archaeological evidence indicates the presence of an equestrian unit from the second half of the first century

A.D. until the end of the third century A.D., when this fort was abandoned. The nearby legionary fort and the civil town of Carnuntum, however, remained of local importance until the final fall of the Danubian limes in this area at the end of the fifth century. The interpretation of the site as a cavalry fort

is corroborated by the faunal remains: bones of equids (mostly horses, but also mules and donkeys) are frequent in many samples, within certain archaeological features like pits and ditches they constitute over 50% of bone weight and over 20% of bone number. In some cases even complete or partial skeletons of horses and mules were discovered, allowing for a detailed analysis of osteological characters like cranial morphology, size, sex and age at death.

2. Archaeological context and taphonomy

All equid remains discussed in this paper are from the southeastern foreland of the fort (Fig.1). They were found at the bottom of wells and dug out earth pits which were probably excavated for building material, and within an outer defensive ditch which was no longer used. As for this latter feature, a similar setting is described by Lauwerier for Nijmegen IV (the Netherlands; Lauwerier, 1988: 162).

The structures were filled up with all kinds of domestic rubbish, including food remains and animal carcasses. Most of the complete and partial skeletons were still articulated, indicating a quick burial. In some cases there are only minimal signs of disarticulation, like the lateral displacement of hyoid bones. Incompleteness of the skeletons, however, was frequently observed, and may have been the result of repeated dumping actions at the same spot, resulting in the disturbance and partial amputation of carcasses already buried (*cf.* Stampfli, 1994, for the same effects in a modern age knackers yard). This holds especially true for the defensive ditch, where a rather complex taphonomic history could be detected (Kunst, 1996; 1997a,b). Due to the position of the skeletons and the almost complete absence of cutmarks, there is no indication of any type of carcass use, the animals were neither cut into pieces nor

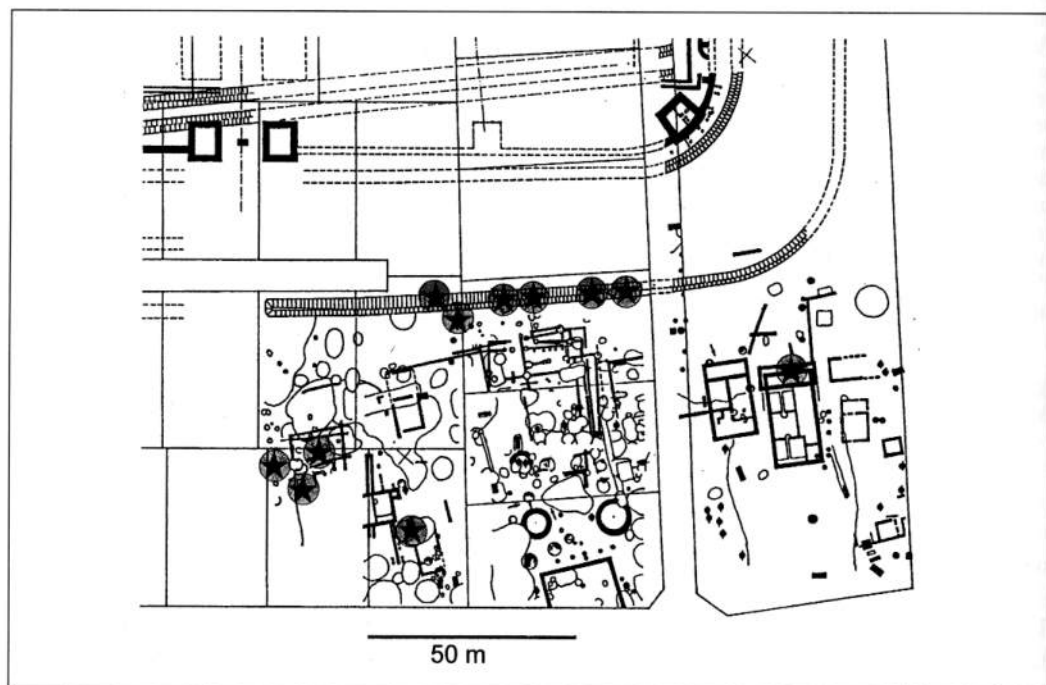


Fig.1 - Carnuntum/Petronell, auxiliary fort: southeastern corner and foreland, with the porta decumana (top left), a corner tower (top right), inner and outer defensive ditch; spots where equid skeletons or skulls were found are marked by an asterisk; linear structures in the foreland possibly indicate fencings of a training ground or a pasture for horses (partly from Kandler, 1997).

skinned before they were buried. There is no regularity in the manner the animals were arranged within the features, some appear to have been forced into the pits with limbs and neck bent, some were found with their extremities stretched out etc. All these features are interpreted as an evidence for the regular, organised disposal process of ride and pack animals which had died for whatever reasons. Later on in the third century, buildings of a civil settlement, maybe a kind of *vicus*, developed in the southeastern foreland (Fig. 1; Kandler, 1997). Thus it cannot be ruled out that some part of the rubbish does not result from a strict military context. Furthermore, some linear structures in this area may represent the traces of the fencing of a training ground for horses (Zimmermann, 1997).

3. Material and methods

All available complete and partial skeletons available were analysed, containing cranial elements and isolated skulls and mandibles of horses, mules and undetermined equids found during the excavation seasons from 1990 onwards (Tab. 1). Chronology was established either by associated pottery or by the overlying structures of the *vicus*. Although not representing a contemporaneous sample in the strict sense, most remains can be attributed to a time interval of about one century. Altogether, there are the remains of 16 specimens (10 horses, 4 mules and 2 unspecified). Even if contemporaneous, they could be regarded only as a tiny percentage of the equid population once present at the fort. Exact numbers of animals in Roman auxiliary forts are debated, but the amount of riding horses alone would certainly total at least several hundred animals, but maybe 800 or more at one time (Sommer, 1995; Zimmermann, 1997).

Discrimination of horses and mules usually represents no problem in the case of skeletons or cranial elements with complete sets of toothrows (*e.g.* Armitage & Chapman, 1979; Uerpman & Uerpman, 1994), but may be

rather difficult in very young animals and in specimens whose teeth are completely worn. Bone measurements were taken according to von den Driesch (1976). Sex was established by the presence or absence of well developed canines. Estimates for the age at death can be based upon the state of epiphyseal fusion, incisor wear and molar height (Duerst, 1922; Habermehl, 1975; Levine, 1982). Epiphyseal fusion is of little relevance in this sample, and molar height was preferably used in old individuals or in case incisors were missing. Sometimes the results obtained by the two methods were slightly different, means are given in table 1. The majority of the investigated equids belongs to the group of young adults and could easily be attributed to the incisor wear stages taken from Duerst (1922) and Habermehl (1975). In some cases, however, individual variation in the enamel margin and, as a consequence, in the cross section of the worn incisor, may render exact ageing difficult. A slightly different incisor conformation in mules represents a further problem (Fig. 2).

In general it was taken for granted that abrasion pattern in mules does not differ too much from the one observed in horses. If donkey and hybrid teeth are somewhat harder than those of horses (Uerpman & Uerpman, 1994), the ages at death given for mules in tab. 1 are likely to be underestimated.

Pathological signs in limbs, vertebrae and dentition were identified according to a veterinary handbook (Stashak, 1989) and to case studies found in archaeozoological literature (*e.g.* Müller, 1985).

4. Results

In Tab. 1, all relevant data such as field numbers, species determination, completeness of the skeletons or fragment type, age estimates, archaeological context as well as the dating are given (*see* Kunst 1997a for further anatomical details of the equid remains)¹. The variability in cranial shape of the horses was found to be considerable, indicating their rather heterogeneous origin.

¹ In Kunst (1997a), the figure captions for the equid skulls were mixed up: fig. 4 and 5 show mules, fig. 6-7 show horses.



Fig. 2. - Carnuntum, auxiliary fort: mesial portion of mandible of a horse (left) and a mule (right); mind differences in the lenght of the diastema and in the configuration of the incisor arc. (photograph by R. Gold)

Tab. 1 - Carnuntum-Petronell. Catalogue of archaeozoological and archaeological data (vert.=vertebrae).

Find no.	Species	Completeness	Pathologies	Age Estimate (years)	Feature Type	Century A.D.
567/90	horse	skeleton	limbs	5	pit	2 nd -3 rd
378/91	horse	skeleton	vert., limbs	11-12	well or pit	late? 3 rd
462/91	horse	skeleton	vert., limbs	5,5-6	pit	middle 2 nd
469/91	horse	skeleton		20-24 months	ditch	early 3 rd
240/93	horse	skull		5	ditch	early 3 rd
1761/93	horse	skull	teeth	20	ditch	early 3 rd
1234/93	horse	mandible		16,5-20	ditch	early 3 rd
1806/93	horse	skull		4,5-5	ditch	early 3 rd
587/97	horse	partial skeleton	vert.	9	pit	2 nd
857/97	horse	skeleton	vert., limbs	7-8	pit	early 2 nd
951/93	mule	partial skeleton		6,5	ditch	early 3 rd
1097/93	mule	mandible	teeth	15-17	ditch	early 3 rd
53/94	mule	partial skeleton	vert.	15-16	ditch	early 3 rd
900/97	mule	skeleton	vert., limbs	6-7	ditch	early 3 rd
788/93	equid	mandible		18-20	ditch	early 3 rd
1166/93	equid	skull+mandible		10-12 months	ditch	early 3 rd

4.1. Sex and age

Virtually all specimens with preserved front teeth, both horses and mules, exhibit fully developed canines and are therefore classified as males. As far as age is concerned, the distribution of the age estimates is also indicated in Fig.3.

Unprecise estimates are distributed equally across the year intervals in this diagram. All skeletons referable to horses yielded estimates of less than 12 years, the majority of under 10 years. There are no skeletons, but some cranial parts of senile or very old horses. One skeleton belongs to a specimen that died at an age of less than two years (Tab.1; Fig.4).

Of the four mules, two specimens are referable to the group of young adults (6-7 years) and to a more advanced age group (15-17 years), respectively. There is one partially preserved skull of a foal of less than one year, which could not be assigned to either horse or mule due to the lack of comparative material in mules. In general, remains of very young individuals are rare among the isolated postcranial equid bones from the southeastern foreland.

4.2. Size

Measurements of metapodials, including some isolated bones from the auxiliary fort, were compared with a vast sample from the

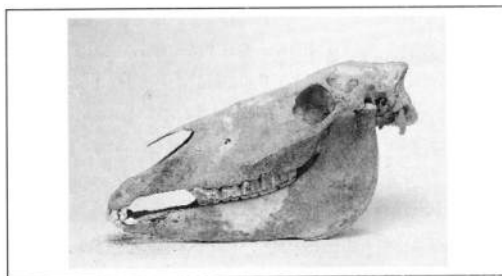


Fig. 3. - Mortality profile for mules and horses (including undetermined equids) from the auxiliary fort Carnuntum and for the Roman horses from Krefeld/Gellep (Nobis 1973). Age classes as indicated, uncertain estimates distributed equally across classes.

Germania Romana and the Danube provinces (the Netherlands, Germany, Switzerland, Austria, Hungary; see Reichstein, 1991 and Kunst, 1997a for a detailed enlistment of sites, including both military and civil settlements). In a bivariate scatterplot (greatest length/distal breadth) for the third metacarpal, both mules and horses from Carnuntum occupy the upper part of the overall variation (Fig. 5). A similar picture can be obtained from the third metatarsals. Withers height estimates calculated from long bone measurements vary considerably according to element and even more so if skull measurements are included (May, 1985).

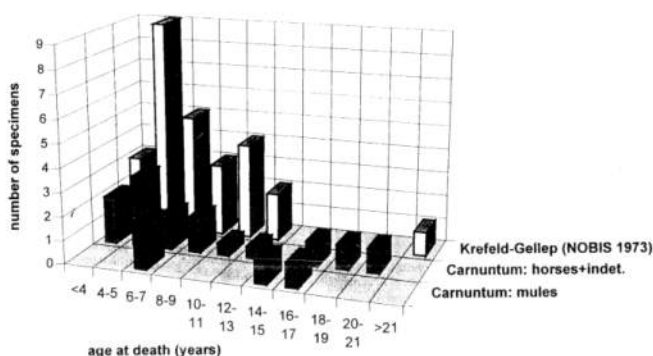


Fig. 4. - Carnuntum, auxiliary fort: Skull and mandible of a young horse (no.469/91) with complete milk dentition and first two molars in wear, part of a complete skeleton. The age estimate for this specimen is 20-24 months, probably corresponding to the earliest possible age at which horses were supplied to the Roman army.

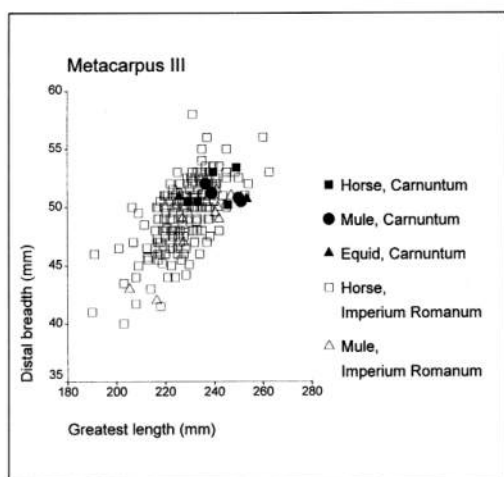


Fig.5 - Horses and mules, third metacarpal: scatterplot of greatest length versus distal breadth (mm); see text for composition of samples.

The observed variability for horses was found to be 135-163cm (based upon long bone measurements only), the highest estimate was taken from a specimen with exceptionally long hind-quarters (no.378/91). If this specimen is excluded, the upper limit approximates 150cm. As for the mules, the values range from just under 140cm up to 155cm. That roman mules would stand about as high at withers as riding horses agrees with historical sources and osteological evidence from other sites (Lipper, 1981; Dixon & Southern, 1992).

4.3. Pathologies

Apart from the skeleton of a young horse (469/91) and the partial skeleton of a young adult mule, all of the (partial) skeletons are affected by some kind of pathological phenomena, either in the vertebral column or in the limbs, or in both (Tab. 1). Most of these lesions are clear responses to unphysiological loading, and some can be seen as an independent proof that these animals actually were ridden (Müller, 1985; Benecke, 1994). Deformations found in the vertebrae (bony bridges between corpora, exostoses around articulations, pseudarthroses

between dorsal spines), some of which are clear signs of *spondylosis deformans* can serve as useful examples. In the horses, these conditions do occur within a particular section cranially limited by the 12th thoracic and caudally by the 3rd lumbar vertebra. In one mule, cranial parts of the vertebral column, from the 5th thoracic vertebra onwards, are affected as well, possibly an effect of a different type of loading in baggage animals. Ironically enough, the transverse breakage of epiphyses of vertebral corpora, usually valued as evidence for riding, was likewise observed in this mule specimen.

As for the limb diseases, exostoses were found in the articular areas of the humerus, of the tarsal bones and of the proximal phalanx. Although some of these exostoses represent possibly an early sign of spavine, complete fusing of elements (*e.g.* tarsal bones) was found to be relatively rare.

Some damage observed in the mandibles (labelled "teeth" in Tab.1), like exostoses on the basal margin of the corpora and irregular, asymmetric wear on second premolars, may be related to pressure caused by the bits and other parts of the harness.

5. Discussion

Further evaluation of the equid remains from Carnuntum is based upon two assumptions: *i.* Most, if not all, of the dumped carcasses and of the isolated parts are in some way related to activities carried out by the fort residents, *i.e.* they are the remains of ride or pack animals actually used by auxiliary troops of the Roman army.

ii. The sample, small though it may be, is more or less representative for the equid population that once died at the site, that means, habits of carcass disposal did not differ too much according to species (horse or mule), sex or age.

Culturally influenced bone assemblages dominated by equid remains are comparatively rare in later prehistory and even in Roman times. Nevertheless, a number of examples are known (*see e.g.* Nobis, 1973; Lauwerier, 1988; Lauwerier & Hessing, 1992; Junkelmann,

1990:250) which allow at least a tentative demographic analysis.

At Carnuntum, even if the archaeological background was completely ignored, strong signs of selectivity are apparent from the composition of the bone remains alone, which is clearly different from the pattern expected at agrarian sites where equids are bred or consumed (e.g. Reichstein, 1991).

5.1. Sex

The most straightforward statements can be made for the sex structure, as both horses and mules are exclusively represented by stallions. A similar situation was found at Krefeld-Gellep, where all skeletons that could be sexed (over 50% of the sample) were classified as males. There is no definite proof for mares at Krefeld-Gellep (Nobis, 1973). At Kesteren, both mares as well as stallions or geldings were present (Lauwerier & Hessing, 1992). On the other hand, written sources and archaeological evidence indicate the simultaneous use of mares and stallions by the same Roman units (Dixon & Southern, 1992: 175). According to pictorial and literary sources, gelding was not employed as a routine procedure in the Roman army (Hyland, 1990; Dixon & Southern, 1992), hence the Carnuntum specimens probably represent entires. Given adequate handling, the use of stallions as cavalry mounts should not be a problem. Hyland (1990: 81) suggests that more males than females were used as military horses, because "*Mares produced the replacements for cavalry and unless barren would be more likely to be kept in the breeding herds.*". Thus the sex structure found at Carnuntum may be a hint to a regular basis of the supply of equids in this province. This explanation, however, makes no sense regarding the exclusive presence of male mules at the site: in this case more archaeological evidence must be awaited.

5.2. Age

An investigation of the mortality curve of a

Roman equid population kept at a military fort raises important questions concerning the start of education and service, the length of use and the time of disposal. There are but a few skeletal series from other sites which allow for a comparison:

i. At Krefeld-Gellep (Lower Rhine area, Germany), over 30 horse skeletons were investigated by Nobis (1973, see also Junkelmann, 1990: 42). These animals were probably killed in a battle during the Batavian revolt in 69 A.D. and buried together with over 40 humans. If the archaeological interpretation is valid, the mortality curve of the Krefeld-Gellep specimens should correspond to a non-selective or "catastrophic"(in palaeontological terms) pattern, representing a synchronic "snapshot" (Lyman, 1994) of the age spectrum of a Roman cavalry unit of the second half of the first century. Most of the specimens whose age could be estimated belong to age classes between 4 and 11 years, with a clear peak in the group of the 4-5 years old (Fig.4). There are three horses aged around 3 years, and one senile specimen (Nobis, 1973).

ii. At Kesteren-De Prinsenhof (the Netherlands), 26 buried horses, associated to a Roman auxiliary fort and a *vicus*, were analyzed by Lauwerier & Hessing (1992). Before, these findings were erroneously interpreted as belonging to rider graves, because a human cemetery extended in the same area that was originally used as a dumping ground. The most probable date for the horse skeletons is the first century.

Apart from belonging to an earlier period, the situation at Kesteren is much more comparable to the one found at Carnuntum, with the skeletons accumulating slowly in the course of repeated dumping episodes. As for the age spectrum of the Kesteren horses, Lauwerier & Heissing (1992: 92) conclude: "*Indications for the ages of horses point in the direction of an age between approximately two and fourteen years, with the majority being between six and eight years of age. Only one horse is older than twenty years of age. This*

means that the horses would have died either because of illness or through violence. A normal group of dead horses would, with the exception of animals dying early through illness, be made up of a relatively larger number of old animals."

In general, the same observations concerning age at death are true for the Carnuntum material as well. However, mortality can only act upon a given age segment, which is likely to be rather restricted at a military site, probably corresponding to the distribution met at Krefeld. The apparent lack of aged animals could be explained either by a rather lowered life expectancy of cavalry mounts or, more likely, by the disposal of aged horses. Likewise, the scarcity of foal remains may be due to the fact that horses were not purchased by the Roman army before a certain age. Davies (1969), Hyland (1990) as well as Dixon & Southern (1992) sum up the remarks of various antic authors concerning the age at which the education of young horses would begin. Basically, the training would start with animals of two or more usually three to four years of age. Hyland (1990: 82): "...Pelagonius says that horses, other than racehorses, can be broken at two years of age (Ars Vet.I); Columella agrees; Varro recommends leaving breaking until three because horses are more muscled up then (de Re Rust.), and Virgil (Georgics III.191) concurs with him. The modern method is normally to break a youngster in at three but not to work it until it is four.", and further, mentioning the Krefeld material: "...This argues for the preferred age of chargers being in the age group that had achieved physical maturity but had not seen the excessive wear and tear of hard usage."

Returning to Carnuntum, the findings of some rather aged horse skull fragments and mandibles contradicts the assumption of the assemblage being built up entirely of equids that died during active service, although "...In optimum circumstances the army would perhaps buy horses at four or five years old and retire them at roughly 17-18 years." (Dixon &

Southern, 1992:174). Fixed prices in the Late Empire indicate that a horse was expected to last approximately three years on active duty (Hyland, 1990:86). The length of service of Roman cavalry horses would certainly largely depend upon the political situation at the times and places concerned. It can neither be excluded that horses withdrawn from military service because of injuries or advanced age were used as pack animals or for breeding purposes (Dixon & Southern, 1992). Altogether, the Carnuntum data suggests either a rather quick turnover or the disposal of horses beyond a certain age. A somewhat enigmatic evidence is represented by the foal skull 1166/93, which cannot be assigned to either a horse or a mule with certainty. As for the mules in general, the sample is still smaller than that of the horses, and comparative data from literature could not be found at all. The pathological conditions in the vertebral column of mule 53/94, aged about 15-16 years, are worse than any similar lesions observed in the Carnuntum horses, indicating that mules were exploited to their very limits (Armitage & Chapman, 1979).

5.3. Size

The size of Roman cavalry horses is discussed at length by various authors (e.g. Hyland, 1990; Junkelmann, 1990; Dixon & Southern, 1992). The bones measurements and the estimates for heights of withers from horses found at the auxiliary fort Carnuntum fit well into the variability given for military horses by the sources mentioned above, yet occupying the upper half of the distribution for a general Roman sample from Middle Europe (Fig. 5), as well as compared to new data from Roman Germany presented by Peters (1994). The question arises, as put by Dixon & Southern (1992:165f.) if "...either some effort was made within each unit or indeed each province to obtain horses of a standard height, ... or that, within certain limits, rigid adherence to a standard size was not considered an important factor, and there was considerable variation. ... it is que-

stionable whether ideal appearance and average size had any relevance to the daily life of a Roman cavalry unit,...".

Results given in figure 5 which includes also material from Pannonia and a comparison with a small sample from a civilian context from neighbouring Noricum (Riedel, 1991) suggest that selection for greater body size may have played a role in the case of Carnuntum. The same holds true for the size of the mules, whose bones, counter a widespread belief among osteologists, can not always be discerned from horses by their smaller dimensions or slender proportions. Bone evidence for large sized Roman mules, expressing "hybrid vigour", is known from London and Bavaria (Armitage and Chapman, 1979; Lipper, 1981).

It is difficult to tell if the pathological phenomena, observed in most of the skeletons, mirror a situation typical of the state of health of cavalry horses and mules under service, or if these very damages did in fact contribute to the eventual death of the animals in each individual case, thus giving a somewhat biased picture.

Aknowledgements

Grateful thanks go to Manfred Kandler, the leader of the excavation team, and to Ursula Zimmermann (both Austrian Archaeological Institute), for providing important archaeological data. All photographs were taken by Rudolf Gold, Institute for Palaeontology, University of Vienna.

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