Animal Husbandry and Hunting in Tác-Gorsium

ANIMAL HUSBANDRY AND HUNTING IN TÁC-GORSIUM
THE VERTEBRATE FAUNA OF A ROMAN TOWN IN PANNONIA

PUBLICATIONES INSTITUTI ARCHAEOLOGICI
ACADEMIAE SCIENTIARUM HUNGARICAE

STUDIA ARCHAEOLOGICA VIII

REDIGIT: L. GEREVICH

AKADÉMIAI KIADÓ, BUDAPEST 1984
AEDES ACADEMIAE SCIENTIARUM HUNGARICAE

ANIMAL HUSBANDRY AND HUNTING IN TÁC–GORSIUM THE VERTEBRATE FAUNA OF A ROMAN TOWN IN PANNONIA

BY

S. BÖKÖNYI

AKADÉMIAI KIADÓ, BUDAPEST 1984

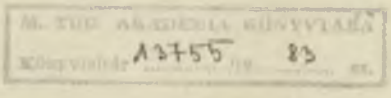
PUBLISHING HOUSE OF THE HUNGARIAN ACADEMY OF SCIENCES

ENGLISH TEXT REVISED BY

DR SUSAN NACEV SKOMAL

ISBN 963 05 3152 6

PRINTED IN HUNGARY



CONTENTS

PREFACE

The name of Gorsium has come down to us from references in *Itinerarium Antonini*, a route guide compiled at the end of the 3rd century.

Research carried out during the course of archaeological excavations begun in 1958 in the surroundings of the Fejér county community of Tác, identified the big Roman site as a way station lying at the cross point of roads leading from Sopianae (Pécs) to Aquincum (Óbuda) and to Brigetio (Ószőny). The name of Gorsium first appears in the archaeological literature in the middle of the 19th century. The museum of Székesfehérvár organized a series of small excavations here between 1934 and 1939 and later in 1955. The systematic excavations carried on since 1958 are among the largest in Hungary, partly as a consequence of the large territory encompassed by the site. Since the middle of the last century, stone monuments uncovered at Gorsium clearly indicated that it was reasonable to search here for the religious centre of Lower Pannonia, for temples to the Caesars, for the chief altar of the province, and finally for the seat of the provincial parliament. Not only was this settlement important in antiquity but practical circumstances make excavation easier here. Towns exist even today on the sites of most of the other ancient Roman towns. Savaria is under Szombathely, Scarbantia is under Sopron, and Sopianae lies under Pécs. In such places it is virtually impossible to open wide, continuous areas. However, no mediaeval town was built over Gorsium. Instead, in the 970s, Géza chose Székesfehérvár to be his sovereign residence as it was more easily defended by surrounding swamps, rather than the ancient town beside the Sárvíz which lay on open ground. Life at Gorsium did not completely end with the slow dying out of Roman culture here. The town was inhabited at the time of the Hungarian Conquest, and in the Middle Ages as well when it appeared in the Charters as Föveny. The small village of maximally 15 to 20 houses was totally destroyed during the Turkish wars and even after the liberation in 1688 it was not reinhabited. As a result of the abandonment, the ancient levels of the town over its whole extent lay under plowlands and pasture thus providing no obstacles to total archaeological recovery.

Plowed up surface remains of sherds, bricks and buildings, as well as air photos indicate that the total area of the ancient settlement can be estimated at three square kilometres. It is remarkably big by ancient standards since then the average city size seldom exceeded 20 to 50 hectares. These surface observations, however, include the outskirts of the city, sporadic clusters of buildings and farmsteads as well. The town of Gorsium itself was of a significantly more modest size typical for the period.

The River Sárvíz divided the settlement into a smaller western area and a larger eastern area. The early military camp and the city centre built over it in the 2nd century, lay on gently rolling land on the eastern bank of the river. The original line of the river bed can be followed in the low flatlands falling east of the modern channel. Its broad bed, divided by small islands, made several wide meanders in the territory of Gorsium. The part of the town lying on the west bank of the river was bordered on the north by an artificial lake, while swampland lay on the southern edge of the eastern section.

Between 1958 and 1978 barely 0.5 per cent of Gorsium had been excavated. Research has been carried out in two territories: one at the centre of the settlement, about one third of which has been excavated, and proportionally smaller works in an area lying south of the city centre.

Even at this stage of investigation, however, the identified levels and approximately 800,000 finds form a definite picture of the history and the character of ancient life in Gorsium.

Just as the mediaeval remains can only be observed in a very narrow territory above the Roman Age layers, in a 100 meter radius in the city centre, so the monuments to the millennia of life preceding the

Roman Conquest appear only as traces. The majority of these traces were themselves destroyed by subsequent Roman building activity. Only in the southern section of the town was it possible to delineate Neolithic and Bronze Age settlements, the material of which makes up less than 0.1 per cent of the whole. The mediaeval material comprises about 2 per cent of the total find sample.

The Roman Imperial Period can be sub-divided into three phases by the character of the settlement. The deepest and earliest levels include the time interval from the first Roman occupation in the middle of the 1st century until the beginning of the 2nd century. The Romans in the eastern part of Pannonia established a military camp here at a cross-road of strategic importance in order to defend a ford of the Sárvíz. Up to 500 mounted soldiers were stationed here. The unit was called *ala I Scubulorum* and came originally from the Balkans. This cavalry was later replaced by an infantry unit, again 500 soldiers, which included a smaller unit of mounted men called *cohors I Alpinorum equitata*. In the neighbourhood of the camp lay a farming village where the relatives of the soldiers, craftsmen and merchants lived in semi-subterranean huts and thatched houses. Most of the military supplies came from Italy at that time.

The second period began in the first decade of the 2nd century. The *limes* fortress built along the Danube made the interior military camp at Gorsium unnecessary and the troops stationed there were ordered to leave. When the government divided Pannonia into two parts in 106, Gorsium was made the religious centre of the Lower Pannonian province. On the place of the former military camp was constructed a great hall of the Caesar cult, a temple to the dead Caesars, the chief altar of the province and the appropriately impressive *Curia* accommodating the provincial parliament. The religious centre at this time was surrounded by densely populated quarters of village-like character. The inhabitants were Celtic *Eravisci* who had come from the larger surrounding area but kept their ancient traditions and clothing even in the town milieu. At the southern edge of the town was a blossoming potters' work area which produced mostly Celtic plates, pots and decorative dishes for more than half a century.

This second period in the town's history is broken by the Marcomannic-Sarmatian wars. Although a new military camp was built in the southern quarter of Gorsium to assure secure supply lines, the town was destroyed anyway. The Sarmatians probably attacked in 178 and totally burned the outer sections while damaging the holy sanctuaries and the government buildings in the city centre. Rebuilding Gorsium went slowly after the war until the 3rd century when the tempo of construction picked up quickly. The rebuilt city differed in its new urban character from the settlement existing before the Sarmatian attack. The wattle and daub constructed buildings were changed for buildings made of stone or at least having stone foundations and which were already decorated in a totally Roman style. This change went together with the coming of new settlers and a decrease in the original Celtic population. These settlers came partly from the east and from the Balkans. The change in the inhabitants' ethnic composition resulted in an expansion of the social strata of merchants and craftsmen. While keeping its religious significance in the 3rd century, Gorsium also developed into a lively economic centre.

The end of the second period is marked by another destruction of the town. In 260 Pannonia was heavily overrun by Sarmatians and Quadians. The discovery of 30 coins illustrates the route taken by the barbarians as they ravaged the centre of the province. At this time, a line of military camps and towns were destroyed. Among these towns was Gorsium where the layers of burning and destruction show all too clearly that no stone was left standing. Because of the difficult war and subsequent economic crisis, the rebuilding of the town took many decades. During the reign of the Caesar Probus in the decade of 280 A.D., life returned to the desolated town as seen from the circulation of minted money. The greater proportion of the building efforts of the next decade of the 290s, was connected with the name of the Caesar Diocletianus. A totally new town was created by the clearing away of the ruins and the remains of old buildings. At this time the name of the settlement was changed to Herculia in honour of the Caesar Maximianus Herculius. The town built at public expense with its proportionally larger city centre probably became the civil administrative centre of Valeria province which had been formed from the northern part of Pannonia Inferior. Beside the mighty Governor's palace there lay a row of stores *(tabernae)*, ancient Christian basilicas and other public buildings on the area of the former religious centre. The inner town was surrounded by vast outer sections so that by the middle of the 4th century the city had reached its greatest size ever. Later, life in Herculia was characterized not only by its

administrative activites but also by its industrial economic significance. Aside from the pottery workshops producing glazed ceramics, Herculia had flourishing glass, bone tool and ornament and iron industries as well as most probably an ongoing weaving industry between its walls.

The city kept its economic significance even after the end of Roman power, when it no longer functioned as an administrative centre. A row of tanners' tubs was constructed in the garden of the Governor's palace and its peristyle. Greenish coloured glass dishes and iron products were made here even in the 5th century.

Beside the two main roads described in *Itinerarium Antonini* archaeological research has uncovered traces of six other routes. These roads made Gorsium–Herculia the most important junction in North-Eastern Pannonia. In addition to its religious and political role the location made Gorsium–Herculia an important commercial centre and from the beginning helped to support its lively local industries. The fact that the settlement continued to be occupied even after the end of Roman dominance in the area can be explained by the existence of roads passing through the town.

J. Fitz

INTRODUCTION

Animal husbandry which originally developed out of the process of domestication, can be further divided into the simple keeping and in later times breeding of animals (Bökönyi, 1969, 220).

Animal keeping is a rather instinctive activity lacking both conscious selection and proper feeding techniques.

The main characteristics of animal keeping are:

(a) While there is only one breed within each species of the domestic animal population that breed generally tends to be very variable.

(b) These domestic animals belong to primitive types and tend to be much smaller than their wild ancestors.

Animal breeding is based on conscious selection of suitable animals as parents and appropriate feeding practices in both the qualitative and quantitative senses. The main characteristics of this advanced phase are as follows:

(a) Each species within a domestic animal population is represented by several breeds.

(b) There is an increase in body size although miniature breeds are known as well.

(c) The production of animals increases.

These changes in turn reflect a change in quality. Without doubt the roots of breeding selection lie prehistorically in the Neolithic, when man discovered that much fewer males than females were needed to maintain and reproduce the population. Some of the males were excluded from the breeding population (castrated or slaughtered) and even some of the females were slaughtered before they reached adult age. This kind of selection differed in one important aspect from real breeding selection in that it was not intended to increase productivity (in, e.g. increased body mass, more meat, milk, eggs, more or better quality wool, greater draught power, etc.).

Conscious animal breeding for a given end product began when people started to think in terms of the individual animal instead of herd structure. Obviously this change occurred within the different domestic species at different times and from this point of view there are considerable differences between various geographic areas as well.

As we now know, the first evidence of conscious animal breeding occurred in sheep raised on the temple farms of Mesopotamia in the second half of the 3rd millennium B.C. (Kraus, 1966) which had individual registration of sheep. This development is further illustrated by the jump in the body mass of sheep (Bökönyi, 1978, 68). During the Bronze Age there was a large influx of these sheep into Europe where they had an initial serious influence on the body size of the local population. Later, however, they seem to have merged into it (Bökönyi, 1978, 68) since the art of breeding did not arrive with them. It is no accident that conscious breeding began in Mesopotamia with sheep. Here could be found the most advanced level of animal keeping in which sheep was the most important animal species with wool as one of its chief products.

Conscious breeding was imported into Europe by the Greeks, and the Scythians. The former passed it along Magna Graecia to the Romans who improved and generalized upon it for all the domestic animal species. The Romans had a significant and special literature on animal breeding of so high a level that some of the authors' opinions and advice hold true even for breeding practices today.

The deliberate breeding practices of the Romans resulted in the formation of improved breeds. These breeds together with the knowledge of conscious animal breeding were brought to all parts of Roman

dominated Europe. We must not forget that the Iron Age marked a nadir in the European history of animal keeping (Bökönyi, 1974, 128) so that the more developed, purposive, planned Roman animal breeding with its basic special literature thus met a rather underdeveloped and primitive local animal husbandry. From the point of view of both economic and animal husbandry history, it is very interesting to study both the meeting of the two forms of animal husbandry and the mutual influence they had on each other. Our basic assumption is that it was the more advanced form which had the more profound effect on the primitive form. However, we must not exclude the possibility of a reverse influence as well.

Seventy-two pieces of bone collected during the first ground-breaking excavations at Tác have already been published (Bökönyi, 1955b, 153–161). At this time eight species were identified from the settlement: cattle, sheep, goat, pig, horse, aurochs, red deer and goose.

During the large scale excavations which began in 1958 under the directorship of Dr. J. Fitz careful collection procedures preserved tens of thousands of bones for further study. In this monograph I will deal with those bones brought to light between 1960 and 1971. Only that part of the bone sample which could be accurately dated was selected for examination because in addition to Roman remains from the 1st through the 4th century there were also traces from earlier prehistoric, later Migration Age and mediaeval occupations. Only faunal material from features and levels containing unmixed Roman archaeological material was studied. Therefore for example, the monograph does not deal with the fragment of camel mandible which comes from a level of mixed Roman and mediaeval material, in spite of the fact that we know from analogy with German, Austrian, Swiss and recent Hungarian finds that some of the camels used by eastern army units appear in the European provinces of the Roman Empire. Of course, there is always a chance that bones from different periods, as opposed to ceramics and other artifacts, could be mixed in with the Roman material. However, in the face of such a huge sample a few sporadic pieces would not seriously influence the general picture. On the other hand I tried to filter out faunal material possibly coming from other periods, using typology and state of preservation as selective criteria.

The bone material was examined principally from two points of view: biology and historical economy. Of course, these two perspectives were not equally relevant for all the different species recovered from the site. In the examination of certain species the first point of view predominated while for other species, the second assumed greatest importance. The two of them are so closely interconnected, however, that they cannot be separated. It is quite clear for example, that the wild species as well as those species with good craniological materiai present, should be evaluated from the biological perspective. Study of the domestic species was carried out from an economico-historical point of view as, for example, in the case of imported breeds. However, even the question of imported species could not be evaluated or understood without the biological aspect. It is not very difficult to understand why the economic perspective predominates in the study of domestic animals: given the high level of the Roman animal breeding found in Tác–Gorsium, such biological problems as local domestication and the distinction of the bones of wild and domestic forms, etc. are of little practical importance. At the same time, the existence of separate breeds has as much historico-economical as biological significance.

Considering that archaeozoology is a biological discipline it is evident that the evaluation of animal husbandry and hunting at Tác–Gorsium should be based predominantly on the faunal material. The bone sample represents first class biological evidence which gives direct information on the species which were bred and hunted and hence on all aspects of animal keeping and hunting.

In order to complete the conclusions drawn from the bone material, I used animal representations as well as descriptions from Roman authors and other literary sources.

In this place I should like to give thanks to Dr. J. Fitz for access to the bone material used in this study, support of my work, and for the archaeological information on dates. For this latter I should also like to thank Dr. Zs. Bánki. I am grateful to Dr. D. Jánossy for the identification of bird bones, to Mr. K. Kónya and Mr. L. Sugár for the photographs and to Ms. N. Dévai and Mr. G. Szittya for the drawings.

THE NATURE OF THE BONE SAMPLE

The bone sample of Tác–Gorsium comprises one of the largest such assemblages from a Roman Imperial Period site. The bone sample of nearly 50,000 bone specimens is of a large enough size to offer good chances of finding historically interesting species (as in the skulls and horn-cores) as well as in helping in the description of variation. Large sample size also helps the determination of accurate faunal composition of the animals living around the town and those animals hunted by the inhabitants.

The majority of the bone material found at Tác–Gorsium is kitchen rubbish. Typical for such faunal remains, there are no complete skeletons, only rarely, articulated bones of the larger body parts or whole crania, and unbroken long bones are preserved only from the meat-poor distal ends of the extremities. The lion's share of the long bones were broken in order to extract marrow while the skulls were opened to get at the brain which has been a food delicacy since earliest prehistoric times. Cattle skulls especially suffered this fate because during the procedure of removing the brain it was precisely those neurocranial regions most critical to craniology and breed determination which were destroyed. It is thus very difficult to find skulls in which the upper part of the forehead, intercornual ridge and horn-cores remained intact. (This situation is worsened by the fact that even those specimens which happened to escape deliberate breakage, usually were damaged anyway by the weight of the soil pressing down on the horns.) Conversely, sheep crania which have shorter horns or which may even be hornless tend to be better preserved. Goat skulls like those of cattle, tend to be broken up as a consequence of their longer horns. The horn-cores themselves, however, are remarkably well preserved, many of them along the whole length. Only occasionally on the base can one see the marks of butchering where the horns were separated from the skull or breakage of the fragile tips. The bones and bone fragments frequently show marks left from skinning, sectioning and fleshing the slaughtered animal as well as tooth marks from the gnawing of dogs. Burned bone occurs too, but not in the same large quantities as may be found on prehistoric sites.

The second category of bones found on the site come from remains of animals which died or were killed, but which were not eaten. In prehistoric times, up to the beginning of the Bronze Age, the meat from all animals, including carrion was consumed. This custom was given up only in the Early Bronze Age and around the end of the period the first meat taboo, the consumption of dog flesh, began in Europe (Bökönyi, 1974, 320). Complete or almost complete skeletons of animals which died naturally or were killed, were found in pits although the greatest number comes from a huge well. The majority of these bones come from dog including about 40 skeletons, in most cases complete with skull. A few cat skeletons from the same well were uncovered by the excavators, while incomplete horse and pig skeletons turned up in pits.

This category of faunal remains proved excellent for the study of different breeds because it consisted almost exclusively of undamaged bones and complete or nearly complete skeletons. There are a large number of whole or nearly whole skulls as well. These latter provide a craniological basis for breed identification research. The unbroken bones can be used for the determination of absolute body size and body proportions.

One can find the remains of sacrificial animals at the site as well. One such offering from the Margaret Settlement ($U^3$6c–$T^3$6d, 2nd century) is a cattle skull with mandible, vertebral column, ribs and pelvis which were found together with the bones from the left and right forelegs of a horse. Unfortunately it is the most critical intercornual and horn-core portions of the cattle skull which have been cut off. In

addition a wolf's skull was found in the sanctuary district (4th century). It is not impossible that other bones also belong to this very difficult to demonstrate category.

The next category is that of debitage from bone and antler tool production. There are very few pieces in all, indicating the lack of importance of bone industry at the settlement.

The last group is that of animals which burrowed into the levels of the site to hide or to hibernate and died there. In this part of the sample are numbered the partial remains of fox and pond tortoise. The latter probably only occur in this particular way.

THE FAUNA

The faunal material of Tác–Gorsium is quantitatively large and varied. There are altogether 41 different species at the settlement of which 11 are domestic, 10 are wild mammals, 16 are wild birds, 1 is reptile, and 3 are fish. The subfossil remains of the little bustard, *Otis tetrax* L., are known exclusively from this site. For a detailed list of species and species frequency see Table 1.

The richness of species extends to both the domestic and wild forms. The number of species found in Iron Age settlements is almost doubled here, which clearly demonstrates the broadening of animal keeping practices as well as the new colour added by the introduction of different domestic animals. Two important additions are the hen and the goose. The hen was first imported into Hungary by the Scythians and after became widespread (Bökönyi, 1974, 35), although it was only during the time of the Caesars that it can be found in really high frequencies. The goose was domesticated in Rome before the Caesars and subsequently during the time of the Caesars it appeared in Germanic settlements as well (Gandert, 1953, 77). The domestic cat and donkey can be found in a majority of the sites from the Roman Imperial Period. The Romans played a key role in the spread of both these animal species through Europe (Bökönyi, 1974, 301; 311). The presence of domestic pigeon was first shown by Gandert (1973, 119ff) although it can be found only in very few sites.

The richness of the wild fauna does not lie first in the variety of the wild mammalian populations. Aside from aurochs, red deer, roe deer and wild pig, found on all sites with large enough bone material, there are six other wild mammal species known. The variety is considerably enhanced by the presence of some 16 species of wild birds in which the proportion of land to water species is 9 to 7. This proportion presents quite a different picture from prehistoric times in Hungary when water birds made up the majority of the bird species found (Bökönyi and Jánossy, 1965, 94). The one reptile species, the pond tortoise, has been commonly found in settlements since the Neolithic and in this case probably represents a secondary deposit. The three fish species found in Tác–Gorsium are also not uncommon. The possible existence of other species could be demonstrated only by detailed comparison with modern bone material.

The significance of animal husbandry in Tác–Gorsium, however, far exceeded the importance of hunting. This last is shown by the proportion of domestic to wild animals which is 97.65 per cent to 2.35 per cent (using the specimen count) or 92.85 per cent to 7.15 per cent (using the number of individuals). These proportions are quite typical for sites of the Roman Imperial Period in Europe, where the ratio of domestic to wild animals is minimally between 87.62 per cent to 12.38 per cent or maximally 99.70 per cent to 0.30 per cent (specimen count) or 80.9 per cent to 19.1 per cent (minimum number of individuals). This ratio was strongly influenced by the character of the settlement. In towns or villas the ratio of wild animal bones was small, showing the smaller importance of hunting, while in military camps and watchtowers the faunal material shows precisely the opposite tendency. These differences naturally reflect the differences in the lifeways of the urban population and of the soldiers (Bökönyi, 1974, 35). Thus, the relatively small number of wild animal bones found at Tác–Gorsium does not come as a real surprise. The relative unimportance of hunting may also be seen by the fact that the majority of these hunted animals are birds which produce insignificant amounts of meat. They were probably more popular as the targets of sport hunting. Some hoofed animals were hunted as well. Hare was a frequent quarry in greyhound hunting.

TABLE 1

The fauna list

	Specimens	%	Individ.	%
cattle – *Bos taurus* L.	17942	38.33	820	36.28
sheep – *Ovis aries* L.	9908	21.17	485	21.46
goat – *Capra hircus* L.				
pig – *Sus scrofa dom.* L.	9017	19.26	470	20.80
horse – *Equus caballus* L.	3072	6.56	155	6.86
ass – *Asinus asinus* L.	34	0.07	9	0.40
cat – *Felis domestica* Briss.	112	0.24	24	1.06
dog – *Canis familiaris* L.	4386	9.37	113	5.00
hen – *Gallus domesticus* L.	2028	4.33	146	6.46
goose – *Anser domesticus* L.	310	0.66	36	1.59
pigeon – *Columba domestica* L.	3	0.01	2	0.09
Domestic animals	46812	100.00	2260	100.00
aurochs – *Bos primigenius* Boj.	106	9.39	17	9.76
red deer – *Cervus elaphus* L.	158	13.99	30	17.23
roe deer – *Capreolus capreolus* L.	30	2.65	8	4.60
wild swine – *Sus scrofa fer.* L.	48	4.25	11	6.32
wild cat – *Felis silvestris* Schreb.	4	0.35	3	1.72
badger – *Meles meles* L.	3	0.27	2	1.15
fox – *Vulpes vulpes* L.	38	3.36	9	5.17
wolf – *Canis lupus* L.	7	0.62	3	1.72
beaver – *Castor fiber* L.	1	0.09	1	0.58
brown hare – *Lepus europaeus* Pall.	155	13.73	24	13.79
jackdaw – *Colaeus monedula* L.	1	0.09	1	0.58
rook – *Corvus frugilegus* L.	2	0.18	1	0.58
crow – *Corvus* sp.	3	0.27	2	1.15
wood pigeon – *Columba palumbus* L.	1	0.09	1	0.58
little bustard – *Otis tetrax* L.	1	0.09	1	0.58
crane – *Grus grus* L.	5	0.44	2	1.15
marsh harrier – *Circus aeruginosus* L.	1	0.09	1	0.58
white-tailed eagle – *Haliaetus albicilla* L.	6	0.53	2	1.15
goshawk – *Accipiter gentilis* L.	2	0.18	1	0.58
tufted duck – *Aythya* cf. *fuligula* L.	1	0.09	1	0.58
pochard – *Aythya ferina* L.	3	0.27	2	1.15
teal – *Anas crecca* L.	1	0.09	1	0.58
garganey – *Anas querquedula* L.	1	0.09	1	0.58
mallard – *Anas platyrhynchos* L.	2	0.18	2	1.15
duck – *Anas* sp.	18	1.59	3	1.72
white stork – *Ciconia cinonia* L.	3	0.27	2	1.15
birds – *Aves* sp. ind.	344	30.47	18	10.34
European pond tortoise – *Emys orbicularis* L.	22	1.95	4	2.30
pike – *Esox lucius* L.	9	0.79	5	2.87
carp – *Cyprinus carpio* L.	12	1.06	5	2.87
catfish – *Silurus glanis* L.	29	2.57	3	1.72
fishes – *Pisces* sp. ind.	112	9.92	7	4.02
Wild animals	1129	100.00	174	100.00
Total	47941		2434	

Cattle dominate the frequencies of domestic animals and this dominance probably reflects their significance in the animal keeping as well. This large ruminant occurred most frequently both in terms of specimen count and number of individuals. There seem to be almost twice the number of cattle at the site than specimens of any other domestic species.

The number of small ruminants (sheep and goat) in the next largest group is not very much greater than the following group of pig. The frequencies of all other domestic species are much smaller, although the proportion of domestic hen remains is reasonably large. There are only two other excavated Roman Imperial sites where the frequency of domesticated hens exceeds the number found in Tác–Gorsium: Ersigen–Murain in Switzerland (Stampfli, 1965–66, 453) and Künzing–Quintana in Germania (Swegat, 1976, 9).

It is worthwhile comparing the frequencies of domestic animals found in Tác–Gorsium and the animal frequencies from other well documented sites from the period of the Roman Empire in Western and Central Europe and Hungary. The rank order of the species is shown in Table 2.

TABLE 2

Order of species frequencies in Roman provincial sites

Order of frequency	Site	Reference
cattle pig sheep/goat	Valkenburg (Holland)	Clason, 1961, 140
cattle sheep/goat pig	Fontaines-Salées and Foissy-sous-Vérelay (France)	Poulain-Josien, 1967, 205
pig cattle sheep/goat	Montmaurin (France)	Poulain-Josien, 1969, 317
sheep/goat pig cattle	Marseille–Bourse (France)	Jourdan, 1976, 292
pig sheep/goat cattle	Alpnach (Switzerland)	Kuhn, 1933, 23
pig cattle sheep/goat	Ersigen–Murain (Switzerland)	Stampfli, 1965–1966, 453
cattle/pig sheep/goat	Augusta Rauriaca (Switzerland)	Schmid, 1970, 1317
cattle pig sheep/goat	Abodiacum (Germania)	Boessneck, 1964, 222
cattle pig sheep/goat	Butzbach (Germania)	Habermehl, 1957, 68
cattle pig sheep/goat	Cambodunum (Germania)	Boessneck, 1953, 104
cattle pig sheep/goat	Hüfingen (Germania)	Sauer-Neubert, 1968, 4
cattle pig sheep/goat	Künzing–Quintana (Germania)	Swegat, 1976, 9
cattle pig sheep/goat	Lauriacum (Germania)	R. Müller, 1967, 8/a
cattle pig sheep/goat	Regensburg (Germania)	Boessneck, 1958b, 21
cattle pig sheep/goat	Colonia Ulpia Traiana near Xanthen (Germania)	Waldmann, 1966, 5

This latter tendency could be seen, measured by specimen count, in Pfaffenhofen (Streitferdt, 1972, 13) and Vemania (W. Piehler, 1976, Table 3) although the minimum number of individuals showed that in the first site the frequencies of both sheep/goat and pig exceeded that of cattle, as does pig in the second site. In Magdalensberg, Carinthia (Hornberger, 1970, 10–11) the number of cattle remains was higher than the number of bone specimens coming from pig and sheep/goat, although if the rank was determined by the minimum number of individuals cattle had the lowest frequency.

Cattle dominated the faunal inventories of archaeological sites in Hungary from the period of the Roman Empire. In Balatonaliga (Bökönyi, 1974, 244) the order of animal frequency is very similar to that of Tác—Gorsium: cattle, sheep/goat, and pig. At the site of Albertfalva in Budapest (Bökönyi, 1974, 351) and in Pilismarót–Watchtower No. 1 (Bökönyi,1974, 392) cattle was followed in importance first by pig and then by sheep/goat.

Although the sites described above represent only a small portion of the total territory of the European provinces of the Roman Empire, three tendencies can be observed:

(1) Cattle farming was the most important branch of animal husbandry in the European territories of the Roman Empire. The dominance of cattle was not surprising given their use as a beast of burden in Roman agriculture and the demand for oxen as draught animals. Beef production had an important role as well in the feeding of the human population, particularly the army, so that the significance and high standards of cattle keeping can hardly be accidental.

(2) Even in Europe with its moderate climate, climatic and geographical factors strongly influenced the animal keeping of the period of the Roman Empire. It is not very difficult to understand why in general pig was more frequent than small ruminants in wooded and wet Germania and Switzerland, while in the dry, Mediterranean environment near Marseille, sheep/goat dominated the faunal material.

Pannonia seems to have been a transitional territory from this point of view, with the changing proportions of sheep/goat and pig never revealing the dominance of one or the other.

(3) In terms of domestic species the character of the settlement seems to have had less of an impact. The only exceptions are the military camps and watchtowers where the frequency of pig reveals the importance of pork in the army diet.

Understandably the faunal material from cavalry encampments contains especially high frequencies of horse.

In addition to the three domestic species of greatest importance it is necessary to mention the great number and proportion of horse bones which reflect significant horse breeding not known in provinces to the west of Hungary. It is most likely that horses were kept here for the army or export to Italy. This latter hypothesis is supported by the high quality of the horse population found at Tác–Gorsium.

The other equid from Tác–Gorsium, the donkey, is clearly imported from Italy but was never of great importance either at Tác–Gorsium or other parts of Pannonia.

There is a high frequency of domestic cat as well as the presence of luxury dog breeds which points to an urban lifestyle at Tác–Gorsium.

The frequency of dog is high so that besides luxury dogs, bones of watchdogs, hunting and herding dogs occur as well. These latter comprise the great majority of the dog bone, demonstrating the great importance of herding in the everyday life of the town's inhabitants.

The large number of domestic bird bones can be considered as a first step toward the development of a modern domestic fauna. The Romans played a great role in the spread of domestic bird which had the ability to completely utilize compact forage and provided much meat for local inhabitants. The development of poultry farming slowed down and suffered several setbacks during the following Migration Period and the early Middle Ages. It was only during the economic lull of the Renaissance when fowl breeding regained its old importance. At the present time 80 per cent of the individual animals slaughtered in Europe for meat production are domestic birds.

During the life of the settlement interesting changes occurred in the relationship of hunting and animal keeping. Similarly, modifications in the frequency and importance of the domestic species also indicate interesting changes.

In order to examine these changes, the faunal material of Tác–Gorsium was divided into three

chronological groups. The first group consisted of the smaller material from the 1st–2nd centuries while the larger material from the 3rd and 4th centuries could be subdivided into two groups.

The calculation of the number of individuals unfortunately seems to be too complicated, so that specimen counts were used to make the comparisons. Given such a huge material, however, specimen count seems to be reliable as well, realistically reflecting the relationships between the various species frequencies. (In fact the number of specimens was comparatively high in the case of dogs and low in the case of donkey, cat and perhaps domestic bird.)

As can be seen in Table 3, the significance of animal keeping slightly decreased between the 1st and 4th century. At the same time there seems to have been an increase in hunting by about 2 per cent although it does seem to have had a great effect on the diet of the human population.

The importance of the wild species within the hunted fauna did not change significantly although there was an increase in the number of fox and hare in the 4th century. This latter species contributed about half of the hunted meat at that time. In addition, while the increase in the number of foxes killed may be accidental, the hares were probably killed during greyhound hunting, a kind of sport hunting introduced at that time.

TABLE 3

The frequencies of domestic and wild animal species from the three periods of Tác–Gorsium

	1st–2nd centuries %	3rd century %	4th century %
cattle	34.99	41.64	47.64
sheep/goat	18.76	23.13	14.02
pig	25.59	21.66	21.81
horse	4.89	5.22	6.74
donkey	0.14	0.06	0.05
cat	0.07	0.14	0.08
dog	8.70	6.05	4.77
domestic birds	6.86	2.10	4.89
meat purpose wild mammals	35.06	32.94	37.19
wild carnivores	3.90	3.53	6.91
wild birds	45.46	43.53	38.75
fish	15.58	20.00	17.15
domestic animals	97.36	96.82	95.33
wild animals	2.64	3.18	4.67

The two most important changes in the animal keeping of this time are the increase in the frequency of cattle from 34.99 per cent to 47.64 per cent and the strong though uneven decrease in the number of small ruminants. It is especially instructive to study the two phenomena simultaneously. While in the 1st, 2nd and 3rd centuries the frequency of small ruminants exceeded 50 per cent of the frequency of cattle, it decreased in the 4th century to less than 30 per cent.

At the same time the originally small frequency in the number of pig rose significantly in the 4th century to exceed the number of small ruminants.

A steady growth can be seen in the number of horses, particularly in the 4th century. The frequency of dogs gradually decreases. Domestic fowl show a frequency curve very similar to that of the pig. The donkey and the cat played no significant role in the periods studied here.

The changes in animal keeping mentioned above can probably most be explained by the fact that by the 4th century the species characteristic of southern types of animal keeping lost their importance while cattle and pig gained in significance since they could adapt better to the local circumstances. The increased importance of horse breeding can perhaps be explained by certain events occurring near the border areas.

It is very likely that by that time (undoubtedly as a result of crossings with Italian breeds) Pannonia developed its own individual style of animal husbandry which was the best for the given environment and, therefore, was also the most productive. In this way local breeders were not only able to supply local needs and the army but could produce horses for export as well. This last is shown by the *Expositio totius mundi* written by a Syrian author around 350 A.D. which mentions cattle exported from Pannonia (Mócsy, 1974, 321).

Domestic cattle (*Bos taurus* L.) and Aurochs (*Bos primigenius* L.)

Cattle were the most important of the domestic animals raised by the inhabitants of Tác–Gorsium in the Roman Imperial Period. This dominance is shown not only by the greater percentage of bone specimens (38.33 per cent) and the greater percentage of the minimum number of individuals (36.28 per cent) within the domestic fauna as a whole but by the larger body size of the cattle as well. This latter indicates that cattle had a much bigger role in meat production than percentages at first glance reveal. The slaughter of one cattle would yield the equivalent of seven sheep or goats or four to five pigs. Calculated this way it can be shown that up to 77 per cent of the meat eaten in Tác–Gorsium was supplied by cattle.

In addition to domestic cattle, its wild ancestor the aurochs could be found around the settlement as well. The inhabitants even hunted it as can be seen by the presence of its bone in the kitchen rubbish. (The presence of the other wild cattle *Bison bonasus* L. cannot be verified absolutely in the faunal material of Tác–Gorsium.)

Domestic cattle and aurochs bones were separated by size parameters using the measurements given by Degerbøl (1942), Dottrens (1947), Nobis (1954), Boessneck (1957b), Requate (1957), Bökönyi (1962; 1972), Stampfli (in Boessneck *et al.*, 1963) and Imhof (1964). These measurements must not be used in a rigid way. The biggest of the domestic cattle of the site overlap with the aurochs' lower size range. In addition, old large individuals have metapodials (these are the most frequent measurable bones) in which the distal end is flattened in a medial/lateral direction. This extension may result in a widening of up to five millimetres particularly in the metatarsus placing these bones within the lower range once again of the aurochs.

In order to avoid the biases caused by these overlapping measurements and for the sake of identification of non-measurable body fragments also, other morphological considerations were used to distinguish between the two cattle types. For example, the aurochs' bones are heavier and the absolute and relative thickness of the bone wall is greater. The same is true of the proportion of compact to spongious bone in the epiphyses (Bökönyi *et al.*, 1964, 3ff; 1965, 330ff). The outer surface of aurochs bone is hard, smooth, and almost brittle while the surface of domestic cattle bone is velvety and rather soft, although this latter depends on deposition and soil conditions.

Unfortunately density tests which are useful for distinguishing between cattle and aurochs this time were not used (Bökönyi *et al.*, 1964; 1965) because in the end they were really necessary for cattle bone from Neolithic sites where local domestication played a bigger role (Bökönyi, 1959, 81; 1962, 185ff; 1974, 28–29). The domestication of aurochs at Tác–Gorsium could only have occurred haphazardly, which does not mean that the cattle breeders of the Roman Empire did not use the wild form to increase and replenish their cattle stock. Vergil writes, for example, that people caught and domesticated aurochs in Northern Italy to replace cattle which died during an epidemic. Such stressful times evidently did not occur at Tác–Gorsium, since no intermediary forms occur between domestic cattle and aurochs. Those large size domestic cattle which fall into the lower range size variation of aurochs can be easily separated on the basis of their lighter and more porous bones.

Any time that one examines a site from Roman Imperial times, the first question that must be addressed is whether the improved breeds were imported from Italy. The question of improved breeding is especially interesting in the case of cattle because the greatest authors of Roman animal husbandry dealt most particularly with the species. In addition, conscious Roman animal husbandry, based on selection and adequate quality and quantity of forage produced some of its best results with this species.

These achievements can truly be appreciated in light of the initial conditions of cattle keeping. The decrease in body size from the Neolithic reached its lowest point during the Iron Age when the average withers height of cattle barely exceeded 110 cm in Central and South-Eastern Europe (Bökönyi, 1974, Figure 9). However, some cattle did occur with withers heights under one meter as for example the smallest cattle in Hallstatt with a height of 98.5 cm (Amschler, 1949, 41). These small size Iron Age cattle represented a primitive stunted type with slow growth. Their cranial morphology indicates a *brachyceros* type although occasionally hornless forms appeared as for example at the Scythian site of Jászfelsőszentgyörgy (Bökönyi, 1974, Figure 23). Representations of cattle found on Scythian sites indicate that thick and long horned varieties were sometimes present (Bökönyi, 1974, Figure 24). These cattle belonged to the erect horned *orthoceros* type group, the presence of which can be explained by the fact that the line of the Scythian migrations passed directly through the main area of distribution of these mammals. With the coming of the Romans there suddenly occurred in the provinces a large size form of cattle, which is accepted by the majority of authors to represent improved Roman cattle of Italian origin. Strangely, however, there is hardly any osteological evidence for these cattle in Italy simply because in general animal bones have not been collected from excavations. Only in one case do Blanc and Blanc (1958–1959, 42) mention such cattle although large cattle have been found near Trieste, in cave material dating from the period of the Roman Empire. The material is not Italian in the strict sense of the word, but rather demonstrates Roman influence ("... un complesso faunistico di animali domestici in particulari bue e cavallo, che sempra di influenza romana.") (Riedel, 1974, 53). At the only place where faunal material was collected at the site of the Roman Niger Lapis on the place of *souvetaurilia* only bones of small size cattle were found. This last indicates that small primitive forms were preferred as offerings (Blanc and Blanc, 1958–1959, 21ff, 46). The withers height was estimated to be about 109 or 110 cm.

Although we do not have direct evidence of this improved Roman breed from the primary osteological sources, a picture of the animal type is created by contemporary representations and descriptions. These show a large size, well proportioned animal with a cranial morphology characteristic of the long-horned *primigenius* type. The creation of the improved Roman breed is reminiscent of the type development of English thoroughbred horses. The basic Italian form was crossed with the renowned forms from other territories. Roman agricultural authors especially appreciated the stud bulls of Gallia Cisalpina but they also mention the import of cows from Epiros. It is not impossible that other "exotic" breeds were imported and brought to the provinces as well. However, this last can be documented only in painting and small sculptures.

It is not very easy to demonstrate the existence of these improved Italian breeds on provincial sites from the period of the Roman Empire. Even the coexistence of multiple breeds at one site is difficult to prove. In the primitive conditions of prehistoric animal keeping there was only one breed per site but that breed was usually very variable morphologically. There was neither breeders' skill nor consumer demand to stimulate the development of different breeds. It was only the conscious animal breeding based on selection which began to shape animals for several purposes, and isolate breeds to maintain their integrity. Considering the above text, the occurrence of two or more breeds on a site is not surprising and reflects a qualitative change. Difficulties are caused by the fact that the demonstration of coexisting multiple breeds requires a gigantic material. In the case of smaller samples, all such attempts are illusory. The recognition and separation of different breeds is made more difficult by two other factors. Breeds themselves are frequently crossed and the high degree of sexual dimorphism caused the females of larger breeds to overlap in size with the bulls of smaller size breeds.

Cross-breeding was easy to understand in the light of the owners' desire to have large cattle which may also explain the existence of Italian imports. They wanted to improve the primitive provincial cattle by crossing them with individuals of the larger and more developed Roman breeds.

The fact that the large size breed is of Italian origin and imported by the Romans or at least is related to these animals may be shown by the following:

(1) These large size, long horn cattle appeared in the provinces at the same time as the Roman conquest.

(2) Outside of the Roman Empire only isolated occurrences are known and never in large numbers at any given site.

(3) In terms of body size, cranial morphology, and primarily the form of the horns these new provincial cattle were identical with those shown in representations from the period of the Roman Empire.

(4) The Roman animal breeding authors wrote about the methodology of cattle raising and breeding. The basis of production of a new cattle breed may not have been scientific as we know it, but the technical literature was still quite advanced.

The cattle bone material of the Imperial Roman town of Tác–Gorsium was perfect for such studies. In the first place, the sample is not only big but in fact is one of the largest cattle bone samples ever found and evaluated from this period. In addition, the material is well preserved. However, it does not contain whole skulls since the horns and intercornual ridges were cut in order to reach the brain, which has been a precious gourmet food from ancient times. In spite of the damages quite a few sections from intercornual ridges could be used for type identification.

The so-called *brachyceros* type which is characterized by small dimensions, a narrow and wavy intercornual ridge, an uneven forehead and finally short horns is represented by at least 25 skull fragments in the cattle bone material of Tác–Gorsium. This type can first be found in Neolithic material both in Asia Minor (Çatal Hüyük, Anatolia 5800 B. C., Perkins, 1969, 178) and in South-Eastern Europe (Nosza–Gyöngypart, Yugoslavia; Bökönyi, 1974, 108).

Figure 1. Cattle horn-cores

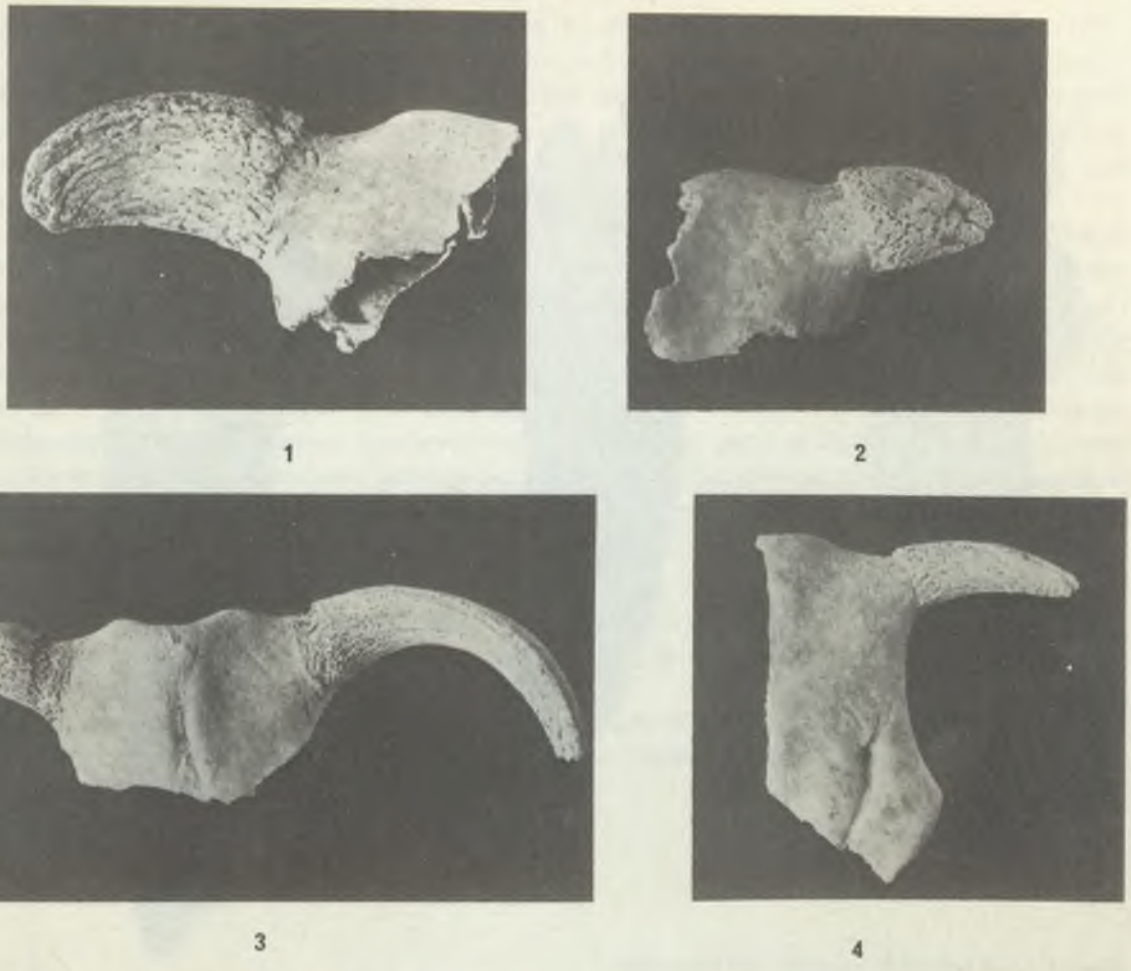


Figure 2. Cattle brain skull fragments with horn-cores

The majority of these 25 fragments have preserved horn-cores as well. The horn-cores are short, small to medium large in diameter. They are strongly curved (4, 5, 9, 10, in Figure 1; 4 in Figure 2). Those of the bulls are more massive but shorter, barely curved and pointing in a lateral direction as seen quite often in bulls which belong to *brachyceros* breeds (1 in Figure 2; 3 in Figure 3). The middle length, mainly thin walled and curved horn-cores belong to oxen (3 in Figure 2). It must be confessed, however, that the horn-cores in many cases cannot be differentiated on the basis of sex. These horn-cores suggest that the proportion of females was slightly larger than that of bulls and these two groups far exceed the frequency of oxen. These *brachyceros* cattle probably represent the cattle of aboriginal population. This last may be concluded from the fact that before the Roman conquest in the late Iron Age almost exclusively this type of cattle is found in Pannonia (Bökönyi, 1974, 127). Such cattle were owned by the original inhabitants of Roman provinces as well (Amschler, 1949, 41–51; Boessneck *et al.*, 1971, 56).

The next group is that of the *primigenius* type cattle which is larger in size and in addition has a skull which resembles that of the aurochs. The intercornual ridge is wide and straight with a flat or concave forehead, and long horns (1–3 and 6–8 in Figure 1; 1,2 in Figure 3). The number of identifiable skull fragments of this type is much smaller but the number of single independent horn-cores is much bigger for the *brachyceros* type. The explanation of this strange phenomenon is that the pressure of soil is most destructive to the horn-cores. The skulls of long horned types are much more susceptible to damage from such pressure than those of the short horned variety. From the *primigenius* type a good part of the horn-cores can be separated by sex. The extremely long, thin and grooved walls of oxen horn-cores are especially easy to distinguish (6, 8 in Figure 1). They are frequently the size of aurochs and it is only their surface texture which differentiates them. The ratio of sexes is roughly the same as with the previous type.

Figure 3. Cattle brain skull fragments with horn-cores

The *primigenius* type can be identified as the improved Roman breed imported from Italy and known from representations and descriptions. These improved cattle can be clearly differentiated from the Hungarian grey cattle (which appears at the end of the Middle Ages and which belongs to the *primigenius* type as well) by the form of the horns. The horns of the Italian animals are open and curve before the frontal plane similarly to the aurochs. The horns of the Hungarian grey cattle on the other hand are more convergent and erect, similarly to the *orthoceros* type.

Crossings between the *brachyceros* and *primigenius* type occurred frequently because the evident aim of the import was to improve the local cattle. This crossing resulted in individuals with mixed cranial characters. Sometimes the *brachyceros* character skulls with a wavy intercornual ridge and uneven forehead have *primigenius*-like horn-cores. In one case for example, a *primigenius* type neurocranium had markedly slender horn-cores.

More than once flattened horn-cores occurred with one or two edges (9 in Figure 1). In another case, a horn-core of triangular cross section was found. These are not independent types or breeds but rather they belong to the variations of European cattle occurring since the Bronze Age.

There were no hornless cattle found in the Roman Imperial site of Gorsium. Such animals have been found only in two British Roman sites, Newstead (Ewart, 1911, 219ff) and Bar Hill (Bryce, 1906 citation from Jewell, 1963). In Newstead there are even two hornless specimens, one of which has a straight intercornual ridge as in the Galloway cattle. The other has a bump in the middle of the intercornual ridge as can be seen in Aberdeen-Angus cattle (Jewell, 1963, 89–90). Hornlessness appeared much later in cattle populations than in those of sheep. Such prehistoric specimens are, therefore, uncommon. The earliest hornless cattle are known from Egypt after about 2500 B.C. (Zeuner, 1963, 211). Several examples are

known from the Neolithic-Copper Age transition in the northern part of Central Europe. (David, 1897, 38; Hoyer, 1923, 14; H.-H. Müller, 1963, 149ff) as well as from the beginning of the Bronze Age in South-Eastern Europe (Bökönyi, in print). The Romans with their advanced deliberate animal breeding were certainly able to produce and distribute hornless cattle. However the breeders' taste as well as fashion, which may also have profound effect on the appearance of animals, dictated that long horns were preferable. The occasionally occurring hornless animals were probably culled from the herd.

The variation in the horn-cores from the cattle of Tác–Gorsium can be seen in Figure 4. This figure gives useful information about horn-cores found on other sites of the same period as well. The scatter diagram of Figure 4 shows the two types clearly with intermediate forms which were probably the results of cross-breeding. The horn sizes of the improved Italian cattle can be seen in the upper part of the diagram with the sexes clearly distinguishable as well as perhaps even the oxen. The group of local cattle types can be seen in the lower part of the diagram. Here the horn-cores of cows, bulls, and oxen are not distinguishable from one another. The horn-core variation of the cattle of Tác–Gorsium fits very well into the overall picture of horn-core variation presented by other Central and West European sites from the period of Imperial Rome. It is only the gigantic horn-cores of two oxen which fall over the size boundary describing these general populations. At the same time, the sizes of cattle coming from territories outside of the Roman Empire such as the Celtic site of Manching (Schneider, 1958; Dürr, 1961; Bachmann, 1962; Boessneck *et al.*, 1971, 51–57) and the Germanic site of Oberdola (Teichert, 1974, 138) fall exactly into the lower size range of the diagram, which clearly demonstrates a similarity with the local animals of Tác–Gorsium.

The measurements of the bones from the extremities give the best information about the size of the Roman Imperial Period cattle of the site. The three most common of these bones, the metacarpus, the

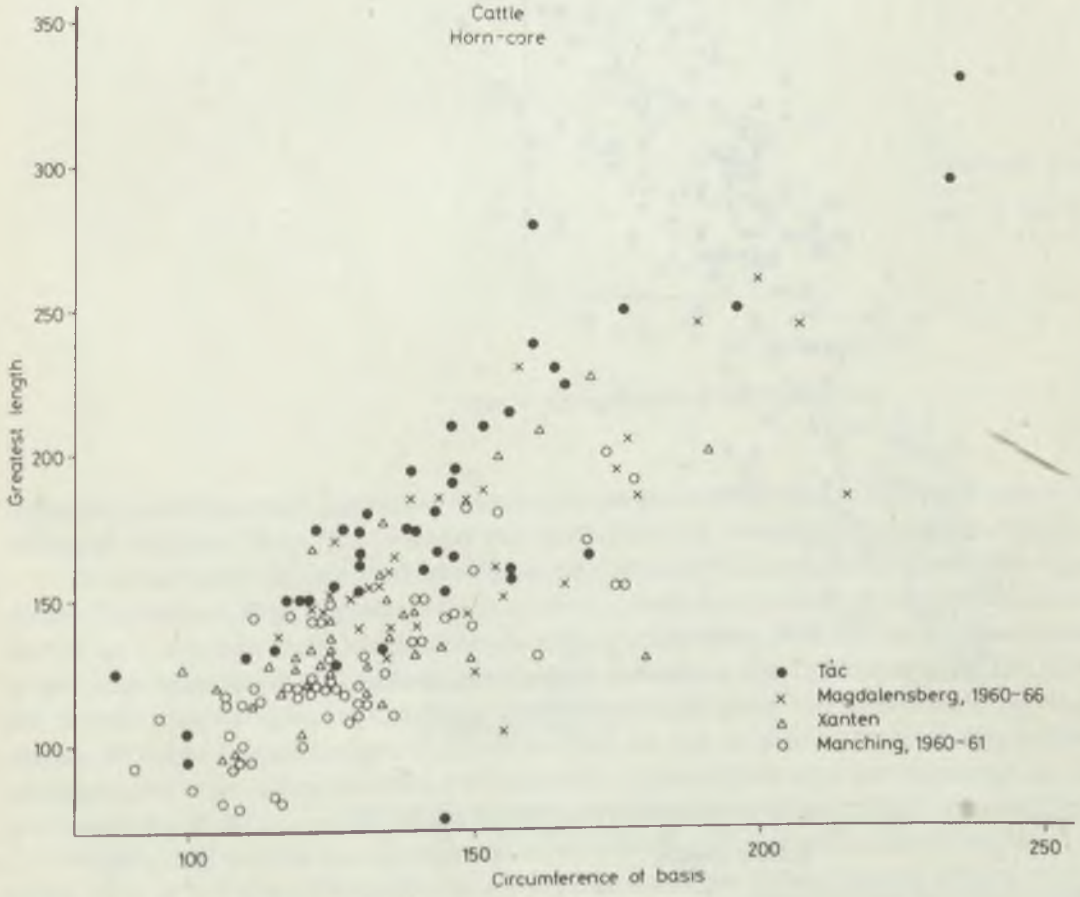


Figure 4. Scatter diagram of cattle horn-cores

metatarsus and astragalus were chosen for purposes of measurement. I used only the bone measurements from adult animals. Thus, only the late ossifying distal ends of the metapodials were taken into consideration, so that younger individuals were excluded from the sample. This kind of differentiation is not applicable to the astragali which are short bones with only one developing ossification center. Despite this problem an effort was made to sort out younger individuals on the basis of the more spongious character of the bone.

The scatter diagrams of the three selected limb bones (Figures 5, 6) show that the size of the site's cattle population is quite variable. The majority of the individuals fall into the size range of Iron Age cattle found in Hungary and surrounding countries. There is, however, another group which far exceeds this range. For several reasons differentiation of breeds, types, or groups is not possible using the limb bones, unlike the possibilities with skull fragments and horn-cores. Limb bones are much more plastic and, therefore, react more sharply to environmental and genetic changes than skull elements and horns. As such, limb bones are more influenced by crossings between local and imported cattle. Consequently individuals produced by cross-breeding connect the two parts of the population. In addition, the overlap in size range which is considerable between large cows and small bulls further confuses that part of the size range which is most important in terms of type differentiation. Last but not least, castration has a strong

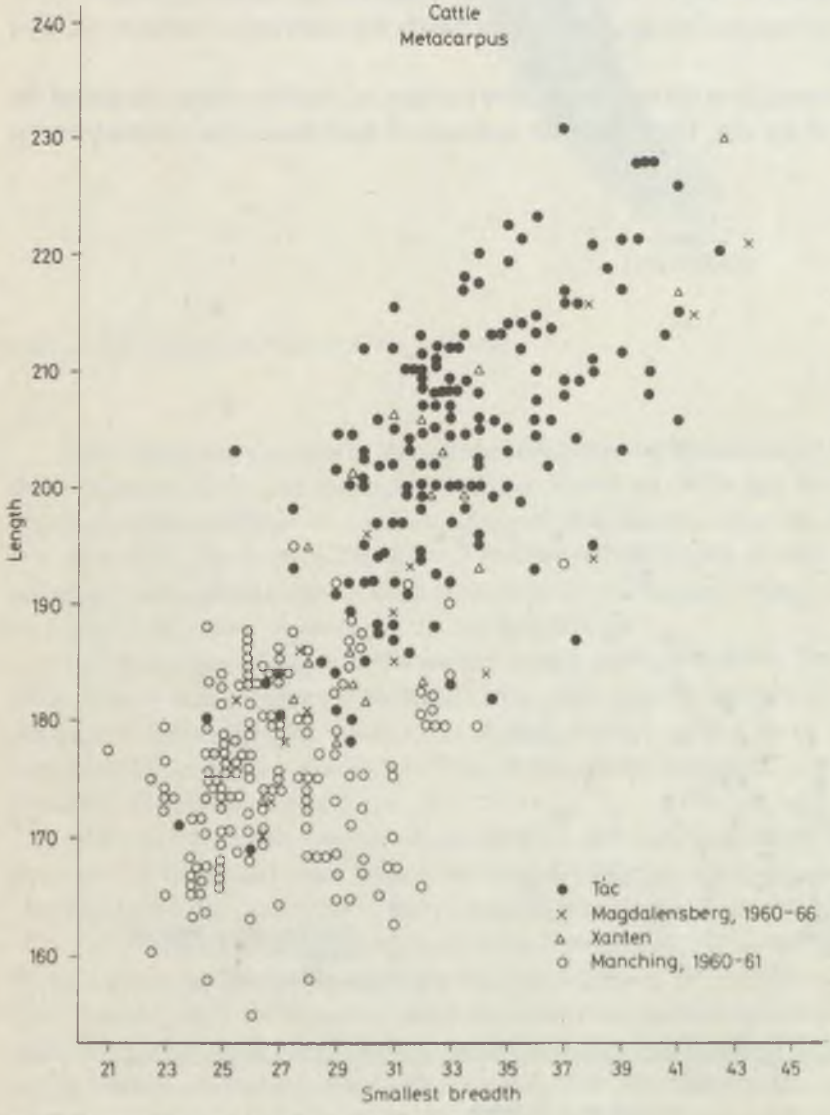


Figure 5. Scatter diagram of cattle metacarpals

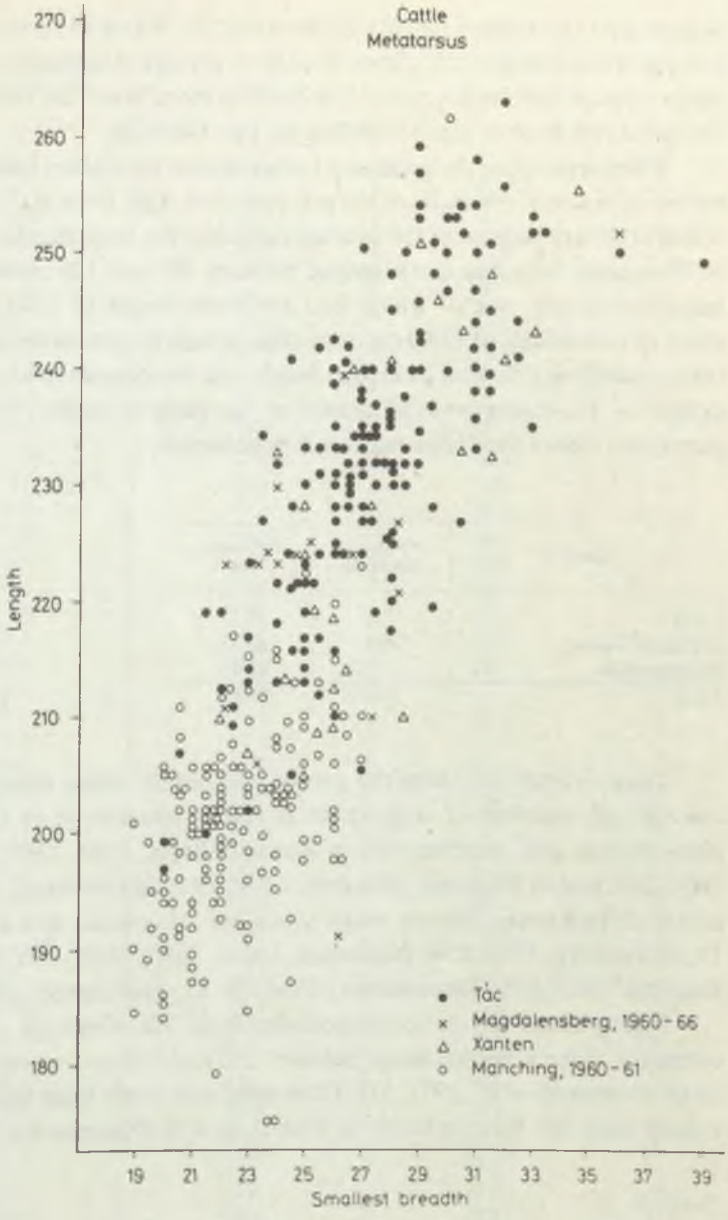


Figure 6. Scatter diagram of cattle metatarsals

influence on the longitudinal growth of extremity bones which in turn effects the ossification of epiphysis-diaphysis hardness. These factors render still more indistinct, variations between the two types.

The large bulls of the imported breed, however, form a well defined group in the upper region of the range. The bones of these large size individuals almost reach the size range of aurochs and in some cases even reach it. It is only their thinner diaphysis walls, less developed muscular surfaces and lesser density which differs from that of the wild form. Similar huge individuals were discovered by Swegat (1976, 22) in the Roman camp of Künzing–Quintana, Germania. In this group the metapodials, particularly the metatarsal bones sometimes have distal ends which are just as wide as those of the aurochs. These specimens, however, came not from wild animals but rather from very old individuals in which the overburdening of the extremities results in this kind of functional hypertrophy in the distal epiphyses.

Withers heights of the Tác–Gorsium cattle were calculated using the indices developed by Matolcsi (1968; 1970, 113). The greatest length of metacarpal bones suggest a range between 104.6 to 143.0 cm with a mean value of 125.88 cm. Similar calculations using the measurements from the metatarsal bones

suggest that the withers heights lay between 107.4 and 143.3 cm with a mean value of 126.77 cm. The average withers height calculated from both groups of metapodials is 126.32 cm. This value exceeds the mean value of Pannonian cattle (124.2 cm) by more than 2 cm (Bökönyi, 1974, 140) which illustrates well the advanced level of cattle breeding in Tác–Gorsium.

When separating the local and Italian breeds by withers heights consideration must be taken of the variation in size of the cattle of the previous Iron Age. Even in this case any distinction between breeds is rather arbitrary because of the overlap caused by the large number of intermediate specimens. The height of Hungarian Iron Age cattle ranged between 102 and 120 cm with the exception of a few particularly large individuals, one of which had a withers height of 126.0 cm. It therefore seems reasonable to consider individuals of 120.0 cm or smaller withers heights as being from a local breed. On the other hand, cattle exceeding 125.0 cm in withers height can be considered improved Italian breeds. If the cattle bone sample of Tác–Gorsium is separated on the basis of withers heights calculated from metacarpal and metatarsal bones the following result is obtained:

Breeds	Number of individuals	Frequency (%)
Local	73	22.12
Improved Italian	206	62.43
Indeterminate	51	15.45
Total	330	100.00

These estimations show the good quality of the cattle population at Tác–Gorsium as well. Such a considerable number of large cattle is rather uncommon in the provinces of Imperial Rome. This phenomenon also occurred only in Raetia (Rüeger, 1944, 236ff; Stampfli, 1959–60, 436–457; Würgler, 1959, 269) and in Pannonia (Bökönyi, 1974, 130). In Germania, which was much farther away from the centre of the Roman Empire, small mountain cattle made up the majority of the stock (Schlosser, 1888, 19; Sickenberg, 1938. 150; Boessneck, 1957a, 108ff; 1959, 13ff; 1964, 224–225; Habermehl, 1957, 74ff; Requate, 1962, 63ff; Dannheimer, 1964, 36–37; Hornberger, 1970, 43).

Pygmy cattle which occur sporadically in Tác–Gorsium appear to form a distinct group. Their estimated withers heights range between 105 and 106 cms which corresponds to the size range of Celtic cattle (Boessneck *et al.*, 1971, 55). Their small size shows them to be of local origin. Similar individuals are known from the Roman levels in Vienna as well (Neumann, 1951, 17).

TABLE 4

Size and slenderness relationships in cattle metapodials

(a) *Metacarpus*

	Greatest length (mm)	Withers height (cm)	Slenderness index	Nobis index	Sex
1	169	104.6	15.4	29.6	♀
2	171	105.8	13.7	26.3	♀
3	178	110.2	16.6	30.1	♀
4	180	111.4	13.6	25.6	♀
5	180*	111.4	16.4	—	—
6	180.5	111.7	15.0	26.6	♀
7	181	112.0	16.0	26.5	♀
8	182	112.7	19.0	33.0	♂
9	183	113.3	14.5	28.1	♀
10	183	113.3	18.0	30.6	♂
11	184	113.9	14.7	26.4	♀
12	184	113.9	15.8	26.6	♀
13	185	114.5	15.4	28.1	♀
14	185	114.5	16.2	27.6	♀
15	186	115.1	16.9	29.0	♀

TABLE 4 *(cont'd)*

	Greatest length (mm)	Withers height (cm)	Slenderness index	Nobis index	Sex
16	187	115.8	16.5	27.3	♀
17	187	115.8	20.1	32.6	♂
18	187.5	116.1	16.3	28.8	♀
19	188	116.4	16.2	—	—
20	188	116.4	16.5	27.9	♀
21	188	116.4	17.3	30.3	♂
22	189	117.0	15.6	27.5	♀
23	191	118.2	15.2	27.7	♀
24	191	118.2	16.5	28.0	♀
25	191.5	118.5	—	27.7	♀
26	192	118.8	15.4	—	—
27	192	118.8	15.6	27.1	♀
28	192	118.8	15.6	29.7	♀
29	192	118.8	16.1	27.9	♀
30	192	118.8	17.2	28.6	♀
31	192.5	119.2	16.9	29.6	♀
32	193*	119.5	14.2	26.9	♀
33	193	119.5	18.7	32.1	♂
34	193.5	119.8	15.8	28.4	♀
35	194	120.1	15.7	27.1	♀
36	194	120.1	16.5	28.1	♀
37	194*	120.1	16.5	—	—
38	195*	120.7	15.4	27.2	♀
39	195	120.7	17.4	—	—
40	195*	120.7	19.5	33.3	♂
41	196	121.3	17.3	29.1	♀
42	197	121.9	15.5	27.7	♀
43	197	121.9	15.7	26.1	♀
44	197	121.9	15.7	28.9	♀
45	197	121.9	16.8	29.4	♀
46	198	122.6	13.9	26.3	♀
47	198	122.6	—	29.8	♂
48	198*	122.6	16.2	28.5	♀
49	198	122.6	16.9	28.8	♀
50	198.5	122.9	17.9	24.7	♀
51	199	123.2	16.1	29.9	♂
52	199	123.2	17.3	31.9	♂
53	199.5	123.5	15.8	29.3	♀
54	200	123.8	14.8	26.3	♀
55	200	123.8	15.0	28.0	♀
56	200	123.8	15.8	28.5	♀
57	200*	123.8	16.3	28.5	♀
58	200	123.8	16.5	29.0	♀
59	200*	123.8	16.5	—	—
60	200*	123.8	17.0	27.0	♀
61	200	123.8	17.0	29.5	♀
62	200	123.8	17.5	—	—
63	200.5	124.1	16,0	27.9	♀
64	200.5	124.1	16.0	27.4	♀
65	201.5	124.7	14.4	27.0	♀
66	202*	125.0	15.1	28.0	♀
67	202	125.0	15.3	27.5	♀
68	202	125.0	15.8	28.0	♀
69	202	125.0	16.8	29.7	♀
70	202	125.0	16.8	29.7	♀
71	202	125.0	18.1	30.0	♂
72	202*	125.0	—	28.7	♀
73	202.5	125.3	14.8	27.2	♀
74	202.5	125.3	16.8	28.1	♀
75	203	125.7	12.6	30.5	♂
76	203	125.7	14.8	27.6	♀
77	203	125.7	15.5	26.8	♀
78	203	125.7	17.2	30.0	♂

TABLE 4 *(cont'd)*

	Greatest length (mm)	Withers height (cm)	Slenderness index	Nobis index	Sex
79	203	125.7	19.2	30.5	♂
80	204	126.3	15.4	29.9	♂♀
81	204	126.3	17.6	32.4	♂
82	204	126.3	18.4	31.9	♂
83	204.5	126.6	14.2	26.4	♂
84	204.5	126.6	14.4	25.4	♀
85	204.5	126.6	15.6	27.9	♀
86	204.5	126.6	16.1	28.4	♀
87	204.5	126.6	16.4	29.6	♀
88	205	126.9	15.1	—	—
89	205	126.9	15.8	28.5	♀
90	205	126.9	16.6	29.0	♀
91	205	126.9	17.1	29.0	♀
92	205*	126.9	—	—	—
93	206	127.5	14.8	—	—
94	206	127.5	16.0	28.6	♀
95	206	127.5	16.5	27.7	♀
96	206	127.5	16.7	29.9	♂♀
97	206	127.5	17.5	31.8	♂
98	206	127.5	17.7	30.6	♂
99	206	127.5	19.9	32.5	♂
100	207	128.1	15.5	27.1	♀
101	207	128.1	15.7	27.5	♀
102	207	128.1	15.9	28.0	♀
103	207.5	128.4	17.3	29.9	♂♀
104	208	128.8	15.6	26.7	♀
105	208	128.8	15.6	26.4	♀
106	208	128.8	15.9	27.9	♀
107	208	128.8	15.9	—	—
108	208	128.8	16.3	27.9	♀
109	208	128.8	17.8	29.6	♂♀
110	208	128.8	19.2	—	—
111	208.5	129.1	15.3	27.3	♀
112	209	129.4	15.8	28.5	♀
113	209	129.4	16.0	29.4	♀
114	209	129.4	17.7	29.4	♀
115	209	129.4	17.9	30.9	♂
116	209	129.4	18.7	29.9	♂♀
117	209.5	129.7	15.3	25.3	♀
118	210	130.0	15.0	27.6	♀
119	210*	130.0	15.0	—	—
120	210*	130.0	15.2	27.1	♀
121	210*	130.0	17.1	28.6	♀
122	210*	130.0	18.1	31.9	♂
123	210	130.0	19.0	31.4	♂
124	210.5	130.3	15.4	26.1	♀
125	211	130.6	15.4	28.0	♀
126	211	130.6	18.0	31.8	♂
127	211.5	130.9	15.1	27.2	♀
128	212	131.2	14.2	27.4	♀
129	212	131.2	14.6	26.9	♀
130	212*	131.2	15.3	29.7	♀
131	212*	131.2	15.6	27.4	♀
132	212	131.2	15.6	27.8	♀
133	212	131.2	16.7	30.4	♂♀
134	212*	131.2	—	—	—
135	213	131.8	15.0	25.8	♀
136	213	131.8	15.7	29.1	♀
137	213	131.8	16.2	26.8	♀
138	213	131.8	16.2	—	—
139	213	131.8	16.9	28.2	♀
140	213*	131.8	19.0	—	—

TABLE 4 *(cont'd)*

	Greatest length (mm)	Withers height (cm)	Slenderness index	Nobis index	Sex
141	213.5	132.2	17.1	31.4	♂
142	214*	132.5	16.4	28.7	♀
143	214	132.5	16.6	29.9	♀
144	214.5	132.8	16.8	29.8	♀
145	215	133.1	19.1	32.1	♂
146	215.5	133.4	14.4	27.4	♀
147	216	133.7	17.1	29.2	♀
148	216*	133.7	17.4	29.6	♀
149	217	134.3	15.4	28.6	♀
150	217	134.3	17.1	30.9	♀
151	217*	134.3	18.0	—	—
152	217.5	134.6	15.6	26.4	♀
153	218	134.9	15.4	28.0	♀
154	218.5	135.3	17.6	29.1	♀
155	219.5	135.9	15.9	31.4	♀
156	220	136.2	15.5	30.9	♀
157	220	136.2	19.3	30.2	♀
158	221	136.8	17.2	31.4	♀
159	221	136.8	17.9	32.1	♂
160	221.5	137.1	16.0	28.2	♀
161	221.5	137.1	17.6	31.2	♂
162	222.5	137.7	15.7	29.2	♀
163	223	138.0	16.1	28.3	♀
164	226	139.9	18.1	31.9	♂
165	228	141.1	17.3	30.0	♂
166	228	141.1	17.3	31.1	♂
167	228	141.1	17.5	31.1	♀
168	231	143.0	16.0	32.9	♂

(b) *Metatarsus*

	Greatest length (mm)	Withers height (cm)	Slenderness index	Nobis index	Sex
1	197	107.4	10.2	19.3	♀
2	199.5	108.7	—	—	♀
3	200*	109.0	10.8	21.0	♀
4	202*	110.1	11.4	19.4	♀
5	205*	111.7	12.2	22.0	♀
6	205.5	112.0	13.1	25.1	♂
7	207	112.8	9.9	19.1	♀
8	209.5	114.2	10.7	20.3	♀
9	210	114.5	12.4	22.9	♀
10	211	115.0	10.7	21.1	♀
11	212*	115.5	12.0	—	—
12	212.5	115.8	10.4	20.7	♀
13	213*	116.1	10.8	20.7	♀
14	213*	116.1	11.3	20.7	♀
15	213*	116.1	11.7	21.6	♀
16	213*	116.1	—	—	—
17	214*	116.6	10.7	—	♀
18	214	116.6	11.7	22.2	♀
19	216	117.7	11.3	20.4	♀
20	216	117.7	11.6	20.4	♀
21	216	117.7	12.0	—	—
22	217*	118.3	11.5	—	♀
23	217*	118.3	11.8	18.7	♀
24	217*	118.3	11.8	21.2	♀
25	217.5	118.5	12.9	23.4	♂
26	218	118.8	11.0	20.6	♀
27	219	119.4	9.8	19.6	♀

TABLE 4 *(cont'd)*

	Greatest length (mm)	Withers height (cm)	Slenderness index	Nobis index	Sex
28	219	119.4	10.0	18.7	♀
29	219	119.4	11.4	20.5	♀
30	219	119.4	12.6	20.8	♀
31	219.5	119.6	13.4	23.5	♂
32	220*	119.9	12.7	—	—
33	221.5	120.7	11.1	21.4	♀
34	222*	121.0	10.8	—	♀
35	222	121.0	11.3	17.3	♀
36	222	121.0	11.3	20.9	♀
37	222*	121.0	11.3	22.1	♀
38	222	121.0	12.6	20.5	♀
39	223	121.5	10.3	19.7	♀
40	223*	121.5	11.2	19.7	♀
41	224	122.1	10.9	—	♀
42	224	122.1	11.4	19.9	♀
43	224	122.1	11.6	20.5	♀
44	224*	122.1	11.6	19.2	♀
45	224	122.1	12.1	21.4	♀
46	225	122.6	11.6	21.8	♀
47	225*	122.6	12.4	24.0	♂
48	225.5	122.9	12.4	21.3	♀
49	226*	123.2	12.4	21.0	♀
50	227*	123.7	10.4	—	—
51	227	123.7	11.5	21.1	♀
52	227	123.7	11.9	22.0	♀
53	227*	123.7	11.9	20.0	♀
54	227*	123.7	13.4	22.5	♂
55	228	124.3	10.7	21.5	♀
56	228*	124.3	11.2	20.6	♀
57	228*	124.3	11.4	—	—
58	228	124.3	11.8	21.1	♀
59	228	124.3	12.9	22.8	♂
60	229.5	125.1	11.5	21.6	♀
61	230	125.4	10.9	20.4	♀
62	230*	125.4	11.3	22.0	♀
63	230*	125.4	11.5	—	—
64	230	125.4	12.0	—	—
65	230	125.4	12.2	21.3	♀
66	230*	125.4	12.4	22.0	♂
67	230.5	125.6	11.5	21.6	♀
68	231	125.9	11.0	21.2	♀
69	231*	125.9	11.3	20.6	♀
70	231*	125.9	11.7	—	—
71	231.5	126.2	12.1	21.2	♀
72	232*	126.4	10.3	20.3	♀
73	232*	126.4	11.4	—	—
74	232*	126.4	11.6	—	—
75	232*	126.4	12.1	—	—
76	232	126.4	11.9	20.5	♀
77	232*	126.4	11.9	—	—
78	232*	126.4	12.3	20.7	♀
79	232*	126.4	12.5	—	—
80	233*	127.0	10.7	20.0	♀
81	233*	127.0	10.9	—	—
82	233*	127.0	11.2	20.4	♀
83	233	127.0	11.2	20.6	♀
84	233	127.0	11.6	20.4	♀
85	233	127.0	11.6	20.4	♀
86	233	127.0	13.3	23.6	♂
87	234*	127.5	10.0	18.4	♀
88	234	127.5	11.5	21.2	♀
89	234	127.5	11.5	20.1	♀
90	234	127.5	11.5	21.4	♀

TABLE 4 *(cont'd)*

	Greatest length (mm)	Withers height (cm)	Slenderness index	Nobis index	Sex
91	234*	127.5	11.8	21.4	♀
92	234.5	127.8	12.4	21.3	♀
93	235*	128.1	11.1	20.4	♀
94	235*	128.1	11.5	19.4	♀
95	235	128.1	11.7	20.6	♀
96	235*	128.1	11.9	—	—
97	235	128.1	14.0	21.9	♀
98	235*	128.1	—	—	—
99	235.5	128.3	11.9	20.8	♀
100	236*	128.6	13.1	23.3	♀♀
101	236.5	128.9	11.8	20.7	♀
102	237	129.2	11.6	21.1	♀
103	237	129.2	12.4	21.5	♀
104	237.5	129.4	11.4	20.4	♀
105	237.5	129.4	12.0	21.7	♀
106	238	129.7	11.3	—	—
107	238*	129.7	13.0	23.1	♂♂
108	238	129.7	13.2	22.9	♂♂
109	238.5	130.0	10.9	21.2	♀
110	239.5	130.5	13.2	21.9	♀
111	240*	130.8	10.8	20.0	♀
112	240*	130.8	11.3	21.3	♀
113	240*	130.8	11.3	—	—
114	240*	130.8	11.7	—	—
115	240*	130.8	12.9	—	—
116	240	130.8	12.1	20.2	♀
117	240*	130.8	12.1	23.5	♀♀
118	240	130.8	12.5	21.0	♀
119	240.5	131.1	11.0	20.4	♀
120	241	131.3	10.2	19.5	♀
121	241	131.3	13.5	24.3	♂
122	242	131.9	10.5	21.1	♀
123	242*	131.9	11.0	19.4	♀?
124	242*	131.9	12.8	22.7	♂♂
125	242*	131.9	13.0	22.7	♂♂
126	242.5	132.2	10.7	19.2	♀
127	242.5	132.2	12.0	20.8	♀
128	243*	132.4	11.9	20.6	♀
129	244	133.0	12.7	23.2	♂♂
130	244	133.0	13.3	22.5	♂♂
131	245	133.5	11.4	19.8	♀
132	245*	133.5	12.9	23.7	♂♂
133	246	134.1	11.8	21.1	♀
134	247*	134.6	12.1	22.5	♂♂
135	247	134.6	12.6	20.9	♀
136	248	135.2	11.3	20.8	♀
137	248	135.2	11.9	22.4	♂♂
138	249	135.7	11.6	19.9	♀
139	250*	136.3	11.4	19.2	♀
140	250*	136.3	12.0	21.4	♂♂
141	250	136.3	12.4	21.4	♂♂
142	250*	136.3	14.4	23.8	♂♂
143	250.5	136.5	10.8	19.6	♀
144	251	136.8	11.8	20.3	♀
145	251	136.8	12.5	23.9	♂
146	252	137.3	12.1	23.4	♂♂
147	252	137.3	13.1	22.8	♂♂
148	252*	137.3	13.3	22.2	♂♂
149	252*	137.3	14.3	25.0	♂♂
150	253*	137.9	11.5	21.5	♀
151	253*	137.9	11.9	21.3	♂♂
152	253*	137.9	11.9	21.7	♂♂
153	253	137.9	13.0	21.7	♂♂

TABLE 4 *(cont'd)*

	Greatest length (mm)	Withers height (cm)	Slenderness index	Nobis index	Sex
154	254*	138.4	11.4	21.7	
155	254	138.4	12.0	20.0	
156	254	138.4	12.2	22.0	
157	256*	139.5	12.5	22.7	
158	257	140.1	11.3	—	
159	258	140.6	12.0	22.9	
160	259	141.2	11.2	20.1	
161	262*	142.8	11.5	21.8	
162	263	143.3	12.2	22.6	

* In the table, the approximate measurements are marked by an asterisk

An attempt was made to separate out sexual differences between cattle metapodials from Tác–Gorsium using the indices of Nobis (1954; 179f). This calculation enables us a more accurate size estimation in the context of sexual dimorphism. Such information also helps in determining sex ratios within the population as well. Differentiation was successful in the majority of cases as shown by Table 4. 150 of 168 complete metacarpal bones could be identified as to sex (Table 5). Sexual dimorphism was not sufficiently expressed in 21 of the 162 metatarsal bones (see Table 5).

TABLE 5

Determination of sex on the basis of metacarpals

Sexes	Number of individuals	Frequency (%)
cows (♀)	106	70.6
bulls (♂)	22	14.7
oxen (♂)	22	14.7
Identified	150	100.0
Unidentified	18	
Total	168	

Determination of sex on the basis of metatarsals

Sexes	Number of individuals	Frequency (%)
cows (♀)	102	72.3
bulls (♂)	10	7.1
oxen (♂)	29	20.6
Identified	141	100.0
Unidentified	21	
Total	162	

Note: Sex ratios were calculated only from the sexually identifiable portions of the samples (100.0%)

Because previously we accepted with reservation the practical value of Nobis' indices for sex identification, the slenderness of the diaphysis was taken into consideration in doubtful cases as well. Figures 7 and 8 show that the experiment was successful since the metapodials of cows can be easily separated from those of the bulls. The metatarsal bones even permit discrimination of oxen, which form a rather well isolated group in the diagram.

The clear differences between the small local cows and bulls shown on these diagrams are of great importance. As was demonstrated here, differentiation would have been impossible on the basis of length. At the same time, castration of both large and small bulls to produce draught animals may be inferred from this data. The latter is not surprising in as much the castration of bulls was practised long before the Romans in Europe, as early as the Neolithic (Krysiak, 1950–51, 228; 1952, 289; Nobis, 1954, 160). Withers heights could be calculated in the sexually divided sample using the same indices (metacarpal 6.19 and metatarsal 5.45). There are no particular differences to be found between the cows and the bulls in the calculations, although, the average withers height of oxen exceeds the values for cows or even those for the bulls (Table 6).

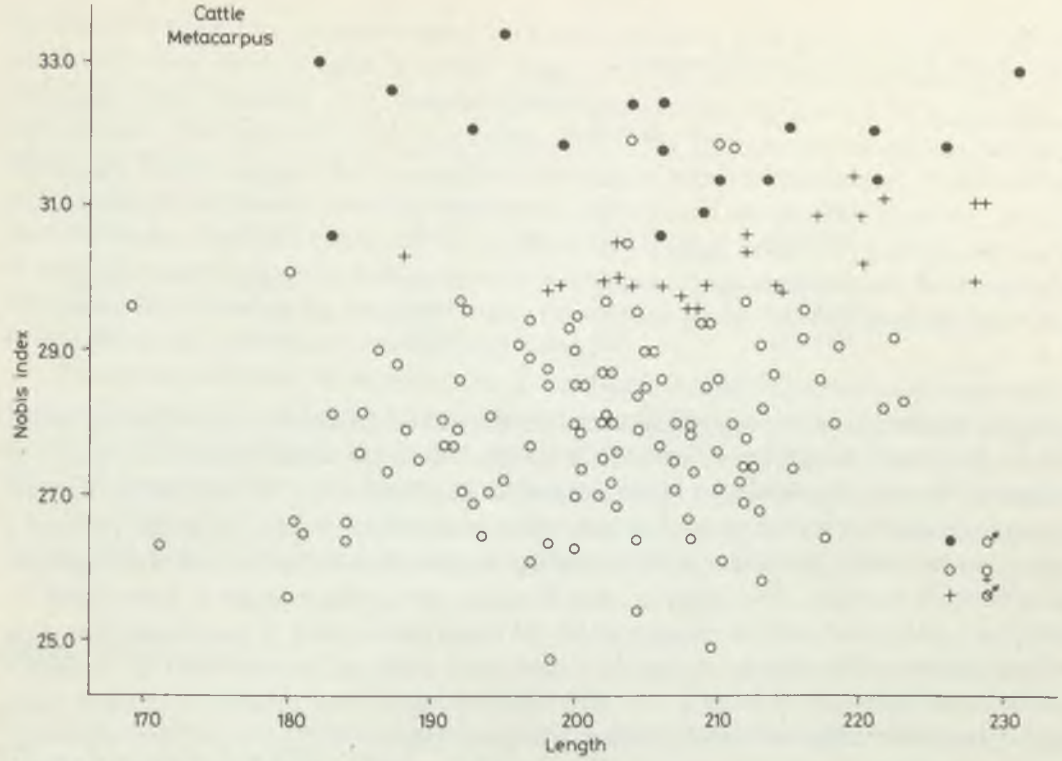


Figure 7. Scatter diagram of Nobis indexes on cattle metacarpals

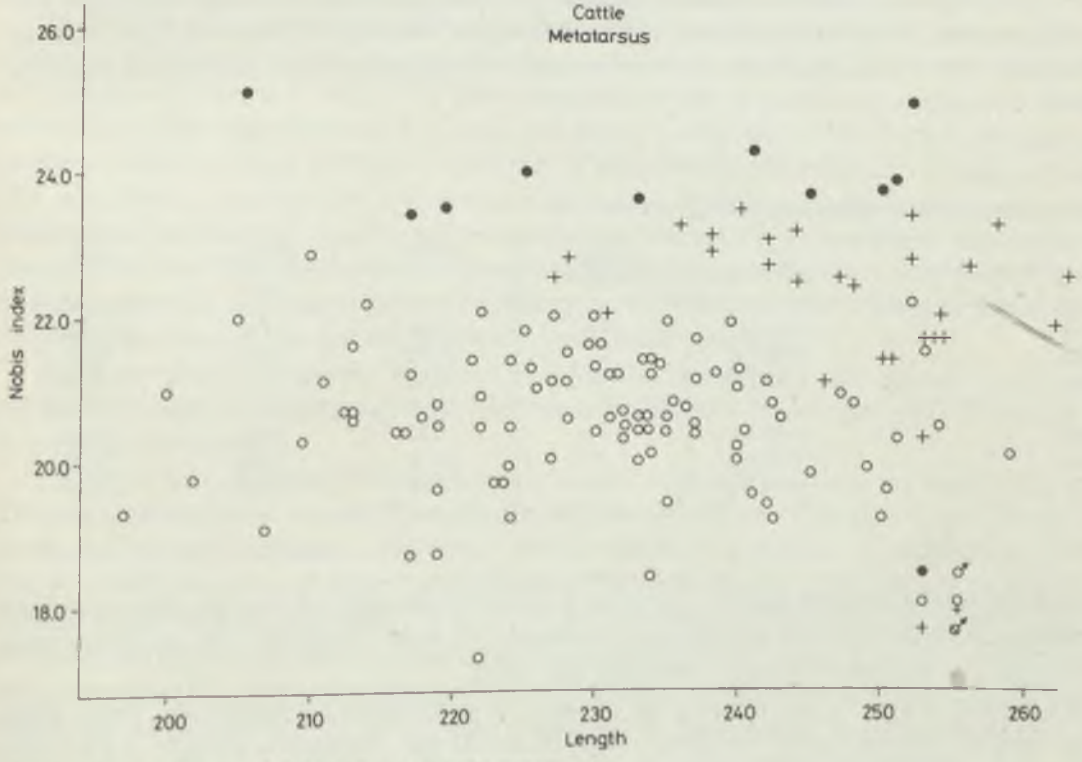


Figure 8. Scatter diagram of Nobis indexes on cattle metacarpals

TABLE 6

Estimated withers heights of cattle from Tác–Gorsium (cm)

Bones used in the calculation	Sexes	Number of individuals	Minimum	Maximum	Mean
			values		
metacarpals	cows (♀)	106	104.60	138.00	124.64
metacarpals	bulls (♂)	22	112.70	143.00	127.63
metacarpals	oxen (♂)	22	116.40	141.10	130.66
metatarsals	cows (♀)	102	107.40	141.20	123.49
metatarsals	bulls (♂)	10	137.30	137.30	127.49
metatarsals	oxen (♂)	29	123.70	143.30	134.73

Interestingly, the slenderness of metapodials seems to reflect sexual dimorphism more than the actual size of animals. (Perhaps it would not be completely useless if someone would create new indices for sexual dimorphism based on the slenderness of the metapodial. Such indices may be more reliable than the recent methodology based on the proximal epiphyses, which tend to display great individual variation.)

As may be seen in Table 7, the indices of Nobis create groups in which the slenderness of metapodials differs greatly between the sexes. The values of oxen, however, are similar to those of cows (Table 7).

Aurochs, the wild form of cattle, is represented by 106 bones from at least 18 individuals. The most important bone specimens from this species are the fragments of skulls and horn-cores as for example a right frontal bone and horn-core of an adult cow, two right horn-cores from subadult bulls and a distal end of a giant horn-core coming from an adult bull. A less typical horn-core fragment has been excavated as well.

Aurochs cows are seldom described. Many of these animals overlap with the size range of domestic bulls and this discouraging fact inhibits authors from trying to identify the bones of such females as positively the remains of aurochs. In spite of this uncertainty, the skull fragment from the Tác–Gorsium aurochs cow belongs, beyond any doubt, to the skeleton of a wild animal. Its intercornual ridge is wide and straight, the forehead is flat, and the bone of the skull is much thicker than in domestic cattle. Moreover, its horns were oriented in a direction typical for aurochs, although the length of only 300 mm and the 220 mm basal circumference places it within the range of variation of *primigenius* type domestic cattle. The wall of the horn-core, however, is very compact, not spongious at all, and its outer surface is not ribbed.

TABLE 7

The slenderness indices of cattle metapodials from Tác–Gorsium (cm)

Bones used in the calculation	Sexes	Number of individuals	Minimum	Maximum	Mean
			values		
metacarpals	cows (♀)	105	13.60	17.90	15.80
metacarpals	bulls (♂)	22	16.00	20.10	18.24
metacarpals	oxen (♂)	22	12.60	19.30	16.90
metatarsals	cows (♀)	97	9.80	14.00	11.46
metatarsals	bulls (♂)	10	12.40	14.40	13.27
metatarsals	oxen (♂)	28	11.40	13.40	12.47

A piece of distal horn-core appears to belong to a strong bull although the two horn-cores from subadult animals come only from medium size individuals. As with the aurochs cow, these horn-cores show the typical horn form of Central European wild cattle.

The extremity bones do not indicate the presence of particularly big individuals. Some of the scapulae, however, with an angulus articularis of 90, 92 and 93 mm, belonged to animals of the middle large size range in the Carpathian basin (Bökönyi, 1962, 175ff; 1972, 23ff). All the other bones come from

smaller individuals. One specimen seems to be especially small. The greatest length of the metacarpal bone is 215 mm which suggests a withers height of 133.1 cm as calculated using Matolcsi's index (Matolcsi, 1968, 3ff; 1970, 113). It is worthwhile mentioning that during the course of a previous excavation at Tác–Gorsium an aurochs metacarpal bone from an animal of very similar size was discovered. It appears to come from a slightly taller animal with a withers height of 136.5 cm. Such bones undoubtedly fall within the size range of domestic cattle from Tác–Gorsium. However, the bone wall is thick, the muscle ridges are heavy, and the specific weight is large. Additionally, since the distal epiphyses of these bones do not show the characteristic broadening in old age so common in the domesticated cattle of the site, they should rather be placed within the aurochs group. As such, they represent the smallest individuals of this species now known from Hungary.

It is not surprising that the wild cattle living in Roman Imperial Pannonia are so small. When the first phase of the extinction of aurochs was finished at the end of the Neolithic (Bökönyi, 1959, 80–81) the already decimated population was broken down still further. The increase in the area of cultivated land (Kultursteppe) exacerbated the situation, producing isolated populations in which decrease in size is an inevitable result. The fact that aurochs were rather rare in the Imperial Period in Pannonia, is shown by the fact that none of the Roman sources describing hunting in this territory mentions this species.

Sheep (*Ovis aries* L.)

The small ruminants are the second most frequent animals following cattle in the bone sample of the Roman Imperial Period at Tác–Gorsium. 1195 of the 9908 specimens of small ruminants can be definitely identified as coming from sheep while 183 come from goat. The separation of sheep and goat was based on the work of a number of authors (Cornevin and Lesbre, 1891; Gromova, 1953; Boessneck *et al.*, 1964). The high degree of fragmentation of the material made this separation possible in only a small portion of the sample. What is available suggests a proportion of 86.72 per cent to 13.28 per cent sheep to goat. As from any Roman site from the same period, the proportion of goat horn-cores is larger because hornless sheep are very frequent as opposed to goat where hornlessness is a rarity.

In the place of origin of small ruminants at the beginning of the domestication process, goat tended to occur more frequently in the mountainous regions while sheep was more frequently to be found on the plain (Hole and Flannery, 1967, 177). This phenomenon was probably connected with the habitat preferences of their wild ancestors. But soon, still during the Neolithic, the situation changed and the number of sheep increased to 20 or 30 times that of goat, even in the mountainous regions (Bökönyi, 1977, 10). There is no doubt that „the goat as a destroyer of woods being useful in the early stages of colonization, the sheep as a grass feeder, being more variable once open wastelands had been created" (Zeuner, 1963, 145–146). Moreover, the greater frequency of sheep is underscored by the fact that wool producing sheep had appeared in the Middle East by the 6th millennium B.C. (Bökönyi, 1976b, 22; 1977, 25) where they can bear the hot steppe climate much better than goat.

From the early Neolithic the frequency of sheep was greater than that of goat in all significant European sites with rich faunal materials. The proportion between the two species fell between 5 : 1 and 10 : 1 in favour of sheep.

On other Roman Imperial Period sites the number of sheep is larger as well although the proportion of the two groups is rather variable. For example, their proportions are 82.82 per cent to 17.18 per cent in Abodiacum–Epfach (Boessneck, 1964, 222), 75.95 per cent to 24.05 per cent in Magdalensberg (Fruth, 1966, 47), 81.82 per cent to 18.18 per cent in Künzing–Quintana (Swegat, 1976, 39) and 79.17 per cent to 20.88 per cent in Vemania (W. Piehler, 1976, 41). At the same time outside the Roman Empire, goat seems to be much less frequent. In Manching goat bone comprises only 4 per cent to 5 per cent of the sheep total (Boessneck *et al.*, 1971, 59). In Haithabu, Schleswig-Holstein they barely exceed 10 per cent of the sheep total (Klein and Reichstein, 1977, 6). In the Sarmatian settlements lying on the plain between the Danube and the Tisza rivers no goat remains could be identified with real certainty (Bökönyi, 1976a, 43).

The nadir of sheep and cattle breeding in Europe occurred during the Iron Age (Bökönyi, 1974, 177ff).

TABLE 8

Size and slenderness relationships in sheep metapodials

(a) *Metacarpus*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	112.2	13.5	54.5	12.0
2	120*	12.9	58.2	10.8
3	122	15	59.2	12.3
4	123	13	59.6	10.5
5	124	13.2	60.1	10.6
6	124.5	15	60.4	12.0
7	125.8	14.5	61.0	11.5
8	126*	13.2	61.1	10.5
9	127	14.8	61.6	11.7
10	127.8	13.2	62.0	10.3
11	128*	14	62.1	10.9
12	129.5	15.9	62.8	12.3
13	130	13.3	63.1	10.2
14	130	15	63.1	11.5
15	131	14	63.5	10.7
16	131	14.4	63.5	11.0
17	131.5	16.5	63.8	12.5
18	132	16.2	64.0	12.3
19	132*	14	64.0	10.6
20	132.2	15.3	64.1	11.6
21	132.3	14.3	64.2	10.8
22	133.3	13.2	64.7	9.9
23	134	14.3	65.0	10.7
24	134	16	65.0	11.9
25	134*	14.5	65.0	10.8
26	135	15.7	65.5	11.6
27	135*	14	65.5	10.4
28	135.5	12.5	65.7	9.2
29	135.5	15	65.7	11.1
30	136	14.2	66.0	10.4
31	136.3	15	66.1	11.0
32	136.5	14	66.2	10.3
33	137	13.7	66.4	10.0
34	137	14.1	66.4	10.3
35	137	14.2	66.4	10.4
36	137.5	14.5	66.7	10.5
37	138	14.3	66.9	10.4
38	139	15.3	67.4	11.0
39	139.5	15.3	67.7	11.0
40	140	15.3	67.9	10.9
41	140	16	67.9	11.2
42	141	15	68.4	10.6
43	142*	15.1	68.9	10.6
44	143	14.5	77.1	10.1
45	143	16	69.4	11.2
46	144	15.1	69.8	10.5
47	144.8	14.8	70.2	10.2
48	145*	14	70.3	9.7
49	145*	16	70.3	11.0
50	146	15.2	70.8	10.4
51	146.5	15.5	70.1	10.6
52	146.5	16	71.1	10.9
53	147	16.5	71.3	11.2
54	147.2	13.8	71.4	9.4
55	147.5	15.3	71.5	10.4
56	148.3	15	71.9	10.1
57	148.5	15	72.0	10.1
58	150	15.1	72.8	10.1
59	151	14.2	73.2	9.4
60	151	15.3	73.2	10,1

TABLE 8 *(cont'd)*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
61	152.3	17.8	73.9	11.7
62	154	15.3	74.7	9.9
63	154	—	74.7	—
64	154.5	15.2	74.9	9.8
65	154.5	15.5	74.9	10.0
66	156	15	76.7	9.6
67	157	14.8	76.1	9.4
68	157	14.8	76.1	9.4
69	157	17.8	76.1	11.3
70	158	15	76.6	9.5
71	159	16	77.1	10.1
72	160	14.5	77.6	9.1
73	160	15.5	77.6	9.7
74	160.5	17	77.8	10.6
75	161	14.8	78.1	9.2
76	161.2	16	78.2	9.9
77	161.3	15.8	78.2	9.3
78	162*	16	78.6	9.9
79	162*	—	78.6	—
80	162.5	14.7	78.8	9.5
81	163*	17.5	79.1	10.7
82	163.5	15.5	79.3	9.5
83	167.5	17.2	81.2	10.3
84	168	16.7	81.5	9.9
85	171.5	16	83.2	9.3
86	172*	17.2	83.4	10.0
87	173	16.2	83.9	9.4

(b) *Metatarsus*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	125	13	56.9	10.4
2	125	10.8	57.0	8.6
3	126*	11.7	57.3	9.3
4	129	13	58.7	10.1
5	131	13.2	59.6	10.1
6	131.5	11	59.8	8.4
7	132	13	60.1	9.8
8	132*	13.6	60.1	10.3
9	132*	—	60.1	—
10	133	11.4	60.5	8.6
11	133	12.3	60.5	9.2
12	133	13.4	60.5	10.1
13	134*	10.7	61.0	8.0
14	134.5	12.5	61.2	9.3
15	135	12.2	61.4	9.0
16	135	13.5	61.4	10.0
17	137	12.5	62.3	9.1
18	137.5	13	62.6	9.5
19	138.5	12	63.0	8.7
20	140	14	63.7	10.8
21	140*	13	63.7	9.3
22	142	12	64.6	8.5
23	142	13.7	64.6	9.6
24	142*	13	64.6	9.2
25	142*	14.2	64.6	10.0
26	143	11.5	65.1	8.0
27	143	12	65.1	8.4
28	143.2	12	65.2	8.4
29	143.8	12.8	65.4	8.9
30	144.5	12.7	65.7	8.8

TABLE 8 *(cont'd)*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
31	145	13.7	66.0	9.4
32	146	13.2	66.4	9.0
33	146*	14.3	66.4	9.8
34	147.5	14.1	67.1	9.6
35	148	12.2	67.3	8.2
36	148*	12.8	67.3	8.6
37	148*	13	67.3	8.8
38	148*	13	67.3	8.8
39	148.2	13.7	67.4	9.2
40	148.5	12.6	67.6	8.5
41	149*	12.5	67.8	8.4
42	149*	12.5	67.8	8.4
43	150	15	68.3	10.0
44	150	12.2	68.3	8.1
45	151	13.9	68.7	9.2
46	151	14.9	68.7	9.9
47	151.3	13.2	68.8	8.7
48	151.5	13.8	68.9	9.1
49	152	13.5	69.2	8.9
50	153	14	69.6	9.2
51	153*	14	69.6	9.2
52	153.5	12.8	69.8	8.3
53	154	14	70.1	9.1
54	155*	13.5	70.5	8.7
55	155.5	12.7	70.8	8.2
56	156	13	71.0	8.3
57	157	13.5	71.4	8.6
58	157*	13.2	71.4	8.4
59	157*	13.8	71.4	8.8
60	157.5	14.9	71.7	9.5
61	158*	14	71.9	8.9
62	158.5	14.9	72.1	9.4
63	159*	15.3	72.3	9.6
64	160	13.5	72.8	8.4
65	162	14	73.7	8.6
66	162	14.3	73.7	8.8
67	162*	13	73.7	8.0
68	162*	14	73.7	8.6
69	162*	—	73.7	—
70	163	13.7	74.2	8.4
71	163*	13	74.2	8.0
72	163*	13	74.2	8.0
73	163*	15	74.2	9.2
74	164	14	74.6	8.5
75	165	13	75.1	7.9
76	165	13.3	75.1	8.1
77	165.5	13	75.3	7.9
78	166	13	75.5	7.8
79	167	14.7	76.0	8.8
80	167*	13.8	76.0	8.3
81	168*	15	76.4	8.9
82	169	14.3	76.9	8.5
83	169*	—	76.9	—
84	169.5	13.2	77.1	7.8
85	170	14.5	77.4	8.5
86	170*	13.5	77.4	7.9
87	173.3	15	78.9	8.7
88	173.5	15	78.9	8.6
89	175.5	14	79.9	8.0
90	177*	16.2	80.5	9.2
91	180	15	81.9	8.3
92	180.5	14.8	82.1	8.2
93	182	15	82.8	8.2
94	188	15.8	85.5	8.4.

* In the table, the approximate measurements are marked by an asterisk

Withers height

	based on the metacarpals	based on the metatarsals	altogether
n	87	94	181
min.	54.4	56.9	54.4
max.	83.9	85.5	85.5
M	69.80	69.31	69.54
Slenderness index			
n	85	91	
min.	9.3	8.4	
max.	12.0	10.4	
M	10.51	8.85	

After the great Bronze Age lull the level of sheep keeping decreased dramatically with the size of the animals decreasing as well. The 69 cm average withers height of Bronze Age sheep sunk below 60 cm. These Iron Age sheep were a primitive type with the typical slow growth characteristic for such breeds. It was the advanced level of animal keeping of the Roman Imperial period which improved the low level of Central European sheep breeding. The Romans imported the crucial elements of conscious sheep breeding from Greece. The improved sheep breeding of the Greeks originated in their provinces in Asia Minor which in turn had close connections with the places of origin of domestic sheep in Mesopotamia.

Although no sheep bones from this period in Greece have been examined in detail, many representations and ancient contemporary records suggest that advanced sheep breeding already existed by the classical period. A large number of different breeds were recognized, many of which from Miletus, Attica and Epeirus produced truly fine wool (Pauly–Wissowa, 1921). This fine wool, which was of better quality than the Egyptian, was found in the 1st Scythian tumulus dating from the 5th century B.C. near the Greek town of Nymphaeum in the Crimea (Ryder, 1972, 355–356). This fact coincides with the legend of the Golden Fleece (Ryder and Hedges, 1973a, 480). The direction of the spread seems to be exactly opposite to that of the legendary one since sheep with fine quality wool were introduced by the Scythians probably under Greek influence.

The improved sheep breeds of Imperial Rome had three kinds of influences on the indigenous sheep populations of the Central European provinces. They increased the withers heights of local breeds, modified the form of the skull (Columella, Palladius and other antique authors mention the high frequency of hornless females among Roman sheep), and changed the quality of the fleece as well. This latter influence is the most important from the point of view of the breeder and will be discussed in detail later along with the other uses for sheep.

The Italian import increased the withers height of sheep relative to those of the Iron Age, by almost 10 cm as estimated from the bones found in Tác–Gorsium (Table 8). This measurement exceeds the same mean values for other Roman sheep not only in Pannonia (Bökönyi, 1974, 178) but also in all other known sites from the Roman Imperial Period in Austria, Germania, Switzerland and France. As with cattle breeding, this larger size marks a high level of sheep breeding in the time of the Caesars in Tác–Gorsium. Figures 9 and 10 illustrate this superiority very well. None of the sheep from the three Germanic sites used for comparison reach the upper third of the size range of the animals found in Tác–Gorsium.

Interestingly, withers heights calculated from the metacarpal and metatarsal bones do not differ significantly from one another. The difference between the two values is less than 0.5 cm. The other interesting fact is that calculations using metacarpal bones produce a larger than average withers height measurement. Except for a period between the 10th through the 13th centuries, this situation stands out uniquely in Hungarian sheep breeding history, in any other period the opposite can be assumed (Bökönyi, 1974, Figure 49).

The sheep found on the Roman site of Tác–Gorsium range widely in size. As may be seen in Table 6 the population contained all sorts of variation from very primitive small forms to large forms which succeeded the Iron Age and imported Italian animals. Unfortunately because of frequent crossbreeding

these various forms cannot be separated out on the diagram. The distinction of sexes based on the dimensions and proportions of the metapodials is impossible as well. The wide use of castration as seen from the horn-cores especially confuses this issue. Some of the long metapodials with small slenderness indices probably belong to such individuals (Table 8).

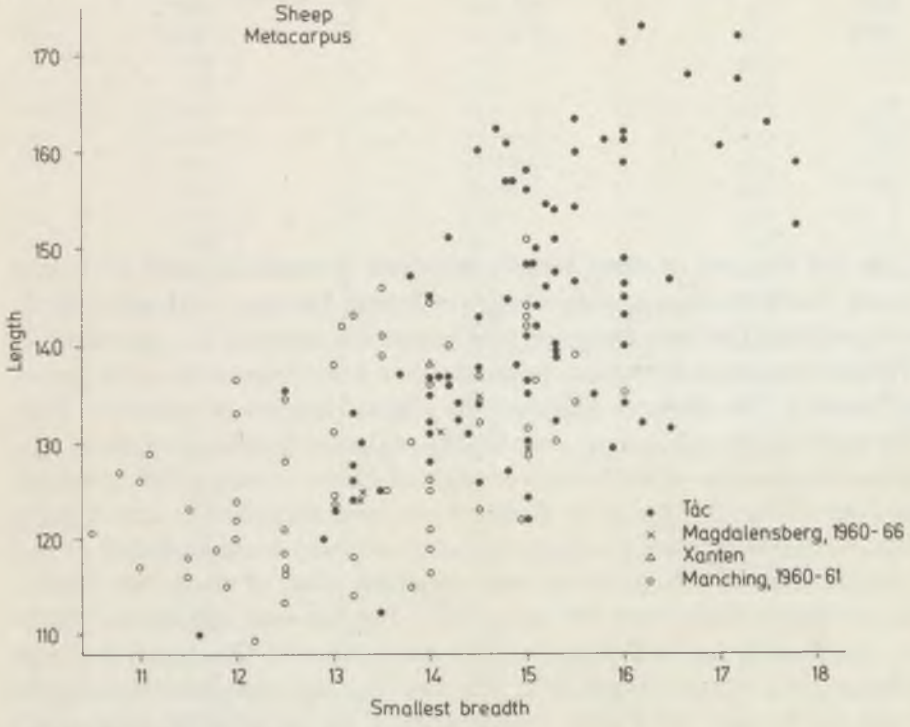


Figure 9. Scatter diagram of sheep metacarpals

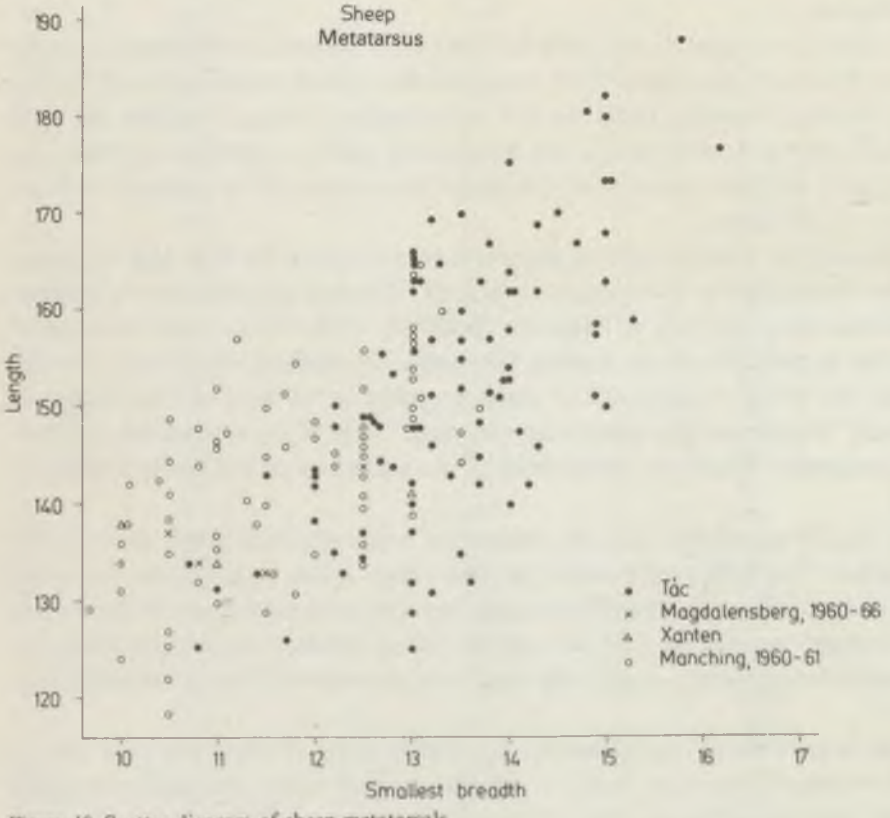


Figure 10. Scatter diagram of sheep metatarsals

Unfortunately, no complete sheep skulls were recovered during the course of excavations at Tác–Gorsium. However, large skull elements are quite frequent as are complete and fragmented horn-cores. These skull elements and attached parts are particularly useful in type identification. On the other hand facial elements are practically useless from this point of view. Sometimes it is even difficult to determine whether they are the remains of sheep or goat.

Altogether 153 horned skull elements and horn-cores were recovered. On the basis of the horn-core form, the following types were defined:

(1) Horn-cores which are long, massive, triangular in cross section at their base and flattened toward the tip, laterally oriented and sometimes almost meet to form an entire circle (this is the so-called "*Copper sheep*" type). 90 horn-cores and fragments (Figure 11).

(2) Horn-cores which are very similar to the previous group only smaller in a dwarf version. Three specimens.

(3) Horn-cores which are short and goat-like in their straightness (this is the so-called *Palustris* type). 21 horn-cores and horn-core fragments (Figure 12).

(4) Horn-cores which are very slender, circular or oval in cross section and rudimentary in character. 21 specimens.

(5) 5–15 mm long horn-core remnants. 12 specimens (Figure 12, 3).

(6) Horn-cores which are short, *Palustris*-like, slender, constricted at the base and with very thin walls. Two specimens.

(7) Horn-cores which are of a cork-screw form very similar to that of the mediaeval Hungarian sheep (Bökönyi, 1961, 93ff; 1974, 183). Two specimens.

Finally no definite type can be ascribed to 14 of the fragments. Additionally 61 neurocranial elements come from hornless sheep (Figure 12, 2; 4–6). Some of these specimens exhibit hornlessness to such an exaggerated degree that a concavity marks the place where the horn would normally be. This last is quite common on modern sheep but is not in and of itself a modern phenomenon. Examples of this trait can be traced back to the Neolithic. These forms are related to the horn-core type of the fifth group by a series of intermediate forms.

Studies by Reitsma have shown that the *Copper sheep* type belongs to rams (Reitsma, 1932). This horn form is known from Roman representations as well (Keller, 1909, 13). Roman agriculturalists too, put an emphasis on the massiveness of rams' horns. However, only a few of these horn-cores actually reach the dimension of Bronze Age ram horn-cores which were closer to the wild form. One can put each horn-core of 230 (with a basal circumference of *c.* 190 mm) 265, 270 and *c.* 295 mm length and horn-core fragments of 165, 170, *c.* 170, 179, 181 and *c.* 190 mm basal circumferences into this group.

As opposed to these large forms the third, fourth and fifth horn-cores and the hornless skull fragments came from ewes. Compared to earlier sites the number of hornless individuals is extremely high, comprising 27 per cent of the total. The increased number may result from the import of Italian improved breeds and intensive cross-breeding.

Naturally some of the hornless skull fragments may come from rams as well. Columella (VII 3) mentions hornless rams. The presence of hornless rams might be demonstrated by thick skull fragments but such fragments have been found neither at Tác–Gorsium nor at other Roman Imperial sites.

The horn-cores which are similar to those of the mediaeval Hungarian sheep probably originated from some kind of eastern sheep. Such animals could easily find their way into Pannonia as part of commerce or military tribute. It is not even impossible that the eastern army divisions imported them.

The cases of the rudimentary "*Copper sheep*" (second group) and horn-cores which are constricted at the base (sixth group) seem to be much more complicated. Considering the fact that some of the metapodials which we have examined previously come from castrated individuals we suggest that these horn-cores also belong to such animals. The influence of castration on horn-core formation was not well understood for a long time. It is well known that this physical manipulation has a depressive effect on the speed of horn-core growth, the nature of which is strongly dependent on the time of castration. Tschirwinsky (1910, 522ff) writes that castration made at one month results in rudimentary horn-cores or even hornlessness. Landauer (1925) found that early castration results in the formation of female-like

Figure 11. "Copper sheep" horn-core fragments

1

2

3

4

5

6

Figure 12. Sheep brain skull fragments

horn-cores. However, Zawadovskij (1926, 47ff) looking at individuals castrated at equally early age noted a horn form which falls between that of rams and ewes.

The problem was solved by series of experiments carried out in the Historical Research Centre in Lejre, Denmark (Hatting, 1975, 345–351). These experiments were made on individuals from breeds so primitive that the young are born with horns. If these animals were castrated within one or two months the form of the horn-cores had basically female character although a little more massive and of the same length. Castration carried out around the sixth month resulted in a decreasing effect on the longitudinal growth as well. Castrated sheep have strikingly large horn-core cavities with paper thin walls. Other deformities such as the constricted base and the finger print like depressions are not the results of castration but rather of periodic malnutrition.

In this way, the rudimentary "*Copper sheep*" horn-cores may come from castrated individuals. In the sixth group, the conspicuously thin walls and probably larger inner cavity also suggest that such animals were castrated. However, the constriction of the base may have other causes. In any case, the frequency of castrated sheep is not very great even if some of the smaller weak horn-cores are included in this group.

In terms of sex ratios one may say that 115 (54.8 per cent) female horn-cores and skull fragments, 90 (42.8 per cent) ram and 5 (2.4 per cent) castrated male horn-cores were found at the site. The 14 unidentified and two eastern type horn-cores were not included in the sample. These numbers suggest that the sex ratio was close to 1 : 1.

The age of the castrated animals at death could not be determined, however, it is still worthwhile comparing age ratios within each sex (Table 9).

TABLE 9

Age ratio of sex groups among sheep in Tác–Gorsium (%)

	Juvenile	Subadult	Adult	Total
Male (♂)	18.7	39.6	41.7	100.0
Female (♀)	3.6	32.1	64.3	100.0

This table clearly shows that females younger than one year were seldom slaughtered. Females not needed for breeding purposes were generally slaughtered in the second year of their lives. In this way about two-thirds of the female stock reached an adult age. On the other hand nearly 60 per cent of the males were killed during the first two years of life, and only about two-fifths were kept into adulthood. Even this number, however, is larger than in the Neolithic when the number of adult rams never reached 10 per cent (Bökönyi, 1976c, 329–330). The basis for this phenomenon in Tác–Gorsium lies in the exploitation of the sheep which will be detailed later.

Goat (*Capra hircus* L.)

Goat was among the rarest of the domestic animals found on temperate European Roman sites and even at that time, as in many places now, it was considered the "poor man's cow" (Pölloth, 1959, 48). Among all the hoofed domestic animals only the horse occurred sometimes in lower frequencies than the goat. At first glance this situation is rather difficult to understand. Goat does not require really good forage while its meat and milk production is larger than that of the other domestic caprovine, sheep. The milk production of goat, relative to the live weight of the animals is in fact greater than that of cows. However, it is likely that sheep were ultimately more highly valued for their wool (the only wool producing breed of goat is the angora), and at the same time the larger absolute milk production of cows meant the competition was hopeless. Additionally, its keeping was soon limited because of the damage its grazing habits did to the forest. Under such circumstances it is not very difficult to understand why goat husbandry would be among the first to be abandoned.

TABLE 10

Size and slenderness relationships in goat metapodials

(a) *Metacarpus*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	116.3	14.7	66.9	12.6
2	117	16	67.3	13.7
3	118*	16	67.9	13.6
4	119	15.3	68.4	12.9
5	120.3	16.9	69.2	14.0
6	123	15.7	70.7	12.8
7	123	16	70.7	13.0
8	123*	18	70.7	14.6
9	124.8	16.8	71.8	13.5
10	125	17.5	71.9	14.0
11	126	15.8	72.5	12.5
12	127.2	21.5	73.1	16.9
13	127.7	19	73.4	14.9
14	129.7	17	74.6	13.1
15	129.7	19.7	74.6	15.2
16	131.6	20.2	75.7	15.3
17	132.2	20	76.0	15.1
18	133.5	20.2	76.8	15.1

(b) *Metatarsus*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	117.2	13.3	62.6	11.3
2	118	11.7	63.0	9.9
3	120*	13.5	64.1	11.3
4	122.5	12	65.4	9.8
5	126*	12.5	67.3	9.9
6	128.3	13.5	68.5	10.5
7	132.5	13.8	70.8	10.4
8	134.5	13	71.8	9.7
9	134.5	14.1	71.8	10.5
10	135*	13.5	72.1	10.0
11	136.5	17.7	72.9	13.0
12	136.7	17.5	73.0	12.8
13	137.5	14.2	73.4	10.3
14	138	14.8	73.7	10.7
15	138.5	17	74.0	12.3
16	139.5	16.3	74.5	11.7
17	140*	16.5	74.8	11.8

* In the tables, the approximate measurements are marked by an asterisk

Withers height

	based on the metacarpals	based on the metatarsals	altogether
n	18	17	35
min.	66.9	62.6	62.5
max.	76.8	74.8	76.8
M	71.79	70.22	71.03

Slenderness index

	metacarpus	metatarsus
n	18	17
min.	12.5	9.7
max.	16.9	13.0
M	14.04	10.94

As with all the other domestic animals dealt with, goat breeding dropped to the lowest level in the Iron Age. Improvement was similarly achieved by the conscious breeding methods of the Romans as well as cross-breeding with imports from the south. This change is illustrated by at least a five centimetres increase in withers height over the Iron Age goat.

The increase can be easily seen in the bone material of Tác–Gorsium as well, although the number of metapodials available for the determination of withers height is not very large (Table 10).

The average withers height of the Tác–Gorsium goat was 71.79 cm as calculated from the metacarpal bones and 70.22 cm as calculated from the metatarsal bones. These measurements are among the largest known from goat in provincial Roman sites. Perhaps only the goat from Hüfingen (Sauer-Neubert, 1968, 52ff) are comparable in size to those of Tác–Gorsium. Even smaller individuals can be found in the bone material from Germanic sites lying outside the boundaries of the Roman Empire (Boessneck *et al.*, 1971, 69; Klein and Reichstein, 1977, 27ff). The few old and large bucks found on these sites may very easily be Roman imports (withers heights calculated were 77.6 cm from Manching and 77.7–81.4 cm from Haithabu).

Table 10 clearly shows the slight variability of the metapodial bones' length. The range of variation in the withers height is only 10 cm based on the metacarpal bones and 12 cm based on the metatarsal bones. These values reflect a goat stock which is quite homogeneous in character. It is rather likely that goat keeping was a quite insignificant activity for the local inhabitants and that the small sized aboriginal stock found here by the Romans was easily improved by crossings with the large goats form the Mediterranean area, which is a classical goat keeping environment even today.

Male and female remains can be rather easily distinguished on the basis of the slenderness of the studied metapodials rather than estimated withers height. Figures 13 and 14 show a strongly isolated

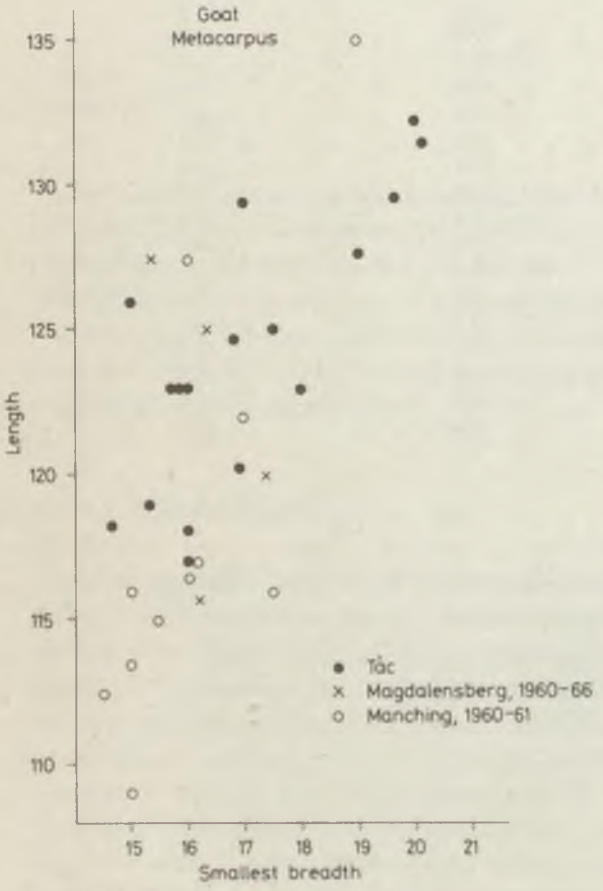


Figure 13. Scatter diagram of goat metacarpals

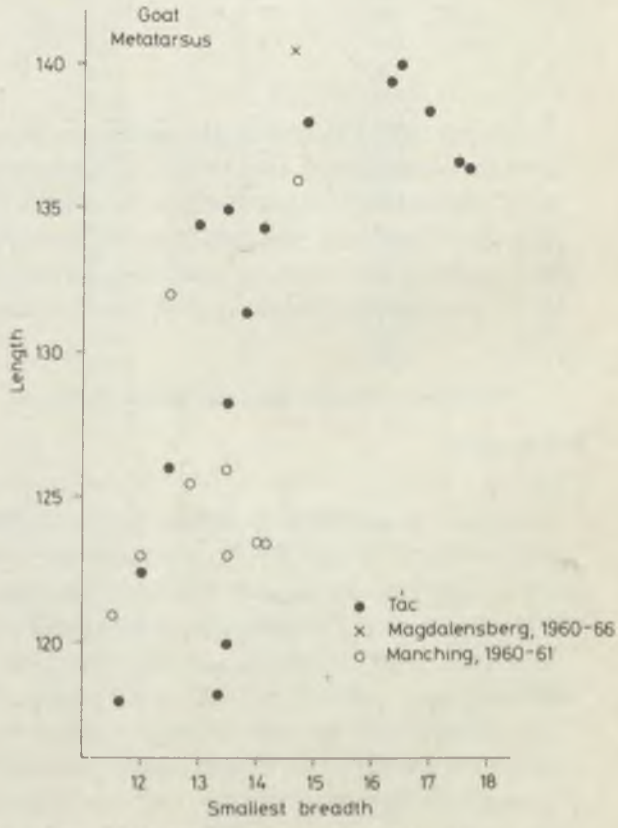


Figure 14. Scatter diagram of goat metatarsals

group with massive bones in the upper right corner of the diagram (♂♂). In contrast to this group, the majority of the metapodials are slender, reflecting a smaller body size (♀♀). A sex ratio of 6 males to 12 females is suggested by the metacarpal bones while the metatarsal bones suggest a ratio of 5 males to 12 females.

It is not likely that castration was widely practised on goats from the settlement since, as can be seen in Table 10 and Figures 13, 14, none of the long metapodials found in Tác–Gorsium are particularly slender. Castration of goat has to date never been proposed for archaeozoological material. Extra males in the stock were probably slaughtered young. Early slaughter seems to be particularly likely because castrated goat, unlike wethers, does not have any secondary purpose.

The majority of the many horn-cores (95 specimens) found belong to the so-called "*prisca*" type. Earlier this horn-core type was associated with an independent wild goat and its domesticated form. It has only recently turned out to be the result of domestication processes. The horn-cores lean outwards and are homonymously twisted. This type is represented by 56 complete and fragmented horn-cores.

The other group of horn-cores belongs to the so-called "*aegagrus*" type which is characterized by a scimitar, untwisted form. This type is similar to the horn-cores of wild goats, although the latter are smaller and flatter. 13 such horn-cores and horn-core fragments have been identified.

Finally 26 pieces of horn-cores were so fragmented that they could not be identified as belonging to any particular type.

Additionally one skull fragment from a hornless goat was found.

Studies made of modern goat show that the "*aegagrus*" and smaller "*prisca*" horn-cores usually belong to females. The larger "*prisca*" horn-cores come from males. Dividing the above horn-core types according to their size we arrive at the following picture (Table 11).

TABLE 11

Type and size variation of goat horn-cores in Tác–Gorsium

	"*Prisca*"	"*Aegagrus*"	Unidentified	Total
Very large	5	0	1	6
Large	5	0	0	5
Medium	10	4	0	14
Small	6	3	0	9
Unidentified	30	6	25	61
Total	56	13	26	95

The results of Table 11 coincide with the observations made on the recent goat breeds, to wit: all the measurable "*aegagrus*" horn-cores were medium or small size so that it is reasonable to assume that they all came from females. This measure provides yet another perspective on sex ratios. The estimated ratio is 11 males to 29 females which is slightly different from the proportion determined by the form of metapodials.

The list of measurements shows that there were some particularly large horned bucks in the faunal material of Tác–Gorsium. A horn-core, approximately 275 mm long with a basal circumference of 157 mm is worth mentioning as well as a horn-core fragment with a 152 mm basal circumference.

The skull fragment of a hornless goat from this site (Figure 15) is of particular interest in the history of domestication. It undoubtedly comes from a goat as can be seen from the T shape of the sutura coronaria, formation of the basioccipital region, and also by the characteristic form of the frontal bone at the place of the horn-cores. Though these parts of the skull are damaged on both sides, but they illustrate well the most important differences between goat and sheep skull morphology. The places where the horn-cores would normally be is oval and spongy even on the flat surface as opposed to the more or less conical remnants of horn-cores coming from various sheep breeds.

Goat hornlessness is a mutation connected to domestication. It has never been found in wild goat populations. The first evidence for hornless goat, dated to 2450 B.C. is known from Lisht, Egypt from the

Figure 15. Brain skull fragment of a hornless goat

5th dynasty. Osteological evidence for this has been found, however, on Roman Imperial sites. In addition to the Tác–Gorsium fragment, skull elements from hornless goat were found in three other sites: Butzbach, Germania (Habermehl, 1957, 89), three pieces from Magdelensberg near Klagenfurt, Austria (Fruth, 1966, 50) and one specimen from Budapest–Albertfalva, Hungary (Bökönyi, 1974, 196). Hornless goat occurred infrequently for a long period of time. The very rich faunal material from mediaeval Hungary for example contained only one neurocranium fragment of goat which lacked horns. It was found in Buda-Vár (Buda Castle) during the excavations of the Turkish Pasha's Palace (Bökönyi, 1974, 200). Hornless goat has recently played a more dominant role in Central Europe, although its remains are much less common in other parts of the world. The proportion of hornless goats is thus much smaller than that of the hornless sheep. Hornlessness occurs first and foremost on female skulls as can be seen by the fine structure of the skull fragment found in Tác–Gorsium. Hornlessness can be found in both sexes of the modern goat.

Pig (*Sus scrofa dom.* L.) and Wild Swine (*Sus scrofa fer.* L.)

Relative to the bones from other species, the pig bone material of Tác–Gorsium was in the poorest state of preservation. The majority of the bones are fragmented or butchered and lack the epiphyses. Gnawing marks are often present. There is only one complete skull, three larger skull fragments, some mandibulae, one complete scapula and two complete long bones (a radius and a tibia) available for study.

There are three reasons for the poor state of preservation of the pig bone:

(1) This species mainly exploited for its meat and, therefore, younger individuals were slaughtered. The incompletely fused epiphyses of such animals were easily lost or destroyed by agents in the soil.

(2) As a consequence of butchering techniques only a very few of the pig bones remained intact.

(3) Finally the soft, greasy, and spongy nature of the bones made them the preferred food of the dogs of the site.

Figure 16. Pig skull

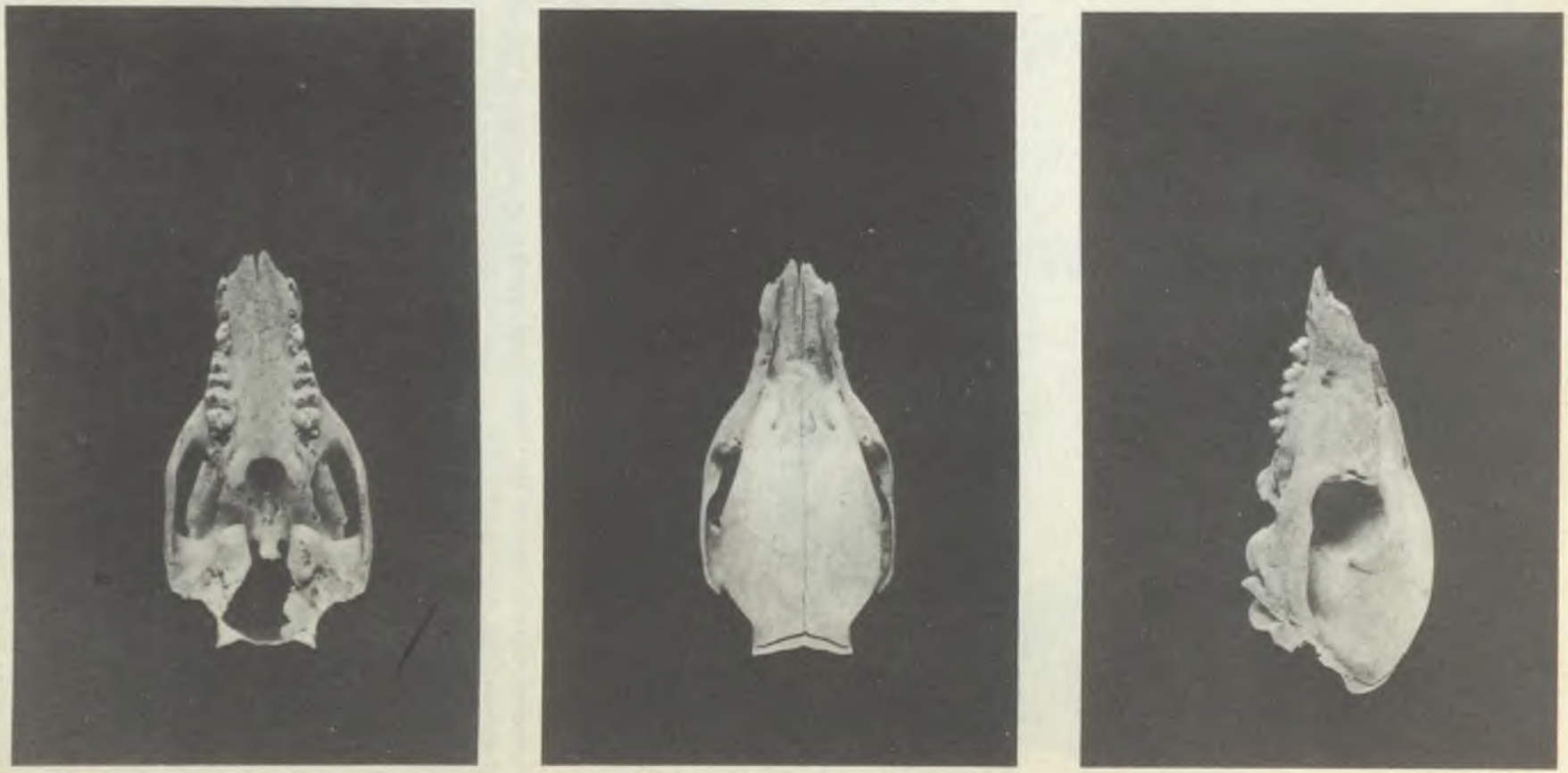


Figure 17. Pig skull fragment

The shape of the skull elements and mandibulae and the size of the extremity bones made it easy to distinguish between domestic pig and the wild boars occasionally hunted by the inhabitants of the town. The bone material did not contain the body parts of transitional individuals which made the differentiation of the wild and domestic forms easier while at the same time showing that no pig at Tác–Gorsium came from newly domesticated stock. Although Plinius (VIII 79) mentions the effect of breeding with wild boar on the domestic pig populations, no signs of this influence was found in the pig bone material.

Changes in pig husbandry occurred as well during the Roman Imperial Period. Advanced methods in keeping and breeding improved the pig stock of the provinces. As a result, the size of pig in the Roman Empire tended to exceed that of pig from the previous Iron Age.

Advanced Italian breeds imported into the province, however, seem to have had much less effect on the local population than as happened with the other domestic species. The withers height of pig increased by only 2 or 3 cm and their morphological type showed very little change, with the majority of the population remaining slow growing and primitive.

Unfortunately the only nearly complete skull (Figure 16) is from a young animal and, therefore, it cannot be used for type identification. The three bigger skull elements show more features of advanced domestication. The heads were markedly shortened and broad with a concave profile. The frontal region of one of the neurocranium fragments is slightly convex (Figure 17).

The few intact lacrimal bones come in the main from pigs with short skulls although two of these are from individuals having more elongated naso-facial regions (Table 12).

The low indices of Table 12 (which are smaller than 1) certainly reflect southern forms and probably represent animals which came from Italy or at least were related to Mediterranean pigs.

The pronounced shortening of the naso-facial region is illustrated by the crowded cheek teeth in the

TABLE 12

Measurements and indices of lacrimal bones of domestic pigs from Tác–Gorsium

Ventral length (mm)	Greatest width (mm)	Lacrimal index
19.0	23.0	0.83
22.0	25.5	0.86
17.0	19.5	0.87
23.0	25.0	0.92
23.0	24.5	0.94
22.5	22.0	1.02
22.0	21.2	1.04
22.0	21.0	1.05
26.5	25.0	1.06
25.5	22.0	1.07
26.5	24.5	1.08
25.0	20.0	1.25
28.0	22.0	1.27
27.0	21.0	1.29
30.0	23.0	1.30
27.5	19.0	1.45
26.0	17.0	1.53

mandible and maxilla, as well as by the frequent absence of the lower P_1 teeth. Some of the teeth even have an oblique position in the tooth row (for details see the chapter on animal pathology in the site).

Based on the adult mandibles (in which the M_3 teeth are fully grown and in some cases even worn) it can be seen that the breeding stock of Tác–Gorsium shows a wide range of variation. None of the pigs, however, ever reached the lower end of the wild swine size range of variation (Table 13).

Table 13 and Figure 18 show the frequency and size of the two sexes as well. Sex identification was based on the canines and/or the shape of their alveolars. There was no evidence in the bone material of castrated animals in the stock. Boars, however, were not significantly larger than the sows. If the 20 mm long M_3 at the low end of the sows' size range were not taken into consideration, then the size of sows' molars would in general actually exceed those of the boars (the small length of this M_3 results from the absence of its aboral cusp reflecting advanced domestication). This size overlap shows that care must be taken when attempting to separate the sexes using bone size as a criterion.

TABLE 13

Variation in the size of the lower M_3 teeth of pig at Tác–Gorsium

Length of the tooth (mm)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Number of boars (♂)	0	0	0	0	0	0	0	0	1	0	1	4	1	1	0	0	0	0
Number of sows (♀)	1	0	0	0	0	0	0	*0	3	3	4	5	5	3	1	0	1	0
Number of pigs of unidentified sex (○)	0	0	0	0	0	1	2	2	4	7	8	15	11	13	3	2	3	1

Summarized data

Sex	Number of individuals	Minimum	Maximum	Mean
		length of the tooth (mm)		
Boars (♂)	8	28	33	30.9
Sows (♀)	26	20	36	30.6
Pigs of unidentified sex (○)	72	25	37	31.2

The mean length of all the M_3s for boars, sows, and individuals with undetermined sex is 31 mm, which corresponds to the average length for West and Central European pigs of the Roman Imperial Period.

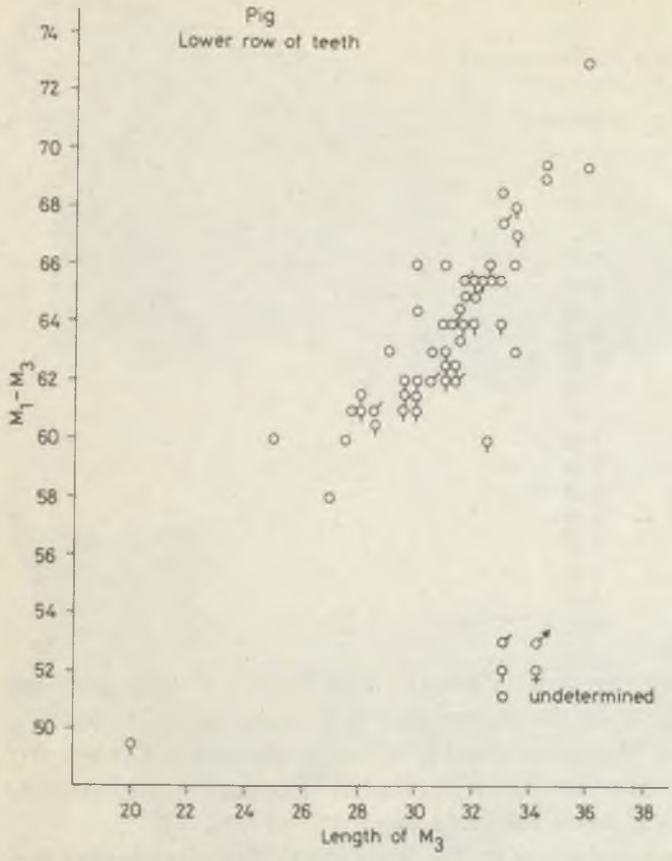


Figure 18. Scatter diagram of lower row of teeth of pig

As is shown in Table 13, the ratio of boars to sows was 8 to 26. This ratio reflects a tendency found since the Neolithic, of the pig breeders' preference for fewer boars in the breeding stock. The same ratio can be found in other Roman Imperial sites. It is only in small samples where the sex ratios may be different. However, the reason for the dominance of boar within the group of adult pigs in Manching, a Celtic site in Germania, cannot be explained (Opitz, 1958, Table 5; Nanninga, 1963, Table 5; Boessneck *et al.*, 1971, 74, Table 148).

The absolute size, the withers height, was calculated with the greatest length of the bones using the coefficients of Teichert (1969, 286). Unfortunately only one complete scapula and two other complete long bones were available for study. In all other cases the calculations were based on astragali and to a lesser extent on calcanei. Because it is difficult to determine whether the astragali came from adult animals it is not impossible that astragali of subadult animals were included in the calculation of withers height. The unfinished growth of subadult individuals may cause the estimated withers heights in Table 14 to be a little lower than the real values for adults would be.

The calculated withers height average of 73.36 cm in Table 14 is larger than the average for other West and Central European Roman Imperial sites which is about 70 cm. In spite of this the pigs of Tác–Gorsium seem to belong to the same primitive slow growing type. No separate breeds could be differentiated in the material.

That the inhabitants of Tác–Gorsium sometimes hunted wild swine as well, may be seen by the occurrence of wild swine bones in the material. These wild individuals were medium to large in size. The length of three complete calcanei suggests that the animals had withers heights of 95.3, 100.9, and 108.3 cm, respectively.

No effects of the crossing of the wild and domestic pig mentioned by Plinius (VIII 79) can be seen in the material of the site. Similarly no bones from newly domesticated pigs were found.

TABLE 14

Estimations of withers height of pig from Tác–Gorsium, using the coefficients of Teichert (1969, 286)

Bone	Length (mm)	Coefficient	Withers height (cm)
scapula	195.0	3.80	74.1
radius	145.0	5.26	76.3
tibia	195.0	3.92	76.4
astragalus	37.5	17.90	67.1
astragalus	38.0	17.90	68.0
astragalus	38.0	17.90	68.0
astragalus	38.5	17.90	68.9
astragalus	39.0	17.90	69.8
astragalus	39.0	17.90	69.8
astragalus	39.0	17.90	69.8
astragalus	39.5	17.90	70.7
astragalus	39.5	17.90	70.7
astragalus	40.0	17.90	71.6
astragalus	40.0	17.90	71.6
astragalus	40.0*	17.90	71.6*
astragalus	40.5	17.90	72.5
astragalus	41.5	17.90	74.3
astragalus	42.0	17.90	75.2
astragalus	42.0*	17.90	75.2*
astragalus	42.5	17.90	76.1
astragalus	42.5	17.90	76.1
astragalus	43.0	17.90	77.0
astragalus	43.0	17.90	77.0
astragalus	43.5	17.90	77.9
astragalus	43.5	17.90	77.9
astragalus	43.5	17.90	77.9
astragalus	44.0	17.90	78.8
astragalus	44.5	17.90	79.7
astragalus	45.0	17.90	80.6
astragalus	46.0	17.90	82.3
astragalus	46.5	17.90	83.2
calcaneus	71.5	9.34	66.8
calcaneus	72.0	9.34	67.2
calcaneus	72.5	9.34	67.7
calcaneus	72.5	9.34	67.7
calcaneus	73.5	9.34	68.6
calcaneus	74.0	9.34	69.1
calcaneus	75.0	9.34	70.1
calcaneus	76.0	9.34	71.0
calcaneus	77.5	9.34	72.4
calcaneus	79.0	9.34	73.8
calcaneus	86.5	9.34	80.8

* In the tables, the approximate measurements are marked by an asterisk

Summarized data

Number of individuals	Minimum	Maximum	Mean
	withers height (cm)		
42	66.8	83.2	73.36

Horse (*Equus caballus* L.)

Horse remains, as opposed to those of pig, are very well preserved on the site. There are two skulls, numerous large skull fragments, and many complete extremity bones in the sample. The lack of fragmentation may be explained by the fact that the inhabitants of Roman Imperial Tác–Gorsium did not eat horses. No skulls or long bones were broken for marrow. Additionally, the majority of horses were used for riding or as draught animals and thus attained adult age, resulting in more compact stronger bones which are more resistant to breakage. One of the two skulls comes from an adult of undetermined sex. It is a medium size wide skull with a flat forehead which rises slightly higher than the dorsal plane of the spacious orbits. The brain case is large in volume and well arched. Unfortunately the tooth rows were broken off making tooth description impossible. This skull bears a strong resemblance to the skull which was found in the Roman camp of Intercisa at Dunaújváros (Bökönyi, 1974, Figure 108).

The other skull shown in Figure 20 comes from a mature animal. The strongly developed canines are those of a stallion. The skull is of medium size with a wide forehead which is oval longitudinally. The brain case is also big and well arched. Unfortunately the molars and the majority of the praemolars are absent. The aboral part of the cranium is damaged as well.

The skull fragments are also from medium size or large skulls. The breadth of the forehead is very variable as are the formations of the brain case, the patterns of the molar and praemolar enamel, and the lengths of the protoconus.

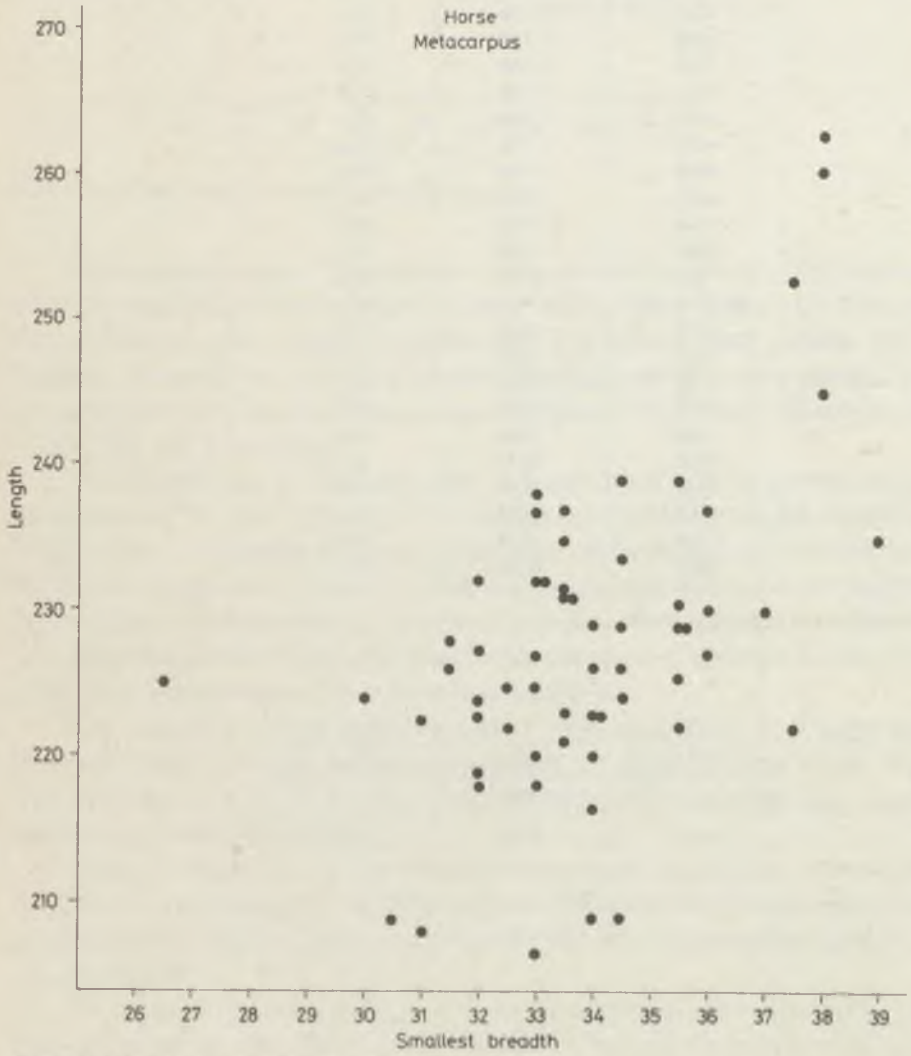


Figure 19. Scatter diagram of horse metacarpals

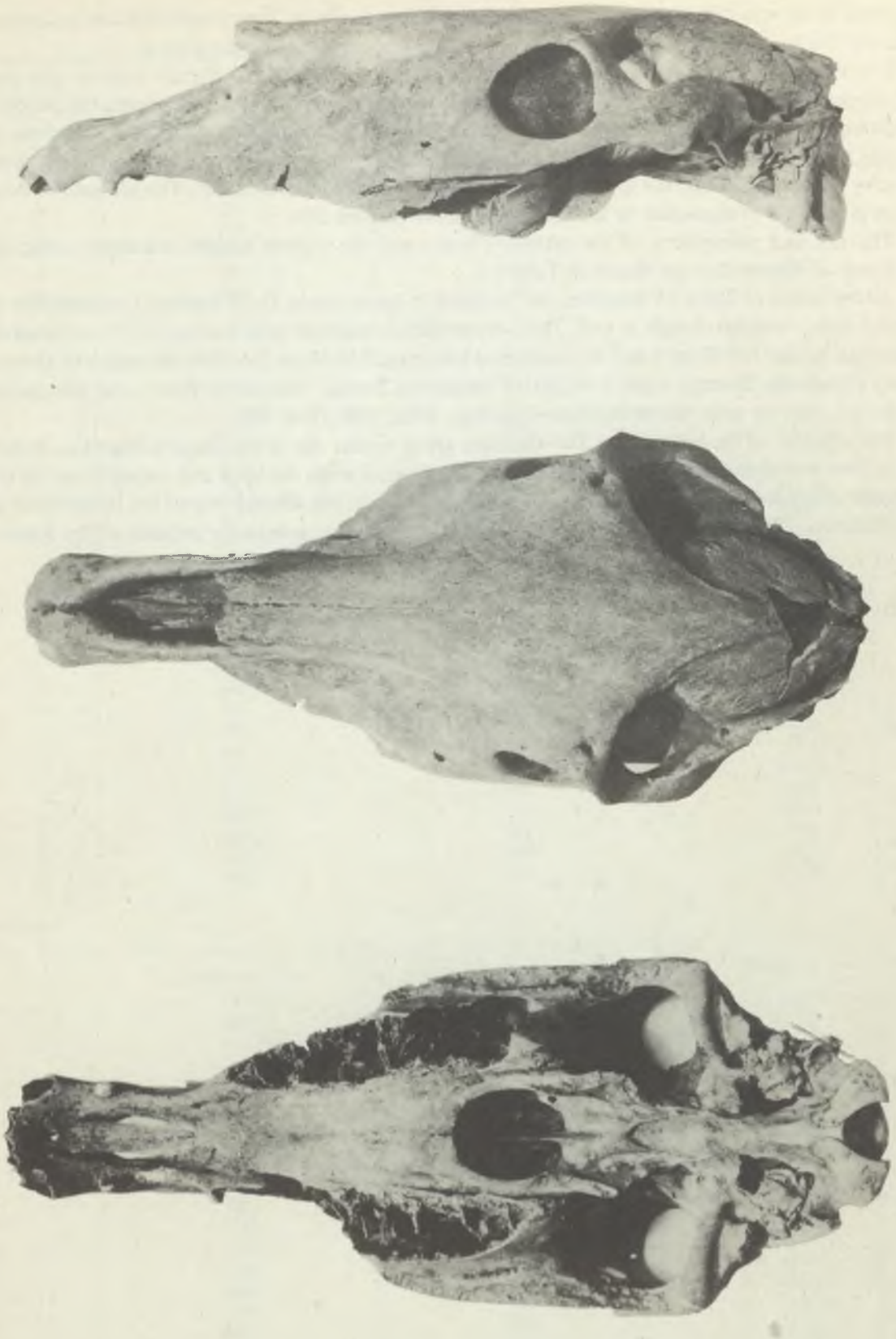


Figure 20. Horse skull

Some of the mandibles found come from rather gracile individuals. Their praemolars and molars are small and the ventral edge is concave. These are all signs of advanced domestication.

The extremity bones are extremely variable and this variability is reflected both in size and proportions. This variability is too large to be explained by sexual dimorphism and suggests the presence of different breeds. Metacarpal bones in particular show these differences well (Figure 19) where in addition to the mass of medium size horses four or five extremely large individuals appear, three of them with very slender legs. There is a group of small size massive legged horses as well. The presence of these groups is not so well expressed by the metatarsal bones (Figure 21).

The size and proportions of the extremity bones and the withers heights calculated using the techniques of Kiesewalter are shown in Table 15.

As the values of Table 15 illustrate, the variation in horse size in Tác–Gorsium is considerable in terms of absolute withers height as well. The average withers height of these horses (137.75 cm based on metacarpal bones, 138.00 cm based on metatarsal bones and 139.07 cm based on the length of all long bones) exceed the average withers height of Migration Period, Germanic, Avar, and Hungarian Conquest horses by only two or three cm (Bökönyi, 1968, 39ff; 1974, 70ff).

The majority of the horses from Tác–Gorsium are of similar size to the Eastern Migration Period horses. This size phenomenon stems from the previous period when the large and strong horses of the Scythians influenced not only the horses of the Carpathian Basin, but through import the Italian stock as well (Bökönyi, 1968, 39ff; 1974, 257ff). They played an important role in the creation of the Roman

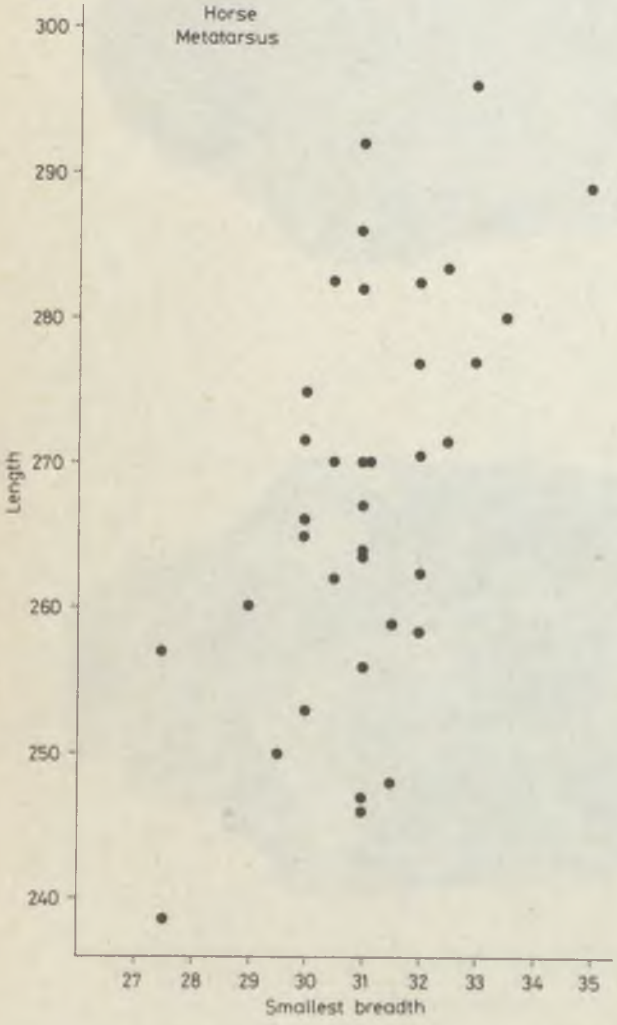


Figure 21. Scatter diagram of horse metatarsals

TABLE 15

Size and slenderness relationships in horse extremity bones

(a) *Humerus*

	Greatest length (mm)	Lateral length (mm)	Withers height (cm)
1	282	282	141.0
2	287	287	143.5
3	288*	288*	144.0
4	289	289	144.5
5	311	311	155.5
6	328*	328*	159.7

(b) *Radius*

	Greatest length (mm)	Lateral length (mm)	Withers height (cm)
1	307	296	128.5
2	320	305	132.4
3	323*	308	133.7
4	323.5	310	134.5
5	325	311	135.0
6	325*	312	135.4
7	326*	312	135.4
8	330.5	315	136.7
9	333*	322	139.7
10	335*	320	138.9
11	336*	320	138.9
12	337*	326	141.5
13	340*	322	139.7
14	342	325	141.1
15	343	328	142.4
16	343	328	142.4
17	346	330	143.2
18	347*	330	143.2
19	348*	333	144.5
20	352*	335	145.4
21	352*	337	146.3
22	376	356	154.5

(c) *Femur*

	Greatest length (mm)	Lateral length (mm)	Withers height (cm)
1	385*	385*	135.1
2	411	411	144.3

(d) *Tibia*

	Greatest length (mm)	Lateral length (mm)	Withers height (cm)
1	336*	315	137.3
2	336	316	137.8
3	338	312	136.0
4	339	310	137.2
5	340	314	136.9
6	340*	314	136.9
7	342	317	138.2
8	345	320	139.5
9	354	327	142.6
10	365	333	145.2
11	374	340	148.2
12	383*	348	151.7
13	387	351	153.0
14	406*	370	161.3

(e) *Metacarpus*

	Greatest length (mm)	Lateral length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	206.5	198	33	126.9	16.0
2	208*	200	31	128.2	14.9
3	209	200	30.5	128.2	14.6
4	209	201	34	130.9	16.3
5	216.5	206	34	132.0	15.7
6	218	209	32	134.0	14.7
7	218	209	33	134.0	15.1
8	219	209	32	134.0	14.6
5	219	209	34.5	134.0	15.8
10	219	210	—	134.6	—
11	220	208	33	133.3	15.0
12	220	210	34	134.6	15.6
13	221	210	33.5	134.6	15.2
14	222	212	32.5	135.9	14.6
15	222	210	35.5	134.6	16.0
16	222	211	37.5	135.3	16.9
17	222.5	211	31	135.3	13.9
18	223*	211	32	135.3	14.3
19	223	212	33.5	135.9	15.0
20	223	211	34	135.3	15.2
21	223	212	34	135.9	15.2
22	224	212	30	135.9	13.4
23	224	211	32	135.3	14.3
24	224	212	34.5	135.9	15.4
25	225*	213	26.5	136.5	11.8
26	225	212	32.5	135.9	14.4
27	225*	212	33	135.9	14.7
28	225.5	212	35.5	135.9	15.7
29	226	212	31.5	135.9	13.9
30	226	213	34	136.5	15.0
31	226	213	34.5	136.5	15.3
32	227	213	33	136.5	14.5
33	227	213	36	136.5	15.9
34	227.5	213	32	136.5	14.1
35	229	215	34	137.8	14.8
36	229	214	34.5	137.2	15.1
37	229	216	35.5	138.5	15.5
38	229	216	35.5	138.5	15.5
39	229	222	—	142.3	—
40	230*	212	36	135.9	15.7
41	230	213	37	136.5	16.1
42	230.5	214	35.5	137.2	15.4
43	231	216	33.5	138.5	14.5
44	231	215	33.5	137.8	14.5
45	231.5	216	33.5	138.5	33.5
46	232*	217	32	139.1	32
47	232	217	33	139.1	14.2
48	232	217	33	139.1	14.2
49	233.5	218	34.5	139.8	14.8
50	235	219	33.5	140.4	14.3
51	235	220	39	141.0	16.6
52	237	220	33	141.0	13.9
53	237	220	33.5	141.0	14.4
54	237	220	36	141.0	15.2
55	238	228	33	146.1	13.9
56	238*	224	—	143.6	—
57	238.5	225	35.5	144.2	14.9
58	239	227	34.5	145.5	14.4
59	245	230	38*	147.4	15.5
60	252.5	236	37.5	151.3	14.9
61	260	240	38	153.8	14.6
62	262.5	244	38	156.4	14.5

(f) *Metatarsus*

	Greatest length (mm)	Lateral length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	238.5	234	27.5	124.7	11.5
2	246	238	31	126.9	12.6
3	247	240	31	127.9	12.6
4	248	240	31.5	127.9	12.7
5	250	243	29.5	129.5	11.8
6	253	245	30	130.6	11.9
7	256	248	31	132.2	12.1
8	257	248	27.5	132.2	10.7
9	258.5	250	32	133.3	12.4
10	259	251	31.5	133.8	12.2
11	260	253	29	134.8	11.2
12	260*	253	30.5	134.5	11.7
13	262	254	30.5	135.4	11.6
14	262	254	—	135.4	—
15	262.5	254	32	135.4	12.2
16	263.5	254	31	135.5	11.8
17	264	255	31	135.9	11.7
18	265	256	30	136.4	11.3
19	266	257	30	137.0	11.3
20	267	257	31	137.0	11.6
21	270	263	30.5	140.2	11.3
22	270	262	31	139.6	11.5
23	270*	262	31	139.6	11.5
24	270.5	262	32	139.6	11.8
25	271.5	262	30	139.6	11.0
26	271.5	262	32.5	139.6	12.0
27	275*	265	30	141.2	10.9
28	277	267	32	142.3	11.6
29	277	267	33	142.3	11.9
30	280	270	33.5	143.9	12.0
31	282	272	31	145.0	11.0
32	282.5	272	30.5	145.0	10.8
33	282.5	273	32	145.5	11.3
34	283.5	275	32.5	146.6	11.5
35	286	277	31	147.6	10.8
36	289	279	35	148.7	12.1
37	292*	281	31	149.8	10.6
38	296	284	33	151.4	11.1

* In the table, the approximate measurements are marked by an asterisk

Withers height:

n 144
min. 124.7
max. 161.3
M 139.07 cm

Slenderness index:

	metacarpus	metatarsus
n	59	37
min.	11.8	10.6
max.	16.9	12.7
M	14.87	11.61

military horse type, so it is not surprising that these latter may have eastern characteristics. Additionally, eastern cavalry units were directed to the Pannonian campaign and brought horses with them (Petõ, 1966, 49). Finally, it is certain that horses were brought into Pannonia through commerce or as booty from the Sarmatians living on the other side of the border, in the Barbaricum.

In Italy under the influence of eastern and Hispanic blood lines and as a result of conscious breeding and advanced feeding techniques, a particularly strong military horse was developed. These horses were almost like modern cold blood horses (Hilzheimer [1924, 151] and Habermehl [1957, 105] considered these horses to be those of the officers); however, the opposite is illustrated not only by the bone material but by the sculpture of Caesar Marcus Aurelius mounted on a horse found on the Capitol in Rome: the fat, overfed but slender-legged animal undoubtedly belongs to the warm blood type of horse. Representations and remains of such horses are known from almost every European province of the Roman Empire. Two particularly large individuals were described by Habermehl in Butzbach (Habermehl, 1957, 84ff). The withers height of the first was 167.8 cm estimated on the basis of a 394 mm long tibia. The second withers height was 161.0 cm calculated from a metatarsal bone of 303 mm greatest length. Both bones come from large horses beyond any doubt, however, the determined withers height value is certainly too high in the case of the tibia and even slightly too high in the case of the metatarsal. This inaccuracy may be due to the improper use of Kiesewalter's measuring points. In the first case, a withers height of more than 157–160 cm is unlikely. A one to two cm smaller withers height would seem to be more probable from the metatarsal bone measurement as well.

The horses found in other Roman sites are usually similar to the average size horses found at Tác–Gorsium. From this point of view the horse remains found at the Germanic site of Gelduba castrum are particularly interesting. In addition, examination of the horses buried after the battle at the site of Krefeld-Gellep was very instructive (Nobis, 1973, 224–252). Here, two very small horse skeletons of 117.0 and 126.5 cm respective withers height and 25 large, 138.0–154.0 cm withers height (average 146.0 cm) were excavated. Nobis considers that these horses probably belonged to the same breed as can be seen by many characteristics of the dental system. It seems more likely, however, that the size differences between

Figure 22. Representation of a horse on a tombstone

the large and small horse skeletons reflect the existence of two breeds and furthermore that the large skeletons represent the remains of the Roman military horse type.

Many bones from really huge individuals were recovered from the excavations of Tác–Gorsium. One of the tibiae has a greatest length of 406.0 mm and 370.0 mm lateral length. The use of Kiesewalter's method results in a 161.3 cm withers height. A humerus, 328 mm long, comes from an individual with a withers height of 159.7 cm, which equals or even exceeds the largest of the Butzbach horses. The withers height calculated from the tibia of the first horse falls within the second category in Vitt's (1952) size classification. Early historic horses seldom fit within the size range of this group of "very large" horses.

The remarkably small individuals of 124.7 and 130.1 cm withers height shown in Figures 20 and 21 and Table 15, probably represent the horses of of the local Celtic population. A representation of this kind of horse can be seen on a tombstone from the 1st century in Tác–Gorsium (Figure 22). Comparison between large samples has shown that the withers height of these horses is in general 10 cm smaller than that of the Scythian horses (Bökönyi, 1964, 233ff; 1968, 36ff). Thus they fit very well within the range of size variation of other Celtic horses.

The slenderness of the extremity bones found at Tác–Gorsium is evident if the smallest breadth of the diaphysis is expressed in terms of percentage of the greatest length. Brauner (1916) distinguished six groups of horses based on the slenderness of metacarpal bones. As can be seen in Table 16, the majority of Roman horses fall within the group of "slightly slender" legged horses. One of the metacarpals reaches the upper value of the range of the "very slender" legged horses, and none of them falls within the range of variation of "massive legged" horses.

TABLE 16

The frequencies of Tác–Gorsium horses in the slenderness categories of the Brauner classification (1916)

Category	Indices	Number of individuals
Very slender legged	less than 13.5	1
Slender legged	13.6–14.5	19
Slightly slender legged	14.6–15.5	26
Medium slender legged	15.6–16.5	10
Slightly massive legged	16.6–17.5	2
Massive legged	more than 17.5	0

This distribution of slenderness indices falls between the mean values for eastern Scythian (15.19) and western Celtic (14.51) horses (Bökönyi, 1968, 25). The slenderness indices for the metatarsal bones tend to be the same. The average slenderness value for horses from Tác–Gorsium (11.61) falls between that for the eastern Iron Age (11.93) and the western Iron Age (11.35) (Bökönyi, 1968, 32ff).

The fact that no *"cold blood"* horses were kept at Tác–Gorsium is confirmed by the fact that no massive legged horses of the Brauner classification were identified in the bone material of the site. Such animals were probably bred only from the end of the Migration Period for carrying knights with heavy armour (Nobis, 1955, 208; 1957, 45; Herre, 1958, 35; Boessneck, 1958a, 293).

The picture of the Tác–Gorsium horse is enlarged still more by the fact that the majority of the hooves are narrow and the soles are concave or even strongly hollowed. Both of these things reflect a steppe type of horse adapted to hard ground. Wider hooves with flat soles occur very infrequently.

All of the above suggests that two or even three horse breeds were kept in Imperial Roman Tác–Gorsium. The Celtic horse, the common Roman horse, and a heavier breed which may only be a variant of the aforementioned Roman breed. The synchronic presence of the three forms in the horse bone material makes sex determination impossible. It is just as impossible to recognize castrated individuals in the material since such recognition would suppose the existence of complete leg skeletons. Aside from slenderness of the metapodial bones, the relatively shorter, more proximal extremity bones

are necessary in the identification of castrated males. In spite of these problems it may be supposed that some of those metapodials with small slenderness indices (values less than 14.0 for metacarpal bones and less than 11.0 for metatarsal bones) come from geldings. Such specimens may be represented in any group of bones.

Ass (*Asinus asinus* L.)

Ass is very rarely found on Imperial Roman sites. From Germania for example, it is known from only four sites. These sites are Cambodunum (Schlosser, 1888, 19), Heidelberg (Lüttschwager, 1967, 355ff), Lauriacum (R. Müller, 1967, 28–30), and Künzing–Quintana (Swegat, 1976, 20). The bones known from the second of these sites, Heidelberg, may not even actually come from an ass, while the bones from the latter two sites are not firmly dated (Swegat, 1976, 20). Ass bones have been described by Poulain-Josien (1962, 238) from the Parisian Roman–Gaul levels as well as by Jourdan (1976, 223ff) from the site of Marseille–Bourse.

Tác–Gorsium is the first Roman Imperial site in Hungary which has yielded ass bones. At the same time, these bones mark the earliest occurrence of domestic ass in Hungary (Bökönyi, 1974, 305). Three ass representations are known from Roman Imperial Pannonia. Two of them are carved in stone, while the third is in a stamped design used to decorate the *terrae sigillatae*. All of these pieces come from Aquincum (Bökönyi, 1974, 305). The ass was the animal of gardeners and millers with its ability to carry enormous burdens relative to its size. Although this species is slower than horse, it requires less specialized forage and being more docile also requires less attention. However, it is much less useful for riding because of its smaller body size and strength. Ass was sometimes harnessed to the coaches of the upper class, while its milk was a well known cosmetic (Plinius, XI 238; Cassius Dio, LXII 28).

Among the ass bones of Tác–Gorsium two bones each, come from young and subadult animals. All the others of determinable age come from adult animals. The majority of the bones come from small size ass, although one fragmented metacarpal bone comes from a large individual (distal breadth: 36.5 mm, distal diameter 27.5 mm).

The ass metatarsal found at Lauriacum (R. Müller, 1967, 30) is very similar to the second metatarsal from Tác–Gorsium. The measurements of the ass bone found at this site in Germania are as follows:

greatest length	213 mm
proximal width	37 mm
smallest width	23 mm
distal width	33 mm

The distal width of a humerus from Künzing–Quintana (Swegat, 1976, 20) differs by only one millimeter from an ass humerus found at Tác–Gorsium.

Mule may possibly have been kept at Tác–Gorsium also as may be seen by the presence of some long bones which are intermediate in size between horse and donkey. A good example of such intermediate cases is a metatarsal measuring 231 mm greatest length and 24.5 mm smallest breadth. Unfortunately this specimen came from a mixed level. The occurrence of mule would not be surprising in a Roman Imperial site since these animals have been found in South-Eastern Europe since the 8th–7th century B.C. according to written sources, shown by representations and seen in bone material.

The Romans did not seem to attach great importance to the improvement of ass breeding. Mediaeval asses found in the Transdanubian site, Zalavár (Bökönyi, 1963b, 361) and in Garvan–Dinogetia, Romania (Gheorghiu and Haimovici, 1965, 180) were much bigger than the Roman individuals of this species.

Domestic Cat (*Felis domestica* Briss.) and Wild Cat (*Felis silvestris* Schreb.)

Wild cat is a constant although not common species found in the fauna of prehistoric Europe. The first domestic cats were imported to Crete around 1100 B.C. from the direction of North Africa. Osteological evidence for cat domestication is found from the 6th and 5th centuries B.C. Several representations come from 5th century Greece and Greek provinces on the northern coast of the Black Sea as well (Zeuner, 1963, 392; Zalkin, 1964, 8). In other parts of Europe cat was imported during the Roman Period. The presence of cat during that time in Pannonia is demonstrated not only by the faunal material of Tác–Gorsium but also by cat remains from the site of Budapest–Albertfalva (Bökönyi, 1974, 311).

The 112 bones of domestic cat found during the excavation of Tác–Gorsium were distinguished from the remains of the wild form using the methods of Szunyoghy (1952, 180) and Kratochwil (1973, 1ff; 1976a–b, 1ff).

TABLE 17

Frequency of domestic cat bones from Tác–Gorsium

Bone type	Number of specimens
skull	7
mandible	5
vertebra	9
rib	6
scapula	9
humerus	14
ulna	7
radius	8
pelvis	9
femur	7
tibia	9
astragalus	1
metapodium	21
Total	112

The frequency distribution for the different domestic cat bone types found during the course of the excavation is shown in Table 17. As illustrated by the figures in this table the frequency of various kinds of bones is similar, with the exception of the low number of tarsal and lack of carpal bones and phalanges. The infrequency of non-occurrence of these latter bones can be explained by limitations in collection techniques. It is not impossible, however, that during the course of occasional skinning of dead cats (if skinning was indeed attempted) the terminal phalanges would have remained in the skin. The bones found are well preserved with no marks of butchering or gnawing to indicate that cat was eaten in the settlement.

55 per cent of the bones come from adult animals, 27 per cent from subadult individuals, and 18 per cent from juvenile cats. The age distribution reflects an animal species which was not kept for its meat. Authors of antiquity emphasized the role of cat in controlling mice, although these small carnivores are also mentioned as popular pets.

Although the majority of bones seem to belong to smaller individuals, cat remains from Tác–Gorsium are highly variable in terms of size, a fact which corresponds to descriptions by Roman authors.

Four bones from three wild cats were found. These are: one humerus from an adult animal, a right tibia from another adult animal, and two femur diaphyses (left and right) from a subadult individual. All of them represent strongly built animals.

Dog (*Canis familiaris* L.) and Wolf (*Canis lupus* L.)

Of all the fanual remains found at Tác–Gorsium the bones of dog and wolf are the best preserved. In addition to numerous complete long bones, 36 skulls, 36 large fragments of skulls, and 160 complete half mandibles were recovered. A complete skull was also among the identified wolf remains. Such preservation is characteristic for sites from the whole territory of the Roman Empire and as a result, the dog is the Roman domestic animal best known as regards craniology, size and body proportions. The fact that dog was not slaughtered and eaten explains the completeness of the material. The dog corpses were not cut into pieces but rather buried, thrown into wells or garbage pits.

From the previous La Tène Period, before the Roman occupation of Pannonia, a small to medium size dog breed was raised. In comparison, the Roman dogs were very variable (Table 18; Figure 23). It was not only the absolute size of these dogs which was extremely variable but their body proportions as well. Figures 24–27 show at least five groups within the extremity bones. These bones, clearly distinguishable from one another were as follows:

(1) Miniature dogs with slender, straight or sometimes slightly twisted legs. The withers height of these dogs falls between 22.8 and 34.2 cm (Mean: 28.13 cm).

(2) Small dogs resembling large dachshunds with short, thick, and twisted legs, of between 34.9 and 42.5 cm withers height (Mean: 36.85 cm).

(3) Slightly larger dogs with short, massive but straight legs, of between 34.9 to 47.0 cm withers height (Mean: 42.05 cm).

(4) Dogs of a medium size between that of fox terrier and German shepherd with withers heights ranging from 48.2 to 68.1 cm (Mean: 57.91 cm). The majority of the studied dog bones come from such individuals.

(5) Greyhound-like dogs with slender legs with between 71.0 and 71.2 cm withers height (Mean: 71.10 cm). Afghan greyhounds correspond most closely to this form with withers heights between 68.0 to 72.0 cm (Epstein, 1971, 148).

Remains from short, slender and straight legged dogs were also found with withers height from between 36.0 to 43.0 cm. The numbers of such bones were too small, however, to justify the formation of a separate group.

The wide range of variation in size and breeds of Roman dogs becomes increasingly evident. This variability was first illustrated by Hilzheimer (1932, 91ff) who defined three primary groups of Imperial Roman dogs on the basis of the basal length of the skull. The majority of the basal lengths measured by him fell between 110 to 130 mm, 150 to 160 mm, and 170 to 180 mm. Lüttschwager successfully identified

Figure 23. Size and form variations of dog tibiae

TABLE 18

Size and slenderness relationships in dog extremity bones

(a) Humerus

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	82.5	8	27.8	9.70
2	82.5	8.2	27.8	9.94
3	97	8	32.7	8.25
4	101.5	8.5	34.2	8.37
5	112.5	13.5	37.9	12.00
6	114.5	12	38.6	10.48
7	115	12	38.8	10.43
8	116.5	11	39.3	9.44
9	123.5	13	41.6	10.53
10	125.5	15.5	42.3	12.35
11	126	14.5	42.5	11.51
12	129.5	16	43.6	12.36
13	139.5	15.5	47.0	11.11
14	143	10	48.2	6.99
15	147	11.5	49.5	7.82
16	148	12	50.0	8.08
17	149	10.5	50.2	7.05
18	149	12	50.2	8.05
19	150	12.5	50.6	8.33
20	151	12	50.9	7.95
21	151	12	50.9	7.95
22	152	10	51.2	6.57
23	155	12	52.2	7.74
24	161	12	54.3	7.45
25	161	13.5	54.3	8.39
26	162	12.5	54.6	7.22
27	162	13.5	54.6	8.33
28	163	12	54.9	7.36
29	165	11	55.6	6.67
30	165	13	55.6	7.88
31	165	13	55.6	7.88
32	165	13	55.6	7.88
33	165.5	13	55.8	7.85
34	166	13	55.9	7.83
35	168	10.5	56.6	6.25
36	169	15	57.0	8.88
37	170	13	57.3	7.65
38	170	13	57.3	7.65
39	171	13	57.6	7.60
40	171.5	13.5	57.8	7.87
41	173	14	58.3	8.09
42	174	14	58.6	8.05
43	175	13	59.0	7.43
44	177	13	59.6	7.34
45	178	12.5	60.0	7.02
46	179	11.5	60.3	6.42
47	179	14	60.3	7.82
48	179	15.5	60.3	8.66
49	179.5	12	60.5	6.69
50	180	14.5	60.7	8.06
51	180	14.5	60.7	8.06
52	180	15	60.7	8.33
53	181	14.5	61.0	8.01
54	181	15	61.0	8.29
55	181	16.5	61.0	9.12
56	182	12.5	61.3	6.87
57	182	14	61.3	7.69
58	182	14	61.3	7.69
59	182	15	61.3	8.24
60	183	16.5	61.7	9.02

TABLE 18 *(cont'd)*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
61	184	13.5	62.0	7.34
62	184	14	62.0	7.61
63	184	16	62.0	8.70
64	184	16	62.0	8.70
65	185	16	62.3	8.65
66	186.5	14.5	62.9	7.77
67	187	12.8	63.0	6.68
68	187	14.5	63.0	7.75
69	187	15.5	63.0	8.29
70	188	15	63.3	7.98
71	189	13.5	63.7	7.14
72	189	15	63.7	7.94
73	190	13	64.0	6.84
74	191	15	64.4	7.85
75	191.5	15	64.5	7.83
76	193	15.5	65.0	8.03
77	194.5	12.5	65.5	6.43
78	194.5	16	65.5	8.22
79	195.5	15.5	65.5	7.93
80	196	15.5	66.1	7.91
81	197	13	66.4	6.60
82	197	15	66.4	7.61
83	201	13.5	67.7	6.71
84	202	13.5	68.1	6.68
85	202	17	68.1	8.42
86	211	13.5	71.1	6.40

(b) *Radius*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	71.5	8.5	23.0	11.89
2	71.5	8.5	23.0	11.89
3	76	10	24.5	13.16
4	87.5	8.5	28.2	9.71
5	92.5	8	29.8	8.65
6	97	9.5	31.5	9.79
7	98.5	12	31.7	12.18
8	99	12.3	31.8	12.42
9	101.5	10	32.7	9.85
10	104	13	33.5	12.50
11	104.3	12.5	33.6	11.98
12	104.5	12	33.6	11.48
13	106	11.3	34.1	10.66
14	106	13.5	34.1	12.74
15	107.7	12	34.7	11.14
16	108.5	17.5	34.9	16.13
17	110.5	17	35.6	15.38
18	112.5	8.5	36.2	7.56
19	113	12.5	36.4	11.06
20	124.5	9.2	40.1	7.39
21	133.5	10	43.0	7.49
22	135.5	14.5	43.6	10.70
23	145.5	11	46.9	7.56
24	148.5	11	47.8	7.41
25	149	11.5	48.0	7.72
26	149	12.5	48.0	8.39
27	150	12.5	48.3	8.33
28	156.5	12.5	50.4	7.99
29	160	12	51.5	7.50
30	161.5	12.5	52.0	7.74
31	162	12	52.2	7.41

TABLE 18 *(cont'd)*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
32	166	14	53.5	8.43
33	167	12	53.8	7.19
34	167	14	53.8	8.38
35	167.5	12	53.9	7.16
36	169	11	54.4	6.51
37	169	12	54.4	7.10
38	169	12.5	54.4	7.40
39	169	13	54.4	7.69
40	169	13	54.4	7.69
41	170	11	54.7	6.47
42	172	12.5	55.4	7.27
43	173	12.5	55.7	7.23
44	174	14	56.0	8.05
45	175	12.5	56.4	7.14
46	175	14	56.4	8.00
47	177	13.5	57.0	7.63
48	177	15	57.0	8.47
49	178	14	57.3	7.87
50	178	14	57.3	7.87
51	178	14	57.3	7.87
52	179	11.5	57.6	6.42
53	179	12.5	57.6	6.98
54	179	13	57.6	7.30
55	179	13	57.6	7.30
56	180	14.5	58.0	8.06
57	181	12.5	58.3	6.91
58	181	15.5	58.3	8.56
59	182	12	58.6	6.59
60	182	14.5	58.6	7.97
61	182.5	14.5	58.8	7.95
62	183	14	58.9	7.65
63	183	14.5	58.9	7.92
64	183	14.5	58.9	7.92
65	183.5	12	59.1	6.54
66	184	14	59.2	7.61
67	184	16	59.2	8.70
68	185	14	59.6	7.57
69	185	14	59.6	7.57
70	185	15	59.6	8.11
71	185	16	59.6	8.65
72	187	14.5	60.2	7.75
73	187	14.5	60.2	7.75
74	188	15	60.5	7.98
75	189	15	60.9	7.94
76	193	14.5	62.1	7.51
77	193.5	14	62.3	7.24
78	195	15	62.8	7.69
79	195.5	13.5	63.0	6.91
80	196	15.5	63.1	7.91
81	196	16	63.1	8.16
82	198	16	63.8	8.08
83	205	13.7	66.0	6.68
84	210	15	67.6	7.14
85	216	14.5	69.6	6.71

(c) *Femur*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	88	8.8	26.5	10.00
2	93	10	28.0	10.75
3	93	10	28.0	10.75
4	109	9	32.8	8.26

TABLE 18 *(cont'd)*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
5	121	12	36.4	9.92
6	121	13	36.4	10.74
7	124	11	37.3	8.87
8	124	12	37.3	9.68
9	125.5	8.5	37.8	6.77
10	126	12.5	37.9	9.92
11	126	13	37.9	10.32
12	128.5	13	38.7	10.12
13	133.5	9	40.2	6.74
14	136	13.5	40.9	9.93
15	137	9.5	41.2	6.93
16	138	15.5	41.5	11.23
17	138	16	41.5	11.59
18	139.5	17.5	42.0	12.54
19	142	9.5	42.7	6.69
20	143	15	43.0	10.49
21	143.5	10	43.2	6.99
22	145.5	10	43.8	6.67
23	146.5	10.7	44.1	7.30
24	155	17	46.7	10.97
25	156	17	47.0	10.90
26	166	12	50.0	7.23
27	166	12	50.0	7.23
28	173	12.5	52.1	7.23
29	173	14	52.1	8.09
30	174	13	52.4	7.47
31	176	12	53.0	6.82
32	177	13	53.3	7.34
33	177	13	53.3	7.34
34	177.5	15	53.4	8.45
35	181	12.5	54.5	6.91
36	182	12.5	54.8	6.87
37	182.5	13	54.9	7.12
38	183	13	55.1	7.10
39	184	12.5	55.4	6.79
40	185	13	55.7	7.03
41	186	12.5	56.0	6.72
42	186	13.5	56.0	7.26
43	186	14.5	56.0	7.80
44	189	11.5	56.9	6.08
45	189	13	56.9	6.88
46	190	12.5	57.2	6.58
47	191	12.5	57.5	6.54
48	191	13	57.5	6.81
49	193	13.5	58.1	6.99
50	194	14	58.4	7.22
51	195	14	58.7	7.18
52	196	14.5	59.0	7.40
53	197	14	59.3	7.11
54	197	14.5	59.3	7.36
55	198	14	59.6	7.07
56	198	14.5	59.6	7.32
57	198	16	59.6	8.08
58	199	13.5	59.9	6.78
59	199	15	59.9	7.54
60	199	16	59.9	8.04
61	200	13	60.2	6.50
62	201	14	60.5	6.97
63	201	14.5	60.5	7.21
64	201	15	60.5	7.46
65	201.5	14.5	60.7	7.20
66	202	14	60.8	6.93
67	202	14.5	60.8	7.18

TABLE 18 *(cont'd)*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
68	202	15	60.8	7.43
69	203.5	15	61.3	7.37
70	204	15.5	61.4	7.60
71	205	14	61.7	6.83
72	205	14.5	61.7	7.07
73	206	16.5	62.0	8.01
74	207	14	62.3	6.76
75	208	15	62.6	7.21
76	210	15	63.2	7.14
77	211.5	14	63.7	6.62
78	212	14	63.8	6.60
79	213	15	64.1	7.04
80	213	16	64.1	7.51
81	214	13.5	64.4	6.31
82	219.5	13	66.1	5.92
83	221	17.5	66.5	7.92
84	223	18	67.1	8.07

(d) *Tibia*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
1	78	8	22.8	10.26
2	85	10	24.8	11.76
3	90.5	7.5	26.4	8.29
4	104	8.7	30.4	8.37
5	115	12.5	33.3	10.96
6	116	11	33.9	12.07
7	117.5	10	34.3	8.51
8	118	13	34.5	11.02
9	118	13	34.5	11.02
10	118.5	12	34.6	10.13
11	119.5	11	34.9	9.21
12	120.7	12	35.2	9.94
13	121	11	35.3	9.09
14	122	14	35.6	11.48
15	122.5	14	35.8	11.43
16	127	16.5	37.1	12.99
17	127	17	37.1	13.39
18	129	13.5	37.7	10.47
19	134	9	39.1	6.72
20	142	16.5	41.5	11.62
21	143	15	41.8	10.49
22	144	9	42.0	6.25
23	163.5	11.1	47.7	6.73
24	165	11.5	48.2	6.97
25	165	12	48.2	7.27
26	171	12	48.9	7.02
27	171	12	49.9	7.02
28	179	12.5	52.3	6.98
29	179.5	12.5	52.4	6.96
30	180	11.5	52.6	6.39
31	181	13	52.9	7.18
32	183	13	53.4	7.10
33	184	12	53.7	6.52
34	184	13	53.7	7.07
35	185.5	12	54.2	6.47
36	186	13	54.3	6.99
37	190	12	55.5	6.32
38	190	13	55.5	6.84
39	190	14.5	55.5	7.63
40	191.5	12	55.9	6.27

TABLE 18 *(cont'd)*

	Greatest length (mm)	Smallest width (mm)	Withers height (cm)	Slenderness index
41	192	13	65.1	6.77
42	193	11.5	56.4	5.96
43	193	12.5	56.4	6.48
44	193	14	56.4	7.25
45	194	13.5	56.6	6.96
46	195	13	56.9	6.67
47	196	13	57.2	6.63
48	198	12.5	57.8	6.31
49	198	13	57.8	6.57
50	198.5	14	58.0	7.05
51	199	12.5	58.1	6.28
52	200	12	58.4	6.00
53	201	12.5	58.7	6.22
54	201	13.5	58.7	6.72
55	201	14	58.7	6.97
56	201	15	58.7	7.46
57	202	15	59.0	7.43
58	203	11.5	59.3	5.67
59	203	14	59.3	6.90
60	203	15	59.3	7.39
61	204	13	59.6	6.37
62	205	13.5	59.9	6.59
63	206	12.5	60.2	6.07
64	206	12.5	60.2	6.07
65	206	13.5	60.2	6.55
66	207	13	60.4	6.28
67	208	14	60.7	6.73
68	209	13	61.0	6.22
69	210	13	61.3	6.19
70	216	15	63.1	6.94
71	217.5	15	63.5	6.90
72	219	14.5	63.9	6.62
73	219	14.5	63.9	6.62
74	220	13.5	64.2	6.14
75	222	15	64.8	6.76
76	222.5	16	65.0	7.19
77	227	14	66.3	6.17
78	227	16	66.3	7.07
79	227	16.5	66.3	7.27
80	228	15.5	66.6	6.80
81	230	15	67.2	6.52
82	243	13	71.0	5.35
83	244	13.5	71.2	5.53

the remains of a miniature dog and the bones of a dog with a withers height of about 52.0 cm, both of which were found in the same grave. He also found a German shepherd size dog of about 60.0 cm withers height on the site of Heilbronn–Bröckingen–Kastell (1966, 85ff). Mennerich demonstrated a wide size variability from miniature dogs to German shepherd size animals even in relatively small samples from Roman sites in the territory of the lower Rhine. Hornberger (1970, 113) describes five groups of dogs from the faunal material of Magdalensberg, Austria:

(a) Miniature dogs.

(b) Dogs about 40.0 cm tall with incipient brachymelia.

(c) Dogs slightly bigger than the animals of (b) with slender extremities.

(d) Dogs of medium size used for hunting and of about 50.0 to 58.0 cm withers height, which form the majority of dogs.

(e) Dogs which exceed the German shepherd in size.

Hemmer and Eichmann (1977, 268) defined the whole type and size variation of Roman dogs from the Imperial Period in Central Europe on the basis of skulls from the surroundings of the Rhine and the

Main. Jourdan (1976, 207–209) distinguished nine types ranging from lap dogs to mastiffs from the Roman levels of Marseille. Other authors, however, have found only parts of this wide range of variation. During his study on Roman dogs in Britain, Harcourt (1974, 151) found great variation in size ranging from 23.0 to 72.0 cm withers height and two or three distinct populations including lap dogs (perhaps pets).

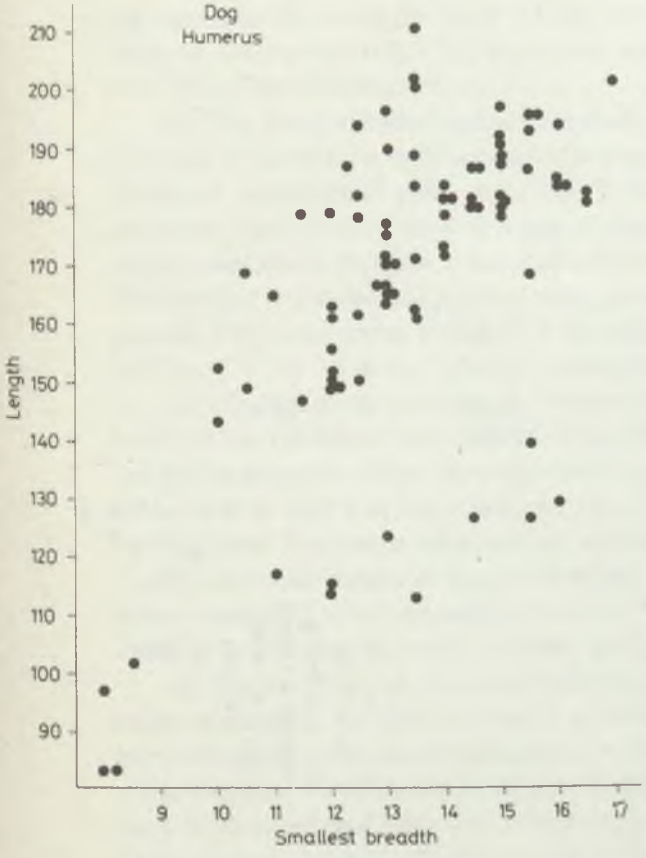


Figure 24. Scatter diagram of dog humeri

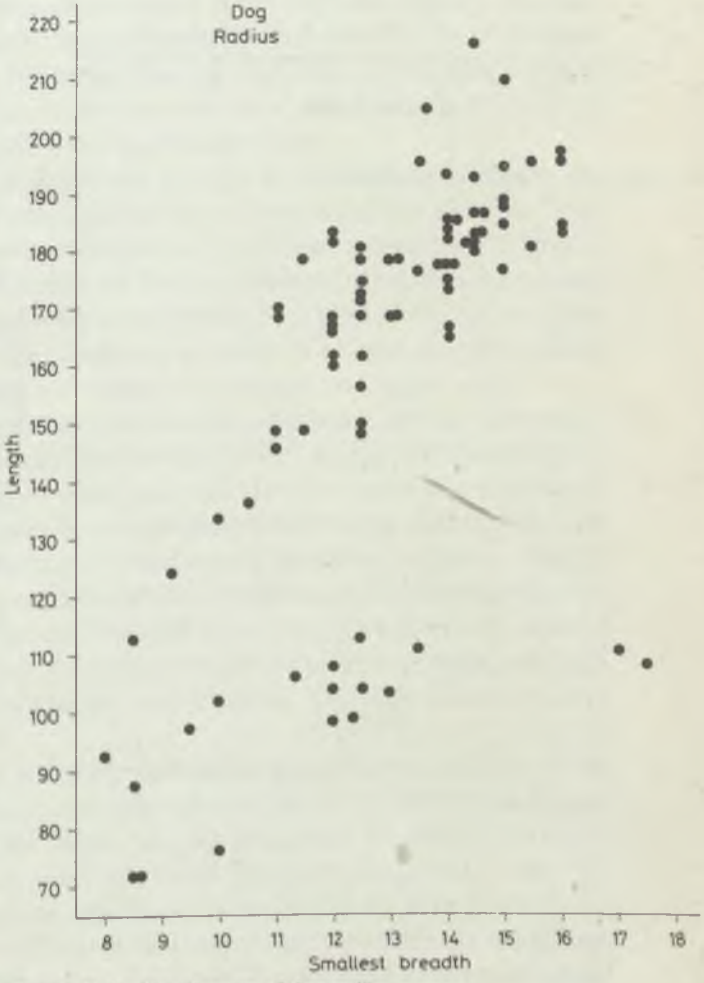


Figure 25. Scatter diagram of dog radii

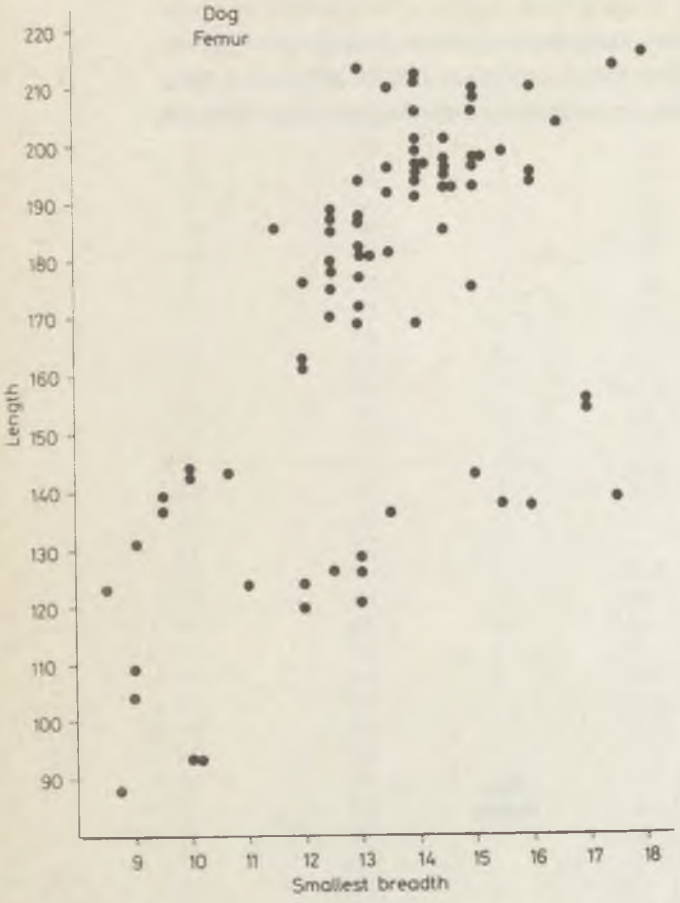


Figure 26. Scatter diagram of dog femora

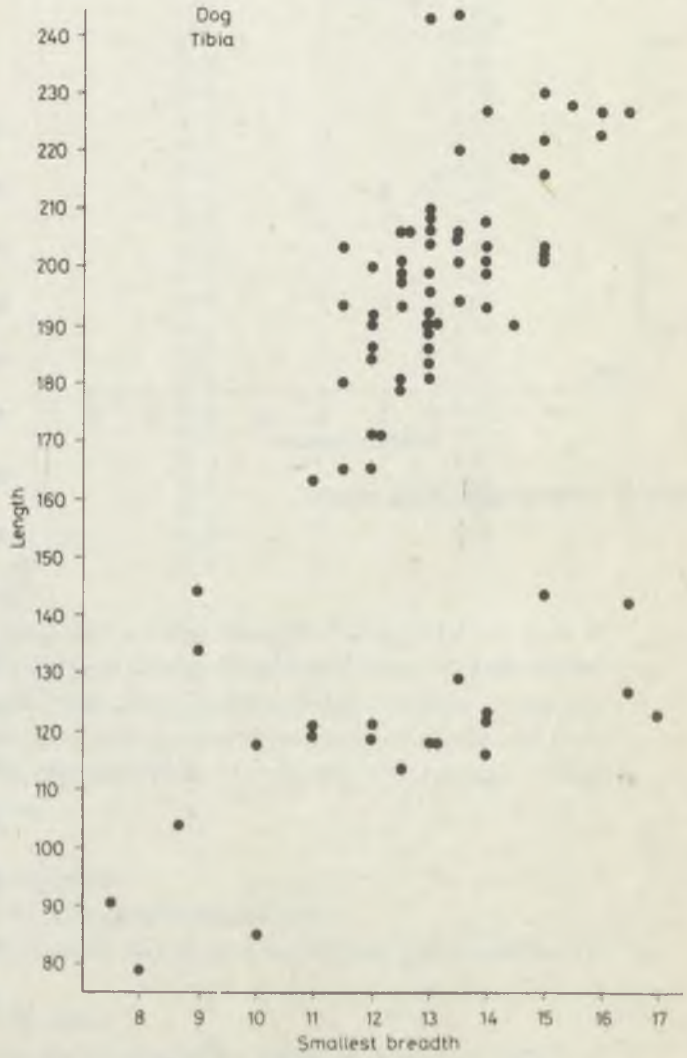


Figure 27. Scatter diagram of dog tibiae

It is rather easy to distinguish cranial types in the material from Tác–Gorsium as well. The dog skulls from the Roman Imperial Period at this site form the following groups:

(1) Small skulls of about 120 mm basal length. The brain case is strongly developed, and well arched. The crista mediana is doubled and even on the aboral parts of the skull is not strongly developed. The lineae semicirculares are flat. The forehead is convex with short and pointed facial parts. There is only one complete skull (Figure 28 and No. 1 in the Table of measurements). One more complete skull appears to belong to this group as well having a basal length of 122 mm, although it was found in levels disturbed by subsequent mediaeval digging. Despite the fact that its state of preservation and its dimensions correspond to that of the first skull, it is not included either in the Table of measurements or diagrams. In addition, there are two skull fragments, a neurocranium and a viscerocranium, respectively (Nos 38 and 54 in the Table of measurements).

(2) This group includes medium size skulls with basal lengths falling between 141.5 and 167.0 mm. The form of the skulls is most similar to the palustris type, although these are somewhat larger. The well developed neurocranial parts with their strongly arched brain cases are nevertheless slightly less developed than those of the first group of dogs. The crista mediana and the lineae semicirculares are barely raised above the plane of the skull while the former points backward, in a slightly aboral direction. The forehead is dombed and medium wide, the nasal region is short to medium long and medium wide to pointed. Within this group belong 13 skulls and numerous measurable cranial fragments (Figures 29–31 and Nos 2–9; 11–14 in the Table of measurements).

(3) This next group has larger skulls than those of the previous group with basal lengths of anywhere from 167.0 to 193.0 mm. The brain case is less developed, narrower and not so arched. The crista mediana and the lineae semicirculares protrude sharply with the first strongly pointing in an aboral direction, while the latter is so high that the medial portion of the medium domed or flat forehead appears depressed between them. The nose is long, medium wide or wide. Spaces frequently occur between the praemolars. Twenty skulls and numerous fragments belong to this group (Figures 32–41; Nos 15–34 in the Table of measurements). It is not impossible that three bigger skulls with wide nasal parts (Nos 26, 28, 31 in the Table of measurements) form a separate group which will be discussed later.

(4) The fourth group consists of medium large skulls with strongly arched neurocranial parts and barely raised crista mediana and lineae semicirculares. The forehead is remarkably flat while the facial parts of the skull are elongated and narrow with small or medium size praemolars spaced apart from each other. There is one complete skull (Figure 42 and No. 10 in the Table of measurements) and a larger skull fragment (a nasofacial part) with a fragment of the brain case attached to it (Figure 43; No. 44 in the Table of measurements) belonging to this group. The complete skull is that of an adult animal, a female with delicate bone structure, while the second seems to belong to a younger and larger male.

The first and the fourth skull types described above can be easily distinguished and correspond rather nicely to the constitutional types listed previously. The first skull is very similar to the skull form of modern dachshunds and corresponds to the second constitutional type. (The first constitutional group of straight and slender legged lap dogs is not represented by any complete skull or large skull fragments in the material. There are only two small pieces of skull and two measurable mandible fragments: Nos 122 and 125 in the Table of measurements from this group.) No skulls or fragments worth mentioning were found which belonged to the third constitutional group. This third group was characterized by massive straight legged animals, about 42.0 cm at the withers. Of all the skulls in the sample, perhaps only skull No. 2 in the Table of measurements corresponds to this last type of animal. This skull does not fit very well within its own cranial group.

The fourth group of skulls can be called those of a greyhound type of dog. With the exception of the recent Italian dwarf greyhound, these Roman dog skulls, although very similar to modern greyhound types, are smaller and less refined. On the other hand they are practically identical with Celtic greyhounds, as for example with the dog skull from Pilismarót–Basaharc (Bökönyi, 1976a, 60; Figure 15) and greyhound skulls from Sarmatian sites (Bökönyi, 1976a, 53–55; Figures 9–11).

The second group of skulls is pointer-like, while the third group closely resembles the Hungarian *kuvasz*. The two types can be differentiated on the diagrams, not only in terms of size but by the strikingly

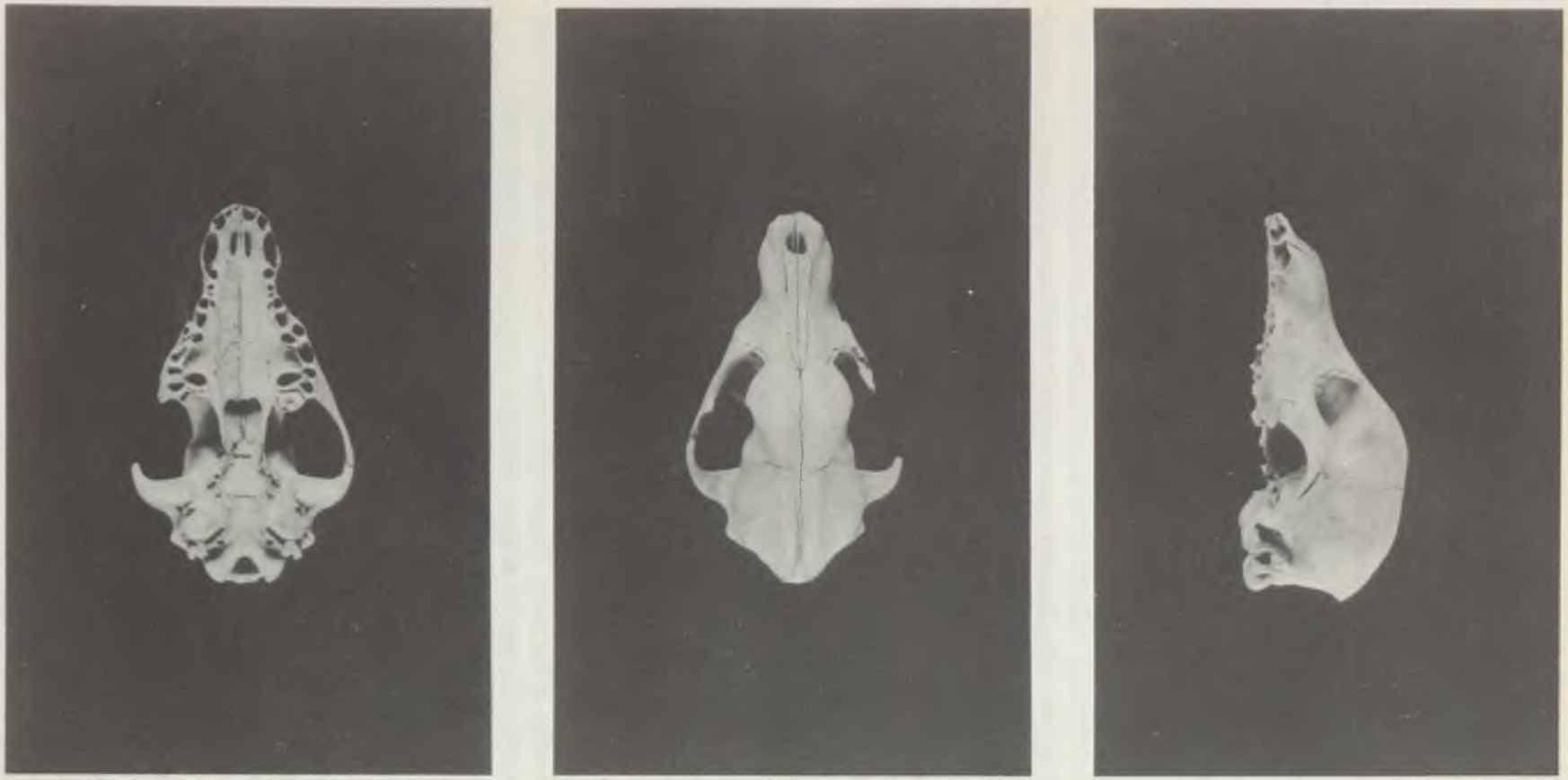


Figure 28. Dog skull. 1st type

Figure 29. Dog skull. 2nd type

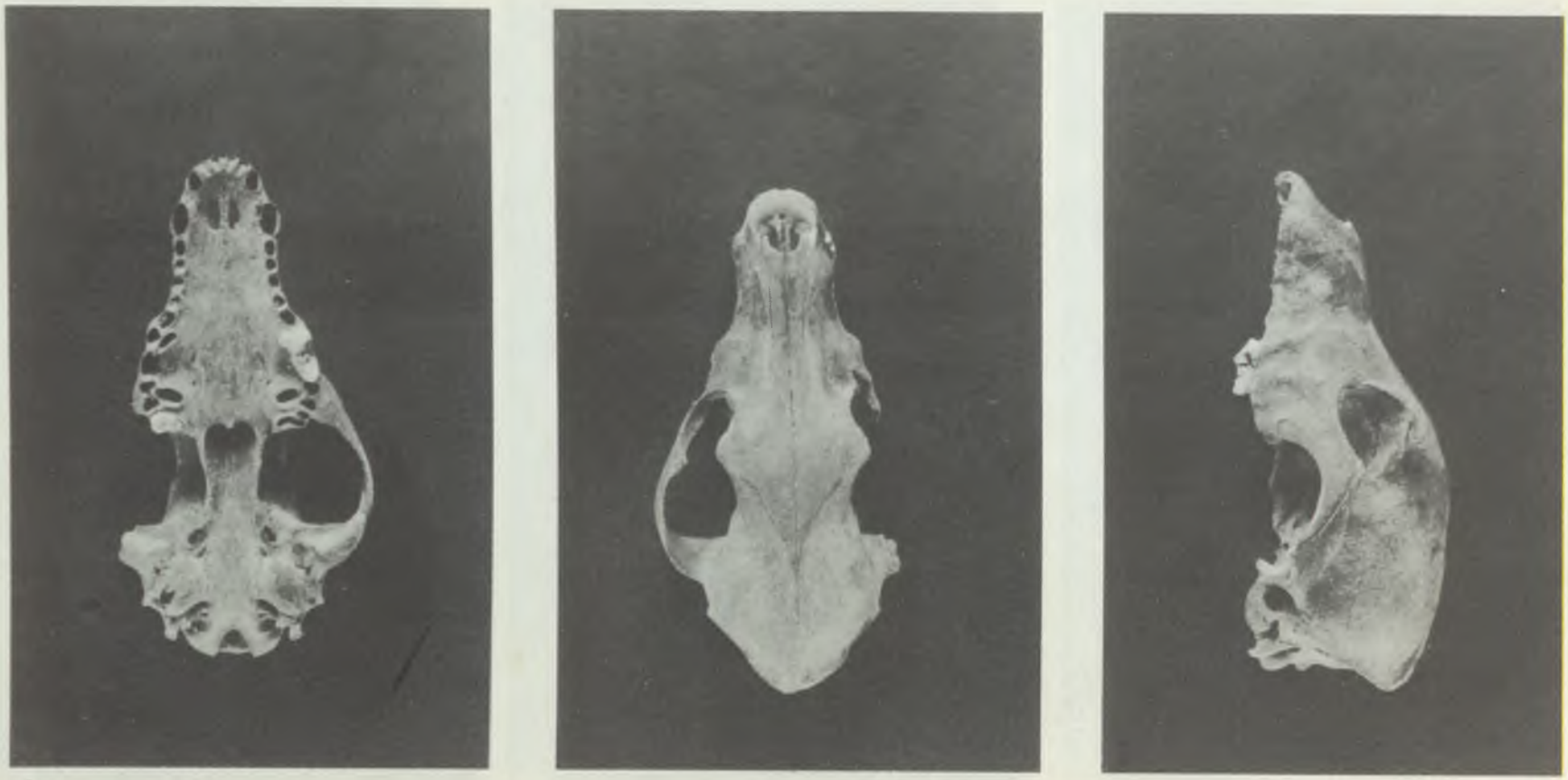


Figure 30. Dog skull. 2nd type

Figure 31. Dog skull. 2nd type

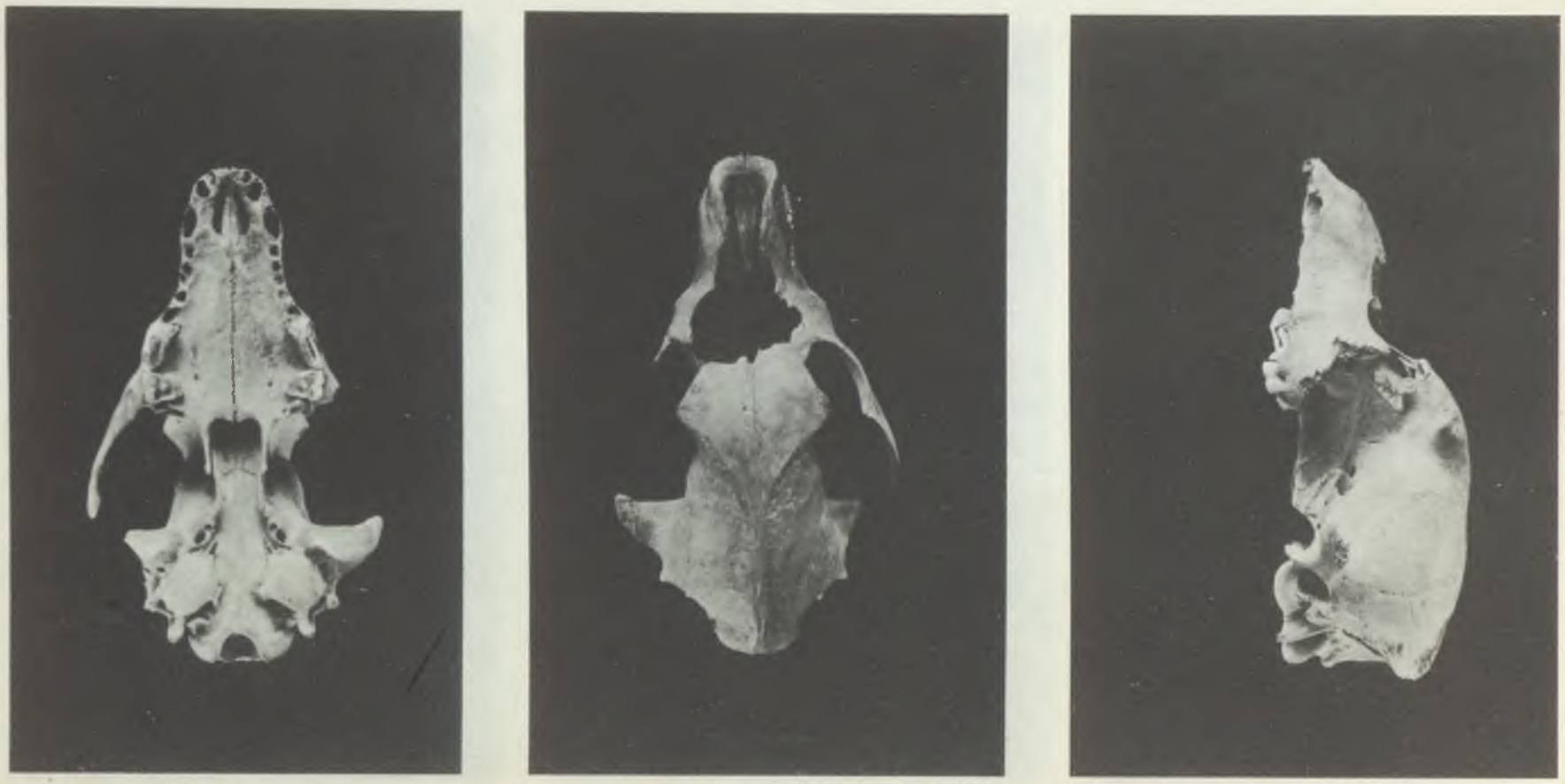


Figure 32. Dog skull. 2nd type

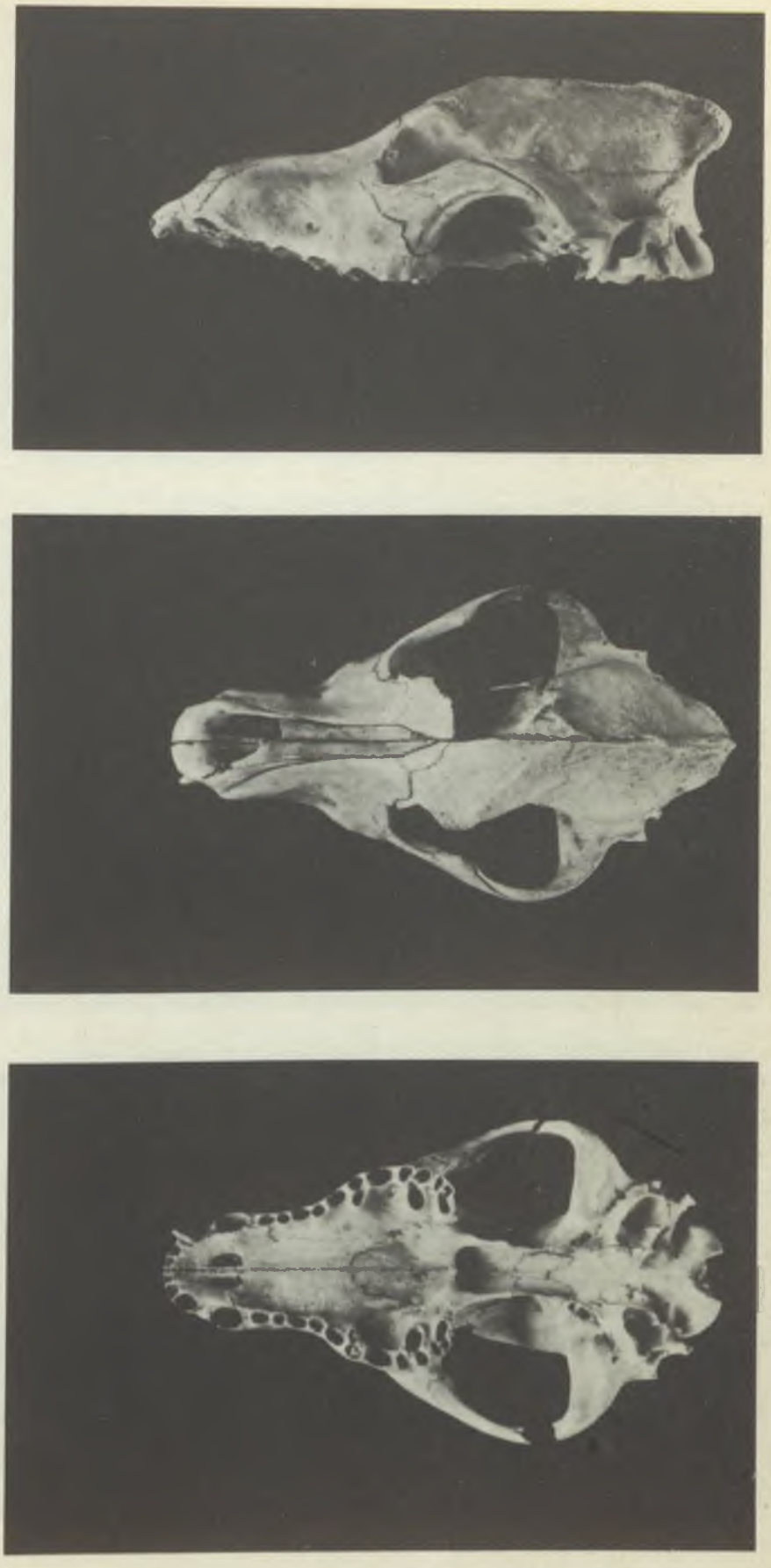


Figure 33. Dog skull, 3rd type

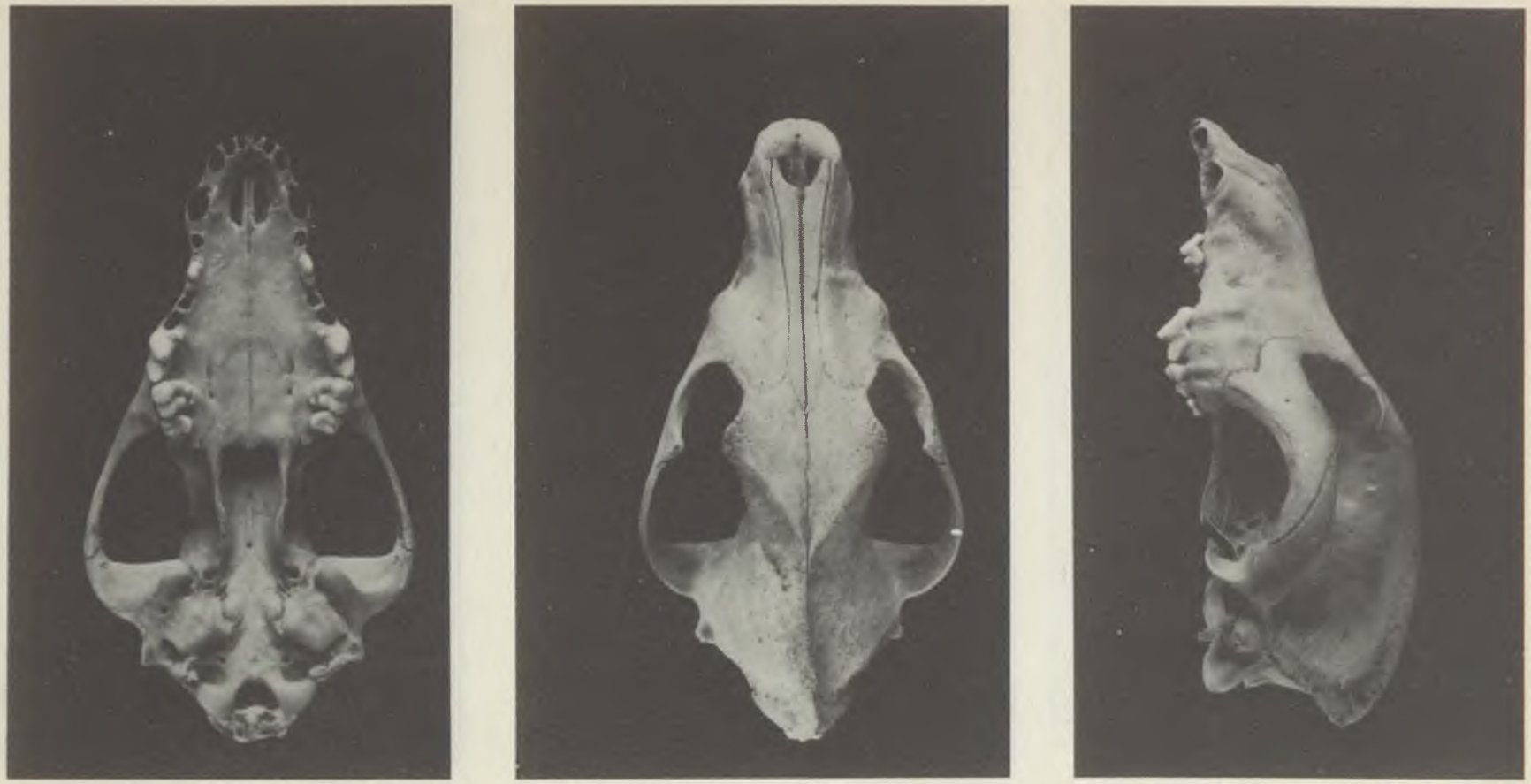


Figure 34. Dog skull. 3rd type

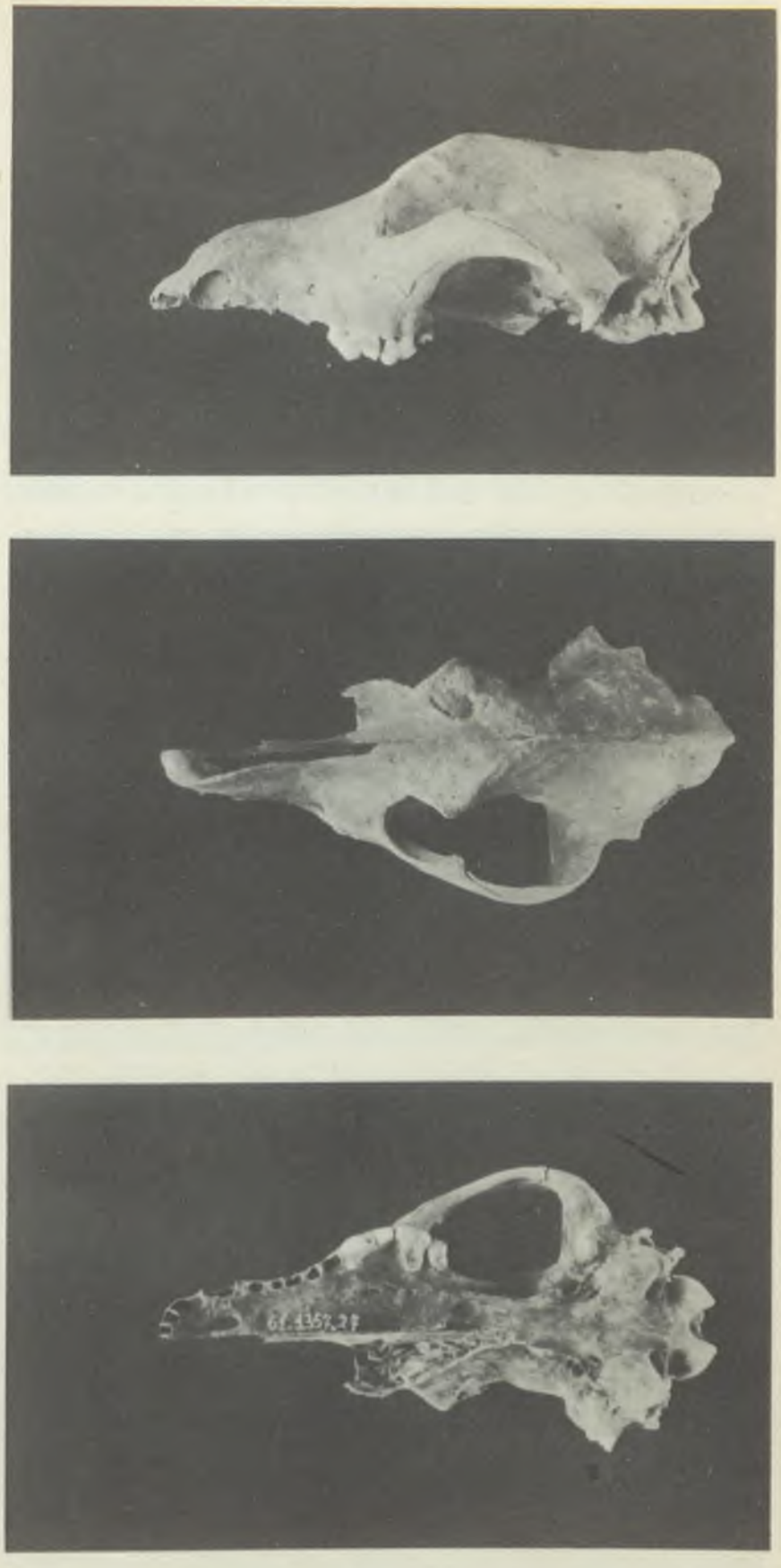
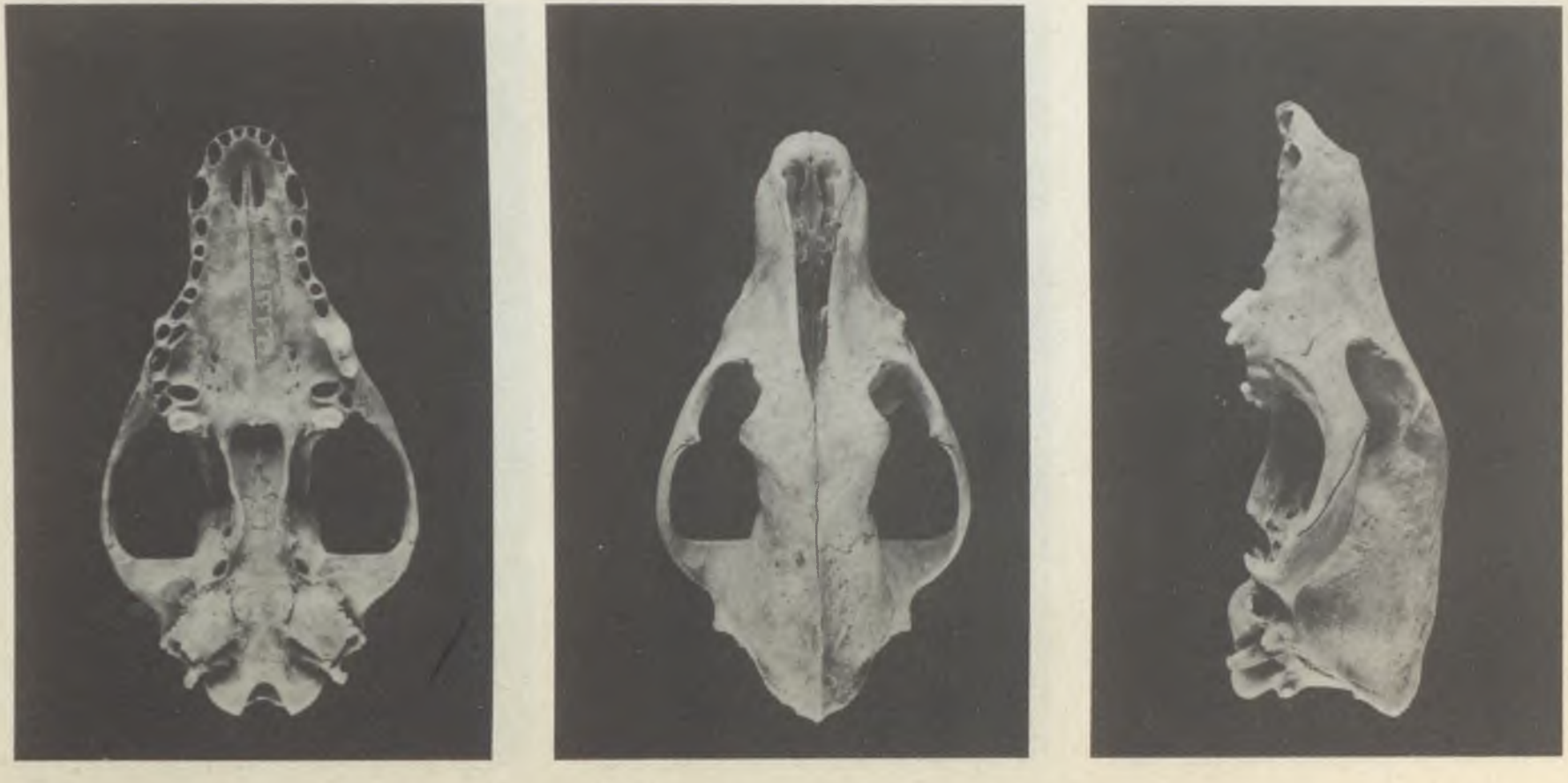


Figure 35. Dog skull. 3rd type

Figure 36. Dog skull: 3rd type

Figure 37. Dog skull. 3rd type



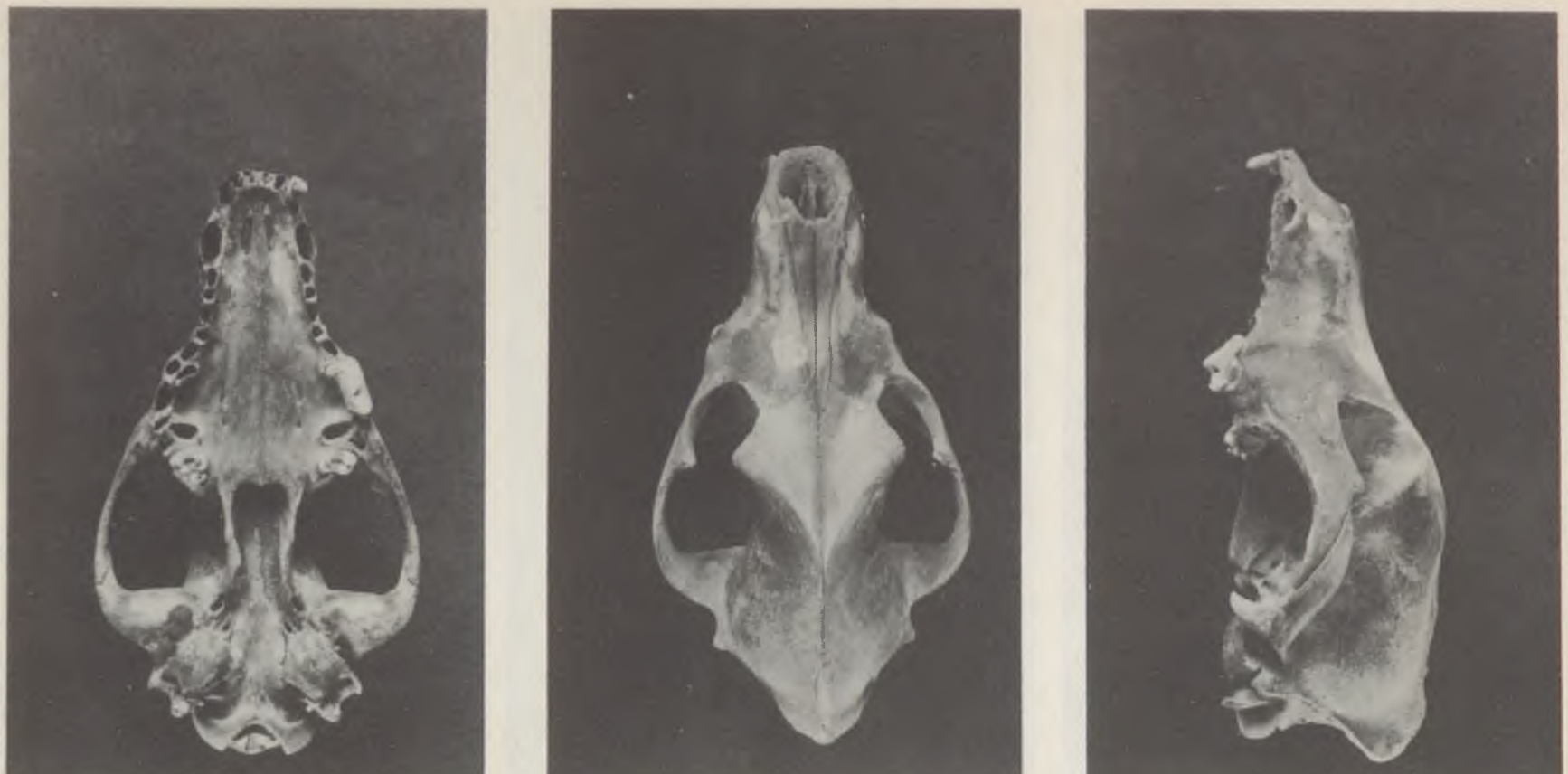


Figure 38. Dog skull. 3rd type

Figure 39. Dog skull. 3rd type

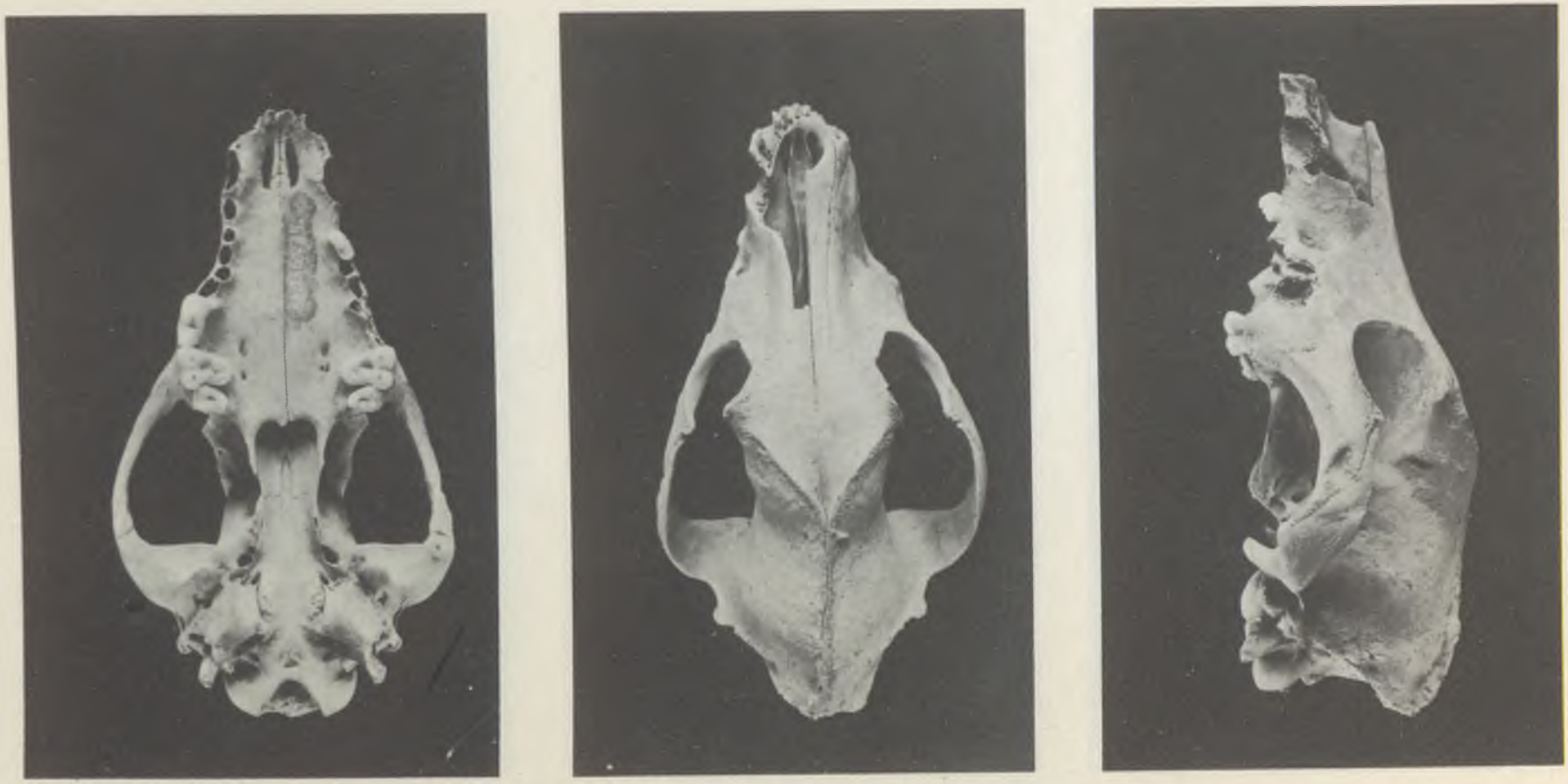


Figure 40. Dog skull. 3rd type

Figure 41. Dog skull. 3rd type

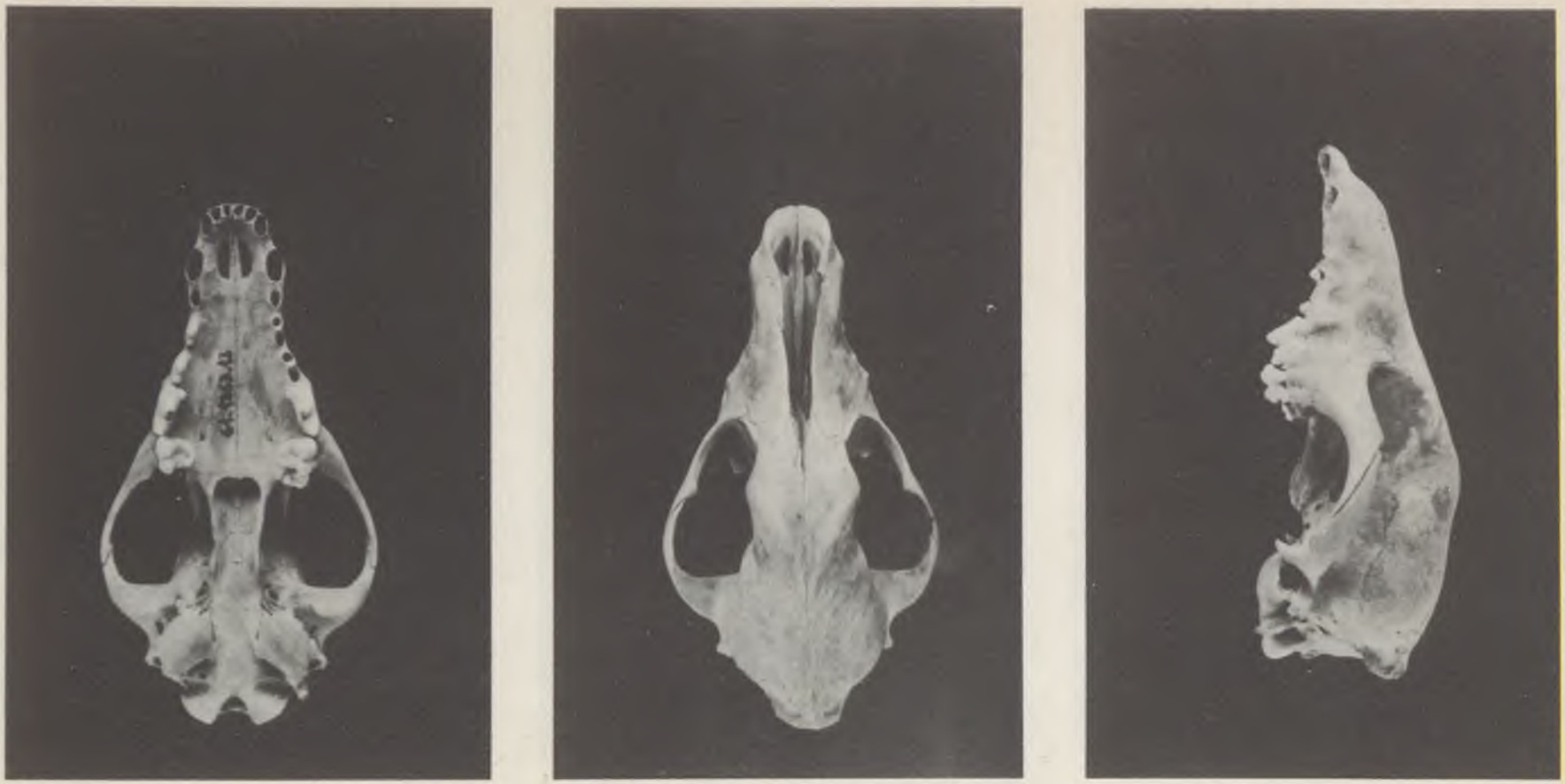


Figure 42. Dog skull. 4th type

Figure 43. Incomplete dog skull. 4th type

large overall length of type three. This latter is caused by the aborally pointed crista mediana. Both of these cranial groups probably belong to the fourth constitutional type with a size range between that of fox terrier and German shepherd and with an average withers height of 57.91 cm. Sometimes very strong individuals occur within this group, reaching the size range of small wolves. Four fragments of mandibles (three of them with 24.0 mm long first molars, and one with a 25.0 mm long first molar) come from such big animals. It is an open question, however, whether this group of a not very homogeneous structure should be considered one breed or rather represents an overlap in body size between two breeds with differing cranial types. In addition, it is far from impossible that this group is actually a mixed population unshaped by the selection of conscious breeding work. Based on the data available to date this problem cannot be solved, although the last of these hypotheses seems most likely for the following reasons:

(1) Even in such a highly civilized society such as the Roman, the majority of dog breeds were not kept separately. With the exception of the luxury dogs (which even today are kept isolated from other breeds), all the watchdogs, herding dogs and pariah dogs had excellent opportunity to interbreed with each other at will.

(2) There are numerous intermediate skulls between the two cranial groups.

The slender legged dogs of Tác–Gorsium may perhaps be identified with the tiny dog of ancient Rome which is known by its Roman name as *catulus melitaeus*. Keller (1909, 92–94) considers this breed to be the ancestor of the Pomeranian dog of Malta. The individuals of this breed found at Tác–Gorsium are probably Italian imports offering additional proof to the Italian character of life in Roman provincial towns.

The dachshund form which resulted from a sudden mutation, could theoretically have been of local origin. Their synchronic appearence over the whole Roman Empire during that period, however, suggests that they were imported from Italy. A good number of these animals were probably luxury dogs, while the rest were used in hunting.

The short, massive, and straight legged dog which was slightly larger than the dachshund was first described at Tác–Gorsium. Thus it may be the result of local mutation. These strong dogs with their good musculature were probably used for hunting in the burrows of game animals (fox, badger, etc.).

The occurrence of greyhound is particularly interesting in Tác–Gorsium. The majority of modern authors feel that in all probability greyhounds spread from two centres. One of these is the southwestern part of Central Asia. The other centre is in South-Western Europe or more exactly in Gallia. The Roman greyhound most likely has its origins in this latter centre. The Asian greyhound on the other hand may have been introduced into the recent territory of Hungary from the first centre by Migration Period peoples like the Magyars. If this last is true, then the modern territory of Hungary could prove to have been an assimilation centre for the greyhounds from these two centres of origin. The Gallian dogs were used for hunting rabbits. The custom was later taken up by the Romans and was the obvious purpose of greyhound keeping in Tác–Gorsium. Relatively few remains of this type are known from Roman Imperial sites, although representations of it are much more common in Italy.

The wolf on the other hand is represented by one skull, one each of the nasofacial and neurocranial region, one scapula, one distal end of the scapula, one femur diaphysis and one metapodial, all of which come from three individuals. These remains come from adult animals, although the ages of the individuals to which the scapulae and the femur belong cannot be determined with complete certainty.

The complete skull and neurocranial fragment are particularly interesting. Both were found within a sanctuary area and may be the remains of offerings. In addition wolf was vigorously hunted down as a destroyer of livestock and as an imagined (or perhaps occasional) threat even to human life in the surroundings of Tác–Gorsium.

The complete wolf skull (No. 35 in the Table of measurements) comes from a rather small individual. The skull measurements of this wild animal barely exceed those of the largest domestic dogs of the settlement. However, the strong dental formation, the characteristic spaces between the praemolars show that this animal was wild. The high and strong crista mediana of the skull and the relatively smaller arch of the neurocranial region indicate also that this individual was certainly a wolf.

The other bones of this species found at the site come from more medium size wolves.

Domestic Hen (*Gallus domesticus* L.)

The hen bones from Tác–Gorsium are among the best preserved from the site. There are neither complete skeletons nor complete skulls in the hen bone sample but the hundreds of undamaged long bones and their measurements allow an accurate description of the variation in size and type for this domestic bird species in the settlement.

Although domestic fowl appeared in Central Europe and on the British Isles before the Romans (Gandert, 1953, 74–75; Zeuner, 1963, 451) the real dispersal of this fowl was carried out by the Celts and Romans. In this way they can be considered the founders of modern animal husbandry in which even today chicken is the most frequent species. It is especially to the credit of the Romans that they introduced conscious breeding into hen husbandry as well as developing and distributing a relatively large size and probably highly improved breed. Two Roman authors, Varro and Columella wrote accurate instructions concerned with selection as well as fowl keeping, forage and the construction of hen houses. The smaller, primitive, aboriginal breeds were soon out-competed by the improved Roman chicken which, although it disappeared with the fall of the Roman Empire, still exercised considerable genetic effect on other breeds for a long time.

The remains of large size Italian import chicken occur in Tác–Gorsium as well and may even be said to dominate the sample. This domination can be seen in the size variability of all extremity bones and particularly well with the tarsometatarsal bones. This group of long bones can be exeptionally well divided by sex based on the presence or absence of the cockspur. Size variability estimates, therefore, are not disturbed by sexual dimorphism which is considerable in many breeds of the species.

The two sexes can be easily differentiated in the diagram showing the size variation of tarsometatarsal bones (Figure 44). The size boundary lies approximately between 77 to 80 mm for the greatest length of this bone in both sexes. There is no great difference in terms of sexual dimorphism in the

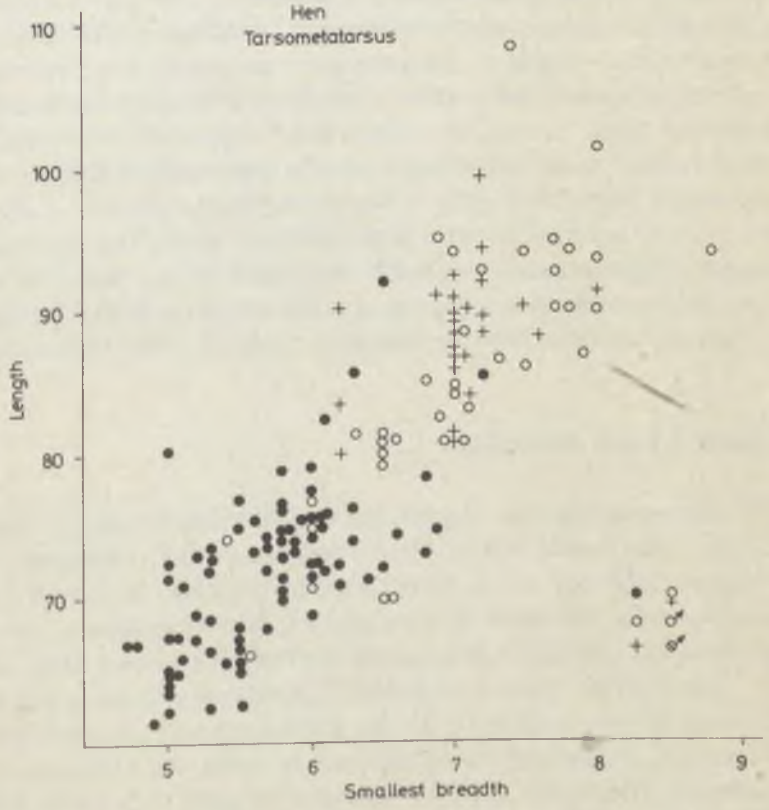


Figure 44. Scatter diagram of hen tarsometatarsals

slenderness of the tarsometatarsals. Four extremely large hen tarsometatarsals for example, fall within the size range of rooster tarsometatarsals, while two small cock bones fall within the size range of hen.

Some of the tarsometatarsals have only very rudimentary cockspurs, probably indicating the presence of capons in the stock. Such undeveloped spurs can occur on the legs of very old hens as well, although these questionable tarsometatarsals do not belong to this category since they fall without doubt into the size range of roosters.

Castration was practised in classical Greek fowl breeding, too (Zeuner, 1963, 450) in order to fatten the birds. The Romans seem to have adapted this method from them or at any rate Varro (III 8) mentions that castration comes from Delos. This group of tarsometatarsals forms a set of specimens which falls into the middle of the male size range.

With further examination of the above-mentioned diagram two size groups can be differentiated within each sex. The individuals of the smaller type probably represent the local, aboriginal breed, while the individuals of the large type represent an imported form. The former are well known from Celtic settlements of the La Tène Period from Hungary as well as from other Central European sites. The latter appeared during the period of the Roman Empire. The size differences between the two forms are so significant that some of the small local cocks fall into the size range of the improved Roman hens. The 80 to 82 mm long rooster tarsometatarsals probably belong to this smaller aboriginal type, although they may come from cross-bred animals as well. Such intermediate forms were undoubtedly present at the site. The lack of capons in the smaller group interestingly suggests that castration was not widely practised by the aboriginal inhabitants. The size differences can most clearly be seen between the two types of hen. Two extremely large roosters from the imported stock were probably old, fully grown birds used for stud purposes.

The small aboriginal breed was very similar in size to the Avar chicken found in the territory of Hungary (Bökönyi, 1955, 214; Matolcsi, 1967–68, 119–121). The weight of these birds was estimated as being between one and one and a half kilograms (Bökönyi, 1955a, 214). The Italian birds found on the site are much closer to modern breeds in size. Since they do reach the middle of the size range of recent hens, their weight obviously must have exceeded two kilograms. The birds belonging to this type occur in the faunal materials of almost all Roman sites excavated to date (Schweizer, 1961, 21; W. Piehler, 1976, 75).

The sex ratio within the fowl populations were interesting as well. On the basis of tarsometatarsals from adult birds, 79 hens, 39 roosters, and 25 capons were identified. The bones of subadult individuals are not reliable in terms of sex determination attempts. The remains of this age group occur very rarely in the sample from Tác–Gorsium. The proportion of roosters is relatively high inasmuch as breeding practices do not justify such a large number of males. One explanation may be that Romans seldom slaughtered young poultry. Another reason may be that cocks were used for cock-fighting as mentioned by some ancient authors. In general, many roosters were kept by the Romans. Columella for example suggested a cock-hen ratio (depending on the breed) of somewhere between one to three and one to five.

Goose (*Anser domesticus* L.)

The domestic goose has a long history. Based on faunal studies, its ancestry can be traced back to ancient Egypt in the second half of the 3rd millennium B.C. (Boessneck, 1960, 199–201) and Asia Minor (Brentjes, 1965, 101) to the 4th or 5th millennium B.C. In spite of this long history the domestic goose does not differ very much from its wild relative (*Anser anser* L.). As a result the presence of domestic goose is very difficult to demonstrate in prehistoric or even early historic sites.

The Romans, however, undoubtedly had domestic geese, which is not only shown by the story of the Capitolium geese but also by the fact that ancient authors mention these birds rather often. It is again worthwhile mentioning the descriptions by Varro and Columella, of the goose farms in the Roman latifundia. Plinius also mentions the import of geese from Gallia Belgica and Germania (Keller, 1913, 221). It was probably the Romans who introduced forced feeding in order to produce enlarged livers, which was a popular delicacy. Flour, milk and honey were used as the feed in this operation. Goose in

addition, was the sacred animal of Juno in Italy. Its fat was used in both external and internal medicines. Goose down was used to make pillows (Keller, 1913, 224–225).

The fact that the bones found at Tác–Gorsium come from domestic geese is illustrated by two things:

(1) An amazingly large number of goose bones were found, almost matching the size of the whole wild bird sample within the bone material of the site.

(2) There is a wide size range which is a well-known characteristic of domestication. Many of these domestic geese appear to exceed the dimensions of wild geese.

This larger size in the domestic form was also found by Dräger at the Austrian site from the period of the Roman Empire, Magdalensberg, (Carinthia, Austria) (Dräger, 1964, 26). Later the presence of domestic geese on that particular settlement could be demonstrated by well defined morphological data. During the process of domestication the fossa sterni became much more shallow in the domestic form, as a consequence of the decreased need for large muscular surfaces (Hornberger, 1970, 131).

Domestic goose bones are usually less frequent in the faunal material of Roman sites than domestic hen bones. The site of Dormagen, Germania, in the lower Rhine region may be an exception. The number of goose bones exceeded that of the domestic hen bones in the faunal sample of this settlement (Mennerich, 1968, 7).

In addition, as mentioned at the beginning, it is very difficult (sometimes even impossible) to distinguish bones of domestic goose from the remains of the wild form, and sometimes the bones of this domestic species may actually be missing.

Domestic Pigeon (*Columba domestica* L.)

Pigeon is one of the rarest of the domestic animals found on Roman Imperial sites. These birds have only been found and described at Berg in Bavaria (Boessneck, 1958b, 26; 111), at the Swiss sites of Ersigen–Murain (Stampfli, 1965–66, 457), and Augusta Rauriaca (Schmid, 1967, 181; 1970, 1319), at the French site of Montmaurin (Poulain-Josien, 1969, 321) and at the Upper Austrian site of Wels (Gandert, 1973, 120ff).

The pigeon was a favourite domestic animal in Italy during the period of the Roman Empire. Its keeping and fattening was described in detail by Varro and Columella.

As with chicken and geese, these smaller domestic birds were also force fed, using in this case pre-chewed white bread (Keller, 1913, 129). The value of pigeons was shown by their prices. A pair of excellent pigeons could sometimes fetch as much as 1000 sestertii in the time of Varro.

The pigeon bones found during the course of excavations at Tác–Gorsium are as follows: one incomplete sternum, one humerus (greatest length 45.5 mm), and one proximal end of a humerus. These three bones come from two full grown individuals.

Red Deer (*Cervus elaphus* L.)

During the excavations at Tác–Gorsium 158 red deer remains were recovered. The number of antler fragments was small and probably in all cases represented tool making debris. Shed antlers were also collected as raw material for this activity as shown by four antler roses found at the site. The extremity bones come from practically all body regions with the same frequency which suggests that the hunted deer were carried intact in their skins and butchered at the settlement. There are only four complete bones (three radii and one metacarpal bone) in the very fragmented sample.

By the end of the period of the Roman Empire the rich red deer population which had characterized the Neolithic greatly diminished along with the size of individuals. The overall reductions can partly be explained by climatic changes. However, the cultivation of larger territories with the resultant increased size of the cultivated land led to a decrease of the vast forest territories. Thus the deer population broke down into smaller segments. By that time red deer had lost its importance as a meat resource and deer hunting had been reduced to nothing more than sport. This kind of deer hunting became characteristic for the Imperial Period. This change was particularly noticeable around urban settlements like Tác–Gorsium.

In such circumstances it is not surprising that none of the measurable deer bones found during the course of excavations at Tác–Gorsium came from really large individuals. The bones belong to the following size categories:

medium to large	37%
medium to small	27%
small	23%
very small	13%

With circumferences of 170 and 175 mm, respectively, two of the measurable antler roses can hardly be considered fine trophies. Three other antler roses, however, have circumferences of 240 mm, 250 mm, and 310 mm which suggests that occasionally large males could still be found near Tác–Gorsium. The last rose measurement especially comes from the notably proportioned antler of a large stag.

Considering the significant sexual dimorphism within this species there is some reason to assume that the bones of larger animals belong to males while the smaller remains come from females. (Understandably only the remains of adult animals were considered so that the smaller bones cannot be said to be those of immature animals.) Based on the size classification, two-thirds of the bones of red deer come from stags. This ratio may indicate some kind of selective hunting. That Roman hunters should consciously spare females is not unthinkable given the often mentioned, advanced level of Roman farming culture and animal breeding. On the other hand, the high frequency of stag bones may also be the consequence of the greater ease of hunting males during the mating season, when they gather to bell, unlike the shyer females which form larger groups for the whole year.

Roe Deer (*Capreolus capreolus* L.)

This species is represented by 30 bones in the faunal material of Tác–Gorsium. There is only one almost complete antler and two antler fragments with measurable rose circumferences (Figure 45). The majority of these remains come from fragmented limb bones with only ten measurable specimens and no complete

Figure 45. Roe deer antler

long bones. The remains come chiefly from adult individuals although some bones from nearly full-grown roe deer were found in the site as well.

The deforestation of the Iron Age and Roman Period probably significantly favoured the increase of roe deer populations. At the same time this kind of human activity disfavoured the larger and stronger red deer which in extreme cases could be a competition in terms of food and territory. Additionally, the new environment of expanded open fields and groves of trees were optimal for this smaller wild ruminant.

These changes in the biotope influenced the body size of roe deer as well. Although the circumference of the smaller antler rose is only 90 mm, the other antler fragment can be considered medium sized with a rose circumference of 117 mm. Half of the measurable limb bones come from medium-small or medium-large individuals. One metatarsal bone with a distal breadth of 27 mm represents an extremely large roe deer. Four other bones certainly come from small animals.

It is worthwhile mentioning here roe deer remains from two other Roman sites. A capital, six branched antler with the rose cut off was found at the site of Magdalensberg, Austria. Large individuals were also identified among the limb bones of roe deer found at this site from the Roman Imperial Period (Hornberger, 1970, 72; 77; 78). Two extremely strong metatarsal bones from this species are known from Abodiacum, Germania (Boessneck, 1964, 232).

The above-mentioned large individual represented by the big metatarsal bone in the faunal material of Tác–Gorsium was undoubtedly a buck. If we assume that the medium size bones come from bucks as well then it seems likely that these roe deer were also hunted selectively as was proposed for red deer.

Badger (*Meles meles* L.)

There are three fragments of badger bones from the site of Tác–Gorsium. There is one mandible, one scapula and one distal tibia fragment. The scapula fragment probably comes from a large individual, while the mandible and tibia fragments suggest medium size badgers.

Badger was probably hunted for fur, although it is not impossible that the meat was consumed as well, as is a custom among some modern forest dwelling people.

Fox (*Vulpes vulpes* L.)

The bones of fox are dominated by halves of mandibles: seven of these are from left and four of them from the right side. These jaws were often found with complete or fragmented skulls which suggests that they are not contemporary with the Roman settlement. Foxes frequently burrow in dry hillsides where they occasionally die.

All these fox bones come from adult individuals. Nearly half of the individuals are large while the others range from medium to small in size.

Although foxes were eaten during prehistoric times, the Romans of the Imperial Period hunted them for their pelts alone.

Beaver (*Castor fiber* L.)

Only one damaged incisor of beaver was found during the course of excavations at Tác–Gorsium. It belongs to a full grown and large individual.

Beaver was a rodent frequently found in the territory of Hungary until the Middle Ages. The meat of this species was consumed, even in more recent times as shown by 18th century cookbooks, although this animal was always hunted chiefly for its rather precious fur.

Brown Hare (*Lepus europaeus* Pall.)

This species is the next most common wild animal on the site after red deer, at least in terms of the frequency of bones found at Tác–Gorsium. The hunting of hare became really popular during the Roman Imperial period, as opposed to the Neolithic when it was only rarely the prey of hunters. Later, however, hare hunting became more frequent as the populations of large wild mammals decreased. Chiefly mature animals were killed, although occasionally immature animals were captured as well. The bones of juvenile animals are found very infrequently in the hare sample of the Tác–Gorsium bone material.

The hare bones display great variability in the size of individuals in the population.

In Tác–Gorsium hare hunting was probably a sport and greyhounds certainly played a role in it. The Romans probably learned to hunt hare with greyhounds from the Gauls (Keller, 1909, 213).

Hare meat was highly popular in Imperial Rome, and this is why captured hares were kept in enclosures called leporaria. It is not likely that such leporaria existed in Tác–Gorsium as well. In such cases the meat of young hares would have been the first to be consumed.

Wild Birds

The wild bird remains from Tác–Gorsium display rather large variation in species. Some of the identified species are strictly water birds as for example the tufted duck (*Aythya* f. *fuligula* L.), the pochard (*Aythya ferina* L.), garganey (*Anas querquedula* L.), teal (*Anas crecca* L.), mallard (*Anas platyrhynchos* L.), an unidentified duck species (*Anas* sp.) and white stork (*Ciconia ciconia* L.). Birds living sometimes close to and sometimes in wet areas include the crane (*Grus grus* L.), marsh harrier (*Circus aeruginosus* L.). Jackdaw (*Colaeus monedula* L.) and rook (*Corvus frugilegus* L.) live in groves and cultivated areas, while the white goshawk (*Accipiter gentilis* L.) is a bird of the forest and open grasslands. Wood pigeon (*Columba palumbus* L.) lives exclusively in forested areas.

The occurrence of birds from three separate habitats shows that the inhabitants of Tác–Gorsium hunted in three different ecozones. The preferred territory for bird hunting was probably the wet marshland, which was abundant in many kinds of water fowl.

In spite of this preference the bones of wild geese were not found although, there is a small possibility that (because of difficulties mentioned previously) such bones could not be adequately separated from the domestic goose bone sample. The same problem arises in the case of mallard and domestic duck. It is very difficult to distinguish between the bones of these two forms using simple bone morphology. For this reason, duck was not even mentioned during the discussion of domestic fowl, since in attempting to distinguish between these two *Anas* species one is reduced to conjecture. Only Stampfli (1959–60, 435), Schmid (1967, 181; 1970, 1319), and Poulain-Josien (1969, 321) were successful in identifying domestic duck from Imperial Roman sites with full certainty. Boessneck (1958b, 113) also identified this species in all probability. In any case, domestic duck is mentioned frequently by Roman authors from Italy.

The bustard (*Otis tarda*), otherwise a rather common bird of the open plains and grasslands throughout all prehistory, is missing from the wild bird sample of the faunal material from Tác–Gorsium. The occurrence of the little bustard (*Otis tetrax* L.) in the avian sample, however, is unique up to the present time from a prehistoric or early historic site in Europe (H.-M. Piehler, 1976, 96–97). Subfossil remains of

four other species, jackdaw, marsh harrier, goshawk, and teal were found for the first time at Tác–Gorsium in Hungary.

Obviously the majority of these bird species, perhaps even including the jackdaw, rook, and white stork were hunted for meat. The probable exception were the raptorial wild bird species such as the marsh harrier, the white goshawk, and the white tailed eagle which were killed for sport.

The detailed list of wild bird remains found during the course of excavations at Tác–Gorsium is shown in Table 19.

TABLE 19

Skeletal remains of birds from Tác–Gorsium

Species	Bone type	Number of specimens	Length (mm)
jackdaw (*Colaeus monedula* L.)	tibia	1	71
rook (*Corvus frugilegus* L.)	ulna	1	72
	tibia	1	79
unidentified rook species (*Corvus* sp.)	humerus fragment	1	—
	ulna	1	83
wood pigeon (*Columba palumbus* L.)	tibia	1	57
little bustard (*Otis tetrax* L.)	tarsometatarsal	1	68
crane (*Grus grus* L.)	humerus fragment	1	—
	femur	1	135
	tibia fragment	2	—
	tarsometatarsal fragment	1	—
marsh harrier (*Circus aeruginosus* L.)	ulna	1	120
white tailed eagle (*Halietus albicilla* L.)	skull	1	—
	sacral bone fragment	1	—
	humerus fragment	1	—
	femur	2	120
			122
	tarsometatarsal fragment	1	—
white goshawk (*Accipiter gentilis* L.)	humerus	1	100
	ulna	1	111.7
tufted duck (*Aythya f. fuligula* L.)	tibia	1	—
pochard (*Aythya ferina* L.)	humerus	1	94.2
	ulna	1	75*
	femur	1	45.2
teal (*Anas crecca* L.)	humerus	1	60
garganey (*Anas querquedula* L.)	ulna	1	55
unidentified duck species (*Anas* sp.)	coracoid fragment	2	—
	scapula fragment	1	—
	humerus	2	85
			88*
	humerus fragment	1	—
	radius	1	—
	ulna fragment	2	—
	femur	2	60
			67.5
	femur fragment	1	—
unidentified duck species (*Anas* sp.)	tibia fragment	4	—
	tarsometatarsal	1	55.5
white stork (*Ciconia ciconia* L.)	ulna fragment	2	—
	tarsometatarsal fragment	1	—

Pond Tortoise (*Emys orbicularis* L.)

There were 22 specimens of tortoise bone in the sample, all exclusively from the shell (carapace and plastron fragments).

Tortoise hibernates during the winter burrowed into smaller dry hillocks or hillsides. This is a critical period in its life cycle and the animal frequently does not survive the cold season. It is not impossible, therefore, that the remains of tortoise shell found at Tác–Gorsium are more recent than those of other species in the Roman Age faunal material. Cutting and butchering marks on these shell fragments would indicate contemporaneity but are not present. As such, the reliability of these remains must be called into question.

Pike (*Esox lucius* L.)

Nine skull and mandible fragments were identified as coming from pike. One fragment certainly came from a large bodied fish and one from a smaller sized pike, while the others come from medium size fish.

It is the opinion of Keller (1913, 371) that pike was not eaten by the inhabitants of ancient Rome although it seems clear that this species of fish was known from the provinces.

Carp (*Cyprinus carpio* L.)

Among the 12 remains coming from carp, species determination was made possible from skull fragments, opercules and pharyngeal teeth. Two fragments belong to medium size individuals and all the others to smaller carps.

The bones of this species as well as the other fish on the site probably come from local waters rather than from the Danube. Cassiodorus, however, mentions in his descriptions that carp were among the gourmet tid-bits on the royal table of King Theodoric (Keller, 1913, 374).

Catfish (*Silurus glanis* L.)

The catfish remains on the site of Tác–Gorsium come from three individuals. Two of these animals were medium sized, and the third was small.

This fish was not known at first by the Romans because it did not live in Italian waters. Catfish was introduced to them by the inhabitants of the provinces. The capture of giant catfish specimens by the Barbarians of the Lower Danube region was described by Aelian.

THE EXPLOITATION OF DOMESTIC ANIMALS AT TÁC–GORSIUM

The main purpose and aim of domestication was the production of meat. The first domestic animals actually acted as living meat conserves which the human population could use as need arose. All the other uses such as milk, wool, draught power, and eggs etc. occurred much after this initial period of animal keeping, and in fact were probably not known until the middle of the Neolithic. From this time onwards it frequently occurred that animals were either domesticated explicitly for one of the so-called secondary purposes (relative to meat production). Horse as a draught animal is a typical example of such domestication. In other cases, the secondary purpose dominated the meat function of the species as for example sheep which became a wool producer during its history.

In general, the exploitation of animals in the period of the Roman Empire is quite well known. It was not only detailed by numerous authors but illustrated by a good number of realistic representations as well. It is not clear, however, whether the degree to which the practices outlined in these sources match the animal keeping practices of the provinces. In other words, how much of Italian animal husbandry was imported to the hinterlands. In terms of this question no differences have been identified between individual sites and site types (for example aboriginal villages, villa farms, towns, military camps and watchtowers) from this period.

Examination of faunal material from several sites give a more reliable picture of local conditions than do the writings of contemporary authors from that time and other ancient sources. In addition, bone material as a biological sample provides primary and objective data, while literary sources can provide only secondary and sometimes inaccurate information. Inevitably literary and bone data are compared in order to help interpret and explain the emerging picture. Without this interplay between types of data it would often be impossible to understand the testimony of bones. It may happen that one species is represented only by adult or old individuals on the site and in such cases literary sources are definitely useful in explaining the techniques of animal keeping and mode of exploitation.

This kind of analysis of a bone sample is based on the kill-off pattern or in other words the proportions of different age groups among the slaughtered animals. Obviously single purpose meat animals were slaughtered young, not only to produce better quality meat, but also to prevent waste forage during critical periods such as winter or during droughts. On the other hand, those animals which produced their particular product only as adults were kept for a longer time. It is not very difficult to understand why draught oxen, dairy cows or goats, wool producing sheep, and egg laying hens were of real value only when kept for a longer time and killed later.

Determination of age groups can be carried out not only on the basis of tooth eruption and change but also by the ossification of sutures, epiphyses and vertebrae. The specific size of bones was considered as well. (The methodology of age determination is described in Bökönyi, 1963a, 418; 1970, 291.) Although the results obtained this way are undoubtedly only approximate, the aim was never the determination of absolute age but rather the stage of ontogeny of the animals. This method has in addition, made available for study a significantly wider range of bones which in turn increases the reliability of the age determination made for the age of slaughter statistics. As may be seen in Table 20 according to the faunal material in Tác–Gorsium, only pig can be considered a single purpose meat producing animal. Almost 73 per cent of the individuals of this species were slaughtered as juveniles or subadults so that merely 27 per cent of the stock reached maturity. It is, therefore, not surprising that the work of a number of classical authors mentions pork as the favourite meat of ancient Rome.

Pig meat was eaten in many different forms, while the teats, uterus, and vulva were considered to be special delicacies (Zeuner, 1963, 263). The meat of sucklings was popular as well, which may explain the large number of bones from newborn piglets found at Tác–Gorsium.

TABLE 20

The age distribution of domestic animals in Tác–Gorsium on the basis of bone specimens (%)

Species	Age					
	newborn	juvenile	subadult	adult	mature/senile	total
cattle	0.20	8.99	31.18	58.85	0.78	100.00
sheep	0.00	14.89	27.66	57.45	0.00	100.00
sheep or goat	0.00	19.34	31.72	45.01	3.93	100.00
pig	4.51	23.28	45.05	25.41	1.75	100.00
horse	1.53	9.16	15.26	70.23	3.82	100.00
dog	0.00	3.39	5.08	91.53	0.00	100.00
hen	4.23	15.49	16.90	61.97	1.41	100.00

Cattle, sheep, goat, chicken, and goose were all eaten in the settlement although they had other secondary purposes which came to play even more important roles. On the other hand, it is not likely that the meat of horse, ass, dog or cat was utilized to any great extent. The proportion of young animals in the bone samples of these species is very small and is probably reflective of the age of natural death. In addition, the bones and even the articulated bones or skeletons do not show butchering, cutting, or chopping marks. Consumption of dog and horse meat, however, was not totally unknown during the period of the Roman Empire. Many remains of dog and horse were found at the site of Augusta Rauriaca in Switzerland, among the kitchen rubbish of a merchants' mansion (Schmid, 1970, 1317).

When only the meat purpose is considered, pig, although used exclusively for this purpose, falls second behind cattle in absolute quantity of meat produced (Table 21). The explanation of this phenomenon is that although cattle were kept chiefly for other purposes they still yielded much more meat per individual than pig when slaughtered at an older (obviously full-grown) age.

It is very difficult to estimate the amounts of meat provided by the different species. Although Kubasiewicz (1956, 235–244) had developed a simple and clever method of calculating the mass of meat produced based on bone weight, it has recently been determined that these sorts of estimations are quite erroneous (Casteel, 1978, 71–77). Since Tác–Gorsium was not completely excavated, however, it is in any case much more interesting to study the proportion of species used in meat production than the absolute weight of meat produced by the different domestic animals.

TABLE 21

Meat production at Tác–Gorsium

Species	Sheep unit	Percentages		
		meat production	specimen count	number of individuals
cattle	5740	76.98	44.95	39.39
sheep/goat	485	6.50	24.82	29.29
pig	705	9.45	22.59	22.57
chicken and goose	26	0.34	5.86	8.74
Domestic animals	6956	93.27	98.22	93.99
aurochs	255	3.42	0.26	0.82
red deer	210	2.82	0.40	1.44
roe deer	8	0.11	0.08	0.39
wild boar	22	0.29	0.12	0.53
other species	7	0.09	0.92	2.83
Wild animals	502	6.73	1.78	6.01
Total	7458	100.00	100.00	100.00

In order to determine the ratio of species a simplified method was chosen. The basic assumption was that the body mass of a cow equals that of seven sheep, while one pig's bodyweight equals that of one and a half of a sheep. The number of individuals within each species were multiplied by these numbers, using one sheep as the base measurement for the estimation of the meat weights for domestic and wild animals consumed by the inhabitants of Tác–Gorsium. The results can be seen in Table 21.

In spite of the approximative nature of these ratios, Table 21 clearly shows how much the figures illustrating relative meat weights differ from the data of bone specimen count or those of the approximate number of individuals. These new data show a trend toward a clear dominance of large size species in meat production: about three quarters of the meat consumption at Tác–Gorsium was based on beef, completely overshadowing the other meat providing animals in terms of quantity of meat. The same trend can be seen in the amount of meat yielded by wild animals: the large aurochs and red deer as well as the two smaller sized wild ungulates, roe deer and wild boar made up almost 99 per cent of the game consumed. Other wild mammals consumed as meat (hare, beaver, and perhaps badger) as well as the rich choice of wild fowl appear to have provided less than 1.5 per cent of the meat production of wild animals hunted near the settlement. In any case it is clearly shown by these data that hunting was not an important source of meat.

The age structure reflected in the bone material suggests that significantly more pig was kept in Tác–Gorsium than was apparently warrented by the local consumption of pork. This hypothesis is based on the fact that the ratio of full grown (adult and senile) individuals exceeded 27 per cent. In contrast, bone material from the Neolithic and Early Bronze Age site of Sitagroi–Photolivos Greece has shown that a pig stock can be maintained on a constant level with a breeding stock of 10 per cent of the population and with one farrowing a year if the number of offspring averaged five. This rate of reproduction does not exceed that for a wild pig population (Bökönyi, in print). Considering the much more sophisticated methods of the Romans' advanced animal breeding the large number of mature animals at Tác–Gorsium probably meant a more intensive increase in reproduction.

The faunal material reflects a ratio of eight boars to 26 sows in the settlement. (Some of these boars may have been castrated.) Keller (1909, 396) has pointed out that Roman authors mention ten sows to one boar as the ideal ratio in Italy.

In a simplified calculation 21 out of 27 adult pigs may be assumed to be sows. In general, seven to eight of the newborn piglets were saved (Keller, 1909, 396). Seven such offspring may be included in this calculation; in addition, if a farrowing average of 1.5 is assumed in any given year (this average is the reproductive rate for primitive and improved Roman breeds) then the 21 sows could produce 220 piglets per year. In this case, even if thirty of the piglets died, the net increase in the stock was 190 individuals each year. Since the first farrowing can occur when the sow is about two years of age (Keller, 1909, 396) the majority of the sample (the 20 individuals previously mentioned) could produce 140 more offspring. Altogether this means an increase of 330 per cent in the stock. If about 73 per cent of the pork was consumed at the settlement, almost 250 per cent of the 330 per cent increase still remained to be sold. This hypothesis is supported by the fact that the bones of all these animals were not found at the site indicating a commerce in livestock.

The lack of bones from juvenile and subadult animals can also be explained by the possible export of pork. In the form of smoked or salted meat, ham or bacon, large amounts of pork could be exported. Although written evidence for such trade to Italy comes only from Gallia, it is not impossible that the province of Pannonia provided similar products as well.

A third explanation for the above phenomenon lies in the fact that Tác–Gorsium played an important role in supplying the military units of nearby border areas. Advanced conservation techniques could produce pork, perfect for such purposes.

It is worth mentioning that the population of Tác–Gorsium chiefly consumed beef which was cheaper, costing eight denars per pound according to the Edictum of Diocletian. The more common parts of pig cost 12 denars per pound, while pork delicacies were sold for up to 22 denars per pound (Keller, 1909, 350; 400). These higher prices may have provided impetus for the export of pork as a local speciality. It would be very instructive to study the faunal materials of other settlements of different

Roman provinces from this point of view. Possible differences between the pork eating habits of different social groups are illustrated by the numerous bones of sucklings found in the faunal material of Tác–Gorsium.

As Columella has written, cattle was used chiefly in agriculture rather than for meat. Draught power, milk and manure were considered the main uses of this species (Keller, 1909, 351). Varro, Columella and Palladius give detailed descriptions of draught oxen. The bone remains of oxen found at Tác–Gorsium fit these descriptions, at least in terms of forehead and horn formation as well as in the strength of the body reflected by the massive bones. These traction oxen were probably famous even beyond the borders of the Roman Empire. The Celts (Boessneck *et al.*, 1971, 56) and the Sarmatians (Bökönyi, 1974, 130; 1976a, 45–46) seized every opportunity, whether through looting or commerce, to obtain these animals.

Cow milk probably played a significant role in the nutrition of the population. In Rome, milk was a fundamental component of any breakfast. Buttermilk and butter (used in a slightly oil-like form) were consumed as well. The new milk produced after birth was considered a delicacy as was frothy cream. Cow milk cheese was, however, less popular (Keller, 1909, 351–353).

Profit from cattle hides was of likely importance in Tác–Gorsium. Italy imported significant amounts of this material and in specific, Aquileia, was the town concerned with receiving these hides in the course of commercial transactions.

The large number of living animals transported to Italy is mentioned in the *Expositio totius mundi* written around 350 (Mócsy, 1974, 321).

The tradition of using cattle as sacrificial animals had deep roots in the Neolithic and reached its peak with the *suovetaurilia* rites.

The main purpose of sheep in Roman animal husbandry was wool. As previously mentioned, these animals were first imported through the economic mediation of Magna Graecia from the Greeks. It is not possible to determine, however, whether sheep with fine wool are of Greek origin as well. Once again, it is worthwhile repeating that such wool was found in Scythian tumuli near the Greek town of Nymphaeum (5th century B.C.) in the Crimea (Ryder and Hedges, 1973a, 480). The other possibility is that the Romans themselves improved the form of the wool. Such fine fibre has certainly been found in Roman period sites in Denmark and Mainz, Germania (Ryder and Hedges, 1973b, 359ff). The good quality of their wool may have provided the Roman sheep competitive advantages over Neolithic sheep or the sheep of the local Pannonian inhabitants. Roman sheep were, in addition, of a remarkably greater size.

The meat and milk of sheep was of much less significance, although sheep cheese was more popular than that from cows. Sheep played an important role in sacrifices as well.

Goat was kept primarily for its milk from which the most commonly eaten cheese of antiquity was made (Keller, 1909, 303). Goat hide was processed in many ways and sold in a variety of forms as well. The list of prizes of Diocletian contains a series of such commodities (Keller, 1909, 304).

The only other purpose for which pig was kept was for the *suovetaurilia* type sacrifices and wedding celebrations or other contractual ceremonies.

The large number of adult horses evidently reflects the importance of this animal as a source of draught power. Horse was also used throughout the Roman Empire as the primary beast of burden in agricultural and commercial transport as well as in military operations. Tác–Gorsium seems to have been one of the provincial towns where truly outstanding horses could be found. These animals were probably among the best of this species to be found in the Roman Empire, or at least in its European provinces. The export of such animals to Italy or even other places is not very difficult to imagine.

Ass was exploited chiefly as an important beast of burden. Females of this species were probably also milked. Ass milk was considered an especially precious thing and had cosmetic value. Plinius and Cassius Dio mention that Poppea, the wife of Nero, took regular baths in the milk of ass mares in order to keep her skin white. Five hundred female asses were kept exclusively for this purpose.

Mules were used as draught animals and beasts of burden as were horse and asses in the settlement.

Domestic cat was probably a luxury animal for the most part. They were kept as pets by Scythian nobility on the northern coast of the Black Sea in the 6th to 5th centuries B.C. as well (Zalkin, 1964, 8). The high frequency of this carnivore species at Tác–Gorsium, however, suggests that they were used to

control small rodents. Such use is particularly likely from the 2nd century when cats began to seriously overtake in frequency weasels and snakes which had previously been kept to catch mice (Keller, 1909, 73; 75–76).

Among the dog breeds kept at Tác–Gorsium, the lap dogs were obviously pets. Dachshund-like dogs, greyhounds, and the breed with short, straight and strong legs, were probably used for different kinds of hunting. The other forms of dogs were likely mixed purpose watchdogs or sheepdogs. Some of these were undoubtedly used in hunting, too. Some Roman authors mention the export of hunting dogs from Pannonia (Mócsy, 1974, 246) probably from the first two groups of hunting dogs. Greyhounds were themselves probably imported from Gallia although this fact does not deny the possibility that they were also exported from the excellent breeding area surrounding Tác–Gorsium.

The age ratios of domestic hen show that the majority of these fowl (both hen and rooster) were killed as mature birds. This ratio suggests that this most important domestic bird of that time was not only kept for its meat. The primary purpose of hens was egg production, while a portion of the many roosters could be used for breeding and as fighting cocks. These suppositions are also supported by the written sources (Zeuner, 1963, 448). Sacrificial roosters were often mentioned also (Keller, 1913, 134ff).

Geese were kept chiefly for their meat at Tác–Gorsium. Goose down was probably only a secondary use.

The bone remains show that pigeons, too, were kept exclusively for meat.

BUTCHERING TECHNIQUES SUGGESTED BY CUT MARKS

The bone material recovered during the course of archaeological excavations at Tác–Gorsium provides interesting information on the ways animals were killed, reflecting butchering techniques.

The bones of cattle, sheep, goat, pig, and chicken are thus interesting to study from this point of view.

In general, cattle were slaughtered either by severing the second and third vertebrae or cutting the throat as opposed to perforating the forehead. There were of course special ways to slaughter during sacrificial rites and extremely brutal destruction of animals is described by some authors in detail. Perforating the forehead would of course have damaged many of the frontal bones which were found. These, however, are quite intact in most cases. In the first stage of processing the body, the horns were cut off separately or else together with the intercornual ridge. This latter method involved opening the braincase as well. Sometimes the horns of the slaughtered cattle were simply sawn off and the braincase opened from the basioccipital direction.

Horn was an important raw material. The nasofacial part was separated from the brain skull in general, by a transverse cut in front of the orbits. The ramus was usually cut together with the tongue, laryngal parts and perhaps even with the remotely connected heart and lungs. The more oral portions of the mandible were significantly poorer in meat and so show fewer signs of butchering.

There are marks which suggest that the skull was separated from the body thus producing cuts around the axis or even around the third cervical vertebra. Few butchering marks are found on the atlas. Other vertebrae are in general heavily damaged although not many were cut in a longitudinal direction. Ribs were separated from the vertebral column by cutting the capituli costae, following which what remained of the rib cage was further sectioned.

The dismembering of the front legs from the body was not too complicated because these extremities are connected to the trunk only by muscle and gristle, not by regular articulations. As butchering continued the scapulae were cut into two halves. The distal region of this bone was consumed in one piece with the meat still on it. Almost every humerus was broken up in order to reach the marrow. The proximal epiphyses of these long bones were generally smashed and not only during the process of fleshing. They were probably too large to be put in a normal sized pot. The radius was cut down at the joint of the elbow and at the carpal bones. It was rarely separated from the ulna. The olecranon, however, was cut in almost all cases. Metacarpals which are practically meatless were rarely broken and display relatively few marks of butchering.

The hind legs were much more difficult to dismember. The separation of the illiosacral joint was possible only in juvenile cattle. In all other cases the illium was simply broken. The femur was much easier to cut at its neck rather than to remove it from the pelvic acetabulum. This last is demonstrated by the very large number of capita femoris found separately, although these bones were also broken in order to reach the marrow. Bone specimens which have been butchered this way are rarely measurable. The tibia was cut down mostly at the knee joint and in general only its distal end remained relatively intact. Sometimes the proximal tarsal bones (calcaneus and astragalus) were damaged as well. The distal segments of these extremities were usually separated at the distally located tarsal bones.

Sheep and goat were probably slaughtered by cutting the throat. Horns were usually cut or else sawn off although sometimes they were left undamaged. All other body parts were dismembered with techniques parallel to those used on cattle, with the exception that the long bones of these small ruminants were not worth breaking for marrow.

Pigs were probably slaughtered by "sticking" them in the throat. This technique was much easier to use on this species than on the small ruminants. Following skinning, the visceral and neural parts of the skull were separated at the orbits. It is not impossible that the complete skulls were cooked as well. Many of the skulls coming from juvenile pigs fell into pieces at the sutures without any particular force being applied. The ramus was often broken. Some mandibles cut around the region behind the praemolars, indicate that the whole nasal part of the head was cut off in one piece.

Extremities were treated similarly to those of other species, with only two important differences. The thigh bones were usually cut below the entire proximal epiphysis rather than at the neck of the caput. Additionally in some cases, the femur and tibia were found together with the calcaneus and astragalus. Unfortunately these remains cannot be considered articulated since they come from young individuals and the unfused epiphyses were lost, making reconstruction of the extremities impossible. Such connected bones probably belong to those salted and smoked hams which were often mentioned by the authors of antiquity. The presence of calcaneus is very interesting in this context since hams were frequently hung by the Achilles tendon which is attached to the tuber calcanei.

Chicken were killed by cutting the neck, wringing the neck or actually tearing the head off. The low number of skulls recovered may be a result of this latter practice. The birds were generally not dismembered completely. Only the distal ends of the wings and the legs were occasionally cut. The body of the chicken was cooked or fried in one piece and then dismembered by hand at the table. This hypothesis seems to be supported in many cases by the extremely small number of butchering marks found on domestic hen bones from the site of Tác–Gorsium. This tendency is characteristic for chicken bones from Roman Imperial sites in general (Swegat, 1976, 101).

ABNORMALITIES AND PATHOLOGICAL CHANGES FOUND IN THE ANIMAL BONE SAMPLE

Studies of the pathology of prehistoric or early historic bone materials is important for the biological reconstruction of the stock. These informations not only reflect the most important of the animal diseases and their frequency in the population but also shed light on husbandry techniques and forage. It is not unusual that even the manner in which the individual animals were treated may leave marks on the bone.

In spite of this importance, the evaluation of pathological archaeological bone material has only developed intensively since World War II. Since that time, numerous veterinarians have joined in the analysis of such faunal materials. Recently papers have been published dealing exclusively with this topic (Lachowicz and Wyrost, 1962, 326ff; Harcourt, 1971, 267–272; von den Driesch, 1975, 413–425; Boessneck, 1955, 138–141; 165–168; 202–205; Boessneck and Dahme, 1959, 101–103; 118–119). The most recent summary of these questions was written by Wäsle (1976).

The rich faunal material of Tác–Gorsium provided a goodly number of bones with pathological changes or other abnormalities. The following list of these phenomena is based on the grouping of Wäsle (1976, 56ff).

Ontogenetic and Dental Abnormalities

(A) ONTOGENETIC ABNORMALITIES

This group is represented by only one case in the entire bone sample. Two cranially situated ribs from a sheep or goat fused in such way that only a 2 by 30 cm hole (where fusion was not total) remained between the rib shafts. No signs of inflammation was found on these bones.

(B) OLIGODONTIA

It is chiefly the mandible where abnormal absence of certain teeth may occur. It is difficult, however, in many cases, to decide whether these absences are ab ovo, or are healed alveoli from teeth lost *in vivo*. The lack of the more orally situated teeth in the praemolar row is particularly common. These teeth do not seem to have especially great functional significance. Oligodontia occurs most frequently in pig. Domestication has after all effected the greatest dietary changes in this species.

From this point of view the herbivores show smaller modification. They grazed on almost the same fibrous forage even after domestication. Absence of P_1 occurred nine times in pig, four times in cattle, and once in dog. No sheep, goat, horse, ass or cat were thus affected.

In two of the dogs, the lower P_2, P_4 and in other two M_3 teeth were missing. In another case the P_3 was missing from the mandible (Figure 46, 1). Most of these latter cases, however, do not seem to be real oligodontiae.

In one pig mandible both the P_1 and P_2 teeth were absent.

In cattle many of the afore-mentioned lack of P_1 teeth reflects oligodontia. At the same time there are also many mandibles and maxillae which had lost one or more teeth during the life of the animals and their alveoli healed over. The majority of them come from old animals whose teeth were worn down. After a certain age this process occurs naturally (Figure 46, 6), although it may appear in younger animals because of infection or other trauma (Figure 46, 2).

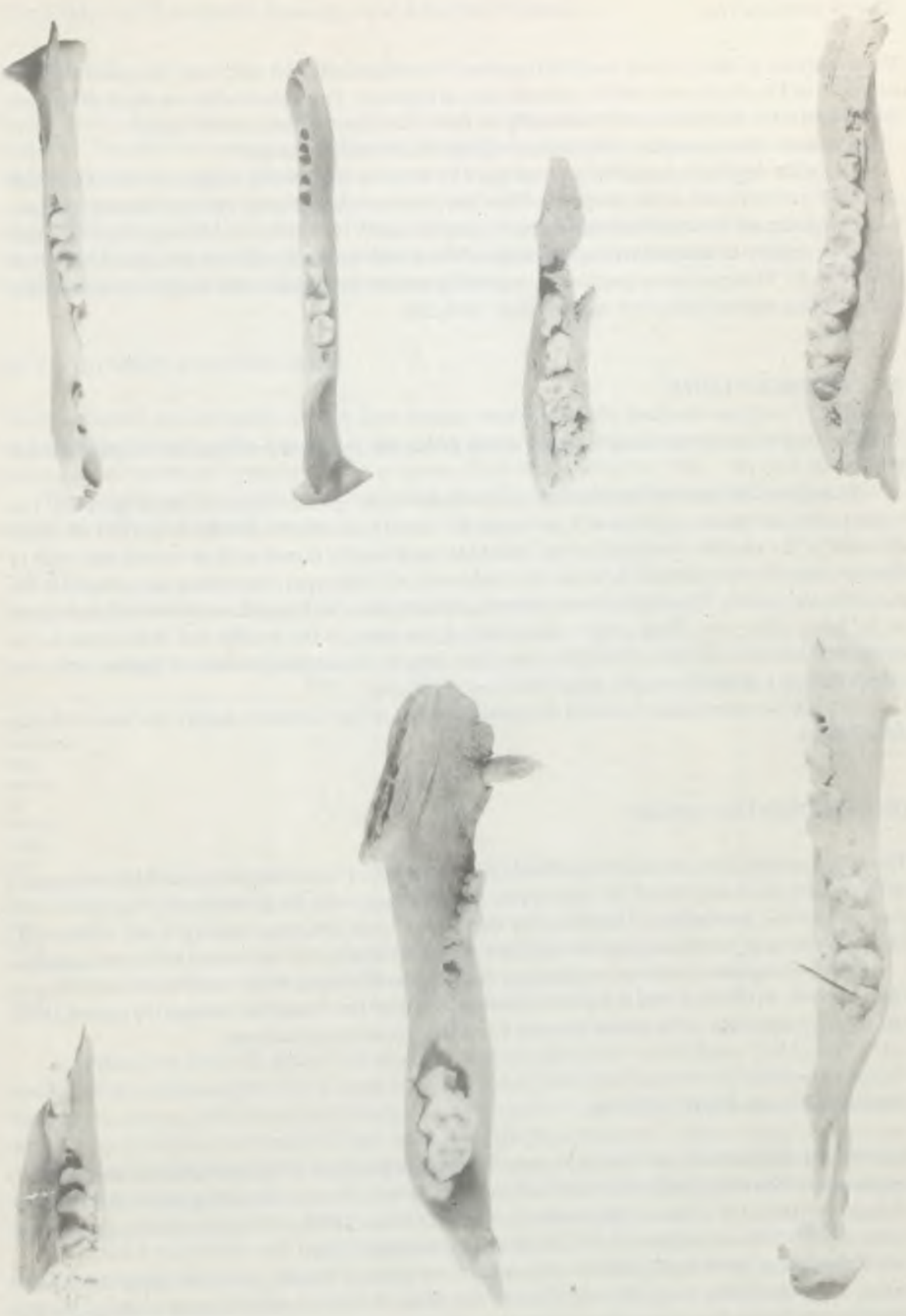


Figure 46. Dental abnormalities

(C) POLYODONTIA

The occurrence of extra teeth is much less common than oligodontia. Its rarity may be seen in both the sample from Tác–Gorsium as well as from the data in literature. This abnormality can result either from the separation of the tooth "bud" prenatally or from the spread of these tooth "buds".

There are three examples of polyodontia in the Tác–Gorsium sample.

One adult dog had a mandible with an extra P_1 while in another dog (Figure 38) an abnormally situated M_3 occurs in the upper molar row. The third case was found in a cow. Here an alveole is present between the second and third praemolars on the lingual side of the toothrow. Although the tooth itself was lost in course of the excavation, the shape of the alveole indicates that it was a permanent tooth (Figure 46, 8). This specimen is particularly interesting because in subfossil material polyodontia usually occurs in dog and pig and never cattle (Wäsle, 1976, 60).

(D) CROWDED TEETH

The crowding of teeth, especially frequent in the praemolar row, is a consequence of domestication (Figure 46, 3–5; 7).

Once again, this abnormality is most common in the dental systems of pig and dog (Figure 28). The whole praemolar region, a portion of it, or simply individual teeth may be affected. In the first two cases the teeth lie in a stepped overlapped series. Individual teeth may be turned on their vertical axis while in extreme cases they may actually lie across the tooth rows. All three types of crowding can be found in the mandible and maxilla. This phenomenon occurs in pig eight times in the upper tooth row and three times in the lower tooth row. Dogs exhibit this crowding five times in the maxilla and three times in the mandible. One cattle mandible has three praemolars lying in this stepped overlapped fashion while one other contains a single praemolar lying in a crossed position.

None of the other species found in the faunal material of Tác–Gorsium display this kind of dental deformation.

(E) INTERDENTAL SPACES

This modification in the teeth can be found only in the praemolar rows of dog and pig in the bone material of Tác–Gorsium. In dog, two of the cases appear simultaneously with the phenomenon of crowded teeth (first and second praemolars). Unfortunately the cause of such abnormal spacing is not understood. There may perhaps be some connection with the changes in the gene pool associated with domestication.

Interdental spaces occur twice in the upper tooth row and 14 times in the lower tooth row of dog in Tác–Gorsium. At the same time in pig such spaces occurred on two mandibles between the second, third and fourth praemolars. (The spaces between P_1 and P_2 are of course natural.)

(F) IRREGULAR TOOTH WEAR

Teeth may wear irregularly for several reasons. The relative positions of the mandible and and maxilla, the material of the teeth, the lack of tooth columns (mostly in the third molars of pig and cattle) and lack of proper acclusion all influence the course of tooth wear. None of these reasons, however, appear very commonly in the bone material of the Tác–Gorsium domestic fauna.

Nevertheless, the following cases were noted: the overgrown aboral part of an upper third cattle molar, a strangely worn lower P_1 from a horse, and finally the abnormal formation of cusps in a pig mandible causing the lingual part of the tooth row to be more worn (very likely the maxillary counterpart would show a similar tooth wear in the opposite position on the lower buccal sides of the teeth).

The Effects of Traumatic Damage and Infected Wounds

(A) SPRAIN

Sprain (luxatio) is extremely rare in subfossil bone samples simply because acute cases cannot be identified. The literature contains only three examples (Wäsle, 1976, 63). Chronic sprains are more easily recognized because of the permanent deformation of the joints involved *(arthritis chronica deformans)*.

Only one such specimen occurs in the bone material of Tác–Gorsium. Here, in the pelvis of a pig, the entire acetabulum is filled with exostoses which left no place for the head of femur. It is possible that this animal had a false joint at some other point in the pelvis. Unfortunately the fragment is far from complete making it impossible to prove the false joint hypothesis.

(B) FRACTURES AND FISSURES

These deformations are usually known from healed specimens in the subfossil samples. The healing process is marked by callus formation, deformed shape, askew fracture scars and exostoses. The occurrence of fistules call attention to the presence of infected fractures as well.

The majority of bone deformations and abnormalities in the faunal material of Tác–Gorsium is caused by such fractures and fissures.

TABLE 22

The distribution of bone fractures by species and bone type at Tác–Gorsium

Bone type	Species					
	cattle	sheep	sheep or goat	pig	dog	hen
skull	–	–	–	–	4	–
horn-core	2	–	–	–	–	–
atlas	–	–	–	–	1	–
vertebra	–	–	–	–	3	–
rib	2	–	–	–	5	–
humerus	–	–	–	–	–	2
radius	–	–	–	–	3	–
ulna	–	–	1	–	1	–
metacarpal	–	1	–	–	–	–
femur	–	–	–	–	1	–
tibia	–	–	1	–	3	1
fibula	–	–	–	2	1	–
metapodial	–	–	–	7	–	–
Total	4	1	2	9	22	3

As is shown by Table 22, almost half of all traumatic breaks occur on dog bone. There may be two reasons for this concentration on dog. Since dogs lived closer to humans than the other domestic animals they were beaten and kicked much more frequently. On the other hand, as non-meat purpose animals and occasional pets they also had a much better chance to survive these fractures. Comparing fractures on dog and pig bone it is clear that for the first species those bones more accessible to kicks (skull, trunk bones and extremity bones above the metapodials) were damaged. Pigs on the other hand, suffered fractures mostly on the distal end of their legs as would occur in simple accidents.

There are a number of really interesting fractures identified in the Tác–Gorsium sample. Figure 2, 2 and 3 show cattle horn-cores. One of them shows signs of a possible infection which later healed. The other right horn-core is broken at the base but shows no signs of subsequent complications.

There are also three interesting fractures identified in the Tác–Gorsium sample, which occur on dog tibiae (Figure 47, 1–3). The fractures resulted in deformation. In two of these cases the two parts of the

broken bone healed in such an askew manner that the two fracture planes slipped beside each other and healed in this position. (Figure 47, 4). Many of the broken dog ribs developed false joints during the healing process (Figure 48).

Finally, in regard to such crudely healed fractures it is worth mentioning a cattle tibia which healed crookedly. In this case three big fistulae also show that the open fracture was badly infected. The animal survived the inflammation, however, as is shown by the almost totally flattened and worn callus.

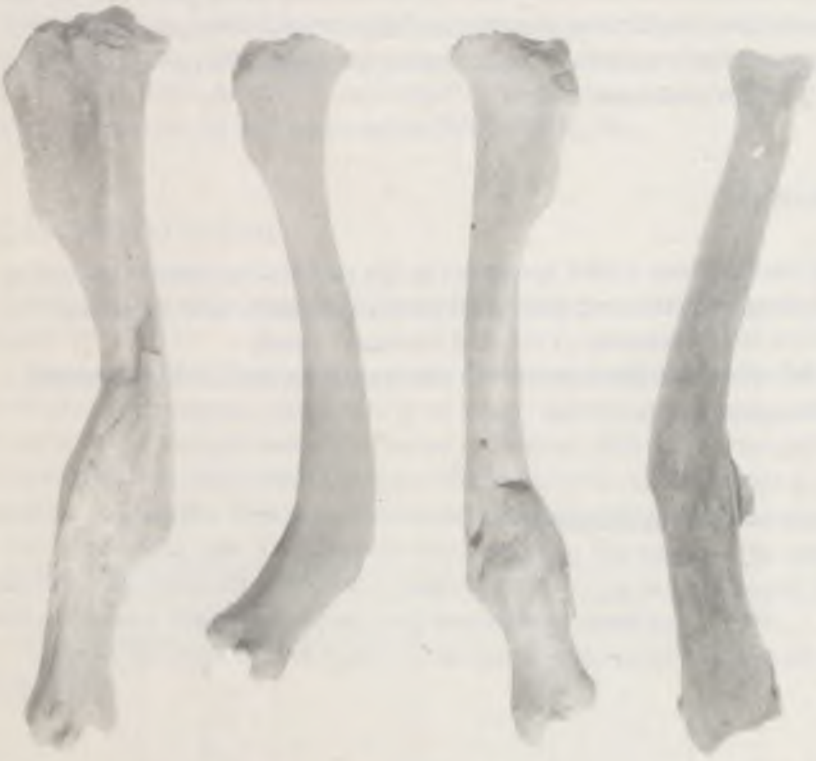


Figure 47. Dog bones with badly healed fractures

Figure 48. Badly healed fractures on dog ribs

(C) PERIOSTITIS

The chronic form of this disease *(Periostitis ossificans)* creates bone growths known as exostoses. These growths can come from both traumas and infections.

This abnormality is less frequent in the Tác–Gorsium bone material than are fractures. It occurs five times on cattle (a metacarpal, a calcaneus, a metatarsal and each a first and second phalanx), four times on dog bones (two femora, a tibia and a calcaneus), three times on horse bones (two metacarpals and a metatarsal) and once on a sheep metacarpal.

It is noteworthy that with the exception of dog where the periostitis occurred on femora and tibia, the affected bones tend to come from the metapodial region or else from even more distal extremity segments.

(D) ARTHRITIS

It is only in chronic cases of this disease *(Arthritis chronica)* that subfossil bones show traces of deformation on joint surfaces and the epiphyses in general.

The frequency of arthritis among the different species living at Tác–Gorsium is as follows: ten cases in cattle (two radii, two pelvises, a metatarsal, two first phalanges, and three phalanges which fused together), two cases in sheep and goat (respectively a metatarsal and a scapula), two cases in pig (two scapulae), one case in horse (a metacarpal), and four cases in dog (four metapodials).

A scapula from a goat provides a special example of chronic arthritis *(Arthritis chronica deformans)* in which the surface of the joint is surrounded by considerable mass of exostoses. The same kind of deformation can be seen on a second phalange from a cow (Figure 49) in which the proximal end is

Figure 49. 2nd phalanx of cattle with exostoses of arthritis chronica deformans

covered with massive exostoses. Also coming from an arthritic cow are three phalanges which are firmly fused by similar exostoses, as a consequence of an inflammation. The other bones display less extreme symptoms such as spongy joint surfaces and less marked exostoses.

(E) PERIODONTITIS

Inflammation of the gums, which leaves its marks on the alveolar row as well usually results from a suppuration caused by bacteria introduced with the forage or with foreign bodies into the mouth. The infection then penetrates the gums through minor wounds.

This disease is rather infrequent, however, in the bone material of the site. It occurs two times in cattle, three times in sheep or goat and once in dog. In all cases the periodontitis was found on the mandibles.

The disease seems to be particularly serious for the ruminants (sheep, goat and cattle). In two of the cases the mandible became spongy and increased three times in size. In another case, further fistulae appeared on the jawbone. The periodontitis is localized on the dog mandible and effects only the buccal side in the region of M_1.

Chronic Deformations

(A) DEFORMATIONS OF THE SPINAL COLUMN

In the past many of these deformations were considered diseases of old age. Recently, however, remains of quite a few younger adult animals with vertebral deformations have also been recovered. These defects occur primarily for two reasons. One reason is that the ossification of the ventral ligament *(ligamentum longitudinale ventrale)* results in the fusion of vertebrae *(spondylosis chronica deformans)* as well as in the inflammation and ossification of the small vertebral joints *(spondylosis ancylopoetica)*. These problems occur chiefly in dog and horse in the subfossil material.

Only these two species show signs of this disease in the faunal material of Tác–Gorsium. Two horses had fused vertebrae. In one case three lumbar vertebrae are attached at the point of the small joints. In the other case all the joint surfaces of two thoracic vertebrae on the caudal side were fused by ossification. It is possible that these phenomena are the initial symptoms of an illness known as Behterew disease. Advanced cases of this abnormality were found in horses from the Hallstatt (Bökönyi, 1968, 51) and the Avar Period (Bökönyi, 1974, 290–291). In addition, there is a good reason to suppose that other Roman horses mentioned in two past publications (Boessneck and Meyer-Lempenau, 1966, 132ff; von den Driesch, 1969, 188) also belong to this category.

Dogs in Tác–Gorsium showed different symptoms in that, rather than having fusion occur at the small joints, exostoses occur on the spinal processes, sometimes bending them in a lateral direction. Ossification of the vertebrae, however, is caused by exostoses on the ventral sides which connect the vertebral bodies (Figure 50).

Figure 50. Dog lumbar vertebrae with exostoses

(B) ABNORMALITIES ON THE LIMB BONES

This group of abnormalities consisting of pathologic changes in the joints and on the muscular surfaces of the bones, is caused by overburdening and long use. Although the irritation may be of very different intensity and strength, these abnormalities generally never reach the stage of arthritis or periostitis.

The deformation of the distal joint surfaces of cattle metapodials (seen chiefly on metacarpals although occasionally metatarsals also exhibit the same symptoms) is a good example of the first form of this problem. As a consequence of heavy body weight, the distal ends of these long bones are almost completely deformed. This latter explains why the deformation is more common on the heavily burdened forelegs which bear so much more of the animals' weight than the rear extremities. As mentioned previously, the distal breadth of the metacarpals may increase so greatly as to cause the final distal breadth to fall into the aurochs size range. Fortunately, none of the other cattle bones resemble the wild ancestor in this way.

Deformation of muscular and tendon surfaces are quite common in horse although they sometimes occur also on cattle bones. They are usually expressed as exostoses on the carpal or tarsal bones and phalanges. On horse the disease sometimes results in slot shaped growths. Other domestic and wild species of the Tác–Gorsium bone material do not exhibit such abnormalities.

Metabolic diseases

RICKETS

This bone abnormality caused by avitaminosis, is the only metabolic disease worth mentioning in connection with the bone material of Tác–Gorsium and even this sickness is rather difficult to identify using bone remains alone. The twisted limb bones of dogs found at Tác–Gorsium are much more likely mutations than the results of rickets. Two pig metapodials on the other hand, swollen two to three times larger than normal size and spongy, more certainly represent rickets in the assembly of diseased bones.

SUMMARY AND CLOSING WORDS

The excavations at the Roman Imperial town of Tác–Gorsium in Pannonia produced a large size animal bone sample. The faunal remains number 50,000 identified bone specimens and may be considered one of Europe's largest such assemblages from the Roman Empire. It is not only the sheer size of the sample which is helpful in producing an accurate picture of ancient animal husbandry.

(1) There are large numbers of specimens which are significant in and of themselves in terms of individual, species or breed morphology (skulls, skull fragments, horn-cores etc.). Such material can also provide important information on the history of the domestic animals on the site.

(2) The enormous bone sample is very rich with 41 species. Eleven are domestic animals (8 mammals and 3 birds). The other 30 wild species (10 mammals, 16 birds, 1 reptile and 3 fish). Even the bones of the little bustard (*Otis tetrax* L.) are present for the first time in subfossil remains.

(3) As the fauna list clearly demonstrates, the importance of domestic species in meat production was far greater than that of the wild ones. On the basis of specimen count, 97.65 per cent of the bones come from domestic animals while only 2.35 per cent come from wild species. The calculation of the approximate number of individuals per species verify this tendency since in this case 92.85 per cent of the individuals were domestic and only 7.15 per cent of the animals were wild.

(4) Compared to the preceding Iron Age, the number of domestic animal species was almost doubled in this Roman Imperial site, expressing the more colourful nature of animal husbandry. Aside from the numerous new species (ass, cat, goose, and pigeon) it is chiefly the frequent occurrence of domestic hen which suggests a more advanced structure of the animal husbandry. Hen played an important role in the formation of modern livestock farming and is a species with a particularly effective utilization of forage.

The most frequently occurring animal in Tác–Gorsium is the cattle, far exceeding the number of individuals from any other species. There appear to be at least twice as many cattle in the sample as any other species. The next most common animals are the small ruminants which slightly exceed the pig in frequency. The number of animals from the other species is significantly smaller although compared to other Roman Imperial sites, the ratios of horse, dog and domestic bird are relatively high.

(5) The decreased significance of hunting is not surprising at Tác–Gorsium considering the decidedly urban character of the settlement. In addition to the four meat purpose ungulates which were hunted (aurochs, red deer, roe deer and wild swine), hare was hunted for sport (which is connected with the presence of greyhounds at the site) as were the majority of wild birds living in the area. The general appearance created by the Tác–Gorsium material is that hunting was on the whole much more a sport than a branch of meat production.

(6) During the period studied in the settlement's life (between the 1st and 4th centuries), the relative significance of hunting seems to have slightly increased. There was, however, no change in the ratios or frequencies of the species.

The bone material shows that the importance of cattle grew steadily during this time so that by the end of the 4th century almost half of the livestock was cattle (an estimation based on specimen count). At the same time the number of small ruminants sharply decreased. After a small decrease, pig also gained in importance relative to sheep and goat, by the 4th century. A similar pattern can be observed for domestic birds. The numbers of horse steadily grew during the four studied centuries as opposed to dog which steadily decreased in number.

The probable explanation of the above-mentioned changes in the fauna of Tác–Gorsium is the growth and formation of an optimal livestock structure by the end of the 4th century. This formation

probably involved the best of the local breeds and some improved breeds imported from Italy in an attempt to maximize meat production.

(7) Almost two-thirds of the cattle population belong to the advanced Italian breed while only about 20 per cent may be considered aboriginal. The origin of the remaining animals cannot be pinpointed with great certainty. The withers height of cattle falls between 104.6 and 143.3 cm (mean 126.32 cm). More than 70 per cent of the cattle population were cows, about 11 per cent were bulls and 17 to 18 per cent were oxen.

Three types of sheep were distinguishable within the bone material of Tác–Gorsium. These included a small local form, a large Italian breed and perhaps a sheep of eastern origin. The presence of more than one breed is also indicated by a considerable size variation in the estimated withers heights. Based on metacarpal measurements their heights fall between 54.4 and 83.9 cm (mean 69.31 cm). These sizes not only exceed the average height of Roman sheep in Pannonia but are greater than almost any of the Central or West European sheep found in similar sites of the period. The ratio of sexes was almost 1 to 1 based on horn-cores. The majority of rams and ewes were slaughtered young, however, so that the sexual ratio of fully grown animals was about two rams to three ewes in the bone material.

The goats found at Tác–Gorsium are among the largest known from sites in the Roman Empire. Their average withers height was 71.79 cm based on the metacarpals' measurements, while measurements from the metatarsals suggest an average height of 70.22 cm. The small variation in the size of goat found during the course of excavations at this Roman Imperial settlement points to a rather homogeneous population. Bucks usually have massive horns and the females possess horns as well. Hornlessness occurs only in one case. The sexual ratio of the species at the settlement is one male to two females based on the metapodials. Horn–cores suggest, however, that males comprised only one third of the goat population at the site.

The pig remains in the bone material do not reveal any serious attempt to improve the local animals by interbreeding with more advanced Italian forms as occurred with cattle and sheep. Withers heights increased only two to three centimeters over those from the preceding Iron Age. The estimated withers height was between 66.8 and 83.2 cm (mean 73.36 cm). In spite of this relatively small change in size the pig bones found at Tác–Gorsium suggest that these animals were still slightly larger than the average pig found in other Central or West European Roman Imperial sites. The vast majority of these animals, however, remained primitive slow-growing pigs. The sex ratio for this species was estimated as eight boars to 26 sows.

The horse bones from Tác–Gorsium show that medium to large size individuals dominated the stock. Other bones falling into separate groups in the sample suggest that there were four or even five really large and six massive legged but small individuals. Although the average withers height calculated was 139.86 cm this value includes individuals with heights as great as about 160 cm as well as heights as low as between 125 to 130 cm. These latter were most probably aboriginal Celtic horses.

The majority of asses were small size animals, although the bones of a large individual were found as well. It may be assumed that mules also occurred at this site, as is shown by some remains from intermediate individuals.

Cat bones in the faunal material of Tác–Gorsium show wide variation in size although small individuals are most characteristic of the sample.

Of all the domestic animals kept at Tác–Gorsium it is the dog which exhibits the greatest richness of form. At least five separate groups within this species can be clearly distinguished (miniature dogs with slender straight legs, dachshund type dogs of a slightly larger size than the modern form, a group of bigger dogs with short, massive, straight legs, a group of individuals varying between fox terrier and German shepherd in size and greyhounds). The dog sample contains four cranial types. Two of these can be associated easily with two of the above-mentioned constitutional groups.

The hen sample could be separated into a local small size group and a group comprised of individuals from the improved large size Roman breed imported from Italy. The live body weight of the first was probably between 1 and 1.5 kg while the weight of the second group certainly exceeded 2 kg.

The chicken population probably included capons. Sex determination based on the study of tarsometatarsal bones indicates that the ratio of hen to rooster was two to one.

The goose bones from the faunal sample show a huge variation in size within the species.

The bone remains of domestic pigeon suggest that these birds were similar to the wild form of the species.

(8) The animal keeping and breeding practices of Roman Imperial Tác–Gorsium are characterized by the mixture of local aboriginal breeds from Pannonia with advanced breeds imported from Italy. For many of the species the local and imported breeds are not adequately separable. Not surprisingly intermediate forms, the products of cross-breeding, tend to blur the differences between the two groups.

The development of animal keeping at Tác–Gorsium is much easier to understand in light of the following model:

> Evidently the Roman Empire wished to utilize both the northern portion of the Balkan Peninsula and Pannonia as an animal breeding territory. But while in the southern Balkans highly productive breeds lived at the time of the Roman conquest and even before it, and could be used to improve the local breeds at the beginning of conscious animal breeding even in Italy itself, the primitive breeds of low productivity from the northern Balkans and Pannonia could not have brought the expected profit. It is possible that the idea of exchanging these primitive types for improved Italian breeds arose, but there lay many obstacles along this particular path to improvement of breed. First, the number of high quality breeding stock in Italy was never great enough to supply all the needs of the provinces. Second, the speedy export of large masses of stud animals was impossible for technical and logistical reasons. Finally, the sudden change from traditional low productivity populations would have upset the local inhabitants and made them resistant to any change.

Given the above problems what strategy could the Romans follow? They undoubtedly exported many stud animals to Pannonia, significantly more for example, than to Germania which was also much further from the centre of the Empire. The owners of the villa-farms and Roman settlers either bred only purebred Italian animals or else (and this was more probable) used the purebred forms in cross-breeding with local domestic types. On the other hand, the aboriginal inhabitants of the province were probably impressed by the relatively enormous productivity of the Italian breeds. They, therefore, tried to procure them or at least take every opportunity to use them for cross-breeding with their own stock. It is not likely that this process took very much time. Advanced Italian forms of domestic animals occurred by the 2nd century in Sarmatian settlements lying far beyond the *limes* border region. Similar phenomena occurred in other border areas of the Roman Empire. Such distribution was most characteristic of draught oxen which obviously could not influence the local cattle stock in terms of reproduction. This change clearly indicates, however, that if Barbarian peoples beyond the *limes* knew the great advantages of the new breeds, then the local inhabitants of the provinces themselves were certainly even more conscious of the possibilities provided by these advanced forms.

Naturally the simple import of an advanced breed or the subsequent cross-breeding of these forms with local primitive breeds was not sufficient. The advanced domestic breeds have much more extensive demands than the less improved populations do. They need more care and attention and better forage. The fact that the Romans did not ignore these factors is illustrated by the dramatic improvement of animal keeping in Pannonia after the Roman conquest. The body size of most species increased in general about 20 per cent over the domestic animals of the preceding La Tène Period. The growth characteristics of domestic species also improved according to the needs of the breeders. These tendencies are clearly manifested in three species: cattle, sheep and hen. Cattle was not only an important draught animal in agriculture, but also provided the majority of the meat. Sheep produced one of the most important new materials for fine textile manufacture (use of such fine wool was quite new at that time). Domestic hen represented a species of a modern type of animal husbandry. Pig and horse breeding on the other hand were chiefly based on local breeds.

It is possible of course that these developments were not the results of centralized organizing work. The general picture of the animal husbandry system is very similar, however, to those found in the Median and Parthian Empires which does suggest some kind of central but not necessarily state

organization. In these two latter empires, well organized conscious breeding was concerned first and foremost with horse because for climatic, geographic, and strategic reasons other species were of much less significance.

(9) The individuals from wild mammalian species are usually smaller than their Neolithic ancestors. Only in the roe deer sample do larger sized individuals appear.

(10) Pig was the only animal from the domestic species in Tác–Gorsium which was used purely for meat. Cattle, sheep, goat, chicken, and goose were also eaten as opposed to horse, ass, dog, and cat which were only occasionally consumed. About 75 per cent of the meat consumed by the inhabitants of the settlement came from cattle. Ten per cent of the meat came from pig, while the meat of sheep and goat made up only 6.5 per cent of the total.

Fowl provided only 0.34 per cent of the meat eaten on the site. These data show that about 93 per cent of the meat consumed at Tác–Gorsium came from domestic animals. The remaining 7 per cent came chiefly from large or medium size game (aurochs, red deer, roe deer, and wild pig) while only 0.09 per cent of the meat came from other species.

The age distribution of pig within the bone sample shows that many more pigs were kept than eaten in Tác–Gorsium. It is very likely that about three quarters of the pork produced at the settlement was sold, that is exported. In this sense the town seems to have been an important meat production and supply centre both for the army and possibly for the province as a whole.

Although beef and dairy goods were important products from cattle, draught power was undoubtedly its chief use.

Milk was not the most important product of sheep but its use, as well as goat milk, was widespread.

Horse also was heavily used as an agricultural draught animal and in addition was used for transportation and in the army. It may be assumed that Tác–Gorsium exported some of its horses.

Ass and mule were evidently not important as beasts of burden. Cat and lap dogs may be considered pets or luxury animals. Dachshunds, greyhounds, and the straight but massive legged dogs were used in hunting, while the other remaining dogs probably served a variety of purposes.

Hens not only produced meat but were also important egg layers.

(11) Evidence from the faunal material indicates that slaughtering techniques varied between the different species. However, the methods of butchering were still quite similar. These differences between species were caused by variation in body size or sometimes by special modes of exploitation.

(12) The bone sample exhibited many ontogenetical abnormalities and pathologic deformations. From these various symptoms it is often possible to gain important information concerning keeping, breeding, feeding technologies and the exploitation and treatment of animals during the period of the Roman Empire.

REFERENCES

AMSCHLER, J. W., 1949, Ur- und frühgeschichtliche Haustierfunde aus Österreich. *Arch. Austr.* **3,** Wien, 1–100

BACHMANN, M., 1962, Schädelreste des Rindes aus dem keltischen Oppidum von Manching. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **14,** München, 1–62

BLANC, G. A. and BLANC, A. C., 1958–59, Il Bove della Stipe votiva del Niger Lapis del Foro Romano. *Bull. di Paletn. Ital. N. S.* **XII, 67–68,** 7–57

BOESSNECK, J., 1953, Tierknochen (von Cambodunum). *Materialh. z. Bayer. Vorgesch.* **9,** 103–116

— 1955, Angeborene Oligodontie bei vor- und frühgeschichtlichen Haustieren, sowie ein Beitrag zur Frage der Oligodontie bei Haustieren und ihren Wildverwandten. *Tierärztl. Umschau* **10,** 138–141, 165–168, 202–205

— 1957a, Funde des Ures, *Bos primigenius* Bojanus, 1827, aus alluvialen Schichten Bayerns. *Säugetierkundl. Mitt.* **5,** 55–69

— 1957b, Die Tierknochen. In: KRÄMER, W., Cambodunumforschungen, 1953–I, *Materialhefte d. Bayer. Vorgesch.*, **9,** 103–116

— 1958a, Herkunft und Frühgeschichte unserer mitteleuropäischen landwirtschaftlichen Nutztiere. *Züchtgskde.* **30,** 289–296

— 1958b, Zur Entwicklung vor- und frühgeschichtlicher Haus- und Wildtiere Bayerns im Rahmen der gleichzeitigen Tierwelt Mitteleuropas. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **II,** München, 1–170

— 1959, Die Tierknochen. In: ULBERT, G., Römische Holzfässer aus Regensburg. *Bayer. Vorgeschichtsbl.* **24,** 13–15

— 1960, Gänsehaltung im alten Ägypten. *Wiener Tierärztl. Monatsschr.* **1960,** 192–206

— 1961, Zu den Tierknochenfunden aus dem Oppidum von Manching. *Germania* **30,** 368–383

— 1962, Die neuen Tierknochenfunde aus dem keltischen Oppidum bei Manching im Vergleich mit den früheren. *Zeitschr. f. Tierzüchtg. u. Züchtgsbiol.* **77,** 47–61

— 1964, Die Tierknochenfunde aus den Grabungen 1954–57 auf dem Lorenzberg bei Epfach. In: WERNER, J., *Studien zu Abodiacum-Epfach.* München, 213–261

BOESSNECK, J. and DAHME, E., 1959, Palaeopathologische Untersuchungen an vor- und frühgeschichtlichen Haustierfunden aus Bayern. *Tierärztl. Umschau* **14,** 101–103, 118–119

BOESNECK, J. and MEYER-LEMPENAU, U., 1966, Pathologisch-anatomische Veränderungen am Rumpfskelett und an den Hufbeinen eines Pferdes aus der römischen Kaiserzeit. *Tierarztl. Umsch.*, **21,** 3, 132–136

BOESSNECK, J., JÉQUIER, J. P. and STAMPFLI, H. R., 1963, Seeberg, Burgäschisee-Süd; Die Tierreste. *Acta Bern.* **II,** 3, Bern, 1–215

BOESSNECK, J., MÜLLER, H.-H. and TEICHERT, M., 1964, Osteologische Unterscheidungsmerkmale zwischen Schaf (*Ovis aries* L.) und Ziege (*Capra hircus* L.). *Kühn-Archiv* **78,** 1–129

BOESSNECK, J., DRIESCH, A. VON DEN, MEYER-LEMPENAU, U. and WECHSLER-VON OHLEN, E., 1971, Die Tierknochenfunde aus dem Oppidum von Manching. *Die Ausgrabungen von Manching.* **6,** Wiesbaden, 1–332

BÖKÖNYI, S., 1955a, Examen des os d'animaux découverts au cimetière avar de Kiskörös-Városalatt. In: LÁSZLÓ, GY., *Etudes archéologiques sur l'histoire de la société des avars.* Arch. Hung. **XXXIV,** Budapest, 211–216

— 1955b, Untersuchung der in der römischen Villa von Tác-Fövenypuszta gefundenen Tierknochen. *Acta Arch. Hung.* **6,** 153–161

— 1959, Die frühalluviale Wirbeltierfauna Ungarns. (Vom Neolithikum bis zur La Tène-Zeit.) *Acta Arch. Hung.* **11,** 39–102

— 1961, Die Haustiere in Ungarn im Mittelalter auf Grund ihrer Knochenfunde. In: *Viehzucht und Hirtenleben in Ostmitteleuropa,* Budapest, 83–111

— 1962, Zur Naturgeschichte des Ures in Ungarn und das Problem der Domestikation des Hausrindes. *Acta Arch. Hung.* **14,** 175–214

— 1963a, A budai várpalota ásatásának állatcsontanyaga, II (Die Tierknochenfunde der Ausgrabungen im Burgpalast von Buda, II) *Bud. Rég.* **20,** 395–425

— 1963b, Die Wirbeltierfauna der Ausgrabungen in Zalavár. In: SÓS, Á. and BÖKÖNYI, S., *Zalavár.* Arch. Hung. **XLVI,** Budapest, 313–371

— 1964, Angaben zur Kenntnis der eisenzeitlichen Pferde in Mittel- und Osteuropa. *Acta Arch. Hung.* **16,** 227–239

— 1968, Data on Iron Age Horses of Central and Eastern Europe. *Bull. of the Amer. School of Prehist. Res.* **25,** Cambridge (Mass.), 1–71

— 1969, Archaeological problems and methods of recognizing animal domestication. In: UCKO, P. J. and DIMBLEBY, G. W. (eds.), *The domestication and exploitation of plants and animals.* London, 219–229

— 1970, A new method for determination of the number of individuals in animal bone material. *Amer. Journ. of Archaeol.* **74,** 291–292

— 1972, Aurochs (*Bos primigenius* Boj.) remains from the Örjeg peat-bogs between the Danube and Tisza rivers. *Cumania* (Kecskemét) **I,** 17–56

— 1974, *History of domestic mammals in Central and Eastern Europe.* Budapest, 1–597

— 1976a, Animal remains from Sarmatian sites from Bács-Kiskun County. *Cumania* (Kecskemét) **IV,** 41–72

— 1976b, Development of early stock rearing in the Near East. *Nature* **264,** 5581, 19–23

— 1976c, The vertebrate fauna from Anza. In: GIMBUTAS, M. (ed.) *Neolithic Macedonia.* Monum. Arch. **I,** Los Angeles, 313–363

— 1977, *The animal remains from four sites in the Kermanshah Valley, Iran: Asiab, Sarab, Dehsavar and Siahbid; the faunal evolution, environmental changes and development of animal husbandry, VIII–III millennia B.C.* Brit. Arch. Reports, Suppl. Ser. **34,** Oxford, 1–118

— 1978, The introduction of domestic sheep to Europe. *Ethnozootechn.* (Paris), **21,** 65–70
— in print, The animal remains of Sitagroi-Photolivos.
BÖKÖNYI, S. and JÁNOSSY, D., 1965, Szubfosszilis vadmadárleletek Magyarországon (Subfossile Wildvogelfunde aus Ungarn) *Vertebr. Hung.* **VII,** 1–2, 85–99
BÖKÖNYI, S. and KUBASIEWICZ, M., 1961, *Neolithische Tiere Polens und Ungarns in Ausgrabungen, I. Das Hausrind.* Wydz. Nauk. Przyrod.-Roln. **VIII–1,** Budapest–Szczecin, 1–93
BÖKÖNYI, S., KÁLLAI, L., MATOLCSI, J., and TARJÁN, R., 1964, Összehasonlító vizsgálatok az őstulok és a szarvasmarha eluiso lábközépcsontján — Vergleichende Untersuchungen der vorderen Mittelfussknochen des Ures und des Hausrindes. *Magy. Mezőgazd. Múz. Közl.* 3–24
— 1965, Vergleichende Untersuchungen am Metacarpus des Ures und des Hausrindes. *Zeitschr. f. Tierzüchtg. u. Züchtgsbiol.* **81,** 330–347
BRAUNER, A., 1916, Materiali k poznaniju domashnikh zhivotnykh Rossii. 1. Loshad kurgannikh pogrebenij Tiraspolskogo uezda, Hersonskoj gubernii, Equus goschkewitschi, mihi. *Zapisk. Imper. Obshch. Selsk. Hozj. Juzhn. Ross.* **86,** 1, Odessa, 1–252
BRENTJES, B., 1965, *Die Haustierwerdung im Orient.* Die Neue Brehm-Bücherei **344,** Wittenberg, 1–112
CASTEEL, R. W., 1978, Faunal assemblages and the "Wiegemethode" or weight method. *Journ. of Field Archaeol.* **V,** 71–77
CLASON, A. T., 1961, Some remarks on the faunal remains from the Roman castellum at Valkenburg, province of South-Holland. *Palaeohist.* **8,** 139–147
— 1967, Animal and man in Holland's past. *Palaeohist.* **XIII, A–B,** 1–247, 1–190
CORNEVIN, CH. and LESBRE, F., 1891, Caractères ostéologiques différentiels de la chèvre et du mouton. *Bull. de la Soc. d'Anthrop. de Lyon* **10,** 47–72
DANNHEIMER, F., 1964, Die Rinderknochen der römischen Zivilsiedlung in Hüfingen (Ldkrs. Donaueschingen). *Baden. Fundber.* **6,** Freiburg, 1–38
DAVID, A., 1897, *Beiträge zur Kenntnis der Abstammung des Hausrindes gegründet auf die Untersuchungen der Knochenfragmente aus den Pfahlbauten des Bielersees.* Diss. (Zürich), Bern, 1–97
DEGERBØL, M., 1942, Et knoglemateriale fra Dyrholmen-Bopladsen, en aeldre stenalder-kökkenmödding. *Det Kong. Dansk. Vidensk. selskab. arkaeol.-kunsthist. skr.* **I,** 1, Köbenhavn, 79–135
DOTTRENS, E., 1947, Le grand Bos des quatre couches néolithiques d'Auvernier et de St.-Aubin. *Ber. d. Schweiz. Palaeont. Ges.* **26**–*Ecl. geol. Helv.* **40,** 360–366
DRÄGER, N., 1964, Tierknochenfunde aus der Stadt auf dem Magdalensberg bei Klagenfurt in Kärnten, I. Die Vogelknochen. *Kärntn. Museumsschr.* **XXXIII,** Klagenfurt, 1–54
DRIESCH, A. VON DEN, 1969, Ein Pferdeskelett der römischen Kaiserzeit aus Gielde, Kreis Goslar. *Neue Ausgrab. u. Forschg. in Niedersachs.* **5,** Hildesheim, 187–192
— 1975, Die Bewertung pathologisch-anatomischer Veränderungen an vor- und frühgeschichtlichen Tierknochen. In: CLASON, A. T. (ed.), *Archaeozoological studies.* Amsterdam–Oxford–New York, 413–425
DÜRR, G., 1961, Neue Funde des Rindes aus dem keltischen Oppidum von Manching. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **XII,** München, 1–48
EPSTEIN, H., 1971, *The origin of the domestic animals of Africa, I–II.* Leipzig, 1–573, 1–713
EWART, J. C., 1911, On skulls of oxen of the Roman military station of Newstead. *Proc. of the Zool. Soc. of London* **1911,** 219–225
FÖRSTER, U., 1960, Die Pferdephalangen aus dem keltischen Oppidum von Manching. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **8,** München, 1–36
FRANK, K. G., 1962, Neue Funde des Pferdes aus dem keltischen Oppidum von Manching. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **13,** München, 1–44
FRUTH, M., 1966, Die Tierknochenfunde aus der Stadt auf dem Magdalensberg bei Klagenfurt in Kärnten, IV. Die Wiederkäuer ohne die Bovini. *Kärntn. Museumsschr.* **XLI,** Klagenfurt, 1–127
GANDERT, O.-F., 1953, Zur Abstammungs- und Kulturgeschichte des Hausgeflügels, insbesondere des Haushuhnes. *Wiss. Abh. d. Deutsch. Akad. d. Landwirtsch. zu Berlin* **6, I,** 69–81
— 1973, Das frühe Auftreten der Haustaube nördlich der Alpen. In: MATOLCSI, J. (ed.), *Domestikationsforschung und Geschichte der Haustiere.* Internationales Symposion in Budapest 1971, Budapest, 119–123
GAUTHIER, A., 1970, Les restes du vicus romain de St-Mard (Province de Luxembourg, Belgique). *Pays gaumais* **31,** 183–194
GHEORGHIU, G. and HAIMOVICI, S., 1965, Caracteristicile mamiferelor domestice descoperite in aşezarea feudala timpurie de la Garvan (Dinogetia) (Les caractéristiques des mammifères domestiques découvertes dans la station du féodalisme incipient de Garvan [Dinogeţia]). *Anal. Ştiint. al. Univ. "Al. I. Cuza" d. Iaşi,* Sect. II, *Ştiint. Nat. a. Biol.* **XI,** 1, 175–189.
GROMOVA, V. I., 1953, *Osteologicheskie otlichija rodov Capra (kozly) i Ovis (barany). (Osteological differences of the genera Capra [goats] and Ovis [sheep])* Trudy komm. po izuch. shtsetv. perioda **X,** 1, Moscow, 1–109
HAAK, D., 1965, *Metrische Untersuchungen an Röhrenknochen bei Deutschen Merinolandschafen und Heidschnucken.* Diss. München, 1–90
HABERMEHL, K. H., 1957, Die Tierknochenfunde im römischen Lagerdorf Butzbach. *Saalburgjahrb.* **XVI,** 67–108
— 1961, *Die Altersbestimmung bei Haustieren, Pelztieren und beim jagdbaren Wild.* Giessen–Berlin, 1–223
HARCOURT, R. A., 1971, The palaeopathology of animal skeletal remains. *The Veterinary Record* **89,** 267–272
— 1974, The dog in prehistoric and early historic Britain. *Journ. of Archaeol. Sci.* **1,** 151–175
HATTING, T., 1975, The influence of castration on sheep horns. In: CLASON, A. T. (ed.), *Archaeozoological studies.* Amsterdam–Oxford–New York, 345–351
HEMMER, H., 1976, Zur Abstammung der Hauskatze *(Felis silvestris f. catus):* Sind Siamkatzen und Perserkatzen polyphylethischen Ursprungs? *Säugetierkundl. Mitt.* **24,** 3, 184–192
HEMMER, H. and EICHMANN, M., 1977, Hunde aus der Römerzeit des Rhein–Main–Gebietes. *Mz. Naturw. Arch.* **11,** 257–274
HERRE, W., 1958, Die geschichtliche Entwicklung der Haustierzüchtung. In: ZORN, W., *Tierzüchtungslehre,* Stuttgart, 17–43
HILDEBRANDT, K., 1966, Tierknochenfunde aus der Stadt auf dem Magdalensberg bei Klagenfurt in Kärnten, V. Die Rinderknochen. *Kärntn. Museumsschr.* **XLII,** Klagenfurt, 1–51

HILZHEIMER, M., 1920, Die Tierreste aus dem römischen Kastell Cannstatt bei Stuttgart und anderen römischen Niederlassungen in Württemberg. *Landw. Jahrb.* **55,** 293–336
— 1924, Die im Saalburgmuseum aufbewahrten Tierreste aus römischer Zeit. *Saalburgjahrb.* **5,** 105–158
— 1932, Römische Hundeschädel aus Mainz, ein fränkischer Hundeschädel und ein Hundeschädel des 15. oder 16. Jahrhunderts ebendaher. *Biol. gen.* **8,** 91–126
— 1933, Die Hunderassen im römischen Germanien. *Forsch. u. Fortschr.* **9,** 35–36, 505–506
HODGSON, G. W. I., 1969, Some difficulties of interpreting the metrical data derived from the remains of cattle at the Roman settlement of Corstopitum. In: UCKO, P. J. and DIMBLEBY, G. W. (eds.), *The domestication and exploitation of plants and animals*, London, 347–353
HOLE, F. and FLANNERY, K. V., 1967, The prehistory of Southwestern Iran: a preliminary report. *Proc. of the Prehist. Soc.*, **XXXIII,** 147–206
HORNBERGER, M., 1970, Gesamtbeurteilung der Tierknochenfunde aus der Stadt auf dem Magdalensberg in Kärnten (1948–1966). *Kärntn. Museumsschr.* **XLIX,** Klagenfurt, 1–144
HOWARD, M. M., 1963, The metrical determination of the metapodials and skulls of cattle. In: MOURANT, A. E. and ZEUNER, F. E. (eds.), *Man and cattle*. Royal Anthrop. Inst., Occas. Paper **18,** London, 91–100
HOYER, H., 1923, Ein hornloser und ein gehörnter Rinderschädel aus der jüngeren Steinzeit. *Bull. Internat. de l'Acad. Pol. d. Sci. et d. Lettr. Cl. Math.* **Sér. B,** 12–22
IMHOF, U., 1964, Osteometrische Untersuchungen an Rinderknochen aus den Pfahlbauten des Bielersees. *Mitt. d. Naturf. Ges. in Bern* **21,** 135–237
JEWELL, P. A., 1962, Changes in size and type of cattle from Prehistoric to Mediaeval times in Britain. *Zeitschr. f. Tierzüchtg. u. Züchtgsbiol.* **77,** 159–167
— 1963, Cattle from British archaeological sites. In: MOURANT, A. E. and ZEUNER, F. E. (eds.), *Man and cattle*. Royal Anthrop. Inst., Occas. Paper **18,** London, 80–91
JOURDAN, L., 1976, *La faune du site gallo-romain et paléo-chrétien de la Bourse (Marseille)*. Paris, 1–338
KELLER, O., 1909, 1913, *Die antike Tierwelt, I–II*, Leipzig, 1–434, 1–617
KIESEWALTER, L., 1888, *Skelettmessungen am Pferde*. Diss. Leipzig, 1–88
KLEIN, P. and REICHSTEIN, H., 1977, Metrische Untersuchungen an den Metapodien von Ziegen und Schafen aus der frühmittelalterlichen Siedlung Haithabu. *Schr. aus der Archäol.-Zool. Arbeitsgr. Schleswig-Kiel* **2,** Kiel, 1–60
KOUDELKA, F., 1885, Das Verhältnis der Ossa longa zur Skeletthöhe bei den Säugetieren. *Verhandl. d. Naturforsch. Ver. Brünn* **24,** 127–153
KRATOCHVIL, Z., 1973, Schädelkriterien der Wild- und Hauskatze (*Felis silvestris silvestris* Schreb. 1777 und *F. s. f. catus* L. 1758). *Acta Sci. Nat. Acad. Sci. Bohemoslov. Brno* **VII,** 10, 1–50
— 1976a, Postkranialskelett der Wild- und Hauskatze (*Felis silvestris* und *F. lybica f. catus*). *Acta Sci. Nat. Acad. Sci. Bohemoslov. Brno* **X,** 6, 1–43
— 1976b, Die Körpermerkmale der Hauskatze (*Felis lybica f. catus*) und der Wildkatze (*Felis s. silvestris*). *Zool. Listy* **25,** 1, 1–12
KRAUS, F. R., 1966, *Staatliche Viehhaltung im altbabylonischen Lande Larsa*. Med. d. Koninkl. Nederl. Akad. v. Wetensch. AFD Leterkd. **29,** 5, Amsterdam, 1–65
KRYSIAK, K., 1950–51, Szczatki zwierzece z osady neolitycznej w Cmielowie (Animal remains from Cmielów neolithic settlement). *Wiad. Arch.* **XVII,** 165–228
— 1952, Szczatki zwierzece z osady neolitycznej v Cmielowie (Animal remains from the neolithic settlement at Cmielów). *Wiad. Arch.* **XVIII,** 251–290
KUBASIEWICZ, M., 1956, O metodyce badan wykopaliskowych szczatkow kostnych zwierzecych (Über die Methodik der Forschungen bei Tierausgrabungsknochen). *Mat. Zachad. Pomorsk.* **II,** Szczecin, 235–244
KUHN, E., 1933, Beiträge zur Kenntnis der Säugetierfauna der Schweiz seit dem Neolithikum. *Rev. Suisse de Zool.* **39,** 531–768
LACHOWICZ, S. and WYROST, P., 1962, Spostrzezenia nad chorobowo zmienionymi szczatkami kostnymi zwierzat ssacych i ptaków wczesnosrediowiecznego Wroclawia. *Medyc. Veterynar.* **18,** 326–330
LANDAUER, W., 1925, Ergebnisse in der Erbanalyse der Behornung von Rind, Schaf und Ziege. *Zeitschr. f. indukt. Abstammungs- u. Vererbungslehre* **39,** 128–155
LIEPE, H.-U., 1958, Die Pferde des Latène-Oppidums Manching. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **IV,** München, 1–32
LÜTTSCHWAGER, J., 1965, Ein Zwerghund aus dem römischen Gräberfeld an der Berliner Strasse zu Heidelberg-Neuenheim. *Zeitschr. f. Säugetierkde.* **30,** 1, 24–30
— 1966, Über ein Hundeskelett aus einer Römersiedlung in Heilbronn am Neckar. *Säugetierkundl. Mitt.* **14,** 85–91
— 1967, Zum Vorkommen von Hauseseln zur Römerzeit nördlich der Alpen. *Zeitschr. f. Säugetierkde.* **32,** 6, 355–361
MATOLCSI, J., 1967–68, Avarkori háziállatok maradványai Gyenesdiáson (Überreste von Haustieren aus dem Zeitalter der Awaren in Gyenesdiás). *Magy. Mezőgazd. Muz. Közl.* 1967–68, Budapest, 85–124
— 1968, A szarvasmarha testnagyságának változása a történelmi korszakokban Magyarország területén (Die Veränderung der Körpergrösse des Rindes in den geschichtlichen Epochen auf dem Gebiete Ungarns). *Agrártört. Szemle* 3–38
— 1970, Historische Erforschung der Körpergrösse des Rindes auf Grund von ungarischem Knochenmaterial. *Zeitschr. f. Tierzüchtg. u. Züchtgsbiol.* **87,** 2, 89–137
MENNERICH, G., 1968, *Römerzeitliche Tierreste aus drei Fundorten des Niederrheingebiets*. Diss. München, 1–174
MÓCSY, A., 1974, *Pannonia and Upper Moesia. A History of the Middle Danube Provinces of the Roman Empire*. London–Boston, 1–453
MÜLLER, H.-H., 1963, Hornlose Rinder aus der Saalmünder Höhensiedlung von Halle-Mötzlich. *Jahresschr. mitteldeutsch. Vorgesch.* **47,** 149–155
MÜLLER, R., 1967, *Die Tierknochenfunde aus den spätrömischen Siedlungsschichten von Lauriacum, II. Wild- und Haustierknochen ohne die Rinder*. Diss. München, 1–143
NAßINGA, O., 1963, Neue Funde des Schweines aus dem keltischen Oppidum von Manching. *Stud. an vor- und frühgesch. Tierrest. Bayerns* XV, München, 1–25

NEUMANN, A., 1951, Ausgrabungen und Funde im Wiener Stadtgebiet 1948/49. *Veröff. d. Hist. Mus. d. Stadt Wien* **17,** 11–19
NOBIS, G., 1954, Ur- und frühgeschichtliche Rinder Nord- und Mitteldeutschlands. *Zeitschr. f. Tierzüchtg. u. Züchtgsbiol.* **63,** 155–194
— 1955, Beiträge zur Abstammung und Domestikation des Hauspferdes nach Studien an ur- und frühgeschichtlichen Funden Nordwest- und Mitteldeutschlands. *Zeitschr. f. Tierzüchtg. u. Züchtgsbiol.* **64,** 201–246
— 1957, Werden und Frühentwicklung der Haustierwelt Nordwest- und Mitteldeutschlands. *Wiss. Abh. d. Deutsch. Akad. d. Landwit. zu Berlin* **III,** 38–47
— 1973, Zur Frage römerzeitlicher Hauspferde in Zentraleuropa. *Zeitschr. f. Säugetierkde.* **38,** 4, 224–252
OPITZ, G., 1958, Die Schweine des Latène-Oppidums Manching. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **VII,** München, 1–40
PAULY-WISSOWA, since 1894, *Realenzyklopädie der klassischen Altertumswissenschaft.* Stuttgart–München
PERKINS, D., 1969, Fauna of Çatal Hüyük: evidence for early cattle domestication in Anatolia. *Science* **164,** 177–179
PETŐ, M., 1966, *Lótartás Pannóniában az i. u. I–V. században (Horse keeping in Pannonia in the 1st to 5th centuries).* Diss. Budapest
PIEHLER, H.-M., 1976, *Knochenfunde von Wildvögeln aus archäologischen Grabungen in Mitteleuropa (Zeitraum: Neolithikum bis Mittelalter).* Diss. München, 1–179
PIEHLER, W., 1976, *Die Knochenfunde aus dem spätrömischen Kastell Vemania.* Diss. München, 1–140
PIETSCHMANN, W., 1977, *Zur Grösse des Rothirsches (Cervus elaphus L.) in vor- und frühgeschichtlicher Zeit (Untersuchungen an Knochenfunde aus archäologischen Ausgrabungen).* Diss. München, 1–153
PÖLLOTH, K., 1959, Die Schafe und Ziegen des Latène-Oppidums Manching. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **VI,** München, 1–54
POULAIN-JOSIEN, TH., 1962, Les chevaux gallo-romains découverts à Paris rue Henri Barbusse (III^e–IV^e siècles). *Zeitschr. f. Tierzüchtg. u. Züchtgsbiol* **76,** 238–242
— 1967, Etude de la faune provenant d'un habitat gallo-romain du IV^e siècle, situé aux Fontaines-Salées à Foissy-sous-Vézelay (Yonne). *Bull. de la Soc. d. Sci. Hist. et Nat. de l'Yonne* **102,** 205–218
— 1969, Etude de la faune. In: FOUET, G., La villa gallo-romaine de Montmaurin (Haute-Garonne). *XX suppl. à Gallia,* Paris, 317–329
REICHSTEIN, H., 1971, Tierknochenfunde aus einem römischen Brunnen in Irrel, Kreis Bitburg–Prüm. *Trierer Zeitschr.* **34,** 93–95
REITSMA, G., 1932, *Zoologisch Onderzoek der Nederlandsche Terpen,* 1. *Het Schaap.* Wageningen, 1–139
REQUATE, H., 1957, Zur Naturgeschichte des Ures *(Bos primigenius* Bojanus 1827) nach Schädel- und Skelettfunden in Schleswig-Holstein. *Zeitschr. f. Tierzüchtg. u. Züchtgsbiol.* **70,** 297–338
— 1962, Tierreste aus dem römischen Kastell Asciburgium. *Zeitschr. f. Tierzüchtg. u. Züchtgsbiol.* **77,** 62–73
RIEDEL, A., 1974, I mammiferi domestici della grotta N. 1745/4558 V. G. e di faune oloceniche minori. *Atti e Mem. d. Commiss. Grotte "Eug. Boegan"* **XIII,** 53–88
— 1976, La fauna del castelliere degli Elleri (Trieste). *Atti d. Mus. Civ. di Stor. Nat. Trieste* **XXIX,** 2, 105–122
RÜEGER, J., 1944, Knochenfunde. In: DRACK, W., Das römische Ökonomiegebäude in Kirchdorf. *Argovia* **56,** Aarau, 236–237
RYDER, M. L., 1972, Wool of the 14th century B.C. from Tell el Amarna, Egypt. *Nature* **240,** 355–356
RYDER, M. L. and HEDGES, J. W., 1973a, Ancient Scythian wool from the Crimea. *Nature* **242,** 480
— 1973b, Römerzeitliche Wollreste aus Deutschland und Dänemark. *Arch. Korrespondentsbl.* **3,** 359–362
SAUER-NEUBERT, A., 1968, *Tierknochenfunde aus der römischen Zivilsiedlung in Hüfingen, II. Wild- und Haustierknochen mit Ausnahme der Rinder.* Diss. München, 1–131
SCHLOSSER, M., 1888, Über Säugetier- und Vogelreste aus den Ausgrabungen in Kempten stammend. *Correspondenzbl. d. deutsch. Ges. f. Anthrop., Ethn. u. Urgesch.* **XIX,** 17–22
SCHMID, E., 1967, Tierreste aus einer Grossküche von Augusta Raurica. *Basl. Stadtbuch* 176–186
— 1970, Über Knochenfunde aus der römischen Stadt Augusta Raurica. *Act. du VII^e Congr. Internat. des Sci. Préhist. et Protohist. Prague,* 21–27 août 1966. Prague, 1316–1320
SCHNEIDER, F., 1958, Die Rinder des Latène-Oppidums Manching. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **V,** München, 1–28
SCHRAMM, Z., 1967, Kosci dlugie a wysokosc w klebie u kozy (Long bones and height in withers of goat). *Roczn. Wyzsz. Szkol. Roln. w Poznan.* **XXXVI,** 89–105
SCHWEIZER, W., 1961, Zur Frühgeschichte des Haushuhns in Mitteleuropa. *Stud. an vor- und frühgesch. Tierrest. Bayerns* **IX,** München, 1–42
SICKENBERG, O., 1938, Vor- und frühgeschichtliche Tierreste und ihre Bedeutung. *Rhein. Vorzeit in Wort u. Bild* **1,** 148–152
STAMPFLI, H. R., 1959–60, Die Knochenfunde auf dem Areal der römischen Villa auf dem Buchsi bei Köniz. *Jahrb. d. Bern Hist. Mus. in Bern* **XXXIX–XL,** 435–437
— 1965–66, Die Tierreste aus der römischen Villa "Ersigen-Murain" in Gegenüberstellung zu anderen zeitgleichen Funden aus der Schweiz und dem Ausland. *Jahrb. d. Bern. Hist. Mus. in Bern* **XLV–XLVI,** 449–469
STREITFERDT, U. K., 1972, *Osteoarchäologische Untersuchungen an den Tierknochenfunden aus vier römischen Stationen im süddeutschen Raum.* Diss. München, 1–117
SWEGAT, W., 1976, *Die Knochenfunde aus dem römischen Kastell Künzing–Quintana.* Diss. München, 1–135
SZUNYOGHY, J., 1952, The effect of castration on the skull of the domestic cat, and the establishment of differentiating characters on the skulls of the domestic cat and the wild cat. *Ann. Hist.-Nat. Mus. Nat. Hung. S. N.* **II,** 177–181
TEICHERT, M., 1969, Osteometrische Untersuchungen zur Berechnung der Widerristhöhe bei vor- und frühgeschichtlichen Schweinen. *Kühn-Archiv* **83,** 3, 237–292
— 1974, *Tierreste aus dem germanischen Opfermoor bei Oberdorla,* Weimar, 1–263
TSCHIRWINSKY, N., 1910, Die Entwicklung des Skeletts bei Schafen unter normalen Bedingungen, bei unzulänglicher Ernährung und nach Kastration der Schafböcke im frühen Alter. *Arch. f. mikrosk. Anat.* **75,** 522–561
VITT, V. O., 1952, Loshadi pazyrykshkikh kurganov (The horses of the Pazyrykh kurgans). *Sovj. Arkh.,* **16,** 163–205
WALDMANN, K., 1966, *Die Knochenfunde aus der Colonia Ulpia Traiana, einer römischen Stadt bei Xanten am Niederrhein.* Diss. München, 1–79

WÄSLE, R., 1976, *Gebissanomalien und pathologisch-anatomische Veränderungen an Knochenfunden aus archäologischen Ausgrabungen*. Diss. München, 1–120

WIJNGAARDEN-BAKKER, L. H. VAN and IJZEREEF, G. F., 1977, Mittelalterliche Hunde aus den Niederlanden. *Zeitschr. f. Säugetierkde.* **42,** 1, 13–36

WÜRGLER, F. E., 1959, Die Knochenfunde aus dem spätrömischen Kastell Schaan. *Jahrb. d. Hist. Ver. f. d. Fürst. Liechtenst.* **58,** 255–282

ZALKIN, V. I., 1961, Izmenchivosty metapodii u ovets (The variability of metapodials in sheep). *Bjull. Mosk. Obshch. Ispit. Prirody, Otd. Biol.* **LXVI,** 115–132

— 1964, Economy of East European tribes in the Early Iron Age. *VII^th Internat. Congr. of Anthrop. and Ethnol. Sci.* Moscow, 1–17

ZAWADOWSKIJ, M. M., 1926, Der Einfluss der Kastration auf das Wachstum der Hörner bei Schafen. *Transact. of the Labor of Experiment. Biol. of the Zoopark of Moscow* **1,** 47–66

ZAWATKA, D. and REICHSTEIN, H. 1977, Untersuchungen an Tierknochenfunden von römerzeitlichen Siedlungsplätzen Bentumersiel und Jemgumkloster an der unteren Ems/Ostfriesland. *Probl. d. Küstenforschg. im südl. Nordseebeg.* **12,** Hildesheim, 85–128

ZEUNER, F. E., 1963, *A history of domesticated animals*. London, 1–490

TABLES OF MEASUREMENTS*

Cattle — Skull

	1	2
1. M_1 — basion	224	—
2. aboral end of palate — basion	145	—
3. P_1—P_3	45.5	45
4. M_1—M_3	77.5	77
5. extreme width of skull	197	—
6. extreme frontal width	197	—
7. distance between medial canthuses	132.5	—
8. distance between the foramina infraorbitalia	86	95
9. distance between the tubera malaria	142	165
10. P_1—P_1	93	116
11. M_3—M_1	128	135
12. distance between the mandibular joints	165	—
13. distance between the condyli occipitales	89	—
14. length of foramen magnum	39	—
15. width of foramen magnum	38.5	—

Cattle — Horn-core

Measurements: 1. greatest length
2. greatest diameter
3. smallest diameter
4. circumference of the base

	1	2	3	4		1	2	3	4
1	72	49	41.5	145	25	163*	46	34.5	130
2	96	32.5	28.5	100	26	165	49	42*	147
3	104	35.5	27.5	100	27	165*	60*	44	170*
4	107*	45	37	130	28	167	48	36	130
5	127*	30	28	93	29	167*	49	39.5	149
6	128	45.5	33.5	127	30	168	49	39	135*
7	130*	39	28*	110	31	173*	44.5	38	130
8	130*	57	36	152*	32	175*	42.5	34	123
9	130*	—	—	—	33	175*	43.5	37	128
10	133	41	33	115	34	175*	47*	39	138*
11	133	45	38.5	134	35	175*	49.5	35	140
12	140*	51.5	38.5	143	36	175*	52	35.5	140
13	145*	—	—	—	37	175*	74.5	53	204
14	150*	39	35.5	118	38	180*	46.5	33*	132*
15	150	40	35	119	39	180*	47*	40	140*
16	150*	39	36	120	40	180*	52	35.5	143
17	153*	46.5	39*	130*	41	190*	49	43	147
18	153*	53	36	145	42	195	50	36.5	139
19	155*	43	36	127	43	195*	55	38.5	147
20	158	55.5	—	157*	44	200	51	45	150
21	160*	42	34	122	45	205	47	39.5	140
22	160	52	38	146	46	210*	51	41	146
23	160*	55*	41.5	157	47	210	47	44	152
24	160*	63	48	175	48	215*	56	38	156

* In the tables, the approximate measurements are marked by an asterisk (*), w = wild

	1	2	3	4
49	215*	57	—	—
50	225*	60	43*	167*
51	230	63.5	43.5	164
52	235	74	50	200
53	238	55*	42.5	160*
54	245*	74.5	56.6	233
55	250*	63	46	177
56	250*	72	51	197*
57	280	51	47.5	160
58	295	81.5	60	233
59	300*	74	65	220
60	300*	—	—	—
61	330	81	66	235
62	—	39	34.5	120
63	—	39.5	32	115
64	—	40	31	113
65	—	40	32.5	109
66	—	41	37	125
67	—	42	36	123
68	—	42	35	123
69	—	42.5	35.5	126
70	—	43*	37	130
71	—	43.5	34.5	—
72	—	44	34	126
73	—	44.5	36	130
74	—	45	37.5	133
75	—	45	38*	130*
76	—	45	38.5	135
77	—	45.5	35	128
78	—	45.5	37	140
79	—	46	38.5	128
80	—	46*	38.5	137*
81	—	46	39	136
82	—	46.5	36	129
83	—	47	35.5	128
84	—	47	36	130
85	—	47	40	138
86	—	47	41	—
87	—	47	44	145
88	—	47.5	36	136
89	—	47.5	39.5	137
90	—	48	33.5	125
91	—	48	36.5	133
92	—	48	39	138
93	—	48	40.5	140
94	—	48	41	140
95	—	49	34	130
96	—	49	37.5	138
97	—	49	39	141
98	—	49.5	36	133
99	—	49.5	37.5	140
100	—	49.5	38	140
101	—	50	38	146
102	—	50.5	38.5	140
103	—	50.5	40	147
104	—	51	36.5	139
105	—	51	37.5	140
106	—	51	38	147
107	—	51	38.5	143*
108	—	51	38.5	145
109	—	51	41	142
110	—	52	36	143
111	—	52	42	152
112	—	52	42	154
113	—	52	42	155
114	—	52.5	39.5	150
115	—	52.5	42	150
116	—	52.5	43	157
117	—	53	38	147
118	—	53	39	150
119	—	53	40.5	151
120	—	53	41	151
121	—	53	43	156
122	—	53	44	153
123	—	53	45	155
124	—	53.5	40	153
125	—	53.5	40.5	155
126	—	53.5	48	160
127	—	54	42	155
128	—	54	43	153
129	—	54	43	150
130	—	54	44	154
131	—	54	44	160*
132	—	54.5	40	152
133	—	55	39	152
134	—	55	41	160
135	—	55	47.5	165*
136	—	55.5	40.5	152
137	—	55.5	41	155
138	—	56*	40.5	150*
139	—	56	41	153
140	—	56	43.5	155
141	—	57	38	160
142	—	57	40	162
143	—	57	43	165
144	—	57.5	37*	162*
145	—	57.5	39	160
146	—	57.5	45.5	167
147	—	57.5	46	165
148	—	58	44	166
149	—	58	46	170
150	—	59	50.5	177
151	—	60	46	158
152	—	60.5	40.5	163
153	—	60.5	51	180
154	—	61	49	172
155	—	61.5	48	180*
156	—	62	42	170
157	—	62	43	170
158	—	62	45.5	178
159	—	62*	51	185*
160	—	63.5	46	180*
161	—	63.5	46.5	175
162	—	64	45	175
163	—	64	48	175
164	—	64	49	182
165	—	64.5	55	195
166	—	65	50	181
167	—	66	49	183
168	—	66.5	51	186
169	—	67.5	38	192
170	—	67.5	43	190
171	—	68	50.5	192
172	—	69.5	54	205*
173	—	70.5	40.5	186
174	—	70.5	49.5	191

Cattle — Horn-core (cont'd)

	1	2	3	4
175	—	70.5	50.5	195*
176	—	71	47	193*
177	—	71	51.5	198
178	—	71	53	199
179	—	71	55	202
180	—	71	61	212
181	—	72.5	51	201
182	—	73	50.5	202
183	—	74	51	196
184	—	76	55	218
185	—	78	49.5	210
186	—	78	56	225
187	—	81	50	210
188	—	82	53	222
189	—	83.5	58.5	235
190	—	88*	68	245* w

Cattle — Upper row of teeth

Measurements: 1. P_1–P_3
2. M_1–M_3

	1	2
1	44	73
2	45	71
3	45	72
4	45	77
5	47	76
6	48	78
7	50	74
8	51	75
9	53	81
10	41	—
11	43	—
12	43	—
13	44	—
14	44	—
15	44	—
16	44.5	—
17	47	—
18	48	—
19	48	—
20	—	68.5
21	—	70*
22	—	71
23	—	72
24	—	72
25	—	72
26	—	72
27	—	74
28	—	74
29	—	74
30	—	75
31	—	75
32	—	75*
33	—	76
34	—	76
35	—	77
36	—	77*
37	—	78
38	—	78
39	—	78
40	—	79
41	—	79
42	—	79
43	—	81
44	—	82.5
45	—	83.5

Measurements:
1. length to the angulus
2. length to the processus coronoideus
3. height at P_1
4. height at M_1
5. height to the articular surface
6. height to the processus coronoideus
7. dental length (I_1–M_3)
8. length of incisor row
9. length of diastema
10. P_1–P_3
11. M_1–M_3
12. length of M_3

	1	2	3	4	5	6	7	8	9	10	11	12
1	317	—	32	40.5	140	—	223*	—	—	46	85	35.5
2	322	—	41.5	51.5	—	—	—	14	98	55	—	—
3	350	—	36.5	49	163	—	240	18.5	88.5	50	86	36
4	353*	—	36*	49	—	—	242	10.5	107	47.5	82	36
5	360	—	40	49.5	—	—	243	14	102	49	81	35
6	363*	—	38	47	165	—	250*	—	—	44	86	37
7	367	—	38.5	53.5	—	—	250	10.5	110	50	81.5	34.5
8	372	—	43	—	—	—	255.5	22	101	48.5	85.5	35
9	386*	—	39	54	—	—	256	—	—	46	85	36
10	390*	—	45	56	181	—	255*	15	112	58	82	36
11	403	—	44	54	—	—	270	16	110*	53	94	40
12	406*	427*	41	50	171	227*	259	17	115	46	86	35
13	407*	—	52	60.5	—	—	274.5	14	134	48.5	94.5	39.5
14	408	430	44.5	59.5	170	218	273	24	108	53	90	38
15	—	—	40.5	56	—	—	242*	—	103	48	84	36
16	—	—	35	45	—	—	242*	—	90*	47	85	36
17	—	—	37	49.5	—	—	243*	16*	102	44	83	35
18	—	—	34.5	45	—	—	246	20	95	47.5	86	36
19	—	—	38	51	—	—	245*	12*	105	48	83	38
20	—	—	40.5	52	172	—	255	15	105	51	89	38.5
21	—	—	42	—	—	—	257	13	109	47	90.5	39
22	—	—	42	54	—	—	258	—	—	51	87	37.5
23	—	—	48	59	—	—	265*	15*	113	55	83	36
24	—	—	41	53	—	—	265	16.5	118	49	91	38
25	—	—	43	51	—	—	267	15	116	52	88.5	38
26	—	—	37	52	—	—	278	22	106	50.5	90	39
27	—	—	53.5	61	—	—	282	19*	115*	54.5	95.5	42
28	—	—	38	43	—	—	—	—	—	41	75	30
29	—	—	36	45	—	—	—	—	—	48	80	31
30	—	—	—	44*	—	—	—	—	—	46	76	33
31	—	—	39	46.5	143	187	—	—	—	42.5	82	33
32	—	—	—	49	—	—	—	—	—	49	76	33.5
33	—	—	—	49	—	—	—	—	—	—	83	33.5
34	—	—	—	49	—	—	—	—	—	51.5	79	33.5
35	—	—	33.5	46.5	—	—	—	—	91*	46	80	34
36	—	—	42	51	155	—	—	—	—	52.8	81	34
37	—	—	38.5	46	—	—	—	—	—	49.5	81	34
38	—	—	—	48.6	—	—	—	—	—	48	81	34
39	—	—	43	51	—	—	—	—	—	45	82.5	34
40	—	—	40	48	—	—	—	—	—	46.5	85.5	34
41	—	—	—	47	—	—	—	—	—	37	87	34
42	—	—	35.5	45.5	—	—	—	—	—	44	80.5	35
43	—	—	40	53.5	—	—	—	—	—	48	80.5	35
44	—	—	—	50	—	—	—	—	—	—	81	35
45	—	—	38	48	—	—	—	—	103	43	81.5	35
46	—	—	38	44.5	—	—	—	—	—	48	82.5	35
47	—	—	38	47	—	—	—	—	—	50	85	35
48	—	—	—	45.5	—	—	—	—	—	—	80.5	35.5
49	—	—	—	55	—	—	—	—	—	45	83	35.5
50	—	—	31	41.5	—	—	—	—	—	51	83	36

Cattle — Mandible (cont'd)

	1	2	3	4	5	6	7	8	9	10	11	12
51	—	—	—	45	—	—	—	—	—	46.5	83	36
52	—	—	—	44.5	—	—	—	—	—	49.5	83	36
53	—	—	—	48	—	—	—	—	—	48	83	36
54	—	—	—	48*	160	—	—	—	—	47.5	83.5	36
55	—	—	—	49	—	—	—	—	—	46.5	84	36
56	—	—	40	—	—	—	—	—	—	47.5	84.5	36
57	—	—	—	51.5	—	—	—	—	—	44	85.5	36
58	—	—	—	54	—	—	—	—	—	47	83	36.5
59	—	—	37	43	—	—	—	—	—	50	85.5	36.5
60	—	—	48	55	—	—	—	—	—	50	88.5	36.5
61	—	—	33	42.5	—	—	—	—	—	45	83	37
62	—	—	43	50.5	—	—	—	—	—	42.5	86	37
63	—	—	—	50	—	—	—	—	—	50	86	37
64	—	—	—	51.5	—	—	—	—	—	43*	86.5	37
65	—	—	—	44	—	—	—	—	—	—	86.5	37
66	—	—	—	49	—	—	—	—	—	—	87	37
67	—	—	—	44	—	—	—	—	—	47	88	37
68	—	—	—	52.5	—	—	—	—	—	49	86.5	37.5
69	—	—	—	52	—	—	—	—	—	47	84.5	38
70	—	—	43	55.5	—	—	—	—	—	50	86	38
71	—	—	—	52	—	—	—	—	—	—	87	38
72	—	—	—	49	—	—	—	—	—	46	87.5	38
73	—	—	40	53	—	—	—	—	—	45.5	88.5	38
74	—	—	39	51	—	—	—	—	—	53.5	89	38
75	—	—	—	57.5	165	—	—	—	—	50	89	38
76	—	—	—	55	—	—	—	—	—	49.5	89	38
77	—	—	—	52	—	—	—	—	—	52	90	38
78	—	—	43.5	55	—	—	—	—	—	49	92	38
79	—	—	46	55	—	—	—	—	—	47	91	38.5
80	—	—	35.5	45	182	—	—	—	—	53	90	39
81	—	—	36.5	47.5	—	—	—	—	—	55	96	39
82	—	—	35	44	—	—	—	—	—	50	96	39
83	—	—	40*	54	—	—	—	—	—	52	88	41
84	—	—	—	54.5	—	—	—	—	—	—	92	41
85	—	—	—	52	—	—	—	—	—	—	98	41

Cattle — Lower row of teeth

Measurements: 1. P_1—P_3
2. M_1—M_3
3. length of M_3

	1	2	3
1	47.5	75	28
2	50	85	29
3	43	75	31
4	45.5	79	31.5
5	42	78	32.5
6	42	77	33
7	44.5	83	33
8	46	82	33.5
9	47	82	33.5
10	46	79	34
11	46	81	34
12	49	83	34
13	49	81	34.5
14	50	81.5	34.5
15	46	80	35
16	46	80	35
17	48	82.5	35
18	48	83	35
19	47	85.5	35
20	46	79	36
21	45	81	36
22	46	83	36
23	50	83	36
24	46	84	36
25	48.5	84	36
26	45	84	36
27	48	84	36
28	49	84	36
29	49	85	36
30	52.5	86	36

Cattle — Lower row of teeth (cont'd)

	1	2	3
31	51	86	36
32	51	86	36
33	46	86.5	36
34	49	91.5	36
35	45.5	81	36.5
36	46	82.5	36.5
37	49.5	85.5	36.5
38	47.5	85.5	36.5
39	50	87	36.5
40	49.5	88	36.5
41	50	88	36.5
42	49	82	37
43	53	83	37
44	48	83	37
45	45	83.5	37
46	48	84	37
47	47	85	37
48	47	85	37
49	45.5	85	37
50	46.5	86	37
51	48	86	37
52	50	86	37
53	50	87.5	37
54	47	88	37
55	51	88	37
56	50.5	89	37
57	59	89	37
58	52.5	76	37.5
59	47	93	37.5
60	44.5	84	38
61	45	85	38
62	50	85.5	38
63	50*	86	38
64	45	86	38
65	44	86	38
66	47	86	38
67	49	86.5	38
68	50.5	87.5	38
69	51.5	87.5	38
70	48	89	38
71	49	90	38
72	49.5	90	38
73	56	91	38
74	52	92.5	38
75	50	83	38.5
76	44	83	39
77	46	86	39
78	45	86	39
79	46	86	39
80	47.5	87	39
81	50	88	39
82	47.5	88.5	39
83	48	89	39
84	48.5	89.5	39
85	49	90	39
86	48	86	39.5
87	46	91	39.5
88	49	88	40
89	49.5	89	40
90	50	91.5	40
91	52	92*	40*
92	49	87	40.5
93	51	87	40.5
94	49	89	40.5
95	48	90*	40.5
96	52	94	41
97	49	91	42
98	49	96	42.5
99	51.5	96	43.5 w
100	—	79	33.5
101	—	80	34
102	—	83.5	34
103	—	84	34
104	84	84	34
105	—	83	35
106	—	85	35
107	—	83	35.5
108	—	83.5	35.5
109	—	83.5	35.5
110	—	88	35.5
111	—	85.5	36
112	—	86	36
113	—	87	36
114	—	87*	36
115	—	80	37
116	—	82	37
117	—	84.5	37
118	—	85	37
119	—	86	37
120	—	88	37
121	—	88.5	37.5
122	—	86.5	38
123	—	88	38
124	—	88	38
125	—	88	38
126	—	92.5	38
127	—	89	38.5
128	—	96	39
129	—	92	39.5
130	—	91	40
131	—	94	40
132	—	—	32*
133	—	—	33
134	—	—	33.5
135	—	—	34
136	—	—	34
137	—	—	34.5
138	—	—	35
139	—	—	35
140	—	—	35
141	—	—	35*
142	—	—	35.5
143	—	—	35.5
144	—	—	36
145	—	—	36
146	—	—	36
147	—	—	36
148	—	—	36
149	—	—	36
150	—	—	36
151	—	—	36.5
152	—	—	36.5
153	—	—	36.5
154	—	—	37
155	—	—	37
156	—	—	37

Cattle — Lower row of teeth (cont'd)

	1	2	3
157	—	—	37.5
158	—	—	38
159	—	—	38
160	—	—	38
161	—	—	38
162	—	—	38.5
163	—	—	38.5
164	42	—	—
165	44	—	—
166	45	—	—
167	45	—	—
168	46	—	—
169	46	—	—
170	46.5	—	—
71	46.5	—	—
72	47	—	—
173	47	—	—
174	47.5	—	—
175	48	—	—
176	48	—	—
177	48.5	—	—
178	48.5	—	—
179	48.5	—	—
180	48.5	—	—
181	48.5	—	—
182	49	—	—
183	51	—	—
184	51.5	—	—
185	52.5	—	—
186	53	—	—
187	57	—	—

Cattle — Atlas

Measurements: 1. length of arcus ventralis
2. length of arcus dorsalis
3. width of cranial articular surface
4. width of caudal articular surface
5. greatest width
6. greatest height

	1	2	3	4	5	6
1	41.5	39.5	92.5	91	126.5	75.5
2	45.5	42	111	103	166	84
3	36.5	—	88.5	88.5	—	—
4	36.5	46	99	—	—	—
5	37	40	90.5	90	—	73
6	40	47	90	82	—	73
7	40*	51.5	—	93	—	—
8	40	—	96	95	—	—
9	40	—	100*	—	—	—
10	40.5	46	97	93.5	—	—
11	40.5	—	92	86	—	—
12	41	44	94	88	—	—
13	41	—	99	93	—	—
14	41.5	48	102	94	—	87.5
15	41.5	49.5	100	90	—	—
16	41.5	51.5	107.5	101	—	84*
17	42	—	—	110	—	88

Cattle—Atlas (cont'd)

	1	2	3	4	5	6	
18	42	—	92*	89	—	—	
19	43*	—	100	—	—	—	
20	44	55.5	113	104	—	87	
21	45*	47	97.5	90	—	—	
22	45	—	110	107	—	—	
23	46	57.5	103	103	—	85	
24	46	—	102.5	—	—	—	
25	46*	—	110	106.5	—	—	
26	47	47.5	98	92*	—	—	
27	47.5	58.5	105	106	—	—	w?
28	49	52	110	111	—	93.5	w?
29	49	—	118	111	—	90	w
30	—	44	94	89	—	—	

Cattle — Epistropheus

Measurements: 1. length of body
2. length of arch
3. length of dens
4. width of dens
5. width of cranial articular surface
6. width of fossa caudalis
7. greatest width
8. height of cranial articular surface
9. height of fossa caudalis

	1	2	3	4	5	6	7	8	9
1	109	—	23.5	45	90	44	—	—	34
2	125*	61.5	22.5	47	—	46..5	—	—	38
3	126	57.5	26	50	111	—	—	60	38
4	132*	63.5	24	45	106	55	—	—	—
5	—	48	20	39	89	—	—	—	—
6	—	51	22	38.5	86.5	—	—	53	—
7	—	53.5	18	37	86.5	—	—	53	—
8	—	55	22.5	41	—	46.5	—	—	—
9	—	55.5	22	40	94	49	—	59	—
10	—	56.5	23	40	—	43	—	—	—
11	—	57	—	44	93	48.5	—	—	—
12	—	57.5	29	43	105	—	—	61	—
13	—	58	19	41.5	92.5	—	—	—	—
14	—	58	19	45	100*	—	—	—	—
15	—	58	22	40	91	—	—	56	—
16	—	59	23	45	100	—	—	—	—
17	—	59.5	23	42.5	94*	—	—	—	—
18	—	60.5	21	40.5	100	49	—	58.5	—
19	—	61	20	43	97	49	—	62	—
20	—	61.5	21	43	94	—	—	52	—
21	—	63	23.5	42	102	—	—	62	—
22	—	64	24	41.5	—	—	—	—	—
23	—	64	25	49	102	—	112	64	—
24	—	66	23	44	99	—	—	65	—
25	—	—	20	40	89	—	—	50	—
26	—	—	20	42.5	90	—	—	51	—
27	—	—	20	43	90	—	—	47.5	—
28	—	—	20	44	96	—	—	53	—
29	—	—	21	40.5	91	—	—	59.5	—
30	—	—	21	42	—	—	—	53	—
31	—	—	22	41	90	—	—	—	—
32	—	—	22	42	—	—	—	—	—

Measurements: 1. greatest length
2. smallest width of collum scapulae
3. width of angulus articularis
4. diameter of facies articularis

	1	2	3	4
1	322*	43.5	65	47
2	358*	53	72	53.5
3	363*	52	75	50*
4	390*	63	80	59.5
5	—	40	54	38.5
6	—	40.5	54.5	38.5
7	—	42	56.5	38
8	—	41.5	57.5	42
9	—	42	58	43
10	—	—	59	40
11	—	47.5	60	—
12	—	45	60.5	46
13	—	47.5	61	46
14	—	44.5	61.5	45
15	—	46	61.5	46.5
16	—	—	61.5	46*
17	—	46	61.5	—
18	—	—	62	47
19	—	44	62*	—
20	—	—	62.5	44
21	—	—	63	47
22	—	—	64	44
23	—	47	64.5	44.5
24	—	45	65	44.5
25	—	43.5	65	47
26	—	—	65*	48
27	—	46.5	65	50*
28	—	47	65*	—
29	—	51	65*	—
30	—	48	65.5	48.5
31	—	—	66	47
32	—	47	66	47.5
33	—	48.5	66	47*
34	—	50	66*	48*
35	—	50.5	66	48
36	—	50	66*	—
37	—	46	66.5	47*
38	—	50	66.5	—
39	—	45	67	44
40	—	47.5	67*	44*
41	—	47.5	67*	44*
42	—	52	67	44
43	—	50	67	45
44	—	47	67	45.5
45	—	47.5	67	45.5
46	—	45.5	67*	46*
47	—	45.5	67*	47*
48	—	45.5	67*	47*
49	—	50	67*	—
50	—	—	67*	52
51	—	48	67.5	—
52	—	53	67.5	—
53	—	42	68	46.5
54	—	53.5	68	45.5
55	—	—	68	47*
56	—	—	68*	47.5
57	—	—	68*	48*
58	—	56	68	49
59	—	—	68*	50*
60	—	45.5	68*	—
61	—	47.5	68*	—
62	—	50	68*	—
63	—	53.5	68.5	50*
64	—	49	68.5	51
65	—	52.5	68.5	—
66	—	48	69	48.5
67	—	—	69*	49*
68	—	52.5	69	50*
69	—	54	69	52*
70	—	51	69	—
71	—	52.5	69	—
72	—	50	69.5	45
73	—	51	69.5	49
74	—	54	69.5	—
75	—	—	70	49.5
76	—	52	70	50
77	—	53.5	70*	50
78	—	46.5	70*	—
79	—	51	70*	—
80	—	51.5	70	—
81	—	51.5	70*	—
82	—	52	70	—
83	—	52	70*	—
84	—	52	70*	—
85	—	53	70*	—
86	—	55.5	70*	—
87	—	—	70.5	49*
88	—	53.5	70.5	—
89	—	52.5	71	44
90	—	—	71	46
91	—	51	71	48
92	—	56.5	71	50
93	—	53	71	52
94	—	—	71*	52*
95	—	56	71	53
96	—	49	71*	—
97	—	48.5	71.5	53
98	—	51*	72*	48*
99	—	56.5	72*	51*
100	—	49.5	72*	51.5
101	—	53.5	72	51.5
102	—	55	72*	53*
103	—	47.5	72*	—
104	—	51	72*	—
105	—	54	72*	—
106	—	54.5	72*	—
107	—	52	72.5	46
108	—	49	72.5	—
109	—	55	72.5	—
110	—	—	73	48
111	—	50	73*	50*
112	—	59	73	51
113	—	54	73*	52*
114	—	—	73	54

Cattle—Scapula (cont'd)

	1	2	3	4
115	—	54	73*	55
116	—	57.5	73*	55
117	—	45.5	73	—
118	—	51*	73*	—
119	—	54.5	73	—
120	—	58	73*	—
121	—	55	73.5	52
122	—	—	74*	50*
123	—	54.5	74	51
124	—	54	74*	53*
125	—	55	74	54*
126	—	56.5	74*	56*
127	—	49.5	74*	—
128	—	50	74*	—
129	—	53	74	—
130	—	57	74*	—
131	—	52	74.5	53*
132	—	54	74.5	53*
133	—	55.5	74.5	53
134	—	—	75	48*
135	—	54	75*	50*
136	—	54	75*	53
137	—	—	75	53
138	—	58	75	54*
139	—	52	75*	—
140	—	53.5	75*	—
141	—	59.5	75	—
142	—	56	76	54*
143	—	54	76*	—
144	—	59	76*	—
145	—	58	76.5	51
146	—	59	76.5	57
147	—	59	76.5	—
148	—	54.5	77	49
149	—	57	77	51
150	—	61.5	77*	56
151	—	56	77*	57*
152	—	58	77*	—
153	—	59*	77*	—
154	—	55	78*	51*
155	—	58.5	78	51
156	—	57	78*	52*
157	—	—	78	54
158	—	57,5	78	55*
159	—	60	78	56
160	—	55.5	78*	—
161	—	56	78.5	57.5
162	—	56.5	79.5	55
163	—	56	80*	53
164	—	59	80	54
165	—	60*	80*	57
166	—	—	80*	58*
167	—	61	80*	60*
168	—	62.5	80*	60
169	—	56	80*	—
170	—	64	80*	— w
171	—	65	80*	— w
172	—	59	80.5	— w
173	—	67	86	61 w
174	—	64.5	87*	60* w
175	—	68	88	66* w
176	—	67.5	90*	62* w
177	—	66.5	93*	66 w

Cattle—Humerus

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	262	—	29.5	68	90	35	69.5
2	298	108	38	85	112	44	82
3	330	110	40	88	114	45	87
4	330	110	39	88	118	45	85
5	—	—	32.5	70	—	38	65
6	—	—	—	70	—	—	69
7	—	—	—	70	—	38	70
8	—	—	33.5	70	—	36	—
9	—	—	30.5	71	—	34	63
10	—	—	32	72	—	42	75
11	—	—	29.5	74	—	40	72
12	—	—	—	74.5	—	37	74
13	—	—	34.5	75	—	37	69
14.	—	—	—	75	—	38	72
15	—	—	—	75	—	—	73

Cattle—Humerus (cont'd)

	1	2	3	4	5	6	7
16	—	—	—	75	—	40	75
17	—	—	—	75	—	—	75
18	—	—	33.5	75	—	45	80
19	—	—	35	75	—	43	—
20	—	—	35	76	—	43	72
21	—	—	36	76	—	42	73
22	—	—	—	76	—	—	73
23	—	—	35	76	—	43	—
24	—	—	36	81.5	—	46	78
25	—	—	—	86	—	48	77
26	—	—	36	86	—	47	84
27	—	—	38	87	—	46	82
28	—	—	—	88	—	—	83
29	—	—	—	94	—	—	91
30	—	—	42	95	—	51	90

Cattle—Radius

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	250*	74.5	39	64.5	38	21.5	43
2	254	71.5	34	62	40	19	38
3	255	—	—	61	—	—	38
4	257*	72	34	63	—	18	38
5	258*	74.5	41.5	64	35	19	43
6	263	72*	34	65	37*	19	39*
7	266	74	40	—	38.5	21	44
8	268*	70	37.5	66	37*	21	42
9	270*	—	42	71	—	22	45
10	273*	—	40	67.5	40	22	43
11	275	—	38	69	42	21	43
12	276	—	—	67.5	39.5	24	42
13	277	—	40	73	45.5	22	49
14	279	75.5	40	71	41	21	42
15	282*	78.5	38	68.5	41.5	20.5	45.5
16	284	81	41	—	43	22.5	—
17	285*	—	—	66	—	—	44
18	285*	84*	40.5	71	45	25	45
19	286	—	40	71	39	22	42
20	287	—	37.5	67	43	20	47
21	287	—	41.5	71.5	41	22.5	43
22	298	—	—	70	—	22	—
23	290*	88*	47.5	77.5	—	—	—
24	290.5	—	—	71.5	41	22	45
25	293	—	43.5	72.5	—	24.5	46
26	298	—	41	73	44	22	42
27	299	83	41.5	74	41	23.5	46
28	299	78*	43	75	—	24	44
29	300*	86	40	77	42	23	47
30	302	—	42.5	—	—	22.5	—
31	302	82.5	44.5	72	43.5	25.5	50
32	305	—	40.5	74	42.5	22	47
33	305*	89	47	—	—	26	—
34	308	92*	46	80	48	26	46
35	310	92*	44	74.5	46	27	52
36	312*	—	42	—	46	25	—
37	315	—	43	77	—	24	47
38	320	—	50	86	—	29	52.5
39	326	93	47	80	51.5	28	56

	1	2	3	4	5	6	7	
40	333*	—	47.5	87	50	24.5	53	
41	—	67.5	—	—	34*	—	—	
42	—	70*	—	—	34	—	—	
43	—	71	—	—	36*	—	—	
44	—	71	—	—	37.5	—	—	
45	—	71*	—	—	38	—	—	
46	—	71.5	—	—	35.5	—	—	
47	—	71.5	38	—	38	—	—	
48	—	72	—	—	36*	—	—	
49	—	72.5	—	—	36.5	—	—	
50	—	72.5	—	—	38	—	—	
51	—	72.5	40	—	—	22.5	—	
52	—	73.5	38	—	—	—	—	
53	—	76.5	—	—	38.5	—	—	
54	—	77*	—	—	40	—	—	
55	—	77	—	—	43	—	—	
56	—	78	—	—	41	—	—	
57	—	78	—	—	41	—	—	
58	—	78	—	—	42*	—	—	
59	—	79	—	—	41*	—	—	
60	—	79	—	—	42	—	—	
61	—	79	—	—	45.5.	25	—	
62	—	79.5	—	—	41.5	—	—	
63	—	80*	—	—	41*	—	—	
64	—	80	—	—	42.5	25	—	
65	—	80	—	—	43	—	—	
66	—	80	—	—	45	—	—	
67	—	80.5	—	—	44	—	—	
68	—	81	—	—	42	—	—	
69	—	81	39.5	—	43	24	—	
70	—	81	—	—	43	—	—	
71	—	82*	—	—	40.5	—	—	
72	—	82	43	—	41*	23.5	—	
73	—	82	—	—	43	—	—	
74	—	82	—	—	43	—	—	
75	—	82*	—	—	43*	—	—	
76	—	83	—	—	45*	—	—	
77	—	85	—	—	40	—	—	
78	—	85	—	—	45*	—	—	
79	—	85*	—	—	46	—	—	
80	—	86*	46.5	—	49*	25	—	
81	—	87*	—	—	45	—	—	
82	—	87	40.5	—	48	23	—	
83	—	87.5	45	—	—	24.5	—	
84	—	88*	—	—	45*	—	—	
85	—	88	43	—	48	25	—	
86	—	88*	—	—	49	—	—	
87	—	88	47	—	—	26	—	
88	—	90*	—	—	51	—	—	
89	—	90*	—	—	—	—	—	
90	—	90.5	—	—	50.5	—	—	
91	—	90.5	41	—	51	27.5	—	
92	—	92.5	—	—	48	—	—	
93	—	92.5	—	—	49	28	—	
94	—	94*	—	—	49	29*	—	w
95	—	95	—	—	—	—	—	w
96	—	95.5	—	—	48.5	—	—	w
97	—	97	50	—	52	27.5	—	w?
98	—	97	—	—	52	—	—	w?
99	—	99	—	—	54.5	—	—	w
100	—	—	—	57.5	—	—	37	
101	—	—	—	62	—	—	39	
102	—	—	—	64	—	—	38.5	

Cattle — Radius (cont'd)

	1	2	3	4	5	6	7
103	—	—	—	64.5	—	—	38
104	—	—	—	64.5	—	—	38
105	—	—	—	65.5	—	—	46
106	—	—	—	66	—	—	39
107	—	—	—	66.5	—	—	42.5
108	—	—	—	67	—	—	41.5
109	—	—	—	67	—	—	42
110	—	—	—	67	—	—	44
111	—	—	—	67.5	—	—	41
112	—	—	—	68	—	—	41
113	—	—	—	68	—	—	44
114	—	—	—	69	—	—	40
115	—	—	—	69	—	—	41
116	—	—	—	69	—	—	42
117	—	—	—	69	—	—	43
118	—	—	—	69	—	—	44
119	—	—	—	69.5	—	—	42
120	—	—	—	69.5	—	—	45
121	—	—	—	70	—	—	45
122	—	—	—	71	—	—	42
123	—	—	—	71	—	—	44
124	—	—	—	71	—	—	45
125	—	—	—	71	—	—	45.5
126	—	—	—	71	—	—	46
127	—	—	—	71	—	—	47
128	—	—	—	71.5	—	—	46
129	—	—	—	72	—	—	43
130	—	—	—	72	—	—	44*
131	—	—	—	72	—	—	45
132	—	—	—	72	—	—	47
133	—	—	—	72	—	—	47
134	—	—	—	72.5	—	—	44
135	—	—	—	72.5	—	—	44
136	—	—	—	72.5	—	—	45
137	—	—	—	72.5	—	—	45
138	—	—	—	73	—	—	43
139	—	—	—	73	—	—	43
140	—	—	—	73	—	—	44
141	—	—	—	73	—	—	44
142	—	—	—	73	—	—	46
143	—	—	—	73	—	—	46*
144	—	—	—	73	—	—	48
145	—	—	—	73	—	—	48
146	—	—	—	73.5	—	—	44
147	—	—	—	73.5	—	—	45
148	—	—	—	74	—	—	43
149	—	—	—	75.5	—	—	44.5
150	—	—	—	75.5	—	—	47
151	—	—	—	76	—	—	48
152	—	—	—	76	—	—	48
153	—	—	—	77	—	—	43
154	—	—	—	77	—	—	45
155	—	—	—	77	—	—	45
156	—	—	—	77	—	—	46
157	—	—	—	77	—	—	49
158	—	—	—	78	—	—	47
159	—	—	—	78.5	—	—	46.5
160	—	—	—	78.5	—	—	48
161	—	—	—	79	—	—	48
162	—	—	—	79	—	—	50
163	—	—	—	79	—	—	52
164	—	—	—	80	—	—	48
165	—	—	—	80	—	—	50

Cattle — Radius (cont'd)

	1	2	3	4	5	6	7	
166	—	—	—	81	—	—	50	
167	—	—	—	81	—	—	50	
168	—	—	—	81.5	—	—	46	
169	—	—	—	81.5	—	—	47.5	
170	—	—	—	82	—	—	48	
171	—	—	—	82.5	—	—	51	
172	—	—	—	83	—	—	47	
173	—	—	—	83	—	—	49	
174	—	—	—	83	—	—	49	
175	—	—	—	83	—	—	52	
176	—	—	—	85	—	—	50*	
177	—	—	—	85*	—	—	55*	
178	—	—	—	88	—	—	52	
179	—	—	—	89	—	—	54	
180	—	—	—	90*	—	—	55	w
181	—	—	—	92	—	—	56	w

Cattle — Metacarpus

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	169	50	26	51.5	32	17.5	27
2	171	45	23.5	45.5	29.5	17.5	27.5
3	178	53.5	29.5	59.5	35.5	19.5	30
4	180	46	24.5	50.5	32.5	19	28
5	180*	—	29.5	—	—	20	—
6	180.5	48	27	53*	38	21.5	—
7	181	48	29	52	33.5	18.5	29*
8	182	60*	43.5	60	37.5	21.5	32.5
9	183	51.5	26.5	52.5	32	21	29*
10	183	56*	33	60.5	38*	18.5	31.5
11	184	48.5	27	49	33	18.5	27.5
12	184	49	29	—	36	—	—
13	185	52	28.5	53.5	34.5	20	30*
14	185	51	30	55.5	37	20.5	30
15	186	54	31.5	58	36	21.5	32
16	187	51	31	57	38	21	31*
17	187	61	37.5	63	37	22	32
18	187.5	54	30.5	57*	34.5	20	30
19	188	—	30.5	56	—	20.5	—
20	188	52.5	31	57.5	38.5	21.5	31
21	188	57	32.5	58.5	40	21.5	—
22	189	52	29.5	55*	36	20	31*
23	191	53	29	57*	35	20.5	—
24	191	53.5	31.5	57	36	23	31.5
25	191.5	53	—	58	34	23	30
26	192	—	29.5	57*	34*	21.5	—
27	192	52	30	56	36	22	31*
28	192	57	30	55.5	37*	20.5	30.5
29	192	53.5	31	56	35.5	21.5	30
30	192	55	33	59	36.5	22	30
31	192.5	57	32.5	57.5	40.5	22.5	
32	193*	52	27.5	—	33	20	—
33	193	62	36	67	43	23.5	35

Cattle — Metacarpus (cont'd)

	1	2	3	4	5	6	7
34	193.5	55	30.5	57	34.5	21	31.5
35	194	52.5	30.5	56	37.5	22	—
36	194	54.5	32	57.5	38	22	31*
37	194*	—	32	62	36	21.5	32
38	195*	53	30*	54*	32*	—	—
39	195	—	34*	58.5	—	—	—
40	195*	65	38	66*	—	24	35*
41	196	57	34	61.5	41.5	21	35
42	197	54.5	30.5	58.5	39.5	20	—
43	197	51.5	31	55	40.5	22.5	30
44	197	57	31	57	38	21.5	32
45	197	58*	33	63	—	21	33*
46	198	52	27.5	54	36	20.5	31
47	198	59	—	60	40	—	32.5
48	198*	56.5	32	58	35	—	32
49	198	57	33.5	—	38	22.5	33*
50	198.5	49	35.5	63	38	—	33
51	199	59.5	32	60.5	43.5	23.5	32.5
52	199	63.5	34.5	66	41	22	34.5
53	199.5	58.5	31.5	60.5	42	22	30.5
54	200*	52.5	29.5	—	36.5	19	—
55	200	56	30	60*	38.5	21	33
56	200	57	31.5	59	40.5	22.5	31.5
57	200*	57	32.5	—	39	23.5	—
58	200	58	33	60	39.5	23	33*
59	200	59	34	62	40	21.5	34*
60	200*	—	33	—	—	23	—
61	200*	54	34	57*	37	—	—
62	200*	—	35	—	38	23	—
63	200.5	56	30	57	38	22.5	32
64	200.5	55	32	62	38	21.5	30
65	201.5	54.5	29	57	36	21.5	31.5
66	202*	56.5	30.5	59	41	21.5	31
67	202	55.5	31	61*	36.5	21.5	—
68	202	56.5	32	57.5	40	21.5	32.5
69	202	58	32.5	61*	37	22	33
70	202	60	34	64.5	39	22	33
71	202	60.5	36.5	65.5	40	22.5	33.5
72	202*	58	—	63	—	23	33*
73	202.5	55	30	55.5	40	21	31.5
74	202.5	57	34	61	37.2	22.5	31.5
75	203*	62	25.5	—	38	22	34*
76	203	56	30	55	38	20.5	31.5
77	203	54.5	31.5	57.5	39*	22.5	34*
78	203	61	35	64.5	39*	22	35*
79	203	62	39	66.5	44	24.5	35.5
80	204	61	31.5	63.5	44	22.5	34.5
81	204	66*	36	68*	42	26	35*
82	204	65	37.5	69.5	45	26	36.5
83	204.5	54	29	58.5	40.5	22	32
84	204.5	52	29.5	57	36	21	31
85	204.5	57	32	59	40	23	31.5
86	204.5	58	33	59.5	37	22	33
87	204.5	60.5	33.5	60.5	38	22	33
88	205	—	31	61.5	—	21	31*
89	205	58.5	32.5	66.5	39.5	22	35
90	205	59.5	34	59	37.5	23.5	33.5
91	205	59.5	35	60	39.5	24	34
92	205*	—	—	—	35	—	—
93	206	—	30.5	59	38*	22.5	33
94	206	59	33	63	40	24.5	36
95	206	57	34	61	37	27	33

	1	2	3	4	5	6	7
96	206	61.5	34.5	63	41.5	23.5	34.5
97	206	65.5	36	70*	42.5	23	36
98	206	63	36.5	71	45	23	38
99	106	67	41	71	43	24.5	36
100	207	56	32	59	38.5	22.5	33.5
101	207*	57	32.5	—	39*	24	32*
102	207	58	33	62.5	42	24	33
103	207.5	62	36	66	38	22	32
104	208	55.5	33	58.5	37.5	23	31
105	208	55	32.5	58.5	37	24	32.5
106	208	58	33	—	40	22	33
107	208	—	33	59*	—	21.5	—
108	208	58	34	62	38.5	23.4	34*
109	208	61.5	37	66	42	25	35
110	208*	—	40	—	—	26	—
111	208.5	57	32	58	39	23	32.5
112	209	59.5	33	61	36.5	22.5	34
113	209	61.5	33.5	64.5	42.5	23	33.5
114	209	61.5	37	66.5	40	22	35
115	209	64.5	37.5	67	44	26.5	36
116	209	62.5	39	67*	41	24	36
117	209.5	53	32	59	36.5	21	33
118	210	58*	31.5	59	36.5	22.5	32
119	210*	—	31.5	—	—	23	34
120	210*	57	32	61	38	24	33.5
121	210*	60	36	—	36.5	—	—
122	210*	67	38	70.5	44	23.5	38*
123	210	66	40	71.5	46	24	36.5
124	210.5	55	32.5	58	39	22	33
125	211	59	32.5	64	41.5	22	34
126	211	67	38	70*	41	26	36
127	211.5	57.5	32	65	41	22.5	36
128	212	58	30	56	34.5	22.5	32
129	212	57	31	60.5	37	21.5	33
130	212*	63*	32.5	—	37	23.5	—
131	212*	58	33	—	37	22.5	—
132	212	59	33	61	37.5	21.5	32.5
133	212	64.5	35.5	69	47	23	37.5
134	212*	—	—	—	—	—	—
135	213	55	32	58	39	23	33.5
136	213	62	33.5	66*	42	23	35*
137	213	57	34.5	60	39.5	23	34
138	213	—	34.5	—	—	25.5	—
139	213	60	36	62.5	42	23.5	33
140	213*	—	40.5	76.5	—	24.5	36*
141	213.5	67	36.5	70	45	25.5	36
142	214*	61.5	35	62	43	23.5	35.5
143	214	64	35.5	67	44	24.5	36
144	214.5	64	36	68.5	42	24	36.5
145	215	69	41	76.5	—	24	38
146	215*	71	41.5	74*	45.5	25	39*
147	215.5	59	31	60	38	25	35
148	216	63	37	67	41.5	24	36
149	216*	64	37.5	—	40	24.5	—
150	217	62	33.5	66.5	40	24	34
151	217	67	37	72.5	47	25.5	38
152	217*	—	39	—	—	25.5	—
153	217.5	57.5	34	60.5	37.5	24.5	34
154	218	61	33.5	65.5	42	21	36
155	218.5	63.5	38.5	67.5	42	24	35.5
156	219.5	69	35	71.5	41	24	38
157	220	68	34	70*	45	24	37.5
158	220	66.5	42.5	76*	45	27	39

	1	2	3	4	5	6	7	
159	221	69.5	38	71.5	47	25.5	38.5	
160	221	69.5	43.5	73	46.5	25	38	
161	221	71	39.5	75*	41.5	25.5	37	
162	221.5	62.5	35.5	69.5	40	24	36	
163	221.5	69	39	72.5	46	26	39	
164	222.5	65	35	68	45	26	35.5	
165	223	63	36	68	42	23.5	36	
166	226	72*	41	72.5	48	26.5	38.5	
167	228	68.5	39.5	72	49	27	37.5	
168	228	71	39.5	77	45.5	29	39	
169	228	71	40	71.5	45.5	27	38.5	
170	231	76	37	72	44	24.5	41	
171	242	71	39.5	68.5	47	26.5	37	w
172	—	43.5	26.5	—	28	—	—	
173	—	45.5	29	—	31	20.5	—	
174	—	46.5	27	—	31.5	—	—	
175	—	47	27.5	—	31	—	—	
176	—	47	—	—	33	—	—	
177	—	47.5	—	—	30.5	—	—	
178	—	47.5	26.5	—	31	—	—	
179	—	48	—	—	28	—	—	
180	—	48	—	—	31	—	—	
181	—	48	—	—	33	—	—	
182	—	48.5	30.5	—	34	—	—	
183	—	49	—	—	30*	—	—	
184	—	49	28	—	30.5	—	—	
185	—	49.5	31	—	34	—	—	
186	—	50	31	—	29	—	—	
187	—	50	—	—	31	—	—	
188	—	50	29.5	—	32.5	—	—	
189	—	50	30.5	—	35.5	—	—	
190	—	50.5	27.5	—	30.5	—	—	
191	—	51	29	—	33.5	—	—	
192	—	51	—	—	34.5	—	—	
193	—	51	28	—	36	19	—	
194	—	51.5	30	—	33	33	—	
195	—	51.5	—	—	34	—	—	
196	—	52	30	—	33	—	—	
197	—	52	—	—	34	—	—	
198	—	52	31	—	35	—	—	
199	—	52*	32	—	35*	—	—	
200	—	52	28.5	—	37	—	—	
201	—	52.5	—	—	31.5	—	—	
202	—	52.5	29	—	32.5	—	—	
203	—	52.5	—	—	33	—	—	
204	—	52.5	30	—	33.5	—	—	
205	—	52.5	—	—	33.5	—	—	
206	—	52.5	27.5	—	34	—	—	
207	—	52.5	31	—	35	—	—	
208	—	53	—	—	32.5	—	—	
209	—	53	—	—	33	—	—	
210	—	53*	—	—	34	—	—	
211	—	53	—	—	35.5	—	—	
212	—	53.5	28.5	—	34	—	—	
213	—	53.5	30	—	35.5	—	—	
214	—	53.5	—	—	35.5	—	—	
215	—	53.5	—	—	37	—	—	
216	—	54	—	—	33	—	—	
217	—	54	—	—	35.5	—	—	
218	—	54	—	—	34	—	—	
219	—	54	—	—	34	—	—	
220	—	54	—	—	34.5	—	—	
221	—	54	—	—	35	—	—	

	1	2	3	4	5	6	7
222	—	54	—	—	36	—	—
223	—	54	—	—	36.5	—	—
224	—	54.5	—	—	32	—	—
225	—	54.5	30.5	—	34.5	—	—
226	—	54.5	—	—	35	—	—
227	—	54.5	28	—	35.5	—	—
228	—	54.5	—	—	36	—	—
229	—	54.5	35	—	37	—	—
230	—	55*	30	—	32.5	—	—
231	—	55*	—	—	32.5	—	—
232	—	55*	31	—	34	—	—
233	—	55	33	—	34	—	—
234	—	55	—	—	34.5	—	—
235	—	55	—	—	35.5	—	—
236	—	55*	—	—	35.5	—	—
237	—	55	—	—	36	—	—
238	—	55	32	—	37	—	—
239	—	55	—	—	37.5	—	—
240	—	55	32.5	—	39	—	—
241	—	55.5	32.5	—	34	—	—
242	—	55.5	—	—	35	—	—
243	—	55,5	—	—	35	—	—
244	—	55.5	—	—	35	—	—
245	—	55.5	—	—	36	—	—
246	—	56*	—	—	33*	—	—
247	—	56*	31	—	33.5	—	—
248	—	56	—	—	33.5	—	—
249	—	56	30	—	34	—	—
250	—	56	32.5	—	35	—	—
251	—	56	33	—	35	—	—
252	—	56	—	—	35.5	—	—
253	—	56	33	—	36	—	—
254	—	56	—	—	36.5	—	—
255	—	56	—	—	37*	—	—
256	—	56	31.5	—	38	22	—
257	—	56	32.5	—	38	—	—
258	—	56	—	—	38	—	—
259	—	56	—	—	38	—	—
260	—	56	32	—	38.5	—	—
261	—	56.5	—	—	34	—	—
262	—	56.5	30	—	34.5	—	—
263	—	56.5	32	—	36.5	—	—
264	—	57	32	—	33	—	—
265	—	57*	31	—	36	—	—
266	—	57	32.5	—	36	—	—
267	—	57	—	—	36.5	—	—
268	—	57	—	—	36.5	—	—
269	—	57	35	—	38	—	—
270	—	57	—	—	38*	—	—
271	—	57	—	—	39	—	—
272	—	57.5	35	—	34.5	—	—
273	—	57.5	—	—	34.5	—	—
274	—	57.5	—	—	34.5	—	—
275	—	57.5	32.5	—	35	—	—
276	—	57.5	32.5	—	35	—	—
277	—	57.5	—	—	35	—	—
278	—	57.5	—	—	39	—	—
279	—	57.5	—	—	41	—	—
280	—	58	33	—	34.5	—	—
281	—	58	33	—	35	—	—
282	—	58	34	—	35	—	—
283	—	58	—	—	35	—	—
284	—	58	—	—	36	—	—

Cattle — Metacarpus (cont'd)

	1	2	3	4	5	6	7
285	—	58	—	—	36	—	—
286	—	58	—	—	36.5	—	—
287	—	58	—	—	37	—	—
288	—	58*	—	—	37*	—	—
289	—	58	33	—	38	—	—
290	—	58	—	—	38	—	—
281	—	58	—	—	39	—	—
292	—	58.8	—	—	36.5	—	—
293	—	58.5	34.7	—	37	23.5	—
294	—	58.5	—	—	37	—	—
295	—	59	—	—	36	—	—
296	—	59	33	—	38	—	—
297	—	59	—	—	38	—	—
298	—	59	34.5	—	39	—	—
299	—	59.5	34	—	37.5	—	—
300	—	59.5	—	—	37.5	—	—
301	—	60	—	—	36	—	—
302	—	60*	—	—	37	—	—
303	—	60	—	—	37.5	—	—
304	—	60	33	—	38.5	—	—
305	—	60	34	—	38*	—	—
306	—	60	—	—	39	—	—
307	—	60	34	—	40	—	—
308	—	60	34	—	40	—	—
309	—	60.5	30.5	—	39	—	—
310	—	61*	—	—	37.5	—	—
311	—	61	—	—	38	—	—
312	—	61	—	—	38.5	—	—
313	—	61.5	35	—	37	—	—
314	—	62	34	—	37.5	—	—
315	—	62	—	—	38.5	—	—
316	—	62	—	—	38.5	—	—
317	—	62	36.5	—	39	24	—
318	—	62	—	—	39	—	—
319	—	62	—	—	40	—	—
320	—	62	—	—	42	—	—
321	—	62.5	—	—	39	—	—
322	—	62.5	34.5	—	40	—	—
323	—	63	28	—	34.5	22	—
324	—	63	35	—	38	21.5	—
325	—	63	34	—	38.5	—	—
326	—	63	—	—	41	—	—
327	—	63	—	—	44	—	—
328	—	64	—	—	38	—	—
329	—	64*	—	—	38*	—	—
330	—	64	29.5	—	38.5	—	—
331	—	64	—	—	39	—	—
332	—	64	—	—	40	—	—
333	—	64	—	—	42	—	—
334	—	64	—	—	44	—	—
335	—	64.5	34.5	—	40	—	—
336	—	64.5	—	—	41	—	—
337	—	65	37.5	—	44	—	—
338	—	66*	—	—	41	—	—
339	—	66	—	—	42	—	—
340	—	67	39.5	—	39	27	—
341	—	67	—	—	41	—	—
342	—	67	—	—	47*	—	—
343	—	67.5	—	—	42	—	—
344	—	67.5	—	—	43	—	—
345	—	67.5	37.5	—	45	—	—
346	—	68	39.5	—	41	—	—
347	—	68	—	—	42	—	—

	1	2	3	4	5	6	7	
348	—	68	—	—	42	—	—	
349	—	68	41	—	45	—	—	
350	—	69	—	—	43.5	—	—	
351	—	69	—	—	45	—	—	
352	—	70	—	—	45	—	—	w
353	—	70*	—	—	42*	—	—	w?
354	—	71.5	—	—	45	—	—	w?
355	—	73	—	—	42*	—	—	
356	—	74	44.5	—	44	—	—	w
357	—	75	—	—	47	—	—	w
358	—	75.5	—	—	45	—	—	w
359	—	—	—	49.5	—	20.5	28	
360	—	—	—	50*	—	18	—	
361	—	—	—	50.5	—	17	26.5	
362	—	—	—	51	—	18.5	26.5	
363	—	—	—	51	—	18.5	27.5	
364	—	—	—	51*	—	18.5	28	
365	—	—	—	51	—	—	30	
366	—	—	—	51.5	—	19	27	
367	—	—	—	51.5	—	—	27.5	
368	—	—	—	51.5	—	20.5	30*	
369	—	—	—	52	—	18.5	27	
370	—	—	—	53	—	18.5	28.5	
371	—	—	—	53	—	20.5	29.5	
372	—	—	—	53	—	21	30	
373	—	—	—	53*	—	21	30*	
374	—	—	—	53.5	—	21.5	31	
375	—	—	—	54	—	18.5	29	
376	—	—	—	54	—	22	30	
377	—	—	—	54.5	—	20	30	
378	—	—	—	54.5	—	19.5	31.5	
379	—	—	—	54.5	—	21.5	31.5	
380	—	—	—	55	—	20.5	30	
381	—	—	—	55	—	22	31	
382	—	—	—	55*	—	21	—	
383	—	—	—	55.5	—	21.5	30	
384	—	—	—	55.5	—	22	30	
385	—	—	—	56	—	18.5	29	
386	—	—	—	56	—	—	30	
387	—	—	—	56	—	21.5	30.5	
388	—	—	—	56	—	—	31	
389	—	—	—	56	—	—	31.5	
390	—	—	—	56	—	—	31.5	
391	—	—	—	56*	—	24	32	
392	—	—	—	56	—	—	32	
393	—	—	—	56	—	21.5	32.5	
394	—	—	—	56	—	19.5	—	
395	—	—	—	56.5	—	22	30*	
396	—	—	—	56.5	—	22	30.5	
397	—	—	—	56.5	—	—	30.5	
398	—	—	—	56.5	—	22	31	
399	—	—	—	56.5	—	21	32.5	
400	—	—	—	57	—	21.5	30.5	
401	—	—	—	57	—	21.5	31.5	
402	—	—	—	57	—	22	32	
403	—	—	—	57	—	22.5	32	
404	—	—	—	57	—	—	32	
405	—	—	—	57	—	—	32	
406	—	—	—	57.5	—	23	31	
407	—	—	—	57.5	—	22	32.5	
408	—	—	—	57.5	—	25.5	34	
409	—	—	—	58	—	21.5	29.5	
410	—	—	—	58	—	22	30*	
411	—	—	—	58*	—	22	30*	

Cattle — Metacarpus (cont'd)

	1	2	3	4	5	6	7
412	—	—	—	58	—	20.5	31
413	—	—	—	58*	—	20.5	31*
414	—	—	—	58	—	21.5	31
415	—	—	—	58	—	23.5	31
416	—	—	—	58	—	21	32
417	—	—	—	58	—	21.5	32
418	—	—	—	58	—	22	32
419	—	—	—	58	—	22	32
420	—	—	—	58	—	22.5	32
421	—	—	—	58	—	23	32
422	—	—	—	58	—	24	32.5
423	—	—	—	58	—	22.5	33*
424	—	—	—	58*	—	23.5	33.5
425	—	—	—	58	—	20	—
426	—	—	—	58	—	22	—
427	—	—	—	58.5	—	20.5	31*
428	—	—	—	58.5	—	22.5	31
429	—	—	—	58.5	—	22	31.5
430	—	—	—	58.5	—	25	32*
431	—	—	—	58.5	—	—	32*
432	—	—	—	58.5	—	21.5	32.5
433	—	—	—	58.5	—	—	33.5
434	—	—	—	59	—	20.5	30
435	—	—	—	59	—	19.5	31
436	—	—	—	59	—	22	31
437	—	—	—	59	—	23	31
438	—	—	—	59	—	22.5	32
439	—	—	—	59	—	23.5	32
440	—	—	—	59	—	24	32
441	—	—	—	59	—	—	32
442	—	—	—	59	—	—	32*
443	—	—	—	59	—	21.5	32.5
444	—	—	—	59	—	22.5	32.5
445	—	—	—	59	—	23	32.5
446	—	—	—	59	—	23	33
447	—	—	—	59	—	23	33
448	—	—	—	59	—	25	33
449	—	—	—	59	—	—	33
450	—	—	—	59	—	23.5	33.5
451	—	—	—	59	—	24	34*
452	—	—	—	59	—	21	—
453	—	—	—	59.5	—	—	31
454	—	—	—	59.5	—	—	31*
455	—	—	—	59.5	—	22.5	32*
456	—	—	—	59.5	—	—	32
457	—	—	—	59.5	—	21.5	33
458	—	—	—	59.5	—	22	33
459	—	—	—	59.5	—	24.5	34
460	—	—	—	59.5	—	25.5	36
461	—	—	—	60*	—	20.5	30*
462	—	—	—	60	—	21	31
463	—	—	—	60	—	21	31.5
464	—	—	—	60	—	—	32
465	—	—	—	60	—	24.5	32
466	—	—	—	60	—	23	32.5
467	—	—	—	60	—	22	33
468	—	—	—	60	—	23	34*
469	—	—	—	60	—	23.5	34
470	—	—	—	60	—	24.5	34.5
471	—	—	—	60	—	25	34.5
472	—	—	—	60	—	19.5	—
473	—	—	—	60	—	22.5	—
474	—	—	—	60.5	—	22	32*

	1	2	3	4	5	6	7
475	—	—	—	60.5	—	23	32
476	—	—	—	60.5	—	—	32
477	—	—	—	60.5	—	22.5	33
478	—	—	—	60.5	—	23.5	33.5
479	—	—	—	60.5	—	—	33.5
480	—	—	—	60.5	—	—	34
481	—	—	—	60.5	—	—	34
482	—	—	—	60.5	—	—	34
483	—	—	—	61*	—	20.5	31.5
484	—	—	—	61	—	22	32.5
485	—	—	—	61	—	—	32.5
486	—	—	—	61	—	23	34
487	—	—	—	61	—	—	34
488	—	—	—	61	—	24	34.5
489	—	—	—	61*	—	22.5	—
490	—	—	—	61.5	—	22.5	32
491	—	—	—	61.5	—	—	32
492	—	—	—	61.5	—	21.5	32.5
493	—	—	—	61.5	—	23	33
494	—	—	—	61.5	—	23.5	33
495	—	—	—	61.5	—	23.5	33
496	—	—	—	61.5	—	25.5	33*
497	—	—	—	61.5	—	23.5	33.5
498	—	—	—	61.5	—	24	35
499	—	—	—	62	—	23	32
500	—	—	—	62*	—	21.5	33
501	—	—	—	62	—	24	33
502	—	—	—	62	—	—	33*
503	—	—	—	62*	—	23	34
504	—	—	—	62	—	24.5	35
505	—	—	—	62	—	24.5	35
506	—	—	—	62*	—	—	35*
507	—	—	—	62	—	23.5	—
508	—	—	—	62.5	—	23	32.5
509	—	—	—	62.5	—	—	32.5
510	—	—	—	62.5	—	23	34
511	—	—	—	62.5	—	—	34
512	—	—	—	62.5	—	23.5	35.5
513	—	—	—	62.5	—	24.5	35.5
514	—	—	—	62.5	—	23	—
515	—	—	—	63*	—	21.5	33*
516	—	—	—	63	—	—	33
517	—	—	—	63	—	23	33.5
518	—	—	—	63	—	23.5	33.5
519	—	—	—	63	—	—	35
520	—	—	—	63	—	—	36
521	—	—	—	63*	—	21.5	—
522	—	—	—	63*	—	23	—
523	—	—	—	63.5	—	24	34
524	—	—	—	64	—	—	33.5
525	—	—	—	64	—	22	33.5
526	—	—	—	64	—	23.5	34.5
527	—	—	—	64	—	25	34.5
528	—	—	—	64.5	—	23.5	33
529	—	—	—	64.5	—	21.5	34.5
530	—	—	—	65*	—	24.5	35*
531	—	—	—	65	—	—	35
532	—	—	—	65	—	—	36
533	—	—	—	65.5	—	—	32
534	—	—	—	66	—	22	33
535	—	—	—	67	—	—	34.5
536	—	—	—	67	—	—	35
537	—	—	—	67	—	23	36

Cattle — Metacarpus (cont'd)

	1	2	3	4	5	6	7
538	—	—	—	67	—	25	36
539	—	—	—	67	—	26	36
540	—	—	—	67	—	—	37.5
541	—	—	—	68	—	27	36.5
542	—	—	—	68*	—	23	37
543	—	—	—	68*	—	—	38
544	—	—	—	68.5	—	—	35
545	—	—	—	68.5	—	25	35.5
546	—	—	—	68.5	—	—	35.5
547	—	—	—	69	—	26	36
548	—	—	—	69	—	26	36.5
549	—	—	—	69.5	—	25.5	37.5
550	—	—	—	70	—	23	35
551	—	—	—	70	—	24	36.5
552	—	—	—	70	—	—	36.5
553	—	—	—	70	—	—	38
554	—	—	—	70.5	—	—	37
555	—	—	—	70.5	—	26.5	35
556	—	—	—	71	—	—	36.5
557	—	—	—	72	—	26	37
558	—	—	—	74	—	—	38
559	—	—	—	74	—	—	40*
560	—	—	—	75	—	25.5	36.5
561	—	—	—	75	—	—	40.5
562	—	—	—	75.5	—	26.5	38

Cattle — Femur

Measurements: 1. length to the trochanter major
2. length to caput
3. width of proximal epiphysis
4. smallest width of diaphysis
5. width of distal epiphysis
6. diameter of proximal epiphysis
7. smallest diameter of diaphysis
8. diameter of distal epiphysis

	1	2	3	4	5	6	7	8
1	421	393	141	40	108	83	44	135
2	421	397	—	40	110	—	42	132
3	423	393	140	41	105*	91	42	—
4	—	315*	—	25	—	—	30	—

Cattle — Tibia

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	297	81	31.5	52.5	76	21.5	40
2	302*	—	33	55	—	24	42
3	303	80	32	52	75	22.5	39
4	315*	—	35	—	—	23.5	—
5	325	—	—	57	—	25.5	43
6	325	—	39.5	60	—	24	46
7	326	—	32	54.5	—	22.5	43.5

	1	2	3	4	5	6	7
8	342	—	—	60	—	—	44.5
9	348	—	39	60.5	—	25.5	47
10	361	—	39	62	—	27	45.5
11	399	112*	46	71	108	29.5	51.5
12	401	—	43	68.5	—	30	51
13	410	—	47	77	—	32	52.5
14	—	94	—	—	94	—	—
15	—	107	—	—	102	—	—
16	—	—	29.5	48	—	23.5	36
17	—	—	28.5	48.5	—	20.5	35
18	—	—	—	49	—	—	36
19	—	—	—	49.5	—	—	39
20	—	—	—	52	—	—	41
21	—	—	—	52	—	—	43
22	—	—	—	52.5	—	—	39
23	—	—	—	52.5	—	—	40.5
24	—	—	—	53	—	—	38
25	—	—	—	53.5	—	—	39.5
26	—	—	32.5	54.5	—	23.5	39.5
27	—	—	—	54.5	—	—	40.5
28	—	—	35	54.5	—	23.5	42
29	—	—	—	55	—	—	40.5
30	—	—	34.5	55	—	23	42.5
31	—	—	—	55.5	—	—	44
32	—	—	33	56	—	24	41.5
33	—	—	—	56	—	—	42
34	—	—	—	56	—	—	42.5
35	—	—	—	56	—	—	43.5
36	—	—	33	56	—	22.5	45
37	—	—	—	56.5	—	—	42
38	—	—	—	57	—	—	42.5
39	—	—	32.5	57	—	23	43
40	—	—	—	57	—	24	44
41	—	—	—	57	—	25.5	44.5
42	—	—	36	57	—	26	45
43	—	—	—	57.5	—	—	42.5
44	—	—	—	57.5	—	—	43
45	—	—	33	57.5	—	25	43.5
46	—	—	—	57.5	—	—	43.5
47	—	—	—	57.5	—	—	44
48	—	—	—	58	—	—	42
49	—	—	—	58	—	—	42.5
50	—	—	—	58	—	25.5	43
51	—	—	—	58	—	—	43.5
52	—	—	—	58	—	—	45.5
53	—	—	—	58	—	—	46
54	—	—	35.5	58.5	—	24	44
55	—	—	—	58.5	—	—	44
56	—	—	35.5	59	—	25	41
57	—	—	—	59	—	—	43
58	—	—	—	59	—	—	44.5
59	—	—	35	59	—	24	45
60	—	—	—	59	—	—	46
61	—	—	—	59	—	—	48
62	—	—	35.5	59.5	—	26	44
63	—	—	—	59.5	—	—	44
64	—	—	—	59.5	—	—	44
65	—	—	—	59.5	—	—	44.5
66	—	—	—	60*	—	—	44*
67	—	—	—	60	—	—	44.5
68	—	—	—	60	—	—	44.5
69	—	—	—	60	—	—	45
70	—	—	—	60	—	—	45

Cattle — Tibia (cont'd)

	1	2	3	4	5	6	7
71	—	—	—	60	—	—	45.5
72	—	—	37	60	—	26	46*
73	—	—	—	60	—	—	46
74	—	—	—	60	—	—	46
75	—	—	—	60*	—	—	46
76	—	—	—	60	—	—	47
77	—	—	—	60.5	—	—	45
78	—	—	38	60.5	—	25.5	45.5
79	—	—	—	60.5	—	—	45.5
80	—	—	37	60.5	—	—	46
81	—	—	—	60.5	—	—	46*
82	—	—	—	60.5	—	—	46.5
83	—	—	—	60.5	—	—	49
84	—	—	—	61	—	—	44
85	—	—	—	61	—	—	45
86	—	—	—	61	—	—	45.5
87	—	—	—	61	—	—	46
88	—	—	—	61	—	—	47
89	—	—	—	61	—	—	47
90	—	—	—	61	—	—	47
91	—	—	—	61	—	—	48
92	—	—	—	61	—	—	49.5
93	—	—	—	61.5	—	—	46
94	—	—	—	61.5	—	—	46.5
95	—	—	—	61.5	—	26.5	47
96	—	—	—	61.5	—	—	47
97	—	—	—	61.5	—	26.5	48
98	—	—	—	61.5	—	—	48
99	—	—	—	62*	—	—	44
100	—	—	—	62	—	—	47.5
101	—	—	—	62	—	—	48
102	—	—	—	62	—	—	49
103	—	—	—	62.5	—	—	44.5
104	—	—	—	62.5	—	—	46.5
105	—	—	—	62.5	—	—	47
106	—	—	—	62.5	—	—	47
107	—	—	—	63	—	26	45
108	—	—	—	63	—	—	46
109	—	—	—	63	—	—	46.5
110	—	—	—	63*	—	—	47
111	—	—	39	63	—	28	48
112	—	—	—	63	—	—	48
113	—	—	—	63	—	—	49
114	—	—	—	63	—	—	50
115	—	—	38	63.5	—	24	45
116	—	—	—	63.5	—	—	46
117	—	—	—	63.5	—	—	46
118	—	—	38	63.5	—	26.5	47.5
119	—	—	—	63.5	—	—	47.5
120	—	—	—	63.5	—	—	48
121	—	—	—	64	—	—	46.5
122	—	—	39	64	—	27	47.5
123	—	—	—	64	—	—	48
124	—	—	—	64.5	—	—	48
125	—	—	39.5	64.5	—	26	48.5
126	—	—	—	64.5	—	—	50
127	—	—	—	65	—	—	47.5
128	—	—	38	65	—	27	48
129	—	—	—	65	—	—	48
130	—	—	—	65	—	—	48
131	—	—	40	65	—	28	48.5
132	—	—	—	65	—	—	48.5
133	—	—	38	65	—	26	49

	1	2	3	4	5	6	7	
134	—	—	—	65	—	—	50	
135	—	—	—	65	—	—	50	
136	—	—	43	65	—	29	50.5	
137	—	—	—	65	—	—	51.5	
138	—	—	—	65.5	—	—	47	
139	—	—	—	65.5	—	—	48	
140	—	—	—	65.5	—	—	50.5	
141	—	—	—	65.5	—	—	51	
142	—	—	—	65.5	—	—	53	
143	—	—	42.5	66*	—	30	47	
144	—	—	—	66	—	—	47.5	
145	—	—	—	66	—	—	48.5	
146	—	—	44	66	—	29	50	
147	—	—	—	66	—	—	50.5	
148	—	—	—	66	—	—	50.5	
149	—	—	—	66.5	—	—	46.5	
150	—	—	—	66.5	—	—	49	
151	—	—	41	67	—	27	48.5	
152	—	—	—	67	—	—	49	
153	—	—	—	67	—	—	49	
154	—	—	—	67.5	—	—	49.5	
155	—	—	—	68*	—	—	50*	
156	—	—	—	68	—	—	51	
157	—	—	—	68	—	—	51	
158	—	—	42.5	68	—	28	52	
159	—	—	—	68	—	—	52	
160	—	—	—	68	—	—	52	
161	—	—	—	68.5	—	—	51	
162	—	—	—	68.5	—	—	52.5	
163	—	—	—	69	—	—	49	
164	—	—	—	69	—	—	49.5	
165	—	—	41	69	—	29	50	
166	—	—	—	69	—	—	50.5	
167	—	—	—	69	—	—	51	
168	—	—	—	69	—	—	53	
169	—	—	—	69	—	—	54*	
170	—	—	44	69	—	29	55	
171	—	—	—	69	—	—	55	
172	—	—	42	69.5	—	29	50	
173	—	—	—	70	—	—	50	
174	—	—	45	70*	—	33	51	
175	—	—	—	70	—	—	52	
176	—	—	46	70	—	29	53	
177	—	—	—	70	—	—	53	
178	—	—	44	71	—	—	53	
179	—	—	45	71	—	34	53.5	
180	—	—	44	71	—	28	55	
181	—	—	—	71	—	—	55	
182	—	—	—	72	—	—	52	
183	—	—	—	72	—	—	53	
184	—	—	—	72	—	—	54.5	w
185	—	—	—	72*	—	—	57	
186	—	—	—	72.5	—	28.5	54	
187	—	—	—	73	—	—	54.5	
188	—	—	44.5	73	—	28	56.5	
189	—	—	—	74	—	—	58.5	
190	—	—	—	74.5	—	—	54.5	
191	—	—	—	74.5	—	—	55	
192	—	—	—	75.5	—	—	55.5	
193	—	—	—	76	—	—	53	w
194	—	—	—	76	—	—	57	w
195	—	—	—	76	—	—	57	w
196	—	—	—	77	—	—	57.5	w

Measurements: 1. greatest length
2. greatest width
3. greatest diameter

	1	2	3
1	53.5	36.5	32.5
2	55.5	35.5	31.5
3	55.5	37.5	33
4	55.5	38	37
5	56.5	37	34
6	56.5	39	33.5
7	57.5	37	33
8	58	38	35.5
9	58	39	32.5
10	58	39.5	33
11	58	40	32.5
12	58	40	33.5
13	58	42	33.5
14	58.5	40	34.5
15	58.5	40.5	32.5
16	59	39	33
17	59	39	33.5
18	59	40	33
19	59	40	35
20	59	43	34.5
21	59.5	38.5	—
22	59.5	41	35.5
23	60*	—	—
24	60	40.5	33.5
25	60	41.5	32.5
26	60	41.5	34
27	60	42	35
28	60	45	34
29	60.5	41.5	36.5
30	60.5	42.5	32.5
31	61	39.5	35.5
32	61	40	35
33	61	40.5	34.5
34	61	40.5	35
35	61	41	34.5
36	61	42.5	36
37	61.5	40	—
38	61.5	40.5	36
39	61.5	41.5	36.5
40	61.5	43	36
41	61.5	43	36*
42	61.5	43.5	37
43	61.5	44.5	35.5
44	62*	39*	—
45	62	40	35.5
46	62	40.5	—
47	62	42.5	36
48	62	43	35
49	62	43	37.5
50	62	43	37.5
51	62	44.5	36
52	62.5	39	34
53	62.5	41	37
54	62.5	42	43.5
55	62.5	43.5	36
56	62.5	44	34.5
57	62.5	45.5	37
58	63	42	36
59	63	42.5	35
60	63	42.5	36.5
61	63	42.5	37
62	63	44	37
63	63	44.5	35.5
64	63*	45	—
65	63*	—	37
66	63.5	42	37
67	64	41.5	—
68	64	41.5	36
69	64	42.5	34
70	64	42.5	38.5
71	64	43	36.5
72	64	44.5	—
73	64	44.5	34.5
74	64	44.5	37
75	64	47.5	38
76	64	—	35.5
77	64.5	42	37.5
78	64.5	43	36
79	64.5	43	36
80	64.5	43.5	38
81	64.5	45.5	37
82	65	42.5	38
83	65	42.5	39
84	65	43	36
85	65	43	37*
86	65	43	37
87	65	43	37.5
88	65*	43	37.5
89	65	43.5	37
90	65	44	37
91	65*	44	37
92	65	44	37.5
93	65	44.5	38
94	65	45	38
95	65	45	—
96	65	45	—
97	65	45.5	36
98	65	46	39
99	65	46.5	36.5
100	65	46.5	—
101	65	47	38
102	65.5	43	38
103	65.5	43.5	37.5
104	65.5	45	36
105	65.5	45.5	36
106	65.5	46	38
107	65.5	46	40
108	65.5	48*	41
109	66	43	36.5
110	66	44	35.5
111	66	44.5	36
112	66	44.5	38
113	66	44.5	38
114	66	44.5	38
115	66	45	37.5
116	66	45	40
117	66	46	—
118	66.6	44	39

	1	2	3
119	66.5	45	37.5
120	66.5	45	38
121	66.5	46	39
122	66.5	46.5	38
123	66.5	47.5	37.5
124	66.5	48	38.5
125	66.5	48.5	38.5
126	66.5	49	37
127	66.5	49	39
128	67	42	36.5
129	67	42.5	38
130	67	43	39
131	67	45	37.5
132	67	45*	39
133	67	45	40
134	67	45*	—
135	67	46	38
136	67	46*	—
137	67	46.5	38.5
138	67	48	38
139	67	50	40.5
140	67	—	—
141	67.5	44	38.5
142	67.5	45	39
143	67.5	45	39
144	67.5	45.5	37.5
145	67.5	45.5	38
146	67.5	45.5	39.5
147	67.5	47	38.5
148	67.5	47	—
149	67.5	47.5	42
150	68	44	39
151	68	44.5	38
152	68	45.5	37.5
153	68	46	37
154	68*	48*	—
155	68	48.5	39
156	68	52.5	40
157	68.5	44.5	39.5
158	68.5	44.5	—
159	68.5	45*	40.5
160	68.5	46	37.5
161	68.5	46	39.5
162	68.5	46.5	39.5
163	68.5	47	41
164	68.5	48	39.5
165	68.5	48	42*
166	68.5	48.5	38.5
167	68.5	48.5	41.5
168	68.5	49	38.5
169	68.5	50.5	40
170	68.5	—	—
171	69	44.5	39.5
172	69	46	39
173	69	46.5	41.5
174	69	47	40
175	69	48	43
176	69	49	—
177	69	49.5	38
178	69	50	40
179	69	50	41.5
180	69.5	46*	38.5
181	69.5	46	40.5
182	69.5	46	40.5
183	69.5	47.5	39.5
184	69.5	47.5	43
185	69.5	48	41
186	69.5	50	39.5
187	70	44	38.5
188	70	46	41
189	70	46.5	40
190	70	47	43
191	70	47.5	40.5
192	70*	48	—
193	70*	49.5	—
194	70	49.5	40.5
195	70	50.5	41
196	70	53*	41
197	70.5	47.5	43
198	70.5	48	41
199	70.5	49	37.5
200	70.5	49	40
201	70.5	50	41.5
202	70.5	51.5	42
203	71	46.5	41
204	71	47.5	39.5
205	71	47.5	40
206	71	48.5	—
207	71	49	41
208	71	49	41.5
209	71	49	42.5
210	71	50	41
211	71	50	41
212	71	50.5	41
213	71	51	41.5
214	71	51.5	43
215	71.5	48	42
216	71.5	49	41
217	71.5	49	41
218	71.5	50	40
219	71.5	50	41
220	71.5	53	43.5
221	72	46.5	39
222	72	48	40
223	72	49	41
224	72	49.5	41
225	72	49.5	42
226	72	55.5	43
227	72	56	44
228	72.5	47	41
229	72.5	48	42
230	72.5	50.5	40
231	72.5	50.5	41
232	72.5	51	—
233	72.5	53	40.5
234	73	47	42
235	73	47*	42
236	73	49	40.5
237	73*	49.5	—
238	73	51	41.5
239	73	53	42
240	73.5	50	42
241	73.5	50*	42
242	73.5	50.5	43
243	74	51	40
244	74	51.5	40

Cattle — Astragalus (cont'd)

	1	2	3	
245	74	51.5	43	
246	74	—	—	
247	74.5	54	44	
248	75	48	—	
249	75	51*	41.5	
250	75	51	43.5	
251	75*	51	44.5	
252	75	51	45	
253	76	53.5	45	
254	76	55	48	
255	76.5	54.5	45	
256	77	53	44.5	
257	77	55.5	44.5	
258	78*	—	—	
259	78.5	52.5	45.5	
260	78.5	55	45.5	
261	78.5	56.5	48	
262	78.5	57	47.5	
263	79*	54	45.5	
264	79	55.5	43.5	
265	79.5	52	—	
266	80*	56.5	46.5	
267	84	60	49	w

Cattle — Calcaneus

Measurements: the same as those of the astragalus

	1	2	3
1	110.5	—	45
2	111	35	46*
3	120	39.5	51.5
4	120*	41	46
5	120	—	—
6	121	41.5	50.5
7	121	43	53
8	121.5	39	50*
9	122	40	48
10	122.5	43	51
11	123	39	44
12	123.5	40	44
13	124	37	47
14	124	40	41
15	124	40	48.5
16	124.5	41	50.5
17	125	42.5	51
18	125	—	—
19	125.5	40	47.5
20	125.5	41	48
21	125.5	41	55
22	125.5	42	—
23	125.5	—	—
24	126	39.5	51.5
25	126.5	41	49
26	126.5	42	50
27	126.5	42.5	51.5
28	127	41	53.5
29	127*	42.5	50
30	127	44	—
31	127	46	51
32	127.5	41	47.5
33	127.5	44	54
34	127.5	45	52
35	128	40.5	52
36	128	41.5	49
37	128	42	53
38	128.5	41.5	44
39	128.5	43	48.5
40	128.5	43.5	—
41	129	39.5	51
42	129*	42.5	—
43	129	44	47.5
44	130	43.5	55
45	130*	45	—
46	130	46	52
47	130	46	—
48	130*	—	—
49	131	42	53
50	131	42.5	52
51	131	43	54
52	132	40.5	53.5
53	132	43	56
54	132	43	56
55	132*	47	53
56	132	—	—
57	132.5	43	46
58	133	41.5	50
59	133	42	—
60	133	44	50

Cattle — Calcaneus (cont'd)

	1	2	3
61	133	44.5	55
62	133*	45	57
63	133	—	—
64	133.5	43	49
65	133.5	43	54
66	134	43	52
67	134*	44	49
68	134	44	56
69	134	46.5	51
70	134	48	55
71	134.5	42	51
72	135	43*	45
73	135	44	46
74	135	44	56
75	135*	—	—
76	136	44	—
77	136.5	41	55
78	136.5	—	—
79	137	41	52
80	137	45.5	54
81	137	—	—
82	137*	—	—
83	138	42*	51
84	138	46	55
85	138*	46	55
86	138.5	46	52
87	139.5	45	55
88	140.5	—	55.5
89	141	45	54.5
90	141	47	—
91	141.5	48	61.5
92	141.5	50	60
93	142*	42	40
94	142	46.5	55
95	142*	53	—
96	142	—	—
97	143	47	52
98	144	47	59
99	144	49	51
100	144	49	60
101	144	49	60
102	144	50	63
103	145	46	58
104	146	47.5	52
105	146	49	56
106	146	—	—
107	147	48	61
108	147	49	51
109	147	50	58
110	147	—	60
111	147.5	50	59
112	148	48	57
113	148*	49	50
114	148	52	58
115	149.5	51	59
116	150	47	57
117	150	51	57
118	150	52	67
119	150.5	52.5	58.5
120	151	48.5	60.5
121	151	49	54
122	151	51	55
123	151.5	50	63
124	152	48	62
125	152	51	57
126	152	51.5	58
127	155.5	49	61 w
128	156	50	52
129	156	52.5	—
130	156	53	60
131	156*	55	63
132	156	55.5	59
133	160	53	54.5
134	161	50	64
135	167	58	67 w
136	169	56	64* w

Cattle — Metatarsus

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	197	38	20	44.5	37.5	20	25.5
2	199.5	—	20	44.5	—	19.5	25.5
3	200*	42*	21.5	—	38.5	19	26.5
4	202*	40*	23	48.5	39.5	21.5	27*
5	205*	45	24.5	50	41	23.5	30*
6	205.5	51.5	27	57	48	23.5	31
7	207	39.5	20.5	44.5	39	20	25.5
8	209.5	42.5	22.5	48.5	41	20	29
9	210	48	26	55	44.5	24	30*
10	211	44.5	22.5	50.5	42.5	22	30.5
11	212*	—	25.5	51*	46	23	29
12	212.5	44	22	50.5	41	22	28
13	213	44	23	50	42	25	29

Cattle — Metatarsus (cont'd)

	1	2	3	4	5	6	7
14	213	44	24	49.5	41.5	23.5	30
15	213*	46*	25	54*	46.5	23.5	29.5
16	213*	—	—	53	—	22.5	30*
17	213*	—	—	53	—	22.5	30*
18	214	47.5	25	—	43.5	22	—
19	216	44	24.5	51	42.5	22	28
20	216	44	25	50.5	43.5	23	33
21	216*	—	26*	50.5	—	22.5	29*
22	217*	—	25	56	—	24.5	30*
23	217	40.5	23	48*	—	20	28
24	217*	46*	25.5	52	—	22.5	30
25	217.5	51	28	58.5	46	25	33
26	218	45	24	48	45	22	29.5
27	219	43	21.5	49.5	42	21.5	28.5
28	219	41	22	47*	41	22	27
29	219	45	25	51	47	24	30
30	219	45.5	27.5	58	45	25	32
32	220*	—	28	59*	—	24.5	—
33	221.5	47.5	24.5	54	44.5	23	31*
34	222*	—	24	55.5	—	23.5	31.5
35	222	44.5	25	51.5	45	24	30.5
36	222	46.5	25	50.5	43	23	28.5
37	222*	49	25	53	—	24	29
38	222	45.5	28	52	45	23	30
39	223	44	23	49	41	23	29*
40	223*	44	25	—	45	24.5	—
41	224	—	24.5	54	—	25	31.5
42	224	44.5	25.5	51	43.5	24	30.5
43	224	46	26	55*	44	24.5	30
44	224*	43	26	52	40.5	24	30
45	224	48	27	54	45	24	31
46	225	49	26	58	45	24.5	30.5
47	225*	54	28	—	—	24.5	34
48	225.5	48	28	54.5	45.5	24.5	31.5
49	226*	47.5	28	62	44	25	30.5
50	227*	—	23.5	52	—	23	—
51	227	48	26	54	46.5	24	33.5
52	227	50	27	56.5	48.5	26	34.5
53	227*	45.5	27	57.5	45.5	26	31.5
54	227*	51	30.5	59.5	49.5	27	32
55	228	49	24.5	52.5	45.5	25.5	31.5
56	228*	47	26.5	56*	44*	25	32
57	228*	—	26	54	—	25	31.5
58	228	48	27	53	45	—	—
59	228*	52	29.5	57.5	48.5	26.5	34
60	229.5	49.5	26.5	55	48.5	24.5	32
61	230	47	25	53.5	46	24	31
62	230*	50.5	26	56.5	48	26	32
63	230*	—	26.5	54	45	24.5	32.5
64	230*	—	27.5	54	45	25	30.5
65	230	49	28	55.5	48	26	32
66	230*	50.5	28.5	60*	49	27	31
67	230.5	48	26.5	53.5	46*	25	32
68	231	49	25.5	54.5	44.5	25	31
69	231*	47.5	26	52*	46	26	30.5
70	231*	—	27	54*	—	25.5	31*
71	231.5	49	28	57	47	26	33
72	232*	47	24	56*	45	25	32*
73	232*	—	26.5	57	—	25.5	31.5
74	232*	—	27	—	—	24	—
75	232	47.5	27.5	54	46	25.5	32.5
76	232*	—	28	58*	—	26	—
77	232*	—	27.5	54.5	—	26.5	32.5

	1	2	3	4	5	6	7
78	232*	48	28.5	55.5	47	25.5	33*
79	232*	—	29	57	—	29	32*
80	233*	46.5	25	53.5	46	24.5	31.5
81	233*	—	25.5	53	—	23.5	31
82	233*	47.5	26	—	44	25	—
83	233	48	26	55.5	46	25	32
84	233	47.5	27	54.5	45.5	25	32
85	233	48	28.5	55	46	26	32.5
86	233	55	31	63.5	52	28	34
87	234*	43	23.5	52.5	43	23	31
88	234	49.5	27	54	54.5	25.5	31.5
89	234	47	27	52.5	45.5	23	32.5
90	234	50	27	56.5	46.5	26	33
91	234	50	27.5	57.5	49	24.5	33.5
92	234.5	50	29	61*	50	27	33
93	235*	48	26	57	48	26	33*
94	235*	45.5	27	55.5	47	25	31.5
95	235	48.5	27.5	53.5	46.5	25	32
96	235*	—	28	—	—	27	—
97	235	50.5	33	—	50.5	—	34.5
98	235*	—	—	—	—	—	—
99	235.5	49	28	57	47	26	34
100	236*	55	31	64	52	29.5	35
101	236.5	49	28	57	48	25	32
102	237	50*	27.5	55	—	26	34
103	237*	51	29.5	63	52	28	35
104	237.5	48.5	27	56	46.5	26.5	32.5
105	237.5	51.5	28.5	58.5	49	27	34
106	238	—	27	57	—	26.5	—
107	238*	55	31	63	50*	27.5	35
108	238	54.5	31.5	65.5	50	29.5	36.5
109	238.5	50.5	26	55	49	26	33
110	239.5	50.5	31.5	61.5	49.5	28	34
111	240*	48	26	53	45	25	32
112	240*	51	27	58.5	50	25.5	33
113	240*	—	27	55	—	27.5	32
114	240*	—	28	59	—	25	33
115	240*	—	31	60.5	—	28.5	34.5
116	240	48.5	29	—	48	—	—
117	240*	56.5	29	62	55*	27	35*
118	240	50.5	30	57	48.5	27	33
119	240.5	49	26.5	55.5	46	24	32
120	241	47	24.5	54.5	47	24.5	32.5
121	241	58.5	32.5	65.5	54.5	28	35
122	242	51	25.5	57	45	27	33
123	242*	47	26.5	54	45	27	33
124	242*	55	31	62.5	54	29.5	33.5
125	242*	55	31.5	66	53.5	28.5	35
126	242.5	46.5	26	52	40.5	24	30
127	242.5	50.5	29	57	47	27	33
128	243*	50*	29	58	48*	26.5	33.5
129	244	56.5	31	78	50	29.5	41
130	244	55	32.5	65	53	28.5	35.5
131	245	48.5	28	58	49	27	33
132	245*	58	31.5	64	56.5	28	37
133	246	52	29	56	49	27.5	32.5
134	247*	55.5	30	65.5	52	26	35
135	247	51.5	31	60.5	53	29	35
136	248	51.5	28	57.7	49.5	27.5	34
137	248	55.5	29.5	66	56	28.5	35
138	249	49.5	29	58	46	26.5	33
139	250*	48	28.5	56.5	48	26.5	33.5
140	250*	53.5	30	60.5	52	29	36

Cattle — Metatarsus (cont'd)

	1	2	3	4	5	6	7	
141	250	53.5	31	60.5	51	28.5	35	
142	250*	59.5	36	—	55.5	—	—	
143	250.5	49	27	53.5	45.5	26	32	
144	251	51	29.5	59	48	26	34*	
145	251	60	31.5	65.5	50	29.5	36.5	
146	252	59	30.5	65	53	28.5	36.5	
147	252	57.5	33	67.5	57	27.5	37	
148	252*	56	33.5	—	51	31.5	—	
149	252*	63	36	78	57*	31.5	40	W
150	253*	54.5	29	65	55	28	35*	
151	253*	54	30	63.5	—	28	36	
152	253*	55	30	64	53	29.5	37	
153	253	55	33	65.5	52.5	30.5	38*	
155	254*	55	29	61.5	—	29.5	36	
156	254	52	30.5	62	53	28.5	34.5	
157	254	56	31	62	49.5	29.5	35*	
158	256*	58	32	70	—	29	38	
159	257*	—	29	67	—	29	36.5	
160	258	59	31	67	55.5	28	37	
161	259	52	29	63*	52	30	36.5	
162	262*	57	30	67	52	32	—	
163	263	59.5	32	70.5	55	31	39.5	
164	—	39.5	20	—	37	—	—	
165	—	40	21.5	—	37	—	—	
166	—	40	—	—	39	—	—	
167	—	40.5	25	—	39	—	—	
168	—	40.5	24	—	40.5	—	—	
169	—	41.5	—	—	39	—	—	
170	—	41*	—	—	41*	—	—	
171	—	41	20	—	41.5	—	—	
172	—	41.5	23.5	—	40.5	—	—	
173	—	41.5	—	—	41	—	—	
174	—	42	23.5	—	39	—	—	
175	—	42	23	—	39.5	—	—	
176	—	42	—	—	40.5	—	—	
177	—	42	21	—	41.5	—	—	
178	—	42.5	29	—	40	—	—	
179	—	42.5	—	—	40	—	—	
180	—	42.5	—	—	40.5	—	—	
181	—	42.5	23.5	—	41	—	—	
182	—	42.5	—	—	41.5	—	—	
183	—	42.5	—	—	42.5	—	—	
184	—	43	23	—	39.5	21.5	—	
185	—	43	22	—	41	22	—	
186	—	43	24.5	—	42	—	—	
187	—	43.5	22	—	40	—	—	
188	—	43.5	23	—	40	—	—	
189	—	43.5	24.5	—	43*	—	—	
190	—	43.5	25	—	43	—	—	
191	—	43.5	24	—	45	—	—	
192	—	44*	23.5	—	40	—	—	
193	—	44	—	—	40.5	—	—	
194	—	44*	—	—	41	—	—	
195	—	44	22.5	—	41.5	—	—	
196	—	44	23	—	42	—	—	
197	—	44	26.5	—	42.5	—	—	
198	—	44.5	—	—	42	—	—	
199	—	44.5	23.5	—	43.5	—	—	
200	—	45	25.5	—	41*	—	—	
201	—	45*	25	—	42*	—	—	
202	—	45	24	—	43	—	—	
203	—	45	25	—	43	—	—	
204	—	45	24.5	—	44	—	—	

	1	2	3	4	5	6	7
205	—	45	—	—	46	—	—
206	—	45.5	27.5	—	44	—	—
207	—	45.5	—	—	44	—	—
208	—	45.5	24	—	45.5	—	—
209	—	45.5	—	—	45.5	—	—
210	—	45.5	—	—	45.5	—	—
211	—	45.5	—	—	45.5	—	—
212	—	46	25.5	—	42	—	—
213	—	46	27	—	43	—	—
214	—	46	—	—	43	—	—
215	—	46	27	—	44	—	—
216	—	46*	27	—	44*	—	—
217	—	46	—	—	44	—	—
218	—	46	25.5	—	45*	—	—
219	—	46	—	—	45	—	—
220	—	46	—	—	45.5	—	—
221	—	46	25.5	—	46	—	—
222	—	46	26	—	46	—	—
223	—	46	—	—	48	—	—
224	—	46.5	—	—	43.5	—	—
225	—	46.5	—	—	43.5	—	—
226	—	46.5	26	—	44	—	—
227	—	46.5	27.5	—	46	—	—
228	—	46.5	—	—	46	—	—
229	—	46.5	—	—	47.5	—	—
230	—	46.5	—	—	48	—	—
231	—	47	27	—	43.5	—	—
232	—	47	25	—	44	—	—
233	—	47	27	—	47	—	—
234	—	47	—	—	45	—	—
235	—	47	—	—	45	—	—
236	—	47	—	—	45	—	—
237	—	47	—	—	46	—	—
238	—	47	—	—	46	—	—
239	—	47	—	—	46	—	—
240	—	47	—	—	46.5	—	—
241	—	47	—	—	47*	—	—
242	—	47.5	25.5	—	43	—	—
243	—	47.5	23.5	—	43	—	—
244	—	47.5	25.5	—	43.5	24.5	—
245	—	47.5	27	—	43.5	—	—
246	—	47.5	26.5	—	47	—	—
247	—	47.5	25.5	—	47.5	—	—
248	—	47.5	26.5	—	47.5	—	—
249	—	47.5	26.5	—	47.5	—	—
250	—	47.5	—	—	47.5	—	—
251	—	47.5	—	—	47.5	—	—
252	—	48	27	—	44.5	—	—
253	—	48	—	—	44.5	—	—
254	—	48	27	—	45	—	—
255	—	48	27	—	45.5	—	—
256	—	48	26	—	46	25.5	—
257	—	48*	26	—	46	—	—
258	—	48	28	—	46	—	—
259	—	48	—	—	46	—	—
260	—	48	—	—	46	—	—
261	—	48	—	—	46	—	—
262	—	48	28.5	—	47	—	—
263	—	48	—	—	47.5	—	—
264	—	48	—	—	47.5	—	—
265	—	48	27	—	48	—	—
266	—	48	28	—	48	—	—
267	—	48	—	—	48.5	—	—

Cattle — Metatarsus (cont'd)

	1	2	3	4	5	6	7
268	—	48	—	—	49	—	—
269	—	48.5	26	—	40.5	—	—
270	—	48.5	—	—	44	—	—
271	—	48.5	25	—	44.5	—	—
272	—	48.5	—	—	45.5	—	—
273	—	48.5	25.5	—	46	—	—
274	—	48.5	27.5	—	46	—	—
275	—	48.5	—	—	46	—	—
276	—	48.5	—	—	46	—	—
277	—	48.5	—	—	46.5	—	—
278	—	48.5	—	—	47	—	—
279	—	48.5	—	—	48	—	—
280	—	48.5	—	—	48.5	—	—
281	—	49	27	—	46	—	—
282	—	49	28.5	—	46	—	—
283	—	49	30	—	46	—	—
284	—	49	—	—	46	—	—
285	—	49	—	—	46	—	—
286	—	49	26	—	47	—	—
287	—	49	28	—	47	—	—
288	—	40	—	—	47	—	—
289	—	49	—	—	47.5	—	—
290	—	49	—	—	48	—	—
291	—	49	—	—	48	—	—
292	—	49	—	—	48	—	—
293	—	49	—	—	48	—	—
294	—	49.5	26	—	45	—	—
295	—	49.5	28	—	46*	—	—
296	—	49.5	26	—	47	—	—
297	—	49.5	29.5	—	49	—	—
298	—	50	—	—	46	—	—
299	—	50	—	—	46	—	—
300	—	50	27	—	47	—	—
301	—	50*	25.5	—	47.5	—	—
302	—	50	—	—	48.5	—	—
303	—	50	—	—	48.5	—	—
304	—	50	28.5	—	49.5	26.5	—
305	—	50.5	27.5	—	46	—	—
306	—	50.5	—	—	47	—	—
307	—	50.5	28.5	—	49	—	—
308	—	50.5	27.5	—	50	—	—
309	—	50.5	28	—	—	—	—
310	—	51	—	—	47.5	—	—
311	—	51	30.5	—	48	—	—
312	—	51	28	—	49	—	—
313	—	51	30	—	49	—	—
314	—	51	—	—	50	—	—
315	—	51.5	28	—	49	—	—
316	—	51.5	30	—	49	27.5	—
317	—	51.5	28.5	—	50	—	—
318	—	51.5	29.5	—	50	—	—
319	—	52	27	—	48	—	—
320	—	52	—	—	48	—	—
321	—	52	—	—	48.5	—	—
322	—	52	27	—	49	—	—
323	—	52	29	—	50	—	—
324	—	52	—	—	50.5	—	—
325	—	52	28	—	51	—	—
326	—	52*	28	—	51.5	—	—
327	—	52	31	—	51	—	—
328	—	52	—	—	52	—	—
329	—	52	26	—	—	—	—
330	—	52	27	—	—	27	—

	1	2	3	4	5	6	7
331	—	52.5	—	—	48	—	—
332	—	52.5	—	—	51	—	—
333	—	52.5	—	—	52	—	—
334	—	53	—	—	52	—	—
335	—	53	—	—	52	—	—
336	—	53	35	—	53	—	—
337	—	53.5	—	—	50	—	—
338	—	54	30	—	51	—	—
339	—	54	—	—	53	—	—
340	—	54	—	—	55.5	—	—
341	—	54.5	—	—	50	—	—
342	—	54.5	33.5	—	53.5	—	—
343	—	55*	—	—	51*	—	—
344	—	55	27.5	—	54	—	—
345	—	56	30	—	50*	—	—
346	—	56	—	—	53*	—	—
347	—	56	—	—	53.5	—	—
348	—	56	32	—	54	—	—
349	—	56	32.5	—	54	—	—
350	—	57	—	—	55	—	—
351	—	58	28.5	—	48	—	—
352	—	58.5	—	—	55	—	—
353	—	58.5	32.5	—	56	—	—
354	—	58.5	32	—	57	—	—
355	—	59	—	—	57	—	—
356	—	60	34.5	—	54	—	—
357	—	60*	36	—	55	—	—
358	—	61	—	—	54.5	—	—
359	—	62*	37	—	60*	—	— w
360	—	—	—	45	—	20	27
361	—	—	—	45.5	—	21.5	28.5
362	—	—	—	46.5	—	21	27
363	—	—	—	46.5	—	22	29
364	—	—	—	47*	—	—	27*
365	—	—	—	47.5	—	21.5	27
366	—	—	—	47.5	—	22	27.5
367	—	—	—	48	—	—	27*
368	—	—	—	48	—	22	28*
369	—	—	—	48	—	21.5	28.5
370	—	—	—	49.5	—	21	28
371	—	—	—	49.5	—	22.5	29.5
372	—	—	—	50*	—	21	27.5
373	—	—	—	50*	—	24	28.5
374	—	—	—	50	—	22	29
375	—	—	—	50	—	22	29
376	—	—	—	50	—	—	29
377	—	—	—	50	—	23	29.5
378	—	—	—	50*	—	23	30
379	—	—	—	50	—	23	31
380	—	—	—	50	—	26	32.5
381	—	—	—	50	—	23	—
382	—	—	—	50.5	—	—	30.5
383	—	—	—	51	—	24	28*
384	—	—	—	51	—	22.5	29
385	—	—	—	51	—	24.5	29
386	—	—	—	51	—	22	29.5
387	—	—	—	51	—	23	30.5
388	—	—	—	51	—	23	30.5
389	—	—	—	51	—	24.5	30.5
390	—	—	—	51	—	23	31.5
391	—	—	—	51.5	—	23.5	30
392	—	—	—	51.5	—	24.5	30.5
393	—	—	—	51.5	—	—	30.5

	1	2	3	4	5	6	7
394	—	—	—	51.5	—	—	32
395	—	—	—	52	—	—	29
396	—	—	—	52	—	24	29.5
397	—	—	—	52	—	24	30
398	—	—	—	52	—	24.5	30
399	—	—	—	52	—	—	30*
400	—	—	—	52	—	—	30*
401	—	—	—	52	—	—	30*
402	—	—	—	52	—	25	30.5
403	—	—	—	52	—	25	31
404	—	—	—	52	—	25.5	31.5
405	—	—	—	52	—	26.5	31.5
406	—	—	—	52.5	—	24	30
407	—	—	—	52.5	—	23.5	31
408	—	—	—	52.5	—	25.5	31
409	—	—	—	53	—	25	30
410	—	—	—	53	—	—	30*
411	—	—	—	53	—	23.5	31.5
412	—	—	—	53	—	25.5	31.5
413	—	—	—	53	—	25.5	33
414	—	—	—	53.5	—	25	30.5
415	—	—	—	53.5	—	—	30.5
416	—	—	—	53.5	—	23.5	31
417	—	—	—	53.5	—	24	31
418	—	—	—	53.5	—	23.5	31.5
419	—	—	—	53.5	—	24	31.5
420	—	—	—	53.5	—	24.5	31.5
421	—	—	—	53.5	—	26	31.5
422	—	—	—	53.5	—	—	31.5
423	—	—	—	53.5	—	24	32
424	—	—	—	53.5	—	—	32
425	—	—	—	53.5	—	25	—
426	—	—	—	54	—	—	29.5
427	—	—	—	54*	—	25.5	30*
428	—	—	—	54	—	24	30.5
429	—	—	—	54	—	23	31
430	—	—	—	54	—	25	31
431	—	—	—	54	—	25.5	31.5
432	—	—	—	54	—	24	32
433	—	—	—	54	—	24.5	32
434	—	—	—	54	—	24.5	32
435	—	—	—	54	—	25.5	32*
436	—	—	—	54	—	26	32
437	—	—	—	54*	—	26	32
438	—	—	—	54	—	25	32.5
439	—	—	—	54	—	—	33
440	—	—	—	54.5	—	22	28.5
441	—	—	—	54.5	—	24.5	30*
442	—	—	—	54.5	—	24	30.5
443	—	—	—	54.5	—	25	30.5
444	—	—	—	54.5	25.5	25.5	32
445	—	—	27.5	54.5	—	25.5	32
446	—	—	—	54.5	—	—	32*
447	—	—	—	54.5	—	25.5	32.5
448	—	—	—	54.5	—	25.5	33
449	—	—	—	54.5	—	26.5	33
450	—	—	—	54.5	—	27	33
451	—	—	—	55	—	24	31*
452	—	—	—	55	—	25.5	31.5
453	—	—	—	55	—	—	31.5
454	—	—	—	55	—	26	32
455	—	—	—	55	—	26	32

	1	2	3	4	5	6	7
456	—	—	—	55	—	27	32
457	—	—	—	55	—	—	32
458	—	—	—	55	—	—	32*
459	—	—	—	55	—	28	32.5
460	—	—	—	55*	—	25.5	33
461	—	—	—	55	—	27	33
462	—	—	—	55	—	—	33.5
463	—	—	—	55.5	—	—	28*
464	—	—	—	55.5	—	25	31
465	—	—	—	55.5	—	25	31
466	—	—	—	55.5	—	26.5	31.5
467	—	—	—	55.5	—	26	32
468	—	—	—	55.5	—	25.5	32.5
469	—	—	—	55.5	—	—	32.5
470	—	—	—	55.5	—	—	32.5
471	—	—	—	56	—	25	31.5
472	—	—	—	56	—	27	32
473	—	—	—	56	—	—	32
474	—	—	—	56	—	28	32.5
475	—	—	—	56	—	26.5	33*
476	—	—	—	56	—	27	33
477	—	—	—	56	—	—	33
478	—	—	—	56	—	25	34
479	—	—	—	56.5	—	—	31*
480	—	—	—	56.5	—	—	32
481	—	—	—	56.5	—	26	32.5
482	—	—	—	56.5	—	26.5	32.5
483	—	—	—	56.5	—	26	33
484	—	—	—	56.5	—	26	33
485	—	—	—	65.5	—	26.5	33
486	—	—	—	56.5	—	—	33
487	—	—	—	56.5	—	—	33
488	—	—	—	56.5	—	26.5	34
489	—	—	—	56.5	—	28	34
490	—	—	—	57	—	24.5	31.5
491	—	—	—	57	—	24.5	32*
492	—	—	—	57	—	26.5	32
493	—	—	—	57	—	—	32
494	—	—	—	57*	—	25.5	32.5
495	—	—	—	57	—	26.5	32.5
496	—	—	—	57	—	25.5	33
497	—	—	—	57	—	25.5	33
498	—	—	—	57	—	26.5	33
499	—	—	—	57	—	—	33
500	—	—	—	57	—	27.5	33.5
501	—	—	—	57	—	25.5	34
502	—	—	—	57	—	26.5	35.5
503	—	—	—	57	—	25	—
504	—	—	—	57.5	—	25.5	31
505	—	—	—	57.5	—	—	31*
506	—	—	—	57.5	—	25	32.5
507	—	—	—	57.5	—	—	33*
508	—	—	—	57.5	—	25.5	33.5
509	—	—	—	57.5	—	28.5	34
510	—	—	—	57.5	—	28	34.5
511	—	—	—	57.5	—	26	35.5
512	—	—	—	58	—	27.5	31*
513	—	—	—	58	—	27	32.5
514	—	—	—	58	—	—	32.5
515	—	—	—	58	—	27.5	33
516	—	—	—	58	—	—	34*
517	—	—	—	58.5	—	24	30*
518	—	—	—	58.5	—	26.5	33

	1	2	3	4	5	6	7	
519	—	—	—	58.5	—	—	33	
520	—	—	—	58.5	—	26.5	33.5	
521	—	—	—	59	—	23.5	31	
522	—	—	—	59	—	26.5	32.5	
523	—	—	—	59	—	26	33	
524	—	—	—	59	—	26	33	
525	—	—	—	59	—	—	33	
526	—	—	—	59	—	26.5	34	
527	—	—	—	59	—	26.5	34.5	
528	—	—	—	59	—	27.5	34.5	
529	—	—	—	59	—	28	34.5	
530	—	—	—	59	—	—	34.5	
531	—	—	—	59	—	26.5	35	
532	—	—	—	59	—	—	36	
533	—	—	—	59.5	—	26	32	
534	—	—	—	59.5	—	28	33	
535	—	—	—	59.5	—	—	34.5	
536	—	—	—	60*	—	—	34	
537	—	—	—	60	—	28	35	
538	—	—	—	60	—	27.5	35.5	
539	—	—	—	60.5	—	—	32	
540	—	—	—	61	—	—	31.5	
541	—	—	—	61	—	26	32.5	
542	—	—	—	61	—	25	33	
543	—	—	—	61*	—	28.5	34	
544	—	—	—	61	—	—	34	
545	—	—	—	61	—	25.5	35	
546	—	—	—	61	—	26	—	
547	—	—	—	62	—	24	31	
548	—	—	—	62*	—	—	33	
549	—	—	—	62*	—	—	34	
550	—	—	—	62	—	27	35.5	
551	—	—	—	62	—	28	35.5	
552	—	—	—	62	—	30	35.5	
553	—	—	—	62	—	30.5	35.5	
554	—	—	—	62.5	—	27.5	33	
555	—	—	—	62.5	—	27	34*	
556	—	—	—	62.5	—	28	34	
557	—	—	—	63	—	26	35	
558	—	—	—	63	—	27.5	35	
559	—	—	—	63*	—	—	35*	
560	—	—	—	63	—	28	36.5	
561	—	—	—	63.5	—	—	35.5	
562	—	—	—	63.5	—	—	36	
563	—	—	—	64	—	28	34	
564	—	—	—	64	—	28.5	34	
565	—	—	—	64	—	29	36	
566	—	—	—	64	—	28	36.5	
567	—	—	—	64.5	—	28	36.5	
568	—	—	—	65	—	29	37.5	
569	—	—	—	65.5	—	—	37	
570	—	—	—	67	—	30	35	w
571	—	—	—	67	—	30	37	
572	—	—	—	67	—	31	37	
573	—	—	—	67.5	—	30.5	36.5	
574	—	—	—	69*	—	29	35	
575	—	—	—	69*	—	29	36	
576	—	—	—	69	—	31	36.5	
577	—	—	—	69	—	31	38.5	
578	—	—	—	69.5	—	—	39	w
579	—	—	—	70	—	—	38.5	
580	—	—	—	71	—	—	37	
581	—	—	—	71.5	—	—	39	
582	—	—	—	72	—	29.5	36	

Sheep — Horn-core (cont'd)

Measuraments:: 1. greatest length
2. greatest diameter
3. smallest diameter
4. circumference of the base

	1	2	3	4
1	18	16	14	46
2	24	15	15	50
3	27	17	16	57
4	32*	15.5	15	54
5	38	25	23.5	80
6	70	28	18.5	78
7	81	31	24	91
8	82	20.5	—	—
9	93	30*	—	—
10	105*	25*	18.5	78*
11	110	30	23	88
12	115	38	28.5	—
13	112	30.5	19	83
14	120	34	23	90
15	130*	—	—	—
16	135	47*	32.5	132*
17	147	40.5	27	110
18	150*	—	21*	—
19	185*	—	—	—
20	210*	47	38.5	138

	1	2	3	4
21	225*	51*	37*	145*
22	230*	55*	41*	190*
23	265*	—	—	—
24	270	—	32*	—
25	295*	—	40*	—
26	—	25	20.5	72
27	—	28	22	81
28	—	30	18	77
29	—	33.5	22.5	90
30	—	36	25.5	97
31	—	48	32	132
32	—	51.5	36	135
33	—	53.5	36	140
34	—	56	39*	152*
35	—	56*	43	165
36	—	58	46*	—
37	—	58*	45*	170*
38	—	58.5	47.5	179
39	—	61	42	170
40	—	66.5	50	181

Sheep — Atlas

Measurements: 1. length of arcus ventralis
2. length of arcus dorsalis
3. width of cranial articular surface
4. width of caudal articular surface
5. greatest width
6. greatest height

	1	2	3	4	5	6
1	29	20	55	50.5	71	41
2	30	23	56	50	72	41.5
3	32	28	58	52	75	43.5
4	33	29	59.5	53	74	44
5	35	30	60	54	77	46
6	35.5	31	60	54.5	76	45

Sheep — Scapula

Measurements: 1. smallest width of collum scapulae
2. width of angulus articularis
3. diameter of facies articularis

	1	2	3
1	19.5	35	22
2	19.5	35	23
3	20.5	35*	—
4	21	35.5	22.5
5	21.7	35.7	22
6	20.5	37	23
7	22	37.5	24

	1	2	3
8	22.5	38.5	25.5
9	23.5	39.5	24
10	23.2	40	24
11	24.5	40	26
12	22.5	40.5	26*
13	25	42*	27
14	25	46*	—

Sheep—Humerus

Measurements: 1. smallest width of diaphysis
2. width of distal epiphysis
3. smallest diameter of diaphysis
4. diameter of distal epiphysis

	1	2	3	4
1	—	30	—	25.5
2	—	31	—	27
3	15	31	15	28
4	—	31.5	—	28
5	15.5	31.5	17.5	28.5
6	16.5	32	17	28
7	—	32.5	—	28.7
8	—	33	—	30
9	—	33.5	—	26.7
10	—	33.5	—	28
11	—	34	—	29.5
12	—	34	—	32
13	16	35	17	28
14	16	35	18	28
15	—	35	—	30
16	—	35.8	—	30
17	—	36	—	32
18	—	36.5	—	30.7
19	—	37	—	31
20	—	37	—	32.5
21	—	37.5	—	32.5
22	—	38.5	—	34*
23	—	38.8	—	35
24	—	39	—	33.5
25	—	40	—	36

Sheep — Radius

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	143*	30.5	15	29	17	7.5	20.5
2	158	31.5	15	30	18.5	8.2	20.5
3	160	—	18	32.5	—	9.8	22
4	167.5	34.5	16.5	32	19	9.5	21
5	167.5	35	17.8	32	20.5	10	23
6	170*	35*	17	—	19	9.5	22
7	170*	—	18	32	19	10	21.5
8	181	35.5	19.7	33	19	10	22*
9	192	38	18	35	23	10	25.5
10	192.5	38	18	35.5	22	10	25.5
11	—	32	16	—	16.5	9	—
12	—	33	—	—	16.5	—	—
13	—	45	—	—	22	—	—
14	—	—	—	29.5	—	—	19.5
15	—	—	—	33	—	—	21
16	—	—	—	33	—	—	23.5
17	—	—	—	33.8	—	—	23
18	—	—	—	34	—	—	24

Sheep — Metacarpus

Measurements: the same as those of the radius

	1	2	3	4	5	6	7
1	112.2	23.1	13.5	25	17.2	9.7	15.3
2	120*	—	12.9	25.3	18.2	9.7	16.2
3	122	24.3	15	27	17.5	10	16
4	123	24.6	13	26	18	9.3	17

Sheep — Metacarpus (cont'd)

	1	2	3	4	5	6	7
5	124	22	13.2	25	17	9.5	16
6	124.5	24	15	25.2	17*	10.5	16.5
7	125.8	24	14.5	26.2	19	10.1	16.2
8	126*	23.2	13.2	25.8	18	9.8	17
9	127	24	14.8	27.8	18.3	9.6	16.2
10	127.8	21.2	13.2	24.8	17.3	10.2	16.4
11	128*	—	14	—	—	—	—
12	129.5	24.7	15.9	26.8	17.8	9.8	16
13	130	—	13.3	—	—	9.3	—
14	130	25	15	27.9	18.2	9.9	18
15	131	24.5	14	26	17	10.2	17
16	131	25	14.4	27	18	10.1	17
17	131.5	24	16.5	27.5	18	10	17.8
18	132	27.8	16.2	—	19	12.3	—
19	132*	—	14	27.3	—	9	17.5
20	132.2	26.2	15.3	28	20	10.3	17
21	132.3	23.5	14.3	24.7	17	8.5	17
22	133.3	26.5	13.2	28	18	9.5	18
23	134	22.5	14.3	26	17.2	10	17
24	134	27	16	28.2	19.3	10.5	18.5
25	134*	25*	14.5	—	19*	—	—
26	135	27	15.7	27.3	19.5	10.7	17.7
27	135*	26*	14	27.5	—	11	18.7
28	135.5	24	12.5	26	18	9.2	17.5
29	135.5	27	15	—	19.3	—	—
30	136	25.3	14.2	27	17.8	9.5	17.7
31	136.3	25.5	15	26.8	19.2	10.3	18
32	136.5	25	14	27.5	18.2	10.3	17.2
33	137	24	17.3	26	17.5	10	17.3
34	137	26.2	14.1	27.8	20.3	10	18.4
35	137	26.2	14.2	27.6	19.9	10	18.5
36	137.5	26	14.5	26.5	—	10.1	18.7
37	138	27.5	14.3	29	19.2	10	18
38	139	26.7	15.3	29.6	20	11.3	18.8
39	139.5	26	15.3	27.2	19.7	10.5	17.8
40	140	26*	15.3	28.5	20	10.4	17.5
41	140	26.5	16	30.3	21	11	19*
42	141	25	15	28	18.5	11	18.2
43	142*	—	15.1	27.5	—	11	17.2
44	143	25.2	14.5	26.3	19.4	10.8	19
45	143	26.2	16	28.8	20	10.3	18
46	144	—	15.1	28	18*	10.9	17
47	144.8	25.5	14.8	28	18.2	11	18.3
48	145*	—	14	27	—	11.2	18.3
49	145*	—	16	28.5	—	10.7	19
50	146	25	15.2	27.3	19.2	10	—
51	146.5	27	15.5	28	20.3	10.9	19.2
52	146.5	28	16	29.5	22	10.8	—
53	147	27	16.5	29	19.7	11.5	19
54	147.2	24.7	13.8	26.7	18	9.3	17.7
55	147.5	25.7	15.3	27	18.2	10.6	18
56	148.3	27.5	15	28	19.8	10.3	18.5
57	148.5	24.8	15	27.8	17.7	10	17.9
58	150	28	15.5	30.2	20.4	11.6	19
59	151	27.5	14.2	29	20.8	10.7	19*
60	151	25.5	15.3	30*	19.8	11	18.5
61	152.3	28.7	17.8	30	21	13.5	19.2
62	154	28.5	15.3	30.2	21	11	20
63	154	—	—	—	—	—	21
64	154.5	27	15.2	30	20	11.2	20
65	154.5	24.8	15.5	26.7	17.8	10	18
66	156	28	15	29	20.5	10.2	19.2

Sheep — Metacarpus (cont'd)

	1	2	3	4	5	6	7
67	157	27.8	14.8	28.2	21	11.4	19
68	157	27.8	14.8	28.2	21.2	11.5	19.8
69	157	29	17.8	31.8	22	12.5	21.2
70	158	27	15	28.2	19*	12	19.2
71	159	28.5	16	29	22.6	12.2	21.3
72	160	26.2	14.5	29.5	19	11.3	18.8
73	160	28	15.5	30.3	21.7	10.8	20
74	160.5	27	17	29.2	21	11	19.5
75	161	28.5	14.8	30	22.2	11.7	20
76	161.2	27.2	16	29.4	21.5	12	19.2
77	161.3	28	15.8	28.7	20.5	12.5	19
78	162*	—	16	29.8	22	12.5	21
79	162*	—	—	30.5	—	—	20*
80	162.5	25.5	14.7	27.5	20.7	12	19
81	163*	29	17.5	32.3	22*	12.3	20.2
82	163.5	27.5	15.5	30.2	20.5	12.5	20.3
83	167.5	30	17.2	31.2	21.7	12.3	21.2
84	168	28	16.7	29.8	22.5	11.7	21
85	171.5	31.4	16	—	23	12	21.3
86	172*	—	17.2	30.7	—	11.7	19.7
87	173	28	16.2	30.8	21.3	12.5	20.8
88	—	21	13	—	16.7	—	—
89	—	21.2	13.1	—	17.3	—	—
90	—	22	13.3	—	17	—	—
91	—	22.3	13.3	—	16.5	—	—
92	—	22.8	14.8	—	16.4	9.9	—
93	—	22.8	14.3	—	17	—	—
94	—	22.8	13.9	—	17.3	—	—
95	—	22.8	15	—	17.5	—	—
96	—	23	13.5	—	16.7	—	—
97	—	23	13	—	17	—	—
98	—	23	13.8	—	18	—	—
99	—	23.1	—	—	17	—	—
100	—	23.2	13.8	—	17.4	—	—
101	—	23.2	13	—	17.5	—	—
102	—	23.2	—	—	18	—	—
103	—	23.3	14.1	—	17.5	—	—
104	—	23.3	—	—	17.8	—	—
105	—	23.5	14.3	—	17.5	—	—
106	—	23.7	—	—	18	—	—
107	—	23.7	14.8	—	18*	—	—
108	—	23.7	—	—	18	—	—
109	—	23.8	—	—	17	—	—
110	—	23.8	15.3	—	17.5	—	—
111	—	23.8	14	—	18	—	—
112	—	24	14.2	—	17	—	—
113	—	24	14.3	—	17.5	—	—
114	—	24	—	—	18	—	—
115	—	24	14	—	18*	—	—
116	—	24	15	—	19*	—	—
117	—	24.2	13.5	—	17.6	—	—
118	—	24.2	13.3	—	18	—	—
119	—	24.2	13.9	—	18	10.2	—
120	—	24.2	14.5	—	18	—	—
121	—	24.2	14.2	—	18.7	—	—
122	—	24.3	—	—	17.2	—	—
123	—	24.3	14	—	17.5	—	—
124	—	24.3	14.8	—	17.7	—	—
125	—	24.5	13.5	—	17	—	—
126	—	24.5	13.8	—	18.7	—	—
127	—	24.5	14.5	—	19.2	10.7	—
128	—	24.7	13.2	—	17.7	—	—

Sheep — Metacarpus (cont'd)

	1	2	3	4	5	6	7
129	—	24.7	15	—	17.5	—	—
130	—	24.7	14.2	—	18	—	—
131	—	24.8	13.2	—	16.8	—	—
132	—	24.8	—	—	17.8	—	—
133	—	24.8	—	—	19.5	—	—
134	—	24.9	—	—	19	—	—
135	—	25	14.5	—	16.5	—	—
136	—	25	14.3	—	17	—	—
137	—	25*	14.2	—	17	—	—
138	—	25	14.2	—	18	—	—
139	—	25	15.7	—	18	—	—
140	—	25	15.2	—	18	—	—
141	—	25	—	—	19.4	—	—
142	—	25	14	—	20*	—	—
143	—	25.2	16	—	18.5	—	—
144	—	25.2	15.7	—	19	10.4	—
145	—	25.2	14.7	—	19.4	—	—
146	—	25.3	14	—	17.5	—	—
147	—	25.3	14.8	—	18.8	—	—
148	—	25.3	15.7	—	19	—	—
149	—	25.3	14.8	—	20	—	—
150	—	25.5	14.5	—	18.3	—	—
151	—	25.5	—	—	18.3	—	—
152	—	25.5	—	—	18.5	—	—
153	—	25.6	14.8	—	18.8	—	—
154	—	25.7	16	—	18.5	—	—
155	—	25.7	—	—	18.8	—	—
156	—	25.7	—	—	19.8	—	—
157	—	26	16	—	18	—	—
158	—	26	—	—	18.5	—	—
159	—	26	—	—	19.5	—	—
160	—	26	14.5	—	19.2	—	—
161	—	26	16	—	19.5	—	—
162	—	26	—	—	19.5	—	—
163	—	26	16	—	19.5	—	—
164	—	26	15.2	—	19.5	—	—
165	—	26	15	—	19.5	—	—
166	—	26	—	—	19.8	—	—
167	—	26	15	—	19.8	10.2	—
168	—	26	13.2	—	19.8	10	—
169	—	26	15	—	19.8	11	—
170	—	26	15	—	19.8	—	—
171	—	26	14.3	—	19.8	—	—
172	—	26	14.3	—	19.8	—	—
173	—	26	14.8	—	20*	—	—
174	—	26	14.8	—	20*	—	—
175	—	26	15	—	20	—	—
176	—	26	15	—	20.2	—	—
177	—	26.2	14.7	—	18.3	—	—
178	—	26.2	15.7	—	18.4	—	—
179	—	26.2	15.3	—	19	—	—
180	—	26.2	—	—	19.5	—	—
181	—	26.2	15	—	19.7	—	—
182	—	26.2	—	—	19.8	—	—
183	—	26.3	16	—	19	—	—
184	—	26.3	16.6	—	19	—	—
185	—	26.3	14.8	—	19	—	—
186	—	26.3	15.2	—	19.8	—	—
187	—	26.3	—	—	20.2	—	—
188	—	26.3	14.8	—	20.5	—	—
189	—	26.5	15.5	—	18.5	—	—
190	—	26.5	16	—	20*	—	—

Sheep — Metacarpus (cont'd)

	1	2	3	4	5	6	7
191	—	26.5	—	—	20	—	—
192	—	26.5	15.7	—	20	—	—
193	—	26.6	16	—	20	—	—
194	—	26.7	14.5	—	18.3	—	—
195	—	26.8	15	—	18.8	11.2	—
196	—	26.8	—	—	19	—	—
197	—	26.8	14.8	—	19.5	—	—
198	—	26.8	15	—	19.7	—	—
199	—	26.8	15.6	—	19.7	—	—
200	—	26.8	—	—	21	—	—
201	—	27	—	—	17.7	—	—
202	—	27	16.3	—	18.5	—	—
203	—	27	16.3	—	19	—	—
204	—	27	15.5	—	19.5	—	—
205	—	27	14.3	—	19.7	—	—
206	—	27	—	—	20	—	—
207	—	27	15	—	20*	—	—
208	—	27	16	—	20	—	—
209	—	27	—	—	20	—	—
210	—	27*	16	—	20.2	—	—
211	—	27	15.5	—	20.2	—	—
212	—	27	—	—	20.2	—	—
213	—	27	15	—	20.2	—	—
214	—	27	14.8	—	20.5	—	—
215	—	27	16	—	20.5	—	—
216	—	27	—	—	21	—	—
217	—	27	14	—	—	—	—
218	—	27.2	17	—	19.5	—	—
219	—	27.2	—	—	19.8	—	—
220	—	27.2	15.8	—	20	—	—
221	—	27.2	15.3	—	20	—	—
222	—	27.2	14.3	—	20.7	—	—
223	—	27.3	16.6	—	21	—	—
224	—	27.5	14	—	18*	—	—
225	—	27.5	—	—	19.5	—	—
226	—	27.5	16	—	19.5	—	—
227	—	27.5	—	—	19.5	—	—
228	—	27.5	18	—	19.5	—	—
229	—	27.5	16.5	—	19.8	—	—
230	—	27.5	15.2	—	20.5	—	—
231	—	27.5	15.2	—	22	—	—
232	—	27.6	—	—	20	—	—
233	—	27.7	16.3	—	20.5	—	—
234	—	27.7	16.3	—	21*	12	—
235	—	27.8	17.6	—	19.8	—	—
236	—	27.8	15.5	—	20	—	—
237	—	27.8	—	—	20	—	—
238	—	28	16	—	20	—	—
239	—	28	—	—	20	—	—
240	—	28	—	—	20.3	—	—
241	—	28	16.4	—	20.3	—	—
242	—	28	16.8	—	20.5	12.3	—
243	—	28	16.2	—	20.8	—	—
244	—	28	15.9	—	21	—	—
245	—	28	16.5	—	21*	—	—
246	—	28*	16.5	—	21*	—	—
247	—	28	—	—	21	—	—
248	—	28	—	—	21	—	—
249	—	28*	17	—	21	—	—
250	—	28	15.7	—	21	—	—
251	—	28	—	—	21	—	—
252	—	28	16	—	21	—	—

	1	2	3	4	5	6	7
253	—	28	—	—	21*	—	—
254	—	28	—	—	21.3	—	—
255	—	28	—	—	21.5	—	—
256	—	28	—	—	21.7	—	—
257	—	28	16	—	22.5	—	—
258	—	28.2	—	—	19.8	—	—
259	—	28.2	16.9	—	22	—	—
260	—	28.3	15.8	—	20.7	—	—
261	—	28.5	16.5	—	21	—	—
262	—	28.5	15.5	—	21.5	—	—
263	—	28.5	—	—	22	—	—
264	—	28.7	16	—	21.5	—	—
265	—	28.9	16.5	—	21	—	—
266	—	28.9	17	—	22.2	12.2	—
267	—	29	14.7	—	21	—	—
268	—	29	—	—	21	—	—
269	—	29*	15.5	—	21*	—	—
270	—	29	—	—	21.5	—	—
271	—	29	—	—	22	—	—
272	—	29	17.8	—	22	—	—
273	—	29	—	—	22	—	—
274	—	29	16.3	—	22.2	—	—
275	—	29*	17.5	—	22.5	13	—
276	—	29	14.7	—	22.5	—	—
277	—	29.2	16.6	—	22	—	—
278	—	29.2	18.4	—	22.5	—	—
279	—	29.3	16.8	—	20.5	—	—
280	—	29.5	17	—	19.8	—	—
281	—	29.5	—	—	21	—	—
282	—	29.5	—	—	21.3	—	—
283	—	30	16.5	—	22*	—	—
284	—	30.2	16	—	22*	—	—
285	—	30.3	—	—	23	—	—
286	—	30.4	17	—	23	12.7	—
287	—	30.6	16	—	22	—	—
288	—	31	18.3	—	21.5	—	—
289	—	31.3	18.8	—	24	—	—
290	—	31.3	—	—	24	—	—
291	—	32	—	—	21.5	—	—
292	—	32	18.8	—	24.2	—	—
293	—	32.5	18	—	22	13.5	—
294	—	33.3	17.5	—	24.5	—	—
295	—	34.5	—	—	25	—	—
296	—	—	—	24.5	—	8.5	15.5
297	—	—	—	25.2	—	9	16
298	—	—	—	25.3	—	8.8	16.7
299	—	—	—	25.8	—	10.9	17.8
300	—	—	—	26.7	—	10	17
301	—	—	—	26.8	—	11	17.3
302	—	—	—	27	—	9.5	16
303	—	—	—	27	—	9	16.7
304	—	—	—	27	—	10	18.5
305	—	—	—	27.5	—	10	18.5
306	—	—	—	27.7		8.5	18*
307	—	—	—	27.7	—	—	18
308	—	—	—	27.8	—	10.2	19.2
309	—	—	—	28	—	9.7	18.5
310	—	—	—	28.2	—	12	18.8
311	—	—	—	28.3	—	10.5	18
312	—	—	—	28.5	—	11.5	19.5
313	—	—	—	28.8	—	11.3	19*
314	—	—	—	28.8	—	11.8	19.9

Sheep — Metacarpus (cont'd)

	1	2	3	4	5	6	7
315	—	—	—	29*	—	10.7	18
316	—	—	—	29	—	10.8	18.5
317	—	—	—	29	—	11	19.7
318	—	—	—	29	—	13	20.2
319	—	—	—	29.3	—	12	20.7
320	—	—	—	29.3	—	12	20.7
321	—	—	—	29.4	—	11	19
322	—	—	—	29.5	—	13.5	20
323	—	—	—	29.7	—	11.2	20.3
324	—	—	—	29.7	—	11.2	20.3
325	—	—	—	30	—	12	20.5
326	—	—	—	30.2	—	13	21
327	—	—	—	30.5	—	13.5	19.5
328	—	—	—	30.7	—	—	19.2
329	—	—	—	31	—	—	20
330	—	—	—	31	—	12	21.6
331	—	—	—	31	—	13	22.5
332	—	—	—	31.5	—	13.5	21
333	—	—	—	31.7	—	12.2	19.5

Sheep — Femur

Measurements: 1. length to the trochanter major
2. length to the caput
3. width of proximal epiphysis
4. smallest width of diaphysis
5. width of distal epiphysis
6. diameter of proximal epiphysis
7. smallest diameter of diaphysis
8. diameter of distal epiphysis

	1	2	3	4	5	6	7	8
1	206	203.5	46*	18	45	39	20	55

Sheep — Tibia

Measurements: the same as those of the radius

	1	2	3	4	5	6	7
1	220	46	16	30*	48*	13	22
2	248.5	49.5	16.5	32.5	53.5	14	25*

Sheep — Astragalus

Measurements: 1. greatest length
2. greatest width
3. greatest diameter

	1	2	3
1	32.5	24.5	—
2	35	25	21.5
3	37	27.5	25

Measurements: the same as those of the radius

	1	2	3	4	5	6	7
1	125	20	13	25	20	11.5	16
2	125.3	19	10.8	22.8	20.2	9	14.8
3	126*	20*	11.7	24.3	—	9.7	16.5
4	129	—	13	24.5	—	11.5	16.4
5	131	21.5	13.2	25.6	20.5	10.2	16.5
6	131.5	19.8	11	—	19.5	9	—
7	132	—	13	25.5	—	11	16.7
8	132*	—	13.6	27	—	11	18*
9	132*	—	—	25.2	—	10.7	16
10	133	20	11.4	23.8	20.5	10.2	16.5
11	133	21.2	12.3	26	21.3	10.7	16.4
12	133	21.8	13.4	24	20	10.8	16.5
13	134*	20.2	10.7	24.1	20.5	9.5	15.8
14	134.5	22	12.5	26.3	22.2	10.2	16.5
15	135	22	12.2	25.8	21.8	9.8	16.5
16	135	23	13.5	27	22	11	17
17	137	22	12.5	26.5	22	11	17.3
18	137.5	21.3	13	26	20	10.2	16.2
19	138.5	21.3	12	24.2	20.8	9.7	16.9
20	140	—	14	26.7	—	11.5	18.4
21	140*	22.2	13	26	23*	11.5	17
22	142	22.6	12	26.2	22	10.2	16
23	142	21.5	13.7	26.2	22	10.3	—
24	142*	—	13	28	—	10.8	18.5
25	142*	24	14.2	28	24.5	12	19.3
26	143	20.8	11.5	25	20.5	10.8	17.3
27	143	22.4	12	25	21.3	10.4	17
28	143.2	21	12	25.7	21.7	10.2	16.8
29	143.8	22.7	12.8	26.2	23	10.5	18
30	144.5	22.8	12.7	25.8	22.5	10.5	18.4
31	145	23.2	13.7	27.8	22.5	10.5	18
32	146	22.7	13.2	26.5	20.7	12.6	18*
33	146*	24.2	14.3	27.4	23.8	11.2	18.8
34	147.5	23	14.1	27	23.3	11.8	18.3
35	148	22	12.2	24.8	21.8	10.2	17.2
36	148*	23.2	12.7	27.2	23.2	11	18.5
37	148*	20.8	13	25.3	21	10.8	17.3
38	148*	22.6	13	26	22*	12	—
39	148.2	22	13.7	27	23.5	11.7	17.5
40	148.5	23.2	12.6	27.2	23	11	18.3
41	149*	23.2	12.5	26.5	22	11.2	18
42	149*	—	12.5	26.2	—	10	17.8
43	150	23.5	15	28	23.7	12.5	18.2
44	150*	—	12.2	—	—	—	—
45	151	22.7	13.9	26.8	22	12.5	18
46	151	25.5	14.9	29.3	24.8	12.7	18.2
47	151.3	23.2	13.2	27	22.5	11	18.2
48	151.5	22.5	13.8	26.8	22	12.2	18
49	152	23	13.5	29.5	23.8	11	19.1
50	153*	25	14	—	24.2	12.7	—
51	153*	—	14	25.3	—	10.2	17.2
52	153.5	22.8	12.8	26.5	22.3	11	18.8
53	154	—	14	27.2	—	12	17.3
54	155*	24	13.5	28	23	12.5	19.5
55	155.5	21	12.7	25	21.8	11	17
56	156	23.2	13	28	23	12	18.8
57	157	23	13.5	27.2	22.3	11.2	18.3
58	157*	22.6	13.2	27.6	24	11.5	18.8
59	157*	24.2	13.8	27.4	23.7	11.2	18.9
60	157.5	23.5	14.9	28.5	23.2	11	19.3
61	158*	—	14	—	—	11.8	—

Sheep — Metatarsus (cont'd)

	1	2	3	4	5	6	7
62	158.5	24.7	14.9	28.8	24.8	12	19.2
63	159*	22.4	15.3	—	22.5	—	—
64	160	24	13.5	—	23.8	12	—
65	162	23	14	26.7	24	11	19
66	162	25.2	14.3	—	24.5	12.6	19.7
67	162*	22.8	13	26.5	—	10.8	18.2
68	162*	—	14	—	—	11.5	—
69	162*	—	—	28.2	—	13	20
70	163	22.3	13.7	26.8	21.8	11.1	16.5
71	163*	—	13	25.3	—	11.3	18
72	163*	—	13	28.5	—	12	19.2
73	163*	24*	15	30	23	13	20
74	164	23.8	14	26.5	23.2	11.6	19
75	165	24.7	13	28	24.8	11.7	19.8
76	165	24.5	13.3	28.2	25	11.9	19
77	165.5	24.5	13	28	25	11.9	19.9
78	166*	24	13	27.3	23	11.8	18.5
79	167	25	14.7	28	24	12.2	19.2
80	167*	23	13.8	27.8	22.5	12.2	19
81	168*	—	15	28.5	—	12.2	19.2
82	169	24.3	14.3	29	24.5	12.7	19
83	169*	—	—	29*	—	12	19*
84	169.5	22.8	13.2	26.4	22.8	12.2	18.7
85	170	26	14.5	28.5	24.5	12.9	19.8
86	170*	24	13.5	27.7	24	13	19.2
87	173.3	24.3	15	29.5	25.3	14	20
88	173.5	24.5	15	28.7	24	12	19.8
89	175.5	24.8	14	29	25.3	12	20
90	177*	—	16.2	31.5	—	14	21
91	180	25	15	28.5	25.7	13	21
92	180.5	25	14.8	28	26	12	20
93	182	29*	15	32.7	27*	13.6	22*
94	188	26.5	15.8	30.2	25.5	14.4	21.5
95	—	19	11.2	—	18.8	—	—
96	—	19	11.9	—	19.2	9.2	—
97	—	19.5	12.5	—	18.8	—	—
98	—	19.5	12.6	—	20.5	—	—
99	—	19.8	11.7	—	19*	—	—
100	—	19.8	11.5	—	20	—	—
101	—	20	11.6	—	19.2	—	—
102	—	20	11.7	—	19.3	—	—
103	—	20	11.2	—	20	—	—
104	—	20*	11.8	—	20.2	—	—
105	—	20	12.2	—	21.2	10.1	—
106	—	20	11.6	—	21.8	—	—
107	—	20	12.2	—	21.9	—	—
108	—	20.2	12	—	20.5	—	—
109	—	20.2	13	—	20.5	—	—
110	—	20.4	12	—	21*	—	—
111	—	20.8	12.7	—	21.7	—	—
112	—	21	13.6	—	20	—	—
113	—	21	12.2	—	20.5	10.2	—
114	—	21	13	—	20.5	—	—
115	—	21	—	—	20.6	—	—
116	—	21	12.2	—	21	10	—
117	—	21	12.5	—	21	—	—
118	—	21	—	—	21.2	—	—
119	—	21	13	—	21.3	—	—
120	—	21	—	—	22	—	—
121	—	21.2	14.2	—	20.3	—	—
122	—	21.3	—	—	19.8	—	—
123	—	21.3	12.2	—	21.3	—	—

	1	2	3	4	5	6	7
124	—	21.3	12.5	—	21.5	10.8	—
125	—	21.3	13.3	—	22.3	—	—
126	—	21.4	—	—	23.2	—	—
127	—	21.5	—	—	21.3	—	—
128	—	21.5	12	—	21.7	—	—
129	—	21.8	11	—	21	—	—
130	—	21.8	12.2	—	21.8	—	—
131	—	21.9	12.8	—	22.8	—	—
132	—	22	12	—	21*	—	—
133	—	22	12.7	—	21.5	—	—
134	—	22	13.4	—	22	—	—
135	—	22	13.5	—	22.3	—	—
136	—	22	14	—	22.3	11.3	—
137	—	22*	14.2	—	22.6	—	—
138	—	22.1	13.1	—	22.2	—	—
139	—	22.2	12.8	—	21	—	—
140	—	22.2	—	—	21.6	—	—
141	—	22.2	12	—	22.2	—	—
142	—	22.2	12.8	—	22.4	10.8	—
143	—	22.2	12.7	—	22.5	—	—
144	—	22.2	13.5	—	22.7	—	—
145	—	22.2	12	—	—	—	—
146	—	22.3	—	—	21	—	—
147	—	22.3	13.7	—	21.5	—	—
148	—	22.3	12.7	—	23	—	—
149	—	22.5	13.5	—	22	12	—
150	—	22.5	13.5	—	22	—	—
151	—	22.5	13.5	—	22.5	—	—
152	—	22.5	14	—	22.5	—	—
153	—	22.5	13.9	—	22.8	11.9	—
154	—	22.5	13	—	—	11	—
155	—	22.8	13.8	—	21.6	—	—
156	—	22.8	12.5	—	22.6	—	—
157	—	22.8	14	—	24.3	—	—
158	—	23	12.9	—	21	—	—
159	—	23	14	—	21.5	—	—
160	—	23	13.7	—	22*	—	—
161	—	23	14.3	—	22*	—	—
162	—	23	—	—	22	—	—
163	—	23	13	—	22.8	—	—
164	—	23	13.9	—	22.8	—	—
165	—	23	—	—	22.8	—	—
166	—	23	13	—	23	—	—
167	—	23	12.5	—	23.2	—	—
168	—	23	13.2	—	23.2	—	—
169	—	23	14.3	—	23.2	—	—
170	—	23	—	—	23.5	—	—
171	—	23	—	—	24	—	—
172	—	23	13.5	—	—	11.5	—
173	—	23.1	15.3	—	24	—	—
174	—	23.2	12.8	—	22.8	—	—
175	—	23.2	13.3	—	23.2	—	—
176	—	23.2	14.3	—	23.3	—	—
177	—	23.2	14.5	—	25	—	—
178	—	23.3	—	—	23.6	—	—
179	—	23.3	14	—	24	—	—
180	—	23.5	13.4	—	22.8	—	—
181	—	23.5	13.2	—	23*	—	—
182	—	23.5	13.7	—	23	—	—
183	—	23.5	14.8	—	23	—	—
184	—	23.5	13	—	23.2	—	—
185	—	23.5	13.2	—	23.5	—	—
186	—	23.5	13	—	23.7	—	—

Sheep — Metatarsus (cont'd)

	1	2	3	4	5	6	7
187	—	23.6	13.8	—	22*	—	—
188	—	23.7	14	—	22	—	—
189	—	23.7	14.7	—	23	12.9	—
190	—	23.7	—	—	23.7	—	—
191	—	23.7	—	—	24.5	—	—
192	—	23.8	—	—	23.2	—	—
193	—	23.8	13	—	23.3	—	—
194	—	23.8	13.3	—	24	—	—
195	—	24	14	—	22.7	—	—
196	—	24	12.3	—	23	—	—
197	—	24	13.8	—	23*	—	—
198	—	24	14.5	—	23	—	—
199	—	24	15	—	23.2	—	—
200	—	24	14.2	—	23.3	—	—
201	—	24	13.8	—	23.4	12.8	—
202	—	24	13.7	—	24	—	—
203	—	24*	14.7	—	24	—	—
204	—	24	14.2	—	24.8	12.5	—
205	—	24	15	—	25	—	—
206	—	24	13.3	—	25.5	—	—
207	—	24	14.7	—	—	12.5	—
208	—	24.2	—	—	22.2	—	—
209	—	24.2	14.2	—	23	—	—
210	—	24.2	15.2	—	24.2	—	—
211	—	24.2	—	—	25	—	—
212	—	24.2	14	—	25.8	13.2	—
213	—	24.3	13.4	—	23.7	—	—
214	—	24.3	14.5	—	24	—	—
215	—	24.3	14.3	—	24.7	—	—
216	—	24.3	14.8	—	25.2	—	—
217	—	24.4	—	—	24	—	—
218	—	24.4	13.2	—	24.2	—	—
219	—	24.5	14.5	—	25	—	—
220	—	24.5	—	—	25	—	—
221	—	24.6	14	—	23.3	12	—
222	—	24.7	—	—	24.3	—	—
223	—	24.8	14.5	—	23.8	—	—
224	—	24.8	13.5	—	24	—	—
225	—	24.8	14	—	24.6	—	—
226	—	24.8	14	—	24.8	—	—
227	—	24.8	14.8	—	25.4	13.1	—
228	—	25	13.9	—	23.8	—	—
229	—	25	14.6	—	24	—	—
230	—	25	14.2	—	24	—	—
231	—	25	14.9	—	24.5	—	—
232	—	25	13	—	25	—	—
233	—	25	14	—	25	—	—
234	—	25	14.5	—	25	—	—
235	—	25	14.8	—	25.2	—	—
236	—	25*	15	—	—	—	—
237	—	25.2	12.9	—	24.2	—	—
238	—	25.2	14	—	24.8	14	—
239	—	25.2	14	—	25.2	—	—
240	—	25.2	—	—	25.5	—	—
241	—	25.2	14.5	—	—	—	—
242	—	25.5	13.9	—	24	—	—
243	—	25.5	14	—	24.8	—	—
244	—	25.5	15	—	25	—	—
245	—	25.5	14.9	—	26	—	—
246	—	25.6	14.8	—	26	—	—
247	—	25.8	14.9	—	25	—	—
248	—	25.8	15	—	25.8	—	—

Sheep — Metatarsus (cont'd)

	1	2	3	4	5	6	7
249	—	26	14.7	—	24.5	—	—
250	—	26	15	—	25*	—	—
251	—	26	13.7	—	25.3	—	—
252	—	26	14.5	—	25.8	—	—
253	—	26.4	14	—	25.8	—	—
254	—	26.5	14.9	—	26.1	13	—
255	—	26.5	15	—	24.5	13	—
256	—	27	15.9	—	26*	—	—
257	—	27.2	15	—	25	—	—
258	—	27.4	—	—	24	—	—
259	—	28	—	—	27*	—	—
260	—	28*	15.8	—	—	13.7	—
261	—	29	15.8	—	28.2	14	—
262	—	—	—	23	—	10.2	15.8
263	—	—	—	24	—	10	15.5
264	—	—	—	24	—	10	16
265	—	—	—	24.3	—	—	16.4
266	—	—	—	24.3	—	10.2	17
267	—	—	—	24.5	—	—	16
268	—	—	—	25	—	10	17
269	—	—	—	25	—	10.7	17.5
270	—	—	—	25.2	—	10.1	17.1
271	—	—	—	25.4	—	—	17.5
272	—	—	—	25.7	—	10.8	17.8
273	—	—	—	25.7	—	11.5	18.1
274	—	—	—	25.8	—	10.6	16.2
275	—	—	—	25.8	—	9.9	16.8
276	—	—	—	25.8	—	11.2	17
277	—	—	—	25.9	—	10.7	18
278	—	—	—	26	—	—	18
279	—	—	—	26	—	11.5	18.2
280	—	—	—	26.2	—	11	16.4
281	—	—	—	26.2	—	10	16.8
282	—	—	—	26.2	—	10.1	17
283	—	—	—	26.5	—	—	16.2
284	—	—	—	26.5	—	10.8	16.8
285	—	—	—	26.5	—	11	17.7
286	—	—	—	26.5	—	11.3	18
287	—	—	—	26.7	—	10.2	16.8
288	—	—	—	26.7	—	—	17
289	—	—	—	26.7	—	11.5	18
290	—	—	—	26.7	—	11.5	18.5
291	—	—	—	26.8	—	11.8	17.3
292	—	—	—	26.8	—	10.5	19
293	—	—	12.8	27	—	12.3	17.5
294	—	—	—	27	—	11	18
295	—	—	—	27	—	11.2	18
296	—	—	—	27	—	11.7	18.3
297	—	—	—	27	—	—	18.3
298	—	—	—	27	—	11.4	18.7
299	—	—	—	27	—	11.7	19
300	—	—	—	27	—	—	19
301	—	—	—	27.2	—	11.2	18.5
302	—	—	—	27.3	—	11.2	18
303	—	—	—	27.3	—	13.1	18
304	—	—	—	27.3	—	11.2	18.8
305	—	—	—	27.5	—	12.2	19.4
306	—	—	—	27.7	—	10.8	17.2
307	—	—	14	28	—	12	18.5
308	—	—	—	28	—	12.2	20.2
309	—	—	—	28.2	—	11	17.5
310	—	—	—	28.2	—	12.8	19.2

Sheep — Metatarsus (cont'd)

	1	2	3	4	5	6	7
311	—	—	—	28.2	—	12.7	20
312	—	—	—	28.2	—	13	20
313	—	—	—	28.3	—	12	18
314	—	—	—	28.3	—	12	19.3
315	—	—	—	28.5	—	12.5	19.2
316	—	—	—	28.5	—	12	21
317	—	—	—	28.6	—	—	19.8
318	—	—	—	28.7	—	12.3	20.2
319	—	—	—	28.8	—	11.2	18.3
320	—	—	—	28.8	—	12	19.3
321	—	—	—	28.8	—	12	19.5
322	—	—	—	28.8	—	12.7	20.2
323	—	—	—	29	—	—	19
324	—	—	—	29	—	13	19.8
325	—	—	—	29.3	—	12.4	21.2
326	—	—	—	29.4	—	13	20.2
327	—	—	—	29.5	—	12	20*
328	—	—	—	29.8	—	12.9	22
329	—	—	—	30	—	11.8	18
330	—	—	—	30.7	—	—	19.8
331	—	—	—	31.5	—	13.5	22*
332	—	—	—	32	—	15.5	23
333	—	—	—	32.3	—	13.5	21.3
334	—	—	—	33	—	15.8	22.2
335	—	—	—	33.2	—	—	22

Goat — Horn-core

Measurements: 1. greatest length
2. greatest diameter
3. smallest diameter
4. circumference at the base

	1	2	3	4
1	104	30	21	84
2	160	35*	24*	95*
3	164	35	21*	97*
4	170*	36*	23*	95*
5	173	36	22*	92*
6	175*	36.5	26.5	99
7	180*	—	23*	—
8	190*	34.5	20*	90*
9	195	37*	24.5	100*
10	197*	31.5	20.5	87
11	200*	—	—	—
12	220*	38	25*	100*
13	220*	—	—	—
14	236	36.5	23	93
15	275*	60*	40*	157*

	1	2	3	4
16	—	28*	20	78*
17	—	31.5	21.5	88
18	—	33	22.5	90
19	—	33.5	24	92
20	—	34	22.5	92
21	—	34.5	22.5	91
22	—	35	21.5	91
23	—	36.5	22*	92*
24	—	37	26	100
25	—	38	25	100
26	—	47*	34.5	127*
27	—	48	30	126
28	—	54*	34	140*
29	—	62*	33.5	152*

Goat — Scapula

Measurements: 1. smallest width of collum scapulae
2. width of angulus articularis
3. diameter of facies articularis

	1	2	3
1	17	29.5	22
2	21	32.5	24
3	20.5	35	21.5
4	21.7	35.5	23.3
5	—	37*	—

Goat — Humerus

Measurements: 1. smallest width of diaphysis
2. width of distal epiphysis
3. smallest diameter of diaphysis
4. diameter of distal epiphysis

	1	2	3	4
1	—	31	—	25
2	—	32.5	—	26
3	16.5	33	20	26.5
4	—	33*	—	27.5
5	—	38	—	32.5
6	—	40	—	33.5
7	—	42	—	33

Goat — Radius

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	182	34	19	32	18	9	23*
2	—	32	18	—	18	8.5	—
3	—	35	19	—	19.5	10	—
4	—	37	20	—	20	10.5	—
5	—	40	23	—	22	11.5	—
6	—	—	—	34	—	—	23

Goat — Metacarpus

Measurements: the same as those of the radius

	1	2	3	4	5	6	7
1	116.3	24.2	14.7	27.2	18	10.3	17.2
2	117	26	16	28.8	18.5	10.5	17.5
3	118*	—	16	29	—	10.8	17.5
4	119	23	15.3	27.2	16.5	10.2	16.8
5	120.3	25	16.9	29	17.7	10.2	17.2

	1	2	3	4	5	6	7
6	123	25	15.7	28.8	18	11	18
7	123	25	16	28.2	18.3	10.3	17.2
8	123*	26.5	18	—	18.7	—	—
9	124.8	25	16.8	28.5	19	10.1	17*
10	125	27	17.5	30.7	19.7	10	19
11	126	25.3	15.8	27.5	19	11.2	17.7
12	127.2	29.2	21.5	33.6	21.5	12.2	19.2
13	127.7	30.2	19	31.8	20.5	13	20
14	129.7	26.2	17	29.8	19	10	19
15	129.7	29.2	19.7	34.8	20.3	13.5	19.8
16	131.6	30*	20.2	32	20*	13	19*
17	132.2	29	20	32.5	20	12.5	18.7
18	133.5	31	20.2	33	21	12.3	20.5
19	—	23.8	16	—	15.8	—	—
20	—	23.8	14.5	—	16.3	—	—
21	—	24	16	—	18.5	—	—
22	—	24	15.4	—	—	11.5	—
23	—	24.7	16.8	—	16.3	—	—
24	—	24.8	16.2	—	17.2	—	—
25	—	24.8	17	—	17.5	—	—
26	—	24.8	17.2	—	19.5	—	—
27	—	25	16.2	—	17.2	—	—
28	—	25	16	—	19	—	—
29	—	25.2	17	—	17.3	—	—
30	—	25.2	16.8	—	18	12	—
31	—	25.3	17	—	18.8	—	—
32	—	25.7	17.6	—	17.8	—	—
33	—	25.7	15.5	—	18	—	—
34	—	26	17.5	—	18	—	—
35	—	26	17	—	18.3	11	—
36	—	26	16	—	18.5	—	—
37	—	26	16	—	19	—	—
38	—	26	16.8	—	20	10.3	—
39	—	26	17.6	—	20	—	—
40	—	26	17.8	—	20*	—	—
41	—	27*	17	—	19*	—	—
42	—	27.2	16.3	—	20*	—	—
43	—	27.4	17	—	19.5	—	—
44	—	28	18	—	20	—	—
45	—	28	20	—	20.5	—	—
46	—	28.2	16.7	—	20	—	—
47	—	28.5	17.5	—	19.5	—	—
48	—	28.5	19.5	—	22*	—	—
49	—	28.8	17.6	—	19.7	12	—
50	—	28.8	19	—	21*	—	—
51	—	29	17.7	—	20	—	—
52	—	29	18.3	—	20*	—	—
53	—	29	—	—	20.5	—	—
54	—	29.2	19.4	—	19.8	—	—
55	—	29.8	18	—	20.7	—	—
56	—	29.8	18.8	—	20.7	—	—
57	—	30	18.2	—	22.5	—	—
58	—	30.5	—	—	21	—	—
59	—	31	19.5	—	20.7	—	—
60	—	—	—	27.2	—	10.7	18
61	—	—	—	28	—	—	17
62	—	—	—	28.8	—	10.6	19.3
63	—	—	—	29*	—	—	17*
64	—	—	16	29	—	10.8	17.5
65	—	—	—	29	—	—	18*
66	—	—	—	29.2	—	10.5	18.8
67	—	—	—	32	—	13	20
68	—	—	—	35.3	—	12.9	20

Goat — Metatarsus

Measurements: the same as those of the radius

	1	2	3	4	5	6	7
1	117.2	—	13.3	23.7	19.5	10	15*
2	118	20	11.7	24.3	18.2	9.2	15.2
3	120*	21.3	13.5	24.2	—	11	16
4	122.5	20.5	12	25.5	19.5	10	—
5	126*	22.3	12.5	27	22*	10.2	18
6	128.3	21	13.5	25.7	19.5	11.2	16.5
7	132.5	23.5	13.8	29.5	22.5	11.5	20
8	134.5	21	13	25.7	20.3	10.3	16.7
9	134.5	22	14.1	26.3	21	11.2	16.3
10	135*	—	13.5	25.3	—	10.5	16.7
11	136.5	24.8	17.7	30.5	23.3	11.7	19
12	136.7	24.5	17.5	32*	23	11.7	19
13	137.5	22	14.2	26.8	20.2	12.4	18
14	138	23	14.8	29.2	22	11.2	18.2
15	138.5	25.8	17	30.3	23	13	19*
16	139.5	25	16.3	30	24	13	—
17	140*	23.5	16.5	29	23.5	13.5	19.2
18	—	21.7	—	—	20.9	—	—
19	—	22	14.5	—	20.5	—	—
20	—	22	15.2	—	20.3	—	—
21	—	22.2	—	—	21.4	—	—
22	—	23	16	—	21.8	—	—
23	—	23	15	—	23.2	—	—
24	—	23	13.5	—	—	—	—
25	—	23.3	14.8	—	23	—	—
26	—	23.7	—	—	23.9	—	—
27	—	23.8	14.8	—	22.3	—	—
28	—	24	15.3	—	22	—	—
29	—	24.3	15.5	—	23.5	—	—
30	—	24.5	16	—	23.2	—	—
31	—	24.8	17	—	23.3	—	—
32	—	24.8	16.7	—	24.2	—	—
33	—	24.8	15	—	—	—	—
34	—	25	15.4	—	23	—	—
35	—	25*	16	—	23	—	—
36	—	25	16.5	—	23	—	—
37	—	25	—	—	25.3	—	—
38	—	—	—	24	—	—	16.3
39	—	—	—	25.5	—	9.8	16.2
40	—	—	—	27.7	—	12.4	18.5
41	—	—	18	28.8	—	11	18

Pig — Skull

	1	2	3
1. aboral end of palate — basion	—	75	—
2. middle of straight line connecting foramina supraorbitalia — opisthion	—	102	—
3. middle of the straight line connecting most lateral parts of ossa frontalia — opisthion	—	62.5	—
4. length of incisor row	—	—	55
5. length of diastema	—	—	51
6. P_1 — P_4	37.5	—	—
7. M_1 — M_3	63	—	—
8. length of M_3	28	—	—
9. extreme frontal width	94	102.5	—
10. extreme width of brain-case	—	76	—
11. width between median canthuses	70	76.5	—
12. width at canines	—	—	78

Pig — Skull (cont'd)

	1	2	3
13. P_1 — P_1	44	—	62
14. M_1 — M_1	59	—	—
15. width at foramina infraorbitalia	34.5	—	—
16. width at foramina supraorbitalia	32	32	—
17. width at meati acustici externi	—	109	—
18. width at condyli occipitales	—	54	—
19. length of foramen magnum	—	28	—
20. width of foramen magnum	—	26	—
21. ventral length of os lacrymale	27	26	—
22. greatest width of os lacrymale	22.5	25.5	—
23. occipital height (basion — opisthion)	—	99.5	—

Pig — Upper row of teeth

Measurements: 1. P_1–P_4
2. M_1–M_3
3. length of M_3

	1	2	3	sex
1	41	59	25	♀
2	39	59	25.5	
3	43	61.5	29	♀
4	43	64	30	♀
5	41.5	66	30.5	
6	—	59	25	
7	—	58	25.5	
8	—	60	25.5	
9	—	60*	25.5	
10	—	57*	26*	
11	—	60	27	
12	—	57	27.5	
13	—	58	28.5	
14	—	60	29	
15	—	62	29	
16	—	62	29	
17	—	66.5	29	
18	—	60	30	
19	—	63	30	
20	—	64	30.5	
21	—	65.5	30.5	
22	—	65.5	30.5	
23	—	67	30	
24	—	63	31	
25	—	63	31	
26	—	64.5	31	
27	—	65	31.5	
28	—	67	31.5	
29	—	64	32	
30	—	63	33	
31	—	64	33	
32	—	—	25	
33	—	—	26*	
34	—	—	27	
35	—	—	27	
36	—	—	28	
37	—	—	28.5	
38	—	—	28.5	
39	—	—	29	
40	—	—	29.5	
41	—	—	29.5	
42	—	—	29.5	
43	—	—	29.5	
44	—	—	29.5	
45	—	—	30	
46	—	—	30	
47	—	—	30	
48	—	—	30	
49	—	—	30*	
50	—	—	30.5	
51	—	—	30.5	
52	—	—	30.5	
53	—	—	30.5	
54	—	—	31	
55	—	—	31	
56	—	—	31	
57	—	—	31	
58	—	—	31.5	
59	—	—	31.5	
60	—	—	32	
61	—	—	33	
62	—	—	33	
63	—	—	33.5	
64	—	—	34	
65	—	—	34	
66	40	—	—	♀
67	40.5	—	—	♀
68	40.5	—	—	♀
69	40.5	—	—	♀
70	40.5	—	—	♂
71	41	—	—	♀
72	41	—	—	♂
73	41.5	—	—	♀
74	41.5	—	—	♀
75	41.5	—	—	♂
76	41.5	—	—	
77	42	—	—	♀
78	42	—	—	♀

Pig — Upper row of teeth (cont'd)

	1	2	3	sex
79	42.5	—	—	♀
80	42.5	—	—	♀
81	43	—	—	♀
82	43	—	—	♂
83	43.5	—	—	♂
84	44	—	—	♂
85	44.5	—	—	♂
86	45	—	—	♂
87	45	—	—	♂
88	45	—	—	
89	45	—	—	
90	46	—	—	♀
91	46	—	—	♂
92	47	—	—	♀

Pig — Mandible

Measurements:
1. length to angulus
2. length to processus coronoideus
3. height at P_1
4. height at M_1
5. height to facies articularis
6. height to processus coronoideus
7. length of row of teeth (I_1—M_3)
8. length of incisor row
9. length of diastema
10. P_1—P_4
11. M_1—M_3
12. length of M_3
13. width at the canines

	1	2	3	4	5	6	7	8	9	10	11	12	13	sex
1	217	200*	—	36.5	102	110*	154	21	—	—	61	28	—	♀
2	225	217	29	38	99	111	163	24	25.5	53	60	—	38	♀
3	229	215	32*	34.5	86.5	93	159	21	23.5	53	62	30	43	♀
4	235	—	30	37	96	—	158	21	22	52.5	62.5	31	—	♀
5	247	—	32	39	—	—	162	24	23	52	60.5	28.5	42	♀
6	—	—	25	39.5	—	—	157	21.5	24.5	49.5	61	29.5	—	♀
7	—	—	25	46	—	—	157*	21*	26	52	62	31	41	♀
8	—	—	—	43.5	—	—	164	20.5	—	—	66	32.5	46	♀
9	—	—	32	—	—	—	165	20	28	50	65.5	32	—	♀
10	—	—	—	44.5	—	—	—	—	27.5	52.5	63	28.5	—	♂
11	—	—	23.5	35.5	—	—	—	—	25	48.5	61	30	—	♀
12	—	—	—	41	—	—	—	—	22	51	64.5	30	—	♀
13	—	—	—	39	—	—	—	—	—	46	64	31	—	
14	—	—	—	37	—	—	—	—	—	48	65.5	32	—	♀
15	—	—	33	45	—	—	—	—	28.5	48.5	67.5	33*	50	♂
16	—	—	29	41	—	—	—	—	26	56	68	33.5	—	♀
17	—	—	23	34	—	—	—	19	20.5	43.5	—	—	—	♀
18	—	—	32	38.5	—	—	—	19.5	24	45	—	—	48	♀
19	—	—	29	40	—	—	—	21	24	45.5	—	—	40	♀
20	—	—	28	39	—	—	—	—	25	46.5	—	—	—	♀
21	—	—	31	—	—	—	—	23.5	24	49*	—	—	44	♀
22	—	—	31	—	—	—	—	22	23	49.5	—	—	44	♂
23	—	—	33	—	—	—	—	26	25	49.5	—	—	48	♂
24	—	—	38.5	—	—	—	—	25	31	—	—	—	56	♂
25	—	—	30	38	—	—	—	23	23	50	—	—	41	♀
26	—	—	27	—	—	—	—	19	24	50.5	—	—	48	♂
27	—	—	28	—	—	—	—	22.5	26	50.5	—	—	48	♂
28	—	—	—	—	—	—	—	—	23.5	51	—	—	—	♀
29	—	—	33	39	—	—	—	—	26.5	52	—	—	—	♀
30	—	—	—	36.5	—	—	—	—	—	52	—	—	—	♂
31	—	—	37	—	—	—	—	—	28.5	52	—	—	52	♂
32	—	—	28	—	—	—	—	25	25.5	52.5	—	—	42	♀
33	—	—	32	37	—	—	—	28	24.5	53.5	—	—	42	♀
34	—	—	25	—	—	—	—	21	24	—	—	—	46	♂
35	—	—	26	—	—	—	—	22.5	22	—	—	—	46	♂
36	—	—	31	—	—	—	—	25.5	23	—	—	—	—	♂
37	—	—	—	—	—	—	—	27	—	—	—	—	54	♂
38	—	—	34	—	—	—	—	28	27.5	—	—	—	52	♂
39	—	—	29	—	—	—	—	29	26	—	—	—	43	♀

Pig — Lower row of teeth

Measurements: 1. P_1–P_4
2. M_1–M_3
3. length of M_3

	1	2	3	sex
1	59.5	49.5	20	♀
2	46	61.5	30	♀
3	56	62	30.5	♂
4	56	62.5	31	♀
5	49	64	31	♂
6	51.5	64	32	♀
7	53	65	32	♂
8	50	64	33	♀
9	—	60	25	
10	—	58	27	
11	—	60	27.5	
12	—	61	28	
13	—	61.5	28	♀
14	—	63	29	
15	—	61.5	29.5	♀
16	—	66*	30*	
17	—	63	30.5	
18	—	62	31	♂
19	—	63	31	♀
20	—	66	31	
21	—	63.5	31.5	
22	—	64	31.5	♀
23	—	64.5	31.5	
24	—	65	32	
25	—	60	32.5	♀
26	—	65.5	33	
27	—	68.5	33	
28	—	63	33.5	
29	—	66	33.5	
30	—	69	34.5	
31	—	69.5	36	
32	—	73	36	♀
33	—	—	26.5	
34	—	—	28	
35	—	—	28.5	
36	—	—	29	
37	—	—	29	
38	—	—	29	
39	—	—	29	
40	—	—	29.5	
41	—	—	29.5	
42	—	—	30	
43	—	—	30	
44	—	—	30	
45	—	—	30.5	
46	—	—	30.5	
47	—	—	31	
48	—	—	31	
49	—	—	31	
50	—	—	31	
51	—	—	31.5	♂
52	—	—	31.5	
53	—	—	31.5	
54	—	—	31.5	
55	—	—	31.5	
56	—	—	31.5	
57	—	—	32	
58	—	—	32	
59	—	—	32	
60	—	—	32	
61	—	—	32.5	
62	—	—	32.5	
63	—	—	32.5	
64	—	—	32.5	
65	—	—	33	
66	—	—	33	
67	—	—	33	
68	—	—	33	
69	—	—	33	
70	—	—	33.5	
71	—	—	33.5	
72	—	—	33.5	
73	—	—	33.5	
74	—	—	34	
75	—	—	34.5	
76	—	—	35.5	
77	—	—	35.5	
78	—	—	36	
79	—	—	36.5	
80	—	—	37	
81	46	—	—	♀
82	46.5	—	—	♀
83	47	—	—	♀
84	47	—	—	♀
85	47.5	—	—	♀
86	47.5	—	—	♀
87	48	—	—	♂
88	48	—	—	♀
89	48	—	—	♀
90	48	—	—	
91	48*	—	—	
92	48.5	—	—	♀
93	48.5	—	—	♀
94	49	—	—	♀
95	49	—	—	0
96	49	—	—	♀
97	49	—	—	
98	49	—	—	
99	49.5	—	—	♂
100	49.5	—	—	♂
101	49.5	—	—	♀
102	50	—	—	♀
103	50	—	—	♀
104	50	—	—	♀
105	50	—	—	♀
106	50	—	—	♂
107	50.5	—	—	♀
108	50.5	—	—	♀
109	50.5	—	—	♂
110	51	—	—	♂
111	51	—	—	
112	52	—	—	♀
113	52	—	—	♀
114	52	—	—	♀
115	52	—	—	♀
116	52	—	—	♂

Pig — Lower row of teeth (cont'd)

	1	2	3	sex
117	52	—	—	♂
118	52*	—	—	♀
119	53	—	—	♀
120	53	—	—	♂
121	53	—	—	♂
122	53	—	—	♂
123	53	—	—	
124	53.5	—	—	♀
125	53.5	—	—	♀
126	54	—	—	♀
127	54	—	—	♀
128	54	—	—	♂
129	54.5	—	—	♀
130	55	—	—	♂
131	55	—	—	♂
132	56	—	—	

Pig — Atlas

Measurements: 1. length of ventral arch
2. length of dorsal arch
3. width of cranial articular surface
4. width of caudal articular surface
5. greatest height

	1	2	3	4	5
1	16	19.5	—	42.5	39
2	17	—	51	48	41
3	19	24.5	60	—	46
4	20	20.5	47*	45.5	47
5	20.5	22.5	54	—	44.5
6	20.5	23.5	58	—	45
7	21.5	20.5	51	50	44

Pig — Epistropheus

Measurements: 1. length of body
2. length of arch
3. length of dens
4. width of dens
5. width of cranial articular surface
6. width of fossa caudalis
7. height of cranial articular surface
8. height of fossa caudalis

	1	2	3	4	5	6	7	8
1	38.5	17	12	9	48	28	17.5	17.5

Pig — Scapula

Measurements: 1. greatest length
2. smallest width of collum scapulae
3. width of angulus articularis
4. diameter of facies articularis

	1	2	3	4
1	195	23	34	24
2	—	21.5	32.5	24
3	—	21.5	34	23
4	—	23	34*	25*
5	—	22	35*	23*
6	—	22.5	35	25*
7	—	23	35	26
8	—	23.5	35.5	27
9	—	24	36*	23*
10	—	25.5	36	25
11	—	24	36.5	26.5
12	—	24.5	37	28*
13	—	23	38	27*
14	—	24.5	38*	27*
15	—	24	38.5	28*
16	—	31.5	45.5	30.5
17	—	23.5	34*	—
18	—	23	34.5	—
19	—	22.5	35*	—
20	—	23	35.5	—
21	—	23.5	35.5	—
22	—	21	36	—
23	—	23	37*	—
24	—	25	37*	—
25	—	25.5	38*	—
26	—	28.5	42.5	—
27	—	—	33.5	24*
28	—	—	34	25.5
29	—	—	37	26.5
30	—	—	37*	27
31	—	—	37.5	27.5
32	—	—	38*	27*
33	—	—	40	27

Pig — Humerus

Measurements: 1. width of proximal epiphysis
2. smallest width of diaphysis
3. width of distal epiphysis
4. diameter of proximal epiphysis
5. smallest diameter of diaphysis
6. diameter of distal epiphysis

	1	2	3	4	5	6
1	46	—	—	62	—	—
2	50	—	—	62.5	—	—
3	—	—	34	—	—	35.5
4	—	—	34.5	—	23	35
5	—	14.5	35	—	22	34
6	—	13.5	35	—	21	34
7	—	—	35	—	—	36
8	—	13.5	35	—	21	37.5
9	—	—	36	—	—	35
10	—	—	36	—	—	36.5
11	—	—	36.5	—	20.5	36.5
12	—	—	36.5	—	—	37
13	—	16	36.5	—	22.5	37.5
14	—	16	37	—	23	34
15	—	—	37	—	—	36.5
16	—	—	37	—	23.5	36.5
17	—	—	37	—	23	37
18	—	14.5	37	—	24	37
19	—	—	37	—	—	38
20	—	—	37	—	—	38
21	—	15	37	—	23	39
22	—	17	37.5	—	22.5	35
23	—	—	37.5	—	—	36.5
24	—	14	37.5	—	24	37.5
25	—	—	37.5	—	22	38*
26	—	—	37.5	—	25.5	38*

	1	2	3	4	5	6	
27	—	—	37.5	—	—	38	
28	—	15	38	—	26	37	
29	—	15	38	—	22	37	
30	—	—	38	—	26	38	
31	—	—	38	—	—	39.5	
32	—	15	38	—	26	40	
33	—	—	38.5	—	—	37.5	
34	—	—	38 5	—	—	37.5	
35	—	15	38.5	—	24	38	
36	—	—	38.5	—	—	38.5	
37	—	—	38.5	—	—	38.5	
38	—	—	38.5	—	26	40	
39	—	—	39	—	22.5	37	
40	—	—	39	—	—	37	
41	—	15.5	39	—	25.5	38	
42	—	—	39	—	26.5	38	
43	—	—	39	—	—	38	
44	—	15.5	39	—	25.5	39	
45	—	—	39	—	—	39	
46	—	—	39	—	26.5	39	
47	—	—	39	—	27.5	39	
48	—	17	39	—	—	39.5	
49	—	—	39	—	—	40*	
50	—	—	39	—	—	40*	
51	—	—	39	—	—	40.5	
52	—	—	39	—	—	42	
53	—	—	39.5	—	—	38	
54	—	—	39.5	—	—	38.5	
55	—	—	39.5	—	22.5	39	
56	—	—	39.5	—	—	39	
57	—	—	39.5	—	—	40	
58	—	—	39.5	—	—	40	
59	—	—	39.5	—	25.5	40.5	
60	—	15	40	—	23	38	
61	—	17.5	40	—	23.5	38	
62	—	—	40	—	—	38	
63	—	16	40	—	24	39	
64	—	—	40	—	24	40	
65	—	—	40	—	—	40	
66	—	—	40	—	—	40	
67	—	—	40	—	—	42	
68	—	17	40.5	—	27	38	
69	—	—	40.5	—	—	39.5	
70	—	16	40.5	—	29	40	
71	—	—	40.5	—	—	40	
72	—	—	40.5	—	—	40	
73	—	—	40.5	—	—	40.5	
74	—	—	40.5	—	—	41	
75	—	—	41	—	28	41	
76	—	17	41.5	—	23.5	40	
77	—	—	41.5	—	—	40.5	
78	—	—	41.5	—	—	41.5	
79	—	—	42	—	—	41	
80	—	—	42	—	—	41.5	
81	—	—	42	—	—	43	
82	—	—	42.5	—	—	44.5	
83	—	20	45	—	30	43*	
84	—	—	47	—	—	42.5	w
85	—	20	50.5	—	34.5	52	w
86	—	—	54	—	—	51	w
87	—	—	55.5	—	—	54.5	w
88	—	—	56	—	—	53	w

Pig — Radius

Measurements: the same as those of the humerus

	1	2	3	4	5	6	
1	27	15	—	19	9.5	—	
2	27*	16	—	20.5	11	—	
3	27	16.5	—	21	12	—	
4	27.5	—	—	21.5	—	—	
5	28	16	—	20*	12	—	
6	28*	16.5	—	—	11	—	
7	28	16.5	—	—	12	—	
8	28*	17	—	21*	12	—	
9	28.5	18	—	21	12.5	—	
10	28.5	—	—	21	—	—	
11	28.5	—	—	21*	—	—	
12	28.5	16	—	22	11	—	
13	28.5	17	—	23	12.5	—	
14	29	18.5	—	22*	13	—	
15	29*	19	—	—	13	—	
16	29.5	17.5	—	20	11.5	—	
17	29.5	18	—	22	12.5	—	
18	29.5	18	—	22	12.5	—	
19	29.5	18	—	22.5	12	—	
20	30	17	—	21.5	12.5	—	
21	30	17.5	—	23.5	12.5	—	
22	30	18	—	23	12	—	
23	30	—	—	24*	—	—	
24	31	18	—	22	12.5	—	
25	31	20.5	—	22*	13	—	
26	31*	18	—	23*	12.5	—	
27	31.5	19	—	22	13	—	
28	37	—	—	28.5	—	—	w
29	38.5	—	—	29	—	—	w
30	40	24.5	—	30	20	—	w
31	—	—	33	—	—	27	
32	—	—	34	—	—	27.5	
33	—	—	35	—	—	27	

Pig — Femur

Measurements: 1. width of distal epiphysis
2. diameter of distal epiphysis

	1	2	
1	47	56.5	
2	65	77	w

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	195	—	19	30	—	13.5	27
2	—	44.5	—	—	48	—	—
3	—	—	16	26.5	—	11.5	23
4	—	—	18	27	—	13	24.5
5	—	—	17.5	27.5	—	14	25
6	—	—	19	28	—	13.5	24*
7	—	—	19	28	—	14	24.5
8	—	—	—	28	—	—	25*
9	—	—	—	28	—	—	25
10	—	—	—	28	—	—	25
11	—	—	17.5	28	—	12	25
12	—	—	19	28	—	14	25
13	—	—	19	28.5	—	13.5	24
14	—	—	17.5	28.5	—	13	25
15	—	—	19	28.5	—	14.5	25
16	—	—	19.5	28.5	—	13.5	25
17	—	—	18	28.5	—	13.5	25.5
18	—	—	17	29	—	12.5	24*
19	—	—	18	29	—	12.5	24.5
20	—	—	18.5	29	—	13	24.5
21	—	—	—	29	—	—	25
22	—	—	—	29	—	—	25
23	—	—	18.5	29	—	13.5	25
24	—	—	—	29	—	—	25
25	—	—	19.5	29	—	14	25.5
26	—	—	20	29	—	14	25.5
27	—	—	—	29	—	—	25.5
28	—	—	19	29	—	15	26
29	—	—	—	29	—	14.5	26
30	—	—	20	29	—	14.5	26
31	—	—	20	29	—	15	26
32	—	—	18	29	—	13.5	26.5
33	—	—	—	29	—	—	27
34	—	—	17.5	29	—	15	27.5
35	—	—	—	29	—	—	27.5
36	—	—	—	29	—	—	—
37	—	—	19.5	29.5	—	13	25.5
38	—	—	20	29.5	—	13	25.5
39	—	—	—	29.5	—	—	25.5
40	—	—	—	29.5	—	—	25.5
41	—	—	—	29.5	—	—	26
42	—	—	20	29.5	—	14	26
43	—	—	—	29.5	—	—	26.5
44	—	—	20.5	29.5	—	15.5	27
45	—	—	17	30	—	12	24.5
46	—	—	19	30	—	14	25
47	—	—	18	30	—	14	25*
48	—	—	17.5	30	—	15.5	25.5
49	—	—	20.5	30	—	13.5	25.5
50	—	—	18	30	—	14	25.5
51	—	—	—	30	—	—	26
52	—	—	20.5	30	—	15	26
53	—	—	17	30	—	13	26
54	—	—	19.5	30	—	15	26.5
55	—	—	—	30	—	—	26.5

Pig — Tibia (cont'd)

	1	2	3	4	5	6	7	
56	—	—	20	30	—	14.5	26.5	
57	—	—	19.5	30	—	14.5	27	
58	—	—	20	30	—	15	27	
59	—	—	—	30	—	—	28.5	
60	—	—	—	30*	—	—	29*	
61	—	—	20	30.5	—	14.5	25	
62	—	—	21.5	30.5	—	14.5	26	
63	—	—	19	30.5	—	14.5	26	
64	—	—	19.5	30.5	—	14.5	26	
65	—	—	19	30.5	—	14	26	
66	—	—	—	30.5	—	—	27	
67	—	—	21.5	30.5	—	15	27.5	
68	—	—	—	30.5	—	—	27.5	
69	—	—	—	31	—	—	25	
70	—	—	—	31	—	—	27	
71	—	—	20	31	—	15	27	
72	—	—	20	31	—	14	27.5	
73	—	—	—	31.5	—	—	26	
74	—	—	18	32	—	13	26	
75	—	—	—	32	—	—	27	
76	—	—	20	32	—	14.5	27	
77	—	—	—	32	—	16	28*	
78	—	—	—	32	—	—	28	
79	—	—	21	32	—	16.5	29	
80	—	—	—	32	—	—	30	
81	—	—	21	32.5	—	16	27.5	
82	—	—	—	33	—	15.5	29	
83	—	—	22	33.5	—	16	—	
84	—	—	—	33.5	—	—	28.5	
85	—	—	—	34.5	—	—	30	
86	—	—	23.5	36.5	—	17.5	31.5	w
87	—	—	—	39.5	—	—	35	w

Pig — Astragalus

Measurements: 1. greatest length
2. greatest width
3. greatest diameter

	1	2	3
1	37.5	24.5	22.5
2	38	21.5	23
3	38	24	23
4	38.5	21.5	24
5	39	22	23
6	39	22.5	24
7	39	25.5	22
8	39.5	25.5	22.5
9	39.5	26	23.5
10	40*	22	—
11	40	22.5	23
12	40	23.5	23.5
13	40.5	25*	23
14	41.5	26	25

	1	2	3
15	42	26	24
16	42*	26	25
17	42.5	23	24.5
18	42.5	27	24
19	43	26.5	23
20	43	27	27
21	43.5	22	24.5
22	43.5	25.5	27
23	43.5	28	25.5
24	44.5	25	26
25	44.5	27	25
26	45	30	26.5
27	46	28	25.5
28	46.5	25	26.5

Pig — Calcaneus

Measurements: the same as those of the astragalus

	1	2	3	
1	71.5	20.5	29.5	
2	72	23.5	28.5	
3	72.5	22	26.5	
4	72.5	22	27	
5	73.5	23.5	30	
6	74	23	29.5	
7	75	21.5	—	
8	76	23.5	29.5	
9	77.5	23	29.5	
10	79	24.5	31.5	
11	86.5	25.5	32.5	
12	102	27	36	w
13	116*	33*	42.5	w

Horse — Skull

	1	2	3	4	5	6	7
1. basal length	479	483	—	—	—	—	—
2. I_1 — M_1	—	264	253	—	—	—	—
3. M_1 — basion	—	220	—	—	—	—	—
4. I_1 — aboral end of palate	262	268	—	—	—	—	—
5. this latter point — basion	218	216	—	—	—	—	—
6. I_1 — middle of the straight line connecting foramina supraorbitalia	368*	375	—	—	—	—	—
7. this latter point — opisthion	—	—	—	175	192	—	—
8. I_1 — middle of the straight line connecting the most lateral points of the frontal bones	376	381	—	—	—	—	—
9. this latter point — opisthion	—	—	—	180	187	—	—
10. length of row of teeth (I_1 — M_3)	295	291	—	—	—	—	—
11. length of incisor row	28	24	34	—	—	—	—
12. length of diastema	94	108	108	—	—	—	—
13. P_1 — P_3	—	85	109	—	—	—	—
14. M_1 — M_3	—	74	—	—	—	78	—
15. greatest width	217.5	207	210	203	228	192	—
16. extreme frontal width	217.5	207	210	203	218	192	—
17. distance between foramina supraorbitalia	146	140	—	137	135	—	149
18. distance between median canthuses	160	144	—	130	147	—	162*
19. extreme width of brain case	118	116	—	118	110	100	116
20. width of incisor row	73	66	70	—	—	—	—
21. distance between canines	66	53	67	—	—	—	—
22. P_1 — P_1	—	101	—	—	—	—	—
23. M_1 — M_1	—	129	—	—	—	—	—
24. distance between mandibular joints	—	186	—	—	222	—	195
25. distance between meati acustici externi	—	114	—	—	125	—	120
26. distance between condyli occipitales	85	80	—	83	90.5	—	95
27. length of foramen magnum	38	38	—	41	36	—	36
28. width of foramen magnum	40	34	—	34	33	—	35
29. occipital height (basion — opisthion)	—	—	—	94	104	—	—
30. horizontal diameter of orbita	—	62	—	—	68	—	—
31. vertical diameter of orbita	—	54	—	—	59	—	—

Horse — Mandible

Measurements:
1. length to the angulus
2. height at P_1
3. height at M_1
4. height to the articular surface
5. length of row of teeth (I_1–M_3)
6. length of incisor row
7. length of diastema
8. P_1–P_3
9. M_1–M_3
10. width of incisor row

	1	2	3	4	5	6	7	8	9	10
1	392	49	80	—	296	20.5	—	96	87	65
2	—	56	80	—	275	20.5	—	80	78.5	68
3	—	—	—	—	—	—	—	81	77	—
4	—	50	72	—	—	—	—	85	83	—
5	—	58	71	—	—	—	—	87	—	—
6	—	53	76	225	—	—	—	88.5	80	—
7	—	—	80.5	210	—	—	—	91	87	—
8	—	58.5	82.5	—	—	—	—	93	82.5	—
9	—	—	75	—	—	23	84	88	80	64
10	—	54	—	—	—	18.5	86	—	—	61
11	—	53	—	—	—	22	87	—	—	66

Horse — Lower row of teeth

Measurements:
1. P_1–P_3
2. M_1–M_3

	1	2
1	74	80
2	76	74
3	81	78
4	88	83
5	91	78
6	98	84
7	85	—
8	95.5	—

Horse — Atlas

Measurements:
1. length of ventral arch
2. length of dorsal arch
3. width of cranial articular surface
4. width of caudal articular surface
5. greatest height

	1	2	3	4	5
1	30.5	—	80	84.5	—
2	31	36	71	72	—
3	31.5	38	86	81	—
4	33.5	44.5	87.5	83	—
5	34	43.5	86	85	—
6	34.5	46.5	87	87	—

Horse — Atlas (cont'd)

	1	2	3	4	5
7	35	44	88.5	82.5	—
8	35.5	45	89	—	—
9	35.5	45	90	87	—
10	35.5	48	—	83	—
11	37	36.5	80	78	—
12	37*	—	88	—	—
13	38	52.5	99	93.5	—
14	40	46	83	85	81
15	40.5	48.5	92.5	89	79
16	42	55	94	90	—

Horse — Epistropheus

Measurements: 1. length of body
2. length of arch
3. length of dens
4. width of dens
5. width of cranial articular surface
6. width of fossa caudalis
7. height of cranial articular surface
8. height of fossa caudalis

	1	2	3	4	5	6	7	8
1	123	59	22	30.5	69	40*	33.5	32
2	152	—	23	35.5	88.5	45	42	—
3	—	73	21	34	81.5	—	41	—
4	—	—	21	37	82	44	41	—
5	—	—	23	37	80.5	—	41	—
6	—	52.5	24	38	83	—	40	—

Horse — Scapula

Measurements: 1. greatest length
2. smallest width of collum scapulae
3. width of angulus articularis
4. diameter of facies articularis

	1	2	3	4
1	345	67	99	49
2	—	57	78	40*
3	—	57	82.5	43
4	—	59.5	84	42*
5	—	—	86*	44*
6	—	—	88*	—
7	—	63	89	46*
8	—	—	90*	43
9	—	—	90*	50*
10	—	61	90	50.5
11	—	62	90.5	46.5
12	—	63.5	92	47.5
13	—	63.5	92	49
14	—	—	92*	51*
15	—	—	94	48
16	—	65	94	50
17	—	61	94*	—
18	—	64	95*	—
19	—	61.5	94.5	49
20	—	—	95*	48
21	—	65.5	95*	49
22	—	—	95	50*
23	—	—	95	53*
24	—	62.5	96	50.5
25	—	—	96	52*
26	—	63	97	46.5
27	—	65	97*	50
28	—	65.5	98	49.5
29	—	67	99.5	51*
30	—	67	99.5	51*
31	—	59	—	45*
32	—	61.5	—	44.5
33	—	62	—	46*
34	—	65.5	—	47.5
35	—	76.5	—	61*

Horse — Humerus

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	282*	86*	33	70	98	43	—
2	287	93.5	35	76	93	40	80
3	288*	86	33.5	72*	97*	43	80*
4	289	91	35	76	100	43	79
5	311	96	37	81	—	44	82
6	328*	96	38	81	100*	44	—
7	—	—	—	72	—	—	76
8	—	—	34	72	—	41.5	80*
9	—	—	—	73*	—	—	75
10	—	—	—	73	—	—	77
11	—	—	—	73	—	37	77
12	—	—	31	74	—	38.5	77
13	—	—	32	74	—	41	78
14	—	—	34	75	—	45	—
15	—	—	—	76	—	—	83*
16	—	—	34	76	—	44	85
17	—	—	37	77	—	46	—
18	—	—	35	77	—	45	82
19	—	—	—	77	—	—	83*
20	—	—	36	77	—	46	84*
21	—	—	35	78	—	44	79
22	—	—	—	78	—	—	82
23	—	—	36	78	—	45	85
24	—	—	36.5	78	—	45	85
25	—	—	38	80	—	44	86
26	—	—	—	80	—	—	84
27	—	—	36	80	—	45	86
28	—	—	36	81	—	47	81
29	—	—	33	82	—	42	85
30	—	—	38	82.5	—	45	84
31	—	—	—	83	—	—	86
32	—	—	—	84	—	—	89
33	—	—	36	87	—	48	85

Horse — Radius

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	307	82	38.5	73	42.5	28.5	43
2	320	75	43.5	—	41	24.5	41.5
3	323*	78	37.5	71.5	45	27	—
4	323.5	75*	35	68.5	—	24	41.5
5	325	77	34	72	45	25	41
6	325*	86	40.5	77	48	27.5	45.5
7	326*	82*	37	74*	46.5	26.5	45
8	330.5	81	35	77	46	26.5	47
9	333*	81	41	74	47	28.5	47.5
10	335*	—	33	69.5	—	23.5	42.5
11	336*	77	40	71.5	46	26	42
12	337*	79	38.5	74	46	25	44

	1	2	3	4	5	6	7
13	340*	80	36.5	70*	43	25	41
14	342	83.5	38.5	74	45.5	24	46
15	343	79	37	75	48	27	46.5
16	343	81	37	74	44	26	44
17	346	81	37.5	76.5	47	28	47
18	347*	80	39	76	48	29.5	46
19	348*	86	41.5	79	47	31	47.5
20	352*	—	39	73*	43	27.5	44
21	352*	87	43	82	49	28.5	49.5
22	376	87	43	82.5	52	31	48
23	—	77	35	—	42	26	—
24	—	78*	35	—	42	28	—
25	—	78	—	—	43.5	—	—
26	—	78	—	—	46	—	—
27	—	78.5	—	—	47	—	—
28	—	80	—	—	43	—	—
29	—	80*	—	—	45	—	—
30	—	80*	—	—	47	—	—
31	—	81	—	—	45.5	—	—
32	—	81	39	—	46*	28.5	—
33	—	82	—	—	45	—	—
34	—	82.5	—	—	46	—	—
35	—	82.5	—	—	48	—	—
36	—	83.5	—	—	45.5	—	—
37	—	83.5	—	—	46	—	—
38	—	84	40.5	—	46	27.5	—
39	—	84	—	—	46.5	—	—
40	—	84.5	—	—	47.5	—	—
41	—	85*	—	—	45.5	—	—
42	—	85	—	—	47.5	—	—
43	—	85*	—	—	48	—	—
44	—	86	—	—	50	—	—
45	—	87*	—	—	48.5	—	—
46	—	87	—	—	50	—	—
47	—	87	—	—	51	—	—
48	—	88*	—	—	49	—	—
49	—	89	—	—	50	—	—
50	—	—	—	66.5	—	—	41
51	—	—	—	67*	—	—	38
52	—	—	—	69	—	—	43
53	—	—	—	71	—	—	44
54	—	—	—	72	—	—	41
55	—	—	—	72.5	—	—	44.5
56	—	—	—	73	—	—	42.5
57	—	—	—	73.5	—	—	43*
58	—	—	—	73.5	—	—	48
59	—	—	—	74	—	—	45
60	—	—	—	75	—	—	44
61	—	—	—	75	—	—	45
62	—	—	—	75	—	—	45
63	—	—	—	75	—	—	45.5
64	—	—	—	76	—	—	41
65	—	—	—	76	—	—	47.5
66	—	—	—	76*	—	—	51
67	—	—	—	78	—	—	47
68	—	—	—	78	—	—	47.5
69	—	—	—	79	—	—	48.5
70	—	—	—	80	—	—	45*
71	—	—	—	80*	—	—	48*
72	—	—	—	81.5	—	—	50
73	—	—	—	83	—	—	51
74	—	—	—	85*	—	—	53
75	—	—	—	88	—	—	53

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	206.5	46.5	33	50*	34	21	34.5
2	208*	42*	31	44*	—	19.5	—
3	209	45.5	30.5	45	31.5	18	32.5
4	209	48.5	34	49.5	35.5	23	34.5
5	216.5	49*	34	50	—	20	35.5
6	218	46	32	47	36*	21	36*
7	218	44	33	—	32	20	—
8	219	49.5	32	48	34	21	35
9	219	—	34.5	—	—	23	—
10	219	47	—	48	33.5	20.5	34.5
11	220	47*	33	47.5	32	21.5	35.5
12	220	50.5	34	51	36	23	36.5
13	221	51	33.5	51	35.5	23	37
14	222	48.5	32.5	49	35	20	37
15	222	49.5	35.5	50.5	33.5	21	36*
16	222	50.5	37.5	50.5	37	22.5	38.5
17	222.5	46.5	31	45	31	20	34
18	223*	48.5	32	47.5	—	20	35*
19	223	51	33.5	51.5	35	25	36
20	223	49.5	34	49.5	35.5	23.5	38
21	223	50	34	49	34.5	23.5	35*
22	224	—	30	—	—	21	—
23	224	51	32	50	37	22.5	35
24	224	50	34.5	50	34.5	22.5	36
25	225*	—	26.5	—	—	—	—
26	225	50	32.5	46.5	37	21.5	35
27	225*	48	33	46*	32*	20.5	32*
28	225.5	46	35.5	47.5	33	21	36
29	226	51	31.5	47	35	24.5	37.5
30	226	50	34	48	36	21	35
31	226	49.5	34.5	50.5	35	22.5	37*
32	227	48.5	33	49	34.5	21.5	38
33	227	51	36	50	36	23.5	38
34	227.5	53	32	47.5	35.5	22.5	37
35	229	51	34	51*	38	24	39.5
36	229	48	34.5	50.5	36	22.5	37
37	229	51*	35.5	49.5	36	23	36.5
38	229	51.5	35.5	52*	37	22.5	37
39	229	50.5	—	49	37.5	23.5	38
40	230*	—	36	50.5	38.5	24	38
41	230	53.5	37	51.5	38	24	38.5
42	230.5	52.5	35.5	52.5	35	24	40
43	231	48.5	33.5	48	36.5	23	38.5
44	231	50.5	33.5	50.5	34	22	37
45	231.5	46	33.5	48	33	20.5	35
46	232*	—	32	50	—	23	—
47	232	52	33	50	33	23	35
48	232	52.5	33	51	36.5	22	39
49	233.5	54.5	34.5	51.5	39	22.5	39.5
50	235	51	33.5	53*	34.5	23	36*
51	235	53	39	52	38	25.5	38.5
52	237	55.5	33	52.5	39	23.5	41
53	237	48.5	33.5	50	34	22	35.5
54	237	55	36	56	38	23	39
55	238	51	33	51*	36	23	36
56	238*	—	—	52*	—	23.5	38*
57	238.5	54	35.5	53	38	25	39
58	239	53.5	34.5	51	38.5	23	38
59	245	56.5	38*	55	38	25.5	40.5
60	252.6	56	37.5	51	39	24	38.5
61	260	54.5	38	56	40	26	43

Horse — Metacarpus (cont'd)

	1	2	3	4	5	6	7
62	262.5	58	38	53	41	24.5	40
63	—	45	—	—	30*	—	—
64	—	46.5	—	—	33.5	—	—
65	—	47	30.5	—	31.5	—	—
66	—	47	—	—	33	—	—
67	—	48	—	—	33	—	—
68	—	48.5	—	—	33	—	—
69	—	50	33	—	34	—	—
70	—	50	—	—	34.5	—	—
71	—	50	34	—	35	—	—
72	—	51	—	—	33.5	—	—
73	—	51	—	—	35.5	—	—
74	—	51	—	—	37	—	—
75	—	51.5	—	—	36.5	—	—
76	—	53	36	—	34.5	—	—
77	—	53	35.5	—	36	—	—
78	—	53	—	—	38	—	—
79	—	53.5	—	—	36	—	—
80	—	54	—	—	36.5	—	—
81	—	54	36.5	—	37	—	—
82	—	54	—	—	38	—	—
83	—	55	—	—	35	—	—
84	—	56	36	—	38	26	—
85	—	—	—	43.5	—	22.5	32
86	—	—	—	45*	—	22	—
87	—	—	—	47	—	21	35
88	—	—	—	48.5	—	21	36
89	—	—	—	49	—	23.5	38
90	—	—	—	50	—	23	38
91	—	—	—	50.5	—	22	37
92	—	—	—	51	—	21	35
93	—	—	—	51	—	—	35.5
94	—	—	—	53	—	24	40
95	—	—	—	53	—	22	40
96	—	—	—	53.5	—	24	39

Horse — Femur

Measurements: 1. length to trochanter major
2. length to caput
3. width of proximal epiphysis
4. smallest width of diaphysis
5. width of distal epiphysis
6. diameter of proximal epiphysis
7. smallest diameter of diaphysis
8. diameter of distal epiphysis

	1	2	3	4	5	6	7	8
1	385*	356	117	41	91	85	49	117
2	411	374	117	41	91	89	47	117
3	—	—	—	—	87	—	—	112
4	—	—	—	37.5	88	—	43.5	—
5	—	—	—	41	89	—	47	115
6	—	—	—	40	89.5	—	47	116
7	—	—	—	41	90	—	47.5	116
8	—	—	—	44	90	—	48	117
9	—	—	—	—	92	—	—	120

Horse — Tibia

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	336*	—	37.5	65.5	—	26	43*
2	336	—	39	68	—	—	44
3	338	—	39.5	74.5	—	29	44.5
4	339	—	39	73.5	—	29	44
5	340	—	39.5	74	—	29	45
6	340*	—	38.5	69	—	30	43.5
7	342	94	40	74	—	28	47
8	345	—	39.5	70	—	28	42.5
9	354	95	42.5	72.5	—	29	45.5
10	365	90*	41.5	70	88*	30.5	47
11	372	—	44	76	—	32	47
12	383*	—	45	79	—	32	53
13	387	—	43	77	—	30	49
14	406*	—	48	80	—	34.5	54
15	—	93	—	—	88	—	—
16	—	101	—	—	101	—	—
17	—	—	34	56.5	—	32.5	40
18	—	—	—	63*	—	—	38
19	—	—	—	63,5	—	—	40
20	—	—	—	65*	—	—	40
21	—	—	—	66	—	—	42.5
22	—	—	—	66.5	—	—	43.5
23	—	—	—	67	—	—	43
24	—	—	38	67.5	—	27	44
25	—	—	—	68	—	—	45.5
26	—	—	—	68	—	—	45.5
27	—	—	41	69	—	28	46
28	—	—	37.5	69*	—	28	46.5
29	—	—	—	69.5	—	—	43
30	—	—	41	69.5	—	29	45
31	—	—	—	69.5	—	—	45
32	—	—	38	70	—	28	44
33	—	—	—	70*	—	—	45*
34	—	—	—	70*	—	—	45
35	—	—	—	70	—	—	47
36	—	—	—	70*	—	—	47*
37	—	—	—	70*	—	—	50*
38	—	—	—	70.5	—	—	44.5
39	—	—	41.5	70.5	—	27.5	46
40	—	—	36.5	71	—	28.5	44
41	—	—	—	71	—	—	45
42	—	—	39.5	71	—	28	46.5
43	—	—	42	71.5	—	29	45.5
44	—	—	—	71.5	—	—	47.5
45	—	—	39.5	72	—	30	45.5
46	—	—	—	72	—	—	47
47	—	—	—	72.5	—	—	45
48	—	—	—	72.5	—	—	45.5
49	—	—	—	72.5	—	—	46
50	—	—	—	72.5	—	—	46
51	—	—	—	73	—	—	45
52	—	—	39.5	73	—	31.5	48
53	—	—	—	73	—	32.5	50
54	—	—	—	73.5	—	—	47
55	—	—	46	75*	—	29.5	50
56	—	—	42.5	75.5	—	31.5	47
57	—	—	44	75.5	—	31	47
58	—	—	—	75.5	—	—	48.5
59	—	—	—	76	—	—	48
60	—	—	—	76	—	—	52.5

Horse — Tibia (cont'd)

	1	2	3	4	5	6	7
61	—	—	41.5	76	—	30.5	49
62	—	—	44.5	77	—	29.5	47
63	—	—	—	77	—	32	53
64	—	—	45	77.5	—	34	50
65	—	—	45	79	—	33	49
66	—	—	—	79	—	—	50*
67	—	—	—	80	—	—	53.5
68	—	—	—	82*	—	—	48*
69	—	—	—	83.5	—	—	55
70	—	—	39.5	—	—	30.5	47

Horse — Astragalus

Measurements: 1. greatest length
2. greatest width
3. greatest diameter

	1	2	3
1	57	60	55
2	59	57.5	57
3	59	60	58
4	59	60	61
5	59	61	57
6	59	63	59
7	60	56	—
8	60	59*	57
9	60	61	60
10	60	61	63
11	61	60	57
12	61	60	58
13	61	61	58
14	61	62	60
15	61.5	61.5	61
16	62	59	59
17	62	61	61
18	63	59	59
19	63	59	59
20	63	60	59
21	63	60	64.5
22	63	63.5	64
23	63	65	62
24	63.5	64	65
25	63.5	65	63
26	64	63	60
27	64.5	63	63
28	65	62	63
29	65	63	—
30	65	63	60
31	66	63	63
32	66	65	61.5
33	67	63	65
34	68	69	68
35	69	65	63
36	69	70	—

Horse — Calcaneus

Measurements: the same as those of the astragalus

	1	2	3
1	98	48.5	46*
2	102*	47.5	—
3	103	47.5	47
4	103	52	50
5	104	—	—
6	105	53	—
7	105*	53	—
8	105	53.5	—
9	105.5	49	45.5
10	107	51	51
11	108	50	54
12	108*	51.5	54
13	111	52	54
14	113	49	51
15	113.5	51.5	55
16	115.5	52	54
17	117	56.5	52
18	118	57	62
19	118	—	—

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	238.5	41.5	27.5	43	41.5	21.5	32
2	246	48.5	31	48	46.5	25	—
3	247	48.5	31	48	45	26.5	38
4	248	47.5	31.5	48	46.5	26.5	38
5	250	44	29.5	42	40.5	22	33
6	253	48	30	48.5	45.5	25.5	37.5
7	256	48	31	51*	48.5	25	38
8	257	45	27.5	41.5	41.5	24.5	32.5
9	258.5	47	32	47.5	45	25	—
10	259	47	31.5	47	45.5	25.5	36.5
11	260	45	29	44.5	41	24	35
12	260*	—	30.5	48.5	—	—	—
13	262	—	30.5	49	—	25	37.5
14	262*	—	—	49	—	24.5	37
15	262.5	50	32	51	45	27	38.5
16	263.5	47.5	31	47	43	26	37
17	264	47.5	31	48	44.5	24.5	36.5
18	265	46	30	—	45.5	23.5	36
19	266	50.5	30	47.5	46	24.5	36.5
20	267	52	31	48	47	24.5	36.5
21	270*	48.5	31	—	—	—	—
22	270	48.5	31	46.5	50	24.5	37.5
23	270	51	30.5	—	46.5	25	—
24	270.5	50.5	32	50.5	48.5	26.5	40
25	271.5	50	30	50	45.5	26	39
26	271.5	53*	32.5	51.5	47.5	27.5	39.5
27	275*	—	30	50*	48.5	26	—
28	277	49.5	33	50.5	47.5	25.5	38
29	277	50	32	—	44*	26	37.5
30	280	51.5	33.5	51	—	26.5	40
31	282	50.5	31	52	49	26	39.5
32	282.5	50.5	30.5	46.5	46	24	37
33	282.5	51	32	53	48.5	27	40.5
34	283.5	54	32.5	52.5	51	29	40
35	286	50.5	31	47	46	25	38.5
36	289	52	35	53	50	28.5	40
37	292*	—	31	—	—	27	—
38	296	52	33	54	49	29	41
39	—	44	—	—	40	—	—
40	—	45	29	—	39	—	—
41	—	46	29.5	—	38.5	—	—
42	—	46	—	—	40.5	—	—
43	—	46	—	—	42	—	—
44	—	47	32	—	43	—	—
45	—	48	—	—	41.5	—	—
46	—	48	—	—	44.5	—	—
47	—	48*	—	—	47.5	—	—
48	—	48.5	—	—	43	—	—
49	—	48.5	33	—	45	—	—
50	—	49*	28	—	44	—	—
51	—	49	28.5	—	44	23	—
52	—	49	33	—	45.5	—	—
53	—	49.5	—	—	43	—	—
54	—	49.5	32	—	43	—	—
55	—	50	31.5	—	44	—	—
56	—	50*	—	—	44*	—	—
57	—	51	—	50	45*	27	38
58	—	51	—	—	45	—	—
59	—	51.5	33	—	43	—	—
60	—	51.5	—	—	47	—	—
61	—	51.5	—	—	43.5	—	—

Horse — Metatarsus (cont'd)

	1	2	3	4	5	6	7
62	—	52	—	—	43.5	—	—
63	—	52	32.5	—	45	—	—
64	—	52*	—	—	46	—	—
65	—	52	—	—	47	—	—
66	—	52.5	—	—	47.5	—	—
67	—	53	—	—	46.5	—	—
68	—	54.5	—	—	51.5	—	—
69	—	57	—	—	52	—	—
70	—	—	—	44.5	—	22.5	32
71	—	—	—	45	—	—	35
72	—	—	—	45	—	24	35
73	—	—	—	46	—	20.5	36*
74	—	—	—	46	—	23	35.5
75	—	—	—	46	—	23.5	36
76	—	—	—	46.5	—	—	36
77	—	—	—	47	—	24.5	36
78	—	—	—	47*	—	24.5	36
79	—	—	—	47	—	23	36.5
80	—	—	—	47.5	—	25.5	35.5
81	—	—	—	47.5	—	23.5	35.5
82	—	—	—	48	—	25	36
83	—	—	—	48	—	—	37
84	—	—	—	48	—	25.5	37
85	—	—	—	48	—	25.5	38
87	—	—	—	49	—	24	36
88	—	—	—	50	—	—	36.5
89	—	—	—	50	—	28	39
90	—	—	—	51	—	24.5	37
91	—	—	—	51	—	27	38
92	—	—	—	51	—	28	39
93	—	—	—	52	—	—	39.5
94	—	—	—	52.5	—	27	41
95	—	—	—	53	—	27	41
96	—	—	—	55	—	29	42.5

Ass — Scapula

Measurements: 1. smallest width of collum
2. width of angulus articularis
3. diameter of facies articularis

	1	2	3
1	42.5	65*	33

Ass — Humerus

Measurements: 1. width of distal epiphysis
2. diameter of distal epiphysis

	1	2
1	55	55*

Ass — Radius

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	260	63	29.5	58	33	19	32.5
2	—	—	27	54	—	—	31.5
3	—	—	28	58	—	17.5	34

Ass — Metacarpus

Measurements: the same as those for the humerus

	1	2
1	31	23
2	36.5	27.5

Ass — Tibia

Measurements: 1. smallest width of diaphysis
2. width of distal epiphysis
3. smallest diameter of diaphysis
4. diameter of distal epiphysis

	1	2	3	4
1	29	50*	20.5	36
2	30	52	20	38

Ass — Astragalus

Measurements: 1. greatest length
2. greatest width
3. greatest diameter

	1	2	3
1	42.5	43	41
2	45.5	45	43

Ass — Metatarsus

Measurements: the same as those for the radius

	1	2	3	4	5	6	7
1	203.5	36	19.5	—	31.5	18	25*
2	212*	37.5	24	35	32	20	28*
3	—	—	—	33	—	—	26.5

Cat — Skull

1. I_1 — aboral end of palate	33.5
2. length of row of teeth (I_1 — M_1)	30.5
3. length of incisor row	2
4. P_2 — M_1	22
5. length of P_4	10.3
6. greatest width of skull	61
7. greatest frontal width	56
8. distance between medial canthuses	18
9. width at canines	23.5
10. M_1 — M_1	37.5

Cat — Mandible

Measurements: 1. length to angulus
2. length to processus coronoideus
3. length of row of teeth (I_1 — M_1)
4. length of diastema
5. P_3 — M_1
6. height at P_3
7. height to processus coronoideus

	1	2	3	4	5	6	7
1	60.5	60.5	33	12	20	10.8	27
2	62.7	63	35	12.5	21	10	28
3	63.8	64.7	36	11.9	21.7	10	28
4	65.6	66	36.2	14	22	12.3	29.2

Cat — Scapula

Measurements: 1. greatest length
2. greatest width
3. smallest width of collum
4. width of angulus articularis
5. diameter of facies articularis

	1	2	3	4	5
1	85*	63	16	18	11.8
2	87	62	18	19.2	12.2
3	—	—	14	16	10
4	—	—	14.2	16.3	11
5	—	—	18	19	12

Cat — Humerus

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7	
1	81.7	12.6	5.5	14	16.3	5.5	9	
2	91.7	15.5	5.5	17	19.5	7.5	10.5	
3	105	16.5	7	18.5	21	9	11.4	
4	107.5	18	7	19.3	22	9.5	12	
5	108	18.5	7.8	19.5	22	8.5	13	
6	—	—	6.1	17.8	—	7	12.9	
7	—	—	6.7	19.3	—	8	12	
8	—	—	7.5	21	—	11.3	14	w
9	—	—	8	22	—	10.3	13.8	w

Cat — Radius

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	91.2	7.2	5	12	6.8	3.5	7.8
2	127	10.2	5.7	11.8	7.8	5	7.7

Cat — Femur

Measurements: 1. length to trochanter maior
2. length to caput
3. width of proximal epiphysis
4. smallest width of diaphysis
5. width of distal epiphysis
6. diameter of proximal epiphysis
7. smallest diameter of diaphysis
8. diameter of distal epiphysis

	1	2	3	4	5	6	7	8
1	101.7	100.3	19.5	7	18	13	7.7	16.5
2	114.2	113	22	9	21	15	8.5	18.2
3	—	—	18.5	7.5	—	12.5	—	—
4	—	—	22	—	—	11	—	—

Cat — Tibia

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	117.5	20.5	7.2	15.2	20.7	6.8	10.1
2	119.5	20.8	7.5	15	19.5	7	10
3	119.8	20.5	7.5	14.5	19.5	7	10
4	128	22	9	17	21.5	7.5	11
5	—	—	7.2	14.2	—	6.5	10.2

Dog and Wolf — Skull

1. basal length
2. overall length
3. I_1—M_1
4. M_1 — basion
5. I_1 — aboral end of palate (length of palate)
6. aboral end of palate — basion
7. I_1 — middle of the straight line connecting the most lateral points of ossa frontalia
8. this latter point — opisthion
9. length of row of teeth (I_1—M_2)
10. length of incisor row
11. length of diastema
12. P_1—P_4
13. M_1—M_2
14. length of P_4
15. extreme width of skull
16. extreme width of front
17. extreme width of brain case
18. width at the mandibular joints
19. width at the external auditory meatuses
20. distance between medial canthuses
21. distance between foramina infraorbitalia
22. width of incisor row
23. width at canines
24. P_1—P_1
25. M_1—M_1
26. distance between processus jugulares
27. distance between condyli occipitales
28. length of foramen magnum
29. width of foramen magnum
30. occipital height (basion — opisthion)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	120	138	55	65.6	66.5	54	84	67	71	8	13	38	17	15.5	80
2	141.5	163	63.5	79	77	66.5	93.5	78.5	77	7	16	40.5	16.5	17	102
3	151	178	70	83	83	68.5	105	87	87	8	16	50	19	16	100
4	152	169	68.5	85	86	67	94	84	79	9	17	44.5	17	16	—
5	153	173	72.5	83	85.5	68	100	84	86	8	17.5	49	17	17.5	110
6	157.5	177.5	69.5	89.5	86.5	73	102.5	86.5	83	9.5	17	46	16	19	104
7	159	180	75	84.5	90	69	104	87.5	91	10.5	16	49	18	19	100
8	160	186	78	83.5	88	73.5	108.5	91.5	93	9.5	18	50.5	19	18.5	—
9	162	185	73	90	91	71.5	105	91.5	93.5	10	19.5	47.5	19	17.5	105
10	164.5	185.5	71.5	93	93	81.5	105	91.5	91.5	12	19.5	46.5	19	18	105
11	166	185.5	80	87	93	74	99	86	96	9	19.5	50	17	17.5	97
12	166*	185*	72*	94	87*	79	108	86	92*	8*	17.5	50	20.5	19	108*
13	166	188	73	94.5	—	—	112	90	92	9.5	18	52	20	19	—
14	167	181	71	96	94	73	105	82.5	90.5	10	19	48	18.5	21	104
15	167	189	76.5	91.5	95	73	105.5	89.5	92.5	9.5	22.5	46	21	17	105
16	172*	206	80.5	92*	101	72*	123.5	94.5	97	10	24	59	19	18	—
17	172.5	195.5	81	92	95.5	75.5	115	90	94	11.5	18.5	53	20	19.5	—
18	174	198	77.5	98	97	78	116	95.5	98	12.5	19.5	52	20	19	117
19	175	191.5	58	118	93	83	109	89.5	93.5	9	17	52	19	19	—
20	176	200	78	98.5	101	76	113	97	97.5	9	21	50	24	19	107
21	177	203	73.5	104	93.5	84	114	98.5	91	9.5	21.5	47	18	16	108
22	179	199.5	84	95.5	100	80	110	97	98.5	11	20	51.5	19	18.5	113
23	180	203.5	82	98.5	101	79	114	99	100	10	20	56.5	20	18	109
24	180	213	81	99.5	104	76.5	119.5	107.5	99	10	21	51.5	20	19.5	113
25	180*	206*	83*	97	102*	78	115*	99	101*	11*	20	57	22	21	110*
26	181	202	80	101	—	—	110	98.5	98	12.5	19.5	53.5	18.5	19	116
27	182	209	80	103	105	77.5	116	107	96.5	10	22	52	20.5	19	115
28	183	206	80.5	104.5	99	85.5	118	98	99	10.5	18	57	21.5	19	110
29	184	214	85.5	102	104	83	126	104	101	12	20.5	56	19	19.5	112
30	185	207	79	107	102	85	116	103	100.5	13	18	52.5	24.5	20.5	—
31	189	208	87	102	104	85	116.5	100	105	10	22.5	55.5	20	18	—
32	190*	216*	87*	103.5	108*	84	117*	105*	104*	—	—	57	20.5	19	116
33	191	212*	79.5	112	105.5	86	121*	107	100.5	8.5	21	51.5	22	20.5	117
34	193	210	86	108	—	—	126	96	106	10	20.5	55	20	20	—
35	196*	220	84	102*	105	91*	120	108.5	102.5	12	20.5	56	20	21	—
36	—	176.5	55	—	84.5	—	99	—	86	10	17	48.5	19	17.5	—
37	—	204	78	—	95	—	121	99.5	100	11	19	55	19.5	20	106*
38	—	—	54	—	64	—	80	—	66	7.5	13	35	14	15.5	—
39	—	—	72	—	—	—	—	—	86.5	9	16	50	20	18	—
40	—	—	70*	—	90*	—	110*	—	87*	8*	17.5	48	20	17	—
41	—	—	76.5	—	95	—	—	—	94	10.5	16	52.5	21	18.5	—
42	—	—	79	—	—	—	—	—	95	9	20	52	22.5	18	—
43	—	—	—	—	—	—	—	—	97	10	21	49	21	16	—
44	—	—	80	—	96	—	118.5	—	97	9.5	17	52	20	19	98
45	—	—	75	—	96.5	—	111	—	97	7.5	21.5	50	19	18	105
46	—	—	80*	—	—	—	—	—	98*	—	22	50	22	17	—
47	—	—	85.5	—	104	—	120	—	99.5	11	20	55	20	19	—
48	—	—	80	—	97	—	112.5	—	100	11	19.5	53	20	18	—
49	—	—	84	—	102.5	—	118	—	100	12	19	56	20	20	116
50	—	—	82.5	—	100	—	—	—	101.5	10	24	53	19.5	19	—
51	—	—	89	—	—	—	—	89	102.5	12	19.5	54	20	19	—
52	—	—	88	—	106	—	—	—	103	13	19.5	55.5	20.5	21.5	—
53	—	—	90*	—	—	—	—	—	108*	8*	24.5	54	23	20	—
54	—	—	—	—	—	50	—	72.5	—	—	—	—	13.5	—	—
55	—	—	—	—	—	—	—	77	—	—	—	—	—	—	—
56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
57	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
58	—	—	83	—	—	—	—	92	—	12	22	52	—	18.5	—
59	—	—	—	—	—	—	—	96.5	—	—	—	—	—	—	—
60	—	—	—	92	—	—	—	82	—	—	—	50	21.5	17	108
61	—	—	—	—	—	—	—	83	—	—	—	—	—	—	—
62	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
38	47	71.5	44.5	24	29	20.5	28	24	53	40	28	14.4	14.7	35
53.5	56	84	52	35.5	34.5	23	35	30	54	45	33.5	15	16.5	42
47	59	87	55	—	34	24	34	30	54	45	33.5	15	16.5	42
55	58	—	60.5	37	38.5	23	36	34.5	62	50.5	37	15.5	19	44
49.5	60	88	59	30.5	36.5	23	33.5	32	62	47	35.5	15.5	19.5	44.5
53.5	62	95	60.5	35.5	38.5	24.5	35.5	34.5	62.5	51	36.5	17	20	44
53	59	88	58.5	39	38	25.5	37.5	34.5	60.5	45.5	34	17	17.5	45
46	61.5	—	58	34.5	37.5	25.5	37.5	34	61.5	49	36	16	19	42.5
54	60	92	59	36.5	41.5	26.5	40.5	36	60	48.5	37.5	17	19.5	45
54	60	92	59	36.5	42.5	26.5	40.5	36.5	66	48.5	37.5	17	19.5	45
39.5	59.5	85	58.5	30	35.5	23	34.5	32	56.5	51	37	16.5	20.5	45.5
48	61	96*	62	37	39	26.5	—	35	65	50*	39	15.5	20	46
53.5	59.5	88	57	38	38	26	39	34	60.5	—	37	16.5	20	49.5
47	59.5	93	61	34	37.5	25.5	36	33.5	61.5	49	39	18	21	44
50	63	97	61.5	34	39.5	25	38	36	63.5	—	37	18	20	50
52*	62	—	66	37.5	41	25.5	37.5	35	65.5	—	—	—	—	—
47	64	96	62.5	34	42	28	—	36.5	66	54.5	41.5	17	20	49
60	66	105	67	41	41.5	28.5	43	39	70	52.5	38.5	20	19	53.5
50.5	61.5	—	62.5	38	41	25.5	39	37	66	54.5	40	17	20.5	46
55.5	64	98	63	38.5	39.5	27	38.5	35	69	54	41.5	16	21.5	49
56.5	62	96	63.5	40	40	24.5	37	34	65	53	37	16.5	19	47.5
60	60	99	63.5	42.5	41	27.5	40.5	37.5	68	54	39.5	17.5	20	53.5
55	62	95	64	37.5	42	27	41	36.5	66.5	—	40	17.5	20	51
55.5	65	102	63	39	41.5	27.5	42	39	67.5	55	42	16	22	52
56.5	63.5	96	63	36.5	41	26	41	36	68	50	40	18.5	20	56
55	64.5	101	66	37.5	45	26	—	37	69	55	37	18	19.5	55
68.5	65.5	105	68	47	41	31	44.5	40	66.5	55	41.5	19.5	21.5	51
51.5	60.5	97.5	65.5	36.5	43	27	41	37	69	54.5	40.5	18	21	53
55.5	64	104	64	41	43	28.5	42	37	71	57	41	17.5	20.5	48.5
56	65	—	68	41.5	45.5	32	46	41.5	75	56	42	17.5	21.5	49
70*	67	—	66	49	45	27.5	42*	35	66	—	43.5	18	23	52
62	70.5	104	69.5	47	46.5	—	—	40	69	58	41	19.5	22	53
60.5	69	106	70	42	41	—	—	40*	72	62	45.5	20	23.5	51
58*	63	96	64.5	—	42	27	40	37	67	55.5	38	17	21	50
67	70	—	72	47	46.5	30	46	42	73	—	46	—	—	57*w
43	58*	—	—	32.5	37.5	24	35	32	62	—	—	—	—	—
52	60*	94*	—	39.5	41	26	37	34	62.5	—	—	—	—	—
41	—	—	—	29.5	27.5	18	26	23.5	49	—	—	—	—	—
—	—	—	—	—	36	24	32	29	59	—	—	—	—	—
56	—	—	—	40	37.5	27	37	34.5	64	—	—	—	—	—
—	—	—	—	37	42	29	41	36.5	69.5	—	—	—	—	—
—	—	—	—	—	40	26	43	37	68	—	—	—	—	—
—	—	—	—	—	44	28	41	38	62	—	—	—	—	—
45.5	56*	86	—	32.5	39.5	25.5	38.5	35	60.5	—	—	—	—	—
54	—	94	—	35.5	37	25*	37	34.5	64.5	—	—	—	—	—
—	—	—	—	—	42*	28	43	38	68	—	—	—	—	—
54	—	—	—	57	43	29	42	39	70.5	—	—	—	—	—
49	62.5	94	—	32.5	41.5	26.5	39.5	37	66	—	—	—	—	—
61	—	—	—	42	46.5	30	46.5	39	70	56	38.5	18.5	18	56
—	—	—	—	34	41	25	36.5	33.5	64	—	—	—	—	—
51	63	93	59	36	37.5	25.5	36	33	62	49	37.5	17	19	—
—	—	—	—	—	40	28	42	38	72	—	—	—	—	—
—	—	—	—	—	—	21	—	—	—	—	—	—	—	—
43.5	52.5	76	43.5	29	—	—	—	—	50	37	28	13	16	37.5
44	54.5	83	54.5	32.5	—	—	—	—	—	43	33	13.5	16.5	39.5
—	57	87	59	—	—	—	—	—	—	—	37.5	16.5	19.5	45
43.5	58	—	54.5	28.5	—	—	—	—	—	45.5	34.5	15	17.5	41
49.5	59	90	61	35.5	—	27	—	—	—	—	40	—	21	—
48	59	—	54	35	—	—	—	—	—	46	33	16	18	43
53	59	96	61	38	40	—	—	—	—	50	37	17.5	19.5	44
52	60	92	56	33	—	—	—	—	—	52	36	17	20	45.5
—	60	88*	58*	—	—	—	—	—	—	50	36.5	15.5	19	44
—	60.5	—	60.5	—	—	—	—	—	—	53	40.5	17	20.5	49.5

Dog and Wolf — Skull (cont'd)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
63	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
64	—	—	—	—	—	—	—	93	—	—	—	—	18	—	—
65	—	—	—	91	—	76	—	88.5	—	—	—	—	22.5	—	107
66	—	—	—	101	—	—	—	95*	—	—	—	—	—	—	—
67	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
68	—	—	—	—	—	—	—	95	—	—	—	—	—	—	—
69	—	—	—	—	—	—	—	95	—	—	—	—	—	—	—
70	—	—	—	—	—	—	—	103.5	—	—	—	—	—	—	—
71	—	—	66	—	84	—	99	—	82	7.5	18.5	41.5	18	17	—
72	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
73	—	—	—	—	—	—	—	103	—	—	—	—	—	—	—
74	—	—	—	—	—	—	—	90	—	—	—	45	18.5	17.5	—
75	—	—	—	—	—	—	—	90*	—	—	—	—	18	17	—

Dog — Upper row of teeth

Measurements: 1. P_1—P_4
2. M_1—M_2
3. length of P_4

	1	2	3
1	36.5	14	12.5
2	48.5	17.5	17.5
3	55	19	22.5
4	55*	20.5	22.5
5	38.5	—	16
6	53	—	19.5
7	53*	—	20*
8	51	—	21
9	—	20	18

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
53.5	61	90	58.5	37.5	—	—	—	—	—	—	38	15.5	—	49
56	62.5	96	61.5	42.5	—	—	—	—	59	52.5	40	17	19.5	50
51	63.5	—	64.5	32	—	—	—	—	62.5	54.5	39	18	19	48.5
—	63.5	—	59	—	—	—	—	—	—	50	38.5	16.5	21	49
50	64	—	62.5	36	—	—	—	—	—	54	41	17	20	50
52	65	97	64	39	—	—	—	—	—	58	43.5	17.5	21.5	52.5
62*	65	104*	66	52*	—	—	—	—	—	—	43.5	19	21	50
50	—	—	—	36	36	22.5	34.5	31.5	59.5	—	—	—	—	—
—	65	98	64	—	—	—	—	—	—	55	41	17.5	21	50
57	67	101	66.5	36	—	—	—	—	—	60.5	43	22	22.5	56
51	—	—	—	38	—	—	—	—	—	—	—	—	—	—
55	—	—	60	40.5	40.5	—	—	—	63*	—	36	14.5	18.5	46

Dog — Lower row of teeth

Measurements: 1. P_1—P_4
2. M_1—M_3
3. length of M_3

	1	2	3
1	35.5	29	17.5
2	35	31.5	19
3	39	34	19
4	39.5	35	20
5	37.5	35.5	20.3
6	39.5	36	21.5
7	43	38	22
8	47	36	22.5
9	46.5	42	23.5
10	44	40.5	24
11	—	37	21.5
12	—	37.5	21.5
13	—	37	22.5
14	—	36	22.7
15	—	—	20*
16	—	—	22.5
17	32	—	17.5
18	36	—	20.5
19	38	—	21
20	34	—	—
21	40.5	—	—
22	43.5	—	—

Measurements:
1. length to the angulus
2. length to the processus coronoideus
3. height at P_1
4. height at M_1
5. height to the articular surface
6. height to the processus coronoideus
7. length of row of teeth (I_1–M_3)
8. length of incisor row
9. length of diastema
10. P_1–P_4
11. M_1–M_3
12. length of M_1

	1	2	3	4	5	6	7	8	9	10	11	12
1	97*	96*	13.5	13.5	16.5	38	70*	3*	11.5	21	35.5	17.5
2	103*	100*	—	14	18.5	37.5	75*	4*	14.5	28	29	18
3	—	—	15	17	—	—	75.3	3	14	31.5	28	16
4	107.5	110	15	17	—	41	77	3	13	31	29	17.5
5	—	111.5	15	17	—	—	77	4	13.5	31	29.5	17
6	—	—	15.5	18	—	—	78.5	4	12.5	32.5	29.5	17.5
7	124	122	17.5	20.5	24	51.5	80.5	4	17	35.5	31	19.5
8	114*	117*	16	18.5	23.5	51	81*	3*	15.5	35.5	29.5	18.5
9	120	117*	17.5	19	21.5	44.5	82.5	4	14.5	33.5	31.5	18.5
10	137	—	18	20	26.5	—	85	4.5	15	33.5	32.5	18
11	123*	—	17	20	21	—	85	4	18	35	33.5	22
12	128*	—	17.5	20.5	26	—	87*	5*	15	33.5	33	18
13	—	—	16	19	—	—	87*	4*	15	36.5	28.5	17
14	128*	—	16	20.5	26.5	—	88*	5*	14.5	37.5	33.5	18.5
15	129*	—	18	20	25	—	88*	—	—	38	31.5	18.5
16	130	—	16.5	21	—	—	88	4.5	16	33*	34.5	20
17	132.5	—	17.5	21	27	—	88	5	15.5	36.5	31	18
18	127	126	15.5	20	22	48	89	5	15	37.5	32	19.5
19	—	—	16.5	21	—	—	89*	4*	15	41	30.5	17.5
20	128*	127*	16.5	21	22.5	50	89*	4*	15.5	39	30.5	17.5
21	—	—	18	25	—	—	90*	—	15.5	36	33	19.5
22	—	123*	16	19.5	—	51.5	90*	5*	15.5	36	32.5	19
23	133	128.5	18	21	27.5	55.5	90	5	15.5	37	34	20
24	—	—	17.5	21.5	26.5	—	90*	5*	15	37.5	33	18
25	128	124	18	19	25	53	90.5	3	17	37	35	20.5
26	126*	126*	17	20	26	50	91*	4*	16	38	32	19
27	134*	—	20	24	26	—	91*	—	—	38.5	36.5	22
28	130	—	19	21	25	—	91	5	16.5	38	33	20
29	135*	134*	19.5	21.5	—	—	91*	—	—	37	36	22.5
30	137.5	135	18	21.5	24	54	92.5	4	16.5	38.5	35.5	21
31	—	127.5	18	19.5	25	52.5	92.5	3.5	14	39	37.5	21
32	—	138	17.5	21.5	—	—	93	4	16	39.5	35	20.5
33	—	—	21	21	—	—	93*	4	15.5	38.5	39	22
34	131.5	126	18.5	19.5	27	51.5	93	5	16	37.5	36.5	21.5
35	137*	134*	18	21.5	24	53	93*	5*	15	38	38	21
36	—	—	18.5	22	—	—	93.5	4.5	18	38	34.5	19.5
37	135	130	20	21.5	24.5	53	94	4	17	40	35	21
38	133	129	18	21.5	26	54.5	94	4	16	39	35	20.5
39	—	—	18	21	—	—	94*	4	14.5	38.5	37.5	23
40	—	—	18.5	22	26.5	54	94	3.5	18	38.5	34.5	20
41	140	—	20.5	22	27.5	—	94*	—	—	40	37.5	22
42	144*	—	18.5	20.5	26.5	94*	94*	6*	16	39*	34	19
43	—	146*	21	23.5	27.5	60	94*	8*	18.3	38	34.5	19
44	148*	—	19	23	29	—	94*	4*	18	41.5	30.5	20.5
45	—	142*	20	22.5	29.5	60.5	94*	4*	14*	38	35.5	19.5
46	144*	—	18	21.5	28	—	94.5	7*	14	41	39	22.5
47	143.5	—	19	22	28.5	—	95	5	17.5	40	35.5	21
48	129*	—	18	20.5	—	—	95*	6*	15	38.5	38	20.5
49	145*	143*	20	23	27.5	61	95*	5*	20	37.5	35	18.5

	1	2	3	4	5	6	7	8	9	10	11	12
50	132*	—	21.5	25	25	—	95*	—	—	38.5	39	22.5
51	135.5	133	16	21	24	51	95.5	4	17.5	39.5	36	20.5
52	—	—	19	21.5	—	—	95.5	4.5	16	38.5	38	22
53	140	139.5	21.5	24	27.5	55.5	96	4	17	39	37	21
54	—	—	19	23	—	—	96	3.5	16	40.5	36.5	21.5
55	152*	—	20	24	30.5	63	96*	5*	20	41.5	31	21.5
56	138*	—	18.5	23	26	—	96*	4*	16	41	36	22.5
57	140*	135*	20	22.5	27	55	96*	—	—	39	37	22.5
58	142	138	19	23.5	29	57	97	5	17.5	38.5	37	22.5
59	143*	—	21	26.5	—	—	97	4.5	18	41	34.5	21
60	137*	134*	17	21	23.5	50	97	5	17	39.5	35	20.5
61	145*	147*	19	24	28	62	97*	5	13	44	36.5	20
62	144*	—	20.5	23.5	25	55	97*	8*	16	40.5	36	23.5
63	140*	137*	21.5	25	26	55	97*	5*	17	39.5	37	21
64	—	123*	18	21	25	54.5	97*	—	—	37	32	19
65	—	136*	21	25	—	—	97*	—	22	37	37	22.5
66	—	136	18.5	24	31.5	—	98	5	17	39.5	38	21
67	146	138	19	24	32	62	98	5.5	18	40	38.5	20.5
68	143	135	17	22	24.5	52	98	4	17	40.5	35	23
69	143	135	17	21	25	52	98	4	18	39.5	35.5	20.5
70	143*	145*	20	23	29	61	98*	4*	18	40	37.5	21
71	—	—	19	25	—	—	98*	5*	18.5	39.5	35.5	19
72	143*	141*	20	24	29	57	98	6	16	38	35	21.5
73	154*	153*	22	26.5	28	65	98*	6*	20.5	41.5	31	23
74	143*	—	19	22.5	25	58	98*	7*	20	37.5	35.5	20.5
75	148.5	148	20	24.5	27.5	60	98.5	6	17.5	40	37	21.5
76	149	—	18	22	28	—	99	4	17.5	40.5	36	20.5
77	146	142	19.5	25.5	29	60.5	99	6	17.5	41.5	35.5	21
78	142.5	140	19	24	27	59	99	5	19.5	39.5	38	22
79	—	146	17.5	22	—	55	100	4	17	43	36.5	21
80	149.5	150	20.5	26	32	66.5	100	4.5	21	41	35.5	21.5
81	—	136	19.5	24.5	—	—	100	3	17	41	38	22.5
82	—	—	17.5	22	—	—	100	4.5	16	41.5	40	23
83	144*	144*	21	25.5	29	61.5	100*	4*	19.5	41	38.5	23
84	153*	—	20	24	—	—	100*	6*	20.5	40.5	35	19
85	—	—	20	23.5	—	—	100*	5*	17	42	38	23
86	148*	146*	21	24.5	30	63	100*	7*	17	41.5	38.5	22
87	—	—	18	22	—	—	100.5	4	19	40.5	38	21.5
88	146	139	17	22	26	53.5	100.5	4.5	18	43	34.5	20.5
89	146	145	17	21.5	26.5	56	100.5	4	16	43.5	37	20.5
90	161	153	22.5	24	29	63	101	4.5	22	41*	35.5	22
91	141*	138*	19.5	22.5	26	51.5	101*	5*	15	42	41	24
92	151*	155*	21	25	30	67	101*	6*	17	41.5	37	21
93	153*	—	21	23.5	31.5	—	101*	—	17.5	43	38	22
94	150	143	20.5	25	28	60	102	8	23.5	36.5	38	23.5
95	—	—	18.5	22	30	62	102*	7	16	41	30	23.5
96	152*	150*	21	25.5	27.5	58	102*	5*	18.5	44	36	22.5
97	152*	140*	19.5	22	28.5	60.5	102*	6*	19	41	36.5	22.5
98	152*	150*	21	26	26.5	57.5	102*	6*	18.5	44	35.5	21
99	150	146	17.5	24	26	55	103	4	18	46.5	35.5	20
100	—	—	19.5	25.5	—	—	103	4	19	42.5	38.5	22
101	155	—	21.5	26	29	65	103	4.5	20	41	38	23
102	147	142	—	23	28	60.5	103	—	—	—	39	23
103	—	144*	18.5	21.5	—	—	103	7	16.5	44.5	37	22
104	153*	143*	19.5	24	29	61.5	103*	6*	20	41	36	21
105	144*	140*	18	22	22.5	55	103*	—	—	41	38.5	25
106	150	150	17.5	23	26	56	103	7	19	42	38	20.5
107	151	145	23	25	28	59	103	3	23	40.5	37.5	21.5
108	159	151	19.5	25	28	61	104	5	20	44	35	20
109	152	150	24	27	30	63	104	7	17	42	37.5	21
110	157	—	18	24	—	—	104	4.5	19.5	44	37	20
111	—	—	20	25.5	—	—	104	5.5	16.5	44.5	39	22.5

Dog — Mandible (cont'd)

	1	2	3	4	5	6	7	8	9	10	11	12
112	158	—	20.5	28	31	65.5	104*	8*	20.5	44	36	21
113	156	149	18.8	24.5	30	61	105	4.5	18.5	46	37	21
114	151*	152*	24	27	29	63	105*	6*	20	41	36.5	22.5
115	—	—	18.5	23.5	—	—	106	4	18	44	40.5	23
116	150*	145*	19	22	27	56	106*	5*	18.5	43.5	39	22.5
117	159	154.5	22	25.5	31.5	64	107	—	—	49	39	22.5
118	155	149	22	24	31	63	107	7	20.5	41	39	22
119	164	—	21	26.5	29.5	—	107	6	23	43	37.5	21.5
120	160*	154*	19.5	26	31	64	107*	7*	19.5	45.5	38	22
121	156	153	21.5	26	30.5	65	109	5	19.5	47	41	23.5
122	—	—	12.5	14	15.5	36	—	—	8	28.2	23.5	14.8
123	—	—	—	13	—	—	—	—	—	32	30	18
124	—	—	16	18	—	—	—	—	15	33	30.5	18.8
125	—	—	13	—	—	—	—	—	—	34	25.5	14
126	—	—	15	16.5	19	—	—	—	—	34	31.5	17
127	—	—	—	16.5	—	—	—	—	—	34.5	30	19.5
128	—	—	18	20.5	—	—	—	—	—	35	33.5	20
129	—	—	17.5	20	—	—	—	—	15.5	35.5	36	21
130	—	—	19	21	26	53.5	—	—	—	36	30	20
131	—	—	16.2	20	—	—	—	—	15.5	36	32.5	19.2
132	—	—	21	21.5	25	52.5	—	—	19	37	35	21
133	—	—	16	19.5	—	—	—	4	11	37	—	17
134	—	—	—	20	—	—	—	—	—	37.5	36.5	20.5
135	—	—	19.5	20.5	—	—	—	—	—	37.5	37	23
136	—	—	18	22	—	—	—	—	16	37.5	—	20.8
137	—	—	18	20	25	49	—	—	—	38	33	19
138	—	—	—	20	24	51.5	—	—	—	38	33	20
139	—	—	—	21	—	—	—	—	—	38	35	20
140	—	—	17	19	—	—	—	—	—	38	—	22
141	—	—	19.5	22.5	—	—	—	—	—	39	36	21.5
142	—	—	20.5	23.5	—	—	—	—	17	39	34.5	22
143	—	—	20	23.5	28.5	57	—	—	—	39	41	22
144	—	—	18	21.5	—	—	—	—	14.5	39.5	36.5	23.5
145	—	—	20	23.5	27	—	—	—	17	39.5	36	21
146	—	—	19.5	23	—	—	—	—	—	39.5	38.5	23
147	—	—	—	23	25	55	—	—	—	40	36	23
148	—	—	20	24.5	25	54	—	—	—	41	38	23
149	—	—	18	23.5	26	54	—	—	16	41.5	35	20
150	—	—	—	22.5	—	—	—	—	19	41.5	36.5	22
151	—	—	—	23.5	—	—	—	—	—	41.5	—	22
152	—	—	21	25	—	—	—	—	—	42	39.5	22.5
153	—	—	21	25.5	32*	60.5	—	—	—	42	38.5	22.5
154	—	—	23	28.2	32	—	—	—	21.5	42	39.5	26
155	—	—	17.5	22.5	—	—	—	4	18	42	—	—
156	—	—	—	23	—	—	—	—	—	42.5	36	20.5
157	—	—	—	27	29.5	63.5	—	—	—	43.5	41	24
158	—	—	—	21.5	27	55.5	—	—	—	44	40	22
159	—	—	20	28	—	—	—	—	—	46.5	38.5	23
160	—	—	22	26.5	31.5	65	—	—	—	46.5	41	24

Measurements: 1. length of arcus ventralis
2. length of arcus dorsalis
3. width of cranial articular surface
4. width of caudal articular surface
5. greatest width
6. greatest height

	1	2	3	4	5	6
1	5.5	13	29	21.5	59	21
2	6	14	31	24	68	23
3	6.5	10	28	22	—	18.5
4	6.5	12.5	30.5	25.5	60	23.5
5	6.5	13.2	34	28	68	25
6	7	11.5	30	25.5	51.5	22
7	7	13	35	28	73.5	26.5
8	7	14.5	32	25	61*	23
9	7.5	14	40	31.5	70	25.5
10	7.5	15	34.5	29	71	26.6
11	7.5	16	40	34	81	27.5
12	8	14.5	40	32.5	—	29
13	8	15	39	31	80.5	28.5
14	8	16	30	30	76	26
15	8	17	38	33	75	27.5
16	8	18.5	40.5	33.5	88	30
17	8	18.5	43.5	34.5	91	30
18	8.5	13.5	36	30.5	—	27
19	8.5	14	38.5	32	76	27
20	8.5	15	38	31.5	78	27
21	8.5	15.5	35	26.5	—	24.5
22	8.5	15.5	40.5	30.5	—	28.5
23	8.5	15.5	41	34.5	84	28
24	9	14.5	38.5	33	80.5	27.5
25	9	15.5	39.5	32	81	28
26	9	16	41	35.5	—	28.5
27	9	16	42	36.5	80	27.5
28	9.3	15.5	40.5	38	90	30
29	9.5	15.5	38	32	80	27
30	9.5	16.5	36.5	31.5	78	27
31	9.5	17	41	33.5	85	28
32	9.5	17	42.5	32	89	31.5
33	9.5	18	41	33.5	88	29.5
34	10	16	39.5	35	86	30.5
35	10	17	41	31.5	78	27.5
36	10	17.5	38	32	87.5	30
37	10	17.8	42.5	37.5	—	27.3
38	10.3	17	41	31.5	80.5	28
39	10.5	15.5	37	30	77	36
40	10.5	18	40	35.5	80	28
41	10.5	18.5	41.5	36.5	90	29.5
42	10.5	18.5	43	35	84	29
43	11.5	15	38.5	31	—	29
44	11.5	20	46	38	—	34
45	11.5	15	38.5	31	—	29
46	11.5	15.5	39.5	32	81	26.5
47	11.5	16.5	41	35	82.5	29
48	11.5	16.5	43	34	92.5	31
49	11.5	20	42.5	36	89.5	30
50	12	18.5	42	34.5	88	30
51	13	19	42	34.5	84	29
52	13.5	17	41.5	34	82	27
53	—	17.5	38	29	—	27

Measurements:
1. length of body
2. length of arch
3. length of dens
4. width of dens
5. width of cranial articular surface
6. width of fossa caudalis
7. greatest width
8. height of cranial articular surface
9. height of fossa caudalis
10. greatest height

	1	2	3	4	5	6	7	8	9	10
1	34.5	14	7.5	5	21.5	12	—	10	7	—
2	36.5	17.5	6	7.5	27.5	16	36	11.5	10	—
3	38*	17.5	9.5	6.5	26	14	36	11.5	—	—
4	39	16.5	9.5	6	25	16	35	11.5	9	32.5
5	45	20.5	11.5	7	27.5	—	—	12	10	37
6	45.5	17	12	7.5	31.5	18.5	39	14	10.5	38
7	46	20.5	11.5	7.5	31	18	37	13.5	10	38.5
8	46	20.5	11.5	8	26.5	17.5	—	13.5	9.5	35
9	46	21	10	8.5	35	19	—	14	11	42
10	47.5	20	13	7.5	30.5	17.5	39.5	16	12	36.5
11	48	21	12	8	32.5	18	—	13.5	9.5	—
12	48.5	19	13.5	8	33.5	20	40	15	11	—
13	49*	21.5	12	8	29	18*	—	14	—	36
14	49	23.5	12.5	7.5	31	21	45.5	14	12	40
15	50	21	14	8.5	33.5	21	—	15	10.5	39.5
16	50	21.5	11.5	6.5	31	18	37	13	11	35
17	50	21.5	10	9	36	21	46*	15.5	12.5	—
18	50	24	12	7	30.7	19	48	14.5	11	42
19	50	24.5	14	8	33	20	42	16	11.5	38
20	50.5	21	12.5	7.5	32	20	44	13.5	11	45
21	51.5	21	13.5	8	34.5	20	—	17	13	—
22	52	21	14	8.5	36	19.5	44	15	12	39
23	52	21.5	13.5	9.5	37	21	—	14	11.5	—
24	52	24	13	7.5	33	19	44	16.5	10.5	—
25	53	22	14	7.5	34	21	46	15	12	40.5
26	53	22	14	7.5	29	18.5	—	13	11	40
27	53	24	13.5	7.5	34.5	19	41	15	12.5	41*
28	54	23	14.5	9.5	34	22	—	13	12.5	45
29	54	24	14	8	33	19.5	—	17	13	42
30	55	22	15	9.5	35	22	47	16	13	—
31	55	24.5	14	8	34.5	19	47.5	18	12.5	—
32	55.5	24	12	7	31	17	37	16.5	11.5	33
33	55.5	24	14	9	35	21	44.5	16	12	41.5
34	65	21	14	8.5	36.5	21	46	13	13	—
35	56	23	14.5	9.5	34	21	45	14.5	13	—
36	56.5	24.5	15.5	7.8	31	18.5	40	14.7	11	39
37	57	24.5	15	8.5	33.5	20	—	15.5	12	41
38	58	23	15	9.5	38.5	22	—	16.5	13.5	43
39	58	23.7	16.5	9.5	36	22*	—	17	14	45.5
40	58.5	24.5	14.5	9	36	20	46	17.5	12.5	42
41	58.5	26	14	9	35.5	19.5	52	16	12	40
42	63	24.5	15	9.5	38	22	51	18	13	46
43	66	30.5	18	11.5	41	25.5	16.5	17.5	16	—
44	—	22	—	—	32.5	20	—	13.5	11.5	40
45	—	23	—	—	37.5	22	—	—	14	—

Measurements: 1. greatest length
2. greatest width
3. smallest width of collum scapulae
4. width of angulus articularis
5. diameter of facies articularis

	1	2	3	4	5
1	85.5	—	18.5	21	13
2	93.5	—	17	21	12.5
3	107	—	20.5	25.5	15.5
4	110.5	—	17	22.5	14.5
5	111	63	19.5	24.5	14.5
6	111	—	26	31.5	18
7	116.5	82*	27.5	32	20
8	118	—	23.5	28	17*
9	122.5	—	24	29.5	19
10	123	—	23	27.5	16.5
11	124.5	—	21.5	27	—
12	125	—	26	30	—
13	129	—	—	—	19.5
14	130	—	22	27.5	17
15	130	—	26	30.5	18*
16	132.5	—	26	—	17.5
17	133	80	26.5	30.5	17.5
18	133.5	—	26	29.5	18
19	135	—	23.5	29*	17.5
20	135*	—	30	33.5	20
21	137	—	—	30*	19.5
22	139.5	—	30	37	22
23	140	—	24.5	31	19
24	140	78	26	31	19
25	141	—	28	32.5	21
26	142	—	22	28	18
27	142	—	28.5	30	18.5
28	144	74	26	29.5	19
29	144	70*	26.5	30	18.5
30	146*	—	29	34.5	20
31	147	84	25.5	31.5	18.5
32	151	—	28	32.5	20.3
33	151	92	31	36.5	24
34	152	—	29	35	22
35	155	87	29.5	33	20.5
36	157	86	28	36	22
37	160	96	29	35	21
38	167	—	35	40	24.5
39	—	—	15.5	18.2	11
40	—	—	15.5	19	11
41	—	—	22	25	15.5
42	—	—	20	25.5	15
43	—	—	21	25.5	16.5
44	—	—	22.5	27	17
45	—	—	—	27	17*
46	—	—	21.5	27	17.5
47	—	—	22.5	28	17
48	—	—	24	28	17.5
49	—	—	23.5	28	18
50	—	—	21.5	28	18*
51	—	—	23	28*	18
52	—	—	—	28.5	18
53	—	—	23	29	17.5
54	—	—	24	29	19
55	—	—	23	29.5	18
56	—	—	23	29.5	19
57	—	—	23	30	17.5

Dog — Scapula (cont'd)

	1	2	3	4	5	
58	—	—	26	30	19	
59	—	—	26	30	19	
60	—	—	25	30	19	
61	—	—	28	30.5	19	
62	—	—	26	30.5	19.5	
63	—	—	26.5	31	18	
64	—	—	27	31*	18	
65	—	—	—	31	18	
66	—	—	24.5	31	19	
67	—	—	24.5	31	20	
68	—	—	26	31	20	
69	—	—	27	31	20	
70	—	—	28	31.5	20	
71	—	—	25	32	20*	
72	—	—	29.5	32	20	
73	—	—	—	32*	22	
74	—	—	27	32.5	20.5	
75	—	—	27.5	32.5	20	
76	—	—	28.5	32.5	20.5	
77	—	—	24	33	20.5	
78	—	—	28	33	20.5	
79	—	—	28	33	20.5	
80	—	—	28	33.5	20	
81	—	—	28.5	33.5	20	
82	—	—	25.5	33.5	20.5	
83	—	—	28	33.5	21	
84	—	—	28	33.5	21	
85	—	—	—	34	19.5	
86	—	—	28	34	20.5	
87	—	—	—	34	20.5	
88	—	—	28.5	34.5	20.5	
89	—	—	29	34.5	20.5	
90	—	—	31.5	34.5	21	
91	—	—	30	35	21	
92	—	—	28.5	35	23	
93	—	—	29	35.5	22.5	
94	—	—	31.5	35.5	22.5	
95	—	—	28.5	35.5	23	
96	—	—	29.5	36.5	22	
97	—	—	33	38	23.5	
98	—	—	33.5	40	24*	w
99	—	—	21	26.5	—	
100	—	—	26	29.5	—	
101	—	—	25.5	31	—	
102	—	—	26	31	—	
103	—	—	28	32.5	—	
104	—	—	27.5	—	20	
105	—	—	28.5	—	20.2	

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	82.5	19	8	19.7	25	8	19
2	82.5	18	8.2	20	25.5	9.5	15.3
3	97	21.5	8	24	28.5	9.5	18
4	101.5	22	8.5	21	29.5	9	17
5	112.5	26	13.5	28.5	34	11	24
6	114.5	—	12	27.5	—	12	22*
7	115	27.5	12	25.5	34	12	23.5
8	116.5	24	11	24.5	32	10.5	20.5
9	123.5	27.5	13	28	37.5	13	24.5
10	125.5	36	15.5	31.5	43	14	30
11	126	32.5	14.5	33	40	13.5	28.5
12	129.5	34	16	33	43	15.5	30.5
13	139.5	36.5	15.5	34.5	46	15.5	33
14	143	—	10	25	34	11.5	23
15	147	28	11.5	29	39.5	13.5	23.5
16	148	25.5	12	30	38	13	24
17	149	25	10.5	28.5	37.5	12	23.5
18	149	26	12	29	37.5	12	25
19	150	—	12.5	28.5	38.5	13	23.5
20	151	28	12	27	34	13.5	22
21	151	27.5	12	26	34	12	24.5
22	152	27.5	10	—	36	13	—
23	155	27	12	29.5	39	12.5	26.5
24	161	29	12	30	40	12	28
25	161	28.5	13.5	30.5	38.5	13.5	26
26	162	32	12.5	30	41	13	25.5
27	162	31.5	13.5	32	40.5	14	28
28	163	29.5	12	29	40	12.5	26
29	165	30	11	—	39	11.5	25.5
30	165	30.5	13	31	40	12.5	28.5
31	165	29.5	13	31	40.5	12.5	27
32	165	28.5	13	31.5	39	13.5	25
33	165.5	31.5	13	32.5	40.5	12.5	26.5
34	166	29	13	30.5	41	13	26.5
35	168	27	10.5	29.5	40	11.5	—
36	169	35	15	36	44.5	16	28.5
37	170	—	13	—	42	13.5	—
38	170	32	13	33	43	14	27
39	171	31	13	31	41	13	27
40	171.5	31.5	13.5	35.5	43	13.5	29
41	173	30*	14	35	42.5	14	27.5
42	174	29.5	14	31.5	39	13.5	27
43	175	30	13	31.5	39	13.5	25.5
44	177	33.5	13	33	40.5	14.5	26.5
45	178	28	12.5	32	41.5	13	26.5
46	179	30.5	11.5	35.5	44	13.5	28.5
47	179	33	14	34.5	41.5	14	30.5
48	179	33.5	15.5	38.5	47.5	16	32
49	179.5	32	12	35	44	13.5	28
50	180	30.5	14.5	36	42.5	13.5	27
51	180	32	14.5	—	43	15	—
52	180	34	15	37	46	16	29.5
53	181	34.5	14.5	36	45.5	15.5	29.5
54	181	33	15	38.5	47	15	31
55	181	34.5	16.5	38.5	46.5	16	30

	1	2	3	4	5	6	7
56	182	29	12.5	33	44.5	13.5	29
57	182	30	14	34.5	46	15	28
58	182	32	14	35	45	14.5	29
59	182*	34	15	35.5	45*	15.5	29.5
60	183	35.5	16.5	38.5	46	15.5	32
61	184	31	13.5	35.5	44.5	13.5	30
62	184	33	14	38.5	47	14	33
63	184	36	16	37	47	15	32.5
64	184	30	16	33	43.5	18	28
65	185	33.5	16	37	48	15.5	29
66	186.5	33.5	14.5	35	44.5	15.5	29.5
67	187	30	12.5	32	44	14.5	28,5
68	187*	—	14.5	36	—	15	29
69	187	35	15.5	39	43	14	29.5
70	188*	—	15	37.5	—	17.5	30
71	189	31	13.5	35	46	16	31
72	189	33.5	15	36	47.5	17	29
73	190*	32*	13	35	46	15	31.5
74	191	36	15	36	48	15.5	31.5
75	191.5	35.5	15	37	48	17	30
76	193	38	15.5	38.5	46*	17	35
77	194.5	31	12.5	35	44.5	14.5	28.5
78	194.5	37.5	16	38	47	16	30
79	195.5	35	15.5	37.5	46	16.5	29.5
80	196	36	15.5	37	48	16	30
81	197	34	13	34	46	15	30
82	197	33.5	15	36*	46	16.5	29
83	201	—	13.5	38	—	14.5	30.5
84	202	32	13.5	37	48.5	15.5	30*
85	202	36	17	39	51	19	31.5
86	211	32.5	13.5	35.5	46.5	16	31
87	—	19	6	—	22	—	—
88	—	27	—	—	36	—	—
89	—	30.5	12	—	42.5	—	—
90	—	31	—	—	43	—	—
91	—	31.5	15	—	47	—	—
92	—	32	—	—	43	—	—
93	—	36	—	—	49	—	—
94	—	—	9	22.5	—	9.8	17.5
95	—	—	9	23	—	9	17.5
96	—	—	—	29	—	11	23
97	—	—	—	29.5	—	—	22.5
98	—	—	12.5	29.5	—	12	28
99	—	—	12.8	30	—	12.5	22.2
100	—	—	12	30	—	12.5	23
101	—	—	13.2	30.3	—	15	23.5
102	—	—	12.5	31	—	13	23.5
103	—	—	13	31.5	—	13	23
104	—	—	13	31.5	—	14	23.5
105	—	—	13.5	31.5	—	14	24
106	—	—	13	31.5	—	14.5	25
107	—	—	13.5	32.5	—	17	26.5
108	—	—	13	32.5	—	13	27.5
109	—	—	12	33	—	15.5	24.5
110	—	—	14	33	—	15	26*
111	—	—	14	33.5	—	14	26
112	—	—	13	33.5	—	14.5	28

Dog — Humerus (cont'd)

	1	2	3	4	5	6	7
113	—	—	13.5	33.7	—	15	—
114	—	—	—	34	—	—	27.5
115	—	—	—	34	—	—	27.5
116	—	—	—	34	—	—	27.5
117	—	—	14.5	34	—	17	28.5
118	—	—	14.5	34	—	17.5	28.5
119	—	—	13.5	34.5	—	14.5	28
120	—	—	13	34.5	—	13	30.5
121	—	—	—	35.5	—	—	28
122	—	—	13	36	—	13.5	27.5
123	—	—	—	36.5	—	—	28
124	—	—	12.5	37	—	14	29
125	—	—	15	38	—	16	—
126	—	—	—	39	—	—	33
127	—	—	16	44	—	18.5	34

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	71.5	12	8.5	14.5	9	5	9
2	71.5	12.5	8.5	14.5	9	5	9
3	76	13	10	16.5	8.2	4.2	10
4	87.5	13.5	8.5	16.3	8.3	4	9
5	92.5	12.5	8	15.5	8.5	4.5	9
6	97	13	9.5	17	9	4	10
7	98.5	16	12	21	12	6	11.5
8	99	17	12.3	21	12.3	6	11.5
9	101.5	13	10	19	9.5	5	11
10	104*	17.5	13	—	13	6.3	—
11	104.3	16.8	12.5	22.7	12*	7	13
12	104.5	15.5	12	21.5	11	6.5	12.5
13	106	15	11.3	19.8	11	5.5	11
14	106	16	13.5	—	10.5	6.5	13
15	107.7	15.8	12	21	11	5.4	12.5
16	108.5	21	17.5	25.5	15.5	9	15
17	110.5	21	17	26	15	8	15
18	112.5	13.5	8.5	—	9	4.5	—
19	113	17	12.5	21.5	12	6.5	12
20	124.5	13.2	9.2	18	9.2	5.2	10.5
21	133.5	15.5	10	18.5	11	6	11.5
22	135.5	14.5	10.5	20	10	5.5	11.5
23	145.5	17	11	21	12.5	6	12
24	148.5	18	11	22	11.3	6.2	13
25	149	16.5	11.5	22	12.5	6.5	12
26	149	16.5	12.5	22	12	6.5	12
27	150	17	12.5	22.5	11.5	6.5	13.5
28	156.5	18	12.5	22	11	6.5	13
29	160	18	12	24	13	6	14
30	161.5	18.5	12.5	24	13.5	6	14
31	162	17	12	23	13	7.5	13
32	166	19.5	14	26.5	14	8	15.5
33	167	17	12	23	12	6.5	13
34	167	20	14	26.5	14	8	15.5
35	167.5	18	12	24	12.5	6.5	14
36	169	17.5	11	23	12	6	13
37	169	18	12	23	12.5	7	14
38	169	18	12.5	24.5	12	6.5	14.5
39	169	20	13	26	13	7	15
40	169	20	13	26	14	7.5	15
41	170	18	11	23	12	6	13
42	172	19*	12.5	26	13	6.5	14
43	173	19	12.5	25	12.5	6.5	14
44	174	19	14	25.5	13	7	15.5
45	175	19	12.5	25	13.5	7	15.5
46	175	19	14	26.5	13	7	16
47	177	19.5	13.5	25.5	15	7	16
48	177	20	15	25.5	13	7.5	15
49	178	19	14	25.5	12.5	8	15
50	178	20	14	26.5	14	7.5	16
51	178	—	14	27	15	8	16
52	179	17.5	11.5	23.5	13	5.5	13.5
53	179	18	12.5	24	12	7	14
54	179	18	13	24	14	6.5	14
55	179	20	13	26	14.5	7	14.5
56	180	21.5	14.5	26	15	8	15
57	181	18	12.5	24.5	12.5	7	13
58	181	22	15.5	29.5	16	8.5	16.5
59	182	19.5	12	26.5	14.5	7	14
60	182	21.5	14.5	29	15	8.5	16

Dog — Radius (cont'd)

	1	2	3	4	5	6	7
61	182.5	21	14.5	27	15	7.5	15.5
62	183	19.5	14	25.5	13	7.5	15
63	183	20	14.5	26.5	14	6.5	15
64	183	20	14.5	27	15	6.5	16
65	183.5	20	12	25.5	13.5	7	14.5
66	184	19	14	25.5	13	7	14.5
67	184	21.5	16	29	14.6	9	16.5
68	185	19.5	14	26	12.5	8	15.5
69	185	19.5	14	26	13	8	14.5
70	185	21	15	29	14.5	9.5	16
71	185	21	16	28.5	14.5	8	16
72	187	20.5	14.5	28	14.5	8	16
73	187	20.5	14.5	28.5	14	7.5	17
74	188	19.5	15	26	14.5	7.5	15
75	189	19.5	15	26	14.5	8	15
76	193	20	14.5	28	14.5	7	16
77	193.5	20	14	28	14	7	16
78	195	20.5	15	28	15	7	17
79	195.5	20.5	13.2	26	14	7.5	14.5
80	196	21.5	15.5	28	14	8.5	16.5
81	196	22.5	16	28	16.5	8.5	15.5
82	198	22.5	16	30	16	8.5	16.5
83	205	22	13.7	27.5	15	7.5	15
84	210	22.5	15	30.5	15.5	9	16.5
85	216	20.5	14.5	27.5	15	7.5	15.5
86	—	13.5	11	—	9	5.5	—
87	—	18	13	—	13	7	—
88	—	18	12.5	—	13	6	—
89	—	18	13.5	—	13.5	6.5	—
90	—	18.5	13	—	13.5	6.5	—
91	—	19	12.5	—	13	6.5	—
92	—	19	13	—	13.5	6	—
93	—	19.5	14	—	13	7.5	—
94	—	19.5	14.5	—	13	8	—
95	—	19.5	13.5	—	13.5	7	—
96	—	20.3	13	—	14	7	—
97	—	20.5	14	—	14	7.5	—
98	—	20.5	14	—	15*	7	—
99	—	20.5	15	—	15.5	8	—
100	—	21.3	—	—	14	7.5	—
101	—	22.5	17.5	—	15.5	8.5	—
102	—	22.5	17	—	16	—	—
103	—	—	—	22	—	—	12
104	—	—	—	22	—	—	12
105	—	—	—	22	—	—	13
106	—	—	—	23	—	—	12.5
107	—	—	—	23.5	—	—	14.5
108	—	—	13	24.5	—	7.5	13.5
109	—	—	—	25	—	—	16
110	—	—	—	25.5	—	—	14.5
111	—	—	—	26	—	—	15.5
112	—	—	14.5	29	—	—	15.5
113	—	—	—	30	—	—	16
114	—	—	—	30	—	—	18
115	—	—	—	32	—	—	20

Measurements: 1. length to trochanter major
2. length to caput
3. width of proximal epiphysis
4. smallest width of diaphysis
5. width of distal epiphysis
6. diameter of proximal epiphysis
7. smallest diameter of diaphysis
8. diameter of distal epiphysis

	1	2	3	4	5	6	7	8
1	88	86.5	24	8.8	21	12*	9	23*
2	93	92	26	10	22.5	16	10	21
3	93	92	26	10	22.5	16	10	21
4	109	109	26	9	23	16	9	24.5
5	120	121	32	12	37	28.5	15	42.5
6	121*	121	33	13	28	18	12.5	31.5
7	124	123	29	11	24.5	18	10	25.5
8	124	122	30	12	24.5	15	11.5	27
9	123.5	125.5	25	8.5	21	16	8	22
10	126	123	35	12.5	29	19.5	13.5	32
11	126	124.5	32	13	28.5	27.5	12.5	31*
12	128.5	124	33	13	28.5	20	13.5	30
13	131.5	133.5	16	9	21	13	8	22.5
14	136	132	33.5	13.5	32	20.5	14	34
15	136.5	137	27	9.5	23	15.5	9	22.5
16	138	134	40.5	15.5	34	26	16	39
17	138	136	39	16	—	19.5	16	—
18	139.5	134.5	39	17.5	33	22	16	36
19	139.5	142	27	9.5	22	15.5	8	24
20	143	139	40.5	15	33.5	26	16.5	40
21	143	143.5	27.2	10	24.8	14	9.2	23
22	143.5	145.5	28	10	23.5	15	9	24.5
23	143*	146.5	30	10.7	—	—	10.3	—
24	155	153	41	17	36	26	17.5	41
25	156	154	41	17	36	26.5	18.5	41
26	161.5	166	34	12	28.5	22	12	31.5
27	162	166	34.5	12	28.5	21.5	12	32
28	170	173	31	12.5	28	17.5	13	27.5
29	166	173	39	14	32.5	25	13.5	—
30	169	174	37.5	13	31.5	23	13.5	32
31	176	—	—	12	31	—	12	34
32	172	177	38.5	13	31	23.5	12.5	33
33	174	177	37	13	31	23	14.5	34.5
34	175	177.5	40.5	15	33.5	25	15	37*
35	175	181	36.5	18.5	30	21	12	31.5
36	178	182	35	12.5	30	24	12	33
37	181	182	41	13	31.5	24.5	14	36
38	181	183	39.5	13	32.5	25	14	35
39	180	184	36	12.5	31.5	21.5	13.5	31.5
40	182	185	37.5	13	31.5	22.5	13	—
41	185	186	37.5	12.5	32	21.5	13	34
42	181	186	38.5	13.5	31.5	25	13	33.5
43	185	186	37	14.5	31.5	22	13	31.5
44	185	189	35	11.5	29.5	18	11.5	32
45	187	189	38	13	30	26.5	13	34.5
46	187	190	39.5	12.5	33.5	22	13.5	36.5
47	189	191	39	12.5	33	24	14.5	35.5
48	188	191	39.5	13	30.5	21	13	34
49	192	193	37	13.5	33.5	22.5	13	35
50	191	194	38	14	32.5	23	15.5	39
51	194	195	39	14	33	24.5	14.5	37
52	193	196	39.5	14.5	33	23	14.5	37
53	195	197	40	14	32	20.5	14.5	35.5
54	193	197	44	14.5	36.5	23.5	15	40

	1	2	3	4	5	6	7	8
55	196	198	40	14	32.5	23.5	15	35.5
56	195	198	40	14.5	33	—	14.5	34
57	194	198	42.5	16	37	24	16	40
58	196	199	41.5	13.5	34	19.5	13	36
59	193	199	40.5	15	34	28	17	38
60	195	199	43.5	16	36.5	23	17.5	39.5
61	194	200	40.5	13	35	26.5	12.5	38
62	201	201	43	14	34	24	15	36.5
63	201	196	45	14.5	36.5	24	14.5	40
64	196	201	42	15	37.5	24.5	14	36.5
65	197	201.5	41.5	14.5	34	26.5	15	36
66	199	202	42.5	14	34.5	24	14.5	34
67	197.5	202	43	14.5	36	34.5	15	39
68	198	202	41.5	15	37	24	14	37.5
69	197	203.5	43	15	37	28.5	15	42.5
70	199	204	42	15.5	35	27.5	16	40
71	197	205	43	14	34.5	25.5	14	39.5
72	—	205	—	14.5	33	—	16	39
73	204	206*	—	16.5	36.5	—	16	38.5
74	206	207	45.5	14	36.5	27	16	41
75	206	208	40	15	34	26	15.5	38*
76	208	210	40.5	15	33.5	25	15.5	38
77	211.5	208	41.5	14	38	27.5	15	40.5
78	212	208	41.5	14	38	27.5	15	40.5
79	210	213	44.5	15	—	25	17	—
80	210	213	43	16	36	—	16	39
81	210	214	44	13.5	35.5	26	14	41
82	213	219.5	46	13	36.5	29	14.5	39.5
83	214	221	46.5	17.5	39	30	19	40.5
84	216	223	46.5	18	39	29	19	39.5
85	—	137.5	—	9.5	22	—	8.5	24.5
86	—	138	—	9	22	—	9.5	24.5
87	—	156	—	12	25	—	11	28
88	—	168	—	—	33	—	—	35.5
89	—	185	—	14	31.5	—	13.5	34
90	—	—	31.5	—	—	17.5	—	—
91	—	—	37	—	—	24	—	—
92	—	—	38.5	—	—	19	—	—
93	—	—	43	14	—	27	15	—
94	—	—	—	—	23.5	—	—	15
95	—	—	—	12.5	27.5	—	13.5	29.5
96	—	—	—	—	30	—	13	31
97	—	—	—	—	30.5	—	15.5	33.5
98	—	—	—	—	31	—	—	35
99	—	—	—	—	31.5	—	—	34
100	—	—	—	—	33	—	—	35
101	—	—	—	—	33	—	—	37
102	—	—	—	—	35.5	—	—	38
103	—	—	—	15	35.5	—	15.5	42

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	78	21.5	8	13.5	22.5	7	10.5
2	85	25	10	16.8	24.5	8	12.2
3	90.5	21	7.5	14	21	7	10
4	104	24	8.7	14.5	26	7	11
5	114	—	12.5	20	31.5	10	15
6	116	—	14	22	34	11	17
7	117.6	26	10	16.5	28	9.5	11.5
8	118	30	13	20.5	34	10.5	15.5
9	118	30	13	20.2	34	10.5	15.3
10	118.5	30	12	21.5	32	10	15
11	119.5	26	11	19.5	27	9.5	13.5
12	120.7	27	12	19.8	27	10	15
13	121	27	11	19.5	28	9.2	13.5
14	122	31	14	21.5	34	12.5	16
15	122.5	—	14	21	—	12	16
16	127	37.5	16.5	24	41.5	13.5	19.5
17	127*	—	17	—	—	15	—
18	129	34.5	12.5	24.2	39.5	13.3	18.7
19	134	23.5	9	18.5	23.5	9	12
20	142	38.5	16.5	25.5	45.5	12	20
21	143	—	15	24	—	11.5	16.5
22	144	—	9	16*	—	7.5	12
23	163.5	—	11	20	—	11	14
24	165	31.5	11.5	20.5	32.5	10.5	15.5
25	165	31.5	12	21.5	32	11	15.5
26	171	31	12	21	34.5	11.5	16
27	171	33	12	21.5	36	12	16
28	179	34.5	12.5	22.5	36.5	10.5	17.5
29	179.5	35	12.5	23	34.5	12.5	17
30	180	32	11.5	23.7	35	11.7	16.2
31	181	35	13	23	35.5	13	17.5
32	183	—	13*	22	—	12	16.5
33	184	34	12	23	37	12	18
34	184	33	13	23.5	37	12.5	17
35	186	34.5	13	23.5	36	11.5	17.5
36	188.5	34	12	22	35	13	16.5
37	190	35.5	12	22	37.5	12	17.5
38	190	35	13	24	39	12	18
39	190	34.5	14.5	24	—	12.5	18
40	191.5	34.5	12	22.5	37	12	15.5
41	192	34.5	13	22.5	37.5	12.5	15.5
42	193	32	11.5	22	35.5	12	16
43	193	33.5	12.5	23	35	12	16
44	193	37	14	24	37.5	14	18
45	194	34	13.5	23.5	37	12.5	18.5
46	195	32	13	24	37	13	17.5
47	196	33.5	13	24	37	12.5	18.5
48	198	33.5	12.5	24	39	13	17.5
49	198	36	13	23.5	40	14	18
50	198.5	37.5	14	24	42.5	13.5	18.5
51	199	34.5	12.5	22.5	35.5	13	17.5
52	200	35.5	12	24	41	12	17
53	201	36	12.5	24	41	12	17
54	201	33.5	13.5	23	38	12.5	17.5
55	201	40	14	27	40.5	12	19
56	201	36.5	15	24	40	13	18.5
57	202	—	15	24	—	13.5	17.5
58	203	34.5	11.5	22	37.5	11.8	17
59	203	37	14	24	40	13.5	19
60	203	39.5	15	28	44	14	21
61	204*	36	13	25.5	39	12.5	19

	1	2	3	4	5	6	7
62	205	37	13.5	25	40	12	18.5
63	206	36	12 5	24	39.5	13	18
64	206	35.5	12.5	22.5	39.5	13.5	19
65	206	40	13.5	26.5	43	14.5	21.5
66	207	35	13	23.5	36	14	18.5
67	208	38	14	24	41.5	13	17.5
68	209	39	13	25.5	43	13	19
69	210	40	13	25.5	43.5	13	19
70	216	35	15	24	40.5	14	19
71	217.5	38	15	26.5	45	14	20
72	219	37	14.5	26	43	14.5	20
73	219	38	14.5	26	44	13.5	20
74	220	37	13.5	26	42.5	13.5	19
75	222	41	15	27.5	44	14	20
76	222.5	38.5	16	27.5	44	16	20.5
77	227	37.5	14	26	43	12	18.5
78	227	39	16	29.5	45.5	16	21
79	227	42	16.5	28.5	45	16	21.5
80	228	40	15.5	28	46	14.5	20
81	230	37	15	28	43.5	14	20.5
82	243	38	13	24.5	43.5	15.5	18
83	224	38	13.5	25	44	15.5	18
84	—	23	—	—	26	—	—
85	—	30.5	—	—	37	—	—
86	—	31	11	—	34	10.5	—
87	—	32	12.5	—	36	12	—
88	—	33	—	—	39*	—	—
89	—	35	—	—	39	—	—
90	—	36	—	—	41.5	—	—
91	—	37.5	—	—	43	—	—
92	—	37.5	—	—	44	—	—
93	—	38	—	—	40	—	—
94	—	39.5	16	—	45.5	12.5	—
95	—	—	9	16*	—	7.5	12
96	—	—	12	19	—	10	13
97	—	—	11	19	—	9.5	14.5
98	—	—	11	20	—	11	14
99	—	—	12.5	20	—	10	14.5
100	—	—	11.8	20.2	—	10.7	15.7
101	—	—	12	21	—	11.5	15
102	—	—	12	21	—	10.5	15.5
103	—	—	13	21	—	9.2	16
104	—	—	11.2	21.2	—	10.8	15.8
105	—	—	13*	22	—	12	16.5
106	—	—	13	23	—	12	17.5
107	—	—	—	23	—	—	17.5
108	—	—	12	23	—	12	18
109	—	—	13	23.5	—	13	17
110	—	—	14	23.5	—	13	17
111	—	—	—	23.5	—	—	18
112	—	—	—	24	—	—	17.5
113	—	—	15	24.5	—	14	20
114	—	—	13	25	—	12.5	17
115	—	—	15	25	—	14	19
116	—	—	—	26	—	—	20
117	—	—	15.5	26.5	—	14.5	18

Dog — Astragalus

Measurements: 1. greatest length
2. greatest width
3. greatest diameter

	1	2	3
1	23	15	13.5
2	24.5	16	14
3	24.5	16	14.5
4	24.5	16.2	14.7
5	25	16.5	15.2
6	25	19.3	17
7	25.7	19.8	17.2
8	26	20	18
9	26	20.2	16
10	26.5	21	16.7
11	27	21.5	15

Dog — Calcaneus

Measurements: the same as those of the astragalus

	1	2	3
1	33	16.5	16
2	41.3	20	20
3	43	20	20.5
4	44*	17	19
5	44	17.5	18.5
6	44	18.2	20
7	44	18.5	19
8	44.8	19	18.8
9	45	19.5	19.5
10	45	19.5	20
11	45.5	19.5	19.5
12	45.5	20.5	19
13	46	20.5	20.5
14	46	21	20.5
15	47	19	20
16	47	19.5	20.5
17	47	20.5	20
18	47	20.5	21
19	48	20.8	20.3
20	48	22.8	24
21	48.3	22	22.8
22	48.3	22.5	22.8
23	48.5	20.5	21
24	48.5	23	22
25	50.5	24.5	23.2
26	51	21	22
27	51	21	24
28	51.2	20	22.7
29	51.3	23	23.5
30	51.5	22	23
31	52.5	21	22.5
32	52.5	21	22.5
33	52.5	21	24
34	53	22.3	23.3
35	55	24	24

Red deer — Lower row of teeth

Measurements: 1. P_1—P_3
2. M_1—M_3
3. length of M_3

	1	2	3
1	48	—	—
2	—	72	29

Red deer—Scapula

Measurements: 1. smallest width of collum
2. width of angulus articularis
3. diameter of facies articularis

	1	2	3
1	38	57	40
2	—	61	46
3	—	65	49

Red deer—Humerus

Measurements: 1. width of distal epiphysis
2. diameter of distal epiphysis

	1	2
1	64	60
2	68	64

Red deer — Radius

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	274	—	32	50.5	32	17	35.5
2	289	52	—	47	32.5	20	37.5
3	309	61.5	38	54.5	37.5	20.5	42
4	320	—	32	53	33	19	40
5	—	60*	—	—	34	—	—
6	—	62	41	—	34	24	—
7	—	62	—	—	34	—	—
8	—	62	—	—	38	—	—
9	—	63	—	—	36	—	—
10	—	65	—	—	38.5	—	—
11	—	—	—	55	—	—	41
12	—	—	—	55	—	—	43
13	—	—	—	56	—	—	42.5
14	—	—	—	56.5	—	—	40
15	—	—	—	58	—	—	43
16	—	—	—	59.5	—	—	43

Red deer — Metacarpus

Measurements: the same as those of the radius

	1	2	3	4	5	6	7
1	270	—	23.5	46.5	—	17.5	29.5
2	—	43	—	—	32.5	—	—
3	—	46.5	—	—	33.5	—	—
4	—	—	—	42.5	—	18	29
5	—	—	—	50	—	—	32*
6	—	—	—	51.5	—	24.5	32.5
7	—	—	—	52	—	21	34

Red deer—Tibia

Measurements: the same as those of the humerus

	1	2
1	53	41
2	54	43

Red deer — Astragalus

Measurements: 1. greatest length
2. greatest width
3. greatest diameter

	1	2	3
1	53*	35	31.5
2	55	36.5	—
3	57.5	37.5	33
4	62	40	40
5	63	41	35
6	63.5	44	37.5
7	65	42.5	35.5

Red deer — Calcaneus

Measurements: the same as those of the astragalus

	1	2	3
1	113*	38	40
2	115	38.5	36
3	119	—	—
4	121	40	43
5	121.5	40	45.5
6	129	44	47

Red deer — Metatarsus

Measurements: 1. width of proximal epiphysis
2. width of distal epiphysis
3. diameter of proximal epiphysis
4. smallest diameter of diaphysis
5. diameter of distal epiphysis

	1	2	3	4	5
1	39.5	—	43.5	—	—
2	—	44.5	—	23	30.5
3	—	44.5	—	23	30.5
4	—	46*	—	21.5	29.5
5	—	46	—	25	30.5
6	—	48.5	—	—	30.5
7	—	50.5	—	—	32
8	—	51	—	—	34

Roe deer—Lower row of teeth

Measurements: 1. P_1—P_3
2. M_1—M_3
3. length of M_3

	1	2	3
1	28	39.5	16.5

Roe deer—Humerus

Measurements: 1. smallest width of diaphysis
2. width of distal epiphysis
3. smallest diameter of diaphysis
4. diameter of distal epiphysis

	1	2	3	4
1	12	29	13.5	25
2	—	30.5	—	28

Roe deer — Radius

Measurements: 1. width of distal epiphysis
2. diameter of distal epiphysis

	1	2
1	26	19

Roe deer — Metacarpus

Measurements: 1. width of proximal epiphysis
2. smallest width of diaphysis
3. width of distal epiphysis
4. diameter of proximal epiphysis
5. smallest diameter of diaphysis
6. diameter of distal epiphysis

	1	2	3	4	5	6
1	20	11.5	—	17	—	—
2	21	12.5	—	18	—	—
3	—	—	23.5	—	9.8	15.5

Roe deer — Tibia

Measurements: the same as those of humerus

	1	2	3	4
1	15	27	13	22*

Roe deer — Metatarsus

Measurements: the same as those of metacarpus

	1	2	3	4	5	6
1	20.5	12.5	—	23	—	—
2	—	—	27	—	13	17.5

Badger — Lower row of teeth

Measurements: 1. P_1—P_4
2. M_1—M_2
3. length of M_1

	1	2	3
1	18	22	16

Badger — Tibia

Measurements: 1. smallest width of diaphysis
2. width of distal epiphysis
3. smallest diameter of diaphysis
4. diameter of distal epiphysis

	1	2	3	4
1	7	16.5	7.5	13.5

Fox — Skull

	1	2	3
1. length of row of teeth (I_1—M_2)	75*	77.5	81
2. length of incisor row	5	6	5.5
3. length of diastema	16	15.5	16
4. P_1—P_4	40	41	46
5. M_1—M_2	15	15	15
6. length of P_4	13	14	15
7. greatest frontal width	37	36	—
8. distance between medial canthuses	27	28	—
9. distance between foramina infraorbitalia	—	31	33.5
10. width of incisor row	—	15.5	16.5
11. distance between canines	—	24.2	25
12. P_1—P_1	—	21	22
13. M_1—M_1	—	42	44

Fox — Upper row of teeth

Measurements: 1. P_1—P_4
2. M_1—M_2
3. length of P_4

	1	2	3
1	39.5	14.5	14
2	43	—	15

Fox — Mandible

Measurements: 1. length to angulus
2. height at P_1
3. height at M_1
4. length of row of teeth (I_1—M_3)
5. P_1—P_4
6. M_1—M_3
7. length of M_1

	1	2	3	4	5	6	7
1	105	10.5	14.5	73	32.5	24	13.5
2	105*	11	15	75*	35.5	25	14.5
3	108.5	10.8	14.2	75.2	33	27	15.2
4	—	11.2	14.2	—	37	26.3	14.8
5	—	10.8	14.2	—	32.5	27.5	15

Fox — Lower row of teeth

Measurements: 1. P_1—P_4
2. M_1—M_3
3. length of M_1

	1	2	3
1	33.5	35	13
2	35	—	14
3	32.7	35.5	14.5
4	—	35.5	14.3
5	—	36.5	15.2

Fox — Atlas

Measurements: 1. length of arcus ventralis
2. length of arcus dorsalis
3. width of cranial articular surface
4. width of caudal articular surface
5. greatest height

	1	2	3	4	5
1	6.3	10	28.5	21	19.8

Fox — Epistropheus

Measurements: 1. length of body
2. length of arch
3. length of dens
4. width of dens
5. width of cranial articular surface
6. width of fossa caudalis
7. greatest width
8. height of cranial articular surface
9. height of fossa caudalis
10. greatest height

	1	2	3	4	5	6	7	8	9	10
1	35	15	8.8	5	20.3	12.2	23*	9.8	8	24

Fox — Scapula

Measurements: 1. smallest width of collum
2. width of angulus articularis
3. diameter of facies articularis

	1	2	3
1	17	19	11

Fox — Humerus

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	131.5	20.5	9.5	23	28.5	8.5	19.5

Fox — Radius

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	125.5	12.5	9.5	16.5	8.5	4.7	9.7

Brown hare — Scapula

Measurements: 1. smallest width of collum scapulae
2. width of angulus articularis
3. diameter of facies articularis

	1	2	3
1	7	14.5	10.5
2	8	14.8	12.5
3	8.8	15.2	12.2
4	8	16	12
5	8.7	16	12
6	9.2	16	12.2
7	9	16	12.5
8	8.5	16.5	12
9	8.5	16.5	12
10	9	16.5	12.5

Brown hare — Humerus

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis
5. diameter of proximal epiphysis
6. smallest diameter of diaphysis
7. diameter of distal epiphysis

	1	2	3	4	5	6	7
1	103.8	18	6	13.8	20.8	6	10
2	105	16.2	6.2	13.3	20.3	6.3	10.2
3	109.3	17.5	7	12.5	20.7	6.8	10
4	110.5	18.5	6	13.5	20.7	6.5	11.5
5	112	17	7	13.5	22.5	6.5	10.5
6	—	—	5.7	12.8	—	5.8	10
7	—	—	5.7	13	—	6	9
8	—	—	7	13	—	6	10.5
9	—	—	—	13	—	—	10.5
10	—	—	6.7	13.5	—	7.5	10.3
11	—	—	7	13.5	—	6	10.5
12	—	—	7.2	14	—	7	11
13	—	—	7	14	—	6	12

Brown hare — Radius

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	113.3	9.2	5	10.5	6.7	4	6.5
2	123	9.8	5.8	11	7.2	4.2	7
3	124.5	10.5	5.5	11.5	7.5	3.7	6.7
4	—	10	5.5	—	7	4	—
5	—	10	5.8	—	7	4.5	
6	—	10	5.7	—	7.2	4.7	—
7	—	10.2	6.3	—	7	3.8	—
8	—	—	—	11	—	—	6.5
9	—	—	—	11.5	—	—	7.2
10	—	—	—	12.7	—	—	7.8

Brown hare — Femur

Measurements: 1. length to trochanter major
2. length to caput
3. width of proximal epiphysis
4. smallest width of diaphysis
5. width of distal epiphysis
6. diameter of proximal epiphysis
7. smallest diameter of diaphysis
8. diameter of distal epiphysis

	1	2	3	4	5	6	7	8
1	135*	128.5	30.5	9.5	—	—	8	—
2	136	132	27.5	10	22.5	13	8	21
3	—	—	27.7	—	—	14	—	—
4	—	—	28.5	—	—	15	—	—
5	—	—	—	—	20.3	—	—	21
6	—	—	—	—	21.5	—	—	21.5
7	—	—	—	10	22.2	—	8	22.5
8	—	—	—	—	22.5	—	—	23.5

Brown hare — Tibia

Measurements: the same as those of the humerus

	1	2	3	4	5	6	7
1	146	21.5	8.5	15.5	24	7	10.5
2	161	23	8.7	15.5	25	7.5	11.2
3	—	22	—	—	25.5	—	—
4	—	23	—	—	25	—	—
5	—	23.5	—	—	25	—	—
6	—	—	8	15.3	—	—	10.8
7	—	—	9	17	—	7	11.5

Brown hare — Calcaneus

Measurements: 1. greatest length
2. greatest width
3. greatest diameter

	1	2	3
1	35	15	13

Hen — Skull

Measurements: 1. ventral length of brain skull
2. greatest width of brain skull
3. greatest width of brain case
4. distance between medial canthuses

	1	2	3	4	
1	34	26	22	12	
2	36	27.5	23.5	11.2	
3	36	—	24	13	

Hen — Os coracoideum

Greatest length: 45.2, 46, 49.8, 50, 51, 51.2, 51.3, 51.8, 52.2, 52.4, 52.6, 52.8, 53, 53, 53, 53.5, 53.6, 53.8, 53.8, 53.9, 54.8, 55.6, 56, 57, 57.2, 58, 58, 58.7, 59.2, 60.5, 61.3, 61.6, 62.8, 63, 64, 70.8

Hen — Scapula

Greatest length: 66.8, 67, 71, 71.4, 73.8, 74.5, 76, 76.2, 78.7, 80.5, 90*

Hen — Humerus

Measurements: 1. greatest length
2. width of proximal epiphysis
3. smallest width of diaphysis
4. width of distal epiphysis

	1	2	3	4
1	60	16.7	5.7	12.4
2	62	16.6	5.5	13
3	63.2	—	6.4	—
4	63.3	18.8	6.3	14.6
5	64.5	17.5	6	13.5

	1	2	3	4
6	64.5	—	6	13.8
7	64.8	17.9	6.4	14.2
8	65.2	18	6.1	13.5
9	65.3	17.3	6	13.7
10	65.4	18	6.5	13.8

Hen — Humerus (cont'd)

	1	2	3	4
11	65.5	18.2	6	14.5
12	65.7	—	6	13.5
13	65.7	18.3	6.2	13.6
14	65.8	17.5	6	13.5
15	66	18.3	6.4	14.5
16	66.1	19	6.1	14.5
17	66.6	—	6.4	—
18	66.7	19.2	7.8	14
19	66.8	18	6.2	14.2
20	67	19.5	6.7	15
21	67	19.6	6.8	17.7
22	67.2	18.7	6.2	14.5
23	67.2	18.6	6.8	14.8
24	67.3	18.7	6.7	14.4
25	68	18.2	5.8	13.3
26	68.2	19.2	6.5	15
27	69	—	6.6	15
28	69	19	6.8	14.7
29	69	19	6.9	14.3
30	69	18.7	7	14.3
31	69.5	18	6.2	14.5
32	69.7	20	6.7	15.5
33	70.5	19.3	6.5	15
34	70.5	20	6.8	15.5
35	70.8	21.5	7.8	16.8
36	71*	—	7	15
37	71.5	20	6.6	15.5
38	71.8	19.3	7	15.3
39	72	19.8	5.8	17.3
40	72	—	6.8	14.4
41	72.2	20	6.6	15.2
42	72.2	19.2	6.8	14.3
43	72.4	19	7	14.8
44	72.7	20.2	6.8	14.8
45	73.8	20.5	6.8	15.3
46	74	20.3	7.3	15.5
47	74.7	20.5	7.2	15.5
48	74.8	21.3	7.5	15.4
49	74.9	21	7.8	16
50	75.9	22	7.5	16.3
51	76	21.5	7	15.2
52	76.1	20	6.9	15.5
53	76.2	20.5	6.7	16
54	76.2	20.2	7.1	15.1
55	76.5	20.8	6.8	15.4
56	76.5	21	7.2	16.4
57	76.5	21.5	8.7	16.2
58	76.6	21.2	7.7	16.3
59	76.7	22.7	7	16.3
60	76.7	22	7.5	15.8
61	77	21	7	16.2
62	77	21	7.2	16
63	77.2	20.3	7.4	15.7
64	77.3	20.3	7.2	15.8
65	78	21	7.2	16.6
66	78	21	7.8	16
67	78.4	22.3	7.9	17.2
68	78.6	21.9	7.1	16.1
69	79.2	21	7.8	16.1
70	79.5	21.3	7.4	16.2
71	79.8	22	7.8	16.5
72	80.3	23	7.5	17.2
73	80.3	22.3	7.8	17
74	81.2	22	7.8	17.2
75	81.8	21.7	8	17.3
76	81.8	22.2	8	17
77	81.8	22.8	8	16.8
78	82	23	8	17.3
79	82.2	23	8.2	18
80	82.5	23	8.2	17.4
81	84	23	7.8	17.2
82	87.5	23.5	8.2	16.5
83	89.2	24	8	18.2
84	90.2	22.3	8	17.3

Hen — Radius

Measurements: the same as those of the humerus

	1	2	3	4
1	56	4.5	2.7	5.5
2	57	4.8	3.1	6.2
3	58.2	4.5	2.8	4.5
4	59	5.3	3.1	6.4
5	59.5	5.2	3	6.3
6	59.8	5	2.8	5.7
7	60	4.7	2.9	5.7
8	61.2	5	3.1	6.3
9	61.3	5.3	3.5	6.7
10	61.3	5	3.5	6.7
11	61.6	5.1	3	6.2
12	62.9	5.3	3.1	6.3
13	63	5.1	3	6.1
14	64	5	2.8	6
15	64.2	5.2	3.9	6.5
16	65.8	5.3	3.7	6.7
17	66	5.5	3	6.8
18	66	5	3.1	6.2
19	66.2	5	3	6.5
20	66.9	5.9	4.2	7.2
21	67.5	5*	2.7	6.7
22	68.2	—	3.2	6.7
23	68.5	6.8	2.8	7
24	69	5	2.8	6.2
25	69.7	6.1	3.7	7.2
26	70.3	5.3	3.6	7.3
27	70.7	5.8	3.7	6.9
28	71	5.2	3.1	7
29	71	5.7	3.5	7
30	72	6	3.9	7.6
31	72.3	6	3.7	7.4
32	72.8	4.8	3	6.8
33	73.8	5.7	3.2	7.2
34	75	6.2	4	7.7
35	75.5	5.2	3.3	6.8
36	76*	6.3	4	—
37	76.2	6	3.3	7.5

Hen — Ulna

Measurements: the same as those of the humerus

	1	2	3	4
1	60*	8	3.8	6.6
2	61.5	8.5	3.5	6.7
3	61.7	8	3.5	7
4	62	8	3.8	6
5	62.6	9	3.9	7.3
6	62.7	8.7	4	7
7	63.3	8.2	3.9	7.4
8	64.2	8.2	3.5	6.8
9	64.6	9.3	4.3	7.7
10	64.6	9.3	4.3	7.7
11	65.2	9	4.1	7
12	66*	8.3	4	8
13	66	9.5	4	—
14	66.2	8	4	7.3
15	66.2	8.5	4	—
16	67.2	9	4	8
17	67.8	9.1	4.1	—
18	69	8.9	4.1	7.4
19	69	10	4.8	7
20	69.8	9.1	4.2	8
21	70	9	4	7.5
22	70	10	4.3	7.7
23	71*	8.9	4.4	—
24	71.2	8.8	4.7	7.6
25	72.4	9.3	4.4	7.8
26	73.1	9.8	4.3	8
27	73.3	8.8	4	—
28	73.3	9.8	4.4	7.2
29	74.5	10	4.3	8
30	76	9.8	4.5	7.8
31	76.5	—	4.8	8.7
32	77*	9.2	5	—
33	77.8	10.3	4.8	8.4
34	78	10.2	4.8	9.1
35	78	10.5	4.8	9
36	78.2	9	4.5	8*
37	78.2	8.8	4.6	8.3
38	78.5	10	4.5	9
39	78.8	11	4.8	9.5
40	79	10.5	5	8.9
41	79.2	9.8	5	7.5
42	80	9.5	5.1	8
43	80.2	10	5	9.3
44	81	11.3	5.2	10
45	81.1	11	4.6	9.4
46	82	10.6	4.8	9.2
47	88	11.1	5.4	9.8

Hen — Femur

Measurements: the same as those of the humerus

	1	2	3	4
1	67	13	5.8	—
2	67.5	13.8	6	14
3	68.2	12.6	5.9	13.4
4	70	14	6.2	13.7
5	70.5	14	5.2	13.8
6	70.8	14.2	6	14
7	71	13.6	5.3	13.4
8	71	14	5.9	13.3
9	71	13.8	6	13.7
10	71.5	13.2	5.7	13.5
11	71.5	13.5	6	13.7
12	72	13.3	6	13.4
13	72.1	14.1	6.1	14
14	72.2	13.8	6	13.7
15	72.3	13.5	6	13.8
16	72.5	—	6.1	14
17	72.7	15.2	6.3	14.8
18	73	14	5.9	13.4
19	74	13.5	6	14
20	74*	15	6	—
21	74*	14.8	6.2	14.1
22	74.2	14.8	6.2	14.2
23	74.3	13.9	6.2	13.9
24	74.3	14	6.2	14.1
25	75	14	6	14
26	75.2	14.2	5.8	14.7
27	75.2	14	6.7	14.8
28	75.4	15.2	6.8	14.3
29	75.8	14	6.3	13.7
30	76*	13.6	6	14
31	76.2	15.6	6.3	15.2
32	76.3	14.2	6	14.4
33	77	14.3	6	15.1
34	77*	14.4	6.3	13.9
35	77*	16.2	6.5	—
36	77*	14.6	6.6	13.3
37	77.3	16.5	6.2	15
38	77.3	15.2	6.9	15
39	77.8	14.8	6.5	14.5
40	78	14.5	6.3	14.3
41	78	13.5	6.5	15
42	78	15.3	6.5	15.5
43	78.1	14.3	6.9	15.8
44	78.5	15.5	7.3	15.8
45	79	14	6.7	15.2
46	79	15	7.3	16.2
47	79.7	16	6.7	15.2
48	80*	15	6.4	14.8
49	80	17	7.2	16.4
50	80*	17.2	7.8	17.2
51	80.2	15.3	6.2	15.3
52	80.3	16.3	6.5	15.5

Hen — Femur (cont'd)

	1	2	3	4
53	80.3	16	6.9	16
54	81	15.5	6.9	16.3
55	81.2	16	7.3	16.5
56	82.2	16	7	17.3
57	82.5	15.7	6.8	15.8
58	83	15.9	7	16.9
59	83*	16	7.1	16.6
60	83*	16.3	7.2	—
61	83.8	17	7.5	17.2
62	84.1	16.7	7.6	16.9
63	84.5	15.5	7	16.5
64	85*	17	7.4	17.2
65	86	16.2	7.2	16.8
66	86.5	17	7	16.4
67	87	16.2	7.2	16.2
68	87.4	17.6	7.8	17.2
69	87.5	16.3	7.2	—
70	88.5	—	7.8	18.1
71	88.8	18.4	7.8	18.2
72	89	16.5	7.2	17.2
73	89.2	17	8.1	18
74	89.3	18.4	7.5	17.8
75	89.3	16.8	8	17.2
76	90	18	7.2	17.3
77	90.5	18.5	7.8	17.3
78	92	18	8	18.1
79	93	18	7.7	18.9

Hen — Tibia

Measurements: the same as those of the humerus

	1	2	3	4
1	96	16.2	5	9.4
2	98.5	17.5	5.2	10
3	98.5	16	5.6	10
4	100*	16	5.5	10
5	100	18	5.5	10.5
6	100.2	18	5	10
7	100.3	16	5.7	10
8	100.5	16	5.5	10
9	100.5	17.2	6.8	10.5
10	100.8	17	5.7	10
11	101	16.5	5.2	9.9
12	102*	17	5.1	10.5
13	102	17	5.3	10
14	102	16.3	5.7	10.2
15	102.8	17.9	5.8	10.2
16	103	15.4	5.1	10.2
17	103*	—	5.5	10.3
18	103	17	5.9	10.2
19	103.2	17.3	6	11
20	103.5	18.5	5.7	11
21	104*	19	6.5	11.5
22	104.2	16.8	5.7	10.8
23	104.2	18.8	5.9	10.8
24	104.8	17.3	6	9.9
25	105	17	5.5	10.2
26	105	18.2	5.5	11
27	105	—	5.7	—
28	105	18	5.7	10.6
29	105	17.8	5.8	11.1
30	105	18	6	11.2
31	105	20	6.3	12
32	105.2	17.8	5.7	10.5
33	105.2	18.3	5.7	11.2
34	105.3	16.8	5.5	11.2
35	105.7	18	6	11.4
36	106	—	5.2	10.2
37	106*	17	5.5	—
38	106	17.5	5.5	11
39	106.3	17.5	5.7	10.4
40	107*	17.2	5.5	10.8
41	107*	18.3	5.8	10.7
42	107	17	6	11.3
43	107	19.5	6	11.8
44	107.5	—	5.3	10.6
45	107.5	18	6	11.5
46	107.5	18.5	6.2	11
47	108	19	5.5	10.8
48	108	18	6	11
49	108	18.5	6	11.2
50	109.3	17.7	5.9	10.8
51	109.6	19.3	6	11.3
52	109.7	20.2	6.2	11.4
53	110	18	5.8	11
54	110*	18.2	6	—
55	110.8	17	6	11
56	110.8	18	6	11.3
57	112	18	6	11.2
58	112*	—	6.1	10.7
59	113	16	6.8	11
60	113.2	19.3	6.2	11.2
61	113.7	20.2	6.2	11.2
62	113.8	18	6.1	11.2
63	114	19	6.2	12
64	114.3	19.7	6	12
65	115.3	19	6	11.2
66	116*	19	6.2	12.8
67	116.3	20.5	6.7	12.2
68	118.2	21	6.3	12.1
69	118.2	21.6	7	12.8
70	119.2	22	6.6	12.3
71	119.5	22	6.6	12
72	119.5	23	6.8	13.5
73	119.8	20	6.7	12.7
74	120*	20	6.5	11.5
75	120.5	20	6.7	11.2
76	121	18	6.8	13
77	121	19	6.8	11.8
78	121.2	21.8	7.1	12.1
79	121.2	21.2	7.2	12.9
80	121.3	21	6.5	13

Hen — Tibia (cont'd)

	1	2	3	4
81	122.2	18.7	6.3	11.9
82	123.5	—	6.7	12.3
83	124	21.2	7.3	12.5
84	124.2	21.4	7.3	13.2
85	124.8	21.5	6.8	13.3
86	124.8	23.3	7.7	—
87	125*	—	6.5	12.2
88	125.5	22	7	12.7
89	125.8	20.8	7.3	12
90	126	18*	7	13.9
91	126*	—	7.2	12.5
92	126.3	27	7	12.2
93	127	—	6.4	12.5
94	127	19.5	7	13
95	127.2	20	7	12.8
96	127.5	22	7	12.7
97	128	22	7.5	12.5
98	128.8	—	7	12.5
99	129.2	21.5	6.2	11.3
100	129.7	20	7	13.1
101	130	20	7	12.3
102	131.2	19	6.8	12.9
103	131.5	22	7	13
104	135*	21.2	7	13.2
105	135.2	—	7	13.3
106	136.7	21.8	7.7	14

Hen — Tarsometatarsus

Measurements: the same as those of the humerus

	1	2	3	4	sex
1	61.5	—	4.9	10.5	♀
2	62.2	11	5	11	♀
3	62.5	11.5	5.3	11	♀
4	62.7	11.7	5.5	11	♀
5	63.8	12	5	11.5	♀
6	64	11.5	5	11.5	♀
7	64.7	12	5	11.2	♀
8	65	11.8	5	11.3	♀
9	65.2	10.5	5	10.7	♀
10	65.2	11	5.5	11.7	♀
11	65.7	11.8	5.5	11.2	♀
12	65.8	11.5	5.4	11.3	♀
13	66	11.3	5.5	11.7	♂♀
14	66	11.8	5.1	11.7	♀
15	66.5	11.5	5.3	11.5	♀
16	66.5	11.5	5.5	11.5	♀
17	67	10.8	4.8	11.3	♀
18	67	11.7	5.5	11.7	♀
19	67.2	10.8	4.7	11.5	♀
20	67.5	10.7	5.2	11	♀
21	67.5	10.8	5	11	♀
22	67.7	11	5	11.2	♀
23	68	11.2	5.5	11.2	♀
24	68.2	13	5.7	11.8	♀
25	68.7	12.5	5.3	12	♀
26	69	11.8	6	11.2	♀
27	69	11.8	5.2	11.8	♀
28	70	12.5	6.5	12	♂♀
29	70	13.5	6.5	13	♂♂
30	70.1	11.8	5.8	11.7	♀
31	70.2	11.8	5.8	—	♀
32	70.7	12	6	11.5	♂♀
33	71	12.7	5.4	12.2	♀
34	71	12.8	5.1	11.8	♀
35	71.5	12.2	5.8	12.4	♀
36	71.4	12	6.4	12.1	♀
37	71.5	12	5	12.5	♀
38	71.5	12.7	6	13	♀
39	72	12	5.7	12	♀
40	72	12.2	5.3	12.2	♀
41	72	13.7	6.1	12.3	♀

Hen — Tarsometatarsus (cont'd)

	1	2	3	4	sex
42	72.2	12.8	6.5	12.8	♀
43	72.3	12.3	6	12.5	♀
44	72.5	12.5	5	11.5	♀
45	72.5	12.8	6.2	12.7	♀
46	72.7	12.2	6	12.1	♀
47	72.8	12.5	5.7	—	♀
48	72.8	13	5.3	12.2	♀
49	73	12	5.8	11.7	♀
50	73.2	13	6.8	13	♀
51	73.3	11.8	5.2	12	♀
52	73.5	—	5.6	12.5	♀
53	73.5	12	5.3	11.5	♀
54	73.5	13	5.9	12.4	♀
55	73.7	12.3	5.9	13	♀
56	74	12.7	5.4	12.2	♂♀
57	74	12.9	6.3	13.2	♂♀
58	74	—	5.8	12.1	♀
59	74.2	12.6	5.7	12.4	♀
60	74.4	13.6	6.6	13.3	♀
61	74.5	12	6	12.8	♀
62	74.5	12.5	5.8	12.5	♀
63	74.8	13.2	6	12.4	♂♀
64	74.9	—	5.8	12.2	♀
65	75	12.8	5.5	12.5	♀
66	75.3	14	6.9	13.4	♀
67	75.5	12.7	6	13.2	♀
68	75.5	12.5	6	12	♀
69	75.5	12.2	6	12	♀
70	75.6	12	5.6	12	♀
71	75.8	12.9	6.1	—	♀
72	75.8	13.5	6	13.3	♀
73	76.3	12.3	5.8	12.8	♀
74	76.3	12.8	6.3	12.7	♀
75	76.4	12.4	5.8	12.7	♀
76	77	12	5.5	13	♀
77	77	13	6	13	♂♀
78	77.5	13	6	13	♀
79	78.5	13	6.8	12.8	♀
80	79	13	5.8	12.8	♀
81	79.2	13	6	13	♀
82	79.5	13	6.5	14	♂♂
83	80	13	6.2	13	♂♂
84	80.5	13	5	13	♀
85	81*	13.4	6.6	—	♂
86	81	14	7	13.7	♂
87	81	14	7	14.5	♂
88	81.2	—	7	14	♂
89	81.2	13	6.5	—	♂
90	81.2	13.3	6.5	13.5	♂
91	81.2	13.7	6.3	14	♂
92	81.5	14	7	14	♂
93	82.4	12.8	6.1	13.4	♀
94	82.5	13.5	6.5	13.5	♂
95	82.5	—	6.9	14	♂
96	83.2	14	7.1	—	♂
97	83.7	14	6.2	14	♂
98	84	14.2	7.1	14.2	♂
99	84.3	14*	7	14.8	♂
100	84.3	14.1	7	14.3	♂
101	85*	—	6.8	14.2	♂
102	85.5	13	7.2	14	♀
103	85.7	13.9	6.3	13.7	♀
104	86	13.8	7	—	♂

Hen — Tarsometatarsus (cont'd)

	1	2	3	4	sex
105	86	14.7	7.5	15	♂
106	86.5	15	7.3	15	♂
107	86.8	14.7	7	—	♂
108	87	14	7	14	♂
109	87*	14*	7.9	15*	♂
110	87.2	14.7	7	12.8	♂
111	88	14.2	7.6	15.4	♂
112	88.3	15	7	14.2	♂
113	88.5	14.2	7	14.3	♂
114	88.5	15.2	7.2	14.7	♂
115	89	14.8	7	14.8	♂
116	89.5	—	7	14.5	♂
117	89.7	14.5	7.2	—	♂/♀
118	89.8	15.5	7.8	14.5	♂
119	89.9	14.2	8	15.1	♂
120	90	13.3	6.2	14.5	♂
121	90	14.2	7.1	15.2	♂/♀
122	90	15	7.7	15.2	♂
123	90.2	14.3	7.5	—	♂/♀
124	91	15	7	14.5	♂
125	91	15.3	8	—	♂/♀
126	91.2	14.2	6.9	14.2	♂/♀
127	92*	—	6.5	14	♀
128	92.1	16.3	7.2	14.7	♂/♀
129	92.3	15.1	7.2	16	♂
130	92.4	15	7	14.7	♂/♀
131	92.7	15.5	7.7	16	♂
132	93.7	—	8	16	♂
133	94	14.5	7	14.2	♂
134	94	15.5	7.5	15	♂
135	94	15.9	8.8	15.2	♂
136	94.2	15.5	7.8	15	♂
137	94.3	14.8	7.2	14.2	♂/♀
138	95	15	6.9	14.5	♂
139	95.2	15.5	7.5	15	♂
140	99.2	15.5	7.2	15.7	♂
141	101.3	15.7	8	15.6	♂
142	108.5	16.9	7.4	16.7	♂

5859