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PROBLEMS WITH USING OSTEOLOGICAL MATERIALS OF WILD ANIMALS FOR COMPARISONS IN ARCHAEOZOOLOGY[1]

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Abstract: *Domestication leads to changes both in the morphology and in size of animals. Osteological differences between domesticates and their ancestors are of great importance in the reconstruction of ancient animal keeping and hunting. In the absence of sufficiently large archaeozoological assemblages and reference collecitons with reliable documentation, however, osteological comparisons between wild animals and their domestic forms must be treated very carefully. This paper is a critical review of morphological distinctions as well as a brief practical summary of osteometric data on the two economically most important animals in the Carpathian Basin, cattle and pig.*

Keywords: *Archaeozoology; Domestication; Wild ancestor; Osteomorphology; Osteometry.*

Among the changes in the animals caused by domestication the morphological ones are the most important at least from the viewpoint of zoologists who are dealing with early phases of animal husbandry. In fact, the careful analysis of such changes can provide them with information of vital importance concerning the existence or lack of domesticated animals in early prehistoric sites. It is well-known that among the proofs of existing animal husbandry in a given prehistoric site, the anatomical changes in the animals in question are the most important ones (Herre 1963, Bökönyi 1969). First of all, the size decrease and the changes in the form and proportions of the whole body or its certain parts are very useful in this respect.

The best way to study these changes is the comparison of the remains of the supposedly domesticated animals to those of their wild forms from the same site. In this way one can directly compare the domesticated and wild populations of the same species from exactly the same geographical environment (Bökönyi 1962). The main advantage of such a comparison is that one can follow the process of domestication without the disturbing effects caused by the differences in the environment and also on the sub-specific level of the species in question.

Nevertheless, such comparisons with the local wild form will be possible only in that case if the remains of the wild form occur in a fair quantity in the site. If they don't, one will have to turn to wild samples of other sites or to recent comparative osteological colletions.

The use of contemporaneous comparative material from a site or sites of the same region is a rather fruitful solution. Though, one has to keep in mind that the comparative material has to be really contemporaneous with the original sample (in other terms, it is not enough to use subfossil material in general, it has to be from the same archaeological period) because wild forms also underwent considerable changes in their Holocene history. Let it be enough to refer to experiences with aurochs, wild swine, red deer, etc.

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[1] In this paper, a theoretical study and a list of relevant, previously unpublished numerical data were merged to commemorate the pioneering work of *Sándor Bökönyi* in the field of archaeozoology. Aside from this arbitrary combination, however, editing was minimized to the addition of figures, footnotes as well as the paragraphs connecting the morphological discussion and metric data. These were compiled by László Bartosiewicz on the basis of recent work and personal communications by Sándor Bökönyi.

Another essential requirement is to use material from the same region. Such wild animals are from the indigeneous wild population of the same area being on a similar level of their post-Pleistocene evolution as the animals of the original site. Subspecies of remote regions can strongly differ both in size and morphology, and this can cause serious confusions in comparisons. If such comparative material is not available from the given region, it will be better to turn to neighbouring territories than to further regions. E. g. lacking bones of wild forms it is more reliable to compare early domesticated cattle and pigs of Southwest Asia or Greece to their wild forms from the Balkans or the Carpathian Basin than from Switzerland or even Northwest Europe, as it happened a couple of times even in the past few years.

The use of osteological material of recent wild animals for comparisons in more risky. First of all, recent wild mammals are generally smaller than the subfossil ones. Already at the beginning of the studies on animal domestication Rütimeyer (1861) described the Swiss subfossil pigs as an independent subspecies under the name of *Sus scrofa antiquus*, and the main differential characteristic of this subspecies was its big size. How much larger prehistoric - early Holocene - wild swines were than their recent counterparts, the fact demostrates that their canines were ca. 25 cm longer than the recent world record (Bökönyi 1974).

Also Degerbøl (1935) and Boessneck (1958) dealt with the size differences between subfossil and recent wild mammals proving that the former ones had sometimes essentially larger dimensions. Degerbøl considered that these size differences reached the sub-specific level. Subsequently, the author could prove that such differences in size existed also in Southwest Asia where the size of Neolithic wild goats and sheeps exceeded that of their recent counterparts by far (Bökönyi 1973).

Secondly, there exist considerable differences both in morphology and size between the subspecies of a given recent wild species in different geographical areas. The size differences can be best demonstrated through a comparison of some of the main skull and teeth measurements of the wolf subspecies carried out by Zollitsch (1969). From his Table V. one can immediately understand how senseless is to use bones of subspecies from remote areas for comparison. The same conclusion can be drawn from an illustration of Zeuner's book (1963) which shows Indian, Persian and eastern European wolves' skulls.

The morphological differences of different subspecies are extremely striking in wild swines. It is an old story how serious confusions were caused among zoologists working on pig domestication and origin that at the beginning only the two end points of wild swine variation – the European and the Southeast Asiatic – were known, and how they could later be connected with forms from territories in between. The clearing up of these confusions was the merit of Kelm (1938, 1939) who proved that the European *scrofa* and Asiatic *vittatus* wild swine did not belong to two different species but were the two extreme points of the variation of one single species which were connected by a series of geographical subspecies. He clearly demonstrated that beside the size differences going from the West to the East the length of the lacrymal bone decreased, its height increased, and at the same time the whole skull became shorter and higher too.

Using bones of wild animals that were kept in zoological gardens or game parks, the main problem one has to face is that they often show changes similar to those which are caused by the domestication. As early as in 1894 Wolfgramm stated that the skulls of wolves which had been born in zoos often got shortened and their teeth crowded. Comparing the dentition of a second generation zoo wolf to that of a wolf that lived and was killed in the free nature, one can observe that the teeth of the real wild wolf are nicely ordered in a row with gaps between the individual premolars on the one hand, and that the premolars of the zoo wolf are crowded in both the upper and lower jaws showing a strong resemblance to the dentition of some early domesticated dogs and pigs on the other (Fig. 1).

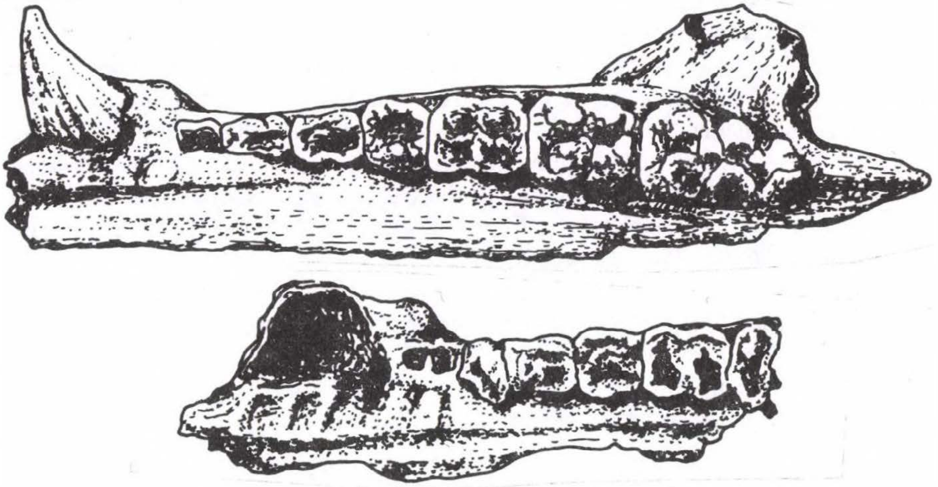

Fig. 1.: Maxilla of a Neolithic domestic pig with crowded praemolars (bottom) resulting from the shortening of the snout (After Bökönyi, 1984. Abb. 3; Redrawn by Ms Lúcia Árkay).

Similar abnormities can be found also in the dentition of wild swines kept in zoos or game parks.

Such animals often show also a size decrease in comparison to their relatives living in the free nature. Their bones become not only smaller but also more porous having a much lower density because of their lower anorganic material content typical of domestication (Fig. 2). This latter phenomenon was observed in the bones of great bustards in the Budapest Zoo (Kállai–Tarján 1963).

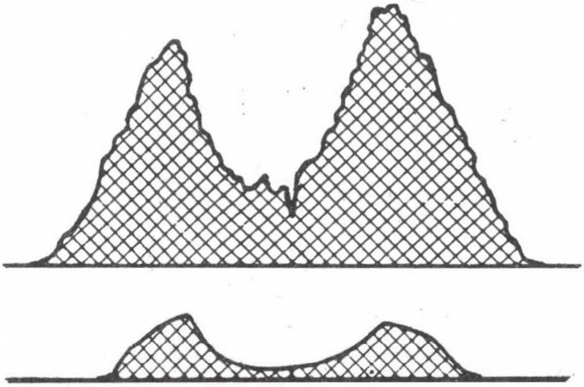

Fig. 2.: Densitograms of of aurochs (above) and domestic cattle metacarpals (below) After Bökönyi–Kállai–Matolcsi–Tarján (1964)

Since zoo animals often reach a high age because of the human protection they enjoy, there is enough time for a lot of abnormities to develop on their skeletons. In this, also the sometimes unhealthy or at least unnatural living conditions play a certain role. Their effect is that the teeth of such animals often are useless for comparisons, and sometimes even their extremity bones show deformations, exostoses, etc. which essentially lower their comparative value.

In addition to morphological changes, increasing size variability is one of the best known consequences of domestication. The standardized osteometric system of Martin was adapted to a number of mammalian taxa by Duerst (1926). Metric differences between the wild and domestic forms, however, are usually difficult to detect in terms of formal statistical significance. Accurate distinction is possible only in the case of the largest assemblages where hundreds of identical, measurable skeletal elements are available from both the wild and domestic forms (Bökönyi–Bartosiewicz 1987).

In the case of the two economically important domestic animal species whose ancestors lived in the Carpathian Basin during prehistory, pig and cattle are represented by sufficiently great numbers of measurable bones to provide a rough framework within which this type of classification can be carried out. Tentative size limits of the most characteristic skeletal elements (without detailed statistical parameters) are listed in the Appendix to this study.[2]

During the practical use of these values, however, one must be aware of the fact that the greater the chronological and geographical distance from prehistoric Hungary, the greater the potential bias in using the size limits outlined in the Appendix.[3] Reliable distinctions between the wild and domestic dorms of the same species can only be expected from the multi-faceted and systematic evaluation from both morphological and metric traits.

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[2] The "Appendix" to this paper is the first, posthumous publication of bone measurements used by the author in the distinction between the wild and domestic forms of pig and cattle. While size ranges are not expressed in terms of standard statistical parameters, empirical values accumulated over several decades of in depth research experience have provided rules of thumb which are of immense help in the primary classification of animal remains during the course of identification work.

[3] The size of wild animals is influenced by slow, more-or-less natural selection and gradual environmental change. The robusticity of bones from domesticates, on the other hand, is equally dependent on artificial selection and conditions of keeping. The different paces of these two parallel processes, therefore, result in diachronic variability in the size overlap between domestic animals and their wild ancestors.

APPENDIX

GUIDELINES FOR THE DISTINCTION BETWEEN WILD AND DOMESTIC FORMS USING BONE MEASUREMENTS

Measurement (mm)	**Sus scrofa ferus L.**	**Sus scrofa domestica L.**
Upper toothrow		
length of the premolar row P^1–P^4	46 – 63	39 – 44
length of the molar row M^1–M^3	77 – 89	51 – 77
length of the third molar M^3	36 – 49	23 – 38
Lower toothrow		
length of the premolar row P_1–P_4	67 – 85	41 – 68
length of the molar row M_1–M_3	76 – 118	49.5 – 79
length of the third molar M_3	40 – 55	20 – 42
Atlas		
length of the ventral arch	28.5 – 37	16 – 21.5
length of the dorsal arch	25 – 33	19 – 24.5
breadth of the cranial articular surface	60.5 – 73	47 – 60
breadth of the caudal articular surface	61 – 76^+	42.5 – 50
greatest height	56 – 71	39 – 47
Epistropheus		
length of the corpus	50 – 52	38.5
length of the arch	19	17
length of the dens	18.5 – 21	12
breadth of the dens	12 – 14	9
breadth of the cranial articular surface	60 – 63	48
breadth of the fossa caudalis	36 – 37	28
height of the cranial articular surface	19 – 25	17.5
height of the fossa caudalis	22	17.5
Scapula		
greatest length	–	195
greatest breadth	–	–
smallest breadth of the collum scapulae	26 – 40	18.5 – 28.5
greatest breadth of the angulus articularis	43 –	59 29.5– 42.5
depth of the facies articularis	28.5 – 41	20 – 30.5
Humerus		
breadth of the proximal epiphysis	62 – 63	46 – 50
breadth of the distal epiphysis	47 – 60	33 – 45.5
depth of the proximal epiphysis	81 – 89	62 – 64
depth of the distal epiphysis	42.5 – 56.5	34 – 47

Radius		
breadth of the proximal epiphysis	35 – 43	25.5 – 36
breadth of the distal epiphysis	40.5 – 48	33.5 – 42
depth of the proximal epiphysis	25 – 30.5	17 – 27
depth of the distal epiphysis	30 – 38	26 – 31
Femur		
breadth of the proximal epiphysis	–	–
breadth of the distal epiphysis	65	47
depth of the proximal epiphysis	–	–
depth of the distal epiphysis	77	56.5
Tibia		
breadth of the proximal epiphysis	–	–
breadth of the distal epiphysis	35.5 – 42	25.5 – 35
depth of the proximal epiphysis	–	–
depth of the distal epiphysis	30 – 37	22.5 – 30
Astragalus		
greatest length	49 – 57	37.5 – 46.5
greatest breadth	29 – 36	23 – 30
greatest depth	30 – 34	21 – 27
Calcaneus		
greatest length	90 – 112	71.5 – 90
greatest breadth	27 – 33	20.5 – 25.5
greatest depth	35.5 – 42.5	26.5 – 33

Measurement (mm)	**Bos primigenius Boj.**	**Bos taurus L.**
Horn core		
greatest length	360 – 760	68 – 540
greatest diameter females	70 – 88	33 – 92
males	92 – 145	33 – 92
smallest diameter females	61 – 75	25 – 74
males	82 – 127	25 – 74
basis circumference females	212 – 257	100 – 258
males	305 – 645	100 – 258
Upper toothrow		
length of the premolar row P^1–P^3	54 – 58	43 – 55.5
length of the molar row M^1–M^3	85 – 92	68 – 85.5
Lower toothrow		
length of the premolar row P_1–P_3	48 – 63	43 – 53
length of the molar row M_1–M_3	93 – 108	76 – 99
length of the third molar M_3	41 – 49.5	31 – 41

Atlas		
length of the corpus	48 – 60	33 – 60
length of the arch	52 – 56	31 – 66.5
breadth of the cranial articular surface	111 – 140	81 – 121
breadth of the caudal articular surface	109 – 127	80 – 112
greatest breadth	206 – 229	131 – 152
greatest height	95 – 106	75 – 95
Epistropheus		
length of the corpus	154 – 162	93 – 123
length of the dens	27 – 31	16 – 26
breadth of the dens	49 – 660	29 – 45.5
breadth of the cranial articular surface	111 – 140	70 – 106
breadth of the fossa caudalis	60 – 68	44 – 57
greatest breadth	152	–
height of the cranial articular surface	66 – 85	44.5 – 63
height of the fossa caudalis	55 – 59	40 – 51
greatest height	185	
Scapula		
greatest length	480 – 483	321 – 390
greatest breadth	270 – 272	–
smallest breadth of the collum scapulae	51 – 86	37 – 64
greatest breadth of the angulus articularis	70.5 – 115 (Aszód)	62 – 80
depth of the facies articularis	52 – 75.5	37 – 64
Humerus		
greatest length	383 – 408	235 – 336
breadth of the proximal epiphysis	113 – 141 (estimate)	108 – 110
smallest breadth of the diaphysis	46.5 – 60.5	29 – 45
breadth of the distal epiphysis	90 – 121	66 – 97
depth of the proximal epiphysis	134 – 140	90 – 118
smallest depth of the diaphysis	48 – 64.5	34 – 51
depth of the distal epiphysis	83 – 107	63 – 96
Radius		
greatest length	333 – 390	250 – 333
breadth of the proximal epiphysis	91 – 122	65 – 100
smallest breadth of the diaphysis	58 – 67	34 – 47
breadth of the distal epiphysis	81 – 111	57.5 – 89
depth of the proximal epiphysis	44 – 63	37 – 50
smallest depth of the diaphysis	38	22 – 26
distal depth of the epiphysis	48 – 81	35 – 52
Metacarpus		
greatest length	219 – 259	176 – 230
breadth of the proximal epiphysis	66 – 89.5	49 – 70
smallest breadth of the diaphysis	37 – 55	19.5 – 42
distal breadth of the epiphysis	68.5 – 88	35 – 74
depth of the proximal epiphysis	42 – 65	33 – 43
smallest depth of the diaphysis	27 – 33.5	21 – 28
depth of the distal epiphysis	37 – 51	32.5 – 40

Femur		
greatest length	395 – 485	350 – 380
greatest length from caput femoris	448 – 450	–
breadth of the proximal epiphysis	168 – 170	117
smallest breadth of the diaphysis	47 – 51	35 – 41
breadth of the distal epiphysis	130 – 136	91 – 119
depth of the proximal epiphysis	117 – 122	55 –
smallest depth of the diaphysis	48 – 61	38 – 43
depth of the distal epiphysis	160 – 169	120 – 145
Tibia		
greatest length	433 – 476	297 – 410
breadth of the proximal epiphysis	112 – 133	80 – 112
smallest breadth of the diaphysis	50 – 56.5	34 – 48
breadth of the distal epiphysis	68.5 – 90	52 – 75
depth of the proximal epiphysis	119 – 134	76 – 108
smallest depth of the diaphysis	36 – 42	21.5 – 35
depth of the distal epiphysis	55 – 70	35 – 58
Astragalus		
greatest length	77 – 97	58 – 79
distal breadth	51 – 69	37 – 56
greatest depth	43 – 56	32 – 46
Calcaneus		
greatest length	150 – 190	115.5 – 161
greatest breadth	49 – 68	35 – 55
greatest depth	54 – 77	41 – 62
Metatarsus		
greatest length	255 – 300	206 – 251
breadth of the proximal epiphysis	55 – 71	37.5 – 59
smallest breadth of the diaphysis	30 – 42.5	16 – 34
breadth of the distal epiphysis	62.5 – 80	48 – 67.5
depth of the proximal epiphysis	32 – 68.5	38.5 – 61.5
smallest depth of the diaphysis	31.5 – 37	21 – 34
depth of the distal epiphysis	36 – 44.5	28 – 40

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