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DIFFERENCES IN THE BODY SIZE OF CATTLE IN THE ARCHAEOZOOLOGICAL MATERIALS IN THE POLISH TERRITORIES

The changes taking place in cattle from the middle Neolithic to early Middle Ages have been studied determining the withers height and the circumference of the horn-core using a scoring system in points common to both these features. This ensured conditions for their comparability. The determination of withers height in points has not yet been used, and the present report is the first quantitative and graphic approach to this problem. On the basis of the obtained results it may be said that in middle and younger Neolithic the prevailing type was that of primigenous cattle, with large withers height and large circumference of the horn-core. A part of the cattle were, however, already of low height, but still with large horn-core, that is these animals constituted a transitional form between the primigenous cattle and the brachycerous cattle. The Neolithic may be thus regarded as the beginning of the time of evolution of this latter type. In the Bronze Age and in the early Iron Age the primigenous cattle was replaced by the brachycerous type, and this has spread widely having already a more stabilized morphological type. However, intermediate forms between these two types kept occurring. In Early Middle Ages the brachycerous type has been definitely stabilized and the intermediate forms disappeared probably.

The earliest studies of the osseous remnants of animals, derived from archaeological finds, were limited to determination of their anatomic form and species of the animal, and to establishing of the number of remnants representing individual species. Whole bones or their fragments of greater morphological value were measured trying to reconstruct from these data the skeletal structure of the animals living in prehistoric times. Sporadic descriptions of single bones from various epochs, chronological periods and from various regions served frequently as a basis for the first theories and generalizations whose validity was later confirmed or refuted by subsequent discoveries.

Owing to the ever greater spread of the awareness that animal remnants are important source of knowledge on the life of man in the prehistoric times and on the natural fauna in his environment an ever greater number of osteological materials began to reach the specialists. The dramatic rise of the number of archaeozoological studies has created a need for elaboration in archaeozoology of own research methods for proper arrangement of the materials and for an objective interpretation of the obtained data.

One of these methods devised for facilitation of a proper evaluation of the morphology of animal skeletons is the scoring system used in this work

(Lasota-Moskalewska 1985). It is based on the conversion of various dimensions of various bones of a given animal species to an appropriate score in points. The starting point of this method is the dispersion of various dimensions from the lowest to the highest values. The dispersion is due to interindividual variability, evolution-dependent variability (due to changes in size with time), sex-dependent variability, geographical variability typical of a given territory. The lowest value of a dimension is treated as 0 points, and the highest value as 100 points. Any value of each dimension can be placed in a proper place on the scale and the proper number of points can be read.

This method makes possible obtaining of abstract values which are comparable, in place of values obtained directly from measurements, that is variously denominated and having various order of size. For example, the circumference of a bone may be compared with the dimensions in length or width of the bone. Small bones (*calcaneal* or *astragalus*) may be compared with large bones (*humerus* or *femur*). The use of this method provides a considerable easiness in the interpretation of the osteometric data, some of these advantages are discussed below. In the examination of whole animal skeletons (e. g. those of sacrificed animals or animals which were the object of worship) a great number of

measurements of various bones are obtained. The transposition of these different dimensions into points makes possible an assessment whether all dimensions are of the same order of magnitude, that is, whether the studied skeleton has a uniform morphological type or is a mixture of features of various types. The latter case was described on the basis of the skeleton of a cow encountered in the Neolithic in a burial cave in the village Wojciechowice in the Tarnobrzeg Province (Lasota-Moskalewska 1985). Owing to the use of the scoring method this cow may be regarded as a transitional link between the primitive type of cattle found in the early periods of domestication (*Bos taurus primigenius*) and the short-horned cattle widespread in Europe from the bronze era on (*Bos taurus brachyceros*).

Another possibility of application of the scoring method was described in the study of the animal remnants from Sandomierz (Lasota-Moskalewska, Świeżyński 1987). This was the most frequently encountered material of post-consumption remnants, in which each measured bone or its fragment is regarded as derived from a different individual. In such materials tens of dimensions of various bones are obtained, and there is no possibility of their common assessment. The transposition of these dimensions into points makes a common assessment showing in a given material the number of bones of small cattle, the number of bones of large or intermediate cattle. This provides information on the whole range of variability of the population and its uniformity or absence of this uniformity. A large number of comparable data from all dimensions of cattle bones makes possible determination whether their distribution is the single mode or bimodal.

In speaking on the advantages derived from the use of the scoring method it is worth mentioning that it may be applied for morphological assessment of the skeletons of other animal species also. Its application for the assessment of the dimensions of the bones of pigs and boars facilitates the differentiation of certain bones or even bone fragments of these two animal forms (Lasota-Moskalewska, Kobryń, Świeżyński 1987).

In this paper the graphic method is presented for conversion of withers height to score in points. This feature, which is not an osteometric feature, has not been taken into account in the already mentioned study on the cow from Wojciechowice, in which the graphs were presented of numerous bone dimensions in cattle. Withers height is always fraught with an error since it is not a direct measurement but calculated on the basis of long bones, but it is of

some value, since it is easily imaginable, especially for the readers of archaeozoological papers whose approach to the scientific problems is rather humanistic, and the authors of most these papers consider rightly this feature. In view of this, it is hoped that evolving of the scale in points of this feature will facilitate comparison of withers height in cattle from various finds and various periods. This is the basic feature for description of animal type. The other important feature is the circumference of the horn-core at its base, which gives an information on the so called thickness of horn processes. The point scale for this feature has been prepared earlier in the mentioned study of A. Lasota-Moskalewska (1985). These two features give us the possibility of imaging the appearance of domestic cattle, and they were used in this paper for investigating the changes of cattle in the period from the middle Neolithic to Early Middle Ages in the Polish territories.

These changes were connected mainly with the persisting and successively increasing process of domestication, with changes in the methods of cattle husbandry and utilization of animals in farms. These studies may serve for establishing what influence on the breed of cattle had the increasing connection of its life with that of man, and the change from primitive breeding to purposeful husbandry.

For the present study the dimensions were taken of bones from own materials, already published or present in typescripts in the archives of the Archaeological-Conservation Department in Warsaw. These materials were obtained from the following archaeological sites: Stryczowice, Province of Kielce (Lasota-Moskalewska 1982), Kierzkowo, Province of Bydgoszcz, Wojciechowice, Province of Tarnobrzeg (Lasota-Moskalewska 1985), Piotrków Trybunalski, Radom, and Sandomierz, Province of Tarnobrzeg (Lasota-Moskalewska, Świeżyński 1987), Tykocin, Province of Białystok, Łeczyca, Province of Płock, Pełczyńska, Province of Kielce, Wyszogród-Drwały, Province of Płock, Pułtusk-Zamek, Province of Ciechanów. Besides that, all earlier materials were used, which had been prepared earlier for a monograph (Lasota-Moskalewska 1980). This group comprised own materials as well as those from the works of other authors published since 1977. A full list of these materials with references has been included into this monograph.

For calculation of withers height only the length of the bones of the metapodial parts of the extremities was used, and the coefficients of J. Fock (1966) were considered in the calculations. The length of other long bones was not considered, since only the metapodial bones can serve for determination of the

sex of the animal. This provides the possibility of establishing the withers height separately for males and females.

Before the beginning of the study on the changes occurring in the appearance of cattle with time, a point scale was prepared for conversion of withers height to points (Fig. 1). For this purpose 453 wi-

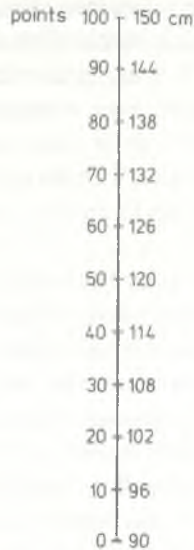


Fig. 1. Point scale of withers height in cattle

thers heights were used (Table 1). For the conversion to points of the circumference of horn-core base the graph was used published elsewhere (Lasota-Moskalewska 1985, 56, Fig 2).

The changes of withers height and horn-core circumference of cattle in time were considered in three time periods, of which two first ones covered about 2000 years each (the middle and the younger

Neolithic and Bronze Age together with the beginnings of the Iron Age) and the third covered about 1000 years (Early Middle Ages). This subdivision was rather arbitrary and based on certain indispensable simplifications, since it was tried to bring the length of these periods to comparable units (about 1000 years or multiples of this unit). In the studies of evolutionary processes by statistical methods this approximation has no significant effect on the results. The purpose of this investigation was to find a general characteristics of this period and description of the trend in the changes taking place with time.

In the present work the term "Neolithic" is used mainly in relation to the materials connected with the Funnel Beaker culture and the Globular Amphora culture, with absence of the materials from the early neolithic period, that is from the time of the Linear Band Pottery culture. Such materials are very scarce in Poland, and obtaining of a representative number of length measurements of the metapodial parts of the extremities and horn-core circumference was not possible. This problem will be discussed again later.

Withers height was considered separately in males and females, and then again in both sexes jointly and together with horn-core circumference. In the Neolithic males were considerably higher than females (Table 2). The absolute value of the difference was 8.5 cm. In the following periods this difference decreased so much that it would be imperceptible visually. In the score scale (Fig. 2) most Neolithic males and females fall into the range between 34 and 66 points. Moreover, both small animals (0-33 points) and large ones (67-100 points) were found. The former were more numerous among females,

Table 1. Distribution of withers height (in cm)

Period	Sex	90	95	100	105	110	115	120	125	130	135	140	145	150
I Neolithic middle and late	males	—	—	—	4	—	3	12	22	23	16	4	4	2
	females	—	—	1	9	—	5	10	8	4	—	—	—	—
II Bronze Age and early Iron Age	males	1	4	3	12	—	15	4	—	—	—	—	—	—
	females	2	7	36	33	—	19	9	7	—	—	—	—	—
III Early Middle Age	males	—	6	12	20	—	4	3	1	—	1	—	—	—
	females	2	20	51	34	—	12	6	—	—	—	—	—	—

Table 2. Withers height of cattle (in cm)

Period	Males			Females		
	\bar{x}	min-max	N	\bar{x}	min-max	N
I Neolithic middle and late	126.0	105.0-149.8	90	117.5	101.4-152.6	39
II Bronze Age and early Iron Age	108.6	94.4-117.5	39	107.6	92.0-122.0	113
III Early Middle Age	106.9	96.6-133.2	47	104.6	93.0-119.3	125

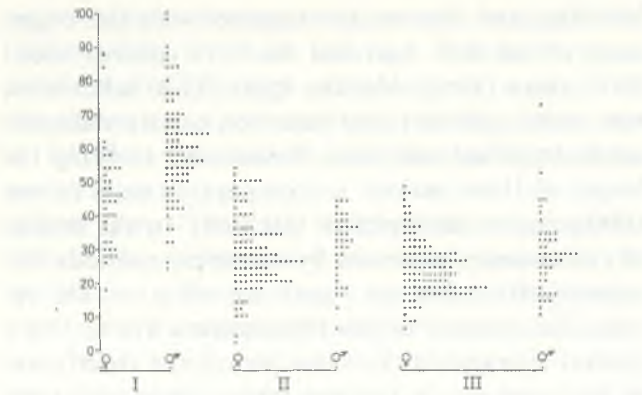


Fig. 2 Changes in withers height of male and female cattle
I - middle and late Neolithic, II - Bronze Age and early Iron Age, III - Early Middle Ages

the latter among males. In the Bronze Age and in the initial periods of the Iron Age most cattle (males and females) were in the range of small animals (0 to 33), and the remaining ones were in the intermediate range. Large animals were not found. A similar pattern was in the cattle population in early Middle Ages. Only one male had a considerable withers height, that is 72 points. However, there was no certainty whether this male had not been castrated and his *metapodium* was not evidently marked in the correlation field serving as a basis for sex identification (Calkin 1960). Castrated males were not considered in this material.

The greatest change in the height of cattle was between the Neolithic and the Bronze Age and early periods of Iron Age. Later on, the withers height had a rather stabilized value.

The joint evaluation of withers height and horn-core circumference (Fig. 3) showed that in the Neolithic cattle varied much more with regard to height (18–100 points) than with regard to the circumference of the horn-core (38–100 points). It may be said that small animals in that time span had at least medium-size horn-cores. Horn-cores of small cir-

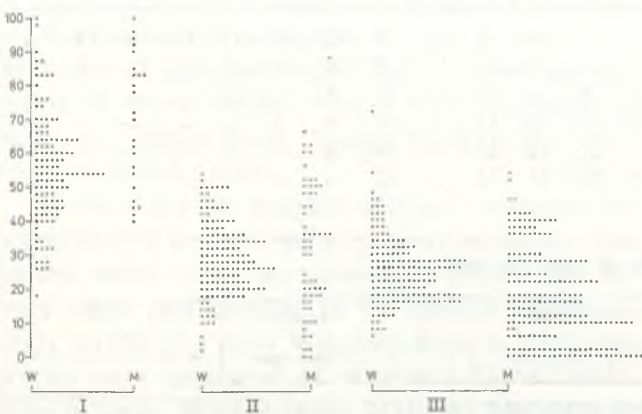


Fig. 3. Changes in withers height (W) and horn-core circumference (M) in cattle
I, II, III as in Fig. 2

cumference were not found at all. Animals with a high value of horn-core circumference accounted for 54.2% of the population, and those with great withers height accounted for only 18.6%. In the Bronze Age and in early periods of the Iron Age these proportions were changed. Horn-core circumference had a greater interindividual variability than withers height. About half the animals had low values of horn-core circumference, the remaining ones had medium-size circumference, and animals with high values of this circumference were not found. A disproportion was revealed in the relative proportions of small cattle and cattle with small horn-core circumference. The former group accounted for 64.5% and the latter one for 52.5% of the population.

In Early Middle Ages the range of variability of horn-core circumference and withers height was similar. Apart from one animal with a large horn-core circumference and one animal with great withers height, the remaining animals fell into the categories of low and intermediate values of these features, but the small values prevailed significantly. Animals with small horn-core circumference accounted for 84.4% and low withers-height ones for 83.7% of the population. The earlier disproportion had disappeared.

The above reported results require a more detailed discussion, since certain conclusions drawn from it may have a relation to the problem of evolution. The Neolithic is regarded as the first stage of cattle domestication. This stage includes such changes in the size and appearance of the skeleton which cause that the skeleton of domestic cattle differs so much from that of the aurochs. There is now no doubt that in various geographical regions the domestication of cattle occurred if only the wild form of this species, that is aurochs, was available. In Poland the aurochs was a very common animal, as evidenced by the multitude of its remnants, and it may be assumed that the domesticated cattle is derived from this wild form. The morphological changes in the cattle in the middle and in the younger Neolithic were already so far advanced that we must assume that they took several scores of generations to occur in this extent, and these changes were due to natural selection or to purposeful selection by man for breeding purposes. On the basis of the available remnants of skeletons certain authors assume that the withers height of the aurochs reached 180–190 cm (quoted after Bogolubski 1968). S. Bökönyi (1974) quoting the data reported by J. Boessneck suggested, however, lower values: 150–155 cm for females and 170 cm for males. The withers height of the Neolithic cattle studied in this work was at most

150 cm (males) and 143 cm (females), and animals with withers height only slightly over 100 cm were not rare in both sexes. It may be supposed that the about one-thousand year duration of the Linear Band Pottery culture was this early stage of cattle domestication, and in that period changes in the size of cattle were much less evident. The data available from the Polish territories (from the Kujawy region) included withers heights of six cattle from the early Neolithic (Sobociński 1985). Four of them fell into the category of middle size cattle (from 47 to 58 points) and two belonged to big cattle (72 to 82 points).

A very large material dated to the time of the Linear Band Pottery culture was published by H.H. Müller (1964) from the GDR (from Magdeburg to Erfurt). These data show that the variability range of withers height in the domestic cattle was from 57 to 92 points, and horn-core circumference from 35 to 110 points. The distribution of all these values coincided with that obtained in the present study, only small-size animals were lacking. On the ground of these comparisons it may be said that, in accordance with the expectations, the cattle in the period of Linear Band Pottery culture was indeed at an earlier stage of domestication than the cattle from the Neolithic studied in this work. The small-size breed which is the final form of *Bos taurus brachyceros* was not yet found then. The medium-size animals may fall still into the range of individual variability and sex-related differences of the cattle type *Bos taurus primigenius*. However, this variability reaches down fairly low, overlapping even the upper part of the dispersion of body dimensions of cattle from the Bronze Age and early periods of the Iron Age, or even cattle from the Early Middle Age.

On the basis of these comparisons one cannot tell that it was the period of the early Neolithic which saw the first stage of cattle domestication. Such a change of the size could not have been the result of a relatively short-lasting contact with man, even if this contact would have included starvation and restriction of locomotor activities, that is factors having a negative effect on the phenotype of the animals. During many generations the effect of these factors could be a selective one, giving preference to the survival of smaller animals of lower calorie requirements. Breeding in herds caused also cross-breeding of animals often consanguineous leading to degeneration of offsprings. In the Neolithic cattle was already advanced in the process of domestication. One may suppose that the so called first stage of domestication was preceded by a preliminary stage in which animal groups came under the con-

trol of man as a source of meat ready available, and in which the first trials of their exploitation were undertaken. H.H. Müller isolated in his material castrated cattle. The knowledge of the technique of castration and advantages derived from it might have, doubtlessly, developed after man's contact with the species during many generations.

It seems that the group of animals studied in this work, coming from the middle and the late Neolithic, was a set of individuals at various stages of domestication. This set might have contained the offsprings of cattle domesticated since several centuries or over thousand years. This is plausible considering that the process of domestication of wild animals lasted as long as it was possible to cross-breed them with the domesticated ones. The wild animals constituted an apparently inexhaustible source of herd increasing or covering of losses suffered by the herds (e.g. in winter).

Early changes in the withers height of cattle were not fully correlated with changes in horn-core circumference. This circumference showed a lower interindividual variability owing to the fact that low values of it were not observed (below 160 mm). That means that cattle with small withers height (below 110 cm) has still fairly thick horn-cores. It may be supposed that this cattle was either an intermediate link between the primigenous cattle and the brachycerous cattle (with a mixture of morphological features) or these animals were extremely emaciated primigenous cattle. The latter supposition is less feasible, since it has been demonstrated experimentally that cattle starvation leads in the first place to reduction of the size of the horn-cores (Bogolubski 1968). The former supposition is suggested by the above mentioned example of the cow from Wojciechowice. Her withers height was evaluated to be 30 points, her horn-core 44 points. Thus it was a small cow with medium sized horn-core. It seems that the era of the middle and the late Neolithic was both, the time of domestication of new animals with their incorporation into herds of domestic cattle of the then prevailing type of primigenous cattle, and the beginning of development of a new type — brachycerous cattle. The latter type might have had at that time no established morphological pattern and presented a combination of the features of both types.

In the Bronze Age and in early period of the Iron Age the withers height of cattle was suddenly reduced. The big cattle disappeared, only medium sized and small animals remained. The range of interindividual variability decreased. This may be interpreted as a result of brachycerous cattle replacing the primigenous one and spreading to new territories, with stabilization of its morphotic type.

This stabilization was, however, not complete judging by a joint analysis of withers height and horn-core circumference, since this circumference showed at that time still a fairly considerable interindividual variability with a greater number of small animals than the number of those with small circumference. The characterization of cattle from this period shows that, besides a large group of animals representing already the brachycerous type, a large group had mixed morphotic features. Thus the process of development of the brachycerous type was still continuing, and at the same time this type spread over large areas of land and became stabilized.

In the Early Middle Ages withers height was similar to that in the preceding time periods, while the circumference of the horn-core diminished due to the increase in the number of animals with a low value of this circumference. Their share in the whole number of animals was similar to that of small animals. It may be assumed that each small animal could have a low value of horn-core circumference, and each medium sized animal has an intermediate value of this feature. This is an evidence of stabilization of the morphotic type of cattle.

The obtained results have brought a new element into the studies on cattle evolution, that is the observation that the decrease of withers height in early stages of domestication was not paralleled by decreasing horn-core circumference. The latter feature was less prone to changes than withers height, and thus the length of the metapodial segments of the extremities (which was the basis for withers height calculation). The evaluation of the body size of cattle, and the suggestions of its belonging to the primigenous type judged only by large horn-core circumference require caution in the case of evaluation of Neolithic materials. Frequently the animals belonged to intermediate types, with small body size but with still high value of horn-core circumference.

Finally, it is worth stressing that the difference of withers height between males and females was observed, as a rule, only in the Neolithic Later on it decreased so much that it could not be used as a feature differentiating the animals belonging to different sexes. It is possible that the sex dimorphism of withers height is characteristic only of the primigenous type and not of the brachycerous type in which it is absent. At the same time, it is known that sex dimorphism of the morphological features decreases in the domesticated animals as compared with their wild ancestors (Bogulubski 1968; Kratochvil 1976). Thus, doubtlessly, the lower stage of domestication of cattle in the Neolithic would be associated with persistence of certain features observed in wild animals.

From the standpoint of archaeology the results obtained in this study may shed new light on the characteristics of early stages of economy. It seems that in the Polish territories the period of two neolithic cultures (Funnel Beaker and Globular Amphora) differed with regard to the process of cattle domestication. The cattle domesticated earlier was undergoing a reduction of body size as a result of increasing exploitation of the animals by man, and due to the action of the factors of natural selection and, perhaps, purposeful selection. Consequently, the type of small size cattle *Bos taurus brachyceros* began to develop. On the other hand, the process of assimilation of new animals was continuing, which were not particularly different in their size from the aurochs. On the basis of comparison with data in the literature it seems that also the period of the early Neolithic connected with the Linear Band Pottery culture could not be the first stage of domestication in the literature accepted meaning. It must have been preceded by a preliminary period in which the domesticated cattle was not different from the aurochs in a way detectable in the values of dimensions. This suggestion has also been put forward by E. Dmitrieva (1963) from the studies of the neolithic materials from the Crimea. The development of agriculture in the Neolithic was associated with a great development of animals breeding, so that remnants of domesticated cattle began to appear on a mass scale in the remains of human settlements, and the dimensions of their bones made possible their identification. This is suggested by the presence in the neolithic remnants of bones of cattle in an advanced stage of domestication, that is this stage which is described in the present study as a period in which forms intermediate between primigenous cattle and brachycerous cattle appeared.

It seems that domestication of new animals was ended in the Bronze Age. At the end of the Neolithic and at the beginning of the Bronze Age a qualitative change appeared in the morphology of cattle. The primigenous cattle was completely replaced by the brachycerous cattle. All animals reached the stage of advanced stage of domestication although many of them had not yet a stabilized morphological type. These were, probably, those animals whose contact with man began later, that is in the Neolithic. In later time periods no such evident changes occurred, and further changes included only a greater stabilization of the morphological type of the brachycerous cattle, *Bos taurus brachyceros*.

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