

## Certain Osteometric Differences Between the Aurochs and Domestic Cattle<sup>1</sup>

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On the basis of osteometric data concerning the aurochs and domestic cattle in Europe and Asia an attempt was undertaken to isolate skeletal features which would make it possible to identify bones (or their fragments) belonging to either form. The critical values of these features were established for facilitating their identification. Of 25 studied features 14 had one-peak curves of frequency distribution curves. Using the remaining 11 features with multipeak curves the ranges of variability of the dimensions were established for differentiation of these skeletal dimensions characteristic of the aurochs and domestic cattle. The critical values were marked on a point scale constructed jointly for the wild and the domesticated form. Overlapping was observed between the skeletal dimensions of both forms, and the range of this overlapping varied. The variation of the dimensions in the aurochs expressed as point scores (and thus comparable) was similar for all studied features, except the circumference of the horncore which had a greater variation. In domestic cattle this variation was also similar, but horncore circumference was again an exception showing, smaller variation. Nearly all compared dimensions had a greater variation in domestic cattle than in the aurochs.

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### 1. INTRODUCTION

The reports of numerous archaeozoologists and our own observations suggest that considerable difficulties are present in the differentiation of the bones of aurochs and domestic cattle (*e.g.* Bökönyi, 1962, 1976, 1984; Clason, 1980; Lasota-Moskalewska & Sanev, in press). These difficulties are increased by the fact that in archaeozoological studies one usually deals with small fragments of bones. Difficulties are encountered even in the evaluation of the osteometric features, since there are no quantitative criteria available for identification of skeletal remnants of wild and domestic cattle. Most frequently descriptive criteria are used

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which may be subjectively biased. This is of essential significance especially in the study of osteological materials from the early neolithic age since the existence of domestic cattle in this age is not certain. In this situation, precise identification is necessary for determining the earliest date of domestication. At the same time, it is important to answer the main question: since when did agricultural and animal husbandry begin in a given region?

In the present study, with a large number of osteometric data available, it was attempted to isolate skeletal features which could serve to identify aurochs or domestic cattle bones (or their fragments). The purpose of the study was also to establish critical values that would make it possible or, at least, facilitating their identification.

## 2. MATERIALS

For the study available osteometric data were used concerning the aurochs (*Bos primigenius* Bojanus, 1827) living in prehistoric times and also in historic times in the Polish territories (31 archaeological sites) and in other European and Asian countries (31 archaeological sites) (Table 1). Only part of these data were obtained by our own investigations. Most skeletal dimensions were taken from the literature. Osteometric data concerning domestic cattle (*Bos primigenius f. taurus*) were also collected. This material came from the early neolithic age to the Middle Ages.

The sites concerning domestic cattle finds were not listed in detail, since the data in this form were only compared with the dimensions of aurochs bones. In most cases they are presented in the monograph of domestic cattle (Lasota-Moskalewska, 1980). The present study also contains a large number of these data (Table 1). Our own unpublished data were also used.

When deciding whether a given dimension was related to the aurochs or domestic cattle the classification according to the authors of various reports was accepted. Sometimes it was based, only on suggestions of the authors (in cases when the author stressed difficulties in precise identification).

All skeletal dimensions reported by various authors were obtained according to Duerst (1926) and then by Driesch (1976). For further analysis 25 osteometric features of 12 bones were chosen (Table 2). Table 2 also shows the abbreviations of dimension names as proposed by Driesch (1976), accepted as obligatory in such analysis. They are used in the following text.

## 3. METHODS

In arranging the material the chronology of the sites from which aurochs bones were obtained was not taken into consideration. However, in relation to domestic cattle the skeletal dimensions from the neolithic sites were separated from those dated to later times.

All dimensions were arranged into an analytical separation series observing

Table 1

List of archaeological sites from which the material used in the study was obtained.\* sites from which, apart from aurochs bones, dimensions of cattle bones from the Neolithic Age were used.

No.	Locality or region	References
1	2	3
POLAND		
1.	Biskupin	Krysiak, 1950: III Spraw. z prac wykop. w Biskupinie, 39 (Poznań).
2.	Łęczycza	Krysiak, 1955: Studia wczesnośredn., 3: 360.
3.	Wolin	Kubasiewicz, 1959: Szczec. Tow. nauk., 2: 1.
4.	Wrocław	Myczkowski, 1960: Przegl. archeol., 12: 150.
5.	Cedynia	Kubasiewicz & Gawlikowski, 1961: Mat. zach.-pomor., 7: 435.
6.	Nosocice	Sobociński, 1961: Przegl. archeol., 13: 122.
7.	Wielkopolska & Kujawy	Gedymin, 1965: Roc. WSR Pozn., 25: 162.
8.	Szczecin	Kubasiewicz, 1965: Przegl. zool., 9: 65.
9.	Gdańsk	Krysiak, 1967: Gdańsk wczesnośredn., 6: 7.
10.	Szczecin	Kubasiewicz & Gawlikowski, 1969: Mat. zach.-pomor., 15: 189.
11.	Prosna, Dolny Śląsk	Chrzanowska, 1971: Przegl. zool., 15: 91.
12.	Dębica	Sobociński, 1973: Roc. AR Pozn., 66: 105.
13.	Jeziro Więcborskie	Schramm, 1974: Acta Univ. N. Coper., 60: 275.
14.	Bruszczewo	Sobociński, 1975: Fon. archaeol. posn., 26: 43.
15.	Gdańsk	Kubasiewicz, 1977: Gdańsk wczesnośredn. 9: 5.
16.	Gniechowice	Sobociński, 1978a: Roc. AR Pozn., 103: 83.
17.	Gniechowice *	Sobociński, 1978b: Roc. AR Pozn., 103: 89.
18.	Smuszewo	Godynicki & Sobociński, 1979: Fon. archaeol. posn., 28: 3.
19.	Janków	Sobociński, 1981: Roc. AR Pozn., 131: 57.
20.	Stryczowice	Lasota-Moskalewska, 1982: Wiad. archeol., 47: 267.
21.	Zalęcino, Żuków *	Sobociński, 1984a: Roc. AR Pozn., 154: 87.
22.	Dąbki	Sobociński, 1984b: Roc. AR Pozn., 154: 101.
23.	Giecz	Sobociński, 1985a: Roc. AR Poznań, 164: 43.
24.	Kujawy *	Sobociński, 1985b: Roc. AR Pozn., 164: 87.
25.	Śląsk	Wyrost & Chrzanowska, 1985: Prace Kom. archeol., 3: 59.
26.	Strachów	Molenda, 1986: Roc. AR Pozn., 172: 77.
27.	Radom	Lasota-Moskalewska, unpub.
28.	Sandomierz	Lasota-Moskalewska, unpub.
29.	Tykocin	Lasota-Moskalewska, unpub.
30.	Wyszogród — Drwały	Lasota-Moskalewska, unpub.
31.	Pułtusk	Lasota-Moskalewska & Kobryń, unpub.
OTHER COUNTRIES		
32.	Belgium *	Clason, 1971: Helinium, 11: 3.
33.	Czechoslovakia *	Clason, 1968: Palaeohistoria, 14: 1.
34.	Czechoslovakia	Ambros, 1972: Zbor. sloven. polnohosp. Muz. v Nitre, 11: 7.
35.	Central Europe	Reichstein, 1973: [In: "Domestikationsforschung u. Geschichte d. Haustiere". J. Matolcsi ed.].
36.	East Europe *	Calkin, 1970: Drevnejšie domašnie životnye Vostočnoj Evropy. Izdat. Nauka: 1—280. Moskva.
37.	Germany, BRD	Requate, 1957: Zeitschr. f. Tierzüchtg. u. Züchtungsbiol., 70: 297.
38.	Germany, BRD	Nobis, 1962: Zeitschr. f. Tierzüchtg. u. Züchtungsbiol., 77: 16.

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Table 1. concluded.

1	2	3
39. Germany, BRD		Bayer, 1970: Diss. 1—48. München.
40. Germany, BRD		Vessely, 1975: Diss. 1—182. München.
41. Germany, BRD *		Clason, 1977: [In: "Die neolith. Besiedl. b. Hienhein". P. J. R. Modderman ed.].
42. Germany, BRD		Wachler, 1978: Diss. 1—213. München.
43. Germany, BRD *		Nobis, 1981: Materialhefte z. bayer. Vorgesch., 44: 160.
44. Germany, BRD		Nobis, 1983: [In: "Ein fundplatz d. frühen Trichterbecherkultur an d. holstein. Ostseeküste". J. Meurers-Balke ed.].
45. Germany, DDR *		Müller, 1964: Deutsche Akad. d. Wissenschaft z. Berlin Schrift. d. Sektion f. Verl. Berlin frühgesch., 17: 6.
46. Germany, DDR		Müller, 1982: Beitr. z. ur- u. frühgesch., 17: 239.
47. Germany, DDR		Ambros, 1986: Veröffentlich. d. Mus. f. ur- u. frühgesch. Potsdam, 20: 175.
48. Hungary		Bökönyi, 1959: Acta archaeol. Acad. Sci. Hung., 11: 39.
49. Hungary *		Matolcsi, 1970: Ztschr. f. Tierzüchtg. u. Züchtungsbiol., 87: 89.
50. Hungary		Bökönyi, 1972: Acta Mus. Ex Com. Bacs-Kiskun, 17: 56.
51. Hungary *		Bökönyi, 1981: Acta archaeol. Acad. Sci. Hung., 33: 21.
52. Hungary		Janossy & Vörös, 1981: Fragm. mineral. et paleontol., 10: 79.
53. Hungary		Bökönyi, 1984: The vertebrate fauna of a roman town in Pannonia. Akademiai Kiado. 1—238. Budapest.
54. Iraq		Lasota-Moskalewska, unpub.
55. Iran		Krauss, 1975: Diss. 1—208. München.
56. Moldavia		Calkin, 1972: Trudy Mosk. Obšč. Isp. Prirody, 48: 38.
57. Roumania		Bolomey, 1968: Ann. Roum. Anthropol., 5: 19.
58. Soviet Union		Dmitrieva, 1961: Sbor. Mat. po Archeol. Adygei, 2: 99.
59. Switzerland		Stampfli, 1979: Archaeol. Forsch., 97: 111.
60. Yugoslavia *		Bökönyi, 1976: Monum. archaeol., 1: 213.
61. Yugoslavia *		Clason, 1980: Palaeohist., 22: 41.
62. Yugoslavia		Lasota-Moskalewska, unpub.

the following classification: aurochs, neolithic domestic cattle and domestic cattle from later ages (Table 2). Using the separation series and disregarding the above mentioned classification, percent curves of frequency distribution were plotted and equalized. The distributions with multipeak curves were chosen and from them the variability ranges were read corresponding to the dimensions of the bones of the aurochs and domestic cattle. If possible, the ranges obtained for male and female aurochs were also read, as well as for two forms of domestic cattle: *Bos taurus primigenius* and *Bos taurus brachyceros*. Both these forms were identified for the first time by Rüttimeyer (1885) and were described in detail by Bogolubski (1968).

Table 2

Frequency distributions of bone dimensions (A — lower class range,  $f_1$  — aurochs,  $f_2$  — neolithic domestic cattle,  $f_3$  — domestic cattle from later periods; \* features with one-peak curves of frequency distributions (see text).

		Cranium — horncore circumference (HBC)																	
		190	170	150	130	110	90	210	230	250	270	290	310	330	350	370	390	410	
A		—	—	—	1	—	—	6	10	17	8	7	12	6	13	9	4	1	2
$f_1$		—	—	4	13	12	6	7	5	4	1	—	—	—	—	—	—	—	—
$f_2$		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
$f_3$		47	80	48	38	16	4	1	3	1	—	—	—	—	—	—	—	—	—
		Scapula — length of the neck (SLC)																	
A		26	30	34	38	42	46	50	54	58	62	66	70	74	78	82	86	90	94
$f_1$		—	—	—	—	—	—	—	2	8	4	10	3	6	7	4	4	—	1
$f_2$		—	—	—	2	1	11	18	21	33	9	6	3	1	—	—	—	—	—
$f_3$		1	1	12	13	32	24	16	2	4	2	1	—	—	—	—	—	—	—
		Humerus — breadth of the distal end (HBD)																	
A		52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
$f_1$		—	—	—	—	—	—	—	—	2	4	4	11	6	9	6	4	6	2
$f_2$		—	—	—	—	2	2	3	10	14	27	3	7	2	4	2	7	—	—
$f_3$		4	10	13	15	46	30	24	9	13	5	1	1	—	1	—	—	—	—
		Radius — breadth of the proximal end (RBP)																	
A		56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120	—
$f_1$		—	—	—	—	—	—	—	—	1	3	11	7	6	4	7	5	2	—
$f_2$		—	—	—	—	4	6	11	23	14	1	—	4	1	1	—	—	—	—
$f_3$		10	29	53	55	34	13	10	10	4	2	2	1	—	—	—	—	—	—
		Radius — breadth of the distal end (RBD)																	
A		44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112
$f_1$		—	—	—	—	—	—	—	—	—	4	3	3	6	6	7	5	3	1
$f_2$		—	—	—	1	—	2	2	15	9	2	1	1	6	1	1	—	—	—
$f_3$		1	4	11	20	27	13	13	11	4	2	3	1	1	—	—	—	—	—

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Table 2. concluded.

Metacarpal bone III+IV — greatest length (McGL)															
A	148	156	164	172	180	188	196	204	212	220	228	236	244	252	260
f <sub>1</sub>	—	—	—	—	—	—	—	1	4	—	3	8	4	6	1
f <sub>2</sub>	—	—	—	—	1	—	1	2	1	1	—	—	—	—	—
f <sub>3</sub>	7	59	161	152	61	25	16	9	10	—	—	1	—	—	—
Metacarpal bone III+IV — breadth of the proximal end (McBP)															
A	36	40	44	48	52	56	60	64	68	72	76	80	84	88	
f <sub>1</sub>	—	—	—	—	1	—	—	3	17	14	10	6	7	3	
f <sub>2</sub>	—	—	1	1	13	23	32	13	14	9	4	—	—	—	
f <sub>3</sub>	4	18	162	152	141	76	30	17	2	2	1	2	2	—	
Metacarpal bone III+IV — breadth of the diaphysis (McSD)															
A	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46
f <sub>1</sub>	—	—	—	—	—	—	—	—	—	2	1	2	7	1	1
f <sub>2</sub>	—	—	—	—	2	3	3	10	4	7	2	3	1	—	1
f <sub>3</sub>	2	5	36	137	79	95	57	34	18	10	12	5	2	—	—
Metacarpal bone III+IV — breadth of the distal end (McBD)															
A	36	40	44	48	52	56	60	64	68	72	76	80	84	88	
f <sub>1</sub>	—	—	—	—	—	—	—	2	8	15	8	9	11	2	
f <sub>2</sub>	—	—	—	2	8	16	36	21	8	13	4	1	—	—	
f <sub>3</sub>	1	1	109	151	117	99	41	24	22	6	—	—	—	—	
Tibia — breadth of the proximal end (TBP) *															
A	62	68	74	80	86	92	98	104	110	116	122	128	134	140	146
f <sub>1</sub>	—	—	—	—	—	—	—	1	1	1	1	1	7	1	2
f <sub>2</sub>	—	—	—	—	—	1	4	5	3	3	—	—	—	—	—
f <sub>3</sub>	2	1	6	11	6	6	1	1	—	—	—	—	—	—	—

*Tibia* — breadth of the distal end (TBD)

A	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104
f <sub>1</sub>	—	—	—	—	—	—	1	2	14	9	15	17	4	1	1	—	—
f <sub>2</sub>	—	—	—	—	—	—	1	2	14	9	15	17	4	1	1	—	—
f <sub>3</sub>	5	11	61	87	68	30	10	9	3	1	—	—	—	—	—	—	

*Astragalus* — lateral length (AGL1) \*

A	50	54	58	62	66	70	74	78	82	86	90	94	98
f <sub>1</sub>	—	—	—	—	—	1	6	24	21	15	12	4	1
f <sub>2</sub>	—	—	—	—	—	37	30	7	—	—	—	—	—
f <sub>3</sub>	24	114	96	65	16	11	4	1	2	—	—	—	—

*Astragalus* — breadth of the distal end (ABD) \*

A	26	30	34	38	42	46	50	54	58	62	66	—	—
f <sub>1</sub>	—	—	—	—	—	7	20	14	13	9	1	—	—
f <sub>2</sub>	—	—	—	—	—	33	22	8	1	—	—	—	—
f <sub>3</sub>	6	28	117	71	21	6	1	—	—	—	—	—	—

*Calcaneus* — greatest length (CGL)

A	92	100	108	116	124	132	140	148	156	164	172	180	—
f <sub>1</sub>	—	—	—	—	—	—	1	4	18	8	10	1	—
f <sub>2</sub>	—	—	—	—	—	23	27	8	4	—	—	—	—
f <sub>3</sub>	4	6	21	30	11	6	1	1	1	—	—	—	—

Metatarsal bone III-IV — greatest length (MtGL) \*

A	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
f <sub>1</sub>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
f <sub>2</sub>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
f <sub>3</sub>	2	11	30	138	78	27	17	8	6	2	1	—	—	—	—

Table 2. concluded.

		Metatarsal bone III+IV — breadth of the proximal end (MtBP) *																
A	30	34	38	42	46	50	54	58	62	66	70	74	78	82	86			
f <sub>1</sub>	—	—	—	—	1	1	3	12	10	4	5	2	—	1	1			
f <sub>2</sub>	—	—	3	5	25	35	17	13	2	—	—	—	—	—	—			
f <sub>3</sub>	3	63	186	134	58	24	13	2	—	—	—	—	—	—	—			
		Metatarsal bone III+IV — breadth of the diaphysis (MtSD) *																
A	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	
f <sub>1</sub>	—	—	—	—	—	—	—	2	—	2	6	—	4	3	—	—	1	
f <sub>2</sub>	—	—	—	—	2	8	9	3	5	4	1	—	—	—	—	—	—	
f <sub>3</sub>	3	58	113	79	99	31	15	15	5	1	2	1	—	—	—	—	—	
		Metatarsal bone III+IV — breadth of the distal end (MtBD) *																
A	34	38	42	46	50	54	58	62	66	70	74	78	82					
f <sub>1</sub>	—	—	—	—	—	—	1	3	7	9	8	6	1					
f <sub>2</sub>	—	—	3	3	10	37	20	7	17	3	—	—	—					
f <sub>3</sub>	1	20	163	95	97	49	27	16	4	1	—	—	—					
		Proximal phalanx — greatest length (PhGL) *																
A	40	44	48	52	56	60	64	68	72	76	80	84	88					
f <sub>1</sub>	—	—	—	—	—	1	1	28	40	30	16	6	1					
f <sub>2</sub>	—	1	2	3	13	55	51	34	7	2	—	—	—					
f <sub>3</sub>	3	30	189	240	120	59	19	9	4	5	—	—	—					
		Proximal phalanx — breadth of the proximal end (PLIBP) *																
A	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48		
f <sub>1</sub>	—	—	—	—	—	—	—	—	6	29	30	31	28	16	8	5	3	
f <sub>2</sub>	—	—	3	1	3	19	33	38	20	16	11	5	1	1	1	—	—	—
f <sub>3</sub>	2	24	81	139	112	102	56	50	21	5	2	2	—	1	1	2	—	—



Proximal phalanx — breadth of the distal end (PhIBD) \*

A	18	20	22	24	26	28	30	32	34	36	38	40	42	44	56	60
f <sub>1</sub>	—	—	—	—	—	2	3	13	26	19	10	18	5	2	—	—
f <sub>2</sub>	—	2	2	3	22	45	46	24	12	6	4	—	—	—	—	—
f <sub>3</sub>	6	51	82	128	60	65	41	18	4	2	1	1	—	—	—	—
Middle phalanx — greatest length (PhIIGL) *																
A	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58
f <sub>1</sub>	—	—	—	—	—	—	1	1	1	1	1	1	1	1	1	1
f <sub>2</sub>	—	1	1	4	3	13	21	38	31	22	17	12	—	—	—	—
f <sub>3</sub>	1	13	30	37	26	36	21	10	4	4	3	—	—	—	—	—

Middle phalanx — breadth of the proximal end (PhIIBP) \*

A	20	22	24	26	28	30	32	34	36	38	40	42	44	46	—	—
f <sub>1</sub>	—	—	1	—	2	1	1	17	19	14	23	13	5	2	—	—
f <sub>2</sub>	—	—	—	—	10	19	43	23	11	8	3	—	—	—	—	—
f <sub>3</sub>	1	4	14	18	21	7	11	3	2	—	—	—	—	—	—	—

Middle phalanx — breadth of the distal end (PHIIBD) \*

A	16	18	20	22	24	26	28	30	32	34	36	38	40	42	—	—
f <sub>1</sub>	—	—	—	1	—	—	1	1	20	19	11	11	7	1	—	—
f <sub>2</sub>	—	—	7	7	18	15	25	11	3	2	3	1	2	—	—	—
f <sub>3</sub>	1	8	9	19	19	10	2	3	—	1	—	—	—	—	—	—

Distal phalanx — diagonal length of the sole (PhIIDLS) \*

A	50	54	58	62	66	70	74	78	82	86	90	94	98	102	—	—
f <sub>1</sub>	—	—	—	7	—	—	—	9	16	9	6	6	6	5	—	—
f <sub>2</sub>	—	—	1	7	14	18	8	10	7	10	1	—	—	—	—	—
f <sub>3</sub>	10	15	19	18	13	13	7	3	2	1	1	—	—	—	—	—

Taking for a standard the maximum variation of the various skeletal dimensions (from the minimum value in domestic cattle to maximum value in the aurochs) a point scale was constructed according to the principles described earlier for domestic cattle (Lasota-Moskalewska, 1984) and for the domestic pig and the wild pig (Lasota-Moskalewska, Kobryń & Świeżyński, 1987). Using the point scores the variation of the measured osteometric features were compared between the aurochs and domestic cattle, and the variation of the values of the individual features.

#### 4. RESULTS

Of 25 analysed features 14 had one-peak curves of frequency distribution (Table 2). High values were found for the aurochs bones, some of the bones of domestic cattle, and sporadically for the bones of cattle from later eras. Low values were found only in the last group. The dimensions of the bones of these three groups overlapped and it was not possible to separate them.

The values of the remaining 11 osteometric features had multipeak

Table 3

Ranges of dimensions of aurochs and cattle bones in mm (*Btp* — *Bos taurus primigenius*, *Btb* — *Bos taurus brachyceros*; symbols of dimensions as in Table 2).

Symbol	Aurochs			Domestic cattle		
	♂♂+♀♀	♂♂	♀♀	<i>Btp</i> + <i>Btb</i>	<i>Btp</i>	<i>Btb</i>
HBC	410—180	410—270	280—180	230—90	—	—
SLC	86—58	86—70	74—58	70—26	—	—
HBD	120—90	—	—	102—52	102—76	86—52
RBP	122—90	122—108	108—90	96—56	96—72	80—56
RBD	112—80	—	—	92—44	92—62	72—44
McGL	260—222	—	—	220—148	—	—
McBP	90—66	90—78	80—66	70—36	—	—
McSD	56—42	—	—	48—18	—	—
McBD	88—64	88—76	78—64	72—38	—	—
TBD	105—66	105—76	80—66	76—40	—	—
CGL	180—150	180—166	170—150	156—92	156—122	134—92

curves of frequency distribution. Such distributions made it possible to read the ranges of the variability of the dimensions characteristic for the aurochs and for domestic cattle (Table 3). For certain features it was also possible to differentiate between bull and cow aurochs bones, and in the case of domestic cattle it was possible to differentiate between *Bos taurus primigenius* and *Bos taurus brachyceros* bones.

Of the mentioned 11 features, only the length of the longest metacarpal bone III+IV (McGL) had different variability ranges in the aurochs and in domestic cattle. The ranges of variability of other di-

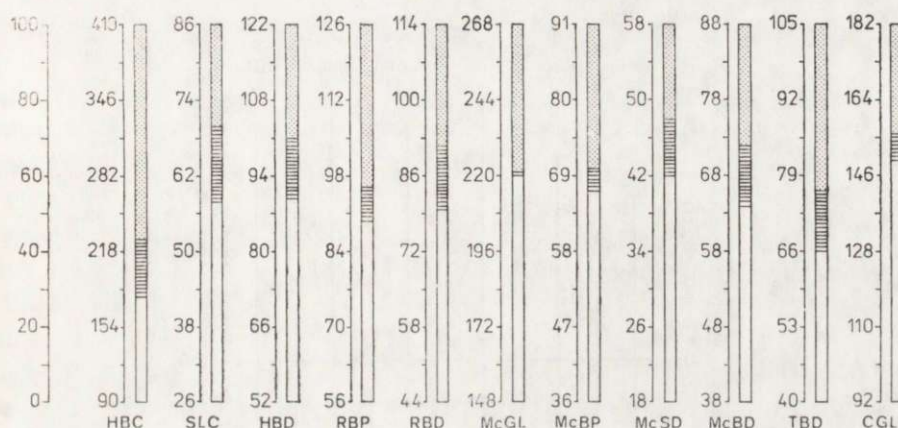


Fig. 1. Points (0—100) and the corresponding absolute values of the dimensions of aurochs bones (dotted field), domestic cattle (empty field) and transient form (dashed field). Symbols of dimensions as in Table 2.

mensions overlapped in part forming overlapping fields common for both these forms, as shown in the point scale (Fig. 1). Then they were read as the numbers of points for making possible their comparison. Most of the presented osteometric features had a greater variation in domestic cattle than in aurochs (Fig. 2). The width of the proximal end of the radial bone (RBP) and the breadth of the distal end of the tibia (TBD) had nearly identical variation. Only the circumference of the horncore (HBC) had a much greater variation in the aurochs than in domestic cattle.

## 5. DISCUSSION

Most of the analysed osteometric features had one-peak curves of distribution. This is evidence that the aurochs in Europe and Asia and the domestic cattle living at the same time in Europe formed one population. Furthermore, it confirms the existence of an evolutionary continuity between the wild and the domesticated form of *Bos primigenius* in Europe, and of local domestication of cattle. The same conclusions were reached by Bökönyi (1962) studying the possibility of differentiating the bones of the aurochs and domestic cattle in Hungary. This author used another method, placing the dimensions in correlation plots determined by the breadth and depth of the ends of long bones.

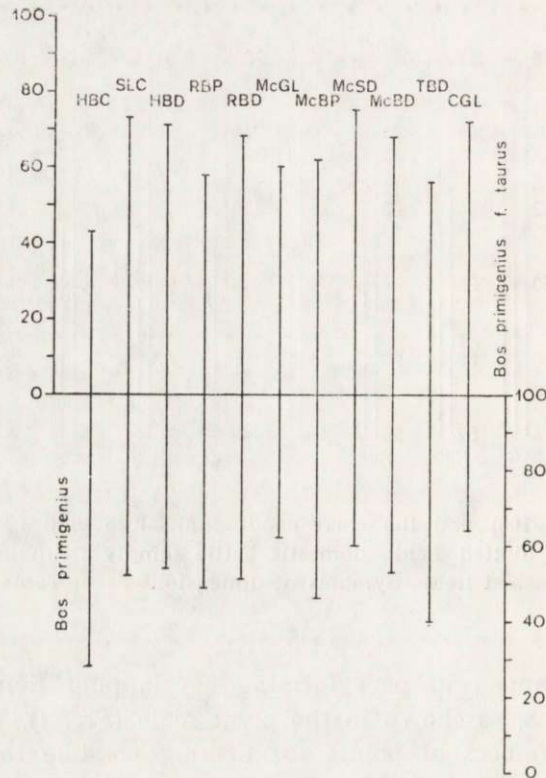


Fig. 2. Comparison of the variation of the values of osteometric features expressed in points for the aurochs (under the line) and domestic cattle (above the line). Symbols of dimensions as in Table 2.

A considerable amount of excavation finds of aurochs and domestic cattle bones was collected by Driesch and Boessneck (1976) in Portugal. They also tried to differentiate the bones of these animal forms by correlation plots, and found that the greatest difference between the aurochs and domestic cattle was in the proportions of the astragalus. In our material the curves of the distribution of the numbers of absolute astragalus dimensions had one peak, and thus it was not possible to differentiate the aurochs from domestic cattle by this method.

The analysis of 11 osteometric features in our study made possible the determination of the variability range of the dimensions characteristic for the aurochs and domestic cattle. A continuity was found in the changes of the dimensions of aurochs bones into the dimensions of cattle bones. This continuity was expressed in various degrees: from continuity of the range of dimensions to fairly considerable overlapping. This finding does not contradict the above hypothesis on the homogeneity

of the population, but only indicates that in the regions of the finds intermediate forms existed between the wild and the domesticated form of the species. It may also indicate various reactions of the osteometric features to changed conditions resulting from domestication. Certain features responded to this change so rapidly and so intensively that the resulting differences could be noted in bone dimensions.

Bökönyi (1982) believed that detectable differences in the descriptive features, such as the thickness of compact bone, the development of the sites of muscle insertions *etc*, became manifest even earlier than the differences of bone dimensions, already in the 1st — 2nd generation of domesticated animals. This could be confirmed, however, only in experimental studies. In the case of domestic cattle derived from the aurochs we shall never know with which generation after domestication we are dealing. It is known that the microscopic structure of the long bones shows no domestication effects even in primitive neolithic age cattle (Lasota-Moskalewska, 1979) although the descriptive macroscopic features are already changed. It seems that the descriptive features change earliest, while changes of the osteometric and micromorphological features follow. Estimation of the number of generations would be, however, too far fetched, especially since domestication was not a one-step process but was certainly preceded by a preliminary period in which herds of wild animals were at first controlled, and then were tamed.

Another fact worth stressing is that the ranges of the variability of bone dimensions characteristic of the aurochs and domestic cattle observed in our material were nearly identical with those obtained by Bökönyi (1962) in Hungary. Similarly nearly identical ranges of astragalus length in the Portuguese excavations were reported by Driesch and Boessneck (1976). Considering this similarity and the fact that the results of the present study were based on a very large and differentiated material it may be accepted that the critical values proposed by us are universal in character for the identification of excavated bones of both these forms in Europe and Asia. These values may be useful also in studies on the geographical and evolutionary variability of aurochs skeletons which will be published in near future.

Ekman (1972) described a female aurochs in southern Sweden and stressed that she was one of the smallest animals of this species found in Sweden and Denmark. We supposed that the dimensions of the skeleton of this animal would define the lower range of variability typical of the aurochs. However, the dimensions of this skeleton were slightly greater than the lower range established by us for this form. This might be due to the fact that this find was dated back to the early postglacial era. The bones analysed by us belonged to the animals

living in various time periods, including the Middle Ages, when aurochs were already nearing extinction, and their skeletal dimensions might be smaller than in the older epochs. Changes in the size of the aurochs in the postglacial times has not yet been explained. The critical values proposed by us should be regarded thus as extremal, independent of the chronology, the region of finds and sex.

The variation of the dimensions of the features studied in the aurochs expressed in relative numbers (point scores) was essentially similar for the studied bones, with the only exception of the variation of horncore circumference values which had a greater range. This may indicate a greater individual variability of this feature in relation to sex, area of occurrence, and time when the studied aurochs were living. It seems that under the living conditions of the wild forms this dimension was more labile than other osteometric features. A reverse situation was observed in domestic cattle where the range of the variability of horncore circumference was smallest. It is worth stressing that all other studied features in domestic cattle had a greater variability range than in the aurochs and only sporadically they were equal. It may be said that the variability of skeletal dimensions after domestication was greater than in the wild animals, probably due to the fact that the living conditions of the domesticated animals were much more diverse than before domestication, since they depended on ecological factors as well as on the knowledge of the breeders and their ability to provide the animals with relatively optimal conditions. These factors could produce considerable phenotypic differences. On the other hand, animal breeding might have led to genotype changes reflected in the development of diverse morphological features, such as *e.g. Bos taurus primigenius* and *Bos taurus brachyceros*. The increase of the interindividual variability in the domesticated animals is regarded as one of the characteristic features of domestication (Fock, 1966; Bogolubski, 1968; Bökönyi, 1972).

Finally, it is worth explaining what is the relation of the point scale constructed for the dimensions of domestic cattle bones in the Polish territory (Lasota-Moskalewska, 1984) to the point scale of bone dimensions of domestic cattle and aurochs presented in this study. The ranges of the dimension values of domestic cattle in both scales were slightly different, which was due to the difference in the materials used for constructed both scales: one scale comprised only cattle from the Polish territories, the other scale had a much greater geographical range. The chronology of our finds also differed. In the former case it ranged from the neolithic Funnel Beaker Culture to the beginning of the iron age. In the latter case it was extended, on the one side by adding the neolithic Linear Pottery Culture, and on the other side, by the addition

of the Middle Ages. In the first material all dimensions of the domestic cattle, including extreme values, were considered. In the second material the ranges were established on the basis of equalized frequency of distribution curves which automatically eliminated the single extreme values. It is worth stressing that the aims of both scales were different. In the first case the aim was a direct comparison of different dimensions of cattle bones, the second scale had to facilitate differentiation of cattle bones from aurochs bones on the basis of osteometric features.

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### NIEKTÓRE RÓŻNICE OSTEOMETRYCZNE POMIĘDZY TUREM I BYDŁEM DOMOWYM

#### Streszczenie

Istnieją duże trudności w odróżnianiu kości tura od bydła domowego, zwłaszcza we wczesnych stadiach udomowienia. Podjęto więc próbę wyodrębnienia takich elementów szkieletu, na podstawie których byłaby możliwa identyfikacja oparta na cechach metrycznych. Wykorzystano dostępne dane osteometryczne tura z czasów prahistorycznych i historycznych zebrane z terenów Polski oraz innych krajów europejskich i azjatyckich (Tabela 1). Z tych samych terenów i okresów uwzględniono także dane osteometryczne bydła domowego. Badaniami objęto 25 cech metrycznych 12 kości. Wszystkie wymiary ułożono w analityczne szeregi rozdzielcze (Tabela 2), z których wykreślono procentowe krzywe rozkładów frekwencji. Większość (14) krzywych miała jeden wierzchołek, co uniemożliwiało rozdzielenie wymiarów kości tura i bydła domowego. Świadczyło także o jedności populacji obu tych form gatunku. Na podstawie pozostałych 11 krzywych wielowierzchołkowych odczytano zakresy zmienności charakterystyczne dla tura i bydła domowego. Wartości krytyczne zaznaczono na skali punktowej skonstruowanej dla wymiarów kości tura i bydła domowego łącznie (Ryc. 1). Wymiary częściowo zachodziły na siebie tworząc pola wspólne o różnej wielkości. W obrębie tych pól nie ma możliwości precyzyjnej identyfikacji kości na podstawie wymiaru. W przypadku kilku krzywych wielowierzchołkowych udało się odczytać zakresy zmienności wymiarów charakterystyczne dla samców i samic tura a także dla dwóch form bydła domowego: *Bos taurus primigenius* i *Bos taurus brachyceros* (Tabela 3). Ze skali punktowej odczytano rozrzuty wymiarów cech, oszacowane liczbami punktów i porównano je między sobą oraz pomiędzy turem i bydłem domowym (Ryc. 2). Po szczególne cechy u tura miały podobne rozrzuty, oprócz znacznie większego dla obwodu mózdzienia. U bydła domowego rozrzuty były także podobne a tylko rozrzut obwodu mózdzienia był mniejszy. Wymiary kości tura cechował mniejszy a co najwyżej równy zakres zmienności niż u bydła domowego. Jedynie obwód mózdzienia tura miał większy zakres zmienności w porównaniu z bydłem domowym. Z obserwacji tych wynika, że bydło żyjące w udomowieniu ma większą zmienność międzysobniczą niż w stanie dzikim. Regule tej nie podlegają mózdzienie, które wykazują odwrotną zależność.