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MORPHOMETRY OF INTESTINES OF THE RACCOON DOG (*NYCTEREUTES PROCYONOIDES*)

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Abstract. Analyses were conducted on 20 adult females of the raccoon dog (*Nyctereutes procyonoides*). The measurements allowed to calculate the mean length of the raccoon dog, amounting to 247.09 cm, and the mean total length of intestines, amounting to 207.83 cm. Mean values of individual intestinal fragments, i.e. duodenum, jejunum, ileum, caecum and colon with rectum amounted to 31.17, 170.00, 6.65, 8.04 and 31.22 cm, respectively. Jejunum had the highest (68.80%) and ileum the lowest (2.70%) share in the total length of intestines. The highest correlation coefficient characterized the relationship between total length of intestines and total length of small intestine.

Key words: raccoon dog, intestine, morphometry

INTRODUCTION

Length of alimentary system is related to the type food in a given species. The relationship is particularly evident in the case of intestines which represent the longest part of alimentary system and play an important role in food digestion. Differences in length of intestines in certain species of animals were presented by [Nickel et al. 1987] Raccoon dog, representing *Carnivora*, belongs to animals carrying a short alimentary tract.

Raccoon dogs are not only free-living animals, they are also breeding animals supplying breeders with precious raw materials, including leather. In breeding their natural diet has been altered, which might have affected measurable characters of their alimentary tract. Change in diet in time represents one of factors affecting morphological variability of alimentary tract [Miller 1976, Paulus 1982, Drobney 1984, Kehoe et al. 1988]. Reports of the literature contain facts on various variables which affect length of intestines in animals, including, for example, intestinal bacteria, intestinal parasites, rhythm of alimentation, amount of consumed food, diet composition and seasonal alterations in diet [Moss 1972, 1974, Pendergast and Boag 1973]. Moreover, Świątek [2007] reported on the effect of the hibernation fast on morphometric traits of alimentary system.

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The aim of the studies involved metric analysis of selected traits in alimentary system and body of female raccoon dogs originating from breeding farms and a comparison of the traits with those obtained by other authors. The results provide grounds for further investigations on alimentary system in free-living raccoon dogs, since the animals are unique members of *Canidae* family which are characterized by winter hibernation interrupted by short periods of activity [Czyżewska 1973]. The assumptions has been put forward that the condition undergoes modification during breeding of the animals, which may affect measurable traits of their intestines.

MATERIAL AND METHODS

Analyses were conducted on 20 adult females of the raccoon dog (*Nyctereutes procyonoides*), coming from a breeding farm. Using a measuring tape body length was measured from the upper edge of the nasolabial plate to the base of the tail. Next the intestine was dissected from the visceral cavity, it was separated from the mesentery, straightened and the length was measured of the duodenum, jejunum, ileum, caecum and the colon together with the rectum.

Based on these measurements the arithmetic mean (\bar{X}), minimum (Min) and maximum (Max) values, standard deviation (SD) were calculated.

In the study the ratio of the length of the small intestine to that of the large intestine was calculated. Moreover, percentage proportions were also determined for individual parts of the small intestine to its entire length, as well as the percentage ratio of the caecum and the colon with the rectum to the entire length of the large intestine. Moreover, the ratio of the length of the trunk of the raccoon dog to the length of the intestine was also calculated.

On the basis of statistical analysis correlation coefficients were calculated between length of individual intestinal segments and the total length of raccoon dog body.

RESULTS AND DISCUSSION

It was shown in conducted studies that the females of raccoon dogs, had intestines with length exceeding almost four times their body length, as illustrated by a ratio of 1:3.86. Brudnicki et al. [2001] demonstrated that the ratio of total body length to the total length of intestines in female raccoon dogs amounted to 1:5.1, while in female foxes the ratio amounted to 1:3.52 [Brudnicki et al. 2008].

The ratio of body length to the length of the small intestine was 1:3.24, while to that of the large intestine it was 1:0.6. According to Brudnicki et al. [2001] the proportions in female raccoon dogs amounted to 1:4.3 and 1:0.8, respectively.

The small intestine was over 5 times longer than the large intestine. The ratio of absolute length of large intestine to the absolute length of the small intestine was 1:5.29.

The mean length of the small intestine was 207.83 cm, which constituted as much as 84.11% total length of intestines in the raccoon dog. The mean length of the large intestine was 39.26 cm. The large intestine accounted for 15.89% total length of intestines. For comparison, the mean length of small intestine in female raccoon dogs in measurements of Brudnicki et al. [2001] amounted to 219 cm. In female foxes small intestine

was shorter and manifested intestinal length of 182.9 cm. Large intestine in female raccoon dogs manifested the mean length of 39.00 cm [Brudnicki et al. 2001] and in female foxes the mean length of 35.5 cm [Brudnicki et al. 2008].

The available literature reports indicate that diet exerts an effect on alimentary system modifying its structure and function. Effects of changes in diet of animals were observed monitoring its macro- and microscopic traits [Sitna 1965, Cymborowski 1968, Radzikowska 1969, 1981, Doroczyńska et al. 1971]. The type of alimentation affects the entire body and even survival of animals [Doroczyńska et al. 1971]. The food administered to animals in breeding conditions differs from the type of food which raccoon dogs consume in natural conditions, which has to modify traits of their body. Thus, the obtained results provide grounds for further investigations.

Data characterizing measurable characteristics of the raccoon dog are presented in Table 1.

Table 1. Intestines length in the raccoon dog
Tabela 1. Długość jelit u jenota (cm)

	X	Min.	Max.	SD
Body length Długość ciała	64.00	60.00	67.00	2.00
Absolute intestines length Całkowita długość jelit	247.09	209.00	283.00	20.50
Absolute small intestine length Całkowita długość jelita cienkiego	207.83	172.00	243.00	21.06
Duodenum length Długość dwunastnicy	31.17	25.00	40.00	4.28
Jejunum length Długość jelita czczego	170.00	137.00	199.00	19.26
Ileum length Długość jelita biodrowego	6.65	5.00	9.00	1.15
Absolute large intestine length Całkowita długość jelita grubego	39.26	32.00	44.00	3.24
Caecum length Długość jelita ślepego	8.04	6.00	10.00	1.07
Colon and rectum length Długość okrężnicy i prostnicy	31.22	24.00	36.00	3.09

The percentage proportions for individual parts of the small and large intestine, i.e. duodenum, jejunum, ileum, caecum and the colon together with the rectum to the absolute length of intestines are presented in Table 2. The highest share in intestinal length is shown by jejunum, the lowest one by ileum.

Table 2. Percentage of respective intestines sections to the intestines as a whole
Tabela 2. Udział procentowy poszczególnych odcinków jelit w jelicie jako całości (%)

Absolute intestines length Całkowita długość jelit	Duodenum length Długość dwunastnicy	Jejunum length Długość jelita czczego	Ileum length Długość jelita biodrowego	Caecum length Długość jelita ślepego	Colon and rectum length Długość okrężnicy i prostnicy
100	12.61	68.80	2.70	3.25	12.64

Based on metric analysis of individual parts of the small intestine it was found that the percentage proportions of the duodenum, jejunum and ileum in the entire small intestine were 15, 81.80 and 3.20%, respectively (Tab. 3). The mean percentage proportions of the caecum in the total length of the large intestine was 20.48 %, while that of colon together with the rectum was as much as 79.52 % (Tab. 4).

Table 3. Percentage of respective intestines sections to the small intestine as a whole
Tabela 3. Udział procentowy poszczególnych odcinków w jelicie cienkim jako całości (%)

Small intestine Jelito cienkie	Duodenum Dwunastnica	Jejunum Jelito czcze	Ileum Jelito biodrowe
100	15.00	81.80	3.20

Table 4. Percentage of respective intestine sections to the large intestine as a whole
Tabela 4. Udział procentowy poszczególnych odcinków w jelicie grubym jako całości (%)

Large intestineum Jelito grube	Caecum Jelito ślepe	Colon and rectum Okreźnica i prośtnica
100	20.48	79.52

In the studies the correlations were also established between individual intestinal fragments and the total body length. The4 obtained results are illustrated in Table 5. The most significant correlation was demonstrated between the total intestinal length and total length of small intestine, similarly to the results obtained by Brudnicki et al. [2008]. A high correlation was demonstrated between the total length of small intestine and the length of jejunum and between the total length of intestines and the length of jejunum.

Table 5. Correlation coefficient of body length and intestines length
Tabela 5. Współczynnik korelacji długości ciała i jelit

	BL	AIL	ASIL	DL	JL	IL	ALIL	CL	CRL
BL	0,00	0,22	0,26	0,55	0,29	0,65	0,73	0,92	0,69
AIL	0,26	0,00	0,00	0,06	0,00	0,03	0,66	0,44	0,85
ASIL	0,25	0,99	0,00	0,05	0,00	0,04	0,26	0,33	0,40
DL	0,13	0,40	0,42	0,00	0,35	0,01	0,38	0,58	0,47
JL	0,23	0,96	0,97	0,21	0,00	0,15	0,30	0,31	0,46
IL	0,10	0,45	0,44	0,50	0,31	0,00	0,96	0,28	0,67
ALIL	0,08	-0,10	-0,25	-0,19	-0,23	-0,01	0,00	0,16	0,00
CL	-0,02	-0,17	-0,21	-0,12	-0,22	0,24	0,30	0,00	0,89
CRL	0,09	-0,04	-0,19	-0,16	-0,16	-0,09	0,94	-0,03	0,00

BL – Body length – Długość ciała.

AIL – Absolute intestine length – Całkowita długość jelit.

ASIL – Absolute small intestine length – Całkowita długość jelita cienkiego.

DL – Duodenum length – Długość dwunastnicy.

JL – Jejunum length – Długość jelita czczego.

IL – Ileum length – Długość jelita biodrowego.

ALIL – Absolute large intestine length – Całkowita długość jelita grubego.

CL – Cecum length – Długość jelita ślepego.

CRL – Colon and rectum length – Długość okrężnicy i prośtnicy.

CONCLUSIONS

1. In females of breeding female raccoon dogs the body length ranged between 60 and 67 cm.
2. Intestines of a raccoon dog belonging to *Canidae* family reach on the average the length of 247.09 cm.
3. The most extensive correlation was noted between the total length of intestines and the total length of small intestine.

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MORFOMETRIA JELIT JENOTA (*NYCTEREUTES PROCYONOIDES*)

Streszczenie. Badania prowadzono na 23 samicach jenota (*Nyctereutes procyonoides*). Na podstawie otrzymanych pomiarów obliczono średnią długość ciała jenota, która wynosiła 247.09 cm oraz średnią całkowitą długość jelit, która wynosiła 207.83 cm. Średnie wartości poszczególnych odcinków jelit, tj. dwunastnicy, jelita czczego, jelita biodrowego, jelita ślepego oraz okrężnicy wraz z prostnicą odpowiadają kolejno wartościom: 31.17; 170.00; 6.65; 8.04 i 31.22 cm. Największy procentowy udział w całkowitej długości jelit miało jelito czcze (68.80%), a najmniejszy – jelito biodrowe (2.70%). Największy współczynnik korelacji wykazano pomiędzy całkowitą długością jelit i całkowitą długością jelita cienkiego.

Słowa kluczowe: jenot, jelita, morfometria

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SEXUAL DIMORPHISM IN HUCUL HORSE BASED ON THE SELECTED MORPHOMETRIC TRAITS

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Abstract. The aim of this study was to evaluate sexual dimorphism of the selected morphometric traits in Hucul horses. Examinations have comprised 276 horses (96 stallions, 140 mares, 40 geldings) of both sexes aged between 6 days and 28 years. Each of them has been subjected to 37 body measurements. The acquired values have been put to statistical analysis. Sexual dimorphism of the examined individuals is barely noticeable. However, it is detectable at the age of 1 year and it occurs with various intensity for respective metric traits. Highly considerable differentiation has been observed in the body build between adult males and females of the examined horse breed. This variation concerns the height at withers, the height at the sacrum, the length of the arm, the length of the forearm and the metacarpus's circumference.

Key words: Hucul horse, morphometry, sexual dimorphism

INTRODUCTION

The term "sexual dimorphism" refers to morphological variations occurring between males and females in some species of animals [Söder 2007]. Consequently, an attempt has been made to evaluate it based on the selected morphometric traits in Hucul horses. In the publications there isn't a lot of information about sexual dimorphism occurring in the horses. Because of this we attempted its description based on the selected morphometric traits in Hucul horses. They are one of the oldest husbandry breeds in Poland and represent a variety of a mountain horse [Cywińska et al. 2000, Budzyńska et al. 2003, Komosa and Purzyc 2009, Purzyc 2006].

MATERIALS AND METHODS

Examinations have been conducted on 276 Hucul horses (96 stallions, 140 mares, 40 geldings) aged between 6 days and 28 years old which have been categorized into 6 groups (Tab. 1). Admittedly they represent almost the whole period of postnatal development occurring in horses of this breed. By use of the zoometric stick, the zoometric compass and the measuring tape the following measurements have been carried out on each individual: 1. the head's length – measured from the nuchal crest to the most prominent point of the nostrils region; 2. the head's zygomatic width – the distance from the exterior surface of the zygomatic process of the frontal bone on the right side to the exterior surface of this process on the opposite side; 3. the facial width of the head – the distance from the end of the right facial crest to the end of the left facial crest; 4. the distance from the end of the facial crest – measured to the nasoincisive notch; 5. the distance from the notch for facial vessels to the angle of mouth; 6. the distance from the temporomandibular joint to the notch for facial vessels; 7. the distance between the bilateral rami of mandible at the widest point; 8. the distance from the middle of the height of the right mandible's ramus to the middle of the height of the left mandible's ramus; 9. the neck's lateral length – measured from the base of the auricula to the middle of the length of the spina of scapulae; 10. the neck's dorsal length – the distance from the basihyoid body to the cranial thoracic aperture; 11. the height at withers – measured from the base, perpendicularly to the highest point of the intrascapular region; 12. the height at the sacrum – measured from the base perpendicularly to the highest point of the sacral region; 13. the thorax's circumference – measured along the line linking the scapula's caudal angle with the olecranal tuberosity of the ulna; 14. the trunk's oblique length (smaller) – measured from the greater tubercle of the humerus to the coxal tuber of the ilium; 15. the trunk's oblique length (greater) – measured from the greater tubercle of the humerus to the ischial tuberosity; 16. the chest's width – measured from the greater tubercle of the humerus on the right and left side; 17. the pelvis's width – measured from the right coxal tuber of the ilium to the left coxal tuber of the ilium; 18. the pelvis's length – measured from the coxal tuber of the ilium to the ischial tuberosity; 19. the distance from the spinous process of the 1st sacral vertebrae to the ischial tuberosity; 20. the distance from the coxal tuber of the ilium to the base of patella; 21. the scapula's length (including withers) – measured from the greater tubercle of the humerus, through the spina of scapulae, to the highest point of the intrascapular region; 22. the arm's length – measured from the greater tubercle of the humerus to the tuber of the olecranal tuberosity of the ulna; 23. the forearm's length – measured from the olecranal tuberosity of the ulna to the wrist joint; 24. the forearm's circumference – measured in the middle of its length; 25. the hand's height – measured from the base to accessory carpal bone; 26. the metacarpal's circumference – measured at 1/3 of the height of the upper metacarpal bone, at its thinnest point; 27. the metacarpus's length – measured from the tuberosity of the third metacarpal bone to the metacarpophalangeal joint; 28. the length of the proximal and middle phalanx of the thoracic limb – measured from the metacarpophalangeal joint to the coronary border of the capsule of the hoof; 29. the height of the capsule of the hoof of the thoracic limb – measured, on the lateral surface, from the coronary border of the capsule of the hoof to its solear border; 30. the thigh's length – measured from the greater trochanter of the femur bone to the base of patella; 31. the distance from the base of patella to the lateral malleolus; 32. the leg's

circumference – measured in the middle of its length; 33. the foot's height – measured from the base to the lateral malleolus; 34. the metatarsus's circumference – measured at 1/3 of the height of the upper metatarsal bone, at the thinnest point; 35. the metatarsus's length – measured from the tuberosity of the third metatarsal to the metatarsophalangeal joint; 36. the length of the proximal and middle phalanx of the pelvic limb – measured from the metatarsophalangeal joint to the coronary border of the capsule of the hoof; 37. the height of the capsule of the hoof of the pelvic limb – measured, on the lateral surface, from the coronary border of the capsule of the hoof to its solear border (Fig. 1–3).

Table 1. Material subjected to investigations with division into sex and age groups

Tabela 1. Materiał poddany badaniom z podziałem na płeć i grupy wiekowe

Age group Grupa wiekowa	I Sucklings Oseki	II Weanlings Odsadki	III Yearlings Roczniki	IV Two-year- -old Dwulatki	V Three- -year-old Trzylatki	VI Adults Dorośle
Age in weeks → Wiek w tygodniach →	1–27	28–53	54–105	106–157	158–209	from 210
Sex ↓ Płeć ↓						
Stallions Ogierzy	20	23	21	10	10	12
Mares Klaczki	21	15	21	20	11	52
Geldings Wałachy	0	0	0	19	10	11

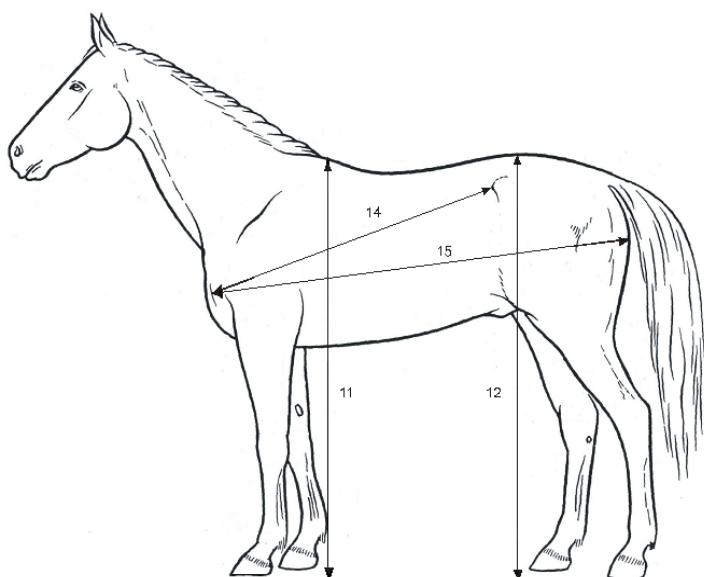


Fig. 1. Parameters measured by the use of the zoometric stick

Rys. 1. Rodzaje pomiarów dokonanych za pomocą łaski zoometrycznej

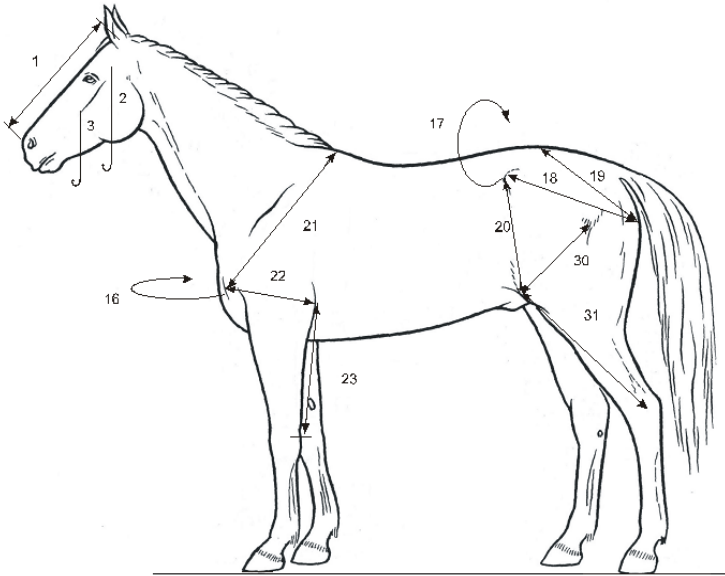


Fig. 2. Parameters measured by the use of the zoometric compass

Rys. 2. Rodzaje pomiarów dokonanych za pomocą cyrkla zoometrycznego

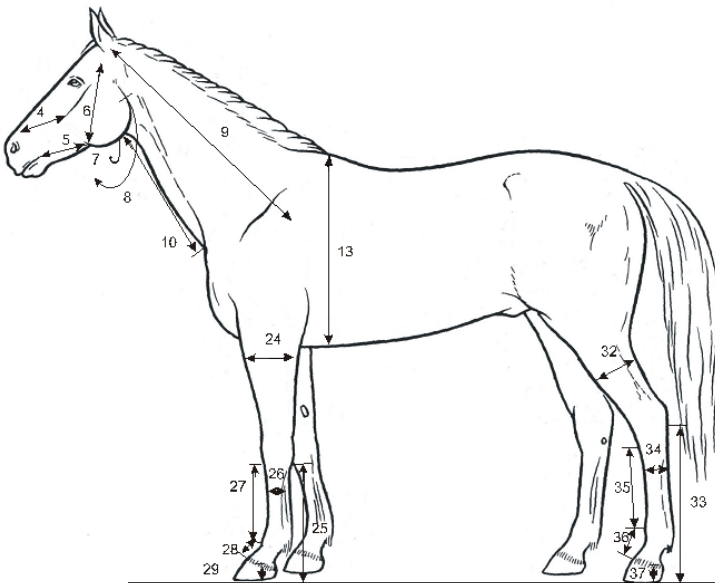


Fig. 3. Parameters measured by the use of the measuring tape

Rys. 3. Rodzaje pomiarów dokonanych za pomocą taśmy mierniczej

The acquired values have been put to statistical analysis by calculating for each parameter the level of significance between mean values in respective groups between stallions, mares and geldings assuming the value for $P < 0.01$ and $P < 0.05$.

Statistical analyses have been conducted by the use of Bartlett test, Kruskal–Wallis test and *t*-Student test.

RESULTS

Examinations of sexual dimorphism which have been carried out on Hucul horses have exhibited that the analyzed morphometric traits do not reveal any variations between stallions and mares in the group of the youngest horses. Variation in the horse's body description between the representatives of both sexes has been detected since about the first year of their life (Tab. 2). Sexual dimorphism has also been observed in the next stages of postnatal development of the examined individuals. However, it has not concerned different parameters and it has been observed with various intensity (Tab. 2). Namely, between adult males and females it has evidently appeared in such parameters as: the height at withers (11), the height at the sacrum (12), the arm's length (22), the forearm's length (23) as well as the metacarpus's circumference (26). Significant variations have been also indicated between adult stallions and mares in the neck's dorsal length (10), the thorax's circumference (13), the chest's width (16), the pelvis's width (17), the distance from the spinous process of the 1st sacral vertebrae to the ischial tuberosity (19), the height of the capsule of the hoof of the thoracic limb – measured on the lateral surface, from the coronary border of the capsule of the hoof to its solear border (29) and the height of the capsule of the hoof of the pelvic limb (37). Variation has also been stated between average stallions and geldings from the oldest group for such traits as the pelvis's width (17) and the leg's circumference (32). Significant difference has been observed between mean values in mares and geldings in the height of the capsule of the hoof of the thoracic limb – measured on the lateral surface, from the coronary border of the capsule of the hoof to its solear border (29) and the height of the capsule of the hoof of the pelvic limb – measured on the lateral surface, from the coronary border of the capsule of the hoof to its solear border (37) (Tab. 2).

Table 2. Statistical differences between mean values of parameters in individual age groups for considered sexes. (*) significant differences where $P < 0.05$, (**) significant differences where $P < 0.01$; s – stallions, m – mares, g – geldings

Tabela 2. Różnice statystyczne pomiędzy średnimi wartościami badanych cech w poszczególnych grupach wiekowych dla uwzględnionych płci. (*) istotne różnice przy $P < 0.05$, (**) istotne różnice przy $P < 0.01$; s – ogiery, m – klacze, g – wałachy

Number of parameters Numer parametru	Age group and sex Grupa wiekowa i płeć											
	I		II		III		IV		V		VI	
	s-m	s-m	s-m	s-m	s-g	m-g	s-m	s-g	m-g	s-m	s-g	m-g
1.	-	-	-	-	-	-	-	-	-	-	-	-
2.	-	-	-	-	-	-	-	-	-	-	-	-
3.	-	-	-	-	-	-	-	-	-	-	-	-
4.	-	*	-	-	-	-	-	-	-	-	-	-
5.	-	-	**	-	-	-	-	-	-	-	-	-
6.	-	*	-	-	-	-	-	-	-	-	-	-
7.	-	-	**	-	-	-	**	**	-	-	-	-
8.	-	-	-	-	-	*	**	-	*	-	-	-
9.	-	*	-	-	-	-	-	*	-	-	-	-
10.	-	-	-	-	-	*	-	-	-	*	-	-
11.	-	-	-	-	-	-	-	-	-	**	-	-
12.	-	-	-	-	-	-	-	*	-	**	-	-
13.	-	-	-	-	-	-	-	-	-	*	-	-
14.	-	-	*	-	*	-	-	-	-	-	-	-
15.	-	-	-	-	-	-	-	-	-	-	-	-
16.	-	-	-	*	-	-	**	-	*	*	-	-
17.	-	-	-	-	-	-	*	-	*	*	*	-
18.	-	-	-	-	-	-	-	-	-	-	-	-
19.	-	-	-	-	-	-	-	-	-	*	-	-
20.	-	-	-	**	-	-	-	-	-	-	-	-
21.	-	-	-	-	-	-	-	-	-	-	-	-
22.	-	-	-	-	-	-	**	-	*	**	-	-
23.	-	*	-	-	-	-	-	-	-	**	-	-
24.	-	*	-	*	-	-	**	-	-	-	-	-
25.	-	-	-	-	-	-	-	-	-	-	-	-
26.	-	-	-	**	-	**	**	*	-	**	-	-
27.	-	-	*	-	-	-	-	-	-	-	-	-
28.	-	-	-	-	**	*	-	-	-	-	-	-
29.	-	-	-	-	-	-	-	-	-	*	-	*
30.	-	-	*	-	-	*	-	-	-	-	-	-
31.	-	-	-	-	-	-	-	-	-	-	-	-
32.	-	**	-	-	-	-	-	-	-	-	*	-
33.	-	-	-	-	-	-	-	-	-	-	-	-
34.	-	-	-	-	-	-	**	-	-	-	-	-
35.	-	-	*	-	-	-	-	-	-	-	-	-
36.	-	-	-	-	*	-	-	-	-	-	-	-
37.	-	*	-	-	-	-	-	-	-	*	-	*

DISCUSSION

Sexual dimorphism of morphometric traits in the examined horses is barely noticeable. Although this phenomenon has been common for long in this species it has not been measurably determined in Hucul horses. Koch [1954], who can be taken as an example, classifies this species in respect of distinctiveness of metric traits in the horse connected with sexual dimorphism, next to such mammals as guinea pigs, cats and rabbits. Despite that it has been possible to reveal inconsiderable variations between stallions and mares beginning already from about the first year of their life. Namely, these horses do not differ in the first months of their life in respect of body dimensions and proportions. Taking into consideration the foregoing statements it is essential to emphasize that variations between adult males and females of this breed have been distinctly noticed in such parameters as: the height at withers (11), the height at the sacrum (12), the arm's length (22), the forearm's length (23) and the metacarpus's circumference (26).

Examinations concerning sexual dimorphism in Hucul horses have been carried out on such numerous material for the first time. They have confirmed the analyses conducted by Starzewski [1927] who stated that stallions of the Hucul breed have longer limbs than mares, which has also been exhibited in our examinations among adult individuals – the parameter of the arm's length (22) and the forearm's length (23). Furthermore, similarly to Starzewski [1927] it has been stated that the chest's width in adult stallions is greater than in mares, but the pelvis's width (17) is relatively greater in mares. In addition, Starzewski [1927] presents differences between males and females of Hucul horses of the parameters which have not been examined by us. He states that in Hucul horses mares have a greater depth of the thorax in comparison to stallions and the back's length is shorter in stallions, which significantly differentiates horses of the examined breed. The author adds that sexual dimorphism in Hucul horses is distinctly noticeable in the shorter jumping joint in mares and higher in stallions, as well as in females in the greater hind depth, i.e. the fold of flank (the length of the pelvic limb in relation to the height at the sacrum).

CONCLUSIONS

1. Sexual dimorphism of the examined individuals has been barely noticeable but it has been detectable at the age of 1 year and it occurs with various intensity for respective metric traits.

2. Between adult males and females it has evidently appeared in such parameters as: the height at withers, the height at the sacrum, the arm's length, the forearm's length as well as the metacarpus's circumference.

3. Variation has also been stated between average stallions and geldings and mares and geldings from the oldest group for some morphometric traits.

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DYMORFIZM PŁCIOWY KONIA HUCULSKIEGO NA PRZYKŁADZIE WYBRANYCH CECH MORFOMETRYCZNYCH

Streszczenie. Celem niniejszej pracy była ocena dymorfizmu płciowego wybranych cech morfometrycznych koni huculskich. Badaniom poddano 276 osobników (96 ogierów, 140 klaczy i 40 wałachów) w wieku od 6. dnia do 28. roku życia. Na każdym z nich dokonano 37 pomiarów biometrycznych. Uzyskane wartości poddano analizie statystycznej. Dymorfizm płciowy u badanych osobników jest słabo zaznaczony. Jednak daje się go już zauważyć od około 1. roku życia i obserwowany jest w różnym natężeniu dla poszczególnych cech metrycznych. W budowie ciała pomiędzy dorosłymi samcami i samicami omawianej rasy koni zaobserwowano wysoce istotną różnicę dla parametrów takich jak wysokość w kłębie, wysokość w krzyżu, długość ramienia, długość przedramienia oraz obwód śródrcza.

Słowa kluczowe: koń huculski, morfometria, dymorfizm płciowy

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THE EVALUATION OF CHOSEN HUCUL HORSES' MORPHOMETRIC TRAITS WITH THE USE OF POINT METHOD

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Abstract. The aim of the study was to evaluate chosen Hucul horses' morphometric traits with the use of point method exemplified by chosen Hucul horses' morphometric traits. The study has been conducted in 561 Hucul horses of both sexes, which were divided into 6 age groups. Each specimen underwent the measurement of the height at withers, the thorax's circumference, the metacarpus's circumference, the head's length, the neck's lateral length, the height at the sacrum, the trunk's oblique length (greater) and the pelvis's width. The obtained results were applied to statistical analysis, including the calculation of a mean arithmetic value, a minimal value, a maximal value and standard deviation, which served for the construction of an appropriate point scale. At the following stage they enabled us to perform the analysis with the use of non-nominal data represented in points. Within the parameters considered, the homogeneity of investigated material was found, which could indicate stable growth of morphometric traits. However, the tendency of metric traits for homogenous but unstable growth was also observed. Moreover, we have found that point values obtained for three-year-old horses, and to a lesser extent the ones obtained for two-year-old horses, were higher than the values calculated for the individuals qualified for the group of adult horses.

Key words: Hucul horse, morphometry, point method

INTRODUCTION

Hucul horses are horses of a primitive breed found in husbandries among others in Poland, Romania, Slovakia, the Czech Republic, Austria and Ukraine. Horses of this breed are of an inconsiderable height: 135,0 cm – 145,0 cm (stallions) and 132,0 cm – 143,0 cm (mares). Biometric pattern for Hucul horses has been established by Hucul Horses International Federation (HIF) in compliance with the regulations in the European Union [Tomczyk-Wrona 2004]. These horses of versatile usability are characterized by persistence and serenity. Owing to their qualities they are used primarily for

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mountain trips and hypotherapy [Brzeski et al. 1993, Brzeski et al. 1995, Kosiniak-Kamysz et al. 2000, Tomczyk-Wrona 2004]. In this compilation attempts have been made at evaluating morphometric features of Hucul horses with the application of the personal point method on the example of the height at withers, the thorax's circumference, the metacarpus's circumference, the head's length, the lateral neck's length, the height at the sacrum, the trunk's oblique length (greater) as well the pelvis's width. The compilation and application of this method has been used for this kind of research for the first time. Possibly, in the future it will be applied for comparative purposes as well as for the objective presentation of the acquired results.

MATERIALS AND METHODS

561 Hucul horses (191 stallions, 318 mares, 52 geldings) have been included in our study. The horses were divided into 6 groups according to their age (Tab. 1). The youngest specimen subjected to observations was 9 days old and the oldest was 28 years old. This material originated from discriminating breeding as well as from private breeding in Poland. The parameters were measured with the use of the measuring stick, the measuring tape and the measuring compasses.

Table 1. Material subjected to investigations with division into sex and age groups
Tabela 1. Materiał poddany badaniom z podziałem na płeć i grupy wiekowe

Age group Grupa wiekowa	I Sucklings Oseski	II Weanlings Odsadki	III Yearlings Roczniaki	IV Two-year-old Dwulatki	V Three- -year-old Trzylatki	VI Adults Dorosłe
Age in weeks → Wiek w tygodniach →	1–27	28–53	54–105	106–157	158–209	from 210
Sex ↓ Płeć ↓						
Stallions Ogierzy	28	42	47	28	16	30
Mares Klaczce	27	33	50	55	30	123
Geldings Wałachy	–	–	–	23	11	18

The observations were as follows: 1. the height at withers – measured from the base, perpendicularly to the highest point of the intrascapular region (A); 2. the thorax's circumference – measured along the line linking the scapula's caudal angle with the olecranal tuberosity of the ulna (B); 3. the metacarpus's circumference – measured at 1/3 of the height of the upper metacarpal bone, at its thinnest point (C); 4. the head's length – measured from the nuchal crest to the most prominent point of the nostrils region (D); 5. the neck's lateral length – measured from the base of the auricula to the middle of the length of the spina of scapulae (E); 6. the height at the sacrum – measured from the base perpendicularly to the highest point of the sacral region (F); 7. the trunk's oblique length (greater) – measured from the greater tubercle of the humerus to the ischial tuberosity (G); 8. the pelvis's width – measured from the right coxal tuber of the ilium to the left coxal tuber of the ilium (H) – (Tab. 2).

Table 2. Statistical analysis of Hucul horses' morphometric traits (A-H); cm. Bold type – minimum and maximum values in each morphometric traits aside from age and sex
 Tabela 2. Analiza statystyczna cech morfometrycznych koni huculskich (A-H); cm. Czcionka pogrubiona – minimalne i maksymalne wartości niektórych cech morfometrycznych niezależnie od wieku i płci

Age Age Grupa wiekowa	Sex Płeć																	
	Stallions Ogierzy								Mares Klaczce								Geldings Walachy	
	n	min.	max.	\bar{x}	sd	n	min.	max.	\bar{x}	sd	n	min.	max.	\bar{x}	sd			
(cm)																		
I	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
The height at withers (A) Wysokość w kłębie (A)																		
I	28	92.0	118.0	102.2	7.0	27	90.0	118.0	104.4	7.3	–	–	–	–	–	–		
II	42	104.0	131.0	118.8	4.4	33	112.0	132.0	117.9	4.2	–	–	–	–	–	–		
III	47	119.0	139.0	128.9	3.9	50	120.0	136.0	128.7	3.6	–	–	–	–	–	–		
IV	28	129.0	142.0	134.9	3.7	55	124.0	144.0	134.6	4.2	23	123.0	143.0	134.8	4.3	–		
V	16	133.0	145.0	138.6	3.6	30	130.0	146.0	137.6	3.3	11	135.0	146.0	138.1	3.1	–		
VI	30	135.0	144.0	139.4	2.7	123	128.0	146.0	137.1	3.6	18	127.5	146.0	138.8	4.8	–		
The thorax's circumference (B) Obwód klatki piersiowej (B)																		
I	28	76.0	128.0	100.5	14.7	27	79.0	138.0	105.4	16.6	–	–	–	–	–	–		
II	42	120.0	165.0	136.0	8.1	33	120.0	164.0	136.0	8.9	–	–	–	–	–	–		
III	47	143.0	177.0	159.9	8.4	50	141.0	169.0	154.9	7.9	–	–	–	–	–	–		
IV	28	152.0	184.0	169.0	6.9	55	150.0	188.0	169.0	8.3	23	153.0	180.0	164.0	6.3	–		
V	16	163.0	189.0	174.6	5.9	30	159.0	204.0	177.6	11.1	11	163.0	188.0	171.9	7.1	–		
VI	30	154.0	192.0	172.6	9.0	123	160.0	202.0	180.6	9.9	18	148.0	184.0	172.4	10.3	–		
The metacarpus's circumference (C) Obwód śródreża (C)																		
I	28	11.0	16.0	12.8	1.3	27	10.8	15.0	12.9	1.3	–	–	–	–	–	–		
II	42	14.0	18.0	16.2	0.9	33	14.5	19.0	16.0	0.9	–	–	–	–	–	–		
III	47	16.0	20.5	18.0	0.9	50	16.0	19.5	17.6	0.7	–	–	–	–	–	–		
IV	28	18.0	21.0	18.8	0.8	55	17.0	21.0	18.4	0.8	23	17.0	20.5	18.8	0.9	–		
V	16	18.5	21.0	19.6	0.6	30	16.5	20.5	18.3	0.9	11	17.5	20.0	18.9	0.7	–		
VI	30	17.5	21.0	19.3	0.8	123	16.5	23.0	18.6	0.9	18	17.0	21.0	19.1	1.0	–		

Table 2. cont.
Tabela 2. cd.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	The head's length (D) Długość głowy (D)															
I	28	28.0	37.0	33.1	2.5	27	29.0	36.0	32.7	2.2	-	-	-	-	-	-
II	42	39.0	49.0	43.6	2.6	33	39.0	48.0	43.1	2.3	-	-	-	-	-	-
III	47	40.0	52.0	48.9	2.0	50	42.0	52.0	47.7	2.1	-	-	-	-	-	-
IV	28	47.0	53.0	49.9	1.4	55	46.0	53.0	49.4	1.7	23	47.0	54.0	49.7	2.0	2.0
V	16	47.0	55.0	51.1	2.0	30	47.0	54.0	50.1	1.8	11	50.0	55.0	51.6	1.5	1.5
VI	30	48.0	56.0	51.7	2.3	123	40.0	55.0	51.4	2.3	18	49.0	55.0	51.7	1.6	1.6
	The neck's lateral length (E) Długość boczna szyi (E)															
I	28	27.0	48.0	38.0	6.1	27	31.0	48.0	39.2	5.8	-	-	-	-	-	-
II	42	47.0	57.0	52.6	2.4	33	47.0	56.0	50.7	2.7	-	-	-	-	-	-
III	47	51.0	62.0	55.1	3.1	50	50.0	67.0	56.3	3.9	-	-	-	-	-	-
IV	28	59.0	67.0	61.8	2.4	55	53.0	71.0	62.2	3.5	23	59.0	65.0	61.3	1.8	1.8
V	16	60.0	71.0	64.6	2.9	30	60.0	72.0	64.5	2.6	11	61.0	66.0	63.4	1.6	1.6
VI	30	60.0	77.0	66.2	4.1	123	58.0	72.0	65.0	2.4	18	61.0	72.0	64.5	2.7	2.7
	The height at the sacrum (F) Wysokość w krzyżu (F)															
I	28	93.0	122.0	104.4	8.1	27	90.0	120.0	106.2	7.6	-	-	-	-	-	-
II	42	106.0	133.5	121.1	4.8	33	114.0	132.5	120.5	4.2	-	-	-	-	-	-
III	47	121.0	140.0	132.4	4.0	50	122.0	139.0	131.7	3.5	-	-	-	-	-	-
IV	28	131.0	145.0	137.5	3.4	55	128.0	147.0	137.4	3.9	23	126.0	147.0	137.0	4.5	4.5
V	16	136.0	148.0	141.0	3.2	30	133.0	148.0	139.3	3.3	11	136.0	147.0	139.8	2.9	2.9
VI	30	133.0	147.0	139.8	3.6	123	131.0	147.0	138.3	3.6	18	132.5	147.0	139.5	4.2	4.2

Table 2. cont.
Tabela 2. cd.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	The trunk's oblique length (greater) (G) Długość skośna tułowia (dłuższa) (G)															
I	28	61.0	115.0	84.4	14.2	27	68.0	123.0	89.0	15.0	-	-	-	-	-	-
II	42	104.0	130.0	116.6	6.6	33	105.0	135.0	115.7	5.7	-	-	-	-	-	-
III	47	115.0	144.0	131.5	5.6	50	122.0	141.0	131.4	5.3	-	-	-	-	-	-
IV	28	131.0	147.0	139.8	3.9	55	125.0	152.0	139.3	5.0	23	124.0	150.0	138.7	5.8	
V	16	136.0	151.0	143.4	4.2	30	132.0	153.0	142.6	5.2	11	136.0	153.0	142.9	5.7	
VI	30	137.0	153.0	145.3	4.6	123	133.0	156.0	143.7	5.3	18	130.0	154.0	142.3	6.4	
	The pelvis's width (H) Szerokość miednicy (H)															
I	28	18.0	34.0	24.5	4.7	27	19.0	34.0	25.3	4.8	-	-	-	-	-	-
II	42	28.0	40.0	34.9	2.6	33	30.0	40.0	34.7	2.2	-	-	-	-	-	-
III	47	36.0	49.0	42.4	2.3	50	35.0	47.0	41.8	2.5	-	-	-	-	-	-
IV	28	42.0	48.0	45.1	1.6	55	39.0	52.0	46.0	2.7	23	42.0	48.0	46.0	1.5	
V	16	45.0	49.0	47.3	1.4	30	46.0	53.0	49.3	1.7	11	45.0	49.0	47.2	1.4	
VI	30	40.0	50.0	46.7	2.1	123	44.0	54.0	49.2	2.2	18	46.0	52.0	48.7	1.5	

Morphological evaluation with the use of the point method was carried out in order to create the conditions of better comparability [Lasota-Moskalewska 1997, Purzyc 2006]. It consisted of converting each nominated measurement to points which were non-nominated values and as a result were comparable to each other. It was assumed that the minimal and maximal value of a given parameter in the whole examined population would match the value ranging from 0 to 100. This led to the creation of the point scale and it enabled me to mark the mean measurements of stallions, mares and geldings from each age group on it (Fig. 1). In the further stage the dispersion of values on the point scale was marked in order to determine the kind of the graph characterized by the examined parameter (Fig. 2).

For statistical analysis we used the Bartlett's test, the Kruskal-Wallis's test, the Student's *t*-test and software for calculations and statistical graphics called "R".

RESULTS

On the basis of the applied point method the mean values of the examined features were transferred to an appropriate scale. Thus, the non-nominated values were acquired and it was possible to compare them in reference with the 8 examined parameters.

1. The height at withers (A) ranged between 90.0 cm and 146.0 cm in these horses. It corresponded to the number of points 21.8 – 88.2 (stallions), 25.8 – 85.0 (mares) and 80.1 – 87.2 (geldings) (Tab. 2, Fig. 1). The arrangement of the values of this trait on the point scale constituted an oblique graph with a predominance of large dimensions (Fig. 2).

2. The thorax's circumference (B) ranged between 76.0 cm and 204.0 cm in these horses. The lowest and highest values in points were 19.1 – 77.1 (stallions), 23.0 – 81.7 (mares) and 68.7 – 75.3 (geldings) (Tab. 2, Fig. 1). The arrangement of the trait values constituted an oblique graph with a predominance of large dimensions (Fig. 2).

3. The metacarpus's circumference (C) ranged between 10.8 cm and 23.0 cm in the representatives of this horse breed. It corresponded to the number value in points: 16.9 – 72.8 (stallions), 17.9 – 64.5 (mares) and 66.1 – 68.6 (geldings) (Tab. 2, Fig. 1). The arrangement of the trait values constituted an oblique graphs with a predominance of large dimensions (Fig. 2).

4. The head's length (D) ranged between the values of 28.0 cm and 56.0 cm in horses of this breed. The mean dispersion of the measurements of the examined horses given in points ranged from 18.3 to 84.8 (stallions), from 16.9 to 83.6 (mares) and from 77.6 to 84.9 (geldings) (Tab. 2, Fig. 1). The distribution of the values of this feature on the point scale created an oblique graph with the predominance of great values (Fig. 2).

5. The neck's lateral length (E) ranged between the values such as: 27.0 cm and 77.0 cm in the examined horses corresponding to the value from 22.0 to 78.4 (stallions), from 24.4 to 76.1 (mares) and from 68.7 to 75.1 (geldings) (Tab. 2, Fig. 1). The distribution of the value of this feature on the point scale created an oblique graph with the predominance of great values (Fig. 2).

6. The height at the sacrum (F) ranged between the values of 90.0 cm and 148.0 cm in the examined breed of the animals. The dispersion of the measurements in points ranged from 24.9 to 87.9 (stallions), from 28.0 to 85.0 (mares) and from 81.0 to 85.8 (geldings) (Tab. 2, Fig. 1). The distribution of the parameters of the examined features on the point scale created an oblique graph with the predominance of great values (Fig. 2).

7. The trunk's oblique length (greater) (G) ranged between 61.0 cm and 156.0 cm in the horses of this breed. It corresponded to the value in points from 24.7 to 88.7 (stallions), from 29.4 to 87.1 (mares) and from 81.7 to 86.2 (geldings) (Tab. 2, Fig. 1). The distribution of the value of the examined feature on the point scale created an oblique graph with the predominance of great measurements (Fig. 2).

8. The pelvis's width (H) ranged between the values of 18.0 cm and 54.0 cm in the representatives of this breed. The dispersion of the measurements in points ranged from 18.1 to 81.4 (stallions), from 20.3 to 86.9 (mares) and from 77.9 to 85.3 (geldings) (Tab. 2, Fig. 1). The distribution of the parameters of the examined feature was created by an oblique graph with the predominance of great values (Fig. 2).

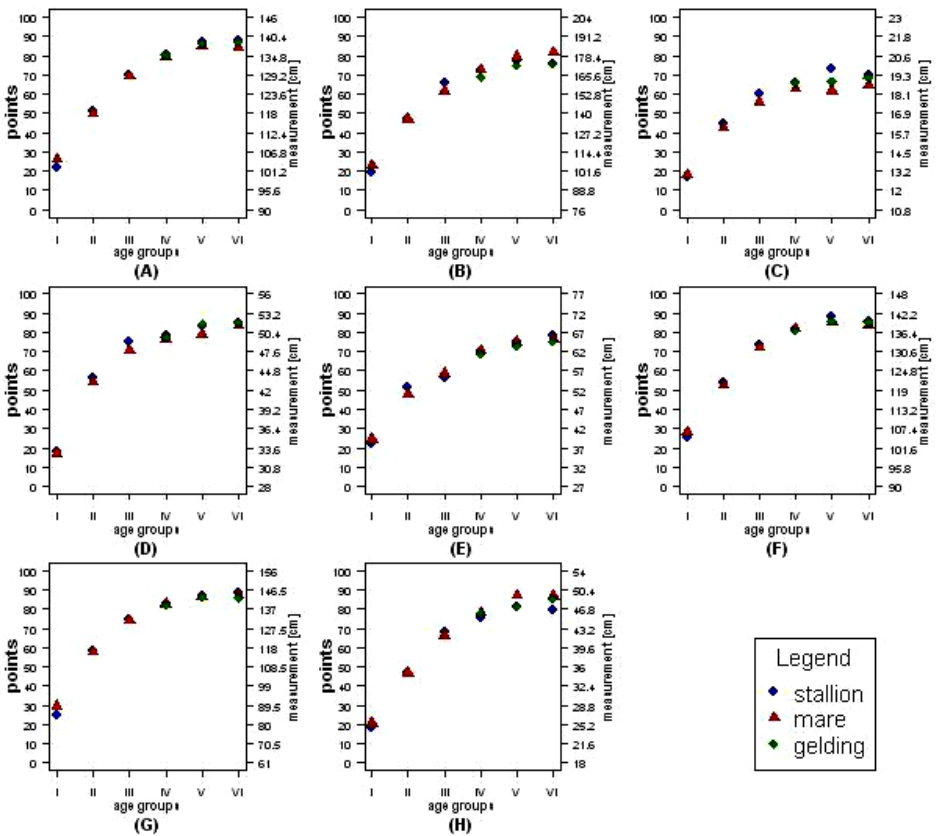


Fig. 1. Mean values of chosen Hucul horses' morphometric traits in age groups and corresponding number of points. The height at withers (A), the thorax's circumference (B), the metacarpus's circumference (C), the head's length (D), the neck's lateral length (E), the height at the sacrum (F), the trunk's oblique length (greater) (G) and the pelvis's width (H)

Rys. 1. Średnie wartości wybranych cech morfometrycznych koni huculskich w poszczególnych grupach wiekowych i odpowiadająca im liczba punktów. Wysokość w kłębie (A), obwód klatki piersiowej (B), obwód śródreżca (C), długość głowy (D), długość boczna szyi (E), wysokość w krzyżu (F), długość skośna ciała (większa) (G) i szerokość miednicy (H)

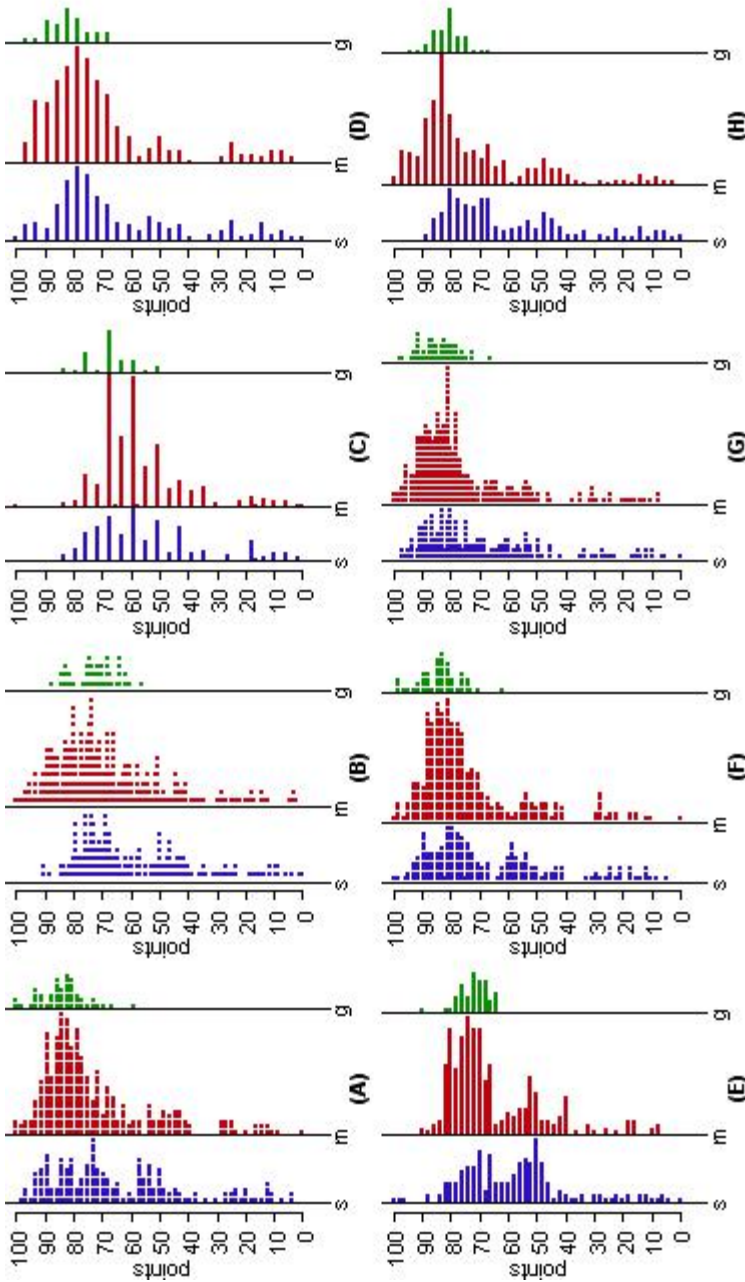


Fig. 2. Spread of values of chosen Hucul horses' morphometric traits expressed in points. The height at withers (A), the thorax's circumference (B), the metacarpus's circumference (C) and the pelvis's width (H); s – stallions, m – mares, g – geldings

Rys. 2. Rozrzut wartości cech morfometrycznych koni huculskich wyrażony w punktach. Wysokość w kłębie (A), obwód klatki piersiowej (B), obwód śródreżca (C), długość głowy (D), długość boczna szyi (E), wysokość w krzyżu (F), długość skośna ciała (większa) (G) i szerokość miednicy (H); s – ogiery, m – klacze, g – wałachy

DISCUSSION

The evaluation with the use of the point scale has been carried out with the purpose of comparing the examined morphological features [Lasota-Moskalewska 1997, Purzyc 2006, 2009]. The analysis used for this work has provided an answer to the question, whether or not the population of the examined horses is homogenous. Homogeneity of the examined material has been exhibited among the studied parameters, which has revealed a steady increase in the morphological features. However, the tendency of the metric features to a homogenous, but unstable increase has been observed. This has been exhibited by the layout of points with the predominance of the great values on the point scale. It can be a result of the elimination measures applied in the stage of the creation of a new morphotype [Lasota-Moskalewska 1997].

Furthermore, the conducted research has revealed that the acquired point values of the three-year-olds, and to a smaller degree of the two-year-olds, were higher than the examined individuals ranked in the group of adult horses. The analogical situation, in reference to the mean values of the height at withers, the thorax's circumference and the metacarpus's circumference has already been observed earlier [Brzeski and Kulisa 1993, Kario and Jackowski 1991, Purzyc 2006, 2009]. Presumably, it is related to an alteration in the kind of usability of this breed, as well as to the mode of breeding and nutrition [Purzyc 2006, 2009]. Most probably, it can be a result of the selection of materials for study as well as of the earlier activities performed with the purpose of increasing the measurements of the Hucul horse in the state husbandries [Cywiński 1958, Hrobni 1958, 1959, 1968, Głębocki 1962, Skuciński 1966].

CONCLUSIONS

1. Within the parameters considered, the homogeneity of investigated material was found, which could indicate stable growth of morphometric traits.
2. It was observed the tendency of metric traits for homogenous but unstable growth.
3. The study has showed that point values obtained for three-year-old horses, and to a lesser extent the ones obtained for two-year-old horses, were higher than the values calculated for the individuals qualified for the group of adult horses.

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OCENA NIEKTÓRYCH CECH MORFOMETRYCZNYCH KONIA HUCULSKIEGO Z ZASTOSOWANIEM METODY PUNKTOWEJ

Streszczenie. Celem niniejszej pracy była ocena cech morfometrycznych konia huculskiego z zastosowaniem metody punktowej na przykładzie wysokości w kłębie, obwodu klatki piersiowej i obwodu śródreżca.

Badania przeprowadzono na 561 koniach huculskich obu płci, które zakwalifikowano do 6 grup wiekowych. Na każdym osobniku dokonano pomiaru wysokości w kłębie, obwodu klatki piersiowej, obwodu śródreżca, długości głowy, długości bocznej szyi, wysokości w krzyżu, skośnej długości ciała (większej) oraz szerokości miednicy. Uzyskane wartości poddano analizie statystycznej, obliczając średnią arytmetyczną, minimum, maksimum i odchylenie standardowe, które posłużyły do skonstruowania odpowiedniej skali punktowej. Na dalszym etapie umożliwiły one przeprowadzenie analizy z zastosowaniem danych niemianowanych wyrażonych w punktach. Wśród rozpatrywanych parametrów stwierdzono jednorodność badanego materiału, co wskazywałoby na ustabilizowany wzrost cech morfometrycznych. Jednak zauważa się również tendencję cech metrycznych do jednolitego, lecz niestabilizowanego wzrostu. Ponadto wykazano, że uzyskane wartości punktowe trzylatków, a w mniejszym stopniu dwulatków, były wyższe od badanych osobników zakwalifikowanych do grupy koni dorosłych.

Słowa kluczowe: koń huculski, morfometria, metoda punktowa

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SPIS TREŚCI CONTENTS

Mirosława Kulawik, Hieronim Frąckowiak, Hubert Jakubowski	
Morphometry of intestines of the raccoon dog (<i>Nyctereutes procyonoides</i>)	3
Morfometria jelit jenota (<i>Nyctereutes procyonoides</i>)	
Halina Purzyc	
Sexual dimorphism in Hucul horse based on the selected morphometric traits.....	9
Dymorfizm płciowy konia huculskiego na przykładzie wybranych cech morfometrycznych	
Halina Purzyc, Jacek Bojarski	
The evaluation of chosen Hucul horses' morphometric traits with the use of point method	17
Ocena niektórych cech morfometrycznych konia huculskiego z zastosowaniem metody punktowej	