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STUDIES OF INTERDEPENDENCES BETWEEN CHARACTERISTICS IN RACCOON DOG (*Nyctereutes procyonoides* Gray)

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ABSTRACT

The measurements of craniometric characteristics in raccoon dog (*Nyctereutes procyonoides* Gray) involved the use of 110 skulls, including 52 male and 58 female skulls from the region of Pomorze and Kujawy. For each skull 24 measurements were taken to facilitate defining craniometric characteristics, their proportions and correlations. The present research shows clearly a shortening of the viscerocranium, as compared with other Canidae, similar to the length of the neurocranium part. Investigating the cranial variation in the skull parameters in raccoon dog, it was found that the highest coefficient of variation in males concerns the length of the frontal bone in the sagittal plane /Br-N/ and the height of the occiput /Op-O/, while in females – the placement of the eye sockets /Ect-Ect/. The calculations made show the range if variation, including the cerebral skull, especially the cerebral skull height /Sph-Br/ and the height of the occiput /Op-O/. A high value of the coefficient of variation was observed also for the cranial cavity volume.In ten measurements there were observed significant differences between the sexes.

Key words: raccoon dog, skull, craniometric measurements, correlation

INTRODUCTION

The skeleton and teeth are a permanent source of numerous species-specific morphometric characteristics; in that respect it is the skull which shows the most potential for successful research. Craniometric characteristics and their variation present morphological characteristics of the animal species researched, especially the effect of the brain on the skull shape. The research also points to the effect of the muscle activity of the jaw and the kind of the food uptaken on the development of the skull.

The study of the skull parameters concerned both the variation in the skull age and the craniometric characteristics of respective species. Many authors demonstrate various relationships between skull parameters and other morphological characters.

The papers on the research into craniometric characteristics in Carnivora include, e.g., reports by Andersen and Wilg [1] and Wig and Andersen [14] on the skull in Eurasian lynx (*Lynx lynx*) and by Buchałczyk and Ruprecht [3], discussing the morphological variation in the skull in least weasel (*Mustela nivalis* L) Schmidt [13], European polecat (*Mustela putorias*) Churchela [5], Jakubowski et al. [8] on American mink (Mustela vison Schreber, 1777) and the reports by Huson and Pager [7] and by Brudnicki et al. [2] on the variation in the skull and its proportions in red fox (*Vulpes vulpes* L.).

For the sake of comparison, the report by Reig, Ruprecht [12] is an interesting paper; it breaks down the craniometric characteristics in the skulls in beech marten and pine marten. The analysis of non-metrical characteristics in connection with the skull anatomy in wolf has been taken up by Buchalczyk et al. [4] and the relationship between the sizes of teeth and the condylobasal length of the skull length in European badger – by Lups and Roper [10].

The applicable literature offers little information on the skull anatomy in raccoon dog [6]. According to the author [6], raccoon dog demonstrates a specific anatomy of the jawbone, especially massive in the posterior region and extremely delicate in the anterior part.

The contemporary raccoon dog is much smaller than the fossil forms, which, according to Martin [11], points to a radical change in nutrition. It is omnivorous, with animal food prevailing. One shall note Nyctereutes-characteristic changes in the structure of teeth located on carnassial teeth. The changes, according to Martin [11], concern the function of crushing and not just simple food friction. One shall conclude that that specialization can remain connected to the plant food uptake.

MATERIAL AND METHOD

The measurements of craniometric characteristics in raccoon dog (*Nyctereutes procyonoides* Gray) were taken for the material which involved 110 skulls; 52 male and 58 female skulls. The material was obtained by hunting in the Kujawy and Pomorze Province. The research involved the use of the skulls of adult individuals (older than one year). The skulls were macerated by cooking and then the muscles were mechanically removed. To clean and to bleach them completely, they were immersed into 10% solution of hydrogen peroxide.

For each skull craniometric points were marked and the following measurements were taken: /B-P/ – skull base length, /Op-P/ – the maximum skull length, /B-St/ – length of neurocranium skull base, /St-P/ – viscerocranium base length, /Zl-Op/ – placement of the eye sockets in the skull, /Zl-P/ – side length of viscerocranium, /Br-N/ – length of the frontal bone in sagittal plane, /Mol-P/ – molar teeth placement, /Pm-Pd/ – length of the dental line from P_1 to M_2, /Zy-Zy/ – the zygomatic width of the skull, /Ect-Ect/ – eye sockets setting, /Eu-Eu/ – the highest neurocranium skull width, /Ot-Ot/ – occipital bone width, /St-N/ – viscerocranium height, /Op-O/ – occiput height, /B-Br/ – neurocranium skull height, /CCV/ – cranial cavity volume, /id-goc/ – maximum jaw length, /DRL/ – length of the dental line of the jaw, /gov-Cr/ – jaw branch height, /gn-id/ – jaw juncture height. The measurement methods are given in phot. 1,2,3,4.

The cranial cavity volume was measured following the Duerst method which involves weighing the amount of pellet fitting into the cranial cavity and the comparison of the result with the weight of 100 cm^3 of the same type of pellet.

There were also calculated, using the method of the analysis of variance in the non-ortogonal design with the T-Student test, the differences in the values of respective measurements of the skull between females and males, as well as the matrix of correlations which occur between all the measurements made.

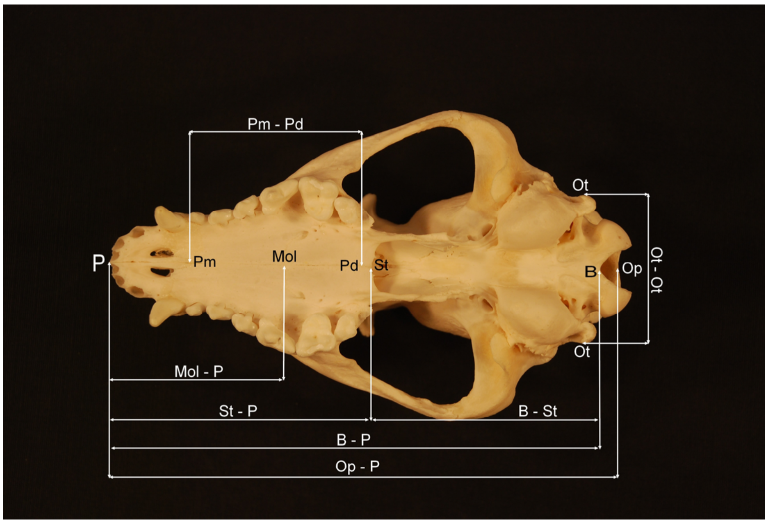

Fig. 1. The skull of the fox (abdominal site): B-P skull base length, Op-P – the maximum skull length, Pm-Pd – length of the dental line from P_1 toM_2, Mol-P – molar teeth placement, B-St – length of neurocranium skull base, Ot-Ot occipital bone width, St-P – length of base of viscerocranium

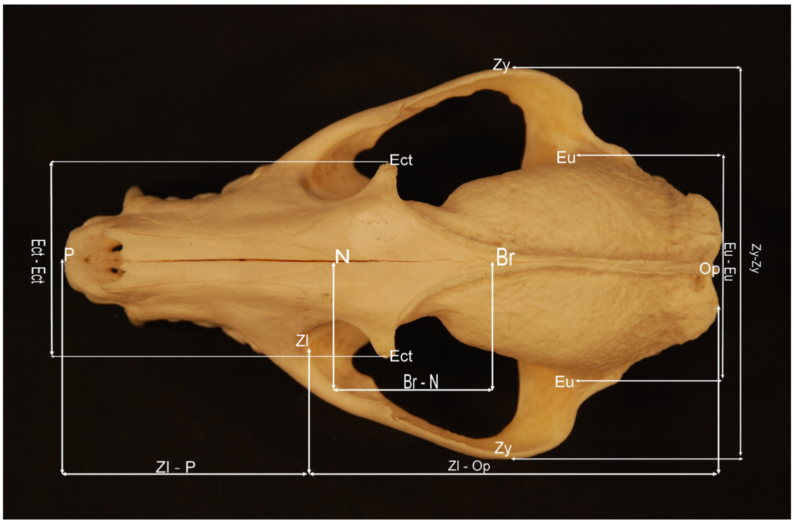

Fig. 2. The skull of the fox (dorsal site): Zl-P – side length of viscerocranium, Zl-Op –placement of an eye socket in the skull, Br-N – length of the frontal bone in sagittal plane, Zy-Zy –the zygomatic width of the skull, Eu-Eu – the neurocranium skull width, Ect-Ect – eye sockets setting

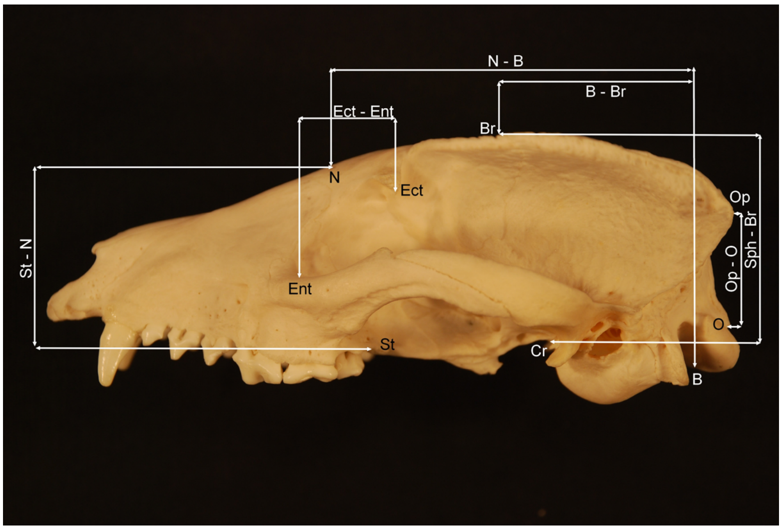

Fig. 3. The skull of the fox(side): Op-O – occiput height, St-N – the height of viscerocranium, B-Br – the height of the cerebral skull

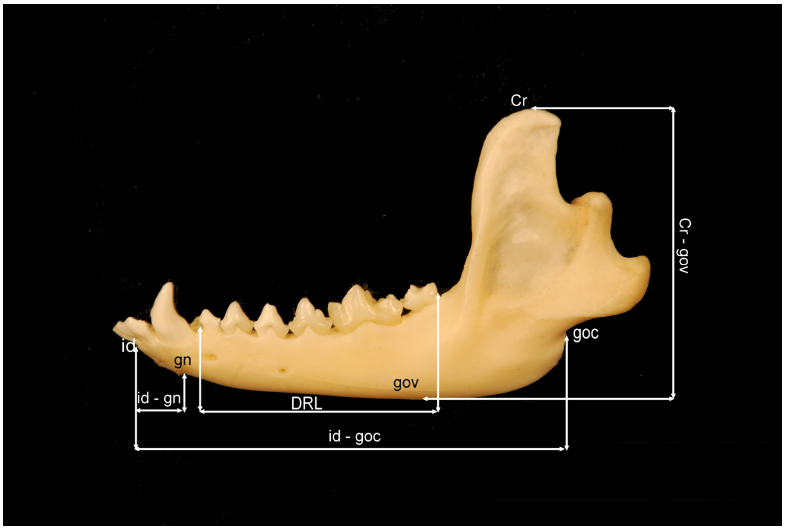

Fig. 4. Measurements of the mandible in raccoon dog id-gn – the height if the jaw's juncture, id-goc-the maximum length of the jaw, gov-Cr – the height of the jaw's branch. DRL – length of the dental line of the jaw

RESULTS

Craniometric measurements of the individuals researched, showing the skull size and proportions as well as the significance of differences between males and females in raccoon dog, are given in Table 1.

Tabela.1. Statistical characteristics of cranial measurements in raccoon dog in the males group

Measure	Sex	n	Interval [cm]	$\bar{x}$ [cm]	S_x	V_x [%]	t_F	S_d
B-P	♂	52	10.8–12.1	11.24	0.29	2.60	1.2	0.722
	♀	58	10.7–11.9	11.16	0.27	2.45		
Op-p	♂	52	11 .2–12.7	11.83	0.32	2.75	0.85	0.640
	♀	58	11.2–12.6	11.75	0.31	2.63		
B-St	♂	52	4.8–5.7	5.32	0,24	4,61	1,04	0,686
	♀	58	4,7–5,7	5,26	0,22	4,27		
St-P	♂	52	5,6–6,4	5,92	0,17	2,87	0,14	0,289
	♀	58	5,2–6,2	5,90	0,21	3,54		
Zl-Op	♂	52	7,1–8,2	7,65	0,25	3,25	0,48	0,508
	♀	58	7,1–8,1	7,60	0,25	3,29		
Zl-P	♂	52	4,5–5,5	4,98	0,24	4,90	27,30	1,000**
	♀	58	4,3–5,0	4,70	0,15	3,27		
Br-N	♂	52	2,8–3,7	3,13	0,24	7,65	7,11	0,990*
	♀	58	2,9–3,8	3,32	0,28	8,49		
Mol-P	♂	52	4,1–4,7	4,38	0,17	3,89	22,90	1,000**
	♀	58	3,9–4,4	4,19	0,12	2,80		
Pm-Pd	♂	52	3,5–4,0	3,75	0,15	4,08	0,48	0,509
	♀	58	3.6–4.0	3.77	0.08	2.25		
Zy-Zy	♂	52	6.4–7.7	7.15	0.30	4.23	5.69	0.979*
	♀	58	6.6–7,4	6.98	0.21	3.05		
Ect-Ect	♂	52	3.0–4.0	3.49	0.23	6.65	0.03	0.144
	♀	58	3.0–4.0	3.47	0.27	7.90		
eu-eu	♂	52	3.8–4.2	4.00	0.12	3.04	1.48	0.771
	♀	58	3.7–4.3	3.96	0.13	3.33		
Ot-Ot	♂	52	3.8–4.6	4.15	0.21	4.97	0.08	0.229
	♀	58	3.7–4.5	4.13	0.19	4.54		
St-N	♂	52	3.2–3.9	3.55	0.16	4.67	7.02	0.989*
	♀	58	3.1–3.7	3.44	0.14	3.99		
Sph-Br	♂	52	3.5–4.1	3.75	0.14	3.79	2.42	0.874*
	♀	58	3.4–4.0	3.69	0.14	3.92		
Op-O	♂	52	2.1–3.4	2.30	0.24	10.67	33.00	1.000**
	♀	58	1.7–2.2	2.01	0.12	5.85		
Ect-Ent	♂	52	1.6–2.2	2.08	0.13	6.23	1.39	0.756
	♀	58	1.7–2.3	2.04	0.12	5.78		
N-B	♂	52	6.8–7.8	7.25	0.26	3.56	1.70	0.801
	♀	58	6.8–7.6	7.16	0.24	3.39		
B-Br	♂	52	4.9–5.9	5.32	0.22	4.08	5.72	0.980*
	♀	58	4.7–5.7	5.18	0.22	4.17		
CCV[1]	♂	52	24.0–32.0	27.35	2.10	7.67	5.18	0.973*
	♀	58	23.0–30.0	26.10	1.95	7.48		
Id-goc	♂	52	7.2–8.5	7.72	0.30	3.90	1.33	0.744*
	♀	58	7.3–8.3	7.83	0.26	3.34		
DRL	♂	52	3.9–4.7	4.27	0.18	4.35	14.20	0.999*
	♀	58	3.8–4.3	4.07	0.13	3.10		
Gov-Cr	♂	52	4.8–5.8	5.18	0.28	5.36	0.54	0.534
	♀	58	4.7–5.6	5.12	0.22	4.34		
Gn-id	♂	52	1.9–2.4	2.09	0.14	6.52	0.36	0.449
	♀	58	1.8–2.3	2.07	0.13	6.10		

CCV[1] – cranial cavity volume [cm^2],
* – significant differences between means at the significance level of $p \leq 0.05$
** – highly significant differences between means at the significance level of $p \leq 0.05$

The biggest skull length /Op-P/ in males was, on average, 11.83 cm and in females – 11.73 cm. The measurement demonstrated a low variation which in males accounted for 2.75% and in females – for 2.73%. The length of neurocranium skull base /B-St/ in males was 5.32 cm, while in females it was slightly lower – 5.26 cm. Analysing the length of the viscerocranium base /St-P/, one can observe very similar results, which are as follows: males – 5.92 cm, females – 5.90 cm. The data suggests that in raccoon dog the length of the neurocranium skull and the viscerocranium were comparable.

The measurement of the placement of eye sockets in the skull /Zl-Op/ assumed a similar mean value in both sexes, whereas the lateral viscerocranium length /Zl-P/, unlike for the above parameters, showed highly significant difference between the two groups.

A significant difference in mean values was noted for the length of the frontal bone in sagittal plane /Br-N/. The measurement in males reached the value of 3.13 cm, and in females – 3.32 cm. It was one of the few cases where the mean value in the female group was higher than in the male group. One shall also consider the high variation which in males accounted for 7.65% and in females – for 8.49%.

The placement of molar teeth in raccoon dog /Mol-P/ is as follows; males – 4.38 cm, females – 4.19 cm. The difference between the means is also highly significant, while the dental line length itself from P1 to M2 /Pm-Pd/ in both groups is very similar: males – 3.75 cm, females – 3.77 cm.

Interestingly, the measurement of the zygomatic width of the skull /Zy-Zy/, which reached a relatively high value and the difference in mean values of the measurement, between males and females was significant.

The greatest width of the neurocranium skull /eu-eu/ in both groups is similar; in males it is 4.00 cm and in females – 3,96cm. The width of the occipital bone /Ot-Ot/ is very similar; the difference between means in both groups is only 0,02 cm.

In the case of the height of the viscerocranium /St-N/, there was noted a highly significant difference between mean measurements in males and in females; in males – 3.55 cm and in females 3.44 cm, whereas the cerebral skull height /Sph-Br/ assumed similar values in both groups.

The measurement of the occiput height /Op-O/ in males was 2.30 cm, while in females – 2.01 cm and it demonstrated a highly significant difference.

The length of the eye socket ring /Ect-Ent/ and the angular height of cerebral skull /N-B/ in both groups were equal. The cranial cavity volume /CCV/, measured with the Duerst method, in males reached the value of 27.35 cm, while in females – 26.10 cm and it was significant.

Analysing the measurements taken for the jaw, one shall note that the maximum length of the jaw /id-goc/ in both sexes was similar, whereas the length of the dental line of the jaw /DRL/ in males was 4.27 cm and in females – 4.07 cm. The difference between the two groups in that case was highly significant; unlike the height of jaw branches /gov-Cr/ and the jaw juncture height /gn-id/ which in both sexes were similar.

Tables 2, 3 present the matrix of correlation between respective skull parameters in raccoon dog males and females.

Both for males and females there was a correlation between the length of the cranial base /B-P/ and the greatest skull length /Op-P/. Cases of very high correlation were reported in 11 pairs in males and 12 in females. A highly significant correlation was demonstrated for 29 pairs of measurements in males and 21 in females. The greatest number of correlations for cranial skull measurements were weak; 74 and 70 pairs, respectively.

As for the correlation between the measurements of the jaw, a high significance occurred in 4 cases in males and in 3 cases in females and an average in two pairs of both sexes (Table 4). A poor correlation was noted for the measurements of the length of the dental line of the jaw and the height of the jaw branches in raccoon dog female.

Table 2. Matrixes of correlation between cranial parameters of male skulls in raccoon dog.

	B-P	Op-p	B-St	St-P	Zl-Op	Zl-P	Br-N	Mol-P	Pm-Pd	Zy-zy	Ect-ct	eu-eu	Ot-Ot	St-N	Sph-Br	Op-O	Ect-Ent	N-B	B-Br	CCV
B-P	x																			
Op-p	0.96	x																		
B-St	0.81	0.75	x																	
St-P	0.55	0.57	-0.04	x																
Zl-Op	0.77	0.81	0.78	0.20	x															
Zl-P	0.25	0.28	0.14	0.24	0.05	x														
Br-N	0.25	0.23	0.25	0.07	0.14	-0.12	x													
Mol-P	0.60	0.66	0.31	0.58	0.37	0.26	-0.07	x												
Pm-Pd	0.47	0.45	0.33	0.33	0.22	0.50	0.30	0.36	X											
Zy-Zy	0.50	0.49	0.43	0.25	0.45	0.39	0.09	0.14	0.19	x										
Ect-Ect	0.46	0.50	0.18	0.53	0.35	0.20	0.01	0.41	0.22	0.70	x									
eu-eu	0.11	0.17	0.13	-0.01	0.23	-0.13	0.46	-0.09	0.14	0.14	-0.07	x								
Ot-Ot	0.47	0.46	0.36	0.31	0.38	0.17	0.08	0.15	0.27	0.80	0.71	0.31	x							
St-N	0.26	0.29	-0.01	0.46	0.25	0.17	-0.02	0.14	0.20	0.47	0.26	0.31	0.49	x						
Sph-Br	0.52	0.59	0.30	0.47	0.56	0.01	0.10	0.30	-0.01	0.68	0.71	0.17	0.69	0.48	x					
Op-O	0.39	0.37	0.44	0.05	0.45	-0.16	-0.07	0.27	0.13	0.39	0.54	-0.15	0.44	0.20	0.42	X				
Ect-Ent	0.59	0.58	0.57	0.20	0.66	-0.11	0.19	0.20	0.27	0.17	0.18	0.21	0.28	0.10	0.25	0.24	x			
N-B	0.63	0.63	0.71	0.07	0.66	0.01	0.68	0.14	0.32	0.47	0.20	0.32	0.36	0.15	0.38	0.30	0.40	x		
B-Br	0.75	0.78	0.67	0.34	0.85	0.24	0.11	0.36	0.27	0.70	0.57	0.24	0.63	0.44	0.76	0.44	0.44	0.62	x	
CCV	0.27	0.31	0.17	0.23	0.26	-0.18	0.13	0.40	0.02	0.07	0.04	0.59	0.19	0.24	0.26	-0.02	0.01	0.14	0.26	x

Correlation:

Low correlation, or not –corelted $0 < r_{XY} < 0.1$	Por correlation $0.1 =< r_{XY} < 0.3$	Average correlation $0.3 =< r_{XY} < 0.5$	High correlation $0.5 =< r_{XY} < 0.7$	Very high correlation $0.7 =< r_{XY} < 0.9$	Full correlation **0.**9 $=< r_{XY} < 1$

Table 3. Matrixes of correlation between cranial parameters of female skull in raccoon dog.

	B-P	Op-p	B-St	St-P	Zl-Op	Zl-P	Br-N	Mol-P	Pm-Pd	Zy-Zy	Ect-Ect	eu-eu	Ot-Ot	St-N	Sph-Br	Op-O	Ect-Ent	N-B	B-Br	CCV
B-P	x																			
Op-p	0.97	x																		
B-St	0.66	0.64	x																	
St-P	0.59	0.58	-0.20	x																
Zl-Op	0.81	0.88	0.71	0.29	x															
Zl-P	0.72	0.73	0.16	0.77	0.49	x														
Br-N	0.21	0.28	-0.01	0.29	0.17	0.53	X													
Mol-P	0.74	0.71	0.28	0.67	0.49	0.75	0.40	x												
Pm-Pd	0.37	0.32	-0.11	0.60	0.05	0.30	-0.16	0.43	x											
Zy-Zy	0.43	0.47	0.24	0.30	0.52	0.45	0.01	0.40	0.12	x										
Ect-Ect	-0.23	-0.20	-0.35	0.07	-0.15	0.04	-0.16	-0.13	-0.15	0.35	x									
eu-eu	0.17	0.23	0.12	0.09	0.26	**0**.16	0.18	0.18	-0.08	0.02	-0.18	x								
Ot-Ot	0.03	0.04	-0.03	0.08	0.12	0.15	-0.22	-0.14	0.09	0.42	0.31	-0.16	x							
St-N	0.05	0.09	0.10	-0.04	0.28	-0.07	-0.30	-0.15	-0.17	0.55	0.56	0.18	0.48	x						
Sph-Br	0.30	0.37	0.26	0.12	0.35	-0.01	-0.18	0.08	0.15	0.36	0.14	-0.01	0.07	0.38	x					
Op-O	0.39	0.43	0.31	0.17	0.45	0.06	-0.10	0.24	0.28	0.26	-0.34	0.09	0.06	0.11	0.53	x				
Ect-Ent	0.45	0.48	0.27	0.30	0.53	0.41	0.17	0.34	-0.08	0.35	0.26	0.24	0.06	0.32	0.15	-0.01	x			
N-B	0.69	0.74	**0**.47	0.40	0.74	0.60	0.42	0.51	0.04	0.50	0.01	0.23	0.30	0.29	0.30	0.11	0.45	x		
B-Br	0.58	0.60	0.53	0.20	0.64	0.12	-0.33	0.22	0.31	0.52	-0.04	0.05	0.26	0.36	0.73	0.50	0.23	0.50	x	
CCV	0.02	0.11	0.17	-0.16	0.28	0.06	0.23	0.02	-0.19	0.05	0.02	0.51	0.14	0.21	-0.15	0.20	0.20	0.11	-0.14	x

Correlation:

Low correlation, or not –corelted $0 < r_{XY} < 0.1$	Por correlation $0.1 =< r_{XY} < 0.3$	Average correlation $0.3 =< r_{XY} < 0.5$	High correlation $0.5 =< r_{XY} < 0.7$	Very high correlation $0.7 =< r_{XY} < 0.9$	Full correlation **0**.9 $=< r_{XY} < 1$

Table 4. Matrix of correlation for the measurements of the jaw in raccoon dog males and females

	Sex	Id-goc	DRL	Gov-Cr	Gn-id
Id-goc	♂	x			
	♀	x			
DRL	♂	0.65	x		
	♀	0.61	x		
Gov-Cr	♂	0.54	0.43	x	
	♀	0.45	0.20	x	
Gn-id	♂	0.61	0.58	0.40	X
	♀	0.58	0.57	0.31	X
Low correlation, or not –corelted $0 < r_{XY} < 0.1$			Average correlation $0.3 =< r_{XY} < 0.5$		High correlation $0.5 =< r_{XY} < 0.7$

DISCUSSION

The craniometric studies of raccoon dog made it possible to determine species-specific skull characteristics.

In raccoon dog there is observed a clear shortening of the viscerocranium the base length of which is even slightly smaller than the cerebral skull base. The characteristics presented here are characteristic for the type of the *mesocephalic skull* (mesocephalia). Additionally, in raccoon dog there is a clearly marked external sagittal crest, so specific for the *dolichocephalic skull* (dolichocephalia), as well as well developed occipital crests.

Kowalski [9], discussing the method of nutrition in raccoon dog, notes that despite the animal food, plant food accounts for a great share in the diet of that species. Some characteristics of the skull anatomy as well as the shape and size of teeth point to the adaptation of raccoon dog to the food with a considerable amount of plants. A similar phenomenon has been described by Żuk [15] in bear. A partial adaptation to the plant diet results in the occurrence of intensive horizontal movements of the jaw, and thus, the occurrence of specific changes in the proportions of the skull and the jaw, due to the effect of masseter muscles.

Investigating the cranial variation in the skull parameters in raccoon dog, it was found that the highest coefficient of variation in males concerns the length of the frontal bone in the sagittal plane /Br-N/ and the height of the occiput /Op-O/, while in females – the placement of the eye sockets /Ect-Ect/. The calculations made show the range if variation, including the cerebral skull, especially the cerebral skull height /Sph-Br/ and the height of the occiput /Op-O/. A considerable value of the coefficient of variation was observed also for the cranial cavity volume.

Drawing on the data given above, one can see clearly that the length of the cerebral skull base /B-St/ and the length of the viscerocranium base /St-P/ are very similar; it is between those measurements that there is observed a negative value of the coefficient of correlation; namely the elongation of the cerebral skull results in shortening of the viscerocranium.

The comparison of the mean values of respective parameters between a group of males and females identified highly significant differences in the lateral viscerocranium length /Zl-P/, molar teeth placement /Mol-P/, height of the occiput /Op-O/. The differences between the parameters were significant also in red fox [2].

Significant differences between sexes were recorded for the length of the frontal bone in the sagittal plane /Br-N/, the zygomatic skull width /Zy-Zy/ and the height of the viscerocranium /St-U/. As seen clearly, the differences between the two groups concerned mostly viscerocranium, whereas as for the neurocranium, only the height of the occiput.

The measurements of the cranial cavity volume show that it was significantly bigger in males. In both groups the measurement is correlated with the width of the neurocranium skull /eu-eu/. Similar results were reported by Brudnicki [2] investigating the relationships between the cranial cavity volume and selected skull parameters in red fox. The author, however, did not record any significant differences for the cranial cavity between males and females. Huson, Page (1980) investigating red fox, observed that in young individuals the cranial cavity volume is similar in both sexes, whereas with age there is noted a greater growth tendency for that parameter in males.

To sum up the present results, one shall note that some characteristics of the raccoon dog skull point to the adaptation of the species to the diet containing a high amount of plant components, which has been reflected in the skull shape and proportions due to the effect of masseter muscles. Interestingly, there occurs a clear shortening of the viscerocranium as compared with silver fox and red fox. The length of the viscerocranium demonstrated a highly significant correlation with the total skull length, whereas it was negatively correlated with the length of the neurocranium skull.

CONCLUSIONS

1. In raccoon dog, as compared with other representatives of the Canidae family, there is observed a considerable shortening of the viscerocranium the length of which was comparable with the neurocranium skull.

2. In the skulls of raccoon dog males the correlations between parameters occur to a much greater extent than in female skulls.

REFERENCES

1. Andersen T., Wilg O., 1984. Growth of the skull of Norwegian Lynx. Acta Theriol., 29, 89–100.
2. Brudnicki W., Nowicki W., Skoczylas B., Jabłoński R., Kirkiłło–Stacewicz K., 2009. Craniometric features in red fox (*Vulpes vulpes* L.). Zesz. Nauk UTP no 252-Zoot., 37, 21–30.
3. Buchalczyk T., Ruprecht A.L. 1977. Skull variability of Mustela putorius Linnaeus 1758. Acta Theriol., 22, 87–120.
4. Buchalczyk T., Dynowski J., Szteyn S., 1981. Variations in Number of Teeth and Asymmetry of the Skull in the Wolf. Acta Theriol., 26, 23–30.
5. Churchel C.S., 1960. Cranial Variation in the North American Red Fox. J. Mammal., 41, 349–360.
6. Czyżewska T., 1973. Origin and spread of raccoon dog (*Nyctereutes Temminck* 1839) Canidae. Przegląd Zoolog., 17, 459–464.
7. Huson L.W., Page R.J.C., 1980. Age related variability in cranial measurements in the Red Fox (*Vulpes vulpes* L.). J. Zool. Lond., 191, 427–429.
8. Jakubowski H, Komosa M., Frąckowiak H., 2008. Allometric analysis of cranial parameters of American mink, including bones of masticatory apparatus. EJPAU 11(3), #02, http://www.ejpau.media.pl /volume11/issue3/art-02.html.
9. Kowalski K., 1964. Poland's vertebrates identification key. PWN Kraków 5, 203.
10. Lups P., Roper T., 1988. Tooth Size in the European Badger (*Meles meles*) with Special Reference to Sexual Dimorphism, Diet and Intraspecific Aggression. Acta Theriol., 33, 21–33
11. Martin R. 1971. The affinities *N. megamastroićes* (Pomel) of the canine from deposit Villafranchlen de St.-Yallier (Drome, France) Palacovertebrath, 4, 30–58.
12. Reig S., Ruprecht A.L., 1989. Skull Variability of *Martes martes* and *Martes foina* from Poland. Acta. Theriol., 34(41), 595–624.
13. Schmidt K., 1992. Skull variability of *Mustel nivalis* Lineaus 1766. Acta Theriol. 37, 141–162.
14. Wilg O., Andersen T., 1988. Non – Metrical Variation in the Skull, of Norwegian Lynx, Acta Theriol., 33, 3–1.
15. Żuk L., 1985. Evolution of the Teeth Function in *Ursus wenzencis*. Przegl. Zool. XXIX, 1, 109–115.

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