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Comparison of metric traits of the digestive and integumentary systems in a population of farmed and wild raccoon dogs*

Dorota Kowalska[1], Małgorzata Piórkowska[1], Andrzej Zoń[2]

[1]National Research Institute of Animal Production,
Department of Animal Genetic Resources Conservation,
ul. Sarego 2, 31-047 Kraków
[2]Experimental Station of the National Research Institute of Animal Production
in Chorzelów,
39-331 Chorzelów

The aim of the study was to determine some differences in the structure of the digestive and integumentary systems in farmed and wild raccoon dogs. The subjects were farmed raccoon dogs and wild raccoon dogs harvested in different regions of Poland in late autumn (16 animals per group in an equal sex ratio). Proper feeding and long-term breeding work were found to have caused differences in many metric traits of the digestive and integumentary systems of these two populations. Compared to farmed raccoon dogs, the wild population had a significantly higher ratio of intestinal length to trunk length (5.779 vs 6.063) and a highly significantly higher ratio of duodenal length to trunk length (0.637 vs 1.202), which was due to the type of food ingested. Proper feeding of animals has a substantial effect on the quality of the products obtained, i.e. skins of high fur quality in the case of fur animals. Nutritional deficiencies of dietary protein, unsaturated fatty acids and micro- or macroelements affected the hair coat quality of the wild raccoon dogs, which was characterized by considerable felting (up to 70% of skin area) and undeveloped down.

KEY WORDS: farmed and wild raccoon dogs / digestive system / integumentary system

The raccoon dog (*Nyctereutes procyonoides*) is a predatory mammal belonging to the family Canidae and the subfamily Caninae. The earliest mentions of raccoon dogs, which were most abundant in the Amur River basin, appeared in 1834. They were described by Gray (1843) on the basis of a skin obtained from China, but this was not a description of a living animal. The geographic range of the raccoon dog increased due to large-scale introduction in the Asian and European parts of the Soviet Union [11]. In Poland, the

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first specimens were observed in 1955 in the Białowieża Forest and in the vicinity of Hrubieszów in the Zamość region. In the years 1957-1960, raccoon dogs appeared in the Suwałki region, the Masurian Lake District and the vicinity of Łomża [7]. The species owes its rapid expansion not only in Poland, but also throughout Europe (single raccoon dog sites are currently observed even in France), to its remarkable plasticity as regards the choice of places to live and eat. Raccoon dogs have long since separated from the main canine phylogenetic trunk and show a number of distinct characteristics in relation to other members of this group. They are omnivores, which makes it much easier for them to live in the wild.

The first cage farming of this species began at the end of the 1920s in the Soviet Union. Raccoon dogs were initially kept next to large rabbit farms, where their food was the meat of dead rabbits. In the 1960s, the breeding of raccoon dogs became very popular in Finland, which still produces the largest number of raccoon dog hides today. In Poland, the raccoon dog is among the fur-bearing animals that have been farmed for the shortest time. They were first bred in a cage system about 35 years ago, although they were brought in much earlier for research purposes, in 1958. The first studies on their breeding and fur performance were conducted at the Experimental Station of the National Research Institute of Animal Production in Chorzelów under the supervision of Professor Jadwiga Ocetkiewicz.

From the early days of raccoon dog farming, the most controversial issue among breeders was the diet of the animals. In the wild, raccoon dogs are omnivorous, and plants can account for 40-50% of their diet [7]. For this reason, raccoon dog breeding, initially carried out next to fox farms, where both species were fed diets with a small proportion of plant components, did not produce the expected economic results.

As a result of long-term, intensive breeding work on raccoon dog farms, the level of performance (domestication) traits in farmed populations of these animals differ greatly from those of wild raccoon dogs. There are marked differences in performance traits undergoing genetic improvement, primarily coat quality, colour, body weight, values of measurable traits of digestive organs, or even the temperament of the animals.

The aim of the study was to determine some differences in the structure of the digestive and integumentary systems of raccoon dogs from farmed and wild populations.

Material and methods

The experimental material consisted of farmed raccoon dogs from a farm owned by the Experimental Station of the National Research Institute of Animal Production in Chorzelów and wild raccoon dogs shot by hunters in the north-east of the country in the late autumn (16 per group, with equal numbers of males and females). The raccoon dogs were kept in standard cages for this species. Both farmed and wild animals were fed the same feed (farmed animals from birth, wild animals for about 2 weeks), with constant access to drinking water. They received a compound feed consistent with the nutritional requirements of this group of animals, prepared from typical components available on the Polish feed market, with the following percentage distribution of ME: protein – 30, fat – 35, carbohydrates – 35.

The stomach contents of the wild raccoon dogs were examined in animals obtained after harvesting in hunting clubs in north-eastern Poland (10 animals).

The tests on live animals included body weight, the rate of passage of food through the digestive tract, and conformation assessment. The rate of passage of food through the digestive tract was tested for 3 days, by marking the feed with iron oxide. The passage time was measured from 30 minutes after feeding until the first defecation.

Body conformation was assessed by a specialist from the National Animal Breeding Centre, when the skins were at full fur maturity (November), according to a new standard [8] in which the phenotype assessment is expressed by the letters A, B+, B and C and the animal is evaluated for the following traits: size and build, colour type, purity of hair colour, and coat quality (which includes the length, density, silkiness and resilience of the hair coat).

At the end of November, the raccoon dogs were slaughtered in accordance with the applicable procedure for this species. The tests conducted after slaughter included measurement of each segment of the gastrointestinal tract, analysis of stomach contents including a basic analysis of nutrients (in the wild animals), skin size parameters (weight, length and planimetric area), organoleptic assessment of hair coat defects, and determination of selected macro- and microelements in the hair coat.

After skinning, the length of the trunk with the neck was measured, from the occipital squama to the base of the tail, and then the body cavity was opened and the internal organs were removed and cleaned. Following removal from the abdominal cavity, the intestine was separated from the stomach. The following measurements were made: length of the oesophagus, stomach, duodenum, jejunum and ileum, caecum, and colon with the rectum. All sections of the gastrointestinal tract were measured with a measuring tape after being spread out on a moist, impermeable surface. The length of the oesophagus was measured from the larynx to the stomach. After the mesentery was removed, the length of the individual sections of the intestine was measured. The length of the duodenum was measured from the point where it joins the pylorus to the duodenojejunal flexure, adjacent to the duodenocolic fold of the peritoneum. The length of the jejunum and ileum was measured jointly from the duodenojejunal flexure to the ileal orifice. The caecum was straightened out by removing connective tissue fragments and then measured from the tip to the ileal orifice. The colon together with the rectum was measured from the ileal orifice to the anus. Based on the measurements obtained, the total length of the intestines and the total length of the small and large intestines were determined. For comparative purposes, the ratios of the length of the gastrointestinal tract, the length of the intestines and the length of the duodenum to the trunk were calculated. The percentage share of individual intestinal sections was determined as well.

In the wild raccoon dogs shot by hunters, the stomach contents were rinsed out, treated with a non-enzymatic detergent and sifted on a sieve with small mesh (0.7 mm) to separate food of plant and animal origin. Food components were weighed on an analytical balance.

The following were determined in the stomach contents of the wild and farmed raccoon dogs: content of dry matter (SOP M.011:2006 – Standard Operation Procedure, M – procedure number at the Central Laboratory of the National Research Institute of Animal Production), crude protein (SOP M.007:2006), crude fat (SOP M.013:2006), crude fibre (SOP M.012:2006) and ash (SOP M.014:2007).

Initial treatment of the skins, fleshing, drying and preservation were carried out in accordance with standards for this species.

The physical parameters of the raw hides and the qualitative traits of the hair coat were evaluated according to Kaszowski and Kawińska [6] and Piórkowska [16, 17]. The following physical parameters were measured in the raw skins: weight (electronic scale, accurate to within 0.1 g), length and width of the skin (measuring tape, accurate to within 1 mm), tail length (with a measuring tape from the base to the tip, not including the hair coat) and the planimetric area of the skin (planimeter).

The composition of the hair coat was evaluated at 6 topographical locations on the skin (neck, shoulder girdle, middle of the back, tail base, side and abdomen). At each site a sample of skin tissue and hair with an area of 0.34 cm^2 was taken with a trocar. Then the hair was cut close to the surface of the skin, weighed and divided into two main fractions – the overhair and down hair. Individual types of hair were weighed and their percentage share of the weight of the entire sample without skin tissue was calculated.

An organoleptic evaluation of the skins was conducted to identify defects and damage to the integumentary system – the skin tissue and hair coat. The defects and scale of damage were defined and measurable defects were measured.

A chemical analysis of the hair was performed as one of the methods of assessing the mineral status of the body. The concentrations of biological elements (iron, zinc, copper, manganese, cobalt, selenium, sulphur, iodine, silicon, calcium, magnesium and aluminium) in the hair were determined with an x-ray fluorescence spectrometer (XRF). This method involves analysing the amount of x-radiation entering the detector after being emitted by the sample.

A statistical analysis of the results was performed. Significance of differences between means in groups was estimated using Student's t-test for independent samples. Calculations were made using the Statistica 7.1 PL statistics package.

Results and discussion

In recent years, breeding of fur animals in Poland has seen intensified production combined with genetic improvement in populations. Nutrition in such farms must meet the highest quality standards. To achieve breeding success, it is not enough to balance the feed rations in terms of basic nutrients; special attention must be paid to improvement of the diet with feed additives and to monitoring of physiological processes.

The study showed that the average body weight of the raccoon dogs before slaughter (November) was statistically significantly higher in the group of farmed animals than in the wild animals (Table 1). The table presents the results broken down by sex.

Table 1
Body weight of raccoon dogs before slaughter (kg)

Sex		Raccoon dogs	
		farmed	wild
♂	$\bar{x}$	12.02^{A*}	6.360^{B}
	SD	0.571	0.428
♀	$\bar{x}$	10.51^{A*}	6.480^{B}
	SD	0.600	0.971
Average for ♂ and ♀	$\bar{x}$	11.26^{A}	6.420^{B}
	SD	0.796	0.711

A, B – numbers in rows with different letters differ significantly at α<0.01
*Numbers in columns differ significantly at α<0.01

The significantly higher body weight of farmed raccoon dogs as compared to wild ones is the result of many years of breeding work. It is worth noting the significant differences in body weight between farmed males and females, whereas no such differences were observed in the wild individuals. Brudnicki et al. [3], in a study on wild raccoon dog populations, showed significant differences between male and female body weight. Similarly, in a study by Kulawik et al. [10] involving measurements of farmed and wild foxes, the differences between sexes for both groups were highly significant.

The measurable traits of the organs of the digestive and integumentary systems of many groups of farmed and wild animals show substantial differences, which are largely linked to the type of feed eaten, the rhythm and the level of feed intake, seasonal changes, intestinal bacteria, intestinal parasites and even fasting during hibernation [10]. The digestive tract of animals is composed of several segments, in which the food is first ingested and treated mechanically, followed by enzymatic digestion, propulsion, absorption and formation of faeces. These segments are specialized depending on the type of food ingested [5].

The passage of food through the digestive tract was highly significantly longer in the wild raccoon dogs (Table 2).

Table 2
Digesta passage rate (peristalsis)

Specification		Raccoon dogs	
		farmed	wild
Average digesta passage rate (in minutes)	$\bar{x}$	601.5^{a}	685.5^{b}
	SD	10.70	14.73

a, b – numbers in rows with different letters differ significantly at α<0.05

Table 3
Measurements of different segments of the digestive tract (cm)

Specification		Raccoon dogs	
		farmed	wild
Trunk length	$\bar{x}$	63.10^{A}	55.30^{B}
	SD	1.055	1.405
Total length of the digestive tract	$\bar{x}$	409.7^{a}	375.2^{b}
	SD	18.61	34.74
Oesophageal length	$\bar{x}$	31.70^{A}	25.79^{B}
	SD	1.273	1.800
Abdominal length	$\bar{x}$	12.87^{a}	13.94^{b}
	SD	0.908	1.239
Total intestinal length	$\bar{x}$	364.7^{a}	335.4^{b}
	SD	18.42	26.79
Small intestine	$\bar{x}$	316.3	298.8
	SD	18.67	31.69
including:			
duodenum	$\bar{x}$	40.22^{A}	66.37^{B}
	SD	0.888	5.425
jejunum and ileum	$\bar{x}$	276.1^{A}	232.5^{B}
	SD	14.81	27.66
Large intestine	$\bar{x}$	48.41^{A}	36.56^{B}
	SD	3.125	2.733
including:			
blind gut	$\bar{x}$	5.350^{a}	4.561^{b}
	SD	0.818	0.550
colon and rectum	$\bar{x}$	43.11^{A}	32.04^{B}
	SD	2.707	3.557
Ratio of digestive tract length to trunk length	$\bar{x}$	6.490	6.781
	SD	0.246	0.583
Ratio of intestinal length to trunk length	$\bar{x}$	5.779^{a}	6.063^{b}
	SD	0.247	0.438
Ratio of duodenal length to trunk length	$\bar{x}$	0.637^{A}	1.202^{B}
	SD	0.017	0.102

A, B – numbers in rows with different letters differ significantly at $\alpha<0.01$
a, b – numbers in rows with different letters differ significantly at $\alpha<0.05$

Barabasz et al. [1] report that the passage of food through the digestive tract is longest in raccoon dogs among all fur-bearing carnivores, as in about 80% of individuals tested the first undigested food remnants are excreted only after 11-12 hours. In our study, the rate of passage was similar to the results cited, but longer in the wild animals.

Anatomical studies of the mammalian digestive tract have focused on various aspects. The shape and size of the digestive tract as a whole as well as its individual segments have been analysed. They are often determined relative to body length and to one another.

With an average body weight of 12.06 kg for the farmed raccoon dogs and 6.398 kg for the wild ones, significant differences were noted for the total length of the gastrointestinal tract, total intestinal length, stomach length, and caecum length, and highly significant differences for the length of the oesophagus, duodenum, jejunum and ileum, large intestine, and colon and rectum (Table 3). The ratio of the length of the gastrointestinal tract to that of the trunk was 1:6.49 for farmed raccoon dogs and 1:6.78 for wild ones. Significant differences in favour of wild raccoon dogs were observed for the ratio of intestinal length to trunk length, and highly significant differences for duodenal length to trunk length.

Analysis of the percentage share of individual intestinal segments in the intestine as a whole revealed a higher proportion of duodenum in the wild raccoon dogs, while the other sections were longer in the farmed animals (Table 4). Highly significant differences between farmed and wild raccoon dogs were found for the length of the duodenum, jejunum and ileum, and colon and rectum.

Table 4
Proportion of intestinal segments in total intestine (%)

Raccoon dogs		Total intestinal length	Duodenal length	Jejunal and ileal length	Caecal length	Colon and rectum length
Farmed	$\bar{x}$	100	11.02^{A}	75.70^{A}	1.460	11.82^{A}
	SD		0.647	3.511	0.186	0.968
Wild	$\bar{x}$	100	19.79^{B}	69.31^{B}	1.359	9.530^{B}
	SD		1.596	2.719	0.181	1.468

A, B – numbers in columns with different letters differ significantly at $\alpha<0.01$

The duodenum is the first part of the small intestine, where gastric digestion transitions to intestinal digestion. Absorption in the duodenum itself is minimal (about 8% of digested food); digestion involving pancreatic juice, bile and intestinal juice takes place here. Depending on the nature of the food, the pH of the duodenum contents can range from 4.0 to 8.5. In wild animals, because their food is heterogeneous and often not reduced to small particles, digestion in the duodenum is much slower, and thus the duodenum is markedly longer. Similarly, food of plant origin, which is the main food of wild raccoon dogs, is broken down more slowly than meat. Kulawik et al. [9] reported that in their study the length of the duodenum in the intestine as a whole was 12.61% in farmed raccoon dogs, ranging from 25 to 40 cm, where the intestinal length ranged from 209 to 283 cm. In our study, while the percentage length of the duodenum in the intestine as a whole corresponded with the results cited, the total length of the intestine was much greater, exceeding 300 cm. Brudnicki et al. [3] report intestinal length in farmed raccoon dogs ranging from 2.36 to 3.03 at a body weight of 4.60-6.70 kg. Therefore, access to specific foods or seasonal variation in the diet may be factors affecting intestinal length. The type of food influences the quantity and pH of the juice, its digestive capacity and the duration of the secretion process. The passage of chyme from the stomach to the intestine also depends on the quality of the food. Poorly chewed food remains in the stomach longer than well-chewed food [18]. Our study found that the stomach was longer in the wild raccoon dogs, although the differences were not statistically confirmed. This may be linked not only to the food ingested, but also to the cyclical nature of its intake. Wild animals often take in food occasionally, when it is available in a given area, and at a specific time, completely filling the stomach.

The wild raccoon dog is an omnivorous animal, which does not necessarily prefer plants, but is often forced by environmental conditions to feed predominantly on plants. For this reason the ratio of body length to intestinal length (1:6.78) is more similar to that of the badger (1:5.13), which prefers plant foods, than to that of the fox (1:3.5) or wolf (1:3.01) [3, 4, 14].

Our study found that in the wild raccoon dogs plant-based food made up the largest the share of the stomach contents (74.2%), followed by invertebrates (20.2%), while vertebrates had the smallest share (5.61%). In the feed prepared on the farm for the farmed raccoon dogs, plant-based feeds accounted for 15-20%, depending on the breeding/feeding period.

Our finding that the total length of the intestines of the wild raccoon dogs in relation to the length of the trunk is greater than in the farmed raccoon dogs can be explained by the fact that the diet of the wild animals included more food of plant origin (Table 3). The stomach also contained fragments of the completely filled digestive system of their herbivorous prey. The plant fibre content affects digestion processes and the length of the digestive tract [13]. Farmed animals receive feeds that are properly balanced, with a different composition and consistency (having been ground) than that of food consumed by wild animals. The type of food eaten not only affects the functioning of the entire digestive tract, but is one of the manifestations of morphological changes. For example, studies show that the secretion of gastric juice is not identical, but is an expression of the adaptation of the work of the stomach glands to the nature of the food ingested [13].

The results of the chemical analysis of the stomach contents showed lower levels of crude protein in the wild raccoon dogs (shot by hunters) than in the farmed animals (7.40 and 11.3), as well as lower levels of crude fat (4.82 and 6.11), crude ash (1.10 and 3.40) and nitrogen-free extract (1.08 and 3.38), and higher content of raw fibre (14.0 and 7.61). Dry matter accounted for 28.4% in the farmed raccoon dogs and 27.3% in the wild ones.

Proper animal nutrition influences the quality of the animal products obtained, which in the case of fur-bearing animals means a skin with high fur quality. The hair coat and skin tissue of fur-bearing animals vary considerably depending on various factors affecting them from birth (e.g. living conditions, type and method of feeding and age). The raccoon dog coat is of the long-haired type, of average density, and fluffy. Dark brown fur covers the head and the entire body, forming a characteristic mane and sideburns on the neck and sides of the head.

In our study, highly significant differences in favour of the farmed raccoon dogs were found for the weight, length, width and area of the raw hide, while only the tail length was similar (Table 5).

Table 5
Measurements of raw skins from raccoon dogs

Specification		Raccoon dogs	
		fermed	wild
Skin weight (g)	$\bar{x}$	657.5^A	382.8^B
	SD	52.26	46.79
Skin length (cm)	$\bar{x}$	106.6^A	80.80^B
	SD	4.247	7.067
Tail length (cm)	$\bar{x}$	26.30	24.30
	SD	1.494	5.375
Skin width (cm)	$\bar{x}$	36.00^A	30.10^B
	SD	0.001	2.024
Skin area (dm^2)	$\bar{x}$	52.27^A	34.32^B
	SD	2.561	3.862

A, B – numbers in rows with different letters differ significantly at $\alpha<0.01$

The low body weight of the wild animals was reflected in the size and area of the hides, which were significantly different from those obtained from farmed animals.

The phenotype assessment showed that none of the wild raccoon dogs tested had a higher score than C (Table 6).

Table 6
Results of raccoon dog conformation assessment (number of raccoon dogs)

Raccoon dogs	A	B+	B	C
Farmed	2	8	6	0
Wild	0	0	0	16

Animals that have received a score of C according to the conformation standard [8] should not be left in the herd and raised further, not only because of their low body weight, but also the quality of the hair coat, which exhibits numerous defects. In the sample of skins from wild raccoon dogs, a significant problem was soiling and a high level of damage caused by parasites, which was particularly evident after tanning.

The percentage of down hair in the wild raccoon coats on individual parts of the body was significantly lower than in the farmed raccoon dogs. Significant differences were found for the sacral region and side, and highly significant difference for the neck, shoulder girdle, and back. The smallest differences in measurements were found for samples taken from the abdomen (Table 7).

Table 7
Skin defects – percentage of down hair in hair coat

Skin parts		Jenoty Raccoon dogs hodowlane farmed	dzikie wild
Neck	$\bar{x}$	60.74[A]	48.66[B]
	SD	4.984	12.06
Shoulder girdle	$\bar{x}$	59.86[A]	38.33[B]
	SD	4.859	15.29
Back	$\bar{x}$	66.63[A]	49.67[B]
	SD	5.057	16.35
Sacral region	$\bar{x}$	75.59[a]	56.38[b]
	SD	5.509	22.59
Side	$\bar{x}$	67.17[a]	55.96[b]
	SD	3.815	12.72
Abdomen	$\bar{x}$	62.78	58.98
	SD	6.768	13.20
Average for skin	$\bar{x}$	65.46[A]	51.33[B]
	SD	3.921	16.22

A, B – numbers in rows with different letters differ significantly at $\alpha<0.01$
a, b – numbers in rows with different letters differ significantly at $\alpha<0.05$

The proper formation of the hair coat and its development in the desired direction depends to a large extent on a rational and properly balanced diet corresponding to the biological properties of the raccoon dog and its natural needs, taking into account the seasonality of these animals' vital functions and metabolism. Hair coat defects which substantially reduce the fur value of the hides include felting and lack of down development. The fur value of the skins of fur-bearing animals is largely determined by the thickness and length of the down hair and overhair, their number, and their ratio. In long-haired skins, the ratio of down hair to overhair should be 60-70:30-40, which gives the coat adequate softness and thermal insulation. Adult raccoon dogs moult once a year, in the spring. During the growth of summer hair, many hair follicles remain inactive and only in mid-August does the winter hair begin to grow [15]. Improper feeding of animals during this period may lead to inadequate development of the winter coat, which was found in our study in the wild raccoon dogs. The amount of down hair on all topographical sites on the skin was significantly lower than in the farmed animals.

Felting of the hair coat was observed in both farmed and wild animals. While in the farmed animals it was noted on the section from the sacral region to the base of the tail, where the tangling of the hair reached a maximum of 1 cm in the sample, in the wild animals it was observed from the neck to the base of the tail and on the side, but apart from shallow and medium felting, deep felting reaching over 1 cm occurred as well (Table 8). Felting of the hair coat in wild raccoon dogs reached up to even 75% of the area of the skin.

According to Scandinavian studies [2, 12] incorrect proportions of the individual layers of the hair coat give the fur a tendency to felt and become tangled. This process is facilitated in hair that is too delicate, which contributes to a loss of elasticity, and the hair becomes limp (woolly hair), making it more susceptible to felting.

Nutritional deficiencies in protein, unsaturated fatty acids or micro- and macronutrients are known to affect the quality of the hair coat. Both an excess and a deficiency of a particular nutrient in the diet may be manifested as poor hair quality, excessive hair loss, desquamation, or keratinization disorders [15]. This is directly reflected in the appearance of individual hairs, determining such parameters as the quality and regularity of the scales and the ratio of the thickness of the medulla to that of the cortex. Improper diet, pathological changes and adverse environmental effects are reflected in the composition of elements in the hair coat. The concentration of elements in the hair largely depends on the current diet. Trace elements of organic origin are absorbed by the body and then deposited in the hair coat.

Evaluation of the level of micro- and macroelements in the hairs of the wild and farmed raccoon dogs showed significant differences in the amount of copper, iodine, silicon and zinc (Table 9). Lower values were obtained for the group of wild raccoon dogs.

Copper and iodine are elements that play an important role in hair growth and in preventing it from falling out. These elements affect the overall appearance of the hair coat and prevent brittleness and decolouration of the hair. Zinc, by stimulating the synthesis of structural proteins (collagen and elastin), improves the appearance of hair and plays a significant role in its growth, while high levels of silicon in the hair make it less brittle. Silicon plays an important role in the formation of connective tissue, keratin and collagen, essential components of hair and nails. A low level or lack of individual elements contributes to the inhibition of hair growth or to hair loss (defect – lack of down development).

In conclusion, proper feeding on farms and breeding work conducted for many years have led to the differentiation of farmed and wild populations of raccoon dogs in numerous metric traits of the gastrointestinal tract and the integumentary system.

In the population of wild raccoon dogs, as compared to the farmed animals, a higher, highly significant ratio of duodenal length to trunk length was observed, which may be linked to the type of feed ingested. Nutritional deficiencies have affected the quality of

Table 8
Hair coat defects – felting

Raccoon dogs	Felting of hair coat*						
	site	number of skins with felting**:			number of skins with defect	% skins with defect	% felting of skin area (min – max)
		shallow	medium	deep			
Farmed	from sacrum to tail end	5	1	0	6	37,5	1 – 5
Wild	from neck to tail end, side	4	1	7	12	75,0	20 – 70

*Skins were grouped according to the highest degree of hair coat felting
**Deep felting: 1 cm or more on a cut sample, including dermal tissue; medium – from 0.5 to 1 cm; shallow – up to 0.5 cm

Table 9
Chemical analysis of hair (mg/kg)

Element		Raccoon dogs	
		farmed	wild
Al (aluminium)	$\bar{x}$	224.6	219.2
	SD	70.72	132.9
Ca (calcium)	$\bar{x}$	248.1	296.0
	SD	149.0	125.6
Co (cobalt)	$\bar{x}$	0.062	0.009
	SD	0.136	0.011
Cu (copper)	$\bar{x}$	8.789[a]	5.632[b]
	SD	3.567	0.950
Fe (iron)	$\bar{x}$	190.9	114.5
	SD	259.4	32.77
I (iodine)	$\bar{x}$	0.156[a]	0.352[b]
	SD	0.051	0.253
Mg (magnesium)	$\bar{x}$	62.20	48.60
	SD	57.25	26.71
Mn (manganese)	$\bar{x}$	6.139	0.612
	SD	17.35	0.174
Se (selenium)	$\bar{x}$	0.192	0.253
	SD	0.076	0.096
S (sulphur)	$\bar{x}$	330.9	328.2
	SD	81.28	80.22
Si (silicon)	$\bar{x}$	405.1[a]	289.9[b]
	SD	130.2	32.91
Zn (zinc)	$\bar{x}$	51.66[a]	22.07[b]
	SD	41.76	7.478

a, b – numbers in rows with different letters differ significantly at $\alpha<0.05$

the hair coat of wild raccoon dogs, which was characterized by considerable felting, a lack of down development and deficiencies of elements favourable to its proper development.

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