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Characterization of the hair coat of the Polish Konik and Hucul pony focusing on the physical features and histological structure of different hair types

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The aim of the study was a comparative analysis of the hair coat of the Polish Konik and Hucul pony, focusing on the histological structure and physical parameters of the hair. Hair samples were obtained from 20 mares—10 of each breed. They were collected in winter, from the side of barrel, the mane, the tail, and front and rear fetlock. The hairs from the barrel were divided into overhair and underhair fractions. A higher percentage of underhair (about 70%) as compared to overhair (30%) was noted in both breeds. The overhair of the Polish Konik was about 50% longer than that of the Hucul pony, while the length of underhair did not differ between breeds. Both the overhair and the underhair of the Polish Konik were about 25% thicker than that of the Hucul pony. Elongation of particular types of hair did not differ significantly between the breeds. It was lowest for fetlock hair (about 45%) and highest for mane hair (about 55%). The histological structure of the cuticle layer of the hair did not differ between breeds.

KEY WORDS: Polish Konik / Hucul pony / hair coat / histology

Knowledge of the hair coat of animals is growing due to rapid advancements in science and continually improving research techniques. Analysis of the histological structure of the hair and its elemental composition finds application in areas such as diagnosis of diseases or mineral deficiencies. Hair may also function as an environmental bioindicator [13, 20]. Detailed knowledge of the morphological and histological structure and physical properties of the hair of individual animal species and breeds enables increasingly wide application of hair, e.g. in species identification.

Three layers are distinguished in the structure of the hair shaft: the outermost layer, i.e. the cuticle, the middle layer, known as the cortex, and the innermost layer, called

the medulla. The most important features of the histological structure of hair for species identification are the scale pattern of the cuticle, the structure of the medulla and the shape of the cross section [4]. The appearance and physical properties of the hair depend on the proportions of its layers. The thicker the medulla, the more the hair is brittle and stiff. The thickness of the cortical layer determines the elasticity of the hair. Different types of hair can be distinguished in the hair coat of mammals: overhair (guard hair and awn hair), underhair (down), performing a thermostatic function, and specialized tactile hairs, known as whiskers or vibrissae. In ungulates, characteristic long hairs are distinguished as well, which in horses form the fetlocks, tail and mane [8].

The hair coat of the Polish Konik is generally abundant and dense, with a thick mane and tail; at the base of the tail there is a characteristic semi-circle of short hair spreading outward [11]. Hucul ponies have short, thick hair and a thick mane and tail [14].

The available literature contains studies on the effect of feed supplements on the content of elements in the hair coat of various horse breeds [3, 6, 10, 17], or on the use of horse hair to determine the degree of environmental contamination [7, 9]. Research has also been conducted on genetic determinants of coat colour in horses [12, 15, 19]. However, there are no studies comparing the hair coat of different horse breeds in terms of its physical parameters and the histological structure of different types of hair.

The aim of the study was to compare the coat hair of two horse breeds with common roots (descended from the tarpan), i.e. the Polish Konik and the Hucul pony, in terms of the histological structure of different types of hair and its physical parameters.

Material and methods

The study was conducted on the hair of the Polish Konik and the Hucul pony. The Polish Konik horses came from the village of Chwałków (Lower Silesian Voivodeship), and the Hucul ponies were from the village of Grodziec (Wielkopolska Voivodeship). Ten mares from each breed, at the age of about 3 years, were selected for the study. Both groups of horses were kept in a stable and pasture system, and their diet was in accordance with current standards. Hair samples were taken during the winter before the horses began to shed (January). Hairs from the mane, tail and the side of the barrel (at the height of the last rib, 30 cm from the spine) were pulled out, and hairs from the front and rear fetlocks were cut with scissors.

The hair from the side of the barrel was divided into fractions (underhair and overhair) on the basis of organoleptic evaluation, taking into account the thickness and external appearance of the hair. This was done with a magnifying glass with 10x magnification. From each sample 1,000 hairs were separated manually. In the sample prepared in this manner the number of each type of hair (underhair and overhair) was counted, and on this basis the percentage of each fraction was determined. The following parameters were determined in 100 hairs of each fraction for each sample: length (mm), thickness (μm), and elongation (%). Length was not determined for the hair of the mane, tail or

fetlocks, because these hairs may have been rubbed against, bitten or pulled out and the results would not be reliable. Elongation could not be measured in the underhair, as these hairs are too short to be placed in the grips of the tensile testing machine.

Hair thickness was measured with an 80 I Eclipse light microscope equipped with Nis-Elements Ar software for morphometric analysis. The hair was analysed in polarized and fluorescent light. In each sample about 100 measurements were made, and these were used to calculate the mean thickness of a given type of hair. The length of the hairs of the winter coat was determined using a Motic stereo microscope with a digital camera and MoticImages Plus 2.0 ML software. Hair elongation was measured using an electronic tensile testing machine with a head that can withstand a load of up to 100 N. The analyses were carried out in the Skin and Hair Evaluation Laboratory of the Institute of Animal Breeding, Wrocław University of Environmental and Life Sciences.

Histological evaluation was performed on all hair types using a LEO 435 VP (Carl Zeiss SMT AG) scanning electron microscope. Photographs were taken of the scale pattern of the cuticle on the surface of all hair types. To prepare the samples for analysis they were cleaned with ether and alcohol, rinsed in an ultrasonic bath, dried, glued onto special tables to ensure the stability of the sample, and then dusted with gold. Histological analysis was performed in the Electron Microscopy Laboratory of the Wrocław University of Environmental and Life Sciences.

Statistical analysis of the results was performed using Statistica 8.0 software. The tables present means and standard deviations. Differences between groups were tested by Student's t-test.

Results and discussion

The results obtained are presented in Tables 1-4 and in Figures 1-3. The proportions of the two hair fractions, i.e. underhair and overhair, were similar in the two breeds. The underhair in both cases accounted for about 70% of the hairs in the samples tested (Tab. 1). The length of the hair types is presented in Table 2. Statistically significant differences were noted in the length of the overhair between the two breeds. The hair of the Polish Konik was about 50% longer than that of the Hucul pony. It was also observed that the underhair and the overhair of the Polish Konik were statistically significantly thicker than the hair of the Hucul pony (Tab. 3). The underhair of the Polish Konik was about 23% thicker and the overhair about 24% thicker than in the Hucul pony. Elongation of the hair was similar in the two breeds and ranged from 45% to 55% (Tab. 4), but no statistically significant differences were noted between breeds or between hair types.

The results of the scale pattern in different types of hair of the Polish Konik and Hucul pony are presented in Figures 1-3. The hairs were characterized according to a key for identification of the hair of mammals [18].

The underhair of the Polish Konik and Hucul pony was characterized by a regular wave of cuticle scales, arranged transversely. The scales overlapped and their edges

Table 1
Percentage content of underhair and overhair (%)

Hair type	Horse breed	
	Polish Konik	Hucul pony
Underhair	69.93 ±2.55	71.11 ±1.07
Overhair	31.07 ±2.55	28.89 ±1.07

Table 2
Length of different types of hair (cm)

Hair type	Horse breed	
	Polish Konik	Hucul pony
Underhair	1.77 ±0.44	1.71 ±0.47
Overhair	4.26^{A} ±1.16	2.72^{B} ±0.56

A, B – means within the same row with different superscripts differ significantly ($p<0.01$)

Table 3
Thickness of different types of hair (μm)

Hair type	Horse breed	
	Polish Konik	Hucul pony
Underhair	68.78^{a} ±9.83	55.70^{b} ±8.39
Overhair	80.08^{a} ±12.09	64.13^{b} ±8.61
Tail	171.56 ±25.94	176.34 ±18.79
Mane	122.91 ±28.17	112.79 ±19.37
Front fetlock	79.51 ±14.36	74.21 ±6.98
Rear fetlock	78.16 ±12.91	73.92 ±7.25

a, b – means within the same row with different superscripts differ significantly ($p<0.05$)

Table 4
Elongation of different hair types (%)

Hair type	Horse breed	
	Polish Konik	Hucul pony
Overhair	52.23 ±10.71	45.62 ±12.79
Tail	51.57 ±9.07	54.87 ±4.93
Mane	55.42 ±7.29	54.35 ±5.11
Front fetlock	46.45 ±9.43	44.11 ±10.37
Rear fetlock	44.78 ±7.98	47.04 ±7.82

were smooth. The overhair of both breeds had scales arranged in a regular wave, transversely to the length of the hair. Individual scales had smooth edges and overlapped (Fig. 1). The results obtained are consistent with those presented by DeMarinis and Asprea [2].

The cuticle scale pattern of the tail hair of both breeds was characterized by an irregular wave oriented transversely. The edges of the scales were ragged and the scales overlapped. The mane hair from both breeds had a regular wave pattern. Their edges of the scales were smooth and arranged transversely to the length of the hair (Fig. 2).

The hair of the front and rear fetlock of both breeds had a regular wave pattern. The scales were arranged transversely to the length of the hair and had very ragged edges (Fig. 3).

On the hairs of the tail and the front and rear fetlocks wear and damage were visible in numerous places on the cuticle surface. These are long hairs [8], which do not shed like overhair or underhair. Damage on their surface may be the result of greater wear.

The histological structure of the hair did not differ between the two breeds. Differences in the histological structure of hair occur between genera and often between species, but not between breeds of the same species [4]. It is important that the analysis should include evaluation of all significant parameters, i.e. the cuticle scale pattern, the structure of the medulla, and the shape of the cross section of the hair. In the present study we analysed only the cuticle scale pattern of the two breeds.

The hair coat of the two breeds consisted of two main types of hair, overhair and underhair, with underhair clearly predominant in both breeds. The composition of such a coat can be described as homogeneous, as one type of hair is dominant. It is likely that the high proportion of underhair was due in part to the time of year, as the underhair

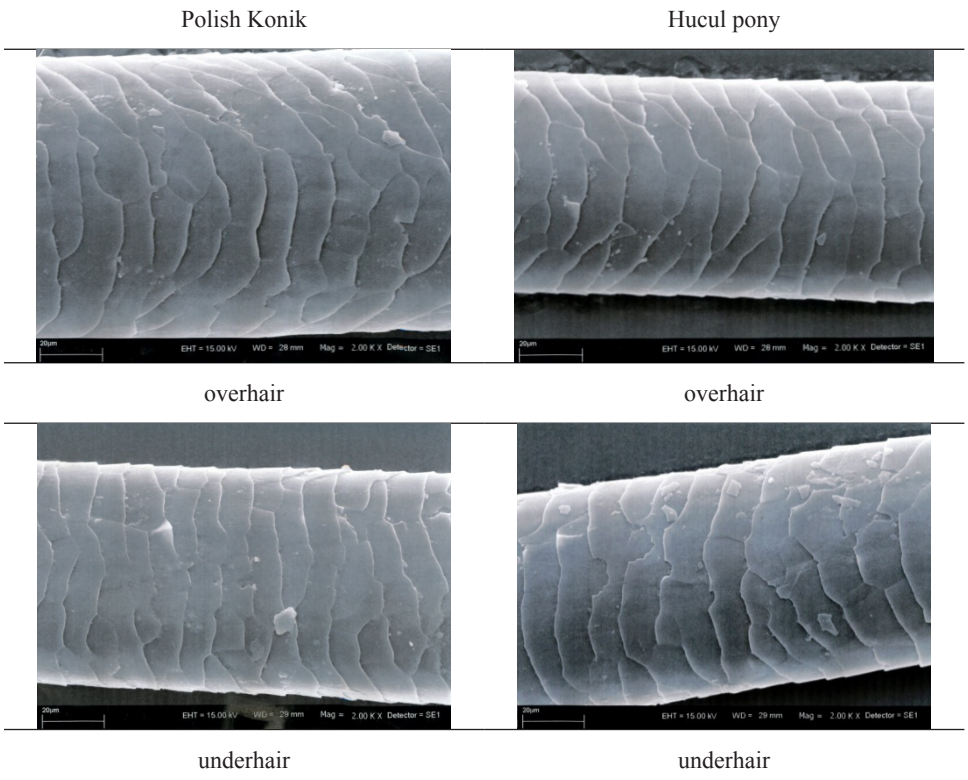

Fig. 1. Cuticle layer of overhair and underhair in the Polish Konik and Hucul pony

fraction in mammals is a thermostatic layer protecting the animal from heat loss during the winter. In the spring a considerable amount of this fraction is shed [5].

A very important trait differentiating hair and placing it in different categories is its thickness [11]. In the present study identical tendencies in hair thickness were noted in the two breeds of horse: the thinnest was the underhair, followed by the overhair, fetlock hair, and mane hair, and the thickest was the tail hair, which was also reported by Bolormaa et al. [1]. Differences were observed between breeds in hair length—the Hucul ponies had shorter overhair. Stachurska et al. [16] showed that the length of the overhair of the Polish Konik was about 5.8 cm, and the difference between winter and summer hair lengths was up to 4.6 cm. In the present study, the length of the overhair of the Polish Konik was 4.26 cm (Tab. 2). In the same study by Stachurska et al. [16], the length of the underhair of the Polish Konik was about 2.2-2.9 cm, while in the

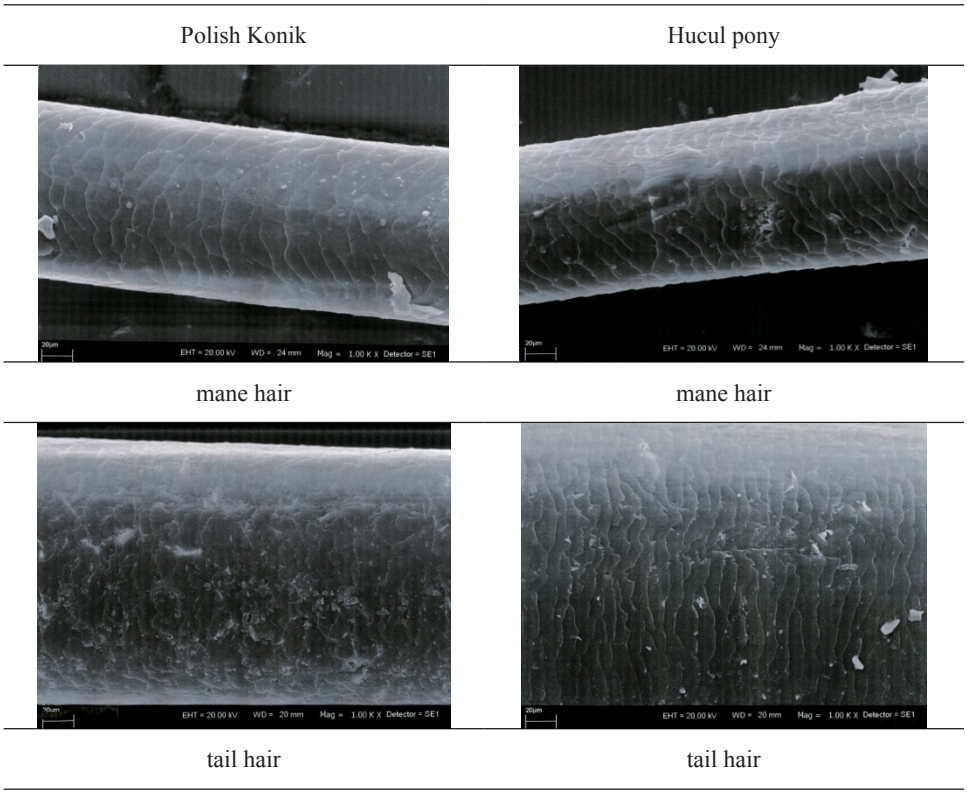

Fig. 2. Cuticle layer of mane and tail hair in the Polish Konik and Hucul pony

present study its average length was 1.8 cm (Tab. 2). These differences may be due to sampling in different months or to differences in living conditions or diet.

Another important trait of hair is its elongation capacity, which indicates the condition of the hair. Weak hair, from sick animals or those kept in poor environmental conditions, is characterized by low elongation, usually below 20%. In the hair analysed in the present study, the value for this parameter was very good and uniform, irrespective of the category of hair or the breed (Tab. 4), which is undoubtedly evidence of the animals' good condition. By comparison, the elongation obtained in the study by Bolormaa et al. [1] on the tail hair of Mongolian horses ranged from 43% to 52% and increased with the thickness of the hair.

The analysis revealed differences in the length and thickness of the overhair and in the thickness of the underhair of the Polish Konik and the Hucul pony. The overhair of

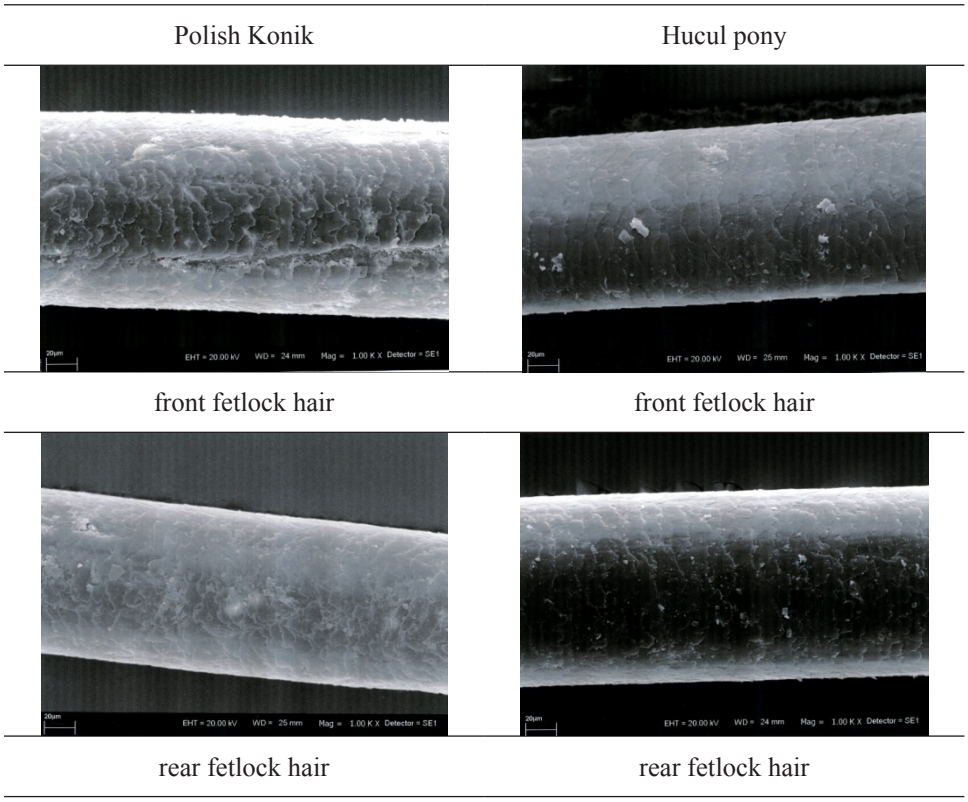

Fig. 3. Cuticle layer of front and rear fetlock hair in the Polish Konik and Hucul pony

the Polish Konik was about 50% longer than that of the Hucul pony. The overhair and underhair of the Polish Konik were about 25% thicker than the hair of the Hucul pony. This may indicate that despite their common origin the coat of the two breeds evolved in somewhat different directions, which may have been linked in part to their living environment. The histological structure of the hair did not differ between the two breeds, which confirms that such differences are not observed within a single species.

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