

Electronic Journal of Polish Agricultural Universities is the very first Polish scientific journal published exclusively on the Internet, founded on January 1, 1998 by the following agricultural universities and higher schools of agriculture: University of Technology and Agriculture of Bydgoszcz, Agricultural University of Cracow, Agricultural University of Lublin, Agricultural University of Poznan, Higher School of Agriculture and Teacher Training Siedlce, Agricultural University of Szczecin, and Agricultural University of Wroclaw.



**ELECTRONIC  
JOURNAL  
OF POLISH  
AGRICULTURAL  
UNIVERSITIES**

**2002  
Volume 5  
Issue 1  
Series  
ANIMAL  
HUSBANDRY**

Copyright © Wydawnictwo Akademii Rolniczej we Wrocławiu, ISSN 1505-0297

PIKUŁA R., GRONET D. 2002. DETERMINATION OF GENETIC DISTANCE BETWEEN HALF-BRED HORSE POPULATIONS IN RELATION TO THEIR COAT COLOUR *Electronic Journal of Polish Agricultural Universities*, Animal Husbandry, Volume 5, Issue 1. Available Online <http://www.ejpau.media.pl>

## **DETERMINATION OF GENETIC DISTANCE BETWEEN HALF-BRED HORSE POPULATIONS IN RELATION TO THEIR COAT COLOUR**

Ryszard Pikuła, Dominik Gronet

*Department of Horse Breeding, Agricultural University of Szczecin, Poland*

[ABSTRACT](#)  
[INTRODUCTION](#)  
[MATERIALS AND METHODS](#)  
[RESULTS AND DISCUSSION](#)  
[CONCLUSIONS](#)  
[REFERENCES](#)

### **ABSTRACT**

Polymorphic blood image of the horses was used to determine genetic distances between groups of horses of different colour. The study covered 1247 half-bred horses, for which the polymorphism of albumin (Al), transferrin (Tf), alkaline esterase (EspH 8.5), vitamin D binding protein (Gc) and X<sub>k</sub> protein were determined. The analysis of genetic distance demonstrated that the studied groups of horses were considerably genetically separated depending on the colour. This allows concluding that there is an association between genetic polymorphism of some blood proteins and the coat colour of horses.

**Key words:** horses, coat colour, genetic distance, polymorphism of blood proteins

### **INTRODUCTION**

At present, genetic distance provides the most comprehensive information, which can be obtained from the frequencies of all marker genes and which illustrates the magnitude of genetic difference between two populations [6].

Blood protein polymorphism allows us to characterise each population and to determine genetic distance between particular breeds, as well as between various lines of the same breed [2].

The aim of this study was to determine genetic distance between groups of half-bred horses of different coat colour, basing on the polymorphism of selected blood proteins.

## MATERIALS AND METHODS

The study covered 1247 half-bred horses reared in the following stud farms: Bielin (176 individuals), Dobrzyniewo (23 individuals), Harenda (18 individuals), Janów Podlaski (118 individuals), Michałów (27 individuals), Nowielice (247 individuals), Panków (18 individuals), Racot (238 individuals), horse training centre Biały Bór (108 individuals), Kwidzyn (151 individuals), and Sopot (123 individuals).

The examined horses represented the following coat colours: chestnut (202 individuals), bay (752 individuals), black (63 individuals), grey (104 individuals), tobiano (62 individuals), and leopard (64 horses). As the coat colour does not represent a selection criterion in half-bred horses breeding, the horses were not grouped according to their breed.

The blood was collected from external jugular vein. Polymorphism of the following blood proteins was determined in blood serum: albumin (Al), transferrin (Tf), alkaline esterase (EspH 8.5), vitamin D binding protein (Gc), and  $X_k$  protein ( $X_k$ ). The separation of the proteins was carried out with polyacrylamide gel electrophoresis (PAGE) according to Juneja [1].

Polymorphic blood image of the examined horses was used in order to compute the distances between particular groups of different coat colours. The following were calculated within the distance analysis:

- coefficient of average heterozygosity and coefficient of average homozygosity [5]
- coefficient of average genetic identity and genetic distance according to Nei [3].

Genetic distance was presented on dendrograms computed with the following methods:

- SLM (single linkage method),
- CLM (complete linkage method),
- UPGMA (unweighted pair group method).

## RESULTS AND DISCUSSION

The genetic distance was worked out in order to get more comprehensive information about the differences that occur between half-bred horses of different coat colour. The degree of genetic consolidation has been expressed with the coefficients of average heterozygosity and average homozygosity ([Table 1](#)).

**Table 1. Coefficients of average heterozygosity and average homozygosity in the analysed populations of half-bred horses in relation to their coat colour**

Specification	Coat colour					
	chestnut	bay	black	grey	tobiano	leopard
Coefficient of average homozygosity	3.3515	3.4694	3.5238	3.4038	3.5323	3.1563
Coefficient of average heterozygosity	0.3297	0.3061	0.2952	0.3192	0.2935	0.3688

Genetic similarity between the horses of different coat colour is described with the coefficient of average genetic identity ([Table 2](#)).

**Table 2. Coefficients of average genetic identity in the analysed populations of half-bred horses in relation to their coat colour**

Coat colour	Chestnut				
Bay	0.99904	Bay			
Black	0.99811	0.99887	Black		
Grey	0.99694	0.99674	0.99469	Grey	
Tobiano	0.94911	0.94411	0.93889	0.94111	Tobiano
Leopard	0.98223	0.97873	0.97605	0.98202	0.93407

Genetic distance acquired its values according to the rule that the higher was the similarity, the lower was the distance ([Table 3](#)).

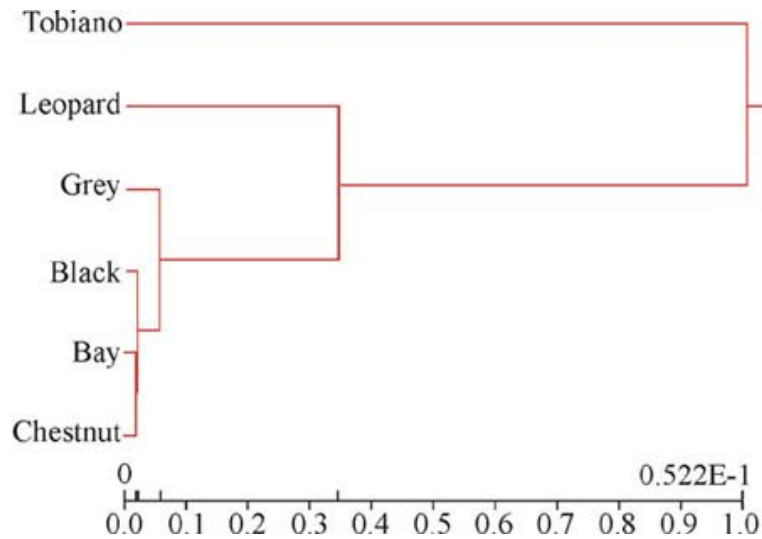
**Table 3. Genetic distance in the analysed populations of half-bred horses in relation to their coat colour**

Coat colour	Chestnut				
Bay	0.00096	Bay			
Black	0.00189	0.00113	Black		
Grey	0.00306	0.00327	0.00533	Grey	
Tobiano	0.05223	0.05752	0.06305	0.06070	Tobiano
Leopard	0.01793	0.02150	0.02424	0.01815	0.06820

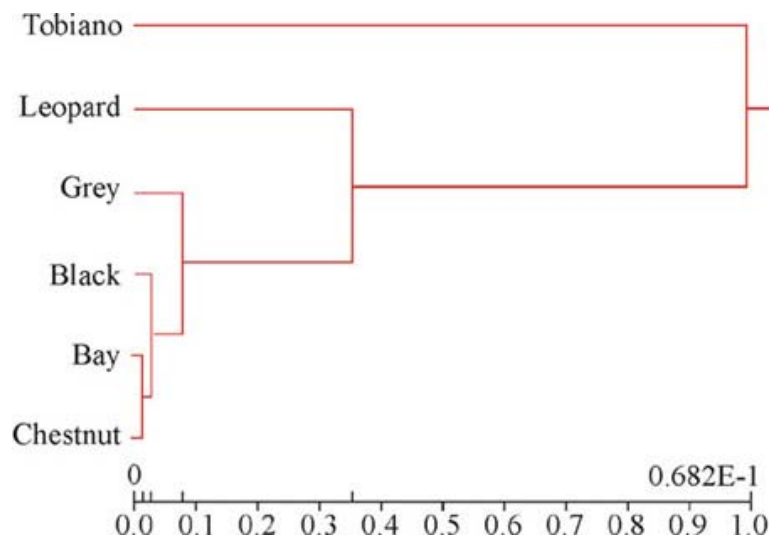
The following dendrograms are a graphical representation of the observed genetic distances between the half-bred horses of different colour:

- single linkage method (SLM) – [Figure 1](#),
- complete linkage method (CLM) – [Figure 2](#),
- unweighted pair group method (UPGMA) – [Figure 3](#).

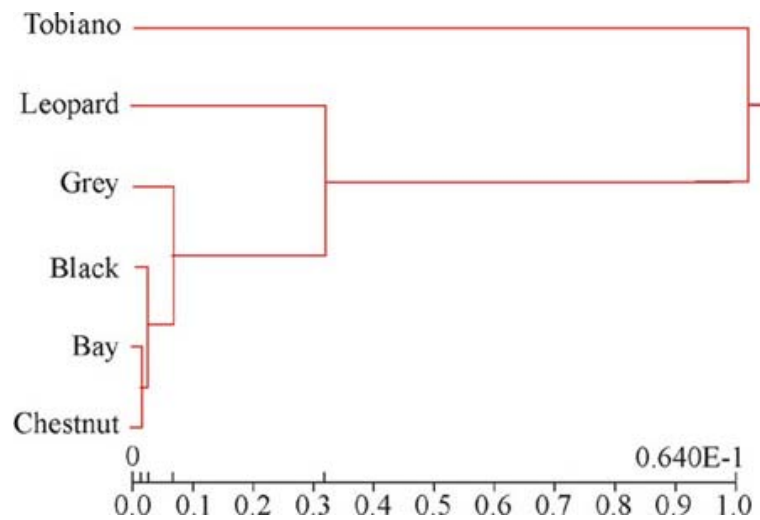
**Fig. 1. Dendrogram – single linkage method – SLM R = 0.8806**



**Fig. 2. Dendrogram – complete linkage method – CLM R = 0.8806**



**Fig. 3. Dendrogram – unweighted pair group method – UPGMA R = 0.8806**



The genetic differences between the differently coloured half-bred horses demonstrated that the strongest genetic consolidation was found in tobiano horses. These horses had the lowest coefficient of heterozygosity (0.2935), thus the highest coefficient of homozygosity (3.5323). The lowest degree of consolidation was observed in the leopard horses (respectively 0.3688 and 3.1563).

The analysis of genetic distance between the studied populations of horses demonstrated their considerable genetic distance depending on their coat colour. The lowest distance was found between the horses of basic colours – chestnut and bay (0.00096), bay and black (0.00113), and chestnut and black (0.00189), which may result from the mechanism of the colour heredity. Longer genetic distance was found between these horses and the horses with grey colour. The grey colour always appears over the given basic colour, and its manifestation is determined by the epistatic gene *G* at locus *G*. Similarly inherited are the genes that are responsible for the tobiano colour – *To* and leopard – *Lp*. The rules of the colour heredity, by some authors called “white coat patterns” [4], should suggest stronger genetic similarity of so coloured horses. tobiano and leopard horses were characterised, however, by manifold longer genetic distance in comparison with the remaining horses, at the same time being the most different from each other (0.06820).

This may demonstrate stronger genetic separateness of the tobiano and the leopard horses from the chestnut, bay, black, and grey, as well as the piebald from the dappled.

## CONCLUSIONS

The results demonstrated that both the tobiano and leopard horses belong to two distinct groups of horses, and the individuals of each of the groups differ genetically from the remaining horses of different coat colour. This allows presuming that a relationship exists between genetic polymorphism of some blood proteins and the kind of the horse coat colour.

## REFERENCES

1. Juneja R.K., 1981. Studies on genetic polymorphism of plasma proteins in domestic animals, Sver. Lantbruksuniv. Uppsala.
2. Kurył J., 1992. Markery genetyczne [Genetic markers]. Zesz. Nauk. PTZ 6, 48–76 [in Polish].
3. Nei M., 1972. Genetic distance between populations, Am. Nat. 106, 283.
4. Stachurska A., Zasadny R., 1999. Klasyfikacja maści oparta na podstawach genetycznych W: Aktualne kierunki hodowli i użytkowania koni w Europie [Colour classification based on genetics. In: Current trends in horse breeding and management in Europe]. Proceedings of conference. Kraków 17–19 September 1999, AR, Kraków, 227–232, [in Polish].
5. Stat-Gen. Analiza genetyczna populacji [Genetic population analysis] Version 1.2, 1994. [in Polish].
6. Żurkowski M., Kurył J., Gralak B., Kossowska A., Niemczewski C., Reklewski T., Pierzchała M., 1995. Markery genetyczne – ich wykorzystanie w hodowli zwierząt domowych [Genetic markers – their application in domestic animals breeding], Prz. Hod., 5, 4–7 [in Polish].

---

Ryszard Piķuła, Dominik Gronet  
Department of Horse Breeding  
Agricultural University of Szczecin  
Doktora Judyma 24, 71-460 Szczecin, Poland  
e-mail: [r.pikula@ar.zsi.pl](mailto:r.pikula@ar.zsi.pl)

---

[Responses](#) to this article, comments are invited and should be submitted within three months of the publication of the article. If accepted for publication, they will be published in the chapter headed 'Discussions' in each series and hyperlinked to the article.

---

[\[BACK\]](#) [\[MAIN\]](#) [\[HOW TO SUBMIT\]](#) [\[ISSUES\]](#) [\[SUBSCRIPTION\]](#)

---