

Analysis of the lines and families of the Žemaitukai horse breed

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Partition of the genetic variability, genetic structure and relationships among the lines and families of the Žemaitukai horse breed were studied using blood typing and electrophoretic analysis of serum proteins.

Investigation of the genetic diversity of blood serum proteins and blood groups among the Žemaitukai horses in a closed population showed that 6 genetic systems from the 7 investigated were polymorphic. This is especially true for the EAA, EAD, Est and Tf systems. The study showed that the distribution of allele frequencies varied with the lines and families.

The genetic similarity between the Astūras and Erelis lines was 0.707 and between the Kaštankė and Žibutė families 0.442.

Key words: horse, allele, blood group, serum protein polymorphism, gene frequency, genetic similarity

INTRODUCTION

The Žemaitukai is an ancient indigenous Lithuanian horse breed known since the 6th–7th centuries. The Žemaitukai became especially famous in the 14th century as excellent war horses during the Lithuanian–Crusader Battles. Later, the Žemaitukai developed into a utility horse.

Žemaitukai horses are small in size, the average measurements being as follows: withers height 128–142 cm, chest girth 165–180 cm, oblique body length 136–148 cm and common bone girth 17–19 cm. The weight of horses amounts to 360–240 kg. However, remarkable endurance, strength, hardiness, disease resistance and longevity are characteristic of the horses [8, 12]. The mares show both high fertility and milk production, yielding approximately 1.875 kg of milk in five lactation months with daily average of 12.5 kg [1].

Žemaitukai horses are noted for their harmonious body proportions, excellent conformation, smooth

and elegant carriage, strong trot, energetic yet compliant disposition. This is an all-purpose breed suitable for work on small farms, driving and riding. The horses show excellent endurance in long distance races. Due to their small size and easily manageable character, Žemaitukai horses are very suitable for children's sports and tourism. In the future the Žemaitukai should become a Lithuanian family horse.

The most widespread colours are bay, black, dark-bay and chestnut. Piebald, white legs or large and wide marks on the forehead are not characteristic. Most Žemaitukai have no white marks at all or have streaks of grey and stars on the forehead. So far, as a consequence of unfavourable historical circumstances, the number of Žemaitukai was very low. In 1994 there were only 30 pure-breed horses left, therefore, their conservation and multiplication became of paramount importance. To prevent the total loss of the breed, the breeding nucleus is currently concentrated in two herds belonging to the Vilnius Stud

and Lithuanian Institute of Animal Science (Baisogala). Several smaller herds are being formed by the country-life museums, agricultural schools and individual holders. In 1997, the Žemaitukai Horse Breeders Association was established to unite breeders, breed-fans and specialists.

The Lithuanian Institute of Animal Science has prepared the conservation programme for the Žemaitukai breed and measures to prevent the disappearance of the breed. The FAO Mission Conference for Central and East European countries recognized the Žemaitukai horse breed as highly valuable and watched internationally.

The Žemaitukai breed should be preserved not only as a national historical and cultural heritage, but also as an invaluable genetic resource for horse breeding. Žemaitukai horses are the founders of two different horse breeds. In the 18th century, Žemaitukai mares basically contributed towards the formation of the Trakehner breed, and in the 20th century the Žemaitukai served as the base for breeding the Lithuanian Heavy Draught and heavy-type Žemaitukai.

MATERIALS AND METHODS

Blood samples were collected from 21 horses of the Astūras line, 32 from the Erelis³ line, 30 from the Kaštankė family and 6 from the Žibutė family. Two 10 ml blood samples were submitted for each horse, one in ACD anti-coagulant to be used as a source of red cells and one in dry tube as a serum source.

Standard immunological procedures involving hemagglutination and complement mediated hemolysis [8] were used to detect red cell alloantigens at 6 internationally recognized blood group loci: A, C, D, K, Q, P (1995) [7].

Standard methods of polyacrylamide gel electrophoresis were used to identify the inherited variants at the following protein loci: albumin (Al), transferrin (Tf), esterase (Es), vitamin D binding protein (Gc), A1b glycoprotein (Xk) [3].

The frequency of antigenic factors, allele frequencies, genetic similarity, degree of homozygosity (Ca) were computed by conventional methods described by Majjala and Lindstrom (1966) [4], Rendel (1967) [6], Matoushek [10], Nei (1972) [5], and Zhitovskii and Mashurov (1974) [9].

RESULTS AND DISCUSSION

At present, the Žemaitukai horse breed consists of two remaining stallion lines and five mare families. In 1959 when the Žemaitukai herd was restored at the Vilnius Stud, the stallion Erelis³, the only one remaining after war, was mated to its daughters, *i.e.* the Žemaitukai were bred by close and very close inbreeding.

In ten years Erelis³ sired 45 offspring. The stallions Daigas 469 and Golfas 477 were the main successors of the Erelis³ line for more than 10 years. In 1983, the semen from Daigas 469 and Golfas 477 was frozen and the horses were sold. Only one stallion sired by Golfas 477 was left to continue the Erelis³ line. The name of the stallion was Aruodas 633 (born in 1975), and its progeny amounted to 23. The following successors of the Erelis line were the sons of Aruodas 633, namely, Klevas 907, Kaukas 902, Aitvaras Žrg 62 and also Patrimpas Žrg 65, the son of Čempionas 906 which in its turn was the grandson of Aruodas 633. At the beginning of 2001, 64 live horses belonged to the Erelis³ line.

For over a decade, the Erelis³ line was the only line sustaining the Žemaitukai horse breed. Therefore, the horses of this line were very closely related. In 1970s, to avoid incest, two variants of blood infusion were attempted: two Polish native stallions Killian 637 and Kipper 638 and an Estonian native horse, Astūras 634, were brought from Poland and Estonia.

The results of crossing Žemaitukai with Polish native horses were not inspiring, while a suitable ancestor of the Žemaitukai breed was selected among the progeny of Astūras 634. This successor was named Agentas 739 and sired 30 offspring. However, among all the sons of Agentas 795 there was only one stallion Aidas 905 which corresponded to the breeding value of his father and continued the Astūras 634 line. At the beginning of 2001 this line comprised 46 live horses.

Out of five mare families, only the family of the mare Kaštankė 0399 is more numerous. At the beginning of 2001, this family numbered 47 mares and fillies. The influence of different stallion lines is mostly evident in this family. The progeny of mares with a larger blood portion from Astūras 634 line are until now born of lighter colours, *i. e.* yellow, yellow dun, mouse-grey, and their chest is narrower, legs longer and head coarser. Meanwhile, the progeny with a higher blood infusion from Erelis³ line are mostly born dark-bay and their exterior is more elegant.

The family of Mirta is not numerous, it has only four mares, but this family is distinguished by its typical Žemaitukai qualities. Very good line continuers (Aruodas 633 and Agentas 795) have originated from this family, and therefore it is very important to multiply the family.

The family of Žibutė was least numerous, but now the family numbers 12 horses as the two mares of this family produced only fillies. The pedigree of the founder of this family, Žibutė, is not exactly known, but the progeny of this family are considered to be highly typical of the Žemaitukai breed.

The peculiarity of the family of Arabė 400 is defined by the fact that the features of the Arab

breed are inherited by the mares in even 4th and 5th generations. The family numbers four mares characterized by the Arab specific shade of temperament, elegant carriage and curved profile of the head; those are typical of only this family.

The family of Tulpė 411 numbers 9 mares and fillies that are distinguished by colour variety, solid constitution and a coarser head. The mares of this family are least typical of the Žemaitukai breed.

At the beginning of 2001, the Žemaitukai population numbered 110 purebred horses of which 64

belonged to the Erelis³ line and 46 to the Astūras 634 line. The Erelis³ line comprised 9 pedigree stallions and 10 non-tested horse foals. The Astūras 634 line comprised 5 pedigree stallions and 10 young horse foals. The families had 76 mares and fillies, of which 47 belonged to Kaštankė 0399, 12 to Žibutė, 9 to Tulpė 411, 4 to Mirta, 4 to Arabė 400 families [2].

Gene frequencies in blood group and serum protein systems. Tables 1 and 2 show the frequencies of alleles in blood group and serum protein systems

Table 1. Allele frequencies in five serum protein systems of the Žemaitukai horse population

Locus	Allele	Astūras line (n = 21)	Erelis line (n = 32)	Kaštankė family (n = 30)	Žibutė family (n = 6)
AL	A	0.8571	0.8594	0.7667	0.8333
	B	0.1429	0.1406	0.2333	0.1667
Ca		75.5%	75.8%	64.2%	72.2%
Gc	F	0.9737	0.6897	0.7885	0.8333
	S	0.0263	0.3103	0.2115	0.1667
Ca		94.9%	57.2%	66.6%	72.2%
Est	F	0.5476	0.1563	0.2333	0.5833
	I	0.1905	0.5937	0.3333	0.4167
	S	0.2619	0.2500	0.4333	
Ca		40.5%	43.9%	35.3%	51.4%
Xk	K	1.000	1.000	1.000	1.000
	S				
Ca					
Tf	D	0.3810	0.5625	0.4833	0.1667
	F	0.4762	0.2187	0.2666	0.6666
	O	0.1428	0.1563	0.1833	0.1667
	R		0.0625	0.0667	
Ca		39.2%	39.3%	34.3%	50.0%

Table 2. Gene frequencies in blood group systems of the Žemaitukai horse population

System	Allele	Astūras line (n = 21)	Erelis line (n = 32)	Kaštankė family (n = 30)	Žibutė family (n = 6)
A	A ^{ad}	0.3333	0.3125	0.2667	0.5000
	A ^{bc}	0.2857	0.1875	0.2167	
	A ^c	0.0714	0.0312	0.1166	0.2500
	A ^b	0.0476	0.0625	0.0660	
	A ^a	0.0238	0.0312	0.0333	
	A ^{cd}	0.0238			
	a ^a	0.2143	0.3750	0.3000	0.2500
Ca		24.7%	27.9%	22.7%	37.5%
D	D ^{egfm}				0.0833
	D ^{dghm}	0.4762	0.4844	0.4166	0.5000
	D ^{ad}	0.0714	0.1562	0.1166	0.0833
	D ^{bcm}	0.0952	0.1250	0.1166	0.0833
	D ^{egm}	0.1428	0.0781	0.1666	
	D ^{dk}	0.0476	0.0156	0.0333	0.1667
	D ^{dl}	0.0238	0.0625		
	d ^d	0.1428	0.0781	0.1500	0.0833
Ca		28.5%	29.1%	25.2%	30.6%

occurring in the population of Žemaitukai Astūras and Erelis lines and Kaštankė and Žibutė families. Variations were observed in all the systems, and results revealed the fact that the allelic constitution was generally similar in the breed. However, A^{cd} allele in EAA system was detected only in Astūras line. In the Tf protein system the R allele was detected only in the Erelis line and Kaštankė family. If compared with the allele frequencies of the same systems in the Erelis and Astūras lines, Kaštankė and Žibutė families, the Al^A, Gc^F, Xk^K, EAD^{dghm} alleles showed high frequencies in the Žemaitukai horse population.

Genetic similarities between the lines and families. Genetic similarities between the Astūras and Erelis lines, Kaštankė and Žibutė families were calculated using the genetic distance coefficients from the allele frequencies in two blood group and five serum protein systems. The genetic similarity between the Astūras and Erelis lines is $r = 0.707$ and between the Kaštankė and Žibutė families $r = 0.442$.

CONCLUSIONS

There are many studies on blood group and serum protein systems of the horse breeds, but there are few reports about the Žemaitukai horses.

Our own test results lead to the following conclusions:

1. Blood group and serum protein systems in Žemaitukai horses are polymorphic. This is especially true for the EAA, EAD, Est and Tf systems.
2. The allele frequencies in these systems were not uniform between the lines and families.
3. The distribution of allele frequencies varied with the lines and families. For instance, the A^{cd} allele was observed only in Astūras line, allele Tf^R only in the Erelis line and Kaštankė family.
4. The genetic similarity between the Astūras and Erelis lines was higher (0.707) than between the Kaštankė and Žibutė families (0.442).

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References

1. Garbačiauskaitė V. Žemaitukų veislės arkliai ir priemonės jų genofondui išsaugoti. Doctoral Dissertation. Baisogala, 1998.
2. Garbačiauskaitė-Macijauskienė V. Žemaitukai. Baisogala, 2000.
3. Juneja R. K., Gahne B., Sandberg K. Genetic polymorphism of vitamin D binding protein and another post-albumin protein in horse serum // *Animal Blood Groups and Biochemical Genetics*. 1978. No. 9. P. 29–36.
4. Majjala K., Lindstorm G. Frequencies of blood group genes and factors in the Finnish cattle breeds with special regard to breed comparison // *Ann. Agric. Fenniae*. 1966. No. 5. P. 76.

5. Nei M. Genetic distances between populations // *Amer. Nat.* 1972. No. 106. P. 283–291.
6. Rendel J. Studies of blood groups and protein variants as a means of revealing similarities and differences between animal populations // *Animal Breeding Abstracts*. 1967. No. 33. P. 307–314
7. Sandberg K. Guidelines for the interpretation of blood typing tests in horses. I. S. A. G. recommendation. 1995.
8. Stormont C., Suzuki Y. Genetic systems of blood groups in horses // *Genetics*. 1964. No. 50. P. 915–929.
9. Живатовский Л. А., Машуров А. М. Методические рекомендации по статистическому анализу иммуногенетических данных для использования в селекции животных. Дубровицы, 1974. 29 с.
10. Матюшек И. Группы крови крупного рогатого скота. Киев, 1964. 145 с.

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ŽEMAITUKŲ VEISLĖS ARKLIŲ LINIJŲ IR ŠEIMŲ ANALIZĖ

S a n t r a u k a

Žemaitukų veislėje yra išlikusios dvi zootechninės linijos ir 5 kumelių šeimos. 2001 metų pradžioje žemaitukų populiaciją sudarė 110 grynaveislių arklių. Iš jų 64 priklauso Erelio³ ir 46 Astūro 634 linijai. Šeimoms priklauso 76 kumelaitės ir kumelės, iš jų 47 – Kaštankės, 12 – Žibutės, 9 – Tulpės, 4 – Mirtos ir 4 – Arabės šeimai.

Atlikti žemaitukų veislės arklių kraujo grupių ir kraujo serumo baltymų genetinės įvairovės tyrimai rodo, kad iš tirtų 7 genetinių sistemų 6 yra polimorfines. Tai ypač ryšku EAA, EAD, Est ir Tf sistemose.

Buvo skaičiuotas genetinis panašumas tarp Erelio ir Astūro linijų (0,707) bei tarp gausesnių Kaštankės ir Žibutės šeimų (0,442).

Raktažodžiai: arkliai, aleliai, kraujo grupės, baltymų polimorfizmas, genų dažnis, genetinis panašumas

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АНАЛИЗ ЛИНИЙ И СЕМЕЙ ЛОШАДЕЙ ЖМУДСКОЙ ПОРОДЫ

Р е з ю м е

Сохранились две зоотехнические линии жеребцов лошадей жмудской породы и 5 семей кобыл. В начале 2001 года популяция жмудской породы включала 110 чистопородных животных, из них 64 особи линии Эрялис, 46 особей – линии Астурас 634. По семьям кобылы (76 животных) распределились так: 47 особей – в семье Каштанке, 12 – в семье Жибуте, 9 – в семье Тулле и по 4 особи – в семьях Мирта и Арабе.

Исследована генетическая изменчивость сывороточных белков и групп крови у лошадей жмудской породы. Установлено, что из 7 исследованных генетических систем 6 являются полиморфными. Это особенно видно по системам EAA, EAD, Est и Tf.

Ключевые слова: лошади, аллели, группы крови, полиморфизм белков, частота генов, генетическая схожесть