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GENETIC STRUCTURE OF TORI HORSE LINES IN UKRAINE

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The largest number of certified descendants of stallions and mares in the lines of the ancestors of stallions-producers Attila 3101 T (n=104) and Hoyus 3939 T (n=44).

In the Attila 3101 T line of the heir to the breeding stallion Akbar, born in 2000 (n=30), in his first son Khramovnik, the Dcgm allele was passed on to his 11 descendants, and the Ddk allele was not passed on to anyone. In Everest's second stallion son, the Ddk allele was passed on to 13 offspring, and the Dd allele was passed on to one offspring. It was found that in other lines, alleles are transmitted more or less chaotically, that is, in different ways. There are four homozygous offspring in the Attila 3101 T line, and one homozygous offspring each in the Hoyus 3939 T and Factor lines.

The highest frequency of the Dcgm allele gene was in the lines of the Foal progenitor Factor (q=0.600). At one level, it was high in the line of the ancestor of the stallion-producer Attila 3101 T, his descendant of the stallion-producer Everest, in the lines of the ancestors of the Agronom and Ukhke 573 TA (q=0.500).

The gene frequency of the Ddk allele was high in the lineage of the ancestor of the breeding stallion Hingstar 317 T (q=0.500) and Attila 3101 T from the heir of the breeding stallion Everest (q=0.441). The rare Dcegm allele was found only in the lineage of the ancestor of the stallion-fruit Hallis 348 T (q=0.167).

The highest level of polymorphism is in the Murmansk line (Ne – 5,538), the average level in the Hoyus 3939 T line (Ne – 4,809) and in the Atilla 3101 T line (Ne – 4,399). The highest coefficient of expected homozygosity in the Factor line (Ca – 0.460) and Agronom line (Ca – 0.389). The highest rate of realization of homozygosity is in the Ukke 573 TA line (W – 0.118) and the Factor line (W – 0.087). Homozygote deficiency in the Factor line (-0,420) and the Agronom line (-0,389).

The identified differences in the spectrum of active alleles of polymorphic blood group systems indicate that each studied horse genealogical line has a certain "genetic passport", and this creates a practical information base for maintaining lines and in general breeds in Ukraine under genetic control.

The information and data contained here can be used to further improve and preserve horse breeds, conducting work on breeding records and exchanging genetic material with the originator country.

Keywords: horses, lines, Tori breed, alleles, frequency, genotypes, genetic indicators.

ГЕНЕТИЧНА СТРУКТУРА ЛІНІЙ КОНЕЙ ТОРІЙСЬКОЇ ПОРОДИ В УКРАЇНІ

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Найбільша кількість атестованих нащадків жеребців та кобил у лініях родоначальників жеребців-плідників Аттіла 3101 Т (n=104) та Хойус 3939 Т (n=44).

В лінії Аттіла 3101 Т спадкоємця жеребця-плідника Акбар 2000 р.н. (n=30) у першого його сина Храмовнік алель Dcgm передався його 11 нащадкам, а алель Ddk нікому не передався. У другого сина - жеребця Евереста алель Ddk передався 13 нащадкам, а алель Dd передався одному нашадку. Встановлено, що в інших лініях алелі передаються більш менш хаотично, тобто по різному. В лінії Аттіла 3101 Т є чотири гомозиготні нащадки, в лініях Хойуса 3939 Т та Фактора – по одному гомозиготному нащадку.

Найвища генна частота алелю Dcgm була в лініях родоначальника жеребця-плідника Фактора (q=0,600). На одному рівні висока вона була в лінії родоначальника жеребця-плідника Аттіли 3101 Т його нащадка жеребця-плідника Евереста, в лініях родоначальників Агронома та Ухке 573 ТА (q=0,500).

По генній частоті алелю Ddk була висока в лінії родоначальника жеребця-плідника Хінгстар 317 Т (q=0,500) та Аттіли 3101 Т від спадкоємця жеребця-плідника Еверест (q=0,441). Рідкісний алель Dcegm був лише в лінії родоначальника жеребця-плідника Халліс 348 Т (q=0,167).

Найвищий рівень поліморфності в лінії Мурманська (Ne – 5,538), середній рівень у лінії Хойус 3939 Т (Ne – 4,809) та у лінії Атілла 3101 Т (Ne – 4,399). Найвищий коефіцієнт очікуваної гомозиготності в лінії Фактора (Ca – 0,460) та Агронома (Ca – 0,389). Найвищий показник реалізації гомозиготності в лінії Ухке 573 ТА (W – 0,118) та лінії Фактора (W – 0,087). Дефіцит гомозигот в лінії Фактора (-0,420) та Агронома (-0,389).

Виявлені відмінності за спектром діючих алелів поліморфних систем груп крові вказують, що кожна досліджена генеалогічна лінія коней володіє певним «генетичним паспортом», і це створює практичну інформаційну базу для ведення ліній та в цілому породи в Україні під генетичним контролем.

Інформація та дані, що містяться тут, можуть бути використані при подальшому удосконаленні та збереженні порід коней, ведення роботи по племінному обліку і обміну генетичним матеріалом із країною-оригінатором.

Ключові слова: коні, лінії, торійська порода, алелі, частота, генотипи, генетичні показники.

Introduction. In 1894, a stallion Hetman, the son of a local (Norfolk Roadster) Stallion Stewart and a queen of unknown origin of the Gunter type (Tori Horse, 2020), was delivered to the Tori stud factory. It became the ancestor of the Tori horse breed, as it corresponded to the most desirable type of agricultural horse of Estonian farmers of that time.

48 breeding stallions and 37 breeding queens were obtained from Hetman. In 1910, at the All-Russian Horse Show in Moscow, the descendants of the Hetman were awarded a gold medal. Hetman's best sons, widely used in Estonian horse breeding, were Heldenkabbe I and Harun 42 T.

The Tori breed was approved as an independent breed by Resolution No. 1256 of the Council of Ministers of the USSR of March 26, 1950.

Tori horses are characterized by good performance. Breed records: 13 min 21.5 sek in 2000 m traction walk with 150 kg deadlift, 4 min 44.8 sek in 2000 m trot with 50 kg deadlift. The maximum traction endurance at 300 kg was 1238 m, and the maximum – 880 kg. The fecundity of the breed is quite high, reaching 86 foals per 100 mares (Breeds of Livestock – Tori Horse; 2025).

The first breeding stallions of the Tori breed were imported to Ukrainian farms, born in 1984-1989 and belonged to 5 genealogical lines: Attila 3101 T, Hoyus 3939 T, Ukhke 573 TA, Hingstar 317 T and Hallis 348 T. In the 2000s, due to the lack of purebred Stallions, introductory crossing with stallions of Hanoverian, Thoroughbred horse was widely used and Trakenen breeds (Tkacheva I. V., 2020).

Tori horses were widely used to improve the local horse population in the north-western regions of Russia, in the western regions of Ukraine and in other regions. According to the Tori horse breeding Association, 1,365 representatives of the breed were registered in 2009 (Tori Horse, 2020).

The Tori horse is a versatile, healthy breed native to Estonia, known for its strong build, broad chest, and well-muscled limbs. Valued for its high fecundity and mainly used for working in sledding, the Tori horse is a versatile breed that perfectly copes with various tasks. Its robust build and efficient gait make it an ideal choice for driving, carriage rides, farm work and Recreation (Tori Horse /Horse Breeds, 2025)

The domestic population of the Tori horse breed meets the standard established by the Estonian Tori breed Association, but at the same time it is characterized by an original phenotype, universal working productivity, and a fairly extensive genealogical structure.

The genetic material of endangered animal breeds is being preserved all over the world. In 2018, it was published under the title "Guide to methods for preserving the valuable genetics of horses in live animals and the postmortem period", which includes data on the breeds of various animals, as the main resource for preserving the genetic diversity of horses. This guide also records the Tori horse breed (Breeds of Livestock – Tori Horse; 2025).

In-depth immunogenetic analysis allows you to track the movement of labeled genetic information over several generations. This allows you to control the inheritance of genes from the ancestor to its valuable successors. Various researchers in their works (Zubets M. V., 1999; podoba B. E., 2013; Efimenko M. Ya., 2005; Kovaleva T. M., 2014, Parasochka I. F., 2009), not only use the latest PCR methods (Behl R., 2007, Kaart, 2018; Sild, E., 2019), but also in parallel immunogenetic by blood groups that complement each other (Zaderykhina O. A., 2019).

The level of polymorphism is an important integral indicator that determines the number of active alleles in a line (Altukhov Yu. P., 1996). So are other indicators of the genetic situation in the animal population.

The aim of the research is to study the genetic markers and genetic indicators of Tori horse lines of Ukrainian selection.

Materials and methods of research. Immunogenetic studies of the D-system of blood groups were performed on 104 blood samples of Tori horses.

Immunogenetic certification of horses by blood types was carried out according to generally accepted methods (Burkat V. P., 2010; Hopka M. V., 2007; Rossokha V. I.,

2016; sow 01.22-37-528: 2006.)[xviii]. Serological testing identified red blood cell alleles, monofactorial systems C and K, and complex polymorphic Systems A and D. Monospecific reagent Sera that were identified with international standards (DSTU ISO 8531:2015)*were used to differentiate red blood cell alleles.

When testing and determining genotypes, we analyzed the immunogenetic structure of the studied horses by antigens and alleles of blood groups as a result of studying the lines and types of horses of the Tori breed, we studied five lines of the Tori breed and four lines of descendants of stallions of other breeds. The lines of descendants of stallions of other breeds are divided into two lines from Hanoverian and two from Thoroughbred breeding Stallions.

Genetic analysis of the frequency of occurrence of alleles of blood groups and genetic indicators (polymorphism level (Ne); expected (Ca) and actual homozygosity coefficient (H) across all loci; homozygosity realization index (W); homozygosity deficit (Def); information index (I), observed (Ho) and expected (He)heterozygosity; unbiased expected heterozygosity (uHe); The Wright fixation index F (Fis) of Tori genealogical lines was calculated both on the lines as a whole and on the descendants of stallions-producers of these lines were carried out using generally accepted methods using the programs "Excel 2003", "GenAlEx 6.502" and "Statistica".

Research results. To date, we have studied 9 lines of horses of the Tori breed of Ukrainian selection, namely: the first line from the ancestors of stallions-producers Attila 3101 T – 10 generations; the second line Hoyus 3939 T – 10 generations; the third line Hallis 348 T – 12 generations; the fourth line Hingstar 317 T – 10 generations; the fifth line Ukhke 573 T – 9 generations. From the sixth to the ninth line, descendants of stallions of other breeds, namely: the sixth line of Verdikt (Hanoverian Breed) – 3 generations; the seventh line of Factor (Hanoverian Breed) – 3 generations; the eighth line of Murmansk (Thoroughbred horse breed) – 5 generations and the ninth line of Agronom (Thoroughbred horse breed) – 2 generations.

In the first line from the ancestor of the stallion-producer Attila 3101 T, there are 3 branches of descendants from stallions-producers. The first branch is from the breeding stallion Aadam 13365T, born in 1991, who has six sons and three daughters of the mare. From his son, the stallion Khrushch, born in 1992, there are three grandchildren, from the grandson of the stallion-producer Khorey, born in 1998, there are a great-grandson Khorvat, born in 2009, and six great-grandchildren.

In the second branch of the breeding stallion Aagur, only one stallion, Khairat, born in 2002, can be traced.

The third very large branch is from the stallion-producer Appolo 19033 T. He has a son, stallion-producer Akbar 2000, who has 1 daughter and four sons of stallions (grandchildren of Appolo 19033 T). That is, it is a Khramovnik born in 2002, Everest born in 2003, Hamlet born in 2011 and Dessert born in 2012.

From the breeding stallion Akbar born in 2000, the third branch branches into two. That is, the branching can be traced from the 2002 Khramovnik stallion and the 2005 Everest stallion.

[xviii] SOW 01.22-37-528: 2006. Animal husbandry. method for determining blood groups, polymorphic blood proteins and examination of the origin of breeding horses. Kiev: Ministry of Agrarian Policy of Ukraine, 2006. 26 p.

(Standard Of The Ministry Of Agrarian Policy Of Ukraine)

*DSTU ISO 8531: 2015. Animal husbandry. Horses. Methods for obtaining and storing antierythrocytic immunodiapgnosticums for identifying horses by polymorphic systems of blood groups. [Effective from 2017-07-01]. Kiev, 2015. 17 p. (information and documentation).

Stallion-producer Khramovnik (born PSP "Kamyshanskoe") has five daughters and four sons of Akbar's grandchildren, these are stallions – Fahim born in 2005, Khokhot born in 2006, Khlopok born in 2007 and Ukrainets born in 2011.Akbar's grandson stallion-producer Ukrainets (born PSP "Kamyshanskoe") has twenty daughters and seven sons of stallions (great – grandchildren of Akbar) – Ustup born in 2013, Uran born in 2015, Ursus born in 2016 Burgui born in 2017, Urahan born in 2020, Uspikh born in 2022 and Rozumnyk born in 2023. The great-grandson of the stallion-producer Akbar Stallion-producer Burgui born in 2017 (born PSP "Kamyshanskoe") has sons of stallions Bulat born in 2020,Uzor born in 2021 and Latif born in 2022.

And another branching from the second son of the stallion-producer Akbar – Everest born in 2005 (born to FG "Amila"), who has four daughters and three sons of stallions (Akbar's grandchildren) – Etalon born in 2011, Versal born in 2012 and Unter born in 2013.

Grandson Etalon born in 2011 (born “Karetny Dvir”) has fourteen daughters and nine stallion sons: Burevii born in 2016, Lider born in 2016, Markiz born in 2017 Fox born in 2017, Epos born in 2018, Arkan born in 2020, Chardash born in 2021, Golden Rei born in 2021 and Yog born in 2024. All of them were born in the " Karetny Dvir". One of Akbar great-grandchildren, the 2020 Arkan breeding stallion, has three daughters and one son, the 2024 Tamerlan stallion (born in “Karetny Dvir”).

Grandson stallion-breeder Versaill born in 2012 (born FG "Amila") has two daughters and three sons stallions Vegas born in 2021, Babylon born in 2021 and Hilton born in 2024, that is, great-grandchildren Akbar.

In the second line, 4 branches can be traced from the ancestor of the breeding stallion Hoyus 3939 T from the breeding Stallions Husaar born in 1990 , Hopsak 11925 T, Uluchbek and Holler 11927T.

So in the first branch from the stallion-producer Husaar 1990, the descendants of two daughters-mares and four stallions (Ukhod born in 1999, Khokhotun born in 2000, Lotos born in 2000 and Dokhod born in 2001 are inherited). First son stallion Ukhod born in 1999 has one daughter. Husaar's second son stallion-producer Khokhotun has a son stallion-producer Dospekh born in 2005 (grandson of Husaar), who has four daughters and four sons Udod born in 2009, Uzhgorod born in 2011, Lider born in 2012 and Udarnik born in 2012 (born Zaporozhye stud farm). Husaar's third son, stallion Lotos, born in 2000 (born stud farm "Shakhtar"), has two daughters and one son, stallion Lilovyi, born in 2008 (born stud farm "Shakhtar"), unfortunately, this stallion's fate is unknown to us.

In the second branch from the stallion-producer Hopsak 11925T there is a descendant of the son stallion-producer Vulkan. From the stallion-producer Vulkan, a descendant of the stallion-producer Khvalenyi, born in 2010, who has one daughter and two sons-Stallions Ukhozhenyi in 2015 and Ukhozhenyi on 2 2016.

The third branch comes from the stallion-producer Uluchbek, who has one daughter and two sons of stallions-producers Taliban born in 1994 (born in I Sumy plemzavod) and Harun born in 1999 (born PSP "Kamyshanskoe"). Tthe stallion-producer Taliban (son Uluchbek) has one daughter and three sons-Stallions: Fant born in 2007, Flirt born in 2009 and Flint was born in 2010 (all of them were born in I Sumy P. Z.). From the second son of the stallion-producer Uluchbek stallion-producer Harun, there are two grandchildren stallion Gorokh born in 2010 and Ushlyi born in 2010 (born PSP "Kamyshanskoe").

The fourth branch is from the stallion-producer Holler 11927 T, who has seven daughters and one son of the stallion Uchvat born in 1996.The stallion-producer Uchvat born in 1996 has four daughters.

In the third line, two branches can be traced from the ancestor of the stallion-producer Hallis 348 T. The first branch is the son of stallion Landush 25, born in 1994 (born to **sooo** "Ukraine") and the second branch is from the son of the stallion-producer Halvet, born in 1996 (born to a private owner), who has five daughters-mares and four sons of stallions. His sons stallions Akhil born in 2014, Gerhan born in 2014, Mansur (not certified) and gelding Socrat born in 2002. From stallion Mansur is the grandson of Halvet stallion Hadzh born in 2012 (born “Karetny Dvir”), who has a son of Stallion Akhil born in 2016. (great – grandson of Halvet) and from Etap - stallion stage 2021 (born "Karetny Dvir") (great-grandson of Halvet). The stallion s Etap has one daughter.

From the stallion-producer Gerhan born in 2014 (born LLC "Zubr"), the second son of Halvet is the son of gelding Grand born in 2020 (born "Karetny Dvir") (grandson of Halvet).

In the fourth line from the ancestor of the stallion-producer Hingstar 317 T, one branch can be traced from the stallion-producer Halvak born in 1995 (born in Energoatom), who has six daughters and one son of the stallion Khmyz born in 2009 (born in FG "Amila"). Stallion Khmyz has four daughters-mares and two sons Graal born in 2018 and stallion Spirit born in 2018 (born in the " Karetny Dvir"), they are the grandchildren of the stallion-producer Halvak born in 1995. And already the breeding stallion Spirit has two sons, Chaos, born in 2022, and Lakmus, born in 2022 (great-grandchildren of Halvak). Unfortunately, they are geldings.

In the fifth line from the ancestor of the stallion-producer Ukhke 573 TA and passes one branch from the stallion Uldes 13435 T from which one daughter and two sons stallion-producer Ural 13430 T born in 1994 (born Energoatom) and the stallion Humat born in 2002 (born in LLC "Agrodibrovka"). The 1994 Ural breeder stallion has one a son, the 2005 surgeon Stallion (grandson of Uldes), who has one son, the 2014 Idol stallion (born “Karetny Dvir”), and seven daughters. The stallion-fruit Idol has one daughter and one son Lotos born in 2020, unfortunately he is a gelding.

From the sixth to the ninth line, the descendants are stallions of other breeds, namely:

In the sixth line from the ancestor of the stallion-producer Verdikt (Hanoverian breed) there is one daughter-mare and a son stallion-producer Hamer born in 2003 (born to FG "Amila"). The breeding stallion Hamer has fifteen mares and four sons of the stallion Khokhot, born in 2013, Khaker, born in 2016, Urahan, born in 2018, and Hetman, born in 2021 (the Stallions were born in FG "Amila”).

In the seventh line from the ancestor of the stallion-producer Factor (Hanoverian breed) (born in LLC "Zubr") go two of his sons stallion Graf 2015 year of birth and Hephest 2016 year of birth. Hephest is accompanied by three sons , Hamlet, born in 2022, Grant, born in 2023, and Granit, born in 2024 (born in in FG "Amila”), and five daughters. They are all grandsons of the Factor.

In the eighth line from the stallion-producer Murmansk (Thoroughbred horse breed) there is one branch from the stallion-producer Emin born in 1995 (born in Mirogoshchansky agricultural College), who has 7 daughters and three sons of stallions Firmach born in 2001 (born in Sumy plemzavod), Menes born in 2001 (born in Mirogoshchansky Agricultural College) and Achilles, born in 2007 (born to a private owner). From a breeding stallion Achilles has a son, Stallion Khalif, born in 2011 (born to a private owner), who is Emin's grandson.

In the ninth line from the ancestor of the stallion-producer Agronom (Thoroughbred horse breed), there are three stallions, namely Usama born in 2004, Hathor born in 2005 and Ak Murun born in 2006 (born Mirogoshchansky Agricultural College).

Today, these lines are large and remain the leading ones in the Tori horse breed. They have breeding qualities and a large number of breeding Stallions.

The largest number of certified descendants of stallions and mares in the lines of the ancestors of stallions-producers Attila 3101 T (n=104) and Hoyus 3939 T (n=44). The average number of certified descendants in the lines of the ancestors of the Stallions-producers Verdikt (n=20) and Murmansk (n=19) (Table 1).

Table 1

Linear composition of the breeding core of certified horses of the Tori breed

Lines	Total horses in the line, head	Including		Most promising branches	In the lines of them the main production warehouse horses, goal									
						Including								
		Stallions-producers	The mothers mares		Total	sons	grandchildren	great-grandchildren	great-great-grandchildren	daughters	granddaughters	great-granddaughters	great - great -granddaughters	great - great - great - granddaughters
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Atilla 3101 T	104	4	-	13365 Aadam	18	1	3	2	-	3	-	3	6	-
		8	-	Akbar	84	4	7	19	4	1	9	36	3	1
Hallis 348 T	15	5	-	Halvet	13	3	2	1	1	5	-	-	-	1
Hingstar 317 T	16	3	-	Halvak	15	1	2	2	-	6	4	-	-	-
Ukhke 573 TA	14	3	1	1343T Ural	11	1	1	1	-	-	7	1	-	-
Hoyus 3939 T	44	5	-	Husaar	19	4	2	4	-	2	3	4	-	-
		3	-	Uluchbek	9	2	5	-	-	1	1	-	-	
		2	-	Vulcan	4	1	2	-	-	1	-	-	-	
		2	-	11927 T Holler	12	1	-	-	-	7	4	-	-	
Offspring of other breeds														
Verdict (Hanover)	20	2	-	Hamer	19	4	-	-	-	15	-	-	-	-
Factor (Hanover)	10	1	-	Graf	-	-	-	-	-	-	-	-	-	-
		2	-	Gefest	8	3	-	-	-	5	-	-	-	-
Murmansk (thoroughbred)	19	2	-	Emin	18	3	2	-	-	7	6	-	-	-
Agronom (thoroughbred)	3	-	-	-	3	3	-	-	-	-	-	-	-	-

More or less descendants in the line of ancestors of the Stallions-producers Hingstar 317 T (n=16) and Hallis 348 T (n = 15).

Thus, in the line of the ancestor of the stallion-producer Attila 3101 T, the largest number of descendants is 84 heads. The average number of 19 descendants in the Hoyus 3939 T lineage is from the Hussar breeding stallion and the Verdikt (Hanover) line from the Hamer breeding stallion born in 2003 (Table 2). Also in the line of the ancestor Murmansk from the stallion Emin born in 1995 and in the line of the ancestor Attila 3101 T from the stallion Aadam 13365 born in 1991, the number of descendants is the same for 18 animals.

Table 2

Number of certified Stallions-producers and Horses by branches of genealogical lines

Lines	Branch	Number of active total										Total
		Stallions					Mother's mares					
		Sons	Grandchildren	Great-grandchildren	Great -great-Grandchildren	Great- great -great-grandchildren	Daughters	Granddaughters	Great-granddaughters	Great - great -granddaughters	Great - great - great - granddaughters	
Atilla 3101 T	13365 Adam 1991	1	3	2	-	-	3	-	3	6	-	18
	Akbar 2000	4	7	19	4	-	1	9	36	3	1	84
Total in line		5	10	21	4	-	4	9	39	9	1	102
Hallis 348 T	Halvat 1996	3	2	1	1	-	5	-	-	-	1	13
Hingstar 317 T	Halvak 1995	1	2	2	-	-	6	4	-	-	-	15
Ukhke 573 TA	1343T Ural 1994	1	1	1	-	-	-	7	1	-	-	11
Hoyus 3939 T	Husaar 1990	4	2	4	-	-	2	3	4	-	-	19
	Uluchbek	2	5	-	-	-	1	1	-	-	-	9
	Vulcan	1	2	-	-	-	1	-	-	-	-	4
	11927 T Holler	1	-	-	-	-	7	4	-	-	-	12
Total in line		8	9	4	-	-	11	8	-	-	-	44
Verdict (Hanover)	Hamer 2003	4	-	-	-	-	15	-	-	-	-	19
Factor (Hanover)	Gefest 2016	3	-	-	-	-	5	-	-	-	-	8
Murmansk (thoroughbred)	Emin 1995	3	2	-	-	-	7	6	-	-	-	18
Agronom (thoroughbred)	-	3	-	-	-	-	-	-	-	-	-	3

Analysis of the distribution of D-system alleles among the descendants of prominent producers showed that the highest frequency of the Dcgm allele gene was in the lines of the Foal progenitor Factor (q=0.600). It was high in the line of the ancestor of the stallion-producer Attila, his descendant of the stallion-producer Everest (q=0.500). The same frequency was observed in the lines of the ancestors of Agronom and Ukhke (q=0.500).

The highest characteristic frequency of the Dad allele gene was in the lineage of the ancestor of the Hoyus stallion (Husaar stallion) (q=0.091). In seven lines, this allele was absent (table. 3).

The highest frequency of the Ddg allele (q=0.429) was in the lineage of the ancestor of the breeding stallion Attila from the heir of the breeding stallion Aadam. This allele was absent in the lines of the progenitors of foals-producers Ukhke, Verdikt and Factor.

The highest gene frequency of the Ddk allele was in the lineage of the ancestor of the breeding stallion Hingstar (q=0.500) and Attila from the heir of the breeding stallion Everest (q=0.441). This allele was absent only in one line of the ancestor of the stallion-the agronomist producer.

The highest frequency of the Dbcm allele was in the lineage of the ancestor of the Hoyus stallion from the heir Uluchbek (q=0.375) and the ancestor of the stallion Agronom (q=0.333). This allele was absent in the lines of the progenitors of stallions-producers Hallis, Verdicts and Factor.

The highest frequency of the Dde allele was in the lineage of the Foal progenitor Factor and Verdict (q=0.300). This allele was absent in the lines of the ancestors of stallions-producers Hingstar and Agronom.

The ancestor line of the Verdict stallion has the highest gene frequency of the Dd allele (q=0.300). This allele was absent in the lines of the ancestors of stallions-producers Ukhke, Factor and Agronom.

The rare Dcegm allele was found only in the lineage of the ancestor of the stallion-fruit Hallis (q=0.167).

There was no significant difference between the values of the gene frequencies of the D-system alleles of the blood groups of the Tori horse breed Attila with the lines, Hallis, Hingstar and Murmansk. As well as the Haliss line with the lines of Hingstar, Ukhke, Verdikt, Factor, Murmansk and Agronom were also not found. There was also no statistically significant difference between the values of the Ukhke line and the Verdikt, Factor, Murmansk, and Agronom lines. In general, there were no statistically significant differences between allele indicators in the Hoyus line with the Murmansk and Agronom lines.

But there were differences to focus on.

Thus, statistically significant (significant) differences were found in the frequency indicators of the Ddg allele ($P \leq 0.05$) between the Attila line with the Ukhke, Verdikt and Factor lines.

When comparing the gene frequency values for the Ddg allele ($P \leq 0.01$), high-level differences were found between the Hoyus line and the Ukhke, Verdict, and Factor lines.

Statistically significant (significant) differences were found between the Hoyus line and the Hallis, Verdict, and Factor lines in terms of gene frequencies for the Dbcm allele ($P \leq 0.05$).

Table 3

Distribution of gene frequencies of alleles of the D-system of blood groups along the lines of Tori horses, M±m

Alleles / Lines		ad	dg	dk	cgm	bcm	de	d	cegm
Attila 3101 T	13365T Adam (n=7)	0,071± 0,069	0,429± 0,232	0,143± 0,094	0,214± 0,109	0,000	0,000	0,143± 0,094	0,000
	Khramovnik (n=15)	0,000	0,000	0,267± 0,081	0,500± 0,091	0,033± 0,033	0,000	0,200± 0,073	0,000
	Everest (n=17)	0,000	0,088± 0,049	0,441± 0,085	0,176± 0,065	0,088± 0,049	0,088± 0,049	0,118± 0,055	0,000
Total in line [1]	(n=42)	0,012± 0,012	0,107± 0,034	0,310± 0,050	0,298± 0,049	0,048± 0,023	0,071± 0,091	0,155± 0,039	0,000
Hallis 348 T[2]	Halvet (n=9)	0,000	0,056± 0,054	0,167± 0,088	0,389± 0,115	0,000	0,111± 0,074	0,111± 0,074	0,167± 0,088
Hingstar 317 T[3]	Halvak (n=6)	0,000	0,083± 0,079	0,500± 0,144	0,167± ,108	0,083± 0,079	0,000	0,167± 0,108	0,000
Ukhke 573 TA[4]	(n=5)	0,000	0,000*[1]	0,200± 0,126	0,500± 0,158	0,200± 0,126	0,100± 0,095	0,000**[1]	0,000
Hoyus 3939 T	Husaar (n=11)	0,091± 0,061	0,364± 0,103	0,136± 0,073	0,227± 0,089	0,136± 0,073	0,045± 0,044	0,000	0,000
	Uluchbek (n=8)	0,000	0,250± 0,108	0,000	0,250± 0,108	0,375± 0,121	0,063± 0,061	0,063± 0,061	0,000
Total in line [5]	(n=23)	0,065± 0,036	0,283± 0,066**[4]	0,130± 0,049	0,239± 0,063	0,217± 0,061*[2]	0,043± 0,030	0,022± 0,022*[1]	0,000
Verdict[6]	Hamer (n=5)	0,000	0,000*[1] **[5]	0,100± 0,095	0,300± 0,145	0,000*[5]	0,300± 0,145	0,300± 0,145	0,000
Factor[7]	(n=5)	0,000	0,000*[1] **[5]	0,100± 0,095	0,600± 0,155	0,000*[5]	0,300± 0,145	0,000**[1]	0,000
Murmansk[8]	Emin (n=6)	0,000	0,167± 0,108	0,083± 0,079	0,167± 0,108	0,250± 0,125	0,167± 0,108	0,167± 0,108	0,000
Agronom[9]	- (n=3)	0,000	0,167±0,152	0,000***[1]	0,500±0,204	0,333±0,192	0,000	0,000**[1]	0,000

*Note: P – significance level; * – p≤0.05; ** – P≤0.01; *** – P≤0.001; 1 – 9 – Tori horse lines hereafter: 1 – Attila 3201 T line, 2 – Hallis 348 T line, 3 – Hingstar317 T line, 4 – Ukhke 573 T line, 5 – Hoyus 3939 T line, 6 – Verdict line, 7 – Factor line, 8 – Murmansk line, 9 – Agronom line.*

Statistically significant (significant) differences were found between the Attila and Hoyus lines in terms of DD allele frequencies (P≤0.05). For the same allele, high-level differences were found between the Attila line and the Ukhke, Factor, and Agronom lines.

In comparison of gene frequency indicators for the Ddk allele (P≤0.001), differences in the absolute level of statistical significance were found between the Attila line and the Agronom line.

Table 4 shows breeding stallions with homozygous and heterozygous genotypes according to the D-system of blood groups, which have the most numerous sample of offspring and have passed immunogenetic certification at the Institute of animal husbandry of the National Academy of Sciences. It was found that there are four homozygous offspring in the Attila line, and one homozygous offspring each in the Hoyus and Factor lines.

Table 4

Genotypes according to the D-system of Tori breeding stallions approved for breeding use

Lines	Stallions-producers from which the largest number of descendants		Genotypes	Number descendants by line			Total descendants by line
				Stallions	Mares	Total	
Atilla 3101T	13365 Aadam		$D^{cgm/dg}$	6	12	18	98
	Acbar	Khramovnic	$D^{cgm/dk}$	14	26	40	
		Everest	$D^{dk/d}$	17	23	40	
Hallis 348T	Halvet		$D^{cgm/dk}$	7	6	13	13
Hoyus 3939T	Husaar		$D^{dk/dg}$	10	9	19	32
	Uluchbek		$D^{bcm/cgm}$	7	2	9	
	Vulcan		$D^{cgm/dk}$	3	1	4	
	11927T Holler		$D^{ad/bcm}$	1	11	12	
Hingstar 317T	Halvak		$D^{dk/d}$	5	10	15	15
Ukhke 573TA	1343T Ural		$D^{bcm/cgm}$	3	8	11	11
Verdict (Hanover)	Hamer		$D^{de/d}$	4	15	19	19
Factor (Hanover)	Gefest		$D^{cgm/cgm}$	3	5	8	8
Murmansk (thoroughbred)	Emin		$D^{bcm/de}$	5	13	18	18
Agronom (thoroughbred)	-		$D^{cgm/cgm}$	3	-	3	3

And we state that in the Attila lineage , one of the Dcgm alleles is inherited, because it is present in the descendants of the stallions-producers Aadam and Akbar.

Similarly, in the Hallis 348 T lines, is inherited by descendants of the Dcgm allele from the stallion-producer Halvet and Hoyus 3939 T from the stallion-producer Vulcan.

A study was conducted on the inheritance of alleles of 9 lines of horses of the Tori breed (table 5).

Table 5

Transfer of marker alleles to offspring from Tori breeding Stallions

Lines	Nickname lines and DKPC number	n, heads	Allele		Number of offspring				χ^2
			I	II	with an allele I	%	with an allele II	%	
Atilla 3101 T	13365 T Aadam	6	cgm	dg	1	16,5	4	67	6,600
	Khramov-nik	14	cgm	dk	11	79	0	0	4,143
	Everest	16	dk	d	13	81	1	6,3	11,247
Hallis 348 T	Halvet	7	cgm	dk	4	57	1	14,3	8,867
Hoyus 3939 T	Husaar	10	dk	dg	2	20	8	80	12,292
	Uluchbek	7	bcm	cgm	4	57	3	43	10,92
Hingstar 317 T	Halvak	5	dk	d	5	100	0	0	5,000
Ukhke 573 TA	13430 T Ural	3	bcm	cgm	0	0	3	100	0,750
Verdict (Hanover)	Hamer	4	de	d	2	50	2	50	6,667
Factor (Hanover)	Gefest	3	cgm	cgm	3	100	0	0	3,000
Murmansk (thoroughbred)	Emin	5	bcm	de	2	40	2	40	17,50
Agronom (thoroughbred)	-	0	cgm	cgm	0	0	0	0	-

Note. χ2 is the Pearson compliance criterion.

Analysis of the distribution of alleles of the D-system among the descendants of prominent breeders showed that in the Attila 3101 T line of the heir of the stallion Akbar born in 2000 (n=30) in his first son Hramovnic, the Dcgm allele was passed on to his 11 descendants, and the Ddk allele was not passed on to anyone. In Everest's second stallion son, the Ddk allele was passed on to 13 offspring, and the Dd allele was passed on to one offspring.

In the Hallis lineage of the heir to the Halvet breeding stallion (n=7), the Dcgm allele was passed on to its 4th stallion offspring, and the Ddk allele was passed on to its 1st offspring.

In the Hoyus 3939 T line of the heir of the Husaar breeding stallion (n=9), the Ddk allele was passed on to the 2nd offspring of the stallion, and the Ddg allele was passed on to the 8th offspring. In the same lineage, in the heir of the breeding stallion Uluchbek

(n=7), the Dbcm allele was passed on to 4 descendants, and the Dcgm allele was passed on to 3 descendants.

In the Hingstar lineage of the Halvak breeding stallion heir (n=5), the Ddk allele was passed on to 5 descendants, while the Dd allele was not passed on to anyone.

In the Murmansk (Thoroughbred horse breed) line of the Emin breeding stallion heir (n=5), the Dbcm allele was passed on to 2 stallion descendants, and the Dde allele was passed on to 2 descendants, except for one descendant.

In the Verdict line (Hanoverian breed) of the Hamer breeding stallion heir (n=4), the Dde and Dd alleles were passed down equally among the stallion's descendants.

A genetic and population analysis of 9 lines of Tori breeding Stallions was carried out (table. 6).

The highest level of polymorphism is found in the Murmansk line (Ne – 5,538), the average level in the Hoyus 3939 T line (Ne – 4,809) and in the Atilla 3101 T line (Ne – 4,399). The lowest in the Factor line (Ne – 2,174).

The highest coefficient of expected homozygosity in the Factor line (Ca – 0.460) and Agronom line (Ca – 0.389).

The highest rate of realization of homozygosity is in the Ukhke 573 T line (W – 0.118) and the Factor line (W – 0.087). Homozygote deficiency in the Factor line (-0,420) and the Agronom line (-0,389).

Thus, each of the nine lines studied in the Tori breed has a unique, significantly different immunogenetic profile.

Most cultural and historical arguments for conservation and improvement are not based on genetic information, but in-depth immunogenetic analysis allows you to track the movement of labeled genetic information over several generations.

Markers help to get a more accurate picture of genotypes in terms of observing the distribution of labeled genetic information in the offspring of producers and its movement over several generations in lines and families. And if we need to preserve genetic diversity, then we need to focus our work on heterogeneous selection. And for fixing the desired allele – homogeneous, that is, an allele that corresponds to liveliness, multiple pregnancies, etc.

Since there are only a few genetic studies of Tori horses, the aim of this work was to provide new information to horse associations about the population structure, genetic characteristics and genetic origin of the Tori horse, as well as its relationship among other horse breeds. We hope that our results will be useful for breeding and breeding plans.

As a summary of our results, we conclude that each studied genealogical line of horses has a certain "genetic passport", and this creates a practical information base for maintaining lines and breeds in general in Ukraine under genetic control.

Conclusions:

1. All nine lines of the Tori horse breed have a peculiar, reliably excellent immunogenetic profile.

2. The largest number of certified descendants of stallions and mares in the lines of the ancestors of stallions-producers Attila 3101 T (n=104) and Hoyus 3939 T (n=44).

3. In the Attila 3101 T line of the heir to the breeding stallion Akbar, born in 2000 (n=30), in his first son Khramovnik, the Dcgm allele was passed on to his 11 descendants, but the Ddk allele was not passed on to anyone. In Everest's second stallion son, the Ddk allele was passed on to 13 offspring, and the Dd allele was passed on to one offspring. There are four homozygous offspring in the Attila line, and one homozygous offspring in the Hoyus and Factor lines. Along other lines, alleles are transmitted more or less randomly, that is, in different ways.

Table 6

Genetic indicators by lines of the Toril horse breed

Line	Offspring of stud stallions	n	Na	Ne	Ca	I	H	W	Ho	He	uHe	Def	F
Attila 3101 T	13365 T Aadam	7	5,000	3,630	0,276	1,438	0,000	0,000	1,000	0,724	0,780	-0,276	-0,380
	Khramovnik	15	4,000	2,761	0,362	1,134	0,013	0,037	0,986	0,638	0,660	-0,349	-0,547
	Everest	17	6,000	3,803	0,263	1,562	0,003	0,013	0,997	0,737	0,759	-0,259	-0,352
	Total in line	42	7,000	4,399	0,227	1,638	0,002	0,009	0,998	0,773	0,782	-0,225	-0,291
Hallis 348 T	Total in line	9	6,000	4,263	0,235	1,613	0,000	0,000	1,000	0,765	0,810	-0,235	-0,306
Hingstar 317 T	Halvak	6	5,000	3,130	0,320	1,358	0,000	0,000	1,000	0,681	0,742	-0,320	-0,469
Hoyus 3939 T	Husaar	11	6,000	4,321	0,231	1,577	0,000	0,000	1,000	0,768	0,788	-0,231	-0,301
	Uluchbek	8	5,000	3,657	0,273	1,408	0,016	0,057	0,984	0,727	0,775	-0,258	-0,355
	Total in line	23	7,000	4,809	0,208	1,696	0,002	0,069	0,998	0,792	0,811	-0,206	-0,260
Ukhke 573 TA	13430 T Ural	5	4,000	2,941	0,340	1,221	0,040	0,118	0,960	0,660	0,733	-0,300	-0,455
Verdict	Hamer	5	4,000	3,571	0,280	1,314	0,000	0,000	1,000	0,720	0,800	-0,280	-0,389
Factor	Gefest	5	3,000	2,174	0,460	0,898	0,040	0,087	0,960	0,540	0,600	-0,420	-0,778
Murmansk	Emin	6	6,000	5,538	0,181	1,748	0,000	0,000	1,000	0,819	0,894	-0,181	-0,220
Agronom	-	3	3,000	2,571	0,389	1,011	0,000	0,000	1,000	0,611	0,733	-0,389	-0,636

4. The highest frequency of the Dcgm allele gene was in the lineages of the Foal progenitor Factor (q=0.600). At one level, it was high in the line of the ancestor of the stallion-producer Attila, his descendant of the stallion-producer Everest, in the lines of the ancestors of the Agronom and Ukhke (q=0.500).

The gene frequency of the Ddk allele was high in the lineage of the ancestor of the breeding stallion Hingstar (q=0.500) and Attila from the heir of the breeding stallion Everest (q=0.441). The rare Dcegm allele was found only in the lineage of the ancestor of the stallion-fruit Hallis (q=0.167).

5. The highest level of polymorphism is in the Murmansk line (Ne – 5,538), the average level in the Hoyus 3939 T line (Ne – 4,809) and in the Atilla 3101 T line (Ne – 4,399). The highest coefficient of expected homozygosity in the Factor line (Ca – 0.460) and Agronom line (Ca – 0.389). The highest rate of realization of homozygosity is in the Ukhke 573 TA line (W – 0.118) and the Factor line (W – 0.087). Homozygote deficiency in the Factor line (-0,420) and the Agronom line (-0,389).

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