



DOI 10.32900/2312-8402-2023-130-216-230

UDC 636.1.082

POPULATION CHARACTERISTICS AND THE CONCEPT OF GENE POOL CONSERVATION FOR THE OF HORSES OF THE NEWLY CREATED UKRAINIAN TROTTING BREED GROUP

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Population characteristics were analyzed and specific features of the newly created Ukrainian trotting breed group of horses were revealed. The main conditions for stable preservation of the horse gene pool, risks and opportunities for the newly created Ukrainian trotting breed group are determined. The quantitative composition of the reproductive population of the Ukrainian trotting breed group of horses, which according to the FAO classification is in the status of "in a state of danger", has been established. The basic population characteristics of the newly created breed group are described. The share of the breed group in the total of trotting horses of Ukraine, which is 37.2%, was determined, the amount of interbreeding improving crossbreeding with the American Standardbred and French trotting breeds was determined, and the expediency of its use was justified. The maximum number of generations in the breed – 11 – was observed in the Scotland line, a branch of Speedy Crown. The use of indicators, one of which is based on the generation interval, and the second is based on the inbreeding coefficient, made it possible to analyze the population and identify specific features of the Ukrainian trotting breed group of horses. The average annual yield of foals and the number of repair young ones were calculated to preserve the gene pool of the breed group at the current level. The generation interval for the breed group was $L=11.57\pm 0.98$ years. It was determined that the generation interval between sires and their male offsprings is greater than between dams and male offsprings, and the generation interval between dams and female offsprings is greater than between sires and female offsprings. The effective number of the population, according to which the new breed group will develop qualitatively, is 688.2 horses of reproductive age. The increase in the inbreeding coefficient for one generation is $\Delta F=0.0063$, and therefore, to prevent the growth of inbreeding, the increase in the effective size of the population per generation should be 79.4 heads. If the quantitative composition of the breed group does not increase, the population will lose 2.36% of genetic diversity in 10 generations.

Key words: horses, Ukrainian trotting breed group, population characteristics, generation interval, inbreeding coefficient, preservation of the gene pool.



ПОПУЛЯЦІЙНІ ХАРАКТЕРИСТИКИ ТА КОНЦЕПЦІЯ ЗБЕРЕЖЕННЯ ГЕНОФОНДУ КОНЕЙ НОВОСТВОРЮВАНОЇ УКРАЇНСЬКОЇ РИСИСТОЇ ПОРОДНОЇ ГРУПИ

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Проаналізувано популяційні характеристики та виявлено специфічні особливості новостворюваної української рисистої породної групи коней. Визначено головні умови сталого збереження генофонду коней, ризики і можливості для новостворюваної української рисистої породної групи. Встановлено кількісний склад репродуктивного поголів'я української рисистої породної групи коней, що за класифікацією ФАО знаходиться у статусі «у стані небезпеки». Описано основні популяційні характеристики новостворюваної породної групи. Визначено частку породної групи у масиві рисистих коней України, що складає 37,2 %, встановлено обсяги міжпородного поліпшуючого схрещування з американською стандартбредною та французькою рисистою породами і обґрунтовано доцільність його використання. Максимальну кількість генерацій в породі – 11 – спостерігали в лінії Скотланда, гілка Сніді Крауна. Використання показників, один з яких заснований на генераційному інтервалі, а другий – на коефіцієнті інбридингу, дозволило проаналізувати популяцію та виявити специфічні особливості української рисистої породної групи коней. Розраховано середньорічний вихід лоша та кількість ремонтного молодняку для збереження генофонду породної групи на сучасному рівні. Генераційний інтервал для породної групи склав: $L=11,57\pm 0,98$ років. Визначено, що генераційний інтервал між жеребцями та їх синами більший, ніж між матерями та синами, а генераційний інтервал між матерями і дочками більший ніж між батьками і дочками. Ефективна чисельність популяції, за якою нова породна група буде якісно розвиватись, становить 688,2 коней репродуктивного віку. Підвищення коефіцієнту інбридингу за одну генерацію становить $\Delta F=0,0063$, а отже, для запобігання зростання інбридингу, приріст ефективної чисельності популяції на одну генерацію має складати 79,4 голів. Якщо кількісний склад породної групи не підвищуватиметься, популяція втрачатиме 2,36 % генетичного різноманіття за 10 генерацій.

Ключові слова: коні, українська рисиста породна група, популяційні характеристики, генераційний інтервал, коефіцієнт інбридингу, збереження генофонду.

For the first time, the issue of preservation of local and endangered breeds of agricultural animals was raised by the geneticist O.S. Serebrovskiy in 1928, and in 1946, at the first session of the Advisory Committee on Agriculture of the FAO, the need for the assessment and conservation of the world fund of animals and plants was discussed.

In June 1992, the Convention on Biological Diversity was adopted in Rio de Janeiro with the aim of sustainable use of its components, obtaining fairly distributed profits from the use of genetic resources, joint use of relevant technologies, taking into account the necessary financing (<http://www.biodiv.org>).

In September 2007, at the International Technical Conference on Animal Genetic Resources for Food Production and Agriculture, the Global Action Plan on Animal Genetic Resources was developed (FAO, 2007).



The second report on the state of animal genetic resources in the world, held in Rome in 2015, identified the main aspects of species extinction, namely, the decrease in animal numbers and the decrease in genetic diversity, which are closely related. This report also identified the most significant threats to the genetic resources of animals in different countries: unsystematic interbreeding, introduction of exotic breeds, ineffective policy of organizational structures, loss of profitability (competitiveness) of breeds, intensification of production systems, weak veterinary control, loss of pastures and production areas, weak inbreeding control (FAO, 2015).

An. Allier et al. (2020) emphasize the need for an effective strategy to expand the genetic base of commercial breeding programs, which includes the determination of optimal crossbreeding schemes that balance expected genetic value and diversity. Slowing down the development of fundamental knowledge, strategies and laws on the conservation of genetic resources hinders the formation of reliable mechanisms for the conservation and management of breed diversity.

The first draft of the framework, released in July 2021, is based on lessons learned from the Strategic Plan for Biodiversity Conservation 2011-2020 and its Biodiversity Targets adopted in Aichi. It recognizes that urgent policy action is needed at global, regional and national levels to transform economic, social and financial models so that trends that have exacerbated biodiversity loss are stabilized by 2030 and allow natural ecosystems to recover with net improvements by 2050 (<http://www.biodiv.org>).

The gene pool preservation strategy should include: genetic monitoring, identification and passporting of animals, creation of databases, organization of gene pool farms, genetic banks, development of breeding programs, preservation and management of breeds, as well as introduction and protection of traditional agricultural management zones. In this regard, FAO proposes a strategy scheme for the control of animal genetic resources, presented in Figure 1.

This scheme also includes parameters for preserving the gene pool of domestically bred animal breeds. To do this, it is necessary to determine the value of each breed, the potential of breed development, the amount of purebred breeding and interbreeding with improving breeds.

In recent decades, the horse population in the world has been relatively stable – about 58 million heads (<https://worldpopulationreview.com>). Such stability of the industry is based on the multifaceted possibilities of using the horse in society. Depending on the level of economic development of the country, natural and climatic conditions, and the traditions of the population, one or another form of horse use dominates.

For horse breeds of world importance, geographically distributed and numbering several thousand breeding mares in different countries of the world, the factor of inbreeding depression is not a threat (thoroughbred horse, Arabian, American Standardbred, French trotter, etc.) (Babenko O., 2020). The analysis of the presence of pedigree (assessed) stock of horses of domestic selection showed (Table 1) that all of them, according to the number of stock capable of reproduction, according to the FAO classification, are "in a state of danger" (from 100 to 1000 females capable of reproduction). In particular, trotting breeds in Ukraine are represented by three populations, two of which have long been the subject of selection by domestic studs - the Orlov trotting breed (194 mares) and the newly created Ukrainian trotting breed group (182 breeding mares) (Tkachova I.V., 2023). Horses of the French trotting breed have been bred quite recently, currently their stock is concentrated in two breeding breeders in the amount of 43 individuals (Suprun I.O., 2020).



Table 1

The number of breeding horses of trotting breeds in breeder of Ukraine

Breeds	2023			
	total		in particular	
	heads	%	male	female
Orlov trotter	465	57.5	30	194
Newly created Ukrainian trotting breed group	301	37.2	15	182
French trotter	43	5.3	3	15

Horses of trotting breeds have been bred in Ukraine since the beginning of the 20s of the XIX century along with the popularization of prize-winning equestrian sports. The Dibriv Stud Farm was founded in 1888 in the Poltava province as the first recognized stud farm in Ukraine for breeding trotting horses. Since then and to this day, this stud farm maintains a leading position in the selection of horses of the Orlov trotting breed and the newly created Ukrainian trotting breed group (Strijak T.A., 2014).

At the beginning of the previous century, trotting horses underwent significant population changes, in particular, a part of horses that, in order to increase liveliness, were crossed with the precocious and lively American Standardbred trotter (bred from a thoroughbred riding breed) (Hered J., 2022). In further selection work with the local population of trotting horses with improved liveliness, reproductive interbreedings with the American Standardbred trotter were used. As a result of purposeful work, a lively type of Ukrainian trotter was selected, which has original phenotypic and genetic qualities. The interbreeding of trotters of the domestic gene pool with the French trotter breed began in Ukraine in 1965, when the Dibriv Stud Farm received several foals from the most lively French trotter of that time – Okapi'S 1.16.6 (2.08.6) min. s, 1958 (Fe Follie X – Jatian V). This interbreeding did not give significant results, the offspring of Okapi'S were inferior in liveliness to their dams and offspring of American Standardbred stallions, although they were on average livelier than their purebred peers. The best was the result of using the French trotting stallion Minden in 1994-2000 1.17 min. (Brutus Lucius – Made) – more than 80 offspring were obtained from it, of which 29.6% entered the liveliness class 2.10 and livelier, 6.2% entered the liveliness class 2.05 and livelier. Since 2004, artificial insemination of domestic prize trotters with the semen of stallions of the French trotting breed has been introduced in the Dibriv and Zaporizhzhya Stud Farms, as well as in the leading stud breeders, the importation of horses of this breed to the studs of Roda Trading House LLC and Komyschanske LLC. As a result of crossbreeding, local horses outperformed purebred peers (both Ukrainian and French), as well as descendants of American Standardbred stallions in liveliness and prize-winning speed.

Taking into account the separation of trotting horse selection directions, the stud farms of Ukraine – Dibriv, Lozivskiyi, Zaporizhzhya and Limarivskiyi, along with the preservation of the population of the original Orlov trotter, through long-term selection for liveliness, prize precociousness, endurance, distance, created their own type of trotting horse, and in 2016 there was the first stage of approbation of the newly created Ukrainian trotting breed group of horses was carried out (Tkachenko O.O., 2016). The main selection method of improving the new breed group is breeding in "self" with limited use of the gene pool of the American Standardbred and French trotting breeds for interbreeding at the level of "infusion of blood" to increase indicators of liveliness and prize maturity.



The main conditions for the sustainable preservation of the gene pool of horses are the presence of an organizational structure responsible for the preservation of national genetic resources, relevant laws on breeding matters, programs for the preservation of the gene pool of animals (Kruglyak O. V., 2016). The gene pool preservation strategy should include: genetic monitoring, identification and passporting of animals, creation of databases, organization of gene pool farms, genetic banks, development of breeding programs, preservation and management of breeds, as well as introduction and protection of traditional agricultural zones.

According to the recommendations of the Commission on genetic resources in the field of food and agriculture of FAO, the following strategy scheme for the control of genetic resources of animals is proposed (Fig. 1).

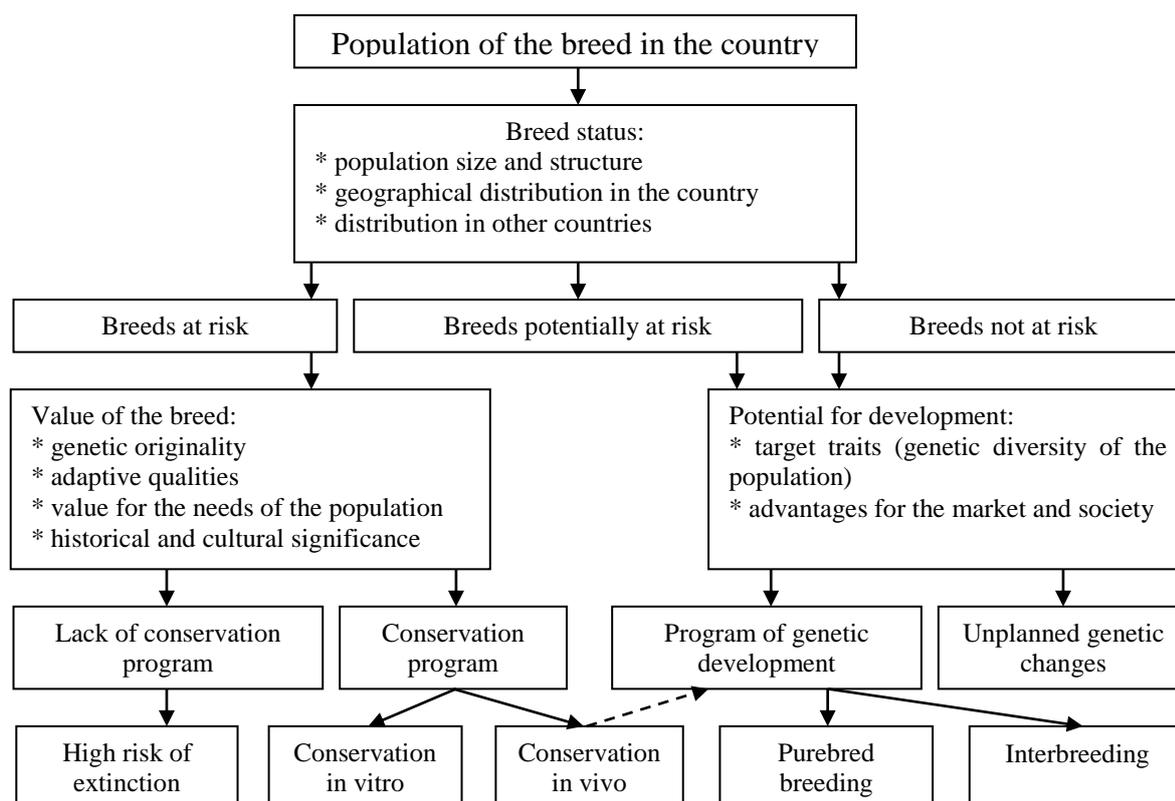


Fig. 1. Scheme of the strategy of control over the genetic resources of animals

The proposed scheme also includes parameters for preserving the gene pool of domestically bred horse breeds. To do this, it is necessary to determine population characteristics, breed development potential, the amount of purebred breeding and interbreeding with improving breeds. It was this goal that was set to determine the population characteristics and justify the concept of preserving the gene pool of the newly created Ukrainian trotting breed group of horses.

Materials and methods. The research material was the database of horses of the Ukrainian trotting breed group with confirmed origin (n=1973). Horses are evaluated based on a complex of breeding traits and population characteristics. The average annual yield of foals and the number of repair young ones were calculated. The share of breeding stallions of different breeds was determined and the amount of interbreeding was established.



The generational interval was defined as the average age of the parents at the birth of the offspring. The average age of the parents at the birth of the offspring was calculated according to the entries in the pedigree books. The final indicator was defined as the average for all years of birth (Bijma P., 2001):

$$L = \frac{L_{mm} + L_{mf} + L_{fm} + L_{ff}}{4}, \quad (4)$$

where L_{mm} – sire-male offspring generation interval;
 L_{mf} – sire-female offspring generation interval;
 L_{fm} – dam-male offspring generation interval;
 L_{ff} – dam-female offspring generation interval.

The effective annual number of the population (N_a) was determined as the increase over the years of the inbreeding coefficient (F_x) and the average population of related animals (f_{xy}):

$$N_a = \frac{1}{2 \cdot (1 - e^\beta)}, \quad (5)$$

where N_a is the effective annual population size; β is the regression coefficient, as $\ln(1 - F_t)$ by year, where F_t is the average value of the inbreeding coefficient.

The variance drift deviation per generation can be described as:

$$\text{Var}(\delta q) = \frac{q(1 - q)}{2N_e}, \quad (6)$$

where N_e is the effective population size; q is the drift frequency of the dispersion.

For a known number of generations in a breed (breed group, line) (L), the variance drift will accumulate to:

$$\sum_{i=1}^L \text{Var}(\delta q)_i = \frac{q_0(1 - q_0)}{2N_e} + \frac{q_1(1 - q_1)}{2N_e} + \dots + \frac{q_{L-1}(1 - q_{L-1})}{2N_e} \quad (7)$$

Setting the ratio

$$q_i(1 - q_i) = q_{i-1}(1 - q_{i-1}) \left(1 - \frac{1}{2N_e}\right), \quad (8)$$

leads to the equation:

$$\sum_{i=1}^L \text{Var}(\delta q)_i = \frac{q_0(1 - q_0)}{2N_e} \left[1 + \left(1 - \frac{1}{2N_e}\right) + \left(1 - \frac{1}{2N_e}\right)^2 + \dots + \left(1 - \frac{1}{2N_e}\right)^{L-1} \right]. \quad (9)$$

By replacing the geometric sequence with its sum in the limits, we get:

$$\sum_{i=1}^L \text{Var}(\delta q)_i = \frac{q_0(1 - q_0)}{2N_e} \cdot \frac{1 - (1 - (1/2N_e))^L}{1/2N_e} = q_0(1 - q_0) \left[1 - \left(1 - \frac{1}{2N_e}\right)^L \right] \quad (10)$$



By comparing the equations for both values, we get:

$$\frac{q(1-q)}{2Ne} = q(1-q) \left[1 - \left(1 - \frac{1}{2Na} \right)^L \right] \text{ and } \frac{1}{2Ne} = 1 - \left(1 - \frac{1}{2Na} \right)^L. \quad (11)$$

According to this method, the effective size of the population was estimated as:

$$Ne(\text{generation}) = \left[2 \left(1 - \left(1 - \frac{1}{2Na} \right)^L \right) \right]^{-1}. \quad (12)$$

Statistical data processing was carried out in the Microsoft Excel software environment (Baranovskii, 2017).

Research results. According to herd monitoring and genealogical analysis, the active part of the population of the new breed group at the time of approval was represented by 204 mares and 27 breeding stallions.

On January 1, 2023, the number of horses decreased to 301 breeding horses were registered in the Ukrainian trotting breed group, including 182 mares of reproductive age (table 2), that is, the breed group is small in number, or, according to the FAO classification, "in a state of danger". The ratio in the reproductive composition of stallions and mares is 7.6% and 92.4%.

Table 2

Quantitative composition of horses of the Ukrainian trotting breed group (on 01.01.2023)

The subject of the breeding case	n	Including:		
		breeding stallions	mares	Repair young horses 2019-2022 born
Zaporizhzhya Horse Breeding No. 86*	62	5	43	14
Lymarivsky Horse Breeding Plant No. 61*	64	4	43	17
Dibriv Stud Farm No. 62*	56	3	31	22
Total in stud farms:	182	12	117	53
PE "Roda" of the Kyiv region.	37	2	10	25
Individuals	82	1	55	26
Total:	301	15	182	104

Note: * - horse studs are branches of SE "Konyarstvo Ukrainy"

The average liveliness of mares of the reproductive age is 2.12.9 min. The liveliest mares are produced in the breeding stock of the branch of "Dibriv Stud Farm № 62" of the SE "Konyarstvo Ukrainy" (average liveliness 2.08.2±0.86 min.). In terms of prize precocity (liveliness at the age of two), fillies of the Zaporizhzhia Stud Farm No. 86 with a high degree of probability (p<0.01) prevail over fillies of other stud farms (average liveliness at the age of 2 – 2.24.9±1.47 min.).

Based on the current number of herds of the newly created breed group – 182 fillies/mares of reproductive age, according to the indicators of the average annual output



of foals 55.7%, from the actual herd of fillies/mares, an average of 101.4 ± 5.19 foals are obtained per year. Assuming that the ratio of newborn male and female foals by breed is almost the same, the average annual number of female foals will be 50 individuals. Taking into account 10% culling, 45 three-year-old fillies per year should be included in the breeding nucleus.

Considering the fact that the Ukrainian trotting breed group was created using the method of backinterbreeding the Orlov trotter, American Standardbred and French trotter breeds, therefore, in order to improve the lively characteristics and refresh the gene pool of the population, the breeding program provides for limited interbreeding with the American Standardbred and French trotter breeds. So, in addition to stallions of the breed group, 3 breeding stallions of the American Standardbred and 3 of the French trotter breeds were involved in the breeding work. French trotter mares, American Standardbred mares and crossbred mares are also involved in breeding. The average liveliness of stallions is 2.00.8 min. The stallions belong mainly to the American lines of Speedy Crown and Victory Song. The share of horses from purebred stallions and those obtained from stallions of other breeds (American Standardbred, French Trotter) in the studied breeding periods is presented in Figure 1.

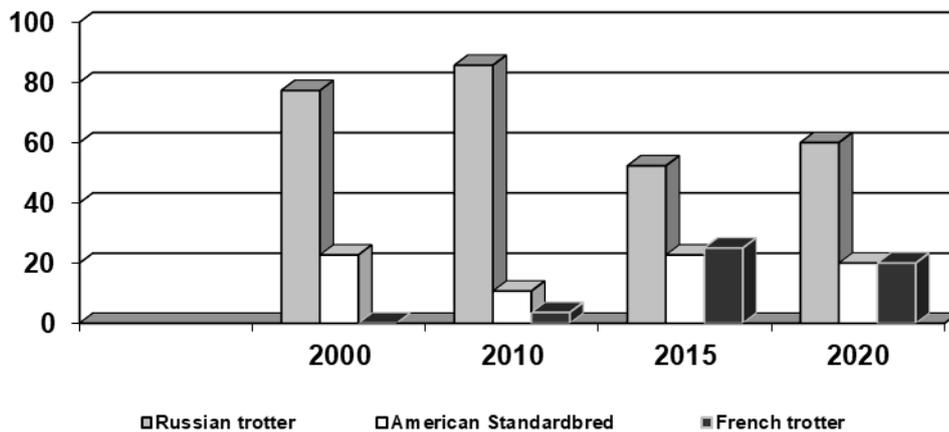


Fig. 1. Share of horses (%) that come from purebred stallions and from stallions of improving breeds

In the period 2010-2015, 10 stallions of the American Standardbred breed and 11 stallions of the French trotter breed were used. In 2015, the share of improving breed stallions was 47.7%, which exceeds the parameters recommended by the breeding program, while the share of breeding stallions of the French trotter breed increased significantly. Considering this, the number of stallions of other breeds was reduced and currently only 40.0% of them are used, which corresponds to the parameters recommended by the breeding program.

Breeding use of trotting colts is allowed at the age of 3, but most of the stallions planned for breeding use (outstanding for prize performance) perform on racetracks up to 5-7 years and older, while fillies, with rare exceptions, perform on racetracks up to 3-4 years old, after which they enter the breeding stock. Nevertheless, from the majority of colts planned for breeding use, based on the results of tests at the age of 2-4, breeders begin to receive offspring (or sperm production) during the tests. The generation change interval depends on these indicators. The maximum number of generations in the breed group – 11 – was observed in the Speedy Crown line.

The main parameters of the population are presented in Table 3.



Table 3

Main parameters characterizing the horse population of the Ukrainian trotting breed group

Population parameters	Indicators
Number of horses of reproductive composition	301
Number of stallions	15
Number of mares	182
The maximum number of generations	11

The main population characteristics of the newly created Ukrainian trotting breed group are presented in Table 4.

Table 4

Population characteristics of fillies/mares of reproductive age of the Ukrainian trotting breed group

Population characteristics	Indicators
Record (lifetime) liveliness at 1600 m, min.	128.9±0.59
Prize precociousness (liveliness at the age of 2), min.	146.4±0.90
Share of fillies/mares in the liveliness class 2.05 min. and livelier, %	12.0
Share of fillies/mares of liveliness class 2.10 min. and livelier, %	36.8
Body measurements, cm:	
height at the withers	159.8±0.32
oblique body length	162.2±0.36
chest circumference	181.4±0.42
cannon bone circumference	19.91±0.06
Credit rating, score	
origin	9.15±0.05
type	8.37±0.06
exterior	8.14±0.06
measurements	8.15±0.10
working capacity	7.37±0.16

Determination of the generation interval and the inbreeding coefficient made it possible to analyze the population and identify specific features of the Ukrainian trotting breed group of horses.

The result of the calculation of the generation interval is shown in Figure 2.

The generation interval calculated for the Ukrainian trotting breed group of the domestic part of the population was: $L=11.57\pm 0.98$ years. This indicator is somewhat lower than that of the French trotter breed according to the results of research by Moureaux S. (Moureaux S. et al, 1996), who established a generation interval for the French trotter breed – 11.8 years. It is also determined that the generation interval between sires and their male offsprings is bigger than between dams and male offsprings, and the generation interval between dams and female offsprings is bigger than between sires and female offsprings.

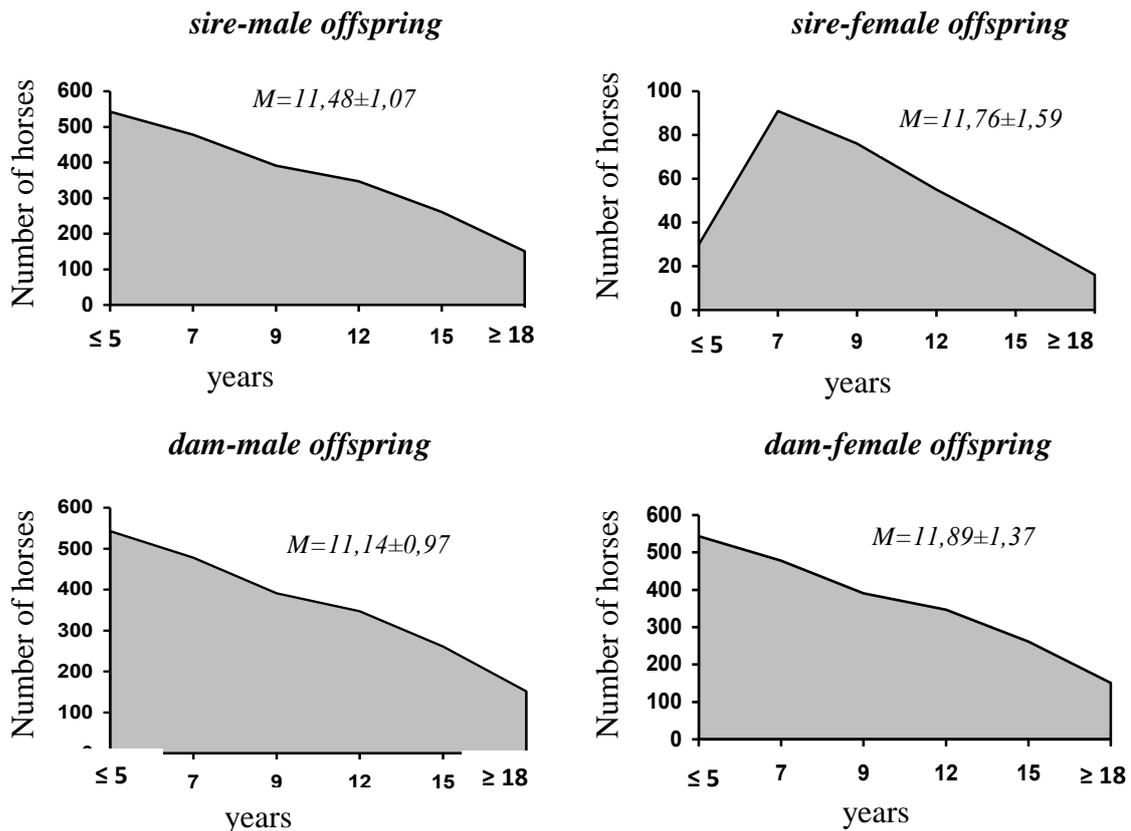


Fig. 2. Generation interval (L) between family groups of horses of the Ukrainian trotting breed group

The effective number of the population, according to which the new breed group will develop qualitatively, is 688 fillies/mares of reproductive age.

The increase in the inbreeding coefficient for one generation, calculated according to formula 3, is $\Delta F=0.0063$, and therefore, to prevent the growth of inbreeding, the increase in the effective size of the population per generation should be 79.4 heads.

If the Ukrainian trotting breed group remains in the number of livestock that it is today – 182 fillies/mares of reproductive age, which is 318 heads below the lower limit of genetic diversity proposed by I.R. Franklin (1980) for small populations and for 838 heads below the limit determined for the number of female individuals (Scherf B., 2009), the population will lose 2.36% of genetic diversity in 10 generations.

Discussion. The main problem of preserving animal breeds of local (national, regional) significance is that their maintenance is often not economically profitable, and therefore the population needs support to ensure their survival. If these breeds are historical and traditional, closely related to demographic processes in different geographical regions, or carry in their genotype unique properties that cannot be reproduced in case of extinction, then society bears responsibility for these breeds beyond commercial profit (Chaudhary P., 2020). That is why national horse breeding is supported in leading European countries at the expense of the state (France) or public organizations (Great Britain). Countries with the largest number of horses in the world: the USA (about 10 million), China, Mexico, Brazil. However, the number of horses in these countries does not exceed the consumer needs of the population, remaining at the level of active reproduction. Even in Great Britain, where sport horse racing is a cult industry, it is shrinking every year due to the needs of the population (British-Racing-Factsheet-October-2019.pdf). Nevertheless, in Great Britain, the share of income from equestrian sports is about £8 billion per year and the industry creates 85,000 jobs (Equine Devel-



opment, 2017). In total, according to the calculations of Steve Elliott from the company Alltech, the annual economic impact of the horse breeding industry is about 300 billion US dollars and 1.6 million jobs. In the US, the horse business has a greater economic impact than the film industry (EQUO, 2017). Considering the fact that Ukrainian horse breeding is much more modest (about 200,000 horses), in accordance with today's political and economic realities, a decrease in the number of horses according to the needs of the population can be seen.

However, the process of preserving the breeds and types of horses traditional for Ukraine continues. It is known that the preservation of the gene pool of animals requires the solution of a number of issues: identification of useful traits, selection of methods for their identification and evaluation, substantiation of the breeding system, establishment of effective and optimal population size, development of methods for preserving genetic variability, methods of control at genetic processes, assessment of erosion of the gene pool (Stolpovsky Yu. A., 2017). The selection process for breeds of local origin is aimed not so much at genetic improvement as at preserving the originality of the traits inherent in this population in given environmental conditions and their constant reproduction in generations. And in these conditions, the optimization of the reproductive population of animals, which is necessary for reproduction without the threat of inbreeding depression, becomes especially important. The calculation of the effective size of the population is complicated by the fact that, where selection is limited by the number of animals, and the duration of the intervals between generations. In addition, the number of breeding stock is closely related to economic indicators, namely, the population's need for horses of a certain direction of economic use. The important step in the preparation of conservation programs for animals with a depleted gene pool is the calculation of the effective population size (N_e), which depends on genetic drift and the inbreeding coefficient in the population (Arden W. R., 2003). Determining the effective number of livestock for active reproduction is necessary to optimize breeding programs, and for this it is necessary to identify the risk status and development trends of breeds in modern conditions, as well as their role, direction of use, cultural and economic value. The concept of preserving the gene pool of animals in the context of population genetics and planning the selection process consists of analyzing the population structure, determining the generation interval, effective population size, the contribution of improving breeds and justifying their use for interbreeding (Haberland A. M., 2012). Recently, the process of population genetics of horses has been accelerated with the use of modern research methods (Petersen, J.L., 2020).

At a low level of effective population size, the rate of loss of genetic diversity increases (Buffalo V., 2021). Thus, when the value of N_e is lower than 500, 250, 125, 50, 25 individuals, in 10 generations the population loses 0.8, 1.6, 4, 10, 18% of genetic diversity, respectively. For the newly created Ukrainian trotting horse breed group, we have proven that it will lose 2.36% of its genetic diversity in 10 generations, if it remains at the current level of the gene pool of 182 fillies/mares capable of reproduction. As the horse population tends to decline, the proportion of genetic diversity that will be lost will increase proportionally.

Franklin I.R. (1980) proposed an effective population size of 500 individuals as the lower limit of genetic diversity and the possibility of its evolution in a changing environment. However, other researchers believe that this limit should be higher (Rizzato, F., 2019). The criteria proposed by the working group "Rare Breeds Survival Fund" (RBST, Great Britain) for the survival of horse breeds as endangered are the number of fillies/mares capable of reproduction of at least 1000 individuals (Maijala K., (19 80). Our research established a criterion for the full preservation and development



of the newly created Ukrainian trotting breed group at the level of 688 fillies/mares capable of reproduction. However, the number of colts/stallions is not of critical importance as the diversity of their genotype is more important due to belonging to different genealogical lines, branches, as well as the involvement in the reproductive process of stallions of improving breeds (American Standardbred, French trotter).

The decrease in the number of animals of the breeding nucleus invariably causes the increase in the level of inbreeding, and therefore, it is necessary to manage the selection process of the entire population of animals kept by the population in order to minimize inbreeding. Hence, the main task of breeding programs is to optimize the genetic trend while simultaneously reducing the level of inbreeding, for which modern software tools are created to control (Schierenbeck S., 2011). In order to substantiate the genetic aspects of gene pool preservation, it is important to consider that even a small degree of inbreeding reduces the reproductive function of the population, especially for low-fertile species of animals with a long period of generation change, to which horses belong. Thus, Chujie Chen and colleagues (2023) confirm that a 10% increase in homozygosity in a horse population reduces reproductive function.

The effective size of the population was used by Bijma R. et al. (2001) as a key parameter in the development of strategies for the identification and conservation of endangered animal species. Thus, the Federal Ministry of Food, Agriculture and Consumer Protection of Germany determined the effective size of a closed population of Trakehner horses, which depends on the number of animals selected for the breeding nucleus, the dispersion of the family size and the average generation interval (Hill W.G., 2000). We came to the same conclusion in our research.

The decrease in the number of animals of the breeding nucleus invariably causes the increase in the level of inbreeding, and therefore, it is necessary to manage the selection process of the entire reproductive stock of animals in order to minimize inbreeding (Fuping Zhao, 2023). In such conditions, branching of the population with the involvement of the best typical representatives of related breeds and types of animals is desirable, which is also proven by our research.

The calculated generation interval and effective population size for the newly created Ukrainian trotting breed group practically coincide with the researches of Moureaux S. et al. (1996) on the French trotter breed.

Modern breeding programs do not use the indicator of the generation interval and effective population size when evaluating animal populations, particularly horses. These indicators were determined by us for the first time for the Ukrainian trotting breed group of horses, and their further use in gene pool conservation programs is reasonable.

Thus, the concept of preserving the gene pool of animals in the context of population genetics and planning the selection process consists of an analysis of the population structure, determination of the generation interval, effective population size, the contribution of improving breeds and justification of their use for interbreeding.

Conclusions. The newly created Ukrainian trotter breed group of horses is a separate population with a limited gene pool, which according to the FAO classification is characterized as "in a state of danger". The reproductive composition of the population consists of 182 fillies/mares of reproductive age, in this state the population will lose 2.36% of its genetic diversity in 10 generations.

According to the results of the evaluation of the breeding stock, a high level of average liveliness of fillies/mares was established, 2.12.9 min. The liveliest fillies/mares are produced in the breeding stock of the branch of "Dibriv Stud Farm No. 62" of the SE "Konyarstvo Ukrainy" (average liveliness 2.08.2±0.86 min.). In terms of prize pre-



cocity (liveliness at the age of two), fillies of the Zaporizhzhia Stud Farm No. 86 with a high degree of probability ($p < 0.01$) prevail over fillies of other stud farms (average liveliness at the age of 2 – $2.24.9 \pm 1.47$ min.) .

In order to avoid inbreeding depression and increase the vitality and prize-winning speed of the newly created Ukrainian trotting breed group of horses, a limited (no more than 40%) crossbreeding with American Standardbred and French trotter breeds was substantiated and included in the selection program, which was justified by the positive results of the previous program. The stallions belong mainly to the American lines of Speedy Crown and Victory Song, which requires further branching of the genealogical structure of the breed group. The maximum number of generations in the breed group – 11 – was observed in the Speedy Crown line.

The established population characteristics of the newly created Ukrainian trotting breed group: record liveliness for a distance of 1600 m – $2.08.9 \pm 0.59$ min., prize precociousness (liveliness at the age of 2) - $2.26.4 \pm 0.90$ min., share of mares liveliness class 2.05 min. and livelier - 12.0%, the share of mares of liveliness class 2.10 min. and more lively - 36.8%, height at the withers 159.8 ± 0.32 cm, oblique length of the body - 162.2 ± 0.36 cm, chest circumference – 181.4 ± 0.42 cm, cannon bone circumference – 19.91 ± 0.06 cm, origin assessment – 9.15 ± 0.05 points, type – 8.37 ± 0.06 points, exterior – 8.14 ± 0.06 points, measurements – 8.15 ± 0.10 points, work capacity – 7.37 ± 0.16 points.

The specific features of the newly created Ukrainian trotting breed group of horses have been revealed. Thus, the generation interval (L) was 11.57 ± 0.98 years. It is also determined that the generation interval between sires and their male offsprings is greater than between dams and male offsprings, and the generation interval between dams and female offsprings is greater than between sires and their female offsprings. The effective size of the population, according to which the newly created Ukrainian trotting breed group will develop qualitatively, is 688.2 horses of reproductive age.

The increase in the inbreeding coefficient for one generation is $\Delta F = 0.0063$, therefore, to prevent the growth of inbreeding, the increase in the effective number of the Ukrainian trotting breed group per generation should be 79.4 fillies/mares of reproductive age. This indicator should be consistent with the consumer needs of the population and the development of the healthy lifestyle, sports and leisure sector using horses as a historical and traditional heritage.

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