Phenogenetic features of the Nenets breed Ural ecotype of the reindeer

Alexander Yuzhakov[1], *Veronika* Kharzinova[2], and *Kasim* Laishev[1,*]

[1] North-West Center for Interdisciplinary Problems of Food Supply, 196608 St. Petersburg-Pushkin, Russia
[2] Federal Science Center for Animal Husbandry named after Academy Member L. K. Ernst, the urban district of Podolsk, Dubrovitsy settlement, 142132 Moscow region, Russia

Abstract. For the first time, comprehensive studies of the phenogenetic features of the Ural ecotype of domestic reindeer of the Nenets breed were performed. It was found out that the Ural reindeer relative to other ecotypes of the Nenets breed have smaller linear dimensions and live body weight. The studied group of reindeer was characterized by the minimum values of the majority of population genetic indicators, including the effective number of alleles (Ne = 4.422 ± 0.614), the Shannon information index (I = 1.663 ± 0.102), and the level of both the observed and expected heterozygosity (Ho = 0.561 ± 0.064 and He = 0.740 ± 0.035, respectively). It exceeded two other samples from neighboring breeding regions (Nenets Autonomous district and the Komi Republic) in the average number of alleles per locus: (Na = 9.667 ± 0.577 versus Na = 9.555 ± 0.669 and Na = 9.557 ± 0.709, respectively). Animals of the Ural population (YAM) have a closer genetic structure with reindeer individuals of the neighboring Nenets Autonomous district (NAO). The studied sample of the Nenets breed was characterized by a shift in genetic diversity towards a lack of heterozygotes, as evidenced by the positive Fis values. The introduction of genetic methods in the reindeer herding will allow improving the breeding work in the industry, revealing intraspecific genetic variation in inbreeding herds and identifying intrabreed groups of animals.

1 Introduction

The global community closely links conservation of cultural traditions and the sustainable development of agriculture to conservation of genetic resources and indigenous breeds of domestic animals. Natural or native breeds are domestic animal breeds that retain the appearance of their ancestral forms and have the least number of non-functional signs of domestication. They are optimally adapted to external conditions, due to poor feeding and harsh living conditions they have a strong constitution, great stamina and resistance to local diseases [1, 2].

Natural breeds with extensive ranges, as a rule, consist of inbreed groups, which can significantly differ in appearance and purpose. There are currently four officially registered aboriginal breeds in reindeer herding, they are the Nenets, the Chukotka, the Even and the Evenk.

An in-depth study of the genetic, phenotypic and productive characteristics of the internal breeds of the largest (1300 thousand animals) Nenets breed is an urgent task of scientific research in reindeer herding and is consistent with the main directions of the agricultural development program in the Arctic zone of the Russian Federation.

Extensive phenotypic examination and genetic analysis of polymorphic systems of blood proteins confirmed the main results of morphological studies of reindeer in the European North and Western Siberia and the validity of their isolation in a separate breed [3, 4].

Analysis of microsatellite profiles of reindeer groups showed a high genetic diversity of the Nenets breed populations [5]. The revealed differences between populations located in different tundra biotopes allow us to evaluate them as independent genetic systems. These studies make it possible to begin to address the issue of rational use of genetic resources in reindeer breeding farms.

Purpose of the study. Based on the field experiments study, to gain a new knowledge about the phenogenetic features of domestic Ural reindeer inbreed type of the Nenets breed.

2 Material, place and research methods

The work was carried out in the department of scientific support for animal husbandry, veterinary medicine and the Federal State Budgetary Institution "North-West Center for Interdisciplinary Problems of Food Supply", in the Ural region of the Yamal-Nenets Autonomous district, in the Federal Science Center for Animal Husbandry named after Academy Member L.K. Ernst. To

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* Corresponding author: layshev@mail.ru

carry out the planned research, a herd of reindeer of the Yamal department of the All-Russian Research Institute of Veterinary Entomology and Arachnology (Salekhard) was selected. In the snowless period, the herd is grazed in the foothills and intermountain valleys of the Polar Urals, in the snowy period, deer are transferred to the forest-tundra zone in the floodplain of the Ob River, where there are rich lichen pastures well protected from winds and ice (Fig. 1).

Fig. 1. Reindeer on the summer foothill pastures of the Polar Urals.

Zootechnical inspection of reindeer was conducted by the methods generally accepted in animal husbandry (Fig. 2).

Fig. 2. Taking measurements from reindeer

A total of 422 animals were examined phenotypically in autumn in the coral. A selection of biological material from 302 reindeer was carried out to do genetic research. The selected material was pieces of the cartilaginous part of the horn or auricle, which were placed in test tubes and fixed with 96° ethanol.

The selected biological material was delivered to the Laboratory of Molecular Breeding of the Federal Science Center for Animal Husbandry named after Academy Member L.K. Ernst, where studies were conducted. The results obtained (YAM) were compared with previously studied material from the reindeer of the Nenets breed contained in the Nenets Autonomous district (NAO, n = 202) and the Komi Republic (KOM, n = 96)

DNA was isolated using the DNA-EXTRAN reagent kit (Syntol CJSC, Russia) according to the manufacturer's protocol.

The polymorphism of nine STR (NVHRT21, NVHRT24, NVHRT76, RT1, RT6, RT7, RT9, RT27, RT30) was determined by our own methods [6]. Capillary electrophoresis was performed on an ABI 3130xl genetic analyzer (Applied Biosystems, USA), followed by determination of the lengths of microsatellite alleles in GeneMapper v software. 4.0. (Applied Biosystems). The average number (Na) and the number of effective (Ne) alleles per locus, the Shannon information index (I), the level of observed (Ho) and expected (He) heterozygosity and inbreeding coefficient (Fis) were determined to characterize the allele pool. The distribution of the total genetic variation between populations and within them was studied by the method of analysis of molecular dispersion (AMOVA). Statistical data processing was performed using the GenAlEx software (ver. 6.5.1) [7].

To process the results of the analysis, a genotype matrix was formed in Microsoft Excel format.

3 Research Results and Discussion

The reindeer of the studied group belong to the Ural type of the Nenets breed ,and are bred in cleanliness and the exchange of males is carried out with neighboring brigades of Salekhardagro JSC and Olenevod LLC (Vorkuta), whose animals are genetically related to the Nenets breed. Phenotypically the Ural reindeer, in comparison with the other ecotypes of the Nenets breed, have smaller linear dimensions and live body weight (Table 1).

Table 1. Live weight (kg), measurements (cm) and body indices (%) of adult reindeer in the Ural region

Name	Males	Females
Live weight	103.3±0.87	82.6±0.55
Measurements, cm		
height at the withers	102.0±0.40	95.0±0.41
chest depth	42.4±0.42	38.94±0.26
chest width	25.8±0.34	25.34±0.27
chest girth	121.5±0.66	113.80±0.42
oblique body length	108.3±0.58	102.6±0.76
metacarpal circumference	11.8±0.05	11.1±0.07
width in maclocs	23.9±0.17	21.4±0.36
oblique length of the backside	32.1±0.25	28.48±0.26
head length	39.3±0.25	34.1±0.26
Indexes,%		
stretch	105.9	106.7
bones	11.7	11.5
leggy	60.3	61.5
massiveness	119.2	113.9
chest	60.7	65.1
downs	112.5	112.1
pelvic	107.1	119.3
pelvic	74.6	73.4
long-headedness	38.4	35.6

Reindeer of the Ural region are relatively low, compact animals with good meat and outstanding working qualities, have a relatively large head with well-developed horns. The color is predominantly brown, of varying intensity: at least 10% of the animals are white and mottled.

The live weight of adult males was 103.3 ± 0.87, females – $82, 6 \pm 0, 55$ kg, which is 14.2% and 9.0% lower than the breed standard, respectively. The height at the withers is 102.0 ± 0.40 and 95.0 ± 0.41 cm, respectively, which corresponds to the breed standard of the Nenets breed.

Based on the obtained microsatellite profiles of the total study reindeer sampler, an assignment test was conducted to determine the genetic diversity of each individual and the population from which it originated, and to assess the likelihood of attributing this individual either to its own population or to another one (Fig. 3).
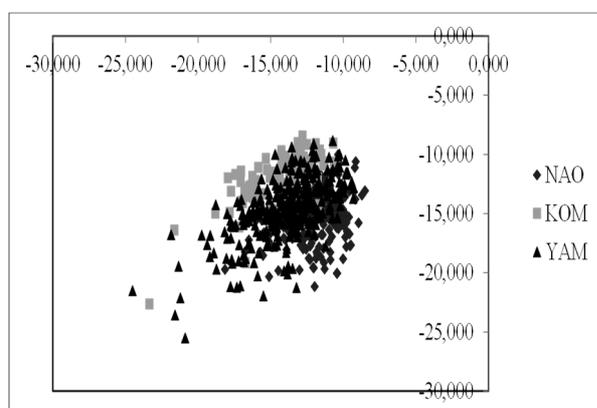

Fig. 3. Localization of reindeer individuals of the studied populations of the Nenets breed in the space of two dimensions based on their genotype by STR markers

The results of the assignment test showed that all regional populations of the Nenets reindeer breed form a tightly grouped array, while the accuracy of assigning each individual to its own population was 89%. The highest accuracy of assignment (and, accordingly, the greatest genetic uniqueness and consolidation) was characteristic of reindeer bred on the territory of the Komi Republic (KOM).

Animals of the Ural population (YAM) have a closer genetic structure with reindeer of the neighboring Nenets Autonomous district (NAD).

The results of the genetic diversity studies of the Ural ecotype in comparison with two other regional populations of the Nenets breed are presented in Table 2.

It shows that the Ural reindeer population was characterized by the minimum values of the majority of population genetic indicators, including the effective number of alleles ($Ne = 4.422 \pm 0.614$), the Shannon information index ($I = 1.663 \pm 0.102$) and the level of both the observed and expected heterozygosity ($Ho = 0.561 \pm 0.064$ and $He = 0.740 \pm 0.035$, respectively).

However, the Ural population exceeded two other two other samples from neighboring breeding regions (Nenets Autonomous district and the Komi Republic) in the average number of alleles per locus: ($Na = 9.667 \pm 0.577$ versus $Na = 9.555 \pm 0.669$ and $Na = 9.557 \pm 0.709$, respectively). This indicator reflects the number of actively acting alleles in a population and is of great interest for the conservation of the genetic intrabreed diversity.

Table 2. Genetic diversity of the Ural population (YAM) of the Nenets reindeer breed in comparison with two regional populations

Indicator	Population		
	NAO	KOM	YAM
Number of goals	202	96	302
Na	9.555±0.669	9.557±0.709	9.667±0.577
Ne	4.779±0.580	4.611±0.575	4.422±0.614
I	1.711±0.111	1.698±0.116	1.663±0.102
Ho	0.615±0.043	0.611±0.042	0.561±0.064
He	0.761±0.032	0.752±0.034	0.740±0.035
Fis	0.188±0.050	0.187±0.038	0.248±0.071

Note: Na – is the average number of alleles per locus, Ne – is the average number of effective alleles per locus, I – is the Shannon information index, Ho – is the observed heterozygosity, He – is the expected heterozygosity, Fis – is the inbreeding coefficient; For the abbreviations of populations, see materials and research methods.

As a result of the frequencies of animal genotypes analysis for all the studiedmicrosatellite loci, we also calculated the inbreeding coefficient (Fis). This indicator determines the relationship between individuals of a particular population (subpopulation) and the population as a whole, in this case the Nenets breed.

Since this indicator quantitatively reflects the deviation of the frequency of occurrence of heterozygous genotypes from the proportion of heterozygotes theoretically expected by Hardy-Weinberg for random mating within the population, it is considered as one of the criteria for the inbredness of the population.

All studied samples of the Nenets breed were characterized by a common feature – a shift in genetic diversity towards a lack of heterozygotes, as evidenced by positive Fis values. However, the highest degree of this indicator was revealed precisely in the Ural population of reindeer ($Fis = 0.248 \pm 0.071$).

Thus, as a result of our molecular genetic studies (microsatellite analysis) of the Ural reindeer population, as well as a comparative analysis with populations of the Nenets breed in other breeding regions (Nenets Autonomous district and the Komi Republic), a minimum level of genetic diversity and a closer genetic structure were revealed with reindeer of the neighboring NAO.

Moreover, the largest number of active alleles of breed diversity characterizes this sample of reindeer. However, the maximum values of the inbreeding coefficient indicate a shift in genetic diversity towards a lack of heterozygotes A further increase in this indicator can lead to the accumulation of inbredness, which will cause the growth of genetically determined dysfunctional traits, and as a result, the appearance of individuals with pathological physiology.

To prevent these processes, it is desirable to control the level of this indicator and ensure the influx of genes from another population of the Nenets breed.

4 Conclusions

Reindeer of the Ural type are small, compact animals with a good meat and outstanding working qualities, have a relatively large head with well-developed horns. The color is predominantly brown, of varying intensity: at least 10 % of the animals are white and mottled (Fig. 4).

Relative to other ecotypes, Ural reindeer of the Nenets breed have smaller linear dimensions and live body weight. The live weight of adult males was 103.3 ± 0.87, females – $82, 6 \pm 0, 55$ kg, which is 14.2 and 9.0 % lower than the breed standard.

The height at the withers is respectively 102.0 ± 0.40 and 95.0 ± 0.41 cm, which corresponds to the breed standard.

Fig. 4. Exterior of reindeer Ural ecotype

Molecular genetic studies showed that the examined reindeer group was characterized by the minimum values of the most population genetic indicators, including the effective number of alleles (Ne = 4.422 ± 0.614), the Shannon information index (I = 1.663 ± 0.102), and the level of both observed and the expected degree of heterozygosity (Ho = 0.561 ± 0.064 and He = 0.740 ± 0.035, respectively).

It exceeded two other samples from neighboring breeding regions (Nenets Autonomous district and the Komi Republic) in the average number of alleles per locus: (Na = 9.667 ± 0.577 versus Na = 9.555 ± 0.669 and Na = 9.557 ± 0.709, respectively). This indicator reflects the number of actively acting alleles in a population and is of great interest for the conservation of genetic intrabreed diversity. Animals of the Ural population (YAM) have a closer genetic structure with reindeer of the neighboring Nenets Autonomous district (NAO).

Inbreeding coefficient (Fis) quantitatively reflects the deviation of the frequencies of heterozygous genotypes from the share of heterozygotes theoretically expected by Hardy-Weinberg; it is considered as one of the criteria for the inbredness of a population.

All studied samples of the Nenets breed were characterized by a common feature – a shift in genetic diversity towards a lack of heterozygotes, as evidenced by positive Fis values. However, the greatest degree of this indicator was revealed precisely in the studied group of reindeer.

The materials obtained in the study can serve as a methodological tool for obtaining new knowledge about the productive, phenotypic, and genetic parameters of domestic reindeer.

The introduction of genetic methods in the reindeer herding will allow improving the breeding work in the industry, revealing intraspecific genetic variation in inbreeding herds and identifying intrabreed groups of animals.

It will also contribute to the growth of the number of the purebred livestock, the improvement of breeding and productive qualities of animals and increase the production of venison.

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