History and problems of reindeer selection in Russia

Alexandr A. Yuzhakov*

Department of Animal Husbandary and Environmental Management of the Arctic, St. Petersburg
Federal Research Center of the Russian Academy of Science, St. Petersburg, Russia

The article describes the history and peculiarities of reindeer selection in USSR and modern Russia. Reindeer selection as an object of research and experimentation was promoted to help the socialist reconstruction of reindeer herding as well as to stimulate the food production in large state-owned enterprises to support the growing population of the Soviet Arctic. In the 1930s, the specially created scientific institute performed an extensive survey of the entire population of (semi)domesticated reindeer in the country from the viewpoint of the animals' morphological and productive parameters. Special attention was paid to the body measures, weight of animals, growth and development of claves, meat productivity. After the Second World War, this research was continued and resulted in isolating and official recognition of four breeds of (semi)domesticated reindeer created by the so-called folk selection: Nenets, Chukchi, Evenki and Even breeds. Instructions for bonitirovka (assessment and selection of animals) for each bread were worked and approved as an official document of the Ministry of Agriculture. Special breeding farms were selection work was performed and breeding reindeer produced to be used in other enterprises were created for each reindeer breed. Some of these farms still exist at least officially. Nowadays, reindeer selection and breeding are subsidized by the state. Breeding animals should satisfy standards for body measures, weight and fatness established for their breeds. On the basis of their assessment (bonitirovka), they are assigned to one of four breeding classes: elite, first, second and third. Reindeer that do not fit any of these classes are recommended for slaughter. Selection work in modern Russia faces serious problems that can be divided in three groups. These are, first of all, the effects of environment, of the unstable and poor fodder, which prevents the animals to realize their genotype completely. The second is the lack of qualified specialists in the enterprises. The third is the absence of heredity records and the market of breeding animals, which makes selection work unprofitable. Some of these problems can be ameliorated by new genetic methods and AI, but they hardly can be solved by these means. Therefore, the folk selection – selection of reindeer by reindeer herders themselves on the basis of traditional criteria and esthetic preferences – remains the main type of selectionist work in modern Russia.

KEYWORDS

reindeer herding, breeding, selection, reindeer breeds, breeding standard

Introduction

This paper is written for the special issue of Pastoralism devoted to what the guest editors of this issue (including the author of this article) name "reindeer-herding science" – to the scientific research on reindeer herding as a particular way of food and goods production (that is an economy rather than a cultural phenomenon) with a basic aim to promote its efficiency. This kind of research has been made in many countries where reindeer herding as productive economy is practiced, which are most notably Fennoscandian countries and the USSR/Russia. Being basically a kind of applied research, which has been believed (in my opinion wrongly) to be of only local interest and application, the reindeer-herding science currently exists in the form of several isolated national traditions whose representatives publish and read predominantly in local languages and usually possess insufficient knowledge about what is going on in other traditions. The aim of the current issue is to rectify this deplorable state of affairs by collecting, in one place and in a common (English) language, texts summarizing the state and current directions of research on different topics in particular traditions[1].

Following this basic thrust, the aim of this paper is to summarize the state of work on one particular topic, namely the reindeer selection in one particular tradition of reindeer herding science, namely the Soviet/Russian tradition. Therefore, this is a review text and it should be treated as such. However, before proceeding to such review, certain theoretical and terminological clarifications are necessary.

First of all, the term "science" as a part of the phrase "reindeer-herding science" should be considered. A large part of the modern intellectual tradition consists of blurring and eliminating distinctions and one particular distinction it has spent particularly strong effort to eliminate is that between science and other kinds of perceiving and knowing. After the seminal works by Foucault, 1972 and Latour and Woolgar (1986) it became almost a mainstream to think that the difference between science and other forms of knowledge is political rather than ontological or epistemological. Although I still struggle to accept this point of view completely for the reasons of personal identity, I do adopt it as a theoretical background for this paper and, in the spirit of Latour, I define scientific research on reindeer selection as a kind of work and knowledge produced in the specific institutional setting (research institutes, research stations, research

projects) created and/or sponsored by the state. This institutional origin differentiates scientific work and knowledge from other kinds of work and knowledge on reindeer selection, including, first of all, the folk selection (*narodnaia selektsia*) as it is named in Russia. Note, that this definition does not entail any special, let alone privileged status of reindeer-herding science and its research and work on reindeer selection vis-à-vis other kinds of knowledge. Indeed, I would deny such a status. What it does entail, however, it is the necessity to trace the institutional setting in which the selectionist work and research have been performed. Therefore, a significant part of this paper is devoted to this.

The second clarification concerns the notion of selectionist work and research itself. In Russia, reindeer-herding science is believed to be a part of so-called agricultural science (*selskokhozaistvennaia nauka),* for which the selectionist work has historically played a very important role: Russian agricultural science emerged in the late 19th century in the large part as the science of plant selection. Therefore, this work has been attributed a special status in the reindeer-herding science as well: in fact, probably the largest part of the Soviet research work on reindeer herding since the 1960s was related to it in one or another way. At the same time, I am perfectly willing to accept that the results of this work have been rather modest: as it is going to be clear from this paper, the main result is the isolation of the four reindeer breeds being the products of folk selection; Russian reindeer-herding science itself has so far failed to produce either any breed of reindeer or any significant improvement in any of the "folk" breeds. It can be argued that even these results are useful. Indeed, due to the special political status of science discussed above, the recognition of the folk breeds has contributed significantly to their protection and preservation particularly during the 1990s. However, I would agree that the lack of the results comparable to those in other branches of animal farming necessitaes particular attention to problems inside the reindeer herding science. The analysis of these problems, therefore, represents a part of this paper and this part is more significant then that devoted to the analysis of achievements.

Therefore, the aim of this paper is to review and analyse the history of work and research on reindeer selection performed in the USSR and Russia in the framework of state-sponsored research institutions and projects with a particular focus on its problems and rather modest achievements. The work on reindeer selection performed outside this institutional settings as well as any other work and research performed in this setting are outside the scope of this paper. In this review I relay first of all on the literature produced by the people involved in the reviewed work and research – on the "archive" the project of reindeer-herding science as a political discourse has produced (see Foucault, 1972). I also relay on my own experience as one of those actively involved in this project during my entire academic career.

A first glance at artificial selection of reindeer in Russia

"Domestication" usually refers to the process of human's manipulating wild animals in such a way that these animals turn domestic – that is, dependent on humans and serving human needs. In the course of human history, only a negligible minority of the vast number of animal species has been domesticated (about 40 species altogether – see Bogolubskii, 1959). Archaeological findings, petroglyphs and other evidence suggest that reindeer may be one of the first species domesticated in the post-glacial period. The antiquity of reindeer herding, which may have existed already in the Paleolith or Mesolith, and definitely existed in the Neolith, is proved by numerous studies in the Siberian Saian-Altai region, probably the place (or one of the places) where reindeer were first domesticated (see Bogoraz-Tan, 1933; Skalon, 1956; Pomishin, 1990)

It is very difficult to identify the exact place and time of reindeer domestication: data are scarce and scholars often disagree on how they should be interpreted. In Russia, the mainstream opinion is that reindeer herding first emerged in the Saian-Altai region, in the proximity of the present-day border between Russia and Mongolia, and then spread from there to the Eurasian Arctic and Subarctic. The alternative hypothesis about independent domestication of reindeer in northern Europe has also been influential in Russian science (Segal, 1962). According to the mainstream hypothesis, reindeer herding of the tundra and the forest-tundra type was first created by Samoedic-speaking people (the predecessors of modern Nenets, Enets, Selkup and Nganasan), while taiga reindeer herding was created by Tungus-speaking groups (the predecessors of modern Evenki and Evens) (Vasilevich and Levin, 1951; Skalon, 1956; Vainshtein, 1970). Other groups adopted reindeer herding from these two (Pomishin, 1990), although for some groups, most notably Saami, the evidence for such an adoption is admittedly problematic.

The transition of reindeer from the wild to the domestic state, their adaptation to people, necessitated working out specific techniques of breeding, including those of the so-called folk selection (in Russian: *narodnaia selektsiia*). These techniques are based on accumulated empirical experience of Northern peoples, which has been transmitted from generation to generation as a part of cultural tradition. Since Northern peoples did not have a developed writing tradition, the techniques of folk selection and the knowledge they have been based on were collected and described by researchers in rather recent times – by the middle of 20th century (Bogoraz-Tan, 1933; Zolotarev and Levin, 1938; Kyzlasov, 1952).

As is well known, any artificial selection reflects practical needs of people in relation to the animals they breed. The most ancient way of using domesticated reindeer is for transportation, first as a beast of burden and then as an animal for riding (Vainshtein, 1970). In order to use the animals in this way, animals were appreciated not only for strength and stamina, but also for calmness and the ability to establish contacts with people and to learn from training. Among reindeer-herding people of the tundra zone, reindeer are kept mostly for their meat and skins; only castrated trained males older than 2 years and, more rarely, infertile females (so-called *khaptorka*) are used for transport. In Russia, reindeer milking is practiced only by some reindeer-herding groups of the taiga zone and only during the two or three summer months, when females normally nurse their calves. The amount of milk and its economic significance are small, even if considered in the framework of the corresponding traditional economies. The folk selection keeps its significance up to now; it is considered a form of vernacular stock breeding in contrast to professional stock breeding, which emerged only in the 20th century.

The first written evidences of the role of reindeer for the people living in the north of modern Russia can be found in the so called "Russian Initial Chronicle" by Nestor and in Novgorod Chronicles (Ssheglov, 1993, 16–18). They take the poetic form of the fairytale about a big cloud from which "small reindeer" fall and grow to become the main source of food and clothes for the locals (Ssheglov, 1993, 17). In the document of the late 15th century titled "On unknown people living in the eastern countries" (*O chelovetsekh neznaiemykh v Vostochnoi strane)* one can read about Nenets (*Samoieds*) who "eat reindeer meat and fish" and "use reindeer for transport" (Ssheglov, 1993, 79). These evidences confirm the existence of domesticated selected reindeer but tell little about them as well as about methods of selection. Various documents from the 16th and 17th centuries describe Russian colonization of the northern territories and encounters, sometimes peaceful but more frequently violent, with the local people. Many of these people are described as riding reindeer or using reindeer sledges for transportation, which enabled them to make victorious rides on Russians. More detailed descriptions of reindeer transportation and reindeer pasturing can be found in books of 18th century by Grigorii Novitski, Vasilii Zuev (see Mandrika et al., 1999) and particularly Johan Gotlieb Georgi (Georgi 1799). These books make it possible to guess about particular techniques of keeping reindeer but not of breeding and selecting them. Unfortunately, expeditions of the 19th century such as those by Schrenck, Goffman Islavin, Brehm, Dunin-Gorkavich did not aim to describe the traditional techniques of reindeer selection either. Therefore, although there can be no doubt that the folk selection of reindeer had been going on, no description of it and no scientific work on reindeer selection had been performed before 1920s. It was only in 1930s that the first accounts of ways reindeer herders select animals for breeding made appearance in literature (Dobrotvorskii and Bogdanovskaia-Guiheneuf, 1938), but even then these methods were not given particular attention by reindeer-herding scientists. In fact the first reindeer-herding scientist who started collecting these techniques was Semion

Pomishin in the late 1960s. He was also the first specialist in Russia who started using the term "folk selection" in his publications (Pomishin, 1975).

Institutional development of reindeer-herding science in the early decades of the Soviet Union

Reindeer herding did not represent an economic branch of any commercial importance for the Russian Empire (Sergeev, 1955). Reindeer meat was traded by middlemen at the markets of Moscow, St. Petersburg and Nizhnii Novgorod, but only seasonally and in rather limited quantities (Kertselli, 1921). Fresh and processed reindeer skins as well as items made of them represented exotic rather than every-day market goods (Bartenev, 1896).

The first circumpolar census of 1926 indicated that the total number of domesticated reindeer in Russia was approx. 2.2 million animals (Sergeev, 1955). All these animals belonged to private herding households, distributed over more than 3.3 million square kilometers of reindeer pasturelands spanning from Karelia to Chukotka and Sakhalin. In contrast to the Czarist government, the Soviet one did believe that reindeer herding had a potential for turning the Russian Arctic into a region of agricultural production, which, in its own turn, was essential to support the ambitious programs of arctic colonization (Bogoraz-Tan, 1933) – both voluntary, through developing industrial enterprises and hiring workers for them, and involuntary, related to the expanding system of forced labor camps (GULAG). However, turning reindeer herding into a productive economic branch of socialist type necessitated a thorough reworking of the "bourgeois mentality" (*chastnosobstvencheskaia mental'nost'*) of Indigenous northerners into a collectivist one. This was to be achieved not only through ideological propaganda, but also by the means of reorganizing the whole system of keeping and owning animals.

As everywhere in the Soviet Union, from the 1930s onwards private reindeer herds were expropriated and transferred to collective (*kolkhoz*) and state-owned (*sovkhoz*) enterprises. Deliberate forced transformations of traditional economy of such a scale and magnitude had been unheard of in the world history by that period. It was not particularly surprising, therefore, that serious scientific research and scientific recommendations were felt to be needed in order to solve the many problems of the socialist re-organization of reindeer herding. However, there was a significant problem here: reindeer as a biological species and reindeer herding as a livelihood had been insufficiently researched by the time, to put it mildly (Kreps, 1934; see also Gulchak, 1954). Even though some information on reindeer herding could be found in ethnographies of the

time, there was hardly any empirical research specifically focused on biology, ecology or technology (zootechnics) regarding reindeer (Gulchak, 1954).

Therefore, reindeer-herding science had to be created completely anew starting from the very basics: looking for specialists, creating basic research institutions, compiling research plans. Of course, this should be repeated, all this was done as a part of the ambitious state program of socialist reconstruction – "The Sovietization of the North" – and this has left its impact on all aspects of the research: its planning, methods, aims, etc. Consequently, the series of scientific contributions to the newly established reindeer-herding science was named "Soviet Reindeer Herding" (*Sovetskoe olenevodstvo*).

The first specialized research institute – the Institute of Reindeer Herding – was founded in Leningrad in 1931. Its researchers were to perform a truly huge job: to study morphology, exterior, reproduction, development of reindeer as well as production rates of reindeer herding in different parts of the country. An important role in the creation of the network of local research stations of the Institute was played by the GUSMP (*Glavnoie upravleniie severnogo morskogo puti* – the Main Administration of the Northern Sea Route), which took responsibility for the Institute after its founder and first director Sergei Kertselli died in 1935. In 1937, the Institute was reformed as the Institute of Polar Agriculture, Animal Breeding and Hunting, and transferred from GUSMP to VASKhNIL (*Vsesoiuznaia akademiia selskokhozaistvennykh nauk imeni Lenina* - All-Soviet Academy of Agricultural Science named after Lenin). Most of the research by the Institute was halted between 1941 and 1945 due to the Second World War. During most of this period, Leningrad was under attack by German and Finnish Army; the Institute was temporarily moved to Khanty-Mansiisk.

In 1957, the Institute was once again renamed as the Institute of Agriculture of the Far North (*Institut selskogo khozaistva krainego severa*) and moved to Norilsk, the former GULAG town, which was turned into a city in 1953. At the same time, institutions and facilities for studying reindeer herding were created in other areas of the Russian Arctic. Still, up to 1970, the entire field of reindeer-herding research in the country was co-ordinated by the institute in Norilsk. The most important personalities in Soviet reindeer herding studies of that time were A. N. Segal, who worked in Karelia, O. L. Rapoport and A. Kh. Laishev (Mumansk Area), B. V. Preobrazhenskii and G. I. Karev (Nenets AO), S. M. Ivanova-Druri and A. I. Chuprov (Komi ASSR), E. K. Borozdin, P. N. Vostriakov, N. O. D'iachenko and A. D. Mukhachev (Tiumen' Area and Krasnoiarskii Krai), S. B. Pomishin, P. I. Stremilov, B. N. Baradiev and A. D. Kuriliuk (Yakutia and Southern Siberia), V. I. Dodzikov, V. I. Ustinov and A. M. Iudin (Chukotskii AO).

The work on formulating techniques and recommendations for reindeer selection started already in the 1930s, using the data

on phenotypes of domestic reindeer from different regions of Russia (Vinogradov, 1938; Dobrotvorskii, 1938) and on details of reindeer reproduction and development of calves (I. V. Druri and Zheleznov, 1936; Shubskaia, 1938; 1940; Gulchak, 1939) that the Institute of Agriculture of the Far North collected through the network of its research bases. The work contributed to creating the new system of large-scale reindeer herding (*krupnotabunnoe olenevodstvo*), i.e. pasturing large herds of reindeer. This system was to be used in *kolkhozes* and *sovkhozes*. The latter, by the way, were planned to serve as blueprint for the former in applying new methods of breeding and herding as well as providing high-quality reindeer for improving the breeds.

Recommendations for reindeer herding and breeding since the 1950s

After World War Two, the selectionist research included adaptation of reindeer being moved from one region to another, performed in order to open up new possibilities of cross-breeding; the selectionist work was further informed by research on optimum herd composition, which would take into account the needs of the growing human population of the Russian Arctic (S. M. Druri, 1956; Diachenko, 1957; Preobrazhenskii, 1963). Since 1961, the process of amalgamation of reindeer-herding *kolkhozes* and their transformation into state property (*sovkhozes*) gained momentum. This reform did result in a significant increase in reindeer herders' standards of life: even in those *kolkhozes* that were not transformed into *sovkhozes*, the reindeer herders started to get warranted monetary salaries in accordance with their qualification as well as some social payments that did not exist in *kolkhozes* previously. Furthermore, many women in nomadic families became employed as "tent-workers" (*chum-rabotnitsa*) and started to receive salaries (admittedly quite small) and pension schemes (Forsyth, 1992; Lincoln, 1994). An increase of production was expected in order to compensate for the reform. This was to be achieved, among other things, by applying new and more efficient techniques, to be designed by the reindeer-herding scientists. The experts were thus given the task to decrease the mortality of calves and grown-up reindeer, reduce the female reindeer infertility rate, find the way to increase slaughter weight of the animals as well as more efficient methods to cure various reindeer diseases. The corresponding methods and recommendations were indeed produced.

For our topic, the differentiation of ecological zones and that of production foci of reindeer herding are probably most important (Preobrazhenskii, 1953; Druri and Mitiushev, 1963). Thus, for the taiga zone, reindeer herding was recommended to specialize on serving transportation needs. Therefore, it demanded breeds of reindeer with large and strong males, which would serve as good transport animals. Experts produced special methods of selecting, growing and teaching

such reindeer (Vostriakov, 1956; Popov, 1956). In contrast, for the tundra zone, the focus on meat and skins as commercial products was recommended. Of course, even in the tundra zone, some reindeer males were to be used for transportation: not only for moving the reindeer herders' camps, but also for e.g. transporting fish from fishing grounds to storage places as well as transporting post and people to and from tundra villages. Still, maximizing meat production was the main objective of selection and breeding in this zone.

As new means of transportation – planes, helicopters, snowmobiles, and all-terrain vehicles – made appearance in the Russian Arctic, the significance of transport animals vanished and selection for qualities needed for transportation eventually stopped throughout the country. Meat production, on the other hand, gained in significance: although exporting reindeer meat to the central and southern parts of Russia and abroad remained limited due to the poor transportation infrastructure, the meat was consumed in growing quantities by cities and industrial towns that mushroomed in the Arctic region since the late 1960s. Furthermore, a growing percentage of reindeer meat was used to feed fur-bearing animals: since the late 1960s, fur farms were organized in numerous reindeer-herding enterprises throughout the country, keeping silver foxes and Arctic foxes in cages. The main reason was to provide work for the growing number of women settled in villages and towns as a result of the campaign for transition from "nomadism as a way of life" to "nomadism as a way of production".[2] Secondly, fur farms were to utilize reindeer meat and produce equally valuable product (pelts) that could be transported and exported more efficiently. The later rationale turned out to work particularly well: from the early 1970s to the late 1980s, Soviet state-owned enterprises combining reindeer herding with fur farming (so-called *olenezverofermy*) were the main producers of furs for the world market, thereby bringing significant profit to the state.

Taking into account the prerogative of maximum meat production, the techniques and measures of scientific reindeer selection included, first of all, a specific herd structure, which would maximize the production of calves. It was commonly accepted among the specialists that the relatively high speed of growth during the first 6 months of life makes calves the cheapest source of meat in reindeer herding. Therefore, it was

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2 In the 1960s, the Soviet government started a campaign for making reindeer-herding nomads sedentary. The plan was to replace the reindeer herders' migration with their families ("nomadism as way of life", *bytovoe kochevanie*) with a system wherein only male herders migrated with herds, while females and children were to stay in settlements ("nomadism as a way of production", *prozivodstvennoe kochevanie*). The administrators reasoned that this would allow to provide for better education and healthcare and make better use of female labor (see Lashov and Litovka, 1982; Donskoi, 1986).

recommended to raise the share of productive females to 70% (Preobrazhenskii, 1963). It was also recommended to select so-called eurysomic[3] animals – also known as "meat-type animals" (*Zhyvotnyie miasnogo tipa*) – for reproduction; experts came up with methods for evaluation of how closely animals resemble this type – either using the naked eye or using body measurements and special formulae (Mukhachev, 1968). Meat production could be further increased by cross-breeding local females and bigger males from other geographic locations, for example Tofa reindeer bulls from the southern Siberian taiga (Pomishin, 1975). To reduce transportation expenses, transportation of frozen reindeer sperm and artificial insemination of reindeer females were proposed (Mkrtchan and Deriazhentsev, 1973). To increase calf survival rates, experts suggested to stimulate the females hormonally for copulating early during the rut and, therefore, to give birth to calves early during the calving period[4]. Admittedly, most of these recommendations remained in the stage of experimental testing, even if the tests were successful. There were, however, scientific works that led to concrete and material results reflected in official documents. One of them was the work on the register of domestic reindeer breeds, as laid out in the next section.

Scientific work on reindeer breeds and selective breeding

Scientific studies to identify reindeer breeds

Russia does not only have the largest population of domestic reindeer in the world, but also is the only country where different breeds of domestic reindeer have been scientifically identified. To achieve this identification, Soviet and Russian scholars engaged in extensive studies of morphological, productive and physiological differences among domestic reindeer from all over the north of Russia. No studies of comparable depth and scope have ever been undertaken by reindeer-herding specialists outside Russia. The studies included zootechnical characterization of reindeer from various regions, detailed description of their pasturelands and fodder, of diseases and mortality structure, techniques of their keeping and pasturing, reproduction patterns and calf development. Works by M. P. Vinogradov, I. V. Druri, S. M. Druri, E. I. Shubskaia, N. O. D'iachenko, P. N. Vostiakov, B. V. Preobrazhenskii, S. B. Pomishin, E. K. Borozdin and A. D. Mukhachev established

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3 Eurysomic means having a broad, thickset body. In Russian language, this Greek word does not have any connotations with the racial theory.

4 It has been demonstrated beyond reasonable doubt that calves born during the first half of the calving period show higher survival rates and growth speed in comparison to calves born in the second half.

the basis for describing different breeds and formulating the basic principles of scientific selectionist work in Russian reindeer herding.

Identification and standardization of reindeer breeds took into account the ethnic and regional specifics of reindeer herding. The words of A. D. Mukhachev, who took active part in the work described, give a good impression of how this happened (Yuzhakov et al., 2023: 5-6):

> "About 15 years of physically and psychologically demanding work were needed to identify the specific breeds of domesticated reindeer in Russia that would satisfy the established criteria and to justify their utility for reindeer herding. . .

> All the digital data on craniology, exterior, productivity was processed biometrically using methods and formulae worked out by Plokhinsky (1961) and Rokitsky (1964).

> The analysis produced statistically significant results showing the existence of four reindeer breeds: Nenets, Chukchee, Evenki and Even reindeer. The results were discussed and approved by the Academic Council of the Institute of Agriculture of the Far North. After that I presented all the data obtained on breeds to the Far North Section (headed by academician E. E. Syroechkovskii) and the Section of Animal Breeding and Hybridization (headed by prof. A. P. Soldatov) of the VASKhNIL presidium. Both sections approved the work and its conclusions.

> All the data on reindeer breeds were sent to the Department of Animal Husbandry, Ministry of Agriculture of RSFSR. The Department also approved the work and sent a recommendation to the USSR Ministry of Agriculture to issue a special decree on reindeer breeds, their protection and use. On 23 August 1985, Valentin Mesiats, who occupied the position of the USSR minister of Agriculture at that time, issued Decree 212 "On Reindeer Breeds." This decree contained the list of approved breeds with their specific traits and ordered to work out and publish an instruction on reindeer quality assessment (*bonitirovka*) which would take into account the breeds."

As can be seen, reindeer breeds were identified on the basis of craniological, exterior and production criteria, taking into account historical, ethnological and environmental factors affecting breeding. Genetic studies of domestic and wild reindeer populations in Russia started only in the late 20th century (Shubin and Iefimtseva, 1988). These studies confirmed many (although not all) results of the previous research on reindeer breeds and established new directions in studying reindeer breeds and populations. All the breeds

TABLE 1 Reindeer breeds by the number of individuals belonging to them and the number of breeding farms in accordance to the official data (see **Yuzhakov et al., 2023**).

Reindeer breed	Number of reindeer, thousands		Percentage of increase (+) or decrease (−)	Number of reindeer-breeding farms
	In 2006	In 2023		
Nenets	908	1,399	+35.0	10
Chukchi	180	226	+20.0	10
Evenki	48	22	−219	3
Even	144	87	−166	3
Total	**1,281**	**1,734**	**+26.0**	**26**

identified were created by folk selection over long periods of time. Therefore, they represent an integral part of traditional cultural heritage of Northern Indigenous peoples in Russia.

The current state of different reindeer breeds in Russia

After the work on identifying reindeer breeds was finished in the mid-1980s, specialized breeding farms were created on the basis of those reindeer-herding enterprises whose herds demonstrated close correspondence to the established standards of breeds. As of January 2024, there were 26 specialized reindeer-breeding farms in Russia (see Table 1). Of these, 10 farms specialized on the Nenets breed of reindeer and another 10 specialized on the Chukchi breed. The Evenki and Even breeds were reared at only three breeding farms each. It should be noted that the number of reindeer belonging to the Even and Evenki breeds has been decreasing continually during the last 15 years. This decrease is worrying, considering that the Even and particularly Evenki breeds (the latter exists exclusively in the taiga zone) have never been numerous and may soon run the risk of extinction.

As can be judged by the current situation in Russian reindeer herding, the main reindeer breed (as far as the number of reindeer, the productive output and the size of breeding stock are concerned) is the Nenets one. This situation is not likely to change over the next five or more years. The Chukchi breed can realistically become a good supplement and alternative to the Nenets breed in production; however, to achieve this, measures are needed for encouraging people to continue reindeer herding in the northeast of Russia, and for stabilizing the breeding stock. The Even breed is in urgent need of stabilizing and growing the breeding stock, which also requires expanding the network of breeding farms. Without this, the number of reindeer of this breed is likely to continue decreasing. Finally, the Evenki breed is currently in deep crisis: urgent measures are needed to save it from extinction.

FIGURE 1
Measuring stick and tape.

Bonitirovka – the ranking of reindeer

Methods of *bonitirovka* (evaluation and selection of individuals suitable for breeding) used in present-day Russia have been adapted from cattle breeding, but thoroughly modified in order to adapt them to the specific parameters of reindeer.

FIGURE 2
Measuring protractor.

Male reindeer are assessed before rut, females immediately after the rut. *Bonitirovka* includes three basic criteria: body weight, exterior (with five basic measures of the reindeer body) and fatness (the development of the fat layer). Each reindeer gets a mark from 1 (lowest) to 5 (highest) separately on weight and exterior and from 1 to 3 on fatness. Specific tables are used for establishing marks depending on the breed, sex and age of the reindeer. Special equipment is widely used for taking the relevant measurements. Thus, body weight is measured using a scale, exterior measures are taking using a measuring stick (Figure 1), a protractor (Figure 2) and a measuring tape. The process of selection usually starts already on this stage. Thus, animals who get a mark lower than 3 on their body weight are

regarded to be unfit for reproduction and should be scheduled for slaughter. Similarly, female reindeer who have not had a healthy calf by the time of *bonitirovka* for two successive years should be scheduled for slaughter. The rest of the animals are assigned to one of four classes (élite, 1st, 2nd, or 3rd) depending on the sum of their marks. Élite reindeer and those of the 1st class are regarded as breeding-stock animals: they can be used for improving breeds inside the enterprise and/or be sold on the market as breed animals. The 2nd and 3rd class reindeer are considered to be unfit for commercial breeding, but they can be used inside the enterprise as members of productive herds. In order to be certified as a specialized breeding farm, an enterprise should demonstrate that no less than 70% of its productive animals belong to the élite and the 1st classes. For ordinary enterprises, it is recommended that at least half of their productive animals should belong to the higher classes, to avoid the degradation of breeds.

Practical challenges in selective breeding

Since the 1980s, departments of reindeer breeding were organized in all district agricultural directorates (*raionnye upravleniia sel'skogo khoziaistva*) in the tundra zone of the country. These departments supervised reindeer selection. Their first task was organizing specialized breeding stocks in reindeer-herding enterprises. In order to do this, the best reindeer were selected, ear-tagged and separated into a special herd, whereafter their cross-breeding and offspring were recorded. Soon the first enterprise was registered as a specialized breeding farm. This was "Iarsalinskii" *sovkhoz* in the Iamal-Nenets AO. In the Evenki AO, "Surindinskii" *sovkhoz* was reorganized into a specialized breeding enterprise, meaning that its production focused on high-class alive reindeer to be used for improving reindeer breeds in other enterprises. However, since the breeding departments were short of personnel, most of the *bonitirovka* and selectionist work fell on *sovkhoz* and *kolkhoz* zootechnics, who mostly lacked the specialized training needed for this kind of work. What was even more important, a market for breeding reindeer had not been created, which meant that reindeer-herding enterprises could not get any commercial revenues from their breeding stocks and their breeding work in general. This explains why all the "specialized breeding farms", contrary to what their title suggests, never actually specialized in breeding: reindeer meat and skins remained their main and, in most cases, only production. Furthermore, even in these farms, reindeer were selected for breeding or slaughter in every herding unit (*brigada*) mostly by reindeer herders themselves on the basis of their taste and, presumably, traditional techniques, rather than by zootechnics on the basis of scientific recommendations. The role of zootechnics and breeding specialists was limited to exchanging reindeer between herding units in a way that, in their opinion,

would increase the overall quality of animals in the herds. Certainly, such a level of selectionist work fell short of the standards recommended by the scientists.

Most importantly, however, even this sub-standard selectionist work continued for less than a decade. In the early 1990s, after the collapse of the Soviet Union and the start of market reforms, breeding departments disappeared, many breeding farms went bankrupt and many specialists in reindeer breeding had to look for a more profitable job. The total number of domestic reindeer in the country almost halved and the breeding stocks met the same fate (Klokov, 2013). It took 15 years for selectionist work to resume with state assistance. By that time, many achievements of the Soviet period were lost; breeding experience had partly sunk into oblivion; in many spheres, the work had to be started anew. Russian reindeer-breeding science owes great gratitude and admiration to the reindeer herding families that continued migrating in the taiga and tundra throughout the 1990s and the early 2000s. It is only due to their patience and adherence to reindeer-herding traditions that the genetic uniqueness of the reindeer breeds and territorial groups of domestic reindeer was maintained.

Nowadays the selectionist science has to repay its debt to them by applying up-to-date methods of breeding in order to help reindeer herders to keep their traditional economy alive, to increase its productivity and to make it more resistant to present-day global challenges, including climate change and new reindeer diseases. As mentioned, there are 26 certified breeding farms in Russian reindeer herding now. These farms get special subsidies from the state for their selectionist work, some of them are involved in genetic studies of breeding animals using new methods of molecular analysis. At the same time, serious problems obviously remain. Some of them are not dissimilar to those faced by reindeer breeding specialists of the late Soviet time.

The current situation and future of reindeer breeding in Russia

Looking at the selectionist work on reindeer today, probably the main problem now consists in scarcity and low reliability of breeding records. Since breeding specialists are still in short supply, *bonitirovka* is carried out rather poorly and mostly by people with insufficient training. Recording is usually limited to tagging reindeer and writing *bonitirovka* protocols. The ancestry of the respective animal is almost never traced and recorded; it is almost never possible to establish which offspring belongs to which pair. This is partly related to the difficulties of recording reindeer copulations in a nomadic pastoralist system, when animals are kept on a pastureland during the rut. However, the main reason is the chronic lack of formally trained specialists in Russian reindeer herding. Thus, even in the majority of breeding farms, most of the selectionist work is still done by

reindeer herders themselves on the basis of their traditional techniques.

Both the scientific work on reindeer selection and breeding and organizing selectionist work demand serious financial investments. At the same time, although the Russian government distributes subsidies for stock breeding work to reindeer-herding enterprises, most of these monies are spent by the enterprises to cover their running costs, which typically have nothing to do with breeding. A widespread belief is that the eyes of experienced reindeer herders represent the best tool of assessment, and that the herders will always select the best animals for breeding on the basis of their appearance. Any scientific study of animals selected in this way, their qualities and genetic underpinnings of these qualities, is believed to be redundant and negligible. Furthermore, in breeding farms, herds of breeding-stock reindeer typically include also personal reindeer belonging to the herders responsible for these herds as well as to their relatives. These personal reindeer take part in ruts and, therefore, hamper the process of selectionist breeding and decrease the quality of animals bred. In the Iamal-Nenets AO, where the density of reindeer is high and migration routes run particularly close to each other, it frequently happens that the breeding-stock herds mingle with herds of other enterprises and/or private herders during the rut. This results in unplanned random copulations of the breeding-stock animals so that individual ancestry records become problematic or even impossible. It should be added that, at least in reindeer herding in the tundra zone, the only form of mating regulation used is what is called "free group mating" (*vol'no-gruppovaia sluchka*): selected groups of male and female reindeer are put together as a separate herd during the rut and kept isolated from other reindeer. Animals in the herd can copulate freely. This kind of mating regulation is one of the least effective kinds in the selectionist work: under these conditions, specialists and herders cannot actively cross-breed specific pairs of animals, despite sometimes being able to record spontaneously occurring copulations by observing the herd from a distance. In practice, however, even the latter is difficult due to little daylight and frequent mists in autumn.

It has thus to be admitted that all the stock-breeding and selectionist work that currently takes place in Russian reindeer herding is carried out by individual enterprises without much guidance and advice by reindeer-herding scientists. Furthermore, scientific methods and standards of selection are often deliberately ignored, and this negatively affects the quality of the breeding animals obtained.

Nonetheless, the breeding of reindeer herds carried out by the enterprises and breeding farms are still considered to be productive: meat and velvet antlers continue to be their main commercial products, while the high-quality breeding reindeer produced in these herds are used almost exclusively inside the enterprise; indeed, the market for breeding-stock reindeer is still absent. Indeed, reindeer in breeding herds do not differ

phenotypically from reindeer of the same age in ordinary herds. The lack of ancestry records does not allow equipping breeding animals with a genetic passport, which would certify the origin of the animal and the productive qualities of its parents and predecessors. Without such a passport, a potential buyer simply cannot assess the quality of the breeding-stock animal on offer. All this leads to a situation whereby nobody can even say how much a breeding-stock reindeer may cost. In this situation, producing breeding-stock reindeer is not economically profitable for any enterprise, including the specialized breeding farms. Therefore, just as in late Soviet times, the farms continue to slaughter the calves they produce for meat and cut velvet antlers in order to get profit. It is the selectionist work and the high percentage of high-rate animals in their herds that gives them the entitlement to be registered as a breeding farm and, therefore, get additional subsidies from the state.

On the societal value of selectionist science and practice

It is widely known that dog and cat breeding have always existed as a private business without any subsidies from the state. This has been possible because there is stable demand for high-quality breeding animals of these species and the market prices for them exceed the expenses for their breeding. In the case of reindeer herding, things are different and, if further development of this economic branch is in the interest of the state, it has to support the selectionist work. There is simply no other way. Having said that, it has to be admitted that the current subsidies on breeding are not effective: as has been mentioned, most of them are not spent on breeding at all, but dissolve in day-to-day expenses of the reindeer-herding enterprises. At the same time, basic measures to improve reindeer breeding are not very expensive. One has to start with limiting the size of breeding herds in accordance with recommendations: a maximum of 1,500 reindeer per herd in the tundra zone and of 800 reindeer per herd in the taiga zone. The next step, which is admittedly more difficult and expensive, is organizing records and recording, particularly documenting the animals' ancestry. All the breeding-stock animals should get genetic passports, reflecting their ancestry and containing information about their offspring and its quality, to be renewed annually. Specialized software, for example "SELEX" (popular among Russian cattle breeders), can be profitably used for this task. Ideally, existing methods of assessing the quality of male reindeer should be expanded by adding a semen assessment. Methods for this are well developed and adapted to reindeer.

Efficient implementation of innovative, scientific, economic, legal and educational measures would demand creating a corresponding institutional structure. This should include, but not be limited to, the recreation of the vertical hierarchy of breeding herds (with specialized breeding farms; selection information centers; and a breeding department at the local agricultural directorate) which existed in the Soviet time. A system of horizontal connections should be added to this hierarchy. Thus, on the level of herds, relations should be established between the donors of breeding animals and their recipients. A system of commercial supply and exchange of breeding animals should be created among breeding farms as well as between these farms and ordinary reindeer-herding enterprises and private reindeer owners. New specialized breeding farms should be registered only after detailed plans and prognoses of breeding work and breeding needs have been designed at local and regional level; all the stages of these plans should be related to the solid basis of scientific methods. Furthermore, selling breeding-stock reindeer to other regions could become one of the ways to remove grazing pressure from tundra pasturelands as well as to resurrect reindeer herding in the taiga zone.

Conclusion: strengthening research on environmental conditions and genetics in reindeer selection science and practice

Forty years of experience in studying economically useful traits of domestic reindeer and methods of selectionist reindeer breeding show that any selectionist work should start with differentiating between the mainly and exclusively inherited traits that can be improved by the means of selection *versus* those traits which are formed under the influence of environmental factors of such magnitude that artificial selection is unlikely to improve them significantly. Unfortunately, it is exactly this basic distinction that we cannot make on the basis of our current state of knowledge. This explains the low efficiency of the selectionist methods that have been used in Soviet/Russian reindeer herding for a long time; and it is the low efficiency that has been causing frustration among both scientists and practitioners. For decades, the main traits reindeer were bred for have been exterior: weight and fattiness in autumn. It should be said that most of the studies on exterior and weight inheritance have been done a long time ago, from the 1930s to the 1960s – that is, in the epoch when genetic theory was either openly denied or taken only cautiously in the Soviet Union. This explains the methods of these studies and the small samples of animals tested as well as the habit of sometimes jumping to conclusions too quickly. From the present-day point of view, therefore, the topic of economically useful traits inheritance among reindeer has to be regarded as insufficiently studied even when this concerns the weight and exterior.
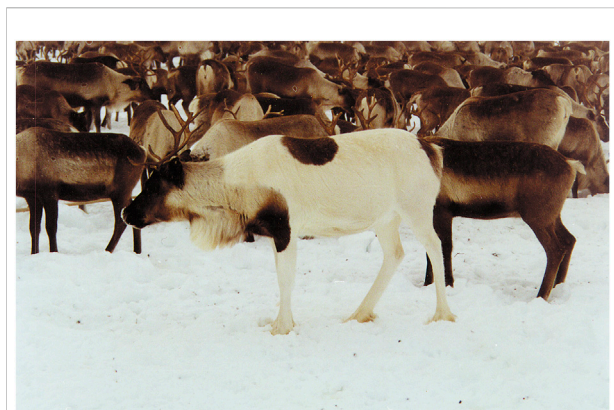
FIGURE 3
A multicolored reindeer (samorot in Nenets), whom Nenets reindeer herders regard as particularly valuable for their folk selection.

Clearly, weight and exterior formed the basis of the standards of breeding; the *bonitirovka* grades, as was laid out earlier in this article, are still ascribed to animals on the basis of the sum of marks for these three parameters. Admittedly, this approach did result in certain progress in selection, but it seems like this progress has its limits, which are set by environmental variables, most notably the quality and quantity of forage, and probably the forces of natural selection. Thus, if the quantity and quality of available forage is insufficient, reindeer cannot completely realize their genetic potential in their bodily appearance; the *bonitirovka* grade may thus underestimate the animal's breeding value. On the other hand, if reindeer are kept in conditions close to natural ones (which is often the case), stabilization of natural selection eliminates individuals that deviate significantly from the population averages, including the average weight and size. This is particularly evident in bad years, in periods of adverse natural conditions, when the biggest and the smallest animals are the first to die, while average animals have better chances to survive: large animals cannot find enough fodder for their size, while small animals cannot sustain competition with other animals in the herd. This shows that selectionist programs should take into account environmental conditions, which are likely to prevail in the course of their realization. Furthermore, existing criteria and methods of *bonitirovka* should be expanded to include traits not directly related to exterior factors. One of them can be unspecific resistance to adverse environmental conditions, i.e. the inherited ability to survive. The other is the amount of milk produced by reindeer females, which is very important for the rate of calf survival (although additional work is needed to find the methods of assessing the former criteria, methods of assessing the later criteria do exist).

Our recent research, involving regressive correlation analysis of exterior assessment indexes of reindeer from enterprises in the Iamal-Nenets AO (Yuzhakov and Laishev, 2022), demonstrated that only for three indexes (total height, chest curve index and width index) a significant portion of variation can be explained by genetic relation between the animals. This means that these indexes can be inherited. Besides that, we have found that the weight of female reindeer corrected for their age and genetic relatedness significantly correlated with their total height, chest curve index and chest volume. Simultaneously, we failed to find any associations between the measured indexes and any microsatellites. This confirms that microsatellites in reindeer are neutral for selection. Indeed, researchers from the Vavilov Institute of General Genetics think that in the case of reindeer, microsatellites are located on those DNA sections that do not code for inherited traits and thus do not influence the animals' adaptiveness, productivity or exterior, despite being a good indicator of the general level of population homozygoticy as well as of private alleles of specific animal groups. Thus, we used 16 microsatellite markers to study genetic proximity and homogeneity of Evenki and Even breeds of reindeer, which are kept in adjacent territories of central Siberia, as well as wild reindeer populations from the same region. Our study confirmed that significant genetic differences exist between Evenki and Even reindeer. Furthermore, we have established that genetic flows between these two breeds of domestic reindeer and wild population were insignificant and the domestic breeds show significant homogeneity. In contrast, wild reindeer have demonstrated significant genetic heterogeneity. Thus, it was established that most of the genetic diversity of central Siberian reindeer is concentrated in the Taimyr population of wild reindeer: out of 179 different alleles found in domestic and wild reindeer in our study, 143 were found in the Taimyr wild population. Furthermore, 30 of 179 alleles were found only in this population.

Nowadays, genetic studies of reindeer gain momentum in Russia. They are carried out in the L. K. Ernst Institute of Animal Husbandry, the Russian Institute of Animal Breeding, the Vavilov Institute of General Genetics, the Severtsov Institute of Ecology and Evolution, at the St. Petersburg Federal Research Center, the Archangelsk Federal Research Center, the Komi Science Center of the Ural Division of the Russian Academy of Sciences (RAS), the Tiumen' Science Center of the Siberian Division (RAS), the Yakutian Academy of Science, the Magadan Institute of Agriculture, the Tyva Institute of Agriculture and some other institutions. One can hope that soon we will have a complete description of the genomic structure of reindeer. Beyond any doubt, further development of selectionist science will be related mainly to these genetic studies.

All these being said, it should be accepted that throughout the Soviet period as well as now, the folk selection has been dominating reindeer breeding and the existing reindeer breeds as well as any other differences (mostly statistical rather then absolute) between the (semi) domesticated and wild reindeer populations have been created and maintained thanks to it. As it

is well known, folk selection is the intentional selection of animals or plants that is based on personal or collective experience, preferences and/or traditions rather than scientific knowledge (the knowledge based on the results of a falsifiable, repeatable and verifiable intentional research). The folk selection started together with domestication and its aim has always been not only (and, frequently, not so much) improving animal productivity, but also changing animal behavior, stamina, survival and exterior details, such as fur color. Thus Nenets and Khanty reindeer herders use reindeer skins to produce fur clothes. Clothes richly decorated by patches of fur of different colors are regarded more valuable, which creates a need for white and multi-colored animals. Therefore, these groups of reindeer herders deliberately select multicolored reindeer for breeding (Figure 3). There are also specific demands to transport reindeer: they should be not only strong and entrant, but also beautiful by the local standards of reindeer beauty (light, preferably white color, branchy antlers, etc.). Qualities that are important for transportation often sacrificed for the sake of physical beauty in the process of selection. Russian reindeer herding science classifies folk selection as a kind of the so called "mass selection work" and makes a distinction between it and the so called "deep selection" carried out by trained specialists and scientists. The aim of science, the reindeer herding science included, is working out and improving the methods of the later. However, in the case of reindeer herding, this aim is not achieved: the existing four breeds of reindeer as well as their possible local variants are products of folk selection, while the newest methods of science, including the genetic and molecular ones described above, have not so far contributed significantly to increasing reindeer productivity and creating new reindeer breeds. It seems to us that the only way to move forward with selectionist work is through co-production of knowledge by scientific and folk practitioners. However, it is still not clear how such a co-production can be organized. I believe that organizing such a co-production is probably the most important field where Russian and Western (particularly Fennoscandian) specialists could cooperate.

Note: Readers who can read Russian and interested in further details on reindeer breeds and reindeer selection in Russia may consult the recently published book by A. A. Yuzhakov, A. D. Mukhachev and K. A. Laishev "Porody i problemy selektsii severnykh olenei Rossii" (Moscow: Nauka, 2023).

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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