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RECEIVED 17 June 2025
REVISED 07 October 2025
ACCEPTED 16 October 2025
PUBLISHED 07 November 2025

CITATION
Laishev KA and Yuzhakov AA (2025)
Veterinary science and veterinary
service in Russian reindeer herding.
Pastoralism 15:15115.
doi: 10.3389/past.2025.15115

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Veterinary science and veterinary service in Russian reindeer herding

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This paper describes the history of and basic directions of research in Russian reindeer veterinary science. The first reports of mass epizooties of reindeer in northern European Russia date back to the mid-19th century. Epizooties took hundreds of thousands of animals, but it was not until 1910 that the first veterinary station was opened in the tundra of European Russia. Veterinary expeditions were organized by the government in 1911, 1912, and 1914. The first research institute dedicated to studying reindeer diseases was founded in Obdorsk (now Salekhard) in 1925. This marked the initiation of regular studies on infectious and invasive reindeer diseases, as well as efforts to develop methods for preventing and curing them. Apart from Siberian anthrax, the diseases that cause the most economic damage to reindeer herding are necrobacteriosis (foot rot), reindeer fly invasions and other insect infestations, brucellosis, and certain lung diseases. By the 1940s, Siberian anthrax was almost completely eliminated among (semi) domesticated reindeer thanks to annual vaccinations. Parasitic invasions, most notably those by reindeer fly, appeared to be more difficult to struggle against, but some means to treat them have finally been developed. These include drugs such as baitex, fention, etacide, ivomek, and aversekt that kill reindeer fly larvae in the first and second stages of their development. Unfortunately, the decades-long effort to find a vaccine against necrobacteriosis has been unsuccessful, and recommended measures against this disease are limited to symptomatic treatment of animals that are already ill. Brucellosis is still registered in reindeer herds, and no treatment against it has been worked out so far. Reindeer that tested positive for brucellosis on the basis of serum reaction are scheduled for immediate slaughter. The work on developing and testing means for preventing and treating reindeer diseases is currently continuing in several research institutions in Russia. The lack of trained veterinary specialists in reindeer herding regions caused by low salaries and difficulties related to the nomadic way of life that these specialists have to lead represents probably the biggest problem of the modern Russian reindeer veterinary.

KEYWORDS

reindeer herding, reindeer diseases, veterinary history, siberian anthrax, necrobacteriosis

Introduction

It is well known that, as far as the numbers of domestic reindeer and active reindeer herders are concerned, Russia is currently a “reindeer herding superpower”: it is the home of approximately two out of approximately three million (semi) domestic reindeer living in the modern world as well as approx. $\frac{3}{4}$ of all reindeer herders (Istomin, 2020). These reindeer herders belong to diverse ethnic groups, and their ways of pasturing their animals, as well as the role this pasturing plays in their economy, differ. Thus, approximately 85% of all (semi) domestic reindeer in Russia are kept in tundra and forest-tundra zones. For their masters, reindeer herding represents their main economic activity, and they use reindeer as a source of marketable products (meat, skins, velvet antlers, etc.) as well as, in many cases, of raw materials for making clothing and dwellings (nomadic tents). Throughout most of the Russian tundra and forest-tundra zones, reindeer are pastured in big herds numbering from several hundred to several thousand animals under more or less permanent control by herders, who nomadize with their animals during the whole year and live in mobile dwellings (tents or wagons). The exception is the Kola Peninsula in the north-west of Russia, where, like it is common in neighboring Fennoscandia, reindeer herders are settled and the animals are allowed to disperse and graze freely, without observation, for most of the year. About half of the total reindeer herd of Russia – and about 1/3 of the total world population of domestic reindeer – are concentrated in the tundra and forest-tundra zones of Western Siberia, between the Urals and the River Yenisei (Yamal-Nenets and the western part of the Taimyr Autonomous Okrug). The absolute majority of these animals belong to Nenets reindeer herders, the biggest group of reindeer herding nomads in the modern world, although some Komi and Khanty reindeer herders also nomadize in this area. The Arctic zone of the European part of Russia (to the west of the Urals) is the second-largest reindeer herding area in the country. Here, reindeer are pastured by Nenets, Komi, and Saami reindeer herders. The third-largest reindeer herding area in Russia is located in the northeast of the country. It includes Chukchi Autonomous Okrug, Kamchatka Oblast (Province), Magadan Oblast (Province), and the North-East of the Sakha (Yakutia) Republic. This area is the home of Chukchi, Koryak, and Even reindeer herders. Finally, a few thousand reindeer are pastured by Dolgan and Enets reindeer herders on the Taimyr peninsula and in adjacent areas of North-Western Sakha (Yakutia). About 15% of reindeer in Russia are kept in taiga (forest), mountainous, and steppe areas to the south of the Arctic zone. These reindeer are kept in relatively small herds (numbering from a few tens to a few hundreds of animals) distributed across the whole of central and southern Siberia. The techniques of their keeping are diverse, as are the ethnic backgrounds of their masters and the purposes for which they keep the animals. Many reindeer herders living in this zone keep reindeer primarily or exclusively as a means of

transportation to be used in hunting, which is the primary basis of their economy. Animals can be kept in fences, pastured under control, or allowed to graze freely in forests, open mountain pastures, or on steppes. Frequently, a combination of these methods is used, and the herders, who can live stationary, move between a few permanent seasonal camps or be extensively nomadic, can flexibly switch between different modes of reindeer keeping depending on season, number of predators, hunting or trading needs, etc. The most important ethnic groups of reindeer herders in this area are Evenki, Khanty, Mansi, Even, Selkup, Todzhu-Tuva, and Buriat.

The diversity of geographic areas and techniques for keeping reindeer creates a diversity in the prevalence and types of reindeer diseases, which represent the primary focus of this paper. As it could be expected, tundra and forest-tundra reindeer herding suffer more from reindeer diseases than the taiga ones. The concentration of animals into large herds, “packing” reindeer together on the pastureland to make their observation easier for the duty herder, and long winters when the animals must survive on lichen (a fodder low in protein), contribute to the rapid spread of contagious diseases here. Historically, tundra reindeer herding in European Russia and Western Siberia (that is, the areas where the number of reindeer was particularly high) suffered from regular epizootics, particularly those of Siberian anthrax, that killed hundreds of thousands of animals and hundreds of people. The development of veterinary services over the last 100 years has contributed significantly to stopping anthrax epizootics. Still, reindeer in tundra and forest tundra herds continue to suffer from such contagious diseases as necrobacteriosis (foot rot) and brucellosis, which cause significant losses of animal lives as well as economic losses for their masters.¹ In the taiga reindeer herding epizootic situation is much better, but reindeer still suffer from parasitic diseases and necrobacteriosis, which can cause significant economic loss.

Although some somewhat naïve descriptions of reindeer diseases in Russian tundras can be found in the literature of the early 19th century, the topic did not attract much academic attention till the 1880s, when the number of domestic reindeer in the Russian Arctic grew so much that the death toll caused by epizootics could not be easily ignored anymore. In the late 1880s, reports about the mass deaths of reindeer in the Timanskaya, Bolshezemelskaya, and Malozemelskaya tundras of the Archangelsk Province (gubernia), as well as in the north of Tobolsk Province, began appearing in the mass press and specialized veterinary literature. Although exact numbers of reindeer losses due to epizootics in the Russian Empire are

1 Although reindeer rarely die from brucellosis, the disease can be contagious for humans through reindeer products. This means that ill reindeer cannot be slaughtered for meat and skins and are, therefore, lost for reindeer herding economy.

unavailable, they likely reached tens, if not hundreds, of thousands of animals (Golitsyn, 1888, p. 67). Reindeer herding nomads fell into poverty and demanded assistance from the administrators (*Gibel olenei na severe*, 1897). On January 24, 1897, the governor of Archangelsk reported that in the Bolshezemelskaya tundra (with a total population of domesticated reindeer exceeding 300,000 at the time), 163,500 reindeer contracted foot-and-mouth disease. 74,000 of them died, and 26,500 were killed. One year earlier (1896), 246,444 reindeer got ill, 118,717 of them died, and 32,085 were killed. To verify these reports, the Veterinary Directorate of the Imperial Ministry of Internal Affairs dispatched N. I. Ekkert, a master of veterinary science, and veterinary doctor V. I. Lastochkin to the Archagelsk province in 1898. They crossed the whole tundra up to the Arctic coast and established that the two principal reasons for the mass death of reindeer were Siberian anthrax and foot-and-mouth disease.

This expedition marks the beginning of professional research on reindeer diseases in Russia. At the same time, as late as the first decade of the 20th century, practicing veterinarians were still unheard of in the Russian tundra, despite the number of domesticated reindeer in Russia having reached two million already by the late 19th century (Sergeev, 1955). The first veterinary institution in the Russian Arctic dates back to 1910. This was the Pechora Polar veterinary and bacteriological laboratory in Oksino (Vyshelesskii, 1916). The primary task of the laboratory was to assist local herders with vaccinating reindeer against Siberian Anthrax and producing hyperimmune Anthrax serum. According to the first annual lab report, it also conducted work on isolating necrobacteriosis (foot rot) bacteria in reindeer (Bauts and Chekanovski, 1912). The laboratory was soon relocated to Archangelsk and renamed the Archangelsk Veterinary and Bacteriological Laboratory.

Since that time and up till 1924, no veterinary research institutions existed in the Russian Arctic *per se*. On the other hand, a number of short-term expeditions were organized in order to study reindeer diseases. Usually, these expeditions were organized during or immediately after large reindeer epizootics and, apart from research, involved some prophylactic work, usually related to vaccination. Thus, at least three veterinary expeditions were organized to the Archangelsk tundra between 1898 and 1906. These expeditions were headed by already mentioned N. I. Ekkert and one of them included E. N. Pavlovski, who later became a famous epidemiologist. Expeditions to the Western Siberian north were headed by S. I. Drachinsky (in 1912 and in 1913) and A. N. Chebotarev (in 1914). Famous S. A. Grüner studied the reindeer of Kamchatka and their diseases.

It was only in 1925 that two stationary veterinary-bacteriological institutes were founded in Obdorsk (nowadays Salekhard) and Izhma (known as the Pechora veterinary-bacteriological institute). They were organized by a special decree of the Council of People's Commissars, issued on

18 October 1924. In 1935, the Obdorsk veterinary-bacteriological institute was renamed as Obdorsk veterinary research station. In the 1930s, all research on reindeer herding, including veterinary studies, was centralized at the Institute of Polar Agriculture in Leningrad. In 1957, this institute was relocated to Norilsk (Krasnoyarsk area) and renamed the Research Institute of Far Northern Agriculture.

As for the North-East of Russia, the first institution for studying reindeer and reindeer herding was created here in 1929 in the village of Snezhnoie, Anadyr District. This was the Anadyr reindeer herding research station. In 1953, it was relocated to the town of Anadyr, the capital of the Chukotka Autonomous Okrug, and reorganized into the Chukotka Station for Comprehensive Agricultural Research. Research on reindeer diseases, most notably necrobacteriosis, was started here next year (1954). In 1961, the station was again reformed into the Magadan provincial (*oblastnaia*) reindeer herding research station, and a year later (1962), it moved to the village of Markovo, Anadyr district. A little earlier, in 1959, a territorial branch of the Far Eastern Research Institute of Agriculture was established in the village of Ola, Magadan Oblast. One year later (1960), this territorial branch was reformed into the Magadan Agricultural Research Station, which, however, did not do reindeer herding research. In 1969, this station and the reindeer herding research station in Markovo mentioned above were merged into a separate Magadan Zonal Research Institute of North-Eastern Agriculture.

This paper summarizes the research conducted in these institutions over the past 100 years and the methods developed to combat reindeer diseases that resulted from this research. Although reindeer veterinary has never been the most thriving and booming area of veterinary research in Russia, the full summary of research in reindeer veterinary would take too much space. Therefore, in this paper, we focus on the most important (from the viewpoint of their danger and economic damage) reindeer diseases: Siberian anthrax, necrobacteriosis (foot rot), brucellosis, and parasitic diseases.

Reindeer necrobacteriosis (foot rot, *kopytka*) and its research in Russia

One of the results obtained by the first professional veterinary expedition to Russian tundras, led by N. I. Ekkert (see introduction), was the description of three separate reindeer diseases: Siberian anthrax, foot-and-mouth disease, and necrobacteriosis. Ekkert specifically mentioned that the reindeer herders could differentiate between foot-and-mouth and necrobacteriosis. The latter disease started with small blisters on the tongue and gum mucosa; filled with liquid, these blisters would soon burst, exposing the submucous tissue. Similar blisters could later emerge between hoof fingers. The burst blisters left suppuration, which could lead

to the hoof wall falling out. Generally, N. I. Ekkert concluded that although the numbers of ill and dead reindeer communicated by the governor of Archangelsk were somewhat exaggerated, the losses experienced by the local reindeer herders were indeed very significant. Furthermore, the economic damage due to these losses actually exceeded the official estimations (Ekkert, 1898).

During his 1898 expedition, N. I. Ekkert produced the first systematic observations of reindeer necrobacteriosis in the history of Russian veterinary science. He also reviewed previous descriptions of this disease, including those in languages other than Russian, which, as observed, were rare, occasional, and far between. These observations, however, did prove that the disease had existed for a long time and was distributed throughout all European tundras (Ekkert, 1903). It appears that the first scholar to describe this disease was botanist Alexander Schrenk, who visited the Archangelsk tundras in 1837 and published his observations (in German) in 1848 and 1854. Here is how he described reindeer necrobacteriosis:

“... Among those diseases that eliminate reindeer yearly in different quantities in Nomads’ herds, the disease of hoofs, which emerges in August and is apparently caused by too wet pasturelands, is particularly widely spread. First, limp is observed in the affected animals, then their legs get swollen; the swollen parts get covered by ulcers with an unpleasant smell. After that, the animals, who are unable to move, lie down and start licking their festering blisters, which causes the disease to spread to their tongues; the tongues also swell and fester. The ulcers further spread across the back and the neck and ultimately the whole body of the animal, which then dies completely emaciated. In the herd, once the epizooty has started, it is contagious, and the nomads know no measures to be taken to curb the infestation [...]” (Schrenck, 1854, pp. 383–384)

Ethnographer V. Islavin, who also visited Archangelsk tundras in the 1840s, mentioned necrobacteriosis as well. He wrote that in July and August, reindeer developed “hoof disease,” and that Samoyeds (Nenets) attempted to treat it by applying turpentine to the damaged areas (Islavin, 1847, p. 48). N. Pavlovsky (1909) observed that domestic reindeer in tundras and forests of the Archangelsk province (*gubernia*) got phlegmons on the phalanges of their legs every year and that this causes enormous losses for the local nomads: from 1.5 to as much as 50% of a total herd can be lost due to the disease.

G. F. Panin, who spent 3 years among reindeer herding nomads of the Turukhan area (lower Yenissei), reported (1930) that 1 to 2 percent of reindeer got kopytka annually and 40 to 50 percent of those who did died or had to be slaughtered. In some instances, when the pathogen was particularly virulent and/or the animals were weak, the morbidity could reach 10%–15% and the mortality could be as high as 85%–90% (Panin, 1930). Observations in reindeer herding enterprises of the Nenets Autonomous Okrug, conducted over 6 years (1937–1942), revealed annual morbidity rates of 5%, 11.4%, 10%, 12.5%, and 10.9%, respectively (Krasnobaev, 1947).



FIGURE 1

Veterinary laboratory in a reindeer tent, 1928. Archive photo reproduced from “Report on the work of Ural antiepidemiological unit in Yamal tundra in 1927”, by D. Kolmakov, from the Yamal Experimental Agricultural Station (Salekhard, Russia).

Scientific studies of reindeer necrobacteriosis began after the Veterinary Bacteriological Institute was established in Obdorsk in 1925. In 1928, A. Revnivkykh, a researcher from this institute, conducted important work on clarifying the etiology of this disease, isolated its pathogen, and studied the pathogen’s biology (Figure 1). This changed scientists’ attitude to the etiology of *kopytka*. Revnivkykh was also the first to coin the term “necrobacteriosis” (Revnivkykh, 1932). In 1934, to check the conclusions made by Revnivkykh, the State Institute of Experimental Veterinary (GIEV), to which the Obdorsk institute was subordinated, sent an expedition headed by S. N. Muromtsev. This expedition confirmed the validity of Revnivkykh’s research (Muromtsev and Novicova, 1935; Krasnobaev, 1947).

After the Second World War, Soviet veterinary research on necrobacteriosis primarily focused on developing prophylactic measures and exploring methods of treating the disease. The latter included trying various sulfanilamide drugs, antibiotics, and some other chemical drugs. This research was conducted at the Institute of Arctic Agriculture (Norilsk), the Murmansk Reindeer Herding Research Station, the Magadan Zonal Research Institute of North-Eastern Agriculture, and the Yakutsk Research Institute of Agriculture².

M. F. Shumilov (1970), who analyzed necrobacteriosis morbidity in different reindeer herding enterprises of the Magadan oblast, was the first to prove the dependency between the way the reindeer were pastured and the probability of the disease. Thus, he pointed out that a reindeer

² Researchers who contributed most to this research are B. N. Bardiev, P. M. Barsov, I. M. Golosov, A. K. Krasnobaev, A. Kh. Laishev, A. G. Maslukhin, L. D. Nikolaevsky, A. A. Pilipenko, N. I. Pisarenko, A. M. Silkov, O. I. Solomakha, V. S. Fedotov.

herding brigade that kept its herd packed together, forced it to graze several times through the same territory, and did not frequently change the camp's position, had 200 sick reindeer by the end of the year. At the same time, another brigade that kept its reindeer dispersed over the territory, let them move to fresh pasturelands in their own tempo, and migrated frequently enough, hardly had any reindeer with necrobacteriosis. He explained another outbreak of necrobacteriosis by the size of the herd (after two brigades were merged, the total number of reindeer pastured together reached approximately 6,000 animals) and the poor quality of the grass. In this case, 6.1% of the reindeer in the herd got necrobacteriosis. In still another case, the reindeer herders had to move to a place poorly fit for summer pasturing due to hot weather and an insufficient water supply. This place had abundant willow stands where reindeer damaged their legs and got necrobacteriosis as a result. This means, by the way, that the system of giant collective or state-owned reindeer herding enterprises (*kolkhozes* and *sovkhozes*), in which reindeer herding was practiced throughout the soviet period, actually contributed to the annual outbreaks of the disease: the animals were pastured in big herds, which were constantly packed together to minimize losing tracks of reindeer, summer campsites were uncorrectly chosen, etc. Indeed, the return to private reindeer herding in the Yamal Nenets Autonomous Area has led to a decrease in necrobacteriosis morbidity, despite the number of reindeer in the area actually increasing.

Since necrobacteriosis pathogens are a group of anaerobic bacteria, *E. Coli*, which are commonly found in reindeer stomach and colon and take part in digestion, it is very difficult to work out an effective necrobacteriosis vaccine that would not cause intolerable side effects in reindeer. Still, many Russian researchers attempted to solve this problem. This has led to three different vaccines being worked out and tested in the USSR. Still, none of them is actually used in practical reindeer herding, mostly due to their side effects, but also because their recommended use does not take into account the reindeer's variation in immunological reactivity from season to season, and/or simply do not fit reindeer herding techniques. Still, Russian specialists in reindeer veterinary continue to consider an effective vaccine against necrobacteriosis one of their principal aims.

Recently, promising results in this research have been obtained by Yu. D. Karavaev, I. G. Machakhtyrov, and their colleagues. Their inactivated vaccine demonstrated not only a prophylactic but also a therapeutic effect, leading to 100% recovery of ill animals. During their trials in the Sakha (Yakutia) Republic, only 260 out of 21,162 vaccinated animals (1.25%) contracted the disease, and 141 of these animals died (resulting in losses of 0.6% of the total sample). On the other hand, in the control group of 33,960 unvaccinated reindeer, 47.5% contracted the disease and 24.3% died (Machakhtyrov, 2000; Karavaev et al., 2003).

It is still unclear, however, whether this or any other vaccine will be able to solve the necrobacteriosis problem. At the moment, the broad conviction among the modern Russian specialists is that the most effective measures against necrobacteriosis are unspecific preventive ones: providing the animals adequate protection from mosquitoes and other blood-sucking insects, avoiding packing the animals together as well as excessively disturbing them during grazing, frequent migrations, and change of pasturelands throughout the warm period of the year. The recommended treatment of necrobacteriosis includes local surgical treatment (cutting out the abscesses) and administering broad-spectrum antibiotics, preferably oxytetracycline-based.

Siberian anthrax

Another reindeer disease responsible for mass epizootics was Siberian anthrax. Furthermore, this disease represented a death threat not only for reindeer, but also for people. Human mortality from Siberian Anthrax varies between 20 and 96 percent depending on the clinical form and, as far as natural Siberian Anthrax is concerned, the absolute majority of cases (up to 90%) result from direct contact with contaminated animals, animal products, or excrement (Cherkasski, 2002).³ As it has been mentioned in the introduction, regular anthrax epizootics occurred in the Russian Arctic throughout the 19th and early 20th centuries, causing massive deaths of reindeer, particularly in the European part of Russia and in Western Siberia, as well as hundreds of human deaths. Although anthrax vaccine for animals was available as early as the late 19th century (it was, in fact, the first vaccine developed by Luis Pasteur and later modernized by several of his followers), attempts to adapt and use this vaccine for reindeer began only in the 1910s at the Oksino reindeer herding station. Even so, no systematic measures were implemented against Siberian anthrax among reindeer until the late 1920s, when veterinary bacteriological institutes were established. The newly established institutes started sending over so-called anti-anthrax teams. Thus, the Obdorsk Institute sent two teams annually (Figure 2). These teams had their own herds of transport reindeer and nomadized in the tundra with reindeer herders from early spring till late autumn. Kolmakov (Kolmakov, 1928), a veterinary doctor and the head of one such

³ These forms of contamination typically result in the skin and/or stomach-colon clinical forms of the disease with up to 50% mortality. Only very rarely and under very specific conditions, which are, however, almost never obtained in tundra, natural spores of Siberian Anthrax can make up a dusty suspension in the air and be inhaled producing the lung clinical form of the disease with its almost absolute mortality (96%). This form of contamination is more usual for modified spores used for military purposes (unfortunately, this use of Siberian Anthrax does exist and rather widely known).

team, has left an interesting and unique description of its work, as well as the attitudes of reindeer herders towards veterinarians, and of the traditional knowledge of Nenets and Komi reindeer herders concerning reindeer diseases. His report gives an interesting description of how the veterinary work and the relationships between the vets and reindeer herders were organized at that time:

The united train of sledges belonging to the epizootic team and the Yamal expedition of the provincial directorate of agronomy started from Obdorsk on April 17th, 1928, towards the Shuchie trading post. Having made 42 migrations, we arrived at the middle part of the Tiutey-yakha river valley, which we selected as the place for our summer camp and as the summer pastureland for our reindeer herd [...].

Samojeds (Nenets) are a vibrant people who enjoy hunting and fishing. They have good visual memory, generally pleasant personalities and they are welcoming to guests. Almost all of them are excellent shooters. A Nenets values his tundra, reindeer, and tent above anything else, and he would never exchange his nomadic life, despite being full of poverty, for a more comfortable settled life in a house. Every Nenets dreams about having many reindeer. It is this perceived value of reindeer, rather than any calculation of costs and benefits, that determines the nature of their reindeer herding economy as well as their controversial attitude to veterinary care.

Throughout our time at the summer place, the Nenets hardly applied to us for veterinary reindeer treatment at all. However, during the summer, the situation changed, and by the early autumn, Nenets, particularly the poorer ones, started to ask us to help their reindeer.

The attitude of reindeer herders towards veterinary. [...] by and large this attitude is very negative. From my conversations with the herders, it follows that Nenets do not treat sick reindeer at all. They say that they do not know how to treat them and, furthermore, they believe that such reindeer should not be treated at all, because otherwise the disease would “get angry and spread to other animals”. They stress that their ancestors did without veterinary treatment, and their children would do the same. At the same time, Nenets take an interest in reindeer diseases: just as Komi reindeer herders, they have developed an extensive nomenclature of reindeer diseases based on the primary organ affected:

Stomach disease – penti khabtse;

Heart disease – seinkhabtse, in Komi – s’ölöm vis’öm ;



FIGURE 2

Work of an anti-Anthrax unit, 1928. Archive photo reproduced from “Report on the work of Ural antiepidemiology unit in Yamal tundra in 1927”, by D. Kolmakov, from the Yamal Experimental Agricultural Station (Salekhard, Russia).

Lung disease – tiwak-khabtse, in Komi – ty vis’öm;

Head disease (antler rot) – naiwo jede khobtse, in Komi – jur vis’öm;

Foot rot (necrobacteriosis) – tobo khaptse, madapts, in Komi – gizh potöm;

Nose inflammation – tense khabtse, in Komi - khanzudei;

Siberian anthrax – pozzy khabtse, mal khabtse, in Komi – kolera, khop vis’öm.

The stomach disease (penti khabtse) referred to above manifests in bloating and/or constipation. The reindeer suffers for three days and dies. The herders say that the disease can be treated by forcing the sick reindeer into a lake and keeping it semi-immersed in it for some time. Probably it is some kind of tympanitis. Komi name this disease utroba vis’öm.

According to the report, veterinarians diagnosed 32 different diseases (including helminthiases) in 542 reindeer and 385 dogs. However, their work was not limited to those. Throughout the 1920s, there were no medical doctors on the Yamal Peninsula at all, and the veterinary doctors had to diagnose and treat not only animals, but also human beings. According to the report, 223 people applied to the vets for medical help (62 of them more than once), with their most frequent diagnoses being conjunctivitis, trauma, furuncles, scabies, and rheumatism. Additionally, veterinarians vaccinated children against smallpox. Therefore, the attempts by early Soviet officials

to solve the problem of anthrax have led to what modern Western specialists call One Health Service Delivery (see, e.g., Griffith et al., 2020). It should be stressed, however, that in the Russian case, this development was not planned and instead reflected the deplorable state of healthcare in the tundra. Furthermore, health and veterinary services have been strictly separated in the USSR/Russia: they have been managed and financed by different ministries, had different agendas, and no attempt to build up a One Health Service as an administrative framework has been made. In the case of reindeer herding, it should also be stressed that the most dangerous (from the viewpoint of zoonosis) disease – the Siberian Anthrax – was successfully combated by veterinarians and, therefore, was not perceived as a serious threat for humans since the late 1930s.

Indeed, throughout the 1930s, veterinary bacteriological institutes performed serious and largely successful work on adapting and modifying existing anthrax vaccines to enable their effective use in reindeer herding (Terentiev, 1946). Furthermore, the systematic work on detecting infected territories and vaccinating reindeer against Siberian Anthrax continued. This work was incidentally made easier by collectivization of reindeer, which started in the Russian Arctic in the 1930s: collective and state-owned reindeer herding enterprises (kolkhozes and sovkhoses) could be simply ordered to present their herds for vaccination and, therefore, veterinarians did not have to chase the nomads in the tundra to vaccinate their animals. All this ultimately yielded positive results: from 1941 to 2016, there were no outbreaks of Siberian Anthrax among domestic reindeer throughout the Soviet Arctic. In 2016, an outbreak occurred in the Yamal district of the Yamal-Nenets Autonomous Okrug. The reason was that annual vaccination against Anthrax was stopped in the area in the 1990s due to the economic crisis and not resumed later because the local veterinary service apparently incorrectly assumed that the disease had been eliminated. It should be stressed, however, that the source of the infection has not been found (Selianinov et al., 2016) and the return of the disease after such a prolonged absence looks rather mysterious. In any case, the annual vaccination of reindeer against Siberian anthrax has now resumed throughout Russia by a special governmental decree, and one can hope that the 2016 outbreak will remain an isolated case.

By now, the intensive scientific research at the reindeer herding research stations of the Institute of Polar Agriculture as well as by several expeditions of the Veterinary Institute of VASKhNIL has resulted in working up and testing vaccines and/or medications for effective local and systemic treatment of the following reindeer diseases: Siberian Anthrax, Brucellosis, Foot-and-mouth, Rabies, Myiasis, Dictyocaulosis, Ringworm. Therefore, all the most dangerous and/or epidemic diseases except necrobacteriosis (see above) can be treated. Along with

the veterinary drugs produced in Russia, imported medicines are also used. For some diseases, recommendations for specific or nonspecific prophylactics have been developed and, in many places, put into use.

Brucellosis

Soviet and Russian vets have always considered Siberian Anthrax and Necrobacteriosis as the “main” reindeer diseases and, therefore, the primary focus of their research. Of course, this has been justified, taking into account the economic damage these diseases have incurred and the danger of Siberian anthrax to people. In comparison to them, reindeer Brucellosis can look relatively benign, but this disease also incurs reindeer losses and, therefore, is economically damaging. What is more important, this disease is damaging to the health of people who consume reindeer herding products.

Borisovich (1961) writes that the theoretical possibility for reindeer to get brucellosis was first proven in the USSR by F. A. Turandin and N. P. Yanushkevich in 1935. These researchers managed to infect reindeer with three types of brucelli. They employed different ways to do that, including keeping reindeer next to infected cattle. Revnivkykh (1936) and Bakhrakh (1936) in controlled experiments infected small groups of reindeer with different brucelli types and established that the disease manifests itself in reindeer by high temperature, general depressed state, and abortions in females. It can be diagnosed by a positive agglutinative reaction of the animals’ blood serum with the brucellosis antigen.

In 1939, A. V. Rudakov suspected Brucellosis in several reindeer herding enterprises in Chukotka, but he was unable to confirm the diagnosis due to a lack of equipment (Rudakov, 1956). It was only in 1948 that the first natural case of Brucellosis was formally proven among reindeer in the USSR by means of serological and allergy tests. This was done on the Taimyr Peninsula by I. M. Golosov while studying the etiology of abortions, bursitis, and otitis among the local animals. He observed an allergic reaction to brucellohydrolysat (brucellin) among the reindeer and then demonstrated that their blood serum contains antibodies that interact with brucellosis antigen (Golosov, 1956).

Bacterial stains of reindeer Brucellosis were isolated for the first time in 1955 by Zabrodin (1956), who became the “founding father” of reindeer Brucellosis studies in Russia. In 1957, Zabrodin argued that in the Taimyr Autonomous Okrug, Brucellosis outbreaks had been occurring annually since at least 1945, and that not less than 4% of the local reindeer were infected (Zabrodin, 1957). Zabrodin (1963) writes that in winter 1960, he first found Brucelli in wild reindeer. They were found in a leg with a damaged synovial bursa, which was removed from a wild male reindeer and brought to the Institute of Polar Agriculture by L. N.

Michurin. The brucelli found there were similar to those found in domestic reindeer.

In 1967 and 1968, Zabrodin investigated 157 samples of blood serum taken from wild reindeer. 52 samples (33.1%) were tested positively for Brucellosis. Later (in 1973) Zabrodin wrote that his investigation of 291 wild reindeer produced 23 brucelli stains (Zabrodin, 1973). Zabrodina (1978), in her large-scale study that included wild and domestic reindeer, wolves, wolverines, polar foxes, ermines, and dogs of the Taimyr Autonomous Okrug, found 234 strains of bacteria belonging to the *Brucella* genus. These brucelli, despite their origin from different animal species, make up a coherent group of microbes, to which the brucelli found in domestic reindeer wholly and neatly belong. Although the Taimyr study was the largest study of its kind in Russia, smaller-scale attempts also took place in other Russian regions and produced similar results. It is worth recalling that, outside Russia, reindeer Brucellosis was first proven in Alaska in 1963 (Huntley et al., 1963), and it had long been unknown whether the disease was endemic to the territory or was being exported with Siberian reindeer. Dieterich (1981, p. 54) reports that at various times the share of caribou/reindeer tested positively for Brucellosis was 30% for the Arctic Caribou Herd, 6.5% for the Nelchina Caribou Herd, and up to 15% for some of the reindeer herds on the Seward Peninsula. This data is closely in line with the results obtained in Russia. Unfortunately, we are not aware of Fennoscandian data, probably due to the linguistic barrier.

It is well known that Brucellosis can be transmitted from animals to humans, and that in locations where outbreaks of Brucellosis occur among animals, a number of people suffering from clinical and/or latent forms of the disease can usually be found. Unfortunately, reindeer Brucellosis is not an exception. Early reports about humans contracting the disease from reindeer appeared in the 1960s, both in the USSR (Merinov and Kosterin, 1961; Cherchenko, 1961; Cherchenko and Bakaeva, 1962) and in North America (Brody et al., 1966). Thus, in 1964, approximately 20% of the residents of Fort Yukon and Arctic Village were found to have positive titers for brucellosis as determined by the rapid slide test, while, in a serologic study of 7 villages from 1962 to 1964, 11% of 763 individuals tested had evidence of past Brucelli infection (Brody et al., 1966). Pinigin (1965) in his study of people from areas hit by epizootics of reindeer Brucellosis in the USSR, got 24% of Brucellosis tests positive and observed single cases of clinical manifestation (joint damage, hepatomegaly, lymphadenopathy, damage to the nervous system, etc.)

The existing research demonstrates that reindeer Brucellosis has certain specific traits, and its danger to reindeer and people is real enough to render organizational and sanitary measures insufficient. Grown-up domestic reindeer should be randomly tested for Brucellosis annually, and in areas where positive tests are observed, all animals should be treated with vaccine, which is

fortunately readily available (Sleptsov et al., 2017). Furthermore, in areas where sick animals are detected, all meat produced should be tested and certified by specialists before it can be sold (Zabrodin et al., 2018). The corresponding veterinary services and procedures existed and were strictly followed in the USSR, but they collapsed after the country's breakup. They are currently in the process of restoration.

Parasitic diseases

Parasitic diseases and their treatment occupy a special place in the history of reindeer veterinary. It is well known that reindeer parasites are diverse, encompassing both helminths and insects. This diversity, combined with the limited opportunities for veterinary manipulations in nomadic reindeer herding, has forced Soviet and Russian veterinary specialists to search for broad-spectrum anti-parasitic medicine. The aim was to find a means to treat effectively Oedemagenosis (the condition caused by the reindeer fly - *Oedemagena tarandi*), Cephomyiasis (the condition caused by the *Cephomyia trompe* fly), and basic helminthiasis at the same time.

Historically, the reindeer flies - *Oedemagena tarandi* and *Cephomyia trompe* – were believed to be particularly dangerous and economically damaging. Indeed, in the peak of the fly period, given the weather is appropriate, every reindeer is attacked by 200–250 reindeer flies every 30 min, while the number of blood-sucking insects can reach tens of thousands. Unable to graze and rest properly, the animals run erratically over pastureland or rotate in a “reindeer mill” for hours or even days. As a result, after several days of harassment by insects, reindeer lose weight and their resistance to diseases decreases. Outbreaks of necrobacteriosis usually follow and cause significant reindeer losses. In winter, larvae and maggots that develop from the eggs of *Oedemagena tarandi* live under reindeer skin, further weaken the animal and, importantly, significantly decrease or nullify the market value of its skin.

Grebelskii (1952) proposed three kinds of measures to prevent and treat diseases caused by the reindeer flies:

1. Preventive measures – destroying the female flies attacking reindeer;
2. Early-stage therapy – destroying the larvae laid by the flies into reindeer in the initial stages of their development before the clinical period
3. Therapy – destroying the parasitic maggots during the clinic period.

In the early period of Soviet reindeer veterinary (1930s–1940s), preventive measures were the only available options, and even these were restricted to killing winged

insects and their pupae. Thus, Sdobnikov (1937) proposed attracting the winged flies (imagos) to specially prepared light-colored reindeer skins and killing them by trampling. This method was later somewhat modernized by Nikolaevski (1951). Other recommendations included moving reindeer herds away from the places where the larva fall out from reindeer bodies before the winged insects would develop from it (that is during the pupa period - Terentiev and Terentiev, 1933; Pushmenkov, 1952); pressing the grown-up larva out from the holes on reindeer skin and killing it; collecting larva and pupae from the ground and killing it; getting infected reindeer through gas chambers (Boldyrev, 1933; Vinogradova, 1935). Boldyrev and Uspenskaia (1936) recommended removing the larva *Cephenomyia trompe* leaves in the reindeer nasopharynx with hands as a means to treat *Cephenomyiasis*. It was also recommended to disinfect calving grounds where most of the larvae fell out and turned into pupae (Nakhlupin and Pavlovsky, 1932), to keep reindeer on pasturelands with poor conditions for pupae development (Sdobnikov, 1937), and to use specially built shelters for keeping reindeer during the peak of the reindeer fly period (Breev and Saveliev, 1958). All these methods were of doubtful effectiveness despite being relatively expensive and labor-demanding.

Since the early 1970s, Soviet veterinary doctors have been experimenting with contact pesticides and repellents as measures against the flies. The aim was to find a combined protection for reindeer against reindeer flies and mosquitoes. The experiments proved successful not only for solving the insects' problem but also for fighting necrobacteriosis: in the herds where the repellents were regularly sprayed, the Necrobacteriosis morbidity was 4.6–6.4 times lower than in the herds where repellents were not used (Samandas and Laishev, 2011). However, the regular spray of repellents over whole reindeer herds was proven to be difficult – in fact, next to impossible – in nomadic reindeer herding. Therefore, it never became a common or widespread practice.

Currently, the most common method of protecting reindeer against reindeer flies in Russia involves using antiparasitic drugs from the ivermectin and avermectin groups. These drugs have proved to be effective: tests have shown that even a single dose eliminated most of the fly larvae in reindeer bodies (Samandas and Laishev, 2011). The drugs are also effective against most reindeer helminths. Most importantly, these drugs can be administered once or twice at the end of the reindeer fly period, whereas repellents must be applied systematically to keep the animals protected. The disadvantages of drugs are their relatively high price: in contrast to diseases with pronounced zoonosis such as anthrax and brucellosis, the measures against parasites are not sponsored by the state and have to be paid for by the reindeer owners themselves. Besides that, they do not protect the animals from actual attacks by insects, and therefore, do not prevent their stress, weakening, and increased incidence of necrobacteriosis.

Veterinary training for reindeer herding and Russian veterinary services

The history of veterinary training in Siberia in the Imperial period was written by Sikorskii (1964). Among the various educational institutions that existed in Western Siberia and were involved in veterinary training, he mentions the veterinary school (*veterinarno-feldsherskaia shkola*) in Tobolsk. In 1881, the first 7 veterinary workers graduated from this school to work in the Tobolsk Province, which included the tundras populated by reindeer herders. Another center of veterinary training in Siberia was the Siberian Veterinary Institute in Omsk. Veterinarians graduated from this institute also worked in the North, but, of course, no special training in reindeer diseases and their treatment was offered.

Little is known about the development of veterinary services during the early socialist period, and no special studies exist on their development in the North. By the late 1920s, eight specialized veterinary training and six zooveterinary training institutes existed in the USSR. Besides them, there were seven veterinary departments in agricultural universities. One should remember, however, that the army, which had several million horses at that time, employed a lion's share of vets who graduated from these institutions.

It was only in the 1930s that the first veterinary training institutions were opened in the far North. Thus, in 1932, the so-called “kolkhoz and sovkhos school” (*kolkhozno-sovkhознаia shkola*) was opened in Naryn Mar. In 1957, this school was renamed the Zootechnician and Veterinary Trade School (*Zooveterinarnyi tekhnikum*). In Salekhard, a reindeer herding trade school (*olentekhnikum*), later renamed as a zootechnician and veterinary trade school, was opened in 1935. In Dudinka, a zootechnician and veterinary trade school was opened in 1959, and at about the same time, such schools were established in Yakutia and in the Magadan Oblast. These schools trained vets specifically for reindeer herding. At the same time, their graduates were considered to be *feldshery*, that is, not real doctors but rather highly trained nurses.

The first center to train veterinary doctors with a specific focus on reindeer herding was the Omsk Veterinary Institute, established on November 4th, 1918. In 1922, this institute was renamed the Siberian Veterinary and Zootechnical Institute, but in 1936, the original title was restored. In 1925, Sergey Grüner established a chair for reindeer herding, which transformed the institute into the world's first center of reindeer veterinary training. The chair still exists and the Institute still trains reindeer veterinarians, who work throughout Russia (Alexeeva, 2009).

In the late Soviet Union, every reindeer herding farm (*kolkhoz or svkhos*) was obliged to employ at least one veterinarian, who was responsible for vaccination and treating basic animal diseases. Besides that, every administrative district (*raion*) had a state-sponsored “Station for fighting animal diseases” (*stantsia po bor'be s bolezniami zhivotnykh*) staffed by professional

veterinarians, who delivered services to private animals and took part in fighting disease outbreaks. Unfortunately, this system of veterinary service delivery did not survive the breakdown of the Soviet Union. The disappearance of *sovkhozes* led in most cases to the disappearance of veterinarians working for them. Only those *sovkhozes* that did not disintegrate but managed to reform themselves into commercial cooperatives could continue to employ a veterinary specialist (and only some of them did that). Many state-sponsored veterinary stations have closed down, and now it is usual for a single station with 4–5 veterinary specialists to be responsible for several administrative districts. As mentioned in the previous paragraph, the state provides measures against zoonotic diseases, which, in the case of reindeer herding, include Siberian anthrax and brucellosis. These measures are provided through the state veterinary stations and include vaccinations, regular (twice per year) taking blood samples from a certain number of animals in every herd (this number is established individually for each area depending on the estimations of epizootic risks), and visual checks of animals. Indeed, vaccinating reindeer against anthrax is obligatory in most Arctic provinces of Russia. Furthermore, certificates of vaccination against anthrax and brucellosis, as well as testing meat for brucellosis, are obligatory prerequisites for being allowed to sell reindeer meat. On the other hand, measures against necrobacteriosis and parasitic diseases are not sponsored, and interested reindeer owners are expected to pay for them. Of course, only a few of these owners, usually large reindeer herding enterprises, have both funds and initiative to buy such services, and the current situation, as far as these diseases are concerned, is rather depressing: thousands of domestic reindeer continue to die of them annually, and their owners continue to suffer significant losses.

Currently, there are approximately 60 specialized institutions and university departments that train veterinary doctors in Russia. However, only an insignificant minority of their students specialize in reindeer veterinary, even as a secondary subject, and only a handful of those who do are later willing to practice their trade in the northern tundras. Therefore, there is a chronic shortage of veterinary doctors and feldshery (nurses) in Russian reindeer herding, and this represents a serious threat to the economy as a whole. Indeed, as the anthrax outbreak in the last decade indicated, reindeer herding is full of surprises and, if the proper veterinary care is absent, one can expect epizootics with a potentially massive number of victims not only among reindeer, but also among humans.

Conclusion

Scientific study of reindeer diseases in Russia has been ongoing for over 100 years. This study was primarily started as a reaction towards epizootics of Siberian anthrax that devastated Russian reindeer herding provinces in the 19th and early 20th centuries and caused massive losses of reindeer and significant losses of human lives. It is not surprising, therefore, that Russian reindeer

veterinary achieved its most important success in fighting Siberian anthrax. Of course, Russian reindeer veterinarians were greatly assisted by the fact that Siberian anthrax had been a widely studied phenomenon, and some effective means to prevent it (including vaccines) already existed by the early 20th century. Therefore, the task of reindeer veterinarians was rather to adapt the existing means against the disease to reindeer as well as to work out an effective system to deliver them (the formation of a command economy with its centrally administrated enterprises was a valuable asset here). Until the outbreak of the disease in Yamal in 2016, it was believed that the disease was completely under control among domestic reindeer. Although the outbreak was worrying, particularly because its reasons are still not clear, the absence of a single case of reindeer anthrax during almost a decade that followed this outbreak seems to be a reason for cautious optimism. The outbreak may remain a mysterious but isolated case.

The second disease that has been the focus of intensive research by Russian reindeer veterinarians is reindeer necrobacteriosis (foot rot). After anthrax has been brought under control, this disease has been the one causing the most economic damage to reindeer herding. The disease has been intensively studied, and by now, we know a great deal about it, including its pathogen, its relationship to methods of keeping reindeer (particularly the size of the herd and how intensively the animals are packed together on the pastureland), landscape, and other diseases, particularly parasitic ones. However, achievements in treating and preventing it are still modest, and it can be said that this area of study will be the primary focus of Russian reindeer veterinary in the coming decades.

Russian reindeer veterinaries have invested significant work into studying and fighting reindeer brucellosis. Although this disease does not cause substantial economic loss for reindeer herders, it is dangerous because it can be transmitted to humans. Nowadays, treatment and preventive measures for this disease are available, and a state-sponsored system is in place to deliver these measures. Therefore, it can be said that the disease is more or less under control now, although we cannot speak about such a success here as in the case of anthrax.

Finally, Russian reindeer veterinarians continue their work on parasitic diseases of reindeer, particularly those caused by reindeer flies. Unfortunately, the measures proposed in Russia for preventing and treating these diseases are not without significant flaws. Furthermore, there is no effective system in place for administering these measures.

One can hope that international cooperation in treating and preventing reindeer diseases will allow some of the described problems to be rectified. Unfortunately, such cooperation hardly exists. There are several reasons for that. Since most of the research on reindeer diseases in the west is carried out in Fennoscandia, it is usually published in local languages and remains unavailable to Russian specialists. Even when literature is available (e.g., in English), Russian specialists more often than not pay attention to literature on animal diseases in the north, particularly among wild caribou.

However, experience of providing veterinary services to southern nomadic pastoralists could be much more relevant to solving problems Russian reindeer veterinarians often face. Thus, the One Health Service Framework proposed for nomadic pastoralists of Africa and some other arid areas can be fruitfully considered in Russia. Therefore, one can only hope that the current problems will not prevent future research cooperation between Russian and Western specialists.

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

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

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