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ORIGINAL ARTICLE

Parasitic reverse zoonosis in Yamalo-Nenets Autonomous Okrug (Russian Federation)

V. N. Domatsky[1], E. I. Sivkova*[1]

[1]All-Russian Scientific Research Institute of Veterinary Entomology and Arachnology Branch of Federal State Institution Federal Research Centre Tyumen Scientific Centre of Siberian Branch of the Russian Academy of Sciences, Russia, Tyumen

**Corresponding author E-mail: sivkovaei@mail.ru*

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The following reverse zoonosises have been registered in the territory of the Yamalo-Nenets Autonomous Okrug (YNAO): trichinellosis of wild animals, echinococcosis, diphyllobothriasis, beef tapeworm, trichinellosis, and opisthorchiasis of carnivores and humans. Fur-bearing animals have nematodosises, that pose a danger to humans - toxocariasis, uncinariasis, trichinellosis; cestodiasis - diphyllobothriasis, dipylidiosis, echinococcosis; trematodiasis - opisthorchiasis and metorchsis, with EI of 0.7-4.3%. Invasiveness of dogs and cats by helminth (toxocariasis, uncinariasis, opisthorchiasis, diphyllobothriasis, dipylidiosis, and alveococcosis) in the territory of YNAO amounts to 1.6-22.3%. The research results are of social and economic significance because they aim to prevent critically dangerous parasitoses in animals and humans. It is necessary to continue research and further monitor the parasitological situation to adjust preventive and therapeutic measures further.

Keywords: reverse zoonosis, Yamalo-Nenets Autonomous Okrug, domestic and wild animals, human, helminths, extent of invasion

Introduction

Epizootiology of reverse zoonosises is an essential section of the medico-veterinary complex of sciences, which studies and analyzes the geographical spread of infectious and invasive diseases common to animals and humans. It compares the epizootic and epidemic processes in various territories, investigates the causes of mass diseases in some regions, while other regions report single cases, and studies geographical characteristics of areas of territorial units in terms of their possible impact on the occurrence and spread of contagious diseases (Bessonov, 1977; Avilov, 1994; Dzhupina, 1996; Cherkassky, 1988; Dimov, 2000; Klyatsky, 2005; Polley, 2005; Thornhill et al., 2010; Messenger et al., 2014; Aubakirov et al., 2020; Domatsky et al., 2020; Aubakirov et al., 2020).

Domestic and wild animals are a reservoir and source of disease pathogens for humans. Thus, reindeer, agricultural and game animals, and the birds can transmit tuberculosis, Siberian plague, brucellosis, leptospirosis, salmonellosis, colibacillosis, pasteurellosis, yersiniosis, vibriosis, listeriosis, tularemia, Q fever, FMD, erysipelas, Auesca disease, sap, melioidosis, epizootic lymphangitis, ornithosis, rabies, and trichophytosis (Pokrovsky, 1983; Cherkassky, 1988; Nelson, 1988; Koneva, 1992; Tarshis & Cherkassky,1997; Strube & Heinz, 2020).

For impartial evaluation, analysis, and prediction of the epizootological situation at any scale of its manifestation, it is necessary to know the biological processes, various anthropogenic effects, and the situations that cause them (Donchenko, 2000). The monitoring system helps identify critical situations, allowing identifying critical impact factors and elements of the epizootic chain that are most susceptible to the anthropogenic influence (Bessonov, 1977; Moskina et al., 2017; Mayurova, 2019).

Yamalo-nenets Autonomous Okrug (YNAO) is of great importance in the economy of Russia due to the fuel and energy sector and the involvement of new natural resources in operations. The development of new territories and the influx of population from different regions have a significant impact on the development of infrastructure of the Tyumen North. However, the traditional croppings of the indigenous population of YNAO, such as reindeer husbandry, hunting, and fishing, cannot be ignored. In this regard, the study of epizootiology of endemic nature focal diseases is of great interest, of particular concern are diseases common to animals and humans (toxocariasis, trichinellosis, opisthorchiasis, diphyllobothriasis) (Neustroev & Khoch A.A, 2000; Guzeeva et al., 2004; Klyatsky, 2005; Sergushin et al., 2005; Zheleznov-Chukotsky, 2012; Methodiev & Bychkov, 2013; Ostapenko & Guzeeva, 2013; Allabergenova et al., 2017; Ostapenko et al., 2017; Fedotova et al., 2018; Olefir & Maslodudova, 2020; Aubakirov et al., 2020; Domatsky et al., 2020; Aubakirov et al., 2020).

In this regard, the stabilization of the epidemiological and epizootological situation is a severe problem. However, solving the problem is impossible without a deep and comprehensive study of the ecological and phenological pathogen regularities at all stages of their development.

The research goal was to assess the state of the parasitological reverse zoonosis situation in the territory of YNAO. Based on the purpose of the research, the tasks were determined: to carry out a retrospective analysis and identify the current reverse zoonosises of commercial and domestic animals in the YNAO.

Materials and methods

The experimental part of the work was carried out in the settlements of the Yamalo-Nenets Autonomous Okrug, in fur farms, in the District Veterinary Laboratory, in animal entomoses of the All-Russian Research Institute of Veterinary Entomology and Arachnology, which is a branch of the Tyumen Siberian Branch of Russian Academy of Science. A retrospective analysis was carried out on the database of veterinary and medical reports and the results of own route studies. The spread of helminthiases in the animals was studied using life and posthumous diagnostics, taking into account epizootic data. At the same time, there were methods of research used: coprological (ovoscopy, larvoscopy, and helminthoscopy) - flotation (according to Fylleborn), and combined flotation and sedimentation (Demidov, Vishniauskas) - a total of 835 silver-black foxes and 687 blue foxes were surveyed. Full and incomplete helminthological autopsy was carried out according to K. I. Scryabin (1928), a total of 55 carcasses of cell animals and 16 carcasses of arctic foxes (Skryabin, 1928).

Results and discussion

Examination of reverse zoonosises in the reindeers, agricultural and carnivorous animals

Retrospective analysis of the reporting data of veterinary and medical services, as well as the results of their studies, showed that the territory of the Okrug territory registers the following reverse zoonosises: echinococcosis, diphyllobothriasis, beef tapeworm, trichinellosis, opisthorchiasis of carnivores and humans (Table 1).

Statistics show that the species composition of the pathogens of parasitic diseases of animals in the farms of the Okrug territory has not changed for many years. Therefore, there are episodic cases of affection of animals with diphyllobothriasis and opisthorchiasis in fur farms. At the same time, the most significant number of diseases comes when the local fish dominate the diet of animals. The predominance of marine fish in the diet reduces invasive animals significantly because it does not contain pathogens of critically dangerous reverse zoonosises. Infection of animals with nematodes is observed in all species. Predisposing factors are climatic conditions, presence of intermediate hosts, violation of feeding and keeping conditions of animals, and the effectiveness and timeliness of preventive and therapeutic measures. In the Russian Federation, the district ranks third in the disease of people with opisthorchiasis. The most significant number of defeats is noted in the regions which are located in the Ob basin (Priural and Shuryshkarsky regions, and the cities of Salekhard and Labytnangi). The most significant number of people invasive with diphyllobothriasis was noted in Krasnoselkupsk, Purovsky, and Yamal districts, with echinococcosis - in Yamal, Priuralsky and Tazovsky; with trichinellosis - in Krasnoselkupsky, Purov and Shuryshkarsky; with beef tapeworm — in Yamal, Tazovsky, Priuralsky, and Purovsky districts. To a greater extent, these diseases are recorded in those populations that traditionally eat meat and fish without heat treatment and w/o veterinary and sanitary examination. Since 2000, the district has seen a pronounced downward trend in the incidence of parasitoses. Consequently, organizational, preventive, and therapeutic activities carried out by territorial divisions and municipal health institutions contribute to the emergence of some positive trends in reducing the incidence of the population with parasitic diseases.

Table 1. Distribution of reverse zoonosis in animals of Yamalo-Nenets Okrug, 1976-2020

Period	Animals	Registered invasive disease	Registration area
1976-1980	Furry animals	Opisthorchiasis, diphyllobothriasis	Yamal, Priuralsky, Shuryshkarsky region Shuryshkarsky district, Krasnoselkupsky
	Dogs	diphyllobothriasis	Private sector
	Cats	Opisthorchiasis	Private sector
	Reindeer	Echinococcosis	All farms
1981-1985	Furry animals	Opisthorchiasis, diphyllobothriasis	Krasnoselkupsky, Nadymsky, Yamal, Priuralsky, Shuryshkarsky region
	Dogs	diphyllobothriasis	Private sector
	Cats	Opisthorchiasis	Private sector
	Reindeer	Echinococcosis	All farms

1986-1990	Furry animals	Opisthorchiasis, diphyllobothriasis	Krasnoselkupsky, Nadymsky, Yamal, Priuralsky, Shuryshkarsky region
	Dogs	diphyllobothriasis	Private sector
	Cats	Opisthorchiasis	Private sector
	Reindeer	Echinococcosis	Priuralsky region, all farms
1991-1995	Furry animals	Toxocariasis, uncinariasis, opisthorchiasis, diphyllobothriasis	Krasnoselkupsky, Yamal, Priuralsky, Shuryshkarsky regions
	Dogs	Opisthorchiasis, diphyllobothriasis	Private sector
	Cats	Opisthorchiasis	Private sector
	Reindeer	Echinococcosis	All farms
1996-2000	Furry animals	Diphyllobothriasis, opisthorchiasis,	Krasnoselkupsky, Yamal, Priuralsky, Shuryshkarsky regions
	Dogs	Diphyllobothriasis, opisthorchiasis,	Private sector
	Cats	Opisthorchiasis	Private sector
	Reindeer	Echinococcosis, finnoz	Tazovsky, Priuralsky regions
2001-2005	Furry animals	Toxocariasis, opisthorchiasis, diphyllobothriasis	Krasnoselkupsky, Yamal, Priuralsky, Shuryshkarsky regions
	Dogs	Toxocariasis, opisthorchiasis, diphyllobothriasis	Private sector
	Cats	Toxocariasis, opisthorchiasis	Private sector
	Reindeer	Echinococcosis, sarcocystosis, finnoz	Tazovsky and Priuralsky region
	Furry animals	Toxocariasis, opisthorchiasis, diphyllobothriasis	Krasnoselkupsky, Yamal, Priuralsky, Shuryshkarsky regions
2006-2010	Dogs	Toxocariasis, opisthorchiasis, diphyllobothriasis	Private sector
	Cats	Toxocariasis, opisthorchiasis	Private sector
	Reindeer	Echinococcosis, finnoz sarcocystosis,	Priuralsky and Tazovsky region
2011-2015	Furry animals	Toxocariasis, opisthorchiasis, diphyllobothriasis	Purovsky, Krasnoselkupsky, Yamal, Priuralsky, Shuryshkarsky regions
	Dogs	Toxocariasis, opisthorchiasis, diphyllobothriasis	Private sector
	Cats	Toxocariasis, opisthorchiasis	Private sector
	Reindeer	Echinococcosis, finnoz sarcocystosis	Priuralsky, Tazovsky regions
2016-2020	Furry animals	Toxocariasis, opisthorchiasis, diphyllobothriasis	Purovsky, Krasnoselkupsky, Yamal, Priuralsky, Shuryshkarsky regions
	Dogs	Toxocariasis, opisthorchiasis, diphyllobothriasis	Private sector
	Cats	Toxocariasis, opisthorchiasis	Private sector
	Reindeer	Echinococcosis, finnoz sarcocystosis	Priuralsky, Tazovsky regions

Opisthorchiasis remains one of the leading health problems of the Yamalo-Nenets Autonomous Okrug is the most common type of natural-focal infestation. At the same time, since 2004, there has been a clear trend in reducing the incidence of opisthorchiasis (the difference between 2004 and 2014 is 49.2% down). In 2014, the incidence rate of opisthorchiasis per 100,000 people was 226.7 cases (244.5 in 2013), including 50.4 among children under 14 years (59.9 in 2013). In absolute values, in 2014, 1228 cases of opisthorchiasis were registered, including 57 among children under 14 years. Opisthorchiasis was recorded everywhere on the territory of the Okrug region. The incidence rate of opisthorchiasis in Salekhard and Labytnangi, and Shuryshkarskiy, Priuralsky, and Yamal districts exceeds the average rate for the district. The high incidence of opisthorchiasis in these municipalities is since the population in these territories consumes fish of carp breeds: ide, roach, and bleak, which have metacercaria incidence between 80% and 90% according to laboratory studies. An acute form of acute opisthorchiasis was revealed in Salekhard – 2 cases, in Gubkinsky city – 2, in Nadym – 1, in Noyabrsk – 1. In total, four municipalities of the Autonomous Okrug have four enterprises of the fish processing industry: in Shuryshkarsky, Purovsky,

Priuralsky, Tazovsky districts. Not all enterprises of the fish processing industry use carp breeds as raw materials. All enterprises processing fish of the carp family are equipped with refrigeration equipment with low freezing conditions (no higher than minus 28 °C). The facts of transfer for decontamination of "conditionally fit" fish in 2014 have not been registered.

Table 2. The incidence of people with reverse zoonosis n in the Yamalo-Nenets district, 1976-2005

Period	Invasion	Patients registered (pers.)	Total
1976-1980	Teniarinhoz	**\206\184\199	589
	Opisthorchiasis	**\2182\1818\1481	5481
	Diphyllobothriasis	**\943\804\676	2423
1981-1985	Teniarinhoz	134\141\63\59	471
	Opisthorchiasis	1705\1468\1678**	4851
	Diphyllobothriasis	839\952\796**	2587
1986-1990	Teniarinhoz	162\177\255\104*	698
	Opisthorchiasis	1899\2425\2642\2057*	9023
	Diphyllobothriasis	1033\831\918\769*	3551
1991-1995	Teniarinhoz	74*\54\51\76	255
	Opisthorchiasis	1397*\1619\1810\2628	7454
	Diphyllobothriasis	747*\564\681\720	2712
	Trichinosis	**\6*\15	21
	Echinococcosis	**\4\2\1	7
1996-2000	Teniarinhoz	43\100\72\44\61	320
	Opisthorchiasis	2537\2625\2465\2563\ 2830	13020
	Diphyllobothriasis	688\799\726\606\ 602	3421
	Trichinosis	***\30\1	31
	Echinococcosis	8\9\18\17\ 13	65
2001-2005	Teniarinhoz	36\47\22\26	119
	Opisthorchiasis	2831\2578\2753\2326	10488
	Diphyllobothriasis	718\672\725\538	2653
	Trichinosis	1*\2*	3
	Echinococcosis	6\8\12\5	31

** - information is absent

In the group of biohelminthiases transmitted through fish, diphyllobothriasis traditionally ranks second. The incidence rate of diphyllobothriasis steadily decreases from 96.4 cases per 100,000 people in 2010 to 47.5 in 2014. According to 2014 data, a high incidence of diphyllobothriasis (above the average district value) was registered in almost all rural areas: Purovsky, Krasnoselkupsky, Yamal, Priuralsky, and Tazovsky districts. Unlike opisthorchiasis, the diphyllobothriasis is more likely to affect the rural population (83.8%); this is because the pathogen parasitizes in various fish available for fishing which is widely consumed in the food of rural residents. For several years, in the autonomous Okrug, a tense situation with echinococcosis continues, reported in reindeer herding families. Of the 15 cases reported in 2014, six were registered in Yamal, five in Tazovsky, one in Nadymsky district, and one in Gubkinsky city, two were found in Noyabrsk. The incidence rate of echinococcosis is in the range of 2.7-5.12 per 1,000 people. Since 2005, there has been a clear downward trend in the incidence of echinococcosis. The cause of all cases of echinococcosis is close contact with animals (dogs, deer) of tundra residents and consumption of raw offal of reindeer. According to the Veterinary Service of YNAO, the incidence of alveo- and echinococci in reindeer of Tazov and Yamal districts is 90%, including the liver affection of 45%.

In general, since 2005, there has been a clear downward trend in the incidence of parasitic diseases (Table 3).

Table 3. The incidence of people with parasitic diseases in YNAO (2005-2018, thousand people)

Invasion	Year					
	2005	2010	2015	2016	2017	2018
Ascariasis	60.4	41.7	24.1	22.5	19.5	18.6
Trichocephalosis	2.3	0.7	0.2	0.2	0.1	0.1
Diphyllobothriasis	15.3	9.5	5.3	4.4	4.2	4.0
Opisthorchiasis	41.2	33.7	22.1	20.8	18.8	19.1

Route studies for the diagnosis of zooanthroponoses of carnivorous wild and domestic animals in the territory of YNAO

Of particular concern for humans and animals are opisthorchiasis, clonorchiasis, metorchsis, diphyllobothriasis, dipylidiosis, and echinococcosis. All the above focuses specialists of the district on the insurance of veterinary well-being of livestock and fur farming industries. According to the "Instructions on Measures for the Prevention and Elimination of Animal Helminthiasic Diseases", in order to determine the helminthiasis situation and timely arrangement of health activities by specialists of the state veterinary service of the district, examination of all animals by helminthocoprological methods at least two times a year

are carried out. The results of these studies are included in laboratory reports, which became the basis for our route studies to analyze the parasitological situation in the fur farms of the Yamal - Nenets Autonomous Okrug. Analysis of veterinary reports showed that only invasive diseases such as opisthorchiasis, diphyllobothriasis, echinococcosis, alveococcosis, toxocariasis, and uncinariasis had been registered officially in the territory of the Yamalo-Nenets Autonomous Okrug.

According to the results of the analysis of veterinary reporting, a more intensive distribution of helminthiasis is registered in settlements with developed cage fur farming and, of course, fishing in lakes and small rivers for feeding of animals; these are farms subzone of forestry tundra. The species composition of parasites the more comprehensive, the more intensive are the activities on importing animals and products, the import and export of breeding fur animals. The fur-bearing animals with nematodosis pose a danger to humans - toxocariasis, uncinariasis, trichinellosis; cestodiasis - diphyllobothriasis, dipylidiosis, echinococcosis; trematodiasis - opisthorchiasis and metorchosis (Table 4).

Table 4. Helminthiases of fur-bearing animals dangerous for human population in Yamalo-Nenets Autonomous Okrug

Disease	EI, %	IO, copy
Toxocariasis	24.3±3.2	14.4 ± 1.10
Uncinariasis	17.3±1.2	11.1± 0.70
Diphyllobothriasis	4.8±1.6	3.7 ± 0.20
Opisthorchiasis, metorhoz	7.8±0.90	14.2±1.30
Echinococcosis	0.7±0.1	3.2±0.20
Dipylidiosis	0.8±0.1	4.3±0.60
Trichinosis (wild arctic foxes)	3.1±0.1	12÷19 Trichinella larvae per 1 g of muscle tissue

Toxocariasis is a widespread disease in fur animal populations. Extensinvaziability of *Toxocara canis* fur animals in our study was 24.3±3.2% with an abundance index equal to 14.4±1.10 individuals (according to the results of pathological studies) or 304.5±20.5 eggs in 1 g of fecal masses (coprological method). The maximum value of the EI indicator was registered in silver-black foxes – 28.9%, and the minimum was12.6% in arctic foxes. In the arctic fox population, *T. canis* occurs in 32.4% with an abundance index of 14.2 individuals. Very significant is the fact of the relatively widespread of uncinariasis among silver-black foxes and blue arctic foxes(*Uncinariap) stenocephala*) with a high degree of invasiveness. This helminthiasis was registered at all fur farms of the region. The same situation is observed in small farms owned by citizens in settlements. At the same time, the indicator of the degree of infection of fur animals (EI) averaged 17.3±1.2%, with an abundance index equal to 11.1±0.70 individuals, and in some farms, the incidence of carnivorous animals with uncinaries reached 36.9% and, mostly, in the puppy population under 2-3 months of age.

The incidence of fur-bearing animals with diphyllobothriasis (*Diphyllobothrium latum*) was relatively low. On average, the EI of diphyllobothriasis was 4.8±1.6%. Both silver-black foxes and blue arctic foxes are predisposed to invasion. The EI of the first equaled an average of 5.8±1.5% and the second of 3.1±0.4%. The relatively low indicator on average also has the index of abundance of 3.6±0.20 individuals. Among trematodosis in fur animals, opisthorchiasis and metorchsis are very widespread, the differential diagnostics performed only by the method of posthumous helminthological autopsy carcasses, by finding parasites in the liver. EI of the animals, on average, was 7.8±0.90% with the abundance index of 14.2±1.30 individuals. We also found that many rivers and other reservoirs contributed to the relatively widespread helminths in all district farms since many fish species of the carp family infected with trematodosis pathogens were caught and fed to animals. Such fish were often given to animals without pretreatment, that is, raw.

Echinococcus were rare among cestoids in organs and tissues of killed or fallen beasts (foxes and arctic foxes). At the same time, it was found that the Extensinvaziability factor of carnivorous animals, on average, equated to 0.7± 0.1% with an abundance index of 3.2±0.20 individuals. The disease was recorded in all settlements of the Okrug region regardless of the type of carnivorous animals. Among cestodiases, we repeatedly, in almost all farms of the Yamalo-Nenets Autonomous Okrug, registered dipylidiosis; however, it is mainly registered among silver-black foxes (EI 0.8±0.1% and abundance index of 4.3±0.60 dipylidiums). Even though trichinellosis was found in wild arctic foxes (EI 3.1±0.1%), the zoo-veterinary and sanitary service of the Yamalo-Nenets district should be assumed that people can also be affected. First of all, those who are serving animals, persons involved in animal slaughter and the primary treatment of skins); therefore, it must stress the need for preventive and therapeutic measures. A tense situation for helminthiasis develops in pets. According to the results of route study, it was found that the invasiveness of dogs and cats by helminths in the territory of YANAO is 1.6-22.3% (Table 5).

Table 5. Extensiveness of helminth invasion in dogs and cats

Helminth species	Dogs, EI, %	Cats, EI, %
Opisthorchis felineus	2.8	22. 3
Toxocara canis / T. Leonina	17. 6	6.4
Diphyllobothrium latum	7.1	6.2
Dipylidium caninum	3.2	4.8
Uncinaria stenocephala	1.8	1.6
Alveococcus multilocularis	0.03	-

To the greatest extent, dogs are infested by *Tohosara canis* (17.6%), and cats are affected by *Opisthorchis felineus* (22.3%), while minimum infestation extensivity rates are established in dogs when infected with *Alveococcus multilocularis* (0.03%) and in cats when infected by *Uncinaria stenocephala* (1.6%).

Conclusions

The following zooanthroponoses are registered in the territory of the Yamalo-Nenets Autonomous Okrug: trichinellosis of wild animals, echinococcosis, diphyllobothriasis, teniarinchosis, trichinellosis, opisthorchiasis of carnivores and humans. In general, since 2005, there has been a clear downward trend in parasitic diseases. Fur-bearing animals were infected with the diseases that pose a danger to humans - toxocariasis, uncinariasis, trichinellosis, cestodiasis - diphyllobothriasis, dipylidiosis, echinococcosis; trematodiasis - opisthorchiasis and metorchis, with EI of 0.7-24.3%.

Invasiveness of dogs and cats by helminth (toxocariasis, uncinariasis, opisthorchiasis, diphyllobothriasis, dipylidiosis, alveococcosis) in the territory of YNAO amounts to 1.6-22.3%.

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