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MODERN EPIZOOTIC AND EPIDEMIOLOGICAL CHARACTERISTICS OF LEPTOSPIROSIS IN THE REPUBLIC SAKHA (YAKUTIA)

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The article presents the results of the study of the forms of contamination of agricultural and wild animals, small mammals, as well as the infection of cohorts of the population with different types of leptospires. A wide variety of animal species, both domestic and wild, act as reservoirs of zoonotic diseases.

The etiological structure of leptospiroses and quantitative and serological indicators of immunological response in animals and humans have been studied. Modern epizootic and epidemiological evaluation of the intensity potential ("softening" of tension) and forecasting of the indicated problem (in the format of reduction, but not elimination of the nosological form) are given.

Occupation is a significant risk factor for humans. Direct contact with infected animals accounts for most infections in fur farmers, livestock technicians and hunters.

Keywords: etiological composition of leptospiroses, infection and immunostructure of agricultural and other animals, risks of human morbidity, monitoring.

Introduction. Leptospirosis in the Far North was first described by I.E. Trop and S.E. Getzold, who conducted a survey of population and animals in the Tyumen region in 1954-1960 [5, 19]. They also observed an outbreak in Khanty-Mansiysk (1959-1960), when the number of the diseased reached 132 people [5, 19].

A further basis for the study of leptospiroses was the disease of calves in one of the farms of the Nenets Autonomous District, when laboratory examination of 1093 domestic reindeers in 1.8% of them revealed antibodies to the leptospira of the serogroup *L. grippotyphosa.* In some herds, animal infection was 6% [7]. Subsequently, a wide spread of leptospiroses in the Far North was detected from the Kola Peninsula to Chukotka [12, 13].

The possibility of rodent leptospirosis in the northern taiga of the Republic Sakha (Yakutia) was reported by E.V. Karaseva and E.I. Korenberg [5], who found in blood serum specific agglutinins to the leptospiroses of the serogroup *L. grippotyphosa* in titer 1:800-1:1000. However, studies indicating the presence of natural foci of leptospirosis in the high latitude zone were few and fragmentary.

In 1984 the first case [15] of human leptospirosis in Yakutia was registered in the Tatta region. During the next decade, zoonosis was registered in 11 regions of the republic, having a flare-up, group and sporadic character [9, 18], amounting to 0.2 to 2.0 cases per 100,000 population.

In the epizootic and epidemiological plan, the most dangerous [8, 11, 12, 13, 22] were animals infected with leptospirosis. Leptospirosis carriage both in the latent course of the infection process and in an infected animal against the background of its natural foci [14, 20] retained its limpopotential [6]. A special line was devoted to occupational risks [17].

The results of monitoring of epizootological and epidemiological observations in different zones of Yakutia were presented in a series of published works [2, 4, 9, 10, 15, 16, 18, 20, 21]. Zoning of the territory [22] and the practice of departmental (veterinary and sanitary) supervision [11, 12, 23] were supplemented by elements of the geoinformational approach (mapping). Scientific and methodological developments were introduced into veterinary and medical practice [1, 2, 3, 8, 22].

The **objective** of this paper is to provide modern epizootic, epidemiological and prognostic assessment of leptospiroses in Yakutia, including information and prevention proposals on the basis of monitoring data.

Materials and research methods. The study included retro- and prospective indicators of epizootic and epidemic processes in leptospirosis in Yakutia on the basis of annual departmental reports, information on antiepizootic measures in form 1-Vet A and infectious animal diseases in form 1-vet of the Department of Veterinary Medicine of the Republic Sakha (Yakutia) for 2003-2018, information on statistical observations and laboratory activity of the FBUZ “Center for Hygiene and Epidemiology” in form No. 2 for 1995-2018 and State reports for the period 1995-2019, stock data, literary publications and their assessment.

Statistical data processing was performed using descriptive statistics and comparative analysis methods in the “Office Microsoft Excel” program.

Results and discussion. Diagnosis of the etiological structure of leptospirosis was carried out on the basis of the Yakut Republican Veterinary Testing Laboratory, according to GOST 25386-91. The annual volume of laboratory tests was: cattle - up to 2100 animals, horses - up to 1600, up to 300 samples from pigs, small cattle and other domestic animals.

A comparative analysis of laboratory studies showed that cattle was the host of leptospira serogroups *L. grippotyphosa* in 34.6% in 2004 and 43.6% of cases in 2018, *L. icterohaemorrhagiae* - 35.1 and 30.7%, *L. tarassovi* - 2.6 and 10.2%, *L. canicola* - 2.1 and 10.2% and *L. pomona* - 4.8 and 5.1%, respectively.

Horses were the hosts for the leptospira serogroup *L. icterohaemorrhagiae* in 22.5% of cases in 2004 and 35.2% in 2018, *L. grippotyphosa* - 38 and 29.5%, *L.tarassovi* - 4.2 and 18.2 %, *L. canicola* - 1.4 and 15.9%, respectively, *L. heb-*

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domadis in 2.8% in 2004, *L. pomona* in 1.1% of cases in 2018.

Leptospirosis among small cattle was represented by an unstable nosounit, manifested singly and periodically. In 2018, small cattle in 36.3% of cases turned out to be the host of the leptospira serogroup *L. sejroe*, in 27.2% of cases - *L. grippotyphosa*, in 18.2% - *L. tarassovi*, in 9.1% - *L. canicola* and *L. Icterohaemorrhagiae*, and in dogs leptospirosis is represented in all cases by one type - *L. canicola*.

When analyzing studies in anthropurgic foci, it was found that the predominant hosts for the leptospira serogroup *L. grippotyphosa* were: cattle, horses and small cattle (43.6, 29.5 and 27.2%, respectively); for *L. icterohaemorrhagiae* - cattle in 30.7% of cases, horses - 35.2% and cattle - 9.1%, for *L. tarassovi* - horses and cattle in 18.2% of cases, cattle - 10.2%, for *L. canicola* - cattle in 10.2% of cases, horses - 15.9%, dogs - 100%, for *L. pomona* - cattle - 5.1%, horses - 1.1%. It was found that the attachment of certain leptospira to animal species was not absolute.

Using cattle as an example, we studied the facts of possible mixing — mixt infections of circulating leptospira species (Fig. 1).

In a comparative, selective, applied characteristic of the etiological structure of leptospira, it was revealed that if in 2006 the proportion of mixed serogroups was 68.2% of the studied ones (*L. pomona* - 1.1%, *L. tarassovi* - 2.9%, *L. grippotyphosa* - 0, *L. hebdomadis* - 0, *L. sejroe* - 1.1%, *L. canicola* - 2.9% and *L. icterohaemorrhagiae* - 20.0%), then in 2018 this figure was 4.6% of the studied (*L. pomona* - 6.8%, *L. tarassovi* - 6.3%, *L. grippotyphosa* - 22.8, *L. hebdomadis* - 0.8%, *L. sejroe* - 10.5%, *L. canicola* - 3.8%, *L. icterohaemorrhagiae* - 40.9%).

The number of foci of leptospirosis of animals during the analyzed period was constantly changing (Fig. 2).

The presented data indicate a fluctuating parameter of the monitored epizootological factor, with a decrease in its quantitative characteristics. The explanatory premise has a multifactorial (natural, economic, anthropogenic, climatic, administrative-economic, business-industrial, etc.) character.

The highest indicator for identifying dysfunctional points on leptospirosis was established in 2009 - 38, which is 15.4% of their total number for 2003-2018 (247 points), and the lowest indicator was established in 2004 - 1.6% (4 points). Their largest number falls on the period 2008-2011 - 128 points, subsequently the number ranged from 4 to 16. The largest proportion of dysfunctional points for this period were horses - 66.4%, cattle - 31.4%, pigs - 1.6%, bison – 0.8%. The share of research over 15 years on agricultural species of animals was: cattle - 47.6%, horses - 35.9, deer - 0.8, pigs - 6.9, small cattle - 8.0, fur animals - 0.8%.

From year to year there was an increase in targeted, applied, laboratory research, which had a planned state character. If in 2003 a total of 1509 animals were examined by the microagglutination reaction (of which 81.6% were studies of cattle, 4.6% of horses, 12.4% of pigs), then in 2018 6185 were conducted (of which 42% were studies of cattle, 38.1 - horses, 8.7 - pigs, 0.4 - deer, 7.9 – small cattle, 0.03 - fur animals and 3.46 - other animal species).

The percentage of studies on leptospirosis from the total population in 2018 was: cattle - 1.5%, horses - 1.4%, pigs - 2.87%, deer - 0.4%, fur animals - 0.03%, which in comparison with 2003 shows an increase by 3 times in cattle (0.4% in 2003), in horses by 28 times (0.05%), in pigs by 7 times (0.4%).

The analysis found that with a monthly cumulative distribution of animals seropositive for leptospirosis, the largest number of animals was detected from April to June and from November to December. It should be noted that the blood sampling was carried out as planned: in cattle and small cattle before pasture and at stabling, and in horses during mass preventive measures (from March to May and from October to November).

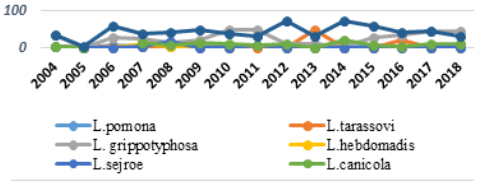

Fig. 1. The structure and dynamics of circulating leptospira species

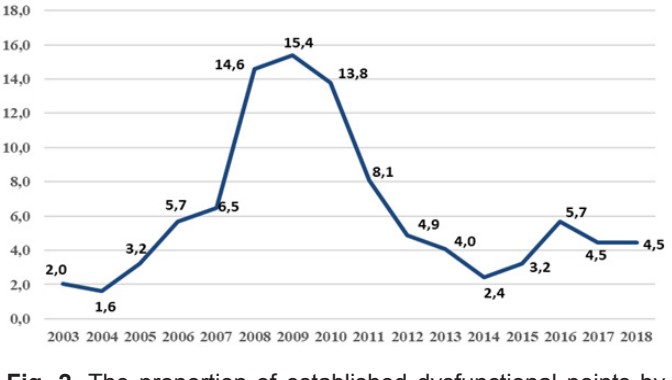

Fig. 2. The proportion of established dysfunctional points by years,%

On the basis of data on dysfunctional sites and the incidence of animals, we determined the territories of the spread of leptospirosis with 4 groups:

- to the 1st group, where the number of dysfunctional points ranges from 0 to 5, 20 districts are assigned, mainly in the Arctic zone (Anabarsky, Abyysky, Allaikhovsky, Bulunsky, Verkhoyansky, Verkhnekolymsky, Gorny, Zhigansky, Lensky, Mirnynsky, Momsky, Neryungrinsky, Nizhnekolymsky, Oleneksky, Oymyakonsky, Srednekolymsky, Tattinsky, Ust-Maysky, Ust-Yansky, Eveno-Bytantaysky). The proportion of dysfunctional points in this zone is 15.6% of their total number;

- 6 districts (Suntarsky, Nyurbinsky, Kobyaysky, Ust-Aldansky, Aldansky) are assigned to the 2nd group, where from 6 to 10 dysfunctional points were registered during the analyzed period. The proportion of dysfunctional points in this zone is 20.5% of the total;

- 7 districts were included in the 3rd group (Olekminsky, Verkhnevilyuysky, Namsky, Tomponsky. Amginsky, Churapchinsky, Yakutsky), where the registered points range from 11 to 20 dysfunctional points. The proportion of dysfunctional points in this zone is 42% of their total number;

- The fourth group consisted of two districts (Vilyuisky and Megino-Kangalassky), where more than 21 dysfunctional points were established.

It should be noted that horse leptospirosis prevails in all groups. So, in the 1st group the number of dysfunctional points for horses is 65.7%, in the 2nd - 71.7, in the 3rd - 55.3, in the 4th - 53.1%. The proportion of dysfunctional points in the cattle in the 3rd group is 38.3%, in the 4th - 34.7%, in the 1st - 20%, in the 2nd - 19.6%. The largest number of dysfunctional points in the small cattle was noted in the 1st group - 14.3%, in the 3rd - 2.1, in the 4th - 2%. The largest number of dysfunctional points for pigs was noted in the 3rd and 4th groups - 14.3%, in the 3rd - 2.1, in the 4th - 2%.

Thus, preliminary evaluations of epizootological zoning indicate that foci of concentration of a large number of horses and cattle are territories of risk for the occurrence and spread of leptospirosis.

The epizootic manifestations of leptospirosis in the Central zone of Yakutia are of particular note. They currently accounted for 80% of the total number in the republic; in the Arctic and North-Eastern zones - by 7.5%, in the Western and Southern zones - by 2.5%.

From a zoological and epidemiological position (for the period 2009-2018), 5911 specimens of mouse rodents were studied for natural foci, the contamination of which in some years was determined by ELISA: 2.03 - 2.7% of cases, and by PCR: among red voles - 0.38%, root voles - 1.9% and in narrow-cranked voles - 5%.

Contamination of people occurred in natural and anthropurgic foci with leptospira serogroups *L. icterohaemorrhagiae*, *L. grippotyphosa* and *L. pomona*. Serological examination of the population showed a wider spread of infection than previously thought. Leptospira serogroup *L. pomona* (25.0%) prevailed in the rural population, and *L. canicola* (27.9%) in the urban population.

A retrospective analysis of the morbidity (Fig. 3) on the territory of the Republic Sakha (Yakutia) demonstrates certain temporal-episodic and epidemiological features of leptospirosis and their determining factors.

The methods of graphic retroanalysis adopted in epidemiology have established that the incidence of leptospirosis was mainly sporadic in nature, with an intensive rate per 100 thousand people ranging from 0.2-2.0. Outbreaks and group cases were relatively rare, and there was a pronounced territorial unevenness. The most intensive epidemic process took place in rural areas, where the incidence of residents of villages and towns (3.7 per 100 thousand people) was several times higher than the incidence of the urban population (0.4 per 100 thousand people). Infection of people occurred in natural and anthropurgic foci in which the main sources of leptospira serological groups of *L. icterohaemorrhagiae*, *L. pomona*, *L. grippotyphosa* were cage breeding foxes, gray rats, root voles (*Microtus oeconomus*) and red voles.

The current features of assessing the degree of tension of the epidemic situation include the facts of its “mitigation”, when at the ascertaining of leptospira circulation among small mammals, there is no morbidity in the population, and no positive results were found in pool studies of materials from people (89 people). A similar situation was noted (2019) in other subjects of the Far Eastern Federal District: Kamchatka, Primorsky Territory, Jewish Autonomous and Amur Regions [13, 14].

Assessing the past monthly dynamics of the incidence rate in the republic, it should be noted that, despite the relatively uniform intra-annual distribution of cases, the largest number of patients with leptospirosis was recorded in April-May. The reason for this was the outbreak of leptospirosis among the workers and maintenance staff of the fur farm and the Mastakh branch of the Mukuchinsky state farm of the Kobyai ulus, where the main etiological factor was the leptospira of the serogroup *L. pomona*, and arctic foxes of cage breeding were the source of infection.

Subsequently, during the examination of 287 persons admitted to the infectious and therapeutic departments of hospitals in Yakutsk, Neryungri, Verkhnevilyuysky, Kobyaysky, Aldansky, Ust-Aldansky, Namsky, Khangalassky, Verkhoyansky, Ust-Maysky, Lensky, Megino-Kangalassky, Mirny and Oymyakonsky uluses with the diseases which are suspicious of leptospira, 96 individuals were revealed with serologically positive results in which titers of specific antibodies to leptospira of nine serological groups reached 1: 100-1: 3200. Taking into account the complex of clinical manifestations of the disease, the results of an epidemiological examination of foci and laboratory tests, the diagnosis of leptospirosis was established in 31 patients. In subsequent years, the designated group was not fixed.

In various age and occupational groups, the morbidity was not the same. To a large extent, it depended on the influence of the leading pathways and transmission factors, reflecting the forms and degree of contact of the population with sources of pathogens. Men at the age of 20-49 years were most at risk: fur farmers, livestock technicians and hunters. The etiological structure of patients represented by leptospira of 5 serological groups was dominated by *L. pomona* (41.9%), *L. grippothyphosa* (25.8%) and *L. icterohaemorrhagiae* (19.3%).

Analysis of the epizootic situation shows that the average incidence rate, increasing from 2003 to 2008 (from 0.73 to 7.71), since 2009 has tendency to a relative decrease (from 0.34 to 3.54). This may be due to an increase of 3 times in the annual vaccination coverage of farm animals against leptospirosis over 10 years and reached 384.407 goals in 2018.

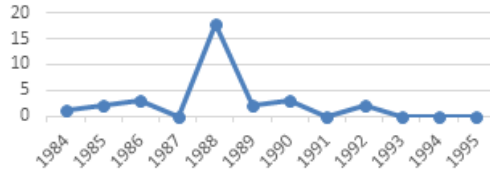

Fig. 3. Leptospirosis morbidity in the RS (Ya)

Thus, due to the systematic, planned, correct organizational and health-improving work of veterinary specialists, the number of dysfunctional points decreased by 19 times, determining the relatively positive epizootiological and epidemiological situation in livestock farms and among the population.

Conclusion. Thus, thanks to the systematic, planned, properly set organizational and health-improving work of veterinary specialists, the number of dysfunctional points decreased by 19 times, determining the relatively positive epizootiological and epidemiological situation in livestock farms and among the population.

The materials presented indicate the need for further monitoring of the established facts and the identified clinical and laboratory, epizootological and epidemiological imbalances in the identified problem.

The choice of adequate and informative methods of laboratory-clinical research and expert assessments should be based on modern ideas about the epizootiological, epidemiological, clinical-laboratory and monitoring algorithm, which will make it possible to maximally objectify agricultural losses (damage) and the degree of percentage disability among the population with various forms of the disease.

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