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Monitoring the Natural Focal Indicators of a Parasitic System in the Rural and Urban Territories

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***Abstract*: Currently, leptospirosis is identified in many countries, on almost all continents of the globe with various frequencies of occurrence and severity. This is one of the most widespread natural focal infections in Russia. Active circulation of the pathogen in the wild creates a constant threat of the disease occurrence, both among animals and humans.**

This article presents the results of expert assessment of the functioning of a leptospirosis parasitic system on the territory of the Nizhny Novgorod region based on the materials of the Regional Veterinary Laboratory for the years 2014 through 2018.

During the work, the etiological structure of leptospirosis, the host composition of its pathogen, and the dynamics of the epizootic process were determined in the populations of cattle, horses, pigs, and other animal species.

Based on the obtained information, a conclusion was made about the trends of developing an infectious parasitic system in animal populations of various species within their ecological niches.

The results of the studies obtained by the team of authors form the scientific and information base — the basis for optimizing and implementing a system of anti-epidemic safety in the Nizhny Novgorod region.

***Keywords* : leptospirosis, etiological structure, parasitic system development dynamics, epizootological monitoring.**

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I. INTRODUCTION

During the last years, a complicated epizootic situation has been developing in the Russian Federation: the number of socially significant and particularly dangerous infectious diseases in animals has not been reducing [1-3].

According to the Federal Service for Veterinary and Phytosanitary Surveillance, in 2018, the Russian Federation was disadvantageous in terms of diseases such as African swine fever, rabies, brucellosis, high-path avian influenza, classical swine fever, bovine leukemia, leptospirosis, sheep and goat smallpox, anthrax, tuberculosis, nodular dermatitis, and contagious aphtha [2-5].

With that, leptospirosis remains one of the most widespread infectious parasitic systems in the country. Every year the country suffers significant economic losses from this disease due to the high mortality rate, decreased productive and reproductive performance of productive animals, shortage of animal yield, degradation of commercial value of the leather obtained from the animals that had the disease, and rejection of livestock products at meat processing factories, as well as significant cost of diagnostic, preventive, curative, and restrictive measures [4, 6].

Regular detection of leptospirosis seropositive animals in the country suggests that the complex of measures for preventing leptospirosis in the territory of the region needs further study and adjustment [7, 8].

The researchers have proven that the morphologically identical leptospira have significantly different characteristics of the epidemic and epizootic manifestations [9, 10].

In this regard, a need arises to study the etiological structure of leptospirosis in specific time and location conditions with regard to its domination in populations of certain kinds of hosts, and formation of the scientific information base that allows epidemiological forecasting, rational planning, and implementing the preventive and anti-epizootic measures for this disease on the territory of the Russian Federation.

The purpose of the study was as follows: epidemiological monitoring of leptospirosis in the Nizhny Novgorod region, determining the etiological structure of leptospira, their host composition,

and the dynamics of leptospirosis development in the populations of various species of animals in the territory of the Nizhny Novgorod region between 2014 and 2018.

II. PROPOSED METHODOLOGY

A. General description

The work was based on the methods of evidence-based epidemiology and epizootological diagnostics (by V. V. Makarov, V. V. Sochnev [et al.]), the concept of self-regulation of the epizootic process, and the functioning of infectious parasitic systems (by V. D. Belyakov), with the use of the comprehensive epizootological approach (by V. P. Urban), as well as the methods of epizootological and mathematical modeling in epizootology.

B. Algorithm

The study was performed together with the specialists of the State-Financed Institution for the Nizhny Novgorod Region (SFI NR) Regional Veterinary Laboratory. The results of the serological studies on the samples of blood of farm and domestic animals were subjected to expert assessment (Table 1).

The degree of leptospirosis in the animals of various involvement of the species in the epizootic process was studied; it was found that from 2014 to 2018, on the territory of the Nizhny Novgorod region, the infection had been circulating in the populations of cattle, horses, pigs, and other animal species (dogs, camels, deer, donkeys, and guinea pigs) (Fig. 1). With that, the greatest number of infected animals was noted in the population of horses – 12.3 %; a significant occurrence rate was also noted in the population of dogs.

III. RESULTS

It was found that during the studied period, specialists of the laboratory had studied 9,778 samples of cattle blood, of which 454 samples (4.6 %) were positive (Fig. 2). The dynamics of leptospirosis development in the population of cattle in the territory of the Nizhny Novgorod region were studied; the results obtained were shown in the form of a linear graphical model diagram (Fig. 3). As shown in Figure 3, leptospirosis in the population of cattle was identified throughout the entire studied period. With that, from 2014 to 2016, the infection had tended to increase from 4.1 % to 8.1 % of the positively reacting animals; in 2017, this number decreased and amounted to 2.3 %, but in 2018, the number of positively reacting animals increased again to 6.5 %.

Table 1: Expert assessment of the dynamics of leptospirosis infection functioning and development on the territory of the Nizhny Novgorod region in 2014 – 2018, based on the materials of the SFI NR Regional Veterinary Laboratory

Year	Number of samples	Positive		Negative		Icterohaemorrhagiae		Canicola		Pomona		Grippotyphosa		Hebdomadis		Sejroe		Tarassovi	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cattle																			
2014	1621	67	4.1	1554	95.9	13	19.4	1	1.5	11	16.4	23	34.3	5	7.5	9	13.4	5	7.5
2015	2907	84	2.9	2823	97.1	4	4.8	4	4.8	0	0	5	5.9	4	4.7	22	26.2	45	53.6
2016	1798	146	8.1	1652	91.9	55	37.7	13	8.9	7	4.8	29	19.9	20	13.7	18	12.3	4	2.7
2017	1579	36	2.3	1543	97.7	1	2.8	7	19.4	2	5.5	15	41.7	2	5.6	9	25	0	0
2018	1873	121	6.5	1752	93.5	17	14	5	4.1	5	4.1	4	3.3	10	8.27	64	52.9	16	13.2
Total	9778	454	4.6	9324	95.4	90	19.9	30	6.6	25	5.5	76	16.7	41	9	122	26.9	70	15.4
Horses																			
2014	216	22	10.2	194	89.8	11	50	3	13.6	2	9.1	2	9.1	0	0	2	9.1	2	9.1
2015	184	23	12.5	161	87.5	7	30.4	1	4.4	3	13	1	4.4	3	13	0	0	8	34.8
2016	124	16	12.9	108	87.1	6	37.5	2	12.5	3	18.7	5	31.3	0	0	0	0	0	0
2017	76	20	23.3	56	73.7	1	5	5	25	3	15	10	50	0	0	0	0	1	5
2018	61	0	0	61	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	661	81	12.3	580	87.7	25	30.9	11	13.6	11	13.6	18	22.2	3	3.6	2	2.5	11	13.6
Pigs																			
2014	261	0	0	261	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	1255	85	6.8	1170	93.2	43	50.6	4	4.7	15	17.6	23	27.1	0	0	0	0	0	0
2016	312	43	13.8	269	86.2	19	44.2	1	2.3	21	48.8	2	4.7	0	0	0	0	0	0
2017	214	2	0.9	212	99.1	0	0	0	0	0	0	0	0	0	0	0	0	2	100
2018	119	2	1.7	117	98.3	1	50	0	0	0	0	1	50	0	0	0	0	0	0
Total	2161	132	6.1	2029	93.9	63	47.7	5	3.8	36	27.3	26	19.7	0	0	0	0	2	1.5
Other animal species																			
2014	205	0	0	205	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	183	1	0.6	182	99.5	1	100	0	0	0	0	0	0	0	0	0	0	0	0
2016	78	2	2.6	76	97.4	0	0	0	0	0	0	0	0	0	0	1	50	1	50
2017	13	0	0	13	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	326	11	3.4	315	96.6	6	54.5	0	0	0	0	0	0	0	0	5	45.5	0	0
Total	805	14	1.7	791	98.3	7	50	0	0	0	0	0	0	0	0	6	42.9	1	7.1
Aborted fetuses																			
2014	77	2	2.6	75	97.4	1	50	0	0	0	0	1	50	0	0	0	0	0	0
2015	108	14	13	94	87	0	0	0	0	0	0	0	0	2	14.3	5	35.7	7	50

2016	33	3	9.1	30	90.9	0	0	1	33.3	0	0	2	66.7	0	0	0	0	0	0
2017	17	3	17.6	14	82.4	0	0	0	0	1	33.3	2	66.7	0	0	0	0	0	0
2018	5	3	60	2	40	0	0	0	0	0	0	0	0	0	0	3	100	0	0
Total	240	25	10.4	215	89.6	1	4	1	4	1	4	5	20	2	8	8	32	7	28

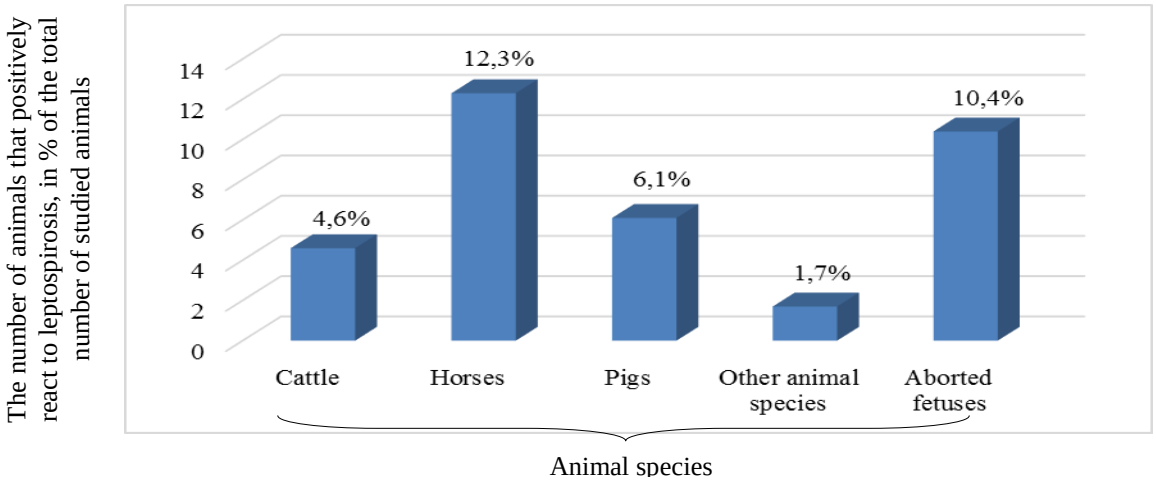

Fig. 1: The degree of populations of animals of various species' involvement in the epizootic process of leptospirosis in the territory of the Nizhny Novgorod region in 2014 – 2018

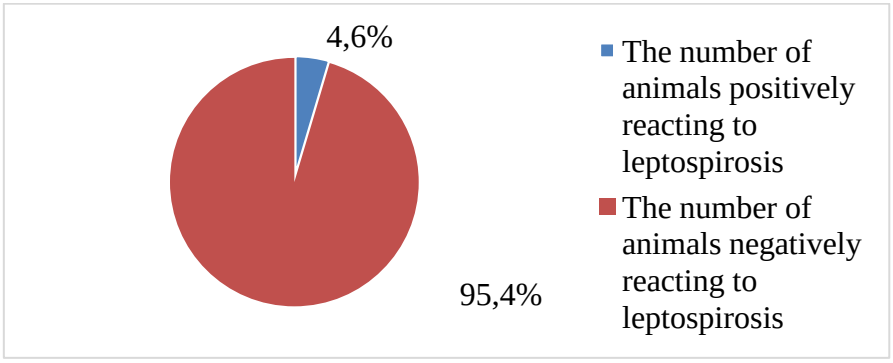

Fig. 2: The degree of cattle populations' involvement in the epizootic process of leptospirosis in the territory of the Nizhny Novgorod region in 2014 – 2018

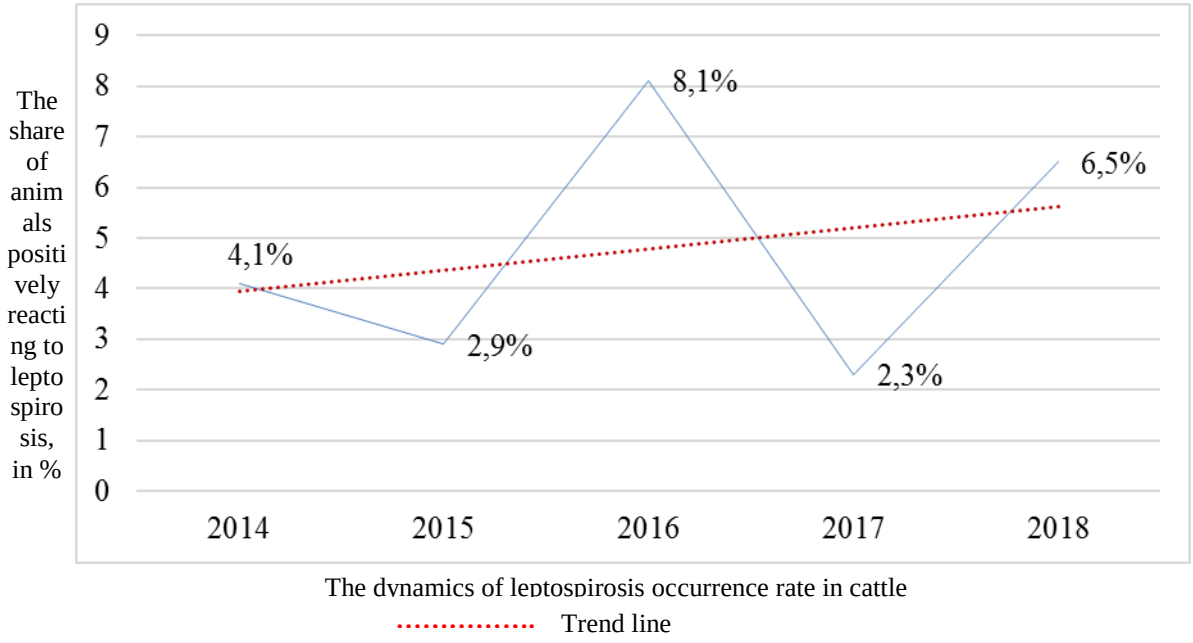

Fig. 3: The dynamics of leptospirosis infection development in the cattle population in the territory of the Nizhny Novgorod region in 2014 – 2018, by the materials of the SFI NR Regional Veterinary Laboratory

The etiological structure of leptospirosis in the cattle population in the territory of the Nizhny Novgorod region was studied. With that, leptospira of seven serological groups were identified: L. Icterohaemorrhagiae, L. Canicola, L. Grippotyphosa, L. Pomona, L. Hebdomadis, L.

Sejroe and L. Tarassovi. Over the period between 2014 and 2018, in the cattle population, leptospira of all seven serogroups were noted with the dominance of the microorganisms of groups L. Sejroe (26.9 %), L. Icterohaemorrhagiae (19.9 %), and L. Grippotyphosa (16.7 %) (Fig. 4).

The dynamics of leptospirosis infection development in the population of horses were studied similarly. The total of 661 blood samples of animals of this species were studied from 2014 to 2018; 81 of them (12.3 %) were positive (Fig. 5). From 2014 to 2017, the infection tended to increase from 10.2 % of the positively reacting animals to 23.3 %. However, in 2018, according to the results of the study, 61 samples of horse blood positively responding to leptospirosis were identified (Fig. 6).

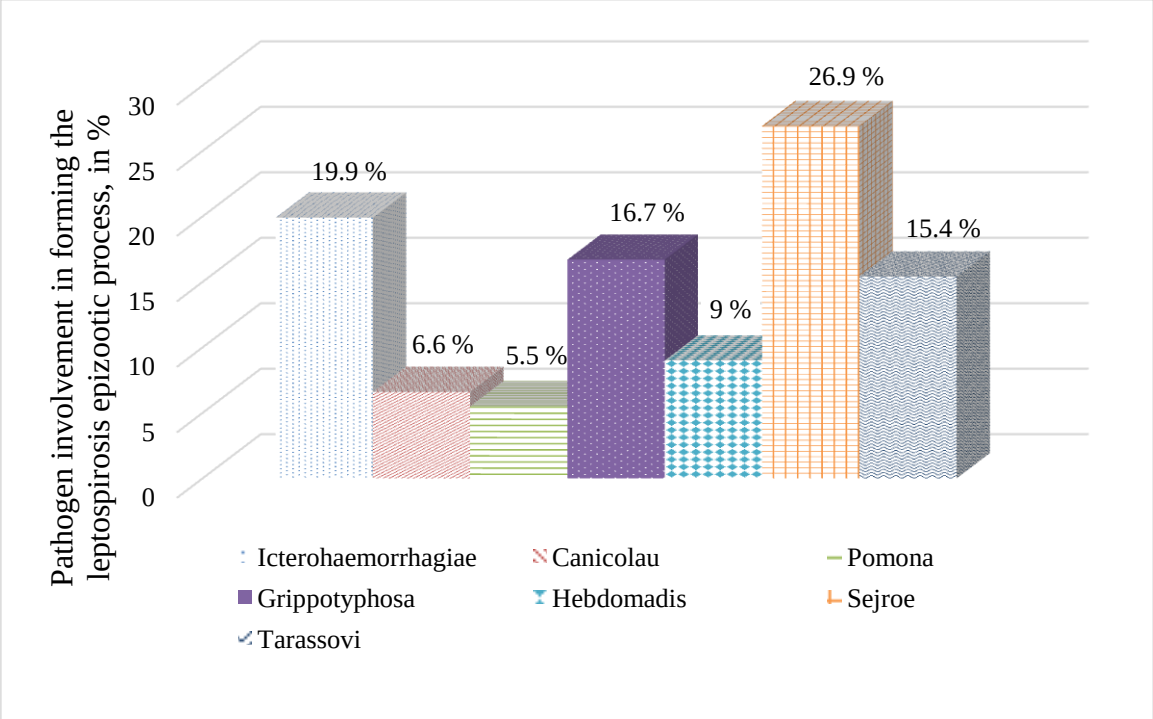

Fig. 4: The etiological structure of leptospirosis in the cattle population in the territory of the Nizhny Novgorod region, 2014 – 2018

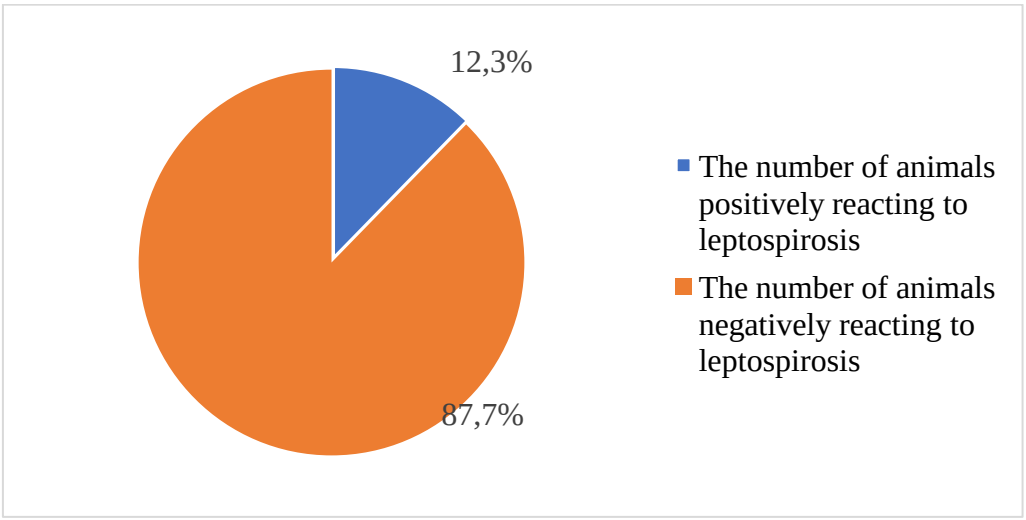

Fig. 5: The degree of the population of horses' involvement in the leptospirosis epizootic process in the territory of the Nizhny Novgorod region for the period from 2014 to 2018

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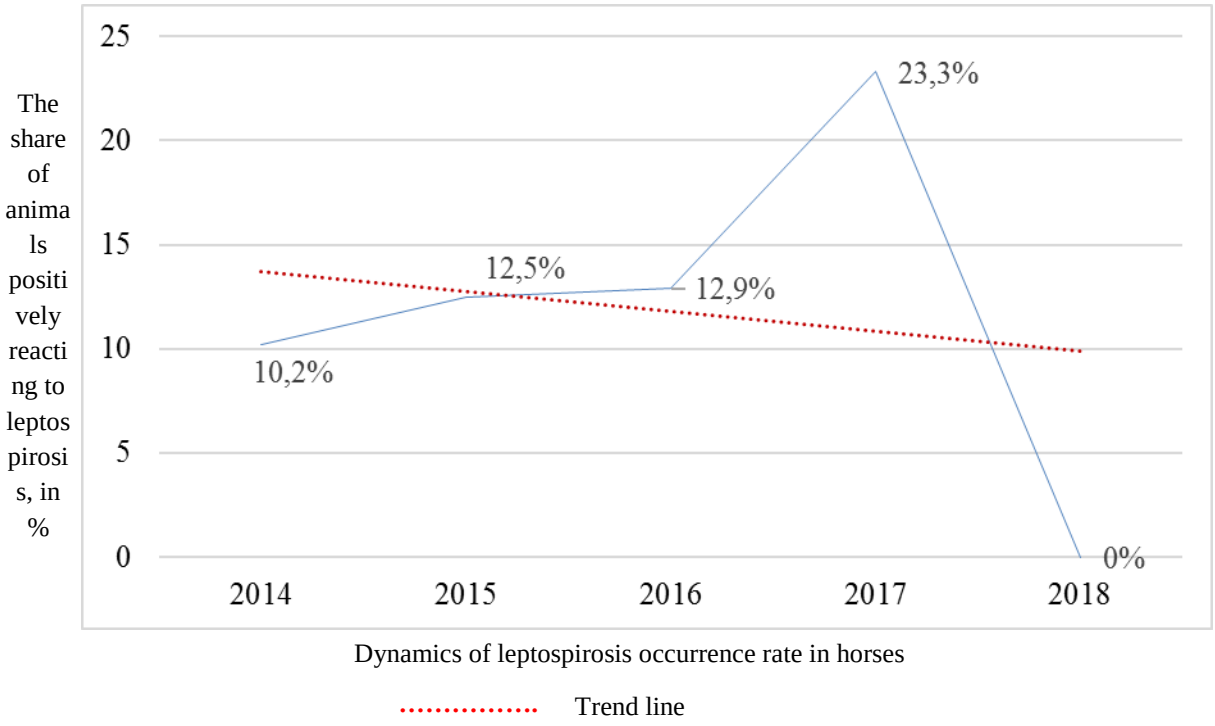

Fig. 6: The dynamics of the leptospirosis infection development in the horse population in the territory of the Nizhny Novgorod region in 2014 – 2018, by the materials of the SFI NR Regional Veterinary Laboratory

In forming the etiological structure of leptospirosis in horses during the studied period, as well as in the population of cattle, Leptospira of seven identifiable serologic groups were involved. With that, leptospira of groups L. Icterohaemorrhagiae (30.9 % of the cases) and L. Grippotyphosa (22.2 %) dominated (Fig. 7).

The dynamics of the leptospirosis epizootic process development in the population of pigs in the studied area were assessed. Over 2014 – 2018, 2,161 samples of the blood of pigs had been studied at the Department of Leptospirosis Diagnosis and Serology, of which 132 samples — 6.1 % - were positive (Fig. 8). With that, in 2014 in the territory of Nizhny Novgorod region, no animals of this species infected with leptospirosis were identified; in 2015, there was a sharp peak in the incidence rate, and the share of positively reacting animals increased to 6.8 %. In 2016, this value increased twice and amounted to 13.8 %, but in 2017 – 2018, it significantly decreased to 0.9 – 1.7 %, respectively (Fig. 9).

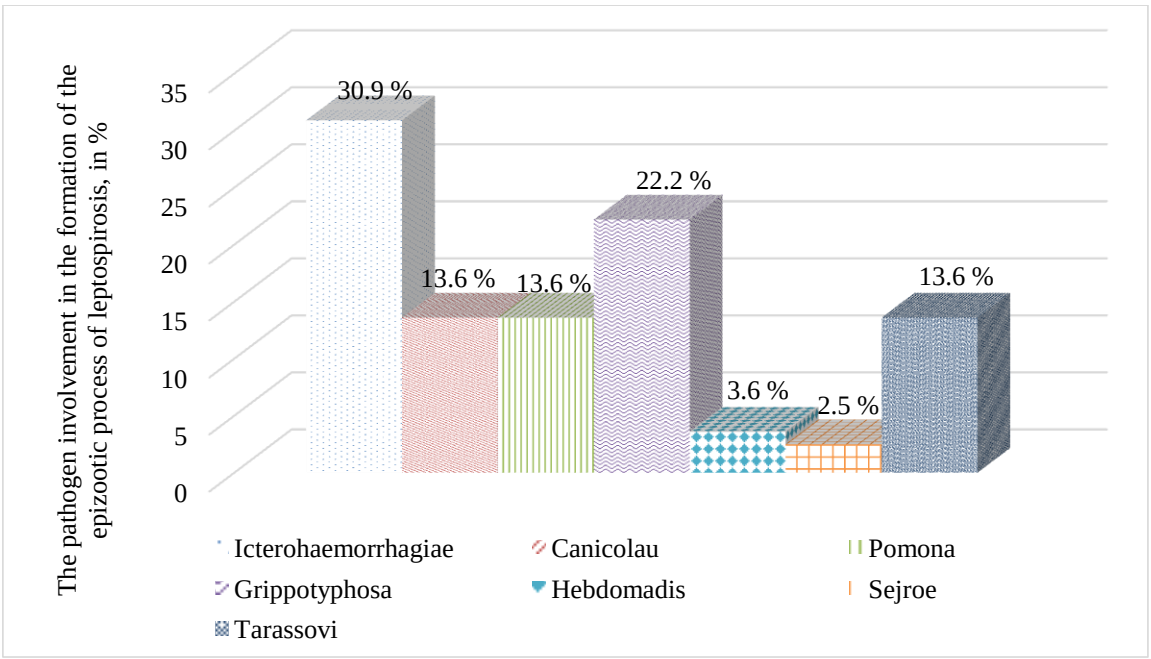

Fig. 7: The etiologic structure of leptospirosis in the population of horses in the territory of the Nizhny Novgorod region, 2014 – 2018

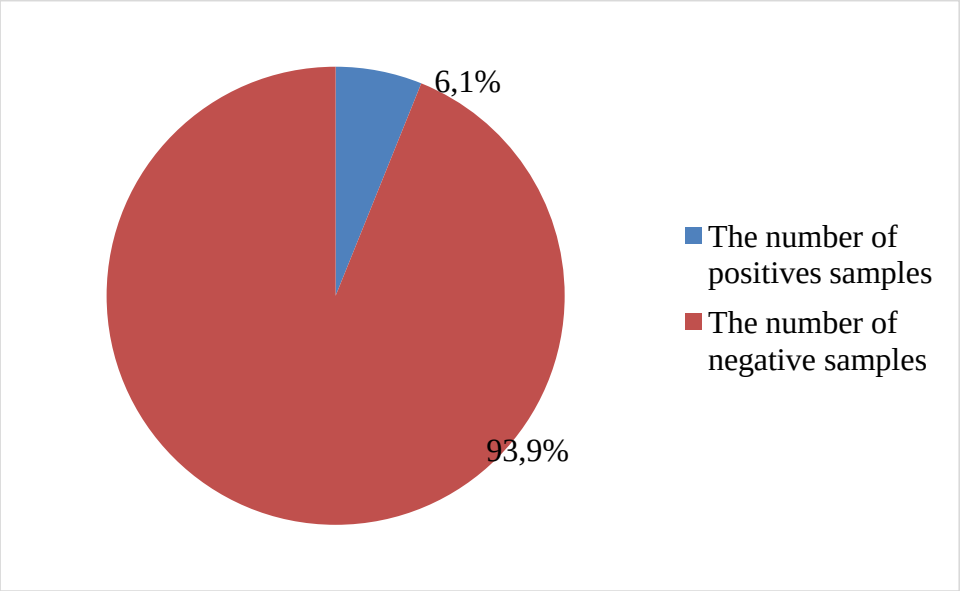

Fig. 8: The degree of the population of pigs' involvement in the leptospirosis epizootic process in the territory of the Nizhny Novgorod region for the period from 2014 to 2018

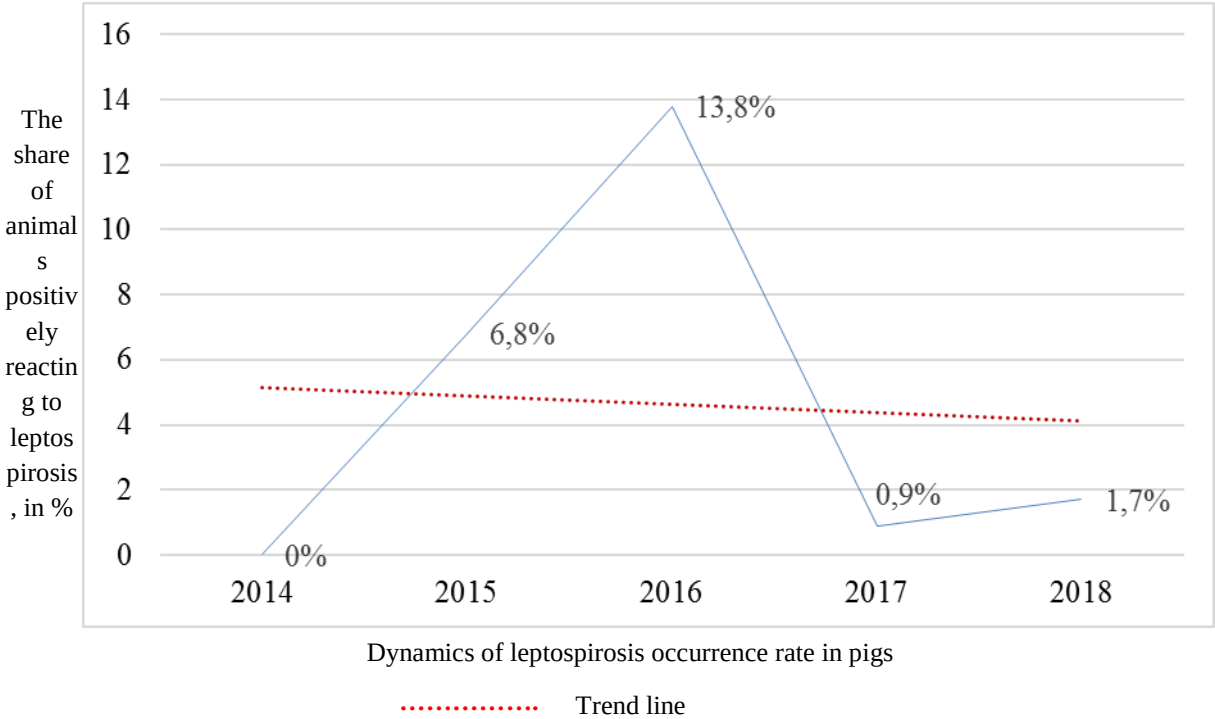

Fig. 9: The dynamics of the leptospirosis infection development in the pig population in the territory of the Nizhny Novgorod region in 2014 – 2018, by the materials of the SFI NR Regional Veterinary Laboratory

The pathogens of the leptospirosis infection in pigs in the territory of the Nizhny Novgorod region over the studied period were the leptospira of the following serological groups: L. Icterohaemorrhagiae, L. Canicola, L. Pomona, L. Grippotyphosa, and L. Tarassovi, of which L. Icterohaemorrhagiae (in 47.7 % of the cases) and L. Pomona (in 27.3 % of the cases) prevailed (Fig. 10).

From 2014 to 2018, 240 aborted fetuses were subjected to laboratory tests for leptospirosis. Pathogens were found in 25 of those (10.4 %) (Fig. 11). With that, an increase in the number of positive reactions was observed during the entire period: in 2014, their share amounted to 2.6 %, in 2015 — 13 %, in 2016 — 9.1 %, in 2017 — 17.3 %, and in 2018 — 60 % (Fig. 12). In the material from the aborted fetuses of various species of animals, leptospirosis pathogens of seven identified serological groups were identified, of which L. Sejroe (32 %), L. Tarassovi (28 %) and L. Grippotyphosa (20 %) were dominant (Fig. 13).

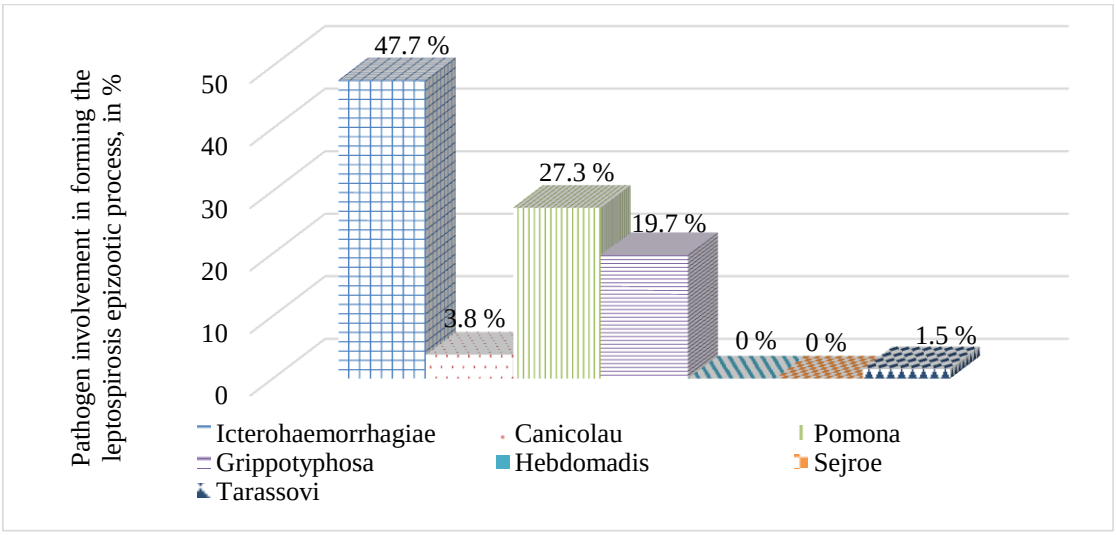

Fig. 10: The etiologic structure of leptospirosis in the population of pigs in the territory of the Nizhny Novgorod region, 2014 – 2018

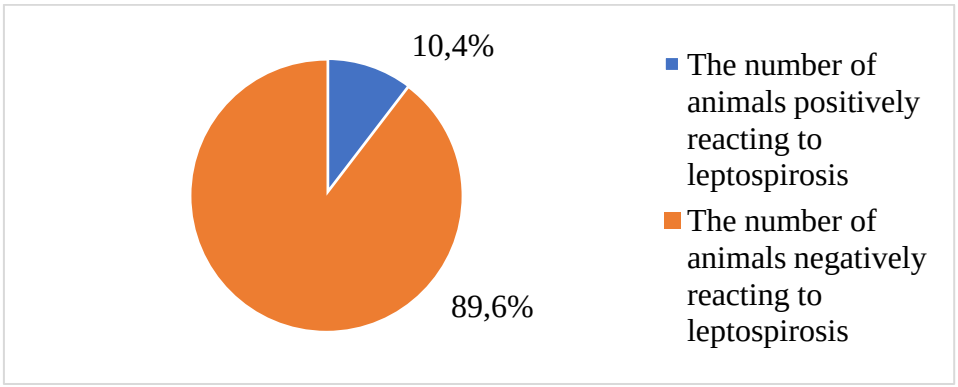

Fig. 11: The results of studying the pathological material (aborted fetuses) for leptospirosis in the period from 2014 to 2018

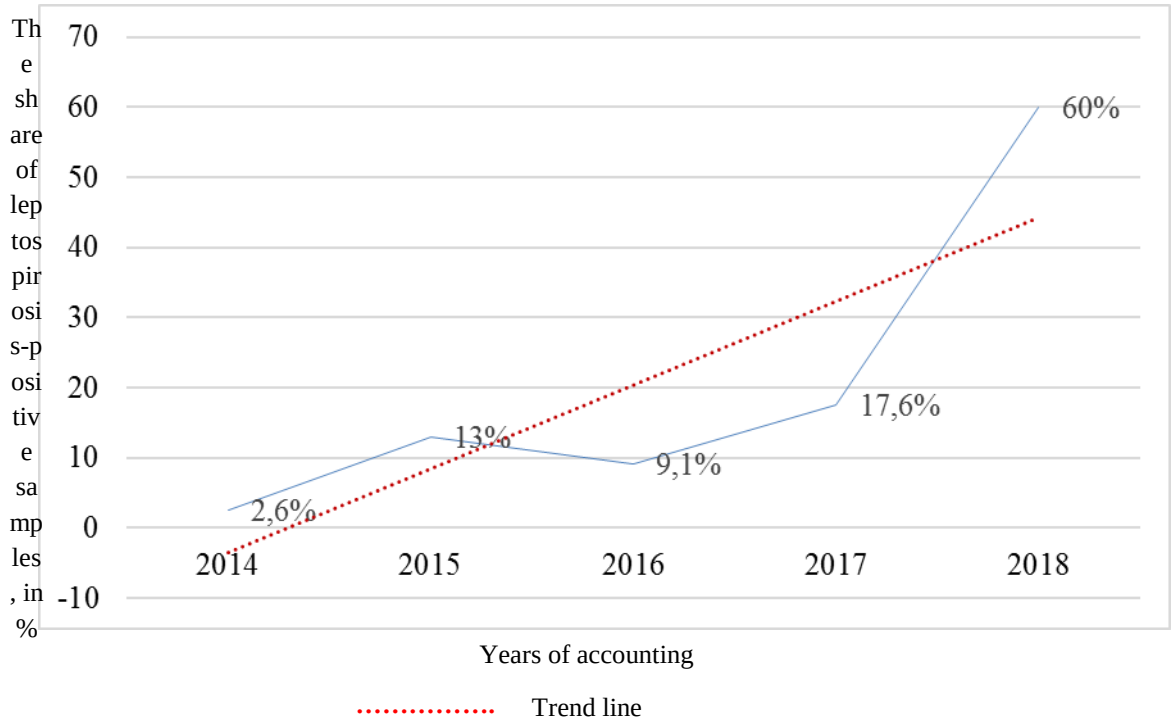

Fig. 12: Analysis of the results of studying the pathological material (aborted fetuses) for leptospirosis in the period from 2014 to 2018

The samples of blood of dogs, camels, deer, donkeys, and guinea pigs, combined in the Other Animals group were also subjected to the study for leptospirosis over the accounting period. From 2014 to 2018, the specialists of the laboratory had studied 805 blood samples from this group of animals, of which 14 were positive (1.7 %) (Fig. 14). In 2014 and 2017, no animals infected with leptospirosis were detected, in 2015, one leptospirosis-positive test was detected, in 2016 – two tests (2.6 %), and in 2018 – 11 tests (3.4 %) (Fig. 15). Among the animals in this group Leptospira of the following serological groups were identified: Icterohaemorrhagiae (50 % of the cases), Sejroe (42.9 %), and Tarassovi (7.1 %) (Fig. 16).

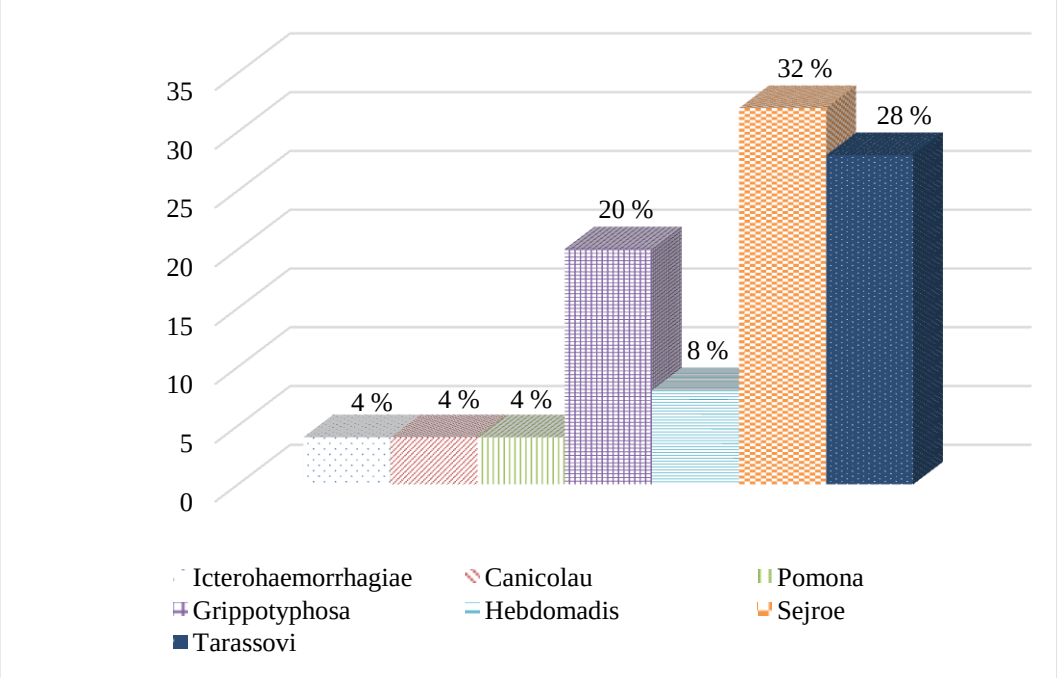

Fig. 13: The pathogens of leptospirosis isolated from the samples of pathological material (aborted fetuses) in 2014 – 2018 in the territory of the Nizhny Novgorod region

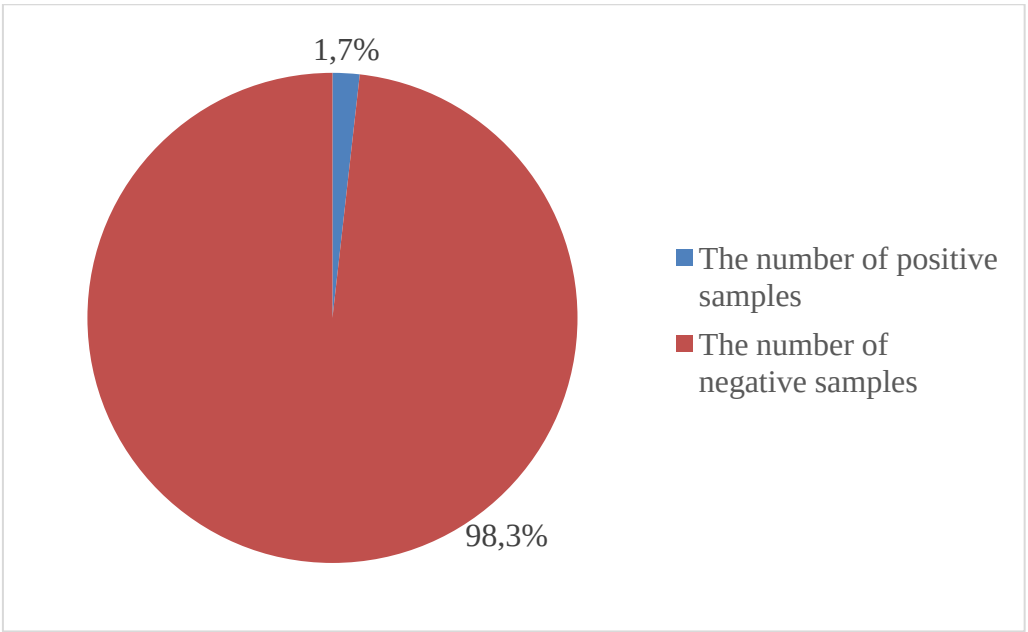

Fig. 14: The degree of animals of various species (dogs, camels, deer, donkeys, and guinea pigs) involvement in the leptospirosis epizootic process in the territory of the Nizhny Novgorod region in 2014 – 2018

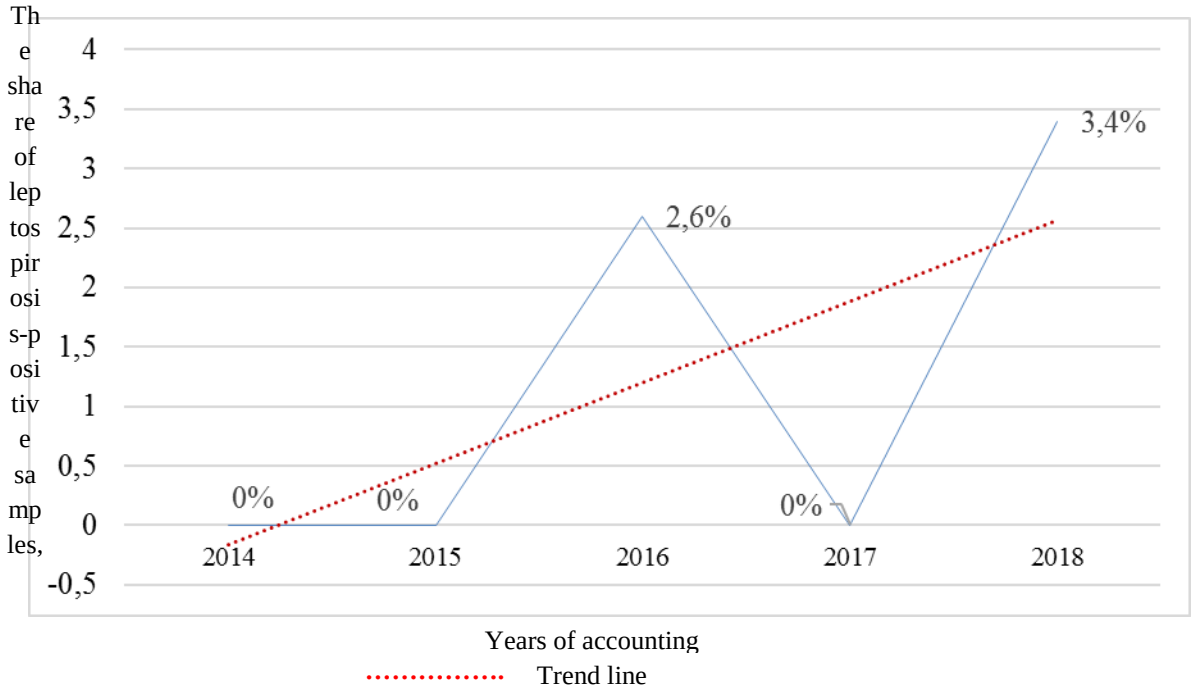

Fig. 15: The dynamics of leptospirosis infection development in populations of animals of various species (camels, deer, donkeys, and guinea pigs) in the territory of the Nizhny Novgorod region in 2014 – 2018, according to the SFI NR Regional Veterinary Laboratory

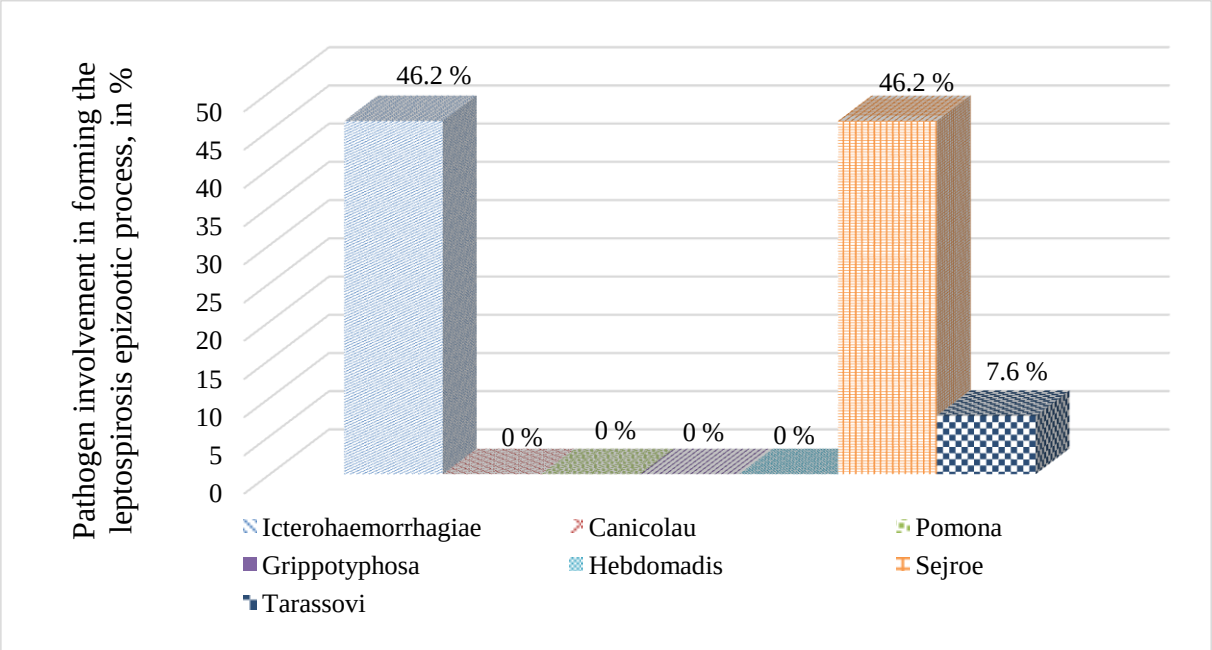

Fig. 16: The etiological structure of leptospirosis in populations of animal of various species (camels, deer, donkeys, and guinea pigs) in the territory of the Nizhny Novgorod region in 2014 – 2018

IV. CONCLUSION

Thus, after an expert assessment of the results of monitoring leptospirosis in animals, it has been found that in the territory of the Nizhny Novgorod region in 2014 – 2018, the degree of involvement of the consociates of animal populations related to various species in the leptospirosis epizootic process had not been uniform, with the pronounced dominance of its epizootic process in the population of horses. The dynamics of the disease also differed significantly in the animal populations of various species; in particular in the population of cattle, camels, deer, donkeys, and guinea pigs, the trend was observed to increasing the number of infected animals, and in the populations of horses and pigs – the trend to decreasing the number of infected animals. Starting with 2014, a sharp increase was observed in the number of positive results in studying the pathological material from the aborted fetuses for leptospirosis.

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