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RABIES EPIZOOTIC SITUATION MONITORING IN KRASNODAR REGION

Abstract. This article presents the results of studies on the manifestation of rabic infection, prevention, registration and diagnosis in the Krasnodar Territory. The main indicators of rabic infection have been identified for predicting and improving antiepzootic measures. . It was found that during the period 2008-2022, rabies was registered annually, and 154 cases of rabic infection were identified. The specific incidence of dogs was 46.8%, cats 24.0%, foxes 13%, cattle 7.1%, and other animal species 9%. During the above period, the minimum number of cases was in 2022 – 1 case, and the maximum in 2008 – 29 cases. The seasonality of rabies in the Krasnodar Territory has its own characteristics. The maximum number of rabies patients is registered in the spring months – 31%, in the winter and summer months - 23.8% each, in the autumn – 21.4%. Currently, rabies studies are conducted using MFA and ELISA methods, including conducting a bioassay on white mice. For the period 2020-2022 MFA – 1886, ELISA – 1886, and bioprobe – 1868 studies were conducted, with a total of 5,640 studies. In addition, it is possible to conduct research on rabic infection by PCR. The directions for the study of indicators affecting the occurrence and spread of rabies foci have been selected, which will make it possible to predict and improve antiepzootic measures.

Keywords. Epizootology, prevention, diagnostics, rabies, Krasnodar Territory.

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**КРАСНОДАР ӨЛКЕСІНДЕ ҚҰТЫРУ ИНДЕТІНІҢ ЭПИЗООТИЯЛЫҚ
ЖАҒДАЙЫН МОНИТОРИНГІЛЕУ**

Аңдатпа. Бұл мақалада Краснодар өлкесінде құтыру инфекциясының көрінісі, алдын-алу, тіркеу және диагностика бойынша зерттеулердің нәтижелері келтірілген. Эпизоотияға қарсы шараларды болжау және жетілдіру үшін құтыру инфекциясы кезіндегі негізгі көрсеткіштер анықталды. 2008-2022 жылдар аралығында құтыру жыл сайын тіркеліп, құтыру инфекциясының 154 жағдайы анықталғаны белгілі болды. Иттердің үлестік аурушандығы (%) – 46,8, мысықтар – 24,0, түлкілер – 13, ірі қара мал – 7,1, жануарлардың басқа түрлерінің үлесіне – 9 құрады. Жоғарыда аталған кезеңде жағдайлардың ең аз саны 2022 жылы – 1 жағдай, ал 2008 жылы – 29 жағдай болды. Краснодар өлкесіндегі құтыру маусымының өзіндік ерекшеліктері бар. Құтырумен ауыратын жануарлардың ең көп саны көктем айларында тіркеледі – 31 %, қыс айлары мен жаз айларында – 23,8 %, күзгі айларда – 21,4 %. Қазіргі уақытта құтыру ауруын зерттеу ақ тышқандарға биосынаманы қоюды қоса алғанда, ФАӘ, ИФТ әдістерімен жүргізіледі. 2020-2022 жылдар кезеңінде ФАӘ – 1886, ИФТ – 1886, биосынама – 1868 әдістерімен зерттеулер жүргізілді, жалпы зерттеу саны 5640. Сонымен қатар, ПТР әдісімен құтыру инфекциясына зерттеулер жүргізуге болады. Эпизоотияға қарсы іс-

шараларды болжауға және жетілдіруге мүмкіндік беретін құтыру ошақтарының пайда болуы мен таралуына әсер ететін көрсеткіштерді зерттеу бағыттары тандалды.

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МОНИТОРИНГ ЭПИЗООТИЧЕСКОЙ СИТУАЦИИ ПО БЕШЕНСТВУ В КРАСНОДАРСКОМ КРАЕ

Аннотация: В данной статье приводятся результаты исследований проявления рабической инфекции, профилактики, регистрации и диагностике в Краснодарском крае. Определены основные показатели при рабической инфекции для прогнозирования и совершенствовании противоэпизоотических мероприятий. Установлено, что за период 2008-2022 гг. бешенство ежегодно регистрировалось, и было установлено 154 случая рабической инфекции. Удельная заболеваемость собак составила (%) – 46,8, кошек – 24,0, лисиц – 13%, крупный рогатый скот – 7,1, на долю других видов животных – 9. За вышеуказанный период минимальное количество случаев было в 2022 году - 1 случай, а максимальное в 2008 году – 29 случаев. Сезонность бешенства в Краснодарском крае имеет свои особенности. Максимальное количество больных бешенством животных

регистрируется в весенние месяцы – 31 %, на зимние месяцы и летние месяцы приходится по 23,8 %, на осенние – 21,4 %. В настоящее время исследования на бешенство проводятся методами МФА, ИФА, включая постановку биопробы на белых мышах. За период 2020-2022 гг. проведено исследований МФА – 1886, ИФА – 1886, биопроба – 1868, с общим количеством исследований 5640. Кроме того, возможно проведение исследований на рабическую инфекцию методом ПЦР. Выбраны направления по изучению показателей, влияющих на возникновение и распространение очагов бешенства, которые позволят прогнозировать и совершенствовать противоэпизоотические мероприятия.

Ключевые слова. Эпизоотология, профилактика, диагностика, бешенства, Краснодарский край.

Introduction. Rabies remains a highly relevant subject of study due to its absolute fatality rate in humans and the significant economic losses caused by infected animals [1].

The epizootic situation of rabies is unfavorable in most countries around the world, with only a few island nations and some Western European countries being exceptions. The disease is also endemic in the majority of countries sharing land borders with the Russian Federation. In an effort to consolidate actions against rabies at the international level, the Intergovernmental Council for Cooperation in Veterinary Medicine, together with the veterinary services of CIS countries, commissioned the Federal Center for Animal Health (FGBI "ARRIAH") to develop the project "Comprehensive Joint Measures of the CIS Member States for the Prevention and Control of Rabies for the Period Until 2025." This project was officially approved by the Council of Heads of Government of the CIS member states on June 1, 2018. Its implementation was entrusted to the governments of the respective states, with coordination and oversight assigned to the Intergovernmental Council for Cooperation in Veterinary Medicine [2].

The elimination of rabies in foxes is a crucial milestone in the control of animal diseases and wildlife zoonoses both nationally and internationally. Germany has played a key role in the development of oral rabies vaccines (ORV) and established standards for the practical implementation of large-scale ORV campaigns across Europe. The success of these efforts lies in long-term planning, a consistent vaccination strategy, and cross-border coordination. Experts consider the fox rabies eradication campaign to be among the most cost-effective animal disease control programs ever implemented in Germany [3].

According to retrospective epidemiological data, from 1945 to 2015, rabies was recorded in 53 mammalian species across the USSR and the Russian Federation—9 domestic and livestock species and 44 wild species—accounting for approximately 14% of all mammalian species inhabiting the country. In natural settings, rabies transmission typically occurs through bites, allowing intraneural inoculation of the virus. However, this method is relatively inefficient from an epizootic standpoint due to several factors: the short duration of pathological aggression in infected animals, the predator's anatomical limitations in effectively transmitting the virus, virus excretion being limited to saliva, and the variability of bite effectiveness. The territorial spread of rabies is determined by the phenology and ethology of the parasitic system host—in Russia, primarily the red fox—and displays a vector-like character: for animals, the main vectors are foxes; for humans, foxes, dogs, cats, raccoon dogs, and wolves. The epizootic process is manifested in rare, sporadic, mostly isolated cases that must nonetheless each be considered an independent epizootic event [4].

Long-term analysis shows that the rabies epizootic process has undergone evolutionary phases and exhibits cyclic behavior. These cycles are largely driven by physiological processes

in the main reservoir of the sylvatic (fox-type) rabies—red foxes. Other species such as the corsac fox, jackal, wolf, and raccoon dog also play a significant role in the virus's transmission. In recent decades, the urban form of rabies has become more widespread than the sylvatic form and is primarily driven by physiological patterns in the main reservoir of the urban (dog-type) rabies. This type typically intensifies during the spring and winter months. Understanding these patterns allows veterinary authorities to plan more effective control measures, taking into account both sylvatic and urban rabies cycles [5].

An epizootic rabies focus refers to a localized area where the pathogen persists, posing a continuous risk to clinically healthy but susceptible animals. Such foci may include residential areas, farmland, pasture lands, and other sites where infected animals, acting as virus reservoirs, may be present. In the context of wildlife, rabies foci may include forested areas, steppes, meadows, and other habitats of virus carriers and spreaders [6].

In Ivanovo Oblast, the rabies epizootic pattern is of a mixed type, with a predominance of the sylvatic form. The epizootic dynamics follow a wave-like pattern with peaks every 3–5 years, associated with increased activity in natural reservoirs. A direct correlation has been observed between canid population density and the incidence of rabies in natural foci. Such patterns have been recorded in the Teikovsky, Vichugsky, Furmanovsky, and Ivanovsky forest districts. The raccoon dog, serving as an additional host, may contribute to the prolonged formation and biological activation of fox rabies foci. A decrease in population susceptibility among red foxes can lead to prolonged infectious periods, lower absolute mortality, and sustained epizootic tension in the region. The joint presence of foxes and raccoon dogs in natural rabies foci—particularly where foxes dominate—leads to long-lasting active foci even with low carnivore population density in Ivanovo Oblast [7].

The Russian Federation is considered persistently unfavorable in terms of rabies. Annually, 1,500 to 4,000 cases of rabies in animals are reported. The disease shows a wave-like dynamic, typical of open biological systems. More than half of rabies cases occur in wild animals, indicating a persistent natural reservoir with ongoing spillover into anthropogenic environments. This spillover increases the risk of transmission to domestic and livestock animals and ultimately to humans. Notably, during a major epizootic surge in 2018, cases in dogs and cats outnumbered those in wild species [8].

In its chronic form, fox rabies follows a full phenological cycle: late autumn–winter (mating), spring (whelping), spring–summer (raising offspring), and late summer–autumn (juvenile dispersal). In this transmission chain, infection is passed from mother to offspring, triggered by birthing stress. During the final stage of the cycle, infected juveniles may migrate into various environments (e.g., suburban areas, pastures, recreational zones), leading to interactions with non-host animal groups and humans, increasing the risk of transmission and contributing to the seasonal peak of cases in autumn. Cases in non-host animals (e.g., livestock, small domestic animals, raccoon dogs, wolves, squirrels, etc.) and humans usually represent terminal infections that do not contribute to lyssavirus circulation [9].

Given the cyclic nature of rabies, an increase in epizootic activity was forecasted for 2022–2023, potentially exacerbated by abnormal temperature increases. During summer, rabies epizootics tend to subside, possibly due to reduced contact with wild carnivores, which are more likely to intrude into populated areas during spring and autumn in search of food. Monthly dynamics of rabies activity in wild carnivores show distinct peaks in winter–spring (November–April), likely reflecting seasonal behavioral and reproductive patterns [10].

Thus, rabies remains the only absolutely fatal and widely distributed infectious disease that, according to the WHO, ranks tenth in global infectious disease mortality and is reported in over 150 countries [11, 12].

Rabies continues to pose a significant and dominant socio-economic problem, the resolution of which requires a deep understanding of the factors influencing both epizootic and epidemiological situations in the Russian Federation and globally [13]. Despite progress in diagnosis, prevention, and control, the rabies problem remains unresolved [14, 15]. In several Russian regions, the rabies situation among animals remains tense, with reactivation of natural foci, rising incidence among wild carnivores, and increasing involvement of domestic animals in the epizootic process, posing a growing threat to humans [2]. Seasonal rabies patterns are of particular importance [5].

Given the above, the aim of this study was to analyze the specific features of rabies infection in Krasnodar Region and to evaluate the anti-epizootic measures being implemented.

Materials and Methods. From 2008 to 2022, original research was conducted to diagnose rabies in animals across the territory of Krasnodar Region. In addition, epizootiological and statistical data were analyzed based on official reports provided by the Kropotkin Veterinary Laboratory.

Rabies diagnosis was performed using a range of diagnostic tools, including fluorescent anti-rabies globulin (FAG) for antigen detection, enzyme-linked immunosorbent assay (ELISA) kits for laboratory diagnosis of animal rabies, and biological testing on white mice.

Results and Discussion. Krasnodar Region is located in the southwest of the Russian Federation and occupies the Kuban–Priazov Lowland. It shares land borders with Rostov Oblast to the north, Stavropol Region to the east, the Karachay-Cherkess Republic to the southeast, the Republic of Abkhazia to the south, and a maritime border with the Republic of Crimea to the west. The Republic of Adygea is situated in the center of the region. The southern shores of the Region are washed by the Black Sea, and the western shores by the Sea of Azov. The Kuban River divides the Region into a steppe-covered plain and a region dominated by forests, mountains, and rocky terrain.

The region's fauna includes over 100 species of warm-blooded animals, 37 species of reptiles and amphibians, more than 300 species of birds, and around 100 species of fish. Large predators such as bears, numerous foxes, wolves, wild boars, badgers, and raccoons inhabit the forests. In the Sochi National Park, efforts are underway to restore the population of the Persian leopard. In the steppe areas, hares, foxes, jackals, and various species of small rodents prevail. The region also hosts large numbers of geese, ducks, waders, and migratory birds. Steppe vipers and grass snakes are also encountered. All warm-blooded animals in Krasnodar Region, except for cold-blooded species, are susceptible to rabies.

In recent years, average monthly temperatures have been rising, and snow cover during winter has become rare across much of the region. These climatic changes naturally affect the population dynamics of small rodents, which are a primary food source for foxes.

All of the above-mentioned environmental and biological factors influence the epizootiology of rabies.

During the study period, isolated cases of rabies were reported in muskrats, donkeys, raccoons, raccoon dogs, martens, ferrets, and jackals. However, among the wide range of warm-blooded animals involved in the epizootic process, dogs, cats, and foxes play the dominant role in the transmission of the rabies virus in Krasnodar Region.

Foxes also have ecological interactions with other species, including shared food sources and omnivorous feeding habits. They may also occupy and repurpose dens dug by other animals (e.g., marmots, badgers). Consequently, healthy animals such as muskrats, raccoons, raccoon dogs, martens, ferrets, jackals, and others can become involved in the rabies epizootic process. These species can pose a potential threat alongside foxes in transmitting the rabies virus to humans, livestock, pets (primarily dogs and cats), and other animals.

Specific prophylaxis against rabies in Krasnodar Region is a critical component of protecting both human and animal life. The following vaccines are used:

- For livestock: inactivated liquid culture rabies vaccine “Rabikov” (strain “Shchelkovo-51”);
- For non-productive domestic animals: inactivated dry culture vaccine “Rabikan” (strain “Shchelkovo-51”), for dogs and cats;
- For wild carnivores: live oral vaccine “Rabistav” against rabies in wild carnivorous animals.

During oral vaccination, the presence of tetracycline is used as a marker to confirm bait consumption.

Despite ongoing preventive measures, rabies continues to be reported annually in Krasnodar Region. The recorded cases of rabies in the region from 2008 to 2022 are presented in Table 1.

Table 1 – Recorded cases of animal rabies in Krasnodar Region

Year	Number of rabies cases in animals by species															Total rabies cases	
	dogs	cats	arge horned	foxes	rats	muskrats	donkeys	goats	raccoons	raccoon dogs	martens	ferrets	hamster	jackals	badger		rabbit
2008	20	5	1	3													29
2009	17	2	1	2													22
2010	6	4	2	1													13
2011	3	2	1	2	1	1											10
2012	2	1		1	1		1										6
2013	4	2	3	4				2									15
2014	5	7		1													13
2015	1	4	1	1					1	1	1						10
2016		2		2													4
2017				1								1					2
2018	7	2															9
2019	1													1			2
2020	4	3	1												1		9
2021	2	2	1	2									1			1	9
2022		1															1
Total	72	37	11	20	2	1	1	2	1	1	1	1	1	1	1	1	154

As shown in Table 1, a total of 154 cases of rabies in animals were registered in Krasnodar Region during the period from 2008 to 2022. The incidence rates were established as follows (%): dogs – 46.8, cats – 24.0, foxes – 13.0, cattle – 7.1, and other animal species accounted for 9.0%. The minimum number of cases was recorded in 2022 with only 1 case, while the maximum was observed in 2008 with 29 cases. The primary source of the pathogen comprises infected and incubating susceptible animals. Transmission factors include saliva of infected susceptible animals, carcasses of animals that died from rabies, as well as contaminated

equipment and environmental objects. The main transmission route for rabies is through bites, which is the defining mechanism of virus spread among animals.

In Krasnodar Region, the main vectors of the rabies virus are domestic and wild animals (foxes, dogs, cats), which together represent 83.8% of the total number of rabies cases during the study period. Foxes alone account for 13% of all registered cases, indicating the natural focality of the disease. Understanding the incidence rates of rabies among different animal species is a critical factor in designing and implementing comprehensive anti-epizootic measures.

Currently, rabies diagnostics are performed using methods such as fluorescent antibody test (FAT), enzyme-linked immunosorbent assay (ELISA), including bioassays on white mice. From 2020 to 2022, a total of 5,640 tests were conducted: 1,886 FAT, 1,886 ELISA, and 1,868 bioassays. Additionally, polymerase chain reaction (PCR) methods are also used for detecting rabies infection.

Table 2 presents data on the number of rabies diagnostic tests performed on pathological materials at the State Budgetary Institution of Krasnodar Region “Kropotkinskaya Regional Veterinary Laboratory” during the period 2020-2022.

Table 2 – Number of rabies tests of pathological material conducted in 2020–2022 at the Kropotkin Regional Veterinary Laboratory (State Budgetary Institution of Krasnodar Krai)

Research methods	Years			Total number of tests conducted in 2020–2022		
	2020	2021	% compared to Previous Year	2022	% compared to Previous Year	
DFA (Direct Fluorescent Antibody Test)	462	673	+31,3	751	+10,4	1886
ELISA (Enzyme-Linked Immunosorbent Assay)	462	673	+31,3	751	+10,4	1886
Bioassay	453	664	+31,8	751	+11,6	1868
Total	1377	2010	+31,5	2253	+10,8	5640

The reservoir of the rabies infection has its own biological cycle and activity, which are closely linked to the specific habitat features of wild carnivores. This interconnection determines the seasonal patterns of rabies incidence among animals.

In Krasnodar Krai, the registration of rabies cases in animals demonstrates distinct seasonal characteristics. The relative number of rabies cases peaks in spring—31%, followed by winter and summer—each at 23.8%, and the lowest incidence occurs in autumn—21.4%.

To improve rabies monitoring and control measures, several key research directions have been identified in Krasnodar Krai, focusing on factors that influence the emergence and spread of rabies outbreaks. These include:

- Natural and climatic conditions of Krasnodar Krai;
- Soil types and soil fertility;
- Wildlife species and biodiversity of wild fauna;
- Climate change in the region;
- Population structure and habitat range of potential rabies carriers;
- Epizootic process of rabies in Krasnodar Krai;

- Seasonal dynamics of rabies occurrence;
- Rabies-specific morbidity rates in animals in the region;
- Correlations between solar activity and the rabies epizootic process;
- Population numbers of foxes and small rodent species;
- Geographic distribution and mapping of rabies cases within Krasnodar Krai;
- Rabies prevention measures in animals;
- Anti-rabies vaccination in animals;
- Study of biological properties and sequencing of rabies virus isolates obtained in Krasnodar Krai;
- Use of GIS technologies and spatial analysis.

Based on the data obtained, we are continuously improving rabies virus isolation methods, as well as the system of preventive and diagnostic anti-rabies measures.

Conclusions. It was established that during the period from 2008 to 2022, rabies was registered annually, with a total of 154 cases of rabies infection identified. The species-specific incidence rate (%) was: dogs – 46.8%, cats – 24.0%, foxes – 13%, cattle – 7.1%, and other animal species – 9%. During the above-mentioned period, the lowest number of cases was recorded in 2022 – 1 case, and the highest in 2008 – 29 cases. The seasonality of rabies in Krasnodar Krai has its own characteristics. The highest number of rabid animals is recorded in spring – 31%, in winter and summer – 23.8% each, and in autumn – 21.4%. Currently, rabies testing is carried out using DFA (Direct Fluorescent Antibody), ELISA (Enzyme-Linked Immunosorbent Assay), including bioassay on white mice. During the period from 2020 to 2022, the number of tests conducted was: DFA – 1,886, ELISA – 1,886, bioassay – 1,868, with a total of 5,640 tests. Additionally, PCR testing for rabies infection is also available. Research directions have been identified to study the indicators influencing the occurrence and spread of rabies outbreaks, which will allow for forecasting and improving anti-epizootic measures.

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