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Echinococcosis of dogs in the North Caucasian Subjects (infrastructural, epizootological and sanitary-hygienic analysis)

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SUMMARY

Based on the official statistics the situation of parasitic diseases in the Russian Federation is still quite unfavorable. The issues of soil contamination with *Echinococcus granulosus* eggs are understudied that's why the objective of the research was to study canine echinococcosis which poses a threat to animal and human disease freedom in the North Caucasian countries. Helminthological tests of the guardian dog feces were performed in seven North Caucasian Subjects: the Stavropol Krai, the Karachay-Cherkessia Republic, the Kabardino-Balkaria Republic, Republic of North Ossetia –Alania, Republic of Ingushetia, the Chechen Republic, and the Republic of Dagestan. As a result, it was determined that the average frequency index of echinococcosis occurrence was 85.07%. The moderate fecal egg count in 1,400 samples was 22.73 ± 1.49 eggs per 10 grams of dog feces. The data obtained are indicative of the disease unfavourable situation in the Subjects and the zoonosis spread at the regional level. Helminthological tests of 14,000 soil samples from near-village pastures for contamination with tapeworm eggs, including *Echinococcus granulosus*, showed that the invasion rate in the Stavropol Krai was 65.80%, in Karachay-Cherkessia republic – 79.00%, in Kabardino-Balkaria – 82.60%, in North Ossetia – Alania – 74.65%, in Ingushetia – 88.20%, in Chechnya – 83.75%, in Dagestan – 79.85%. The results obtained testify to the high level of soil contamination with the infective eggs. It was demonstrated that there is a relationship between the distribution of viable *Echinococcus granulosus* eggs in pasture soils and ecological characteristics of the Subject: the largest number of viable *Echinococcus granulosus* eggs was observed in submountain areas, fewer eggs were observed in flatlands, and the least number of eggs – in the mountain areas. The number of eggs detected in the soil samples from pastures is indicative of the disease persistence in humans and animals. Results of the helminthological tests of 7,500 soil samples from 119 cattle-driving routes of the North Caucasus demonstrate 100% contamination with parasitic agents which poses a threat of epidemiological and epizootological situation of echinococcosis in the Subject.

Keywords: North Caucasus, guardian dogs, cestode, *Echinococcus granulosus* species, examination, feces, eggs, distribution, pollution, pastures, soil

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Эхинококкоз собак в субъектах Северного Кавказа (инфраструктурный, эпизоотологический и санитарно-гигиенический анализ)

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РЕЗЮМЕ

Согласно данным официальной статистики, в Российской Федерации ситуация по паразитарным болезням остается неблагополучной. Вопросы санитарного загрязнения почв разных объектов яйцами *Echinococcus granulosus* остаются недостаточно изученными, поэтому целью исследования являлось изучение эхинококкоза собак как угрозы эпизоотическому, эпидемиологическому и санитарно-гигиеническому благополучию субъектов Северного Кавказа. Гельминтологические исследования проб фецес приотарных собак провели в семи регионах Северного Кавказа: Ставропольском крае, Карачаево-Черкесской Республике, Кабардино-Балкарской Республике, Республике Северная Осетия – Алания, Республике Ингушетия, Чеченской Республике, Республике Дагестан. В результате установлено, что средний индекс встречаемости инвазии эхинококкоза составил 85,07%. В 1400 пробах средний индекс обилия яиц *Echinococcus granulosus* был равен 22,73 ± 1,49 экз. в 10 г фецес собак. Полученные данные свидетельствуют о санитарном неблагополучии субъектов по данной инвазии и широком распространении зооноза в региональном масштабе. Санитарно-гельминтологические исследования 14 000 проб почвы присельских пастбищ на обсемененность яйцами тениат, в т. ч. *Echinococcus granulosus*, показали, что в Ставропольском крае инвазированность составила 65,80%, в Карачаево-Черкесии экстенсивный показатель инвазии почв составил 79,00%, в Кабардино-Балкарии – 82,60%, в Северной Осетии – Алании – 74,65%, в Ингушетии – 88,20%, в Чечне – 83,75%, в Дагестане – 79,85%. Представленные результаты указывают на высокий уровень контаминации почв региона инвазионными элементами. Показано, что обсемененность почв пастбищных угодий жизнеспособными яйцами *Echinococcus granulosus* находилась в прямой зависимости от экологических особенностей региона: наибольшее количество жизнеспособных яиц *Echinococcus granulosus* содержалось в почвах предгорной зоны, меньшее – на равнинной территории и минимальное – в горной зоне. При этом установленного количества яиц в пробах почвы пастбищ достаточно для поддержания стойкого неблагополучия субъектов по эхинококкозу животных и человека. Результаты санитарно-гельминтологической экспертизы 7500 проб почв 119 скотопрогонных трасс субъектов Северного Кавказа свидетельствуют о 100%-й обсемененности паразитарными агентами, что создает угрозу осложнения эпидемиологической и эпизоотической обстановки по эхинококкозу на территории региона.

Ключевые слова: Северный Кавказ, приотарная собака, цестода, вид *Echinococcus granulosus*, экспертиза, фецес, яйца, обсемененность, загрязнение, пастбища, почва

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INTRODUCTION

Multiple investigations showed that *Echinococcus granulosus* (*E. granulosus*) is a dangerous parasite for more than 100 animal species and humans. This helminthic species poses epidemiological risk for human health in the Russian Federation [1–12].

In accordance with the OIE and FAO the average prevalence of echinococcosis in domestic and wild carnivores in South Africa was 86.5% [13–16], in Southeast Asia – 75.9% [17, 18], in Latin America – 68.3% [19], and in North America – 62.8% [20].

Based on the OIE and FAO data echinococcosis in domestic and wild ruminants in Africa occurs in the form of epizootics, it's prevalence is 42.8%, in more than 40 of them prevalence is 58.5% [14, 21]. In Southeast Asia echinococcosis prevalence in ruminants is 39.6% [18], in Latin America – 34.5% [22], in North America – 28.4% [20, 23–25].

According to the World Health Organization (WHO) echinococcosis is among diseases of parasitic etiology posing global epidemiological risk and its prevalence is 300–1,250 cases per 100 thousand people [4].

In the Russian Federation echinococcosis of sheep and cattle is a major problem for many livestock sectors and one of the main reasons for decreased productivity in more than 500 breeds and lineages of productive animals and it 2–3.5 times exceeds the similar morbidity parameters in the European countries [26].

In the Russian Federation as well as in the entire world the contamination of soil at different infrastructure facilities with *E. granulosus* eggs is still quite understudied [2, 27].

The research was aimed at studies of echinococcosis being the threat to welfare of the North Caucasian Subjects in terms of animal and human diseases as well as compliance with sanitary and hygienic requirements.

MATERIALS AND METHODS

In seven North-Caucasian Subjects (Stavropol Krai, Karachay-Cherkess Republic, Kabardino-Balkarian Republic, Republic of North Ossetia – Alania, Republic of Ingushetia, Chechen Republic, and Republic of Dagestan) 1,400 feces samples collected from 1,400 guardian dogs were tested for *E. granulosus* epizootic activity using life-time diagnosis methods (coproscopy, helminthoscopic methods, direct smear method, Demidov and Fülleborn methods).

When carrying out a sanitary and helminthological examination of the soil for taenia egg contamination, including *E. granulosus*, 14,000 soil samples from pastures and 7,500 soil samples from 119 livestock routes were tested using certified parasitological ovoscopic methods.

Statistical processing of the material was carried out using Biometrics computer software.

RESULTS AND DISCUSSION

Helminthological tests of samples collected from guardian dog feces for echinococcosis with subsequent determination of the *E. granulosus* prevalence and abundance were performed under experimental conditions in seven North Caucasian Subjects to assess the risks for human and animal health (Table 1).

As a result, it was determined that the average prevalence of canine echinococcosis was 85.07%, which is indicative of the wide spread of the zoonotic parasite infection at the regional level.

The average index of *E. granulosus* abundance determined during tests of 1,400 feces samples was 22.73 ± 1.49 eggs in 10 g of dog feces which indicates that the Subjects are infected with the disease.

The results of examining near-village soil for contamination with taenia eggs (%), including *E. granulosus*, in the North Caucasus based on the feces sample tests are demonstrated in Table 2.

It was found that in the Stavropol Krai the pasture soils were contaminated in 65.80% of cases, in the Karachay-Cherkess Republic – in 79.00%, in the Kabardino-Balkarian Republic – in 82.60%, in the Republic of North Ossetia – Alania – in 74.65%, in the Republic of Ingushetia – in 88.20%, in the Chechen Republic – in 83.75%, and in the Republic of Dagestan – in 79.85% of cases. Thus, the prevalence of the echinococcosis agent eggs in soil samples of this category was 79.12%, which indicates a high level of contamination of the region's soils with invasive elements.

The tests of 14,000 soil samples from near-village pastures demonstrated that the abundance index of

Table 1
The results of helminthological tests of guardian dog feces samples for echinococcosis caused by the cestode *E. granulosus* in the North Caucasian Subjects (according to Ova and Parasite Test of feces samples, %)

North Caucasian Subjects	Amount of dogs tested	Amount of dogs infested with taenia eggs, including *E. granulosus*	Prevalence, %	Mean abundance index for *E. granulosus* eggs in 10 g of dog feces
Stavropol Krai	200	155	77.50	18.76 ± 1.20
Karachay-Cherkess Republic	200	170	85.00	23.40 ± 1.50
Kabardino-Balkarian Republic	200	179	89.50	26.82 ± 1.70
Republic of North Ossetia – Alania	200	164	82.00	20.79 ± 1.40
Republic of Ingushetia	200	182	91.00	28.65 ± 1.90
Chechen Republic	200	169	84.50	21.21 ± 1.30
Republic of Dagestan	200	172	86.00	19.50 ± 1.40
Total	1,400	1,191	85.07	22.73 ± 1.49

Table 2
The results of the sanitary and helminthological examination of the pasture soils for contamination with taenia eggs, including *E. granulosus*, in the North Caucasian Subjects

North Caucasian Subjects	Amount of soil samples tested	Amount of soil samples infested with taenia eggs, including *E. granulosus*	Prevalence of taenia eggs, including *E. granulosus*, %	Average abundance index for *E. granulosus* eggs in 10 g of soil samples
Stavropol Krai	2,000	1,316	65.80	15.72 ± 0.90
Karachay-Cherkess Republic	2,000	1,580	79.00	20.40 ± 1.20
Kabardino-Balkarian Republic	2,000	1,652	82.60	23.81 ± 1.40
Republic of North Ossetia – Alania	2,000	1,493	74.65	16.78 ± 1.10
Republic of Ingushetia	2,000	1,764	88.20	24.60 ± 1.50
Chechen Republic	2,000	1,675	83.75	19.20 ± 1.20
Republic of Dagestan	2,000	1,597	79.85	17.48 ± 1.10
Total	14,000	11,077	79.12	19.71 ± 1.20

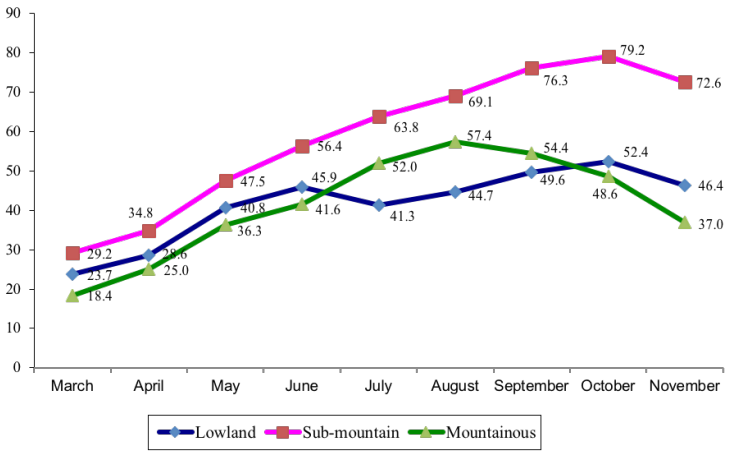

Fig. Average proportion of pasture soil samples where viable E. granulosus eggs were detected, in the warm period of 2020 in the Karachay-Cherkess Republic climatic zones, %

E. granulosus eggs was 19.71 ± 1.20 eggs per 10 g sample, which is indicative of epidemiologically hazardous contamination.

Thus, the results of helminthological tests of dog feces samples and sanitary and helminthological examination of soils showed that all seven North Caucasian Subjects (Stavropol Krai, Karachay-Cherkess Republic, Kabardino-Balkarian Republic, Republic of North Ossetia – Alania, Republic of Ingushetia, Chechen Republic and Republic Dagestan) have the status of echinococcosis infection. The reason for this is the poor implementation of anti-epizootic measures addressing this invasion and non-compliance with the dog deworming schedule.

Tests carried out during the growing season of 2020 in the lowland, sub-mountain, and mountainous areas of the Karachay-Cherkess Republic showed that the quantitative content of viable *E. granulosus* eggs in soil samples of all pasture lands directly correlated with the ecological characteristics of the region, where the determining factors are the effective temperature sum and humidity. The results are demonstrated in Figure.

So, in the lowland natural and climatic conditions in the area under study the share of samples with viable eggs of the parasite in the soil in June was 45.9% of the number of samples tested, in July – 41.3%, in October – 52.4% and at the end of November – 46.4%. In the sub-mountain area, this parameter in March was equal to 29.2%, in October – 79.2%, and in the third decade of November – 72.6%. In the mountainous area, the number of viable eggs of *E. granulosus* in soil samples from pasture lands of the Subject from March to August gradually increased from 18.4% to 57.4%, and by the end of November decreased to 37.0%.

Thus, when comparing samples from all pastures, the largest number of viable *E. granulosus* eggs was in the soils of the sub-mountain, the smallest number – in the lowland, and the minimum – in the mountainous area. At the same time, the detected amount of viable *E. granulosus* eggs in the pasture soil samples is sufficient for maintaining echinococcosis persistence in animals and humans in the region.

At the next stage of the research, a sanitary and helminthological examination of 7,500 soil samples from 119 livestock routes in six North Caucasian Subjects was carried out for the detection of taenia eggs, including *E. granulosus* (Table 3).

The results of the sanitary and helminthological examination indicate a high level of contamination of the soils from livestock routes by invasive elements of the parasite. All tested soil samples (100%) collected from the livestock routes were contaminated with viable eggs of *E. granulosus,* which may become one of the main threats to the sanitary-epidemiological and epizootic situation in six North Caucasian Subjects.

CONCLUSION

As shown by the results of the sanitary and helminthological examination of feces samples of guardian dogs in the North Caucasian Subjects (Stavropol Krai, Karachay-Cherkess Republic, Kabardino-Balkarian Republic, Republic of North Ossetia – Alania, Republic of Ingushetia, Chechen Republic, Republic of Dagestan), the average prevalence of echinococcosis invasion amounted to 85.07%, which indicates a wide distribution of this zoonosis in the region. In 1,400 feces samples, the abundance index of *E. granulosus* eggs was 22.73 ± 1.49 eggs in 10 g canine feces.

Sanitary and parasitological studies of the soils of the near-village pastures in the Stavropol Krai demonstrated that 65.80% of samples were contaminated with taenia

Table 3
The results of the sanitary and helminthological examination of the cattle-driving routes for contamination with taenia eggs, including *E. granulosus*, in the North Caucasian Subjects

North Caucasian Subjects	Cattle-driving routes under testing	Amount of tested soil samples	Amount of soil samples contaminated with *E. granulosus*	*E. granulosus* prevalence, %
Karachay-Cherkess Republic	18	900	900	100
Kabardino-Balkarian Republic	22	1,230	1,230	100
Republic of North Ossetia – Alania	15	700	700	100
Republic of Ingushetia	10	500	500	100
Chechen Republic	13	670	670	100
Republic of Dagestan	41	3,500	3,500	100
Total	119	7,500	7,500	100

eggs, including *E. granulosus*, in the Karachay-Cherkess Republic the extensive soil invasion rate was 79.00%, in the Kabardino-Balkarian Republic – 82.60%, in the Republic of North Ossetia – Alania – 74.65%, in the Republic of Ingushetia – 88.20%, in the Chechen Republic – 83.75%, in the Republic of Dagestan – 79.85%. Thus, the average prevalence of the echinococcosis causative agent eggs in soil samples of this category was 79.12%, which indicates a high level of soil contamination with cestode eggs. When testing 14,000 soil samples, the abundance index of *E. granulosus* eggs was 19.71 ± 1.20 in 10 g sample, which is evident of dangerous contamination of pasture soils in the North Caucasus.

Studies carried out during the growing season of 2020 under the conditions of different climatic zones of the Karachay-Cherkess Republic showed that the largest number of viable *E. granulosus* eggs was in the sub-mountain area, less – in the lowland and the minimum – in the mountainous area. At the same time, the detected amount of viable *E. granulosus* eggs in the pasture soil samples is sufficient to maintain the persistent infection in the entire region.

The results of the sanitary and helminthological examination of the soils from the cattle driving routes of the North Caucasian Subjects indicate a 100% contamination with taenia eggs, including *E. granulosus*, which poses a threat of worse epidemiological and epizootic situation for echinococcosis in the region.

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