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Epizootiological characteristics of echinococcosis in dogs, sheep and goats and measures to combat it in Caspian Sea region of Russia

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SUMMARY

The paper presents the results of the study of the epizootiological characteristics of echinococcosis in dogs, sheep and goats in the Caspian Sea region of Russia where *Echinococcus* occurrence varies from 30 to 80%, as well as the results of tests of the complex product Prazibars (at different doses) for its effectiveness against this parasitosis. The extensity of *Echinococcus* invasion in sheep and goats in the Caspian Depression is 38.6%; it is expansive and affects more and more areas. Some researchers report that *Echinococcus granulosus* occurrence in sheep in the Caspian Sea region of Russia increases by 0.2–0.3% annually and averages 32.8%. It is demonstrated that *Echinococcus granulosus* invasion intensity and extensity in sheep dogs in the natural altitudinal zones of the region average 3,136.7 ± 343.0 parasites/animal and 30.1%, respectively. In the zones covered by the study, *Echinococcus* species are detected in adult pasture-raised sheep throughout the year, the invasion intensity and extensity average 22.3 ± 2.1 parasites/animal and 23.0%, respectively. It was found that echinococcosis was reported in adult sheep and goats in all the Caspian Sea region areas covered by the study. Complete helminthological necropsy revealed the presence of fertile larva cysts in 1 mL of echinococcal fluid in sheep and goats of all age groups, except for animals under 1 year of age; their number averaged 23.02 ± 1.28 larval cysts/animal. It is shown that echinococcosis is widely spread in carnivores and livestock across all altitudinal zones of the Caspian Sea region of Russia, including Dagestan, and this suggests the necessity of continuous epizootiological control and monitoring of the situation with respect to cestodes of the family *Taeniidae*, in particular *Echinococcus granulosus*. Since echinococcosis in dogs and other carnivores constitutes a large-scale social problem and is a helminthiasis that is dangerous for humans, seeking state-of-the-art ways and means to combat this parasitic disease of carnivores is an urgent challenge. Based on the results of the tests performed, the complex product Prazibars administered individually one time at a dose of 15.0 mg/kg of live weight in admixture with minced meat demonstrated high effectiveness against spontaneous echinococcosis in dogs and other carnivorous animals.

Key words: sheep, goats, echinococcosis, fertile larval cysts, *Echinococcus granulosus*, sheep dogs, invasion, intensity of invasion, extensity of invasion, Prazibars

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Эпизоотологические особенности эхинококкоза собак, овец и коз и меры борьбы с ним в условиях Прикаспийского региона России

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РЕЗЮМЕ

Представлены результаты изучения эпизоотологических особенностей эхинококкоза собак, овец и коз в условиях Прикаспийского региона России, где распространенность указанной инвазии колеблется от 30 до 80%, а также испытания эффективности различных доз комплексного препарата Празибарс при данном паразитозе. В Прикаспийской низменности экстенсивность инвазии овец и коз эхинококком равна 38,6%, она проявляется экспансивно с охватом все новых и новых территорий. Некоторые исследователи указывают на то, что зараженность овец *Echinococcus granulosus* на территории Прикаспийского региона России ежегодно повышается на 0,2–0,3% и в среднем достигает 32,8%. Показано, что интенсивность и экстенсивность инвазии возбудителем эхинококкоза *Echinococcus granulosus* у чабанских собак в природных зонах вертикальной поясности региона в среднем составляет 3136,7 ± 343,0 экз/особь и 30,1% соответственно. В обследованных зонах у взрослых овец пастбищного содержания эхинококк выявляют в течение всего года с интенсивностью и экстенсивностью инвазии в среднем 22,3 ± 2,1 экз/особь и 23,0% соответственно. Установлено, что эхинококкоз регистрируется у взрослых овец и коз во всех обследованных районах Прикаспийского региона. При полном гельминтологическом вскрытии у овец и коз всех возрастных групп, кроме животных до года, в 1 мл эхинококковой жидкости обнаружены фертильные ларвоцисты, количество которых в среднем составило 23,02 ± 1,28 экз/особь. Показано, что в Прикаспийском регионе России, в том числе и Дагестане, эхинококкоз плотоядных и сельскохозяйственных животных широко распространен во всех зонах вертикальной поясности, что предполагает необходимость постоянного эпизоотологического контроля и мониторинга ситуации в отношении цестод семейства *Taeniidae*, в частности *Echinococcus granulosus*. Учитывая, что эхинококкоз собак и других плотоядных представляет масштабную социальную проблему и является опасным для человека гельминтозом, изыскание современных средств борьбы с этим паразитозом плотоядных является актуальной задачей. Проведенными исследованиями установлена высокая эффективность комплексного препарата Празибарс при индивидуальном однократном применении в смеси с фаршем в дозе 15,0 мг/кг живого веса при спонтанном эхинококкозе собак и других плотоядных.

Ключевые слова: овцы, козы, эхинококкоз, фертильные ларвоцисты, *Echinococcus granulosus*, чабанские собаки, инвазия, интенсинвазированность, экстенсинвазированность, Празибарс

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INTRODUCTION

The Caspian Sea region, including the Republic of Dagestan, is one of the leading livestock production regions of Russia. A distinctive feature of animal husbandry practices adopted in this region is the movement of animals (twice a year, in spring and autumn) between summer mountain pastures and winter flatland pastures. This creates optimum conditions for persistence of synanthropic foci of echinococcosis in the Republic.

Echinococcosis caused by *Echinococcus granulosus* is one of the most dangerous parasitic diseases that affects multiple animal species and humans; it is spread worldwide, including Russia [1–16].

Many authors point out that human and animal diseases caused by *Echinococcus* species tend to be widely spread in different regions of the country [17–25].

Echinococcosis is widely spread among carnivores and livestock across all altitudinal zones in the Caspian Sea region of Russia, including Dagestan, and this suggests the necessity of continuous epizootiological control and monitoring of the situation regarding cestodes of the family *Taeniidae*, in particular *Echinococcus granulosus* [22, 25–28].

The extensity of *Echinococcus* invasion in stray dogs in the flatland altitudinal zones of the North Caucasus Subjects reaches 80%. According to various sources, there are

about 40 thousand stray dogs in the Republic of Dagestan alone, and this, in its turn, seriously aggravates sheep and goat echinococcosis epizootic situation in the region.

The extensity of *Echinococcus* invasion in sheep in the Caspian Depression is 38.6%; it is expansive and affects more and more areas. Some researchers report that *E. granulosus* occurrence in sheep in the Caspian Sea region of Russia increases by 0.2–0.3% annually and averages 32.8% [24, 25].

Improvement of echinococossis epizootic situation in the Caspian Sea region of Russia requires continuous monitoring of livestock for epizootiological characteristics of the disease and the causative agent activity.

Since echinococcosis in dogs and other carnivores constitutes a large-scale social problem [2, 17, 18] and is a helminthiasis that is dangerous for humans, seeking state-of-the-art ways and means to combat this parasitic disease is an urgent challenge.

MATERIALS AND METHODS

Echinococcosis development and spread in dogs of different types were studied by coproovoscopic examination of fecal samples.

The specific features of biology of *E. granulosus* causing echinococcosis in sheep of various ages were studied using K. I. Skryabin's method of complete helminthological necropsy (1928).

Internal organs from each animal were examined, the number of *E. granulosus* larval cysts was calculated and average intensity and extensity of invasion were determined. The number of *E. granulosus* eggs in 1 g of feces and that of protoscoleces in 1 mL of echinococcal fluid were counted using the counting chamber developed by the All-Union Institute of Helminthology named after K. I. Skryabin VIGIS.

The tests of Prazibars, a novel biogenous polydisperse complex product, were carried out in 13 dogs aged up to 2 years treated for spontaneous echinococcosis in the settlement of Gerpegezh (the Kabardino-Balkarian Republic).

The animals were divided in two test (n = 10) and one control (n = 3) groups. The complex product Prazibars was individually given one time to group 1 and 2 dogs spontaneously infected with *Echinococcus* (marita stage) at a dose of 10.0 and 15.0 mg/kg of live weight, respectively. The product was not given to the control group dogs.

On days 3, 5, 7, 10 and 15 after the treatment, fecal samples from all the dogs in the experiment were subjected to coproovoscopic examination.

Handling, feeding and keeping conditions were the same for all the animals. The animals were observed on a daily basis.

All the tests were carried out in strict compliance with ethical standards of Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes.

The test results were subjected to computer processing using the Biometrics software.

RESULTS AND DISCUSSION

The results of the studies of *E. granulosus* invasion in sheep dogs and pasture-raised sheep by altitudinal zones of the region are presented in Tables 1 and 2.

Echinococcus invasion extensity and intensity in sheep dogs were found to be as follows: in the mountain zone 32.6% and 2,948 ± 344 parasites/animal; in the pre-mountain zone 29.3% and 3,698 ± 388 parasites/animal and in the flatland zone 28.6% and 2,764 ± 297 parasites/animal; on average 30.1% and 3,136.7 ± 343.0 parasites/animal, respectively.

Table 1
***Echinococcus* invasion extensity and intensity in sheep dogs by altitudinal zones of the region**

Physical and climatic zones	Number of tested animals	Number of infected animals	Invasion extensity, %	Invasion intensity, parasites/animal
Mountain	46	15	32.6	2,948 ± 344
Pre-mountain	58	17	29.3	3,698 ± 388
Flatland	49	14	28.6	2,764 ± 297
Total	153	46	–	–
On average	–	–	30.1	3,136.7 ± 343.0

Table 2
***Echinococcus* invasion extensity and intensity in pasture-raised sheep by altitudinal zones of the region**

Physical and climatic zones	Number of tested animals	Number of infected animals	Invasion extensity, %	Invasion intensity, parasites/animal
Mountain	100	25	25.0	23.6 ± 2.3
Pre-mountain	100	20	20.0	20.5 ± 1.9
Flatland	100	24	24.0	22.8 ± 2.1
Total	300	69	–	–
On average	–	–	23.0	22.3 ± 2.1

Echinococcus invasion extensity and intensity in pasture-raised sheep were as follows: in the mountain zone 25.0% and 23.6 ± 2.3 parasites/animal; in the pre-mountain zone 20.0% and 20.5 ± 1.9 parasites/animal; in the flatland zone 24.0% and 22.8 ± 2.1 parasites/animal; on average in the region 23.0% and 22.3 ± 2.1 parasites/animal, respectively.

During the next stage of the study, *E. granulosus* larval cyst fertility was investigated based on the results of complete helminthological necropsy of sheep of various ages.

Sheep under the age of 1 year demonstrated a complete absence of *E. granulosus* larval cysts.

In 2-year-old animals, the number of oocysts was found to be 12.4 ± 0.63 per animal and the number of protoscoleces in 1 mL of echinococcal fluid averaged 0.83 ± 0.076 thousand; in 3-year-old animals, the number of larval cysts was 18.2 ± 1.03 per animal and the number of protoscoleces was 1.40 ± 0.21 thousand; in 4-year-old animals 20.5 ± 1.17 oocysts/animal and 1.92 ± 0.17 thousand protoscoleces; in 4-year-old animals 27.3 ± 1.69 oocysts/animal and 2.58 ± 0.26 thousand protoscoleces; in 6-year-old animals 36.7 ± 1.88 oocysts/animal and 3.06 ± 0.49 thousand protoscoleces, respectively.

As a result of the tests performed, it was found that there was a direct relationship between the age of animals and the number of fertile larval cysts and protoscoleces.

The complete helminthological necropsy of sheep and goats of all age groups, except for young animals under the age of 1 year, revealed the presence of fertile *E. granulosus* larval cysts in 1 mL of echinococcal fluid; their number averaged 23.02 ± 1.28 per animal.

The test results are indicative of the increasing role and significance of ovine *E. granulosus* strains.

The helminthological examination of the small intestines of twenty stray puppies aged 3–6 months revealed the presence of *E. granulosus* eggs in 17 of them, and this corresponds to the invasion extensity of 85.0%.

Echinococcus invasion extensity in stray dogs aged 1–2 years and adult dogs was 95.0 and 75.0%, respectively, and the invasion intensity was 7.6 ± 1.9 and 11.8 ± 3.0 thousand parasites/animal, respectively, and this is indicative of a high invasive potential of *E. granulosus* in such animals.

Twenty fecal samples were collected from sheep dogs on the small scale farm "Bukhty" in the Kizlyar zone of distant pastures. Tests revealed the presence of *Taeniidae* species eggs in four of them, which makes 20.0%.

According to the data from the Veterinary Committee of the Republic of Dagestan for 2020, the postmortem examination of livestock carcasses demonstrated the presence of echinococcosis-associated lesions in 4,407 cattle carcasses, in 1,899 sheep and goat carcasses, in 97 pig carcasses. For the purpose of echinococcosis control, 7,509 dogs in Dagestan were subjected to treatment in 2020.

High *Echinococcus* invasion extensity (29.0%) was observed in sheep and goats in the pre-mountain and mountain zones of the Kabardino-Balkarian Republic, while the invasion intensity was found to be medium (14.50 ± 1.04 parasites/animal). Sheep and goats are driven to the summer pastures through these territories, and this leads to a high level of pasture contamination with the eggs of cestodes of the family *Taeniidae*, in particular *E. granulosus*.

Echinococcus invasion extensity in sheep and goat population in the Republic of Ingushetia is 20.0–27.0%. Only ovine *E. granulosus* is biologically active and functional in animals in this region.

Echinococcus invasion extensity reported in sheep in the Kabardino-Balkarian Republic is 12.0–18.6%; all *E. granulosus* cysts are fertile, i.e. they can actively infect susceptible animals.

At the mass slaughter sites, the carcasses and internal organs (liver, lungs, spleen) of 1.5–2-year-old sheep were tested for the presence of *Echinococcus* invasion.

As Table 3 shows, the total of 1,062 internal organs from slaughtered animals were tested, *E. granulosus* invasion was detected in 146 samples, which make up 13.7%.

Table 3
Results of tests of internal organs of sheep for *Echinococcus* invasion

No.	Raion of origin of animals	Number of tested organs	Positives detected	
			number of samples	%
1	Gunibsky Raion	110	13	11.8
2	Khunzakhsky Raion	94	12	12.8
3	Kumtorkalinsky Raion	100	14	14
4	Akhtynsky Raion	100	15	15
5	Gergebilsky Raion	100	15	15
6	Akushinsky Raion	118	17	14.4
7	Tlyaratinsky Raion	110	14	12.7
8	Kulinsky Raion	130	16	12.3
9	Laksky Raion	100	13	13
10	Rutulsky Raion	100	17	17
Total		1,062	146	13.7

In the same area, 70 fecal samples from dogs were tested. *Taeniidae* species eggs were detected in 33 (47.1%) samples, adult *Toxocara canis* were detected in 7 samples.

In the settlement of Shangoda (Gunibsky Raion), material from 45 dogs and 55 slaughtered animals was tested; *Taeniidae* species eggs were detected in 13 (28.9%) and 15 (27.3%) samples, respectively.

The helminthological and coprological tests of 30 fecal samples collected from stray dogs in the Kirovsky district of the city of Makhachkala revealed the presence of *Taeniidae* species eggs in 15 (50.0%) samples.

The complex product Prazibars administered at different doses was tested for its effectiveness against spontaneous echinococcosis in dogs in the settlement of Gerpegezh (Kabardino-Balkarian Republic); the tests were performed in 13 animals aged 8–24 months.

Based on the results of the tests performed, it was found that the extenseffectiveness and intenseffectiveness of the tested product administered individually one time at a dose of 10.0 mg/kg of live weight in admixture with minced meat against spontaneous echinococcosis in dogs were 60.00 and 67.22%, respectively.

When administered one time at a dose of 15.0 mg/kg of live weight in admixture with minced meat, the complex product Prazibars demonstrated 100% extenseffectiveness and intenseffectiveness against spontaneous echinococcosis in dogs.

The invasion in control animals was confirmed by tests; fecal egg count was 82.2 ± 7.3 to 84.5 ± 7.7 eggs per 10 grams of fresh feces.

CONCLUSION

The intensity and extensity of *E. granulosus* invasion in sheep dogs in the zones of the region covered by the study averaged 3,136.7 ± 343.0 parasites/animal and 30.1%, respectively.

The intensity and extensity of *E. granulosus* invasion in adult pasture-raised sheep in the altitudinal zones of the Caspian Sea region throughout the year averages 22.3 ± 2.1 parasites/animal and 23.0%, respectively. Echinococcosis was reported in adult sheep in all the raions of the region covered by the study.

The complete helminthological necropsy revealed the presence of fertile larval cysts in 1 mL of echinococcal fluid in sheep of all age groups, except for the animals under the age of 1 year; the larval cyst number averaged 23.02 ± 1.28 per animal.

Echinococcus invasion extensity in stray dogs aged 1–2 years and adult dogs was 95.0 and 75.0%, respectively; the invasion intensity was 7.6 ± 1.9 and 11.8 ± 3.0 thousand parasites/animal, and this is indicative of a high invasive potential of *E. granulosus* in such animals.

There is a relationship between the levels of epizootic process activity of *Echinococcus* invasion in sheep dogs, sheep and goats in all the altitudinal zones of the Republic. The lack of regular deworming treatment of sheep dogs, inappropriate stray animal management, neglect of public awareness raising in sanitation and hygiene are the main reasons of high *Echinococcus* occurrence in the ecosystem.

The complex product Prazibars administered individually one time at a dose of 15.0 mg/kg of live weight in admixture with minced meat was found to have 100% extenseffectiveness and intenseffectiveness against spontaneous echinococcosis in dogs.

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