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Peculiarities of Cattle Paramphistomosis Propagation in the Tyumen Region (Russia)

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Abstract

Cattle infestation with paramphistomosis causative agents is widespread, and causes significant economic damage to the agriculture due to the negative effect on the organisms of animals. In the period from 2002 to 2014, propagation of cattle paramphistomosis on the territory of the Tyumen region in the context of natural subzones was studied. The effect of the hydrothermal factor, the amount of precipitation and the average temperatures in May-June on the extensiveness of the paramphistomosis invasion was studied. Cattle infestation with paramphistomosis causative agents was determined with the use of scatoscopy by the methods of ether-acetic sedimentation followed by flushing (n=7,838). In the territory of the Tyumen region, during the period of the research (2002-2014), a decrease in cattle infestation with paramphistomosis agents was observed from 13.2% in 2004 down to 0.24% in 2014. The average extensiveness of infestation in the forest-steppe subzone was on the average 2.42±1.52%, in the Northern forest-steppe subzone - 2.55±1.23%, in the small-leaved aspen-and-birch forests - 1.34±0.99%, with the maximum extensiveness of infestation by subzones: 15.22% (2004), 14.72% (2004), and 12.0% (2003), respectively. No explicit dependence between the extensiveness of cattle infestation with paramphistomosis causative agents and the farms' attachment to certain natural subzones has been found. The reduction of animals' infestation with paramphistomosis pathogens was associated with dehelmintization. The correlation coefficient between the extensiveness of cattle infestation with paramphistomosis agents and the hydrothermal coefficient, the sum of average monthly temperatures, and the precipitation was 0.15 (P=0.65), 0.29 (P=0.36), and 0.57 (P=0.05), respectively. The correlation coefficient indicates the average positive relationship between the number of animals infected with Paramphistoma and the sum of the average temperatures. Studying the effect of the environmental factors on the propagation of cattle infestation with paramphistomosis causative agents should be considered in the context of special veterinary measures.

Keywords: cattle, paramphistomosis, propagation, Russia, Tyumen region.

INTRODUCTION

Paramphistomosis pathogens are parasites in the organisms of wild and domestic animals, including cattle and small ruminants [1, 2]. Cattle infestation with Trematoda caused by Paramphistomum parasites is widespread both in the world and on the territory of the Russian Federation. Cattle infestation with pathogens of paramphistomosis is noted in Asian countries [3-5], in Europe [2, 6-8], in Africa [9, 10], in North and South America [11, 12], and in Australia [13, 14]. Cattle infestation rate with Paramphistomum in India varies from 17.33% in the state of Uttarakhand [3] to 32.17% in West Bengal [15], in the South-East of Iran it reaches 36.9%, [16], in the Eastern regions of Turkey it decreases to 8.95[17]. In Europe, cattle infestation rate with pathogens of paramphistomosis varies from 12% in the North of Portugal and Northwest of Spain [18] to 55.9% in Italy (Sardinia) [2]; with that, during animals' slaughtering in Ireland, it reaches 52% [19], and in Poland, in the imported animals from Germany, Czech Republic and France it is on the average 50.9% [8]. In Africa, cattle infection rate with paramphistomosis pathogens reaches 7.3% in Egypt [9]; and in Algeria it varies between 1.2% and 7.5% [10]. The most disadvantaged state in North America in terms of cattle infestation with paramphistomosis causative agents is Mexico, where the share of affected animals reaches 39.10% [20], and in South America - Uruguay, 7% [12]. In Russia, cattle paramphistomosis is registered in the Vologda, the Nizhny Novgorod, and the Leningrad regions with the infestation extensiveness equal to 4.8-17.8%, 28.04%, and 2-18%, respectively [21-23]. In the Republic of Mordovia, cattle infestation with paramphistomosis agents has been registered at the level of 1.8% [24], in Udmurtia - less than 1% [25]; in Chechnya - 35.2% [26], in Kabardino Balkariya - 32.3% [27], and in the Altai Mountains it varies between 6.0 and 26.9% [28].

Due to the fact that paramphistomosis pathogens are soil-transmitted helminths, development of the epizootic process in case of such infection is largely determined by environmental factors. Khan & Maqbool in their paper [29] note that the ambient temperature plays an important role in the development of the parasite's intermediate hosts, as it affects the rate of metabolic processes in the organisms of snails. And Díaz et al. [7] in their paper stress out that in the regions with the oceanic climate, the risks of cattle infection with pathogens of paramphistomosis increases in the periods of strong rainfall (May to June, November to December). Thus, studying the peculiarities of cattle paramphistomosis infection propagation is an important task of the researchers.

This work was aimed at studying the propagation and the effect of environmental factors on cattle infection with pathogens of paramphistomosis at farms in the Tyumen region (Russia).

MATERIALS AND METHODS

The research was performed at the laboratory of animal myiases of the All-Russian Research Institute of Veterinary Entomology and Arachnology - a branch of TumSC of SB RAS and agricultural enterprises in the South of the Tyumen region on the territory of the Isetsk, Omutinsk, Yurginskoe, Armizon, Ishim, Kazanka, Sladkovo, Sorokino and Vikulovo areas in the period between 2003 and 2015 (Fig. 1). Cattle paramphistomosis propagation was studied by means of scatoscopical diagnostics (n=7,838) with consecutive flushing and ether-acetic sedimentation [30, 31]. The method of flushing was used according to the standard procedure; the method of ether-acetic sedimentation was modified [32].

The degree of propagation of cattle infection with paramphistomosis at farms was assessed with the calculation of the extensiveness of invasion (EI), which showed the percentage of infected animals in the total number of examined animals. In studying the extensiveness of animals' infection with pathogens of paramphistomosis in the context of the natural-geographical zones, the authors used the zoning proposed in the papers of Richter [33]. The influence of climatic conditions on the development of cattle infection with paramphistomosis was studied through the calculation of the hydrothermal coefficient in the context of the years of the research [34]. The hydrothermal coefficient was calculated by the following formula:

$$HTC = P_{M-J}/T_{M-J},$$

where P_{M-J} was the amount of precipitation in May, June, and July; and T_{M-J} was the sum of the average monthly temperatures for the same months. The results of the research

were processed using the methods of variational statistics with the help of the BIOSTAT application.

Figure 1. Map of the Tyumen region (except for the Khanty-Mansi and the Yamal-Nenets autonomous districts)

RESULTS

Cattle paramphistomosis was registered in all regions of the research, except for the Armizon region. The animals infected with paramphistomosis were identified in the period between 2003 and 2011, and in 2014. The average annual extensiveness of infection varied from 13.2% in 2004 down to 0.24% in 2014. In 2003, extensiveness of infection was 6.49%, in 2005 - 1.97%, in 2006 - 1.66%, in 2007 - 0.51%, in 2008 – 0.42%, in 2009 – 0.29%, in 2010 – 0.85%, and in 2011 – 0.39%. From the perspective of the regions, the most trouble-free ones were the Ishim, the Yurginskoe, the Kazanka and the Omutinsk districts, where the animals' infection rate was determined twice. Thus, at the farms in the Ishim district, paramphistomosis was registered in 2003 and in 2004 with the infection extensiveness equal to 4.03% and 14.05%, respectively. In the Kazanka district, cattle infection with Paramphistoma was registered in 2004 with the infection extensiveness equal to 15.63%, and in 2006 – 1.10%. In the Yurginskoe district, cattle infection with Paramphistomum was registered in 2003 (12.0%) and in 2005 (0.62%). In the Omutinsk district, cattle infection with Paramphistomum was registered in 2006 (9.09%) and in 2007 (2.91%). The research has shown that animals at the farms in the Golyshmanov, the Sladkovo, the Sorokino, the Vikulovo and the Isetsk districts were the most infected with Paramphistoma. At the farms in the Golyshmanov district, cattle were infected with Paramphistoma in the period from 2003 to 2006, the maximum extensiveness of infection was 12.03% in 2004; in other years the infection rate was 4.26% in 2003, 1.15% - in 2005, and 2.37% - in 2006. In the Sladkovo district, cattle paramphistomosis was diagnosed in 2003, 2004, and in 2006. The highest infection rate had been registered in 2003 with the infection extensiveness of 15.50%, after which a slight decrease to 14.8% was observed in 2004, and in 2006 it was 3.08%. In the animals at farms of the Sorokino district, infestation with paramphistomosis agents was detected between 2003 and 2006, after which it was diagnosed in 2008, 2010 and 2011, whereas EI varied from 0.33% in 2008 to 0.24% in 2004. In 2003 it was 7.41%, in 2005 - 10.38%, in 2006 - 2.59%, in 2010 - 1.71%, and in 2011 - 1.57%. At farms in the Isetsk district, infection was recorded from 2003 to 2005, then in 2010 and 2014. In 2003 and 2004, infection extensiveness was equal to 10.77% and 11.67%, respectively. In subsequent years, the infection rate was 3.92% in 2005, 1.42% in 2010, and 2.08% in 2014.

It is known that pathogens of paramphistomosis develop with the participation of intermediate hosts, namely, freshwater mollusks, which, undoubtedly, are influenced by the environmental factors, such as temperature, amount of precipitation, etc. [29]. The authors studied the changes in the extensiveness of paramphistomosis infection of cattle, depending on the farms' attachment to certain natural zones of the Tyumen region. According to Richter [33], in the South of the Tyumen region, zones of forest-steppe and forest divided into subzones may be allocated. The regions of the research belong to the subzones of the Northern and the Southern forest-steppe, and to the subzones of small-leaved aspen-birch forests (Table 1).

As the table shows, in the moderate forest-steppe subzone, paramphistomosis was registered in 2003, 2004 and 2006 with infection extensiveness equal to 11.90%, 15.22%, and 1.96%, respectively. In the Northern forest-steppe subzone, the highest animals infection with pathogens of paramphistomosis was observed; with that infection was registered from 2003 to 2008, and then in 2010, 2011, and 2014. Extensiveness of infection ranged from 0.44% in 2014 to 14.72% in 2004. In the subzone of aspen-birch forests, paramphistomosis in cattle was diagnosed only in 2003, 2005, 2006, and 2009, with the variability in infection extensiveness varying from 0.53% in 2005 to 12.0% in 2003.

Development of epizootological process in case of cattle paramphistomosis is greatly influenced by the climate [7, 35]. Therefore, the authors performed a research to identify probable dependencies between the extensiveness of paramphistomosis infection and the hydrothermal coefficient (HTC, according to Zotov) [34], and the sum of average temperatures and precipitation in May through July on the territory of the Tyumen region (Fig. 1).

Table 1. Propagation of cattle paramphistomosis in the natural-geographical subzones of the Tyumen region (according to Richter [33])

No.	Year of research	Extensiveness of infection (%) in the context of natural-geographical subzones in the South of the Tyumen region		
		Moderate forest-steppe	Northern forest-steppe	Small-leaved aspen-birch forests
1.	2003	11.90	5.93	12.0
2.	2004	15.22	14.72	0
3.	2005	0	4.39	0.53
4.	2006	1.96	2.00	0.65
5.	2007	0	0.74	0
6.	2008	0	0.35	0
7.	2009	0	0	2.94
8.	2010	0	1.44	0
9.	2011	0	0.63	0
10.	2012	0	0	0
11.	2013	0	0	0
12.	2014	0	0.44	0
Average		**2.42±1.52**	**2.55±1.23**	**1.34±0.99**

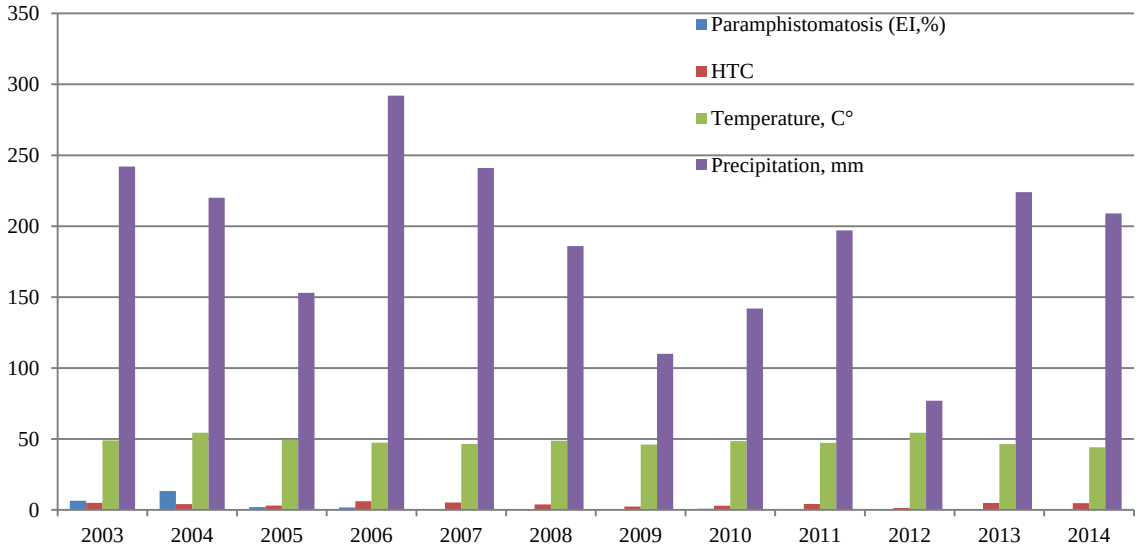

Figure 1. The rate of cattle infection with Paramphistoma and HTC indicators, the sum of the average monthly temperatures and precipitation (May through July, 2004 to 2014)

According to the data shown in the figure, no pronounced dependence among the studied indicators was observed; therefore, the authors statistically processed the results of the study with the computation of the correlation coefficient (r). With that, the correlation coefficient in the period from 2004 to 2014 between extensiveness of infection with paramphistomosis and HTC was 0.15 (P=0.65), between extensiveness of infection with paramphistomosis and the amount of precipitation - 0.29 (P=0.36), and between extensiveness of infection with paramphistomosis and the sum of average temperatures - 0.57 (P=0.05).

DISCUSSION

Paramphistoma in the organism of cattle have negative impact on the animal organisms, which results in qualitative and quantitative losses of milk [36] and meat [37] production. Cattle infestation with paramphistomosis causative agents is registered in the countries of Asia, Europe, Africa, North and South America, and Australia. In Asia, the highest Paramphistoma occurrence rate in animals was recorded in the South-Eastern parts of Iran [16], in Europe - in Italy (Sardinia) [2], and on the North American continent - in Mexico [20]. In Africa, cattle infection with Paramphistoma is insignificant [9, 10]. At farms of the Tyumen region over the period of studies (2002-2014), the decreased extensiveness of cattle paramphistomosis extensiveness was registered - from 13.2 percent in 2004 to 0.24% in 2014, while in the period from 2005 to 2011, the occurrence rate in the animals was below 2%. The most disadvantaged in terms of paramphistomosis were farms in the Golyshmanov, Sladkovo, Sorokino, Vikulovo, and Isetsk districts. In the farms of the Ishim, Yurginskoe, Kazanka and Omutinsk districts, cattle paramphistomosis occurred sporadically.

Studying the peculiarities of paramphistomosis propagation in the context of the natural zones of the research has shown that in the moderate forest-steppe subzone, infection was registered only in 2003, 2004, and 2006 with the maximum infection extensiveness of 15.22% in 2004, followed by a sharp decrease to 1.96% in 2006. In the subzone of Northern forest-steppe the animals' infection during the period of the research was not registered only in 2009, 2012 and 2013; in the remaining years, it ranged from 0.35% in 2008 to 14.72% in 2004. In the subzone of small-leaved aspen-birch forests, paramphistomosis was registered sporadically, and varied from 0.53% in 2005 to 12.0% in 2003. The shown data do not allow to assert that in the territory of the South of the Tyumen region, a pronounced relationship was registered between extensiveness of cattle paramphistomosis and farms' attachment to the certain natural subzone; however, in the subzone of Northern forest-steppe, this pathology was detected more frequently than in the subzones of moderate forest steppe and small-leaved aspen-birch forests. In the opinion of the authors, a more detailed study of this issue requires research aimed at studying the intermediate hosts of Paramphistoma. Assessing the occurrence rate of paramphistomosis in animals in the South of the Tyumen region in the period from 2003 to 2014, one can note the overall decrease in the extensiveness of the infection, which is related to dehelmintization of cattle with Albendazole, Closalben 10 and Febtal. The correlation coefficient between the extensiveness of cattle infestation with paramphistomosis agents and the HTC, the sum of average monthly temperatures, and the precipitation in May through July in 2004 to 2014 was 0.15 (P=0.65), 0.29 (P=0.36), and 0.57 (P=0.05), respectively. The correlation coefficient indicates the average positive relationship between the number of animals infected with Paramphistomum and the sum of the average temperatures, which is consistent with studies of Khan, U. J., & Maqbool, A. [29]. Thus, studying the peculiarities of cattle paramphistomosis propagation over the territory of the Tyumen region revealed the decreased rate of animal infection with pathogens, and the presence of a medium positive relationship with the sum of average temperatures (May, June, July). Further research is required for studying the effect of anthropogenic suppression and environmental factors on both intermediate and main hosts of the Paramphistoma.

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