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Zoonotic Helminths in Small Rodents on the Areas Transformed by Reclamation

Shimalov VV *

Faculty of Pedagogy and Psychology, Brest State University, Belarus

***Corresponding author:** Vladimir Vasilievich Shimalov, Faculty of Pedagogy and Psychology, Brest State University, Boulevard of Cosmonauts 21, 224665 Brest, Belarus

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Abstract

The result of study of small rodents with zoonotic helminths on model reclamation systems in Brest Polesie (South-West Belarus) during 2015–2019 (3rd research period) are presented. Nine zoonotic helminth species were found in 6 species of small rodents. 7.3 % animals were infected with these helminths. The results obtained are compared with data conducted on the same systems in 1996–1999 (1st research period) and 2005–2010 (2nd research period). It was found that with an increase in the number of small rodents, their infection with zoonotic helminths. Attention is drawn to the medical aspect of the problem of zoonotic helminths. A total 15 zoonotic helminth species were found in 9 species of small rodents during three research periods. The prevalence varied from 7.3 % (1st research period) to 9.9 % (2nd research period) and 7.3 % (3rd research period). The largest number of such helminth species (10) and the highest percentage of infection with them (15.3) were found in the striped field mouse. This animal can be used as one of the indicators for assessing the unfavorable of reclaimed areas in terms of zoonotic helminths.

Keywords: Reclamation; Drainage Channel Banks; Rodents; Zoonotic Helminths; Brest Polesie; Belarus

Introduction

Many territories in the world have been drained and transformed as a result of land reclamation. There are open drainage channels. Their banks and beds are inhabited by various animals, including small rodents. Due to these animals, their own specific complex of helminths with zoonotic species is formed. According to World Health Organization [1,2], zoonoses is diseases common for animals and humans, they are freely transmitted from animal to animal and to humans. Among their causative agents are helminths, and the diseases they cause are a serious problem for many countries around the world.

I have been conducting a helminthological investigation of small rodents living on the drainage channel banks of model reclamation systems located in Brest Polesie (Brest, Zhabinka and Malorita districts of the Brest region; South-West Belarus) since 1996. The 1st work period (fundamental research) was carried out in 1996-1999 [3] and the 2nd period (monitoring study) in 2005-2010 [4]. 15,500 trap-days were worked on the drainage channel banks running in mixed forests, on arable lands, pastures and along roads. 13 species of small rodents was established.

After the 1st research period, it was proposed to consider channels in reclaimed areas as one of the potential

helminthoses centers have medical and veterinary significance, and to organize constant ecological and parasitological monitoring the helminth fauna of small rodents there [3]. In total, 12 species of zoonotic helminths were identified in 10 species of small rodents (mice, voles, rats) over two periods [3,4] and it was established that the infection rate of small rodents with helminths of medical significance may exceed 9 % [4].

The aim of the study is to conduct a helminthological investigation of small rodents inhabiting the drainage channel banks on model reclamation systems in Brest Polesie during 2015–2019 (3rd research period), to establish the zoonotic helminth species, their hosts and infection with them, and to compare the data obtained with previous research periods.

Materials and Methods

The helminthological investigation of small rodents living on the drainage channel banks running in mixed forests, on arable lands, pastures and near roads of model reclamation systems in Brest Polesie (Brest, Zhabinka and Malorita districts of the Brest region) was carried out in 2015–2019.

The small rodents were caught by mousetraps. 25 mousetraps were placed in line along the banks of drainage channels at intervals of 1.5-2 m from each other for 4 days. This equaled 100 trap-days. The total number of trap-days was 4,000: 1,000 at each place of passage of the drainage channel. Pieces of rye bread, cut into cubes and lightly fried in sunflower oil, were bait for animals. 510 specimens of small rodents of 8 species were caught.

The animals were examined using the method of complete helminthological dissection, which also included compression of tissues and organs [5].

The species composition, number of small rodents examined and infected with zoonotic helminths are illustrated in Table 1.

Species of rodents	Number			Prevalence %
	investigated	per 100 trap-days	infected with zoonotic helminths	
Hazel dormouse – *Muscardinus avellanarius Linnaeus*, 1758	1	0.025	–	–
Common vole – *Microtus arvalis* Pallas,1778	172	4.3	2	1.2
Root vole – *M. oeconomus Pallas*, 1776	62	1.55	1	1.6
Red-backed vole – *Myodes glareolus* (Schreber, 1780)	93	2.325	11	11.8
Striped field mouse – *Apodemus agrarius Pallas*, 1771	90	2.25	11	12.2
Yellow-necked mouse – *A. flavicollis Melchior*, 1884	79	1.975	11	13.9
Wood mouse – *A. sylvaticus Linnaeus*, 1758	11	0.275	1	9.1
House mouse – *Mus musculus Linnaeus*, 1758	2	0.05	–	–
Total:	510	12.75	37	7.3

Table 1: Species composition, number of small rodents examined and infected with zoonotic helminths on the drainage channel banks of model reclamation systems in Brest Polesie (2015–2019).

Results and Discussion

Eight species of small rodents were caught on the drainage channel banks of model reclamation systems in Brest Polesie during 2015–2019, and only in 6 species were found zoonotic helminths (Table 1). Of the 13 rodent species caught on the drainage channel banks in the 1st and 2nd research periods [3,4], only 8 were found in the 3rd period. The field vole, the water vole, the harvest mouse, the brown rat, and the northern birch mouse were absent from the 2015–2019 collections. These rodent species periodically appear and disappear on the drainage channel banks. The harvest mouse will probably disappear there due to the constant mowing of the banks and slopes of the channels. The hazel dormouse also accidentally appears on the channel banks, since it leads a predominantly arboreal lifestyle.

The total number of small rodents was 12.75 individuals per 100 trap-days. It increased from 12.31 in the 1st research period [3] to 18.7 in the 2nd research period [4], and then decreased in the 3rd research period. The same trend was observed in relation to infection with zoonotic helminths: 7.3 % (10 zoonotic helminth species) in the 1st research period, 9.9 % (9 zoonotic helminth species) in the 2nd research period, and 7.3 % (9 zoonotic helminth species) in the 3rd research period. This may be due to such abiotic factors as

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temperature and precipitation (cold snowless winters with thaws and hot dry summers), which negatively affected the survival of helminth eggs, intermediate and definitive hosts of zoonotic helminths. Possibly, anthropogenic factors are added to them-periodic mowing of plants on the banks and slopes of channels, which significantly increased in the 3rd research period, as well as my removal of a certain number of rodents for scientific study. This may also be due to natural fluctuations in animal numbers.

In general, common voles are dominant: 4.79, 4.92 and 4.3 individuals per 100 trap-days, respectively, in the research periods. They prefer open spaces and were the background species among small rodents on the channel banks on arable lands (10.3 individuals per 100 trap-days) and pastures (5.3 individuals per 100 trap-days) in the 3rd research period, but near roads they gave the dominant position to the striped field mouse (4.2 individuals per 100 trap-days, while the common vole had 1.6 individuals per 100 trap-days).

Summarizing the three research periods, it can be stated that on the channel banks in mixed forests, the background species among small rodents are red-backed voles and yellow-necked mice, on arable lands – common voles and striped field mice, on pastures – common voles (here in the 3rd period the number of root voles increased to 2.9 individuals per 100 trap-days), near roads – common voles and striped field mice (the former dominated in the first two research periods, and the latter increased their numbers in the 3rd period; here in the 3rd period the number of root voles also increased to 1.8 individuals per 100 trap-days).

Helminth zoonotic species	Host	Prevalence %	No. helminths (min-max; total; mean)
Trematoda			
Diplostomidae			
Alaria alata (Goeze, 1782), larvae	Red-backed vole	3.2	1-4; 7; 2.33
Echinostomatidae			
Echinostoma revolutum (Frölich, 1802)	Striped field mouse	1.1	1; 1; 1.0
Plagiorchiidae			
Plagiorchis. elegans (Rudolphi, 1802)	Striped field mouse	1.1	1; 1; 1.0
	Yellow-necked mouse	1.3	9; 9; 9.0
Cestoda			
Hymenolepididae			
Hymenolepis diminuta (Rudolphi, 1819)	Red-backed vole	7.5	1-2; 9; 1.29
	Striped field mouse	5.6	1-8; 15; 3.0
	Yellow-necked mouse	3.8	1-6; 9; 3.0
	Wood mouse	9.1	3; 3; 3.0
Rodentolepis fraterna (Stiles, 1906)	Striped field mouse	2.2	2-4; 6; 3.0
Mesocestoididae			
Mesocestoides lineatus (Goeze, 1782), larvae	Striped field mouse	1.1	98; 98; 98.0
	Yellow-necked mouse	1.3	112; 112; 112.0
Taeniidae			
Taenia martis (Zeder, 1803), larvae	Red-backed vole	1.1	3; 3; 3.0
T. taeniaeformis (Batsch, 1786), larvae	Common vole	1.2	1-1; 2; 1.0
	Root vole	1.6	1; 1; 1.0
	Yellow-necked mouse	7.6	1-2; 7; 1.17
Acanthocephala			
Moniliformidae			
Moniliformis moniliformis (Bremser, 1811)	Striped field mouse	1.1	1; 1; 1.0
Total:	6 host species	7.3	1-112; 284; 7.7

Table 2: Infection with zoonotic helminths of small rodents living on the drainage channel banks of model reclamation systems in Brest Polesie (2015-2019).

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Nine zoonotic helminth species were found in small rodents in 3rd research period (Table 2). A total of 284 parasites were collected in small rodents with the average intensity of infection being 7.7. All adult helminths (5 species) were located in the intestine and larval forms (4 species) in various tissues and organs. So, larvae of trematode *Alaria alata* (Goeze, 1782) were in the lungs, fat deposits on the neck, back and liver, larvae of cestode *Taenia taeniaeformis* (Batsch, 1786) in the liver, larvae of cestode *Taenia martis* (Zeder, 1803) in the pectoral and abdominal cavities, larvae of cestode *Mesocestoides lineatus* (Goeze, 1782) in the abdominal cavity. Most helminths infected one host and only cestode *Hymenolepis diminuta* (Rudolphi, 1819) four, larvae of cestode *T. taeniaeformis* three and trematode *Plagiorchis elegans* (Rudolphi, 1802) two. Small rodents were most often infected with cestode *H. diminuta*. The obligatory definitive hosts of larval stages of helminths are canids (for trematode *A. alata*, cestodes *M. lineatus* and *T. taeniaeformis*), mustelids (for cestode *T. martis*). Birds are also obligatory hosts for trematodes *Echinostoma revolutum* (Frölich, 1802) and *P. elegans*. Obligatory definitive hosts for other helminth species are rodents.

To these zoonotic helminth species should be added six more (3 species of cestodes, 3 species of nematodes) found in small rodents in the first two research periods [3,4]. These are the cestode *Rodentolepis straminea* (Goeze, 1782) (host: striped field mouse), the larvae of the cestodes *Echinococcus multilocularis* Leuckart, 1863 (hosts: common vole and red-backed vole) and *Taenia crassiceps* (Zeder, 1800) (hosts: common vole and striped field mouse), the nematodes *Calodium hepaticum* (Bancroft, 1893) (host: red-backed vole) and *Syphacia obvelata* (Rudolphi, 1802) (host: house mouse), and the larvae of the nematode *Baylisascaris devosi* (Sprent, 1952) (hosts: red-backed vole and yellow-necked mouse).

A total of 15 zoonotic helminth species (3 species of trematodes, 8 species of cestodes, 3 species of nematodes and 1 species of acanthocephalans) were identified during all research periods in 9 species of small rodents living on the drainage channel banks of model reclamation systems in Brest Polesie. All these zoonotic helminth species are capable parasitize humans and pose a health care problem for many countries the world. Cestodes *H. diminuta* and *E. multilocularis* are of the greatest importance for the health service of Belarus and especially for residents of Brest Polesie, as they are detected by medical workers in the population of this country [6,7].

Five zoonotic helminth species are characterized by consistency in the infection of small rodents and were noted in all research periods: the trematode *P. elegans*, larvae of trematode *A. alata*, the cestode *H. diminuta*, and larvae of cestodes *M. lineatus* and *T. taeniaeformis*.

As a result of the monitoring study in the 3rd period, a new zoonotic helminth species for Belarus was discovered – the acanthocephalan *Moniliformis moniliformis* (Bremser, 1811) (host: striped field mouse) [8] and a new host for the trematode *E. revolutum* in Belarus was established – the striped field mouse [9]. Both species of helminths were localized a single specimen in the intestines of adult males.

The number of zoonotic helminths species was greater, and the percentage of infection was higher in the striped field mouse (10 and 15.3, respectively) for all research periods. For other rodents, the number of which on the drainage channel banks is quite high, these indicators were as follows: common vole – 7 and 2.9; red-backed vole – 7 and 5.1; yellow-necked mouse – 6 and 8.3. It is the striped field mouse among small rodents that can be used as one of the main indicators for assessing the unfavorable of reclaimed areas in terms of zoonotic helminths.

The centers of alariosis (1 causative agent), echinostomosis (1 causative agent), plagiorchiosis (1 causative agent), hymenolepiosis (1 causative agent), rodentolepiosis (2 causative agents), mesocestoidosis (1 causative agent), echinococcosis (1 causative agent), taeniosis (3 causative agents), baylisascariosis (1 causative agent), calodiosis (1 causative agent), syphaciosis (1 causative agent) and moniliformiosis (1 causative agent) can function on the drainage channel banks on reclaimed areas and pose a danger to humans. Small rodents (mainly voles and mice) help maintain them.

Conclusion

Nine zoonotic helminth species parasitize 6 species of small rodents caught on the drainage channel banks of reclamation systems in Brest Polesie during 3rd research period (2015–2019). Striped field mouse established as new host in Belarus for trematode *E. revolutum* and acanthocephalan *M. moniliformis* (this helminth is a new species in the fauna of Belarus).

A total 15 zoonotic helminth species were found for all research periods in 9 species of small rodents living on the drainage channel banks. All of them have medical significance and pose a danger to human health.

An interesting trend was revealed across the research periods: the number of small rodents and infection with zoonotic helminths first increases and then decreases to initial values (12.31, 18.7 and 12.75 individuals per 100 trap-days, and 7.3 %, 9.9 % and 7.3 %, respectively for research periods). It can be concluded that the increase in the number

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of small rodents leads to an increase in their infection with zoonotic helminths. Whether this regularity will persist may be shown by the 4th research period, which will be possible with financial support for the investigations. So far, scientific work has been carried out free of charge on the personal initiative of the author.

It should be taken into account that on the drainage channel banks in reclaimed areas, small rodents (mainly mice and voles) can cause the formation of helminth zoonoses centers, worsen the epidemiological situation in the region where they are located.

No one in the world except me has conducted such research on reclaimed areas.

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Conflict of Interest

The author states that there is no conflict of interest.

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