PARASITE FAUNA OF *Myodes glareolus* FROM THE NATURAL RESERVE "PLAIUL FAGULUI" OF THE REPUBLIC OF MOLDOVA

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Abstract. *Myodes glareolus* is a forest species that can be met in woods, forest glades, in shrubs at the forest edge, in wet biotopes with tree and shrub vegetation. Parasitological investigations of the species revealed a prevalence of *Plaghiorchis elegans* with13.8%, of *Mesocestoides lineatus larvae* – 14.0%, of *Paranoplocephala omphaloides* – 10.3%, of *Rodentolepis straminea* – 69.0%, of *Hydatigera taeniaformis* – 10.3%, of *Catenotaenia cricetorum* – 10.3%, of *Skrjabinotaenia lobata* – 10.3%, of *Taenia pisiphormis* – 13.7%, of *Calodium hepaticum* – 27.5%, of *Syphacia stroma* – 17.2%, of *Syphacia obvelata* – 24.1%, of *Heligmosomoides polygirus* – 10.0%, of *Strongyloides ratti* – 6.9%, of *Mastophorus muris* – 17.2% and of *Trichocephalus muris* with 17.2%. Taxonomically the parasite fauna is constituted from representatives of 4 classes, 12 families, 14 genera and 15 species. The diversity structure is formed by one parasite species from the class Trematoda (*Plaghiorchis elegans*), by 7 species from the class Cestoda (*Skrjabinotaenia lobata, Catenotaenia cricetorum*, *Paranoplocephala omphaloides*, *Rodentolepis straminea*, *Hydatigera taeniaeformis*, *Taenia pisiformis*, *Mesocestoides lineatus*), 5 species from the class Secernentea (*Syphacia stroma*, *Syphacia obvelata*, *Heligmosomoides polygirus*, *Mastophorus muris*, *Strongyloides ratti*) and 2 species from the class Adenophorea (*Trichuris muris*, *Calodium hepaticum*).

Keywords: parasites, *Myodes glareolus*, prevalence, rodents.

Rezumat. Fauna parazită de *Myodes glareolus* din Rezervaţia Naturală „Plaiul Fagului" din Republica Moldova. *Myodes glareolus* fiind o specie silvicolă se întâlneşte în păduri luminoase (poiene), în sectoare cu subarboret şi la lizieră, pe terenuri umede de la marginea bălţilor, poate fi întâlnit în depozite şi locuinţele oamenilor. Investigarea parazitologică a speciei respective pune în evidenţă o prevalenţă cu *Plaghiorchis elegans* de 13,8%, respectiv cu *Mesocestoides lineatus larvae* - 14,0%, *Paranoplocephala omphaloides* – 10,3%, *Rodentolipis straminea* – 69,0%, *Hydatigera taenieaformis* – 10,3%, *Catenotaenia cricetorum* – 10,3%, *Skrjabinotaenia lobata* – 10 ,3%, *Taenia pisiformis* – 13,7%, *Calodium hepaticum* – 27,5%, *Syphacia stroma* – 17,2%, *Syphacia obvelata* – 24,1%, *Heligmosomoides polygirus* – 10,0%, *Strongyloides ratti* – 6,9%, *Mastophorus muris* – 17,2%, iar cu *Trichocephalus muris* prevalenţa este 17,2%. Taxonomic parazitofauna este constituită din 4 clase, 12 familii, 14 genuri şi 15 specii. Astfel, structura diversităţii este constituită dintr-o specie parazitară din clasa Trematoda (*Plaghiorchis elegans*), din 7 specii din clasa Cestoda (*Skrjabinotaenia lobata, Catenotaenia cricetorum*, *Paranoplocephala omphaloides*, *Rodentolepis straminea*, *Hydatigera taenieaformis*, *Taenia pisiformis*, *Mesocestoides lineatus*) şi 5 specii din clasa Secernentea (*Syphacia stroma*, *Syphacia obvelata*, *Heligmosomoides polygirus*, *Mastophorus muris*, *Strongyloides ratti*), 2 specii din clasa Adenophorea (*Trichuris muris*, *Calodium hepaticum*).

Cuvinte cheie: paraziţi, *Myodes glareolus*, prevalenţă, rozătoare.

INTRODUCTION

Parasitism in natural ecosystems is considered an ecological phenomenon, also representing a form of interspecific relation. Due to the diversity of ecological connections, parasites are an important factor for the numerical regulation of host populations and, respectively, for its functioning (BEKLEMISHEV, 1970; KONTRIMAVICHYUS, 1982).

Anthropisation becomes an omnipresent phenomenon where the anthropic factor has a considerable influence on the processes in nature. The action of an anthropogenic factor on parasites as essential components of biota can lead to changes in biodiversity and ecological status. In such conditions some helminth species may have epidemiological and epizootic significance. This makes necessary the monitoring of the biodiversity and ecology of helminth associations in concrete areas (ROMASHOVA, 2003).

Many small rodent species are considered pest animals because they cause damage to agricultural production, are involved in the transmission of various pathogen agents (viruses, bacteria, parasites) both in humans and domestic and wild animals (SINGH et al., 1995; DURDEN et al., 2000; STOJCEVIC et al., 2004; MALSAWMTLUANGI et al., 2009). Helminths from genera *Trichinella*, *Angiostrongylus*, *Capillaria*, *Hymenolepis*, *Raillentina*, *Echinococcus*, *Schistosoma*, *Paragonimus* and *Echinostoma*occuring in small rodents have zoonotic impact upon human health, while *Capillaria hepatica* and *Angyostrongylus cantonensis* cause severe syndromes in humans, as well as wild and domestic animals (CHECHULIN et al., 2011; FUEHRER et al., 2011).

The parasites of wild rodents have been studied for a long period in various European countries, such as Poland (KISELEWSKA, 1970; KISELEWSKA at al., 1973), Czech Republic (TENORA, 1967; TENORA & STANEK, 1995), Finland (HAUKISLAMI, 1986; HAUKISLAMI & HENTONEN, 1993), Great Britain (ELTON, 1931; LEWIS, 1968; MONTGOMERY & MONTGOMERY, 1988, 1989, 1990), Latvia (KONTRIMAVICHYUS, 1964, 1982), Russia (SHALDYBIN, 1963, 1969, 1972, 1983; RYJIKOV et al., 1978, 1979; SHAHMATOVA, 1989; ROMASHOVA, 2003), Ukraine (SHARPILO, 1973, 1975, 1976; VYSOTSKAYA, 1997), Belarus (ARZAMASOV, 1983; CHIKILEVSKAYA, 1986, 1987, 1990), Moldova (ANDREYKO, 1960, 1961, 1973, 1984), Romania

(CHIRIAC & BARBU, 1962, 1963; CHIRIAC & HAMAR, 1966; POPESCU & BARBU, 1971; POPESCU et al., 1974) and Hungary (MESZAROS F, 1980; MURAI, 1987; KRISKA, 1993).These studies describe the influence of different ecological factors (host species, density, age, sex, range, season etc.) and elucidate the temporality, location, abundance as well as diversity of parasite communities in wild rodents from different regions.

Infestation in humans can occur through direct contact with rodent excretions or consumption of food contaminated by fallen fur, feet, urine or faeces, and indirectly by bites of the ectoparasite vectors such as fleas and ticks (SINGLA et al., 2008). In carnivorous mammals such as foxes (ESKERT & DEPLAZES, 2004), dogs (DESPOMIER, 2003; DEPLAZES et al., 2005), cats (HILL & DUBEY 2002; KAPEL et al., 2006) infestation occurs during the direct consumption of infected rodents.

The extensive description of parasite fauna in small rodents in the Republic of Moldova was firstly performed by Andreico O. in 1958-1984. Thus, Trematoda species have a share of 2.14%, Cestoda - 17.54%, Nematoda - 61.7% and Acanthocephala - 0.58%. The class Trematoda includes 3 species, Cestoda - 16 species, and Nematoda - 18 species of parasites. In the helminth fauna of the investigated rodents, parasites specific to man and domestic animals were found: *Echinococcus granulosus*, *Mesocestoides sp*., *Hymenolepis diminută*, *Strobilocercus fasciolaris*, *Tricihinela spiralis*, *Hepaticola hepatica*, *Syphacia stroma* and *Syphacia obvelata* (ANDREIKO, 1960, 1961, 1973, 1984).

Thus, from the above mentioned, the monitoring of parasite fauna in small rodents in different areas holds a bio-ecological, medical and veterinary importance in the prevention of the transmission of pathogens to humans and other animals involved in biological cycles of zoonotic and epizootic pests.

The bank vole (*Myodes glareolus*) is one of the dominant rodent species among small mammal fauna of the republic, especially in forest ecosystems. *M. glareolus* is a forest species that can be met in woods, forest glades, in shrubs from the forest edge, in wet biotopes with tree and bush vegetation, as well as different ecotone zones between forest and adjacent habitats. In previous studies from the "Plaiul Fagului" reserve, the bank vole is mentioned as common and wide spread species with constant and eu-constant ecological significance for all reserve ecosystems (MUNTEANU et al., 2004; NISTREANU et al., 2015).The aim of this research was the study of parasite fauna in the bank vole from the Natural Reserve "Plaiul Fagului".

MATERIAL AND METHODS

The reserve is located in the Ungheni district, at a distance of 70 km to the north-west of Chisinau, with coordinates N 47°18' and E 28°02'. The landscape is fragmented, with steep slopes and deep valleys, representing almost a mountain landscape. The capture of small rodents was carried out at the ecotone zone of forest and paludous ecosystem. The tree and bush vegetation is rather abundant and rich, represented by oak, hornbeam, ash, burning bush, hazelnut, horn. Grassy vegetation is abundant and dense, represented by hygrophilous and meadow species. The given ecosystem is a recreational area for visitors, and direct or indirect contact with rodents is particularly high, thus increasing the risk of wildlife parasites spreading to humans. 100 live traps were placed at a distance of 5 m from each other, which is recommended for biotopes with well-developed bush vegetation and abundant herbaceous vegetation (PELIKAN et al., 1975).

The parasitological studies were carried out within the laboratory of Parasitology and Helmintology of the Institute of Zoology of the ASM. The individuals of *M. glareolus* collected for parasitological investigations were euthanized with chloroformi pro narcosi solution that inhibits conductibility at the level of heart centers, causing instant death without suffering. Laboratory investigations were performed by total rodent dissection and microscopic examination of the muscles (masseter, arms and diaphragm muscles), of thoracic organs (trachea, lungs, heart) and of abdominal organs (aesophagus, stomach, intestine, colon, liver, spleen, kidney, urinary bladder) to establish parasitological indices. The identification of parasite species was carried out after (RYJIKOV, 1978, 1979]. Degree of infestation with *Calodium hepaticum*, was estimated by volumetric established of affected portion liver (+ is 25.0%, ++ – 50.0%, +++ – 75.0%, ++++ – 100%). For the parasitological assessment the prevalence (%), the intensity (specimens per animal) and the abundance (specimens per lot) of the parasitic species in the rodents were determined. The results obtained were statistically processed in the Excel software.

RESULTS AND DISCUSSIONS

In total 8 rodent species were caught (*Apodemus sylvaticus, A. falvicollis, A. agrarius, A. uralensis, Mus musculus, Microtus rissiaemeridionalis, Myodes glareolus* and *Pitymys subterraneus*). At the ecotone between forest and pond 29 individuals of *M. glareolus* were collected. The trappability coefficient of rodents varied between 10.7% and 34.6%, that of the bank vole was 2.7% to 29.3%. The bank vole was the second species after its abundance (18.4%-39.8%) among all the species and was registered in most of the studied biotopes of the reserve. The species frequency constituted 100% in woods, tree plantations, ecotone zone of forest and 88% in forest belt, in paludous biotopes with shrub vegetation. The ecological significance of the bank vole was constant at ecotone zone, in paludous biotopes with shrub vegetation (H'=7.48%) and characteristic in forest biotopes (12.87%). At forest-pond ecotone the ecological significance of the species was characteristic (11.73%).

Thus, the bank vole is a typical forest species, common in deciduous forests, widely spread in wood habitats, at forest edge and in various ecotone zones of the woods. The species was mentioned as one of the dominant in various forest ecosuystems all over the republic territory (SAVIN et al., 2011; NISTREANU et al., 2015).

The parasitological studies included the investigation of 29 individuals of *M. glareolus* collected from the Reserve „Plaiul Fagului" at the ecotone between forest and pond.

The taxonomic structure (Table 1) of parasite fauna in collected *M. glareolus* is formed by 4 classes, 12 families, 14 generaand 15 species. The diversity structure consists of one parasite species from the Trematoda class (*Plaghiorchis elegans*), 7 species from the Cestoda class (*Skrjabinotaenia lobata, Catenoteania cricetorum, Paranoplocephala omphaloides, Rodentolepis straminea, Hydatigera taeniaeformis, Taenia pisiformis, Mesocestoides lineatus*), 5 species from the Secernentea class (*Syphacia stroma, Syphacia obvelata, Heligmosomoides polygyrus, Mastophorus muris, Strongyloides ratti*) and 2 species from the Adenophorea class (*Trichuris muris, Calodium hepaticum*). It must be mentioned that among parasite species, 2 have a zoonotic impact (*Syphacia stroma, Syphacia obvelata*).

Table 1. Taxonomic structure of parasite fauna in *M. glareolus.*

Class	Family	Species	Total
Trematoda	*Plagiorchidae*	*Plagiorchis elegans* (Rudolphi, 1802)	**1 species**
Cestoda	*Catenotaeniidae*	*Skrjabinotaenia lobata* (Baer, 1925)	**7 species**
		Catenotaenia cricetorum (Kirshenblat,1949)	
	Anoplocephalidae	*Paranoplocephala omphaloides* (Herman, 1783)	
	Hymenolepididae	*Rodentolepis straminea* (Goeze, 1782)	
	Taeniidae	*Hydatigera taeniaeformis* (Batsch, 1786)	
		Taenia pisiformis (Bloch, 1780)	
	Mesocestoididae	*Mesocestoides lineatus* (Goeze, 1782)	
Secernentea	*Oxyuridae*	*Syphacia obvelata* (Rudolphi, 1802)	**5 species**
		Syphacia stroma (Linstow, 1884)	
	Heligmosomidae	*Heligmosomoides polygirus* (Dujardin, 1845)	
	Spirocercidae	*Mastophorus muris* (Gmelin, 1790)	
	Strongyloididae	*Strongyloides ratti* (Sandground, 1925)	
Adenophorea	*Trichuridae*	*Trichuris muris* (Scrank, 1788)	**2 species**
	Capilariidae	*Calodium hepaticum* (Bancroft, 1893)	

The diversity structure highlighted prevalence with *Plaghiorchis elegans* of 13.8%, intensity of 3.8 specimens and abundance of 0.51 sp., with *Mesocestoides lineatus larvae* – 14.0%, 1.5 sp., 0.2 sp., *Paranoplocephala omphaloides* – 10.3%, 2.7 sp., 0.28 sp., *Rodentolepis straminea* – 69.0%, 3 sp., 0.2 sp., *Hydatigera taeniaeformis* – 10.3%, 1 sp., 0.1 sp., *Catenotaenia cricetorum* – 10.3%, 2.7 sp., 0.28 sp., *Skrjabinotaenia lobata* – 10.3%, 3 sp., 0.31 sp., *Taenia pisiphormis* – 13.7%, 1.0 sp., 0.14 sp., *Calodium hepaticum* – 27.5%, and intensity was average (+++), *Syphacia stroma* – 17.2%, 94 ex, 22.8 ex, *Syphacia obvelata* – 24.1%, 84.9 sp., 23.4 sp., *Heligmosomoides polygirus* – 10.0%, 5.3 sp., 0.72 sp., *Strongyloides ratti* – 6.9%, 23.3 sp., 2.4 sp., *Mastophorus muris* – 17.2%, 3.6 sp., 0.62 sp. And with *Trichuris muris* the prevalence is of 17.2%, intensity of 3.8 sp. and abundance of 0.65 sp. (Table 2).

Table 2. Structure of parasite fauna diversity in *M. glareolus.*

Class	Species	Prevalence %	Intensity sp.	Abundance sp.
Trematoda	*Plagiorchis elegans*	13,8	3,8	0,51
Cestoda	*Skrjabinotaenia lobata*	10,3	3,0	0,31
	Catenotaenia cricetorum	10,3	2,7	0,28
	Paranoplocephala omphaloides	10,3	1,0	0,1
	Rodentolepis straminea	69,0	3,0	0,2
	Hydatigera taenieaformis	10,3	1,0	0,1
	Taenia pisiformis	13,7	1,0	0,1
	Mesocestoides lineatus	14,0	1,5	0,2
Secernentea	*Syphacia obvelata*	24,1	84,9	23,4
	Syphacia stroma	17,2	94,0	22,8
	Heligmosomoides polygirus	10,0	5,3	0,72
	Mastophorus muris	17,2	3,6	0,6
	Strongyloides ratti	6,9	23,3	2,4
Adenophorea	*Trichuris muris*	17,2	3,8	0,6
	Calodium hepaticum	27,5	+++	-

The most abundant were the species *Syphacia stroma* with an intensity of 94 sp./host and *Syphacia obvelata* with an intensity of 84.9 sp./host.

The increase of the invasive indices of all rodent species of investigated hosts is due to the fact that some Nematoda species are geohelminths (*Heligmosomoides polygirus*, *Trichocephalus muris, Calodium hepaticum*), which do not require intermediate hosts, the larvae of which are resistant, live freely and feed in the environment with successive development (*Syphacia stroma, Syphacia obvelata*), whose females lay fertilized eggs in the perianal region of the host, and infestation occurs by self-invasion or individual contact between the hosts thus omitting the

development in the environment or their eggs are transmitted by predators (*Vulpes vulpes*) that consume the infested hosts. Biohelminths (*Mesocestoides lineatus, Hydatigera taenieaformis*) have the fox as final host, which at their turn represent the main way of spread of invasive forms in the environment. The individual activity area of a fox is about 500 ha and in the Republic of Moldova the fox density exceeds 10 individuals per 1000 ha. The massive abundance of foxes on large areas, including thigh ecological plasticity with a synanthropic tendency, are the primary factors in the formation, maintenance and spread of parasitosis outbreaks with zoonotic and epizootic impact in different natural and anthropogenic ecosystems.

The results of the studies performed in the Republic of Moldova at the beginning of 60's of the past century are different from our data, where the infestation level with the Cestoda species varies depending on the host. Thus, the prevalence of the species *Paranoplocephala omphaloides* in *Microtus arvalis* was of 0.76%, *Catenotaenia cricetorum* in *M. arvalis* – 1.51%, in *Clethrionomys glareolus* – 22.32% and of *Skrjabinotaenia lobata* in *Apodemus flavicollis* constituted 4.37%, in *A. sylvaticus* – 2.67%. Some Nematoda species suc as *Heligmosomoides polygirus* in *A. flavicollis* constituted 0.95%, in *A. sylvaticus* – 1.06%, *Trichocephalus muris* in *A. sylvaticus* – 1.62% and in *Mus musculus* – 2.5%. Te most abundant species were *Syphacia obvelata* in *A. flavicollis* with intensity of 21.9% and *Syphacia stroma* – 10.47% (ANDREIKO, 1973). In Russia the helminth fauna in *A. flavicollis*is constituted by *Syphacia stroma* with a prevalence of 76.2%, *Heligmosomoides polygirus* – 29.3% *Syphacia obvelata* – 15.7% and *Trichocephalus muris*with 0.82% (ROMASHOVA, 2003). Some parasite species ave been reported from Lituania, as follows: *Trichocephalus muris* wit a prevalence of 33.3% in *C. glareolus*, 16.7% in *Microtus agrestis*; *Syphacia* sp. – 33.3% in *M. agrestis* (MAZEIKA et al., 2003). In Hungary the results of parasitological investigations in *Mus musculus* revealed the prevalence of some parasitic species: *Trichocephalus muris* of 8.5%, *Heligmosomoides polygirus* – 10.8%, *Syphacia obvelata* – 5.4% and *Syphacia stroma* – 0.2% (KRISKA, 1993).

Compared with previous years, the obtained results show a significant increase in invasive indices. This is probably due to large areas of fallow ground with favourable conditions for the development of small rodents. These factors would add to the considerable increase in the number of foxes (by 10 times), in which diet the rodents dominate (70%), and as a result they spread the parasitic forms, polluting different areas.

Similar parasitological studies were performed in Romania, where in 13 species of small mammals (*Crocidura leucodon*, *C. suaveolens*, *Sorex araneus*, *S. minutus*, *Neomys anomalus*, *Apodemus agrarius*, *A. flavicollis*, *A. sylvaticus*, *A. uralensis*, *Microtus agrestis, M. arvalis*, *M. subterraneus*, *Clethrionomys glareolus*) 29 parasite species were registered, among which: 3 species (10.3%) of Digenea, 14 species (48.3%) of Cestoda, one species (3.5%) of *Acanthocephala* and 11 species (38.0%) of Nematoda (GUBANYI et al., 2015). In Russia the parasite fauna in *A. flavicollis* is constituted: 16 species (18.8%) of Trematoda, 4 species (25.0%) of Cestoda, 8 species (50,0%) of Nematoda and one species (6.25%) of Acanthocephala (ROMASHOVA, 2003).

Some authors from Russia (ROMASHOVA, 2003) report a more diverse helminth fauna that is spread among more habitats in the host *A. flavicollis*. The longsome was (era scris gresit, Trebuie sa fie "In lung some species were found" found (*Syngamus* sp.) in the thoracic cavity – 2 species (*Alaria alata*, *Macrocanthorynchus catulinus*), in the liver – 4 species (*Taenia hydatigena larvae*, *Hydatigera taenieaformis larvae*, *Skrjabinoplagiorchis vigisi*, *Capilaria hepatica*), in the small intestine – 5 species (*Syphacia stroma*, *Heligmosomoides polygirus*, *Anoplocephaloides dentata*, *Plaghiorchis elegans*), and in the large intestine – 3 species (*Syphacia obvelata*, *Ganguloterakis spumosa*, *Trichocephalus muris*).

The obtained data elucidates the potential of the parasitic pollution risk of the interfering area between natural and anthropized ecosystems and as a result the transmission of invasive forms from wild animals to domestic animals, including to humans. At the same time, the rodents as component of the trophic chain of larger predators, and at their turn they as vectors of invasive forms in the environment, ensure the functional stability of the host-parasitic systems within the investigated biocenoses.

The investigations were carried out within the framework of the fundamental projects 15.817.02.12F financed by the Supreme Council for Science and Technological Development of the Academy of Sciences of Moldova.

CONCLUSIONS

1. The taxonomic structure of parasite fauna is constituted of 4 classes, 12 families, 14 genera and 15 species, of which 6.6% belong to the Trematoda class, 46.7% belong to the Cestoda class, and 46.7% belong to the Nematoda class. La fel: class Trematoda etc.
2. The rodents *M. glareolus* have the role of formation and maintenance of parasitic diseases foci, because they have individual activity sectors of several square meters.

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Received: March 28, 2018
Accepted: May 12, 2018