ASSESSMENT OF PARASITE FAUNA IN FIELD VOLE (*Microtus arvalis*, Pallas, 1778) FROM DIFFERENT BIOTOPES OF THE REPUBLIC OF MOLDOVA

CHIHAI Oleg

Abstract. The aim of this paper is to study the diversity of parasite fauna in *Microtus arvalis* from various biocenoses, depending on the species and age of the host. The results of parasitological investigations showed a prevalence of *Paranoplocephala omphaloides* of 16.1%, respectively of *Rodentolipis straminea* - 19.3%, *Catenotaenia cricetorum* - 6.5%, *Skrjabinotaenia lobata* - 22.5%, *Mesocestoides lineatus* larvae 12.9 %, *Hydatigera taeniaeformis* larvae - 12.9%, *Capillaria hepatica* - 22.6%, *Syphacia stroma* - 16.1%, *Syphacia obvelata* - 38.7%, *Heligmosomoides polygirus* - 19.4%, *Strongyloides ratti* - 12.9%, *Mastophorus muris* - 29.0% and invasion with *Trichocephalus muris* has a prevalence of 22.5%. The taxonomic structure consists of 3 classes, 11 families, 12 genera and 13 species, of which 6 parasitic species belong to the Cestoda class, with a share of 46.2% of the total species, 5 species - to the Secernentea class with a share of 38,4%, and 2 species - to the Adenophorea class, constituting 15.4% of the total identified species. The development characteristic is represented by 6 species that develop according to the monoxen model (*S. stroma*, *S. obvelata*, *C. hepatica*, *T. muris*, *H. polygirus*, *S. ratti*), 7 species with polygenic evolution, including 6 species with development after the dixen model with the presence of exogenous forms (*H. taeniaeformis larvae, M. muris, S. lobata, C. cricetorum, P. omphaloides, R. straminea*) and one species evolving according to the trixen model (*M. lineatus larvae*).

Keywords: parasite fauna, *Microtus arvalis*, biotopes, Republic of Moldova.

Rezumat. **Evaluarea parazitofaunei șoarecelui de câmp (*Microtus arvalis* Pallas, 1778) din diverse biotopuri ale Republicii Moldova.** Scopul acestei lucrări constă în studiul diversității parazitofaunei la *Microtus arvalis* din diverse biocenoze, în funcție de vârstă și specia gazdei. Rezultatele investigațiilor parazitologice au pus în evidență o prevalență cu *Paranoplocephala omphaloides* de 16,1%, respectiv cu *Rodentolipis straminea* – 19,3%, *Catenotaenia cricetorum* – 6,5%, *Skrjabinotaenia lobata* – 22,5%, *Mesocestoides lineatus larvae* 12,9%, *Hydatigera taeniaeformis larvae* – 12,9%, *Capillaria hepatica* – 22,6%, *Syphacia stroma* – 16,1%, *Syphacia obvelata* – 38,7%, *Heligmosomoides polygirus* – 19,4%, *Strongyloides ratti* – 12,9%, *Mastophorus muris* – 29,0%, invazia cu *Trichocephalus muris* are o prevalență de 22,5%. Structura taxonomică este încadrată în 3 clase, 11 familii, 12 genuri şi 13 specii, dintre care 6 specii parazitare aparţin clasei Cestoda, cu o pondere de 46,2% din totalul de specii, 5 specii – clasei Secernentea cu o pondere de 38,4%, iar 2 specii – clasei Adenophorea constituind 15,4% din totalul de specii identificate. Caracteristica evolutivă este reprezentată de 6 specii care se dezvoltă după modelul monoxen (*S. stroma*, *S. obvelata*, *C. hepatica*, *T. muris*, *H. polygirus*, *S. ratti*), 7 specii cu evoluție polixenă, inclusiv 6 specii cu dezvoltare după modelul dixen cu prezența formelor exogene (*H. taeniaeformis* larvae, *M. muris*, *S. lobata*, *C. cricetorum*, *P. omphaloides*, *R. straminea*) și o specie cu evoluție după modelul trixen (*M. lineatus* larvae).

Cuvinte cheie: parazitofaună, *Microtus arvalis*, biotopuri, Republica Moldova.

INTRODUCTION

The study of biological diversity at different levels of biota organization is the primary goal of modern ecology, which aims at the conservation and sustainable use of natural biosystems in the dynamic conditions of anthropogenic pressure. The parasites play a key role in the numerical regulation of host populations, in maintaining the structure of vertebrate communities, including their biodiversity, and prevent the penetration of external biotic elements (BEHNKE, 2008). The diversity of parasite species, their life cycles and parasitic connections, are the characteristics that contribute to the formation of highly flexible and receptive mechanisms. The stability of parasitic biosystems certainly makes them such mechanism for ecosystem stabilizing (BECLEMISHEV, 1970; KONTRIMAVICHIUS, 1982; LEBEDEVA et al., 2002).

In natural and anthropized ecosystems the small rodents are biotic and sometimes even essential components. Through various ecological connections, helminths together with specific hosts form parasitic systems with increased bioecological stability and represent appropriate models for studying the diversity and variability of parasite-host biosystems (HAUKISALMI et al., 1999; KRIVOPALOV, 2011).

Rodents are important links in the food chain of predators. Therefore, the rodents are involved in the zoonotic chain as vectors (biological, mechanical) of various pathogens (viruses, bacteria, parasites) in humans, domestic and wild animals, which is why these animals are considered dangerous (SINGH et al., 1995; DURDEN et al., 2000; STOJCEVIC et al., 2004; MALSAWMTLUANGI et al., 2009).

Parasitic zoonoses are widespread in large number of wild and domestic animals, including human populations and children are the most affected. The danger results from the fact that some parasitozoons are contracted in childhood, but with late clinical manifestation, misdiagnosis and serious consequences after several years. Currently, more than 250 infections and invasions are known, and one of the characteristics of natural outbreaks of zoonoses is that the causative agents of these diseases are constantly circulating in wildlife populations (DIDĂ, 2002).

In this context, many helminth species from genera *Trichinella*, *Angiostrongylus*, *Capillaria*, *Hymenolepis*, *Raillentina*, *Echinococcus*, *Schistosoma*, *Paragonimus* and *Echinostoma* identified in small rodent shave a zoonotic impact on public health, and invasions of *Capillaria hepatica* and *Angyostrongylus cantonensis* cause severe syndromes in humans, domestic and wild animals (CHECHULIN et al., 2011; FUEHRER et al., 2011).

The field vole (*Microtus arvalis* Pallas, 1778) inhabits different biotopes with natural vegetation or agricultural crops (alfalfa, clover, grass, corn, sunflower) from the steppe and forest-steppe areas (MUNTEANU et al., 2004), it can also be found at the limits of big cities, in parks and gardens. After harvesting it finds shelter in stogs (straw, weeds, hay). Demographic explosions with mass reproduction and rapid recovery of the population after its decline are characteristic for the species. It is considered the main natural carrier of the pathogens of tularemia, leptospirosis, salmonellosis and other infectious diseases (PAVLINOVA, 1999).

Parasitological research conducted during the years 1958-1960 on the territory of the Republic of Moldova showed that some parasitic species characteristic of humans and domestic animals have been identified in the helminthofauna of small rodentsso: *Plagiorchis* sp., *Echinococcus multilocularis*, *Mesocestoides* sp., *Hymenolepis diminută*, *Strobilocercus fasciolaris*, *Tricihinela spiralis*, *Hepaticola hepatica*, *Syphacia stroma* and *Syphacia obvelata* (ANDREYKO, 1973).

The above data confirm that the monitoring of parasitofauna in small rodents in different areas has a bioecological importance, which is why the purpose of this paper is to study the diversity of parasitofauna in field vole from various biocenoses.

MATERIALS AND METHODS

Small rodents were collected in the period 2015–2020, from different natural and man-made ecosystems of the Republic of Moldova. The capture of the specimens was carried out by placing 100 live traps at a distance of 5 m from each other. This methodology is recommended for biotopes with a well-developed sub-tree floor and abundant grass cover (PELICAN et al., 1975).

The parasitological researches were carried out in the laboratory of Parasitology and Helminthology of the Institute of Zoology, on 31 individuals of *Microtus avralis* (9 – ♂, 22 – ♀) caught in various agrocenoses of the Republic of Moldova. Laboratory investigations were performed through the total dissection of rodents (previously euthanized) and microscopic examination of the muscular system (masseter muscles, arms, diaphragm) and internal organs (trachea, lungs, heart, tongue, aesophagus, stomach, small intestine, large intestine, liver, spleen, kidneys, bladder) in order to establish the structure of the helminthofauna and to determine the parasitological indices. Species identification was performed after Ryjikov (1978, 1979). The parasitological evaluation was performed by determining the degree of spread (prevalence, %) and the number of parasites / animal (intensity, ind.). The degree of infestation with *Capillaria hepatica* was determined by volumetric estimation of the affected portion of the liver (+ constitute 25,0%, ++ – 50,0%, +++ – 75,0%, ++++ – 100%).

RESULTS AND DISCUSSIONS

The results of parasitological studies (Table 1) performed on *Microtus avralis* show a prevalence with *Paranoplocephala omphaloides* of 16,1% and the mean intensity is of 2 ind., with *Rodentolipis straminea* – 19,3% and 3,5 ex., respectively, *Catenotaenia cricetorum* – 6,5%, 2,5 ind., *Skrjabinotaenia lobata* – 22,5%, 2,43 ind., *Mesocestoides lineatus larvae* 12,9%, 1,0 ex., *Hydatigera taeniaeformis larvae* – 12,9%, 1,5 ex., *Capillaria hepatica* – 22,6%, medium intensity (++), *Syphacia stroma* – 16,1%, 64 ind., *Syphacia obvelata* – 38,7%, 64,4 ind., *Heligmosomoides polygirus* – 19,4%, 5,2 ind., *Strongyloides ratti* – 12,9%, 15,7 ind., *Mastophorus muris* – 29,0%, 3,7 ex., invasion with *Trichocephalus muris* has a prevalence of 22,5% and an intensity of 4,8 ex. Out of the total of 31 specimens of the examined host species, 80.6% (25 ind.) were infested with an average intensity of 33.5 ind./ animal.

The data obtained indicate that the species of the Cestoda class have a prevalence of 54.8% and an intensity of 2.9 ex, respectively those of the Secernentea class - 71.0%, 71.0 ex., and those of the Adenophorea class - 42 .0%, 2.6 ex.

The highest degree of spread was found in *M. muris* and *S. obvelata* (29.0 - 38.7%), the level of frequent spread was identified in *R. straminea*, *T. muris*, *H. polygyrus*, *S. lobata*, *C. hepatica* (19.3 - 22.6%), a relative level of spreading was found in *H. taeniaeformis*, *M. lineatus*, *S. ratti*, *P. omphaloides*, *S. stroma* (12.9 - 16.1%), and a rare spread (6.5%) was registered in the *C. cricetorum* species.

The highest level of invasion intensity was found in *S. stroma* and *S. obvelata* (64.0 - 64.4 ex./animal), the average level - in *S. ratti* (15.7 ex./animal), and the lower level - in *S. lobata*, *C. cricetorum*, *H. taeniaeformis larvae*, *M. lineatus* larvae, *P. omphaloides*, *R. straminea*, *T. muris*, *M. muris*, *H. polygirus* (1,0 - 5,2 ex./ animal).

Previous research conducted on the territory of the Republic of Moldova between the 1960s – 1970s shows that parasitological indices in small rodents were at a much lower level. Therefore, parasitological investigations in *Microtus arvalis* revealed a prevalence with *P. omphaloides* of 0,76%, with *C. cricetorum*– 1,51%, *H. horrida* – 3,03%, *R. straminea* – 0,76%, *T. hydatigena* larvae – 0,76%, *H. taeniaeformis* larvae – 0,76%, *H. hepatica* – 0,76%, *H. costellatum* – 1,51%, *H. polygirus* – 11,57%, *H. skrjabini*–1,51%, *T. colubriformis* – 1,51%, and with *S. obvelata* – 42,42% (ANDREYKO, 1973).

Table 1. Structure of parasite fauna diversity.

Class	Family	Species	Prevalence, %	Intensity, ex
Cestoda	*Catenotaeniidae*	*Skrjabinotaenia lobata* (Baer, 1925)	22,3	2,4
		Catenotaenia cricetorum (Kirshenblatt, 1949)	6,5	2,5
	Taeniidae	*Hydatigera taeniaeformis* (Batsch, 1786)	12,9	1,0
	Mesocestoididae	*Mesocestoides lineatus* (Goeze, 1782)	12,9	1,0
	Anoplocephalidae	*Paranoplocephala omphaloides* (Herman, 1783)	16,1	2,0
	Hymenolepididae	*Rodentolepis straminea* (Goeze, 1782)	19,3	3,5
Secernentea	*Oxyuridae*	*Syphacia obvelata* (Rudolphi, 1802)	38,7	64,4
		Syphacia stroma (Linstow, 1884)	16,1	64,0
	Heligmosomidae	*Heligmosomoides polygyrus* (Dujardin, 1845)	19,4	5,2
	Spirocercidae	*Mastophorus muris* (Gmelin, 1790)	29,0	3,7
	Strongyloididae	*Strongyloides ratti* (Sandground, 1925)	12,9	15,7
Adenophorea	*Trichuridae*	*Trichuris muris* (Scrank, 1788)	22,5	4,8
	Capilariidae	*Capillaria hepatica* (Bancroft, 1893)	22,6	++

This considerable increase in invasive indices between 2015 – 2020, compared to previous years, is probably due to the large areas of ponds with favourable conditions for the development of small rodents (CHIHAI et al., 2020). These conditions emerged in the last two decades following radical changes in the economic sector as a result of land ownership and abandonment, as well as changes in the livestock sector after the reorganization of large units with the relocation of domestic animals to multiple small farms, and as a result crowding of a large number of various species of animals on a limited area of pasture (ERHAN et al., 2001).

The taxonomic structure is classified into 3 classes, 11 families, 12 genera and 13 species, of which 6 parasite species belong to the Cestoda class class, with a share of 46.2% of the total species, 5 species - to the Secernentea class class, with a share of 38.4%, and 2 species - to the Adenophorea class, constituting 15.4% of the total identified species (Tab. 1).

The hierarchical characteristic (Table 2) was evaluated according to the dominance index of the parasitic species within the helminthofauna, expressed by the prevalent share of each parasitic species within the investigated host species (DEDIU, 2007, 2010). Based on this index, 4 species (*M. lineatus larvae*, *S. lobata*, *C. cricetorum*, *H. taeniaeformis larvae*) were established with a subrecedent share (0.5 - 0.7%), 1 species (P. *omphaloides*) with a recedent share (1.3%), 4 species (R. *straminea, H. polygirus, M. muris, T. muris*) - subdominant (2.1 - 4.1%), 1 species (*S. ratti*) - dominant, 2 species (*S. stroma, S. obvelata*) - with eudominant share (25.3 - 51.7%).

Table 2. Dominance of parasite species.

Species	%	Categories	Total
Mesocestoides lineatus	0,5	subrecedent	
Skrjabinotaenia lobata	0,6	subrecedent	4 species
Catenotaenia cricetorum	0,6	subrecedent	
Hydatigera taeniaeformis	0,7	subrecedent	
Paranoplocephala omphaloides	1,3	recedent	1 species
Rodentolepis straminea	2,1	subdominant	4 species
Heligmosomoides polygyrus	3,7	subdominant	
Mastophorus muris	3,8	subdominant	
Trichuris muris	4,1	subdominant	
Strongyloides ratti	5,6	dominant	1 species
Syphacia obvelata	51,7	eudominant	2 species
Syphacia stroma	25,3	eudominant	

After the distribution of the results obtained, according to the sexual character (♂, ♀) of the investigated host (Table 3), it was found that females are infested with 12 species out of a total of 13 parasite species as follows: 5 species of the Cestoda class (*M. lineatus, P omphaloides, R. straminea, H. taeniaeformis, S. lobata*) with a prevalence of 63.6% and an intensity of 2.4 ex.; 5 species of the Secernentea class (*S. stroma, S. obvelata, H. polygirus, S. ratti, M. muris*) with a prevalence of 81.8% and intensity of 33.9 ex .; 2 species of the Adenophorea class (*C. hepatica, T. muris*) with a prevalence of 27.3% and an intensity of 4.5 ex. While males are infested with only 9 species as follows: 3 species of the Cestoda class (*P. omphaloides, R. straminea, C. cricetorum*) with a prevalence of 55.6% and intensity of 3.0 ex. ; 4 species of the Secernentea class (*S. stroma, S. obvelata, H. polygirus, M. muris*) with a prevalence of 55.6% and an intensity of 29.0 ex .; 2 species of the Adenophorea class (*C. hepatica, T. muris*) with a prevalence of 3.2% and intensity of 7.0 ex.

The mentioned data indicate that the parasitological indices are lower in males compared to females. Therefore, the total invasion index is lower by 19.7%, but the average intensity of the invasion is lower by 23.4%, and the diversity of the parasitofauna is reduced by 3 species.

Table 3. Parasitological indexes in males and females.

Taxon	Females			Males		
	Prevalence, %	**Intensity, ex.**	**Species, no**	**Prevalence, %**	**Intensity, ex.**	**Species, no**
Cestoda	63,6	2,4	5	55,6	3,0	3
Secernentea	81,8	33,9	5	55,6	29,0	4
Adenophorea	27,3	4,5	2	3,2	7,0	2
Total	**86,4**	**36,3**	**12**	**66,7**	**27,8**	**9**

Analysing the results according to the age of the investigated host (Table 4), we find that the subadult individuals are infested with only 9 species, including 3 species of the Cestoda class (*P. omphaloides, H. taeniaeformis, S. lobata*) with a prevalence of 33.3% and intensity of 2.5 ex.; 4 species of the Secernentea class (*S. stroma, H. polygirus, S. ratti, M. muris*) with a prevalence of 83.3% and an intensity of 15.5 ex.; 2 species of the Adenophorea class (*C. hepatica, T. muris*) with a prevalence of 33.3% and an intensity of 5.0 ex. While adult specimens are infested with 12 species out of a total of 13 parasitic species identified, as follows: 5 species of the Cestoda class (*M. lineatus, P. omphaloides, R. straminea, H. taeniaeformis, S. lobata*) with a prevalence of 64.7% and intensity of 2.8 ex. ; 5 species of the Secernentea class (*S. stroma, S. obvelata, H. polygirus, S. ratti, M. muris*) with a prevalence of 82.4% and an intensity of 38.4 ex .; 2 species of the Adenophorea class (*C. hepatica, T. muris*) with a prevalence of 39.1% and an intensity of 12.0 ex.

These data indicate that in subadult specimens, the level of cestode infestation is 31.4% lower, probably due to the fact that these species are biohelminths, and the infestation can occur through contact with intermediate hosts. The total invasion index is also lower by 5.0%, but the average intensity of the invasion by 53.9%, and the diversity of parasitofauna is reduced by 3 species, compared to adult specimens.

Table 4. Parasitological indexes by age groups.

Taxon	Subadult			Adult		
	Prevalence, %	**Intensity, ex.**	**Species, no**	**Prevalence, %**	**Intensity, ex.**	**Species, no**
Cestoda	33,3	2,5	3	64,7	2,8	5
Secernentea	83,3	15,5	4	82,4	38,4	5
Adenophorea	33,3	5,0	2	29,4	3,4	2
Total	**83,3**	**18,0**	**9**	**88,2**	**39,1**	**12**

The evolutionary characteristics (Table 5) is represented by 6 species that develop according to the monoxen model (*S. stroma, S. obvelata, C. hepatica, T. muris, H. polygirus, S. ratti*), 7 species with polygenic evolution, including 6 species with development after the dixen model with the presence of exogenous forms (*H. taeniaeformis* larvae, *M. muris, S. lobata, C. cricetorum, P. omphaloides, R. straminea*) and 1 species evolving according to the trixen model (*M. lineatus* larvae).

Table 5. Evolutionary characteristics of parasites.

Model	Class			Total
	Cestoda	**Secernentea**	**Adenophorea**	
Monoxenic	-	*S. obvelata* *S. stroma* *S. ratti* *H. polygirus*	*C. hepatica* *T. muris*	**6 species**
Dixenic	*H. taeniaeformis* *S. lobata* *C. cricetorum* *P. omphaloides* *R. straminea*	*M. muris*	-	**6 species**
Trixenic	*M. lineatus*	-	-	**1 species**

The epidemiological characteristics (Table 6) include 3 categories of parasitosis (zoonotic, mixed, rodent specific). Out of the category of parasitosis with zoonotic impact (parasitozoonoses), we can mention 3 species of the Secernentea class class (*S. stroma, S. obvelata, S. ratti*). Mixed-impact parasites (zoonotic + epizootic) are caused by 3 species, including 2 species of the Cestoda class class (*M. lineatus larvae, H. taeniaformis* larvae) and 1 species of the Adenophorea class (*C. hepatica*). Of the rodent characteristics, a total of 7 species were found, including 4 species of the Cestoda class (*P. omphaloides, C. cricetorum, S. lobata, R. straminea*), 2 species of the Secernentea class (*H. polygirus, M. muris*) and 1 species in the Adenophorea class (*T. muris*).

Table 6. Epidemiological characteristics of parasitoses.

Impact	**Class**			**Total**
	Cestoda	**Secernentea**	**Adenophorea**	
Zoonotic	-	*S. stroma* *S. obvelata* *S. ratti*	-	**3 species**
Mixt	*H. taeniaeformis* *M. lineatus*	-	*C. hepatica*	**3 species**
Rodent	*P. omphaloides* *C. cricetorum* *S. lobata* *R. straminea*	*H. polygirus* *M. muris*	*T. muris*	**7 species**

After analyzing the bioecology of parasites, it was found that parasitic species with zoonotic impact *M. lineatus* larvae *and H. taeniaformis* larvae of the Cestoda class, parasitize in the adult form in the intestine to canids (*Canis lupus, Vulpes vulpes, Felis catus*), and the larval form called Metacestoda (*Cisticercus fasciolaris*) parasitizes the liver and peritoneal cavity in rodents (Muridae and Cricetidae), including humans (*Homo sapiens*). *C. hepatica* is a geohelminth that parasitizes in the liver of rodents, lagomorphs (leporidae), pigs, carnivores, primates and humans, and the fox acts as a mechanical vector host that spread parasitic forms. *S. stroma* and *S. obvelata* are undeveloped ageohelminths in the environment and parasitize the small and large intestine in rodents and humans.

The species particular for rodents such as *S. lobata, P. omphaloides, C. cricetorum* of the Cestoda class parasitize in the intestine of the rodents. H. *polygirus, T. muris, M. muris, R. straminea* are geohelminths that parasitize in the small intestine in rodents.

Similar research in Romania was performed on 13 species of small rodents including *M. arvalis* revealed 29 parasitic species, of which: 3 species (10.3%) of the Digenea class, 14 species (48.3%) of the Cestoda class, one species (3.5%) of the Acanthocephala class and 11 species (38.0%) of the Nematoda class (CHIRIAC et al., 1962; 1963). More recently in Sălaj County, Romania, in *M. arvalis* there was found an invasion of *R. asymmetrica* with a prevalence of 1.7%, *P. omphaloides* - 4.5%, *S. nigeriana* - 1.0% and with *H. laevis* – 0.7% (GUABANYI et al., 2015). In Russia the parasite fauna in *M. Arvalis* consists of 16 taxons as follows: one species from the Trematoda class *(A. alata larvae* – 0.88%); 4 speciesfrom Cestoda class (*A. dentata* – 6.8%, *P. omphaloides* – 4.5%, *H. taeniaformis larvae* – 2.3%, *T. hydatigena larvae* – 0.88%); 9 species from the Nematoda class (*C. hepatica* – 6,8%, *H. costellatum* – 40.9%, *H. laevis* – 29,5%, *S. nigeriana* – 18.2%, *T. muris* – 15,9%, *B.minutus* – 9.1%, *A. tetraptera* – 2,3%, *A. dinniki* – 0.64%) (ROMASHOVA, 2003).

CONCLUSION

The obtained data reveal the potential risk of parasitic pollution by transmitting invasive forms from wild to domestic animals, including humans, thus ensuring the functional stability of parasitic biosystems and determine the natural focality of biocenoses. In this context, the monitoring of parasitofauna in small rodents in different areas has a bioecological, medical and veterinary importance in preventing the transmission of pathogens to humans and other mammals involved in the biological cycles of parasites with zoonotic and epizootic role, which is why mitigation measures are needed of the level of infestation in wild animals.

The studies were performed within the State Program project 20.80009.7007.12 at the Institute of Zoology.

REFERENCES

ANDREYKO O. F. 1973. *Parazity mlekopitayushchih Moldavii*. Kishinev. Shtiintsa. 185 pp.

BEHNKE J. M. 2008. Structure in parasite component communities in wild rodents: predictability, stability, associations and interactions or pure randomness*? Parasitology.* PubMed. **135**: 751–766.

BEKLEMISHEV V. N. 1970. Biotsenoticheschie osnovy sravnitelnoi parazitologii. *Nauka.* Moskva. 501 pp.

CHECHULIN A. I, KARPENKO S. V, PANOV V. V. 2011. Ecology of Hepaticola hepatica infection in rodents in southern west Siberia. Contemporary Problems of Ecology. *Nauka. Interperiodica*. **4**(4): 423-427.

CHIHAI O., TODERAȘ I., ERHAN D., RUSU Ș., TĂLĂMBUŢĂ N., NISTREANU V., LARION A., ZAMORNEA M., MELNIC G., NAFORNIŢĂ N. 2020. Structura epidemiologică a parazitofaunei la șoarecele scurmător (Clethrionomys glareolus, Schreber, 1780) din rezervația naturală „Plaiul Fagului", Republica Moldova. *Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţele vieţii.* Moldova. **1**(340): 126-134.

CHIRIAC E. & BARBU P. 1962. Contribuții la cunoașterea helmintofaunei micromamiferelor din împrejurimile Măcinului (Dobrogea de Nord*). Studii Cercetări Biologice*. Analele Universității București. **14**: 385-392.

CHIRIAC E. & BARBU P. 1963. Cu privire la helmintofauna unor micromamifre din R. P. R. *Studii Cercetări Biologice*. *Analele Universității București.* 1**2**: 181-191.

DEDIU I. 2007. *Tratat de ecologie teoretică, studiu monografic de sinteză*. Edit. Balacron. Chișinău. 258 pp.

DEDIU I. 2010. *Enciclopedie de ecologie*. Edit. Știința, Chișinău. 833 pp.

DIDĂ I. C. & DUCA I. 2002. Zoonozele parazitare, factor de risc epidemiologic. *Scientia Parasitologica.* Facultatea de Medicină Veterinară. Timișoara. **2**: 13-16.

DURDEN L. A & OLIVER J. H. 2000. Rodents ecto-parasites from two locations in northwestern Florida. In. *Journal Vector Ecolology*. PubMed. **25**: 222-228.

ERHAN D., LUNCAŞU M., GRATI N., CONOVALOV IU., ZAMORNEA M., RUSU Ş., CHIHAI O., MELNIC G., SEROTILĂ P., BUZA V. 2001. Rolul factorilor antropogeni şi naturali la infestarea animalelor sălbatice şi domestice cu endo- şi ectoparaziţi in Republica Moldova. *Materialele Conf. IV a Zoologilor din Republica Moldova cu participare Internaţională „Diversitatea, valorificarea raţională şi protecţia lumii animale".* Chişinău:15–21.

FUEHRER H. P, PETRA IGEL P., AUER H. 2011. Capillaria hepatica in man: An overview of hepatic capillariosis and spurious infections. *Parasitology Research*. PubMed. 1**09**: 969-979.

GUABANYI A., MATSKASI I., MESZAROS F. 2015. Helminthological investgations of small mammals in the Sălaj county, Romania. *Studia Universitatis "Vasile Goldis", Seria Științele Vieții*. Arad. **25**(3): 169-173.

KONTRIMAVICHIUS V. L. 1982. Parazitarnye sistemy i ih znachenie v noulyatsionnoy biologii gelmintov. *Prazitologia.* Published online. **16**(1-4): 197-215.

KRIVOPALOV A. V. 2011. Fauna y ecologya gelmintov mysheobraznyh gryzunov chernevoitaygi Severo-vostochnogo Altaya. Avtoreferat disertatsii na sosiscanii uchyonoi stepeni candidata biologichescih. *Nauck*. Novosibirsk. 22pp.

HAUKISALMI V. & HENTTONEN H. 1999. Determinants of helminth aggregation in natural host populations: individual differences or spatial heterogeneity? Ecography. *Parasitology Research*. PubMed. **22**: 629-636.

LEBEDEVA N. V., KRIVOLUTSKI D. A., PUZACHENKO YU. G., DYAKOV K. N., ALESHCHNKO G. M., SMUROV A. V., MAXIMOV B. N., TIKUNOV B. C., OGUREEVA G N., KOTOVA T. V. 2002. *Geografya i monitoring bioraznoobrazya*. Izdatelstvo nauchnogo i obuchitelskogo tsentra. Moskva: 432.

MALSAWMTLUANGI C. & TANDON V. 2009. *Helminth parasite spectrum in rodent hosts from bamboo growing areas of Mizoram, north-east India*. *Journal Parasitology Diseases*. Published online. **33**(1-2): 28-35.

MUNTEANU A. & LOZAN M. 2004. *Lumea animală a Moldovei*. *Mamifere.* Editura "Știința". **4**:74 -75.

PAVLINIVA I. Ya. 1999. *Mlekopitayushchie*. Bolshoy entsiclopedichescy slovari. AST. Moskva: 251.

PELIKAN J., ZEJDA J., HOLISOVA V. 1975. Influence of trap spacing on the catch size of dominasnt species of small forest mammals. *Zoologic Listy*. Brno. **24**(4): 313-324.

ROMASHOVA N. B. 2003. Ecologya i bioraznoobrazie gelmintov myshevidnyx gryzunov v uslovyah ostrovnyh lesov tsentralinogo chernozemya. Dissertatsya kandidata biologicheskix. *Nauka.* Voronej. 177 pp.

RYJIKOV M., GVOZDEVE V., TOKOBAEVM. M. 1978. Opredeliteli gelmintov gryzunov fauny SSSR. *Tsetody I trematody*. Moskva. 232 pp.

RYJIKOV M., GVOZDEVE V., TOKOBAEVM M. 1979. Opredeliteli gelmintov gryzunov fauny SSSR. *Nematodyi acantotsefaly*. Moskva. 272 pp.

SINGH Y. P., GANGWAR S., KUMAR D. 1995. Rodent pests and their management in the northeastern hill region. *Research bulletin. ICAR research complex for NEH region.* Barapani, Meghalaya. **37**: 1-35.

STOJCEVIC D., MIHALJEVIC Z., MARINCULIC A. 2004. Parasitological survey of rats in rural regions of Croatia. *Veterinární Medicína.* Scimago Press. Paris. **49**(3): 70-74.

Chihai Oleg
Institute of Zoology, Academiei str.1, MD – 2028, Chisinau, Republic of Moldova.
E-mail: olegchihai@yahoo.com

Received: March 30, 2021
Accepted: September 7, 2021