Parasitic fauna at the hare (*Lepus Europaeus Pallas*, 1778) from the "Codrii" natural reservation, Republic of Moldova

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Abstract
The study of the parasitic fauna at the hare (Lepus europaeus Pallas, 1778) from the "Codrii" natural reservation, Republic of Moldova revealed species of parasites that fall taxonomically in 3 classes (Trematoda, Secernentea and Conoidasida), 9 families (Fasciolidae, Dicrocoeliidae, Trichuridae, Strongyloidida, Trichostrongylidae, Oxyuridae, Trichuridae, Molineidae, Eimeriidae) and 9 genera (Fasciola, Dicrocoelium, Trichuris, Strongyloides, Trichostrongylus, Passalurimus, N and Passalurimus), and Parasitological research has shown an increased level of infestation at hares with various parasitic agents: Tematoda class 2 species (Fasciola hepatica with EI of 7.5% cases and II of 4,6 ex., Dicrocoelium lanceolatum with EI – 11.3% of cases, II-2.4 ex.); Class Secernentea 8 species (Trichocephalus leporis with EI – 16.1% cases, II -7.1 ex., Strongyloides papillosusi with EI – 69.2% cases, II- 14.7 ex., Trichostrongylus retortaeformis with EI – 5.3% cases, II -2.4 ex., Passalurus ambiguus with EI – 34.6% cases, II-5.2 ex., Trcihostrongylus probolurus with EI – 17.1% cases, II- 4,3ex., Trichuris leporis with EI – 7.1% cases, II-3,5ex., Graphidium strigosum with EI – 2.3% cases, II -1,4 ex., Nematodirus abnormalis with EI – 3.7% cases, II- 5.5 ex.) and Conoidasida Class with 6 species: Eimeria leporis with EI – 51.4% cases and II- 18.5 oocysts. Eimeria magna with EI – 31.3% of cases, II- 12.4 oocysts, Eimeria stiedae with EI – 57.1% cases, II- 18.7 oocysts, Eimeria perforans with EI – 12.9% of cases, II- 17.6 oochişti; Eimeria exigua with EI – 48.1% of cases, II- 15.3 oocysts; Eimeria intestinalis with EI – 14.3% of cases, II – 17.2 oocysts. It has been established that hares from the "Codrii" Natural Reserve are infested in the form of monoinvasions in 28,1% of cases, and in the form of polyinvasions - in 71,9% of cases.
Keywords: *parasitic fauna, hare, "Codrii" natural reservation*

Introduction

Changes in climatic factors, along with socio-anthropic changes, which have been reported in recent years, cause changes in the structure of wildlife communities as a whole and those of economic interest. In the last two decades, agrocenoses have undergone structural changes expressed through the parcelling of land with a greater diversity of agricultural crops, the disappearance of monocultures, the appearance of ponds, etc [3, 6].

Along with global warming, droughts are quite common during the summer and early fall. These factors have a contradictory influence in the increase of the number of fur game, especially of the most important game species in the open lands - the agrocenoses in our country, of the hare. Other factors are parasitic diseases, poaching, the excessive presence of predators - foxes, stray and wild dogs and cats [1].

Neutralizing these negative factors and implementing the necessary recommendations will give the opportunity to organize the hunting household at an effective hunting level. We must mention that the management of hunting households in Central and Eastern European countries (Czech Republic, Slovakia, Hungary, Romania) has shown that acclimatization of hares imported from other regions does not give spontaneous results, so it is necessary to maintain and optimize local population density by making recommendations for the protection of various parasitic and infectious diseases, stimulating the reproductive process and rational exploitation of the species. The most visible changes in the reporting period are as a result of assessments of the number of main game species and hunting results [5, 6].

The hare (*Lepus europaeus Pallas*, 1778) or the common rabbit is a mammal of the leporidae family. This species inhabits open and semi-open lands in the temperate zone of Europe and parts of Asia. The number of hares is declining due to the intensification of agriculture. The

hare is not related to the domestic rabbit (Oryctolagus cuniculus domesticus) and does not breed with it [5, 6, 7].

This species is one of the largest from the lagomorphs. The length of the body together with the head varies from 60 to 75 cm and the length of the tail from 7.2 to 11 cm. The weight is usually between 3 and 5 kg. The color of the fur is brownish-yellow on the back; reddish on shoulders, feet and neck; white on the lower body and black on the tail and on the tips of the ears [6, 10].

The hare is a mostly nocturnal animal and spends a third of its time feeding. During the day, the hare hides in the shelter in a hollow in the ground. The hares can run at up to 70 km /h and, in the event of a predator attack, they rely on their superiority in speed [6, 8, 14].

In generally they are thought to be solitary, but can be seen in large and small groups. They don't seem to be territorial, living in vital areas in common of about 300 ha. They communicates through a wide range of visual cues. To show interest, they raises their ears, while their lowered ears warn the others to stay away. The hare can live up to 12 years.

Childbirth takes place in a hollow in the ground. The hare can have up to 3 calvings per year with a gestation period of 41-42 days. The bunnies weigh about 130 g at birth. The bunnies are covered in fur and are able to leave the nest at shortly time after birth, an adaptation to the absence of physical protection comparable to that offered by a den. The bunnies disperse during the day and gather in the evening near the place where they were born to be breastfed by their mother. After two weeks they can eat solid food and after four weeks they are already weaned [5, 6].

The hare is an important part of the hunting fauna. Starting with 2012, we have an increase in the number of hares in the autumn population from 62 thousand in 2012 to about 233 thousand in the fall of 2018, with an increase of the average annual number for the field hare population in the hunting fund of open lands of 20.5% [1, 7].

Most parasitological studies have focused on domestic animals, but it has recently been established that parasitic infestations are equally common and important in wildlife, which can serve as a potential reservoir for parasites. The hare hosts a wide range of parasites, which are a great interest to hunting fund managers and veterinarians, being considered important sources of zoonotic agents [4,8,13].

The study of the process of infestation of wild animals with various parasitic agents, the development of innovative measures to reduce and control them is an important, fundamental and, especially, applicative problem, because some species serve as definitive hosts in the development cycle and as their vectors being dangerous for both domestic animals and humans. Parasitosis is the most common disease in wildlife in game, resulting in substantial economic losses [2, 3, 7, 9, 11, 12].

The fauna of hunting interest is the component part of the national hunting heritage. Both the number and the total spectrum of main and complementary species determine the value of this fund. Therefore, the study of parasitic fauna at wild animals from hunting fauna has a special significance [9,14].

The purpose of the research is to study the diversity of parasitic fauna at the hare (*L. europaeus Pallas*), from the "Codrii" Nature Reserve from the Central Area of the Republic of Moldova.

Materials and methods

The parasitological researches were carried out in the laboratory of Parasitology and Helminthology of the Institute of Zoology on 214 biological samples collected from the hare during 2017-2019, from the forest ecosystem of the Nature Reserve "Codrii".

In order to achieve the proposed objectives, were used the coproovoscopic methods (Fulleborn, Darling), the coprolarvoscopic methods (Popov, Baermann) and the successive washing method . The intensity of the invasion with nematodes was established in 5 g of fetuses, and the oocysts of *Eimeria spp*., eggs of *Fasciola hepatica,* eggs of *Dicrocoelium lanceolatum*, etc. in 10 visual microscopic fields (10x40).

Systematic determination of parasite species was performed according to European fauna [6]. The parasitological evaluation is based on the determination of the extensivity of the *EI* invasion (%) and the Intensity of the invasion (specimens / animal) at the investigated animals. The obtained results were statistically processed in the Excel program.

Results and discussions

The parasitological research carried out on the study of parasitofauna at the hare from the forest ecosystem of the "Codrii" Nature Reserve, Republic of Moldova, shows that they are parasitized with various dangerous parasitic agents with various locations, systematically classified into 3 classes (*Trematoda, Secernentea, Conoidas*), 9 families (*Fasciolidae, Dicrocoeliidae, Trichuridae, Strongyloididae, Trichostrongylidae, Oxyuridae, Trichuridae, Molineidae, Eimeriidae*) and 9 genera (*Fasciola, Dicrocoelium, Trichuris, Strongyloides, Trichostrongidus E* and *Trichostrongidus*.

As a result of the parasitological research carried out, an increased level of infestation was established at hares with various parasitic agents: Tematoda class 2 species (*Fasciola hepatica* with *EI* of 7.5% cases and *II* of 4.6 ex., *Dicrocoelium lanceolatum* with *EI* – 11.3% of cases, *II*-2.4 ex.); Class Secernentea 8 species (*Trichocephalus leporis* with *EI* – 16.1% cases, *II* -7.1 ex., *Strongyloides papillosusi* with *EI* – 69.2% cases, *II*- 14.7 ex., *Trichostrongylus retortaeformis* with *EI* – 5.3% cases, *II* -2.4 ex., *Passalurus ambiguus* with *EI* – 34.6% cases, *II*-5.2 ex., *Trcihostrongylus probolurus* with *EI* – 17.1% cases, *II*- 4.3ex., *Trichuris leporis* with *EI* – 7.1% cases, *II*-3.5ex., *Graphidium strigosum* with *EI* – 2.3% cases, *II* -1.4 ex., *Nematodirus abnormalis* with *EI* – 3.7% cases, *II*- 5.5 ex.) and Conoidasida Class with 6 species: *Eimeria leporis* with *EI* – 51.4% cases and *II*- 18.5 oocysts. *Eimeria magna* with *EI* – 31.3% of cases, *II*- 12.4 oocysts, *Eimeria stiedae* with *EI* – 57.1% cases, *II*- 18.7 oocysts, *Eimeria perforans* with *EI* – 12.9% of cases, *II*- 17.6 oochişti; *Eimeria exigua* with *EI* – 48.1% of cases, *II*- 15.3 oocysts; *Eimeria intestinalis* with *EI* – 14.3% of cases, *II* – 17.2 oocysts (tab.1).

The parasitological examination performed on 214 coprological samples collected from hares from the forest ecosystem of the "Codrii" Nature Reserve showed that in 203 samples (94.8% of cases) are present parasitic agents.

Table 1

The diversity of parasitic fauna at the hare from the forest ecosystem of the "Codrii" Nature Reserve

Class	Family	Species	EI, %	II, ex.
Trema-toda	Fasciolidae	*Fasciola hepatica (Linnaeus, 1758)*	7.5	4.6
	Dicrocoeliidae	*Dicrocoelium lanceolatum (Rudolphi, 1819)*	11.3	2.4
	Trichuridae	*Trichocephalus leporis (**Frolich, 1789**)*	16.1	7.1

Secernentea	Strongyloididae	*Strongyloides papillosus (Wedl, 1856)*	69.2	14.7
	Trichostrongylidae	*Trichostrongylus retortaeformis (Zeder,1800)*	5.3	2.4
		Trcihostrongylus probolurus (Railliet,1896)	17.1	4.3
		Graphidium strigosum (Dujardin, 1845)	2.3	1.4
	Oxyuridae	*Passalurus ambiguus (Rudolphi, 1819)*	34.6	5.2
	Trichuridae	*Trichuris leporis (Frölich, 1789*	7.1	3.5
	Molineidae	*Nematodirus abnormalis (May, 1920*	3,7	5,4
Conoidasida	Eimeriidae	*Eimeria leporis* ***(Nieschulz, 1923)***	51.4	18.5
	Eimeriidae	*Eimeria magna (Pérard, 1925)*	31.3	12.4
	Eimeriidae	*Eimeria stiedae* ***(Lindemann, 1865)***	57.1	18.7
	Eimeriidae	*Eimeria perforans(Leuckart, 1879)*	12.9	17.6
	Eimeriidae	*Eimeria exigua (Yakimoff, 1934)*	48.1	15.3
	Eimeriidae	*Eimeria intestinalis (Cheissin, 1948)*	14.3	17.2

Parasitic invasions consisting of a single parasite species (monoinvasions) were present in 57 samples (28.1% cases), and parasitic associations consisting of several species of parasites (polyinvasions) being recorded in the remaining investigated samples -146 samples (71.9%).

From the total of polyparasitic samples, the following polyparasite associations were established: with 2 species of parasites - 60 samples (41.1%): *Strongyloides papillosus* + *Eimeria stiedae* –14 samples (23.3%); *Strongyloides papillosus* + *Eimeria leporis* - 11 samples (18.3%); *Strongyloides papillosus* + *Eimeria exigua* - 8 samples (13.3%); *Strongyloides papillosus* + *Trichocephalus leporis* - 7 samples (11.6% of cases); *Passalurus ambiguus* + *Eimeria leporis* - 7 samples (11.6%); *Strongyloides papillosus* + *Dicrocoelium lanceolatum* - 4 samples (6.7%); *Strongyloides papillosus* + *Fasciola hepatica* - 4 samples (6.7%); *Strongyloides papillosus* + *Trichostrongylus retortaeformis* - 3 samples (5.0%); *Trichostrongylus retortaeformis* + *Nematodirus abnormalis* - 2 samples (3.3%).

In 46 samples (31.5%) examined, had been established polyparasite associations consisting of 3 species of parasites *: Strongyloides papillosus* + *Eimeria leporis* + *Eimeria stiedae* - 13 samples (28.3%); *Passalurus ambiguus* + *Eimeria perforans* + *Eimeria intestinalis* - 9 probe (19.5%); *Strongyloides papillosus* + *Eimeria leporis* + *Dicrocoelium lanceolatum* - 8 samples (17.4%); *Trichocephalus leporis* + *Dicrocoelium lanceolatum* + *Eimeria exigua* - 7 samples (15.2%); *Strongyloides papillosus* + *Trcihostrongylus probolurus* + *Graphidium strigosum*- 5 probe (10.9%); *Nematodirus abnormalis* + *Trichuris leporis* + *Fasciola hepatica* - 4 samples (8.7%).

Polyparasitic associations consisting of 4 species of parasites were identified in 25 samples (17.1%) and consisting of: *Strongyloides papillosus* + *Eimeria magna* + *Fasciola hepatica* + *Eimeria stiedae* - 8 samples (2.8%); *Dicrocoelium lanceolatum* + *Fasciola hepatica* + *Trichocephalus leporis* + *Strongyloides papillosus* - 6 samples (1.8%); *Strongyloides papillosus* + *Trichuris leporis* + *Passalurus ambiguus* + *Eimeria stiedae* - 6 samples (2.3%); *Dicrocoelium lanceolatum* + *Strongyloides papillosus* + *Eimeria leporis* + *Nematodirus abnormalis* - 4 samples (2.8%).

As a result of the laboratory parasitological examination, it was possible to highlight in 11 samples (7.5%), parasitic associations consisting of 5 species of parasites: *Strongyloides papillosus* + *Trichuris leporis* + *Trichocephalus leporis* + *Fasciola hepatica* + *Eimeria stiedae* - 3 samples

(27.2%) ; *Strongyloides papillosus + Trichostrongylus retortaeformis + Eimeria stiedae + Passalurus ambiguous + Eimeria leporis* - 2 samples (18.2%); *Strongyloides papillosus + Dicrocoelium lanceolatum + Nematodirus abnormalis + Eimeria magna + Eimeria leporis* - 2 samples (18.2%); *Strongyloides papillosus + Trichuris leporis + Passalurus ambiguus + Eimeria stiedae + Trichocephalus leporis* -2 sample (18.2%); *Strongyloides papillosus + Eimeria magna + Dicrocoelium lanceolatum + Graphidium strigosum + Trichuris leporis* - one sample (9.1%); *Strongyloides papillosus + Eimeria leporis + Trichocephalus leporis + Trichuris leporis + Eimeria stiedae* - one sample (9.1%).

Polyparasitic associations consisting of 6 species of parasites were identified in 4 samples (2.8%) and consisting of: *Strongyloides papillosus + Trichostrongylus retortaeformis + Trichuris leporis + Trichocephalus leporis + Eimeria stiedae + Fasciola hepatica* - 2 samples (75.0%) *Strongyloides papillosus + Eimeria magna + Fasciola hepatica + Eimeria stiedae + Passalurus ambiguous + Trichocephalus leporis* - one sample (25.0%); *Strongyloides papillosus + Dicrocoelium lanceolatum + Eimeria magna + Eimeria leporis + Passalurus ambiguous + Graphidium strigosum* - a sample (25.0%).

It was highlighted the division of parasite species according to the way of development cycles in: biohelminths (12.5%) - parasite species, whose development cycle requires a complementary host; geohelminths (87.5%) - species of parasites that do not require a complementary host in their development cycle (fig. 1).

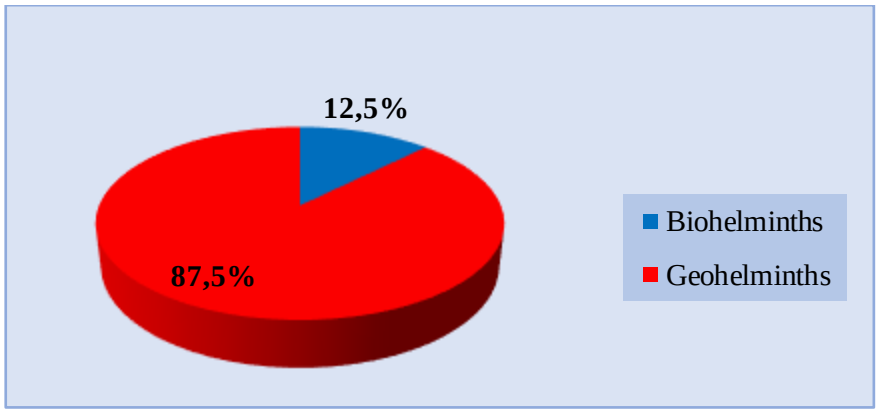

Fig. 1. Division of parasitic species, identified at hare, according to the way of development cycles

The results of parasitological research conducted on hares in the Natural Reserve "Codrii" Republic of Moldova show an increased level of infestation with various parasitic agents dangerous to both domestic animals and humans. Of the total number of parasitic species identified (16 species): 10 species (62.5%) are specific only to hares (*Trichuris leporis, Trichocephalus leporis, Passalurus ambiguous, Graphidium strigosum, Eimeria leporis, Eimeria magna, Eimeria stiedae, Eimeria perforans, Eimeria small, Eimeria intestinalis*); 4 species (25.0%) are common to other species of wild and domestic animals (*Strongyloides papillosus, Trcihostrongylus probolurus, Trichostrongylus retortaeformis, Nematodirus abnormalis*), and 2 species (12.5%), (*Fasciola hepatica, Dicrocoelium lanceolatum*), are common for both animals and humans.

Therefore, some parasitic species identified at hares from the "Codrii" Natural Reserve are common for both wild and domestic animals, as well as for humans.

These results can be explained by the fact that the hare is a herbivorous wild mammal that prefers open fields with isolated thickets for shelter. They are very adaptable and thrive on mixed agricultural lands. They need shelter, such as forest strips, ditches and permanent shelter areas. It shows a preference for agricultural lands in the areas of plains, hills and low hills, where small forest bodies are scattered. When food becomes deficient, it retreats to forests, but often approaches localities, where it enters the gardens of people who are adequate places of mutual contamination between different types of parasitic hosts (permanent, intermediate, complementary) terrestrial and aquatic.

Conclusions

1. The study of the parasitic fauna carried out on 214 biological samples collected from the hares, from the forest ecosystem of the Natural Reserve "Codrii" revealed species of parasites that fall taxonomically in 3 classes (*Trematoda, Secernentea and Conoidasida),* 9 families *(Fasciolidae, Dicrocoeliidae, Trichuridae, Strongyloidida, Trichostrongylidae, Oxyuridae, Trichuridae, Molineidae, Eimeriidae*) and 9 genera (*Fasciola, Dicrocoelium, Trichuris, Strongyloides, Trichostrongylus, Passalurimus, N* and *Passalurimus*).
2. Parasitological research has shown an increased level of infestation at hares with various parasitic agents: Tematoda class 2 species (*Fasciola hepatica, Dicrocoelium lanceolatum*); Class Secernentea 8 species (*Trichocephalus leporis, Strongyloides papillosusi, Trichostrongylus retortaeformis, Passalurus ambiguus, Trcihostrongylus probolurus, Trichuris leporis, Graphidium strigosum, Nematodirus abnormalis*) and Conoidasida Class 6 species (*Eimeria leporis, Eimeria magna, Eimeria stiedae, Eimeria perforans, Eimeria exigua, Eimeria intestinalis*).
3. It has been established that hares from the "Codrii" Natural Reserve are infested in the form of monoinvasions in 28,1% of cases, and in the form of polyinvasions - in 71,9% of cases.
4. It was found that out of the total (16) of parasitic species identified at hares: 10 species (62.5%) are specific only to hares (*Trichuris leporis, Trichocephalus leporis, Passalurus ambiguous, Graphidium strigosum, Eimeria leporis, Eimeria magna, Eimeria stiedae, Eimeria perforans, Eimeria exigua, Eimeria intestinalis*), 4 species (25.0%) *Strongyloides papillosus Trcihostrongylus probolurus Trichostrongylus retortaeformis, Nematodirus abnormalis* are common to other species of wild and domestic animals, and 2 species (12.5%) (*Fasciola hepatica, Dicrocoelium lanceolatum*), are common in both animals and humans.

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