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Review

An Overview of the Helminths of Moor Frog *Rana arvalis* Nilsson, 1842 (Amphibia: Anura) in the Volga Basin

Igor V. Chikhlyaev [1] and Alexander B. Ruchin [2,*]

[1] Samara Federal Research Scientific Center RAS, Institute of Ecology of Volga River Basin RAS, 10 Komzina Street, 445003 Togliatti, Russia; diplodiscus@mail.ru
[2] Joint Directorate of the Mordovia State Nature Reserve and National Park "Smolny", 30 Krasnaya Street, 430005 Saransk, Russia
* Correspondence: ruchin.alexander@gmail.com

Abstract: This is the first review of the helminth fauna of the moor frog *Rana arvalis* Nilsson, 1842 from the Volga river basin (Russia). The article summarizes the authors' and literature data on the helminthic fauna of this species. The method of complete helminthological dissection was used. Thirthy-eight helminth species were recorded from three classes: Cestoda (1), Trematoda (28), and Chromadorea (9). Nine helminth species are new to the moor frog in Russia: trematodes *Gorgodera varsoviensis* Sinitzin, 1905, *Strigea falconis* Szidat, 1928, larvae, *Neodiplostomum spathoides* Dubois, 1937, larvae, *Tylodelphys excavata* (Rudolphi, 1803), larvae, *Pharyngostomum cordatum* (Diesing, 1850), larvae, *Astiotrema monticelli* Stossich, 1904, larvae and *Encyclometra colubrimurorum* (Rudolphi, 1819), larvae, nematodes *Strongyloides spiralis* Grabda-Kazubska, 1978 and *Icosiella neglecta* (Diesing, 1851). The cestode *Spirometra erinacei* (Rudolphi, 1918), larvae were observed of this amphibian species in the Volga basin for the first time. The nematodes *Rhabdias bufonis*, *Oswaldocruzia filiformis*, *Cosmocerca ornata* and the trematode *Haplometra cylindracea* form the core of the helminth fauna of the moor frog. Information on species of helminths includes systematic position, localization, areas of detection, type and scheme of life cycle, geographical distribution, and degree of specificity to host amphibians.

Keywords: helminthes; cestodes; trematodes; nematodes; moor frog; *Rana arvalis*; The Volga river basin

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1. Introduction

In recent decades, the study of amphibian parasites has become more relevant. This is due to the crisis that this group of vertebrates is experiencing. Amphibian populations are sharply declining around the world [1–3]. About a third (32.4%) of the world's amphibian species are on the verge of extinction [4]. The disappearance, degradation, and pollution of habitats as a result of anthropogenic activities are the main factors contributing to the reduction of the range and abundance of many species [5–8]. There are constant reports of amphibian diseases caused by viruses [9,10], bacteria [11], mycos [12–14], and helminths.

The pathogenic effect of helminthic invasion on amphibians has a wide range of manifestations: from cellular changes to inhibition of behavioral reactions. Trematodes play an important role in these processes. For example, multiple clusters of *Holostephanus volgensis* cysts during the metamorphosis of moor frog larvae cause the appearance of skeletal anomalies [15]. Cercariae of the genus *Ribeiroia* lead to limb malformations in tadpoles of North American amphibians [16–18]. The formation of deviant forms of skeletal elements significantly reduces the survival rate of the young generation of amphibians and facilitates their consumption by predators. Another type of pathology is a violation of the functioning of the internal organs of the hosts, leading to their death. For example,

multiple renal invasion by *Echinostoma* and *Echinoparyphium* metacercariae contributes to the development of edema and renal failure [18]. The concentration of *Pleurogenes hepaticola* in the bile ducts of the green frog causes liver cirrhosis and enlargement and deformation of bile-ducts and gall-bladder [19,20]. Metacercariae *Codonocephalus urnigerus*, when intensely infested, causes pathological changes in the gonads (ovarian dystrophy, testicular tumors) in the moor frog and lead to parasitic castration of the hosts. In infected individuals, food reflexes, sexual instincts, territorial and migration behavior are suppressed. Such individuals do not participate in the breeding process, do not respond to threats, are inactive, and become easy prey for predators [21]. Localization of *Brandesia turgida* in the duodenum of *Pelophylax ridibundus* is accompanied by granulomatous inflammation of its serous membrane with the development of a clinical picture of histological and cytological pathologies [22].

The moor frog, *Rana arvalis* Nilsson, 1842 is a widely distributed Eurasian species ranging from the Eastern France in the west to the Baikal Lake in the east and from Kola Peninsula in the north to the southern part of the Pannonian Basin [23]. This species lives in a wide variety of natural and anthropogenic biotopes. It is found in various types of forests, swamps, meadows, and pastures, in ravines, near streams and rivers, and it inhabits rural areas and suburban parks [24–27]. The moor frog is resistant to freezing, which is the reason for its wide distribution [28].

Parasitologists from Sweden [29], Denmark [30], Germany [31–33], Poland [34–37], Hungary [38] and the former Czechoslovakia [39–45] studied helminths of the moor frog in Europe. Similar studies were carried out in the republics of the former USSR [46], for example, in Belarus [47–50]. According to the latest reports [51–53], 47 species of helminths of five groups have been registered in this host in Europe: monogeneans (1 species), cestodes (1), trematodes (26), nematodes (18), and acanthocephales (1). The species of six of them have not been identified. Later, a representative of another class of helminths, leeches, was found [54].

The Volga is the longest river in Europe. Its length is 3,690 km and the basin area is about 1.4 million km^2. It occupies 33% of the territory of European Russia and almost 13% of Europe. It flows through different types of biomes from taiga in the North to semi-desert in the South [55]. The Volga basin includes total or part of the territory of 38 regions of Russia [56], which are home to 13 species of tailless and tailed amphibians, including 2 species of brown frogs (genus *Rana*): *Rana temporaria* Linnaeus, 1758 and *R. arvalis* [57].

In contrast to other frogs, whose helminthic fauna was studied in detail earlier in the Volga basin [58–61], data on helminths of moor frog remain scattered. Prior to this research, there was no summary on the helminths of *R. arvalis*, which inhabit the Volga river basin. Such a paper is needed due to the abundance of such information, changes in the systematics of helminths, and the long-term nature of the observations. The first information on this issue was obtained in the second half of the last century in the Republics of Bashkortostan [62,63], Tatarstan [64,65], and the Nizhny Novgorod (former Gorky region) region [66–69]. Some of these studies are presented in the monograph of K. M. Ryzhikov et al. [46], which was then included in the European reports [52,53]. In the last 15 years, new information has become available from the Vologda, Ivanovo, Samara and Saratov regions, the Republic of Mordovia, and data from the Republic of Bashkortostan has been updated. This publication is the first review of the *R. arvalis* helminth fauna from populations in the Volga river basin (Russia).

Study area: This study is based on the results of our own research, as well as on the data of other authors for the period from 1974 to 2020. The material for the study was personal fees and information about helminths from 990 specimens of moor frogs from eight regions of the Volga basin: Vologda, Ivanovo, Nizhny Novgorod, Samara and Saratov regions, the Republics of Mordovia, Tatarstan, and Bashkortostan (Figure 1).

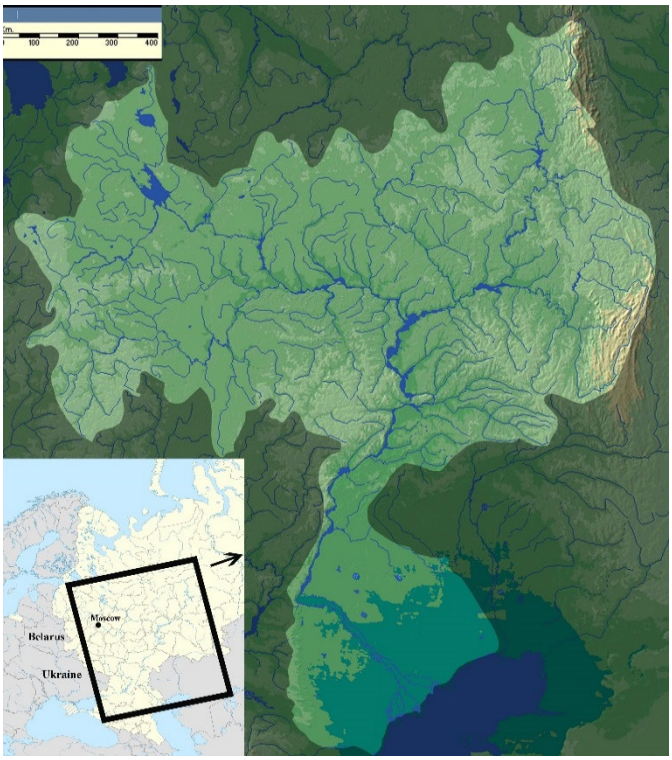

Figure 1. Location of the Volga basin.

The method of complete helminthological dissection was used. Collection, fixation and processing of helminthological material were performed by standard methods. Trematodes and cestodes were immobilized by heating, fixed with 70% ethanol under pressure, and stained with alum carmine and encased in Canadian balsam. A dimethyl phthalate solution was used to enlighten flatworms. The nematodes were straightened by heat and fixed with Barbagallo liquid (3% formalin solution in NaCl saline). Nematodes were studied both on temporary vouchers with enlightenment in lactic acid, and on total vouchers with the conclusion in glycerol-gelatin. Own vouchers of worms and partially amphibian hosts are stored in Parasitological and Herpetological collections of the Institute of Ecology of Volga Basin of RAS, Samara Federal Research center Russian Academy of Sciences, Togliatti, Russia. The species of helminths was identified according to the determinants of K. M. Ryzhikov et al. [46] and V. E. Sudarikov et al. [70]. The systematics of helminths is based on modern data on trematodes [71–74] and nematodes [75]. For describing the intermediate hosts of trematodes and cestodes, data was used from the website "Fauna Europaea" (http://www.faunaeur.org) [76].

There is an annotated list of species of the moor frog helminths inhabiting protected and transformed biocoenoses of the Volga river basin (Appendix A). It includes the systematic position and localization of the parasite, the areas of detection, and geographical distribution.

2. Results

The helminth fauna of the moor frog *R. arvalis* in the Volga river basin includes 38 species of helminths. Systematically, they belong to 30 genera, 16 families, 7 orders, and 3 classes: Cestoda–1, Trematoda–28, and Chromadorea–9 (Table 1). Nine helminth species are new to this host in Russia: trematodes—*Gorgodera varsoviensis* Sinitzin, 1905, *Strigea falconis* Szidat, 1928, larvae, *Neodiplostomum spathoides* Dubois, 1937, larvae, *Tylodelphys excavata* (Rudolphi, 1803), larvae, *Pharyngostomum cordatum* (Diesing, 1850), larvae, *Astiotrema monticelli* Stossich, 1904, larvae и *Encyclometra colubrimurorum* (Rudolphi, 1819), larvae, nematodes—*Strongyloides spiralis* Grabda-Kazubska, 1978 и *Icosiella neglecta* (Diesing,

1851). Another cestode species *Spirometra erinacei* (Rudolphi, 1918), larvae, was first recorded in a moor frog in the Volga basin.

Table 1. Helminths of a moor frog *Rana arvalis* in the Volga basin regions.

Helminths Species	VL	IV	NN	SM	SR	MR	TT	BS
Spirometra erinacei, larvae						+		
Halipegus ovocaudatus							+	
Diplodiscus subclavatus			+	+		+	+	+
Gorgodera cygnoides						+	+	+
Gorgodera microovata			+			+		
Gorgodera pagenstecheri			+			+		
Gorgodera varsoviensis				+				
Gorgoderina vitelliloba			+			+		+
Haplometra cylindracea	+	+	+	+	+	+		+
Dolichosaccus rastellus				+	+	+		+
Opisthioglyphe ranae			+	+		+	+	+
Haematoloechus variegatus		+		+		+		+
Haematoloechus asper	+		+					
Skrjabinoeces similis				+	+			+
Brandesia turgida								+
Pleurogenes claviger				+		+		+
Pleurogenes intermedius				+		+		+
Pleurogenoides medians	+		+			+		+
Prosotocus confusus			+	+				+
Paralepoderma cloacicola, larvae				+	+	+		
Strigea strigis, larvae				+	+	+		+
Strigea sphaerula, larvae				+		+		+
Strigea falconis, larvae				+		+		
Neodiplostomum spathoides, larvae				+		+		
Tylodelphys excavata, larvae				+				
Alaria alata, larvae				+	+	+		+
Pharyngostomum cordatum, larvae				+				
Astiotrema monticelli, larvae				+		+		
Encyclometra colubrimurorum, larvae				+	+			
Rhabdias bufonis	+	+	+	+	+	+	+	+
Strongyloides spiralis				+				
Oswaldocruzia filiformis	+	+	+	+	+	+	+	+
Aplectana acuminata	+	+	+				+	+
Cosmocerca ornata	+	+	+	+	+	+	+	+
Cosmocerca commutata			+				+	+
Neoraillietnema praeputiale			+			+		
Oxysomatium brevicaudatum			+			+		+
Icosiella neglecta						+		
Species in total	7	6	16	24	10	26	9	22
Cestoda	-	-	-	-	-	1	-	-
Trematoda	3	2	9	20	7	19	4	16
Chromadorea	4	4	7	4	3	6	5	6
Examined, specimens	8	35	95	138	15	325	126	248

Notes: VL—Vologda region; IV—Ivanovo region; NN—Nizhny Novgorod region; SM—Samara region; SR—Saratov region; MR—The Republic of Mordovia; TT—The Republic of Tatarstan; BS—The Republic of Bashkortostan.

According to the degree of hostal specificity, all species of helminths are divided into 3 groups. Most of them (23 species) are polyhostal parasites of tailless amphibians. A minority (14) are oligohostal for frogs of the family Ranidae. Another nematode species,

Cosmocerca commutata (Diesing, 1851), is a monohostal parasite of the green toad (*Bufotes viridis* Laurenti, 1768).

The moor frog serves as the definitive host for most helminth species (22), which parasitize exclusively at the adult stage of development (Table 1). For some cestode (1) and trematode (10) species that parasitize at the larval stage, the amphibian is an intermediate, intercalary (mesocercarial), additional (metacercarial), and/or paratenic (metacercarial) host. The remaining 5 species of trematodes (*G. vitelliloba*, *H. cylindracea*, *D. rastellus*, *O. ranae*) and nematode (*C. commutata*) combine the larval and adult stages of development in the amphibian body. In relation to such helminths, the moor frog plays the role of an amphixenic host. Brief information on the biology of helminths with the indication of host categories is given in Table 2.

Table 2. Life cycles of helminths of a moor frog *Rana arvalis.*

Helminths Species	Life Cycle	Citation
Spirometra erinacei, larvae	cyclops (Cyclopidae) [1]–frogs, snakes, rodents [3]–crows, mammals (Eulipotyphla, Mustelidae) [4]–predatory mammals [5] (Canidae, Felidae)	[77]
Halipegus ovocaudatus	gastropods (Planorbidae) [1]–cyclops (Cyclopidae) [3]–dragonflies (Calopterygidae, Coenagrionidae, Lestidae, Libellulidae) [3]–amphibians (Amphibia) [5]	[78]
Diplodiscus subclavatus	gastropods (Planorbidae) [1]–amphibians (Amphibia) [5]	[79,80]
Gorgodera cygnoides	bivalves (Sphaeriidae) [1]–dragonflies (Corduliidae) [3]–frogs (Ranidae) [5]	[81]
Gorgodera microovata	unknown	
Gorgodera pagenstecheri	bivalves (Sphaeriidae) [1]–dragonflies (Calopterygidae, Corduliidae), caddis flies (Limnephilidae) [3]–frogs (Ranidae) [5]	[81]
Gorgodera varsoviensis	bivalves (Sphaeriidae) [1]–dragonflies (Calopterygidae), caddis flies (Limnephilidae) [3]–frogs (Ranidae)[5]	[81]
Gorgoderina vitelliloba	bivalves (Sphaeriidae) [1]–tadpoles, alderflies [3]–anurans (Anura) [5]	[40,82,83]
Haplometra cylindracea	gastropods (Lymnaeidae) [1]–tadpoles (Anura) [3]–anurans (Anura) [5]	[84,85]
Dolichosaccus rastellus	gastropods (Lymnaeidae) [1]–tadpoles (Anura) [3]–anurans (Anura) [5]	[83,86]
Opisthioglyphe ranae	gastropods (Lymnaeidae) [1]–gastropods (Lymnaeidae), tadpoles (Anura) [3]–anurans (Anura) [5]	[86,87]
Paralepoderma cloacicola, larvae	gastropods (Planorbidae) [1]–anurans (Anura) [3]–snakes (Colubridae) [5]	[88,89]
Haematoloechus variegatus	gastropods (Planorbidae) [1]–mosquitos (Culicidae), dragonflies (Calopterygidae, Libellulidae) [3]–anurans (Anura) [5]	[90,91]
Haematoloechus asper	gastropods (Planorbidae) [1]–dragonflies (Calopterygidae, Lestidae) [3]–anurans (Anura) [5]	[92]
Skrjabinoeces similis	gastropods (Planorbidae) [1]–dragonflies (Aeshnidae, Calopterygidae, Coenagrionidae, Corduliidae, Lestidae, Libellulidae) [3]–frogs (Ranidae) [5]	[93]
Brandesia turgida	unknown	
Pleurogenes claviger	gastropods (Bithyniidae) [1]–dragonflies, bugs, mayflies, caddis flies, alderflies, crustaceans (Gammaridae, Asellidae) [3]–anurans (Anura) [5]	[94,95]
Pleurogenes intermedius	unknown	
Pleurogenoides medians	gastropods (Bithyniidae) [1]–dragonflies, bugs, mayflies, caddis flies, alderflies, mosquitos, crustaceans (Gammaridae, Asellidae) [3]–anurans (Anura) [5]	[94,96]
Prosotocus confusus	gastropods (Bithyniidae) [1]–dragonflies, bugs, caddis flies, alderflies, crustaceans (Gammaridae) [3]–anurans (Anura) [5]	[94,97]
Strigea strigis, larvae	gastropods (Planorbidae) [1]–tadpoles (Anura) [2]–anurans (Anura) [3,4]–snakes (Colubridae), mammals (Eulipotyphla, Mustelidae, Canidae) [4]–owls (Strigiformes) [5]	[98–101]
Strigea sphaerula, larvae	gastropods (Planorbidae) [1]–tadpoles (Anura) [2]–anurans (Anura)[3,4]–snakes (Colubridae) [4]–crows (Corvidae), warblers (Acrocephalidae)[5]	[98,99,101–103]

Strigea falconis, larvae	gastropods (Planorbidae) [1]–tadpoles (Anura) [2]–anurans (Anura) [3,4]–snakes (Colubridae), mammals (Eulipotyphla, Mustelidae, Canidae) [4]–birds of prey (Accipitriformes, Falconiformes) [5]	[98,101,104]
Neodiplostomum spathoides, larvae	gastropods (Planorbidae) [1]–frogs (Anura) [3]–snakes (Colubridae), crows, seagulls, ducks [4]–birds of prey (Accipitriformes, Falconiformes) [5]	[105–107]
Tylodelphys excavata, larvae	gastropods (Planorbidae) [1]–frogs (Anura) [3]–long-legged birds (Ciconiiformes), buzzards (Accipitriformes) [5]	[105,108]
Alaria alata, larvae	gastropods (Planorbidae) [1]–anurans (Anura) [2]–frogs, snakes, crows, seagulls, ducks, owls, birds of prey, rodents, insectivorous and predatory mammals [4]–canids (Canidae) [5]	[109–111]
Pharyngostomum cordatum, larvae	gastropods (Planorbidae) [1]–frogs (Ranidae) [3]–snakes, crows, rodents, insectivorous and predatory mammals [4]–predatory mammals (Canidae, Felidae) [5]	[111,112]
Astiotrema monticelli, larvae	gastropods (Bithyniidae) [1]–anurans (Anura) [3]–snakes (Colubridae, Viperidae) [5]	[113,114]
Encyclometra colubrimurorum, larvae	gastropods (unknown) [1]–anurans (Anura) [3]–snakes (Colubridae, Viperidae) [5]	[114]
Rhabdias bufonis	soil–oligochaetes, gastropods [4]–anurans (Anura) [5]	[33,115,116]
Strongyloides spiralis	unknown	
Oswaldocruzia filiformis	soil–amphibians (Amphibia) [5]	[117–119]
Aplectana acuminata	unknown	
Cosmocerca ornata	water–anurans (Anura) [5]	[120,121]
Cosmocerca commutata	soil–anurans (Anura) [1,5]	[122,123]
Oxysomatium brevicaudatum	soil–anurans (Anura) [5]	[118,122]
Neoraillietnema praeputiale	unknown	
Icosiella neglecta	wood lice (Ceratopogonidae) [1]–frogs (Ranidae) [5]	[124,125]

Note: [1]—intermediate host; [2]—intercalary host; [3]—additional host; [4]—paratenic host; [5]—definitive host.

The largest number of helminth species has been recorded in the moor frog from the Republic of Mordovia (26 species), the Samara region (24), and the Republic of Bashkortostan (22); the smallest number has been recorded in the Republic of Tatarstan (9), Vologda (7), and Ivanovo (6) regions. The same indicator for this host in the Nizhny Novgorod (16) and Saratov (10) regions is characterized by intermediate values (Table 1). The reasons for the differences are usually complex: from the different number of amphibians studied in a particular region to the biotopic differences in their habitats, types of biomes, geographical location, climate, and the degree of anthropogenic impact. It is difficult to carry out statistical processing of data that were obtained by different authors at different times and in different seasons. However, even on the basis of the mentioned information, conclusions can be drawn. It is not only the intensive study of helminth fauna that has affected the list of species in recent years. For example, the number of materials studied was similar in the Republic of Mordovia and the Republic of Tatarstan. However, the species richness of helminths differed significantly. We think that this depends on the geographical and climatological characteristics of the range of *R. arvalis*. The Republic of Tatarstan has a more continental climate, which influences the activity of amphibians.

The composition of helminths of the moor frog differs in certain regions of the Volga basin. Comparative analysis shows that only three species out of 38 were found in all samples: the nematodes *Rh. bufonis*, *O. filiformis*, and *C. ornata*. Among trematodes, the most widespread species is *H. cylindracea*, which has been recorded in seven regions. This group of helminth species (4) forms the core of the helminth fauna of the moor frog in the Volga river basin. Largest group of species (26) are common parasites of this host, occurring sporadically: in five (3 species), four (6), three (9), and two (8) regions. The last 8 species of cestodes (*S. erinacei*, larvae), trematodes (*H. ovocaudatus*, *G. varsoviensis*, *B.*

turgida, *T. excavata*, larvae, *Ph. cordatum*, larvae) and nematodes (*S. spiralis* and *I. neglecta*), belong to the group of rare or accidental parasites of the moor frog and have a strict local confinement (Table 1).

3. Discussion

The biology and ecology of the moor frog is characterized by a number of life-history traits: (1) active terrestrial lifestyle in wet forest, forest-steppe, and even steppe stations; (2) feeding on terrestrial invertebrates (oligochaetes, mollusks, insects, millipedes, arachnids); (3) visiting ponds and lakes during spawning; (4) "mating fasting". The range of *R. arvalis* in the Volga basin is extensive and the habitats are extremely diverse [126].

These factors determine the species composition, structure and community of the helminth fauna in this frog, distinguishing 3 groups of parasite species. The first group (18 species) includes adult biohelminths (trematodes). They are characterized by a variety of species, but usually have a low infestation level. The reason is feeding on terrestrial prey, the seasonal visit of water bodies for reproduction and the "mating fasting" of the host. The second group (8) includes adult geohelminths (nematodes). With a smaller number of species, they have a wide distribution, frequent occurrence and a high level of invasion, which is influenced by the lifestyle of the moor frog. The third group (11) includes larval biohelminths (trematodes, cestodes). They occur sporadically and with different infestations depending on the presence of predators of a higher trophic level and the degree of habitat degradation.

The moor frog plays an important biocoenotic role as prey of a number of predators: snakes, owls, crows and diurnal birds of prey, canine and feline mammals. This is evidenced by the presence of larval stages of helminths (cestodes and trematodes). They circulate through trophic levels and complete their development in the body of representatives of these groups of vertebrates. In addition to the definitive hosts, this amphibian species has the ability to transmit mesocercariae and metacercariae of individual trematode species (families Strigeidae, Diplostomidae) a vast number of their reservoir hosts: green frogs, vipers and lizards, ducks, gulls and chickens, rodents, martens, insectivorous and canine mammals, wild boars. These facts indicate the significant role of the moor frog in the circulation of parasites in terrestrial and near-water natural biocoenoses of the Volga river basin. Changes in natural communities can negatively influence the population of *R. arvalis*. A decrease in the number of this species will lead to changes in the circulation of helminths along trophic chains within the ecosystem. In this regard, it is necessary to monitor the impact of climate change on the helminth fauna of *R. arvalis* in different parts of its range.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Annotated List of *Rana arvalis* Helminths in the Volga River Basin

Phylum Plathelminthes Schneider, 1873
Class Cestoda Rudolphi, 1808
Order Diphyllobothriidea Kuchta, Scholz, Brabec et Bray, 2008
Family Diphyllobothriidae Lühe, 1910

Spirometra erinacei (Rudolphi, 1918), larvae
Localization: musculature.
Areas of detection: The Republic of Mordovia [127]. It was discovered in the moor frog of the fauna of the Volga basin for the first time.
Biology: Oligohostal parasite of frogs (Ranidae). Trixenic life cycle (Table 2).
Distribution: cosmopolite.

Class Trematoda Rudolphi, 1808
Order Hemiurida Skrjabin et Guschanskaja, 1956
Family Derogenidae Nicoll, 1910

Halipegus ovocaudatus (Vulpian, 1859)
Localization: oral cavity.
Areas of detection: The Republic of Tatarstan [65].
Biology: Polyhostal parasite of anurans (Anura). Tetraxenic life cycle (Table 2).
Distribution: Europe.

Order Paramphistomida Skrjabin et Schulz, 1937
Family Diplodiscidae Cohn, 1904

Diplodiscus subclavatus (Pallas, 1760)
Localization: rectum, small intestine.
Areas of detection: Nizhny Novgorod [66,68,69] and Samara [128–133] regions, the Republics of Mordovia [131,134–138], Tatarstan [64,65] and Bashkortostan [62,63,139–141].
Biology: Polyhostal parasite of amphibians (Amphibia). Dixenic life cycle (Table 2).
Distribution: cosmopolite.

Order Fasciolida Skrjabin et Schulz, 1935
Family Gorgoderidae Looss, 1899

Gorgodera cygnoides (Zeder, 1800)
Localization: bladder.
Areas of detection: The Republics of Mordovia [138], Tatarstan [64] and Bashkortostan [63,139,140,142,143].
Biology: Polyhostal parasite of anurans (Anura). Trixenic life cycle (Table 2).
Distribution: Palaearctic.

Gorgodera microovata Fuhrmann, 1924
Localization: bladder.

Areas of detection: Nizhny Novgorod region [68], the Republic of Mordovia [135,136,138].

Biology: Oligohostal parasite of frogs (Ranidae). Life cycle is not known. Probably the same as in other trematodes of the Gorgoderidae family.

Distribution: Europe.

Gorgodera pagenstecheri Sinitzin, 1905

Localization: bladder.

Areas of detection: Nizhny Novgorod region [68,69], the Republic of Mordovia [134–136].

Biology: Oligohostal parasite of frogs (Ranidae). Trixenic life cycle (Table 2).

Distribution: Palaearctic.

Gorgodera varsoviensis Sinitzin, 1905

Localization: bladder.

Areas of detection: Samara region [128–130,133,135]. It was discovered in the moor frog of the fauna of Russia and the Volga basin for the first time.

Biology: Oligohostal parasite of frogs (Ranidae). Trixenic life cycle (Table 2).

Distribution: Europe.

Gorgoderina vitelliloba (Olsson, 1876)

Localization: bladder.

Areas of detection: Nizhny Novgorod region [68,69], the Republics of Mordovia [135,136,138] and Bashkortostan [63,139,140,142,143].

Biology: Polyhostal parasite of anurans (Anura). Trixenic life cycle (Table 2).

Distribution: Palaearctic.

Order Plagiorchiida La Rue, 1957

Family Plagiorchiidae Luhe, 1901

Haplometra cylindracea (Zeder, 1800)

Localization: lungs.

Areas of detection: Vologda [144,145], Ivanovo [146], Nizhny Novgorod [67–69], Samara [128–130,132,133,135] and Saratov [131,135] regions, the Republic of Mordovia [131,134–138] and Bashkortostan [63,139–141].

Biology: Oligohostal parasite of frogs (Ranidae). Trixenic life cycle (Table 2).

Distribution: Palaearctic.

Family Telorchiidae Looss, 1899

Dolichosaccus rastellus (Olsson, 1876)

Localization: small intestine.

Areas of detection: Samara [132,133,135] and Saratov [131,135] regions, the Republics of Mordovia [131,134–136] and Bashkortostan [141].

Biology: Oligohostal parasite of frogs (Ranidae). Trixenic life cycle (Table 2).

Distribution: Palaearctic.

Opisthioglyphe ranae (Frohlich, 1791)

Localization: small intestine.

Areas of detection: Nizhny Novgorod [66,67] and Samara [128–133,135] regions, the Republics of Mordovia [138], Tatarstan [65], and Bashkortostan [63,139,140].

Biology: Polyhostal parasite of amphibians (Amphibia). Trixenic life cycle (Table 2).

Distribution: Palaearctic.

Family Leptophallidae Dayal, 1938

Paralepoderma cloacicola (Luhe, 1909), larvae
Localization: musculature, kidneys.
Areas of detection: Samara [128–133,135] and Saratov [131,135] regions, the Republic of Mordovia [131,134–138].
Biology: Polyhostal parasite of amphibians (Amphibia) at the metacercariae stage. Trixenic life cycle (Table 2).
Distribution: Palaearctic.

Family Haematoloechidae Freitas et Lent, 1939

Haematoloechus (=*Pneumonoeces*) *variegatus* (Rudolphi, 1819)
Localization: lungs.
Areas of detection: Ivanovo [146] and Samara [128,129,131,133,135] regions, the Republics of Mordovia [134–136] and Bashkortostan [63,139–141].
Biology: Polyhostal parasite of anurans (Anura). Trixenic life cycle (Table 2).
Distribution: Palaearctic.

Haematoloechus (=*Pneumonoeces*) *asper* (Looss, 1899)
Localization: lungs.
Areas of detection: Vologda [144,145] and Nizhny Novgorod [67] regions.
Biology: Oligohostal parasite of frogs (Ranidae). Trixenic life cycle (Table 2).
Distribution: Europe.

Skrjabinoeces similis (Looss, 1899)
Localization: lungs.
Areas of detection: Samara [131,133,135] and Saratov [131,135] regions, the Republic of Bashkortostan [142,143].
Biology: Oligohostal parasite of frogs (Ranidae). Trixenic life cycle (Table 2).
Distribution: Palaearctic.

Order Plagiorchiida La Rue, 1957
Family Pleurogenidae Looss, 1899

Brandesia turgida (Brandes, 1888)
Localization: pouch-like herniations (diverticula) in the wall of the duodenum.
Areas of detection: The Republic of Bashkortostan [63,139,140].
Biology: Oligohostal parasite of frogs (Ranidae). Life cycle is not known.
Distribution: Palaearctic.

Pleurogenes claviger (Rudolphi, 1819)
Localization: small intestine.
Areas of detection: Samara region [131,133,135], the Republics of Mordovia [131,134–137] and Bashkortostan [62,63,139,140].
Biology: Polyhostal parasite of amphibians (Amphibia). Trixenic life cycle (Table 2).
Distribution: cosmopolite.

Pleurogenes intermedius Issaitchikov, 1926
Localization: pouch-like herniations (diverticula) in the wall of the bladder, intestine, and abdominal musculature.
Areas of detection: Samara region [132,133], the Republics of Mordovia [131,134–136,138] and Bashkortostan [62,63,139–143].
Biology: Oligohostal parasite of frogs (Ranidae). Life cycle is not known.

Distribution: Palaearctic.

Pleurogenoides medians (Olsson, 1876)
Localization: small intestine.
Areas of detection: Vologda [144,145] and Nizhny Novgorod [66,68,69] regions, the Republics of Mordovia [138] and Bashkortostan [62,63,139–141].
Biology: Polyhostal parasite of anurans (Anura). Trixenic life cycle (Table 2).
Distribution: Palaearctic.

Prosotocus confusus (Looss, 1894)
Localization: stomach, small intestine.
Areas of detection: Nizhny Novgorod [66,68,69] and Samara [128,129,131,133,135] regions, the Republic of Bashkortostan [63,139–141].
Biology: Polyhostal parasite of anurans (Anura). Trixenic life cycle (Table 2).
Distribution: Palaearctic.

Order Strigeidida (La Rue, 1926)
Family Strigeidae Railliet, 1919

Strigea strigis (Schrank, 1788), larvae
Localization: serous coat of inner organs, mesentery, musculature.
Areas of detection: Samara [128,129,131,133,135] and Saratov [131,135] regions, the Republics of Mordovia [131,134–138] and Bashkortostan [141].
Biology: Polyhostal parasite of anurans (Anura) at the mesocercariae and metacercariae stage. Tetraxenic life cycle (Table 2).
Distribution: Palaearctic.

Strigea sphaerula (Rudolphi, 1803), larvae
Localization: serous coat of inner organs, pericardium, mesentery, musculature.
Areas of detection: Samara region [128,129,133], the Republics of Mordovia [131,134–138] and Bashkortostan [139–141,147].
Biology: Polyhostal parasite of anurans (Anura) at the mesocercariae and metacercariae stage. Tetraxenic life cycle (Table 2).
Distribution: Europe.

Strigea falconis Szidat, 1928, larvae
Localization: musculature.
Areas of detection: Samara region [133] and the Republic of Mordovia [134–138]. It was discovered in the moor frog of the fauna of Russia and the Volga basin for the first time.
Biology: Polyhostal parasite of anurans (Anura) at the mesocercariae and metacercariae stage. Tetraxenic life cycle (Table 2).
Distribution: cosmopolite.

Family Diplostomidae Poirier, 1886

Neodiplostomum spathoides Dubois, 1937, larvae
Localization: musculature, body cavity, subcutaneous tissue.
Areas of detection: Samara region [128,129,131–133,135] and the Republic of Mordovia [138]. It was discovered in the moor frog of the fauna of Russia and the Volga basin for the first time.
Biology: Oligohostal parasite of frogs (Ranidae) at the metacercariae stage. Trixenic life cycle (Table 2).
Distribution: Palaearctic.

Tylodelphys excavata (Rudolphi, 1803), larvae

Localization: spinal cord canal.

Areas of detection: Samara region [133]. It was discovered in the moor frog of the fauna of Russia and the Volga basin for the first time.

Biology: Polyhostal parasite of anurans (Ranidae, Discoglossidae) at the metacercariae stage. Trixenic life cycle (Table 2).

Distribution: Palaearctic.

Alaria alata (Goeze, 1782), larvae

Localization: musculature, mesentery, serous coat of the internal organs.

Areas of detection: Samara [128–133,135] and Saratov [131,135] regions, the Republics of Mordovia [131,134–138] and Bashkortostan [63,139–141,147].

Biology: Polyhostal parasite of anurans (Anura) at the mesocercariae stage. Trixenic life cycle (Table 2).

Distribution: cosmopolite.

Pharyngostomum cordatum (Diesing, 1850), larvae

Localization: musculature, mesentery, pericardium, body cavity, stomach, and intestinal walls.

Areas of detection: Samara region [128,129,131,133,135]. It was discovered in the moor frog of the fauna of Russia and the Volga basin for the first time.

Biology: Oligohostal parasite of frogs (Ranidae) at the metacercariae stage. Trixenic life cycle (Table 2).

Distribution: Palaearctic.

Incertae sedis group

Astiotrema monticelli Stossich, 1904, larvae

Localization: intestine mesentery.

Areas of detection: Samara region [132,133,135] and the Republic of Mordovia [131,134–136]. It is observed for the first time in moor frog on the territory of Russia and Volga basin.

Biology: Polyhostal parasite of anurans (Anura) at the metacercariae stage. Trixenic life cycle (Table 2).

Distribution: Europe.

Encyclometra colubrimurorum (Rudolphi, 1819), larvae

Localization: body cavity, serous coat of internal organs (liver, spleen, ovary), mesentery.

Areas of detection: Samara [132,133,135] and Saratov [131,135] regions. It was discovered in the moor frog of the fauna of Russia and the Volga basin for the first time.

Biology: Polyhostal parasite of anurans (Ranidae, Pelobatidae) at the metacercariae stage. Trixenic life cycle (Table 2).

Distribution: Palaearctic.

Phylum Nematoda Cobb, 1932

Class Chromadorea Inglis, 1983

Order Panagrolaimida Hodda, 2007

Family Rhabdiasidae Railliet, 1915

Rhabdias bufonis (Schrank, 1788)

Localization: lungs.

Areas of detection: Vologda [144,145], Ivanovo [146], Nizhny Novgorod [66–69], Samara [128,129,131,133,135], and Saratov [131,135] regions, the Republics of Mordovia [131,134–138], Tatarstan [65] and Bashkortostan [62,63,139–143].

Biology: Polyhostal parasite of anurans (Anura). Monoxenic life cycle (geohelminth) (Table 2).

Distribution: Holarctic.

Family Strongyloididae Chitwood et McIntosh, 1934

Strongyloides spiralis Grabda-Kazubska, 1978

Localization: rectum

Areas of detection: Samara region [128,129,131,133,135]. It was discovered in the moor frog of the fauna of Russia and the Volga basin for the first time.

Biology: Oligohostal parasite of frogs (Ranidae). Life cycle is not known.

Distribution: Holarctic.

Family Trichostrongylidae Leiper, 1908

Oswaldocruzia filiformis (Goeze, 1782)

Localization: small intestine.

Areas of detection: Vologda [144,145], Ivanovo [146], Nizhny Novgorod [66–69], Samara [128–133,135] and Saratov [131,135] regions, the Republics of Mordovia [131,134–138], Tatarstan [65], and Bashkortostan [62,63,139–143,147].

Biology: Polyhostal parasite of amphibians (Amphibia). Monoxenic life cycle (geohelminth) (Table 2).

Distribution: Palaearctic. The results of partial sequencing and molecular phylogenetic analysis of CoxI mtDNA gene showed that all *Oswaldocruzia* species in this study belonged to the same species [119].

Order Spirurida Railliet, 1914

Family Cosmocercidae Travassos, 1925

Aplectana acuminata (Schrank, 1788)

Localization: intestine.

Areas of detection: Vologda [144,145], Ivanovo [146] and Nizhny Novgorod [66] regions, the Republics of Tatarstan [64,65], and Bashkortostan [63,139–141,143].

Biology: Polyhostal parasite of tadpoles, less often—adult anurans (Anura). Monoxenic life cycle (geohelminth) (Table 2).

Distribution: Europe.

Cosmocerca ornata (Dujardin, 1845)

Localization: rectum.

Areas of detection: Vologda [144,145], Ivanovo [146], Nizhny Novgorod [66–69], Samara [128–133,135] and Saratov [131,135] regions, the Republics of Mordovia [131,134–138], Tatarstan [64,65], and Bashkortostan [141–143].

Biology: Polyhostal parasite of amphibians (Amphibia). Monoxenic life cycle (geohelminth) (Table 2).

Distribution: Europe.

Cosmocerca commutata (Diesing, 1851)

Localization: rectum.

Areas of detection: Nizhny Novgorod region [66], the Republics of Tatarstan [64,65], and Bashkortostan [63,139,140,143].

Biology: Monohostal parasite of the green toad (*Bufotes viridis* Laurenti, 1768). Monoxenic life cycle (geohelminth) with obligatory amphixeny (Table 2).

Distribution: Palaearctic.

Oxysomatium brevicaudatum (Zeder, 1800)

Localization: rectum.

Areas of detection: Nizhny Novgorod region [66–69], the Republics of Mordovia [131,135–137] and Bashkortostan [63,139,140].

Biology: Polyhostal parasite of amphibians (Amphibia). Monoxenic life cycle (geohelminth) (Table 2).

Distribution: Holarctic.

Neoraillietnema praeputiale (Skrjabin, 1916)

Localization: rectum.

Areas of detection: Nizhny Novgorod region [66,68,69] and the Republic of Mordovia [127].

Biology: Polyhostal parasite of anurans (Anura). Monoxenic life cycle (geohelminth) (Table 2).

Distribution: Europe.

Family Onchocercidae (Leiper, 1911)

Icosiella neglecta (Diesing, 1851)

Localization: muscles, subcutaneous tissue.

Areas of detection: The Republic of Mordovia [138]. First observed in the moor frog of Russia and the Volga basin.

Biology: Oligohostal parasite of frogs (Ranidae). Dixenic life cycle (Table 2).

Distribution: Palaearctic.

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