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Review

Trematodes of Land Birds from the Republic of Mordovia with a Checklist of Avian Trematodes of the Middle Volga Region (European Russia)

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Abstract: We studied the trematode fauna in land birds from the Republic of Mordovia (European Russia) in 2018–2022. In total, we identified 16 digenean species in 45 species of birds from the orders Passeriformes, Piciformes, Caprimulgiformes and Falconiformes. The trematodes *Phaneropsolus micrococcus* and *Morishitum polonicum* were recorded for the first time in the birds' parasite fauna of Russia. We obtained the first data on helminths in *Hippolais icterina* and *Ficedula albicollis* from Russia and in *Coccothraustes coccothraustes* from the Middle Volga region. New host records resulting from our study include *Brachylaima mesostoma* from *Coccothraustes coccothraustes*; *Urogonimus macrostomus* from *Sylvia atricapilla*, *Ficedula albicollis*, *Ficedula hypoleuca* and *Acrocephalus palustris*; *Plagiorchis maculosus* from *Ficedula albicollis* and *Hippolais icterina*; and *Lyperosomum alaudae* from *Ficedula hypoleuca*. The common parasite of rallid birds *Leucochloridium holostomum* is recorded for the first time from *Turdus merula* in Russia. Taking into account the newly obtained data, we carried out a review of trematodes in land birds of the Middle Volga region, of which the Republic of Mordovia is a part. Currently, the list of land bird digeneans in the Middle Volga region includes 56 species. Among all the studied land birds, members of the order Passeriformes have the richest trematode fauna (33 species). The diversity of trematodes found in passerines is due to the large number of both individuals and species studied and the variety of habitats and diet preferences of these land birds. Most of the identified trematode faunas (47 species) are obligate parasites of land birds. Nine species parasitize land birds accidentally and/or facultatively. In the Middle Volga area, the fauna of trematodes is the most diverse in land birds of the Nizhny Novgorod region, where 31 species are revealed. Fewer species of trematodes are identified in birds from the Bashkortostan (20), Mordovia (17) and Samara regions (15). For the birds of Chuvashia and Tatarstan, only eight and one species of trematodes are known, respectively. Six trematode species, found in land birds, have veterinary and medical significance as potential pathogens of dangerous helminthiases.

Keywords: Aves; Trematoda; land birds; European Russia; Middle Volga region; Mordovia; overview

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1. Introduction

Wild land birds are an inseparable part of natural ecosystems and are involved in the life cycles of parasitic worms, including trematodes. Parasitic infections may cause the morbidity, a reduction in fecundity or even the mortality of birds [1,2]. Land birds are involved in the maintenance and spreading of natural foci of zoonoses, especially in relation to migratory bird species [3,4]. They have a number of helminthiases in common with domestic birds and gamebirds, and can be sources of infection for them [5,6]. In this regard, the study of trematode fauna of birds is relevant. In addition, studies on the parasitic worms, in particular trematodes, of vertebrates is important for biodiversity research. Therefore, the study of the trematode fauna of land birds is of great scientific and practical significance.

About 300 species of birds (sedentary, migratory and vagrant) belonging to 21 orders inhabit the territory of the Middle Volga region [7–10]. The diversity of the avifauna of the Republic of Mordovia is due to the location of the region at the junction of broad-leafed forests, southern taiga and forest-steppe zones. The bird fauna includes 259 species, of which 189 nest in the region. Land birds are represented by 165 species from 11 orders [11].

Helminths in birds on the territories of Russia and adjacent countries have been the focus of parasitological studies for more than 130 years [6,12]. However, among studies related to bird helminths in the fauna of Mordovia, only the works by Oliger [13–15] on parasites of Galliformes can be mentioned.

Data on the parasitic worms (and in particular trematodes) of birds in Mordovia are rare, therefore we presented the results of our own research with an overview of the digenean fauna of land birds in the Middle Volga region.

2. Materials and Methods

2.1. Trapping of Land Birds

The material for this work was from our own field studies of helminths in land birds in the territory of the Republic of Mordovia, which were carried out in period 2018 to 2022. Trematode specimens were collected from land birds at thirteen sites in the Republic of Mordovia (European Russia): Mordovia Nature Reserve (54°48′37″ N, 43°19′1″ E), Novenkiy cordon (54°42′29″ N, 43°12′45″ E), Inorki Lake (54°43′41″ N, 43°8′60″ E), Picherki Lake (54°44′47″ N, 43°7′4″ E), Taratinskiy cordon (54°44′42″ N, 43°5′12″ E), Pushta village (54°43′7″ N, 43°13′46″ E), Novenkovskiy cordon (54°55′54″ N, 43°25′17″ E), Pavlovka village (54°44′57″ N, 43°24′4″ E), the vicinity of Veseliy village (54°34′6″ N, 43°13′16″ E), Mitryashki Lake (54°44′41″ N, 45°30′21″ E), Obrezki village (54°50′8″ N, 45°22′57″ E), Barakhmanovskoye forestry (54°45′58″ N, 45°33′45″ E) and Ichalkovskiy district (54°42′24″ N, 45°21′9″ E). The research sites were located mainly surrounding the Mordovia State Nature Reserve and the National Park "Smolny". Figure 1 shows the study sites of the trematode fauna in land birds.

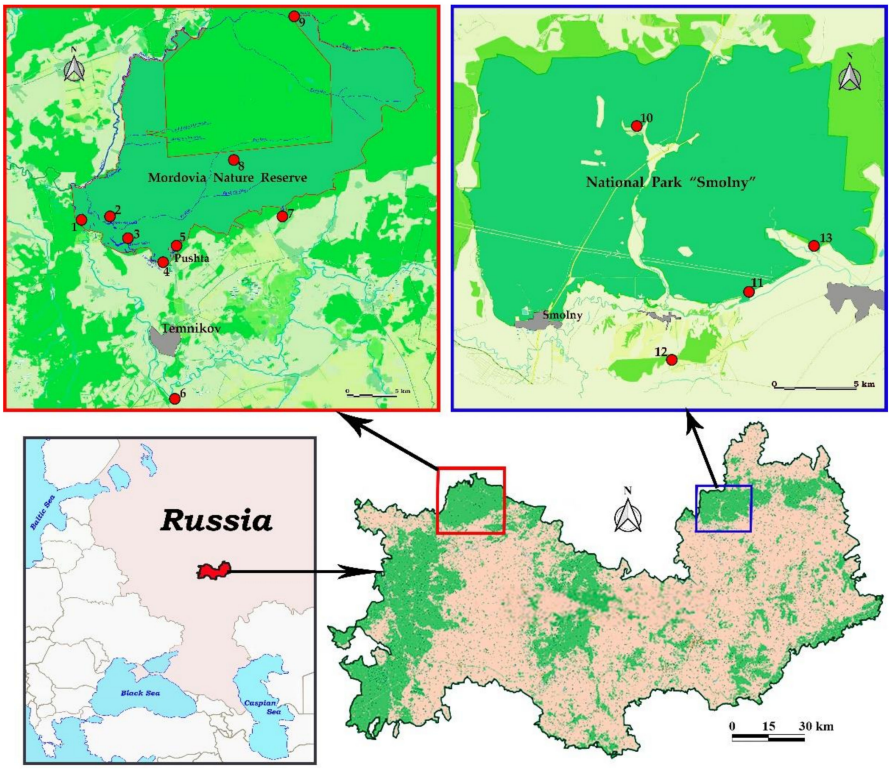

Figure 1. A map of land birds' trapping places in the Republic of Mordovia (European Russia). Red circles in the map show the bird trapping sites. 1—Taratinskiy cordon, 2—Inorki Lake, 3— Picherki

Lake, 4—Novenkiy cordon, 5—Pushta village, 6—vicinity of Veseliy village, 7—Pavlovka village, 8—Mordovia Nature Reserve, 9—Novenkovskiy cordon, 10—Obrezki village, 11—Mitryashki Lake, 12—Ichalkovskiy district, 13—Barakhmanovskoye forestry.

A total of 391 birds of 45 species from four orders were studied (Table 1). Our work also uses the data by Oliger [13–15].

Table 1. List of land birds examined in Mordovia.

Bird Species	Examined/Infected	Bird Species	Examined/Infected
Passeriformes		**Passeriformes**	
Garrulus glandarius	1(1)	*Motacilla alba*	8(2)
Corvus frugilegus	7(2)	*Anthus trivialis*	3(3)
Hirundo rustica	1(1)	*Coccothraustes coccothraustes*	2(1)
Aegithalos caudatus	8(0)	*Passer montanus*	1(1)
Poecile montanus	21(8)	*Pyrrhula pyrrhula*	2(2)
Parus major	71(6)	*Spinus spinus*	1(0)
Cyanistes caeruleus	23(0)	*Carpodacus erythrinus*	1(0)
Sitta europaea	2(0)	*Fringilla coelebs*	42(8)
Turdus philomelos	26(10)	*Carduelis chloris*	2(0)
Turdus merula	4(4)	*Carduelis carduelis*	16(0)
Turdus iliacus	1(1)	*Emberiza citrinella*	5(3)
Turdus viscivorus	3(0)	*Acrocephalus palustris*	3(2)
Phylloscopus collybita	4(1)	*Acrocephalus dumetorum*	1(0)
Phylloscopus sibilatrix	1(1)	*Hippolais icterina*	5(1)
Sylvia nisoria	1(0)	**Galliformes**	
Sylvia borin	8(1)	*Lyrurus tetrix*	24(1) [1]
Sylvia atricapilla	26(7)	**Falconiformes**	
Sylvia communis	1(0)	*Buteo buteo*	1(1)
Muscicapa striata	1(1)	**Caprimulgiformes**	
Ficedula hypoleuca	16(3)	*Caprimulgus europaeus*	4(4)
Ficedula albicollis	5(2)	**Piciformes**	
Phoenicurus phoenicurus	11(2)	*Dendrocopos leucotos*	2(2)
Erithacus rubecula	27(3)	*Dendrocopos major*	10(1)
Luscinia luscinia	8(0)	*Picus canus*	1(0)
Lanius collurio	2(0)	*Jynx torquilla*	2(0)

Note: [1]—data by Oliger [13–15].

Birds were trapped with mist nets. We used the common method of stretching the net between two vertical poles [16–18]. Telescopic fishing rods 7 m long were used as poles, tied to metal pegs placed into the ground. Moreover, birds that died from natural causes and roadkill specimens were taken for the study.

2.2. Parasite Examination

Birds were examined by the methods of complete helminthological dissection [19]. Trematodes were collected from birds and fixed in 70% ethanol. Digeneans were stained with aceto-carmine and dehydrated in a graded ethanol series (70–96%). Then parasitic worms were cleared in clove oil and mounted in Canada balsam.

The trematode identification was carried out at the Laboratory of Population Ecology of the Institute of Ecology of the Volga Basin of the Russian Academy of Sciences (Togliatti, Russia). The helminth species were identified mainly according to publications of Bykhovskaya-Pavlovskaya [12,20], Skrjabin [21], Sudarikov [22], Sharpilo [23] and Kirillov with co-authors [6,24,25]. Trematode specimens were stored in the helminth collection in the Institute of Ecology of Volga Basin of RAS—a Branch of the Samara Federal Research Center of RAS.

The following parameters were used to characterize the trematode infection in birds: the prevalence of infection (P, %) and the number of infected among the studied bird individuals and the mean abundance (MA). For parasites, the following features were

given: Latin name, the general geographical distribution, the sites of findings and host species in the studied territory. The recent taxonomy of trematodes was given according to Fauna Europaea (https://faunaeu.org/, accessed on 3 January 2023) [26].

2.3. Trematode Data Collection

We conducted a review of trematodes in land birds of the Middle Volga area, which includes the territories of Chuvashia, Mordovia, Mari El, Tatarstan, Western Bashkortostan, Nizhny Novgorod, Samara, Ulyanovsk, the Penza regions, the West of Orenburg region and the North of Saratov region. Our review of the trematode fauna was based on the analysis of the literature data, as well as on the results of the authors' own research in the Republic of Mordovia and Samara regions. We searched parasitological literature on the land birds' trematodes using international databases Web of Science Core Collection, Scopus, Google Scholar and eLIBRARY.ru (Russian scientific electronic library). However, most of the references for our review were taken from the former USSR parasitological literature in Russian, not indexed in electronic databases. Literature sources were collected in the Nizhny Novgorod State Regional Universal Scientific Library, Samara Regional Universal Scientific Library and Scientific Library of Mordovia Nature Reserve. The analysis of literary sources was conducted between 1925 and 2022. We also used reviews on the helminths of the former USSR, Russia and adjacent countries [6,12,22–25,27].

3. Results

3.1. Trematodes of Land Birds in Mordovia (European Russia)

It was found that out of 46 species of birds studied in Mordovia, 31 species of them were infested with trematodes (Table 1). A total of 17 species of trematodes were found in land birds of Mordovia. Sixteen species were identified as a result of our research and one species was identified in the Galliformes birds of Mordovia by Oliger [13–15].

Parasite–Host checklist of trematodes from birds in Mordovia

Family Brachylaimidae

1. *Brachylaima mesostoma* (Rudolphi, 1803)

   Hosts: *Turdus philomelos*, *Turdus merula*, *Coccothraustes coccothraustes*.
   Site: small intestine.
   Localities: Mitryashki Lake—*T. philomelos* (P = 33.3%; in 1 of 3 examined; MA = 1.3); Obrezki village—*T. merula* (50.0%; in 1 of 2 examined; 1.5), *C. coccothraustes* (50.0%; in 1 of 2 examined; 0.5).

Family Leucochloridiidae

2. *Leucochloridium holostomum* (Rudolphi, 1819)

   Host: *Turdus merula*.
   Site: cloaca.
   Locality: Novenkiy cordon (100%; in 1 examined; 3.0).

3. *Leucochloridium phragmitophila* Bykhovskaja-Pavlovskaja et Dubinina, 1951

   Host: *Erithacus rubecula*.
   Site: small intestine, cloaca.
   Localities: Picherki Lake (33.3%; in 1 of 3 examined; 4.0), Obrezki village (15.4%; in 2 of 13 examined; 0.9).

4. *Urogonimus macrostomus* (Rudolphi, 1802)

   Hosts: *Dendrocopos leucotos*, *Dendrocopos major*, *Turdus philomelos*, *Turdus merula*, *Turdus iliacus*, *Garrulus glandarius*, *Muscicapa striata*, *Fringilla coelebs*, *Hirundo rustica*, *Parus major*, *Ficedula hypoleuca*, *Ficedula albicollis*, *Acrocephalus palustris*, *Poecile montanus*, *Sylvia atricapilla*, *Pyrrhula pyrrhula*.
   Site: large intestine, cloaca.

Localities: Obrezki village—*F. coelebs* (11.8%; in 2 of 17 examined; 0.2), *D. leucotos* (100%; in 2 examined; 11.0), *T. philomelos* (41.7%; in 5 of 12 examined; 2.0), *T. merula* (50.0%; in 1 of 2 examined; 1.0), *T. iliacus* (100%; in 1 examined; 9.0), *G. glandarius* (100%; in 1 examined; 5.0), *F. hypoleuca* (20.0%; in 1 of 5 examined; 1.4), *F. albicollis* (20.0%; in 1 of 5 examined; 3.4), *A. palustris* (66.7%; in 2 of 3 examined; 34.0), *P. montanus* (40.0%; in 8 of 20 examined; 11.7), *S. atricapilla* (20.0%; in 5 of 25 examined; 1.6), *P. major* (5.1%; in 2 of 39 examined; 0.3); Pushta village—*H. rustica* (100%; in 1 examined; 2.0), *F. coelebs* (100%; in 1 examined; 65.0), *P. pyrrhula* (100%; in 2 examined; 1.5), *M. striata* (100%; in 1 examined; 1.0), *P. major* (50.0%; in 1 of 2 examined; 1.5); Picherki Lake—*F. coelebs* (14.3%; in 1 of 7 examined; 3.0), *D. major* (50.0%; in 1 of 2 examined; 1.5); Mitryashki Lake—*T. philomelos* (66.7%; in 2 of 3 examined; 2.3); Pavlovka village—*T. philomelos* (50.0%; in 1 of 2 examined; 18.5); Inorki Lake—*T. philomelos* (33.3%; in 1 of 3 examined; 14.3).

Family Plagiorchiidae

5. *Plagiorchis elegans* (Rudolphi, 1802)

   Hosts: *Caprimulgus europaeus*, *Parus major*, *Passer montanus*, *Phylloscopus collybita*.
   Site: small intestine.
   Localities: Pushta village—*C. europaeus* (100%; in 1 examined; 2.0), *P. major* (50.0%; in 1 of 2 examined; 1.0); Barakhmanovskoye forestry—*C. europaeus* (100%; in 2 examined; 2.0); Picherki Lake—*P. collybita* (33.3%; in 1 of 3 examined; 0.7); Taratinskiy cordon—*C. europaeus* (100%; in 1 examined; 3.0); Smolny village—*P. montanus* (100%; in 1 examined; 1.0); Obrezki village—*P. major* (5.1%; in 2 of 39 examined; 0.1).

6. *Plagiorchis maculosus* (Rudolphi, 1802)

   Hosts: *Fringilla coelebs*, *Emberiza citrinella*, *Anthus trivialis*, *Ficedula hypoleuca*, *Ficedula albicollis*, *Phoenicurus phoenicurus*, *Phylloscopus sibilatrix*, *Sylvia atricapilla*, *Sylvia borin*, *Motacilla alba*, *Hippolais icterina*.
   Site: small intestine.
   Localities: Obrezki village—*F. coelebs* (23.5%; in 4 of 17 examined; 0.5), *E. citronella* (60.0%; in 3 of 5 examined; 0.8), *A. trivialis* (100%; in 3 examined; 1.7), *F. hypoleuca* (20.0%; in 1 of 5 examined; 0.4), *F. albicollis* (20.0%; in 1 of 5 examined; 0.2), *P. phoenicurus* (28.6%; in 2 of 7 examined; 0.3), *P. sibilatrix* (100%; in 1 examined; 1.0), *S. atricapilla* (80.0%; 0.1), *S. borin* (12.5%; in 1 of 8 examined; 0.1), *M. alba* (66.7%; in 2 of 3 examined; 2.3); Novenkovskiy cordon—*H. icterina* (100%; in 1 examined; 1.0).

Family Eumegacetidae

7. *Eumegacetes triangularis* (Looss, 1899) (= *Eumegacetes emendatus* Braun, 1901)

   Host: *Caprimulgus europaeus*.
   Site: large intestine.
   Locality: Taratinskiy cordon—100%; in 1 examined; 2 specimens.

Family Lecithodendriidae

8. *Phaneropsolus micrococcus* (Rudolphi, 1819)

   Host: *Caprimulgus europaeus*.
   Site: small intestine.
   Locality: Taratinskiy cordon—100%; in 1 examined; 5 specimens.

9. *Mosesia amplavaginata* (Oschmarin, 1961)

   Host: *Fringilla coelebs*.
   Site: small intestine.
   Locality: Picherki Lake (14.3%; in 1 of 7 examined; 1.0).

Family Dicrocoeliidae

10. *Brachylecithum attenuatum* (Dujardin, 1845)

    Host: *Turdus merula*.
    Site: liver ducts.
    Locality: Novenkiy cordon—100%; in 1 examined; 6 specimens.

11. *Brachylecithum fringillae* (Layman, 1923)

    Host: *Fringilla coelebs*.
    Site: liver ducts.
    Locality: Pavlovka village—8.3%; in 1 of 12 examined; 2.3.

12. *Lyperosomum alaudae* (Shtrom et Sondak, 1935)

    Hosts: *Turdus philomelos*, *Ficedula hypoleuca*.
    Site: gallbladder.
    Localities: Mitryashki Lake—*T. philomelos* (33.3%; in 1 of 3 examined; 2.0); Obrezki village—*F. hypoleuca* (20.0%; in 1 of 5 examined; 1.0).

13. *Lyperosomum longicauda* (Rudolphi, 1809)

    Host: *Corvus frugilegus*.
    Site: liver ducts.
    Locality: Ichalkovskiy district—28.6%; in 2 of 7 examined; 2.0.

Family Prosthogonimidae

14. *Prosthogonimus ovatus* (Rudophi, 1803)

    Host: *Lyrurus tetrix*.
    Site: bursa fabricii.
    Locality: Mordovia Nature reserve—40.0%; in 2 of 5 examined; 2.8 [13–15].

Family Strigeidae

15. *Cotylurus cornutus* (Rudolphi, 1808) s. l.

    Host: *Turdus philomelos*.
    Site: small intestine.
    Locality: Mitryashki Lake—66.7%; in 2 of 3 examined; 5.3.

16. *Parastrigea robusta* Szidat, 1928 (= *Apharyngostrigea parastrigiformis* Bykhovskaya-Pavlovskaya & Zhukov, 1953)

    Host: *Buteo buteo*.
    Site: small intestine.
    Locality: Veseliy village surroundings—100%; in 1 examined; 11 specimens.

17. *Morishitium polonicum* (Machalska, 1980)

    Hosts: *Turdus merula*, *Turdus philomelos*, *Coccothraustes coccothraustes*.
    Site: air sacs, body cavity.
    Locality: Obrezki village—*C. coccothraustes* (50.0%; in 1 of 2 examined; 2.5), *T. merula* (100%; in 2 examined; 5.0); Inorki Lake—*T. philomelos* (33.3%; in 1 of 3 examined; 23.7); Picherki Lake—*T. merula* (100%; in 1 examined; 22 specimens).

Three hundred and six individuals (78.3%) of 15 bird species were free from trematodes: *Picus canus*, *Jynx torquilla*, *Aegithalos caudatus*, *Cyanistes caeruleus*, *Carduelis chloris*, *Carduelis carduelis*, *Spinus spinus*, *Carpodacus erythrinus*, *Sitta europaea*, *Turdus viscivorus*, *Sylvia nisoria*, *Sylvia communis*, *Luscinia luscinia*, *Lanius collurio* and *Acrocephalus dumetorum* (Table 1). As a total, we collected 956 specimens of trematodes from the land birds helminthologically examined in Mordovia. The common infection of birds was P = 21.7%, MA = 2.5.

No species was found to parasitize the entire range of infected bird species in Mordovia. The most widespread was *Urogonimus macrostomus*, revealed in 16 bird species from two

orders. *Plagiorchis maculosus* was recorded in 11 species of birds of the order Passeriformes. *Plagiorchis elegans* was found in four bird species. *Brachylaima mesostoma* and *Morishitium polonicum* each had three bird species as hosts. *Lyperosomum alaudae* was found in two species of birds. Eleven trematode species were identified only in a single host species.

We found the largest number of trematode species in *Turdus philomelos*, *T. merula* (5 species each) and *Fringilla coelebs* (4). Fewer species of digeneans were recorded in *Caprimulgus europaeus*, *Ficedula hypoleuca* (3 each), *Parus major*, *Ficedula albicollis*, *Sylvia atricapilla* and *Coccothraustes coccothraustes* (2 species each). In the other 20 species of land birds, only one species of trematodes was detected.

The trematodes *Phaneropsolus micrococcus* (in *Caprimulgus europaeus*) and *Morishitium polonicum* (in *Coccothraustes coccothraustes*, *Turdus philomelos* and *T. merula*) were recorded in the land birds of Russia for the first time. *Brachylecithum attenuatum*, *Lyperosomum longicauda* and *Parastrigea robusta* were revealed in the territory of the Middle Volga region for the first time. *Leucochloridium holostomum* was first recorded in Russia in *Turdus merula*. Previously, the parasite was found in the Middle Volga region only in *Crex crex* [28].

In our study, new trematode hosts were identified including *Coccothraustes coccothraustes* for *Brachylaima mesostoma*; *Sylvia atricapilla*, *Ficedula albicollis*, *Ficedula hypoleuca* and *Acrocephalus palustris* for *Urogonimus macrostomus*; *Ficedula albicollis* and *Hippolais icterina* for *Plagiorchis maculosus*; and *Ficedula hypoleuca* for *Lyperosomum alaudae*.

3.2. List of Trematodes of Land Birds in the Middle Volga Region

Studies of the trematode fauna in land birds in the Middle Volga area were carried out in six of 11 regions: Chuvashia, Mordovia, Bashkortostan, Tatarstan, Nizhny Novgorod and Samara regions (Figure 2).

Figure 2. Map of the Middle Volga area showing regions with cases of trematode species reported in the land birds (dark red: more than 20 trematode species found in this region; medium red—10 or more trematode species; light red—fewer than 10 species; white—without helminthological studies of birds. The numbers show the quantity of identified trematode species).

In total, 126 species of trematodes were registered in 130 species of birds from the Middle Volga region [6,12,24,25,28,29]. Of these, 50 species were noted in 74 studied species of land birds from 10 orders. Taking into account the results of our research, the fauna of land bird trematodes included 56 species found in 79 bird species (Table 2).

Table 2. List of trematodes reported from land birds from the Middle Volga region (European Russia).

Helminth Species	D	Hosts	Locality	References
Family Brachylaimidae				
Brachylaima mesostoma (Rudolphi, 1803)	P	*Turdus philomelos*	Samara region	[24,29]
		Turdus philomelos, *Turdus merula*, *Coccothraustes coccothraustes*	Mordovia	This study
Family Leucochloridiidae				
Leucochloridium paradoxum Carus, 1835	H	*Emberiza aureola* *Luscinia svecica*	Nizhny Novgorod region	[24,27,30]
Leucochloridium phragmitophila Bykhovskaja-Pavlovskaja & Dubinina, 1951	P	*Motacilla alba*	Samara region	[24,29]
		Erithacus rubecula	Nizhny Novgorod region	[24,27]
		Erithacus rubecula	Mordovia	This study
Leucochloridium holostomum (Rudolphi, 1819)	C	*Turdus merula*	Mordovia	This study
Urogonimus certhiae (McIntosh, 1927)	H	*Tetrastes bonasia* *Oriolus oriolus*	Nizhny Novgorod region	[13–15,24,27,30]
Urogonimus macrostomus (Rudolphi, 1802)	H	*Dendrocopos major*, *Dendrocopos leucotos*, *Dryocopus martius*, *Picoides tridactylus*, *Tetrastes bonasia*, *Oriolus oriolus*, *Nucifraga caryocatactes*, *Turdus philomelos*, *Turdus iliacus*, *Carpodacus erythrinus*, *Fringilla coelebs*, *Passer montanus*	Nizhny Novgorod region	[24,27,30–35]
		Dendrocopos leucotos, *Dendrocopos major*, *Turdus philomelos*, *Turdus merula*, *Turdus iliacus*, *Garrulus glandarius*, *Muscicapa striata*, *Fringilla coelebs*, *Hirundo rustica*, *Parus major*, *Ficedula hypoleuca*, *Ficedula albicollis*, *Acrocephalus palustris*, *Poecile montanus*, *Sylvia atricapilla*, *Pyrrhula pyrrhula*	Mordovia	This study
		Sturnus vulgaris, *Carpodacus erythrinus*, *Fringilla coelebs*, *Anthus trivialis*, *Parus major*, *Muscicapa striata*, *Phylloscopus sibilatrix*	Samara region	[24,29]
		Oriolus oriolus, *Garrulus glandarius*, *Corvus cornix*, *Emberiza hortulana*, *Hirundo rustica*	Chuvashia	[24,27,28]
Family Cyclocoelidae				
Morishitium polonicum (Machalska, 1980)	P	*Turdus philomelos* *Turdus merula* *Coccothraustes coccothraustes*	Mordovia	[36], this study
Family Echinostomatidae				
Echinostoma revolutum (Frohlich, 1802)	C	*Corvus cornix*, *Corvus frugilegus*	Nizhny Novgorod region	[24,27,33,37]
		Corvidae sp.	Bashkortostan	[38]
Echinoparyphium agnatum Dietz, 1909	E	*Buteo buteo*	Nizhny Novgorod region	[24,27,32]

Table 2. *Cont.*

Helminth Species	D	Hosts	Locality	References
Echinoparyphium schulzi Mathevossian, 1938	P	*Columba livia*	Bashkortostan	[24,38,39]
Stephanoprora graciosa (Sudarikov, 1950)	E	*Pandion haliaetus*	Nizhny Novgorod region	[24,27,40]
Family Opisthorchiidae *Opisthorchis geminus* (Looss, 1896)	P	*Circus aeruginosus*	Bashkortostan	[24,38,41,42]
Opisthorchis dendriticus Morgan, 1927	P	*Circus aeruginosus*	Bashkortostan	[24,38,41,42]
Metorchis bilis (Braun, 1790)	H	*Circus aeruginosus*	Bashkortostan	[24,38,41,42]
Holometra exigua (Mühling, 1898)	P	*Circus aeruginosus*	Bashkortostan	[24,38,41,42]
Family Plagiorchiidae				
Plagiorchis elegans (Rudolphi, 1802)	H	*Anthus trivialis*, *Parus major*, *Passer montanus*, *Hirundo rustica*	Samara region	[25,29]
		Tetrastes bonasia, *Oriolus oriolus*, *Pica pica*, *Corvus cornix*, *Turdus pilaris*, *Lanius collurio*, *Anthus trivialis*, *Erithacus rubecula*, *Passer domesticus*, *Passer montanus*, *Motacilla flava*, *Acrocephalus schoenobaenus*, *Emberiza aureola*	Nizhny Novgorod region	[13–15,25,27,30,32–35,43–45]
		Caprimulgus europaeus, *Parus major*, *Passer montanus*, *Phylloscopus collybita*	Mordovia	This study
		Poecile montanus, *Sylvia curruca*, *Dendrocopos leucotos*, *Falco subbuteo*, *Circus aeruginosus*, Corvidae sp.	Bashkortostan	[25,38,42]
Plagiorchis laricola Skrjabin, 1924	P	*Parus major*	Samara region	[25,29]
Plagiorchis maculosus (Rudolphi, 1802)	C	*Fringilla coelebs*, *Emberiza citrinella*, *Anthus trivialis*, *Ficedula albicollis*, *Ficedula hypoleuca*, *Phoenicurus phoenicurus*, *Phylloscopus sibilatrix*, *Sylvia atricapilla*, *Sylvia borin*, *Motacilla alba*, *Hippolais icterina*	Mordovia	This study
		Corvus cornix, *Pica pica*, *Garrulus glandarius*, *Turdus iliacus*, *Lanius collurio*, *Phoenicurus phoenicurus*, *Fringilla coelebs*, *Ficedula hypoleuca*, *Passer domesticus*, *Passer montanus*, *Riparia riparia*	Nizhny Novgorod region	[27,30,32,34,35,37,45]
		Fringilla coelebs, *Emberiza citrinella*, *Anthus trivialis*, *Hirundo rustica*	Samara region	[25,29]
		Turdus philomelos, *Poecile montanus*, *Sitta europaea*, *Passer montanus*	Bashkortostan	[25,38,46]
		Apus apus, *Hirundo rustica*	Chuvashia	[25,27,28]

Table 2. *Cont.*

Helminth Species	D	Hosts	Locality	References
Plagiorchis multiglandularis Semenov, 1927	P	*Cuculis canorus*, *Corvus cornix*, *Corvus frugilegus*, *Pica pica*, *Nucifraga caryocatactes*, *Passer montanus*	Nizhny Novgorod region	[25,27,32,35,37,44,45]
Plagiorchis nanus (Rudolphi, 1802)	P	*Fringilla coelebs*, *Fringilla montifringilla*	Bashkortostan	[25,38]
		Picus viridis	Nizhny Novgorod region	[25,27,31,33]
Plagiorchis notabilis Nicoll, 1909	C	*Parus major*	Samara region	[25,29]
		Caprimulgis europeus	Tatarstan	[12,25,28]
		Caprimulgis europeus	Chuvashia	[12,25,27,28]
Family Collyriclidae *Cortrema magnicaudata* (Bychowskaya-Pavlovskaya, 1950)		*Acrocephalus schoenobaenus*	Nizhny Novgorod region	[25,27,32]
Family Eucotylidae				
Tamerlania zarudnyi Skrjabin, 1924	C	*Lanius collurio*	Samara region	[25,29]
		Garrulus glandarius, *Corvus monedula*, *Turdus iliacus*, *Anthus trivialis*, *Luscinia svecica*, *Erithacus rubecula*, *Fringilla coelebs*	Nizhny Novgorod region	[25,27,30,47]
Tamerlania japonica (Yamaguti, 1935)	P	*Garrulus glandarius*	Nizhny Novgorod region	[25,27,47]
Tanaisia fedtschenkoi Skrjabin, 1924	C	*Corvus cornix*	Nizhny Novgorod region	[25,27,33]
Family Eumegacetidae				
Eumegacetes triangularis (Looss, 1899) (= *Eumegacetes emendatus* Braun, 1901)	P	*Parus major*	Bashkortostan	[25,38]
		Caprimulgis europeus	Mordovia	This study
		Merops apiaster	Samara region	[25,29]
Family Lecithodendriidae				
Laterotrema vexans (Braun, 1901)	P	*Fringilla coelebs*	Samara region	[25,29]
		Passer domesticus, *Passer montanus*, *Pica pica*	Nizhny Novgorod region	[25,27,30,48]
Mosesia amplavaginata (Oschmarin, 1961)	P	*Fringilla coelebs*	Samara region	[25,29]
		Fringilla coelebs	Mordovia	This study
Phaneropsolus micrococcus (Rudolphi, 1819)		*Caprimulgis europeus*	Mordovia	This study
Family Prosthogonimidae				
Prosthogonimus cuneatus (Rudolphi, 1809)	C	*Circus macrourus*, Corvidae sp.	Bashkortostan	[25,38,39,41]
		Tetrastes bonasia, *Lyrurus tetrix*	Mordovia	[13–15,25,27]
		Tetrastes bonasia, *Lyrurus tetrix*, *Tetrao urogallus*, *Corvus cornix*, *Corvus frugilegus*, *Pica pica*, *Garrulus glandarius*, *Sturnus vulgaris*, *Anthus trivialis*	Nizhny Novgorod region	[13–15,25,27,32,33,37]
		Pica pica, *Garrulus glandarius*	Chuvashia	[25,27,28]

Table 2. *Cont.*

Helminth Species	D	Hosts	Locality	References
Prosthogonimus ovatus (Rudolphi, 1803)	C	*Falco vespertinus*, *Dendrocopos leucotos*, Corvidae sp.	Bashkortostan	[25,38,39]
		Cuculus canorus	Chuvashia	[25,27,28]
		Tetrastes bonasia, *Lyrurus tetrix*, *Tetrao urogallus*, *Turdus iliacus*, *Turdus pilaris*, *Corvus cornix*, *Nucifraga caryocatactes*, *Sturnus vulgaris*, *Anthus trivialis*, *Erithacus rubecula Muscicapa striata*, *Acrocephalus schoenobaenus*, *Sylvia nisoria*, *Passer domesticus*, *Passer montanus*	Nizhny Novgorod region	[13–15,25,27,30, 35,37,45]
		Turdus merula, *Parus major*, *Fringilla coelebs*	Samara region	[25,29]
		Lyrurus tetrix	Mordovia	[13–15,25,27]
Prosthogonimus rarus Braun, 1901	P	*Turdus pilaris*, *Corvus cornix*, *Phoenicurus phoenicurus*	Nizhny Novgorod region	[25,27,30,48]
Family Dicrocoeliidae *Brachylecithum asovi* (Layman, 1926)	P	*Luscinia luscinia*	Nizhny Novgorod region	[25,27]
Brachylecithum attenuatum (Dujardin, 1845)	P	*Turdus merula*	Mordovia	This study
Brachylecithum donicum (Issaitschikoff, 1919)	P	*Caprimulgis europeus*	Chuvashia	[25,27,28]
Brachylecithum fringillae (Layman, 1923)	P	*Fringilla coelebs* *Fringilla coelebs* *Fringilla coelebs*	Samara region Nizhny Novgorod region Mordovia	[25,29] [25,27,34] This study
Brachylecithum laniicola (Layman, 1926)	P	*Emberiza citrinella*	Samara region	[25,29]
Brachylecithum mosquensis (Skrjabin & Issaitschikoff, 1927)	H	*Fringilla coelebs*	Nizhny Novgorod region	[25,27,34]
Lyperosomum alaudae (Shtrom & Sondak, 1935)	E	*Turdus philomelos*, *Ficedula hypoleuca* *Alauda arvensis* *Anthus trivialis*	Mordovia Nizhny Novgorod region Samara region	This study [25,27,30] [25,29]
Lyperosomum clathratum (Deslongchamps, 1824)	P	*Apus apus*	Chuvashia	[25,27,28]
Lyperosomum longicauda (Rudolphi, 1809)	P	*Corvus frugilegus*	Mordovia	This study
Skrjabinus kalmikensis (Skrjabin & Issaitschikov, 1927)	E	*Sylvia atricapilla*	Nizhny Novgorod region	[25,27]
Skrjabinus petrovi Ajupov, 1951	P	*Columba livia*	Bashkortostan	[25,41]
Family Renicolidae *Renicola pandioni* Sudarikov, 1947	E	*Pandion haliaetus*	Nizhny Novgorod region	[25,27,49,50]
Renicola undecima Sudarikov, 1947	E	*Pandion haliaetus*	Nizhny Novgorod region	[25,27,49,50]

Table 2. *Cont.*

Helminth Species	D	Hosts	Locality	References
Family Strigeidae				
Strigea strigis (Schrank, 1788)	P	*Asio flammeus*, *Bubo scandiacus*, *Strix aluco*, *Strix uralensis*, *Aegolius funereus*	Bashkortostan	[25,38,42]
		Bubo bubo, Corvidae sp.	Nizhny Novgorod region	[25,27,32]
Strigea falconis Szidat, 1928	C	*Accipiter gentilis*, *Buteo buteo*, *Buteo lagopus*, *Falco vespertinus*, *Circus aeruginosus*, *Circus pygargus*	Bashkortostan	[25,38,42]
		Aquella chrysaetos	Nizhny Novgorod region	[25,27,32]
Strigea sphaerula (Rudolphi, 1803)	P	*Turdus philomelos*, *Corvus cornix*	Bashkortostan	[25,38,42,46]
Cotylurus cornutus (Rudolphi, 1808) s.l.	P	*Turdus philomelos*, Corvidae sp.	Bashkortostan	[25,38,39,46]
		Turdus philomelos	Mordovia	This study
Parastrigea flexilis (Dubois, 1934)	P	*Circus aeruginosus*	Bashkortostan	[25,38,42]
Parastrigea robusta Szidat, 1928	P	*Buteo buteo*	Mordovia	This study
Nematostrigea serpens (Nitzsch, 1819)	E	*Pandion haliaetus*	Nizhny Novgorod region	[22,25,27]
Family Cyathocotylidae				
Paracoenogonimus ovatus Katsurada, 1914	P	*Milvus migrans*	Nizhny Novgorod region	[22,25,27]
Family Diplostomidae				
Conodiplostomum spathula (Creplin, 1829)	H	*Circus pygargus*	Nizhny Novgorod region	[22,25,27]
		Buteo buteo, *Aquila chrysaetos*, *Clanga clanga*	Chuvashia	[25,27,28]
Neodiplostomum canaliculatum (Nicoll, 1914)	H	*Circus aeruginosus*	Bashkortostan	[25,38,42]
Neodiplostomum spathoides Dubois, 1937	P	*Circus aeruginosus*, *Circus pygargus*	Bashkortostan	[25,38,42]

Note: D—Distribution, E—Europe, C—Cosmopolitan, H—Holarctic, P—Palearctic.

The trematodes found in land birds in the Middle Volga region belonged to 16 families. The most represented family was Dicrocoeliidae (11 digenean species). Fewer trematodes were revealed from the families Strigeidae (7), Plagiorchiidae (6) and Leucochloridiidae (5) in birds. The families Opisthorchiidae and Echinostomatidae included four species of trematodes each, while the families Lecithodendriidae, Eucotylidae, Prosthogonimidae and Diplostomidae contained three trematode species each. The family Renicolidae was less represented in the helminth fauna of land birds from Mordovia and included two trematode species. Another five families (Brachylaimidae, Cyclocoelidae, Collyriclidae, Eumegacetidae and Cyathocotylidae) were represented by only one species each.

The most studied region of the Middle Volga area is the Nizhny Novgorod region, where 31 species of parasites were revealed in land birds (mainly in passerines) (Table 2 and Figure 2). Twenty species of trematodes were found in land birds in the Republic of Bashkortostan. Seventeen digenean species were recorded in birds from the Republic of Mordovia. Fifteen trematode species were identified in land birds in the Samara region. The least studied trematode fauna in birds was in Chuvashia and Tatarstan, where eight and one species of digeneans were known, respectively (Table 2 and Figure 2).

Obligate parasites of land birds are widespread in the Middle Volga region and in the world as a whole. The trematodes *Plagiorchis maculosus* and *Prosthogonimus ovatus* were found in land birds in five regions of the Middle Volga area. Three species *Urogonimus*

macrostomus, *Plagiorchis elegans* and *Prosthogonimus cuneatus* parasitized birds in four regions. The four trematode species *Plagiorchis notabilis*, *Eumegacetes triangularis*, *Brachylecithum fringillae* and *Lyperosomum alaudae* were recorded in birds from three of the regions studied. Eleven species of trematodes were revealed in birds in three studied regions of the Middle Volga area. The other thirty-five trematode species were each found in only one region studied (Table 2).

Most of the trematode species identified in land birds from the Middle Volga region (32 species) are common to the Palearctic region. Eight species of digeneans are cosmopolitan. Eight trematode species are distributed in the Holarctic. The distribution of seven species of digeneans is limited to Europe.

4. Discussion

This study reports 16 species of trematodes from birds from the orders Passeriformes, Piciformes, Caprimulgiformes and Falconiformes in Mordovia, bringing the total number of helminths known from the land birds of Mordovia to 17 species [13–15]. Most of the trematode species recorded are obligate parasites of land birds. Only one species, *Leucochloridium holostomum,* is a host-specific parasite of the rails (Rallidae) and occurs facultatively in thrushes. *Brachylaima mesostoma*, *Urogonimus macrostomus*, *Phaneropsolus mirococcus* and *Lyperosomum alaudae* are common polyhostal parasites of passerine birds. *Plagiorchis maculosus*, *Mosesia amplavaginata*, *Eumegacetes triangularis*, *Prosthogonimus ovatus*, *Parastrigea robusta* and *Cotylurus cornutus* s.l. belong to common polyhostal parasites of birds from different orders. *Leucochloridium phragmitophila* only parasitizes birds of the family Passeridae. *Brachylecithum attenuatum* and *Morishitium polonicum* are host-specific obligate parasites of thrushes. *Lyperosomum longicauda* is a host-specific parasite of corvids, while *Brachylecithum fringillae* is a monohostal parasite of *Fringilla coelebs*. *Plagiorchis elegans* is a polyhostal parasite found in a wide range of vertebrates of different classes (birds, mammals and reptiles), more common in passerines.

Before our research, 50 species of digeneans were known in land birds from the Middle Volga region (Table 2) [6,12,27]. As a result of our research, six species have been added to the list of land bird trematodes: *Leucochloridium holostomum*, *Phaneropsolus mirococcus*, *Morishitum polonicum*, *Brachylecithum attenuatum*, *Lyperosomum longicauda* and *Parastrigea robusta*.

The diversity in the trematode fauna of land bird species from Mordovia is due, first of all, to the diet preferences and habitat differences. Birds become infected with most trematode species by eating larvae and imagoes of aquatic and semi-aquatic insects. These parasites include trematodes of the genus *Plagiorchis*, *Prosthogonimus ovatus*, *Mosesia amplavaginata* and *Eumegacetes triangularis* [6,23]. Birds obtain trematodes of the genus *Leucochloridium*, *Brachylaima mesostoma* and *Urogonimus macrostomus* from land gastropods [6,12,51,52]. The infection of land birds by *Cotylurus cornutus* s.l. occurs when they feed on aquatic invertebrates (gastropods and leeches) [22]. The infection of the buzzard *Buteo buteo* with *Parastrigea robusta* apparently occurs by eating amphibians or fish, which are intermediate hosts of the parasite [22]. The life cycles of the trematodes *Brachylecithum fringillae*, *B. attenuatum*, *Lyperosomum alaudae*, *L. longicauda*, *Morishitum polonicum* and *Phaneropsolus mirococcus* were not studied, but apparently, the infection of birds also occurs when they feed on land invertebrates.

The study of the trematode fauna of land birds in Mordovia showed that the largest number of species was revealed in passerines (13 species from 8 families). This is primarily due to the large number of both studied species and specimens of passerine birds (371 specimens of 39 species) (Table 1). In addition, different species of Passeriformes are characterized by a variety of habitats and diets. In most of the studied passerine species, the diet is mixed, including both animal (land and semi-aquatic invertebrates) and herbal (seeds and berries) components.

The greatest diversity in trematodes of this order was found in members of the family Turdidae (7 species) and the family Fringillidae (6). The richness of trematodes in thrushes is mainly due to close contact with the soil litter, from which birds collect various

invertebrates—the second intermediate hosts of trematodes. Meanwhile, the richness of digenean species in finches is caused by the different lifestyles and the diet preferences in these birds.

Before our studies in the Middle Volga region, 31 species of trematodes from 12 families were known for passerines [6,12,27]. Our research on the territory of Mordovia added two species to the list of passerine trematodes: *Lyperosomum longicauda* and *Morishitum polonicum*. Another eleven species of trematodes found by us in Mordovia previously were recorded in the passerine fauna of the Middle Volga region. Currently, the majority of trematode species (28 species) detected in Passeriformes of the Middle Volga region are their obligate parasites, and five species of trematodes are facultative parasites.

Forty species of passeriform birds of 125 known in Middle Volga region [8–10] were subjected to helminthological research. In the Middle Volga region, the helminth fauna of these birds was studied in the Bashkortostan, Tatarstan, Chuvashia, Nizhny Novgorod and Samara regions (Table 2).

The only member of the Caprimulgiformes order, the European nightjar *Caprimulgus europaeus*, inhabits the Middle Volga region (Table 1). In Mordovia, we identified three species of trematodes from three families of this bird (Table 2). Previously, these species of trematodes were not found in *C. europaeus* from the Middle Volga region. On the territory of the region, the helminth fauna of *C. europaeus* was studied in Tatarstan and Chuvashia, where two species of trematodes were revealed: *Plagiorchis notabilis* and *Brachylecithum donicum* [27,28]. No host-specific trematode species were revealed in *C. europaeus* from the Middle Volga region. All trematodes detected can parasitize birds of different orders. The diet of the bird includes only insects [7,53], by eating which *C. europaeus* becomes infected with trematodes.

In Mordovia, we studied four species of the order Piciformes, but trematodes were revealed only in *Dendrocopos leucotos* and *D. major* (Table 1). The only trematode species recorded in woodpeckers was *Urogonimus macrostomus*. In addition, three more species of trematodes—*Plagiorchis elegans*, *Plagiorchis nanus* and *Prosthogonimus ovatus*—were revealed in woodpeckers of the Middle Volga region (Table 2). No host-specific species of trematodes were found in woodpeckers. All digenean species detected in woodpeckers from Mordovia also parasitize birds of other orders, while *Plagiorchis elegans* parasitizes animals of different classes. The diet of woodpeckers includes insects and other invertebrates such as spiders and land gastropods, which can be intermediate hosts of trematodes [7,53]. In the fauna of the Middle Volga region, the order Piciformes is represented by eight species [7,9,10], which, to a greater or lesser extent, were subjected to helminthological study. In the Middle Volga area, the helminth fauna of woodpeckers was studied in Bashkortostan, Nizhny Novgorod and Samara regions (Table 2). Previously, in the Samara region, we studied the helminth fauna of *Jynx torquilla*, *Dendrocopos major* and *Picoides minor*, in which no trematodes were found [29].

In the only studied specimen of *Buteo buteo* (order Falconiformes) in Mordovia, one trematode species, *Parastrigea robusta*, was revealed (Table 2). This trematode species was recorded for the first time in birds in the Middle Volga region.

A total of 18 species of trematodes were previously found among members of the order Falconiformes of the Middle Volga region (Table 2). Currently, five of 19 species of trematodes (*Stephanoprora graciosa*, *Renicola pandioni*, *R. undecima*, *Holometra exigua* and *Parastrigea flexilis*) are host-specific parasites of diurnal birds of prey. The other 14 trematode species of falconids are common parasites of different orders of birds, while *Plagiorchis elegans* also parasitizes reptiles and mammals. The infection of falconid birds with all trematodes occurs through food objects—various vertebrates and invertebrates, which are second intermediate and paratenic hosts of parasites. The diet of diurnal birds of prey is diverse, but many members of the order Falconiformes have the food preferences ornithophages, myophages or ichthyophages. However, all birds of prey can change their diet [7,53].

The 12 species of 29 Falconiformes species inhabiting the Middle Volga region were subjected to helminthological research [6,7,9,10,12,27,41]. The helminth fauna of Falconi-

formes was studied in Bashkortostan, Chuvashia and the Nizhny Novgorod region (Table 2). We have studied two specimens of *Buteo buteo* in the Samara region, but no trematodes were found in the birds [6].

In this present study we have not investigated the birds of the order Galliformes of Mordovia. Previously, birds of this order were studied here by Oliger [13–15] who found only one trematode species, *Prosthogonimus ovatus,* in *Tetrao urogallus* (Table 2).

In total, 11 trematode species were listed in birds of the order Galliformes from the Middle Volga region (Table 2). A characteristic feature of the trematode fauna of the Galliform birds in region is the absence of host-specific parasites. All species recorded in Galliformes belong to common polyhostal parasites of birds from different orders. Although Galliform birds are herbivorous, land invertebrates are found in their diet during the warm season [7,53], consuming which birds are infested with trematodes. The five species of six Galliformes inhabiting the Middle Volga region were subjected to helminthological research [6,7,9,10,12–15,27]. On the territory of the region, helminths of Galliform birds were studied in Bashkortostan, Tatarstan and the Nizhny Novgorod region (Table 2).

Our study did not include members of five orders: Apodiformes (one species), Columbiformes (4), Coraciiformes (3), Cuculiformes (2) and Strigiformes (12) [7,10]. In the Middle Volga region, the two of four Columbiformes species were subjected to helminthological research [6,7,10,12,28]. Helminthological studies of columbiform birds were carried out in Bashkortostan and the Nizhny Novgorod region (Table 2). No trematodes were found in *Streptopelia turtur* from the Nizhny Novgorod region [33]. Two species of host-specific parasites *Echinoparyphium schulzi* and *Skrjabinus petrovi* were noted in *Columba livia* from the Middle Volga region. The main diet component of pigeons are the seeds of cultivated and wild plants. Animal feed is a minority of the bird diet; it is mostly small land invertebrates [7]. Most likely, the infection of birds with trematodes could occur when eating land gastropods (possible second intermediate hosts of parasites), which have been consistently noted in the diet of pigeons [7].

The one of two Cuculiformes species inhabiting the Middle Volga region, the Common cuckoo *Cuculus canorus,* was subjected to helminthological research [6,7,9,10,12,27]. The diet of *C. canorus* includes insects, with caterpillars accounting for more than half of the food spectrum [7,53]. Helminths of *C. canorus* were studied in the Bashkortostan, Chuvashia and Nizhny Novgorod region (Table 2). In Bashkortostan, no trematodes were found in *C. canorus* [38]. Only two species of trematodes were identified in *C. canorus*: *Plagiorchis multiglandularis* (in the Nizhny Novgorod region) and *Prosthogonimus ovatus* (in Chuvashia) (Table 2). Infection with these trematodes occurs when birds feed on larvae and adults of near-aquatic insects [6,23].

Helminths of 7 of 12 Strigiformes species that inhabit the Middle Volga region were studied [6,7,9,10,12,27]. The basis of the diet of owls is micromammals, primarily myomorph rodents. A small part of the bird feed composition includes amphibians, reptiles, birds, insects and gastropods [7,53]. The helminth fauna of birds of the order Strigiformes in the Middle Volga region was studied in Bashkortostan and the Nizhny Novgorod region [27,32,38,42,50]. No trematodes were found in owls in the Nizhny Novgorod region. The trematode fauna of owls in the Middle Volga region is relatively poor. Only two trematode species, *Strigea falconis* and *S. strigis,* were recorded (Table 2). Owls become infected with strigeids through consumption of amphibians or reptiles, the second intermediate and paratenic hosts of these trematodes [22].

In the avifauna of the Middle Volga region, the order Apodiformes is represented by a single species, the Common swift *Apus apus*. On the territory of the Middle Volga region, helminths in *A. apus* were studied in Chuvashia and the Nizhny Novgorod region. Only two host-specific species of trematodes, *Lyperosomum clathratum* and *Plagiorchis maculosus* were recorded in *A. apus* (Table 2). Swifts are exclusively insectivorous birds [7,9,10]. The infection of birds with *P. maculosus* occurs when feeding on chironomids [23]. The life cycle of *L. clathratum* has not been studied, but it is most likely that infection also occurs through insects.

Three species of birds of the order Coraciiformes inhabit the Middle Volga region [7,9,10], of which helminths of the European roller *Coracias garrulus* and the European bee-eater *Merops apiaster* were studied. No trematodes were found in *C. garrulus* in the Nizhny Novgorod region [27,32,40,50]. In the Samara region, we revealed only one trematode species, *Eumegacetes triangularis*, in *M. apiaster* (Table 2). The diet of *M. apiaster* includes insects, mainly Hymenoptera, Odonata and Diptera [7]. Birds become infected with *Eumegacetes triangularis* by eating dragonflies [20].

The trematode fauna of land birds varies greatly in the different regions of the Middle Volga area. These differences are due to many factors, the main one of which is the number of studied orders, species and individuals of birds in one region or another. Thus, for more than 100 years of helminthological studies of birds on the territory of the Middle Volga region, 79 species of land birds from 10 orders have been studied to varying degrees. The most studied bird trematodes are in the Nizhny Novgorod region and Bashkortostan, where the land birds of nine and seven orders were studied, respectively. Therefore, in these regions they have the largest number of trematode species. The trematode fauna of land birds in Chuvashia (5 orders), Mordovia (5) and the Samara region (4) is less studied. There are few data on the land bird trematodes in Tatarstan (one order). So, in these regions, the trematode fauna of land birds is less diverse (Table 2 and Figure 2). Helminthological studies were not carried out on the avifauna in Mari El, Ulyanovsk, Penza, Saratov and the Orenburg regions.

In addition, differences in the trematode fauna of land birds are related to the diversity of biocenoses in different regions of the Middle Volga area, as well as with the richness of the fauna of vertebrates and invertebrates, which can be the final and intermediate hosts of trematodes.

With regard to the species composition of helminths (and trematodes, in particular), birds of the order Passeriformes are better studied, in which 33 species of trematodes were found, and to a lesser extent, Falconiformes (19) and Galliformes (11). Little is known about the helminths of birds from the orders Caprimulgiformes (5), Piciformes (4), Columbiformes (2), Cuculiformes (2), Strigiformes (2), Apodiformes (2) and Coraciiformes (1). Birds of the orders Otidiformes and Upupiformes were not studied in the Middle Volga region.

Six species of trematodes of 56 listed in land birds of the Middle Volga region are of medical and veterinary importance: *Metorchis bilis*, *Prosthogonimus cuneatus*, *P. ovatus*, *P. rarus*, *Cotylurus cornutus* s.l., *Parastrigea robusta* and *Paracoenogonimus ovatus*. Of these species, only *Metorchis bilis* were sporadically reported in humans [54,55].

5. Conclusions

The trematode faunas of Mordovia land birds from the orders Passeriformes, Falconiformes, Caprimulgiformes and Piciformes were studied for the first time. In total, we found 16 species of trematodes. Of these, the two species *Phaneropsolus micrococcus* and *Morishitum polonicum* were first noted in birds of the Russian fauna. As a result of our research, six species were added to the list of the land bird trematodes in the Middle Volga region: *Leucochloridium holostomum*, *Phaneropsolus micrococcus*, *Morishitum polonicum*, *Brachylecithum attenuatum*, *Lyperosomum longicauda*, and *Parastrigea robusta*. The list of land bird trematodes in the region includes 56 species of digeneans at present. *Leucochloridium holostomum* was first recorded in Russia in *Turdus merula*. The first data about the helminths of *Hippolais icterina* and *Ficedula albicollis* in Russia, and *Coccothraustes coccothraustes* in the Middle Volga region were obtained. In our study, new trematode hosts have been identified, including *Coccothraustes coccothraustes* for *Brachylaima mesostoma*; *Sylvia atricapilla*, *Ficedula albicollis*, *F. hypoleuca* and *Acrocephalus palustris* for *Urogonimus macrostomus*; *Ficedula albicollis* and *Hippolais icterina* for *Plagiorchis maculosus*; and *Ficedula hypoleuca* for *Lyperosomum alaudae*.

Among all the land birds studied in the Middle Volga region, members of the order Passeriformes have the richest trematode faunas, listing 33 species. The diversity of trematodes found in passerines is due to the large number of both individuals and species studied and the variety of habitats and diet preferences of these land birds, which were

studied in all regions of the Middle Volga region, where helminthological studies were carried out.

Most of the identified faunas of trematodes are obligate parasites of land birds—47 species. The other nine species (*Leucochloridium holostomum*, *Echinostoma revolutum*, *Metorchis bilis*, *Plagiorchis laricola*, *P. multiglandularis*, *P. nanus*, *Tanaisia fedtschenkoi*, *Prosthogonimus rarus*, *Cotylurus cornutus* s.l.) parasitize birds of different orders. In the Middle Volga region, the most studied trematode faunas in the land birds are in the Nizhny Novgorod region, where 31 species were revealed. Fewer species of trematodes were registered in land birds in Bashkortostan (20), Mordovia (17) and Samara regions (15). For the birds in Chuvashia and Tatarstan, only eight and one species of trematodes are known, respectively. Among 56 trematode species found in land birds, six parasites have veterinary and medical significance as potential pathogens of dangerous helminthiases.

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