



Helminthofauna of wetland birds in Uzbekistan

F. Akramova*, U. Shakarbaev*, I. Arepbaev**, Z. Yorkulov*, S. Saidova*, K. Saparov***, A. Mirzaeva*, Z. Hamrokulova****, G. Turemuratova**, U. Turemuratova**, D. Azimov*

* Institute of Zoology, Academy of Sciences of Uzbekistan, Tashkent, Republic of Uzbekistan

** Karakalpak State University, Nukus, Republic of Uzbekistan

*** Tashkent State Pedagogical University, Tashkent, Republic of Uzbekistan

**** Samarkand State University, Samarkand, Republic of Uzbekistan

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Institute of Zoology, Bogishamol st.,
232b, Tashkent, 100053,
Republic of Uzbekistan.
Tel.: +99-894-625-08-10.
E-mail: ushakarbaev@gmail.com

Karakalpak State University, Abirov
st., 1, Nukus, 230112, Republic of
Uzbekistan. Tel.: +99-891-377-77-
76. E-mail: ushakarbaev@mail.ru

Tashkent State Pedagogical Univer-
sity, Bunyodkor st., 27, Tashkent,
100185, Republic of Uzbekistan.
E-mail: qalandar.saparov@mail.ru

Samarkand State University,
University av., 15, Samarkand,
140104, Republic of Uzbekistan.
Tel.: +99-897-404-80-32.
E-mail: jaloliddin.azimov@mail.ru

Poltava State Agrarian Academy,
Skovorody st., 1/3, Poltava, 36003,
Ukraine. Tel.: +38-050-183-78-78.
E-mail: evstva@ukr.net

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The study of the helminthofauna of birds is not only very interesting from the theoretical aspect, but also has great practical significance, as the obtained knowledge is used to develop measures to combat numerous helminthiases of domestic, commercial and wetland game birds. Some helminthiases of wetland birds are also dangerous for humans. However, these and other issues related to helminthiases of these birds have been poorly studied in Uzbekistan. This work analyses the current state of the helminthofauna of wetland birds from 8 orders – Podicipediformes, Pelecaniformes, Ciconiiformes, Phoenicopteriformes, Anseriformes, Gruiformes, Charadriiformes and Falconiformes, inhabiting wetlands in central, north-eastern and north-western Uzbekistan. Helminths collected from wetland birds in various bodies of water during hunting seasons between 2018 and 2024 were used as material for this research. The large number of highly diverse and extensive habitats in Uzbekistan accounts for the high species diversity of wetland birds in the country. There are more than 500 different water bodies suitable for the habitation of this group of birds. These wetlands are highly important for humans. They provide biological resources to the population, ensure the stability of local climates, and serve as habitats for many sedentary and migratory wetland birds. We surveyed about 40 species of this group of birds from different orders. Our work provides information on the species composition of helminths of wetland birds in Uzbekistan (*Tachybaptus ruficollis*, *Podiceps cristatus*, *Podiceps griseogenus*, *Pelecanus onocrotalus*, *Phalacrocorax carbo*, *Ph. pygmaeus*, *Botaurus stellaris*, *Egretta alba*, *Ardea cinerea*, *Phoenicopterus roseus*, *Anser anser*, *Anas platyrhynchos*, *Anas crecca*, *Netta rufina*, *Bucephala clangula*, *Gallinula chloropus*, *Fulica atra*, *Porzana porzana*, *Tringa glareola*, *Larus ridibundus*, *Larus hyperboreus*, *Sterna hirundo*, *Haliaeetus albicilla*, *Circus aeruginosus* and other). Our studies identified representatives of Cestoda from the genera *Diphyllobothrium*, *Ligula*, *Digramma*, *Schistocephalus*, *Tetrabothrius*, *Paradilepis*, *Lateriporus*, *Anomotaenia*, *Aploparaksis*, *Cloacotaenia*, *Diorchis*, *Drepanidotaenia*, *Fimbriaria*, *Microsomacanthus*, *Myxolepis*, *Flamingolepis*, *Sobolevicanthus*, *Wardium* and *Tatria*. Trematodes are represented by the genera *Echinostoma*, *Echinoparyphium*, *Petasiger*, *Echinochasmus*, *Mesorchis*, *Aporchis*, *Pegosomum*, *Cyclocoelum*, *Notocotylus*, *Catatropis*, *Microphallus*, *Opistorchis*, *Tanaisia*, *Plagiorchis*, *Strigea*, *Cotylurus*, *Apatemon*, *Diplostomum*, *Bilharziella*, *Trichobilharzia*, *Ornithobilharzia*, *Austrobilharzia*, *Dendritobilharzia*, *Gigantobilharzia* and other. Acanthocephala in our research included representatives of 4 genera: *Polymorphus*, *Centrorhynchus*, *Mediorhynchus*, *Filicollis*. A large number of genera were recorded among nematodes: *Capillaria*, *Thominx*, *Strongyloides*, *Amidostomum*, *Contraecaecum*, *Ganguleterakis*, *Tetrameres*, *Streptocara*, *Desmidocercella*, *Paronchocerca*, *Pharyngosetaria*, *Avioserpens* and other. A total of 138 species of parasites were identified; 42 species from the class Cestoda, 66 Trematoda, 6 Acanthocephala and 24 Nematoda. 35 species had never been recorded in wetland birds in Uzbekistan before. The article also discusses issues related to changes in the faunistic complexes of helminths of the studied birds. The work identifies trophic and ecological relationships between helminths and their hosts and specifies the species diversity of parasites of wetland birds in the current ecological background of Uzbekistan. The authors also paid attention to ways birds are infected with helminths in various types of water bodies in Uzbekistan.

Keywords: helminths; fauna; ecology; distribution; wetland birds; Uzbekistan.

Introduction

The Republic of Uzbekistan is located in the central part of Central Asia, in the area between the Syr Darya and Amu Darya rivers. Uzbekistan borders on five other states: Kyrgyzstan in the north-east, Kazakhstan in the north and north-west, Turkmenistan in the south-west, Tajikistan in the south-east and Afghanistan in the south. The area of the country is 448,970 km², with highly contrasting landscapes. Most of the territory of the country, stretching from north-west to south-east, is flat, occupied by monotonous grey deserts and steppes, while the south-eastern part consists of foothills and mountains with high snow-capped peaks. Surface streams are very unevenly distributed across Uzbekistan, which forms a drainless part of Central Asia. There is not a single river or lake in the entire vast

lowlands in the west of the country. The foothills and mountainous areas are cut by a branched network of streams. This uneven distribution of surface waters is the result of the region's climate and geography. The main waterways, the Syr Darya and Amu Darya and their tributaries, as well as other Central Asian rivers, rise outside Uzbekistan. The total average annual flow of these two rivers is about 187 km³, their water used for various economic purposes not only in Uzbekistan, but also in other Central Asian countries.

Currently, there are more than 500 lakes and reservoirs on the territory of Uzbekistan. The largest of them are Lake Sudochye, the Aidar-Amasai lake system and Dengizkul. These bodies of water are listed in the Convention on Wetlands as internationally important habitats for wetland birds.

The parasitological fauna of the large lakes with their extensive wetlands, crossed by a network of migration routes and inhabited by numerous and diverse species of birds, including aquatic and semi-aquatic ones, remains poorly studied. What makes these helminthological studies significant is that wetland birds living there are important objects of amateur hunting; in addition, many of the species are protected and listed as endangered in Uzbekistan. It should also be borne in mind that birds transmit various helminthiases. Trematodes occupy a special place among parasites, causing serious problems to fish, birds and humans. The available information on helminths of wetland birds (Sultanov, 1963; Turemuratov, 1964) is quite outdated and does not reflect the current helminthological situation.

Turemuratov (1964) reports about 133 species of helminths from the classes Cestoda (24 species), Trematoda (67 species), Acanthocephala (4 species) and Nematoda (38 species) recorded in 819 individuals of fish-eating birds representing 30 species and inhabiting the Aral Sea basin. The infected birds studied by the author were from the orders Podicipediformes, Pelecaniformes, Ciconiiformes, Gaviiformes and Falconiformes. The total prevalence was 90.7%. According to classes, the birds showed the following prevalences: 37.4% of birds were infected with Cestoda, 72.4% with Trematoda, 0.48% with Acanthocephala and 64.6% with Nematoda. Sultanov (1963) provides some information about the helminth species composition in birds inhabiting various bodies of water and river valleys in Uzbekistan in his monograph *Helminths of Birds in Uzbekistan*. The author presents the results of his research into wetland birds from the orders Anseriformes, Ciconiiformes and Gruiformes. The studied 643 birds showed a prevalence of 66.3%. The author identified a total of 94 species of parasites in domestic and wild wetland birds. The largest number of helminth species (84) was recorded in Anseriformes, which were followed by Ciconiiformes (24 species) and Gruiformes (21 species). Previous studies (Sultanov, 1963; Turemuratov, 1964) recorded 145 species of helminths in wetland birds in Uzbekistan, of which 34 species were from the class Cestoda, 69 Trematoda, 4 Acanthocephala and 38 Nematoda.

However, these studies were conducted more than 50 years ago and are quite outdated and do not reflect the current situation in the helminth fauna of wetland birds in Uzbekistan. Moreover, a number of factors such as the global climate change, the desertification and anthropogenic transformation of landscapes, and unreasonable use of water and land resources negatively impacts biodiversity, including the species diversity of helminths in wetland birds in the studied regions. The development of new and existing agricultural lands in the basins of the Amudarya and Syrdarya without taking into account the needs of ecosystems and associated aquatic biological diversity led to the well-known Aral Sea disaster. Currently, due to the dramatic shrinkage of its water area and high mineralisation, the Aral Sea has lost its status as a large body of water attracting numerous species of wetland birds. The change in the water resources triggered changes in the structure and distribution of wetland birds, hosts of parasites. Bird species that had inhabited the resource-rich Aral Sea in the past moved to other water bodies or completely abandoned the region. Probably, these factors also induced changes in the helminthofauna of wetland birds in Uzbekistan. Therefore, it is necessary to ensure systematic monitoring of the helminthological situation among specific groups of host animals.

Thus, the goal of this study is to characterise the current status of the helminth fauna of wetland birds in Uzbekistan, taking into account the changes in the environment and management of natural resources that have taken place over the past 35 years.

Materials and methods

Helminths collected from wetland birds within the basins of the Amudarya, Syrdarya and Zeravshan rivers (Lakes Sudochoye, Mashankul, Dautkul, Zhylyrtbas, Dengizkul, Tudakul, Ayakagytna and Karakir, the Aidar-Amasay lake system in central, north-eastern and north-western Uzbekistan) were used as material for this study (Fig. 1). The birds were examined during the hunting seasons of 2018 to 2024. The material also included birds killed by hunters and those collected by fishermen in fishing nets (cages, shutter nets).



Fig. 1. Map of Uzbekistan: 1 – North-West, 2 – Central, 3 – North-East

924 individuals of wetland birds belonging to 40 species and 8 orders were examined using the helminthological dissection method (Table 1).

Birds were dissected, helminths were found, extracted and coloured, and temporary and permanent preparations were produced according to standard parasitological methods (Dubinina, 1971). The trematodes were studied, measured, photographed and drawn using Olympus CK2-TR microscopes, the trinocular No.300 m Ningbo Yongkin Optics microscope and the Microsogar V2.0 software. Helminth species were identified by well-known monographs and guides (Baruš et al., 1978; Borgarenko, 1981, 1984, 1990; Anderson, 2000; Gibson et al., 2002, 2005, 2008). The taxonomy of birds is given according to Stepanyan (2003).

Table 1
Species of wetland birds in Uzbekistan examined for helminths

Order	Number of species and individuals	
	number of species	number of individuals
Podicipediformes	3	84
Pelecaniformes	3	14
Ciconiiformes	6	71
Phoenicopteriformes	1	3
Anseriformes	18	548
Gruiformes	13	101
Charadriiformes	7	100
Falconiformes	3	6
Total	44	928

Molluscs, crustaceans and insects, potential intermediate hosts of dominant species of Cestoda, Trematoda, Acanthocephala and Nematoda, were also collected and studied using known methods (Jadin, 1952; Petrochenko & Kotelnikov, 1976; Kabilov, 1983) in spring, summer and early autumn in 2020, 2022 and 2023. In total, 5,154 individuals of molluscs, 8,690 individuals of crustaceans, 1,240 individuals of oligochaetes and 4,225 individuals of insects were collected in various types of water bodies and studied. The insects were collected from biotopes around bodies of water inhabited by wetland birds. In total, more than 1,600 insects were examined, mainly orthopterans and coleopterans.

The detected larvae of Cestoda, Trematoda, and Acanthocephala were soaked in 70% ethyl alcohol, and larvae of nematodes in 1.5–2.0% formalin. Most of the detected helminth larvae were studied live and later used to infect birds (ducks and geese) for experimental purposes.

Results

Our team established that the current helminth fauna of wetland birds in Uzbekistan consists of 138 species from 4 classes – Cestoda, Trematoda, Acanthocephala and Nematoda, with 42 species belonging to the class Cestoda, 66 Trematoda, 6 Acanthocephala and 24 Nematoda (Table 2).

The cestodes (42 species) recorded in the studied regions of Uzbekistan turned out to be representatives of 3 orders (we think it right to use the general rules of adding the suffix *-ida* in relation to orders in the class Cestoda (Azimov et al., 2015)) – Pseudophyllida Carus, 1863, Tetraphyllida Carus, 1868, and Cyclophyllida Braun, 1900. Among them, Cyclophyllida (35 species) in wetland birds is characterised by the highest species diversity. The remaining orders include from 2 to 5 species of tapeworms.

Table 2

List of helminths parasitising wetland birds in Uzbekistan (2018–2024)

No.	Helminth species	Host species	Localisation	Intensity of infection	Distribution area, records coordinates
Class Cestoda					
Family Diphylobothriidae					
1	<i>Diphylobothrium ditremum</i> (Creplin, 1825)	<i>Podiceps griseigena</i> (Boddaert, 1783), <i>Pelecanus onocrotalus</i> Linnaeus, 1758, <i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Ardea cinerea</i> Linnaeus, 1758, <i>Larus hyperboreus</i> Gunnerus, 1767	Intestine	1–3	43.480256° N, 58.318660° E; 43.572655° N, 59.803652° E; 40.782678° N, 67.621140° E; 40.915189° N, 67.767301° E;
Family Ligulidae					
2	<i>Ligula colymbi</i> Zeder, 1803	<i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Phalacrocorax pygmaeus</i> (Pallas, 1773), <i>Podiceps griseigena</i> (Boddaert, 1783), <i>Ardea cinerea</i> Linnaeus, 1758, <i>Nycticorax nycticorax</i> (Linnaeus, 1766)	Intestine	2–6	43.493769° N, 58.338299° E; 43.240552° N, 58.858362° E; 40.715498° N, 67.630764° E; 40.953890° N, 67.246835° E;
3	<i>Ligula intestinalis</i> (Linnaeus, 1758) Gmelin, 1790	<i>Sterna hirundo</i> Linnaeus, 1758, <i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Tachybaptus ruficollis</i> (Pallas, 1764), <i>Ardea cinerea</i> Linnaeus, 1758, <i>Phalacrocorax carbo</i> (Linnaeus, 1758)	Intestine	1–7	43.511722° N, 58.350105° E; 43.579053° N, 59.875522° E; 40.636162° N, 67.609725° E; 40.889650° N, 67.457746° E;
4	<i>Digramma interrupta</i> (Rudolphi, 1810)	<i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Podiceps griseigena</i> (Boddaert, 1783), <i>Ardea cinerea</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom.	"	3–13	42.874303° N, 59.292119° E; 40.550038° N, 67.611021° E; 40.809262° N, 67.752042° E;
5	<i>Schistocephalus solidus</i> (Müller, 1776) Steenstrup, 1857	<i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Podiceps griseigena</i> (Boddaert, 1783), <i>Pelecanus onocrotalus</i> Linnaeus, 1758	"	1–4	43.531866° N, 58.390291° E; 43.257233° N, 58.882383° E; 40.734945° N, 67.159291° E;
Family Tetrabothriidae					
6	<i>Tetrabothrius macrocephalus</i> (Rudolphi, 1808) Rudolphi, 1819	<i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Podiceps griseigena</i> (Boddaert, 1783)	"	1–9	42.870674° N, 59.293887° E; 43.607381° N, 59.777719° E;
7	<i>Tetrabothrius cylindraceus</i> Rudolphi, 1819	<i>Sterna hirundo</i> Linnaeus, 1758, <i>Pelecanus onocrotalus</i> Linnaeus, 1758	"	1–3	43.543575° N, 58.406849° E; 43.262332° N, 58.895879° E;
Family Dilepididae					
8	<i>Paradilepis scolecina</i> (Rudolphi, 1819)	<i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Phalacrocorax pygmaeus</i> (Pallas, 1773)	"	1–3	42.886781° N, 59.301298° E; 40.526396° N, 67.444458° E; 40.782678° N, 67.621140° E;
9	<i>Lateriporus clerici</i> (Johnston, 1912) Fuhrmann, 1932	<i>Ardea cinerea</i> Linnaeus, 1758, <i>Phalacrocorax carbo</i> (Linnaeus, 1758)	"	1–4	40.715498° N, 67.630764° E; 40.915189° N, 67.767301° E;
10	<i>Anomotaenia microrhyncha</i> (Krabbe, 1896) Cohn, 1900	<i>Tringa glareola</i> Linnaeus, 1758, <i>Charadrius dubius</i> Scopoli, 1786	"	3–15	43.607381° N, 59.777719° E; 40.636162° N, 67.609725° E; 40.889650° N, 67.457746° E;
11	<i>Anomotaenia microphallos</i> (Krabbe, 1896)	<i>Tringa totanus</i> (Linnaeus, 1758), <i>Vanellus vanellus</i> (Linnaeus, 1758)	"	2–6	42.888380° N, 59.304571° E; 40.480565° N, 67.569542° E; 40.734945° N, 67.159291° E;
Family Hymenolepididae					
12	<i>Aploparaksis clavata</i> Spasskaya, 1968	<i>Gallinago stenura</i> (Bonaparte, 1831), <i>Tringa glareola</i> Linnaeus, 1758, <i>Tringa totanus</i> (Linnaeus, 1758), <i>Arenaria interpres</i> (Linnaeus, 1758)	"	1–45	43.480256° N, 58.318660° E; 39.189130° N, 64.108705° E; 40.550038° N, 67.611021° E;
13	<i>Aploparaksis furcigera</i> (Rudolphi, 1819)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom., <i>Arenaria interpres</i> (Linnaeus, 1758)	"	1–16	42.888380° N, 59.304571° E; 40.656079° N, 64.516911° E; 40.526396° N, 67.444458° E;
14	<i>Cloacotaenia megalops</i> (Nitzsch, 1829)	<i>Tadorna tadorna</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Bucephala clangula</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> dom., <i>Podiceps cristatus</i> (Linnaeus, 1758)	"	3–29	43.531866° N, 58.390291° E; 39.166547° N, 64.129583° E;
15	<i>Dicranotaenia coronula</i> (Dujardin, 1845)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom., <i>Bucephala clangula</i> (Linnaeus, 1758)	"	2–18	43.266370° N, 58.876043° E; 39.828834° N, 64.724457° E; 40.915189° N, 67.767301° E;
16	<i>Diorchis elisae</i> (Skrjabin, 1914)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas chryseata</i> Linnaeus, 1758, <i>Fulica atra</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom.	"	1–74	40.480565° N, 67.569542° E; 40.610013° N, 64.589714° E;
17	<i>Diorchis myrocoides</i> Spasskaja, 1961	<i>Anas acuta</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758	"	1–67	40.617669° N, 64.590469° E; 40.809262° N, 67.752042° E;
18	<i>Diorchis brevis</i> Rybicka, 1957	<i>Fulica atra</i> Linnaeus, 1758,	"	1–7	40.526396° N, 67.444458° E;

No.	Helminth species	Host species	Localisation	Intensity of infection	Distribution area, records coordinates
19	<i>Diorchis flavescens</i> Krefl, 1871	<i>Aythya ferina</i> (Linnaeus, 1758) <i>Anas penelope</i> Linnaeus, 1758, <i>Aythya fuligula</i> (Linnaeus, 1758)	"	1–5	40.608463° N, 64.470088° E; 40.480565° N, 67.569542° E;
20	<i>Diorchis inflata</i> (Rudolphi, 1819)	<i>Fulica atra</i> Linnaeus, 1758, <i>Aythya ferina</i> (Linnaeus, 1758)	"	1–8	40.782678° N, 67.621140° E; 39.915843° N, 64.908231° E;
21	<i>Diorchis myrocae</i> Yamaguti, 1935	<i>Aythya ferina</i> (Linnaeus, 1758), <i>Aythya fuligula</i> (Linnaeus, 1758), <i>Anas crecca</i> Linnaeus, 1758, <i>Anas chryseata</i> Linnaeus, 1758	"	3–29	40.636162° N, 67.609725° E; 42.882167° N, 59.292373° E;
22	<i>Diorchis ransomi</i> Shulz, 1940	<i>Fulica atra</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758	"	2–36	40.809262° N, 67.752042° E; 40.484867° N, 63.268703° E;
23	<i>Diorchis acuminatus</i> (Clerc, 1782)	<i>Anas strepera</i> Linnaeus, 1758 <i>Anas penelope</i> Linnaeus, 1758, <i>Fulica atra</i> Linnaeus, 1758	"	6–28	40.889650° N, 67.457746° E; 40.617669° N, 64.590469° E;
24	<i>Diploposthe laevis</i> (Bloch, 1782)	<i>Anas crecca</i> Linnaeus, 1758, <i>Aythya ferina</i> (Linnaeus, 1758), <i>Aythya marila</i> (Linnaeus, 1761), <i>Anas platyrhynchos</i> dom., <i>Podiceps grisegena</i> (Boddaert, 1783)	"	3–12	43.561044° N, 58.480452° E; 40.953890° N, 67.246835° E;
25	<i>Drepanidotaenia spinulosa</i> Dubinina, 1953	<i>Anser anser</i> (Linnaeus, 1758), <i>Netta rufina</i> (Pallas, 1773)	"	2–18	40.915189° N, 67.767301° E; 40.653593° N, 64.577481° E; 43.561044° N, 58.480452° E;
26	<i>Drepanidotaenia lanceolata</i> (Bloch, 1782)	<i>Anser anser</i> (Linnaeus, 1758), <i>Netta rufina</i> (Pallas, 1773), <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom., <i>Aythya fuligula</i> (Linnaeus, 1758)	"	3–17	43.257233° N, 58.882383° E; 40.663722° N, 64.556482° E; 40.734945° N, 67.159291° E;
27	<i>Fimbriaria fasciolaris</i> (Pallas, 1781) Froelich, 1802	<i>Podiceps grisegena</i> (Boddaert, 1783), <i>Anser anser</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom., <i>Anas acuta</i> Linnaeus, 1758, <i>Anas chryseata</i> Linnaeus, 1758, <i>Netta rufina</i> (Pallas, 1773), <i>Anas penelope</i> Linnaeus, 1758, <i>Bucephala clangula</i> (Linnaeus, 1758)	"	6–45	43.543575° N, 58.406849° E; 39.108929° N, 64.231787° E; 40.889650° N, 67.457746° E;
28	<i>Microsomacanthus arcuata</i> (Kowalewski, 1904)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Aythya fuligula</i> (Linnaeus, 1758)	"	1–13	39.885673° N, 64.938820° E; 40.889650° N, 67.457746° E; 43.242632° N, 58.860071° E;
29	<i>Microsomacanthus microsoma</i> (Creplin, 1829)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom.	"	3–13	42.874303° N, 59.292119° E; 40.550038° N, 67.611021° E; 39.885673° N, 64.938820° E;
30	<i>Microsomacanthus compressa</i> (Linton, 1892)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Aythya marila</i> (Linnaeus, 1761), <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom., <i>Anas crecca</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758	"	5–105	43.579053° N, 59.875522° E; 40.432795° N, 63.323677° E; 40.480565° N, 67.569542° E;
31	<i>Myxolepis collaris</i> (Batsch, 1786)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom.	"	3–29	40.953890° N, 67.246835° E; 42.878389° N, 59.287911° E; 43.531866° N, 58.390291° E;
32	<i>Flamingolepis tengizi</i> Gvozdev et Maksimova, 1968	<i>Phoenicopterus roseus</i> Pallas, 1811	"	1–2	43.564368° N, 58.475733° E; 39.828834° N, 64.724457° E;
33	<i>Flamingolepis megalorchis</i> (Lühe, 1898)	<i>Phoenicopterus roseus</i> Pallas, 1811	"	1–3	42.865661° N, 59.291824° E; 40.617669° N, 64.590469° E;
34	<i>Flamingolepis flamingo</i> (Skrjabin, 1914)	<i>Phoenicopterus roseus</i> Pallas, 1811	"	1–4	43.288582° N, 58.899082° E; 39.053114° N, 64.320774° E;
35	<i>Sobolevicanthus gracilis</i> (Zeder, 1803)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom.	"	3–27	43.257233° N, 58.882383° E; 39.928896° N, 64.872642° E; 40.480565° N, 67.569542° E;
36	<i>Sobolevicanthus dafilae</i> (Polk, 1942)	<i>Anas crecca</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom., <i>Fulica atra</i> Linnaeus, 1758	"	1–3	40.889650° N, 67.457746° E; 39.796924° N, 64.927061° E; 40.480565° N, 67.569542° E;
37	<i>Sobolevicanthus octacanthus</i> (Krabbe, 1869)	<i>Anas acuta</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Fulica atra</i> Linnaeus, 1758	"	1–9	40.782678° N, 67.621140° E; 43.266370° N, 58.876043° E; 39.150170° N, 64.145606° E;
38	<i>Sobolevicanthus fragilis</i> (Krabbe, 1869)	<i>Anas chryseata</i> Linnaeus, 1758, <i>Aythya fuligula</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758	"	1–6	40.550038° N, 67.611021° E; 39.928896° N, 64.872642° E; 43.257233° N, 58.882383° E
39	<i>Tschertkovilepis setigera</i> (Frölich, 1789)	<i>Anser anser</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom.	"	2–21	43.607381° N, 59.777719° E; 40.432795° N, 63.323677° E; 40.550038° N, 67.611021° E;

No.	Helminth species	Host species	Localisation	Intensity of infection	Distribution area, records coordinates
40	<i>Wardium fusa</i> (Krabbe, 1869)	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758	"	1–8	43.57033° N, 58.519150° E; 40.734945° N, 67.159291° E;
41	<i>Wardium spasskii</i> Shigin, 1961	<i>Himantopus himantopus</i> (Linnaeus, 1758), <i>Sterna hirundo</i> Linnaeus, 1758	"	1–17	43.257233° N, 58.882383° E; 40.915189° N, 67.767301° E; 39.092538° N, 64.260191° E;
Family Amabiliidae					
42	<i>Tatria brevis</i> Kowalewski, 1904	<i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Podiceps grisegena</i> (Boddaert, 1783)	"	1–5	40.409307° N, 63.352847° E; 40.480565° N, 67.569542° E;
Class Trematoda					
Family Echinostomatidae					
43	<i>Echinostoma revolutum</i> (Fröhlich, 1802) Looss, 1899	<i>Fulica atra</i> Linnaeus, 1758, <i>Porzana porzana</i> (Linnaeus, 1766), <i>Larus cachinnans</i> Pallas, 1811, <i>Anser anser</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anser anser</i> (Linnaeus, 1758), <i>Anas crecca</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom.	"	3–35	42.874303° N, 59.292119° E; 40.631672° N, 64.572383° E; 40.809262° N, 67.752042° E; 39.790713° N, 64.833523° E; 40.583507° N, 64.587673° E; 43.262332° N, 58.895879° E;
44	<i>Echinostoma dietzi</i> Skrjabin, 1923	<i>Fulica atra</i> Linnaeus, 1758, <i>Podiceps grisegena</i> (Boddaert, 1783), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anser anser</i> dom.	"	2–22	42.870674° N, 59.293887° E; 40.656724° N, 64.489236° E; 40.480565° N, 67.569542° E; 43.564368° N, 58.475733° E;
45	<i>Echinostoma paraulum</i> Dietz, 1909	<i>Anser anser</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Netta rufina</i> (Pallas, 1773)	"	3–27	43.574041° N, 59.890877° E; 40.432795° N, 63.323677° E; 40.734945° N, 67.159291° E; 39.092538° N, 64.260191° E; 40.480565° N, 67.569542° E;
46	<i>Echinostoma miyagawai</i> Ishii, 1932	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Anas crecca</i> Linnaeus, 1758	"	1–11	42.874303° N, 59.292119° E; 40.526396° N, 67.444458° E;
47	<i>Echinostoma robustum</i> Yamaguti, 1935	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom.	"	2–33	43.242632° N, 58.860071° E; 39.796924° N, 64.927061° E; 40.636162° N, 67.609725° E;
48	<i>Echinostoma transfretanum</i> Dietz, 1909	<i>Fulica atra</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758	"	1–5	43.288582° N, 58.899082° E; 39.166547° N, 64.129583° E;
49	<i>Echinostoma stantschinskii</i> Semenov, 1927	<i>Gallinago gallinago</i> (Linnaeus, 1758), <i>Ardea cinerea</i> Linnaeus, 1758	"	1–3	40.809262° N, 67.752042° E; 40.610013° N, 64.589714° E;
50	<i>Echinoparyphium recurvatum</i> (von Linstow, 1873) Lühe, 1909	<i>Sterna hirundo</i> Linnaeus, 1758, <i>Vanellus vanellus</i> (Linnaeus, 1758), <i>Limosa limosa</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom., <i>Anas crecca</i> Linnaeus, 1758	"	2–54	43.531866° N, 58.390291° E; 39.150170° N, 64.145606° E; 40.915189° N, 67.767301° E;
51	<i>Echinoparyphium cinctum</i> (Rudolphi, 1803) Baschkirova, 1941	<i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Bucephala clangula</i> (Linnaeus, 1758)	"	1–5	42.865661° N, 59.291824° E; 40.809262° N, 67.752042° E; 43.262332° N, 58.895879° E;
52	<i>Echinoparyphium aconiatum</i> Dietz, 1909	<i>Fulica atra</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas chrypeata</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Sterna hirundo</i> Linnaeus, 1758	"	1–25	40.889650° N, 67.457746° E; 43.574041° N, 59.890877° E; 40.617669° N, 64.590469° E; 40.915189° N, 67.767301° E;
53	<i>Petasiger aeratus</i> Oshmarin, 1947	<i>Ardea cinerea</i> Linnaeus, 1758, <i>Phalacrocorax carbo</i> (Linnaeus, 1758)	"	1–3	43.543575° N, 58.406849° E; 39.828834° N, 64.724457° E;
54	<i>Petasiger skjabini</i> Baschkirova, 1941	<i>Podiceps grisegena</i> (Boddaert, 1783), <i>Ardea cinerea</i> Linnaeus, 1758	"	1–3	43.262332° N, 58.895879° E; 40.480565° N, 67.569542° E;
55	<i>Petajifer bilobus</i> (Rudolphi, 1819) Dietz, 1909	<i>Plegadis falcinellus</i> (Linnaeus, 1766), <i>Podiceps grisegena</i> (Boddaert, 1783)	"	1–5	42.863445° N, 59.287121° E; 43.574041° N, 59.890877° E; 39.053114° N, 64.320774° E;
56	<i>Paryphostomum radiatum</i> (Dujardin, 1845) Dietz, 1909	<i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Rallus aquaticus</i> Linnaeus, 1758	"	1–7	43.607381° N, 59.777719° E; 40.550038° N, 67.611021° E; 42.874303° N, 59.292119° E;
57	<i>Hypoderaeum conoideum</i> (Bloch, 1782) Dietz, 1909	<i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Anas acuta</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Tadorna tadorna</i> (Linnaeus, 1758), <i>Fulica atra</i> Linnaeus, 1758	"	1–43	43.511722° N, 58.350105° E; 39.166547° N, 64.129583° E; 40.526396° N, 67.444458° E;
Family Echinochasmidae					
58	<i>Echinochasmus coxatus</i> Dietz, 1909	<i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Tachybaptus ruficollis</i> (Pallas, 1764),	"	3–60	43.607381° N, 59.777719° E; 40.809262° N, 67.752042° E;

No.	Helminth species	Host species	Localisation	Intensity of infection	Distribution area, records coordinates
		<i>Ardea cinerea</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758			
59	<i>Echinochasmus euryporus</i> (Looss, 1896) Dietz, 1909	<i>Podiceps grisegena</i> (Boddaert, 1783), <i>Anas crecca</i> Linnaeus, 1758, <i>Ardea cinerea</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Circus aeruginosus</i> (Linnaeus, 1758)	"	2–5	42.886781° N, 59.301298° E; 39.915843° N, 64.908231° E; 40.734945° N, 67.159291° E;
60	<i>Echinochasmus petrowi</i> Schachtach-tinskaja & Sailov, 1966	<i>Podiceps grisegena</i> (Boddaert, 1783), <i>Ardea cinerea</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Larus argentatus</i> Pontoppidan, 1763	"	1–32	43.531866° N, 58.390291° E; 40.715498° N, 67.630764° E; 42.870674° N, 59.293887° E; 40.480565° N, 67.569542° E;
61	<i>Mesorchis denticulatus</i> (Rudolphi, 1802) Dietz, 1909	<i>Larus cachinnans</i> Pallas, 1811, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Larus hyperboreus</i> Gunnerus, 1767	"	3–9	42.863445° N, 59.287121° E; 43.543575° N, 58.406849° E; 42.874303° N, 59.292119° E;
62	<i>Aporchis rugosus</i> Linton, 1928	<i>Sterna hirundo</i> Linnaeus, 1758, <i>Larus hyperboreus</i> Gunnerus, 1767	"	1–3	40.715498° N, 67.630764° E; 43.586968° N, 58.543070° E; 42.874303° N, 59.292119° E;
63	<i>Aporchis massiliensis</i> Timon-David, 1955	<i>Larus cachinnans</i> Pallas, 1811, <i>Sterna hirundo</i> Linnaeus, 1758	"	1–2	40.480565° N, 67.569542° E; 40.526396° N, 67.444458° E; 40.608463° N, 64.470088° E;
64	<i>Pegosomumu saginatum</i> (Ratz, 1898) Ratz, 1903	<i>Ardea alba</i> Linnaeus, 1758	Liver	1–4	43.262332° N, 58.895879° E; 43.586968° N, 58.543070° E;
65	<i>Pegosomumu spiniferum</i> Ratz, 1903	<i>Ardea alba</i> Linnaeus, 1758, <i>Ardea cinerea</i> Linnaeus, 1758	Liver	1–3	43.543575° N, 58.406849° E; 42.865661° N, 59.291824° E; 40.617669° N, 64.590469° E;
Family Cyclocoeliidae					
66	<i>Cyclocoelum mutabile</i> (Zeder, 1800) Brandes, 1892	<i>Fulica atra</i> Linnaeus, 1758, <i>Gallinula chloropus</i> (Linnaeus, 1758), <i>Tringa totanus</i> (Linnaeus, 1758), <i>Himantopus himantopus</i> (Linnaeus, 1758)	Air sacs	1–3	43.480256° N, 58.318660° E; 39.915843° N, 64.908231° E; 43.288582° N, 58.899082° E; 40.809262° N, 67.752042° E;
67	<i>Cyclocoelum obscurum</i> (Leidy, 1887) Harrah, 1922	<i>Tringa totanus</i> (Linnaeus, 1758), <i>Tringa glareola</i> Linnaeus, 1758, <i>Fulica atra</i> Linnaeus, 1758, <i>Gallinula chloropus</i> (Linnaeus, 1758)	Air sacs	1–7	43.266370° N, 58.876043° E; 40.583507° N, 64.587673° E; 43.564368° N, 58.475733° E; 40.526396° N, 67.444458° E;
68	<i>Typhlocoelum cucumerinum</i> (Rudolphi, 1809) Stossich, 1903	<i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Aythya fuligula</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758	Trachea	1–4	42.870674° N, 59.293887° E; 39.166547° N, 64.129583° E; 42.886781° N, 59.301298° E;
69	<i>Typhlocoelum sisowi</i> (Skrjabin, 1913)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom.	Trachea, bronchus	2–3	43.607381° N, 59.777719° E; 43.543575° N, 58.406849° E; 40.480565° N, 67.569542° E;
Family Notocotyliidae					
70	<i>Notocotylus attenuatus</i> (Rudolphi, 1809) Kossack, 1911	<i>Fulica atra</i> Linnaeus, 1758, <i>Anser anser</i> (Linnaeus, 1758), <i>Tadorna tadorna</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom.	Intestine	3–14	42.886781° N, 59.301298° E; 40.663722° N, 64.556482° E; 40.550038° N, 67.611021° E; 39.828834° N, 64.724457° E; 39.132848° N, 64.177408° E; 40.480565° N, 67.569542° E;
71	<i>Notocotylus chionis</i> Baylis, 1928	<i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Rallus aquaticus</i> Linnaeus, 1758, <i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Fulica atra</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758	Intestine	2–16	43.543575° N, 58.406849° E; 43.586968° N, 58.543070° E; 42.865661° N, 59.291824° E; 40.526396° N, 67.444458° E;
72	<i>Catatropis verrucosa</i> (Frölich, 1789) Oehlner, 1905	<i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Anas strepera</i> Linnaeus, 1758, <i>Bucephala clangula</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758	"	5–20	43.493769° N, 58.338299° E; 39.166547° N, 64.129583° E; 40.915189° N, 67.767301° E; 43.574041° N, 59.890877° E;
73	<i>Paramonostomum bucephalae</i> Yamaguti, 1935	<i>Podiceps grisegena</i> (Boddaert, 1783), <i>Tadorna tadorna</i> (Linnaeus, 1758), <i>Anas acuta</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom.	"	1–15	42.874303° N, 59.292119° E; 43.257233° N, 58.882383° E; 39.885673° N, 64.938820° E;
74	<i>Paramonostomum elongatum</i> Yamaguti, 1934	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Tadorna tadorna</i> (Linnaeus, 1758), <i>Anas penelope</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom.	"	1–56	43.242632° N, 58.860071° E; 43.586968° N, 58.543070° E; 42.874303° N, 59.292119° E; 40.550038° N, 67.611021° E;
Family Gymnophallidae					
75	<i>Cryptocotyle concavum</i> (Creplin,	<i>Larus argentatus</i> Pontoppidan, 1763,	"	3–152	43.511722° N, 58.350105° E;

No.	Helminth species	Host species	Localisation	Intensity of infection	Distribution area, records coordinates
1825)		<i>Sterna hirundo</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Fulica atra</i> Linnaeus, 1758, <i>Podiceps grisegena</i> (Boddaert, 1783), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Ardea cinerea</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom.			39.166547° N, 64.129583° E; 42.870674° N, 59.293887° E; 43.574041° N, 59.89087° E; 40.526396° N, 67.444458° E;
Family Microphallidae					
76	<i>Microphallus claviformis</i> (Brandes, 1889) Baer, 1944	<i>Vanellus vanellus</i> (Linnaeus, 1758), <i>Arenaria interpres</i> (Linnaeus, 1758), <i>Tringa totanus</i> (Linnaeus, 1758), <i>Anas acuta</i> Linnaeus, 1758, <i>Larus ridibundus</i> (Linnaeus, 1758)	"	1–10	43.574041° N, 59.890877° E; 40.636162° N, 67.609725° E; 42.870674° N, 59.293887° E;
77	<i>Microphallus pigmaeus</i> (Levinsen, 1881) Baer, 1944	<i>Charadrius alexandrinus</i> Linnaeus, 1758, <i>Tringa totanus</i> (Linnaeus, 1758), <i>Anas acuta</i> Linnaeus, 1758	"	5–8	42.874303° N, 59.292119° E; 43.531866° N, 58.390291° E; 40.480565° N, 67.569542° E;
Family Opistorchidae					
78	<i>Opistorchis geminus</i> (Looss, 1896) Looss, 1899	<i>Anas platyrhynchos</i> dom., <i>Circus aeruginosus</i> (Linnaeus, 1758), <i>Ardea cinerea</i> Linnaeus, 1758	Liver	1–4	43.242632° N, 58.860071° E; 39.150170° N, 64.145606° E; 42.865661° N, 59.291824° E;
79	<i>Metorchis xanthosomus</i> (Creplin, 1846) Braun, 1902	<i>Fulica atra</i> Linnaeus, 1758, <i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom.	Liver	3–11	43.531866° N, 58.390291° E; 43.257233° N, 58.882383° E; 39.116086° N, 64.204112° E; 40.480565° N, 67.569542° E;
Family Renicolidae					
80	<i>Renicola lari</i> Timon-David, 1933	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Ardea cinerea</i> Linnaeus, 1758, <i>Larus hyperboreus</i> Gunnerus, 1767	Kidneys	1–13	43.586968° N, 58.543070° E;
Family Clinostomatidae					
81	<i>Clinostomum complanatum</i> (Rudolphi, 1819) Braun, 1899	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Ardea cinerea</i> Linnaeus, 1758	Stomach	1–19	43.226367° N, 58.845973° E; 40.550038° N, 67.611021° E;
Family Eucotylidae					
82	<i>Eucotyle colmi</i> Skrjabin, 1924	<i>Podiceps grisegena</i> (Boddaert, 1783), <i>Anser anser</i> (Linnaeus, 1758)	Kidneys	1–2	42.885728° N, 59.297629° E; 40.734945° N, 67.159291° E;
83	<i>Tanaisia atra</i> (Nezlobinski, 1926) Byrd & Denton, 1950	<i>Fulica atra</i> Linnaeus, 1758, <i>Tringa totanus</i> (Linnaeus, 1758), <i>Sterna hirundo</i> Linnaeus, 1758, <i>Tachybaptus ruficollis</i> (Pallas, 1764), <i>Nycticorax nycticorax</i> (Linnaeus, 1766), <i>Anas platyrhynchos</i> Linnaeus, 1758	Kidneys	1–7	43.602073° N, 59.825811° E; 39.092538° N, 64.260191° E; 42.865661° N, 59.291824° E;
Family Plagiiorchiidae					
84	<i>Plagiiorchis elegans</i> (Rudolphi, 1802) Braun, 1902	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Rallus aquaticus</i> Linnaeus, 1758, <i>Podiceps nigricollis</i> (Brehm, CL, 1831), <i>Podiceps grisegena</i> (Boddaert, 1783), <i>Tringa glareola</i> Linnaeus, 1758	Intestine	3–20	42.878389° N, 59.287911° E; 40.653593° N, 64.577481° E; 40.636162° N, 67.609725° E; 43.579053° N, 59.875522° E;
85	<i>Plagiiorchis laricola</i> Skrjabin, 1924	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Plegadis falcinellus</i> (Linnaeus, 1766), <i>Anser anser</i> (Linnaeus, 1758)	Intestine	1–11	43.226367° N, 58.845973° E; 40.715498° N, 67.630764° E;
Family Pachytrematidae					
86	<i>Pachytrema calculus</i> Looss, 1907	<i>Sterna hirundo</i> Linnaeus, 1758, <i>Larus argentatus</i> Pontoppidan, 1763	Liver	1–2	43.586968° N, 58.543070° E; 39.779872° N, 64.794431° E; 40.915189° N, 67.767301° E;
Family Prosthogonimidae					
87	<i>Prosthogonimus ovatus</i> (Rudolphi, 1803) Lühe, 1899	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Podiceps grisegena</i> (Boddaert, 1783), <i>Tachybaptus ruficollis</i> (Pallas, 1764), <i>Ardea cinerea</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Fulica atra</i> Linnaeus, 1758, <i>Larus hyperboreus</i> Gunnerus, 1767, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anser anser</i> (Linnaeus, 1758), <i>Bucephala clangula</i> (Linnaeus, 1758)	Bursa of Fabricius	1–15	43.493769° N, 58.338299° E; 39.116086° N, 64.204112° E; 40.636162° N, 67.609725° E; 40.809262° N, 67.752042° E; 39.132848° N, 64.177408° E;
88	<i>Prosthogonimus cuneatus</i> (Rudolphi, 1809) Braun, 1901	<i>Anser anser</i> (Linnaeus, 1758), <i>Fulica atra</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758	Bursa of Fabricius	1–3	43.602073° N, 59.825811° E; 40.503211° N, 63.296190° E; 40.782678° N, 67.621140° E;
Family Psilostomatidae					
89	<i>Psilostomum brevicolle</i> (Creplin, 1829) Braun, 1902	<i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Anas platyrhynchos</i> Linnaeus, 1758,	Intestine	2–9	43.572655° N, 59.803652° E; 40.550038° N, 67.611021° E; 43.288582° N, 58.899082° E;

No.	Helminth species	Host species	Localisation	Intensity of infection	Distribution area, records coordinates
		<i>Anas penelope</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Bucephala clangula</i> (Linnaeus, 1758)			43.597692° N, 59.841899° E;
90	<i>Psilotrema spiculigerum</i> (Mühling, 1898) Odhner, 1913	<i>Anser anser</i> (Linnaeus, 1758), <i>Fulica atra</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758	"	3–12	43.257233° N, 58.882383° E; 40.631672° N, 64.572383° E; 40.583507° N, 64.587673° E;
91	<i>Psilochasmus oxyurus</i> (Creplin, 1828) Lühe, 1909	<i>Anas platyrhynchos</i> dom., <i>Anas acuta</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758	"	1–25	43.524198° N, 58.377295° E; 39.150170° N, 64.145606° E; 43.262332° N, 58.895879° E; 40.636162° N, 67.609725° E;
Family Strigeidae					
92	<i>Strigea falconis</i> Szidat, 1928	<i>Circus aeruginosus</i> (Linnaeus, 1758), <i>Haliaeetus albicilla</i> (Linnaeus, 1758)	"	1–9	43.226522° N, 58.849564° E; 39.823427° N, 64.957027° E;
93	<i>Cotylurus cornutus</i> (Rudolphi, 1809) Szidat, 1928	<i>Anser anser</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom.	"	3–28	43.524198° N, 58.377295° E; 39.150170° N, 64.145606° E; 40.550038° N, 67.611021° E;
94	<i>Apatemon gracilis</i> (Rudolphi, 1819) Szidat, 1928	<i>Cygnus cygnus</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Aythya marila</i> (Linnaeus, 1761), <i>Anas platyrhynchos</i> dom.	"	1–19	43.240552° N, 58.858362° E; 39.779872° N, 64.794431° E; 40.915189° N, 67.767301° E;
95	<i>Apharyngostrigea flexilis</i> Dubois, 1934	<i>Ardea cinerea</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Circus aeruginosus</i> (Linnaeus, 1758)	"	3–5	43.597692° N, 59.841899° E; 43.574041° N, 59.890877° E; 39.150170° N, 64.145606° E; 40.636162° N, 67.609725° E;
Family Diplostomatidae					
96	<i>Diplostomum spathaceum</i> (Rudolphi, 1819) Olsson, 1876	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758	"	1–7	43.531866° N, 58.390291° E; 40.653593° N, 64.577481° E; 40.550038° N, 67.611021° E;
97	<i>Diplostomum commutatum</i> (Diesing, 1850) Dubois, 1937	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Larus cachinnans</i> Pallas, 1811, <i>Larus hyperboreus</i> Gunnerus, 1767	"	1–17	43.572655° N, 59.803652° E; 42.885728° N, 59.297629° E; 40.734945° N, 67.159291° E; 39.885673° N, 64.938820° E;
98	<i>Codonocephalus unigigerus</i> (Rudolphi, 1899)	<i>Haliaeetus albicilla</i> (Linnaeus, 1758), <i>Botaurus stellaris</i> (Linnaeus, 1758)	"	1–3	40.432795° N, 63.323677° E; 43.257233° N, 58.882383° E;
99	<i>Postdiplostomum brevicaudatum</i> (von Nordmann, 1832)	<i>Ardea cinerea</i> Linnaeus, 1758, <i>Haliaeetus albicilla</i> (Linnaeus, 1758), <i>Podiceps cristatus</i> (Linnaeus, 1758)	"	1–7	42.886781° N, 59.301298° E; 40.617669° N, 64.590469° E;
100	<i>Tylodelphus clavata</i> (von Nordmann, 1832)	<i>Ardea cinerea</i> Linnaeus, 1758, <i>Circus aeruginosus</i> (Linnaeus, 1758), <i>Podiceps griseogen</i> (Boddaert, 1783)	"	1–8	43.579053° N, 59.875522° E; 39.915843° N, 64.908231° E; 40.715498° N, 67.630764° E;
101	<i>Neodiplostomum spathula</i> (Creplin, 1829) La Rue, 1926	<i>Circus aeruginosus</i> (Linnaeus, 1758), <i>Haliaeetus albicilla</i> (Linnaeus, 1758)	"	2–5	42.874303° N, 59.292119° E; 39.823427° N, 64.957027° E;
Family Schistosomatidae					
102	<i>Bilharziella polonica</i> (Kowalewsky, 1895) Looss, 1899	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas chryseata</i> Linnaeus, 1758, <i>Aythya ferina</i> (Linnaeus, 1758), <i>Rallus aquaticus</i> Linnaeus, 1758, <i>Tachybaptus ruficollis</i> (Pallas, 1764), <i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Tringa totanus</i> (Linnaeus, 1758), <i>Sterna hirundo</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom.	Blood vessels	1–27	43.561044° N, 58.480452° E; 39.116086° N, 64.204112° E; 40.550038° N, 67.611021° E; 39.928896° N, 64.872642° E; 40.734945° N, 67.159291° E; 43.574041° N, 59.890877° E;
103	<i>Trichobilharzia ocellata</i> (La Valette St. George, 1855) Brumpt, 1931	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Aythya fuligula</i> (Linnaeus, 1758), <i>Anas acuta</i> Linnaeus, 1758, <i>Bucephala clangula</i> (Linnaeus, 1758), <i>Anser anser</i> (Linnaeus, 1758), <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom.	"	1–8	42.874303° N, 59.292119° E; 40.610013° N, 64.589714° E; 40.550038° N, 67.611021° E; 39.823427° N, 64.957027° E; 40.526396° N, 67.444458° E;
104	<i>Ornithobilharzia canaliculata</i> (Rudolphi, 1819) Odhner, 1912	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Hydroprogne caspia</i> (Pallas, 1770), <i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Tringa glareola</i> Linnaeus, 1758, <i>Arenaria interpres</i> (Linnaeus, 1758), <i>Rallus aquaticus</i> Linnaeus, 1758, <i>Gallinula chloropus</i> (Linnaeus, 1758), <i>Fulica atra</i> Linnaeus, 1758	"	1–17	43.240552° N, 58.858362° E; 39.132848° N, 64.177408° E; 40.734945° N, 67.159291° E; 43.543575° N, 58.406849° E;
105	<i>Austroilharzia chapini</i> (Price, 1929)	<i>Sterna hirundo</i> Linnaeus, 1758, <i>Gallinago gallinago</i> (Linnaeus, 1758),	"	2–10	43.543575° N, 58.406849° E; 43.564368° N, 58.475733° E;

No.	Helminth species	Host species	Localisation	Intensity of infection	Distribution area, records coordinates
		<i>Netta rufina</i> (Pallas, 1773), <i>Larus argentatus</i> Pontoppidan, 1763, <i>Anser anser</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Rallus aquaticus</i> Linnaeus, 1758			43.288582° N, 58.899082° E; 40.550038° N, 67.611021° E;
106	<i>Dendritobilharzia loossi</i> Skrjabin, 1924	<i>Pelecanus onocrotalus</i> Linnaeus, 1758, <i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Netta rufina</i> (Pallas, 1773), <i>Fulica atra</i> Linnaeus, 1758	"	3–5	42.863445° N, 59.287121° E; 39.053114° N, 64.320774° E; 39.915843° N, 64.908231° E; 40.631672° N, 64.572383° E;
107	<i>Dendritobilharzia pulverulenta</i> (Braun, 1901) Skrjabin, 1924	<i>Fulica atra</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Netta rufina</i> (Pallas, 1773), <i>Anser anser</i> (Linnaeus, 1758), <i>Anas crecca</i> Linnaeus, 1758	"	1–6	43.574041° N, 59.890877° E; 40.432795° N, 63.323677° E; 40.636162° N, 67.609725° E;
108	<i>Gigantobilharzia acotylea</i> Odnher, 1910	<i>Ardea cinerea</i> Linnaeus, 1758, <i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758	"	1–3	43.561044° N, 58.480452° E; 40.480565° N, 67.569542° E;
Class Acanthocephala					
Family Polymorphidae					
109	<i>Polymorphus minutus</i> (Goeze, 1782)	<i>Fulica atra</i> Linnaeus, 1758, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Larus cachinnans</i> Pallas, 1811, <i>Bucephala clangula</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas acuta</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anser anser</i> (Linnaeus, 1758), <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Tadorna tadorna</i> (Linnaeus, 1758), <i>Gallinula chloropus</i> (Linnaeus, 1758), <i>Tringa glareola</i> Linnaeus, 1758	Intestine	1–9	43.564368° N, 58.475733° E; 40.953890° N, 67.246835° E; 40.734945° N, 67.159291° E; 40.889650° N, 67.457746° E; 39.779872° N, 64.794431° E; 39.885673° N, 64.938820° E;
110	<i>Polymorphus magnus</i> Skrjabin, 1913	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom.	"	1–13	43.242632° N, 58.860071° E; 40.636162° N, 67.609725° E;
Family Centrorhynchidae					
111	<i>Centrorhynchus spinosus</i> (Kaiser, 1893)	<i>Circus aeruginosus</i> (Linnaeus, 1758), <i>Haliaeetus albicilla</i> (Linnaeus, 1758)	"	1–2	43.242632° N, 58.860071° E; 39.823427° N, 64.957027° E;
112	<i>Centrorhynchus globocaudatus</i> (Zeder, 1800)	<i>Circus aeruginosus</i> (Linnaeus, 1758)	"	1	43.607381° N, 59.777719° E; 40.550038° N, 67.611021° E;
Family Gigantorhynchidae					
113	<i>Mediorhynchus papillosus</i> Van Cleave, 1916	<i>Circus aeruginosus</i> (Linnaeus, 1758)	"	1–2	43.543575° N, 58.406849° E; 40.915189° N, 67.767301° E;
Family Filicollidae					
114	<i>Filicollis anatis</i> (Schrank, 1788)	<i>Fulica atra</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom.	"	1–13	42.878389° N, 59.287911° E; 40.610013° N, 64.589714° E; 40.550038° N, 67.611021° E;
Class Nematoda					
Family Capillariidae					
115	<i>Capillaria anseris</i> Madsen, 1945	<i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Podiceps cristatus</i> (Linnaeus, 1758)	"	1–3	42.885728° N, 59.297629° E; 40.636162° N, 67.609725° E;
116	<i>Thominx anatis</i> (Schrank, 1790)	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom.	"	1–5	43.531866° N, 58.390291° E; 40.480565° N, 67.569542° E; 40.809262° N, 67.752042° E; 39.899083° N, 64.808940° E;
117	<i>Thominx skrjabini</i> Lubimov, 1947	<i>Aythya ferina</i> (Linnaeus, 1758), <i>Anas crecca</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Sterna hirundo</i> Linnaeus, 1758	"	1–3	42.863445° N, 59.287121° E; 40.526396° N, 67.444458° E;
Family Diotrophymidae					
118	<i>Eustrongylides tubifex</i> (Nitzsch, 1819) Jägerskiöld, 1909	<i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Bucephala clangula</i> (Linnaeus, 1758)	Proventriculus	1–2	42.886781° N, 59.301298° E; 40.631672° N, 64.572383° E; 40.610013° N, 64.589714° E; 40.550038° N, 67.611021° E;
119	<i>Eustrongylides mergorum</i> (Rudolphi, 1809)	<i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Tachybaptus ruficollis</i> (Pallas, 1764), <i>Himantopus himantopus</i> (Linnaeus, 1758)	Proventriculus	2–3	43.579053° N, 59.875522° E; 43.262332° N, 58.895879° E; 39.828834° N, 64.724457° E;
Family Strongyloididae					
120	<i>Strongyloides turkmenica</i> Kurtieva, 1953	<i>Gallinula chloropus</i> (Linnaeus, 1758), <i>Himantopus himantopus</i> (Linnaeus, 1758), <i>Porzana porzana</i> (Linnaeus, 1766)	Intestine	1–11	43.242632° N, 58.860071° E; 40.809262° N, 67.752042° E; 39.023763° N, 64.408443° E;
Family Amidostomatidae					

No.	Helminth species	Host species	Localisation	Intensity of infection	Distribution area, records coordinates
121	<i>Amidostomum anseris</i> (Zeder, 1800)	<i>Anser anser</i> (Linnaeus, 1758), <i>Anser anser</i> dom., <i>Anas acuta</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Tachybaptus ruficollis</i> (Pallas, 1764), <i>Fulica atra</i> Linnaeus, 1758	Gizzard	1–15	43.586968° N, 58.543070° E; 43.240552° N, 58.858362° E; 43.564368° N, 58.475733° E; 43.607381° N, 59.777719° E;
122	<i>Amidostomum monodon</i> (Linstow, 1882) Skrjabin, 1915	<i>Anas crecca</i> Linnaeus, 1758, <i>Anas querquedula</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Aythya fuligula</i> (Linnaeus, 1758)	"	1–3	43.288582° N, 58.899082° E; 40.782678° N, 67.621140° E; 39.823427° N, 64.957027° E; 39.189130° N, 64.108705° E;
123	<i>Amidostomum acutum</i> (Lundahl, 1848)	<i>Anas crecca</i> Linnaeus, 1758, <i>Anas querquedula</i> (Linnaeus, 1758), <i>Anas strepera</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Bucephala clangula</i> (Linnaeus, 1758), <i>Vanellus vanellus</i> (Linnaeus, 1758)	"	1–19	43.240552° N, 58.858362° E; 40.636162° N, 67.609725° E; 43.288582° N, 58.899082° E; 43.564368° N, 58.475733° E; 40.636162° N, 67.609725° E;
124	<i>Amidostomum skrjabini</i> Boulenger, 1926	<i>Anser anser</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas chryseola</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Fulica atra</i> Linnaeus, 1758	"	1–16	43.561044° N, 58.480452° E; 40.480565° N, 67.569542° E; 40.809262° N, 67.752042° E; 43.262332° N, 58.895879° E;
Family Trichostrongylidae					
125	<i>Trichostrongylus tenuis</i> (Mehlis, 1846)	<i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Anas platyrhynchos</i> Linnaeus, 1758	"	1–7	42.886781° N, 59.301298° E; 40.734945° N, 67.159291° E; 40.617669° N, 64.590469° E;
126	<i>Epomidiostomum uncinatum</i> (Lindahl, 1848)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom.	"	2–3	43.602073° N, 59.825811° E; 40.809262° N, 67.752042° E; 40.526396° N, 67.444458° E;
Family Anisakidae					
127	<i>Contracaecum spiculigerum</i> (Rudolphi, 1809) Railliet & Henry, 1912	<i>Sterna hirundo</i> Linnaeus, 1758, <i>Podiceps cristatus</i> (Linnaeus, 1758), <i>Pelecanus onocrotalus</i> Linnaeus, 1758	Stomach, intestine	3–15	43.574041° N, 59.890877° E; 40.734945° N, 67.159291° E; 40.915189° N, 67.767301° E;
128	<i>Contracaecum microcephalum</i> (Rudolphi, 1819) Baylis, 1920	<i>Anas platyrhynchos</i> dom., <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Ardea cinerea</i> Linnaeus, 1758	Stomach, intestine	1–22	42.888380° N, 59.304571° E; 40.915189° N, 67.767301° E; 39.053114° N, 64.320774° E; 40.645803° N, 64.462534° E;
129	<i>Porrocaecum crassum</i> (Deslongchamps, 1824)	<i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas chryseola</i> Linnaeus, 1758, <i>Anas platyrhynchos</i> dom., <i>Gallinula chloropus</i> (Linnaeus, 1758)	Stomach, intestine	4–13	43.543575° N, 58.406849° E; 40.889650° N, 67.457746° E; 39.823427° N, 64.957027° E; 39.915843° N, 64.908231° E;
Family Heterakidae					
130	<i>Ganguleterakis dispar</i> (Schrank, 1790)	<i>Anser anser</i> dom., <i>Anas platyrhynchos</i> dom., <i>Anser anser</i> (Linnaeus, 1758), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Tadorna tadorna</i> (Linnaeus, 1758)	Intestine	3–17	42.874303° N, 59.292119° E; 40.631672° N, 64.572383° E; 40.526396° N, 67.444458° E;
Family Acuariida					
131	<i>Cosmocephalus firlottei</i> Rao, 1951	<i>Larus argentatus</i> Pontoppidan, 1763, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Tringa glareola</i> Linnaeus, 1758	Oesophagus	1–2	43.531866° N, 58.390291° E; 40.645803° N, 64.462534° E; 40.734945° N, 67.159291° E;
Family Tetrameridae					
132	<i>Tetrameres fissispina</i> (Diesing, 1861)	<i>Anas platyrhynchos</i> dom., <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758, <i>Anas chryseola</i> Linnaeus, 1758, <i>Anas penelope</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Fulica atra</i> Linnaeus, 1758, <i>Netta rufina</i> (Pallas, 1773), <i>Ardea cinerea</i> Linnaeus, 1758	Proventriculus	1–9	43.262332° N, 58.895879° E; 40.550038° N, 67.611021° E; 39.116086° N, 64.204112° E; 39.108929° N, 64.231787° E;
133	<i>Tetrameres spinosa</i> (Maplestone, 1931)	<i>Aythya fuligula</i> (Linnaeus, 1758), <i>Netta rufina</i> (Pallas, 1773), <i>Anas penelope</i> Linnaeus, 1758, <i>Anser anser</i> dom.	"	1–4	42.882167° N, 59.292373° E; 40.631672° N, 64.572383° E; 40.550038° N, 67.611021° E;
Family Streptocaridae					
134	<i>Streptocara crassicauda</i> (Creplin, 1829) Skrjabin, 1916	<i>Anas platyrhynchos</i> dom., <i>Tachybaptus ruficollis</i> (Pallas, 1764), <i>Anas platyrhynchos</i> Linnaeus, 1758, <i>Anas crecca</i> Linnaeus, 1758, <i>Anas strepera</i> Linnaeus, 1758, <i>Anser anser</i> dom., <i>Tringa glareola</i> Linnaeus, 1758	Gizzard	1–13	42.886781° N, 59.301298° E; 40.645803° N, 64.462534° E; 40.608463° N, 64.470088° E; 40.526396° N, 67.444458° E;
Family Desmidocercidae					
135	<i>Desmidocercella numidica</i> (Seurat,	<i>Ardea cinerea</i> Linnaeus, 1758,	Air sacs	3–14	43.531866° N, 58.390291° E;

No.	Helminth species	Host species	Localisation	Intensity of infection	Distribution area, records coordinates
1920)	Yorke & Maplestone, 1926	<i>Phalacrocorax carbo</i> (Linnaeus, 1758), <i>Phalacrocorax pygmaeus</i> (Pallas, 1773)			39.166547° N, 64.129583° E; 40.636162° N, 67.609725° E;
Family Oswaldoliliariidae					
136	<i>Paronchocerca tonkinensis</i> (Chow, 1939)	<i>Ardea cinerea</i> Linnaeus, 1758, <i>Ardea purpurea</i> (Linnaeus, 1766), <i>Phalacrocorax pygmaeus</i> (Pallas, 1773)	Blood vessels	1–2	43.574041° N, 59.890877° E; 40.715498° N, 67.630764° E;
Family Onchocercidae					
137	<i>Pharyngosetaria marcinowskyi</i> (Skrjabin, 1923)	<i>Ardea cinerea</i> Linnaeus, 1758, <i>Ardea purpurea</i> (Linnaeus, 1766)	"	3–7	42.888380° N, 59.304571° E; 39.209448° N, 64.077146° E; 39.796924° N, 64.927061° E;
Family Dracunculidae					
138	<i>Avioserpens galliardii</i> Chabaud et Campana, 1949	<i>Botaurus stellaris</i> (Linnaeus, 1758), <i>Larus cachinnans</i> Pallas, 1811, <i>Sterna hirundo</i> Linnaeus, 1758, <i>Ardea cinerea</i> Linnaeus, 1758, <i>Fulica atra</i> Linnaeus, 1758, <i>Podiceps cristatus</i> (Linnaeus, 1758)	Under oral mucosa, trachea	1–4	43.226522° N, 58.849564° E; 43.561044° N, 58.480452° E; 42.865661° N, 59.291824° E; 39.108929° N, 64.231787° E; 40.809262° N, 67.752042° E;

The class Trematoda is represented by 66 species belonging to 17 families. The largest number of species (14) were from the family Echinostomatidae.

Only 6 species from the class Acanthocephala were identified. The class Nematoda is represented by 24 species from 13 families.

35 of the total of 138 species were recorded in wetland birds in Uzbekistan for the first time. Among them, 15 are from the class Cestoda: *Schistocephalus solidus*, *Tetrabothrius macrocephalus*, *Tetrabothrius cylindraceus*, *Lateriporus clerci*, *Diorchis elisae*, *Diorchis levis*, *Diorchis flavescens*, *Diorchis inflata*, *Diorchis ransomi*, *Myxolepis collaris*, *Flamingolepis megalorchis*, *Flamingolepis flamingo*, *Sobolevicanthus dafialae*, *Wardium fusa*, *Wardium spasskii* and *Tatria bremsis*; 16 from the class Trematoda: *Petasifer aerates*, *Petasifer bilobus*, *Echinochasmus petrovi*, *Echinochasmus coxatus*, *Echinochasmus euryporus*, *Mesorchis denticulatus*, *Aporchis rugosus*, *Aporchis massiliensis*, *Pegosomum skrijabini*, *Paramonostomum bucephalae*, *Microphallus claviformis*, *Metorchis xanthosomus*, *Tanaisia atra*, *Plagiorchis laricola*, *Pachytrema paniceum*, and *Austrobilharzia chapini*; 4 from the class Nematoda: *Eustrongylides tuffex*, *Eustrongylides mergorum*, *Paronchocerca tonkinensis* and *Pharyngosetaria marcinowskyi*.

Discussion

The helminthofauna is unequally distributed across the 8 orders of the studied birds (Falconiformes, Charadriiformes, Gruiformes, Anseriformes, Phoenicopteriformes, Ciconiiformes, Pelecaniformes and Podicipediformes). Anseriformes show the highest helminth species diversity (75 species). The smallest number of helminth species (6) was observed in Falconiformes.

About 145 species of wetland birds have been registered on the territory of Uzbekistan. This category includes several species of diurnal raptors, which also live mainly on or near bodies of water. A significant por-

portion of the species have adapted to inhabiting bodies of water in the studied regions of Uzbekistan, where wetland birds concentrate in large numbers during seasonal migrations from Siberia and Kazakhstan to their wintering grounds in the Caspian Sea, India, Pakistan and Africa. Given below is a faunistic analysis of helminths recorded in certain orders of birds (Table 3).

Helminths of Podicipediformes. These are birds of medium and small size associated with the aquatic environment. There are 22 known species in the world fauna. 5 species are recorded in Central Asia, all of them also registered in Uzbekistan (Kreuzberg-Mukhina et al., 2005; Shemazarov et al., 2006).

Habitats: lowland lakes, reservoirs, shallow bodies of water and river floodplains covered with emergent aquatic vegetation. They are also widespread in Uzbekistan, inhabiting areas in the lower reaches of the Amu Darya and other rivers. These are migratory and nesting birds. They also forage by diving under water. They feed on invertebrates and small fish. The numbers are quite stable. We studied 84 individuals of birds belonging to 3 species – *Tachybaptus ruficollis*, *Podiceps grisegena*, and *Podiceps cristatus*, 76 of which were infected with helminths (90.4%). The helminth fauna recorded in Podicipediformes in Uzbekistan consists of 44 species (Cestoda – 13, Trematoda – 24, Nematoda – 7). Trematoda noticeably predominate in terms of species composition. The Cestoda fauna consists mainly of representatives of the families Ligulidae, Hymenolepididae and Tetrabothriidae. Trematoda are represented by 24 species, which is more than half (54.3%) of the helminthofauna recorded in Podicipediformes. The highest species diversity is observed in the families Echinostomatidae, Notocotyliidae, Strigeidae, Diplostomatidae, and Schistosomatidae. Nematodes in Uzbekistan are represented only by 7 species. They are mainly heteroxenous helminths parasitising grebes, whose intermediate hosts are aquatic invertebrates inhabiting bodies of water in the studied region. About 15 species from the classes Cestoda, Trematoda and Nematoda are common in domestic birds and Podicipediformes.

Table 3
Distribution of helminths across hosts – wetland birds of Uzbekistan (2018–2024)

Host, bird order	Number of parasite species				
	Total	Cestoda	Trematoda	Acanthocephala	Nematoda
Podicipediformes	44	13	24	–	7
Pelecaniformes	17	2	12	–	3
Ciconiiformes	45	10	26	–	9
Phoenicopteriformes	18	6	7	1	4
Anseriformes	75	17	36	4	8
Gruiformes	39	8	22	2	7
Charadriiformes	57	13	33	1	10
Falconiformes	6	–	6	–	–

Helminths of Pelecaniformes. Large and medium-sized birds of various body shapes. There are 4 species from this order registered in Uzbekistan. They inhabit large lowland bodies of water: lakes, rivers and their deltas. They feed on fish. We studied 2 individuals of *Pelecanus onocrotalus* and 3 individuals of *Phalacrocorax pygmaeus*, which had died naturally or been killed by poachers. 4 individuals of the great cormorant were caught during hunting seasons on large bodies of water in Karakalpakstan (Lakes Sudochoye and Dengizkul and Aidar-Amasai lake system).

12 of the 14 examined individuals of three species of Pelecaniformes (*Pelecanus onocrotalus*, *Phalacrocorax carbo*, and *Ph. pygmaeus* – the great white pelican and the great and pygmy cormorants) were infected with helminths. According to our research (Akramova, 2011; Saparov, 2016), all the Pelecaniformes species (4) in the fauna of Uzbekistan are known as hosts to helminths. The helminthofauna of Pelecaniformes consists of 17 species: Cestoda – 2 species, Trematoda – 12 species, and Nematoda – 3 species. Nematoda show an extremely poor species composi-

tion. The most interesting helminth representatives found in Pelecaniformes are *Ligula intestinalis*, *Prosthogonimus cuneatus*, *Strigea falconis*, *Diplostomum commutatum*, *Postdiplostomum brevicaudatum*, *Dendrobilharzia loossi*, *Dendrobilharzia pulverulenta*, *Contracaecum microcephalum*, *Porrocaecum crassum* and *Desmidocercella numidica*, which are of considerable epizootological and epidemiological significance.

Helminths of Ciconiiformes. These birds are mainly large and medium-sized. Representatives of 13 species from 3 families have been recorded in Uzbekistan: Ardeidae (9 species), Ibiidae (2 species) and Ciconiidae (2 species). They nest on lakes with thickets of reeds and cattails. During migration and wintering, they are found widely along the shores of flatland bodies of water in north-western Uzbekistan. Ciconiiformes are mainly ichthyophages, they forage in shallow water for aquatic and terrestrial animals. We studied 70 individuals of 5 species – *Botaurus stellaris*, *Nycticorax nycticorax*, *Egretta alba*, *Ardea cinerea* and *Plagadis falcinellus*, which turned out to be infected with helminths. In total, we identified 45 helminth species, 10 of which were from the class Cestoda, 26 Trematoda and 9 Nematoda. The helminthofauna of Ciconiiformes characterises these birds as typical fish-eaters. This is confirmed by the domination of representatives of Trematoda. Most of the trematode species are metacercariae, which develop in fish (Strigeidae, Diplostomatidae).

Helminths of Phoenicopteriformes. Large birds with very long legs. The overall colour of the plumage is white with a pink tinge of varying intensity or red. The order includes 5 species from 1 family – Phoenicopteridae, of which 1 species, *Phoenicopus roseus*, inhabits Uzbekistan. It lives on the open sides of large bodies of water. Currently, it is recorded in the country mainly during migration and wintering. This is a migratory and breeding species in the region. The birds nest in large colonies (Jumanov, 2017; Ametov, 2019). The authors report the nesting of a large colony of *Phoenicopus roseus* on the eastern edge of Lake Sudochoye (25 May 2014), where about 7,000 individuals were recorded and 2,985 nests found. They feed on aquatic invertebrates, mainly small crustaceans and molluscs, dipteran larvae and the seeds of aquatic plants. Vulnerable, naturally rare species. 3 individuals which had died and been killed by poachers near Lake Sudochoye, were examined. All the 3 individuals were infected with helminths. The helminth fauna of *Phoenicopus roseus* consists of 18 species (Cestoda – 6, Trematoda – 7, Acanthocephala – 1 and Nematoda – 4). The discovered Cestoda are predominantly represented by the family Hymenolepididae (6 species), with 3 species – *Flamingolegis tengizi*, *F. megalorchis* and *F. flamingo* – specific to this bird. Trematoda are represented by common species that occur in other orders of wetland birds. The data on the helminthofauna of flamingo in Uzbekistan are merely provisional.

Helminths of Anseriformes. Aquatic birds of varying size. They are also widely distributed in the territory of Uzbekistan. They nest on the waterside or in waterside thickets, feed on various plant and animal food. More than 36 species from the family Anatidae inhabit Uzbekistan (Kreuzberg-Mukhina et al., 2005; Shernazarov et al., 2006). We examined 548 individuals of birds belonging to 17 species. The most fully studied are some species from the genera *Anser*, *Anas*, *Aythya*, *Mergus*, *Netta* and *Bucephala*. We have material on 17 species. The total prevalence of infection in this bird class is quite high. Of the 548 dissected individuals, 515, or 93.9%, turned out to be infected with parasites. The helminthofauna in Anseriformes consists of 75 species (Cestoda – 17, Trematoda – 36, Acanthocephala – 4 and Nematoda – 18). The intensity of infection, with rare exceptions, ranges from single to dozens of individuals. In most cases, helminths occur in a mixed form. Most of the helminths are parasites of the digestive system: they are represented by about 50 species from the classes Trematoda, Cestoda, Acanthocephala and Nematoda. The components of parasitocenosis form various combinations: from three to seven species associations. Most often, three to five species were recorded in the parasitocenoses of Anseriformes. For the majority of helminth species Anseriformes are obligate hosts, which play an important role in the distribution of parasitic worms in Uzbekistan. About 45 species of helminths are common to wild Anseriformes and domestic waterfowl (ducks and geese).

Helminths of Gruiformes. The Gruiformes fauna of Uzbekistan is represented by Gruidae, Rallidae and Otidae. Most of them are semi-aquatic birds living in damp places with dense vegetation, on lakes with

thickets and wet meadows. They feed mainly on plants, but can also eat animal food. In Uzbekistan, this order is represented by 3 families: Gruidae (3 species), Rallidae (7 species) and Otidae (3 species). We examined 101 individuals belonging to three species – *Gallinula chloropus*, *Fulica atra* and *Porzana porzana*, of which 22 individuals were infected with helminths (68.3%). The helminthofauna of Gruiformes consists of 39 species, representing Cestoda (8 species), Trematoda (22 species), Acanthocephala (2 species) and Nematoda (7 species). The highest helminth species diversity was recorded in *Fulica atra*, which is directly associated with its aquatic lifestyle. Gruiformes in Uzbekistan are mainly infected with heteroxenous forms of helminths.

Helminths of Charadriiformes. The order Charadriiformes unites birds of varying biology and ecology. The vast majority of its species are aquatic or semi-aquatic. Representatives of 8 families are recorded in Uzbekistan. They eat mainly animal food (insects, worms, aquatic and terrestrial molluscs, crustaceans, and fish). Their diet also includes plants – algae, aquatic plants, their seeds and berries. Charadriiformes in Uzbekistan are represented by 73 species. We studied 100 individuals of birds belonging to fourteen species in this order: *Himantopus himantopus*, *Charadrius dubius*, *Vanellus vanellus*, *Arenaria interpres*, *Tringa totanus*, *Tringa glareola*, *Gallinago gallinago*, *Gallinago stenura*, *Larus ridibundus*, *Larus cachimans*, *Larus argentatus*, *Larus hyperboreus* and *Sterna hirundo*. The total prevalence was 80.4%; the intensity of infection ranged from single to dozens of parasite individuals. The helminthofauna of the studied Charadriiformes includes 57 species. The class Cestoda is represented by 13 species, Trematoda by 33 species, Nematoda by 10 species and Acanthocephala by only one species. The highest helminth species diversity in Charadriiformes was shown by Trematoda, which accounted for 56.1% of the total helminth fauna. Of the recorded Trematoda species (33), representatives of the families Echinostomatidae, Notocotylidae, Microphillidae, Plagiorchidae, Prosthogonimidae, Strigeidae and Schistosomatidae are the commonest in the studied region.

Helminths of Falconiformes. Falconiformes are birds of prey; mostly carnivorous, foraging for live prey or carrion. There are about 40 species in the fauna of Uzbekistan, some of which are closely associated with water bodies by their lifestyle and depend on fish or wetland birds. We examined 3 individuals of birds belonging to two species – *Haliaeetus albicilla* and *Circus aeruginosus*. Both were infected with helminths. We identified 6 species of Trematoda: *Opistorchis geminus*, *Plagiorchis elegans*, *Strigea falconis*, *Diplostomum spathaceum*, *D. commutatum* and *Neodiplostomum spathula*. Data on the helminth fauna of the Falconiformes obtained by us is of a purely representative nature. Further research based on sufficient material is needed.

Thus, in central, north-eastern and north-western Uzbekistan, helminths were recorded in 40 species of wetland birds. The helminth fauna is unequally distributed across the orders of wetland birds. The highest helminth species diversity is recorded in Anseriformes (75 species), Charadriiformes (57 species) and Ciconiiformes (45 species). Significantly fewer species were recorded in Falconiformes (6 species). The noticeable similarity of helminth faunas in different orders of birds (with the exception of Falconiformes and Phoenicopteriformes, which have not been sufficiently studied) is obvious due to the high trophic plasticity of wetland birds and the natural and climatic conditions of Uzbekistan. As is known, the diet of wetland birds is highly diverse, and intermediate and reservoir (=paratenic) hosts of recorded helminths make up a significant portion of it.

Way in which helminths infect birds. Analysis of the sources of helminth infection for individual groups of wetland birds showed that the vast majority of the identified helminth species are heteroxenous forms, developing with the involvement of intermediate hosts. They include all species of Cestoda, Trematoda and Acanthocephala.

Monoxenous forms of helminths were found only among nematodes (*Strongyloides turkmenica*, *Trichostrongylus tenuis*, *Epomidiostomum uncinatum* and 4 species from the genus *Amidostomum*), which makes up 5.1%.

When we attempted to specify the sources of infection for wetland birds, it turned out that the entire life cycles of many helminth species had not yet been studied. Therefore, we thought it advisable to study the intermediate hosts of helminths of wetland birds in Uzbekistan, taking into account the trophic and ecological characteristics of host birds (Table 4).

Table 4

List of helminth larvae parasitising intermediate hosts in Uzbekistan (2018–2024)

Class	Family	Host	Identified species of parasitic larvae in intermediate hosts			
			Cestoda	Trematoda	Nematoda	
Oligochaeta	Lumbricidae	<i>Eisenia faetida</i> (Savigny, 1826)	<i>Aploparaksis clavata</i>	–	–	
		<i>Allolobophora kaznakovi</i> (Michaelsen, 1910)	–	–	<i>Porrocaecum crassum</i>	
	Lumbriculidae	<i>Lumbriculus variegatus</i> (Müller, 1774)	<i>Aploparaksis furcigera</i>	–	–	
		<i>Dendrobaena veneta</i> (Rosa, 1886)	–	–	<i>Porrocaecum crassum</i>	
Gastropoda Cuvier, 1795	Lymnaeidae	<i>Lymnaea auricularia</i> (Linnaeus, 1758)	–	<i>Echinostoma revolutum</i> , <i>Echinostoma miyagawai</i> , <i>Echinoparyphium recurvatum</i> , <i>Hypoderaeum conoideum</i> , <i>Notocotylus attenuatus</i> , <i>Cotylurus cornutus</i> , <i>Apatemon gracilis</i> , <i>Diplostomum spathaceum</i> , <i>Diplostomum commutatum</i> , <i>Neodiplostomum spathula</i> , <i>Trichobilharzia ocellata</i> , <i>Ornithobilharzia canaliculata</i>	–	
		<i>Lymnaea stagnalis</i> (Linnaeus, 1758)	–	<i>Godonocephalus urniger</i> , <i>Plagiorchis elegans</i>	–	
	Planorbidae	<i>Planorbis planorbis</i> (Linnaeus, 1758)	–	<i>Notocotylus chionis</i> , <i>Cyclocoelum mutabile</i> , <i>Cyclocoelum obscurum</i> , <i>Strigea falconis</i> , <i>Bilharziella polonica</i> , <i>Dendrotrichobilharzia loossi</i>	–	
		<i>Anisus spirurbis</i> (Linnaeus, 1758)	–	<i>Dendrotrichobilharzia pulverulenta</i> , <i>Gigantobilharzia acotylea</i>	–	
	Rafinesque, 1815	<i>Gyraulus albus</i> (O.F.Müller, 1774)	–	<i>Prosthogonimus ovatus</i> , <i>Prosthogonimus cuneatus</i>	–	
		<i>Macrocyclops albidus</i> (Jurine, 1820)	<i>Microsomacanthus microsoma</i> , <i>Microsomacanthus compressa</i>	–	<i>Avioserpens galliardi</i>	
	Crustacea Brünnich, 1772	Cyclopidae	<i>Eucyclops macrurus</i> (Sars G.O., 1863)	<i>Drepanidotaenia lanceolata</i> , <i>Fimbraria fasciolaris</i>	–	–
			<i>Cyclops vicinus</i> Uljanin, 1875	<i>Diorchis ransomi</i>	–	<i>Avioserpens galliardi</i>
		Rafinesque, 1815	<i>Cyclops streuus</i> Fischer, 1851	<i>Diorchis elisae</i> , <i>Fimbraria fasciolaris</i>	–	<i>Avioserpens galliardi</i>
			<i>Diacyclops bicuspidatus</i> (Claus, 1857)	<i>Drepanidotaenia lanceolata</i>	–	–
<i>Acanthocyclops trajani</i> Mirabdullayev & Defaye, 2004		<i>Microsomacanthus compressa</i> , <i>Fimbraria fasciolaris</i>	–	<i>Avioserpens galliardi</i>		
<i>Megacyclops viridis</i> (Jurine, 1820)		<i>Diorchis brevis</i> , <i>Fimbraria fasciolaris</i>	–	–		
<i>Apocyclops dengizicus</i> (Lepeshkin, 1900)		<i>Diploposthe laevis</i> , <i>Microsomacanthus compressa</i>	–	–		
<i>Mesocyclops leuckarti</i> (Claus, 1857)		<i>Diploposthe laevis</i> , <i>Microsomacanthus microsoma</i>	–	–		
Insecta Linnaeus, 1758		Carabidae	<i>Scarites bucida</i> (Pallas, 1776)	<i>Myxolepis collaris</i>	–	–
			<i>Scarabaeus sacer</i> Linnaeus, 1758	–	–	–
	Scarabaeidae	<i>Carabus tshatkalensis</i> Linnaeus, 1758	<i>Myxolepis collaris</i>	–	–	
Culycidae	Linnaeus, 1758	<i>Aedes caspius</i> (Pallas, 1771)	–	–	<i>Paronchocerca tonkinensis</i>	
		<i>Culex pipiens</i> Linnaeus, 1758	–	–	–	

As we know, a wide range of intermediate hosts – oligochaetes, gastropods, crustaceans and insects – can participate in the life cycles of helminths of wetland birds in Uzbekistan. The total prevalence of the larval stages of helminths was 33.9%. Cestoda larvae were recorded in oligochaetes (2.0%) and crustaceans (8.0%); Trematoda larvae – in aquatic molluscs (16.3%); Acanthocephala – in crustaceans (0.8%). Nematoda larvae were found in three groups of invertebrates: oligochaetes (2.0%), crustaceans (3.2%) and insects (1.3%). Below we analyse the species composition of helminth larvae found in certain groups of intermediate hosts.

Oligochaeta were identified as intermediate hosts to 3 species of helminths – *Aploparaksis clavata* Spasskaya, 1970, *Aploparaksis furcigera* (Rudolphi, 1819) and *Porrocaecum crassum* (Deslongchamps, 1824).

Gastropods are intermediate hosts to 20 species of trematodes from the families Echinostomatidae (5 species), Cyclocoeliidae (2), Notocotylidae (2), Plagiorchidae (1), Strigeidae (4), Diplostomatidae (1) and Schistosomatidae (5). Secondary intermediate and reservoir hosts represented by numerous species of molluscs, insects, fish, amphibians and reptiles take part in the life cycles of a number of trematode species (Bykhovskaya-Pavlovskaya, 1961; Ginetsinskaya, 1963; Chemogorenko, 1983; Sudarikov, 1984).

Crustaceans are intermediate hosts to 19 species of helminths of wetland birds in Uzbekistan. Larval stages were detected in copepods: about 15 species of cestodes (families Ligulidae, Dilepididae and Hymenolepi-

didae) and 4 species of nematodes (*Contraecacum*, *Streptocara* and *Tetrameris*). Secondary intermediate and reservoir hosts also participate in the life cycles of known species (Ryzhikov et al., 1973, 1974; Petrochenko & Kotelnikov, 1976; Anderson, 2000). Intermediate and reservoir hosts are important components of the wetland birds' diets, which makes them key in transmitting the larvae to definitive hosts.

Insects in our study were identified as intermediate hosts to 6 species of helminths of wetland birds, one of which belongs to the class Cestoda (*Paradilepis scolecina* (Rudolphi, 1819)), four to Trematoda (families Prosthogonimidae and Plagiorchidae), and one to Nematoda (Onchocercidae).

Fish, amphibians, and reptiles are also known as the secondary and reservoir hosts to helminths. Our studies confirmed that in relation to fish and amphibians.

Thus, a vast majority of wetland bird species in Uzbekistan become infected with obligate and facultative parasites when they eat their intermediate and reservoir hosts. We will try to find out which are the various ways parasitic larvae use to penetrate their definitive hosts – wetland birds.

Classifying ways helminths use to enter a definitive host, Kontrimavicius (1969) identifies the following four:

- 1) a helminth penetrates the host when the latter eats other organisms, which as intermediate or reservoir hosts are included in its diet;
- 2) a helminth enters the host as mechanical impurity in food or water;

3) a parasite actively penetrates the host's body;

4) a helminth is transmitted by an intermediate host eaten by a definitive one.

Our studies demonstrate all these ways helminths use to infect host birds. Crustaceans inhabiting various types of water bodies, oligochaetes and insects turned out to be intermediate hosts to representatives of the class Cestoda (Table 3). The recorded prevalence of larvae in them ranged from 1.0 to 8.0%. Reservoir hosts also take part in their life cycles.

Trematodes of birds in our study used aquatic molluscs as intermediate hosts, of which 16.3% turned out to be infected with larval stages. Various species of insects, fish and amphibians are also identified as secondary intermediate hosts.

Nematodes in our study use a wide range of intermediate hosts – oligochaetes, crustaceans and insects. Fish and amphibians were registered as their secondary and reservoir hosts.

As is known, among the main factors determining helminthofaunas and helminths' abundance are evolutionarily established parasite-host connections (Kontrimovicius, 1969; Azimov et al., 2015), which work on the basis of trophic and topical relationships. According to our study, helminths infect their definitive hosts trophically, that is, when the latter eat the parasites' intermediate (reservoir) hosts. Helminths using topical relationships include mainly monoxenous nematodes, whose life cycles exclude the participation of an intermediate host (Table 5).

Table 5 proves that the helminthofauna of wetland birds in Uzbekistan is strongly dominated by helminths connected with their hosts trophically (89.0% of all species: Cestoda – 100.0%, Trematoda – 90.9%, Acan-

thocephala – 100.0% and Nematoda – 62.5%). 37% of helminth species use topical relationships. Cercariae of 6 species of trematodes (from the genera *Bilharziella*, *Trichobilharzia*, *Ornithobilharzia*, *Dendritobilharzia* and *Gigantobilharzia*) and larvae of one species of nematodes (*Strongyloides turkmenica*) penetrate into the body through the skin. 6 species of monoxenous nematodes (25%) can parasitise only orally, when infectious eggs or larvae are ingested accidentally. Only 2 species (8.7%) of nematodes (*Paronchocerca tonkinensis* and *Pharyngosetaria marcinowskyi*) are transmitted by blood-sucking dipterans.

The food chains of individual orders of wetland birds largely determine the composition of helminths parasitising them and are the main factor in the formation of their helminth fauna. These processes in time and space strictly depend on environmental factors. The combination of these factors determines the appearance of the modern helminthofauna of wetland birds in Uzbekistan.

The species composition of helminths of wetland birds varied greatly from region to region (Table 6). The most diverse helminth fauna was recorded in north-western Uzbekistan (Republic of Karakalpakstan and Khorezm region), which proved to be inhabited by 112 species from the classes Cestoda, Trematoda, Acanthocephala and Nematoda. In this part of the country trematodes showed the highest species diversity – 57. With 78 helminth species, north-eastern Uzbekistan (Tashkent, Syrdarya and Jizzakh regions) occupied the second place and was followed by the central part of the country, where slightly fewer species (75) were identified in wetland birds.

Table 5

Distribution of helminths of wetland birds across groups depending on the way of infecting a definitive host

Groups	Nature of coenotic relationship	Way of infecting animals	Number of species				
			total	Cestoda	Trematoda	Acanthocephala	Nematoda
1	Trophic	Eating animals as food objects	122	41	60	6	15
2	Topical	Accidental ingestion of eggs and larvae	6	–	–	–	6
3	Topical	Active penetration of larvae through the skin	7	–	6	–	1
4	Topical	Transmission by biting insects	2	–	–	–	2

Table 6

Distribution of helminths of wetland birds across the regions of Uzbekistan (2018–2024)

Regions	Number of parasite species				
	Total	Cestoda	Trematoda	Acanthocephala	Nematoda
Central Uzbekistan	75	29	25	–	21
North-Eastern Uzbekistan	78	29	27	3	19
North-Western Uzbekistan	112	28	57	4	23

So, our research shows that the largest number of helminth species of wetland birds (112) inhabit the north-western part of Uzbekistan, which is followed by the north-eastern region of the country (78 species). The lowest helminth species diversity (75 species) was recorded in central Uzbekistan (Bukhara, Navoi and Samarkand regions), which is probably associated with its climatic, geographical and ecological features.

Among the discovered helminths of wetland birds, a number of species are pathogenic (Ligulidae, Hymenolepididae, Echinostomatidae, Notoctylidae, Prostogonimidae, Strigeidae, Diplostomatidae, Schistosomatidae, Polymorphidae, Amidostomatidae, Ascarididae, Anisakidae, Acuariidae, Streptocaridae, Tetrameridae, Desmidocercidae), causing dangerous helminthiases of wild and domestic birds, fish and humans.

The earliest data about the helminthofauna of fish-eating birds in Uzbekistan was provided by Skjabin (1924), who reported about the discovery of 12 species of helminths in the white pelican, gulls, terns and grebes (trematodes – 9 species, cestodes – 2 and nematodes – 1). Turemuratov (1964) conducted similar studies of helminths of fish-eating birds in the Aral Sea area. Based on this and previous research, we established that the number of helminth species parasitising fish-eating birds in the Aral Sea area is 133, with the class Cestoda represented by 24 species, Trematoda – 67, Acanthocephala – 4 and Nematoda – 38. Data about the helminthofauna of birds in Uzbekistan can be obtained from general faunistic works (Sultanov, 1963), where the author provides fragmentary material collected from a limited number of species of wetland birds. In general, comprehensive studies of the helminth fauna of wetland birds, with the exception of fish-eaters, have not been conducted.

In recent years, the research into specific groups of the helminthofauna of birds in Uzbekistan has resumed (Akramova, 2011; Saparov, 2016), which has resulted in the publication of a series of papers on trematodes (Schistosomatida) and nematodes (Spirurida) parasitising wetland birds in Uzbekistan. The Schistosomatidae fauna of wetland birds consists of 12 species, representing the following genera: *Bilharziella* (1 species), *Trichobilharzia* (4 species), *Macrobilharzia* (1 species), *Ornithobilharzia* (1 species), *Dendritobilharzia* (3 species), *Gigantobilharzia* (1 species) and *Gigantobilharziella* (1 species) (Akramova, 2011).

Nematodes from the order Spirurida parasitising birds in Uzbekistan, including wetland ones, are represented by 53 species belonging to the families Filariidae, Aproctidae and Diplotrienidae (Saparov, 2016). The author notes that the total prevalence of nematodes from the order Spirurida in birds is 13.8%. Across various groups of birds, the prevalence ranges from 2.0% to 31.6%. The data on the species diversity of helminths of wetland birds in Uzbekistan provided by Sultanov (1963) and Turemuratov (1964) are quite outdated and do not reflect the modern helminthofauna. This is confirmed by the results of our research. We identified 138 species of helminths parasitising wetland birds in Uzbekistan.

More than 20 of the formerly recorded species (Turemuratov, 1964) were absent in our material: in the class Cestoda – species from the genera *Tatria*, *Dendrouterina*, *Dubininolepis*, *Wardium*; Trematoda – *Euclinostomum*, *Diplostomum*, *Bolboforus*, *Hysteromorpha*, *Neodiplostomum*, *Postdiplostomum*, *Pegosomum*, *Tanaisia*, *Phylophthalmus*, *Renicola*; Nematoda – *Antennocara*, *Cosmocephalus*, *Streptocara*, *Skjabinocara*, *Eucoleus*, *Chinesocerca*, *Cyatosoma*, *Agamospirura*. This was probably

caused by changes in the environmental situation associated with the catastrophe in the Aral Sea area. Birds that had lived there previously moved to other bodies of water, where the parasite-host relationships with the above-mentioned groups of helminths probably did not stabilise and, as a result, they were removed from the common helminthofauna of wetland birds. At the same time, we have recorded a number of helminth species which had never been found before in wetland birds in Uzbekistan. These include 15 species of cestodes, 16 species of trematodes and 7 species of nematodes.

Wetland birds are known to have a high ecological and trophic flexibility. Birds are mainly infected trophically, when they eat their food objects – helminths' intermediate and reservoir hosts, which is typical for heteroxenous helminths. This is supported by numerous national and foreign publications (Schultz & Gvozdev, 1972; Gibson et al., 2002, 2005, 2008). The larvae of some species (Schistosomatidae and Strongyloidiidae), thought not to be part of the birds' diet, penetrate actively through their skin (Akramova, 2011).

The studies show that animals from a number of classes (oligochaetes, molluscs, crustaceans, insects, fish, amphibians, and reptiles) participate in the transmission of invasive elements of helminths of birds. They can act as intermediate or reservoir hosts (Panin, 1957; Kamranova, 1968; Smogorzhevskaya, 1976; Krasnolobova, 1987; Anderson, 2000).

Comparing the modern helminthofauna of wetland birds in Uzbekistan with that discussed in earlier studies (Sultanov, 1963; Turemuratov, 1964), we can see some changes in the species diversity of parasites, probably, caused by the current environmental situation in Uzbekistan.

Conclusion

The helminthofauna of wetland birds in Uzbekistan is characterised by high species diversity. Faunistic complexes consisting of 138 species representing four classes of helminths (Cestoda, Trematoda, Acanthocephala and Nematoda) show the originality of the helminthofauna of birds – inhabitants of wetland ecosystems. The diversity of parasite species and their ratios are determined by the history of the formation of water bodies and the distribution of helminths across main hosts.

The class Trematoda is dominant in terms of species diversity (66 species) and abundance in the studied region. During our studies, we identified 35 helminth species that had never been previously recorded in wetland birds in Uzbekistan. These included 15 Cestoda species – *Schistocephalus solidus*, *Tetrabothrius macrocephalus*, *T. cylindraceus*, *Lateriporus clerci*, *Diorchis elisae*, *D. levis*, *D. inflata*, *D. ransomi*, *Myxolepis collaris*, *Flamingolepis megalorchis*, *F. flamingo*, *Sobolevicanthus dafflae*, *Wardium fusa*, *W. spasskii* and *Tatria bremsis*; 16 Trematoda species – *Petasiger aerates*, *Petasifer bilobus*, *Echinochasmus petrovi*, *Echinochasmus coaxatus*, *E. euryporus*, *Mesorchis denticulatus*, *Aporchis rugosus*, *A. massiliensis*, *Pegosomum skjabini*, *Paramonostomum bucephalae*, *Microphallus claviformis*, *Metorchis xanthosomus*, *Tanaisia atra*, *Plagiorchis loricola*, *Pachytrema paniceum* and *Austrobilharzia chapini*; and 4 Nematoda species – *Eustrongylides tuffex*, *Eustrongylides mergorum*, *Paronchocerca tonkinensis* and *Pharyngosetaria marcinowskyi*. These species had not been mentioned in previous studies. Presumably, the 35 new species have appeared in the helminthofauna of wetland birds in Uzbekistan in recent years and have most likely been brought by migrating birds.

The specific ecological characteristics and location of large bodies of water account for the diversity of helminths of aquatic and semi-aquatic birds. These bodies of water provide a high variety of faunistic complexes and trophic relationships and, as a result, ensure optimal conditions for the circulation of parasites in various stages of their life cycles.

Analysis of the sources of helminth infection for wetland birds shows that the vast majority of the identified helminth species are heteroxenous, developing with the involvement of intermediate and reservoir hosts. They include all species of Cestoda, Trematoda and Acanthocephala and several species of Nematoda. Most of the recorded helminth species enter the body of birds together with their intermediate, additional and reservoir hosts, which are eaten by the birds. The food chains of individual orders of wetland birds largely determine the composition of helminths parasitising them and are the main factor in the formation of their helminth fauna.

These processes in time and space strictly depend on environmental factors. The combination of these factors determines the appearance of the modern helminthofauna of wetland birds in Uzbekistan.

In general, the obtained data expand the helminthofauna of wetland birds in Uzbekistan and specify general trends in changes in the parasites' species diversity driven by environmental factors.

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