

## A systematic review of flukes (Trematoda) of domestic goose (*Anser anser* dom.)

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Trematodes are one of the most numerous and widespread groups of parasitic invertebrates among helminths, characterized by a complex life cycle. As the final host, digenetic flukes parasitize vertebrates, including domestic waterfowl. Infection of hosts with parasitic digenetic worms causes huge economic damage to poultry. But trematode fauna of domestic geese are presented mainly only for individual regions. Despite the fact that there is already a systematic review of tapeworms and acanthocephala of domestic birds – geese and ducks, there are, unfortunately, no review articles on the taxonomy of digenetic flukes for geese (*Anser anser* dom.). Taking into account the relevance of the topic, based on our own and extensive literature data, we set the task to determine the general species composition of digenetic flukes (Trematoda), parasitizing in domestic geese which have been recorded in the world until 2020. Each Trematoda species is provided with the following data: scientific name, authority and year, first, second intermediate, auxiliary and final hosts, site in the host body, collecting localities and geographic distribution, and literature sources. Currently it is established that there are 149 species of helminths parasitizing domestic geese. The taxonomic composition of the class Trematoda registered in domestic geese consists of 2 classes, 14 families, 30 genera and 65 species. Of all the species of trematodes parasitizing in domestic geese, 44 species have been recorded in Europe, 26 species in Asia, 6 species in North America, 1 species in South America, 1 species in Africa and 2 species in Oceania. Three species are registered in domestic geese (*Echinoparyphium recurvatum*, *Echinostoma revolutum*, *Prosthogonimus ovatus*) are cosmopolitan parasites. The biggest species diversity is characterized by the families Echinostomatidae (17 species) and Notocotylidae (12 species). There are 11 species of digenetic flukes recorded in domestic geese *Cyclocoelum mutabile*, *Echinostoma grande*, *E. parvulum*, *E. revolutum*, *E. robustum*, *Hypoderaeum conoideum*, *Paryphostomum novum*, *P. pentalobum*, *Catatropis verrucosa*, *Notocotylus attenuatus*, *N. parviovatus* on the territory of Azerbaijan. Four of them (*Echinostoma revolutum*, *Hypoderaeum conoideum*, *Paryphostomum novum*, *Notocotylus attenuatus*) were also noted in the course of our helminthological studies. The trematode *Cyclocoelum mutabile* was recorded in domestic ducks only in Azerbaijan. Most species of trematodes were found in the north-eastern part (total 9 species) and southern part (total 5 species) of Azerbaijan. This is due to the widespread distribution of molluscs – intermediate hosts of digenetic flukes, in these regions. Eighteen species of digenetic flukes parasitize both birds and mammals (Rodentia, Carnivora, Lagomorpha, Artiodactyla). And eleven species of trematodes are of medical importance, registered in humans.

**Keywords:** fauna; systematic classification; helminths, water bird, Azerbaijan.

### Introduction

Trematodes, a class of digenetic flukes, being biohelminths, have the largest number of species among helminths in wetland birds, including domestic waterfowl. Infection of hosts with parasitic digenetic worms causes huge economic damage to poultry. The study of the species composition of bird helminths, including trematodes of domestic geese (*Anser anser* dom.) has been carried out in some countries (Lapage, 1961; McDonald, 1969; Smogorzhevskaya, 1976; Sitko et al., 2006; Shakarbayev et al., 2012; Kirillov & Kirillova, 2013; Berenice et al., 2014), including in Azerbaijan (Shirinov, 1961; Vahidova, 1978). In recent years (2005–2020), on the territory of the republic, the helminth fauna of domestic waterfowl and some ecological aspects have been studied by us (Rzayev, 2008, 2013; Rzayev & Ibrahimova, 2015; Seyidbeyli & Rzayev, 2018; Rzayev et al., 2020; Seyidbeyli et al., 2020). However, it should be noted that data on the trematode fauna of domestic geese are presented mainly for individual regions. Despite the fact that there is already a systematic review of tapeworms and acanthocephala of domestic birds – geese and ducks (Rzayev, 2021; Rzayev et al., 2021; Rzayev & Gasimov, 2021), there are unfortunately no review articles on the taxonomy of digenetic flukes for the above birds. Taking into account the relevance of the topic, based on our own and literature data, we set the task to determine the general species composition of digenetic flukes (Trematoda), parasitizing in domestic geese which have been recorded in the World until 2020.

### Material and methods

In addition to the extensive literature data, we carried out a parasitological study to determine the helminth fauna of domestic waterfowl, including domestic geese, in the territory of Azerbaijan. In total, 470 domestic geese from private poultry farms in various regions of the Republic were researched by the method of complete parasitological examination (Skrjabin, 1928; Dubinina, 1971). The collected flukes were stained with carmine and dehydrated, and then permanent preparations were prepared with Canadian balsam. The preparations were studied under a Primo Star light microscope (Carl Zeiss, Germany). We used an identification guide for species identification (Ryzhikov, 1967). In total, 21 species of helminths were identified in geese. Of these, 4 species are digenetic flukes.

The Trematoda list is arranged following the nomenclature and classification from three volumes of books “Keys to Trematoda” by Gibson et al. (2002), Jones et al. (2005), Bray et al. (2008), with phylogenetic updates by Olson et al. (2003). We also took into account the classification adopted by the database of World Register of Marine Species (WoRMS, www.marinespecies.org). Each Trematoda species is provided with the following data: scientific name, authority and year, first, second intermediate, auxiliary and final hosts, site in host body, collecting localities and geographic distribution, prevalence (PI) and intensity (II) of infection and literature sources.

## Results

Based on our own research and analysis of extensive literature data, 149 species of helminths have been established today among domestic geese. The taxonomic composition of the class of trematodes (Trematoda) registered in domestic geese consists of two classes (Diplostomida – 9 and Plagiorchiida – 56), 14 families (Strigeidae – 4, Cyathocotylidae – 2, Schistosomatidae – 3, Cyclocoelidae – 2, Echinochasmidae – 1, Echinostomatidae – 17, Philophthalmidae – 4, Psilostomidae – 7, Typhlocoelidae – 1, Heterophyidae – 3, Opisthorchiidae – 4, Notocotylidae – 12, Zygocotylidae – 1, Prosthogonimidae – 4), 30 genera and 65 species. These species are presented below according to the above taxonomy:

Phylum: Platyhelminthes Gegenbaur, 1859

Class: Trematoda Rudolphi, 1808

Subclass: Digenea Carus, 1863

Order: Diplostomida Olson, Cribb, Tkach, Bray, Littlewood, 2003

Family: Strigeidae Railliet, 1919

Genus: *Apatemon* Szidat, 1928

1. *Apatemon gracilis* (Rudolphi, 1819) Szidat, 1928

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Annelida – Hirudinea; Pisces – Cyprinidae, Salmonidae, Gasterosteidae, Nemachellidae.

Final hosts: Aves – Anseriformes, Charadriiformes, Columbiformes.

Site in host: Small intestine.

Locality: Georgia and Kazakhstan (Petrochenko & Kotelnikov, 1976), China – Zhenjiang, Jiangsu Province (Liu et al., 2018), Russia – Amur, Krasnoyarsk regions, mouth of the Volga River (Ryzhikov, 1967; Petrochenko & Kotelnikov, 1976; Kirillov & Kirillova, 2013), Slovakia and Czech Republic (PL 1.5%) (Busta, 1980).

Distribution: Europe, Asia, Africa, North and South America.

Genus: *Cotylurus* Szidat, 1928

2. *Cotylurus cornutus* Rudolphi, 1808

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Annelida – Hirudinea; Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Falconiformes, Galliformes, Charadriiformes, Columbiformes, Passeriformes, Mammalia – human.

Site in host: Small intestine.

Locality: Ukraine – Danube Delta, upper and lower Dniester (Smogorzhevskaya, 1976; Iskova et al., 1995), Russia – Rostov and Moscow regions (Ryzhikov, 1967; Petrochenko & Kotelnikov, 1976), Slovakia and Czech Republic (PL 0.1%) (Busta, 1980).

Distribution: Europe, Asia, Africa, North and South America.

3. *Cotylurus flabelliformis* Faust, 1917

First and second intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Galliformes.

Site in host: intestine, caecum.

Locality: USA (McDonald, 1969).

Distribution: Europe, Asia, North America.

Genus: *Ichthyocotylurus* Odening, 1969

4. *Ichthyocotylurus pileatus* (Rudolphi, 1802) Odening, 1969

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Pisces – Percidae.

Final hosts: Aves – Anseriformes.

Site in host: Intestine.

Locality: Ukraine (Smogorzhevskaya, 1976).

Distribution: Europe, Asia, North America.

Family: Cyathocotylidae Muhling, 1898

Genus: *Cyclocoelum* Brandes, 1892

5. *Cyclocoelum mutabile* (Zeder, 1800) Brandes, 1892

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Charadriiformes.

Site in host: air sacs, nasal cavity.

Locality: Azerbaijan – Lenkaran region (Vahidova, 1978).

Distribution: Europe, Asia, North America.

6. *Cyclocoelum robustum* Stossich, 1903

First and second intermediate hosts: unknown.

Final hosts: Aves – Anseriformes.

Site in host: nasal cavity, air sacs.

Locality: Far East (Ryzhikov, 1967; Petrochenko & Kotelnikov, 1976).

Distribution: Europe, Asia, Australia.

Family: Schistosomatidae Stiles & Hassall, 1898

Genus: *Bilharziella* Looss, 1899

7. *Bilharziella polonica* Kowalewski, 1895

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Podicipediformes, Ciconiiformes, Gruiformes, Charadriiformes.

Site in host: abdominal veins, especially portal veins; intestine, lungs, kidneys.

Locality: Slovakia and Czech Republic (Barus et al., 1977; Sitko et al., 2006), Poland (Bezubik, 1956), Germany (Lapage, 1961), Uzbekistan (Shakarbayev et al., 2012), Ukraine (PL 0.1%, II 1–6) (Smogorzhevskaya, 1976; Iskova et al., 1995), Russia (Ryzhikov, 1967).

Distribution: Europe, Asia, Africa, North America.

Genus: *Trichobilharzia* Skrjabin & Zakharov, 1920

8. *Trichobilharzia adamsi* Edwards & Jansch, 1955

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes.

Site in host: liver.

Locality: Canada (McDonald, 1969; Brant & Loker, 2009).

Distribution: North America.

9. *Trichobilharzia oregonensis* Macfarlane et Macy, 1946

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes.

Site in host: portal veins, veins of intestinal and caecum walls.

Locality: USA (Macy et al., 1955; McDonald, 1969).

Distribution: North America.

Order: Plagiorchiida La Rue, 1957

Family: Cyclocoelidae Stossich, 1903

Genus: *Hyptiasmus* Kossack, 1911

10. *Hyptiasmus arcuatus* (Brandes, 1892) Kossack, 1911

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Gruiformes, Charadriiformes.

Site in host: nasal cavity, trachea.

Locality: Czech Republic and Slovakia – Presov (Barus et al., 1977; Sitko et al., 2006), Germany (Lapage, 1961).

Distribution: North America, Europe, Asia.

11. *Hyptiasmus laevigatus* Kossack, 1911

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes.

Site in host: nasal cavity, trachea.

Locality: Ukraine and Kazakhstan (Ryzhikov, 1967).

Distribution: North America, Europe, Asia.

Family: Echinochasmidae Odhner, 1910

Genus: *Echinochasmus* Dietz, 1909

12. *Echinochasmus beleocephalus* (Linstow, 1873) Dietz, 1909

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Amphibia – Pelobatidae, Ranidae; Pisces – Cyprinidae.

Final hosts: Aves – Anseriformes, Ciconiiformes, Galliformes.

Site in host: small intestine, caecum.

Locality: Russia (Ryzhikov, 1967), Ukraine – Danube Delta, Upper and Lower Dniester (Iskova et al., 1995).

Distribution: Europe, Asia, Africa.

- Family: Echinostomatidae Looss, 1899  
Genus: *Echinoparyphium* Dietz, 1909
13. *Echinoparyphium cinctum* Rudolphi, 1802  
First and second intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Charadriiformes.  
Site in host: intestine.  
Locality: Uzbekistan (Shakarbayev et al., 2012), Ukraine (Smogorzhevskaya, 1976), Russia – Omsk and Chelyabinsk regions and Belarus (Ryzhikov, 1967; Petrochenko & Kotelnikov, 1976).  
Distribution: Europe, Asia.
14. *Echinoparyphium recurvatum* Linstow, 1873  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Amphibia – Pelobatidae, Ranidae; Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes, Ciconiiformes, Galliformes, Gruiformes, Charadriiformes, Columbiformes, Strigiformes; Mammalia – Rodentia, Carnivora and humans (Lu, 1982).  
Site in host: small intestine.  
Locality: Ukraine (Iskova et al., 1995; Yuskiv & Melnychuk, 2020), Russia – Bashkortostan, along the Volga River, Dagestan (Kirillov & Kirillova, 2013; Marzhokhova & Zhigunova, 2008), New Zealand (Rind, 1974; Weekes, 1982; McKenna, 2010), Turkey – Marmara (Merdivenci, 1967; Gicik & Arslan, 2003), Uzbekistan (Shakarbayev et al., 2012), Czech Republic and Slovakia (Sitko et al., 2006).  
Distribution: cosmopolitan.
- Genus: *Echinostoma* Rudolphi, 1809
15. *Echinostoma dietzi* Skrjabin, 1923  
First and second intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes, Galliformes, Gruiformes.  
Site in host: small intestine.  
Locality: Ukraine (Petrochenko & Kotelnikov, 1976), Uzbekistan (Shakarbayev et al., 2012), Russia – Bashkortostan, along the Volga River, Moscow region (Kirillov & Kirillova, 2013; Ryzhikov, 1967; Petrochenko & Kotelnikov, 1976).  
Distribution: Europe, Asia.
16. *Echinostoma grande* Bachkirova, 1946  
First and second intermediate hosts: unknown.  
Final hosts: Aves – Anseriformes, Gruiformes.  
Site in host: small intestine, caecum.  
Locality: Russia (McDonald, 1969), Azerbaijan – Shabran region (PL 0.45%, II 1–6) (Shirinov, 1961).  
Distribution: Europe, Asia.
17. *Echinostoma lindoense* Sandground & Bonne, 1940  
First and second intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes, Galliformes; Mammalia – Rodentia and humans (Carney et al., 1980).  
Site in host: small intestine.  
Locality: Malaysia (McDonald, 1969).  
Distribution: Asia.
18. *Echinostoma miyagawai* Ishii, 1932  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Mollusca – Gastropoda; Amphibia – Ranidae.  
Final hosts: Aves – Anseriformes, Galliformes, Charadriiformes, Columbiformes; Mammalia – Rodentia and humans (Mao, 1991).  
Site in host: small and large intestine.  
Locality: Russia – Bashkortostan, along the Volga River (Ryzhikov, 1967).  
Distribution: Europe, Asia.
19. *Echinostoma parvulum* Dietz, 1909  
First and second intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes, Podicipediformes, Galliformes, Charadriiformes, Columbiformes; Mammalia – humans (Yu & Mott, 1994).  
Site in host: intestine.
- Locality: Russia – along the Volga River, North Caucasus, Ural, Amur, Kaluga, Bryansk, Kursk regions (Kirillov & Kirillova, 2013; Marzhokhova & Zhigunova, 2008), Kazakhstan and Georgia (Petrochenko & Kotelnikov, 1976), Azerbaijan – Shabran region (PL 0.6%, II 1–2) (Shirinov, 1961; Vahidova, 1978).  
Distribution: Europe, Asia.
20. *Echinostoma revolutum* Fröhlich, 1802  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Amphibia – Bufonidae, Ranidae.  
Auxiliary hosts: Pisces – Cyprinidae, Ictaluridae.  
Final hosts: Aves – Anseriformes, Podicipediformes, Ciconiiformes, Falconiformes, Galliformes, Gruiformes, Charadriiformes, Columbiformes, Strigiformes, Passeriformes; Mammalia – Rodentia, Carnivora, Lagomorpha, Artiodactyla and humans (Carney, 1991; Sohn et al., 2011).  
Site in host: intestine.  
Locality: Ukraine (PL 0.3%, II 1–13) (Smogorzhevskaya, 1976; Iskova et al., 1995; Yuskiv & Melnychuk, 2020), Russia – Bashkortostan, Dagestan, Kaluga, Kursk, Ryazan, Tula regions, along the Volga River (Ryzhikov, 1967; Kirillov & Kirillova, 2013), New Zealand – Rakaia, Coleridge, Ashburton, Banks Peninsula, Waimakariri, Kaikoura, Kaitangata (Rind, 1974; Weekes, 1982; McKenna, 2010), UK (Griffiths et al., 1976), Turkey – Gars and Marmara (Merdivenci, 1967; Gicik & Arslan, 2003), Czech Republic and Slovakia (Barus et al., 1977; Sitko et al., 2006), Uzbekistan (Shakarbayev et al., 2012), Azerbaijan – Mughan, Lenkaran, Astara, Jalilabad, Bilasuvar, Shabran, Guba, Khachmaz, Shamkir, Absheron regions (PL 5.7%, II 1–21) (Shirinov, 1961; Vahidova, 1978; Aghayeva, 2018), own data – Masally region (PL 0.12%, II 1).  
Distribution: cosmopolitan.
21. *Echinostoma robustum* Yamaguti, 1935  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Amphibia – Ranidae.  
Auxiliary hosts: Pisces – Cyprinidae.  
Final hosts: Aves – Anseriformes, Galliformes, Columbiformes.  
Site in host: small intestine.  
Locality: Ukraine – Black Sea coast (PL 0.03%, II 13–16) (Smogorzhevskaya, 1976; Iskova et al., 1995), Russia – Bashkortostan, Amur region, along the Volga River (Kirillov & Kirillova, 2013), Azerbaijan – Shabran region (PL 0.9%, II 1–4) (Shirinov, 1961).  
Distribution: Europe, Asia.
22. *Echinostoma sudanense* Odhner, 1911  
First and second intermediate hosts: unknown.  
Final hosts: Aves – Anseriformes, Ciconiiformes.  
Site in host: small intestine, large intestine.  
Locality: Ukraine (Smogorzhevskaya, 1976).  
Distribution: Europe, Africa.
- Genus: *Hypoderaeum* Dietz, 1909
23. *Hypoderaeum conoideum* Bloch, 1782  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia.  
Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Columbiformes; Mammalia – human (Bhaibulaya et al., 1964; Yokogawa et al., 1965).  
Site in host: small intestine.  
Locality: Czech Republic and Slovakia (PL 0.1%) (Busta, 1980; Sitko et al., 2006), Russia – Bashkortostan, along the Volga River (Kirillov & Kirillova, 2013), Ukraine (PL 0.7%, II 5–54) (Iskova et al., 1995; Yuskiv & Melnychuk, 2020), Turkey – Marmara (Merdivenci, 1967; Gicik & Arslan, 2003), Uzbekistan (Shakarbayev et al., 2012), Azerbaijan – Masally, Shabran regions (Shirinov, 1961; Vahidova, 1978), own data – Nakhchivan AR – Babek region (PL 2.2%, II 2–3).  
Distribution: Europe, Asia, Africa, North America.
24. *Hypoderaeum dingeri* Lie, 1964  
First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Mollusca – Gastropoda; Amphibia – Rhacophoridae.

Final hosts: Aves – Anseriformes, Columbiformes.

Site in host: small intestine.

Locality: Malaysia (McDonald, 1969).

Distribution: Asia.

Genus: *Neoacanthoparyphium* Yamaguti, 1958

25. *Neoacanthoparyphium echinatoides* Filippi, 1854

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Mollusca – Gastropoda, Bivalvia.

Final hosts: Aves – Anseriformes, Columbiformes, Galliformes, Charadriiformes, Passeriformes; Mammalia – Rodentia, Lagomorpha.

Site in host: small intestine.

Locality: Slovakia (McDonald, 1969).

Distribution: Europe.

26. *Neoacanthoparyphium petrovi* Nevostrueva, 1953

First and second intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes.

Site in host: small intestine.

Locality: Russia – Moscow region (Ryzhikov, 1967).

Distribution: Europe, Asia.

Genus: *Petasiger* Dietz, 1909 (Syn.: *Paryphostomum* Dietz, 1909)

27. *Paryphostomum novum* Verma, 1936

First intermediate hosts: unknown.

Second intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes.

Site in host: intestine.

Locality: Far East (McDonald, 1969), Azerbaijan – Shabran region (PL 0.6%, II 1–2) (Shirinov, 1961), own data – Lenkaran region (PL 0.86%, II 1).

Distribution: Europe, Asia.

28. *Paryphostomum pentalobum* Verma, 1936

First intermediate hosts: unknown.

Second intermediate hosts: unknown.

Final hosts: Aves – Anseriformes, Charadriiformes.

Site in host: intestine.

Locality: India (McDonald, 1969), Azerbaijan – Shabran region (EI 0.45%, II 1) (Shirinov, 1961; Vahidova, 1978).

Distribution: Asia.

29. *Petasiger radiatus* (Dujardin, 1845) Tkach, Kudlai, Kostadinova, 2015

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Pisces.

Final hosts: Aves – Anseriformes, Podicipediformes, Pelecaniformes, Gruiformes.

Site in host: intestine.

Locality: Pakistan (McDonald, 1969).

Distribution: Europe, Asia, Africa, Australia.

Family: Philophthalmidae Looss, 1899

Genus: *Philophthalmus* Looss, 1899

30. *Philophthalmus cupensis* Richter, Vrazic & Aleraj, 1953

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes.

Site in host: eye – under nictitating membrane.

Locality: Serbia (Richter et al., 1953; McDonald, 1969).

Distribution: Europe.

31. *Philophthalmus gralli* Mathis & Leger, 1910

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Struthioniformes; Mammalia – Lagomorpha, Rodentia and human (Dissanaike & Bilimoria, 1958; Mimori et al., 1982).

Site in host: eye – conjunctival sac.

Locality: China (McDonald, 1969) and Taiwan (Kingston, 1984).

Distribution: Europe, Asia, Oceania, North America, Africa.

32. *Philophthalmus hovorkai* Busa, 1956

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Galliformes, Falconiformes, Columbiformes, Ciconiiformes, Gruiformes, Charadriiformes; Mammalia – Rodentia, Lagomorpha and humans (Kanev et al., 1993).

Site in host: eye – conjunctival sac.

Locality: Slovakia – Jahodna, Senne, Sturovo (Sitko et al., 2006), Uzbekistan – Tashkent (Shakarbayev et al., 2016), Austria – near Vienna (Kanev et al., 1993), Czech Republic and Bulgaria (Busa, 1956; Vassilev, 1962, 1973; Vassilev & Denev, 1965, 1971), Germany (Siebold, 1835), France (Beneden, 1858).

Distribution: Europe, Asia.

33. *Philophthalmus posaviniensis* Richter, Wrazic, & Aleraj, 1953

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes.

Site in host: eye – under nictitating membrane.

Locality: Serbia (Richter et al., 1953; McDonald, 1969).

Distribution: Europe.

Family: Psilostomidae Looss, 1900

Genus: *Psilochasmus* Lühe, 1909

34. *Psilochasmus longicirratus* Skrzjabin, 1913

First and second intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Ciconiiformes, Columbiformes.

Site in host: small intestine – anterior region, caecum.

Locality: Kazakhstan (Petrochenko & Kotelnikov, 1976).

Distribution: Europe, Asia, North America.

35. *Psilochasmus oxyurus* (Creplin, 1825) Lühe, 1909

First and second intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Galliformes, Charadriiformes.

Site in host: small intestine – anterior region.

Locality: Brazil – State of Rio de Janeiro, Mage; State of Sao Paulo, Sao Jose do Rio Preto (PL 20%) (Berenice et al., 2007).

Distribution: Europe, Asia, Africa, North and South America.

Genus: *Psilotrema* Odhner, 1913

36. *Psilotrema oligoon* Linstow, 1887

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Columbiformes; Mammalia – Rodentia.

Site in host: small intestine.

Locality: Russia (McDonald, 1969).

Distribution: Europe, Asia.

37. *Psilotrema simillimum* Muhling, 1898

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Gruiformes; Mammalia – Rodentia.

Site in host: small intestine.

Locality: Germany (McDonald, 1969), Russia and Kazakhstan (Ryzhikov, 1967).

Distribution: Europe, Asia.

38. *Psilotrema spiculigerum* Muhling, 1898

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Galliformes, Gruiformes; Mammalia – Rodentia.

Site in host: small intestine.

Locality: Kazakhstan and Russia (Ryzhikov, 1967; Petrochenko & Kotelnikov, 1976).

Distribution: Europe, Asia.

Genus: *Ribeiroia* Travassos, 1939

39. *Ribeiroia ondatrae* (Price, 1931) Price, 1942

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Pisces – Centrarchidae, Poeciliidae, Percidae.

Final hosts: Aves – Anseriformes, Falconiformes, Galliformes, Columbiformes, Passeriformes; Mammalia – Rodentia.

Site in host: proventriculus – in mucosa.

Locality: USA and Canada (Lapage, 1961; McDonald, 1969; Crompton & Nesheim, 1976).

Distribution: North and South America.

Genus: *Sphaeridiotrema* Odhner, 1913

40. *Sphaeridiotrema globulus* (Rudolphi, 1819) Odhner, 1913

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Gruiformes, Charadriiformes.

Site in host: small intestine.

Locality: UK (Crompton & Nesheim, 1976).

Distribution: Europe, Asia, North America.

Family: Typhlocoelidae Harrah, 1922

Genus: *Tracheophilus* Skrjabin, 1913

41. *Tracheophilus sisowi* Skrjabin, 1913

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Charadriiformes.

Site in host: trachea, bronchi, oronasal passage, air sacs.

Locality: Russia – along the Volga River (Ryzhikov, 1967; Petrochenko & Kotelnikov, 1976; Kirillov & Kirillova, 2013).

Distribution: Europe, Asia, Africa, North and South America, Australia.

Family: Heterophyidae Leiper, 1909

Genus: *Cercarioides* Witenberg, 1929

42. *Cercarioides aharoni* Witenberg, 1929

First and second intermediate hosts: unknown.

Final hosts: Aves – Anseriformes, Charadriiformes.

Site in host: intestine.

Locality: Egypt and Ukraine (Gohar, 1935; McDonald, 1969; Smogorzhevskaya, 1976).

Distribution: Europe, Asia, Africa.

Genus: *Cryptocotyle* Lühe, 1899

43. *Cryptocotyle concava* Creplin, 1825

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Pisces – Atherinidae, Gobiidae, Catostomidae, Gasterosteidae, Gobiidae, Mugilidae, Mullidae.

Final hosts: Aves – Anseriformes, Gaviiformes, Podicipediformes, Pelecaniformes, Ciconiiformes, Galliformes, Charadriiformes, Columbiformes, Strigiformes; Mammalia – Lagomorpha, Rodentia, Carnivora, Artiodactyla.

Site in host: intestine, caecum.

Locality: Russia (Ryzhikov, 1967).

Distribution: Europe, Asia, North America.

Genus: *Pygidiopsis* Looss, 1907

44. *Pygidiopsis genata* Looss, 1907

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Pisces – Atherinidae, Mugilidae, Cichlidae, Cyprinidae, Poeciliidae.

Final hosts: Aves – Anseriformes, Podicipediformes, Pelecaniformes, Ciconiiformes, Falconiformes, Galliformes, Charadriiformes, Columbiformes, Strigiformes; Mammalia – Lagomorpha, Rodentia, Carnivora and humans (Boulos et al., 1981).

Site in host: intestine.

Locality: Ukraine (Smogorzhevskaya, 1976).

Distribution: Europe, Asia, Africa, North America.

Family: Opisthorchiidae Looss, 1899

Genus: *Metorchis* Looss, 1899

45. *Metorchis orientalis* Tanabe, 1920

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Pisces – Cyprinidae.

Final hosts: Aves – Anseriformes, Podicipediformes, Ciconiiformes, Galliformes, Strigiformes; Mammalia – Rodentia, Carnivora and humans (Li et al., 2010).

Site in host: Gall bladder, bile ducts of liver.

Locality: China – Tsingkiangpu, Kiangsu (Zhan et al., 2017).

Distribution: Asia, North America.

46. *Metorchis taiwanensis* Morishita & Tsuchimochi, 1925

First intermediate hosts: unknown.

Second intermediate hosts: Pisces – Cyprinidae.

Final hosts: Aves – Anseriformes, Falconiformes, Galliformes, Gruiformes.

Site in host: gall bladder, bile ducts of liver.

Locality: Russia (Ryzhikov, 1967).

Distribution: Asia.

47. *Metorchis xanthosomus* (Creplin, 1846) Braun, 1902

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Pisces – Cobitidae, Gasterosteidae, Nemachilidae, Cyprinidae.

Final hosts: Aves – Anseriformes, Gaviiformes, Podicipediformes, Pelecaniformes, Falconiformes, Galliformes, Gruiformes, Passeriformes; Mammalia – Carnivora.

Site in host: gall bladder, bile ducts of liver, intestine.

Locality: China (McDonald, 1969).

Distribution: Asia, Europe.

Genus: *Opisthorchis* Blanchard, 1895

48. *Opisthorchis simulans* Looss, 1896

First and second intermediate hosts: unknown.

Final hosts: Aves – Anseriformes, Ciconiiformes, Falconiformes, Gruiformes.

Site in host: bile ducts of liver.

Locality: Ukraine (Smogorzhevskaya, 1976; Petrochenko & Kotelnikov, 1976; McDonald, 1969).

Distribution: Europe, Asia, Africa, North America.

Family: Notocotylidae Luhe, 1909

Genus: *Catatropis* Odhner, 1905

49. *Catatropis verrucosa* Froelich, 1789

First intermediate hosts: Mollusca – Gastropoda.

Second intermediate hosts: Oligocheata – Clitellata.

Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Charadriiformes.

Site in host: intestine, caecum.

Locality: Russia – Bashkortostan, Dagestan, Ural and Amur regions, along the Volga River, North Caucasus (Marzhokhova & Zhigunova, 2008; Kirillov & Kirillova, 2013), Turkey – Marmara (Merdivenci, 1967; Gicik & Arslan, 2003), Czech Republic (Barus et al., 1977), Uzbekistan (Shakarbayev et al., 2012), Azerbaijan – Shabran, Khachmaz regions (Shirinov, 1961).

Distribution: Europe, Asia, Africa, North America.

Genus: *Notocotylus* Diesing, 1839

50. *Notocotylus attenuatus* (Rudolphi, 1809) Kossack, 1911

Intermediate hosts: Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Charadriiformes; Mammalia – Rodentia.

Site in host: caecum, large intestine.

Locality: Czech Republic and Slovakia (PL 0.3%) (Busta, 1980; Sitko et al., 2006), Russia – along the Volga River, Dagestan, North Caucasus (Marzhokhova & Zhigunova, 2008; Kirillov & Kirillova, 2013), England (Soliman, 1955; Griffiths et al., 1976), Uzbekistan (Shakarbayev et al., 2012), Ukraine (PL 0.07%, II 4–10) (Smogorzhevskaya, 1976; Iskova et al., 1995), Turkey – Marmara (Merdivenci, 1967), Iraq – Ninevah governorate (Al-Tae et al., 2011), Azerbaijan – Astara, Shabran, Khachmaz regions (PL 2.3%, II 2–10) (Shirinov, 1961; Vahidova, 1978) own data – Khudat, Bilasuvar regions, Nakhchivan AR – Julfa region (PL 1.1%, II 7–12).

- Distribution: Europe, Asia, North and South America, Australia.
51. *Notocotylus ephemera* Nitzsch, 1817  
Intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes, Galliformes.  
Site in host: caecum.  
Locality: Germany – Berlin (McDonald, 1969).  
Distribution: Europe.
52. *Notocotylus imbricatus* Looss, 1893  
Intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes, Galliformes.  
Site in host: caecum.  
Locality: China (Chang-Tung, 1937; Gower, 1939; McDonald, 1969).  
Distribution: Europe, Asia, North America.
53. *Notocotylus parviovatus* Yamaguti, 1934  
Intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes.  
Site in host: caecum, intestine.  
Locality: Ukraine (Iskova et al., 1995; Yuskiv & Melnychuk, 2020),  
Russia – along the Volga River (Kirillov & Kirillova, 2013), Uzbekistan  
(PL 3.1%, II 1–8) (Shakarbayev et al., 2012), Azerbaijan – Garabakh  
(Vahidova, 1978).  
Distribution: Europe, Asia.
54. *Notocotylus seineti* Fuhrmann, 1919  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Mollusca – Gastropoda; Artrophoda –  
Cyprididae.  
Final hosts: Aves – Anseriformes.  
Site in host: caecum, intestine.  
Locality: Germany (Heinemann, 1936).  
Distribution: Europe, North America.
55. *Notocotylus stagnicolae* Herber, 1942  
Intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes, Galliformes, Charadriiformes;  
Mammalia – Rodentia.  
Site in host: caecum.  
Locality: USA (McDonald, 1969).  
Distribution: North America.
56. *Notocotylus thienemanni* Szidat & Szidat, 1933  
Intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes.  
Site in host: caecum.  
Locality: Germany (Heinemann, 1936).  
Distribution: Europe.
- Genus: *Paramonostomum* Lühe, 1909
57. *Paramonostomum alveatum* (Mehlis, 1846) Lühe, 1909  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Crusta-  
cea – Gammaridae.  
Final hosts: Aves – Anseriformes, Galliformes.  
Site in host: caecum, intestine, cloaca.  
Locality: Ukraine (Smogorzhevskaya, 1976).  
Distribution: Europe, Asia, North America.
58. *Paramonostomum bucephalae* Yamaguti, 1935  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Crusta-  
cea – Gammaridae.  
Final hosts: Aves – Anseriformes.  
Site in host: caecum.  
Locality: Ukraine (McDonald, 1969; Smogorzhevskaya, 1976).  
Distribution: Europe, Asia, North America.
- Genus: *Uniserialis* Beverley-Burton, 1958
59. *Uniserialis gippensis* Beverley-Burton, 1958  
Intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes.  
Site in host: caecum, bursa of Fabricius.  
Locality: New Zealand – Ashburton, Avon R., Banks Peninsula,  
L. Coleridge, Otago (Rind, 1974; Weekes, 1982; McKenna, 2010).  
Distribution: Europe, Oceania.
60. *Uniserialis tadornae* Bisset 1977  
Intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes.  
Site in host: caecum.  
Locality: New Zealand (Bisset, 1977; Weekes, 1982).  
Distribution: Oceania.
- Family: Zygotocylidae Ward, 1917  
Genus: *Zygotocyle* Stunkard, 1917
61. *Zygotocyle lunata* Diesing, 1836  
Intermediate hosts: Mollusca – Gastropoda.  
Final hosts: Aves – Anseriformes, Galliformes, Charadriiformes;  
Mammalia – Rodentia, Artiodactyla.  
Site in host: caecum, intestine.  
Locality: France (Travassos, 1933).  
Distribution: Asia, Europe, Africa, North and South America.
- Family: Prosthogonimidae Lühe, 1909  
Genus: *Prosthogonimus* Lühe, 1899 (Syn.: *Schistogonimus* Lühe, 1909)
62. *Prosthogonimus anatinus* Markov, 1903  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Insecta – Aeshnidae.  
Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Chara-  
driiformes.  
Site in host: bursa of Fabricius.  
Locality: USA – Michigan (Gower, 1939).  
Distribution: Europe, Asia, North America.
63. *Prosthogonimus cuneatus* (Rudolphi, 1809) Braun, 1901  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Insecta – Aeshnidae, Cordiliidae, Libelli-  
ludae.  
Final hosts: Aves – Anseriformes, Podicipediformes, Pelecaniformes,  
Ciconiiformes, Falconiformes, Galliformes, Gruiformes, Charadriiformes,  
Piciformes, Passeriformes.  
Site in host: bursa of Fabricius, cloaca, oviduct, rectum.  
Locality: Ukraine – Odesa region (Smogorzhevskaya, 1976; Iskova  
et al., 1995), Russia – Dagestan, Bashkortostan, along the Volga River,  
North Caucasus, Rostov, Moscow, Omsk regions (Petrochenko & Kotel-  
nikov, 1976; Marzhokhova & Zhigunova, 2008; Kirillov & Kirillova,  
2013).  
Distribution: Europe, Asia, Africa, North and South America.
64. *Prosthogonimus ovatus* (Rudolphi, 1803) Lühe, 1899  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Insecta – Aeshnidae, Cordiliidae, Libelli-  
ludae.  
Final hosts: Aves – Anseriformes, Podicipediformes, Pelecaniformes,  
Ciconiiformes, Falconiformes, Galliformes, Gruiformes, Charadriiformes,  
Cuculiformes, Strigiformes, Coraciiformes, Piciformes, Passeriformes.  
Site in host: bursa of Fabricius, oviduct, cloaca, large intestine.  
Locality: Uzbekistan (Shakarbayev et al., 2012), Ukraine (Smogorz-  
hevskaya, 1976; Iskova et al., 1995), Russia – Krasnoyarsk region and  
Kazakhstan (Petrochenko & Kotelnikov, 1976).  
Distribution: cosmopolitan.
65. *Schistogonimus rarus* Braun, 1901  
First intermediate hosts: Mollusca – Gastropoda.  
Second intermediate hosts: Insecta – Coenagrionidae, Lestidae.  
Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Chara-  
driiformes.  
Site in host: bursa of Fabricius.  
Locality: Russia – Dagestan (Ryzhikov, 1967).  
Distribution: Europe, Asia, North America.

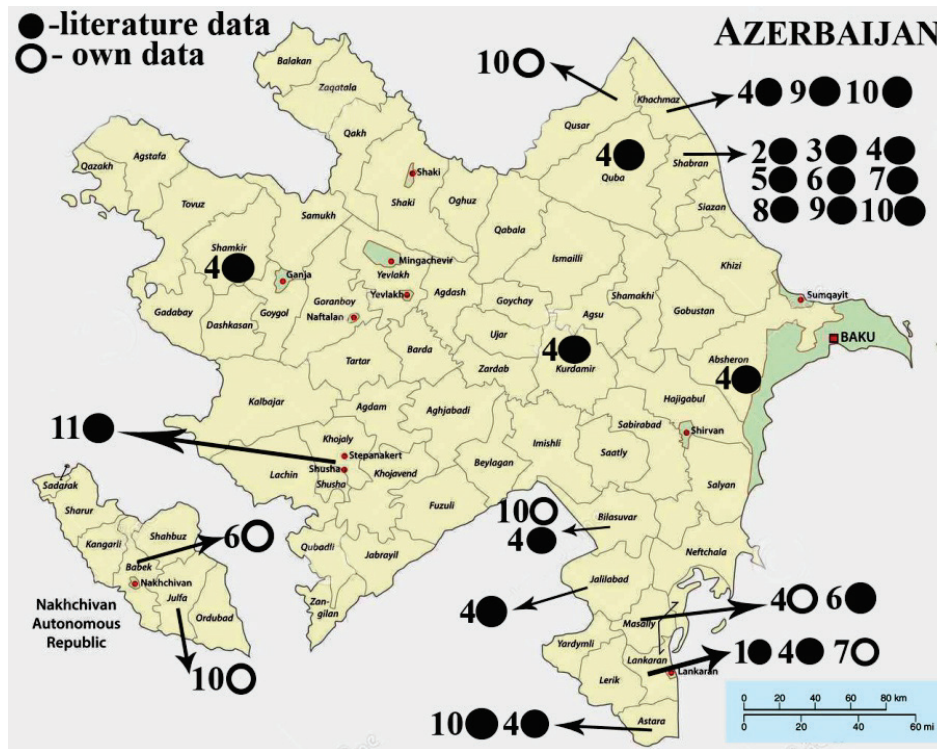
## Discussion

Of the 65 species of trematodes parasitizing in domestic geese, 44 species were recorded in Europe, 26 species in Asia, 6 species in North America, 1 species in South America, 1 species in Africa and 2 species in Oceania. Three species registered in domestic geese (*E. recurvatum*, *E. revolutum*, *P. ovatus*) are cosmopolitan parasites. In the territory of Europe, domestic geese are mainly parasitized by species belonging to the families Strigeidae, Cyathocotylidae, Cyclocoelidae, Echinostomatidae, Echinostomatidae, Philophthalmidae, Psilostomidae, Typhlocoelidae, Heterophyidae, Notocotylidae, Zygocotylidae, Prosthogonimidae, in Asia – Echinostomatidae, Psilostomidae, Opisthorchiidae, Philophthalmidae, in North and South America – Strigeidae, Schistosomatidae, Psilostomidae, Notocotylidae, Prosthogonimidae, in Africa – Heterophyidae, in Oceania – Notocotylidae. The greatest species diversity is characterized by the families Echinostomatidae (17 species) and Notocotylidae (12 species), and the smallest Echinostomatidae, Typhlocoelidae, Zygocotylidae (1 species for each). Eleven species of digenetic flukes were recorded in domestic geese (*C. mutabile*, *E. grande*, *E. paraulum*, *E. revolutum*, *E. robustum*, *H. conoideum*, *P. novum*, *P. pentalobum*, *C. verrucosa*, *N. attenuatus*, *N. parviovatus*) on the territory of Azerbaijan. Four of them (*E. revolutum*, *H. conoideum*, *P. novum*, *N. attenuatus*) were also noted in the course of

our helminthological studies. The distribution of all 11 species of trematodes on the territory of the republic is shown in Figure 1. The trematode *C. mutabile* was recorded in domestic ducks only in Azerbaijan.

Most species of trematodes were found in the north-eastern part (total 9 species) and southern part (total 5 species) of Azerbaijan. In the above-mentioned regions, there are favourable conditions for the spread of mollusks, intermediate hosts of digenetic flukes involved in the development of trematodes. The aforementioned areas are located on the shores of the Caspian Sea, and most of the country's rivers flow through these areas and flow into the sea.

Eighteen species of digenetic flukes (*E. recurvatum*, *E. lindoense*, *E. miyagawai*, *E. revolutum*, *N. echinatoides*, *P. hovorkai*, *P. gralli*, *P. oligoon*, *P. simillimum*, *P. spiculigerum*, *R. ondatrae*, *C. concava*, *P. genata*, *M. orientalis*, *M. xanthosomus*, *N. attenuatus*, *N. stagnicola*, *Z. lunata*) parasitize both birds and mammals (Rodentia, Carnivora, Lagomorpha, Artiodactyla). And eleven species (6 species from the family Echinostomatidae – *E. recurvatum*, *E. lindoense*, *E. paraulum*, *E. revolutum*, *E. miyagawai*, *H. conoideum*, 2 species from the family Philophthalmidae – *P. gralli*, *P. hovorkai*, 1 species from the family Strigeidae – *C. cornutus*, 1 species from the family Heterophyidae – *P. genata*, 1 species from the family Opisthorchiidae – *M. orientalis*) of trematodes are of medical importance, registered in humans.



**Fig. 1.** Map of the areas of occurrence of trematodes in domestic geese in Azerbaijan: 1 – *Cyclocoelum mutabile*, 2 – *Echinostoma grande*, 3 – *Echinostoma paraulum*, 4 – *Echinostoma revolutum*, 5 – *Echinostoma robustum*, 6 – *Hypoderaeum conoideum*, 7 – *Paryphostomum novum*, 8 – *Paryphostomum pentalobum*, 9 – *Catantropis verrucosa*, 10 – *Notocotylus attenuatus*, 11 – *Notocotylus parviovatus*

## Conclusion

Own research and analysis of extensive literature data showed that the taxonomic composition of the Trematoda of domestic geese consists of 2 classes, 14 families, 30 genera and 65 species (Europe – 44, Asia – 26, North and South America – 7, Africa – 1, Oceania – 2, Cosmopolitan – 3). The greatest species diversity is typical for the families Echinostomatidae (17 species) and Notocotylidae (12 species).

On the territory of Azerbaijan, among domestic geese, 11 species of digenetic flukes have been registered. Four of them (*E. revolutum*, *H. conoideum*, *P. novum*, *N. attenuatus*) were also noted during our helminthological studies. The trematode *C. mutabile* has been registered in domestic ducks only in Azerbaijan. Most of the trematode species were found in the northeastern (9 species in total) and in the southern part (5 species in total) of Azerbaijan.

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