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

F. H. Rzayev

Azerbaijan Medical University, Baku, Azerbaijan
Institute of Zoology of ANAS, Baku, Azerbaijan

Article info
Received 01.07.2021
Received in revised form 02.08.2021
Accepted 04.08.2021

Abstract

Trematodes are one of the most numerous and widespread groups of parasitic invertebrates among helminths, characterized by a complex life cycle. At 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 goose 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 goose 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 parasitising domestic goose. The taxonomic composition of the class Trematoda registered in domestic goose consists of 2 classes, 14 families, 30 genera and 65 species. Of all the species of trematodes parasitizing in domestic goose, 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 goose (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 goose Cycocoeum mutabile, Echinostoma grande, E. paraulum, E. robustum, Hypodermaeum conoideum, Parapharynx novum, P. pentalobum, Cattus trophius, Notocotylus attenuatus, N. parviovatus) on the territory of Azerbaijan. Four of them (Echinostoma revolutum, Hypodermaeum conoideum, Parapharynx novum, Notocotylus attenuatus) were also noted in the course of our helminthological studies. The trematode Cycocoeum 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: flukes, systematic classification, helminthes, 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 goose (Anser anser dom.) has been carried out in some countries (Lapage, 1961; McDonald, 1969; Smogorzhevskaya, 1976; Sitko et al., 2006; Shakarbeyov 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; Seyidibeyli & Rzayev, 2018; Rzayev et al., 2020; Seyidibeyli et al., 2020). However, it should be noted that data on the trematode fauna of domestic goose 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 goose 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 goose, in the territory of Azerbaijan. In total, 470 domestic goose from private poultry farms in various regions of the Republic were researched by the method of complete parasitological examination (Skjabin, 1928; Dubinin, 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, Palastomidae – 7, Typhlocoelidae – 1, Heterophyidae – 3, Opisthorchiidae – 4, Notocotylidae – 12, Zygocotylidae – 1, Prosthogonimidae – 4), 8 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
2. Apatemon cornutus Rudolphi, 1808

Genus: Cyrturhis Szidat, 1928
1. Cyrturhis cornutus Rudolphi, 1808
2. Cyrturhis atavus Rudolphi, 1808

Genus: Cotylurus Rudolphi, 1802
1. Cotylurus poliokosmis Rudolphi, 1802
2. Cotylurus cornutus Rudolphi, 1808

Genus: Cotylurus Rudolphi, 1808
1. Cotylurus rupee Rudolphi, 1808
2. Cotylurus flavus Rudolphi, 1808

Genus: Ichthyocotylurus Odening, 1969
4. Ichthyocotylurus plebeus Rudolphi, 1802 Odening, 1969

Genus: Cyclocoelum Brandes, 1892
5. Cyclocoelum mutabile (Zeder, 1800) Brandes, 1892

Site in host: Small intestine.
Locality: Georgia and Kazakhstan (Petrochenko & Kotelnikov, 1976), Russia – Rostov and Moscow (Iskova et al., 1995), Russia – Far East (Ryzhikov, 1967; Petrochenko & Kotelnikov, 1976). Distribution: Europe, Asia, North America.

First and second intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Galliformes, Charadriiformes, Gruiformes, Chordariformes.

Site in host: air sacs, nasal cavity.
Locality: Azerbaijan – Lenkoran 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, 1895

Genus: Bilharziella Looss, 1899
7. Bilharziella polonica Kowalewski, 1895

Intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Podicipediformes, Ciconiiformes, Gruiformes, Chordariformes.
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) (Smogorzhevska, 1976; Iskova et al., 1995), Russia (Ryzhikov, 1967).
Distribution: Europe, Asia, Africa, North America.

Genus: Trichobilharzia Krubavin & Zakharov, 1920
8. Trichobilharzia adams Edwards & Jarsch, 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 Mac, 1946

Intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes.
Site in host: portal veins, veins of intestinal and caecum walls.
Locality: USA (McKer et al., 1955; McDonald, 1969).
Distribution: North America.

Genus: Hystias Kossack, 1911

10. Hystias arcuatus (Brandes, 1892) Kossack, 1911

Intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Gruiformes, Chordariformes.
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. Hystias 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.

Genus: Echinococccus Odening, 1969

12. Echinococcus belozerophanes Linstow, 1873 Dietz, 1909

First intermediate hosts: Amphibia – Pelobatidae, Ranidae; Pisces – Cyprinidae.
Second intermediate hosts: Mollusca – Gastropoda.
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.
**Genus: Echinostoma** Rudolphi, 1809

15. *Echinostoma dieteri* Sierabin, 1923
First and second intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Galliformes, Gruiformes

16. *Echinostoma grande* Bachkurova, 1946
First and second intermediate hosts: unknown.
Final hosts: Aves – Anseriformes, Galliformes.

17. *Echinostoma lindoense* Sandground & Bonne, 1940
First and second intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Galliformes, Mammalia – Rodentia, Carnivora and humans (Carney et al., 1980).

18. *Echinostoma miyagawai* Ishii, 1932
First intermediate hosts: Mollusca – Gastropoda.
Second intermediate hosts: Mollusca – Gastropoda, Amphibia – Pelobatidae, Ranidae.

19. *Echinostoma parasudanense* Dietz, 1909
First and second intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Podicipediformes, Galliformes, Charadriiformes, Columbiformes, Mammalia – humans (Yu & Mott, 1994).

**Genus: Hypoderaeum** Dietz, 1909

20. *Hypoderaeum floricich* Erfflich, 1802
First intermediate hosts: Mollusca – Gastropoda.
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Amphibia – Bufonidae, Ranidae.

**Genus: Hypoderaeum** Dietz, 1909

21. *Hypoderaeum robustum* Yamaguti, 1935
First intermediate hosts: Mollusca – Gastropoda.
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Amphibia – Ranidae.

22. *Hypoderaeum sudanense* Odhner, 1911
First and second intermediate hosts: unknown.
Final hosts: Aves – Anseriformes, Columbiformes.

**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, Columbiformes, Mammalia – humans (Bhatialula et al., 1964; Yokogawa et al., 1965).

**Family: Echinostomatidae** Looss, 1899

**Genus: Echinoparyphium** Dietz, 1909

13. *Echinoparyphium cinctum* Rudolphi, 1809
First and second intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Charadriiformes.

**Genus: Hypoderaeum** Dietz, 1909

24. *Hypoderaeum dingeri* Lie, 1964
First intermediate hosts: Mollusca – Gastropoda.

**Genus: Echinostoma** Rudolphi, 1809

14. *Echinostoma recurvatum* Linstow, 1873
First intermediate hosts: Mollusca – Gastropoda, Bivalvia.
Second intermediate hosts: Amphibia – Pelobatidae, Ranidae; Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Ciconiiformes, Galliformes, Gruiformes, Charadriiformes, Columbiformes, Strigiformes, Mammalia – Rodentia, Carnivora, Lagomorpha, Aves, and humans (Yu & Mott, 1994).

**Genus: Echinostoma** Rudolphi, 1809

15. *Echinostoma robustum* Yamaguti, 1935
First intermediate hosts: Mollusca – Gastropoda.
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Amphibia – Ranidae.

**Genus: Echinostoma** Rudolphi, 1809

16. *Echinostoma grande* Bachkurova, 1946
First and second intermediate hosts: unknown.
Final hosts: Aves – Anseriformes, Galliformes.

**Genus: Echinostoma** Rudolphi, 1809

17. *Echinostoma lindoense* Sandground & Bonne, 1940
First and second intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Galliformes, Mammalia – Rodentia, Carnivora and humans (Lu, 1982).

**Genus: Echinostoma** Rudolphi, 1809

18. *Echinostoma miyagawai* Ishii, 1932
First intermediate hosts: Mollusca – Gastropoda.
Second intermediate hosts: Mollusca – Gastropoda, Amphibia – Pelobatidae, Ranidae.

**Genus: Echinostoma** Rudolphi, 1809

19. *Echinostoma paraudum* Dietz, 1909
First and second intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Podicipediformes, Galliformes, Charadriiformes, Columbiformes, Mammalia – humans (Yu & Mott, 1994).

**Genus: Hypoderaeum** Dietz, 1909

20. *Hypoderaeum floricich* Erfflich, 1802
First intermediate hosts: Mollusca – Gastropoda.
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Amphibia – Bufonidae, Ranidae.

**Genus: Hypoderaeum** Dietz, 1909

21. *Hypoderaeum robustum* Yamaguti, 1935
First intermediate hosts: Mollusca – Gastropoda.
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Amphibia – Ranidae.

**Genus: Hypoderaeum** Dietz, 1909

22. *Hypoderaeum sudanense* Odhner, 1911
First and second intermediate hosts: unknown.
Final hosts: Aves – Anseriformes, Ciconiiformes.

**Genus: Echinostoma** Rudolphi, 1809

14. *Echinostoma recurvatum* Linstow, 1873
First intermediate hosts: Mollusca – Gastropoda, Bivalvia.
Second intermediate hosts: Amphibia – Pelobatidae, Ranidae; Mollusca – Gastropoda.

Final hosts: Aves – Anseriformes, Ciconiiformes, Galliformes, Gruiformes, Charadriiformes, Columbiformes, Strigiformes, Mammalia – Rodentia, Carnivora, Lagomorpha, and humans (Carney, 1991; Sohn et al., 2011).

**Genus: Echinostoma** Rudolphi, 1809

15. *Echinostoma robustum* Yamaguti, 1935
First intermediate hosts: Mollusca – Gastropoda.
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia; Amphibia – Ranidae.

**Genus: Echinostoma** Rudolphi, 1809

16. *Echinostoma grande* Bachkurova, 1946
First and second intermediate hosts: unknown.
Final hosts: Aves – Anseriformes, Galliformes.

**Genus: Echinostoma** Rudolphi, 1809

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).

**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, Columbiformes, Mammalia – humans (Bhatialula et al., 1964; Yokogawa et al., 1965).

**Genus: Hypoderaeum** Dietz, 1909

24. *Hypoderaeum dingeri* Lie, 1964
First intermediate hosts: Mollusca – Gastropoda.
Genus: Neoacanthoparyphium Yarnaguti, 1958
25. Neoacanthoparyphium echinatoidea Filippi, 1854
First intermediate hosts: Mollusca – Gastropoda, Bivalvia.
Second intermediate hosts: Mollusca – Gastropoda, Bivalvia.
Final hosts: Aves – Anseriformes, Columbiformes, Galliformes, Charadriiformes, Paseriformes, Mammalia – Rodentia, Lagomorpha.
Site in host: small intestine.
Locality: Slovakia (McDonald, 1969).
Distribution: Europe, Asia.

Genus: Petasiger Dietz, 1909 (Syn.: Parapharyxomatium Dietz, 1909)
27. Parapharyxomatium 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 0.45%, II 1) (Shirinov, 1961; Vahidova, 1978).
Distribution: Europe, Asia.

Genus: Petasiger radiatus (Dujardin, 1845) Tkach, Kudlai, Kostadino-va, 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 capensis 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, Struthio- 
iformes, Mammalia – Lagomorpha, Rodentia and human (Dissuanae & Bilomoria, 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, Co-
Iumbiformes, 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 (Shakarbuyev 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 (Benedix, 1859).
Distribution: Europe, Asia.

33. Philophthalmus pasaviniensis 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 Skrabin, 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 ovum (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 oligocon Verma, 1936
First and second intermediate hosts: Mollusca – Gastropoda.
Final hosts: Aves – Anseriformes, Galliformes, Gruiformes, Colum-
Iumbiformes, Mammalia – Rodentia.
Site in host: small intestine.
Locality: Russia (McDonald, 1969).
Distribution: Europe, Asia.

37. Psilotrema similimum 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.

Genus: Ribeiroia Travassos, 1939
38. 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 globula (Rudolphi, 1819) Odhner, 1913
Intermediate hosts: Mollusca – Gastropoda.
First 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: Trachoeophilus Skrjabin, 1913
41. Trachoeophilus suisov Skrjabin, 1913
Intermediate hosts: Mollusca – Gastropoda.
First 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: Cercariaoides Wittenberg, 1929
42. Cercariaoides aharoni Wittenberg, 1929
First and second intermediate hosts: unknown.
First 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.
First hosts: Aves – Anseriformes, Gaviiformes, Podicipediformes, Pelecaniiformes, Falconiformes, Galliformes, Charadriiformes, Columbiformes, Strigiformes; Mammalia – Lagomorpha, Rodentia, Carnivora, Artiodactyla.
Site in host: intestine, caecum.
Locality: Russia (Ryzhikov, 1967). Distribution: Europe, Asia, North America.

Genus: Pygidiplois Loos, 1907
44. Pygidiplois genuata Loos, 1907
First intermediate hosts: Mollusca – Gastropoda.
Second intermediate hosts: Pisces – Atherinidae, Mugilidae, Cichlidae, Cyprinidae, Poeciliidae.
First hosts: Aves – Anseriformes, Podicipediformes, Pelecaniiformes, 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 Loos, 1899
Genus: Metorchis Loos, 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, Kangsu (Zhan et al., 2017). Distribution: Asia, North America.

46. Metorchis taiwanensis Morishita & Tsachimochi, 1925
First intermediate hosts: unknown.
Second intermediate hosts: Pisces – Cypriidae.
First 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, Neomachidae, Cyprinidae.
First hosts: Aves – Anseriformes, Gaviiformes, Podicipediformes, Pelecaniiformes, 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 Loos, 1896
First and second intermediate hosts: unknown.
First 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: Oligochaeta – Clitellata.
First 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 (Merdvenci, 1967; Gieck & 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.
First hosts: Aves – Anseriformes, Galliformes, Gruiformes, Charadriiformes; Mammalia – Rodentia.
Site in host: caecum, large intestine.
Locality: Czech Republic and Slovakia (PL 0.3%) (Busta, 1980; Silko et al., 2006), Russia – along the Volga River, Dagestan, North Caucasus (Marzhokhova & Zhigunova, 2008; Kirillov & Kirillova, 2013), England (Soliman, 1955; Grifiths et al., 1976), Uzbekistan (Shakarbayev et al., 2012), Ukraine (PL 0.07%, II 4–10) (Smogorzhevskaya, 1976; Iskova et al., 1995), Turkey – Marmara (Merdvenci, 1967), Iraq – Nineveh governorate (Al-Taei 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 parvivonatus Yarnaguti, 1934
   Intermediate hosts: Mollusca – Gastropoda.
   Final hosts: Aves – Anseriformes.
   Site in host: caecum, intestine.
   Locality: Ukraine (Iskova et al., 1995; Yuskiv & Melnychuk, 2020), Russia – Dagestan, Bashkortostan, along the Volga River, Azerbaijan – Garabakh (Vahidova, 1978).

Genus: Paramonostomum Nütz. 1817

54. Paramonostomum seintei Fuhrmann, 1919
   First intermediate hosts: Mollusca – Gastropoda.
   Site in host: Mollusca – Gastropoda; Artropoda – Cypriidae.
   Final hosts: Aves – Anseriformes.
   Site in host: caecum, intestine.
   Locality: Germany (Heinemann, 1936).
   Distribution: Europe, North America.

55. Paramonostomum stagnicola Herber, 1942
   Intermediate hosts: Mollusca – Gastropoda.
   Final hosts: Aves – Anseriformes, Galliformes, Charadriiformes;
   Mammalia – Rodentia.
   Site in host: caecum.
   Locality: USA (McDonald, 1969).
   Distribution: Europe, America.

Genus: Notocotylus Nütz. 1817

56. Notocotylus thienemanni Szidat & Szidat, 1933
   Intermediate hosts: Mollusca – Gastropoda.
   Final hosts: Aves – Anseriformes.
   Site in host: caecum.
   Locality: Germany (Heinemann, 1936).
   Distribution: Europe, North America.

57. Notocotylus alveatum (Mehlis, 1846) Lühe, 1909
   Site in host: Mollusca – Gastropoda, Bivalvia; Crustacea – Gammaridae.
   Final hosts: Aves – Anseriformes, Galliformes.
   Site in host: caecum, intestine, cloaca.
   Locality: Ukraine (Smogorzhevskaya, 1976).
   Distribution: Europe, Asia, North America.

58. Paramonostomum haezephalae Yamaguti, 1935
   First intermediate hosts: Mollusca – Gastropoda.
   Site in host: caecum, intestine.
   Locality: Ukraine (Smogorzhevskaya, 1976).
   Distribution: Europe, Asia, North America.

Genus: Uniseriola Beverley-Burton, 1958

59. Uniseriola gippysensis Beverley-Burton, 1958
   Intermediate hosts: Mollusca – Gastropoda.
   Final hosts: Aves – Anseriformes.
   Site in host: caecum, intestine, rectum.
   Locality: Ukraine – Odesa region (Smogorzhevskaya, 1976; Iskova et al., 1995), Russia – Dagestan (Ryzhikov, 1967).
   Distribution: Europe, Asia, Africa, North and South America.
Digenetic flukes have been recorded. Four of them (H. conoideum, E. revolutum, P. novum, P. pentalobum) are cosmopolitan parasites. In the territory of Europe, domestic geese are mainly parasitized by species belonging to the families Echinostomatidae, Cyclocoelidae, Echinocraclididae, Echinostomatidae, Philophthalmidae, Psilostomidae, Opisthochridae, Philothoidea, in North and South America – Strigeidae, Cyathocotylidae, Cyclocoelidae, Echinocraclididae, Echinostomatidae, Philophthalmidae, 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 Echinaeschidae, 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 abovementioned regions, there are favourable conditions for the spread of mol lusks, 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. revolutum, E. lindoense, E. miyagawai, E. revolutum, N. echinatoides, P. hovorkai, P. gralli, P. oligocon, P. simillimum, P. spiculigerus, R. ondatrae, C. concava, P. genata, M. orientalis, X. antrocomos, N. attenuatus, N. stagnicolae, Z. uninata) parasitize both birds and mammals (Rodentia, Carnivora, Lagomorpha, Artiodactyla). And eleven species (6 species from the family Echinostomatidae – E. revolutum, 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 Opisthorchidae – M. orientalis) of trematodes are of medical importance, registered in humans.

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. revolutum, E. revolutum, P. ovatus) are cosmopolitan parasites. In the territory of Europe, domestic geese are mainly parasitized by species belonging to the families Strigeidae, Cyclocoelidae, Cyclocoelidae, Echinocraclididae, Echinostomatidae, Philophthalmidae, Psilostomidae, Typhlocoelidae, Heterophyidae, Notocotylidae, Zygocotylidae, Prosthogonimidae, in Asia – Echinostomatidae, Psilostomidae, Opisthochridae, Philothoidea, in North and South America – Strigeidae, Schistostomatidae, Psilostomidae, Notocotylidae, Prosthogonimidae, in Africa – Heterophyidae, in Oceania – Notocotylidae. The greatest species diversity is typical for the families Echinostomatidae (5 species in total) of Azerbaijan.

On the territory of Azerbaijan, among domestic geese, 11 species of digenetic flukes were recorded. 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.

Fig. 1. Map of the areas of occurrence of trematodes in domestic geese in Azerbaijan: 1 – Cyclocoelium mutabile, 2 – Echinostoma grande, 3 – Echinostoma paradum, 4 – Echinostoma revolutum, 5 – Echinostoma robustum, 6 – Haplorchium contosum, 7 – Parophocotylus noston, 8 – Parophocotylus pentalobum, 9 – Catatropis 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.

References

Aghayeva, Z. T. (2018). Azerbaycanın musafid ruyanlarında qaz (Anser anser dom.) ve ordeklerin (Anas plathyrhynchos dom.) helminthin bioloji-xususiyetleri, helminthin oyrenilmis [Study of bio-ecological features of helminths of goose (Anser anser dom.) and duck (Anas plathyrhynchos dom.) in different regions of Azerbaijan]. Elm, Baku (in Azerbaijani).

Al-Taee, A. F., Mohammed, R. G., & Mohammed, N. H. (2011). Diagnosis of some helminth eggs in faces of ducks and geese in Nineveh governorate, Iraq. Iraqi J Vet Sci., 25(1), 5–10.

Barus, V., Micolasek, A., & Busta, J. (1977). Influence of breeding technology on helminths in domestic geese. Folia Parasitologica, 24, 305–314.

Benaden, P. J. V. (1858). Mémoire sur les vers intestinaux [Dissertation about intestinal worms]. PI Brailliere & Fils, Paris (in France).

Bozähr, B. (1956). Helminthologia däckes kacker (podredzinia Anatinae) W. J. Liefeldského i Białostockiego [Helminthological fauna in wild ducks (subfamily...
tion of vertebrates, including humans]. Moscow State University, Moscow (in Russian).

Smogorzhevskaya, L. A. (1976). Gel’minty vodoplavayushchih i bolotnyh ptits fauny Ukrainy [Helminths of waterfowl and wading birds of the fauna of Ukraine]. Nauka Dumka, Kiev (in Russian).

Sohn, W. M., Chai, J. Y., Yong, T. S., Eom, K. S., Yoon, C. Y., Sinuon, M., Socheat, D., & Lee, S. H. (2011). Echinostoma revolutum infection in children, Pursat Province, Cambodia. Emerg. Infect. Dis., 17(1), 117–119.

Soliman, K. N. (1955). Observations on some helminth parasites from ducks in Southern England. Journal of Helminthology, 29, 17–26.

Travassos, L. P. (1933). Observations sur Zygocotyle lataatum (Diesing, 1835) (Trematoda: Paramphistomidae). Comptes Rendus des Seances de la Societe de Biologie et des ses Filiales (Paris), 114(35), 958–959.

Vahidova, S. M. (1978). Gel’minty prits Azerbaydzhana [Helminths of birds of Azerbaijan]. Elm, Baku (in Russian).

Vassilev, I. (1962). On the helminthofauna of domestic geese (Anser anser domest.) in Bulgaria. Izvestja Tsentr Khelmintologycheskoy Laboratorii (Sofia), 7, 11–17.

Vassilev, I. (1973). On the ecology of paratenogenetic stages of philophthalmids from Yugoslavia. Izvestja Tsentr Khelmintologycheskoy Laboratorii (Sofia), 16, 25–29.

Vassilev, I., & Denev, I. (1965). Research into the life history of Philophthalmus sp. recovered from geese in Bulgaria. I. Zeitschrift Fur Parasitenkunde, 25, 320–329.

Vassilev, I., & Denev, I. (1971). Research into the life history of Philophthalmus sp. recovered from geese in Bulgaria. II. Zeitschrift Fur Parasitenkunde, 37, 70–84.

Weekes, P. J. (1982). Checklist of helminth parasites of birds in New Zealand. New Zealand Journal of Zoology, 9, 451–460.

Yokogawa, M., Harinasuta, C., & Charoenlarp, P. (1965). Hypoderaeum conoides (Bloch, 1782) Dietz, 1909. A common intestinal fluke of man in Northeast Thailand. Japanese Journal of Parasitology, 14, 148–183.

Yu, S. H., & Mott, K. E. (1994). Epidemiology and morbidity of food-borne intestinal trematode infections. Tropical Diseases Bulletin, 91, 125–152.

Yuskiv, I. D., & Melnychuk, V. (2020). Spetsial’ni zaxody protigel’mintoznogo kompleksu za nayavnosti endoparazitoziv u guse (Anser anser domesticus and Anser cygnoides domesticus Linnaeus, 1758) [Special measures of anti–helminthoses complex in case of goose endoparasitoses (Anser anser domesticus & Anser cygnoides domesticus Linnaeus, 1758)]. Bulletin of Poltava State Agrarian Academy, 1, 222–242 (in Ukrainian).

Zhan, X., Li, C., Wu, H., Sun, E., & Zhu, Y. (2017). Investigation on the endemic characteristics of Metorchis orientalis in Huainan Area, China. Nutr Hosp., 34, 675–679.