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Comparative analysis of the helminth fauna of domestic water birds in Azerbaijan

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One of the factors that prevent the production of high-quality food products from geese and ducks, which contribute to satisfying people's demand for poultry meat, is helminthiasis. Determining the species composition of pathogens and determining the changes in the composition of the fauna over a certain period and its comparative analysis are of great scientific interest. For this purpose, in the years 2012–2024, 940 domestic water birds (*Anser anser* dom. and *Anas platherhynchos* dom.) from various economic regions of the Azerbaijan Republic were studied by the method of complete parasitological dissection. Some of the collected helminths was fixed in 70% alcohol or 4% formaldehyde, and permanent preparations were prepared from the rest and examined under light microscopes. Helminths were identified with the use of identification guides. It was found that in the period of study (2012–2024) 29 species of helminths (cestodes – 8, trematodes – 7, nematodes – 13, acanthocephalans – 1) were parasitic in domestic water birds. The results of studies conducted in the country in the years 1935–1982 were compared with these data. It was determined that the helminth list of domestic geese and ducks in the country in all periods consisted of 54 species (cestodes – 14, trematodes – 20, nematodes – 17, acanthocephalans – 3). As a result of the comparative analysis of the parasitic fauna, it was found that the number of species parasitic in birds decreased from 49 to 29. On the other hand, 5 new species of parasitic worms (cestodes – *Diorchis inflata*, *Ligula intestinalis*, trematode – *Echinostoma chloropodis*, nematode – *Hystrichis tricolor* and acanthocephalan – *Polymorphus magnus*) were included in the fauna. These species have a wide host range and are also found to infest waterfowl at high intensity. Twenty-five species of parasites mentioned in previous studies have not been encountered in the named hosts in the country in recent years. They include *Dicranotaenia coronula*, *Microsomacanthus collaris*, *M. compressa*, *M. paracompressa*, *Sobolevicanthus gracilis*, *S. octacanthus* cestodes and *Cyclocoelum mutabile*, *Echinoparyphium westsibiricum*, *Echinostoma grande*, *E. robustum*, *E. stromi*, *Neoacanthoparyphium petrovi*, *Paryphostomum pentalobum*, *Psilochasmus caspicum*, *P. gaibovi*, *P. skrjabini*, *Typhlocoelum cucumerinum*, *Catatropis verrucosa*, *Notocotylus parviovatus* trematodes. Nematodes (*Amidostomum anseris*, *Echinuria uncinata*, *Baruscapillaria anseris*, *Trichostrongylus medius*) and acanthocephalans (*Polymorphus kostylewi*, *P. diploinflatus*) are among the systematic groups that have undergone relatively few changes. Separately, it was found that the number of helminth species in domestic geese decreased from 32 to 22, and in domestic ducks from 41 to 21. When looking at the systematic groups of helminths, while there is few change in the number of nematodes, a significant decrease in the diversity of digenetic worms (from 19 to 7 species) is observed. This is most likely due to the decrease in the number of intermediate hosts involved in the development cycle of helminths or their absence in the current changing ecological conditions.

Keywords: *Anser anser* dom.; *Anas platherhynchos* dom.; helminth fauna; Azerbaijan; comparative analysis.

Introduction

Parasitic worms, which are the causative agents of a number of helminthic diseases in vertebrates, including poultry, spread and cause serious pathologies in the host organism, affecting their productivity and meat quality. Despite the implementation of various preventive measures against invasive diseases of geese and ducks in many countries, helminths are still encountered with high intensity and extensiveness (Begum et al., 2019; Starodub, & Melnychuk, 2020; Yevstafieva et al., 2022). As a result of anthropogenic impacts, changes occur in the ecosystem and its components to varying degrees. The current ecological conditions have an impact on many living beings, including birds. In this regard, comparing their helminth fauna with previous years (the last 50 years), the increase or decrease in the number of parasites, which species have disappeared and which new ones have appeared, is of great scientific interest. Although studies on the helminth fauna of domestic waterfowl have been carried out in a number of countries (Marinova et al., 2013; Arabuli et al., 2023), there are few sources for comparative analysis of the parasitic fauna at different times (Fernandes & Kohn, 2015; Jones & Garcia, 2019). Only studies devoted to changes in helminth fauna depending on the age, sex and seasons of birds have been identified (Anisuzzaman et al., 2005; Farjana et al., 2008; Khanum et al., 2021). Unicellular parasites of geese and ducks and the pathologies they cause in the host organism (liver) were studied by histological methods in Iraq (Al-Taee, 2022). In that study, the dynamics of infection of domestic waterfowl of different age groups with the *Eimeria truncata* parasite were compared and it was determined that geese were more infected than ducks. In Ahvaz province of Iran, 14% of the same hosts were found to be infected with parasites belonging to the genus *Eimeria* (Talazadeh et al., 2023). In Gilan province, in addition to domestic birds, ducks were also studied and the helminths *Echinostoma revolutum*, *Hypoderaeum conoideum*, *Cloacotaenia megalops*, *Ascaridia galli* and *Heterakis gallinarum* were encountered (Eslahi et al., 2024). Helminthological studies were conducted in several areas of Samsun province, Turkey (Canik, Charshamba, Havza, Kavak, Terme and Tekkekoy) and *Baruscapillaria obsignata*, *B. anseris*, *Trichostrogylus tenuis*, *Amidostomum anseris* and *Heterakis* sp. nematodes were found in the digestive and respiratory organs of domestic geese with infestations of 59.4%, 32.8%, 1.6%, 9.4% and 1.6%, respectively (Parlak & Gürler, 2023). In another study, it was determined that three species of digenetic worms (*E. revolutum*, *H. conoideum* and *Echinoparyphium recurvatum*) parasitize in domestic geese. It was established that the extensiveness of goose invasion in the forest–steppe zone was 76.7%, in the steppe zone – 54.5%, in the mountain–forest zone – 36.7% (Mullayarova et al., 2024). Nematodes belonging to the genera *Raillietina* and *Ascaridia* have been found in the digestive tract of domestic ducks in India. It has been found that birds kept on farms have a lower percentage of helminth infections than those raised on domestic household premises (Dalal et al., 2024). In addi-

tion to European and Asian countries, there are data on the study of the helminth fauna of domestic waterfowl in recent years in the African continent. It was found that 41.4% of female domestic ducks and 22.5% of male domestic ducks studied were infected with parasites in Nigeria. Both protozoa (*Eimeria*, *Cryptosporidium*) and helminths (*Ascaridia*, *Strongyloides*, *Capillaria*, *Heterakis*) have been found in the hosts (Onyeabor & Onunkwo, 2024). There are data (Egypt) that the total infection of domestic ducks with nematodes and protozoa parasites is 46%, and that the protozoa are *Eimeria anatis*, *E. mullardi*, *Tyzerria* spp. and *Wenyonella anatis*, and the nematodes are *A. galli* and *Trichuris* spp. (Hasanien et al., 2025). From the data mentioned, it is clear that the research on the helminth fauna of domestic waterfowl in different countries is carried out in local areas and does not fully cover the entire country territory. Helminths of geese and ducks have been studied in different periods and in different regions of the Republic of Azerbaijan (Aghayeva, 2014; Seyidbeyli & Maharramov, 2018; Rzayev et al., 2021). It should be noted that studies on the comparative analysis of helminth fauna, grouping these data by year, have not been conducted until now. Taking into account the above, the aim was to compare the species composition of helminths parasitic in domestic waterfowl in previous years (1935–1982) and recent periods (2012–2023) and to detect changes.

Material and methods

Helminthological studies were carried out in 2012–2024, and parasitological materials were obtained from 12 of the 14 economic regions of the country (excluding Eastern Zangazur and Nakhchivan) (Fig. 1). In order to determine the species composition of the fauna, a total of 940 domestic waterfowl were studied. The number of birds involved in this study, separately for geese and ducks, as well as by economic region, is presented in Table 1. The birds were studied using the full helminthological dissection method (Dubinina, 1971).

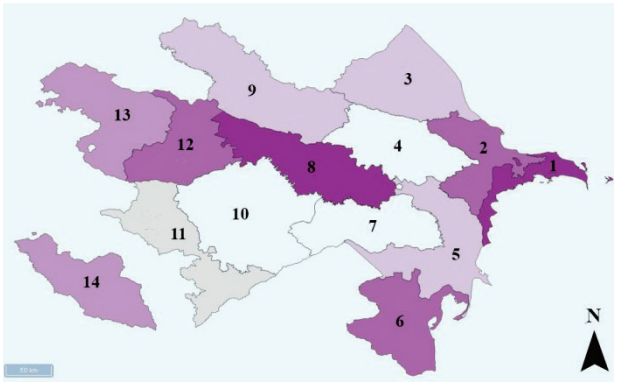

Fig. 1. Economic regions of Azerbaijan which received parasitological materials for this research: *1–2* – Baku and Absheron–Khizi, *3* – Guba–Khachmaz, *4* – Daghlig Shirvan, *5* – Shirvan–Salyan, *6* – Lankaran–Astara, *7* – Mil–Mughan, *8* – Central Aran, *9* – Shaki–Zagatala, *10* – Karabakh, *11* – Eastern Zangazur, *12* – Ganja–Dashkasan, *13* – Gazakh–Tovuz, *14* – Nakhchivan economic regions

Some of the collected helminths was fixed in 70% alcohol, the others in 4% formaldehyde and brought to the Laboratory of Parasitology, Zoology Institute of the Ministry of Science and Education of the Republic of Azerbaijan. Here, the worms were stained with carmine, made transparent, and permanent preparations were prepared with the help of canada balsam or glycerin–gelatin. Live helminths were examined under an MBS–9 (Russia) magnifier, fixed preparations under Amplival (Germany) and DM1000 (Leica, Germany) light microscopes, and images of parasites were taken with a DFC425 (Leica, Germany) camera. The helminths were identified based on the identification guide (Ryzhikov, 1967). The list of helminths is compiled in accordance with the nomenclature for individual systematic groups: cestodes (Khalil et al., 1994; Olson et al., 2001; Caira et al., 2014), trematodes (Gibson et al., 2002; Jones et al., 2005; Bray et al., 2008), nematodes (Anderson et al., 2009; Gibbons, 2010) and acanthocephalans (Amin, 2013).

Table 1
Number of geese and ducks surveyed in economic regions of Azerbaijan (N = 940)

Economic regions of Azerbaijan	Geese, n	Ducks, n
Baku and Absheron–Khizi	30	35
Guba–Khachmaz	145	128
Daghlig Shirvan	25	22
Shirvan–Salyan	20	22
Lankaran–Astara	30	52
Mil–Mughan	15	18
Central Aran	58	30
Shaki–Zagatala	26	26
Karabakh	22	18
Ganja–Dashkasan	99	55
Gazakh–Tovuz	47	17
Total	517	423

Results

Helminths of domestic geese and domestic ducks in Azerbaijan were intensively studied in 1952–1982 and 2012–2023. Taking into account the long break between the studies and the ecological and anthropogenic impacts that occurred, the results obtained by conditionally dividing these periods into two parts were compared with each other. Therefore, first of all, the species composition of helminths recorded in domestic waterfowl in the Republic during 1935–1982 was prepared in Table 2. It was determined that a total of 49 species of helminths were parasitic in domestic geese and domestic ducks during the study years. Of these, 12 species were cestodes, 19 species were trematodes, 16 species were nematodes, and 2 species were acanthocephalans. Of the mentioned parasitic worms, 8 species were found only in domestic geese (cestodes – 2, trematodes – 1, nematodes – 5), 17 species in domestic ducks (cestodes – 5, trematodes – 8, nematodes – 2, acanthocephalans – 2), and 24 species in both domestic birds (cestodes – 5, trematodes – 10, nematodes – 9). Thus, 32 species of parasitic worms were found in domestic geese and 41 species in domestic ducks. Our own data and the results of native researchers (2012–2023) are presented in Table 3. A total of 29 species of helminths were recorded in domestic geese and domestic ducks in the territory of the Republic during the research years. Of these, 8 species were tapeworms, 7 species were digenetic worms, 13 species were nematodes, and 1 species was acanthocephalans. Of the mentioned parasitic worms, 5 species were found only in domestic geese (cestodes – 2, trematodes – 1, nematodes – 2), 7 species in domestic ducks (cestodes – 2, trematodes – 3, nematodes – 2), and 17 species in both domestic birds (cestodes – 4, trematodes – 3, nematodes – 9, acanthocephalans – 1). Thus, 22 species of parasitic worms were found in domestic geese and 24 species in domestic ducks. Among the detected helminths, 3 species of nematodes (*A. anseris*, *H. dispar*, *T. tenuis*) had a higher extensiveness of invasion (20.1%<) than the other worms.

Table 2
Species composition of helminths recorded in domestic water birds in Azerbaijan (1952–1982 years)

No.	Helminth species	I		II		III		IV		V	
		G	D	G	D	G	D	G	D	G	D
	Cestodes										
1	*Cloacotaenia megalops* Nitzsch, 1829	–	–	–	–	–	+	–	+	–	+
2	*Dicranotaenia coronula* Railliet, 1892	–	–	–	+	+	+	+	+	+	+
3	*Drepanidotaenia lanceolata* Railliet, 1892	–	–	+	+	+	+	+	+	+	+

No.	Helminth species	I		II		III		IV		V	
		G	D	G	D	G	D	G	D	G	D
4	*Drepanidotaenia przewalskii* Lopep–Neyra, 1942	–	–	–	–	+	–	+	–	+	–
5	*Fimbriaria fasciolaris* Pallas, 1781	–	–	–	–	–	+	–	+	–	+
6	*Microsomacanthus collaris* Batsch, 1786	–	–	–	+	+	+	+	+	+	+
7	*Microsomacanthus compressa* Linton, 1892	–	–	–	–	+	+	–	+	–	+
8	*Microsomacanthus paracompressa* Czaplinski, 1956	–	–	–	–	–	+	–	+	–	+
9	*Microsomacanthus paramicrosoma* Gasowska, 1931	–	–	–	–	–	+	–	+	–	+
10	*Sobolevicanthus gracilis* Zeder, 1803	–	–	–	–	–	+	–	+	+	+
11	*Sobolevicanthus octacanthus* Krabbe, 1869	–	–	–	–	+	–	+	–	+	–
12	*Tschertkovilepis setigera* Frölich, 1789	–	–	–	+	–	+	–	+	–	+
	Trematodes										
13	*Cyclocoelum mutabile* Brandes, 1892	–	–	–	–	–	–	+	–	+	+
14	*Echinoparyphium recurvatum* Linstow, 1873	–	–	–	+	–	+	–	+	–	+
15	*Echinoparyphium westsibiricum* Issaitschikoff, 1924	–	–	–	–	–	+	–	+	–	+
16	*Echinostoma grande* Bachkirova, 1946	–	–	–	–	+	+	–	+	–	+
17	*Echinostoma paraulum* Dietz, 1909	–	–	–	–	+	+	+	+	+	+
18	*Echinostoma revolutum* Fröhlich, 1802	–	–	–	–	+	+	+	+	+	+
19	*Echinostoma robustum* Yamaguti, 1935	–	–	–	–	+	+	–	–	+	–
20	*Echinostoma stromi* Baschkirova, 1946	–	–	–	–	–	+	–	+	–	+
21	*Hypoderaeum conoideum* Bloch, 1782	–	–	–	+	–	+	+	+	+	+
22	*Neoacanthoparyphium petrovi* Nevostrueva, 1953	–	–	–	–	–	+	–	+	–	+
23	*Paryphostomum novum* Verma, 1936	–	–	–	–	+	+	+	+	+	+
24	*Paryphostomum pentalobum* Verma, 1936	–	–	–	–	+	–	+	+	+	+
25	*Psilochasmus caspicum* Shirinov, 1961	–	–	–	–	–	+	–	–	–	–
26	*Psilochasmus gaibovi* Shirinov, 1961	–	–	–	–	–	+	–	–	–	–
27	*Psilochasmus skrjabini* Gnedina, 1946	–	–	–	–	–	+	–	+	–	+
28	*Typhlocoelum cucumerinum* Rudolphi, 1809	–	–	–	–	–	–	–	+	–	+
29	*Catatropis verrucosa* Froelich, 1789	–	–	–	–	–	+	–	–	+	–
30	*Notocotylus attenuatus* Kossack, 1911	–	–	+	–	+	+	+	–	+	–
31	*Notocotylus parviovatus* Yamaguti, 1934	–	–	–	–	–	–	+	–	+	–
	Nematodes										
32	*Amidostomum acutum* Seurat, 1918	–	–	–	+	–	+	–	+	–	+
33	*Amidostomum anseris* Railliet & Henry, 1909	+	–	+	–	+	+	+	+	+	+
34	*Trichostrongylus tenuis* Mehlis, 1846	+	–	+	–	+	+	+	+	+	+
35	*Trichostrongylus medius* Oliger, 1950	–	–	–	–	+	–	+	–	+	–
36	*Heterakis altaica* Spaul, 1929	–	–	–	–	+	+	+	+	+	+
37	*Heterakis dispar* Schrank, 1790	+	–	+	+	+	+	+	+	+	+
38	*Heterakis gallinarum* Freeborn, 1923	–	–	–	–	+	–	+	–	+	–
39	*Ascaridia anseris* Schwartz, 1925	–	–	–	–	+	–	+	–	–	–
40	*Ascaridia galli* Freeborn, 1923	–	–	–	–	+	–	+	–	+	–
41	*Porrocaecum crassum* Deslongchamps, 1824	–	–	–	–	–	+	–	+	–	+
42	*Tetrameres fissispina* Diesing, 1861	–	–	+	–	+	+	+	+	+	+
43	*Echinuria uncinata* Rudolphi, 1819	–	–	–	–	+	+	+	+	+	+
44	*Capillaria anatis* Schrank, 1790	+	–	–	–	–	–	+	–	+	+
45	*Eucoleus contortus* Creplin, 1839	–	–	–	–	–	+	–	+	+	–
46	*Baruscapillaria anseris* Madsen, 1945	–	–	+	–	+	–	+	–	–	–
47	*Baruscapillaria obsignata* Madsen, 1945	–	–	–	–	+	+	+	+	+	+
	Acanthocephala										
48	*Polymorphus diploinflatus* Lundström, 1942	–	–	–	–	–	+	–	+	–	+
49	*Polymorphus kostylewi* Petrochenko, 1949	–	–	–	–	–	+	–	+	–	+

Note: G – geese, D – duck;s I – Cavadov (1935); II – Shahtahtinskaya (1952); III – Shirinov (1961, 1962); IV – Vahidova (1978); V – Vahidova et al. (1982).

Table 3

Species composition of helminths recorded in domestic water birds in Azerbaijan (2012–2023 years)

No.	Helminth species	I		II		III		IV	
		G	D	G	D	G	D	G	D
	Cestodes								
1	*Cloacotaenia megalops* Nitzsch, 1829	–	–	–	–	–	–	–	+
2	*Diorchis inflata* Clerc, 1903	–	–	–	–	–	–	+	+
3	*Drepanidotaenia lanceolata* Railliet, 1892	–	–	–	++	+	+	+	–
4	*Drepanidotaenia przewalskii* Lopep-Neyra, 1942	–	–	–	–	–	–	+	–
5	*Fimbriaria fasciolaris* Pallas, 1781	–	–	–	–	++	+	+	+
6	*Microsomacanthus paramicrosoma* Gasowska, 1931	–	–	–	–	–	–	–	+
7	*Tschertkovilepis setigera* Frölich, 1789	–	–	–	–	+	+	+	+
8	*Ligula intestinalis* Gmelin, 1790	–	–	–	–	–	–	+	–
	Trematodes								
9	*Echinoparyphium recurvatum* Linstow, 1873	–	–	–	–	–	–	–	+
10	*Echinostoma chloropodis* Zeder, 1800	–	+	–	–	–	–	–	–
11	*Echinostoma paraulum* Dietz, 1909	–	+	–	–	–	–	–	–
12	*Echinostoma revolutum* Fröhlich, 1802	+	–	+	–	–	–	+	+
13	*Hypoderaeum conoideum* Bloch, 1782	–	–	–	–	+	+	–	+
14	*Paryphostomum novum* Verma, 1936	–	–	–	–	–	–	+	–
15	*Notocotylus attenuatus* Kossack, 1911	–	–	–	–	+	+	+	+
	Nematodes								
16	*Amidostomum acutum* Seurat, 1918	–	–	–	–	–	–	+	+
17	*Amidostomum anseris* Railliet & Henry, 1909	+++	–	+++	++	+++	+++	+++	++

No.	Helminth species	I		II		III		IV	
		G	D	G	D	G	D	G	D
18	*Trichostrongylus tenuis* Mehlis, 1846	–	–	–	–	++	+++	+++	+
19	*Heterakis altaica* Spaul, 1929	–	–	–	–	–	–	+	–
20	*Heterakis dispar* Schrank, 1790	–	–	+++	+++	+++	+++	+++	+
21	*Heterakis gallinarum* Freeborn, 1923	–	–	–	–	–	+	+	+
22	*Ascaridia galli* Freeborn, 1923	+	–	+	–	+	–	+	–
23	*Porrocaecum crassum* Deslongchamps, 1824	–	–	–	–	–	+	–	+
24	*Tetrameres fissispina* Diesing, 1861	–	–	–	–	–	+	+	+
25	*Hystrichis tricolor* Dujardin, 1845	–	–	–	–	–	–	–	+
26	*Capillaria anatis* Schrank, 1790	–	–	–	–	–	–	++	++
27	*Eucoleus contortus* Creplin, 1839	–	–	–	–	+	–	+	+
28	*Baruscapillaria obsignata* Madsen, 1945	–	–	+	–	+	+	++	+
	Acanthocephala								
29	*Polymorphus magnus* Skrjabin, 1913	–	–	–	–	–	–	+	+

Note: G – geese, D – ducks; I – Hasanova (2012); II – Aghayeva (2014); III – Seyidbeyli (2021); IV – Rzayev (2023); '+' – extensiveness of invasion < 10%, '++' – 10.1–20.0%, '+++' – >20.1%.

Discussion

If we look at the research works of various scientists (Table 2), we will see that in the first years of research, only 4 species of nematodes were recorded in domestic geese, and no helminths were recorded in domestic ducks (Cavadov, 1935). In the following years (1952), 7 species of cestodes, 1 species of trematodes and 5 species of nematodes were recorded in domestic geese, and 8 species of cestodes, 4 species of cestodes, 2 species of trematodes and 2 species of nematodes were recorded in domestic ducks (Shahtahtinskaya, 1952). In 1961–1962, 25 species of cestodes, 7 species of trematodes and 12 species of nematodes were recorded in domestic geese, and 37 species of cestodes, 15 species of trematodes, 10 species of nematodes and 2 species of acanthocephalans were recorded in domestic ducks (Shirinov, 1961, 1962). In 1978–1982, 30 species of cestodes, 10 species of trematodes and 14 species of nematodes were recorded in domestic geese, and 36 species of cestodes, 13 species of trematodes, 11 species of nematodes and 2 species of acanthocephalans were recorded in domestic ducks (Vahidova, 1978; Vahidova et al., 1982). The infection of geese and ducks with more types of helminths is revealed in the studies of Shirinov (1961) and Vahidova (1978). The reason for this is the large number of domestic waterfowl studied and the relatively large study areas. As can be seen from Table 2, more helminths were recorded in domestic ducks than in domestic geese. The higher number of helminths in domestic ducks than in geese can be explained by their lifestyle. Of the 49 species of helminths found, all those belonging to cestodes, trematodes and acanthocephalans (a total of 33 species) have a complex development cycle and are biohelminths. Of the 16 nematode species, 11 are geohelminths (*A. acutum*, *A. anseris*, *T. tenuis*, *T. medius*, *H. altaica*, *H. dispar*, *H. gallinarum*, *A. anseris*, *A. galli*, *B. anseris*, *B. obsignata*), and 5 are biohelminths (*P. crassum*, *T. fissispina*, *E. uncinata*, *C. anatis*, *E. contortus*). In total, 38 species are biohelminths, and 11 species are geohelminths. In helminthological studies conducted in the country in the last century, the species composition of parasitic worms belonging to different systematic groups in domestic waterfowl (with the exception of acanthocephala) differed little from each other. Of the acanthocephalans, only 2 species – *P. diploinflatus* and *P. kostylewi* – were recorded as parasites in domestic ducks. As a result of the analysis of literature data, it was found that only 12 species of acanthocephalans parasitize domestic waterfowl (Rzayev & Gasimov, 2021). Both of the helminths mentioned above are considered specific parasites of birds belonging to the Anseriformes order, spreading only in them. Among the helminths frequently mentioned by various authors in the country during the research years, the following can be mentioned: *D. coronula*, *D. lanceolata*, *M. collaris*, *T. setigera* cestodes, *E. recurvatum*, *E. paraulum*, *E. revolutum*, *H. conoideum*, *P. novum*, *P. pentalobum*, *N. attenuatus* trematodes, *A. acutum*, *A. anseris*, *T. tenuis*, *H. altaica*, *H. dispar*, *T. fissispina*, *E. uncinata*, *C. anatis*, *B. obsignata* nematodes.

In recent years (2012–2023), the parasitic fauna of domestic waterfowl in the territory of the Republic of Azerbaijan has been studied by scientists (Hasanova, 2012; Aghayeva, 2014; Seyidbeyli & Maharramov, 2018). Our own data (Rzayev, 2021a, 2021b, 2023) and the results of the above–mentioned researchers are presented in Table 3. As a result of the analysis of the obtained literature and our own data, it became clear that the number of species composition of the helminth fauna of domestic geese and ducks was almost identical during the years of research. In our opinion, the reason for this was that in most cases geese and ducks were kept together and used the same ponds for recreation. Of the mentioned 29 species of helminths, tapeworms, digenetic worms and acanthocephala (16 species) also participate in the development cycle of intermediate and reservoir hosts. Therefore, they are biohelminths. Some species of nematodes found in domestic waterfowl do not involve intermediate hosts in their development. Geohelminth nematodes are of 8 species and are as follows: *A. acutum*, *A. anseris*, *T. tenuis*, *H. altaica*, *H. dispar*, *H. gallinarum*, *A. galli*, *B. obsignata*. The other 5 species (*P. crassum*, *T. fissispina*, *H. tricolor*, *C. anatis*, *E. contortus*) are biohelminths, as are trematodes, cestodes and acanthocephalans. Thus, out of the 29 species recorded in domestic waterfowl, 21 are biohelminths and 8 are geohelminths. Helminths parasitic in domestic waterfowl represent various systematic groups. Nematodes (13 species) dominate among them. The reason for this is most likely due to the simple development cycle of most nematodes, as mentioned above. The second and third places are occupied by cestodes and trematodes. They are represented by 8 and 7 species, respectively. In the last place, the acanthocephalans take the position with 1 species (*P. magnus*). This species was recorded only by us in both domestic geese and domestic ducks in the Khachmaz region (Rzayev, 2023). The intermediate hosts of the parasitic worm are crustaceans, second intermediate hosts are several species of fish belonging to the orders Cypriniformes, Perciformes, and the final hosts are birds belonging to the orders Anseriformes, Gaviiformes, Falconiformes, Galliformes, Gruiformes, Charadriiformes, Passeriformes and mammals (muskrat). It is also clear from the mentioned list that the acanthocephalan *P. magnus* is a parasite with a wide specificity and has numerous hosts. In this regard, it is not accidental that it is also found in domestic geese and ducks in the country. In recent years (2012–2023 years), the species frequently noted by various researchers among the parasitic worms recorded in domestic waterfowl in the country have also been clarified. Thus, the following species of cestodes can be mentioned: *D. lanceolata*, *F. fasciolaris*, *T. setigera*; the species of trematodes: *E. revolutum*, *N. attenuatus*; and the species of nematodes: *A. anseris*, *T. tenuis*, *H. dispar*, *A. galli*, *B. obsignata*. The dominance of nematodes is clearly visible in this list. Among the species encountered, the final hosts are birds, as well as mammals and sometimes humans, which has led to the transformation of these parasites into helminths of medical importance. As a result of the analysis of the data, it was determined that the final hosts of 8 species of parasitic worms included in Table 3 (2 species of cestodes – *D. lanceolata* and *L. intestinalis*, 5 species of trematodes – *E. recurvatum*, *E. paraulum*, *E. revolutum*, *H. conoideum*, *N. attenuatus*, 1 species of acanthocephala – *P. magnus*) were determined to be mammals, including humans (5 species), in addition to birds.

There are few sources on the comparative analysis of the helminth fauna of domestic waterfowl in Azerbaijan (Seyidbeyli, 2021). In this literature, a comparative analysis was conducted not on the

entire helminth fauna of domestic waterfowl across the country, but only in certain regions, for example, Absheron–Kurdamir, Masalli–Lankaran or seven regions of the Nakhchivan Autonomous Republic. Therefore, Tables 2 and 3 were prepared and a comparative analysis of the obtained data was conducted. Looking at Tables 2 and 3, it is revealed that a serious decrease in the species composition of the helminth fauna of domestic waterfowl has been observed in the current period. Thus, the total number of species has decreased from 49 to 29. This pattern applies to helminths from all systematic groups. In general, in terms of the number of species, cestodes in domestic geese and ducks have decreased by 33%, trematodes by 63%, nematodes by 19%, and acanthocephalans by 50%. It is clear from this that the number of trematode species has decreased sharply. This situation gives reason to say that it is due to the decrease in intermediate and additional hosts that are sensitive to environmental influences against the background of ecological changes taking place in the current period. The decrease in acanthocephalans does not have a serious impact on the overall indicators because in terms of species, their number has decreased from 2 to 1. Therefore, the percentage rate was taken as high. Another noteworthy point is the limited change observed in the number of nematode species. The reason for this is most likely that most of the worms included in that systematic group do not have intermediate hosts in their development cycle. When comparing studies of previous years (1935–1982) with recent years (2012–2023), it is observed that the number of species parasitizing domestic geese has decreased from 32 to 22. On the other hand, when analyzing the systematic groups to which helminths belong, while there is no significant difference in cestodes and nematodes (the number of cestodes species decreased from 7 to 6, and the number of nematodes from 14 to 11), a sharp decrease in the trematode fauna was recorded. Thus, the species composition of digenetic worms parasitizing domestic geese decreased from 11 to 4. A similar pattern was found in the helminth fauna of domestic ducks. Here, the number of helminth species decreased almost 2 times (from 41 to 21 species). While there was no change in the number of nematodes belonging to different systematic groups, a decrease was found in cestodes from 10 to 6 species, and in trematodes from 18 to 6 species (3 times). The sharp decrease in the helminth fauna of cestodes and trematodes in domestic ducks can be attributed to the decrease in intermediate and additional hosts involved in the development cycle of parasites and, accordingly, their failure to reach the adult form and reproduce. In general, in addition to the decrease in the species composition of helminths parasitic in domestic waterfowl compared to previous years, there are also species that are identical for both study periods. Thus, a total of 24 species – 6 species of cestodes, 6 species of trematodes and 12 species of nematodes – are currently found in domestic waterfowl in the fauna of Azerbaijan. In recent years (2012–2023), 5 species of helminths (2 species of cestodes – *D. inflata*, *L. intestinalis*, 1 species of trematode – *E. chloropodis*, 1 species of nematode – *H. tricolor* and 1 species of acanthocephalan – *P. magnus*) have been added to the parasitic fauna of geese and ducks. These species were not recorded in previous studies (1935–1982) in the country. It is appropriate to provide more detailed information about these parasitic worms. The final hosts of the *D. inflata* cestodes are 18 species of birds belonging to the order of Anseriformes, including domestic geese and domestic ducks. In addition, it is also found in birds belonging to the orders Gruiformes, Galliformes, Podicipediformes (only one species of bird from each order) (Rzayev, 2023). Analysis of the data shows that the *D. inflata* cestode parasitizes in waterfowl with similar ecological conditions.

This species is recorded in domestic ducks and geese in Slovakia and Ukraine (Smogorzhevskaya, 1976; Hanzelova et al., 1995). Another tapeworm is *L. intestinalis* species, which has a wide range of hosts. Intermediate hosts are crustaceans, second intermediate hosts are fish, and final hosts are numerous bird species and mammals (Carnivora and Lagomorpha) belonging to different ecological groups of different orders. The parasite with a wide specificity is recorded abroad, in Taiwan and Ukraine, in domestic waterfowl (Sugimoto, 1934; Smogorzhevskaya, 1976). The intermediate hosts of the *E. chloropodis* digenetic worm are mollusks (*Planorbis planorbis*, *Anisus spirorbis*, *Viviparus contectus*), and final hosts are birds belonging to the order of Anseriformes, Gruiformes, Charadriiformes (9 species). This species has been recorded in domestic ducks only in Azerbaijan. It is considered advisable to continue research in the direction of the distribution of the *E. chloropodis* species and the specification of its hosts. *H. tricolor* nematode is a biohelminth, recorded in birds belonging to a number of orders, including domestic geese and ducks in various countries (USA, Slovakia, Ukraine, Georgia, etc.) (Gower, 1939; Tepper, 1955; Kurashvili, 1983). *P. magnus*, which was first recorded in domestic waterfowl in the country, is a biohelminth with intermediate, auxiliary and wide final hosts. The parasite is found in both domestic ducks and domestic geese in Ukraine and other areas (Lisitsyna, 2019; Yuskiv & Melnychuk, 2020). If we combine the data from Tables 2 and 3, we obtain data on the total helminth fauna of domestic water birds in the territory of Azerbaijan for the entire period of research. It is clear from this that a total of 54 species of helminths (cestodes – 14, trematodes – 20, nematodes – 17, acanthocephalans – 3) have been identified as parasitic in domestic waterfowl in Azerbaijan to date. Of these, 38 species of helminths are found in domestic geese and 48 species in domestic ducks.

Conclusion

Thus, based on the obtained literature data and our own materials, the species composition of helminths parasitic in domestic waterfowl in the territory of the Republic of Azerbaijan was compared for previous years (1935–1982) and recent years (2012– 2023). It was found that the helminth fauna of domestic waterfowl has decreased from 49 species to 29 species. Twenty five species of parasites mentioned in previous studies have not been encountered in recent years, and 5 species of helminths have been newly included in the fauna. When looking at the systematic groups of helminths, the greatest decrease is observed in digenetic worms (a decrease from 19 species to 7 species). This is most likely due to the decrease in the number of intermediate hosts participating in the development cycle of helminths under the current changing ecological conditions.

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