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Parasites of fish in the water bodies of Uzbekistan

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This work studies communities of parasites of fish in water bodies in three regions of Uzbekistan with a varying environmental background. In each region the research was conducted during the fishing seasons. The team of researchers identified 116 species of parasites in 10 classes. The protists are represented by the following families: Trypanosomatidae (*Tripanosoma carassi*, *T. percae*, *T. scardini*), Bodonidae (*Ichthyobodo necator*), Cryptobiidae (*Cryptobia cyprini*, *C. branchialis*), Caliptosporidae (*Goussia leucisci*), Eimeriidae (*Eimeria esoci*, *E. gasterostei*, *E. percae*), Myxidiidae (*Myxidium macrocapsulare*, *M. pfeifferi*, *M. rhodei*, *Zschokkella nova*), Myxobilatidae (*Myxobilatus legeri*), Myxosomatidae (*Myxosoma acutum*, *M. multiplicatum*), Myxobolidae (*Myxobolus bramae*, *M. carassi*, *M. dispar*, *M. mülleri*, *M. musculi*, *Henneguya lobosa*), Amphileptidae (*Hemiophrys branchiarum*, *H. disciformis*), Chilodonellidae (*Chilodonella piscicola*), Trichophryidae (*Capriniana piscium*), Trichodinidae (*Trichodina acuta*, *T. esocis*, *T. mutabilis*). Monogenoidea shows the highest species diversity and is represented by 30 species: Dactylogyridae (*Dactylogyrus auriculatus*, *D. anchoratus*, *D. borealis*, *D. cordus*, *D. crassus*, *D. crucifer*, *D. difformis*, *D. falcatus*, *D. formosus*, *D. intermedius*, *D. micracanthus*, *D. nanus*, *D. mallus*, *D. parvus*, *D. ramulosus*, *D. similis*, *D. tuba*, *D. vastator*), Ancyrocephalidae (*Silurodiscoides siluri*, *S. obscurus*), Gyrodactylidae (*Gyrodactylus cyprini*, *G. elegans*, *G. carassii*, *G. montanus*, *G. vicinus*), Diplozoidae (*Diplozoon paradoxum*, *D. hamaion*, *D. nipponicum*, *Diplozoon megan*). Cestoda (*Khawia rossittensis*, *Kh. sinensis*, *Triaenophorus nodulosus*, *T. crassus*, *Bothriocephalus opsariichthydis*, *Diphyllobothrium latum*, *D. ditremum*, *Schistocephalus pungitii*, *Ligula intestinalis*, *L. colymbi*, *Digramma interrupta*, *Proteocephalus cernuae*, *Proteocephalus osculatus*, *Proteocephalus torulosus*, *Gryporhynchus pusillus*, *Paradilepis scolecina*), Trematoda (*Ornithodiplostomum scardini*, *Posthodiplostomum brevicaudatum*, *Diplostomum helviticum*, *D. spathaceum*, *D. rutili*, *Hysteromorpha triloba*, *Tylodelphus clavata*, *Apharingostrigea cornu*, *Apatemon fuligulae*, *Cotylurus pileatus*, *Tetracotyle sogdiana*, *Bucephalus polymorphis*, *Ripidocotyle campanula*, *Azygia lucii*, *Sanguinicola inermis*, *Echinochasmus coaxatus*, *Petasiger neocomense*, *Allocreadium siluri*, *Metorchis xanthosomus*, *Phyllodistomum elongatum*) and Nematoda (*Pseudocapillaria tomentosa*, *Dioctophyme renale*, *Eustrongylides excisus*, *Eu. mergorum*, *Raphidascaris acus*, *Contracaecum microcephalum*, *Porrocaecum reticulatum*, *Camallanus lacustris*, *Phylometra ovata*, *Ph. rishta*, *Phylometroides sanguinea*, *Rhabdochona denudata*, *Streptocara crassicauda*, *Desmidocercella numidica*, *Gnathostoma hispidum*) are represented by 18, 20 and 15 species, respectively. Only 2 species were identified within the class Acanthocephala (*Acanthocephalus anguillae*, *Pomphorhynchus laevis*). 10 species and 7 genera were recorded for the first time in Uzbekistan. Bodies of water within the Syr Darya basin proved the most abundant in endoparasites (55 species), with a slightly smaller number of helminths from this group (48 species) registered in the Amu Darya bodies of water. Bodies of water in the Zeravshan basin are characterised by the smallest number of species of parasitic worms (28). Our research established that endoparasites use fish as their definitive (41.8%), intermediate (50.8%), and reservoir hosts (7.2%). The material suggests a rather complex relationship between endoparasites and fish. This biocoenotic relationship has probably developed over a long period of time, resulting in the formation of the modern endoparasitic fauna in Uzbekistan.

Keywords: helminths; endoparasites; bodies of water; fish; biocoenotic relationship; Uzbekistan.

Introduction

The Republic of Uzbekistan is located in the central part of Central Asia, in the area between the Syr Darya and Amu Darya rivers. Uzbekistan borders on five other states: Kyrgyzstan in the north-east, Kazakhstan in the north and north-west, Turkmenistan in the south-west, Tajikistan in the south-east and Afghanistan in the south. The territory of the country is 448,970 km^2, with highly contrasting landscapes. Most of the territory of the country, stretching from north-west to south-east, is flat, occupied by monotonous grey deserts and steppes, while the south-eastern part consists of foothills and mountains with high snow-capped peaks. Surface streams are very unevenly distributed across the territory of Uzbekistan, which forms a drainless part of Central Asia. There is not a single river or lake in the entire vast flatlands in the west of the country. The foothills and mountainous areas are cut by a branched network of streams. This uneven distribution of surface waters is the result of the region's climate and geography. The main waterways, the Syr Darya, Amu Darya and Zeravshan with their tributaries, as well as other Central Asian rivers, rise outside Uzbekistan. The total average annual flow of these two rivers is about 187 km^3, their water used for various economic purposes not only in Uzbekistan, but also in other Central Asian countries (team of authors, Geographical Atlas of Uzbekistan, Tashkent, 2012). Currently, there are more than 500 lakes and reservoirs on the territory of Uzbekistan. The largest of them are Lake Sudochye, Aidar-Arnasai lake system and Dengizkul. These bodies of water are listed in the Convention on Wetlands as internationally important habitats for wetland birds and freshwater fish.

The parasitological fauna of the large lakes with their extensive wetlands, crossed by a network of migration routes and inhabited by numerous and diverse species of birds and fish, remains poorly studied. What makes these helminthological studies significant is that fish living here are an important object of amateur fishing; in addition, many of the species are protected and listed as endangered in Uzbekistan. It should be borne in mind that fish transmit various helminthiases from other animals, as well as humans. Among them, Trematoda and Cestoda should be given special attention, since many of their species pose real threat to birds and mammals, including humans. The available information on parasites of fish in Uzbekistan (Osmanov, 1971; Osmanov et al., 1976) is quite outdated and does not reflect the parasitological situation at the present stage. Earlier studies of fish parasites were focused mainly on bodies of water in Karakalpakstan, mainly in the Aral Sea. The general analysis of the results of the study can be found in the monograph *Parasites of Fish in Uzbekistan* (532 pages) by Osmanov (1971). According to the author, 364 species of parasites were recorded in 57 fish species: flagellates – 24, Apicomplexa – 5, Cnidosporidia – 63, Plasmosporidia – 5, ciliates – 25, coelenterates – 1, Monogenoidea – 106, cestodes – 23, trematodes – 42, Acanthocephala – 6, nematodes – 43, leeches – 4, mollusks – 1, and parasitic crustaceans – 16.

The first researchers to study parasites of aquatic animals in the Aral Sea were V. Dogel and B. Bykhovsky more than 95 years ago. They examined 381 individuals of 22 species of fish (Dogel & Bykhovsky, 1934). The researchers registered 72 species of parasites. Protozoa were represented by 14 species, Monogenoidea – 19, Trematoda – 11, Cestoda – 9, and Nematoda – 10 species. The situation has greatly changed over time. The development of new and existing agricultural lands in the basins of the Amu Darya and Syr Darya without taking into account the needs of ecosystems and associated aquatic biological diversity led to the well-known Aral Sea disaster. Currently, due to the dramatic shrinkage of its water area and high mineralisation, the Aral Sea is no longer a large body of water. The result is that most of the numerous fish species that used to inhabit the Aral Sea in the past have completely disappeared. Probably, these factors also induced changes in the helminthofauna of fish in Uzbekistan. All this requires systematic monitoring of the parasitological situation of fish, which is a host to a wide range of helminths in various bodies of water.

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

Materials and methods

The material of this work is mainly based on parasites collected from fish in various bodies of water in the basins of the Amu Darya, Syr Darya, and Zeravshan rivers (Sudochye, Karajar and Kyzyljar lake systems, lakes Dengizkul, Tudakul, Ayakagytma and Karakir, Aydar-Arnasay lake system and some large artificial reservoirs) in the Central, North-Eastern, and North-Western Uzbekistan.

The research covers a total of 2,467 individuals of fish represented by various species (Table 1, Fig.).

Table 1
Species composition and extent of parasitological studies of fish in bodies of water in Uzbekistan

Family	Species	Examined, individuals
Salmonidae Jarocki or Schinz, 1822	*Oncorhyncus mykiss* Walbaum, 1792	105
Ecosidae Cuvier, 1816	*Esox lucius* Linnaeus, 1758	256
Cyprinidae Bonaparte, 1832	*Hypophthalmichthys molitrix* (Valenciennes, 1844)	202
	Arystichthys nobilis (Richardson, 1845)	110
	Carassius gibelio (Bloch, 1782),	300
	Cyprinus carpio Linnaeus, 1858	260
	Schizothorax intermedius Kessler, 1972	58
	Abramis brama Linnaeus, 1958	48
	Rutilus rutilus (Linnaeus, 1758)	284
	Ctenopharyngodon idella (Valenciennes, 1844)	225
Siluridae Rafinesque, 1815	*Silurus glanis* Linnaeus, 1758,	252
Clariidae Bonaparte, 1846	*Clarias gariepinus* Burchchell, 1822	36
Channidae Fowler, 1934	*Channa argus* (Cantor, 1842)	101
Percidae Rafinesque, 1815	*Sander lucioperca* Linnaeus, 1758	240
Total:		2467

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

Of the total number of fish, 2,467 were examined through complete helminthological dissection and 803 through incomplete dissection of various organs. Recently caught fish, mostly live, was used for complete parasitological study. Before the examination, the researchers identified the fish species, weighed the individual and measured its length. Scale samples were taken from each fish and forwarded to a laboratory to specify the age of this individual. The species was identified based on a set of morphometric features (Vasilyeva & Luzhnyak, 2013). The morphometric features were measured according to a method generally accepted in ichthyology (Pravdin, 1966). These features included: "length of the entire fish; length of the body to the end of the tail fork; length of the body to the end of the scale covering; length of the snout" and other.

Measurements were carried out using an ichthyological ruler and calipers. The weight of the fish was measured in grams using a CAS SWN-6 scale with 1 g calibration. The researchers also measured the total body weight and the weight of the carcass (without internal organs). The age of the fish was specified by scales (Pravdin, 1966; Kafanova & Petlina, 1984; Sterligova, 2016). For this purpose, all the mucus was removed from the surface of the fish body and at least 15 scales were taken from along the lateral line. After drying, the material was washed in dilute ammonia and cleaned of mucus (Pravdin, 1966). These manipulations made it possible to see annual rings on the scales, which were counted using an SME-2 stereoscopic microscope (magnification $^{x}10$).

The sex was established after dissecting the fish and detecting gonads. The parasites were collected, recorded and analysed in a laboratory using methods generally accepted in parasitology (Scriabin, 1928; Bykhovskaya-Pavlovskaya, 1985; Vasilkov et al., 1989). In case of the complete parasitological dissection, the fish organs were examined in a specific order. In cases of incomplete analysis, the fish was examined for specific parasites (such as, for example, *Ligula* or *Raphidascaris*). The material collected during the field research was processed in the laboratory to make preparations and identify.

To study representatives of Protista, we took smears of tissue mucus with a coverslip and made mixed glycerin and gelatin preparations. Monogenoidea were cleaned of mucus and fixed in a 4% formalin solution. Preparations were made from the fixed parasites. Representatives of Cestoda and Trematoda were fixed in 70% alcohol, while Nematoda were soaked in Barbagallo solution. The species of the discovered parasites were identified according to the *Guide to Parasites of Freshwater Fish in the Fauna of the USSR* in three volumes (1984, 1985, 1987). We also used the *Catalogue of Parasites of Freshwater Fish in North Asia* in four volumes (Pugachev, 2001, 2002, 2003, 2004).

Currently, opinions diverge regarding the parasites' taxonomy. The taxonomies proposed by various researchers vary significantly in either the number of taxons or their order in the system. To identify representatives of the kingdom Protista we referred to Krylov (1994, 1996), and we mainly used the taxonomy offered by Bykhovsky (1957) for the identification of the class Monogenoidea. The class Cestoda was identified according to Khalil et al. (1994). The taxonomy offered by Pugachev (2004) in his *Catalogue of Parasites of Freshwater Fish in North Asia* was used to identify Nematoda and Acanthocephala.

Results and discussion

Our research team established that the current parasite fauna of commercial fish in water bodies in Uzbekistan consists of 116 species: 6 of them belong to the class Kinetoplastida, 4 to Coccidea, 12 to Myxosporidea, 2 to Litostomatea and 5 to Phyllopharingea. The class Monogenoidea is represented by the largest number of species (30) from five families (Table 2). The class Cestoda is represented by 18 species, Trematoda – 20 species, and Nematoda – 15 species. Only 2 species were recorded in the class Paleacanthocephala. Nematoda are represented by 9 families (Table 2).

Table 2
Parasite fauna of commercial fish in bodies of water in Uzbekistan

Class	Family	Species	Host
		Phylum Kineoplastida Haeckel, 1866	
Kinetoplastida Honiberg, 1963	Trypanosomatidae Doflein, 1901	*Tripanosoma carassi* (Mitrophanov, 1883)	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758
		Tripanosoma percae Brumpt, 1906	*Cyprinus carpio* Linnaeus, 1758, *Rutilus rutilus* (Linnaeus, 1758)
		Tripanosoma scardini Brumpt, 1906	*Scardinius erythrophthalmus* (Linnaeus, 1758)
	Bodonidae Stein, 1878	*Ichthyobodo necator* (Henneguy, 1883)	*Cyprinus carpio* Linnaeus, 1758
	Cryptobiidae Poche, 1911	*Cryptobia cyprini* (Plehn, 1903)	*Cyprinus carpio* Linnaeus, 1758, *Carassius gibelio* (Bloch, 1782)
		Cryptobia branchialis Nie, 1956	*Carassius gibelio* (Bloch, 1782)
		Phylum Sporozoa Leuckart, 1872	
Coccidea Leuckart, 1879	Caliptosporidae Overstreet et al., 1984	*Goussia leucisci* (Schulman et Zaika, 1964)	*Leuciscus lehmani* Brandt, 1852, *Petroleuciscus squalisculus* (Kessler, 1872)
	Eimeriidae Minchin, 1903	*Eimeria esoci* Shulman et Zaika, 1964	*Leuciscus lehmani* Brandt, 1852
		Eimeria gasterostei (Thelohan, 1890)	*Cyprinus carpio* Linnaeus, 1758, *Rutilus rutilus* (Linnaeus, 1758)
		Eimeria percae (Riviere, 1914)	*Scardinius erythrophthalmus* (Linnaeus, 1758), *Cyprinus carpio* Linnaeus, 1758
		Phylum Cnidosporidia Doflein, 1901	
Myxosporidea Bütschli, 1881	Myxidiidae Thelohan, 1892	*Myxidium macrocapsulare* Auerbach, 1910	*Cyprinus carpio* Linnaeus, 1758, *Cyprinus carpio* Linnaeus, 1758
		Myxidium pfeifferi Auerbach, 1908	*Rutilus rutilus* (Linnaeus, 1758)
		Myxidium rhodei Leger, 1905	*Rutilus rutilus* (Linnaeus, 1758)
		Zschokkella nova Klokaceva, 1914	*Carassius gibelio* (Bloch, 1782), *Hypophthalmichthys molitrix* Valenciennes, 1844
	Myxobilatidae Schulman, 1953	*Myxobilatus legeri* (Cepede, 1905)	*Rutilus rutilus* (Linnaeus, 1758)
	Myxosomatidae Poche, 1913	*Myxosoma acutum* (Fujita, 1912)	*Cyprinus carpio* Linnaeus, 1758
		Myxosoma multiplicatum (Reuss, 1906)	*Cyprinus carpio* Linnaeus, 1758
	Myxobolidae Thelohan, 1892	*Myxobolus bramae* Renss, 1906	*Rutilus rutilus* (Linnaeus, 1758)
		Myxobolus carassi Klokacewa, 1914	*Carassius gibelio* (Bloch, 1782)
		Myxobolus dispar Thelohan, 1895	*Rutilus rutilus* (Linnaeus, 1758)
		Myxobolus mülleri Bütschli, 1882	*Carassius gibelio* (Bloch, 1782)
		Myxobolus musculi Keysseliitz, 1908	*Carassius gibelio* (Bloch, 1782)
		Henneguya lobosa (Cohn, 1895)	*Sander lucioperca* (Linnaeus, 1758)
		Phylum Ciliophora Doflein, 1901	
Litostomatea Small et Lynn, 1981	Amphileptidae Butschli, 1889	*Hemiophrys branchiarum* (Werich, 1924)	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758
		Hemiophrys disciformis Chen, 1956	*Carassius gibelio* (Bloch, 1782)
Phyllopharyngea de Puytorac et al., 1974	Chilodonellidae Deroux, 1970	*Chilodonella piscicola* (Zacharias, 1894)	*Carassius gibelio* (Bloch, 1782), *Silurus glanis* Linnaeus, 1758
	Trichophryidae	*Capriniana piscium* (Bütschli, 1889)	*Esox lucius* Limnaeus, 1758, *Stizostedion lucioperea* (Linnaeus, 1758)
	Trichodinidae Raabe, 1959	*Trichodina acuta* Lom, 1961	*Carassius gibelio* (Bloch, 1782), *Rutilus rutilus* (Linnaeus, 1758)

Class	Family	Species	Host
		Trichodina esocis Lom, 1960	*Carassius gibelio* (Bloch, 1782)
		Trichodina mutabilis Kazubsky et Migala, 1968	*Cyprinus carpio* Linnaeus, 1758
		Phylum Plathelminthes Gegenbaur, 1859	
Monogenoidea (van Beneden, 1858) Bychowsky, 1937	Dactylogyridae Bychowsky, 1933	*Dactylogyrus auriculatus* (Nordmann, 1832)	*Abramis brama* Linnaeus, 1758
		Dactylogyrus anchoratus (Dujardin, 1845)	*Cyprinus carpio* Linnaeus, 1858
		Dactylogyrus borealis Nubelin, 1936	*Capoetobrama kuschakewitschi* (Kessler, 1872)
		Dactylogyrus cordus Nubelin, 1937	*Petroleuciscus squaliusculus* (Kessler, 1872)
		Dactylogyrus crassus Kulwiec, 1927	*Carassius gibelio* (Bloch, 1782)
		Dactylogyrus crucifer Wagener, 1857	*Rutilus rutilus* (Linnaeus, 1758)
		Dactylogyrus difformis Wagener, 1857	*Scardinius erythrophthalmus* (Linnaeus, 1758), *Rutilus rutilus* (Linnaeus, 1758)
		Dactylogyrus falcatus (Weld, 1857)	*Abramis brama* Linnaeus, 1758, *Scardinius erythrophthalmus* (Linnaeus, 1758)
		Dactylogyrus formosus Kalwiec, 1927	*Carassius gibelio* (Bloch, 1782)
		Dactylogyrus intermedius Wegener, 1910	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758
		Dactylogyrus micracanthus Nubelin, 1937	*Rutilus rutilus* (Linnaeus, 1758), *Petroleuciscus squalisculus* (Kessler, 1872)
		Dactylogyrus nanus Dogiel et Bychowsky, 1934	*Rutilus rutilus* (Linnaeus, 1758)
		Dactylogyrus mallus Linstow, 1877	*Luciobarbus capito* (Güldenstädt, 1773)
		Dactylogyrus parvus Wegener, 1909	*Scardinius erythrophthalmus* (Linnaeus, 1758), *Cyprinus carpio* Linnaeus, 1758
		Dactylogyrus ramulosus Malewitzkaja, 1941	*Leuciscus idus* (Linnaeus, 1758), *Rutilus rutilus* (Linnaeus, 1758)
		Dactylogyrus similis Wegener, 1910	*Rutilus rutilus* (Linnaeus, 1758), *Pelecus cultratus* (Linnaeus, 1758)
		Dactylogyrus tuba Linstow, 1878	*Carassius gibelio* (Bloch, 1782), *Rutilus rutilus* (Linnaeus, 1758)
		Dactylogyrus vastator Nybelin, 1924	*Cyprinus carpio* Linnaeus, 1758
	Capsalidae Baird, 1853	*Nitzschia sturionis* (Abilgaard, 1749)	*Acipenser nudiventris* Lovetsky, 1828
	Ancyrocephalidae Bychowsky, 1937	*Silurodiscoides siluri* (Zantt, 1924)	*Silurus glanis* Linnaeus, 1758
		Silurodiscoides obscurus (Gusev et Strelkow, 1960)	*Silurus glanis* Linnaeus, 1758
	Gyrodactylidae Van Beneden et Hesse, 1863	*Gyrodactylus cyprini* Diarova, 1964	*Cyprinus carpio* Linnaeus, 1758
		Gyrodactylus elegans Nordmann, 1832	*Cyprinus carpio* Linnaeus, 1758, *Capoeta steindachneri* Kessler, 1872
		Gyrodactylus carassii Malmberg, 1957	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758
		Gyrodactylus montanus Bychowsky, 1957	*Schizothorax eurystomus* Kessler, 1972
		Gyrodactylus vicinus Bychowsky, 1957	*Schizothorax eurystomus* Kessler, 1972
	Diplozoidae Palombi, 1949	*Diplozoon paradoxum* Nordmann, 1832	*Abramis brama* Linnaeus, 1758, *Leuciscus aspius* (Linnaeus, 1758)
		Diplozoon hamaion Bychowsky et Nagibina, 1959	*Rutilus rutilus* (Linnaeus, 1758), *Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758
		Diplozoon nipponicum Goto, 1891	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1858
		Diplozoon megan Bychowsky et Nagibina, 1959	*Petroleuciscus squaliusculus* (Kessler, 1872)
Cestoda Rudolphi, 1808	Lytocestidae Hunter, 1927	*Khawia rossittensis* (Szidat, 1937)	*Carassius gibelio* (Bloch, 1782)
		Khawia sinensis (Hsü, 1935)	*Ctenopharyngodon idella* (Valenciennes, 1844), *Cyprinus carpio* Linnaeus, 1758
	Triaenophoridae Lönnberg, 1889	*Triaenophorus nodulosus* (Pallas, 1781)	*Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
		Triaenophorus crassus Forel, 1868	*Sander lucioperca* (Linnaeus, 1758), *Silurus glanis* Linnaeus, 1758
	Bothriocephalidae Blanchard, 1849	*Bothriocephalus opsariichthydis* Yamaguti, 1934	*Cyprinus carpio* Linnaeus, 1758, *Ctenopharyngodon idella* (Valenciennes, 1844), *Cyprinus carpio* Linnaeus, 1758, *Silurus glanis* Linnaeus, 1758
	Diphyllobothriidae Lühe, 1910	*Diphyllobothrium latum* (Linnaeus, 1758) larvae	*Sander lucioperca* (Linnaeus, 1758), *Silurus glanis* Linnaeus, 1758, *Petroleuciscus squaliusculus* (Kessler, 1872), *Lota lota* Linnaeus, 1758
		Diphyllobothrium ditremum (Creplin, 1825) larvae	*Pungitius pungitius* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
		Schistocephalus pungitii Dubinina, 1959	*Cyprinus carpio* Linnaeus, 1758, *Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758
		Ligula intestinalis (Linnaeus, 1758)	*Cyprinus carpio* Linnaeus, 1758, *Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758
		Ligula colymbi Zeder, 1803	*Scardinius erythrophthalmus* (Linnaeus, 1758)
		Digramma interrupta (Rudolphi, 1810)	*Carassius gibelio* (Bloch, 1782), *Abramis brama* Linnaeus, 1758, *Cyprinus carpio* Linnaeus, 1758
	Proteocephalidae La Rue, 1911	*Proteocephalus cernuae* (Gmelin, 1790)	*Pungitius pungitius* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
		Proteocephalus osculatus (goeze, 1782)	*Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)

Class	Family	Species	Host
		Proteocephalus torulosus (Batsch, 1786)	*Rutilus rutilus* (Linnaeus, 1758), *Leuciscus idus* (Linnaeus, 1758), *Schizothorax eurystomus* Kessler, 1872, *Leuciscus aspius* (Linnaeus, 1758)
	Dilepididae Railliet et Henry, 1909	*Gryporhynchus pusillus* Nordmann, 1832	*Ctenopharyngodon idella* (Valenciennes, 1844), *Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758, *Channa argus* (Cantor, 1842), *Silurus glanis* Linnaeus, 1758
		Paradilepis scolecina (Rudolphi, 1819)	*Alburnus chalcoides* (Güldenstädt, 1772), *Pelecus cultratus* (Linnaeus, 1758), *Leuciscus aspius* (Linnaeus, 1758), *Cyprinus carpio* Linnaeus, 1758, *Carassius gibelio* (Bloch, 1782)
Trematoda Rudolphi, 1808	Diplostomidae Poirier, 1886	*Ornithodiplostomum scardini* (Schulman, 1952)	*Scardinius erythrophthalmus* (Linnaeus, 1758), *Carassius gibelio* (Bloch, 1782)
		Posthodiplostomum brevicaudatum (Nordmann, 1832)	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758
		Diplostomum helviticum (Dubois, 1929)	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758, *Hypophthalmichthys molitrix* Valenciennes, 1844
		Diplostomum spathaceum (Rudolphi, 1819)	*Rutilus rutilus* (Linnaeus, 1758), *Abramis brama* Linnaeus, 1758, *Ballerus sapa* (Pallas, 1814), *Scardinius erythrophthalmus* (Linnaeus, 1758), *Cyprinus carpio* Linnaeus, 1758
		Diplostomum rutili Razmashkin, 1969	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758, *Rutilus rutilus* (Linnaeus, 1758), *Hypophthalmichthys molitrix* Valenciennes, 1844, *Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
		Hysteromorpha triloba (Rudolphi, 1819)	*Cyprinus carpio* Linnaeus, 1758, *Carassius gibelio* (Bloch, 1782)
		Tylodelphus clavata (Nordmann, 1832)	*Rutilus rutilus* (Linnaeus, 1758), *Scardinius erythrophthalmus* (Linnaeus, 1758), *Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758, *Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
	Strigeidae Railliet, 1819	*Apharingostrigea cornu* (Zeder, 1800)	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1858, *Alburnus chalcoides* (Güldenstädt, 1772)
		Apatemon fuligulae Yamaguti, 1933	*Scardinius erythrophthalmus* (Linnaeus, 1758), *Cyprinus carpio* Linnaeus, 1758, *Rutilus rutilus* (Linnaeus, 1758)
		Cotylurus pileatus (Rudolphi, 1802)	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758, *Rutilus rutilus* (Linnaeus, 1758), *Abramis brama* Linnaeus, 1758
		Tetracotyle sogdiana (Pavlowsky et Anitschkov, 1923)	*Schizothorax eurystomus* Kessler, 1972, *Cyprinus carpio* Linnaeus, 1758
	Bucephalidae Poche, 1907	*Bucephalus polymorphis* Baer, 1827	*Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758), *Neogobius fluviatilis* Pallas, 1811, *Carassius gibelio* (Bloch, 1782)
		Ripidocotyle campanula (Dujardin, 1845)	*Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758), *Carassius gibelio* (Bloch, 1782), *Abramis brama* Linnaeus, 1758, *Ballerus sapa* (Pallas, 1814)
	Azygiidae Lühe, 1909	*Azygia lucii* (Müller, 1776)	*Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
	Sanguinicolidae Graff, 1907	*Sanguinicola inermis* Plehn, 1905	*Cyprinus carpio* Linnaeus, 1758, *Schizothorax eurystomus* Kessler, 1972, *Carassius gibelio* (Bloch, 1782)
	Echinostomatidae Looss, 1899	*Echinochasmus coaxatus* Dietz, 1909	*Scardinius erythrophthalmus* (Linnaeus, 1758), *Carassius gibelio* (Bloch, 1782)
		Petasiger neocomense Fuhrmann, 1927	*Carassius gibelio* (Bloch, 1782), *Rutilus rutilus* (Linnaeus, 1758), *Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
	Allocreadiidae Looss, 1902	*Allocreadium siluri* Osmanov, 1967	*Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
	Opisthorchiidae Looss, 1899	*Metorchis xanthosomus* (Creplin, 1846)	*Rutilus rutilus* (Linnaeus, 1758), *Asipenser nudiventris* Lovetsky, 1828, *Leuciscus idus* (Linnaeus, 1758)
	Gorgoderidae Looss, 1899	*Phyllodistomum elongatum* Nybelin, 1926	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758, *Ballerus sapa* (Pallas, 1814)
		Phylum Acanthocephala (Rudolphi, 1808)	

Class	Family	Species	Host
Palaeacanthocephala Meyer, 1931	Echinorhynchidae Cobbold, 1876	*Acanthocephalus anguillae* (Müller, 1780)	*Cyprinus carpio* Linnaeus, 1758, *Carassius gibelio* (Bloch, 1782), *Asipenser nudiventris* Lovetsky, 1828
	Pomphorhynchidae Yamaguti, 1939	*Pomphorhynchus laevis* (Zoega, 1776)	*Rutilus rutilus* (Linnaeus, 1758), *Carassius gibelio* (Bloch, 1782)
		Phylum Nemathelminthes Schneider, 1873	
Nematoda Rudolphi, 1808	Capillariidae Railliet, 1915	*Pseudocapillaria tomentosa* (Dujardin, 1843)	*Cyprinus carpio* Linnaeus, 1758, *Rutilus rutilus* (Linnaeus, 1758), *Scardinius erythrophthalmus* (Linnaeus, 1758)
	Dioctophymatidae Railliet, 1915	*Dioctophyme renale* (Goeze, 1782)	*Leuciscus idus* (Linnaeus, 1758), *Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758), *Leuciscus aspius* (Linnaeus, 1758)
		Eustrongylides excisus Jagerskiold, 1909	*Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
		Eustrongylides mergorum (Rudolphi, 1809)	*Sander lucioperca* (Linnaeus, 1758)
	Anisakidae Railliet et Henry, 1915	*Raphidascaris acus* (Bloch, 1779)	*Scardinius erythrophthalmus* (Linnaeus, 1758), *Cyprinus carpio* Linnaeus, 1758, *Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
		Contracaecum microcephalum (Rudolphi, 1819)	*Cyprinus carpio* Linnaeus, 1758, *Hypophthalmichthys molitrix* Valenciennes, 1844, *Carassius gibelio* (Bloch, 1782), *Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
		Porrocaecum reticulatum (Linstow, 1890)	*Rutilus rutilus* (Linnaeus, 1758), *Leuciscus aspius* (Linnaeus, 1758) *Cyprinus carpio* Linnaeus, 1758, *Hypophthalmichthys molitrix* Valenciennes, 1844, *Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
	Camallanidae Railliet et Henry, 1915	*Camallanus lacustris* (Zoega, 1776)	*Cyprinus carpio* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
	Phylometridae Baylis et Daubney, 1926	*Phylometra ovata* (Zeder, 1803)	*Rutilus rutilus* (Linnaeus, 1758), *Abramis brama* Linnaeus, 1758, *Scardinius erythrophthalmus* (Linnaeus, 1758)
		Phylometra rishta skrjabin, 1923	*Rutilus rutilus* (Linnaeus, 1758), *Scardinius erythrophthalmus* (Linnaeus, 1758)
		Phylometroides sanguinea (Rudolphi,1819)	*Carassius gibelio* (Bloch, 1782), *Cyprinus carpio* Linnaeus, 1758
	Rhabdochonidae Travassos, Artigas et Pereira, 1928	*Rhabdochona denudata* (Dujardin, 1845)	*Cyprinus carpio* Linnaeus, 1758, *Carassius gibelio* (Bloch, 1782)
	Acuaridae Seurat, 1913	*Streptocara crassicauda* (Creplin, 1829)	*Cyprinus carpio* Linnaeus, 1758, *Carassius gibelio* (Bloch, 1782)
	Desmidocercidae Cram, 1927	*Desmidocercella numidica* (Seurat,1920)	*Rutilus rutilus* (Linnaeus, 1758), *Silurus glanis* Linnaeus, 1758, *Sander lucioperca* (Linnaeus, 1758)
	Gnathostomatidae Railliet, 1845	*Gnathostoma hispidum* Fedtschenko,1873	*Cyprinus carpio* Linnaeus, 1758, *Rutilus rutilus* (Linnaeus, 1758), *Cyprinus carpio* Linnaeus, 1758

Table 2 shows that the kingdom Protista is characterised by the highest species diversity in the studied bodies of water in Uzbekistan: we have registered about 30 species in 3 phyla – Kinetoplastida (6 species), Sporozoa (4 species), Cnidosporidia (13 species), and Ciliophora (7 species). Earlier, some parasites from the above phyla were recorded in fish in the Aral Sea (Osmanov, 1971). A number of parasite species are new to Uzbekistan (*Tripanosoma carassi*, *Ichthyobodo necator*, *Gousia leucisci*, *Eimeria esoci*, *E. percae*, *Hemiophrys branchiarum*, *H. disciformis*, *Chilodonella piscicola*, *Trichodina acuta*, and *T. esocis*).

We added 10 species of parasites of fish found in bodies of water in Uzbekistan to the earlier list of representatives of the kingdom Protista (Osmanov, 1971; Osmanov et al., 1976). We recorded complexes of parasitic worms representing the classes Monogenoidea, Cestoda, Trematoda, Palaeacanthocephala, and Nematoda, in commercial fish in the studied bodies of water in Uzbekistan. The total number of parasitic worm species was 85 (Table 2). The class Monogenoidea, as already mentioned, in Uzbekistan includes 30 species belonging to the families Dactylogyridae, Capsalidae, Ancyrocephalidae, Gyrodactylidae and Diplozoidae. These ectoparasites commonly infest various fish species in bodies of water in Uzbekistan, causing grave damage to fish farming. In previous studies, Monogenoidea (75 species) were recorded in fish in Karakalpakstan, mainly in the Aral Sea (Osmanov, 1971; Osmanov et al., 1976).

The current species composition of endoparasites of fish in Uzbekistan deserves special attention. They are represented by numerous species in the classes Cestoda, Trematoda, Acanthocephala, and Nematoda. Cestoda in our material include 18 species from 6 families: Lytocestidae, Caryophyllaeidae, Triaenophoridae, Bothriocephalidae, Diphyllobothriidae, Proteocephalidae and Dilepididae. Plerocerci of two parasite species were for the first time observed in Uzbekistan (Osmanov et al., 1976). *D. latum* was recorded in the zander, catfish, dace, and burbot, and *D. ditremum* – in stickleback and zander, in water bodies in the lower reaches of the Amu Darya and the middle course of the Syr Darya.

We registered 20 species from the class Trematoda, where the most numerous were representatives of the families Diplostomidae and Strigeidae. The other Trematoda families – Bucephalidae, Azygiidae, Sanguinicolidae, Echinostomatidae, Allocreadiidae, Opisthorchiidae and Gorgoderidae – included 1–2 species (Table 2). Trematodes *Azygia lucii*, *Echinochasmus coaxatus*, *Petasiger neocomense*, and *Metorchis xanthosomus* were for the first time recorded in fish in Uzbekistan.

The class Palaeacanthocephala was represented by two species, *Acanthocephalus anguillae* and *Pomphorhynchus laevis*. The latter species was for the first time recorded in fish in Uzbekistan. This species of Acanthocephala is often found in carp in various bodies of water in the middle course of the Syr Darya.

We recorded Nematoda in 15 fish species from 9 families (Table 2). Each family is represented by 1 to 3 species. The infection rate is quite high. Nematodes in the basins of the Amu Darya and Zeravshan are common in different fish species from different age groups. The nematode species *Eustrongylides excisus*, *Eu. mergorum*, *Phylometra rishta*, *Phylometroides sanguinea*, and *Streptocara crassicauda* recorded in our studies had not been previously registered in Uzbekistan (Osmanov, 1971; Osmanov et al., 1976).

In our research, Spirurida showed the highest species diversity – 8 species, or 53.3%, some of which are important from medical and veterinary aspects. The larval forms of *Gnathostoma hispidum* and *Dioctophyme renale* from this order are found in the musculature and intestinal wall, respectively, in many species of fish (carps and predators). They were previously observed in fish in Uzbekistan (Osmanov, 1971; Safarova, 2017; Abduganiev, 2022).

The quantitative distribution of endoparasites in bodies of water in the Amu Darya, Syr Darya and Zeravshan river basins is highly uneven, as evidenced by our research. The largest number of helminth species (55) inhabits the Syr Darya basin, followed by the Amu Darya basin (48 species). The endoparasite fauna in the Zeravshan comprises the lowest number of species (28), which is probably associated with its specific environment and terrain (Table 3).

Table 3
Distribution of endoparasites of fish in the studied river basins in Uzbekistan (2018–2025)

Class	Number of parasite species, bodies of water			
	total	Amu Darya	Syr Darya	Zeravshan
Cestoda	18	16	18	11
Trematoda	20	17	20	9
Palaeacanthocephala	2	2	2	0
Nematoda	15	13	15	8
Total	55	48	55	28

According to the ways parasitic worms (endohelminths) infect fish in Uzbekistan, they can be divided into three groups:

– helminths that parasitise fish in the adult stage, for which fish is a definitive host;

– helminths that infect fish in the larval stage, for which fish is an intermediate host;

– helminths whose infective larvae use fish as a reservoir host (Table 4).

Table 4
Fish in Uzbekistan as host of helminths

Helminths	Host type		
	definitive	intermediate	reservoir
Cestoda	10 (55.5%)	8 (44.4%)	–
Trematoda	4 (20.0%)	16 (80.0%)	–
Palaeacanthocephala	2 (100.0%)	–	–
Nematoda	7 (44.4%)	4 (26.6 %)	4 (26.6%)
Total	23 (41.8%)	28 (50.8%)	4 (26.6%)

Table 4 shows how endoparasites (55 species in total) of fish in Uzbekistan use fish as different types of hosts: 41.8% of helminths use it as a definitive host, 50.8% as an intermediate host, and 7.2% as a reservoir host, which indicates a very complex parasite-host relationship. This biocoenotic relationship has probably developed over a long period of time, resulting in the formation of the modern endoparasitic fauna in Uzbekistan.

One of the main factors determining the parasite fauna, as mentioned above, is the biocoenotic relationship between the hosts and parasites. We think it possible to use endoparasites to discuss the dependence of the parasitic worm fauna on the ecology of freshwater fish. Of the total number of species (55) of helminths recorded in fish in Uzbekistan, the vast majority enter the body of their hosts with food (trophic relationship).

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

1. A helminth penetrates the host when the latter eats other organisms, which as intermediate or reservoir hosts are included in its diet.

2.A helminth enters the host as mechanical impurity in food or water.

3. A parasite actively penetrates the host's body.

4. A helminth is transmitted by an intermediate host eaten by a definitive one. Applying this rule to our analysis, we can see how parasites of fish use ways 1 and 3 (Table 5).

Table 5
Ways used by helminths to infest their definitive host – fish*

Nature of coenotic relationship	Way of infecting a host	Number of species			
		Cestoda	Trematoda	Acanthocephala	Nematoda
Trophic	Eating animals as food objects	10 (100%)	4 (80%)	2 (100%)	6 (100%)
Topical	Accidental ingestion of eggs or larvae	–	–	–	–
Topical	Active penetration of larvae through the skin	–	1 (20%)	–	–
Topical	Transmission by biting insects	–	–	–	–
	Total	10	5	2	6

Note: * – only obligate parasites (mature forms) of fish are included in this table.

Table 5 shows how the helminthofauna of freshwater fish in Uzbekistan is strongly dominated by parasites penetrating their hosts using trophic ways (80–100%). This group includes 10 species of Cestoda, 4 species of Trematoda, 2 species of Acanthocephala and 6 species of Nematoda. Only one trematode species, *Sanguinicola inermis*, infects fish topically.

In this regard, the study of the parasitofauna of fish inhabiting aquatic ecosystems is of particular interest. We examined a number of features in parasites of fish in Uzbekistan, which made it possible to compare them with data from previous studies. A monograph by Berg (1908) provides the first information about parasites of fish in Uzbekistan, reporting the discovery of several species of parasitic worms (trematodes and cestodes) in fish in the Aral Sea. The systematic study of fish parasites in the Aral Sea was initiated by B. E. Bykhovsky and V. A. Dogel. The researchers' joint monograph *Fauna of Parasites of Fish in the Aral Sea* (1934) lists 72 species representing Protozoa, 11 – Digenea, 9 – Cestoda and 10 – Nematoda. In subsequent years, starting in 1951, a series of comprehensive studies of fish parasites were carried out in the Aral Sea. The results of parasitological studies of aquatic animals were summarised in S. O. Osmanov's monograph *Parasites of Fish in Uzbekistan* (Osmanov, 1971, 532 pages), which reported the discovery of 364 species of parasites, including flagellates – 24, Apicomplexa – 5, Cnidosporidia – 63, Plasmosporidia – 5, ciliates – 25, coelenterates – 1, Monogenoidea – 106, cestodes – 23, trematodes – 42, Acanthocephala – 6, nematodes – 43, leeches – 4, molluscs – 1, and parasitic crustaceans – 16. A comparative analysis of the current (2025) fish parasite fauna and that specified in earlier research shows a significant decrease in the number of parasite species. Our research identified 116 species of endo- and ectoparasites infesting fish in the water bodies of Uzbekistan. The other 148 species of parasites (30.2%) were absent in our material. This situation probably results from a drastic change in the hydrological regime of bodies of water in the modern environment. This is also supported by the studies of fish endoparasites from various groups (Safarova, 2017; Abduganiyev, 2022). Thus, only 49 species of endoparasites from the classes Cestoda (13 species), Trematoda (18 species), Acanthocephala (4 species) and Nematoda (14 species) were recorded in carp in North-Eastern Uzbekistan. Abduganiyev (2022) registered 35 species of helminths in predatory fish (catfish, zander and pike) in the water bodies of the Syr Darya, of which 10 were Cestoda, 11 Trematoda, 3 Acanthocephala, and 11 Nematoda.

The fish parasitofauna was earlier studied in the neighboring Central Asian countries. The most comprehensive research was carried out in Kazakhstan and Tajikistan (Agapova, 1966; Karimov, 2007). In total, more than 240 species of fish parasites were registered in Kazakhstan: flagellates – 6, Cnidosporidia – 29, ciliates – 6, coelenterates – 1, Monogenoidea – 77, cestodes – 25, trematodes – 43, Acanthocephala – 7, nematodes – 28, leeches – 5, and parasitic crus-

taceans – 14 (Agapova, 1966). Slightly fewer species of fish parasites (115) were recorded in Tajikistan (Karimov, 2007).

The research into fish parasitofauna carried out in Russia, Ukraine, Belarus and other countries is also very interesting. The results can be found in the *Guide to Parasites of Freshwater Fish in the Fauna of the USSR* (1984, 1985, 1987). The guide lists the fauna of fish parasites: protozoan parasites – 750 species (volume 1); multicellular parasites – 560 species (volume 2); parasitic multicellular cestodes – 876 species, Aspidogastrea – 2, trematodes – 206, nematodes – 107, Acanthocephala – 36, leeches – 6, molluscs – 12, parasitic crustaneous – 95, and ticks – 5 (576 species in total) (volume 3). In total, the guide describes 1,886 species of fish parasites. This unique work became the main source of information for many generations of parasitologists and made a great contribution to the development of parasitology of aquatic animals.

Fish parasites in Russia and the CIS countries have been studied for more than 200 years. For a long time, the studies were merely faunal and taxonomic, and from the middle of the 20th century they have covered various fundamental aspects of ecology, life cycles, population biology, physiology and biochemistry, as well as the molecular biology of fish parasites. Many of the studies dealt with parasites and diseases of economically important fish, which could transmit these diseases to humans, as well as the use of parasites as indicators of the state of the environment. In the *Catalogue of Parasites of Freshwater Fish in North Asia* in four volumes (Pugachev, 2001, 2022, 2003, 2004), the data on the fauna of fish parasites were summarised using North Asia as a case study. It covered a vast territory from the Urals to Chukotka and Kamchatka, including bodies of water in Northern Kazakhstan, Mongolia, Baikal and Transbaikalia regions. The work contains detailed information about the distribution of about 800 species of parasites in 111 species of fish.

Fish parasites have also long been subjects of works by foreign parasitologists from many countries in America, Europe, Asia, Australia and Africa. Large-scale research is currently being conducted in the following areas of parasitology: biodiversity of ecto- and endoparasites, molecular phylogeny, taxonomy of parasites, the role of parasites in fish pathology, ecology and evolution of parasites, geographical distribution, epizootology of parasitic diseases of commercial fish, development of methods for the diagnosis and prevention of basic parasitic diseases (Moravec, 1994, 2011; Nowak, 2011; Scholz, 2011; Kuchta & Scholz, 2011; Cribb et al., 2016).

An analysis of the literature dedicated to parasites of freshwater fish indicates that various regions across the world are unevenly covered by the studies. All in all, the faunal complexes of fish parasites have now been studied quite fully in most countries. The population ecology, biology, and life cycles of the dominant parasitic worms – Cestoda, Trematoda, Acanthocephala, and Nematoda – are studied quite poorly. The situation about the development of methods and means for the prevention and control of parasitic diseases of valuable fish species is also disappointing.

As for Uzbekistan, except for bodies of water in the lower reaches of the Amu Darya (Osmanov, 1971), parasites of fish have received little attention in other regions of the country. To date, many natural and artificial bodies of water formed using the water resources of the Amu Darya, Syr Darya, and Zeravshan, have been poorly studied or not studied at all. All this urgently requires comprehensive parasitological research in Uzbekistan's water bodies in the context of the current environmental background. This research is also essential to improve methods to diagnose and prevent fish diseases caused by ecto- and endoparasites in fish farms.

Conclusion

Our research shows that the fauna of fish parasites in the water bodies of the Amu Darya, Syr Darya and Zeravshan (within Uzbekistan) is represented by 116 species of ecto- and endoparasites from 10 classes and 7 phyla. The phylum Plathelminthes is characterised by the highest species diversity – 85 species. Sporozoa and Acanthocephala are least representative in this respect – 4 and 2 species, respectively.

The classes Monogenoidea, Trematoda, Cestoda and Nematoda are represented by the largest number of species and individuals in the studied bodies of water in Uzbekistan, which is confirmed by earlier literary data specifying their large role in the pathology of freshwater fish. Most of the parasite species are ecologically related to certain groups of freshwater fish. The biocoenotic relationships of the components of the parasitic system and geography have probably determined the appearance of the modern fauna of fish parasites in Uzbekistan. At the same time, infected fish transmits diseases to other groups of vertebrates – birds and mammals, including humans. All this necessitates systematic monitoring of the helminthological situation in water bodies and the implementation of a complex of measures to prevent helminthiasis of the studied freshwater fish.

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