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ENDOHELMINTHS OF CYPRINIFORM FISH FROM WATERBODIES OF THE SYRDARYA RIVER: FAUNA AND DISTRIBUTION

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Endohelminths of Cypriniform Fish from Waterbodies of the Syrdarya River: Fauna and Distribution. Safarova, F. E., Akramova, F. D., Azimov, D. A., Golovanov ,V. I., Shakarboev, E. B. — Fauna and distribution patterns of the endohelminths of Cypriniformes from water bodies of the mid-course of the Syrdarya River were investigated. Forty-nine endohelminth species were recorded from Cypriniformes in this region, including 18 species of trematodes, 13 species of cestodes, 14 species of nematodes and 4 species of acanthocephalans. Twenty-nine species are first reported from this region. Original data on the composition and structure of endohelminth communities are given.

Key words: Endohelminths, cestodes, trematodes, acanthocephalans, nematodes, fauna, Cypriniformes, Syrdarya, Uzbekistan.

Гельминты карпообразных рыб водоёмов реки Сырдарьи: фауна и распространение. Сафарова Ф. Э., Акрамова Ф. Д., Азимов Д. А., Голованов В. И., Шакарбоев Э. Б. — Изучены некоторые особенности фауны эндогельминтов карпообразных рыб, их распространения в водоёмах среднего течения Сырдарьи. Всего зарегистрировано 49 видов эндогельминтов: трематоды — 18 видов, цестоды — 13, нематоды — 14 и акантоцефалы — 4. 29 видов указываются для рассматриваемого региона впервые. Приведены оригинальные данные по составу и структуре сообществ эндогельминтов.

Ключевые слова: Эндогельминты, цестоды, трематоды, акантоцефалы, нематоды, фауна, карпообразные рыбы, Сырдарья, Узбекистан.

Introduction

The basin of the Syrdarya River is a natural geographic complex lying in the transboundary territory, where waterbodies with different ecological conditions are situated. Currently, a large number of reservoirs covering hundreds of thousands hectares have been created for an integrated use. The reservoirs are a new type of water bodies distinguished by their specific ecological conditions (Isaev, Karpov, 1989). Studies of biocenoses and fish populations in the water bodies of the River Syrdarya will serve as the basis for sustainable activities in the sphere of nature use at a national level.

Due to intensive human commercial activities connected with the use of water resources, noticeable qualitative and quantitative changes take place in the biocenoses and fish populations.

Parasitic diseases inevitably occur in fish, causing declines in the numbers of valuable species and deterioration of epizootic situation in water bodies. Parasitic diseases of fish not only cause a significant economic loss connected with fish yields, they are also dangerous for human health (Osmanov, 1971).

The analysis of literature (Kolesnikova, 1965; Allamuratov, 1966; Agapova, 1966; Osmanov, 1971; Karaev, 1975; Karimov, 2007) has shown that the fish inhabiting the water bodies in the Syrdarya River plain are parasitized by a diverse fauna of parasites, which were mainly noted in the fish of the upper and lower streams of this river. Available data (Kolesnikova, 1965; Agapova, 1966; Osmanov, 1971; Karimov, 2007) on the fauna of fish endohelminths in the mid-stream of the Syrdarya River are fragmentary and insufficient. As the endohelminths are important in the pathology of fish in natural and artificial water bodies, the study of the species composition of endohelminths in Cypriniformes inhabiting the mid-course of the Syrdarya River is quite important.

The aim of this work is the study of fauna and distribution of parasitic worms of cypriniform fish inhabiting the water bodies of the mid-course of the Syrdarya River.

Material and methods

The study was conducted in 2009–2013 in the water bodies of north-eastern Uzbekistan (the Syrdarya River, the Chirchik River, Aidar-Arnasay lake system, Tuyabuguz reservoir and fish farms Balykchi, Damachi and Tashkent fish farm), in Syrdarya, Tashkent and Djizak provinces (fig. 1).

Collection and study of fish endohelminths were conducted using conventional methods (Skrjabin, 1928; Dogel, 1933; Bykhovskaya-Pavlovskaya, 1985). We studied 2424 individuals of 15 species of Cypriniformes (Cyprinidae, 12; Cobitidae, 3). Besides, we carried out incomplete dissections of 1338 fish individuals and prepared 1250 temporary and permanent whole mounts. The cameral treatment and identification of trematode species was carried out at the Laboratory of General Parasitology of the Institute of Gene Pool of Plants and Animals of Uzbek Academy of Sciences. Endohelminth species were identified using the Reference Guide of Freshwater Fishes (Bykhovskaya-Pavlovskaya, 1985; Agapova, 1966; Shigin, 1986; Khokhlova, 1986) and the Catalogues (Pugachev, 2002, 2003, 2004).

The mounts were examined under the microscope MBI-3 and MBI-4, the drawings were produced using the drawing tubes RA-4 and RA-5.

Results and discussion

We found that the endohelminths of cypriniform fish[1] in the basin of the mid-stream of the Syrdarya River belong to forty-nine species: 18 species of Trematoda, 13 of Cestoda, 14 of Nematoda, and 4 of Acantocephala. The most numerous were trematodes: 17 species from 4 orders (table 1), represented predominantly by Prosostomidea Skrjabin et Guschanskaja, 1962.

Thirteen species from four orders of Cestoda were found in the Cypriniformes. The most widespread are the families Caryophyllaeidae Leuckart, 1878 and Dilepididae Fuhrmann, 1907 (four species of each).

The Acanthocephala included four species: *Neoechinorhynchus rutili* Müller, 1780, *Pomphorhynchus laevis* Müller, 1776, *Acanthocephalus lucii* Müller, 1776 and *A. anguillae* Müller, 1780. The recorded acanthocephalan species, except for *A. lucii*, had been previously found in the cypriniform fish in the mouth of the Syrdarya River (Kolesnikova, 1965; Agapova, 1966; Osmanov, 1971).

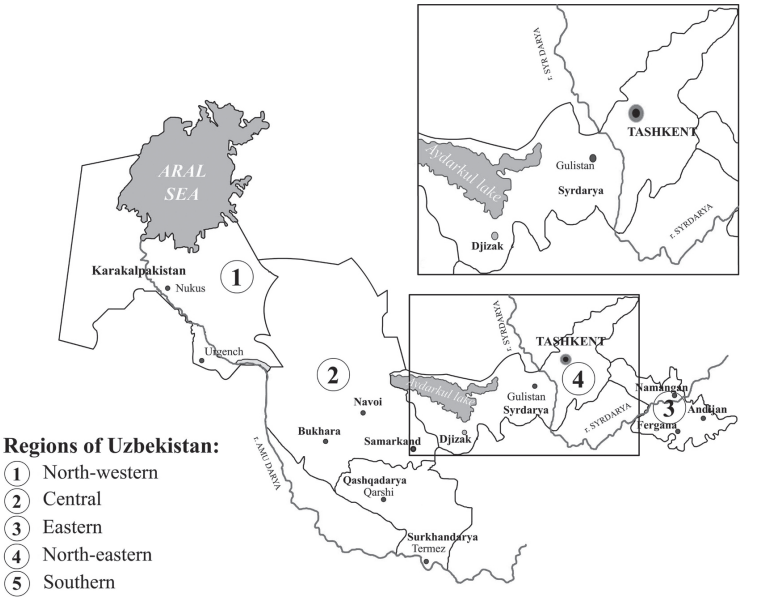

Fig. 1. Map of the studied region.

Рис. 1. Карта исследованного региона.

[1] The species of Cypriniformes were identified by U.T. Mirzaev, PhD

The phylum Nematoda is notable for its significant species diversity in the water bodies of the mid-stream of the Syrdarya River; we recorded fourteen species belonging to four orders (table 1). Trichocephalida Skrjabin et Schulz, 1928 is represented by one species, *Capillaria tomentosa* Dujardin, 1843, which was found in most Cypriniformes in natural and artificial water bodies in north-eastern Uzbekistan. The highest species diversity was observed in the Spirurida Chitwood, 1933, for which we recorded eight species. Other orders were represented by one or two species, common parasites of Cypriniformes. Worthy of note are the findings of *Dioctophyme renale* Goeze, 1782 larvae III in Cypriniformes in the studied region. Previously this species was reported in many fish inhabiting water bodies along the Amydarya River and in the lower reaches of the Syrdarya River (Karmanova, 1961; Osmanov, 1971).

The conducted studies revealed the highest number of endohelminth species in the water bodies of the Syrdarya River (39), followed by the Chirchik River (15). The lowest number of endohelminths was recorded in the Aidar-Arnasay lake system (AALS), where only eight endohelminth species were found: 2 cestodes, 3 trematodes, and 3 nematodes. In our opinion, this is connected with peculiar ecological conditions in different water bodies (table 2). Ten endohelminth species were found in the fish farms. Of those, the most frequently recorded were *Sanguinicola inermis* Plehn, 1905, *Diplostomum spathaceum* (Rudolphi, 1819), *Tylodelphys clavata* (Nordmann, 1832), *Khawia sinensis* (Hsü, 1935), *Bothriocephalus opsariichthydis* (Yamaguti, 1934), *Ligula intestinalis* (Linnaeus, 1758) larvae, *Digramma interrupta* (Rudolphi, 1810) larvae and *Raphidascaris acus* (Bloch, 1779) larvae.The poor diversity of the parasite fauna in Cypriniformes in landlocked waterbodies and an almost complete absence of a number of specific parasites are undoubtedly associated with the acclimatization, where natural processes of the formation of respective groups of considered endohelminth hosts were disturbed.

During acclimatization, fish species enter water bodies with different hydro-chemical conditions and fish, plankton and benthos composition, which results in significant changes in their parasite fauna.

Total regularities of these changes established by a number of researchers (Petrushevsky, 1954; Agapova 1966; Osmanov, 1971), provided an opportunity to formulate the following principles: 1) a general impoverishment of the parasite fauna of fish takes place at the acclimatization of fish; 2) a complete or partial loss of parasites typical for fish in original water bodies; 3) acquiring new parasites common for these fish or widespread there, and conservation at acclimatization of parasites with direct development.

These principles hold true for the parasite fauna of fish in the studied region of Uzbekistan.

The data that we obtained on the quantitative composition of the Cypriniformes helminth fauna in the basin of the mid-course of the Syrdarya River enabled us to identify three types of communities:

1) endohelminths parasitizing Cypriniformes fish as definitive hosts;
2) endohelminths parasitizing Cypriniformes fish as intermediate hosts;
3) endohelminths parasitizing Cypriniformes fish as paratenic hosts;

The distribution of indicated endohelminth communities in the region depends on a number of well-known biotic and abiotic factors. The first type includes 25 endohelminth species: 7 cestodes, 7 trematodes, 11 nematodes and 4 acanthocephalans (table 3). Fish are infected here mainly through the digestive canals of hosts, as well as directly by a free-swimming nematode larvae (*Capillaria tomentosa* Dujardin, 1843)[1] and penetration of trematode cercariae (*Sanguinicola inermis* Plehn, 1905) through the cover of cypriniform fish. There is no uniform opinion (Ginetsinskaya, 1958; Mozgovoy, Kosinova, 1963; Engashev, 1965;

[1] The life cycle of *Capillaria tomentosa* is studied insufficiently. Possible participation of oligochaeta in the life cycle of this nematode in experiments (Lomakin, Trofimenko, 1982) and Moravec's (1983) findings require additional studies.

Table 1. Species diversity of endohelminths in Cypriniformes in the studied region

Таблица 1. Видовое разнообразие эндогельминтов карпообразных рыб в исследованном регионе

Order	Family	Endohelminth species	Hosts	Localization
			Trematoda	
Bucephalida	Bucephalidae	*Rhipidocotyle campanula*	*R. rutilus, S. erythrophthalmus, A. aspius, A. orientalis*	Gills, musculature, eyes
Sanguinicolida	Sanguinicolidae	*Sanguinicola inermis*	*Cyprinus carpio, Carassius auratus gibelio, Hypophthalmichthys molitrix*	Blood system
Clinostomida	Clinostomidae	*Clinostomum complanatum*	*Rutilus rutilus, Scardinius erythrophthalmus, C. auratus gibelio*	Muscles under the skin, body cavity
Fasciolida	Gorgoderidae	*Phyllodistomum elongatum*	*R. rutilus, S. erythrophthalmus, Aspius aspius, Abramis brama orientalis, C. carpio, C. auratus gibelio*	Ureter, kidney
	Orientocreadiidae	*Orientocreadium siluri*	*Schizothorax intermedius, C. carpio*	Intestines
	Allocreadiidae	*Allocreadium isoporum*	*C. carpio, S. intermedius*	Intestines
		A. transversale	*C. auratus gibelio, C.carpio, S. intermedius*	Intestines
	Monorchidae	*Asymphylodora kubanicum*	*R. rutilus, S. erythrophthalmus, A. aspius, A. orientalis, C. carpio*	Intestines
Strigeiida	Diplostomidae	*Diplostomum spathaceum*	*R. rutilus, S. erythrophthalmus, Ctenopharyngodon idella, A. aspius, S. intermedius, C. auratus gibelio, C. carpio, Hypophthalmichthys molitrix*	Lens, sometimes eyeball
		Tylodelphys clavata	*R. rutilus, A. aspius, S. erythrophthalmus, C. auratus gibelio, C. carpio*	Vitreous body, eyeball
		Bolbophorus confusus	*A.orientalis, C. auratus gibelio, R. rutilus*	Musculature, gills, walls of the intestine
		Hysteromorpha triloba	*R. rutilus, S. erythrophthalmus, C. auratus gibelio, C. carpio*	Musculature
		Conodiplostomum perlatum	*C. auratus gibelio*	Swim bladder, kidney, musculature
		Ornithodiplostomum scardinii	*R. rutilus, S. erythrophthalmus*	Gastric cavity
		Posthodiplostomum cuticola	*S. erythrophthalmus, R. rutilus, C. auratus gibelio, C. carpio, H. molitrix*	Skin, gills, musculature, swim bladder
		P. brevicaudatum	*R. rutilus, S. erythrophthalmus, C. auratus gibelio, C. carpio*	Eyes
	Strigeidae	*Apharyngostrigea cornu*	*C. idella, S. erythrophthalmus*	Walls of the intestine, mesentery, musculature
		A. sogdiana	*C. carpio, S. intermedius*	Body cavity
Cestoda				
Caryophyllidea	Caryophyllaeidae	*Caryophyllaeus laticeps*	*R. rutilus, A. orientalis, C. carpio*	Intestines
		C. fimbriceps	*C. carpio, C. auratus gibelio*	Intestines
		Biacetabulum appendiculatum	*A. aspius, C. auratus gibelio, C. carpio*	Intestines
		Khawia sinensis	*C. auratus gibelio, C. carpio, C. idella*	Intestines
Pseudophyllidea	Amphicotylidae	*Bathybothrium rectangulum*	*S. intermedius, Diptychus dybowskii*	Intestines
	Bothriocephalidae	*Bothriocephalus opsariichthydis*	*C. idella, C. auratus gibelio, C. carpio, R. rutilus, A. aspius, H. molitrix*	Intestines
	Ligulidae	*Ligula intestinalis*	*S. erythrophthalmus, R. rutilus, S. intermedius, Hemiculter leucisculus, A. orientalis*	Body cavity
		Digramma interrupta	*C. auratus gibelio, A. orientalis, C. carpio, H. leucisculus, A. aspius*	Body cavity

Proteocephalidea	Proteocephalidae	*Proteocephalus torulosus*	*R. rutilus*, *A. aspius*, *A. orientalis*, *S. erythrophthalmus*, *S. intermedius*	Intestines
Cyclophyllidea	Dilepididae	*Paradilepis scolecina*	*S. erythrophthalmus*, *A. aspius*, *R. rutilus*, *A. orientalis*, *C. auratus gibelio*, *C. carpio*	Body cavity, mesentery, walls of the intestine
		Gryporhynchus cheilancristrotus	*R. rutilus*, *A. aspius*, *C. carpio*, *S. erythrophthalmus*, *Tinca tinca*, *A. orientalis*	Walls of the intestine
		G. pusillus	*C. auratus gibelio*, *C. carpio*, *R. rutilus*, *A. aspius*, *A. orientalis*, *S. erythrophthalmus*, *C. idella*	Intestines
		Dilepis unilateralis	*R. rutilus*, *S. erythrophthalmus*, *A. aspius*, *C. auratus gibelio*, *C. carpio*, *H. molitrix*	Gallbladder
Nematoda				
Trichocephalida	Capillariidae	*Capillaria tomentosa*	*S. erythrophthalmus*, *R. rutilus*, *A. aspius*, *S. intermedius*	Intestines
Dioctophymida	Dioctophymidae	*Dioctophyme renale*	*R. rutilus*, *A. aspius*	Walls of the intestine, liver, gonads
Spirurida	Rhabdochonidae	*Rhabdochona denudata*	*C. auratus gibelio*, *R. rutilus*, *S. intermedius*	Intestines
		R. gnedini	*C. carpio*, *S. intermedius*	Intestines
	Desmidocercidae	*Desmidocercella numidica*	*S. erythrophthalmus*, *A. orientalis*	The vitreous of the eye
	Gnathostomidae	*Gnathostoma hispidum*	*C. carpio*, *R. rutilus*, *S. erythrophthalmus*, *A. aspius*	Body cavity, musculature, liver, walls of the intestine
	Camallanidae	*Camallanus truncatus*	*S. erythrophthalmus*, *A. aspius*, *C. carpio*	Stomach, intestines
	Philometridae	*Philometra ovata*	*R. rutilus*, *A. aspius*, *Hemiculter leucisculus*, *A. orientalis*	Body cavity
		Ph. abdominalis	*R. rutilus*, *S. intermedius*	Body cavity
		Ph. intestinalis	*S. erythrophthalmus*, *A. aspius*	Intestines
Ascaridida	Anisakidae	*Contracaecum spiculigerum*	*S. erythrophthalmus*, *A. aspius*, *C. auratus gibelio*, *C. carpio*	Body cavity
		C. microcephalum	*S. erythrophthalmus*, *R. rutilus*, *A. aspius*, *C. auratus gibelio*, *C. carpio*	Body cavity, liver, kidney
		Porrocaecum reticulatum	*A. aspius*, *C. carpio*	Body cavity, serous coverings of the internal organs
		Raphidascaris acus	*R. rutilus*, *S. erythrophthalmus*, *A. aspius*, *H. molitrix*, *C. auratus gibelio*, *C. carpio*	Body cavity, liver, walls and lumen of the intestines, gonads
Acanthocephala				
Neoechinorynchida	Neoechinorhynchidae	*Neoechinorhynchus rutili*	*S. intermedius*, *C. carpio*	Intestines
Echinorhynchida	Pomphorhynchidae	*Pomphorhynchus laevis*	*A. aspius*, *C. carpio*, *S. erythrophthalmus*, *A. orientalis*	Intestines
	Echinorhynchidae	*Acanthocephalus lucii*	*C. carpio*, *A. aspius*	Intestines
		A. anguillae	*A. aspius*	Intestines

Table 2. Distribution of endohelminths of Cypriniformes in water bodies of different types of the Syrdarya River (2009–2013)

Таблица 2. Распределение эндогельминтов карпообразных рыб в разнотипных водоёмах реки Сырдарьи (2009–2013 гг.)

Endohelminths	Total number of species	Water bodies			
		Mid-course of the Syrdarya	Chirchik River	Aidar-Arnasay lake system	Fish farms
Cestoda	13	13	5	2	4
Trematoda	18	9	7	3	4
Nematoda	14	13	2	3	2
Acanthocephala	4	4	1	–	–
Total	49	39	15	8	10

Table 3. Biological peculiarities of endohelminths of Cypriniformes in the studied region

Таблица 3. Биологические особенности эндогельминтов карпообразных в исследованном регионе

Taxa	Number of endohelminth species	Hosts				Source
		intermediate hosts		Paratenic	Definitive	
		first	second			
Cestoda	13					
Caryophyllaeidae	4	Oligochaetes			Cypriniformes	Osmanov, 1971
Amphicotylidae	1	Cyclops			Cypriniformes	Osmanov, 1971
Bothriocephalidae	1	Cyclops			Cypriniformes	the present study
Ligulidae	2	Cyclops	Cypriniformes		Birds	the present study
Proteocephalidae	1	Cyclops			Cypriniformes	Karimov, 2007
Dilepididae	4	Cyclops			Birds	Kolesnikova, 1965
Trematoda	18					
Bucephalidae	1	Mollusks	Cypriniformes		Cypriniformes and other fish	the present study
Sanguinicolidae	1	Mollusks			Cypriniformes and other fish	the present study
Allocreadiidae	2	Mollusks			Cypriniformes and other fish	Osmanov, 1971
Gorgoderidae	1	Mollusks			Cypriniformes and other fish	Shakarboev, 2009
Monorchidae	1	Mollusks			Cypriniformes and other fish	Shakarboev, 2009
Orientocreadiidae	1	Mollusks			Cypriniformes and other fish	Shakarboev, 2009
Clinostomidae	1	Mollusks	Fish		Birds	Shakarboev, 2009
Diplostomidae	8	Mollusks	Fish		Birds	Shakarboev, 2009 and the present study
Strigeidae	2	Mollusks	Fish		Birds	Shakarboev, 2009 and the present study
Nematoda	14					
Capillariidae	1				Cypriniformes and other fish	the present study
Dioctophymidae	1	Oligochaetes	Cypriniformes		Mammalians	the present study
Rhabdochonidae	2	Oligochaetes			Cypriniformes	the present study
Desmidocercidae	1			Cypriniformes	Birds	the present study
Camallanidae	1	Cyclops			Cypriniformes	the present study
Philometridae	3	Cyclops			Cypriniformes	the present study
Gnathostomatidae	1	Cyclops		Cypriniformes, amphibians	Mammalians	Osmanov, 1971
Anisakidae	4	Oligochaetes and Copepoda	Cypriniformes, dragonflies	Cypriniformes	Birds, predatory fish	the present study
Acanthocephala	4					
Neoechinorhynchidae	1	Ostracoda	Megaloptera, Hirudinea		Cypriniformes	Osmanov, 1971
Echinorhynchidae	2	Amphipoda			Cypriniformes and other fish	the present study
Pomphorhynchidae	1	Amphipoda			Cypriniformes and other fish	Osmanov, 1971

Moravec, 1970; Smith, 1984, cited by Pugachev, 2004) regarding the participation of different categories of hosts (both intermediate and paratenic) in the recorded nematodes of the family Anisakidae Skrjabin et Karokhin, 1945: *Raphidascaris acus* (Bloch, 1779), *Porrocaecum reticulatum* (Linstow, 1890), *Contracaecum spiculigerum* (Rudolphi, 1809) and *C. microcephalum* (Rudolphi, 1819). Views of the authors are contradictory, sometimes excluding one another.

Nevertheless, we find acceptable the viewpoints of Ginetsinskaya (1958) and Engashev (1965), who considered Cypriniformes as second intermediate hosts of *Raphidascaris acus*. We also find this view reasonable for the species of *Porrocaecum* and *Contracaecum*.

The second type is characterized by the fact that some species of Cypriniformes are the second intermediate hosts for 19 endohelminth species: 2 cestodes, 12 trematodes and 5 nematodes. Definitive hosts (predatory fish, fish-eating birds and mammalians) are infected consuming cypriniform fish infected by endohelminth larvae.

Participation of Cypriniformes as paratenic hosts in the transmission of the considered endohelminths is in many respects questionable. Nevertheless, Cypriniformes, according to literature, were noted as paratenetic hosts (Pugachev, 2004).

According to our findings, they are noted for two nematode species of the genera *Desmidocercella* and *Gnathostoma*, which should be assigned to the third type.

Conclusion

In the last few years, a tendency of intensive use of waterbodies situated in the mid-stream of the Syrdarya River for rearing fish, mainly Cypriniformes, has surfaced. In this connection, we set ourselves the task to specify species diversity of parasitic worms and their distribution. Previously, some efforts were made to study endohelminths of fish in waterbodies of the Syrdarya River. In some Cypriniformes twenty-five endohelminth species were found (Osmanov, 1961; Kolesnikova, 1965; Agapova, 1966; Karimov, 2007).

However, in the studied waterbodies of the mid-stream of the Syrdarya River we found forty-nine species of parasites including cestodes, trematodes, nematodes and acanthocephalans in Cypriniformes. Trematodes (18 species) were dominant. Species diversity of cestodes and nematodes reached 13 and 14 species, respectively. The numbers of fish endohelminths were different in various parts of the Syrdarya River: we found 10 species in the upper course, 49 species in the mid-course, and 25 species in the lower reaches. These findings suggest that the most optimal conditions for the functioning of respective endohelminth communities exist in the waterbodies of the mid-course of the Syrdarya River. A high number of groups of invertebrate animals inhabit aquatic ecosystems; some are the intermediate hosts of parasites of Cypriniformes, while the aggregation of waterfowl and mammalians in these areas enable circulations of respective endohelminths.

Thus, dixenic and trixenic life cycles, which have been established in the relations between the components of the parasitic system, are characteristic for most endohelminths of Cypriniformes of the waterbodies situated in the mid-stream of the Syrdarya River. The species diversity of Cypriniformes in the studied region is relatively rich and various. This is supported by the monitoring of parasitological situation relating to fish helminthoses in specific waterbodies of the region, which must be taken into account while developing preventive measures.

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