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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<sup>1</sup> 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 Guschan-skaja, 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 Acantocephala 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.

<sup>1</sup> 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 *Diectophyme 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), *Tyloodelphys 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)<sup>1</sup> 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;

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<sup>1</sup> 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		
Bucephalida Sanguinicola Clinostomida  Fasciolida   Strigeiida	Bucephalidae Sanguinicolidae Clinostomidae	<i>Rhipidocotyle campanula</i> <i>Sanguinicola inermis</i> <i>Clinostomum complanatum</i>	<b>Trematoda</b>			
			<i>R. rutilus</i> , <i>S. erythrocephalus</i> , <i>A. aspius</i> , <i>A. orientalis</i> <i>Cyprinus carpio</i> , <i>Carassius auratus gibelio</i> , <i>Hypophthalmichthys molitrix</i> <i>Rutilus rutilus</i> , <i>Scardinius erythrophthalmus</i> , <i>C. auratus gibelio</i>	Gills, musculature, eyes Blood system Muscles under the skin, body cavity		
			<i>R. rutilus</i> , <i>S. erythrocephalus</i> , <i>Aspius aspius</i> , <i>Abramis brama orientalis</i> , <i>C. carpio</i> , <i>C. auratus gibelio</i>	Ureter, kidney		
	Gorgoderidae Orientocreadiidae Allocreadiidae Monorchidae	Orientocreadiidae Allocreadiidae	<i>Orientocreadium siluri</i> <i>Allocreadium isoporum</i> <i>A. transversale</i> <i>Asymphylogora kubanicum</i>	<i>Schizothorax intermedium</i> , <i>C. carpio</i> <i>C. carpio</i> , <i>S. intermedium</i> <i>C. auratus gibelio</i> , <i>C. carpio</i> , <i>S. intermedium</i> <i>R. rutilus</i> , <i>S. erythrocephalus</i> , <i>A. aspius</i> , <i>A. orientalis</i> , <i>C. carpio</i>	Intestines Intestines Intestines Intestines	
				<i>Diplostomum spathaceum</i>	<i>R. rutilus</i> , <i>S. erythrocephalus</i> , <i>Ctenopharyngodon idella</i> , <i>A. aspius</i> , <i>S. intermedium</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i> , <i>Hypophthalmichthys molitrix</i>	Lens, sometimes eyeball
				<i>Tylodelphys clavata</i> <i>Bolbophorus confusus</i> <i>Hysteronompha triloba</i> <i>Conodiplostomum perlatum</i>	<i>R. rutilus</i> , <i>A. aspius</i> , <i>S. erythrocephalus</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i> <i>A. orientalis</i> , <i>C. auratus gibelio</i> , <i>R. rutilus</i> <i>R. rutilus</i> , <i>S. erythrocephalus</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i> <i>C. auratus gibelio</i>	Vitreous body, eyeball Musculature, gills, walls of the intestine Musculature Swim bladder, kidney, musculature
	Cestoda Caryophyllidea   Pseudophyllidea   Ligulidae	Strigeidae	<i>Ornithodiplostomum scardinii</i> <i>Posthodiplostomum cuticola</i> <i>P. brevicaudatum</i> <i>Apharyngostrigea cornu</i>  <i>A. sogdiana</i>	<i>R. rutilus</i> , <i>S. erythrocephalus</i>	Gastric cavity	
				<i>S. erythrocephalus</i> , <i>R. rutilus</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i> , <i>H. molitrix</i>	Skin, gills, musculature, swim bladder	
				<i>R. rutilus</i> , <i>S. erythrocephalus</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i> <i>C. idella</i> , <i>S. erythrocephalus</i>	Eyes Walls of the intestine, mesentery, musculature Body cavity	
		Caryophyllaeidae	<i>Caryophyllaeus laticeps</i> <i>C. finibriceps</i> <i>Biacetabulum appendiculatum</i> <i>Khaawia sinensis</i> <i>Bathyocephalum rectangulum</i>	<i>R. rutilus</i> , <i>A. orientalis</i> , <i>C. carpio</i> <i>C. carpio</i> , <i>C. auratus gibelio</i> <i>A. aspius</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i>	Intestines Intestines Intestines	
				<i>C. auratus gibelio</i> , <i>C. carpio</i> , <i>C. idella</i> <i>S. intermedium</i> , <i>Diptychus dybowskii</i>	Intestines Intestines	
				<i>C. idella</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i> , <i>R. rutilus</i> , <i>A. aspius</i> , <i>H. molitrix</i>	Intestines	
		Amphicoelidae Bothriocephalidae Ligulidae	<i>Bothriocephalus opsarichthydis</i> <i>Ligula intestinalis</i>  <i>Digramma interrupta</i>	<i>S. erythrocephalus</i> , <i>R. rutilus</i> , <i>S. intermedium</i> , <i>Hemiculter leucisculus</i> , <i>A. orientalis</i> <i>C. auratus gibelio</i> , <i>A. orientalis</i> , <i>C. carpio</i> , <i>H. leucisculus</i> , <i>A. aspius</i>	Body cavity Body cavity	

Proteocephalidea	Proteocephalidae	<i>Proteocephalus torulosus</i>	<i>R. rutilus</i> , <i>A. aspius</i> , <i>A. orientalis</i> , <i>S. erythrophthalmus</i> , <i>S. intermedius</i>	Intestines
Cyclophyllidea	Dileptidae	<i>Paradileptis scolecina</i>	<i>S. erythrophthalmus</i> , <i>A. aspius</i> , <i>R. rutilus</i> , <i>A. orientalis</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i>	Body cavity, mesentery, walls of the intestine
		<i>Gryporhynchus cheilancristrotus</i>	<i>R. rutilus</i> , <i>A. aspius</i> , <i>C. carpio</i> , <i>S. erythrophthalmus</i> , <i>Tinca tinca</i> , <i>A. orientalis</i>	Walls of the intestine
		<i>G. pusillus</i>	<i>C. auratus gibelio</i> , <i>C. carpio</i> , <i>R. rutilus</i> , <i>A. aspius</i> , <i>A. orientalis</i> , <i>S. erythrophthalmus</i> , <i>C. idella</i>	Intestines
		<i>Dilepis unilateralis</i>	<i>R. rutilus</i> , <i>S. erythrophthalmus</i> , <i>A. aspius</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i> , <i>H. molitrix</i>	Gallbladder
<b>Nematoda</b>				
Trichocephalida	Capillariidae	<i>Capillaria tomentosa</i>	<i>S. erythrophthalmus</i> , <i>R. rutilus</i> , <i>A. aspius</i> , <i>S. intermedius</i>	Intestines
Diactophymida	Diactophymidae	<i>Diactophyme renale</i>	<i>R. rutilus</i> , <i>A. aspius</i>	Walls of the intestine, liver, gonads
Spirurida	Rhabdochomidae	<i>Rhabdochoma denudata</i>	<i>C. auratus gibelio</i> , <i>R. rutilus</i> , <i>S. intermedius</i>	Intestines
		<i>R. gnedini</i>	<i>C. carpio</i> , <i>S. intermedius</i>	Intestines
	Desmidocercidae	<i>Desmidocercella numidica</i>	<i>S. erythrophthalmus</i> , <i>A. orientalis</i>	The vitreous of the eye
	Gnathostomidae	<i>Gnathostoma hispidum</i>	<i>C. carpio</i> , <i>R. rutilus</i> , <i>S. erythrophthalmus</i> , <i>A. aspius</i>	Body cavity, musculature, liver, walls of the intestine
	Camallanidae	<i>Camallanus truncatus</i>	<i>S. erythrophthalmus</i> , <i>A. aspius</i> , <i>C. carpio</i>	Stomach, intestines
	Philometridae	<i>Philometra ovata</i>	<i>R. rutilus</i> , <i>A. aspius</i> , <i>Hemiculter leucisculus</i> , <i>A. orientalis</i>	Body cavity
		<i>Ph. abdominalis</i>	<i>R. rutilus</i> , <i>S. intermedius</i>	Body cavity
		<i>Ph. intestinalis</i>	<i>S. erythrophthalmus</i> , <i>A. aspius</i>	Intestines
Ascaridida	Anisakidae	<i>Contracaecum spiculigerum</i>	<i>S. erythrophthalmus</i> , <i>A. aspius</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i>	Body cavity
		<i>C. microcephalum</i>	<i>S. erythrophthalmus</i> , <i>R. rutilus</i> , <i>A. aspius</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i>	Body cavity, liver, kidney
		<i>Porrocaecum reticulatum</i>	<i>A. aspius</i> , <i>C. carpio</i>	Body cavity, serous coverings of the internal organs
		<i>Raphidascaris acis</i>	<i>R. rutilus</i> , <i>S. erythrophthalmus</i> , <i>A. aspius</i> , <i>H. molitrix</i> , <i>C. auratus gibelio</i> , <i>C. carpio</i>	Body cavity, liver, walls and lumen of the intestines, gonads
<b>Acanthocephala</b>				
Neoechinorhynchida	Neoechinorhynchidae	<i>Neoechinorhynchus rutili</i>	<i>S. intermedius</i> , <i>C. carpio</i>	Intestines
Echinorhynchida	Pomphorhynchidae	<i>Pomphorhynchus laevis</i>	<i>A. aspius</i> , <i>C. carpio</i> , <i>S. erythrophthalmus</i> , <i>A. orientalis</i>	Intestines
	Echinorhynchidae	<i>Acanthocephalus lucii</i>	<i>C. carpio</i> , <i>A. aspius</i>	Intestines
		<i>A. anguillae</i>	<i>A. aspius</i>	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 Сырдарья (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			
<b>Cestoda</b>	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
<b>Trematoda</b>	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
<b>Nematoda</b>	14					
Capillariidae	1				Cypriniformes and other fish	the present study
Diectophymidae	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
<b>Acanthocephala</b>	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), *Contraecaecum 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 *Contraecaecum*.

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 mammals) 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 paratenic 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 mammals 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.

## References

- Agapova, A. I. The parasites of fish in the waterbodies of Kazakhstan. — Alma-Ata : Nauka, 1966. — 342 p. — Russian : *Агапова А.И. Паразиты рыб водоемов Казахстана.*
- Allamuratov, B. A. Parasites of fish in the basin of the Surkhandarya River : Abstract of Ph. D. thesis. — Kiev, 1966. — 20 p. — Russian : *Алламуратов Б. А. Паразиты рыб бассейна реки Сурхандарья.*
- Vyhovskaya-Pavlovskaya, I. E. Parasites of fishes. The manual. — Leningrad : Nauka, 1985. — 121 p. — Russian : *Быховская-Павловская И. Е. Паразиты рыб. Руководство по изучению.*

- Ginetsinskaya, T. A.* Life cycles and the biology of the larval stages of parasitic worms of fish // Main problems of the fish parasitology. — Leningrad : Leningrad State University, 1958. — P. 144–184. — Russian : *Гинетцинская Т. А.* Жизненные циклы и биология личиночных стадий паразитических червей рыб.
- Dogel, V. A.* Problems of the study of fish parasites (techniques and problems of ichthyo-parasitological studies) // Trudy Leningradskogo obshchestva estestvoispytatelei . — 1933. — **62**, is. 3. — P. 247–268. — Russian : *Догель В. А.* Проблемы исследования паразитов рыб (Методика и проблематика иктиопаразитологических исследований).
- Engashev, V. G.* Biology of *Raphidascaris acus* (Bloch, 1779), epizootology and prevention of fish *Raphidascaris* infection : Abstract of Ph. D. thesis. — Moscow, 1965. — 19 p. — Russian : *Енгашев В. Г.* Биология *Raphidascaris acus* (Bloch, 1779), эпизоотология и профилактика рафидаскаридоза рыб.
- Isaev, A. I., Karpov, E. I.* Fish farming of reservoirs : Reference guide. — Moscow : Agropromizdat, 1989. — 256 p. — Russian : *Исаев А. И., Карпов Е. И.* Рыбное хозяйство водохранилищ.
- Karaev, R. M.* The fauna of fish parasites in the basin of the River Kashkadarya : Abstract of Ph. D. thesis. — Tashkent, 1975. — 22 p. — Russian : *Караев Р. М.* Фауна паразитов рыб бассейна реки Кашкадарья.
- Karimov, S. B.* Parasites of fish in the Ferghana Valley : Abstract of Doct. thesis. — Tashkent, 2007. — 187 p. — Russian : *Каримов С. Б.* Паразиты рыб Ферганской долины.
- Karmanova, E. M.* The first report of finding the larvae of the *Diocotophyme renale* (Goeza, 1782) in fish in the USSR // Trudy gelmintologicheskoi laboratorii. — 1961. — **2**. — P. 118–121. — Russian : *Карманова Е. М.* Первый случай обнаружения личинок нематоды *Diocotophyme renale* (Goeza, 1782) у рыб СССР.
- Khalil, L. F., Jones, A., Bray, R. A.* Keys to the cestode parasites of vertebrates. — Cambridge, 1994. — 856 p.
- Khokhlova, I. G.* Acanthocephalans of the terrestrial vertebrate animals in the fauna of the USSR. — Moscow, 1986. — 276 p. — Russian : *Хохлова И. Г.* Акантоцефалы наземных позвоночных фауны СССР.
- Kolesnikova, M. N.* Parasite fauna of fish in the basin of the lower reach of the Syrdarya River : Abstract of Ph. D. thesis. — Kiev, 1965. — 24 p. — Russian : *Колесникова М. Н.* Паразитофауна рыб бассейна низовьев реки Сырдарья.
- Moravec, F.* On the life history of the nematode *Raphidascaris acus* (Bloch, 1779) in the natural environment of the River Bystrice // J. Fish Biol. — 1970. — **2**. — P. 313–322.
- Mozgovoy, A. A., Kosinova, V. G.* The study of the cycle of development in *Raphidascaris acus* (Bloch, 1799) // Proceedings of the scientific conference of All-Union Society of Helminthologists : Abstracts of reports. — Moscow, 1963. — P. 124–127. — Russian : *Мозговой А. А., Косинова В. Г.* Изучение цикла развития *Raphidascaris acus* (Bloch, 1799).
- Osmanov, S. O.* On the forthcoming scientific-industrial conference on the Aral // Bulletin of the Karakalpak Branch of the Academy of Sciences of UzSSR. . — 1961. — N 4. — P. 40–43. — Russian : *Османов С. О.* К предстоящей научно-производственной конференции по Аралу.
- Osmanov, S. O.* Fish parasites in Uzbekistan. — Tashkent : Fan, 1971. — 532 p. — Russian : *Османов С. О.* Паразиты рыб Узбекистана.
- Petrushkevsky, G. K.* A change in the parasite fauna of fish due to their acclimatization // Trudy problemnyh i tematicheskikh soveshchaniy ZIN AN SSSR. — 1954. — **4**. — P. 29–38. — Russian : *Петрушевский Г. К.* Изменение паразитофауны рыб в связи с их акклиматизацией.
- Pugachev, O. N.* Component parasitic communities and fish spawning // Parasitology. — 2002. — **36**, N 1. — P. 3–10. — Russian : *Пугачев О. Н.* Компонентные паразитарные сообщества и нерест рыб.
- Pugachev, O. N.* A catalogue of parasites of freshwater fishes in northern Asia (trematodes) // Proceedings of the Zoological Institute of the Russian Academy of Sciences. — St. Petersburg, 2003. — Vol. 298. — P. 218. — Russian : *Пугачев О. Н.* Каталог паразитов пресноводных рыб Северной Азии (Трематоды).
- Pugachev, O. N.* A catalogue of parasites of freshwater fishes in northern Asia (nematodes, acanthocephalans, Hirudinea, mollusks, crustaceans, ticks) // Proceedings of the Zoological Institute of the Russian Academy of Sciences. — St. Petersburg, 2004. — Vol. 304. — P. 244. — Russian : *Пугачев О. Н.* Каталог паразитов пресноводных рыб Северной Азии (Нематоды, скребни, пиявки, моллюски, ракообразные, клещи).
- Shakarboev, E. B.* The trematodes of vertebrates in Uzbekistan (species composition, ways of circulation and ecological-biological peculiarities) : Abstract of Doct. thesis. — Tashkent, 2009. — 243 p. — Russian : *Шакарбоев Э. Б.* Трематоды позвоночных Узбекистана (видовой состав, пути циркуляции и эколого-биологические особенности).
- Shigin, A. A.* Trematodes in the fauna of the USSR: the genus *Diplostomum*. Metacercariae. — Moscow : Nauka, 1986. — 253 p. — Russian : *Шигин А. А.* Трематоды фауны СССР: Род *Diplostomum*. Метациркаррии.
- Skrjabin, K. I.* The methods of complete helminthological dissections of vertebrate animals, including humans. — Moscow : Izdatelstvo Moscow University, 1928. — 45 p. — Russian : *Скрябин К. И.* Методы полных гельминтологических вскрытий позвоночных, включая и человека.
- Smith, J. D.* Development of *Raphidascaris acus* (Nematoda, Anisakidae) in paratenic, intermediate, and definitive hosts // Can. J. Zool. — 1984. — **62**. — P. 1378–1386.

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