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Ecological analysis of the fish cestode fauna of the mouth of Kura River Sh.R. Ibrahimov, S.N. Mamedova

The research was conducted in 2014–2019 in the mouth of Kura River. A total of 334 fish specimens of 24 species were examined by the method of full parasitological dissection. As a result, 17 tapeworm species in two orders and eight families were found: *Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*, *Eubothrium acipenserinum*, *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Proteocephalus filicollis*, *P. gobiorum*, *P. ocellata*, *P. osculatus*, *Siluritaenia siluri*, *Gryporhynchus pusillus*, and *Paradilepis scolecina*. Of these, seven species are specific cyprinid parasites, two species are specific sturgeon parasites, two species are specific to sticklebacks, two species to catfish, and one species to gobies; the other three species parasitize in fishes of various families. The main organ of cestode localisation in the studied fishes is the intestinal lumen, where 11 worm species were found. In other fish organs (body cavity, mucous membrane of the anterior intestine, liver, mesentery, and intestinal walls), the number of tapeworm species ranged from one to four. One cestode species invaded from one to seven fish species. In the bream, we found six tapeworm species, while in the other fish species, from one to five. Among the cestodes found, 14 species infect zooplankton-eating fish and only three species (*Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*) infect fish that feeds on benthic invertebrates. The largest trophic group was the benthophages; they hosted 12 cestode species. In the planktophages and predators, we found eight and seven tapeworm species, respectively. Predatory fishes like pike, asp, round and bighead gobies accumulate parasites from the bodies of their preys, consequently, their cestode fauna is the richest. Most recorded fishes are euryhaline. Nevertheless, due to the absence of typical marine forms among the found cestodes, we registered more tapeworm species in the fish occurring the highly desalinated area of the Kura mouth than in more mineralized water. Six recorded species (*Caryophyllaeus fimbriceps*, *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Digramma interrupta*, and *Paradilepis scolecina*) are causative agents of fish diseases. *Ligula colymbi* and *L. intestinalis*, which have large plerocercoids, caused pathogenic changes in fish organisms. The other pathogenic species did not induce noticeable disorders. They are much smaller, and, thereto, had comparatively low invasion rate in the examined fish.

Key words: parasites, cestodes, fish, Kura River, Caspian Sea.

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Introduction

As the largest river in the Caucasus, the Kura is 1515 km long and has a catchment area of 188,000 km². Originating in Turkey, it passes through Georgia and Azerbaijan, and flows into the southwest part of the Caspian Sea. The river delta is formed by several small and two main branches, which account for 85 % of the total flow. The delta area is 15 000 ha, its width is about 15 km, and its length is 20 km in the southeast direction. The water salinity in the river mouth fluctuates within 2–7 ‰. Its soil consists of sand, silty sand and silt; the microphytes are well developed there. Invertebrate fauna numbers 34 species of zooplankton and 83 species of zoobenthos. There are some semi-migratory fishes, such as roach, kutum, zante, asp, shemaya, silver bream, bream, carp, catfish, and zander, which spawn in the delta. Sturgeons, Caspian common sprat, Caspian shad, black-backed shad, pike, South Caucasian bleak, stickleback, atherina, golden mullet, perch and gobies also occur there. The delta is a habitat of a large number of waterfowl, including fish-eating birds, as well as amphibians and reptiles: green toad, tree frog and marsh frog, Caspian tortoise, European pond terrapin, and grass snake (Potential Ramsar Sites of Azerbaijan, 2000; Ismayilov, 2005).

Despite the fact that investigation of fish cestodes in the area in question is of great practical and theoretical importance, these parasites remained unstudied prior to our works. In contrast, other areas of the Caspian Sea (Ibragimov, Mamedova, 2005, 2007; Ibragimov, 2012; Mamedova, 2016; Mamedova, Veliyeva, 2017, etc.), as well as various water bodies of Azerbaijan (Mikailov, 1975; Mikailov, Ibragimov,

1980) were investigated well. Therefore, the purpose of our study was to make a list of fish cestodes occurring in the mouth of Kura River and to analyse their ecological traits.

Material and methods

In 2014–2019, we examined 334 fishes of 24 species caught in the mouth of Kura River: Persian sturgeon – *Acipenser gueldenstadti*, Caspian sprat – *Clupeonella delicatula caspia*, Caspian shad – *Alosa caspia caspia*, black-backed shad – *A. kessleri kessleri*, pike – *Esox lucius*, Caspian roach – *Rutilus rutilus caspius*, kutum – *R. frisii kutum*, Caspian asp – *Aspius aspius taeniatus*, shemaya – *Chalcalburnus chalcoides*, Transcaucasian bleak – *Alburnus hohenerkeri*, Transcaucasian silver bream – *Blicca bjoerkna transcaucasica*, bream – *Abramis brama orientalis*, Caspian zante – *Vimba vimba persa*, golden carp – *Carassius gibelio*, carp – *Cyprinus carpio*, catfish – *Silurus glanis*, small southern stickleback – *Pungitius platygaster*, pipe fish – *Syngnathus nigrolineatus caspius*, atherina – *Atherina boyeri caspia*, golden mullet – *Chelon auratus*, zander – *Sander lucioperca*, perch – *Perca fluviatilis*, round goby – *Neogobius melanostomus*, bighead goby – *Ponticola gorlap*. Fish species were identified using Abdurakhmanov, 1962, Bogutskaya et al., 2013, and Reshetnikov, 2003, the scientific nomenclature follows Freyhof et al., 2020. The method of full parasitological dissection (Bykhovskaya-Pavlovskaya, 1985; Pronina, Pronin, 2007) was applied and the corresponding keys (Gaevskaya et al., 1975; Dubinina, 1987) were used to identify tapeworm species occurred in the fish. The obtained material in the form of permanent slides is deposited at the Department of Medical Biology and Genetics of the Azerbaijan Medical University. A schematic map of the study area and collecting localities is given in Fig. 1.



Fig. 1. A schematic map of the study area and collecting localities

Results

In the course of fish study in the mouth of Kura River, we found 17 helminths species of the class Cestoda. A taxonomic overview of these species is provided with the host names, prevalence (%) and intensity (specimens) of invasion, and parasite localisation in the fish body.

Class TAPEWORMS – CESTODA Rudolphi, 1808
Order CARYOPHYLLIDEA Van Beneden in Carus, 1863
Family Caryophyllaeidae Leuckart, 1878

Caryophyllaeus fimbriceps Annenkova-Chlopina, 1919

Hosts: roach (11.8 %), bream (21.4 %), golden carp (15.4 %), carp (16.7 %); invasion intensity in the study area: 1–6 specimens.

Localization: intestine.

The adult form parasitizes in the intestine of cyprinids, intermediate hosts are oligochaetes of the family Tubificidae (Dubinina, 1987).

C. laticeps (Pallas, 1781)

Hosts: roach (17.7 %), asp (15.4 %), silver bream (30.0 %), bream (14.3 %), carp (16.7 %); invasion intensity in the study area: 1–14 specimens.

Localization: intestine.

The adult form parasitizes in the intestine of cyprinids, the larvae are tubificid parasites (Dubinina, 1987).

Caryophyllaeides fennica (Schneider, 1902)

Hosts: roach (5.9 %), silver bream (10.0 %), bream (21.4 %), golden carp (23.1 %); invasion intensity in the study area: 1–7 specimens.

Localization: intestine.

Parasitizes in the intestine of cyprinids. Presumed intermediate hosts are oligochaetes (Dubinina, 1987).

Order PSEUDOPHYLLIDEA Carus, 1863

Family Amphicotyliidae Ariola, 1899

Eubothrium acipenserinum Cholodkovsky, 1918

Host: sturgeon (in one of the two examined individuals); invasion intensity in the study area: 7 specimens.

Localization: intestine.

Parasitizes in the intestine of sturgeon. Its life cycle is unstudied; the assumed intermediate hosts are benthic invertebrates (Dubinina, 1987).

Family BOTHRIOCEPHALIDAE Blanchard, 1934

Bothriocephalus acheilognathi Yamaguti, 1934

Hosts: roach (29.4 %), asp (22.2 %), shemaya (16.7 %), carp (20.0 %), round goby (17.7 %), bighead goby (25.0 %); invasion intensity in the study area: 2–12 specimens.

Localization: intestine.

Parasitizes in the intestine of cyprinids, sometimes occurs in some predatory fish; intermediate hosts are cyclops (Musselius, 1974).

Family LIGULIDAE Claus, 1885

Ligula colymbi Zeder, 1803

Hosts: shemaya (5.6 %), bleak (9.5 %); invasion intensity in the study area: 1–3 specimens.

Localization: body cavity.

Plerocercoids live in the body cavity of cyprinids and cobitids (mainly spined loaches), the first intermediate host is copepods, the definitive ones are grebes, less common are gulls and other fish-eating birds (Dubinina, 1966).

L. intestinalis (L., 1758)

Hosts: bleak (23.8 %), silver bream (20.0 %), bream (30.8 %), golden carp (7.7 %); invasion intensity in the study area: 1–3 specimens.

Localization: body cavity.

Plerocercoids parasitize in the body cavity of cyprinids, proceroids occur in the body cavity of copepods, adult worms – in the intestine of fish-eating birds, more common in gulls (Dubinina, 1966).

Digamma interrupta (Rudolphi, 1810)

Hosts: bleak (14.3 %), bream (14.3 %), carp (6.7 %); invasion intensity in the study area: 1–4 specimens.

Localization: body cavity.

Plerocercoids parasitize in the body cavity of cyprinids, proceroids occur in the body cavity of copepods, adult worms – in the intestine of fish-eating birds (Dubinina, 1966).

Schistocephalus pungitii Dubinina, 1959

Hosts: stickleback (33.3 %); invasion intensity in the study area: 1–3 specimens.

Localization: body cavity.

Plerocercoids are parasites of the body cavity of sticklebacks; proceroids occur in the body cavity of copepods, adult worms – in the intestine of fish-eating birds (Dubinina, 1966).

Family CYATOCEPHALIDAE Nybelin, 1922

Bothrimonus fallax Lühe, 1900

Hosts: sturgeon (in both studied individuals); invasion intensity in the study area: 1–12 specimens.

Localization: intestine.

Parasitizes in the digestive tract of sturgeon, intermediate host is an amphipod *Dikerogammarus haemobaphes* (Sudarikov, Kurochkin, 1964).

Family Proteocephalidae La Rue, 1911

Proteocephalus filicollis (Rudolphi, 1810)

Hosts: stickleback (42.9 %); invasion intensity in the study area: 1–4 specimens.

Localization: intestine.

Parasitizes in the intestine of sticklebacks, intermediate hosts are cyclops (Dubinina, 1987).

P. gobiorum Dogiel et Bychowsky, 1939

Hosts: round goby (23.5 %), bighead goby (33.3 %); invasion intensity in the study area: 1–14 specimens.

Localization: intestine.

Parasitizes in the digestive tract of gobies (Dubinina, 1987).

P. ocellata (Rudolphi, 1802)

Hosts: pike (10.0 %), zander (16.7 %), perch (34.5 %); invasion intensity in the study area: 1–9 specimens.

Localization: intestine.

Parasite of the intestine of perch, pike, asp, sometimes in other predatory fish, intermediate hosts are cyclops (Dubinina, 1987).

P. osculatus (Goeza, 1782)

Host: catfish (91.6 %); invasion intensity in the study area: 21–276 specimens.

Localization: intestine.

Parasitizes in the European catfish intestine (Dubinina, 1987).

Siluritaenia siluri (Batsch, 1786)

Host: catfish (83.3 %); invasion intensity in the study area: 11–76 specimens.

Localization: intestine.

Parasitizes in the European catfish intestine (Dubinina, 1987).

Family GRYPORHYNCHIDAE Spassky et Spasskaya, 1973

Gryporhynchus pusillus Nordmann, 1832

Hosts: shemaya (22.2 %), bleak (19.1 %), bream (14.3 %), carp (13.3 %), catfish (16.7 %), bighead goby (25.0 %); invasion intensity in the study area: 1–9 specimens.

Localization: mucous membrane of the anterior intestine.

Parasitizes in the mucous membrane of the anterior intestine of various fishes, mainly cyprinids (Dubinina, 1987).

Family DILEPIDIDAE Railliet et Henry, 1909

Paradilepis scolecina (Rudolphi, 1819)

Hosts: kutum (6.7 %), asp (38.4 %), bleak (23.8 %), silver bream (20.0 %), zante (12.5 %), round goby (23.5 %), bighead goby (33.3 %); invasion intensity in the study area: 2–16 specimens.

Localization: body cavity, liver, mesentery, intestinal walls.

Plerocercoids occur in the body cavity, in the liver, on the mesentery and the intestinal walls of various fishes. Proceroids parasitize in copepods, the adult worms – in the intestine of cormorants, (Jarecka, 1970).

Out of 17 cestode species registered, the six are fish parasites at the larval stage (*Ligula colymbi*, *L. intestinalis*, *Digamma interrupta*, *Schistocephalus pungitii*, *Gryporhynchus pusillus*, and *Paradilepis scolecina*). They reach sexual maturity in the body of fish-eating birds, which are their definitive hosts. The other 11 species use fish only as definitive hosts. The most typical organ of the parasite localization is the intestinal lumen: 11 cestode species were registered there. Four species were found in the body cavity and one species in the mucous membrane of the anterior intestine. One species invaded various organs; body cavity, liver, mesentery and intestinal walls.

One cestode species can infect from one to seven fish species: *Paradilepis scolecina* has seven host species, *Bothriocephalus acheilognathi* and *Gryporhynchus pusillus* – six, *Caryophyllaeus laticeps*, *Caryophyllaeus fimbriceps*, *Caryophyllaeides fennica*, and *Ligula intestinalis* – four, *Proteocephalus ocellata* – three, *Ligula colymbi*, *Digamma interrupta* and *Proteocephalus gobiorum* – two, *Eubothrium acipenserinum*, *Schistocephalus pungitii*, *Bothrimonus fallax*, *Proteocephalus filicollis*, *P.osculatus*, and *Siluritaenia siluri* – only one fish species.

The largest number of tapeworm species was found in the bream. It was a host of six cestode species: *Caryophyllaeus fimbriceps* (21.4 %), *C. laticeps* (14.3 %), *Caryophyllaeides fennica* (21.4 %), *Ligula intestinalis* (30.8 %), *Digamma interrupta* (14.3 %), and *Gryporhynchus pusillus* (14.3 %). The bleak had five cestode species: *Ligula colymbi* (9.5 %), *L. intestinalis* (14.3 %), *Digamma interrupta* (14.3 %), *Gryporhynchus pusillus* (19.1 %), *Paradilepis scolecina* (23.8 %); the carp – five species: *Caryophyllaeus fimbriceps* (16.7 %), *C. laticeps* (16.7 %), *Bothriocephalus acheilognathi* (20.0 %), *Digamma interrupta* (6.7 %), *Gryporhynchus pusillus* (13.3 %); the roach – four species: *Caryophyllaeus fimbriceps* (11.8 %), *C. laticeps* (17.7 %), *Caryophyllaeides fennica* (5.9 %), *Bothriocephalus acheilognathi* (29.4 %); the silver bream – four species: *Caryophyllaeus laticeps* (30.0 %), *Caryophyllaeides fennica* (10.0 %), *Ligula intestinalis* (20.0 %), *Paradilepis scolecina* (20.0 %); the bighead goby – four species: *Bothriocephalus acheilognathi* (25.0 %), *Proteocephalus gobiorum* (33.3 %), *Gryporhynchus pusillus* (25.0 %), *Paradilepis scolecina* (33.3 %); the asp – three species: *Caryophyllaeus laticeps* (15.4 %), *Bothriocephalus agobycheilognathi* (22.2 %), *Paradilepis scolecina* (38.4 %); the shemaya – three species: *Bothriocephalus acheilognathi* (16.7 %), *Ligula colymbi* (5.6 %), *Gryporhynchus pusillus* (22.2 %); the golden carp – three species: *Caryophyllaeus fimbriceps* (15.4 %), *Caryophyllaeides fennica* (23.1 %), *Ligula intestinalis* (7.7 %); the catfish – three species: *Proteocephalus osculatus* (91.6 %), *Siluritaenia siluri* (83.3 %), *Gryporhynchus pusillus* (16.7 %); the round goby – three species: *Bothriocephalus acheilognathi* (17.7 %), *Proteocephalus gobiorum* (23.5 %), *Paradilepis scolecina* (23.5 %); the sturgeon – two species: *Eubothrium acipenserinum* (in one of the two examined individuals), *Bothrimonus fallax* (in both studied individuals); the sticklebacks – two species: *Schistocephalus pungitii* (33.3 %), *Proteocephalus filicollis* (42.9 %); the pike – one species: *Proteocephalus ocellata* (10.0 %); the zante – one species: *Paradilepis scolecina* (12.5 %); the zander – one species: *Proteocephalus ocellata* (16.7 %); and the perch – one species: *Proteocephalus ocellata* (34.5 %).

No cestodes were found in six fish species – Caspian sprat, Caspian shad, black-backed shad, pipefish, atherina and golden mullet.

A large number of the recorded cestodes are specific cyprinid parasites (*Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*, *Ligula colymbi*, *L. intestinalis*, and *Digamma interrupta*). *Bothriocephalus acheilognathi* should also be included in this group, although it occurs in various predatory fish of other families. Presumably, it gets in the predators when they feed on infected cyprinids. Two species – *Proteocephalus osculatus* and *Siluritaenia siluri*, are specific to the European catfish. The other cestodes listed above are specific parasites of the fishes of other families or have a wide host range that includes various fish families. For example, *Eubothrium acipenserinum* and *Bothrimonus fallax* are the parasites of sturgeon, *Schistocephalus pungitii* and *Proteocephalus filicollis* – of sticklebacks, *Proteocephalus osculatus* and *Siluritaenia siluri* – of European catfish, *Proteocephalus gobiorum* – of goby fish, *Proteocephalus ocellata*, *Gryporhynchus pusillus* and *Paradilepis scolecina* parasitize in fishes of several families. The presented data shows that most cestode species, except the two from the European catfish, have a relatively wide range of hosts and show specificity at the rank of family or a group of families.

The intermediate hosts of most recorded cestodes are zooplankters. Fish is infected with these helminths when feeding on invertebrates that live in the water column. Only three species (*Caryophyllaeus fimbriceps*, *C. laticeps*, and *Caryophyllaeides fennica*) get into the fish intestine with invertebrate hosts occurring in benthos.

The studied fish belong to four trophic groups: eight predatory species – black-backed shad, pike, asp, catfish, zander, perch, round goby, bighead goby; six planktophages – Caspian sprat, Caspian shad, shemaya, bleak, pipe fish, atherina; nine benthophages – sturgeon, roach, kutum, silver bream, bream, zante, golden carp, carp, stickleback; and one species that feeds on detritus – golden mullet. As mentioned above, the black-backed shad, the sprat, the Caspian shad, the pipefish, the atherina, and the golden mullet were not infected with tapeworms.

Since the most identified cestodes invade the fish body when it feeds on planktonic invertebrates, one might assume that the planktophages are more infected with tapeworms than the fishes of other trophic groups. However, our research did not prove that. In our case study, the benthophages had the richest cestode fauna that included 12 species: *Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*, *Eubothrium acipenserinum*, *Bothriocephalus acheilognathi*, *Ligula intestinalis*, *Digamma interrupta*, *Schistocephalus pungitii*, *Bothrimonus fallax*, *Proteocephalus filicollis*, *Gryporhynchus pusillus*, and *Paradilepis scolecina*. The predators were the hosts of eight cestode species: *Caryophyllaeus laticeps*, *Bothriocephalus acheilognathi*, *Proteocephalus gobiorum*, *Proteocephalus ocellata*, *Proteocephalus osculatus*, *Siluritaenia siluri*, *Gryporhynchus pusillus*, *Paradilepis scolecina*; while the planktophages hosted seven species: *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Digamma interrupta*, *Proteocephalus ocellata*, *Gryporhynchus pusillus*, *Paradilepis scolecina*.

Table 1. Occurrence of cestode species in the areas with various water mineralization

Parasite species names	2–3 ‰	4–5 ‰	6–7 ‰
<i>Caryophyllaeus fimbriceps</i>	+	-	-
<i>C. laticeps</i>	+	-	-
<i>Caryophyllaeides fennica</i>	+	-	-
<i>Eubothrium acipenserinum</i>	-	+	+
<i>Bothriocephalus acheilognathi</i>	+	-	-
<i>Ligula colymbi</i>	+	-	-
<i>L. intestinalis</i>	+	-	-
<i>Digamma interrupta</i>	+	-	-
<i>Schistocephalus pungitii</i>	+	+	+
<i>Bothrimonus fallax</i>	-	-	+
<i>Proteocephalus filicollis</i>	+	+	+
<i>P. gobiorum</i>	+	+	-
<i>P. ocellata</i>	+	-	-
<i>P. osculatus</i>	+	+	-
<i>Siluritaenia siluri</i>	+	+	-
<i>Gryporhynchus pusillus</i>	+	-	-
<i>Paradilepis scolecina</i>	+	-	-
Number of species found	15	6	4

This phenomenon can be explained by two reasons. First, the benthophages were the largest trophic group of the studied fishes in the Kura mouth. Only these fishes had all the three cestode species that invade fish body with benthic invertebrates. Only one of them was found in the predators and no one invaded planktophages. Second, when the predators feed on other fish infected with tapeworms, these helminths survive and accumulate in the predator body. This is confirmed by the higher number of predatory species infected with these helminths in comparison with fish of other trophic groups. For example, the invasion rate of a predatory bighead goby with the cestode *Gryporhynchus pusillus*, whose intermediate hosts are planktonic organisms, is higher (25.0 %) than that in both zooplanktophages (shemaya, 22.2 % and bleak, 9.1 %) and benthophages (bream, 14.3 % and carp, 13.3 %). The same pattern is observed in the *Paradilepis scolecina* invasion: in the predators – asp (38.4 %), round goby

(23.5 %), and bighead goby (33.3 %), its invasion rate is not lower, sometimes even higher, than in the planktophages (bleak, 23.8 %) and benthophages (kutum, 6.7 %; silver bream, 20.0%; zante, 12.5 %). It is noteworthy that in the typical ichthyophages like asp and bighead goby, these parasites are more common than in the round goby, whose primary diet includes a large number of invertebrates.

The studied fishes have different adaptability to water salinity. Evidently, migratory and semi-migratory fish have the widest reaction rate to the water salinity. This group of fishes includes 13 species – sturgeon, black-backed shad, roach, kutum, asp, shemaya, zante, silver bream, bream, carp, golden carp, catfish, and zander. In addition, three euryhaline species (stickleback, round goby and bighead goby) form both freshwater and marine coastal populations. We also examined five species of typical marine fishes (Caspian sprat, Caspian black-backed shad, pipefish, atherina and golden mullet), occasionally entered the highly desalinated areas of the Caspian. The number of typical freshwater fish, poorly adapted to changes in water salinity, is relatively small – three species only (pie, bleak and perch).

Since all cestodes are endoparasites, they have no contact with the external aquatic environment at the parasitic stage of their individual development. Consequently, they do not react to changes in water salinity. However, all the studied cestodes have free-living stages (eggs and larvae) that depend on water mineralization. Moreover, all cestodes get into the fish intestine with the invertebrate hosts, which serve as food for fish. These invertebrates differ in their adaptability to water salinity and range from steno- to euryhaline. As a result, dependence of the fish cestode fauna on water salinity manifests itself only in the places where the invasion process takes place. A relationship of cestode invasion and water mineralization is a challenging task to establish.

Table 1 shows occurrence of different cestode species in the areas of various water salinity. Fifteen species were recorded in the areas with 2–3 ‰. The typical freshwater species (*Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*, *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Digamma interrupta*, *Gryporhynchus pusillus*, *Proteocephalus ocellata*, and *Paradilepis scolecina*) (Ibragimov, 2012) were found only in these areas. *Schistocephalus pungitii* and *Proteocephalus filicollis*, specific parasites of a highly euryhaline sticklebacks, were registered in the areas with a wide range of salinity, from 2–3 ‰ to 6–7 ‰. This was to be expected based on available publications (Mitenev, Shulman, 2005; Butorina et al., 2018), which claim that specific stickleback parasites are euryhaline like their hosts. A similar pattern, when euryhaline fish have specific euryhaline parasites, is observed in migratory sturgeon and its parasites *Eubothrium acipenserinum* and *Bothrimonus fallax*, in migratory catfish and parasitic *Proteocephalus osculatus* and *Siluritaenia siluri*, in both round and bighead gobies and their parasite *Proteocephalus gobiorum*.

Although most examined fishes are euryhaline, the species richness of their cestode parasites was higher in the desalinated area of the Kura mouth than in the areas with more mineralized water. We can explain this proportion by the absence of marine forms among the studied cestodes.

Only six cestode species found (*Caryophyllaeus fimbriceps*, *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Digamma interrupta*, and *Paradilepis scolecina*) are pathogenic for fish (Bauer et al., 1977; Golovina et al., 2003). We observed pathogenic phenomena caused by the large plerocercoids of *Ligula colymbi* and *L. intestinalis*. Even in case of their small number, they had a strong mechanical impact. Other pathogenic species, being much smaller and having relatively low invasion intensity, did not cause noticeable pathogenic changes. Nevertheless, all the causative agents should be taken into account in fishery activities.

Conclusion

In the course of parasitological investigation of 334 individuals of 24 fish species caught in the mouth of Kura River, 17 tapeworm species of two orders and eight families were recorded. Of these, seven species are specific cyprinid parasites, two species are specific to sturgeons, two species to sticklebacks, two species to catfish, and one species to gobies; three species parasitize in fishes of various families. The main organ of cestode localization was the intestinal lumen, where 11 species were registered. In the other fish organs, we found from one to four tapeworm species. One cestode species invaded from one to seven fish species. The largest number – six tapeworm species, was recorded from the bream; in the other fish species, we found from one to five tapeworm species. Among the cestodes found, 14 species infect fish that feed on zooplankton and only three species (*Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*) invade fishes with benthic invertebrates. In terms of trophic preferences, most studied fish are benthophages; they hosted 12 cestode species; eight tapeworm

species were found in predators and seven species in planktophages. Predatory fishes viz. pike, asp, round and bighead gobies accumulate parasites from the bodies of their preys. Most recorded fishes are euryhaline. Nevertheless, due to the absence of typical marine forms among the found cestodes, we registered more tapeworm species in the fish occurring in a highly desalinated area of the Kura mouth than in the fish caught in more mineralized water. Six species are causative agents of fish diseases. Due to moderate cestode invasion, these parasites did not cause pathogenic changes in fish.

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Екологічний аналіз фауни цестод риб гирла річки Кури Ш.Р. Ібрагімов, С.Н. Мамедова

У 2014–2019 роках у гирлі річки Кури методом повного паразитологічного розтину досліджено 334 екз. риб, що належать до 24 видів. У результаті проведених досліджень виявлено 17 видів стьожкових червів, що належать до 2 рядів і 8 родин: *Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*, *Eubothrium acipenserinum*, *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Digamma interrupta*, *Schistocephalus pungitii*, *Bothrimonus fallax*, *Proteocephalus filicollis*, *P. gobiorum*, *P. ocellata*, *P. osculatus*, *Siluritaenia siluri*, *Gryporynchus pusillus*, *Paradilepis scolecina*. З них 7 видів є специфічними паразитами корокових риб, 2 види специфічні для осетрових, 2 види – для колючок, 2 види – для сома, а 1 вид – для бичкових, 2 види паразитують у риб, що належать до різних родин. Основним органом локалізації виявлених видів паразитів є порожнина кишечника, де було зареєстровано 11 видів цестод. В інших органах риб – в порожнині тіла, в слизовій переднього відділу кишечника, в печінці, брижі і стінках кишечника було відзначено від одного до чотирьох видів. Кожен з видів цестод був констатований у від одного до семи видів риб. Найбільшу кількість – 6 видів стьожкових червів зареєстровано у ляца, у інших досліджених видів риб знайдено від 1 до 5 видів цестод. 3 виявлених цестод 14 видів заражають риб при поїданні зоопланктонних і тільки 3 види (*Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*) – при поїданні бентичних безхребетних. Більшість досліджених риб належить до трофічної групи бентофагів, у них зазначено 12 видів цестод, у планктофагів і хижаків зареєстровано, відповідно, 8 і 7 видів. Має місце акумуляція цестод проковтнутих риб в кишечнику хижаків – щуки, жереха, бичків кругляка і головача. Більшість досліджених риб належать до евригалінних форм, однак в зв'язку з тим, що серед виявлених видів цестод відсутні типово морські форми, у риб, виловлених у сильно опрісненій ділянці гирла Кури, констатовано більше видів цих паразитів, ніж на ділянках з більш мінералізованою водою. Серед всіх виявлених цестод 6 видів – *Caryophyllaeus fimbriceps*, *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Digamma interrupta* і *Paradilepis scolecina* є збудниками захворювань риб. Спостерігалися патогенні зміни, викликані видами *Ligula colymbi* і *L. intestinalis*, плероцеркоїди яких мають великі розміри. Решта патогенних видів, маючи значно менші розміри, при тій порівняно невисокій інтенсивності інвазії, яка мала місце серед досліджених риб, не викликали помітних патогенних явищ.

Ключові слова: паразити, цестоди, риби, річка Кура, Каспійське море.

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Экологический анализ фауны цестод рыб устья реки Куры Ш.Р. Ибрагимов, С.Н. Мамедова

В 2014–2019 годах в устье реки Куры методом полного паразитологического вскрытия исследовано 334 экз. рыб, относящихся к 24 видам. В результате проведенных исследований обнаружено 17 видов ленточных червей, относящихся к 2 отрядам и 8 семействам: *Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*, *Eubothrium acipenserinum*, *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Digamma interrupta*, *Schistocephalus pungitii*, *Bothrimonus fallax*, *Proteocephalus filicollis*, *P. gobiorum*, *P. ocellata*, *P. osculatus*, *Siluritaenia siluri*, *Gryporynchus pusillus*, *Paradilepis scolecina*. Из них семь видов являются специфическими паразитами карповых рыб, два вида специфичны для осетровых, два вида – для колюшек, два вида – для сома, один вид – для бычковых, а три вида паразитируют у рыб, относящихся к разным семействам. Основным органом локализации обнаруженных паразитов является просвет кишечника, где было зарегистрировано 11 видов цестод. В остальных органах рыб – в полости тела, в слизистой переднего отдела кишечника, в печени, брыжейке и стенках кишечника было отмечено от одного до четырех видов. Один вид цестод поражал от одного до семи видов рыб. Наибольшее число – 6 видов ленточных червей зарегистрировано у леща, у остальных исследованных видов рыб найдено от одного до пяти видов цестод. 14 обнаруженных видов цестод заражают рыб при поедании зоопланктонных и только три вида (*Caryophyllaeus fimbriceps*, *C. laticeps*, *Caryophyllaeides fennica*) – при поедании бентических беспозвоночных. Большинство

исследованных рыб относится к трофической группе бентофагов, у них отмечено 12 видов цестод, у планктофагов и хищников зарегистрировано, соответственно, 8 и 7 видов. Имеет место аккумуляция цестод проглоченных рыб в кишечнике хищников – щуки, жереха, бычков кругляка и головача. Большинство исследованных рыб относится к эвригалинным формам, однако, так как среди обнаруженных видов цестод отсутствуют типично морские формы, у рыб, выловленных в сильно опресненном участке устья Куры, найдено больше видов этих паразитов, чем на участках с более минерализованной водой. Среди всех обнаруженных цестод, шесть видов – *Caryophyllaeus fimbriceps*, *Bothriocephalus acheilognathi*, *Ligula colymbi*, *L. intestinalis*, *Digramma interrupta* и *Paradilepis scolecina* являются возбудителями заболеваний рыб. Наблюдались патогенные изменения, вызванные *Ligula colymbi* и *L. intestinalis*, плероцеркоиды которых имеют крупные размеры. Остальные патогенные виды, будучи значительно меньше, при сравнительно невысокой интенсивности инвазии в исследованном регионе не вызывали у рыб заметных отклонений.

Ключевые слова: паразиты, цестоды, рыбы, река Кура, Каспийское море.

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