Fish parasitofauna of the amudarya river delta lakes

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Abstract. The paper deals with changes in the parasitofauna of some fish species of the Amudarya delta lakes. Recent data on the parasitofauna of 8 indigenous commercial fish species of the Amudarya delta lakes in the degraded natural environment (2019-2023) are presented. Impoverishment of ichthyoparasite fauna under the influence of continuous anthropogenic pressure and its causes is shown. Species of parasites with constant high infestation and pathogenic forms that are potential agents of fish diseases in extreme environmental conditions of the region are indicated. The research conducted between 2019 and 2023 revealed a significant reduction in parasite species previously widespread among commercial fish in the lakes of the Amudarya River delta. Anthropogenic factors, such as water pollution by industrial and agricultural wastes, as well as the reduction of water levels in the river due to intensive use of water resources for irrigation, played a decisive role in these changes. A detailed analysis of the factors causing changes in the fish parasitofauna has shown that anthropogenic impacts, including pollution, changes in the water temperature regime and its chemical composition, are causing significant changes in the ecosystem of the Amudarya delta lakes. In the future, this may lead to even greater changes in the microbiological composition of the water and, as a consequence, to the emergence of new epidemics among fish.

1 Introduction

The Amudarya river was second in size and biodiversity after the Volga River. Natural water inflow to the Amudarya delta and the Aral Sea began to decrease as early as the second half of the 20th century. In recent years, significant water withdrawal for irrigation has significantly changed the natural conditions in the average and lower part of the river.

In the Amudarya deltas, many freshwater lakes have dried up, and new water bodies have been formed due to collector-drainage water discharges, highly saline (1.5-5 mg/l), polluted with residues of mineral fertilizers, herbicides and pesticides. Completely unacceptable ecological conditions for hydrobionts were formed in them.

As a result, the number of hydrobionts, mainly fish and forage aquatic invertebrates, which acted as intermediate hosts for many helminths, decreased from year to year in the water bodies of the Amudarya delta. Moreover, the visit of water bodies by waterfowl which

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are definitive hosts of a number of fish parasites, is of particular importance. The impact of anthropogenic factors, such as pollution of water bodies and changes in runoff regimes, has further aggravated this problem, leading to deterioration of conditions for the habitat and reproduction of aquatic organisms. The gradual decline in biodiversity created unfavorable conditions for maintaining ecological balance in the ecosystems of the region. This situation poses an objective for scientists and ecologists to develop a set of measures aimed at restoring the river ecosystem and creating favorable conditions for the existence of hydrobionts.

In the Republic of Karakalpakstan, efforts are now being made to restore and increase fish stocks in inland water bodies through the establishment of lake farms. As part of these efforts, a number of measures are being implemented, including control of dangerous parasites and fish diseases, which requires detailed studying of ichthyoparasitological situation of water bodies of the Amudarya river delta under changed ecological conditions.

2 Materials and methods

Fisheries water bodies of the Amudarya river delta, located in the central zone of the Aral ecological crisis, were selected for our research. Materials on parasitology were collected in the period from 2019 to 2023 in Muynak and Sarybas bays, as well as in lakes Shegekul and Makpalkul. Eight species of fish were studied by the method of complete parasitological autopsy (Dogel, 1933; Bykhovskaya-Pavlovskaya, 1985). Their species composition and abundance are given in the respective sections.

3 Results and discussion

Parasites belonging to the following groups, for instance, coccidia, myxosporidia, ciliates, monogeneans, cestodes, trematodes, nematodes, leeches and crustaceans were found in 8 species of fish in the Amudarya delta. These parasites differ in their biological characteristics, developmental cycles, and pathogenic effects on their hosts. Coccidia, for instance, are known for their complex life cycles and intracellular parasitism, often causing serious disease in fish.

Mixosporidia, on the other hand, have a characteristic spore structure with several polar capsules, making it possible for them to attach effectively to host tissues. They can infect various organs and systems, including gills and muscles, causing significant damage to fish. Ciliary parasites such as Ichthyophthirius multifiliis often cause epizootics in fish farms by infecting the body surface and gills of fish.

Monogeneans are flatworms that live mainly on the gills and skin of fish, causing pathological changes in these organs and leading to breathing difficulties and a decrease in the general condition of the fish. Cestodes have chitinous hooks and suckers, with which they are attached to the intestinal wall, causing impaired absorption of nutrients and anemia.

Trematodes enter the host body through the skin or by ingesting infected intermediate hosts such as snails or small crustaceans, and can affect various organs including the liver, gastrointestinal tract, and gills. Nematodes, roundworms, are known for their diversity and adaptability to different habitats, and they can cause mechanical tissue damage and block important physiological processes in their hosts.

Leeches, as ectoparasites, suckle on the outer skin of fish, feeding on their blood and causing open wounds that can become infected with secondary pathogens. Finally, crustacean parasites such as carp-eaters and acroleus attach themselves to the body and gills of fish, feeding on their blood and soft tissues, often causing significant damage and immune impairment in fish.

Redfin-*Scardinius erythrophalmus (Linne*). Redfin (*Scardinius erythrophthalmus, Linnaeus*) was studied in lakes in the amount of 31 specimens, with a total infestation of 93.5%. Eight different species of parasites were detected in these fish, which belong to myxosporidia (1 species), monogenea (1 species), trematodes (2 species), nematodes (2 species) and crustaceans (2 species). The frequency of infestation was 93.5%. The specific monogenea Dactylogyrus difformis (75-80%) and metacercariae Diplostomum spathaceum (46.6-50%) had high infestation rates. Other parasite species were rare and in small numbers. Half of the parasites recorded in redfin redfin had a complex life cycle.

In the middle of the 20th century, there were 11 different systematic groups of parasites in redfin, and today there are only 5. Under the new conditions, the number of parasite species in redfin has decreased by 4.5 times.

Bream - Abramis brama orientalis Berg. Forty-nine specimens were dissected: 15 in Sarybas Bay, 16 in Shegekul and 18 in Makpalkul lakes. Total infestation amounted to 88.0%. The studied fish were infested with 14 species of parasites, including myxosporidia (1 species), monogenea (4 species), cestodes (1 species), trematodes (5 species), nematodes (2 species) and crustaceans (1 species). Among them, 8 species (57.1%) have intermediate hosts. Parasites specific to bream gills, such as Dactylogyrus wunderi (86.6-90%), D. zandti (45.5-56.2%) and Diplozoon paradoxum (27.2-33.3%), stand out. In the fauna of bream parasites, a significant place is occupied by species that are widely distributed in other carps. For instance, the metacercariae Diplostomum spathaceum (20-83.3%, eyes) and the nematode Contracaecum microcephalum (55.5-66.6%, intestine) are often found at low infection rates. Under extreme conditions of the lower Amudarya river, species diversity of parasites in bream decreased by 17 species (54.8%), which is 2.2 times less.

Carassius auratus gibelio (Bloch). Forty-four specimens were examined in lakes Shegekul (16 specimens) and Makpalkul (28 specimens). The total degree of infestation was 95.4%. Thirteen species of parasites were found in crucian carp, including monogeneans (7 species), cestodes (1 species), trematodes (3 species), nematodes (1 species) and crustaceans (1 species) with a wide range of hosts. Monogeneans, which are not specific to crucian carp, account for more than half (53.8%) of its parasites. The number of parasites with a complex development cycle is slightly more than a third (38.4%). The parasitological composition of crucian carp has changed insignificantly: 2 species of cestodes, one species of trematodes and one species of crustaceans have disappeared, but 5 species of dactylogirus have been added (D formosus, D. baueri, D inexpectatus, D. dogieli, D arcuatus).

Carp (Cyprinus carpio Linne) was studied in all bays and lakes, 71 specimens were examined. The overall level of infestation is high (91.5%). The parasite fauna of carp, compared to other fish, is quite extensive and includes 18 species of parasites: coccidia (1 species), myxosporia and ciliates (2 species each), monogenea (4 species), cestodes and trematodes (3 species each), nematodes (2 species), leeches and crustaceans (1 species each). The parasites of carp are dominated by specific coccidia species Eimeria carpelli (46.6-77.7%), monogeneans Dactylogyrus extensus (86.6-100%), D. anchoratus (40.0-72.2%) and widespread metacercariae D. spathaceum (53.5-80.0%) of trematodes. Cyrodactylus medius monogenea characteristic of this host is also found in small numbers. The intestinal nematode C. microcephalum (33.3-55.5%), which has also been recorded in other fish species, is common.

Other parasites of carp have a wide host affiliation and occur in small numbers. Of the parasitofauna of carp, 57.9% belong to species with a direct developmental cycle and 42.1% to species with a complex cycle. Previously, the richest parasitofauna among native fish of the region was in carp (49 species), including 12 groups: flagellates, coccidia, microsporidia (1 species each), myxosporidia (6), leeches (2), mollusks (1) and crustaceans (5). Only 4 species of monogenes have now been detected out of the previously recorded 10. Recent research has also failed to detect 4 species of myxosporidia, nematodes and crustaceans, as well as 3 species each of ciliates and trematodes, and 2 species of cestodes. Among the parasites of carp, flagellates, microsporidia and molluscs are now absent. The carp has lost about 61.3% of its parasites, mainly those that develop with the participation of intermediate hosts (Table 1).

Table 1. Data on parasitofauna of fish of the Amudarya River delta (2019-2023)

Parasite group	Redfin	Bream	Crucian carp	Carp
Flagellates	-	-	-	-
Sporophytes	-	-	-	1
Myxosporidia	1	1	-	2
Microsporidia	-	-	-	-
Ciliary	-	-	-	2
Monogenes	1	4	7	4
Cestodes	-	1	1	3
Trematodes	2	5	3	3
Nematodes	2	2	1	2
Leeches	-	-	-	1
Molluscs	-	-	-	-
Crustaceans	2	1	1	1
Total quantity	8	14	13	19

The extreme conditions of the region reduced the abundance and diversity of planktonic and benthic organisms that are food for fish. It is important to note that under these extreme environmental conditions, the studied fish had a consistently high infestation of certain species of parasites, especially those that live on the gills and in the form of metacercariae (D. spathaceum, T. clavata). Flagellates (5 species), microsporidia (1 species), leeches (2 species) and mollusc larvae (1 species) disappeared from the parasite fauna of the studied fish altogether.

Among the reported species of fish parasites, parasitic protozoa are pathogenic ones: Eimeria carpelli, Myxobolus pseudodispar, Ichthyophthirius multifiliis, Trichodinella epizootica, monogenes Dactylogyrus extensus, cestodes Caryophyllaeus fimbriceps, Bothriocephalus opsarichthydis, Gryporhynhus pusillum, trematodes D. spathaceum, Posthodiplostomum cuticola, nematodes Raphidascaris acus, Contracaecum microcephalum, leeches Piscicola geometra, crustaceans Ergasilus sieboldi. These types of parasites can be considered as possible pathogens for fish in our region. Under suitable breeding conditions, they can cause epidemics among fish in a short period of time. Particularly dangerous are certain species of Dactylogirus and the widely occurring Diplostomatidae, which consistently show high infection rates.

Pike (Esox Lucius Linne.) was studied in all the water bodies we investigated. A total of 66 specimens were dissected. The total infestation amounted to 89.3%. Ten species of parasites were recorded, belonging to ciliates (1 species), monogeneans (1 species), cestodes (1 species), trematodes (4 species), nematodes (2 species) and crustaceans (1 species). Young forms of crustaceans were also noted. Among them, 7 species develop with the participation of intermediate hosts.

The largest number of pike parasites are trematodes. High level of infestation was shown by ocular species: Diplostomum spathaceum (43.7-64.7%), Tylodelpys clavata (33-76.4%), as well as the monogenetic gill parasite Tetraonchus monenteron (66-100%) and the intestinal nematode Raphidascaris acus (20-50%). Other species were rarely encountered. During this time, the species diversity of pike parasites decreased threefold. Flagellates (1 species), myxosporidia (2 species) and leeches (1 species) disappeared. The number of species of cestodes and crustaceans (2 species disappeared each), trematodes (by 7 species) and nematodes (by 4 species) decreased significantly. Additionally, 1 species of infusoria was not found.

Asp (Aspius aspius taeniatus n. ibloides, Kessler) 36 samples from Sarybas Bay (20 specimens) and Lake Shegekul (16 specimens) were processed. Thirteen species of parasites were found in the stud: one species of ciliate worms, two species of monogenes, two species of cestodes, three species of trematodes, three species of nematodes and two species of crustaceans. Among the parasites found, more than half (8 species) have a complex life cycle.

Fish were found to be 100% infested with the characteristic gill parasite Dactylogyrus tuba with high intensity - up to 351 parasites per fish (average 216.5). Frequent (56-75%) infestation with the ocular form of D. spathaceum was also detected, with the intensity of infestation reaching 38 parasites per fish (average 13). In addition, significant infestation with nematodes Contracaecum microcephalum (43.7%), C. spiculigerum (18.7-25%) and the crayfish Lamproglena pulchella (60%) was recorded at low intensity. In the lower reaches of the Amudarya river, 34 species of parasites were previously recorded in the stud, of which now 21 species have been lost, which is 61.8%, which means that the parasitofauna has decreased by 2.6 times.

Wels catfish (Silurus glanis Linne). A total of 34 specimens were uncovered in Sarybas Bay (16) and Lake Shegekul (18). The total infestation level was 91.1%. Catfish were infested with 10 species of parasites, including characteristic monogenes (3 species), common cestodes, trematodes, nematodes (2 species of each) and crustacean (1 species). A complete infestation with the monogenes Silurodiscoides siluri and S. vistulensis was observed. A high degree of invasion by cestodes Bothriocephalus opsarichtydis (28.8-43.7%), Proteocephalus osculatus (38.8-56.2%) and crustacean Lamproglena pulchella (38.8-75.5%) was observed. A high percentage of catfish infestation (81.25%) with D. spathaceum metacercariae was detected in Sarybas Bay. Among catfish parasites, 60% of species undergo development with the change of hosts.

In the lakes of the Amudarya river delta, catfish were previously infected with 32 species of parasites: flagellates (1 species), ciliates (3), monogenes (3), cestodes (5), trematodes (10), nematodes (6), mollusks (1) and crustaceans (7). Eight species of trematodes, 4 species of nematodes, 3 species of cestodes and 2 species of crustaceans are now extinct. Flagellates, ciliates and molluscs were not found at all. As a result, 22 species (68.8%) have disappeared from the catfish parasitofauna, resulting in its reduction by 3.2 times.

Pikeperch Lucioperca lucioperca (Linne) was studied in Muynak Bay (15) and lakes Shegekul and Makpalkul (16) in the amount of 31 specimens. The total infestation rate was 88.2%. Eight species of parasites were identified, including one species of infusoria, one species of monogenea, four species of trematodes and two species of nematodes. Among the parasites of pikeperch, the common parasites were the specific monogenea Ancyrocephalus paradoxus (33.3-50%), ocular metacercariae D. spathaceum (50.0-56.2%) and T. clavata (26.6-40%) of the trematode group. Infusoria Trichodina luciopercae was found in 80% of cases in Muinak Bay, while intestinal trematodes Bucephalus polymorphus and nematode Cammallanus truncates in Lake Makpalkul were found in 43.7% of cases (Fig.1).

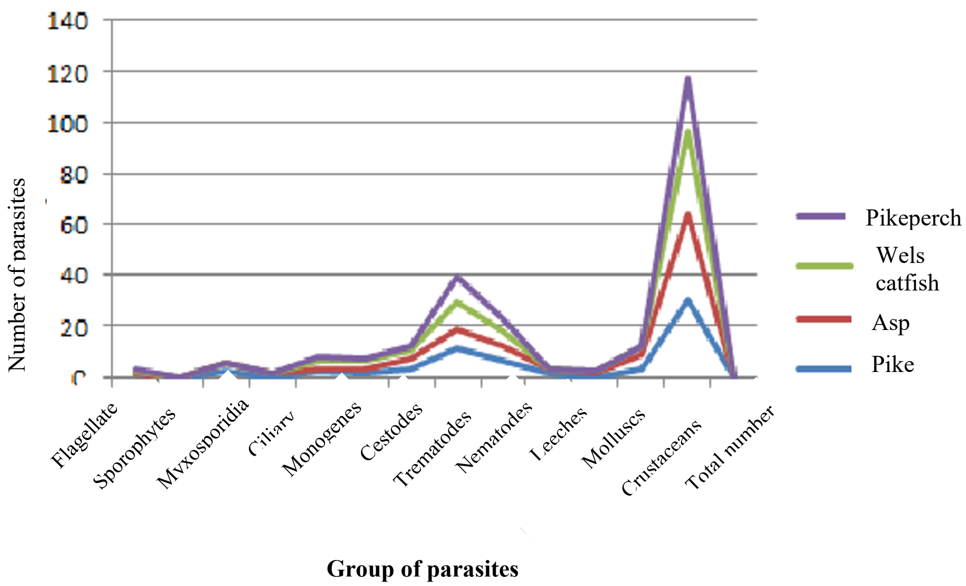

Fig. 1. Data on parasitofauna of predatory fish species in the lower reaches of the Amudarya River (2019-2023)

4 Conclusion

During the present research of lakes in the Amudarya river delta (2019-2023), the parasitofauna of 8 fish species was studied. The qualitative and quantitative composition of parasites is largely determined by the frequency of occurrence of the host itself. A large number of hosts creates possibilities for contact even with rare parasites (Dogel, 1962). In this region, due to anthropogenic impacts, fish populations are decreasing annually. Apparently, this is the main reason for the low infestation of fish with many parasite species.

According to our research, a relatively diverse parasite fauna was observed in carp (18 species) and crucian carp (16 species). In pike, 10 species of parasites were recorded. Previously, there were 34 species of parasites in zherech, but now 21 species have disappeared, which is 61.8%. Thus, the parasite fauna of zherekh has decreased by 2.6 times. In catfish, 22 species of parasites (68.8%) have recently been undetected, resulting in a 3.2-fold reduction in its parasite fauna. Pikeperch has a 2.6-fold reduction in its parasitofauna. This indicates that the number of these fish in the water bodies of the region remains relatively stable.

Ectoparasites such as parasitic protozoa, leeches, mollusk larvae and parasitic crustaceans were not observed in the studied fish, or their invasion was insignificant, which is explained by changes in the hydrochemical regime, especially increased salinity. Water chemistry also affects the species composition and abundance of foraging invertebrates, in which the larval stages of many fish helminths develop. Under extreme conditions in the lower reaches of the Amudarya river, the abundance and species composition of planktonic and benthic organisms on which fish feed decreased.

Thus, our research revealed a significant diversity of parasites affecting fish of lakes in the Amudarya delta, which emphasizes the need for an integrated approach to studying and controlling this phenomenon for the sake of preserving the health of fish populations in this region. To develop effective control measures against parasites, it is necessary to have detailed factual data on their bioecological features at the population level, which is currently an important issue in parasitological research on Amudarya delta lakes.

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