

CURRENT STATUS AND COMPARATIVE ANALYSIS OF THE PARASITE FAUNA OF COMMON CARP (*CYPRINUS CARPIO* L.) IN THE KURA RIVER BASIN WITHIN AZERBAIJAN

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Abstract. The article is devoted to the study of the parasitic fauna of the common carp (*Cyprinus carpio* L.) in the Kura River basin in the territory of Azerbaijan and a comparative analysis of data from 1975 years to the present days. Of these, protozoa (Protista - 16 species) and, accordingly, digenetic (Trematoda - 9 species) and monogenetic (Monogenea - 7 species) flukes dominate. We were noted 16 species of parasites (Protista - 5 species, Monogenea - 2 species, Cestoda - 2 species, Trematoda - 2 species, Nematoda - 1 species, Mollusca - 1 species, Crustacea - 3 species) in common carp in the Kura river basin in 2017-2022 years. For the comparative analysis were taken data for 1975, 2001 and 2017-2022 years (our data). Analysis of the above data for such a long period allows us to get a complete picture of the changed environmental situation in this area. It was found that out of 23 species, 15 species of parasites found in 1975 were not noted either by us or by other authors who conducted parasitological studies of common carp in this territory. A study in 2001 showed that the fishes lost up to 70% of their parasites, but gained 14 new species in return, and in the end there were total 21 species. Seven species are identical for both studies (1975 and 2001 years). This means that only 18.9% of the parasites noted before 2001 were able to get along with their host in the changed environmental conditions. Our studies have shown that the parasitic fauna of the common carp has again changed significantly in this area. Only 6 species of parasites registered in 2001, have been noted at present days. In recent years (2017-2022 years), common carp has lost about 84% of the current parasites, but in their place was acquired 9 new species that were not previously recorded in this area. Two parasite species *D. extensus* and *N. cheilancristrotus* were recorded in the Kura River basin over the entire long period of research (1975-2022 years). These species were able to settle down to their hosts in the Kura River basin, despite the changed environmental conditions.

Keywords: common carp, parasites, Kura River, current status, comparative analysis

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1. Introduction

Despite the fact that the parasite fauna of the common carp (*Cyprinus carpio* L.) in the Kura River basin has been studied by some scientists, it is still impossible to talk about the complete completion of this work. (Mikailov, 1975; Mikailov & Kaziyeva, 2001; Kaziyeva, 1984). Since, the above pool occupies a very large area. Also because of the long period of research, it does not fully cover the environmental situation that changes from year to year. Neighboring countries that cover the territory of the basin discharge 3 million m³ of wastewater into the Kura River every year (Mammadov & Khalilov, 2006). Therefore, the study of fish parasites in this region is of great scientific importance. First, this study reveals new data on the particular state of the parasite

fauna. Secondly, information is obtained on the impact of changing environmental conditions to the parasite fauna.

To date, 46 species of parasites have been found in common carp in the Kura River basin within Azerbaijan, some of them are specific to this host (Mikayılov, 1975; Kaziyeva, 1984; Mikailov & Kaziyeva, 2001; Abdullayeva, 2011, 2012; Suleymanova & Nasirov, 2016; Nasirov *et al.*, 2021; Seyidli *et al.*, 2021). Literature data for a comparative analysis of the carp parasite fauna are given on the basis of materials collected in the Middle Kura River in the territory of Azerbaijan (Mikayılov, 1975; Mikailov & Kaziyeva, 2001). A comparative analysis of the parasite fauna with the materials of past years gives a complete picture of exactly what species of parasites have been infected common carp for many years and helps to create a picture of the ecological state in the study areas. An analysis of the data of 1975 year revealed that some species of parasites of common carp have disappeared from the fauna of this fish, and this necessitates new research. The author has been noted 23 species of parasites in common carp in the Kura River basin in 1975 (Mikayılov, 1975). And there were 21 species of parasites on the same territory in 2001 (Mikailov & Kaziyeva, 2001). However, does this indicate a change in the ecological situation, despite the absence of significant similarities between parasite species over a period of almost 45 years, except for specific species? To find the answer to this question, the parasitic fauna of the common carp was studied in the Kura River basin.

2. Material and methods

Ichthyoparasitological material was collected from common carp (*Cyprinus carpio* L.) for specimens in the Kura River basin (Varvara reservoir, Mingechevir reservoir, Middle Kura) in 2017-2022. The fish were examined by the method of complete parasitological dissection developed by V.A. Dogel and improved by his colleagues (Markevich, 1950; Gusev, 1983; Bykhovskaya-Pavlovskaya, 1985). Both living and recently dead fishes were used for the study. To determine the species of trichodines, smears were first prepared from the collected materials, and then they were stained with a solution of silver nitrate. Trematodes, crustaceans, molluscs were fixed in 70% alcohol, nematodes in 4% formalin solution. To determine the species of monogeneans, first of all, preparations were prepared using glycerol-gelatin. Trematodes and cestodes were stained with carmine, nematodes were clarified with lactic acid, and then they were all of them identified (Bykhovskaya-Pavlovskaya, 1985). There were examined some parameters in this study - Invasion Extensity (I.E.), Invasion Intensity (I.I.), and Abundance Index (A.I.). The parasite preparations were studied under a light microscope Primo Star (Zeiss) and images were taken with a digital camera EOS D650 (Canon). The parasites, which found in the common carp, were identified based on the book "Key to Fish Parasites" (Bauer, 1984, 1985, 1987).

3. Results

We noted 16 species of parasites (2 species of cnidosporids, 3 species of ciliates, 2 species of monogeneans, 2 species of trematodes, 2 species of cestodes, 1 species of nematodes, 3 species of crustaceans and 1 species of molluscs) in common carp, belonging to different systematic groups (Tab. 1).

Table1. List of parasites found by us in common carp

No	Species of parasites	I.E. (%)	I.I. (ind.)	A.I. (ind.)
	Myxozoa			
1	<i>Myxobolus cyprini</i> Doflein, 1898	1,7±1,17	-	-
2	<i>Thelohanellus nikolskii</i> Achmerov, 1955	3,3±1,63	-	-
	Ciliophora			
3	<i>Ichthyophthirius multifiliis</i> Fouquet, 1876	30,8±4,21	-	-
4	<i>Apiosoma carpelli</i> Banina, 1968	1,7±1,17	-	-
5	<i>Trichodina nigra</i> Lom, 1960	3,3±1,63	-	-
	Monogenea			
6	<i>Gyrodactylus medius</i> Kathariner, 1895	0,8±0,34	3	0,025
7	<i>Dactylogyrus extensus</i> Mueller van Cleave, 1932	30,8±4,21	5-120	1
	Cestoda			
8	<i>Caryophyllaeus fimbriceps</i> Annenkova-Chlopina, 1919	6,7±2,28	1-2	0,017
9	<i>Neogriporhynchus cheilancristrotus</i> Wedl, 1955	43,7±4,53	10-50	0,42
	Trematoda			
10	<i>Diplostomum chromatophorum</i> Shigin, 1986	6,7±2,28	20-100	0,77
11	<i>Posthodiplostomum cuticola</i> Nordmann, 1832	2,5±1,42	1-2	0,016
	Nematoda			
12	<i>Contracaecum spiculigerum</i> Rudolphi, 1809	5,0±1,99	1-4	0,033
	Mollusca			
13	<i>Anodonta cyrea</i> Drouet, 1881	5,0±1,99	1-4	0,033
	Crustacea			
14	<i>Ergasilus sieboldi</i> Nordmann, 1832	2,5±1,42	2-3	0,025
15	<i>Lernea cyprinacea</i> L., 1758	75,0±3,95	2-4	0,033
16	<i>Argulus foliaceus</i> L., 1758	2,5±1,42	1-2	0,017

Intermediate hosts do not participate in the development cycle in some parasites found in common carp. From protozoa parasites of common carp, myxosporidiums - *Myxobolus cyprini* and *Thelohanellus nikolskii*, as well as ciliates - *Ichthyophthirius multifiliis*, *Apiosoma carpelli* and *Trichodina nigra* were found on the surface of the body and on the gills. Spores of myxosporidium *M. cyprini* were founded in the kidneys of the studied fishes. Also, for the first time, myxosporidium *Th. nikolskii* was registered in the water basins of Azerbaijan. In addition to the description of this species, a comparative morphological structure with other related species of the same genus was given (Seyidli *et al.*, 2021). The monogenean *Dactylogyrus extensus* was found on the gills in most of the examined common carps (Fig. 1A) and *Gyrodactylus medius* was found on the fins and gills on the only one fish. Ciliates *Ich. multifiliis* in fish always have been found together with the specific parasite of these hosts - the monogenean *D. extensus*. This indicates the absence of antagonism between these parasites. Parasites including those with a complex development cycle were registered in common carp. These include cercaria of the digenetic flukes *Posthodiplostomum cuticola*, *Diplostomum chromatophorum*, which actively invade the host organism, and larval stages of cestodes such as *Neogriporhynchus cheilancristrotus* (Fig.1. C and D) and *Caryophyllaeus fimbriceps*. Studies have shown that the cestode *N. cheilancristrotus* founded in common carp, parasitizing in the stage of cysticercoid, sometimes one (Fig. 1D), and sometimes two individuals (Fig.1C) are observed in one capsule. Of the crustaceans, *Argulus foliaceus* and *Lernea cyprinacea* were noted in

common carp. The larval stage of the mollusc *Anodonta cyrea* was founded on the dorsal fins in some fishes.



Fig. 1. A – monogenea *Dactylogyrus extensus*; B – larval stage of nematode *Contracaecum spiculigerum*; C and D – Cysticercoid stage of cestode *Neogriporhynchus cheilancristrotus*; E and F – crustacea *Ergasilus sieboldi*

The larval stage of nematode *Contracaecum spiculigerum* was founded in the intestinal mesentery of the studied fishes (Fig. 1B). The parasitic crustacean *L. cyprinacea* turned out to be the most infecting species of common carp in the studied area. This parasite was founded on the surface of the body in 85 fishes. *A. foliaceus* was founded on the fins and on the scales in other studied common carps. In addition, we recorded another adult individual of the crustacean *Ergasilus sieboldi* (Fig. 1E and F), on the fin of the common carp.

4. Discussion

A comparative analysis of parasites of common carp was carried out with our data and data of other authors who conducted research in 1975 and 2001 in the Kura River basin (Tab. 2). In total, 46 species of parasites were noted in common carp (Protista - 16, Monogenea - 7, Cestoda - 2, Trematoda - 9, Nematoda - 5, Acanthocephala - 1, Hirudinea - 1, Mollusca - 1, Crustacea - 4). Thus, when comparing the data, it was found that the parasites registered in 1975 (*Eimeria carpelli*, *Myxobolus dogieli*, *Myxobolus ellipsoides*, *Myxobolus oviformis*, *Trichodinella subtilis*, *Dactylogyrus vastator*, *Asymphylogora kubanicum*, *Asymphylogora imitans*, *Asymphylogora markewitschi*, *Hysteromorpha trilobea*, *Eustrongylides* sp., *Porrocaecum reticulatum*, *Pomphorhynchus laevis*, *Piscicola geometra*, *Caligus lacustris*) of the common carp were not recorded either by us or by other authors who conducted parasitological studies in this area (Mikayılov, 1975). Table 2 shows that common carp had lost up to 70% (16 species) of its current ones, but acquired 14 species in return and eventually rose to the 21st species of parasites by the 2001 years. It should be noted that the following species were recorded in common carp only in 2001: *Tripanasoma danilyewskiy*, *Cryptobia cyprini*, *Myxosoma circulus*, *Hemiophrys branchiarum*, *Gyrodactylus stankovici*, *Gyrodactylus cyprini*, *Diplostomum parasphthaceum*, *Metagonimus yokoqowai*, *Capillaria brevispicula*, *Contracaecum squalii* (Mikailov & Kaziyeva, 2001). These species were not founded in other authors, including ours too. Despite these data, there are species of parasites that are nevertheless noted by both authors (*Myxobolus dispar*, *Hemiophrys circulus*, *Dactylogyrus anchoratus*, *Dactylogyrus extensus*, *Gyrodactylus sprostonae*, *N. chellancristrotus*, *Ph. elongatum*). It turns out that out of 37 species of parasites noted until the 2001, only 7 species (18.9%) were in favorable ecological conditions in the Kura River basin until the mentioned time. In recent years (2017-2022), our studies have shown that the parasite fauna of the common carp has again changed significantly in this area. At the moment, of the parasites recorded in the 2000's, only 6 species have been noted (*T. nigra*, *D. extensus*, *N. chellancristrotus*, *C. fimbriceps*, *A. foliaceus*, *P. cuticola*). Under the changed environmental conditions in recent years, common carp has lost about 84% of the previous parasites, but in their place acquired 9 new species (*M. cyprini*, *Th. nikolskii*, *A. carpelli*, *Ich. multifilliis*, *G. medius*, *D. chromathophorum*, *L. cyprinacea*, *E. sieboldi*, *C. spiculigerum*), which were not previously registered in this area. Two species of parasites, monogenean - *D. extensus* and cestode - *N. cheilancristrotus* were noted by all authors, including us. These species despite the changed environmental conditions were able to settle down with their host in the Kura River basin. *D. extensus* is although an ectoparasite, but this is a specific species for common carp.

It should also be noted that among the protozoan parasites, myxosporidia (despite the fact that separate species, but belonging to the same genus) were noted in all authors, including ours. Since the spores of these species are heavy, they are absorbed by carp during their feeding.

Table 2. List of parasites of carp registered by different authors in the Kura River basin on the territory of Azerbaijan

№	Species of parasites	1	2	3
	Kinetoplastida			
1	<i>Tripanasoma danilyewskiy</i> Vinnichenco, 1971	-	+	-
2	<i>Cryptobia cyprini</i> Plehn, 1903	-	+	-
	Sporozoa			
3	<i>Eimeria carpelli</i> Leger et Stankovitch, 1921	+	-	-
	Myxozoa			
4	<i>Myxosoma circulus</i> Achmerov, 1960	-	+	-
5	<i>Myxobolus dogieli</i> Bychowsky, 1940	+	-	-
6	<i>Myxobolus dispar</i> Thelohan, 1895	+	+	-
7	<i>Myxobolus cyprini</i> Doflein, 1898	-	-	+
8	<i>Myxobolus ellipsoides</i> Thelohan, 1892	+	-	-
9	<i>Myxobolus oviformis</i> Thelohan, 1882	+	-	-
10	<i>Thelohanellus nikolskii</i> Achmerov, 1955	-	-	+
	Ciliophora			
11	<i>Hemiophrys circulus</i> Kahl, 1931	+	+	-
12	<i>Hemiophrys branchiarum</i> Weinrich, 1925	-	+	-
13	<i>Ichthyophthirius multifiliis</i> Fouquet, 1876	-	-	+
14	<i>Apiosoma carpelli</i> Banina, 1968	-	-	+
15	<i>Trichodina nigra</i> Lom, 1960	-	+	+
16	<i>Trichodinella subtilis</i> Lom, 1959	+	-	-
	Monogenea			
17	<i>Dactylogyrus vastator</i> Nybelin, 1924	+	-	-
18	<i>Dactylogyrus extensus</i> Mueller, 1932	+	+	+
19	<i>Dactylogyrus anchoratus</i> Dujardin, 1845	+	+	-
20	<i>Gyrodactylus stankovici</i> Ergens, 1970	-	+	-
21	<i>Gyrodactylus sprostonae</i> Ling, 1962	+	+	-
22	<i>Gyrodactylus medius</i> Kathariner, 1895	-	-	+
23	<i>Gyrodactylus cyprini</i> Diarova, 1964	-	+	-
	Cestoda			
24	<i>Caryophyllaeus fimbriceps</i> Annenkova-Chlopina, 1919	-	+	+
25	<i>Neogriporhynchus chellancristrotus</i> Wedl, 1955	+	+	+
	Trematoda			
26	<i>Asymphyiodora kubanicum</i> Issaitschikov, 1923	+	-	-
27	<i>Asymphyiodora imitans</i> Muhling, 1898	+	-	-
28	<i>Asymphyiodora markewitschi</i> Kulakowskaya, 1947	+	-	-
29	<i>Phyllodistomum elongatum</i> Nybelin, 1926	+	+	-
30	<i>Diplostomum parasphthaceum</i> Shigin, 1965	-	+	-
31	<i>Diplostomum chromathophorum</i> Shigin, 1986	-	-	+
32	<i>Posthodiplostomum cuticola</i> Nordmann, 1832	-	+	+
33	<i>Hysteromorpha trilobica</i> Rudolphi, 1819	+	-	-
34	<i>Metagonimus yokoqowai</i> Katsurada, 1912	-	+	-
	Nematoda			
35	<i>Capillaria brevispicula</i> Linstow, 1873	-	+	-
36	<i>Eustrongylides</i> sp.	+	-	-
37	<i>Porrocaecum reticulatum</i> Linstow, 1899	+	-	-
38	<i>Contracaecum squalii</i> Linstow, 1908	-	+	-
39	<i>Contracaecum spiculigerum</i> Rudolphi, 1809	-	-	+
	Acanthocephala			
40	<i>Pomphorhynchus laevis</i> Muller, 1776	+	-	-
	Hirudinea			

41	<i>Piscicola geometra</i> L., 1761	+	-	-
	Mollusca			
42	<i>Anodonta cyrea</i> Drouet, 1881	+	-	+
	Crustacea			
43	<i>Ergasilus sieboldi</i> Nordmann, 1832	-	-	+
44	<i>Lernaea cyprinacea</i> L., 1758	-	-	+
45	<i>Caligus lacustris</i> Steenstrup & Lutken, 1861	+	-	-
46	<i>Argulus foliaceus</i> L., 1758	-	+	+
	Total	23	21	16

Note: 1– Mikayilov, 1975; 2 – Mikayilov & Kaziyeva, 2001; 3 – own data.

5. Conclusion

Summing up our and literature data, for the entire period of research (1975-2022 years) in the Kura River basin within Azerbaijan, only 46 species of parasites were identified in common carp. A comparative analysis of the data with other authors showed that the parasite fauna of the common carp at the initial stage (1975) of the study was 23 species, by the 2001s it had decreased to 21 species, but lost about 70% of the species, but instead acquired 14 new species. To date, we have identified 16 species, of which 9 species are recorded for the first time in common carp in the above area. Despite the changed environmental conditions during the entire period of the study, only two species of the parasite *D. extensus* and *N. cheilancristrotus* managed to settle down in their host in this area.

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