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THE PARASITE FAUNA OF THE SILVER CARP (*Hypophthalmichthys molitrix* Val., 1844) IN THE MINGACHEVIR SCIENTIFIC AND EXPERIMENTAL BASELAKES AND COMPARATIVE ANALYSIS

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Abstract. The article presents a comparative analysis of the parasite fauna of the silver carp (*Hypophthalmichthys molitrix* Val., 1844) in its natural habitat (Amur River), in the lakes of the Mingachevir scientific and experimental base, various fish farms in Azerbaijan and water bodies of other countries where this fish was reintroduced. It has been established that 62 species parasitized in silver carp. Of these, 25 species were identified in their natural habitat, and 37 species were acquired after reintroduction. 15 species are registered in Azerbaijan, including 6 species in the Mingachevir scientific and experimental base. For the trematode *D. chromatophorum*, the nematode *C. spiculigerum*, and the mollusk *A. cyrea*, we for the first time identified the silver carp as a host.

Keywords: *silver carp, parasites, current status, comparative analysis.*

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1. Introduction

On the territory of the Republic of Azerbaijan there are various reservoirs suitable for the development of fisheries. The State Program for the Development of Aquaculture in the Republic for 2023-2027 addresses issues that should provide the population with high-quality fish and fish products, reduce dependence on imports, increase export potential, reduce the anthropogenic impact of natural reservoirs and other issues. To achieve this goal, fishes are imported into the country that are considered more favorable than other fish species in terms of rearing conditions, endurance and feed requirements for artificial lake fish farms. One of the main fishes used in lake fishing in Azerbaijan is the silver carp (*Hypophthalmichthys molitrix* Val., 1844). It was brought to Azerbaijan in 1962 for the purpose of acclimatization from individuals living in the freshwater basins of the Chinese territory (Abdullayeva, 2010).

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In addition to proper maintenance and feeding of fish in farms, in order to achieve high productivity in lake fisheries, the parasitological situation should be constantly monitored and thoroughly studied. There is a possibility that parasites that do not belong to the local fauna may also fall with imported fish. What makes the parasitological study of such fish relevant is that the parasites they bring to the basin have certain effects on the ecological characteristics of the local parasitic fauna. All this allows us to see in advance the process of preventing the damage that parasites can do to fish farms. There is an experience of keeping domestic waterfowl in fish farm lakes. However, we should not forget that both fish and birds participate in the development cycle of some parasites (Seyidbeyli & Rzayev, 2018; Rzayev, 2021a, 2021b; Rzayev *et al*., 2021a, 2021b). There are some literatures about the parasites of silver carp in the territory of our country (Abdullayeva, 2010, 2012; Suleymanova, 2004). Large-scale studies have been conducted in other countries to study the parasites of the mentioned fish (Yukhimenko, 1972; Ali *et al*., 1989; Alam*et al*., 2012; Mhaisen & Al-Rubaie, 2016; Yakhchali, 2018; Thakur *et al*., 2020).

Ichthioparasitological monitoring of such fish grown in fish farms allows finding more effective methods from parasites. The acquisition of such information helps to plan the density of fish breeding in fish farms and to prevent disease-causing parasites from entering the farm. Taking into account all the above, by conducting a parasitological and morphobiological study of the silver carp cultivated in the lakes of the Mingachevir Scientific Experiment Base, the aim was to determine their parasite fauna in the current period, and to provide a comparative analysis with the parasite fauna of the mentioned fish in different areas of the country and its borders.

2. Material and methods

Researches were carried out in 2021-2023, and ichthyoparasitological materials were collected from 64 silver carp fishes caught from the lakes of Mingachevir Scientific Experiment Base of Institute of Zoology (Ministry of Science and Education of the Republic of Azerbaijan). Collection, fixation, and processing of parasitological material was carried out on the basis of generally accepted methods (Dogel, 1933; Markevich, 1951; Gusev, 1983; Bykhovskaya-Pavlovskaya, 1985; Shigin, 1986). Freshly caught fish and sometimes fixed in 4% formalin solution were used for research. MBS-1 (Russia) binocular loupe, Amplival Carl Zeiss (Germany) and MBI-3 (Russia) light microscopes were used in the work process. Determinant atlases were used in the identification of parasite species (Bauer, 1984, 1985, 1987; Pugachev, 2001).

3. Results and discussion

During the complete parasitological study of the silver carp grown in the lakes of the Mingachevir Scientific Experiment Base, we noted 6 species (1 species of monogenean – *Gyrodactylus elegans*, 1 species of trematode – *Diplostomum chramotophorum*, 1 species of nematode – *Contracaecum spiculigerum*, 2 species of crustaceans – *Lernaea cyprinacea*, *Argulus foliaceus*, 1 species of mollusc – *Anadonta cyrea*) of parasites in them. Of them, 4 species are ecto- (monogenean, crustaceans and molluscs), and 2 species are endoparasites (trematode and nematode). The total extent of parasite infection was 64.29%, and the intensity was 1-30 examples. Compared to

other fish grown in the lakes in the study area, parasite infestation was lower for the number of species composition. Thus, 13 species of parasites were recorded in the common carp fish grown in those lakes (Nasirov*et al.*, 2021; Seyidli *et al.*, 2021, 2022). Among the parasites recorded in silver carp, 2 species (trematode - *D. chromatophorum* (40%) and mollusc - *A. cyrea* (26.1%)) differed from others due to their high rate of extensiveness. In the remaining four species (*G. elegans, C. spiculigerum, L. cyprinacea, A. foliaceus*), the percentage of infection is low and the IE varies from 2.40 to 4.78%. Due to its intensity, only one species prevailed (*D. chromatophorum* – 20-30 examples). Therefore, 1 species (*D. chromatophorum*) out of 6 species of parasites found in the studied silver carp in the lakes in the territory of the Mingachevir Scientific Experiment Base stands out from the others due to both the intensity and extensiveness of the infection. Such infection is due to the swimming of the silver carp near the aquatic plants where the intermediate hosts of the parasite live. Infection of silver carp with one or more types of parasites (mix invasion) has also been noted in the territory of experimental base. Thus, in 84.62% of fish infected with parasites, 1 species, 11.54% of 2 species, and 3.84% of 3 species of parasites were recorded. Despite the low intensity of some parasites, they can cause serious damage to the host's body. One of these species is the parasitic crustacean *L. cyprinacea* which found in the silver carp. Copepodite forms of the parasite have been found on the skin of fish, especially on the base of the pectoral fins. But it was the adult form of the crustacea that caused the most damage to the silver carp. Compared to other fish, one of the main reasons for the small number of parasite infections in silver carp is that most of them are not yet fully exposed to parasites at early age, and compared to other fish, they have a strong immunity against parasites.

In the territory of the country, several research works have been carried out in the direction of the study of the parasite fauna of the silver carp (Abdullayeva, 2010, 2012; Suleymanova, 2004). Nine species of parasites were noted by the researcher in silver carps from the Absheron fish-commodity farm (2 species of protozoa – *M. muelleri*, *Ch. piscicola,* 2 species of monogenea – *D. ctenopharyngodonis, E. nipponicum,* 1 species of cestoda – *B. acheilognathi,* 1 species of nematoda – *C. complanatum,* 3 species of crustacean - *A. foliaceus, L. cyprinacea, Ergasilus sieboldi*) (Suleymanova, 2004). Another author who conducted research in different areas of Azerbaijan (Shirvan and Mingachevir auxiliary fisheries, Oryad full-system lake farm, Neftchala fish-commodity farm, Ashig Bayramli reservoir of Ismayilli region) has a total of 6 species of parasites in silver carp (2 species of cestodes - *B. acheilognathi, D interrupta*, 1 species of trematode - *D. spathaceum*, 3 species of crustaceans - *E. sieboldi, L. cyprinacea, A. foliaceus*) (Abdullayeva, 2010). It should be noted that ectoparasites are the majority of the parasites recorded by both researchers, as well as by us. Crustaceans dominated among ectoparasites in all research studies.

Thus, as a result of the analysis of literature data and the results of our own research, it was determined that 15 species of parasites (2 species of protozoa - *M. muelleri, Ch. piscicola,* 3 species of monogeneans - *G. elegans, D. ctenopharyngodonis, E. nipponicum,* 3 species of trematodes - *D. chromatophorum, D. spathaceum, C. complanatum,* 2 species of cestodes - *B. acheilognathi, D. interrupta*, 1 species of nematode - *C. spiculigerum*, 3 species of crustaceans - *E. sieboldi, L. cyprinacea, A. foliaceus,* 1 species of mollusc - *A. cyrea*) covering almost all systematic groups were recorded in the fishery-commodity farms in silver carp in the territory of Azerbaijan. It should also be noted that 1 species of monogenean - *G. elegans,* 1 species of trematode

- *D. chromatophorum*, 1 species of nematode - *C. spiculigerum* and 1 species of mollusc - *A. cyrea* were identified for the first time in fish farms in silver carp on the territory of the country. In all the studies conducted in the direction of the study of the parasites of the silver carp in the country, as well as in our work, only two species (crustaceans - *L. cyprinacea, A. foliaceus*) out of 15 species of parasites were identical. Two species of protozoan parasites were recorded only in the Absheron fish-commodity farm in the territory of country (Suleymanova, 2004).There is information about the detection of three parasitic species (*D. spathaceum*, *E. sieboldi*, *L. cyprinacea*) in silver carp in Mingachevir auxiliary fisheries (Abdullayeva, 2010). Only *L. cyprinacea* crustacean was recorded from the mentioned parasitic species among the silver carp grown in the lakes of the Mingachevir Scientific Experiment Base.

In the countries covering the range of distribution and the reintroduced areas of the silver carp, extensive research works have been carried out in the direction of studying their parasites (Yukhimenko, 1972; Ali *et al.,* 1989; Alam *et al*., 2012; Mhaisen & Al-Rubaie, 2016; Yakhchali, 2018; Thakur *et al.,* 2020). Analyzing local and foreign literature data and summarizing the results obtained from our own research, we have prepared a table containing the list of parasites found in silver carp fish. It was found that a total of 62species (protozoa - 22 species, monogenea - 18 species, tapeworms - 2 species, trematodes - 5 species, nematodes - 4 species, acanthocephala - 2 species, crustaceans - 7 species, molluscs - 2 species) of parasites were recorded in silver carp. Forty-nine species of parasites are ectoparasites and 13 species are endoparasites. It was determined that there are more protozoa (22 species) and monogeneans (18 species) in silver carp (Table 1).

Table 1. A general list of parasites noted in silver carp

Species		1	2	3	4	5	6
Myxozoa							
1	*Myxosoma sphaerica*	+	-	-	-	-	-
2	*Myxobolus pavlovskii*	+	-	-	-	-	-
3	*Myxobolus dispar*	+	-	-	-	-	-
4	*Myxobolus drjagini*	+	-	-	-	-	-
5	*Myxobolus pfeifferi*	-	-	+	-	-	-
6	*Myxobolus rohitae*	-	+	-	-	-	-
7	*Myxobolus muelleri*	-	-	-	-	-	+
8	*Thelohanellus oculileucisci*	+	-	-	-	-	-
Ciliophora							
9	*Ichthyophthirius multifiliis*	+	+	+	-	-	-
10	*Trichodina nobilis*	+	-	-	-	-	-
11	*Trichodina nigra*	+	-	+	-	-	-
12	*Trichodina strelkovi*	+	-	-	-	-	-
13	*Trichodina cottidarum*	-	-	+	-	-	-
14	*Trichodina domerguei*	-	-	+	-	-	-
15	*Trichodina pediculatus*	-	+	-	-	-	-
16	*Apiosoma piscicola*	+	-	+	-	-	-
17	*Apiosoma cylindriformis*	+	-	+	-	-	-
18	*Apiosoma amoebae*	-	-	+	-	-	-
19	*Chilodonella cyprini*	+	-	+	-	-	-
20	*Chilodonella piscicola*	-	-	-	-	-	+
21	*Tetrahymena pyriformis*	+	-	-	-	-	-
22	*Hemiophrys macrostoma*	+	-	-	-	-	-

Monogenea							
23	*Dactylogyrus skrjabini*	+	-	+	+	-	-
24	*D. hypophthalmichthys*	+	-	+	-	-	-
25	*Dactylogyrus suchengtaii*	+	-	-	-	-	-
26	*Dactylogyrus wuhuensis*	+	-	-	-	-	-
27	*Dactylogyrus nasalis*	+	-	-	-	-	-
28	*Dactylogyrus vaginulatus*	+	-	-	-	-	-
29	*Dactylogyrus aristicthys*	-	-	-	+	-	-
30	*Dactylogyrus nobilis*	-	-	-	+	-	-
31	*Dactylogyrus thaihoansis*	-	-	-	+	-	-
32	*Dactylogyrus extensus*	-	-	+	-	-	-
33	*Dactylogyrus inexpectatus*	-	-	+	-	-	-
34	*Dactylogyrus latituba*	-	-	+	-	-	-
35	*Dactylogyrus vastator*	-	+	-	-	+	-
36	*D. ctenopharyngodonis*	-	-	-	-	-	+
37	*Gyrodactylus elegans*	-	+	+	-	+	+
38	*Gyrodactylus macracanthus*	-	-	+	-	-	-
39	*Gyrodactylus malmbergi*	-	-	+	-	-	-
40	*Eudiplozoon nipponicum*	-	-	-	-	-	+
Cestoda							
41	*Bothriocephalus acheilognathi*	-	-	-	-	+	+
42	*Digramma interrupta*	-	-	-	-	-	+
Trematoda							
43	*Metagonimus yokogawai*	+	-	-	-	-	-
44	*Diplostomum spathaceum*	+	-	+	+	-	+
45	*Diplostomum indistinctum*	-	-	+	-	-	-
46	*Diplostomum chromatophorum*	-	-	-	-	-	+
47	*Clinostomum complanatum*	-	-	-	-	-	+
Nematoda							
48	*Rhabdochona hellichi*	-	-	+	-	-	-
49	*Camallanus hypophthalmichthys*	+	-	-	-	-	-
50	*Camallanus ophiocephali*	-	+	-	-	+	-
51	*Contracaecum spiculigerum*	-	-	-	-	-	+
Acanthocephala							
52	*Neoechinorhynchus rutili*	-	-	+	-	-	-
53	*Pallisentis ophiocephali*	-	+	-	-	-	-
Crustacea							
54	*Sinergasilus lieni*	+	-	-	-	-	-
55	*Lamproglena orientalis*	+	-	-	-	-	-
56	*Argulus foliaceus*	-	-	+	-	-	+
57	*Ergasilus mosulensis*	-	-	+	-	-	-
58	*Ergasilus sieboldi*	-	-	+	-	-	+
59	*Paraergasilus inflatus*	-	-	+	-	-	-
60	*Lernaea cyprinacea*	-	-	+	-	-	+
Mollusca							
61	*Unio pictorum*	-	-	+	-	-	-
62	*Anadonta cyrea*	-	-	-	-	-	+

Note: 1- Yukhimenko, 1972 (Russia, Amur river); 2 –Alam *et al.*, 2012 (Bangladesh, Rajshahi City); 3 – Mhaisen & Al-Rubaie, 2016 (Iraq, many farms); 4 - Yakhchali, 2018 (Iran, Hassanlu Reservoir); 5 - Thakur *et al.*, 2020 (India); 6 - Abdullayeva, 2014, Suleymanova, 2007 and own data.

As a result of the scientific research conducted in the natural area of the silver carp (Amur River and its basins), 25 species of parasites (protozoa - 14 species, monogeneans - 6 species, trematodes - 2 species, nematodes - 1 species, crustaceans - 2

species) were recorded in the host (Yukhimenko, 1972). Out of 15 species of parasites observed in the mentioned fish in the territory of Azerbaijan, both by us and according to the data of other researchers, only one is identical with the species found in the natural habitat – *Diplostomum spathaceum* (Trematoda). The other 24 species were lost in the reintroduced silver carp to the territory of Azerbaijan, and the owners acquired new parasites in artificially created fisheries. In fish, 22 out of 25 species parasites which recorded in the natural habitat are ectoparasites, and they are more sensitive to changes in the external environment (chemical composition of water, temperature, etc. changing environmental conditions). Therefore, it can be cited as one of the reasons why fish parasites species in their natural range are not found in new areas where they have adapted. It is the information about the occurrence of the endoparasite *D. spathaceum* in both areas that confirms our opinion once again.

There is information on the species composition of parasites of reintroduced silver carp in India, Bangladesh, Iran and Iraq in recent years (2012-2022) (Yukhimenko, 1972; Alam*et al.*, 2012; Mhaisen & Al-Rubaie, 2016; Yakhchali, 2018; Thakur *et al.*, 2020). Silver carps with a species composition rich in parasites has been found in Iraq. By conducting parasitological studies in many commercial fishing farms of the country, 27 species (protozoa - 9 species, monogenea - 8 species, trematoda - 2 species, nematoda - 1 species, acanthocaphala - 1 species, crustacea - 5 species, mollusc - 1 species) of parasites have been identified in silver carp of different ages (Mhaisen & Al-Rubaie, 2016). Of them, 23 species are ectoparasites, and 4 species belong to endoparasites. Among the parasites found in those farms, only *Ich. multifiliis, T. nigra, A. piscicola, A. cylindriformis, Ch. cyprini, D. skrjabini, D. hypophthalmichthys, D. spathaceum* (8 species) were the same as the species found in the natural area of the silver carp. The other 19 species were acquired later.

Only one species (*Ich. multifiliis*) of the seven species (protozoa - 3, monogenea - 2, nematoda - 1, acanthocephala - 1) recorded in silver carp in the farms operating in the territory of Bangladesh is identical to the species observed in the natural habitat of the fish (Alam *et al.*, 2012).Other six species were later acquired by the host. In Iran (Hassanlu Reservoir) and India, five (monogenea – 4, trematoda – 1) and four (monogenea – 2, cestoda – 1, nematoda – 1) species of parasites have been recorded in silver carp, respectively (Yakhchali, 2018; Thakur *et al.*, 2020). Monogenea *D. skrjabini* and trematoda *D. spathaceum* found in fishes in the territory of Iran have also been recorded in the natural habitat of the silver carp. In the Indian territory, none of the parasites observed in the silver carp were found in the fish distributed in the Amur River basin. Those species have acquired their new parasites in reintroduced areas.

5. Conclusion

Thus, as a result of the analysis of literature data and our own materials, it was found that, while 25 of the 62 species of parasites recorded in silver carp were found in their natural area, only 8 (protozoa - *Ich. multifiliis, A. cylindriformis, C. cyprini, A. piscicola, T. nigra,* monogenea - *D. hypophthalmichthys, D. skrjabini,* trematoda - *D. spathaceum*) of them were observed in the reintroduced areas (fish farms). Reintroduced silver carp have acquired an additional 37 species (protozoa – 8, monogenea– 12, cestoda – 2, trematoda – 3, nematoda – 3, acanthocephala – 2, crustacea – 5, mollusc – 2) of parasites in fish farms. Among them, 14 species belong to all authors conducting research in the territory of Azerbaijan, and four species (*G. elegans, D.*

chromatophorum, C. spiculigerum, A. cyrea) belong to our research only. In addition, in the lakes in the territory of the Mingachevir Scientific Experiment Base, for the first time, the silver carp was recorded as a host for *D. chromatophorum* trematode, *C. spiculigerum* nematode and *A. cyrea* mollusc.

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