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Helminthofauna of the Caspian fish (*Vimba vimba persa*) of the Agrachan Bay

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Abstract. The parasitofauna of the fish (*Vimba vimba persa* (Pallas, 1814)) in Northern Agrachan was studied in the spring of 2019, 2021 and 2023. This work examines the degree of infestation of the fish by individual parasites and identifies the qualitative and quantitative composition of the fish parasitofauna. The material was collected from commercial and scientific catches. The Agrachan Bay is located in the Caspian Sea, where the sturgeon and other fish species spawn. Eight species of parasites were detected, belonging to four classes: Monogenea, Trematoda, Cestoda, and Nematoda. Changes in hydrochemical parameters, water levels in the Agrachan Bay, and the overall decline in the Caspian Sea's level have a direct impact on the parasitic fauna of fish, including the sturgeon. The water temperature in shallow waters has a significant impact, varying from freezing to overheating depending on the season, as well as the hydrological regime, which affects the quantitative and qualitative composition of hydrobionts involved in the food chain and the reproduction chain. The conducted studies have revealed changes in the number of invasive diseases in fish. It can be noted that the intensity of infestations and the extensiveness of infestations of such numerous species as *Caryophyllaeus laticeps* and *Diplostomum spathaceum* have decreased. The decrease in the infestation of fish may indicate a deterioration in the hydrological condition of the water body, as well as a decrease in the number of waterfowl, which can disrupt the development cycle of helminths. The obtained indicators of fish infection with the zoonosis pathogen *A. schupakovi* indicate the persistence, active functioning, and circulation of powerful natural foci of anisakidiasis.

Keywords: Caspian Sea, parasitic fauna of fish, intermediate host, flat and roundworms

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Научная статья

Гельминтофауна каспийского рыбца (*Vimba vimba persa*) Аграханского залива

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Аннотация. Паразитофауну рыбца (*Vimba vimba persa* (Pallas, 1814)) в Северном Аграхане исследовали в весенний период 2019, 2021–2023 гг. Изучена степень зараженности рыбца отдельными паразитами, выявлен качественный и количественный состав паразитофауны рыб. Материал отбирался из промысловых и научных уловов. Аграханский залив находится в Каспийском море, где нерестятся рыбец и другие виды рыб. Было обнаружено 8 видов паразитов из 4 классов: Monogenea, Trematoda, Cestoda, Nematoda. Изменения гидрохимических показателей, уровня воды в Аграханском заливе и в целом падение уровня Каспийского моря оказывают непосредственное влияние и на паразитофауну рыб, в том числе рыбца. Большое влияние оказывают температура воды на мелководье, которая меняется от замерзания до перегрева в зависимости от времени года, а также гидрологический режим, при котором меняется количественный и качественный состав гидробионтов, участвующих в пищевой цепи и в цепи размножений паразита. Проведенные исследования позволили выявить изменения численности инвазивных заболеваний рыбца. Можно отметить, что снизилась численность интенсивности инвазий и экстенсивность инвазий таких многочисленных видов, как цестоды *Caryophyllaeus laticeps* и трематоды *Diplostomum spathaceum*. Снижение зараженности рыбца может указывать на ухудшение гидрологического состояния водоема, а также на уменьшение количества водоплавающих птиц, что приводит к нарушению цикла развития гельминтов. Полученные показатели зараженности рыб возбудителем зоонозов *A. schupakovi* свидетельствуют о сохранении, активном функционировании и циркуляции мощных природных очагов инвазии анизакидоза.

Ключевые слова: Каспийское море, паразитофауна рыбца, промежуточный хозяин, плоские и круглые черви

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Introduction

The Agrachan Bay is located on the north-western coast of the Caspian Sea, at the junction of its Northern and Middle regions.

The diversity of zooplanktonic and benthic organisms in the studied bay creates favorable conditions for the feeding, overwintering, and migration of various species of riverine, semi-anadromous, and anadromous fish, which in turn contributes to the increase of their stocks.

From literary sources, it is known that the Caspian Sea is home to 141 species of fish, with more than 42% of them being commercially important, including the rudd (*Vimba vimba persa* (Pallas, 1814)), which has a wide habitat range along the Dagestan coast of the Caspian Sea [1].

However, during the winter, a significant portion of the fish population is found in the marine zone, and only in early spring, in March, does it migrate to the

coastal waters south of the Samur River. The mass spawning of the fish in the delta reservoirs and in the Northern and Southern Agrachan is observed in late April at a water temperature of 14–16 °C [1, 2].

It is known that anthropogenic impact on marine and inland water bodies remains intensive at the current stage. The introduction of toxic substances from both industrial and agricultural production into natural water bodies causes disruption of both the hydrochemical and, sometimes, the hydrological regime of the environment, resulting in a decrease in the number and species diversity of aquatic invertebrate fauna, and, consequently, of ichthyoparasites [3–5].

The aim of this study was to investigate the parasitofauna of the fish in the Agrachan Bay.

The study of the parasitofauna, on the example of the ruff and other fish species, allows not only to determine the diversity of parasites in a given body of water,

but also to identify their species that pose a danger both to the fish organism and, possibly, to humans, since the ruff is an object of fishing.

In literary sources there are data on the parasitofauna of the ruff, mainly inhabiting rivers, lakes and reservoirs [4, 5-8].

The parasitofauna of the Caspian Sea fish is poorly studied. There are fragmentary data from studies conducted in 2015-2018 in the Caspian Sea, the northern and southern parts of the Agrachan Bay [8], where the authors report that 10 species of helminths were identified in the fish: 2 species of the Monogenea class, 6 species of the Trematoda class, and 2 species of the Nematoda class. Also, in the work of Khasbulatova [8] (2019) are reflected 9 species of helminths of the fish: 2 species of nematodes – *Anisakis*, *Eustrongylides excisus*, 4 species of trematodes – *Bucephalus polymorphus*, *Diplostomum spathaceum*, *Tylodelphys clavata*, *Hysteromorpha triloba*, 2 species of monogenei – *Dactylogyrus cornu*, *Diplozoon paradoxum* and 1 species of acanthocephalans – *Corynosoma strumosum*.

Material and research methods

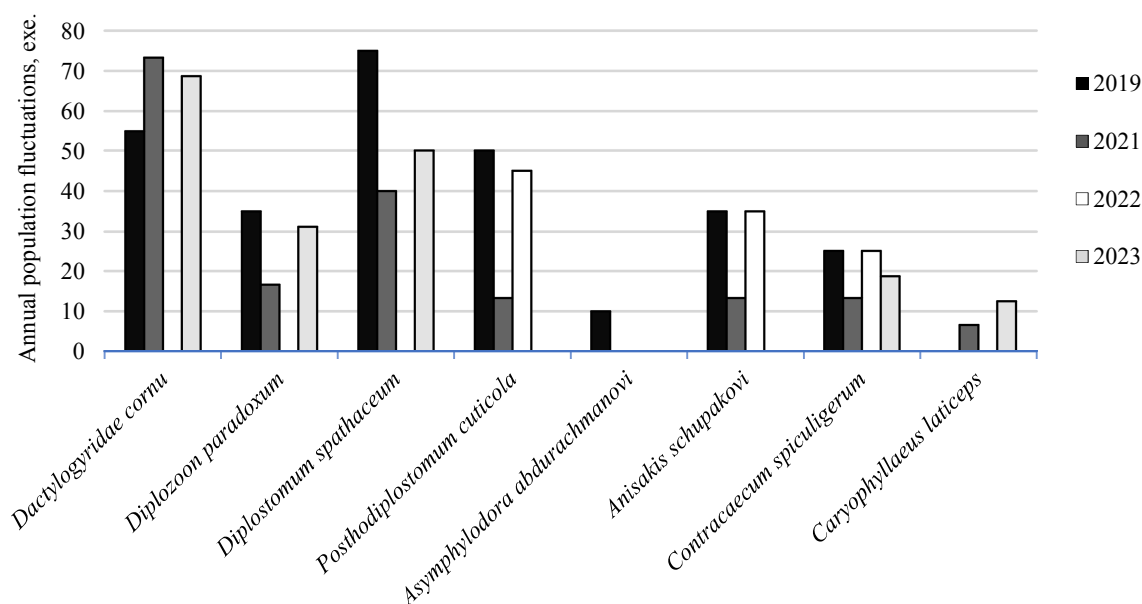
The material for the work was parasitological studies of 86 specimens of the fish of the senior age group, during commercial fishing of fish in the spring period of 2019, 2022-2023. The method of complete parasitological opening of Bykhovskaya-Pavlovskaya [9, 10] was used. Parasites were identified according to the "Identification of Parasites of Freshwater Fish of the USSR Fauna" [10], using the Mikmed-5 biological microscope and the MBS-10V stereoscopic microscope.

The studies evaluated the extent and intensity of infestation, as well as the abundance index of parasites. The extent of infestation is the percentage of infected fish in a herd, population, etc. The intensity of infestation is the number of parasites on a single fish specimen. The average intensity of infestations is the average number of parasites per infected fish. The abundance index is the average number of parasites per individual.

The investigation of the result

The composition of the fauna of the bay of those wishing to try the new Year. The deputy researcher of the Agrakhansky Institute observed a change in fish parasites. 8 species and 4 classes of helminthiasis were identified: *Dactylogyrus cornu* (Monogenea: Dactylogyridae), *Diplozoon paradoxum* (Monogenea: Diplozoidae), *Diplostomum spathaceum*, *Posthodiplostomum cuticola*, *Abdurachmanovi asphyllodora* (Trematoda: Diplostomidae), *Anisakis schupakovi*, *Contracaecum spiculigerum* (Nematoda: Anisakidae), *Caryophyllaeus laticeps* (Cestoda: Caryophyllaeidae).

Dactylogyrids are a very numerous groups of gill flukes. Two species have been identified in the studied specimens of the fish: *Dactylogyrus cornu* and *Diplozoon paradoxum*. *D. cornu* has a direct development cycle and is localized on the gill flaps. When there is a large number of flukes, the gills are covered with a thick layer of mucus, which can lead to the destruction of individual gill flaps, hemorrhages, and anemia. Depending on the time of year, the intensity of infestations reaches up to 500 individuals, the prevalence in 2021 was 73.3% (Fig.).



Annual fluctuations in the parasite fauna of vimba

The trematode *D. spathaceum* belongs to the allogenetic group, which uses the fish as an intermediate host and reaches sexual maturity in a marine waterfowl. The free-floating cercariae of *D. spathaceum* actively penetrate the eyes of fish and develop into metacercariae [11]. The infection rate during the study period ranged from 50 to 75% (Fig.) with an infection

intensity of 1-50 specimens. Metacercariae were detected in the lens of fish, and at high intensity (more than 15-20 specimens), the lens becomes cloudy, decreases in size, and fish without a lens are often found.

The maximum infection rate of *D. paradoxum* was more than 35% with an invasion rate of 2-30 specimens (Table).

Vimba infection rates

Type of parasite	Intensity of invasions (max-min)	Extent of invasions, %	Average intensity of invasions, exe.	Abundance index, exe.
<i>Dactylogyridae cornu</i>	60-10	51.1	7.1	3.6
<i>Diplozoon paradoxum</i>	16-2	19.7	5.1	0.8
<i>Diplostomum spathaceum</i>	9-1	41.8	2.4	1.0
<i>Posthodiplostomum cuticola</i>	114-20	26.7	27.9	7.4
<i>Asymphylogora abdurachmanovi</i>	2-1	2.3	2.0	0.02
<i>Anisakis schupakovi</i>	12-1	30.2	4.7	1.4
<i>Contracaecum spiculigerum</i>	7-1	19.7	4.0	0.7
<i>Caryophyllaeus laticeps</i>	4-2	2.3	3.0	0.02

Nematodes *A. schupakovi* and *C. spiculigerum* belong to the Anisakidae family and are widely specific parasites of carp and other representatives of the ichthyofauna of the Caspian Sea. *A. schupakovi* was found in the fish with weakly expressed morphometric features on the surface of the liver, spleen, in the body cavity, in the intestines, and in the musculature. An obligate parasite with a complex development cycle in fish, it parasitizes only in the larval stage and reaches sexual maturity in a single mammal, the seal, which lives in the Caspian Sea [12, 13]. In 2019-2023, the fish parasite had an infection rate of 13.3 to 35% (Fig.), with an infection intensity of 1 to 12 specimens.

The infestation rate of *C. spiculigerum* in the fish was 25%. They are found in the intestines of the fish in the larval stage, with an intensity of 1-10 specimens. The fish become infected by eating intermediate hosts, such as copepods, and the definitive host is a waterfowl. The larvae of the Anisakidae family remain viable in both saltwater and freshwater environments.

The intermediate host of the digenetic fluke *Asymphylogora abdurachmanovi* is a gastropod mollusk, through which the fish is infected. In the intestines of the fish, *A. abdurachmanovi* was found with an II of 1-2 specimens (Table). From literary sources, it is known that this species of trematode is found in the water bodies of Azerbaijan that are connected to the Caspian Sea [14, 15]. It is possible that the fish was infected in this area, in the mollusk's habitat, during its migration route.

The *P. cuticola* trematode belongs to euryxenic parasite species. The fish is infected with *P. cuticola* ranges from 13 to 50%. The infestation of fish is indicated by characteristic black nodules on the surface of the body, on the fins, on the gill covers and, on the head [15, 16]. Microscopically, it was detected in the muscle layer and subcutaneous tissue of fish, while the largest number of metacercariae was noted in the mus-

cle mass. Fish become infected when they eat the first intermediate host, the gastropod mollusk *Pianorbiscarinatus*, etc. The second intermediate host is a fish. The definitive host of these trematodes is an egret or other fish-eating birds, in whose small intestine the adult worms parasitize. When the fish migrates, the metacercariae survive in both marine and river water. If the infection is severe (more than 100 worms), the fish loses weight and develops poorly, and there is no fat tissue.

Caryophyllosis is one of the most common parasitic diseases of carp species in the Agrakhan Bay and inland water bodies of Dagestan, caused by parasitic worms from the family Caryophyllaeidae. In our studies, the infestation of the fish with cestodes was no more than 12%, and the intensity of cestode infestations was 2-4 specimens. *C. laticeps* was found in the intestines of the fish, as they enter the digestive system by eating intermediate hosts, such as low-bristled worms.

Conclusion

In recent years, the Gyrodactylus group has not been found among the monogenea species, and the number of Dactylogyrus has decreased. In 2019, the intensity of infestations was 10-60 specimens, but in 2022, only a few Dactylogyrus were found, while the number of *D. paradoxum* increased. In 2019, the intensity of infestations of *D. paradoxum* was 2-8 specimens, but in 2022, the infection rate reached 18 specimens. The decrease in the intensity of the invasion during the study period may be due to a number of factors, one of which is the change in certain hydrochemical parameters of the water body. The gill fluke *D. paradoxum* is an indicator of water bodies, and an increase in the number of parasites indicates a negative impact on the Agrakhan Bay. However, the conducted studies have revealed a decrease in the number of diplostomids, which have a complex life cycle and change

hosts, and this may also be due to changes in the number of birds. The high levels of fish infection with the zoonotic pathogen *A. schupakovi* indicate the persistence, active functioning, and circulation of powerful natural foci of anisakidiasis. The Caspian seal plays a key role in the spread, replenishment, and preservation of the pathogen's foci in the Caspian Sea. There has been a noticeable decrease in the infestation of fish with pinworms, which may indicate a deterioration in

the hydrological condition of the water body, as well as a decrease in the number of waterfowl, which leads to a disruption in the development cycle of helminths. The conducted parasitological studies on fish have revealed epidemiologically and epizootiologically significant helminths, such as *Anisakis schupakovi*, *Contracaecum spiculigerum*, *Diplostomum spathaceum* and *Posthodiplostomum cuticola*.

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