

Original Research Paper

Epizootiology of Opisthorchiasis in Carnivores, Fish and Mollusks in the West Kazakhstan Region

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Abstract: Investigating the infestation of opisthorchiasis in domestic animals can help identify areas with high infection rates and develop targeted control measures to reduce transmission. The work aimed to study the opisthorchiasis infestation in domesticated carnivores (dogs and cats), fish of the *Cyprinidae* family, and mollusks to identify their infestation status. The study was carried out in the coastal villages of the Ural River in the West Kazakhstan region in 2021-2022. It was found that the infestation extensity of *Opisthorchis felineus* infestation averaged 89.7% and the infestation intensity was 19.6 ± 1.6 units/animal in dogs and 97.9% and 34.4 ± 2.9 units/animal in cats, respectively. A high fish infestation by *O. felineus* metacercariae in the family *Cyprinidae* was noted. The infestation extensity and infestation intensity averaged 70.4% and 22.6 metacercariae/specimen, respectively. The maximum infestation rates were recorded in the ide. During the study of fish infestation with *Opisthorchis* metacercariae, an increase in infestation with age was found. The maximum infestation intensity in ide reached 340 metacercariae per specimen at 3 years. The population density of mollusks of the genus *Bithyniidae* in the reservoirs of the middle Urals basin was 5.1 specimens/m² and the infestation with *O. felineus* cercariae was 5.7%. The epizootological conditions of the middle Urals basin were unfavorable concerning the opisthorchiasis infestation. In the coastal settlements of the Ural River, domesticated carnivores are infested with *O. felineus*. In the reservoirs of the middle Urals basin, fish from the family *Cyprinidae* and mollusks and the genus *Bithyniidae* are infested with *Opistorchis* larvae.

Keywords: Cats, Cercariae, Dogs, Metacercariae, Ural-Caspian Lowland

Introduction

One of the epidemiological significant problems of Kazakhstan, including the West Kazakhstan region, is opisthorchiasis, the most clinically significant trematode infestation in humans and carnivores, which are the final hosts of *Opisthorchis felineus*. Dogs and cats of coastal settlements are most often infested with *O. felineus* metacercariae by eating raw fish and are the main source of infestation. Monitoring the dogs' and cats' infestation with *O. felineus* is important for assessing the epizootic situation in the region (Beer, 2005; Beisenbieva *et al.*, 2016; Nurzhanova *et al.*, 2021).

Foci of opisthorchiasis is most common among the population and carnivorous animals in river basins where there are favorable conditions for mollusks and cyprinids

(Proskurina *et al.*, 2020). Humans and carnivorous animals infested with opisthorchiasis pollute freshwater reservoirs by secreting helminth eggs with feces, which are swallowed by the first intermediate hosts (mollusks *Bithyniidae*). In the intestines of mollusks, the development of miracidium occurs. The development period from the miracidium to the cercarium lasts 2-2.5 months. Meeting the second intermediate host, fish (*Cyprinidae*), cercariae penetrate the subcutaneous adipose tissue and into the muscles of fish, where they turn into metacercariae.

The metacercariae enter the body of the final host (dogs, cats, and humans) with infested fish. The metacercariae penetrate the hepatobiliary system and the pancreas and reach maturity in 3-4 weeks. Thus, the full development cycle of the parasite lasts 4-4.5 months, after which egg production begins. The life expectancy of

adult *O. felineus* in the body of the final hosts reaches 15-25 years (Stepanova, 2002).

A well-known factor of infestation with this parasitosis in humans and carnivorous animals is the consumption of fish of the *Cyprinidae* family infested with *O. felineus* larvae. Metacercariae are the larval stage of *Opisthorchis* and a tissue parasite of cyprinids. In the body of the final host, metacercariae parasitize in the liver ducts and pancreas for up to 20-25 years, causing various complications of the hepatobiliary system. The foci of this bio helminthiasis are confined to floodplain-river ecosystems (Beer, 2005).

The range of *O. felineus* extends almost continuously from the eastern to western borders of the Republic of Kazakhstan, covering the territories of many regions. In the West Kazakhstan region, which is rich in freshwater reservoirs, one can note a high opisthorchiasis infestation rate in humans and animals (Nurzhanova *et al.*, 2021).

Social factors and environmental conditions contribute to the spread of opisthorchiasis in the region. The territory of the West Kazakhstan region is located in the Ural-Caspian lowland. Ecological conditions in the Ural River basin, in floodplain reservoirs and small rivers, communicating with the Urals are favorable for the spread of opisthorchiasis: A dense network of freshwater reservoirs, which during snowmelt or flood waters can be polluted with fecal masses; the richness of *Cyprinidae* fish; abundance of vegetation in the coastal part of reservoirs; the presence of biotopes for the first intermediate hosts; fish infestation with *Opisthorchis* metacercariae (Beer, 2005).

In many localities, amateur fishers, dogs and cats consume fish infested with opisthorchiasis. The urban population consumes self-caught fish or fish purchased at retail outlets in the city, where it does not always pass veterinary and sanitary control for the presence of *Opisthorchis* larvae. According to a study conducted in Northern Kazakhstan, intensive migration of the population also causes an increase in the incidence of opisthorchiasis (Aubakirov *et al.*, 2022). There were no studies on opisthorchiasis infestation in domesticated carnivores, fish, and mollusks conducted in the West Kazakhstan region, so the focus of the study was directed to this region.

Indicators of fish and mollusks infestation with *O. felineus* larvae are important in determining the infestation intensity (II) in the foci of opisthorchiasis, which determined the relevance of studies aimed at identifying the II of additional hosts of this helminthiasis (Simakova *et al.*, 2021; Proskurina *et al.*, 2020).

We aimed to study the opisthorchiasis infestation in domesticated carnivores (dogs and cats), *Cyprinidae* fish, and mollusks to identify their infestation status in the West Kazakhstan region.

Materials and Methods

Ethical Approval

The plan of the experiment and the treatment of animals within the framework of the study was approved and discussed at a meeting of the local ethical committee of the Kazakh research veterinary institute, a branch of the West Kazakhstan research veterinary station on March 24, 2022 (protocol no. 1).

Study Period and Location

The study was carried out during the year 2021-22 in the West Kazakhstan region, in the coastal settlements of the Ural River: Darinsk, Rubyzhka, Yanvartsevo, Volodarka, Tryokino, Kirsanovo, Krasnoarmeyskoye, and Ozyornoye.

Sample Collection and Analysis

To determine the extent and intensity of the infestation of dogs and cats with opisthorchiasis, a helminthoscopy of 223 fecal samples from dogs and 197 from cats was performed by methods of sequential washing and flotation according to Shcherbovich, as well as a helminthological examination of the liver in 69 dogs and 186 cats according to K.I. Skryabin.

Dogs and cats are domestic carnivores—an order of placental mammals (*Mammalia*), consisting of suborders of canids (*Caniformia*) and felines (*Feliformia*). Amateur fishermen from coastal villages, when catching fish from the reservoirs of the Ural River basin, feed raw freshly caught fish infested with *Opisthorchis* metacercariae to their dogs and cats, which, becoming infected with opisthorchiasis, release opisthorchiasis eggs into the external environment, polluting water bodies. For the study, dogs and cats of different sexes and ages which often ate raw fish were selected from farmsteads in coastal settlements near the reservoirs of the Ural River basin.

Diagnostic studies of fish were aimed at identifying larval stages of opisthorchiasis (metacercariae), invasive for carnivorous animals and humans. 183 fish specimens belonging to 7 species were studied: Roach (*Rutilus rutilus* L.), rudd (*Scardinius erythrophthalmus* L.), Prussian carp (*Carassius auratus* L.), bream (*Abramus brama* L.), ide (*Leuciscus idus* L.), white bream (*Blicca bjoerkna* L.) and Tench (*Tinca tinca* L.). The fish was examined by the compressor method under the MBS-9 microscope (Fig.1). According to the results of the study, the following indicators of fish infestation were calculated: The Infestation Extensity (IE) and the II (Fig. 1).

The collection of mollusks was carried out according to the malacological method, using hydrobiological fishing gear. The mollusks located on the twigs of aquatic plants or the surface of pieces of wood along the shores of the reservoir were collected manually. Samples of benthos

and phyto- or zooplankton were taken with bottom samplers, benthic nets, as well as improved scrapers. 60 benthos samples were examined for the presence of mollusks by washing. The material was fixed with 75% ethanol and species identification was carried out using conchological and anatomical methods. To determine the *Opisthorchis* cercariae infestation in the collected 140 mollusks (*Bithynia leachii*), the tip (the last 2-3 whorls of the shell) was separated and examined by the compressor method under the MBS-9 microscope (Fig. 2) (Beer, 2005).

To characterize the epizootic process, the indicator of the frequency of occurrence was used. The *IE* value was calculated using formula 1:

$$IE = n_k \times 100\% \div N \quad (1)$$



Fig. 1: Preparation of sections of fish muscles for microscopy (original)



Fig. 2: Bitiniid mollusks from the genus Bithynidae (a-*Bithynia leachii*, b-*Bithynia troschli*) (original)

Where, n_k is the number of host animals invaded by *O. felineus* and N is the total number of animals studied.

The *II* is an arithmetic mean of the number of parasites per infested host animal. The *II* value was calculated by Eq. 2:

$$II = P_{ar} \div N_p \quad (2)$$

where, P_{ar} is the number of detected parasites in N_p -infested hosts.

Statistical Analysis

The processing of the received digital material was carried out by the method of variation statistics using the Microsoft Excel 2007 software.

Results

The Infestation of Dogs and Cats with O. Felineus in the West Kazakhstan Region

The *IE* of opisthorchiasis in dogs averaged 82.9%. A total of 211 out of 223 examined dogs were infested. On average, the *IE* according to fecal helminthoscopy equaled 94.5% (Table 1).

According to the helminthological autopsy, a total of 56 out of 69 examined dogs were infested. On average, the *IE* equaled 80.5% and the *II* equaled 21 ± 1.7 units/animal (Table 2).

The *IE* of opisthorchiasis infestation in cats, according to the fecal helminthoscopy and helminthological autopsy, averaged 95.05%. A total of 188 out of 197 examined cats were infested. On average, the *IE* according to fecal helminthoscopy equaled 95.4% (Table 3).

According to the helminthological autopsy, a total of 178 out of 186 examined cats were infested. On average, the *IE* and the *II* equaled 94.7% and 32.2 ± 2.6 units/animal (Table 4).

Differences in the extent of helminth infestation in dogs and cats between the data of helminthoscopy and a helminthological autopsy were insignificant.

The Infestation of Cyprinids with O. Felineus Larvae in the West Kazakhstan Region

The most species-rich water body in fish fauna was the Ural River, the old river bed of the Ural River near the village of Krasnoarmeyskoye, and the Bagyrlyay River. Most of the catch belonged to the following fish species: Ide, roach, crucian carp, and Tench (Table 5).

In the course of the conducted studies, we observed infestation of the following fish species with *O. felineus* larvae: Ide, roach, Rudd, bream, white bream, and Tench (Table 6).

Table 1: Infestation of dogs with *O. felineus* in the West Kazakhstan region according to fecal helminthoscopy

No.	Place of the study	Studied, animals	Infested, animals	IE, %
1.	Darinsk	28	27	96.40
2.	Rubyozhka	27	26	96.20
3.	Yanvartsevo	29	28	96.50
4.	Volodarka	29	27	93.10
5.	Tryokino	30	29	96.60
6.	Kirsanovo	26	24	92.30
7.	Krasnoarmey skoye	29	27	98.88
8.	Ozyornoye	25	23	92.00
Total		223	211	
On average				94.50

Table 2: Infestation rate of dogs with *O. felineus* in the West Kazakhstan region according to helminthological autopsy data

No.	Place of the study	Studied, animals	Infested, animals	IE, %	II, units /animal
1.	Darinsk	8	7	87.5	26±2.1
2.	Rubyozhka	7	5	71.4	12±1.0
3.	Yanvartsevo	10	8	80.0	23±1.9
4.	Volodarka	9	8	88.9	27±2.3
5.	Tryokino	10	9	90.0	30±2.5
6.	Kirsanovo	8	6	75.0	25±2.0
7.	Krasnoarmey skoye	10	8	80.0	27±2.3
8.	Ozyornoye	7	5	71.4	24±2.0
Total		69	56		
On average				80.5	21±1.7

Table 3: Infestation of cats with *O. felineus* in the West Kazakhstan region according to fecal helminthoscopy

No.	Place of the study	Studied, animal	Infested, animals	IE, %
1.	Darinsk	23	23	100.0
2.	Rubyozhka	25	24	96.0
3.	Yanvartsevo	27	26	96.2
4.	Volodarka	24	24	100.0
5.	Tryokino	26	25	96.1
6.	Kirsanovo	25	23	92.0
7.	Krasnoarmey skoye	24	22	91.6
8.	Ozyornoye	23	21	91.3
Total		197	188	
On average				95.4

Table 4: Infestation of cats with *O. felineus* in the West Kazakhstan region according to helminthological autopsy data

No.	Place of the study	Studied, animals	Infested, animals	IE, %	II, units/animal
1.	Darinsk	27	27	100.0	52.0±3.50
2.	Rubyozhka	26	25	96.2	39.0±3.20
3.	Yanvartsevo	25	25	100.0	43.0±3.60
4.	Volodarka	23	23	100.0	21.0±2.60
5.	Tryokino	22	21	95.5	17.0±1.60
6.	Kirsanovo	21	19	90.4	23.0±1.90
7.	Krasnoarmey skoye	22	20	90.9	38.0±3.10
8.	Ozyornoye	20	18	90.0	25.0±2.00
Total		186	178		
On average				94.7	32.2±2.60

Table 5: Species diversity of the studied fish in the water bodies of the West Kazakhstan region

Species of the fish	Ural river the city of Uralsk, specimens	Ural river Krasnoarmeyskoe village, specimens	Ural River Rubyozhka village, specimens	Bagyrlay River Akzhaiksky district, specimens	Kushum River Bayterek district, specimens	Total, specimens
Crucian carp	8	4	4	10	2	28
Bream	2	3	3	-	5	13
Roach	12	6	-	8	6	32
Rudd	4	5	1	5	-	15
Ide	8	7	5	14	3	37
White bream	5	7	4	-	-	16
Tench	7	12	6	5	12	42
Total fish	46	44	23	42	28	183

Table 6: Infestation of fish species with *O. felineus* metacercariae in the water bodies of the West Kazakhstan region

Species of the fish	Studied, specimens	Invaded, specimens	Localization of the parasite	IE, %	II, metacercariae, /specimen min-max, average
1	2	3	4	5	6
Ural River, Uralsk					
Crucian carp	8	0	-	-	-
Bream	2	1	Muscles	50	1-3 (2)
Roach	12	7	Muscles	58.3	1-9 (5)
Rudd	4	3	Muscles, fins	75	1-32 (17)
Ide	8	8	Muscles, fins	100	1-145 (73)
White bream	5	1	Muscles, fins	20	1-12 (7)
Tench	7	3	Muscles	42.8	1-5 (3)
Total	46	23			
On average				57.7	17.8
Ural River, Krasnoarmeyskoye village					
Crucian carp	4	0	-	-	-
Bream	3	1	Muscles	33.3	1-5 (3)
Roach	6	5	Muscles	83.3	1-21 (11)
Rudd	5	3	Muscles, fins	60	1-34 (18)
Ide	7	7	Muscles, fins	100	1-237 (119)
White bream	7	3	Muscles, fins	42.8	1-20 (11)
Tench	12	5	Muscles	41.6	1-3 (2)
Total	44	24			
On average				60.2	27.3
Ural River, Rubyozhka					
Crucian carp	4	0	-	-	-
Bream	3	1	Muscles	33.3	1-8 (5)
Rudd	1	1	Muscles, fins	100	1-20 (11)
Ide	5	5	Muscles, fins	100	1-85 (43)
White bream	4	4	Muscles, fins	100	1-9 (5)
Tench	6	1	Muscles	16.6	1-3 (2)
Total	23	12			
On average				69.9	13.2
Bagyrlay River, Akzhaiksky district					
Crucian carp	10	0	-	-	-
Roach	8	8	Muscles, fins	100	1-15 (8)
Rudd	5	5	Muscles, fins	100	1-50 (26)
Ide	14	14	Muscles, fins	100	1-340 (171)
Tench	5	4	Muscles	80	1-5 (3)
Total	42	31			
On average				95	41.6
Kushum River, Bayterek district					
Crucian carp	2	0	-	-	-
Bream	5	3	Muscles	60	1-6 (4)
Roach	6	5	Muscles, fins	67	1-14 (7.5)
Ide	3	3	Muscles, fins	100	1-75 (38)
Tench	12	6	Muscles	50	1-5 (3)
Total	28	17			
On average			69.3	13.1	

The maximum *IE* was noted in the ide and amounted to 100% with an *II* from 1-340 metacercariae in the muscle tissue on average per one fish. Ide is the main carrier of *O. felineus* larvae in many water basins. It is more often invaded by the parasite's metacercariae than other fish species. The infestation degree and the *II* were 77.2% and 1:21 metacercariae/specimen in roach, 80% and 1:50 metacercariae/specimen in rudd, 45.2% and 1:5 metacercariae/specimen in Tench; 46.1% and 1:8 metacercariae/specimen in bream and 50% and 1:20 metacercariae/specimen in white bream.

There were more adult age groups among ide, rudd, and roach, which could be the reason for the high *IE* and *II* in these fish species.

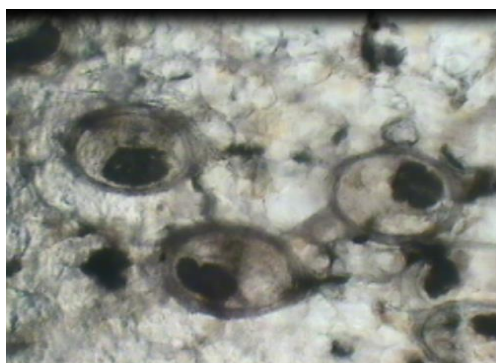
In our studies, the average number of parasite metacercariae in the ide ranged between 1-20 metacercariae/specimen in 1-year-old and 10-90 metacercariae/specimen in the two-year-old fish. The maximum *II* in ide reached 340 metacercariae per specimen of three-year-old fish.

The largest and adult individuals contained the largest number of metacercariae. This indicated not only their greater availability for the penetration of larvae but also the preservation of metacercariae for a long time and their accumulation in the fish body with age.

The identification of the quantitative distribution of metacercariae in the fish body allowed for identifying a certain localization of the parasite larvae. The main part of the metacercariae is distributed in the surface layers of the back muscles. A small amount of them is concentrated in the muscles of the tail. A small number of cysts were found in the dorsal fins.

With a high *II* in the muscles of the studied fish, more than 20-30 metacercariae could be detected in one field of view. In those areas, metacercariae of different sizes were found. This probably indicates the presence of metacercariae of different ages. "Young" metacercariae are 1.5-2 times smaller than mature ones.

Mature metacercariae are oval-shaped cysts, inside which the helminth larva is present in a bent state. Metacercariae are visible in the compressor through a transparent shell. The shape of the cyst is slightly oval or rounded with a thick connective tissue shell, inside which there is a mobile larva (Fig. 3).



a



b

Fig. 3: (*O. felineus* metacercariae a) in the muscles of the ide; b) in the muscles of the rudd (original)

Thus, the epidemiological significance of individual fish species was determined by the infestation indicators of adult fish that have reached commercial sizes, consumed by humans and domesticated carnivores.

Therefore, the *Cyprinidae* fish pose a danger as a source of infestation for dogs, cats, and humans.

Population Density of Mollusks and their Infestation by Opisthorhis Felineus Cercariae in Reservoirs of the West Kazakhstan Region

As a result of the conducted studies, we recorded that *Bithyniidae* did not live in some of the studied reservoirs. From April to August 2021-22, we examined 116 benthos samples from 14 reservoirs in the Ural River basin, of which 60 samples were from the Rubyozhka, Embulatovka, Bykovka, Utva, and Tyoploe water bodies. Of the 60 samples studied, 29 contained mollusks of the genus *Bithyniidae*. The average density of mollusks was 5.06 specimens/m² (Table 7).

The intermediate host of opisthorchiasis is a *Bithyniidae* mollusk that was found in 5 of the 14 studied water bodies of the Middle Urals, in shallow, well-heated areas, with underwater and above-water vegetation in the rivers Rubyozhka, Embulatovka, Malaya Bykovka, Utva, and Lake Tyoploe. In other studied reservoirs, hydrological conditions were unsuitable for mollusk habitats.

The density of mollusks in reservoirs was the following: In the rivers Rubyozhka 6.5, Embulatovka 5, Malaya Bykovka 4.5, and Utva 4.25 specimens/m² and in Lake Tyoploe 5.1 specimens/m². The average density of mollusks in these reservoirs was 5.1 specimens/m². The low number of mollusks can be explained by their high mortality during freezing in winter as the littoral area drains.

Table 7: Population density of mollusks and their infestation by *O. felineus cercariae* in water bodies of the West Kazakhstan region

Name of the Waterbody	Number of examined biotopes	Examined area of the infested biotopes, m ²	Number of simple examined		Total number of mollusks, units	The density mollusks, specimens/m ²	Invaded, specimens	IE, %
			Total	Simple with mollusks				
Rubyozhka	3	24	12	2	13	6.5	1	07.7
Embulatovka	3	24	12	2	10	5.0	0	0
Bykovka	3	24	12	6	27	4.5	3	11.1
Utva	3	18	09	4	17	4.3	0	0
Tyoploe	3	30	15	15	73	5.1	7	09.6
Total	15	120	60	29	140			
On average						5.1		05.7

The IE of intermediate hosts by *Opisthorchis cercariae* was 7.7% in the rivers Rubyozhka, 11.1% in Malaya Bykovka, and 9.6% in Lake Tyoploe. In other studied water bodies, *Opisthorchis cercariae* were not found in mollusks. It is possible that the high number of parasite eliminators in these water bodies, as well as the small number of mollusks, could contribute to the low infestation of intermediate hosts with *Opisthorchis*.

Thus, the population density of mollusks in the water bodies of the West Kazakhstan region averages 5.1 specimens/m² and the IE of their infestation with *O. felineus cercariae* is 5.7%.

Discussion

In Kazakhstan and Russia, opisthorchiasis is a widespread disease, which is facilitated by favorable environmental conditions (Ogorodova *et al.*, 2015; Beisenbieva *et al.*, 2016). According to many authors, cyprinid fish species from local water bodies are a source of infection for humans, dogs, and cats with *Opisthorchis metacercariae*. Eating contaminated raw or undercooked carp fish is common among people and domestic animals and contributes to the widespread of opisthorchiasis in settlements coastal to water bodies (Simakova *et al.*, 2019; Proskurina *et al.*, 2020; Aubakirov *et al.*, 2022).

Based on the results obtained, unfavorable epizootological conditions of the middle Urals basin concerning opisthorchiasis infestation were established. According to the totality of facts, the leading role of domesticated carnivores (cat and dog) in the existence and spread of opisthorchiasis invasion has been demonstrated.

The large infestation of dogs and cats with opisthorchiasis observed by us indicates that they are the main source of *O. felineus* infestation and play a key role in the circulation of opisthorchiasis foci in the Ural River basin. In the course of the research, we found that dogs and cats become infected with *O. felineus* when their owners feed them raw freshly caught fish infested with *Opisthorchis metacercariae*. According to researchers, the

main role in maintaining the foci of opisthorchiasis also belongs to dogs and cats (Yurlova *et al.*, 2017).

The species composition and infestation of fish with *Opisthorchis metacercariae* have been determined. Previous studies show that the main role in infecting humans, dogs, and cats belongs to such types of fish as ide, dace, bream, bleak, roach, Tench, crucian carp, rudd, and silver bream. The maximum extensiveness of invasion was noted in ide (up to 100%), dace (70-80%), and Tench and bream (40-50%) (Simakova *et al.*, 2019; Proskurina *et al.*, 2020; Aubakirov *et al.*, 2022). The same priorities are preserved at present, which is confirmed by the results of our research. In our study, the main carriers of *Opisthorchis metacercariae* are fish of the Cyprinidae family (*Cyprinidae*): Ide (100%), Rudd (60-100%), bream (33-60%), Roach (58-100%), Tench (16-80%) and silver bream (20-100%). Of these, the highest infestation was noted in ide, Rudd, Roach, Tench, and white bream.

Many researchers have noted an increase in the fish infestation rate with age. It should be noted that fish of the same species and age, for various reasons, can be infested to varying degrees and contain from one to several hundred or thousand metacercariae (Yurlova *et al.*, 2017; Simakova *et al.*, 2019; 2021).

It has been established that populations of mollusks of the *Bithyniidae* genus living in shallow, well-warmed areas with underwater and surface vegetation suitable for their vital activity are infested with cercariae. Many authors note that certain hydrobiological conditions are necessary for the infestation of mollusks (Serbina, 2022). The main biotopes of bitinia are, as a rule, dry-up (completely or partially) floodplain water bodies, which are flooded during spring floods and, as the water subsides, become isolated from the riverbed. In the West Kazakhstan region, natural and climatic conditions and hot summers (increase in water temperature at the surface from 15-20°C) contribute to the active life of mollusks.

The natural and ecological conditions of the region and the consumption of raw, undercooked or salted, pickled, smoked, or dried infested fish and low sanitary awareness of the population about opisthorchiasis

contribute to the maintenance of foci of infestation and the spread of the disease (Simakova *et al.*, 2021).

The data indicated unfavorable epizootological conditions concerning opisthorchiasis in the West Kazakhstan region. Socioeconomic factors, such as sanitary illiteracy and migration of the population outside the country, also play an important role in the spread of opisthorchiasis.

In the West Kazakhstan region, the following modern methods of prevention and measures are used to reduce the level of infection with opisthorchiasis:

1. Regular preventive examinations of the population of dogs and cats for infection with opisthorchiasis
2. Planned deworming of infected people, dogs, and cats
3. Strict observance of the rules for the neutralization of carp fish by proper heat treatment and freezing of fish at a temperature of -40°C for 7 h
4. Sanitary education of the population: The eradication of the habit of eating raw and half-cooked fish and its products and washing hands and equipment after cutting and cooking fish
5. Treatment of biotopes of the first intermediate hosts (mollusks) by using modern molluscicides-copper sulfate and 5,4'-dichloro salicyl anilide

Conclusion

The epizootological conditions of the middle Urals basin are unfavorable concerning the opisthorchiasis infestation. In our study, it was found that in the coastal settlements of the Ural River, the *IE* by *O. felineus* averaged 82.9% and the *II* equaled 21 ± 1.7 units/animal in dogs and 95.05% and 32.2 ± 2.6 units/animal in cats. In the West Kazakhstan region, a high infestation of *O. felineus* metacercariae in *Cyprinidae* fish was noted. The *IE* and *II* averaged 70.4% and 22.6 metacercariae/specimen, respectively. The maximum infestation rates were recorded in the ide.

An increase in infestation rates was recorded with increased age. The maximum *II* in ide reached 340 metacercariae per specimen at the age of 3 years. The population density of *Bithyniidae* mollusks in the reservoirs of the Middle Urals basin was 5.1 specimens/m² and the infestation with *O. felineus cercariae* was 5.7%. Prospects for further research include the development and improvement of methods for the prevention of opisthorchiasis at all phases of its development cycle.

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Author's Contributions

All authors equally contributed to this study.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues are involved.

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