

Original Research Paper

# Epizootology and Epidemiology of Opisthorchiasis in Northern Kazakhstan

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**Abstract:** The aim was to study the epizootological situation, as well as the characteristics of the territories of Kostanay and North Kazakhstan regions on fish opisthorchiasis. The object of the study is the reservoirs of Kostanay and the North Kazakhstan region (rivers Torgai, Tobol, and Ishim). To date, there is a need to develop monitoring methods to assess the epidemiological and epizootological significance of various environmental objects in the transmission of invasive material and the spread of invasions. These studies will contribute to the rationalization of veterinary and sanitary supervision. The conducted studies have allowed us to define the leading factors of the spread of opisthorchiasis in Kazakhstan. A diagnostic algorithm has been developed to improve its efficiency. The results can be used in the organizational and methodological aspects when conducting epidemiological surveillance of opisthorchiasis. The area of the pathogen of opisthorchiasis *Opisthorchis felineus* covers the territories of Pavlodar, Akmola, Karaganda, Aktobe, and West Kazakhstan regions, extending from the eastern to western borders of Kazakhstan. This disease, according to the Republican Epidemiological Station, has recently been trending upward among the population, which indicates an alarming epidemiological situation in Kazakhstan. As a result of epidemiological monitoring of the incidence of opisthorchiasis in the Kostanay and North Kazakhstan regions, it was found that over the past 10 years (2011-2021), 549 and 29 cases of opisthorchiasis had been registered, respectively. In the Kostanay region, the largest number of cases occurred in 2011 and 2012 (76 and 77 cases, respectively).

**Keywords:** Epidemiological Situation, Fish, Metacercariae, Opisthorchiasis, Reservoirs

## Introduction

The struggle against zoonanthropic helminthiasis, widespread in the Republic of Kazakhstan, is one of the state goals in the field of healthcare and veterinary medicine. There are natural foci of many dangerous parasitic diseases on the territory of Kazakhstan, which requires the veterinary service to take effective measures to monitor, prevent and prevent the spread of these diseases to other regions of Kazakhstan. As evidenced by numerous scientific publications of recent years, the epizootic and

epidemiological situation for many parasitic diseases, such as opisthorchiasis in the Republic of Kazakhstan remains tense and poses a certain threat to the public health.

Currently, the proportion of fish and fish products in the human diet has increased, which has increased the risk of infecting people with particularly dangerous invasive diseases, among which opisthorchiasis is of the greatest importance in human pathology (Zvonareva *et al.*, 2018).

To date, there is a need to develop monitoring methods to assess the epidemiological and epizootological significance of various environmental objects in the

transmission of invasive material and the spread of invasions. These studies will contribute to the rationalization of veterinary and sanitary supervision.

Opisthorchiasis is a dangerous parasitic disease that is caused in humans and fish-eating mammals by the fluke *Opisthorchis felineus* (*Plathelminthes*, *Trematoda*), also called the cat fluke or liver fluke. One becomes infected with this parasite by eating fish infected with parasites of the Cyprinid family (the *Cypriniformes* order). In fish, opisthorchid flukes are localized in the muscles and are not visible during normal examination with the naked eye. Therefore, the risk of infestation with this pathogenic parasite in humans is very high when eating lightly salted or undercooked (fried or boiled) fish (Beer, 2005; Gouveia *et al.*, 2017; Zhan *et al.*, 2017; Bibik, 2020).

The novelty of this study lies in the study of the ecological features of the pathogens of opisthorchiasis and the epizootological dynamics of this disease in the Kostanay and North Kazakhstan regions of the Republic of Kazakhstan. The study of fish living in reservoirs and the identification of the most dangerous species, the development of preventive measures, and forecasting and monitoring of the development of the parasitological situation reduce the risk of morbidity in the population in the region.

The study aimed to evaluate the epizootological situation regarding fish opisthorchiasis on the territory of Kostanay and North Kazakhstan regions of the Republic of Kazakhstan, starting from 2011 to December 2021 (analysis of statistical reports for 2011-2021) and perform a current analysis of the parasitological situation for September-December 2021.

## Materials and Methods

The study of the epizootological situation of fish opisthorchiasis was carried out on the territory of Kostanay and North Kazakhstan regions of the Republic of Kazakhstan in the period from September to December 2021. The object of the study was the reservoirs of Kostanay and the North Kazakhstan region (rivers Torgai, Tobol, Ishim, etc.). The following species of fish of the cyprinoid family were caught for the study: Ide, roach, bream, carp, and tench in the amount of 477 specimens (Fig. 1). Fish of this family have one dorsal fin and a clearly defined lateral line. To establish the degree of invasion by opisthorchiasis, scales of the fish were removed from one side under the dorsal fin, and then the skin was incised in two directions. The first incision was made in front of the dorsal fin perpendicular to the longitudinal axis of the body to the lateral line and the second one from the end of the first incision towards the caudal fin along the lateral line. The edge of the skin was lifted with tweezers and prepared on an area of up to 25 cm so that the subcutaneous tissue remained on the surface of

the muscles. After that, the surface layer of muscles with a thickness of 0.2–0.5 cm was cut off, cut into small pieces, and placed over the entire surface of the lower glass of the compressor, then covered with the upper glass and compressed using screws. All the pieces taken from one fish were examined under a microscope. Metacercariae are visible to the naked eye in transmitted light: Encapsulated opisthorchid larvae have the appearance of white formations similar in color and size to semolina (MARF, 2009; Voronin *et al.*, 2019).

To study the epizootological situation on the territory of Kostanay and North Kazakhstan regions for especially dangerous diseases, opisthorchiasis of fish, the staff of the Department of Veterinary Medicine of the A. Baitursynov Kostanay Regional University (KRU) NJSC visited 2 districts (Yesilsky and Shal-Akyn) in the North Kazakhstan region and 9 districts (Fedorovsky, Karabalyk, Amangeldinsky, Zhangelinsky, Naurzumsky, Denisovsky, Kamystinsky, Uzunkolsky, Mendykarinsky) and 3 cities (Arkalyk, Zhitikara, Lisakovsk) in the Kostanay region. For dissection and examination, we used fish of the cyprinoid family in the above-mentioned areas.

The incidence of opisthorchiasis among the population in the regions of Northern Kazakhstan was analyzed according to the data of operational monitoring gathered by the Department of Epidemiological Surveillance of Especially Dangerous Infections (EDI) and tuberculosis of the Department of Quality Control and Safety of Goods and Services of the Kostanay region of the Committee for Quality Control and Safety of Goods and Services of the Ministry of Health of the Republic of Kazakhstan.

## Results

It has been established that opisthorchiasis is a widespread disease among people living in the Kostanay region and North Kazakhstan regions.

In the period from 2011 to 2021, 549 and 29 cases of opisthorchiasis had been registered in the Kostanay and North Kazakhstan regions, respectively. In the Kostanay region, the largest number of cases occurred in 2011 and 2012 (76 and 77 cases, respectively), and the smallest number of 8 cases was registered in 2021.

The epidemiological situation of opisthorchiasis in humans is constantly changing and the incidence rate of the population varies from 0.9 to 8.8% per 100.0 thousand people. The lowest incidence of human opisthorchiasis, 0.9, was recorded in 2021. The recalculation of cases of the disease per 100 thousand people indicates that this type of zoonotic invasion is most widespread in the Arkalyk, Taranovsky, Fedorovsky districts, Kostanay, and Rudny, where the disease rate is 28.0; 24.4; 13.7, 11.0, 9.0%, per 100 thousand people, respectively. In 2012, the maximum incidence of opisthorchiasis in the region was registered, amounting to 8.8% per 100 thousand people (Forma No. 1, 2015).

The maximum number of positive reactions to opisthorchiasis was recorded from 2011 to 2014 and from 2015 to 2018 when the incidence rate of people was 8.7; 8.8; 6.8; 7.9; 6.3; 6.3; 5.4, and 7.0% respectively (Fig. 2).

From 2012 to 2020, the incidence rate of people with opisthorchiasis decreased significantly and varied from 5.2 to 3.4% per 100.0 thousand people. The lowest incidence of opisthorchiasis in humans, 1.5%, was recorded in 2011. The recalculation of cases of the disease per 100 thousand people indicates that this type of zoonotic invasion is most widespread in the Shal-Akinsky, Ayyrtayu districts, and the city of Petropavlovsk, where the disease rate is 1.1; 0.2; 0.19%, per 100 thousand people, respectively. In 2015, the maximum incidence of opisthorchiasis in the region was registered, amounting to 6.3% per 100 thousand people (News Petropavlovsk, 2017).

The maximum number of positive reactions to opisthorchiasis was recorded from 2012 to 2014 and from 2016 to 2020 when the incidence rate of people was 5.2; 4.5; 3.4; 3.5; 3.3; 1.3; 2.0, and 3.4% respectively (Fig. 3).

It was found that out of 549 cases in the Kostanay region and 195 cases in the North Kazakhstan region, the incidence of opisthorchiasis of people falls in the adult population older than 18-20 years (Forma No. 1, 2015; News Petropavlovsk, 2017).

The peaks of opisthorchiasis invasion among people in the Kostanay region were registered from 2011- 2018 and in the North Kazakhstan region from 2012- 2020. At the same time, a decrease in the invasion of opisthorchiasis among people in the Kostanay region was observed in 2019-2021 and has been observed in North Kazakhstan since 2021.

In the period 2011-2021, zoning and regionalization of the territory of Kostanay and North Kazakhstan regions were carried out according to the degree of intensity of the epizootic and epidemiological situation for opisthorchiasis (Forma No. 1, 2015; News Petropavlovsk, 2017).

According to the researchers, Dr. Vet. Sci., Professor Gershun and Kovaleva (2012), "The results of the veterinary and sanitary examination of fish for opisthorchiasis in some reservoirs of the Kostanay region of the Republic of Kazakhstan" indicates information on the detection of metacercariae of opisthorchis in fish from two lakes Akkol and Karasor and in the Uly-Zhilanchik river of the Zhangel'dinsky district of the Kostanay region, where a natural focus of opisthorchiasis invasion was established in the past years.

During the survey of the Akkol and Karasor lakes and the Uly-Zhilanchik river, a significant accumulation of the intermediate host of the shellfish of the Bithynia genus was found in the coastal waters.

In 2011, metacercariae of opisthorchis were found in 22 fish specimens (20.4%). The highest infestation rate was found in ide (68%) and bream (40%) and the one found in tench was relatively insignificant (14.3%). Metacercariae were not found in carp and crucian carp.

The authors' literature data also indicate that, regarding the infestation with opisthorchis larvae, ide has the highest proportion among other additional hosts. Infestation of fish with opisthorchis metacercariae was established in all surveyed reservoirs (Gershun and Kovaleva, 2012; Karmaliev and Kereev, 2013; Kereev and Karmaliev, 2013; Sidikhov, 2020).

In 2012, during the survey of the Tobol, Torgai (Kostanay region), and Ishim (North Kazakhstan region) rivers, a significant accumulation of the intermediate host of the Bithynia mollusk was found in the coastal waters (Beer, 2005; Saijuntha *et al.*, 2022).

Also, metacercariae of opisthorchis were found in 12 fish specimens (9%). The highest infestation rate was found in tench (42%) and bream (40%) and the level found in ide was relatively insignificant (18%). Metacercariae were not found in carp and crucian carp.

In 2013, according to the literature data of Dr. Vet. Sci., Professor Gershun, in the coastal waters of the rivers Tobol, Torgai (Kostanay region), and Ishim (North Kazakhstan region) opisthorchiasis metacercariae in fish (tench, ide, crucian carp, bream) were not found. When re-examining the above reservoirs in 2014, metacercariae of opisthorchis were found in bream (3 specimens) and rudd (2 specimens).

The information on the detection of opisthorchiasis infestation of fish caught from two lakes Akkol and Karasor and in the Tobol and Torgai rivers of the Kostanay region, where a natural focus of opisthorchiasis invasion was found, is indicated according to the data of the Sanitary Epidemiological control service (Internal report form No. 1 "Internal report form No. 1 "Comparative data on the infectious morbidity of the population of the Republic of Kazakhstan", 01.12.2015) for 2015. Metacercariae of opisthorchis were found in 30 fish specimens (23%). The highest infestation rate was found in carp (71%) and less in crucian carp (29%). Metacercariae were not found in tench and ide. In the Ishim River of the North Kazakhstan region in 2016, metacercariae of opisthorchis were found in 10 fish specimens (8%), namely rudd (90%) and crucian carp (10%).

The maximum number of infested fish was detected in 2017 in the Torgai river of the Kostanay region. Metacercariae were found in 50 fish specimens (30%) during a veterinary sanitary examination at the Arkalyk mini-market by veterinarians.

The highest infestation was found in carp (48%) and ide (42%) and the level found in crucian carp (7%) and tench (3%) was relatively insignificant. Metacercariae were not found in rudd.

In 2018 and 2019, according to Dr. Vet. Sci., Professor Gershun, in the coastal waters of the rivers Tobol, Torgai (Kostanay region), and Ishim (North Kazakhstan region) opisthorchiasis metacercariae in fish (tench, ide, crucian carp, bream) were not found. In the north of Kazakhstan, opisthorchiasis has become more common (Sidikhov, 2020).

In 2020, a small number of fish infected with *opisthorchis metacercariae* were found in the above reservoirs (2 specimens in crucian carp). (Internal report form No. 1 "Internal report form No. 1 "Comparative data on the infectious morbidity of the population of the Republic of Kazakhstan", 01.10.2020). In parallel with the data on the immunological diagnosis of human opisthorchiasis, its zoning, and regionalization in the territory of Kostanay and North Kazakhstan regions, in the period from September to December 2021, studies were conducted on the infestation of fish from the Torgai, Tobol, Ishim rivers with fluke larvae of *Opisthorchis felineus*.

The purpose of the work was the selection of freshwater fish of the cyprinoid family (tench, ide, carp, etc.) in lakes and reservoirs to survey the detection of *opisthorchis metacercariae*. In this regard, in September-December 2021, field studies were conducted on the water bodies of the Torgai and Tobol rivers of the Kostanay region and Ishim River of the North Kazakhstan region.

To diagnose *metacercariae* of *opisthorchis*, a compressor method was used. The results of the studies are shown in Table 1.

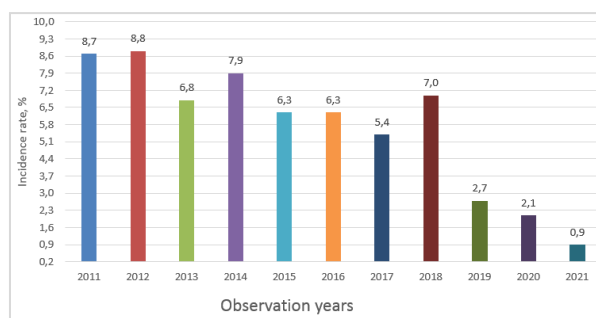
In the period from September to December 2021, 477 specimens of fish (ide, bream, carp, tench) were caught in the water bodies of river basins and lakes located in the territory of Kostanay and North Kazakhstan regions were examined (Fig. 4).

The largest number of 273 specimens were roach (*Rutilus rutilus*) and the smallest number of 20 specimens were tench (*Tinca tinca*). Other fish species were caught in the following numbers: Ide: 90; bream: 59 and carp (common carp): 35 Specimens. It was established that the basins of the rivers Tobol, Ayat, Verkhnetobolsky reservoir, Uly-Zhilanchik, Moildy, Zhelkuar, Ishim, Sergeyevsky reservoir, and lakes Alakol, Karasor, Akkol, Sarybalyk, Karasu were populated by the following fish from the cyprinoid family: Carp (common carp), roach, bream, tench, ide, crucian carp, and gudgeon. The main commercial fish in Kostanay and North Kazakhstan regions is crucian carp and carp (common carp). The objects of recreational fishing are ide, bream, and tench. During the current period, no cases of fish infestation with *opisthorchis metacercariae* have been detected in the Kostanay region and North Kazakhstan regions.

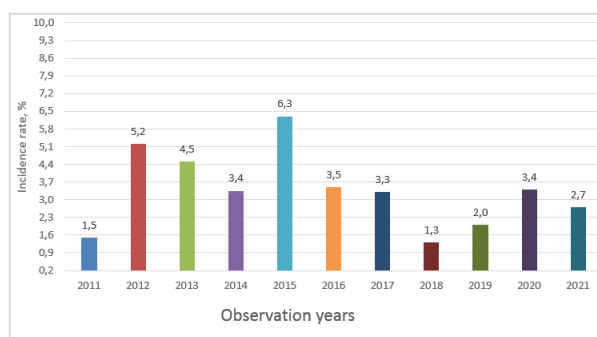
To confirm the diagnosis in September and October of this year, 3 batches of caught fish of the cyprinoid family (ide, bream, carp, tench) were sent to the laboratory of the Kazakh Scientific Research Veterinary Institute LLP. The study continues.



**Fig. 1:** Ide (*Leucis cusidus*) and bream (*Abramis brama orientalis*) examined for infestation with *Opisthorchis felineus* larvae



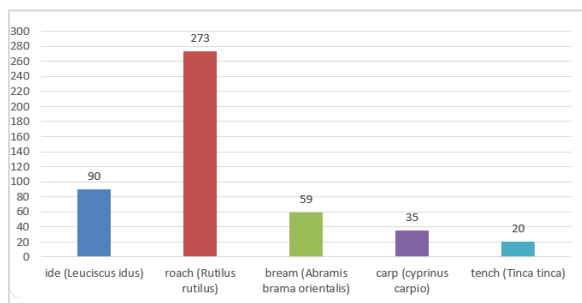
**Fig. 2:** Dynamics of the incidence of opisthorchiasis in the Kostanay region in 2011-2021



**Fig. 3:** Dynamics of the incidence of opisthorchiasis in the North Kazakhstan region for 2011-2021

**Table 1:** Species composition and number of fish examined for infestation with *Opisthorchis felineus* larvae on the territory of Kostanay and North Kazakhstan regions (September-December 2021)

| Types of fish                             | Rivers |        |       | Lakes |        | Total |
|---|--------|--------|-------|-------|--------|-------|
|   | Tobol  | Torgai | Ishim | Akkol | Karasu |       |
| Ide ( <i>Leucis cusidus</i> )             | 29     | 27     | 13    | 12    | 9      | 90    |
| Roach ( <i>Rutilus rutilus</i> )          | 81     | 65     | 66    | 35    | 26     | 273   |
| Bream ( <i>Abramis brama orientalis</i> ) | 14     | 15     | 11    | 8     | 11     | 59    |
| Carp ( <i>cyprinus carpio</i> )           | 2      | 3      | 4     | 14    | 12     | 35    |
| Tench ( <i>Tinca tinca</i> )              | 4      | 3      | 3     | 4     | 6      | 20    |
| Total:                                    | 130    | 113    | 97    | 73    | 64     | 477   |



**Fig. 4:** Species composition and number of fish caught on the territory of Kostanay and North Kazakhstan regions (September to December 2021)

## Discussion

According to various sources, up to 40 million people currently suffer from opisthorchiasis and up to 600-750 million people in Eurasian countries are at risk. This is a serious public health problem in the Russian Federation, Ukraine, Belarus, and Kazakhstan (Fedorova *et al.*, 2018; Sidikhov, 2020; Domatskii and Kornikova, 2020).

Currently, the epidemiological situation regarding the incidence of opisthorchiasis in Kazakhstan remains unfavorable. As the results of the analysis of statistical data in the Kostanay region for 2012-2020 showed, the incidence of opisthorchiasis did not decrease and varied from 5.2 to 3.4% per 100.0 thousand people. This suggests that there are stationary natural foci of opisthorchiasis in the region and there are favorable conditions that allow the pathogen to freely circulate in the biocenosis. The main factor in human infestation with opisthorchiasis is the consumption of non-disinfected fish of the cyprinoid family, as reported in the works of many authors from China, Thailand, and Portugal (Zhan *et al.*, 2017; Saijuntha *et al.*, 2014; Vale *et al.*, 2020).

The presence of foci of opisthorchiasis and their territorial distribution is tied to freshwater reservoirs, primarily to small rivers. On the other hand, the functional stability of foci is due to the presence of the necessary links involved in the implementation of the life cycle of opisthorchid flukes: Intermediate hosts (*Bithynia* shellfish) (the first intermediate host), cyprinid fish species (the second

intermediate host) and definitive hosts (Romashova and Romashov, 2015; Belyaeva, 2016; Simakova *et al.*, 2021).

On the territory of Kazakhstan in the Ural River basin, a high (57.2%) infestation of Cyprinid fish with *O. felineus* metacercariae was detected. The prevalence of invasion of dogs and cats by *Marita* of this type of trematodes averaged 55.5 and 71.4% (Kereev and Karmaliev, 2013). A similar situation is observed in other regions of the Republic of Kazakhstan (Kereev and Karmaliev, 2013; Sidikhov, 2020; Domatskii and Kornikova, 2020).

According to the results of our study, carp (common carp), roach, bream, tench, ide, crucian carp, and gudgeon live in the reservoirs of Kostanay and North Kazakhstan regions. The most dangerous species are ide, bream, and carp (common carp), which are especially often sources of human opisthorchiasis. The high degree of invasiveness of these fish species can be found in the works of many authors from Russia, Thailand, and Portugal (Fedorova *et al.*, 2018; Saijuntha *et al.*, 2014; Vale *et al.*, 2020).

The data obtained by the Department of Epidemiological Surveillance of EDI and tuberculosis of the Department of Quality Control and Safety of Goods and Services of Kostanay region, the Committee for Quality Control and Safety of Goods and Services of the Ministry of Health of the Republic of Kazakhstan confirm that opisthorchiasis is a widespread disease among people living in Kostanay and North Kazakhstan regions.

The high incidence rates of opisthorchiasis are aggravated by social factors, such as the increase of home-cooked fish and home-made fish products in the diet of the population of coastal towns and villages (it is impossible to overcome the habits of the local population to eat raw fish); an increase in the number of recreational fishers and population migration (Petney *et al.*, 2018; Saijuntha *et al.*, 2014; Bibik, 2020; Tantrawatpan *et al.*, 2020). We have constantly identified these factors in the course of conducting our study, which once again proves the paramount significance of eating fish containing *O. felineus* metacercariae from permanently unfavorable natural foci of opisthorchiasis located on the territory of Kostanay and North Kazakhstan regions in the occurrence of human opisthorchiasis.

Thus, opisthorchiasis remains an urgent and serious socially significant problem in the medical and biological

fields, including veterinary medicine. To solve it, it is important to know the ecological patterns of circulation of pathogens of opisthorchidosis in specific conditions of the region. A comprehensive study of this problem will allow us to develop effective preventive measures, as indicated by many researchers from Thailand and Russia (Khuntikeo *et al.*, 2018; Bibik, 2020).

## Conclusion

The incidence of opisthorchiasis in the Kostanay and North Kazakhstan regions is associated with the consumption of fish of the cyprinoid family, which are the main commercial species in the region. Consequently, the population of these areas is constantly associated with the risk of infestation with opisthorchiasis. This fact causes the need for constant monitoring of the parasitological situation, veterinary and sanitary examination of fish entering the sales network, the study of the area, and examination of intermediate hosts for the presence of pathogens of opisthorchiasis, as well as the development of effective preventive measures.

For further studies on opisthorchiasis, we consider it important to continue studying the objects of the parasitic system, including intermediate hosts, to obtain an objective assessment of the epidemiological and epizootological state of specific territories, forecasting and monitoring the development of the parasitological situation in the region.

## 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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