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Results of Parasitological Research on Hydrobionts from Water Bodies in West Kazakhstan Region

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ABSTRACT

Control fish catches in the reservoirs of the Ural-Kushum water-irrigation system and the Derkul, Ankaty, Shiderta, Buldyrty, Utva, and Rubezhka rivers allowed the establishment of the extensiveness and intensity of infestation by the main helminth species among fish and the studied reservoirs. Ligulosis pathogens had the highest prevalence in the territory of West Kazakhstan region, found in 5 of 9 surveyed reservoirs, and postodiplostomosis in 4 of 9. Diseases were registered predominantly among carp family fish, and the extensiveness of infestation was 4.1 and 3.2%, respectively, of the total number of fish. The main species in which helminths have been detected are redfin, roach, and goose. Among anthropozoonotic diseases, in which fish are intermediate hosts, individuals with opistorchosis metacercariae were found in Derkul and Rubezhka rivers. The extensiveness of infestation was 16% of the carp population, which was significantly lower than the results of earlier studies. Of the other diseases dangerous to humans, no anisacid larvae were detected, which also did not agree with literature sources. Parallel to the parasitological examinations of fish, an examination of caught crayfish was carried out to determine the number of diseased crayfish. The survey revealed that about 20% of the river crayfish caught in the reservoirs had signs of rust-stain disease.

Key words: Control catch, Opisthorchiasis, Postodiplostomosis, Ligulosis, Anazakidosis, Metacercariasis, Rust-staining crayfish disease.

INTRODUCTION

Aquaculture is currently one of the fastest growing agricultural sectors in Kazakhstan. This is supported by the state programme for fisheries development, which will run until 2030. It envisages a budget allocation of 177.4 billion tenge, of which more than 75% will be allocated for the maintenance of breeding herds, purchase of stocking and other areas. Such an approach will solve food security problems, saturate the market with healthy foods and make them available to all segments of the population, as fish are superior to most warm-blooded animals in terms of their use of feed for growth. In 2021, the volume of farmed fish in Kazakhstan was 14.9 thousand tonnes. This is 17% more than in 2020 (Galushko 2022). In order to achieve sustainable growth rates in aquaculture in the country, it is necessary to ensure the veterinary welfare of the ichthyofauna. Infectious and parasitic diseases reduce the safety of fish during their cultivation and do not allow for maximum productivity. Parasitic diseases also reduce the quality of fish products. Sick fish are stunted, they lose their marketable appearance through the development of clinical signs of helminth infestation and are not recommended for human and animal consumption without special decontamination (Biyashev et al. 2016; Nurzhanova et al. 2021).

Given the increasing number of fish products in the human diet, this may cause an increased risk of human exposure to dangerous invasive diseases whose pathogens use fish as an intermediate host (Bulegenova et al. 2018; Kitphati et al. 2020; Maksimova 2021). Due to the focality of invasive diseases, they have to be considered regionally specific. Thus, a number of authors Aubakirov et al. (2022), Proskurina et al. (2020), Sultanov et al. (2014) in medical periodicals indicate a rather significant focus of opistorchosis in northern and western Kazakhstan with

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annual incidence of up to 1500-1700 cases. There are also occasional reports of human and other animal cases of infectious diseases transmitted through fish and other ichthyofauna, such as anisacidosis (Nurzhanova et al. 2022), ligulosis (Adilbekov et al. 2020) and other diseases.

Given the population size of the West Kazakhstan Oblast and the significant development of the fishing industry in this region, there remains a risk of the spread of a number of parasitic fish diseases that are dangerous to human health (Sidikhov 2020). This is facilitated by the geographical location of these areas in the coastal region of the Caspian Sea and the dense network of freshwater rivers and lakes. There are six large (Ural, Chagan, Derkul, Kushum, Bolshoy and Malyi Uzen) and up to 200 small rivers with a total length of about 4500 km, there are also more than 60 freshwaters and up to 100 salt lakes in the region. In terms of area, the largest are Shalkar, Rybny Sakryl and the system of Kamysh-Samara lakes. Therefore, pathogens characteristic of both riverine and marine ecosystems is identified in this region (Tokpan et al. 2020). Among invasive fish diseases that are registered in this region of Kazakhstan and are dangerous for humans or other farm animals and birds, opisthorchiasis (*Opisthorchis felineus*), anisacidosis (*Anisakis simplex*), ligulosis (*Ligula imestinalis*), postodiplostomosis (*Posthodiplosto-muni cuticola*) and crayfish aphanomycosis (*Aphanomyces astaci Schikora 1906*) are common (Kyrychuk and Muzyka 2017; Sergaliyev et al. 2017).

Proceeding from the above-mentioned materials, the aim of the work is to carry out parasitological research of hydrobionts inhabiting water bodies of West Kazakhstan region, to reveal and determine the spread of infestation of fish in this region, which will improve epidemiological and epizootological indicators.

MATERIALS AND METHODS

The main scope of work was carried out from May to October 2021 at the Laboratory of Veterinary Sanitary Examination at the Institute of Veterinary Medicine and Animal Husbandry of the Zhangir Khan West Kazakhstan Agrarian Technical University. Field works were carried out at such water bodies as Ural-Kushum water-irrigation system, right bank of the Ural River and a number of small water bodies of local importance in West Kazakhstan oblast: Derkul, Ankaty, Shiderta, Buldyrty, Utva, Rubezhka rivers. The locations of fish catches for helminthological survey are mapped (Fig. 1).

Initial examination of the caught fish and collection of pathological material were carried out directly at the catching sites (Fig. 2).

425 specimens of 15 species of river fish and 40 river crayfish were selected for the study. The following fish species were analysed: pike – 38 specimens, redfin – 37, carp – 18, bream – 27, perch – 37, crucian carp – 17, roach – 44, asp – 28, silver carp – 18, ide – 12, whitefish – 36, goose – 47, pikeperch – 37, carp – 13 and catfish – 16 specimens.

The catching was carried out from the rivers Derkul, Ankaty, Shiderta, Buldyrty, Utva, Rubezhka and reservoirs Bitikskoe, Kirovskoe, Pyatimarskoe. Water bodies were selected so that 4 districts of the region, which according to literature sources and the Department of Sanitary and Epidemiological Control of West Kazakhstan region were considered to be unfavourable for different parasitic diseases, were subjected to survey. The following areas were included to the number of these areas: Baiterek (Derkul), Syrymskiy (Ankaty, Shiderta, Buldyrty), Burlinskiy (Utva, Rubezhka), Akzhaikskiy (reservoirs Bitikskoe, Kirovskoe, Pyatimarskoe). Ichthyological and parasitological studies were carried out according to generally accepted methods (Mustafin and Volkov 1984; Simakova et al. 2018). Species diagnosis of parasites was carried out according to the methodology described in the freshwater fish parasite identifier (Bauer 1987). By full parasitological analysis method, 315 fish specimens were dissected to detect possible complex infestation of ichthyofauna with anisakidosis, ligulosis, postodiplostomosis and opisthorchosis. And 110 fish caught in unstable water bodies for opisthorchiasis were partially dissected to detect metacercariae.

To detect possible infestation for postodiplostomosis, an external inspection of the caught fish was carried out to detect pigment spots and a partial autopsy was carried out by dissecting the muscle tissues with a parallel cut method to detect metacercariae. To detect opisthorchiasis metacercariae, a compressive method was used, followed by microscopy at 20-40x magnification. Partial autopsy techniques were performed according to Rules of Veterinary and Sanitary Examination of Freshwater Fish and Crayfish (Zaitseva 1989) and MUK 3.2.988-00 “Prevention of parasitic diseases: Methods of sanitary-parasitological examination of fish, mollusks, crustaceans, amphibians, reptiles and products of their processing” (2001). Statistical analysis was carried out using genetic-mathematical and biometric methods, using a descriptive statistical tool in the application package “MS Excel 2010”.

The analysis of publications of the results of research works conducted in previous periods, materials, and results of surveys of the Department of Sanitary and Epidemiological Control for the West Kazakhstan region allowed to determine the optimal places for fish catching in order to maximize coverage of territories, unfavourable for a number of parasitic diseases, which are transmitted with fish. The study was limited to fish as an intermediate chain in the spread of a number of helminths in the development of human and animal infestations. Fish was caught by nets at intervals of a month and a half in the rivers Derkul, Ankaty, Shiderta, Buldyrty, Utva, Rubezhka and the cascade of water reservoirs on the Kushum River – Bitikskoe, Kirovskoe, Pyatimarskoe. During the experiment period, 2-3 fish catches were conducted in each of the controlled water bodies with subsequent summation by species of fish caught and taking into account the results of parasitological examination. Externally, sick fish do not differ from healthy fish, so partial and complete dissections were carried out on all pelagic fish of the carp family – roach, roach, bream, crucian carp, goose and others, followed by compressive examination to detect metacercariae. Metacercariae detected in field conditions were fixed for detailed study and differential diagnostics in conditions of Laboratory of Veterinary Sanitary Examination.

RESULTS

The results of the species composition of fish caught in the West Kazakhstan region regulated water bodies presented in the form of a diagram (Fig. 3).

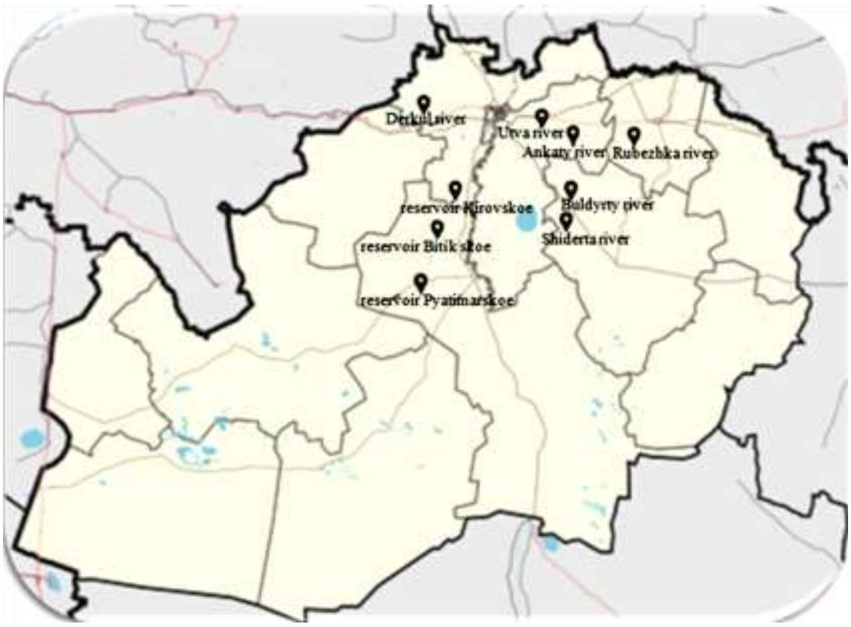

Fig. 1: Fishing grounds for helminthological testing: Source: authors' own development.

Fig. 2: Parasitological research on fish in the field: Source: photo taken by the authors.

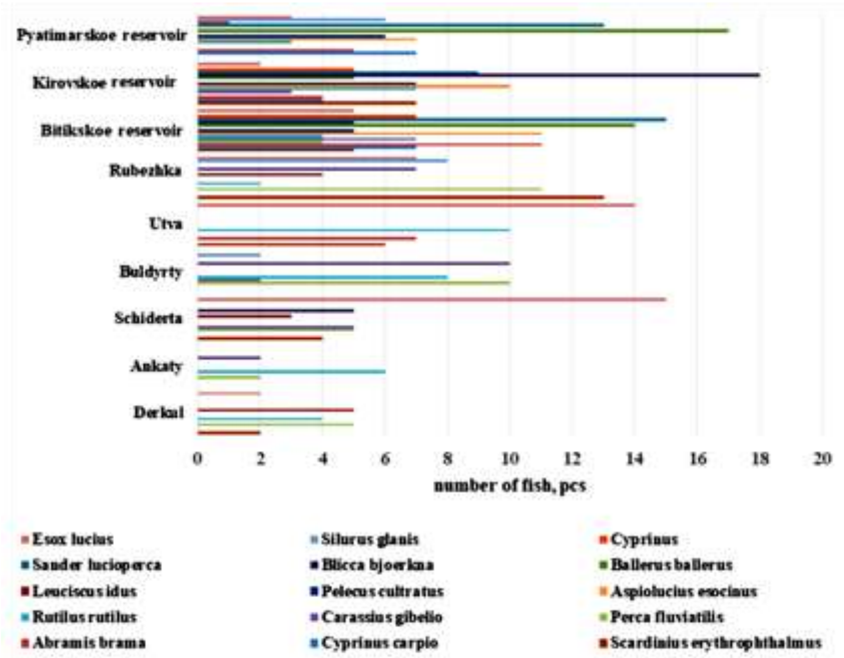

Fig. 3: Fish species caught for study in controlled water bodies of the Ural-Kushum water-irrigation system, the right bank of the Ural River and rivers of West Kazakhstan Oblast: Source: compiled by the authors on the basis of the results of the fish catch.

All fish caught, regardless of species or age, were used for parasitological examination. Before autopsy, fish were examined for possible clinical signs of infestation. In most cases, fish that were later found to be infested with parasites differed markedly from healthy fish even on external inspection – the presence of pigmented areas on the body and fins, an unnaturally enlarged belly, emaciated fish, etc. Only after the external examination, a decision was made whether a full or partial autopsy was advisable. The parasitological survey detected infestations of fish with helminths of ligulosis and metacercariae of postodiplostomosis and opisthorchiasis in seven of the nine water bodies examined. No fish infested with anisakids were found in any of the water bodies (Fig. 4).

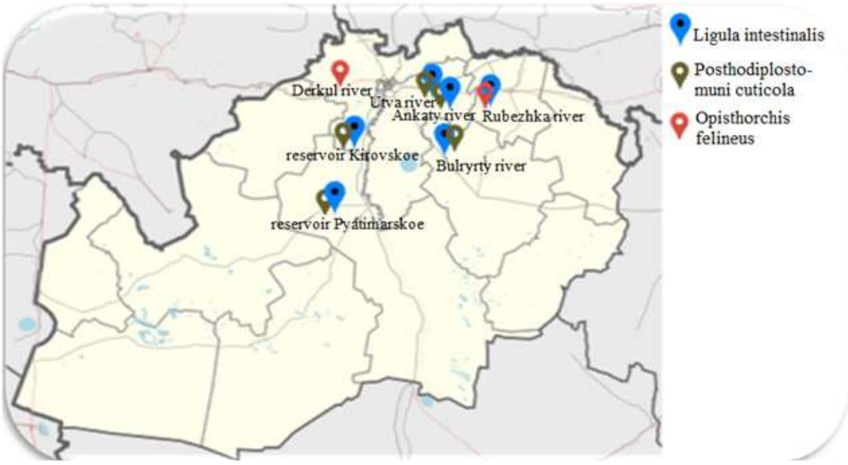

Fig. 4: Locations where contaminated fish are found: Source: compiled by the authors on the basis of research conducted.

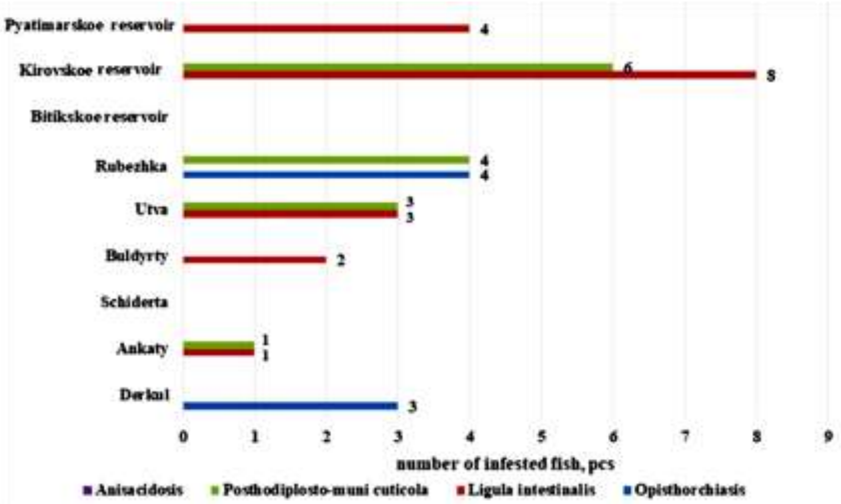

Fig. 5: Indicators of infestation of fish by water bodies, n = 425: Source: compiled by the authors on the basis of research conducted

The study found that, when caught in the same water bodies at different times, the number of infected fish differed both between and within the species caught. Predominantly parasite infestation was observed in fish of the carp family – redfin, ide, roach, and others, while no parasites were found in predatory fish. A tendency was noticed that with increasing water temperature, the risk of fish morbidity for the majority of parasitic diseases increased in the studied water bodies. Unfortunately, the existing sampling of fish within infested species in individual water bodies was not representative, and the results obtained do not allow a clear statement of this fact. Therefore, it is planned to conduct further surveys, in the same water bodies, next year in order to detect seasonal and age-specific recurrence of infestation. Ligulosis was the most common parasitic disease in the surveyed water bodies. These helminths infected fish from 5 water bodies (Fig. 5).

Infestation of fish with ligulosis could only be determined by external signs, but to confirm the diagnosis and to differentiate between possible complex infestation of hydrobionts, different helminth species, a full autopsy of fish with characteristic clinical signs was carried out. On initial inspection of the fish caught, an increase in abdominal volume was visually observed mainly in the anterior part of the abdomen. Palpation examinations revealed a dense, hard seal inside the fish. On autopsy, flat, tapeworms were found in the abdominal cavity of the body. Partial atrophy of the parenchymatous organs, especially of the liver, was noted in all dissected fish. The intestine was compressed in various places and intertwined with a ribbon-like helminth body, and the intestinal wall was thinning. The helminths detected were relatively large, strap-shaped, white-yellow worms, reaching a length of 5-18 cm and a width of up to 1cm. In some fish, the helminths were mobile on autopsy. The main species in which helminths causing ligulosis developed were redfin, goose bream and roach. According to the research results, the intensity of infestation for ligulosis was higher in Kirovskoe and Pyatimarskoe reservoirs compared to the number of sick fish in Ankaty, Buldyrty, Utva rivers. This is due to higher water temperature, due to the lack of current in the reservoirs, and more active reproduction of plankton – cyclops and diaptomys, which are intermediate hosts for parasite larvae. In rivers, due to considerable flow, some larvae die due to lack of contact with intermediate hosts, which is reflected in the results of disease manifestation. Thus, study of fish ligulosis prevalence in West Kazakhstan region showed that fish caught both from reservoirs and rivers are subjected to infestation. At the same time, the extensiveness of infestation was 4.1% and the intensity of infestation of infestation was 3 specimens per individual.

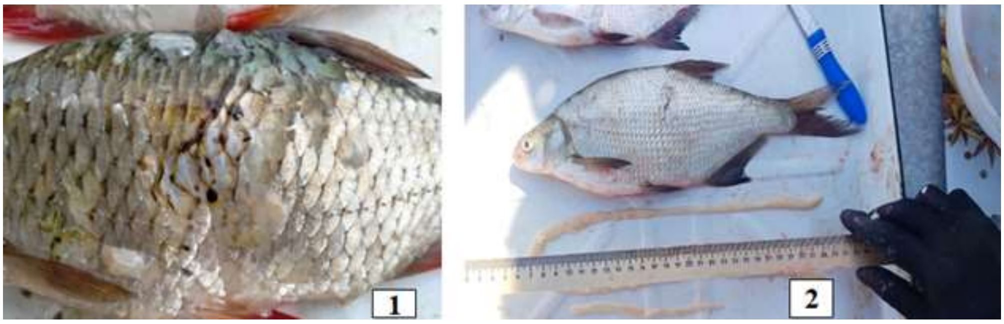

Fig. 6: Photo of infected fish: Note: 1 – postodiplostomosis; 2 – ligulosis: Source: photo taken by the authors.

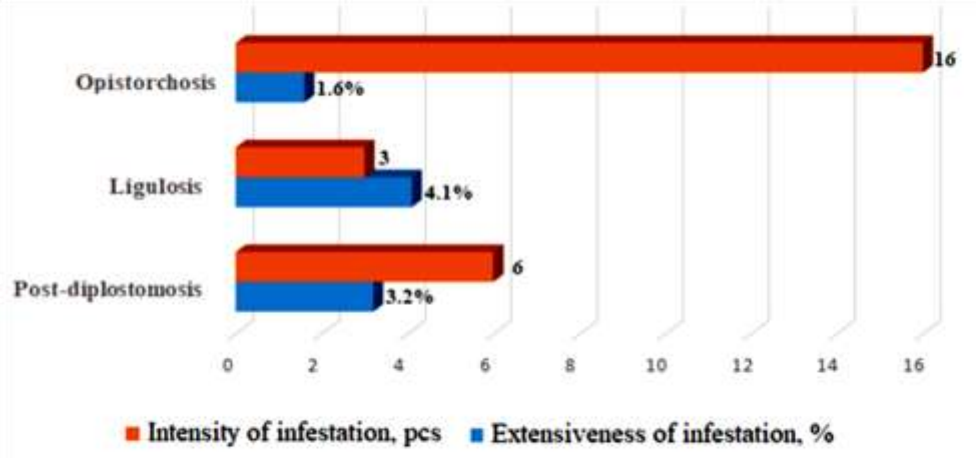

Fig. 7: Fish infestation by disease in West Kazakhstan Oblast: Source: compiled by the authors on the basis of research conducted.

The second most widespread disease in water bodies of West Kazakhstan oblast was postodiplostomosis. Metacercariae of this disease were isolated both in river fish and in aquaculture from reservoirs. The spread of postodiplostomosis in fish is closely linked to the development of the disease in waterfowl and should therefore be considered in close relation to the spread and infection of the birds themselves in the areas where the fish are caught. Unfortunately, this study was limited to the spread of infestation among members of the ichthyofauna. Therefore, comprehensive studies are planned for next year in order to investigate in more detail the development of the disease in all animals that are included in the helminth's life cycle in this region. The preliminary diagnosis for postodiplostomosis was made by the presence of characteristic clinical signs – black spots and tubercles on the skin, fins and in the muscular layer under the skin throughout the body. In appearance, fish infested with *Postodiplostomum cuticola* larvae do not differ from healthy fish, except for the characteristic black spots on the body and fins and the paler colour of the muscles of the infested fish. Fish with a significant degree of infestation had a moderate degree of emaciation and they also exhibited a reduction in the marketability of fish (Fig. 6).

In order to confirm the diagnosis, a partial examination of fish with clinical signs and subsequent determination of the metacercariae species affiliation was carried out. The studies revealed that fish from the Rubezhka, Ankaty, Utva rivers and Kirovskoye reservoir were susceptible to postodiplostomosis disease. At the same time in all water bodies under control the extensiveness of infestation for postodiplostomosis was 3.2%, and its intensity was up to 6 specimens per individual. The laboratory results obtained the following indicators of the development of the infestation process – the extensiveness of the infestation (1.6%) and its intensity was 16-21 specimens (Fig. 7).

Despite the results of earlier surveys in this area of Kazakhstan, where an anisakid infestation was detected, all fish caught in the controlled water bodies showed no signs of infestation with this helminth. This may have been due to catching fish in other water bodies located at a considerable distance from the Caspian Sea coast, as anisakids predominantly develop in seawater. These data indicate that there are persistent natural foci of opisthorchiasis, ligulosis, postodiplostomosis in water bodies, formed both naturally – by migrating fish species, and by infestation by man or waterfowl. The existence of natural foci, particularly in West Kazakhstan region, is supported by the presence of infected wild or domestic mammals in the epizootic process, which should be taken into account when assessing the parasitic situation on helminthozoonosis and its prediction.

In addition to examining fish for parasitic diseases, a parallel survey was carried out on river crayfish, which were caught in sufficient numbers, for septicaemia or rust-stain disease, which is caused by the parasitisation of different species of fungi in the family *Mucedinaceae*. The crayfish were mainly caught in the Kushum reservoirs and in the reservoir on the Barbastau River while fishing for parasitological studies. At the same time, signs of disease were observed in the crayfish population, which were manifested by decreased motor activity of the crayfish, their lethargy, and the presence of discoloured spots on the carapace (Fig. 8).

Fig. 8: Signs of rust-stained crayfish disease: Source: photo taken by the authors.

Of the 40 crayfish caught, 20% of the individuals had shell lesions in the form of dark brown spots, in the caudal and thoracic segments of the body. Foci of tissue necrosis was observed in the affected areas, and partial immobility of individual limbs was observed in deep lesions. No dead crayfish or crayfish shells were found at the catching sites. These clinical symptoms are characteristic of crayfish septicemia or rust-stain disease.

DISCUSSION

Almost all the crayfish that showed signs of the disease were caught in areas with low flow (reservoirs), while no sick crayfish were observed in rivers with normal flow. According to Lukicheva (2022), the spread of pathogens among lower crustaceans, which serve as food for crayfish, could contribute to the transmission of diseases within crayfish populations. Additionally, areas with standing water may be more prone to fish infestation with ligulosis and rust-spot disease. The rust-spot disease is caused by a microscopic fungus belonging to the Mucedinaceae family, which is typically present in water bodies. Although crayfish with clinical signs of the disease may be frequently found in the population, their reduced immunity due to stress or changes in habitat conditions can weaken their defence capacity and potentially lead to population-wide outbreaks and mortality. To summarize, various factors, such as pathogen transmission through lower crustaceans, fish infestation with ligulosis, and the presence of a microscopic fungus, can contribute to the spread of diseases among crayfish populations. Additionally, reduced immunity in crayfish due to stress or changes in habitat conditions can further exacerbate their vulnerability to these diseases, potentially resulting in widespread mortality.

Infectious diseases transmitted by freshwater fish pose a significant threat by making humans, farm animals and domestic animals sick. Such fish can also cause human food toxicoses and toxic infections and develop persistent allergic reactions. Therefore, regular sanitary and epidemiological testing for helminths in fish will reduce or even prevent human infection with these diseases. In the studies on fish infestation conducted in the water bodies of West Kazakhstan oblast, the aim was to monitor the spread of helminth infections among the main ichthyofauna species used for industrial catch and recreational fishing in this region. The most dangerous of the parasitological diseases that are transmitted with fish or fish products, in terms of epidemiological condition, is opisthorchiasis (Ángeles-Hernández et al. 2020). This is due to the fact that the disease is anthropozoonotic, i.e., it can affect humans as well. Analysis of opistorchosis dynamics in the region for the last few years shows that even with the implementation of certain preventive measures there is no stable tendency to decrease these diseases among the population (Antipova and Pilin 2020). Annual registration of cases of opistorchosis in settlements adjacent to rivers shows that the population continues to get untreated fish and fish products containing larvae of dangerous biohelminths, in particular, cat louse (Abzhaliyeva et al. 2018).

The most dangerous parasitic disease that is transmitted by fish in this region of Kazakhstan is opisthorchiasis. This is due to the fact that one of the main hosts in the development cycle of this trematode is humans (Kirichuk and Stadnichenko 2004). In this regard, the Department of Sanitary and Epidemiological Control for West Kazakhstan oblast keeps records of human cases and periodic laboratory tests for the detection of metacercariae in fish, as the oblast is opistorchosis-prone. Recently, the number of human cases for opistorchosis in this region has decreased significantly. There has also been a reduction in the number of opistorchosis outbreaks as a result of the control fishery as compared to the work of ten years ago, the results of which are described in the article by Karmaliev and Kereev (2013). As a result of control catching in water bodies of West-Kazakhstan oblast opisthorchiasis metacercariae were detected in fish caught only in Derkul and Rubezhka rivers. Of all fish species caught in these water bodies, only ide was found to be infested, which agrees with the results of previous surveys.

According to Karmaliev and Kereev (2013), the extent of infestation with opisthorchiasis metacercariae among carp fish of this region was more than 60%, a little less was fish infestation after 9 years. Thus, in the work of Nurzhanova et al. (2021) in 2020 the extent of infestation was already about 50% among such fish species as redfin, crucian carp, ide, roach, tench, and bream. In surveys carried out in 2021, the infestation among carp fish in water bodies where opisthorchiasis metacercariae was detected was only 16% (or 1.6% of the total number of fish caught). The difference in the infestation of fish, between almost simultaneous surveys, was due to the different locations at which they were caught. Whereas in the studies conducted in 2020, the Ural River was the main reference fish catching location, in 2021 it was small rivers and a cascade of reservoirs on the Kushum River. And since opisthorchiasis is considered a focal disease, the infestation could differ significantly depending on the study site (Bardhan 2022).

The following invasive fish diseases, although not dangerous for humans, cause considerable damage to commercial fish farming (Gutiérrez 2022). This is reflected in the death or stunting of ligulosis and postodiplostomosis-infected fish. In control catches, the maximum rate of infestation was observed with these helminths. The disease affects mainly fish belonging to the carp family: tench, bream, roach, roach, taran, redfin, crucian carp, goose, gustard, bleak, and some others. The disease affects fish more often in shallow bodies of water with a slow current, and less often in rivers with a fast current (Maira et al., 2020). The shallow depths of rivers and lakes, slow currents, and extensive aquatic vegetation contribute to the intensity of infestation. In a study by Adilbekov et al. (2021), these pathogen species also prevailed in fish caught in the North Kazakhstan region. Studies have noted a tendency for infestation intensity to increase during periods when the water is at its warmest. The seasonality of helminth infestations is also confirmed in studies by Juntaban et al. (2021) conducted on a large population of fish under subtropical conditions. It is possible that the rate of helminth development depends on the time of year, the pollution of the water body and the presence of favourable conditions for further existence of parasites. Unfortunately, the number of caught infected fish of different species in the controlled water bodies did not allow to confirm the reliability of the influence of seasonality on the intensity of infestation. Under the conditions of the West Kazakhstan oblast, apart from water temperature, the intensity of water flow in infestation foci and the intensity of aquatic vegetation development in them will be possible influencing factors (Hailu and Mitiku 2021). Therefore, it is planned to continue these studies next year in the same water bodies to investigate the seasonal and age-specific recurrence of infestations.

In addition, a study of only fish infestation with helminths would not be complete without a parallel study of the status of infestation in the waterfowl population as well, which will also be the subject of future research studies. Another parasitic fish disease for which a targeted search for pathogens was planned as part of this scientific study was anisakidosis. The disease, like opisthorchiasis, is anthropozoonotic, i.e., the pathogen can cause disease in humans (Mel'nychuk and Hryshchenko 2014). Until recently, the parasite was only detected in marine ichthyofauna, but recently there have been increasing reports of anisakids in freshwater fish close to the coast (Dana et al. 2018; Falla-Zuñiga et al. 2021; Ozuni et al. 2021). Similar reports apply to rivers in the Caspian Basin (Pilin et al. 2014; Abdybekova et al. 2020; Zhatkanbaeva et al. 2021; Nurzhanova et al. 2022). Predominantly Nurzhanova et al. (2022), Zhatkanbaeva et al. (2021) and Pilin et al. (2014) reported the presence of anisacid larvae in predatory fish such as perch, pike, and zander. Also, in selected members of the carp family such as silverfish, asp and bluefin. In the parasitological studies described in this article, no anisakid larvae were detected in the bodies of caught fish during control catches. When analyzing the reasons for the discrepancy between the survey results and the literature data on the incidence of anisakidosis in the territory of West Kazakhstan oblast, it can be assumed that this is due to the different locations of fish catches. As one of the hosts in the development cycle of the parasite is the Caspian seal, which lives only in seawater, it is logical to assume that infestation of fish can only occur in those bodies of water that have contact with the sea (Ye Kyrychuk and Muzyka, 2016).

Thus, in the articles (Pilin et al. 2014; Zhatkanbaeva et al. 2021; Nurzhanova et al. 2022; Zhumabaev 2022), the main catch locations of fish in which anisakids have been found are in different parts of the Ural River, which flows into the Caspian Sea. And the studies in this article were caught in small rivers and a cascade of reservoirs on the Kushum River, which do not connect to the Caspian Sea. Therefore, no anisakid larvae were detected. Parallel to the parasitological surveys among fish, crayfish that were caught together with fish in the same water bodies were examined for disease. All caught crayfish were examined clinically. Crayfish without clinical signs of disease were released back into the aquatic environment, while those with symptoms of the disease were taken to the Laboratory of Veterinary Sanitary Examination at the Institute of Veterinary Medicine and Animal Husbandry of the Zhangir Khan West Kazakhstan Agrarian-Technical University for further microbiological and parasitological studies. Since it was not possible to find scientific publications on the incidence of crayfish in the West Kazakhstan Oblast published in previous years, there was nothing to compare the results with. The lack of information on the incidence of this type of river organism makes such studies a priority in the study of ichthyofauna not only in a particular region, but also within the whole country, as river crayfish are in constant demand due to their excellent taste and high biological value of the meat. The main catch of crayfish was in reservoirs, where the highest percentage of rust-stained fish was also observed. This indicates that the increased reproduction of microscopic fungi, which are pathogenic agents, is likely to take place in stagnant reservoirs with warmer water temperatures. Alternatively, it could be attributed to the larger population of lower crustaceans, which serve as vectors for the pathogen. Therefore, this aspect of the work touched upon in this article also needs further research.

Conclusion

Based on the research conducted and the analysis of publications on the problem of the spread of parasitic fish diseases in the West Kazakhstan region, the following conclusions and suggestions for future scientific work have been made. In small rivers of the region and in the Kushum River reservoir cascade the main parasitic diseases that were registered during the study were ligulosis and postodiplostomosis. Fish of the carp family (redfin, roach, and silver carp) were predominantly affected by helminths. There is a tendency to increase the risk of infecting fish with pathogens of these diseases with increasing water temperature. Therefore, the study of seasonal and species dynamics of these diseases will be promising for future studies.

Fish with opisthorchiasis metacercariae infestation was detected in only two of the nine surveyed water bodies. However, the extensiveness of the infestation was only 16%, which is significantly lower than other results from studies conducted in the same region. This is due to the different fishing grounds. Therefore, continuous monitoring of fish infestation in the affected areas will make it possible to control new outbreaks of the disease and prevent the spread of opisthorchiasis among humans and animals. As part of the targeted detection of fish morbidity for parasitic diseases in the West Kazakhstan region, no signs of fish infestation by anisakids were detected in the Derkul, Ankaty, Shiderta, Buldyrty, Utva, Rubezhka rivers and the Kushum reservoir cascade. The discovery of a significant lesion (up to 20%) of river crayfish due to rust-stain disease during control catches highlights the lack of literature data on crayfish morbidity in the river system of the West Kazakhstan region. This finding emphasizes the importance of conducting further research on the health of river crayfish in this area, which holds potential for future scientific investigations.

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Author Contributions

Conceptualization, UT, BK; methodology, BN, ZK, AT; software, AZ, BK, UT, ZK.; investigation, AZ, BN; resources, BK, AT, ZK; data curation, AZ, BN; writing-original draft preparation, UT, BK, ZK, AT, AZ; writing-review and editing, BN, AZ; visualization, ZK, UT, BK.

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