Impact of Industrial Transformation of Irelyakh River on Fish Parasite Fauna

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Abstract. Diamond industry has a negative impact on fish parasites with complex and simple life cycles that parasitize on fish skin. At the same time, direct development cycle species, as well as those whose larvae attack fish actively, are preserved.

1. Introduction
Any industrial activities around water bodies including the construction and operation of diamond industry facilities have negative impacts on the respective water ecosystems. The direct and indirect negative impacts of deposit development, especially dredger-based, include the changes of river course morphology, bottom deposits, the hydrological and hydrochemical regimen of the water bodies, as well as the reduction and redistribution of surface runoff. The character, intensity, and duration of these factors determine the degree of their impacts, which is manifested in the degree of the restructuration of water ecosystems combined with reduced productivity of hydrobionts, including fish parasites. The reactions of various groups of parasites to the anthropogenic pollution are diverse and may include the reduced survivability of free-living stages (eggs and larvae), the dying-out of intermediary and definitive hosts, and the reduction of fish resistance [1, 2, 3] (Pietrock, Marcogliese, 2003; Marcogliese, 2005; Pietrock et al., 2008). The diversity of parasitic species may also reduce due to the higher mortality rates among the infected hosts as a result of the pathogenic impacts of the parasites themselves.

2. Relevance
The Irelyakh river is one of the main tributaries of the Malaya Botuobia river. The river bed mainly consists of sand and pebbles with some rocky-pebble bars. Since 1964, the middle reaches of the Irelyakh (40 km upstream of the estuary are regulated by the Irelyakh reservoir dam. This reservoir is the only source of potable water for the Mirny industrial hub. The reservoir is subject to the special water management regimen: any activities, including fishing and recreation, are banned on the water and surrounding protection area (0.5 km). The sanitary conditions of the water are controlled by the
Mirny Mining and Processing Plant industrial sanitation laboratory, the environmental condition analysis laboratory of the Yakutinproalmaz Institute, and the Mirny Center of Gossanepidnadzor [4]. The section of the Irelyakh river from the Irelyakh reservoir dam to the dredging sites (about 6 km) is within the Mirny city limits. It is a chain of streams with lake-like extensions covered in thick water and wetland vegetation. The width of the river fluctuates between 3 and 10 meters during the low water season and can exceed 50 meters during the high water season. The riverbed is covered in small and medium-sized rocks, pebbles, sand, and a lot of silt. During summers and autumns, the water blooms and bottom deposit fouling. In the section near the No. 5 washing plant, the river is dammed up with slurry pipes, water conduits, power line pylons, and an engineering machine road located on the dam. In this section, all of the Mirny storm and sewage waters enter the Irelyakh river. Previously, the No. 3 washing plant discharge its wastewater from the 1st and 2nd order tailing dumps here. Currently, the plant uses a recirculated water supply system. Like the previous section, this one lost all the features typical of a semi-mountain river. In the upper reach of the section, 6.5 km of the riverbed and surrounding valley are technically reclaimed and left for self-organized vegetation. In this section of the river, the No. 5 washing plant has been discharging its wastewaters for a long time. Further down the stream, the course of the Irelyakh is essentially invisible. This section of the river features dredging sites that operate during the open water season and over the entire river valley (the river course, the floodplain, and the terraces). Dredging sites are small reservoirs where the dredgers of the Mirny Mining and Processing Plant Irelyakh mine work. The section is completely transformed because the dredging sites cover the entire river valley including the terraces above it. Thus, the middle and lower reaches of the Irelyakh river have been regulated for over 40 years by various waterworks, and the river has lost its original character due to the anthropogenic impacts. Besides, the volume of the water retrieved from the Irelyakh water reservoir for drinking and household needs currently equals 90% of the annual runoff of the river. In view of the above, the study of the impacts of anthropogenic transformation on the fish parasite fauna is very relevant.

3. Problem statement
The purpose of this research is to study the impacts of the anthropogenic transformation of the Irelyakh river on the fish parasite fauna. To do this, we set the following objectives:
- studying fish parasite fauna in water bodies with different degrees of anthropogenic transformation;
- determining the distribution of fish parasites across the classification groups in water bodies with different degrees of anthropogenic transformation.

4. Theory
In September 2018, the parasitological research of fish was carried out in the anthropogenically transformed diversion channel of the Irelyakh river dredging sites and the Vilyui river below the Svetly reservoir. In the Irelyakh river, we examined 34 specimens of 6 fish species including 2 burbots, 3 pikes, 11 perchies, 2 roaches, and 6 crucians. In the Vilyui river, we examined 36 specimens of 7 fish species including 5 burbots, 1 pike, 6 perchies, 8 daces, 9 tuguns, 6 ruffs, and 1 Siberian sculpin. We used the generic fish parasitology methods to study and process the materials.
We collected, recorded, and performed laboratory analysis of the parasitological materials using standard practices (Bykhovskaya-Pavlovskaya, 1985). We identified the parasite species using the Field Guide to the USSR Freshwater Fish Parasite Fauna (1984, 1985, 1987). The calculate fish infection rates, we used the following indicators: infection prevalence (IP), infection intensity (II) (specimens per one fish), and the abundance index (M).
During parasitological thanatopsy, we identified 21 parasite species belonging to the following classification groups: Myxosporidia – 2, Monogenea – 2, Cestoda – 6, Trematoda – 7, Nematoda – 3, Acanthocephala – 1. There are no significant differences in the parasitic fauna of the two sampling spots, and the general infection rate for them is 91.4%. Trematodes are the most widespread species. For the dace, the metacercaria Diplostomum sp infection rate is 94.7% with an II (infection intensity)
of 7-25 specimens, *Ichtyocotylurus platycephalus* is 84.2% with an II of 1-53 specimens, while the nematode and acantocephala infection rates are 20.1 and 15.7% respectively with the minimum II of 1-4 specimens. *Cyathocephalus truncates* cestodes were found in the perch, while *Triaenophorus nodulus* and *Eubothrium rugosum* with the minimum infection intensity were found in the burbot. None of the fish species had ciliates, which signifies high anthropogenic loads on the waterbody according to many authors. Considering fish parasite infections with epidemiological consequences, we found that the pike, burbot, ruff, and tugun were infected with *Diphyllobothrium latum* plerocercoids, while the tugun was also infected with *D. dendriticum*, which means that sewage is discharged in the waterbody.

![Figure 1. The distribution of fish parasites across the taxonomic groups in the diversion channel of the Irelakh and Vilyui rivers below the Svetly reservoir.](image)

5. **Applicability**

The study of fish parasites in the Vilyui basin waterbodies transformed into industrial pools showed that the parasitological data adequately reflect the consequences of the anthropogenic transformation of the natural water body (see Figure). Changes in the hydrochemical composition of the water result in changes to the plankton and benthos species compositions and productivity, as well as the structural changes in the fish parasite fauna. Thus, rare and scanty fish parasites with complex life cycles belonging to various taxonomic groups disappear from northern waterbodies. The fish-specific representatives of cestodes, trematodes, and acanthocephalans are absent, while common (widespread and dominating) trematode species of the *Diplostomum* genus are preserved. The fish parasite fauna is comprised of direct development cycle species and the species whose larvae actively attack fish.

6. **Conclusions**

The anthropogenic transformation of waterbodies has negative impacts on fish parasites with complex life cycles and ectoparasites.

The anthropogenic transformation results in the preservation of direct development cycle species and the species whose larvae actively attack fish.
7. References

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