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ON THE TREMATODE FAUNA OF FISH OF THE FAMILY *PERCIDAE* IN THE LAKE VEROYARVI OF LENINGRAD REGION

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Abstract. Introduction. The lakes of the Vsevolozhsky District of the Leningrad Region are considered to be popular places of tourist importance, where intensive amateur fishing is conducted. Data on the parasite fauna of the fish species most commonly found in the biocenoses are important in ichthyopathology and medicine. **The aim** of the study was to determine the systematic affiliation of trematode larvae in fish of the family *Percidae* from Lake Veroyarvi in the Vsevolozhsky District of the Leningrad Region and to assess the safety of objects of fishing by the presence of trematode larvae pathogenic to humans. **Materials and methods.** The material was collected in the summer and autumn of 2022–2023. 15 individuals of perch (*Perca fluviatilis*) were studied by the method of complete parasitological autopsy. Fixation and staining of the detected trematode metacercariae were performed using carmine acetic acid. The fixed samples were studied using an XSP-128-201 binocular microscope. **Results.** Metacercariae of the family *Diplostomidae* were found in the eyes of 14 out of 15 individuals of the perch. Numerous metacercariae of the *Strigeidae* family have been identified in the connective tissue membrane of the swim bladder, the parenchyma of the ovary, and mesentery of fish. Based on the analysis of the literature data, the life cycles, vertebrate and invertebrate hosts of the identified trematodes are considered. The first intermediate hosts are gastropods; fish of the *Percidae* family are the second intermediate hosts. Vertebrates, mainly birds, act as the final hosts. **Conclusion.** Larvae of trematodes of the families *Diplostomidae* and *Strigeidae*, which do not pose a danger to humans, have been identified in the organisms of fish of the *Percidae* family in Lake Veroyarvi, Leningrad Region.

Keywords: Trematode fauna, family *Diplostomidae*, family *Strigeidae*, family *Percidae*, ichthyopathology

О ТРЕМАТОДОФАУНЕ РЫБ СЕМЕЙСТВА *PERCIDAE* ОЗЕРА ВЕРОЯРВИ ЛЕНИНГРАДСКОЙ ОБЛАСТИ

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Резюме. Введение. Озера Всеволожского района Ленинградской области относят к популярным местам туристического значения, на которых ведется интенсивное любительское рыболовство. Данные о паразитофауне наиболее часто встречающихся видов рыб в рассматриваемых биоценозах имеют значение в ихтиопатологии и медицине. **Цель исследования** — определение систематической принадлежности личинок трематод

в рыбах семейства Окуневые (*Percidae*) из озера Вероярви Всеволожского района Ленинградской области и оценка безопасности объектов рыболовства по наличию в них личинок трематод, патогенных для человека.

Материалы и методы. Сбор материала проведен летом и осенью 2022–2023 гг. в полевых условиях. Методом полного паразитологического вскрытия исследовано 15 особей окуня обыкновенного (*Perca fluviatilis*). Фиксацию и окрашивание обнаруженных метацеркарий трематод проводили с использованием уксуснокислого кармина. Изучение фиксированных образцов осуществляли с использованием бинокулярного микроскопа XSP-128-201. **Результаты.** В глазах 14 из 15 особей окуня обыкновенного обнаружены метацеркарии семейства *Diplostomidae*. В соединительнотканной оболочке плавательного пузыря, паренхиме яичника и брыжейке рыб выявлены многочисленные метацеркарии семейства *Strigeidae*. На основании анализа литературных данных рассмотрены жизненные циклы, позвоночные и беспозвоночные хозяева обнаруженных трематод. Первыми промежуточными хозяевами являются брюхоногие моллюски, рыбы семейства Окуневые — вторые промежуточные хозяева. В роли окончательных хозяев выступают позвоночные животные, преимущественно птицы. **Выводы.** В организмах рыб семейства *Percidae* в озере Вероярви Ленинградской области определены личинки трематод семейств *Diplostomidae* и *Strigeidae*, не представляющие опасность для человека.

Ключевые слова: трематодофауна, семейство *Diplostomidae*, семейство *Strigeidae*, семейство *Percidae*, ихтиопатология

INTRODUCTION

One of the most clinically significant groups of parasitic organisms are trematodes (class *Trematoda*). Representatives of this class of flatworms have a variety of adaptations to parasitism and are of enormous importance in the biosphere. In addition, many types of trematodes are parasites of humans and economically significant animal species [1, 2, 12, 16].

The reservoirs of the Vsevolozhsky district of the Leningrad region are popular for tourism. Due to the spread of recreational fishing, the question arises about the safety of eating caught fish [5, 10]. Most studies on parasite fauna of fish in large bodies of water of commercial and fishery importance [8]. The parasite fauna of fish living in small lakes of the Karelian Isthmus of the Leningrad Region, both stagnant and flowing, is currently little studied. This work focuses on the study of trematodes that are important in ichthyopathology and medicine. For the first time, data on the parasite fauna of fish of the family *Percidae* in Lake Veroyarvi in the Leningrad Region are provided.

AIM

To determine the systematic affiliation of trematode larvae in the organisms of fish of the family *Percidae* in Lake Veroyarvi in the Leningrad Region and to assess the safety of fisheries based on the presence of trematode larvae pathogenic to humans.

MATERIALS AND METHODS

The basis for this work was the material collected in the summer and autumn (June to September) of 2022–2023 in

Lake Veroyarvi, Vsevolozhsky District, Leningrad Region. Collection, primary processing and study of the material were carried out in field conditions. The body length and weight of 15 common perch (*Perca fluviatilis*, family *Percidae*) were assessed. A complete parasitological dissection of the fish was performed to detect parasites of different systematic groups [3] using an MBS-10 stereomicroscope (LZOS, Russia). After the isolation of trematode larvae, they were processed in accordance with the generally accepted method [15]. Acetic carmine was used to fix and stain metacercariae [15]. The fixed samples were studied at the Department of Medical Biology of St. Petersburg State Pediatric Medical University using a binocular microscope XSP-128-201 (Optitech, China). Photo and video recording was carried out using a digital camera C510 (Levenhuk). To determine the systematic affiliation of parasites, a guide to parasites of freshwater fish was used [9]. Morphometric studies were carried out in ImageJ software. For calibration, a transmitted light micrometer object (LOMO, Russia) with a division value of 0.01 mm was used.

RESULTS AND DISCUSSION

During a parasitological dissection of 15 common perches, ranging in size 93 to 180 mm, weighing 9 to 89 g, larvae of the family *Diplostomidae* were found in eyes of 14 individuals: the genus *Diplostomum* (Fig. 1, 2) and the genus *Tylodelphys* (Fig. 3).

To determine the systematic classification of trematode metacercariae, the number, location, and shape of calcareous bodies (elements of the secondary excretory system) were taken into account [15]. Detection of calcareous bodies

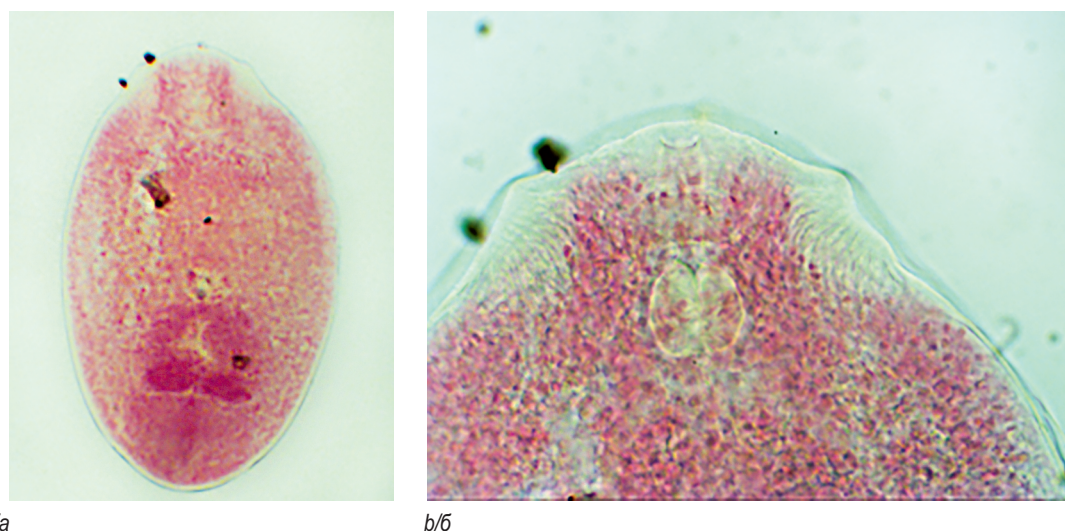


Fig. 1. Metacercaria of *Diplostomum* sp. from the eye of a perch, Lake Veroyarvi, Leningrad Region; stained with acetic carmine: a — general morphology, $\times 10$ objective; b — anterior end of the body, $\times 40$ objective (photo by Makarov D.V. — here and below)

Рис. 1. Метациркария *Diplostomum* sp. из глаза окуня обыкновенного, озеро Вероярви, Ленинградская область; окраска — уксуснокислый кармин: а — общая морфология, объектив $\times 10$; б — передний конец тела, объектив $\times 40$ (фото Макарова Д.В. — здесь и далее)

is possible during observation *in vivo* and in unstained preparations (Fig. 2).

According to literature sources [10], representatives of the family *Diplostomidae* are the most common fish parasites that cause trematodosis. These trematodes are characterized by complex life cycles, including development with a change of three hosts: two intermediate and one definitive. Mature *Diplostomidae* parasitize in the digestive system of birds, while metacercariae (one of the larval stages) live in the body of fish or amphibians. The development of parthenites of these trematodes occurs inside the body of the mollusc [13].

Parasitism of the genera *Diplostomum* and *Tylodelphys* of the family *Diplostomidae* in the eyes of fish has a negative effect on functioning of the visual organ and modifies feeding behavior [21, 26]. It is known that the presence of metacercariae of various species of the genus *Diplostomum* in the eye lens leads to development of parasitic cataracts (diplostomosis) in fish. Metacercariae parasitism in the eyes of young fish is especially dangerous. This parasite causes significant harm to fish farming.

Unlike the metacercariae of *Diplostomum*, the metacercariae of species of the genus *Tylodelphys* are localized in the vitreous body and have significant mobility. Parasitism of *Tylodelphys* metacercariae in the vitreous body does not result in the development of parasitic cataracts in fish. However, due to ability to actively move inside the eye, *Tylodelphys* metacercariae can change the behavior of their intermediate hosts depending on the day time, which is important for implementation of



Fig. 2. Metacercaria of *Diplostomum* sp. from the eye of a perch, Lake Veroyarvi, unstained preparation, $\times 10$ objective

Рис. 2. Метациркария *Diplostomum* sp. из глаза окуня, озеро Вероярви, неокрашенный препарат, объектив $\times 10$

the parasite's life cycle [26]. Infected fish lose an ability to orient themselves normally in space and become easy prey for the final host.

In our study, the work was carried out in field conditions, which allowed us to study the eyes of fish with live larvae. In the vitreous body, mobile metacercariae were found, which was recorded during video filming (Fig. 3 — frame from the video record).

Results of the study indicate a high level of infected fish of the family *Percidae* with larvae of trematodes of the family *Diplostomidae* and are consistent with data obtained

during the study of other reservoirs of the Leningrad Region in 2005–2023 [8, 10]. Despite the large number of larvae in the eyes, they were not found in brain of fish. However, according to literary data, the brain is one of the most affected organs after the eyes [18, 19, 24]. Metacercariae parasitism in the eyes of fish (especially young fish) can cause their death. However, representatives of the genera *Diplostomum* and *Tylodelphys* do not pose any danger to humans.

Numerous (several dozen) metacercariae of the family *Strigeidae* were found in the connective tissue membrane of the swim bladder (Fig. 4, a) of three individuals of *Perca fluviatilis*, in parenchyma of the ovary (Fig. 4, b) of one fish, and in mesentery of two individuals. The larvae of trematodes of the family *Strigeidae* are often enclosed

in thick-walled capsules of complex structure, with a cartilaginous or gelatinous consistency. Mechanical extraction of metacercariae from such capsules for the purpose of research is difficult [3].

The life cycle of most trematodes of the family *Strigeidae* includes three hosts: a definitive host and two intermediate hosts [14]. The first intermediate hosts are gastropods, the second are various invertebrates (molluscs, some annelids) and vertebrates including fish. The final hosts are vertebrates, mainly birds. Sexually mature individuals of these trematodes live in their bodies. Some representatives of the family, for example, *Alaria* spp., include a fourth (reservoir) host and an additional stage, mesocercaria, in the life cycle [4]. In this case, the reservoir host may be a human [17, 20, 22]. The representatives of the family *Strigeidae* that we found and identified have no medical significance, but the presence of parasites of the families *Diplostomidae* and *Strigeidae* may affect the ichthyopathological condition of fish, the organoleptic properties of fish raw materials and, accordingly, the quality of fish products for human nutrition.

According to the literature, metacercariae of trematodes of the *Paracoenogonimus ovatus* spp. of the family *Cyathocotylidae* [11], the *Metorchis bilis* spp. of the family *Opisthorchiidae* [7] and *Clinostomum complanatum* spp. of the family *Clinostomidae* [6] are found in the fish body of the family *Percidae*, which are pathogenic for humans. In our study, larvae of these species were not detected.

The first intermediate hosts of the trematode *Paracoenogonimus ovatus* are molluscs of the genus *Viviparus*, the second are various species of fish, and the final hosts are predatory and fish-eating birds, as well as some mammals,

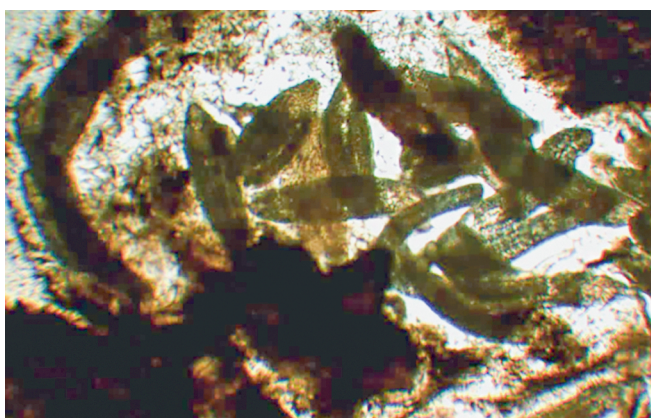
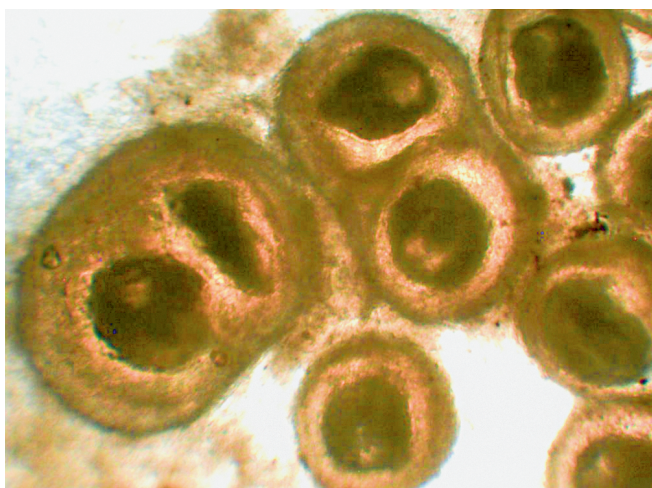
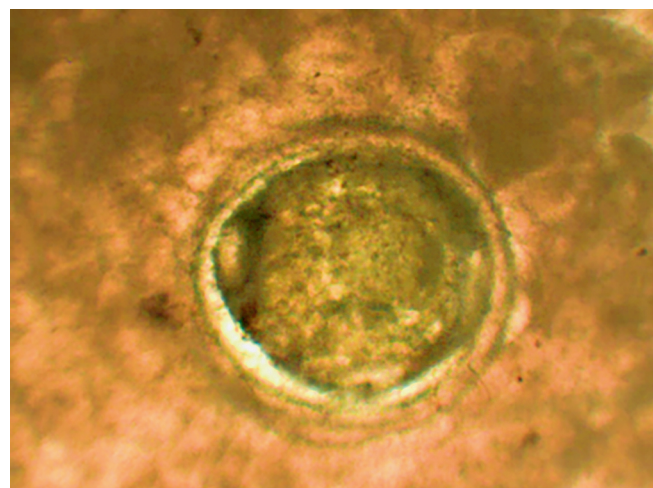


Fig. 3. Metacercariae of *Tylodelphys* sp. from the vitreous body of the eye of a perch (still from a video recording)

Рис. 3. Метациркории *Tylodelphys* sp. из стекловидного тела глаза окуня обыкновенного (кадр из видеозаписи)



a/a



b/b

Fig. 4. Metacercariae of the *Strigeidae* family in the tissues of the internal organs of the perch: a — from the wall of the swim bladder in the connective tissue membrane; b — from the ovarian tissue

Рис. 4. Метациркории семейства *Strigeidae* в тканях внутренних органов окуня обыкновенного: а — из стенки плавательного пузыря в соединительнотканной оболочке; б — из ткани яичника

including humans [25]. The first intermediate hosts of the *Metorchis bilis* spp. are molluscs of the family *Bithyniidae*, the second intermediate hosts are fish (mainly the family *Cyprinidae*), the final hosts are vertebrates that feed on fish (birds, mammals), and humans can also act as a final host [23]. The larvae of the *Clinostomum complanatum* spp. are found in fish of the family *Percidae*. The first intermediate host of the parasite are freshwater gastropods (pond snails of the genus *Lymnaea*, etc.). The final hosts are many species of fish-eating birds (herons, etc.), in which sexually mature helminths are localized in the pharynx, and in some cases, mammals and humans [6].

CONCLUSION

1. In tissues and organs of fish of the family *Percidae* from Lake Veroyarvi in the Vsevolozhsky district of the Leningrad region, trematode larvae of the families *Diplostomidae* and *Strigeidae* were found.

2. The most common parasites of a perch are representatives of the family *Diplostomidae*, found in 14 out of 15 individuals.

3. The study did not identify any trematode species that are dangerous to humans.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

Competing interests. The authors declare that they have no competing interests.

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Experiments with animals were carried out in accordance with international rules (Directive 2010/63/EU of the European Parliament and of the Council of the European Union of September 22, 2010 on the protection of animals used for scientific purposes).

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

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