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DEVELOPMENTAL LEVEL OF THE BENTHOFAUNA IN THE FISHERY AS AN INDICATOR OF THE ECOLOGICAL CONDITION OF THE WATER BODIES

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Abstract:

The water quality of water bodies specify the developmental level of hydrobionts' lifecycle habituating in them and is an essential component in the ecological characteristics of any water bodies. This article highlights the data on the chemical structure of water, species composition and abundance of zoobenthos in the fishponds at the Research Institute of Fishery in 2020. Moreover, saprobity indices and biodiversity in different ponds of the Research Institute of Fishery were calculated based on hydrochemical and hydrobiological indicators, the ecological condition of fishponds in the Research Institute of Fishery was analyzed.

Keywords: Bioindication, benthofauna, zoobenthos, saprobity index, macrophytes, fishponds.

INTRODUCTION

Water is such a medium that the whole life processes of fish occur in this environment. Hence, the pisciculturist must not only acquire knowledge about the physical and chemical properties of water, but also be able to determine their optimal limits and maintain them in an appropriate level.

Water contains a high dissolving feature. Owing to this property, water bodies contain numerous mineral and organic substances, gases. The validity of water in fisheries is determined by the qualitative composition and the amount of salts dissolved in it. Bacteria, emergent and submerged macrophytes consume mineral substances dissolved in water. Plant organisms serve as food for aquatic animals.

Nowadays, a great number of organic substances (feed residues, excrement, etc.) accumulate in ponds with a high level of intensification, this process, in turn, negatively affects the sanitary state and hydrochemical regime of the ponds. The content of dissolved oxygen decreases, free carbon dioxide accumulates, and the amount of ammonium nitrogen increases in such water ponds.

The organization of regular monitoring of the state of the gas regime and the salt composition in the water is the only means of preventing the deterioration of the hydrochemical regime of the ponds and creating favorable conditions for fish farming.

MATERIALS AND METHODS

The study was conducted in the fish farm of the Scientific Research Institute of Fishery (Yangiyul district of the Tashkent region), as there is an appropriate material and technical base for carrying out the research, as well as a laboratory for conducting hydrochemical and hydrobiological studies.

When carrying out this research, standard hydrochemical methods were used in practice.

The hydrochemical parameters was determined in the production laboratory of SRIF (Scientific Research Institute of Fishery), certified in Uzstandard (Certificate of attestation №. 0840, registered in the State Register TV.AMT.01.0887, on 23.11.2018).

The oxygen regime was studied using the Winkler method [15], the sensitivity of the method was 0.05mg O_2/l. The relative standard deviation at concentrations of 7-10mg O_2/l amounts 0.3%.

pH was determined by means of a portable device pH scan 30, produced in PRC. The water temperature was measured with a mercury-in-glass-thermometer.

The content of biogenes was determined by colorimetric express methods [15].

Zoobenthos. Selection and processing of zoobenthos specimens were conducted in accordance with the given methods and recommendations [5]. Dominant specimens were identified by their occurrence frequency. The structure of benthic species was assessed by means of the number of taxa (S), the Shannon-Wiener diversity index (H, bit/ind), abundance (ind/m^2), and biomass (g/m^2). Water quality for zoobenthos was characterized by the following metrics, such as modified biotic index (MBI), adapted to the conditions of Central Asia and Woodiwiss biotic index [5]. Specialists of Uzhydromet (V.N. Talskikh and G.P. Bulgakov) introduced scales of relative abundance of macrozoobenthos organisms, which are similar to the frequency of occurrence on the gas scale that was used to calculate the saprobity index by the Pantle and Bukk method, modified by Sladechek [5].

In this period, 12 quantitative and qualitative specimens of macrozoobenthos were obtained. Selection was conducted during the daytime, mainly in sunny weather, using a scraper. For one scraper or 1x, soft soil or washed stones were taken with the scrapers' cutting edge of 50 cm [5,7].

The collection of fouling from thalli of higher aquatic vegetation was carried out only in those cases when there were no other substrates. Specimens were taken from the surface of leaves and stems of macrophytes by washing off the overgrowth with a soft brush. A small piece of *Phragmites*, reeds, was placed in a 0.5 l sampler with water and rinsed thoroughly. The treated plant was extracted, and the washed out growth was preserved for further analysis.

A small amount of the selected material together with water was placed in a wide-necked jar with a lid with a capacity of 0.2-0.5 liters and with a large supply of air, the specimens were preserved at the sampling site with 40% formalin.

In the laboratory, the specimens taken before processing were placed in a Petri dish and the material was disassembled using a Biolam D-13 microscope according to generally accepted methods [5,7]. (Talskikh, 1987, Mustafaeva et al., 2017).

In order to determine the species composition of macrophytes, keys of freshwater macrophytes in accordance with the analyzed group of aquatic organisms and other generally accepted keys were used [5,7]. Furthermore, specimens were obtained from macrophytes.

Table 2 shows the classification of water surface quality according to the value of the saprobity index.

Table 2. Classification of water surface quality by SI value [5]

Class of water	Quality of water	SI value
I	**Very clean**	**< 1,0**
II	**Clean**	**1,1 – 1,5**
III	**Moderately contaminated**	**1,6 – 2,5**
IV	**Heavily contaminated**	**2,6 – 3,5**
V	**Very heavily contaminated**	**3,6 – 4,0**
VI	**Very polluted**	**> 4,0**

In the laboratory, macrozoobenthos specimens were disassembled, fixed with a 4% formalin solution and systematized into groups, in which the species composition of organisms was established, the number and biomass of each species were determined. The species composition of zoobenthos organisms was carried out according to the keys [1, 2, 4, 9-13].

RESULTS

The Bozsu main canal and the heated water inflow of the TashGRES provide the Salar canal with water. The water temperature of the upper section of the Salar canal is higher than in the upper section of the Karasu canal, which determines a higher level of trophicity of the head section of the Salar canal.

Water samples for determining the hydrochemical composition of water in fishponds at the Research Institute of Fishery were obtained from January to June, 2020.

Tables 3-4 provide more detailed data on the hydrochemical composition of water in the supply canal and ponds of the Research Institute of Fishery.

Table 3. Hydrochemical composition of water in the supply canal 2020 (January-June)

CANAL				
Parameter	**Technological standard**	**Minimum value**	**Maximum value**	**Average value**
Temperature, °C		6.8	22.0	14.4
pH	6.5-8.5	7.5	9.0	8.25
Oxygen, mg/l	5-6	1.8	6.4	4.2
Ammonia nitrogen, mg/l	to 1.0	0.0	2.0	1.0
Nitrite, mg/l	No more than 0.2	0.02	0.02	0.02
Ammonia, mg/l	0.01-0.07	0.0	0.05	0.0025

Table 4. Hydrochemical composition of water in fishponds 2020 (January-June)

PONDS				
Parameter	**Technological standard**	**Minimum value**	**Maximum value**	**Average value**
Temperature, °C		6.5	32	19.25
pH	6.5-8.5	8.0	9.0	8.5
Oxygen, mg/l	5-6	2.4	8.0	5.2
Ammonia nitrogen, mg/l	to 1.0	0.0	2.0	1.0
Nitrite, mg/l	No more than 0.2	0.01	0.2	0.15
Ammonia, mg/l	0.01-0.07	0.0	0.01	0.005

Thus, according to the data in tables 3-4, we can see that the water quality indicators both in the supply canal and in the ponds do not always correspond to the technological standard. For example, at the end of the winter period, the pH values were above 9.0. The dissolved oxygen content dropped to 1.8 mg/l in the canal and to 2.4 mg/l in ponds before dawn. The values of ammonium nitrogen (4.0 mg/l) and, accordingly, ammonia (0.02 mg/l), which is toxic to fish and other aquatic organisms, also reached dangerous values. Since almost 90% of the water in the SRIF ponds comes from the Salar canal, which is full of wastewater, the need to control water quality is especially important.

Fluctuations in water temperature were observed during the sampling period, the water temperature was only +14 - +16°C at the beginning of spring, the water temperature reached +24 - +28°C during the summer months.

A planned survey was carried out within the framework of which hydrobiological samples were taken from the abovementioned ponds, from June 5 to 18, 2020, then 07/09/2020 and 10/12/2020, consequently, total 12 zoobenthos samples were obtained.

Taxonomic characteristics of zoobenthos biocenoses

In the zoobenthos of "Zero Pond" (06/05/2020), 23 species of zoobenthos organisms were found in the macrophytes spots, situated 2 m away from the coast, at a depth of 0.6-0.7 m. These species include the followings: 1 species of mayfly (Ephemeroptera), 1 species of dragonflies (Odonata), 4 species of beetles (Coleoptera), 1 species of bugs (Hemiptera), 9 species of midges, mainly from the family Chironomidae, 1 species of molluscs (Mollusca) and 4 species of small bristle worms (Oligochaeta).

In the zoobenthos composition of the supply canal, 9 species of zoobenthos organisms were sampled from soft soils at a depth of 0.6-0.7 m. These species include the followings: 5 species of small-bristle worms, 1 species species of midges, mainly from the family Chironomidae, 3 species of molluscs (Mollusca).

In the zoobenthos composition of the "Winter pond – 20", total 15 species of zoobenthos organisms were found in macrophytes spots, situated 2 m away from the coast: 1 species of caddis flies (Trichoptera), 1 species of dragonflies (Odonata), 7 species of Chironomidae family, 4 species of oligochaetes, 4 species of mollusks (Mollusca).

In the zoobenthos composition of the "Fish seeds pond – 1", total 22 species of zoobenthos organisms were sampled from the ground at a depth of 0.6-0.8 m. They include 11 species of Chironomidae family, 4 species of oligochaetes, 2 species of molluscs (Mollusca), 2 species of crustaceans and 7 species of small-bristled worms.

In the zoobenthos composition of the "Growing pond – 7", total 21 species of zoobenthos organisms were found from macrophytes spots and soil at a depth of 0.5 m. They include 1 species of mayflies (Ephemeroptera), 2 species of dragonflies (Odonata), 7 species of midges, mainly from the Chironomidae family, 2 species of molluscs, 1 species of water bugs, 1 species of crustaceans, 1 species of beetles, 1 species of leeches, planaria, and 4 species of small-bristled worms.

In the zoobenthos composition of the "Growing pond – 9", total 8 species of zoobenthos organisms were sampled from macrophytes spots and soil at a depth of 0.5 m. These species include the followings: 2 species of dragonflies (Odonata), 3 species of midges, mainly from the Chironomidae family, 1 species of molluscs, 1 species of crustaceans and 1 species of small-bristle worms.

In the zoobenthos composition of the fishpond "Summer broodstock pond 1-3", total 16 species of zoobenthos organisms were found in the macrophytes spots and soil at a depth of 0.5 m. They include 1 species of dragonflies (Odonata), 8 species of midges mainly from the Chironomidae family and 1 species of other Diptera, 1 species of beetles, 3 species of small-bristled worms and 2 species of leeches.

In the zoobenthos composition of the "Growing pond – 13", total 6 species of zoobenthos organisms were found in the macrophytes spots and soil at a depth of 0.5 m. They include 1 species of dragonflies (Odonata), 2 species of midges mainly from the Chironomidae family, 1 species of molluscs, 2 species of small-bristled worms.

In the zoobenthos composition of the canal (next to "Growing pond – 13"), total 6 species of zoobenthos organisms were found, of which: 1 species of caddisflies (Trichoptera), 2 species of dragonflies (Odonata), 1 species of flatworms, 1 species of leeches and 1 species of small-bristled worms.

In the zoobenthos composition of the fishpond "Growing pond – 16", total 10 species of zoobenthos organisms were found in macrophytes spots and soil at a depth of 0.5 m, of which: 6 species of the Chironomidae family, 1 species of molluscs, 3 species of small-bristled worms.

In the zoobenthos composition of fishpond "Fish seeds pond – 16", total 19 species of zoobenthos organisms were found, of which: 1 species of mayflies, 4 species of dragonflies, 6 species from the Chironomidae family and 1 species of other Diptera, 3 species of mollusks, 1 species of leeches, 4 species of small-bristled worms.

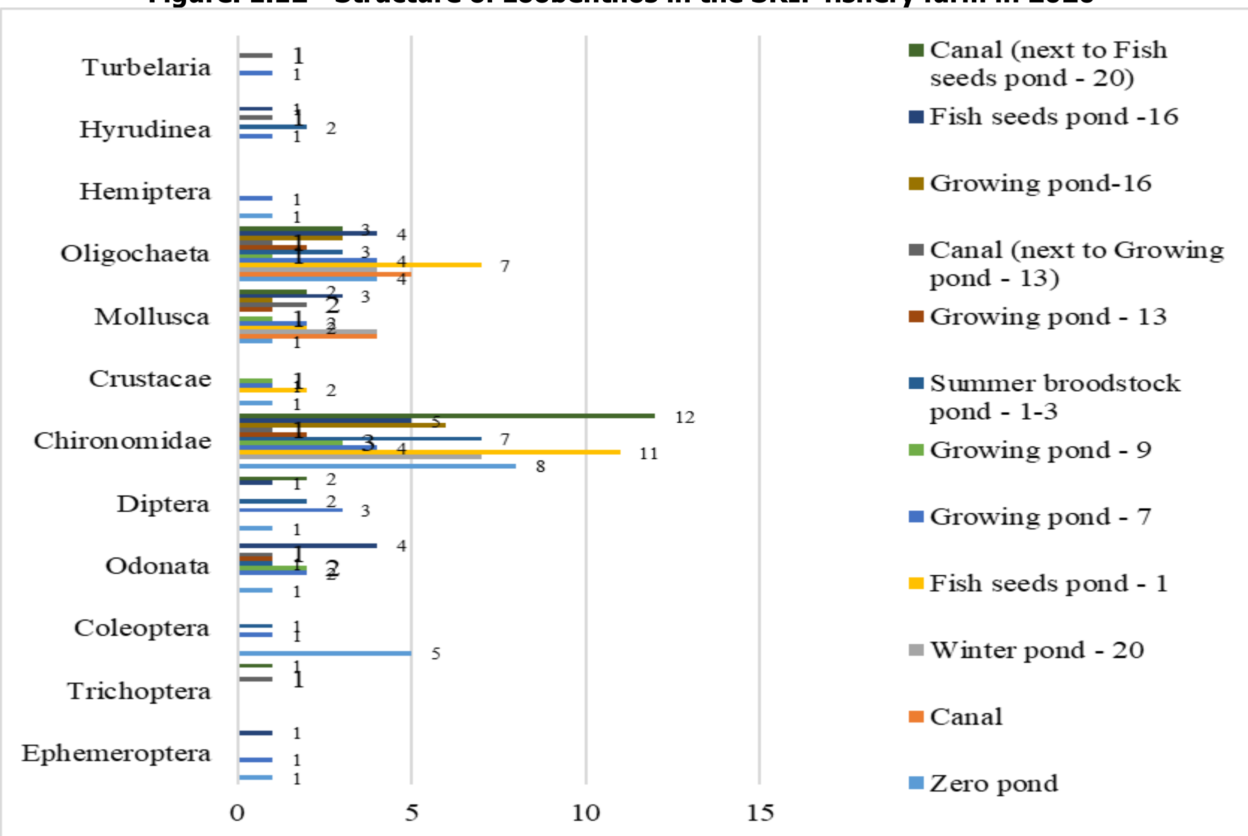
In the zoobenthos composition of the canal (next to "Fish seeds pond -20"), total 20 species of zoobenthos organisms were found, of which: 1 species of caddis flies (Trichoptera), 12 species from the Chironomidae family and 2 species of other Diptera, 2 species of mollusks, 3 species of small-bristled worms.

During the summer selection, the greatest species diversity of zoobenthos organisms among the fishponds of the Scientific Research Institute of Fishery was determined in the "Zero Pond" (23 species from 8 taxonomic groups), "Fish seeds pond – 1" (22 species from 4 taxonomic groups), "Growing pond – 7" (21 species from 10 taxonomic groups). The smallest number of species was noted in "Growing pond – 9" (8 species from 5 taxonomic groups) and a supply canal (9 species from 3 taxonomic groups).

A complex of freshwater and saltwater species of organisms characterizes the zoobenthos of the fishponds of SRIF. This situation is based on true benthic fauna, represented mainly by Chironomidae larvae and phytophilic fauna, in the places of emergent macrophytes, represented by dragonflies, oligochaetes, mollusks, chironomids, beetles, which are characteristics of moderately polluted and eutrophied waters.

The zoobenthos of the fishponds in SRIF is quite diverse in terms of species (about 70 species for the entire survey period). Dark gray, almost black silt, fine-grained sand and pebbles, interspersed with clay, mainly represent the basis of the benthofauna and benthic sediments at the above sampling places of zoobenthos. They involve mollusks, mainly *Physa ocuta Draparnaud and Lymnaea ovate*, dragonflies, dipterans, mainly chironomids: several representatives of the genus *Chironomus*, as well as *Cricotopus gr. bicinctus*, as well as oligochaetes: *Nais elinguis*, *Paranais litoralis*, and representatives of the family *Tubificidae*.

Figure. 1.12 - Structure of zoobenthos in the SRIF fishery farm in 2020



According to the recommendations written by I. B. Bogatova, N.P. Zhemaeva and L.A. Kiseleva (1986), low-productive water bodies are those, where the total biomass of zoobenthos organisms does not exceed 5 g/m^2. Furthermore, water bodies with an average productivity include those, where the total biomass of zoobenthos organisms varies from 5 g/m^2 to 10 g/m^2, and the highly productive reservoirs include the zoobenthos biomass of more than 10 g/m^2.

The total number of zoobenthos organisms collected in the coastal zone of fishpond called "Zero Pond" (06.05.2020) was 1273 ind/m^2, and the biomass was 13.936 g/m^2. The total number of zoobenthos organisms in the "Growing pond – 7" (06.17.2020) was 1876 ind./m^2, and the biomass was 16.925 g/m^2, this case in "Growing pond - 16" (07.09.2020) was 156 ind/m^2, and the biomass was 14.1 g/m^2, for the pond "Fish seeds pond - 16" (10.12.2020), the result was 2950 ind./m^2, and biomass was 94.181 g/m^2.

Thus, in terms of zoobenthos quantity, Zero Pond and "Growing pond – 7", "Growing pond -16" and "Fish seeds pond – 16" can be attributed to reservoirs with high productivity, and given the degree of development of macrophytes along the perimeter of reservoirs, it can be recommended to stock it with both herbivorous fish species and bentho-eating fish species.

The total number of zoobenthos organisms in the supply canal (06/05/2020) was 738 ind./m^2, and the biomass was 62.477 g/m^2, mainly due to small-bristle worms living in silt and soft soil. A sample taken from the canal near "Growing pond – 13" (07/09/2020) showed the following results in terms of zoobenthos: the number of zoobenthos organisms was 94 ind./m^2, and the biomass was 2.701 g/m^2. In a sample taken from the canal at a point near "Fish seeds pond - 20" (10/12/2020), the results were as follows: the number of zoobenthos organisms was 2617 ind./m^2, and the biomass was 5.367 g/m^2.

The total number of zoobenthos organisms sampled in the coastal zone of "Winter pond – 20" was 513 ind./m^2, and the biomass was 3.651 g/m^2, this amount in the pond "Fish seeds pond -1" equals to 1581 ind./m^2, and the biomass was 3.414 g/m^2. Moreover, the total number of zoobenthos organisms in the "Growing pond – 9" was 124 ind./m^2, and biomass was 0.654 g/m^2, the results for the "Growing pond –13" were 89 ind./m^2, and biomass was 1.414 g/m^2, the results for the pond "Summer broodstock pond – 1- 3" were 321 ind./m^2, and biomass was 2.334 g/m^2.

These reservoirs belong to low-feed reservoirs, with dense fish planting, it will be necessary to supplement it with artificial food, or introduce benthic and zooplankton organisms, such as: small-bristle worms, amphipods, mysids, shrimps, etc.

Figure. 2.13 The total number of zoobenthos organisms in the SRIF fishery farm in the summer-autumn period of 2020

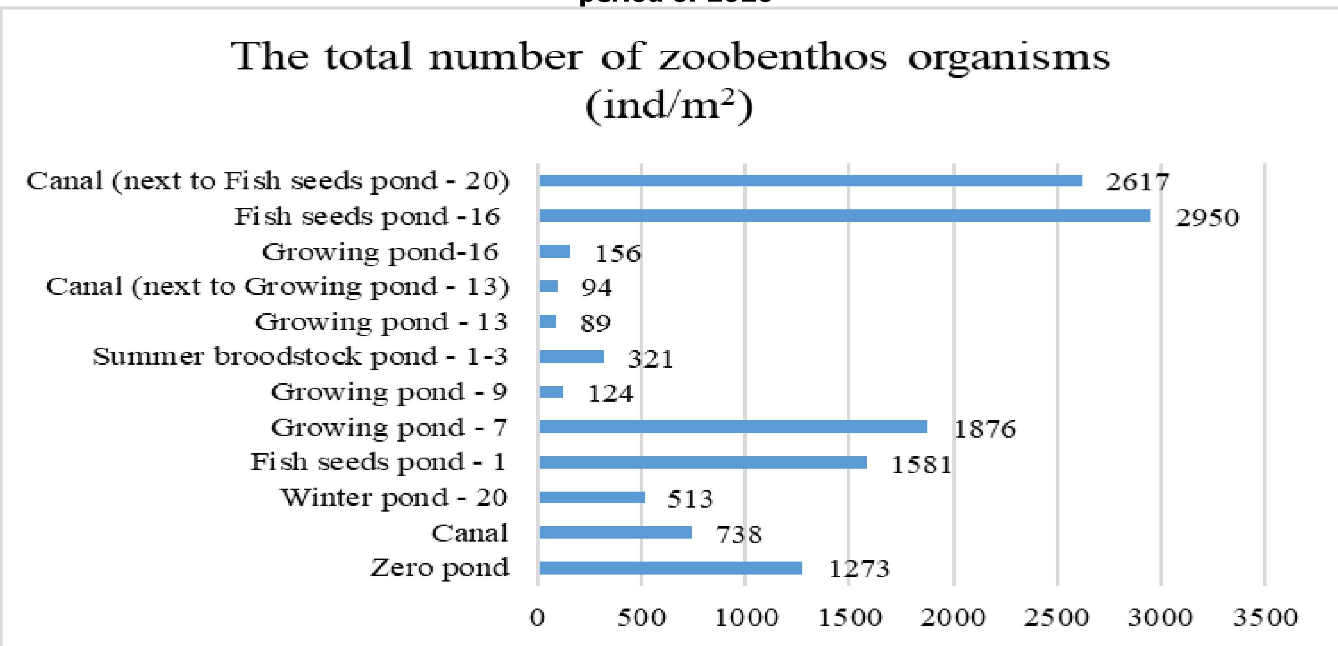


Figure. 3.14 Total biomass of zoobenthos organisms in the SRIF fishery farm in the summer-autumn period of 2020

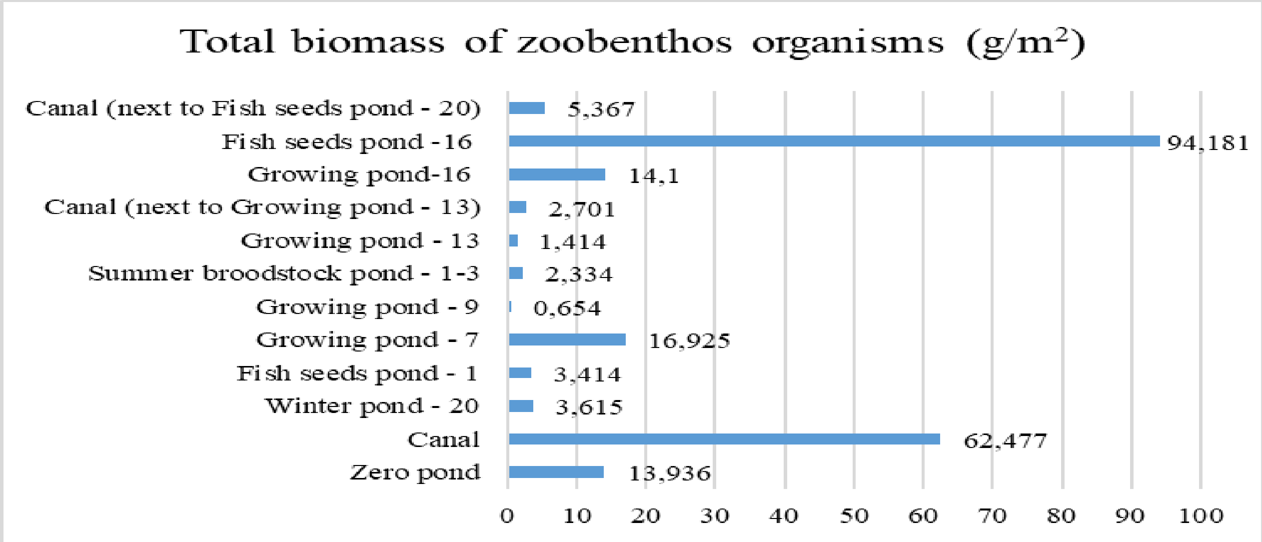
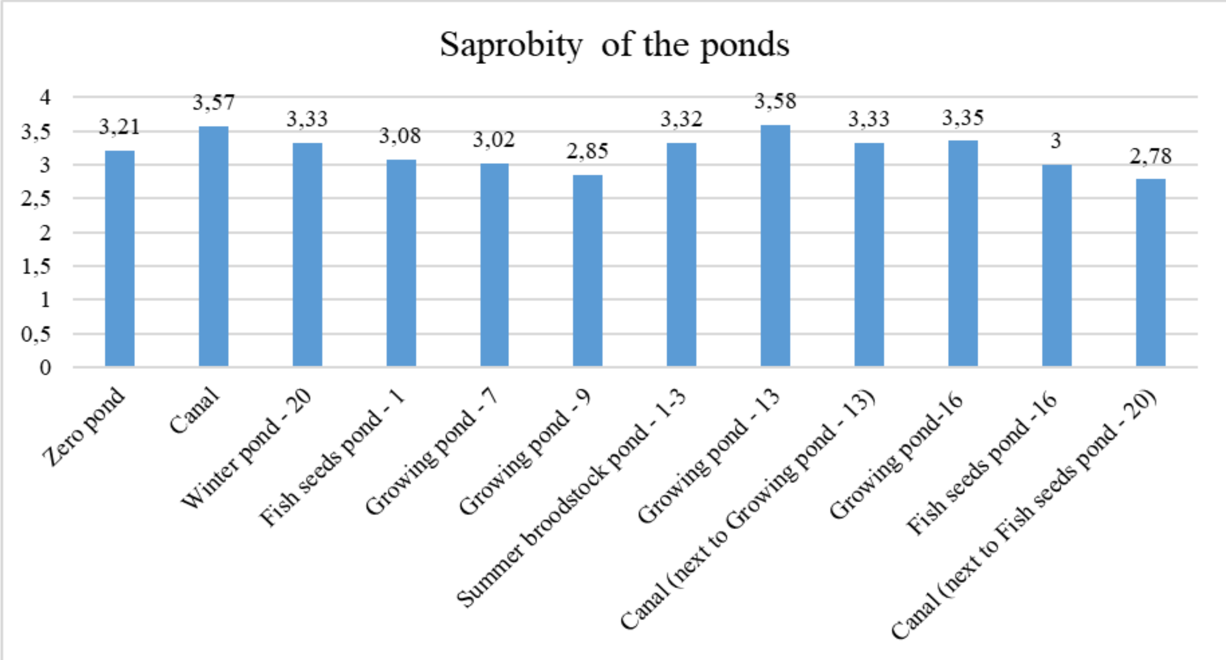


Figure 4.15 Saprobity of the ponds in the SRIF fishery farm in the summer-autumn period of 2020



DISCUSSION

1. The absolute indicators of the abundance of organisms can change under anthropogenic impact, therefore, to a certain extent, reflect its value. For example, a number of researchers who worked on the lake. Michigan, came to the conclusion that the density of oligochaetes up to 1 thousand ind./m^2 indicates weak pollution, from 1 to 5 thousand ind./m^2 - medium, over 5 thousand ind./m^2 - strong [19]. Later it was clarified that severe pollution is characterized by a density of oligochaetes over 10 thousand ind./m^2 [19]. n the Russian Federation, this approach was used in various types of water bodies [19], but in the areas of reservoirs with a high degree of flow, the abundance of rheophilic species of oligochaetes leads to an underestimation of the degree of pollution. In these cases, it is better to use the abundance of tubificid alone [19].

2. The distribution of the number and biomass of organisms in samples is characterized by certain statistical laws. For benthic organisms, negative binomial or lognormal distributions are most characteristic, and at low abundance, Poisson distribution. When the living conditions of animals change, for example, due to pollution, the parameters of statistical distributions change; usually, when conditions deteriorate, the asymmetry increases, and when conditions improve, it decreases [19], sometimes the curve has several peaks [18].

The reliability of the differences in distributions can be assessed using the appropriate statistical criteria (c 2, Kolmogorov-Smirnov, etc.). When applied to marine benthos, this method has shown some advantages over traditional methods [19]. Its disadvantages include the need to collect a large number of samples, for example, when using the Pearson criterion c 2, ³ 50 samples are required.

3. Warwick [17] proposed the so-called "ABC-method" (abundance / biomass comparison), ie, comparison of abundance and biomass. This method is based on the construction of the so-called K-dominance curves [19]. On one graph, the abscissa shows the ranks of species in decreasing order of their abundance and biomass (preferably on a logarithmic scale), the ordinate shows the corresponding cumulative values of the relative abundance and biomass, i.e., the share of the first species, then the sum of the shares of the first and second species , first, second and third types, etc. Warwick proceeded from the empirically established phenomenon in the study of marine benthos, which consists in the fact that under normal habitat conditions the K curve - biomass dominance goes above the K curve - abundance dominance. Under moderate stress (regardless of its cause), these curves approximately coincide, and under strong stress, the biomass curve goes below the abundance curve. In the future, to replace graphic information with digital, it was proposed to calculate special indices [19]. The small and contradictory experience of using this method does not yet allow to unambiguously resolve the issue of the conditions for its applicability to freshwater zoobenthos.

4. Pollution usually decreases the total number of animal species in the community, and this decline is often faster than the decrease in the abundance of organisms. As a result, the value of the specific species richness index decreases, found, for example, by the Margalef formula S ¢ = (S - 1) / ln N, where S is the total number of species, N is the total number of individuals of all species. Both indicators, S and S ¢, turned out to be quite sensitive when studying the effect of pollution on the zoobenthos of the Ivankovo reservoir, and a strong relationship was found between their values, Spearman's rank correlation coefficient was 0.85.

In Uzbekistan, the bioindication of zoobenthos organisms uses the method developed by G.P. Bulgakov, which are similar to the frequency of occurrence on the gas scale that was used to calculate the saprobity index by the Pantle and Bukk method, modified by Sladechek [5].

CONCLUSIONS

A survey of the ecological state of fishponds at the Scientific Research Institute of Fishery in terms of zoobenthos indicators in 2020 yielded the following results:

"Growing pond – 9" (17.06.2020), canal ("20 whitebait") (12.10.2020) correspond to the β-α-mesasaprobic zone, i.e. saprobity indices (S) range between 2.5 and 3.00. This, in turn, means that the water quality corresponds to the III-IV class: a transitional state from moderately contaminated waters to highly contaminated waters.

β-α-mesasaprobic zone is characterized by the presence of nitrogen compounds, in the form of nitrates and nitrites in water. Other constituents, such as amino and amido acids can be noted, due to which the conditions of the hydroenvironment tend to turn into a semi-anaerobic regime. There is not so much oxygen dissolved in water, as in the β-mesasaprobic zone, therefore, deaths at daytime and at night due to the cessation of photosynthesis are noted much more often. The presence of hydrogen sulfide in large quantities (layered gray and dark gray silts with the smell of hydrogen sulfide) is noted, the nature of biochemical processes is reductive-oxidative.

Canal (next to "Growing pond – 13"), "Zero Pond", "Winter pond – 20", "Growing pond – 7", "Fish seeds pond - 1", "Summer broodstock pond 1-3", "Winter pond – 16", "Fish seeds pond – 16" correspond to α-mesasaprobic zone, i.e. saprobity indices (S) range between 3.00 and 3.50. This, in turn, means that the water quality corresponds to the IV class – highly contaminated water.

The α-mesasaprobic zone is characterized by the presence of amino and amido acids in the water, the conditions of the hydroenvironment tend to turn into a semi-anaerobic regime. There is little oxygen dissolved in the water, which can cause freezing at daytime and at night due to the cessation of photosynthesis. The presence of hydrogen sulfide in large quantities is noted (layered gray and dark gray, or even black silts with the smell of hydrogen sulfide), the nature of the biochemical processes is reductive-oxidative.

The supply canal (06/05/2020) at the upper point, where the zoobenthos samples were taken, corresponded to the α-ρ-saprobic zone, the same can be said about the pond VP-13 (10/12/2020), i.e. saprobity indices (S) range between 3.50 and 4.00. This, in turn, means that the water quality corresponds to IV-V class - a transitional state from highly contaminated to very highly contaminated waters.

The α-ρ-saprobic zone is characterized by the presence of decomposing proteins in water, a large amount of hydrogen sulfide and methane. Organisms are deficient in oxygen dissolved in water, because the environment is practically anaerobic, the nature of the biochemical processes is regenerative.

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REFERENCES

1. I.B. Bogatova, N.P. Jemaeva and L.A. Kiseleva (1986): Life in the freshwaters of the USSR. Vol.1.-M.-L.: Publishing house of the Academy of Sciences of the USSR, 1940 . page 460.
2. Jadin V.I. Molluscs of fresh and brackish waters in the USSR. M.-L .: Publishing house of the Academy of Sciences of the USSR, 1952 . page 376.
3. Kurylenko V.V., Zaitseva O.V., Novikova E.A., Osmolovskaya N.G., Ufimtseva M.D. Fundamentals of ecogeology, bioindication and biotesting of aquatic ecosystems. (Edited by V.V. Kurylenko). 2003. page 448.
4. Lukin E.I. Fauna of the USSR. Leeches. Vol.1. - L .: Nauka, 1976 . p 484.
5. Methods of hydrobiological monitoring of water bodies in the Central Asia region, edited by Talskikh V.N. // Uzhydromet under the Cabinet of Ministers of the Republic of Uzbekistan, 1997, p 58.
6. Miseiko G.N., Bezmaternykh D.M., Tushkova G.I., Biological analysis of fresh water quality. - Barnaul: AltSU, 2001. p 201.
7. Mustafaeva Z.A., Mirzaev U.T., Kamilov B.G. Methods of hydrobiological monitoring of water bodies in Uzbekistan. Toolkit. T. - Ed. "Navruz", 2017, p 104.
8. Opekunova M.G., Bioindication of pollution. 2004, St. Petersburg, publishing house of St. Petersburg State University.
9. Keys to freshwater invertebrates of the European part of the USSR (plankton and benthos). - L.: Gidrometeoizdat, 1977 . p 510.
10. Pankratova V.Y. Larvae and pupae of mosquitoes of the Chironominae subfamily of the USSR fauna (Diptera, Chironomidae). - L .: Nauka, 1983 . p 296.
11. Pankratova V.Y. Larvae and pupae of mosquitoes of the Orthocladiinae subfamily of the USSR fauna (Diptera, Chironomidae). - L .: Nauka, 1970 . p 344.
12. Pankratova V.Y. Larvae and pupae of mosquitoes of the subfamily Podonominae and Tanypodinae of the fauna of the USSR (Diptera, Chironomidae). L .: Nauka, 1977.p 153.
13. Chekanovskaya O.V. Aquatic small-bristled worms of the fauna of the USSR. –M.-L .: Publishing house of the Academy of Sciences of the USSR, 1962. p 41.
14. Baranov S.A., Esipova M.A., Instructions for operational control over the state of water and prevention of fish death in pond farms. M / VNIIPRKh. 1981.
15. Hawmiller R.P., Beeton A.M. Biological evaluation of environmental quality, Green Bay, Lake Michigan // J. Water Pollut. Control Fed. 1971. V. 43, № 1. P. 123-133.
16. Washington H.G. Diversity, biotic and similarity indices. A review with special relevance to aquatic ecosystems // Water Res. 1984. V. 18. № 6. P. 653-694.
17. Warwick R.M. A new method for detecting pollution effects on marine macrobenthic communities // Mar. Biol. 1986. V. 92. № 4. P. 557-562.
18. Ugland K.I., Gray J.S. Lognormal distributions and the concept of community equilibrium // Oikos. 1982. V. 39. № 2. P. 171-178.
19. Biology of inland waters. 2000. No. 1. S. 68-82. and in the collection "Quantitative methods of ecology and hydrobiology (in memory of A.I. Bakanov)", 2005.