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THE IMPACT OF AGRICULTURAL MEASUREMENTS ON WATER QUALITY PARAMETERS AT FISHPOND BARDAČA

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Abstract

The impact of agricultural measurements on water qulity at fishpond Bardača was studied during the year 2011. On the basis of physical, chemical, bacteriological, biochemical and saprobiological water analysis it can be concluded that the water of fishpond Bardača is highly loaded with organic matter. High organic production reflected also in the increased development of phytoplankton and water in basin Sinjak in 2011 belonged to the category of eu-polytrophic water. The greatest amount of basic nutrients in the water was recorded at the beginning of the year despite the fact that in the period from April to June fertilization was carried out in order to increase primary production of pond. Higher concentrations of these compounds were found also after maximum development of phytoplankton, and after increased degradation of dead planktonic organisms. On the other hand, during the summer, usually in July, there was a complete consumption of basic nutrients from the water. The limiting factor for phytoplankton development was the lack of nitrogen compounds, while orthophosphates could have been found in the water throughout the whole year, at least in low concentrations. Fertilization and introduction of calx into the water had great influence to the composition of the phytoplankton.

Keywords: *water quality, fishpond, Bardača.*

Introduction

The Bardača fishpond is located near the confluence of the river Vrbas into the river Sava. It is a system of 11 ponds separated by dikes. At February, 2nd, 2007 Bardača has been declared as a Ramsar site number 1658 as "Important Bird Area" and on that way it has been confirmed its international importance. Unfortunately, after gaining this prestigious status, under human influence, there was a significant devastation and ruining of this vulnerable ecosystem. Currently, only three ponds are in use for fish farming (Sinjak, Rakitovac and Brzajski). This is a warm-water pond with primarily production of carp, and to significantly lesser extent, bighead carp and grass carp. In the carp ponds occur particularly complex physical, chemical and biological processes since it is necessary to ensure the optimal environment for fish life and to rationally exploit the biological cycling of matter in the water. Since the depth of the water in the pond ranges usually from 1 to 3 meters, temperature of the water and concentration of dissolved oxygen have great importance to the chemical and biological processes in pond. The optimal temperature for the cultivation of carp is between 20 and 28 °C, and the optimal concentration of dissolved oxygen in the water is between 6 and 9 mg/l. For fish, as well as for the lower aquatic organisms, the presence of ammonia in the water, mostly from anaerobic decomposition of proteins, is very harmful. Nitrogen in water occurs also in the form of nitrate NO_3^- and nitrite NO_2^- ions which are essential nutrients necessary for the development of primary producers. The nitrogen content in the ponds

usually increases by the addition of mineral fertilizers to achieve its concentration of 1 to 1.5 mg/l. Another essential nutrient for the growth of primary producers is phosphorus that is present in the water in the form of phosphates. Phosphates can also take in the water by fertilization in order to achieve a desirable concentration of 0.2 - 0.3 mg/l (Bogut et al., 2006). The main aim of these agricultural measures is to encourage the development of primary producers in the pond and to reduce additionally feeding of fish. High concentration of nutrients in the water can disrupt homeostasis in aquatic ecosystems. It can lead to excessive production of algae which leads to daily fluctuations in the concentration of dissolved oxygen and pH values and, at the end, to the increased mortality of fish and other aquatic organisms (Sigee, 2004). In order to prevent an excessive growth of algae and aquatic plants, calx can be thrown into the water periodically during the vegetation period. Fertilization and additional feeding of fish increase organic production of the pond, but at the same time they deteriorate physical and chemical characteristics of water (Bojčić et al., 1982).

Materials and methods

Samples for analysis of water quality in the basin Sinjak of fishpond Bardača were collected monthly during the year 2011.Water samples were collected in sterile dishes in aseptic terms by prescribed procedure (Karakašević, 1967). Water and air temperature, pH values, electroconductivity, concentration of dissolved oxygen, oxygen saturation and turbidity were determined on the spot. Then, samples were transported on ice on temperature of +4°C. Concentrations of dissolved ammonia, nitrates, nitrites and orthophosphates were determined with spectrophotometer HACH DR2800, so as total suspended substances (DR2800, 2009). Biochemical oxygen demand is determined with oxymeter. (Petrović, 1998). Total number of bacteria is determined by indirect breeding methods (Hribar, 1978; Petrović et al., 1998). Membrane filter method was not used because this method is not suitable for water with high turbidity (Chapman, 1996). The concentration of chlorophyll "a" was determined by a standard spectrophotometric method by extraction of chlorophyll with 90% aqueous solution of acetone(APHA-AWWA-WEF, 1998). Identification of the algae is carried out by using the following keys for determination: Cvijan & Blaženčić (1996), Hindak (1978, 2005 i 2008), John et al (2005), Krammer & Lange-Bertalot, (1988a; 1988b), Lazar (1960) and www.algaebase.org.

Results and discussion

The lowest water temperature of pond Sinjak was measured in January (2.5 °C), and the highest (29.8 °C) was measured in July. During the whole year water was alkaline, with an annual average value of 8.32. The high abundance of phytoplankton is possible cause for higher values of pH. In the process of photosynthesis phytoplankton consumes CO_2 from the water. CO_2 usually bonds with water molecules, forms a carbonic acid and decreases pH value of water (Sigee, 2004). Conductivity varied from the 291 µS/cm in September to 582 µS/cm in March. During the period from July to October 2011 water of pond Sinjak was loaded by a high concentration of suspended solids (above 60 mg/l), which caused high turbidity (52.3 NTU in September) and low opacity (below 40cm). Water was well saturated with dissolved oxygen during the whole year. Lower saturation value was measured only in May (84.1%). Due to the intensive development of phytoplankton and intensive process of photosynthesis from June to September, oxygen saturation was above 130%. In 8 of 12 measurements during the year water was hypersaturated, with an annual average saturation of 115%. Concentrations of basic nutrients in water were lower than the recommended values for fishponds. The average annual concentration of ammonia nitrogen in water was 0.19 mg/l, nitrite nitrogen 0.010 mg/l and nitrate nitrogen was 0.74 mg/l. The highest concentration of nitrates was measured in April (1.4 mg/l), after the pond was drained and fertilized, and in August (1.3 mg/l), after significant decreasing of phytoplankton abundance. Phytoplankton

reached its annual maximum abundance in July. The intensive development of phytoplankton led to a complete depletion of ammonium, nitrate and nitrite nitrogen (Chart 1). The lowest concentration of orthophosphate (0.05 mg/l) was also measured in the same sample. Depletion of basic nutrients in water caused the decreasing of phytoplankton abundance in August (Chart 2). Due to degradation of their dead cells, there was an increase in concentrations of basic nutrients in water.

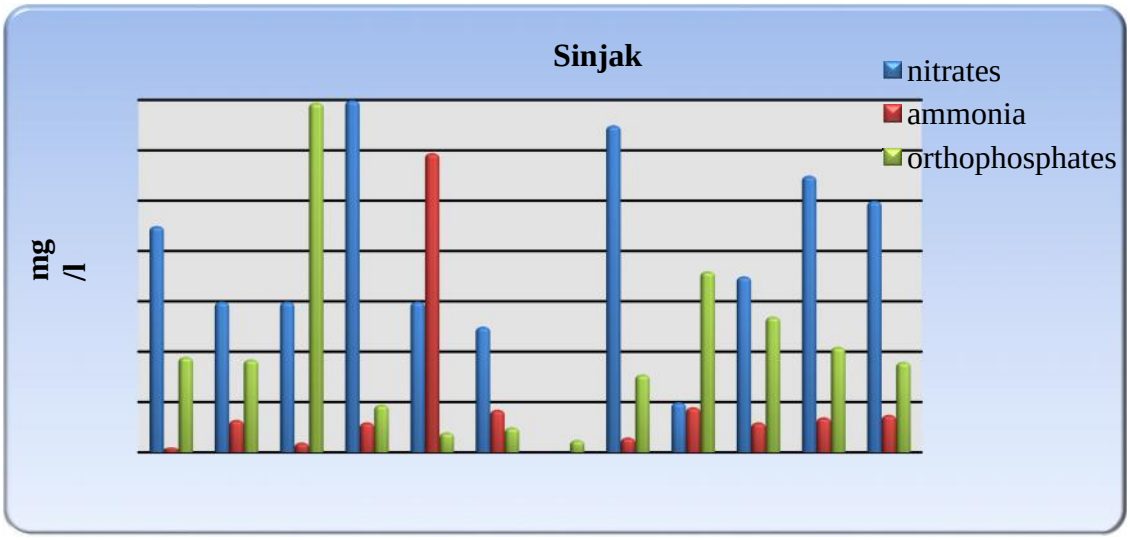

Chart 1. Distribution of basic nutrients in water of pond Sinjak (Bardača).

The highest concentration of ammonia in water was measured after fertilization in May. Orthophosphates were present in higher concentrations than recommended for a fishponds during the whole year, with an average annual concentration of 0.41 mg/l. The greatest amount of basic nutrients in water was recorded at the beginning of the year (March and April), despite the fact that in the period from April to June fertilization was carried out in order to increase primary production of pond.

With an increase of water temperature during the year, the number of heterotrophic bacteria was also increasing. This group of microorganisms had reached a maximum abundance in May (121514 CFU/ml) corresponding to III-IV class by Kohl. According to this parameter, water quality in June and July corresponded to III class by Kohl. The number of bacteria increased again in August, when abundance of phytoplankton decreased, and water quality of pond Sinjak again responded to III-IV class by Kohl. The average annual value of biochemical oxygen demand (BOD_5) was 5.71 mgO_2/l, which is an indicator of the β-α-mesosaprobic water by Felföldy (Petrović et al, 1998). However, in the period from May to August there were recorded higher BOD_5 values which were indicators of α-mesosaprobic water. In the same period the largest amount of bacterioplankton was isolated, too. These two parameters are closely related because bacteria consume available oxygen in processes of oxidation of organic matter (Sigee, 2004).

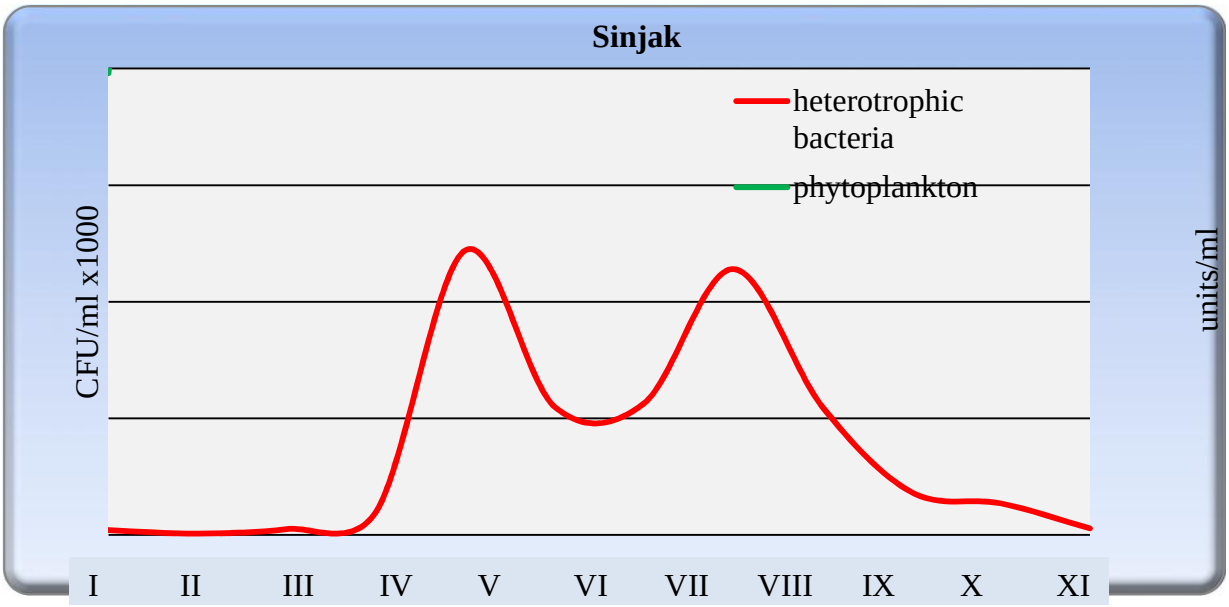

Chart 2. Distribution of heterotrophic bacteria and phytoplankton in water of pond Sinjak (Bardača).

During the year 2011 in water of fishpond Sinjak 95 different algal taxa were identified, including cyanobacteria. The lowest number of phytoplankton was recorded in sample from January (295337 units/liter). After that, abundance of phytoplankton was slowly increasing and in July it reached a maximum number of 27.04×10^6 units/liter. Already in August, due to the lack of nitrogen compounds in the water, that number dropped to 7.81×10^6 units/liter. The number of algae in water again increased in September (14.01×10^6 units/liter). The high abundance of algae in July was a result of intensive development of cyanobacteria from the genus *Microcystis* and *Aphanizomenon*, which also dominated in August. Beside them, three different groups of algae dominated in September: green algae from the genus *Pediastrum* and *Mougeotia* and silicate algae *Nitzschia acicularis*. There was an algal bloom of cyanobacteria *Oscillatoria sp*. in October which accounted for 53% of total phytoplankton. In spring, from April to June, the most numerous algae in the water were representatives of the genus *Pediastrum* and *Scenedesmus*. Green algae *Crucigenia tetrapedia* dominated in May, and in June began the development of a *Microcystis*. Bojčić et al (1982) reported that in ponds during the summer generally dominated green algae and cyanobacteria. However, in water of fishpond Bardača we cannot ignore the presence of silicate algae, which are present in the water column in large numbers throughout the whole year. The cause for that can be thick layer of mud and shallow water. The concentration of chlorophyll "a" varied within the interval of 10.50 mg/m^3 in January to 132.54 mg/m^3 in July. Extremely high values of this parameter in July, September and October have contributed to its average annual value (50.23 mg/m^3) corresponds to eutrophic waters, which in some periods (July and October) had the characteristics of eu-polytrophic water by Felföldy.

Distribution of bacterioplankton and phytoplankton in pond Sinjak is not common in shallow reservoirs. It is expected that the intensive development of phytoplankton occurs much earlier in the spring time, and after that there should be pure water phase (Sigee, 2004; Grginčević & Pujin, 1998). Also, it is expected that the maximum development of bacterioplankton in a shallow reservoirs occurs after the vernal and autumnal maximum development of phytoplankton when it starts to die (Straskrabova & Komarkova, 1979). Significant impact on the seasonal dynamics of bacterioplankton and phytoplankton had agricultural measures. Once a month from April to June calx was thrown into the water to reduce the development of cyanobacteria. There was also carried out chlorination in May to prevent the growth of

pathogens of fish. Due to intensive water treatment with aggressive chemicals there was no conventional spring maximum development of phytoplankton. On the other hand, the first peak bacterioplankton had in May, when implemented agricultural measures increased amount of dead organic matter in the water. High values of BOD_5 in May also indicate that water was loaded with organic matter. Aerob heterotrophic bacteria decompose the dead organic matter to mineral forms which phytoplankton then use for their own development (Sigee, 2004). The main objective of implemented agricultural measures was achieved only partial: algae bloom was delayed, but undesirable cyanobacteria that had no nutritional value for fish, developed in large number. Cyanobacteria also produce a lot of cyanotoxins which have negative impact on fish and human health (Simeunović et al, 2005). Kvet and colleagues also pointed out that agricultural measures, such as fertilization and insertion of calx, could lead to the changes of phytoplankton seasonal dynamics (Kvet et al, 2002).

Conclusion

On the basis of physical, chemical, bacteriological, biochemical and saprobiological water analysis it can be concluded that the water of fishpond Bardača is highly loaded with organic matter. Availability of nutrients and high temperature of water resulted in intensive bacteriological activity which abundance matched to the III-IV class by Kohl. High organic production was reflected also in the development of phytoplankton and high concentrations of . chlorophyll "a". The greatest amount of basic nutrients in water was recorded in March and April, when rain was bringing the surrounding land into the water. Limiting factor for phytoplankton development was the lack of nitrogen compounds, while the orthophosphates could be found in water all year round, even in low concentrations. Insertion of calx into water and chlorination led to the changes of phytoplankton seasonal dynamics. Because of permanent high content of organic matter in the water and because of fertilization, there was no pure water phase. From the perspective of fishery, the largest problem of pond Sinjak was extremely high organic production of those species of phytoplankton which zooplankton can not eat. Men with agricultural measures change the composition of phytoplankton and zooplankton. However, those measures had not lead to the development of desirable species of phytoplankton from the group of green algae.

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