PHYTOPLANKTON DYNAMIC OF SMALL FISHPONDS DURING THE APPLICATION OF BACTERIAL PRODUCT

MARIJA RADOJICIC, BARBORA MUSILOVA, RADOVAN KOPP
Department of Zoology, Fisheries, Hydrobiology and Apiculture
Mendel University in Brno
Zemedelska 1, 613 00 Brno
CZECH REPUBLIC

radojicic.marija88@gmail.com

Abstract: Qualitative and quantitative analyses of phytoplankton community were carried out in fishponds Bohuslavice 1, Bohuslavice 2 and Bohuslavice 3 situated in the District Prostějov, during the period from April to August 2017. In Bohuslavice 2 and 3 bacterial product PTP PLUS was applied in several repetitions in April and May with the aim of decomposing the organic sediments at the bottom and improving the oxygen regime. At the same time, selected hydrochemical parameters were measured. The highest values of oxygen saturation were documented at the beginning of the season, after which they continuously decreased. Taxa from eight divisions were recorded in the phytoplankton community. In terms of diversity, Chlorophyta was the most diverse group, followed by Bacillariophyta and Euglenophyta in each of the studied fishponds. The highest abundance in Bohuslavice 1 and 2 was recorded in the beginning of the research period, and this was the only time when cyanobacteria were present in higher numbers. In Bohuslavice 2 the highest value of abundance was in July, with *Tetrastrum triangulare* as the most dominant species (48.87% of total amount of cells); and this was the highest abundance registered in all three ponds during the entire research period. The most dominant group during greater part of the season was Chlorophyta with common representatives from genera *Monoraphidium, Desmodesmus, Planktosphaeria, Tetrastrum*. Very numerous members of phytoplankton community were also genera *Trachelomonas*, from the group Euglenophyta and colonial *Fragilaria* from Bacillariophyta. The oxygen content, diversity and abundance of phytoplankton were probably influenced by the cover of free floating plants *Lemna minor* and *Spirodela polyrhiza*, which were present in different scales in all three ponds.

Key Words: green algae, composition, physicochemical parameters, taxon, duckweed

INTRODUCTION

Fishponds are generally man–made shallow water bodies and their functioning is conditioned by human activity. Czech Republic is one of the European countries with the highest density of fishponds (Wezel et al. 2013). Function of fishponds could be different, e.g. provision of habitat to support freshwater biodiversity (De Bie et al. 2008), ornamental, recreational, but in Czech Republic most of them are used for fish production.

Phytoplankton, as the photoautotrophic part of the plankton, is a major primary producer of organic carbon in the pelagic of the seas and of inland waters (Reynolds 2006) and forms the base of the aquatic food webs, which supports the zooplankton and fish (Graham et al. 2009).

Continual succession of dominant species of phytoplankton communities occurs due to dynamic changes of growth factors such as light, temperature and nutrient concentration in an aquatic environment (Chan 1980), as well as the presence of zooplankton, fish stock density (Azim et al. 2003) and presence of submerged and floating plants (Bicudo 2007).

Intensive fish production has an important influence on both the structure and dynamics of an aquatic ecosystem. According to the seasonal means in concentrations of total phosphorus at the end of 20th century, about 80% of Czech fishponds were described as eutrophic (Přikryl 1996). However, the fishery management is not the only source of nutrients, but also run-off from surrounding land and in present time internal loadings area a very important factor. It is known that most of the ponds have a nutrient pool in sediments.

Phosphorus precipitation, aeration, sediment treatment, sediment removal, biomanipulation and different chemical and bacterial products have all been used for restoration of water systems and reducing of the internal load of nutrients.

Phytoplankton analysis gives an overall idea of the environmental condition of the water body. Both quality and quantity abundance of plankton communities in fishponds are of great importance for successful aquaculture management.

MATERIAL AND METHODS

The studied fishponds Bohuslavice 1 (B1) (1 ha), Bohuslavice 2 (B2) (0.8 ha), Bohuslavice 3 (B3) (0.6 ha) are situated along the flow of the Šumický stream in municipality Bohuslavice in the District Prostějov, within the Olomouc Region (Czech Republic). In two of the ponds (Bohuslavice 2 and 3) bacterial product PTP PLUS (Baktoma) was repeatedly applied in May and June 2017 with the goals to decompose the organic sediments at the bottom and in the water column. One of the benefits of this treatment, according to the producer, should also be increased oxygen content (Baktoma 2017).

A cover of free floating duckweed plants (*Lemna minor* and *Spirodela polyrhiza*) was noticed at the monitored ponds in beginning of April. In August, these plants have completely overgrown B3, while 80–90% surface of B1 was covered, and B2 was covered to a small extent during July and August. From June to August the submerged plants (mainly genera *Ceratophyllum*) were documented in B1 and B3.

Temperature, dissolved oxygen, pH, transparency and conductivity were measured immediately on locality using mobile instruments (Hach Lange, Hanna instruments, USA and Secchi disk) always in the same place (outflow) at the same time (in the morning).

The samplings of phytoplankton were conducted once a month in the period from April to August 2017, except in the period of applying product PTP PLUS, when samples were collected bi-weekly. Samples were taken using 20 µm planktonic net. Phytoplankton species and genera were identified in the live material under a light microscope Olympus BX51 using standard keys. Determined taxa were classified into eight divisions: Cyanobacteria, Dinophyta, Cryptophyta, Chrysophyta, Xantophyta, Bacillariophyta, Euglenophyta and Chlorophyta (Reynolds 2006).

Quantitative phytoplankton samples, 50 ml each, were taken with plastic bottles from the surface water layer and preserved in Lugol's solution. Samples were concentrated using filtration equipment by Marvan (Marvan 1957), after which the abundance of algae and cyanobacteria was calculated by counting cells in a Bűrker chamber. The data were expressed as a number of cells per millilitre.

RESULTS AND DISCUSSION

The values of measured physicochemical parameters in all three fishponds are summarized in Table 1.

Table 1 Minimum, maximum and mean values of the measured abiotic parameters in monitored fishponds

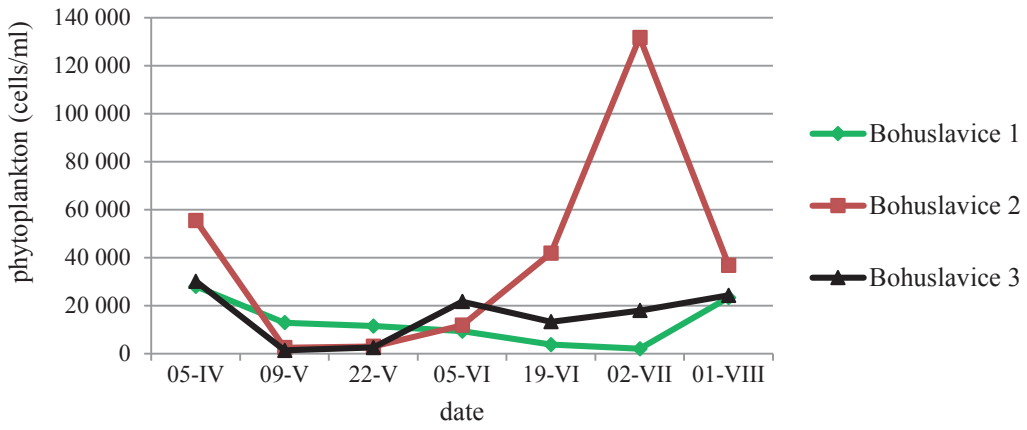
Area	Bohuslavice I			Bohuslavice II			Bohuslavice III		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Temperature (°C)	21.9	17.9	13.9	21.4	17.7	12.8	20.1	17.1	12.9
Dissolved oxygen (%)	122.4	57.5	3.2	131.9	44.7	5.5	142.5	61.5	5.2
pH	8.25	7.21	6.35	8.69	7.42	6.48	8.85	7.75	6.78
Conductivity (mS/m)	50.8	43.0	34.6	45.8	43.8	42.7	42.2	39.2	35.4
Transparency (cm)	110	95	50	100	63	25	125	98	50

The oxygen content was high in the spring, while in the following months it decreased, reaching a minimum during the summer months in every pond. The cover of free floating plants, which was very developed throughout most of the sampling period, could be the cause of oxygen depletion in the water (Pasztaleniec and Poniewozik 2013, Parr et al. 2002). During the course of this study, the positive effect of the applied bacterial product PTP PLUS on oxygen content was not documented.

A total of 116 taxa from eight divisions were documented in Bohuslavice 1 fishpond, 88 in Bohuslavice 2 and 92 in Bohuslavice 3. The most diverse group was Chlorophyta with 43.10% in B1, 48.86% in B2 and 39.13% in B3, followed by Euglenophyta 17.24% (B1), 19.32% (B2) and 19.57% (B3) and Bacillariophyta 19.83% (B1), 17% (B2) and 19.57% (B3). Cyanobacteria were registered in all three ponds, with 7 taxa (6.03%) in B1, 3 (3.41%) in B2 and 5 (5.43%) in B3, but majority of them was documented in April and July. Chlorophyta was the most diverse division during the entire sampling period, with exception of May in B1 and B3, when Bacillariophyta was the most common, and August, when Euglenophyta was the most diverse group in B3.

The greatest phytoplankton abundance was observed in July in Bohuslavice 2, while in Bohuslavice 1 and 3 the most abundant phytoplankton was documented in April, but with lower values than in Bohuslavice 2. The lowest abundance was in the first half of May in Bohuslavice 2 and 3 and in Bohuslavice 1 in July (Figure 1).

Figure 1 Change in phytoplankton abundance in studied fishponds



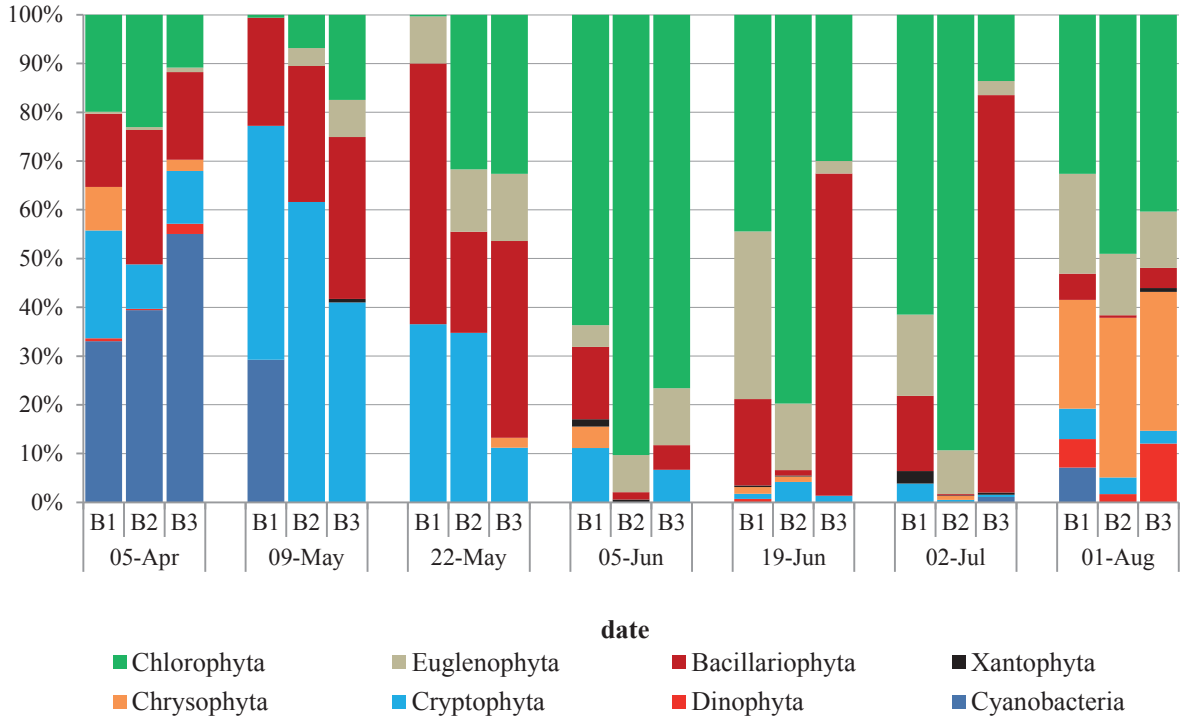
The most abundant group in April was Cyanobacteria (Figure 2), represented by *Aphanizomenon* and *Pseudanabaena*. *Aphanizomenon* was the most abundant taxon in B2 (28.69%) and B3 (51.38%), while in B1 *Cryptomonas* (22.12%) was the most numerous. In May, *Cryptomonas* and colonial diatom *Fragilaria* were the most dominant taxa in all ponds. Green algae represented mainly by *Planktosphaeria gelatinosa* and different species of Euglenophyta were also present in a significant percent in B2 and B3 during the second half of May (Figure 2).

The dominant phytoplankton organisms in all monitored fishponds from June to August were the representatives of green algae, with the exception of second half of June and July, when Bacillariophyta was the most abundant division in Bohuslavice 3 (Figure 2).

In the first half of June, *Planktosphaeria gelatinosa* was the most numerous in B1 and B2, while the representatives of genus *Monoraphidium* were the most dominant in B3. In the second half of June and in July, when in Bohuslavice 1 the lowest abundance was documented, the most dominant were genus *Trachelomonas* and common genera of green algae (*Scenedesmus, Desmodesmus*). The same organisms were also the most dominant in Bohuslavice 2 at the end of June, while in July when the abundance reached a maximum in value (Figure 1), *Tetrastrum triangulare* was the most numerous species (48.87% of the total amount of cells) in this pond. At the same period, colonial diatom *Fragilaria* was the most dominant taxon in Bohuslavice 3.

In August the green algae were still the most abundant group in each of the ponds. However, Chrysophyta and Euglenophyta also comprised a significant part of the phytoplankton community (Figure 2), with *Mallomonas* and *Trachelomonas* in B1 and B2, and *Synura, Dinobryon* and *Trachelomonas* in B3 as the main representatives.

Figure 2 Abundance of cyanobacteria and algae divisions documented in Bohuslavice 1 (B1), Bohuslavice (B2) and Bohuslavice 3 (B3) during the season from April to August 2017



In this study, the influence of bacterial product on phytoplankton community in ponds was not registered. Abundance of phytoplankton in B1 (without application) and B3 (application) over entire season was similar; while in B2 (application) was considerably higher only in July. Likewise, in some months, dominant species were same in different fishponds.

Although the highest richness of species was documented in B1, majority of them were common to all three ponds. The majority of dominant representatives tolerate a lower nutrient content, but with different light requirements (Kruk et al. 2012). Persistence of a floating cover can be the cause of low phytoplankton abundance, due to a low light intensity, which impairs photosynthesis (O'Farrell et al. 2009, Pasztaleniec and Poniewozik 2013). The abundance of phytoplankton in B1 and B3 was low during entire season. On the other side, in B2, it fluctuated throughout the season, while reaching its highest peak in July, when the duckweed cover, which was highly developed in June, was present only near the bank. *Ceratophyllum*, which was registered from June to August in B1 and B3, could also be the reason for lower abundance in these two fish ponds. It is well known that species of the genus *Ceratophyllum* can suppress the phytoplankton community through different mechanisms (van Donk 2002).

CONCLUSION

The phytoplanktonic community of monitored fishponds during most of the study period was dominated by the representatives of green algae. Cyanobacteria were the dominant division only at the beginning of season, while during the rest of the season they had been observed in a negligible number. Cryptophyta were documented during the entire period, but only in April and May in high proportions. Bacillariophyta and Euglenophyta were important members of the phytoplankton community throughout the study period. During the course of this study, the effect of the applied bacterial product PTP PLUS on phytoplankton was not recorded. The free floating plant cover impaired the development of phytoplankton community, resulting in the low abundance throughout the greater part of the season. In Bohuslavice 1 and Bohuslavice 3, the lower abundance values then in Bohuslavice 2 were additionally influenced by the presence of a submerged plant *Ceratophyllum*. However, for a more detailed analysis of the fishpond phytoplankton, data on the fishpond management, which is currently unattainable, are also required.

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