Quantitative analyses of phytoplankton in Zámecký pond – three years research

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Abstract: Quantitative analyses of phytoplankton in Zámecký pond were conducted during the period from April to October in years 2014, 2016 and 2017. Abundance was determined by counting cells in Bűrker chamber. The lowest abundance during the vegetative season was in the year 2014, and highest in 2017. Centric diatoms were the most dominant in April 2014. Genera of Chlorophyta (*Scenedesmus*, *Desmodesmus, Oocystis*, *Monoraphidium*, *Coelastrum*) common for fishponds were recorded in all months in different number, but with the highest density in June 2014 and April 2016. During the rest of the study period Cyanobacteria, which were mainly represented by the genera *Dolichospermum, Microcystis*, *Aphanizomenon* and species *Cuspidothrix issatschenkoi, Pseudanabaena limnetica* and *Planktothrix agardhii* was the most dominant division. Algal bloom occurred every year, with highest peaks in August 2014, September 2016 and July 2017. However, the big difference in abundance among study years was noticed. The highest phytoplankton density was recorded in July 2017, when 7.98 million cells per ml of water were registered, of which 55% was *Dolichospermum flos-aquae* and 44% species of genus *Microcystis*. The obtained abundance values from 2016 and 2017 are higher than any recorded before.

Key Words: cyanobacterial bloom, season, *Microcystis*, abundance

INTRODUCTION

Zámecký fishpond is situated close to the village Lednice in the District Břeclav (South Moravian Region, Czech Republic). The area of fishpond is 27 ha, mean depth is 1.15 m and it is supplemented with water from the river Stará Dyje. The owner and the user of the fishpond is The National Heritage Institute. Zámecký fishpond, together with four others (Nesyt, Hlohovecký, Prostřední and Mlýnský fishponds), has been a part of the National Nature Reserve Lednické rybniky since 1953. This Reserve is one of the most important bird areas in the Czech Republic. These fishponds are also (since 1990) recognized as Wetlands of International Interest under the Ramsar Convention. Lednické rybníky, with the surrounding landscape, are a part of the Lednice-Valtice area, which was inscribed on the UNESCO World Cultural and Natural Heritage List in 1996.

First phytoplankton research of Zámecký fishpond dated from 1920. Interestingly, even in this period, when fish breeding was extensive, fishpond was characterized as eutrophic (Bayer and Bajkov, 1929). After the Second World Word intensification of fishpond management increased (including feeding, fertilization and larger quantity of stocked fish), leading to increment of phytoplankton abundance. To restore the species diversity of aquatic organisms, a maintenance plan for Lednické rybníky was prepared (Lázničková 1993). According to the plan, fishery in Zamecký fishpond was regulated by declines in fish stocking and lower introduction of herbivorous fish. However, despite the regulation of stock, phytoplankton abundance was still high. Decreases in the number of stocked fish (since 1998) were accompanied by increases in fish numbers from the Dyje river. During the 2000–2003 period, cyanobacteria-forming water bloom was observed in a great amount (Kopp 2006).

Zámecký fishpond has been left without stocking since 2004 (AOPK 2012). This led to a short-term decrease in phytoplankton abundance and chlorophyll a values, and increase in water transparency (Kopp 2006). Low fish stocks enabled the growth of submerged aquatic macrophytes and filamentous algae, which were later replaced by the free-floating aquatic plants influencing the chemical and light regime of water column. At first, reduction of stocking had a positive influence on water quality,

however an increase in chlorophyll a values and abundance of phytoplankton have been recorded again since 2008 (Kopp et al. 2016). According to the newest management plan for The National Nature Reserve Lednické rybniky for the period 2012–2021 (AOPK 2012), Zámecký pond should be harvested at least once in a three-year interval. However, harvesting has not been done even once since year 2007.

In water bodies, such as Zámecký pond, which are important bird areas, research of phytoplankton development and its effects on water transparency is of great importance. Under conditions of low water transparency, bird brood cannot find suitable food. According to Musil (2006) fishponds with conditions suitable for breeding water bird species are those having a water transparency of more than 50 cm.

Aim of the study was to compare the phytoplankton community of Zámecký fishpond during the vegetative season over a three-year period.

MATERIAL AND METHODS

Water temperature, pH and conductivity were measured immediately on site using mobile instruments (Hach Lange and Hanna instruments), always at the outflow at the same time (in the morning).

Phytoplankton research was conducted during 2014, 2016 and 2017. Samples were taken in 2014 once a week and in 2016 and 2017 once a month during the vegetation season from April to October. Samples for the determination of the phytoplankton species and genera were collected using the 20 µm mesh planktonic net and live material was analysed 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, were taken with tube water sampler (Andělova tyč) from the surface water layer (0–30 cm), put in 50 ml plastic bottles and preserved in Lugol's solution. Samples were concentrated using filtration equipment by Marvan (1957), after which the abundance of algae and cyanobacteria was calculated by counting cells in a Bűrker chamber. Colonies of genera *Microcystis* were disintegrated using ultrasound. Approximately 25 ml of the samples were exposed to ultrasound SONOPULS HD 2070 (Bandelin electronic, Germany) for 3 minutes with 20% strength. The data are expressed as a number of cells per millilitre. Average values of week samples are used to present monthly values of phytoplankton abundance in 2014.

RESULTS AND DISCUSSION

Values of *in situ* measured parameters are presented in Table 1.

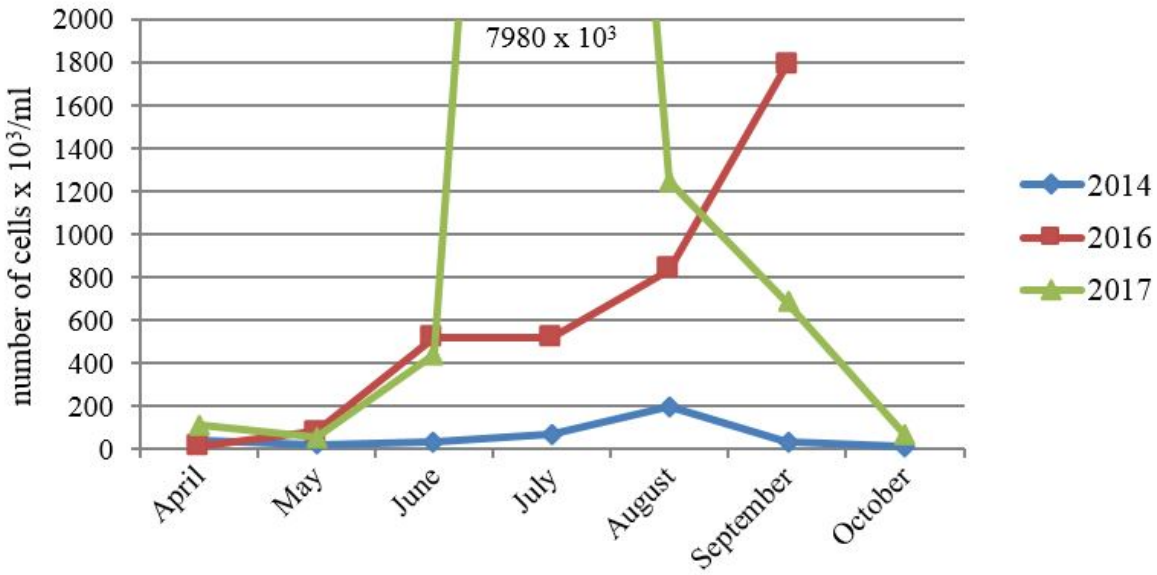
Table 1 Values of the measured abiotic parameters in Zámecký pond

Zámecký fishpond	Water temperature (°C)			pH			Conductivity (µS/cm)		
	2014	2016	2017	2014	2016	2017	2014	2016	2017
April	13.5	17.0	15.1	8.96	7.80	8.69	626	565	621
May	17.0	17.8	14.4	8.18	8.88	8.15	696	517	453
June	21.6	23.9	21.3	8.21	9.24	8.17	725	538	703
July	22.5	23.2	22.3	8.59	9.40	8.25	656	509	618
August	20.4	23.7	25.0	9.23	9.02	9.61	569	534	549
September	19.9	21.2	23.1	8.67	8.91	9.19	640	541	590
October	12.5	-	12.5	8.76		7.91	570		905

The highest phytoplankton abundance in Zámecký pond was observed in July 2017, and the lowest in April 2016. The maximal peak of abundance in every year was in a different month (Figure 1).

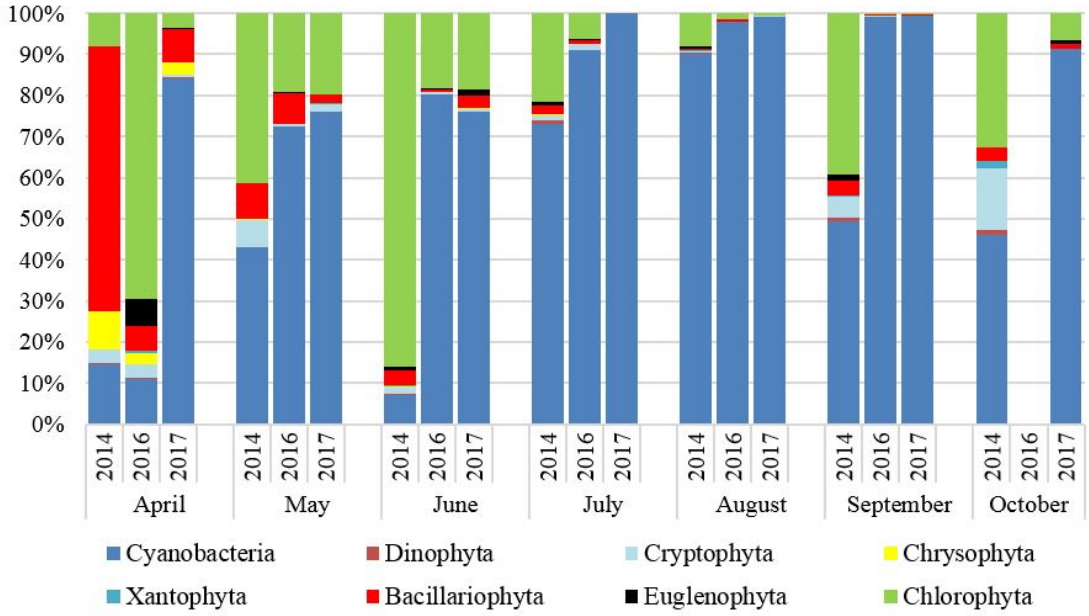
Throughout the study period cyanobacteria was the most dominant division. Only in April 2014 and 2016, and June 2014 this group was not the most abundant one (Figure 2).

Figure 1 Change in phytoplankton abundance in studied fishpond



The lowest abundance during the entire season was recorded in 2014, when compared to 2016 and 2017. Centric diatoms represented mainly by *Cyclostephanos invisitatus* and genus *Stephanodiscus* were the most numerous in April 2014. Colonial cyanobacteria *Eucapsis densa* was the most dominant species in May, while small Chlorophyta *Monoraphidium minutum* was the most numerous one in June 2014. From July to September, the most abundant representatives belonged to the group of cyanobacteria, with the dominance of *Dolichospermum flos-aquae* and *D. perturbatum,* which were the most numerous species from July to September, followed by *Cuspidothrix issatschenkoi* in July, and *Planktothrix agardhii* in August. In October 2014, genus *Aphanizomenon* was the most abundant. Genera of Chlorophyta (*Scenedesmus, Desmodesmus*, *Oocystis, Pediastrum, Aktinastrum, Coelastrum*) were recorded in all months in different numbers.

Figure 2 Abundance of cyanobacteria and algae divisions documented in Zámecký pond



Green algae *Pseudopediastrum boryanum* was the most abundant at the beginning of the season 2016, after which the dominance of Cyanobacteria was recorded (Figure 2). *Aphanizomenon* was the most numerous in May 2016, *Planktothrix agardhii* and *Pseudanabaena limnetica* in June, when *Cuspidothrix issatschenkoi* was also registered in a noticeable quantity. *Dolichospermum flos-aquae*

was the most dominant species in July; representatives of genus *Microcystis* in August, and these two taxa were equally represented in September.

Cyanobacteria were the most dominant group over the entire 2017 (Figure 2). *Microcystis* was registered in high numbers in every month, with its dominance in April, May and October. *Planktothrix agardhii* was the most numerous in June, while *Dolichospermum flos-aquae* together with representatives of genus *Microcystis* was dominant from July to September.

Algal blooms were recorded in every year of the study period, but with high variance in the cell number. The main algal species responsible for bloom in Zámecký fishpond are the *Dolichospermum flos-aquae*, *Microcystis aeruginosa*, *M. ichtyoblabe*, and *M. wesenbergii* and this was confirmed in different studies (Sukop and Kopp 2001, Sukop and Kopp 2002, Ramezanpoor et al. 2004, Kopp 2006, Heteša 2018).

The highest value of abundance was in July 2017 when *Dolichospermum flos-aquae* was the most dominant with 4.42 million cells per ml, followed by genus *Microcystis* with 3.55 million cells per ml. Previous research of phytoplankton in Zámecký fishpond has also shown a high abundance of cyanobacteria in summer months, but not as high as in this study. Kopp (2006) and Ramezanpoor et al. (2004) state that in the summer months of 2000–2003, a significant growth of cyanobacteria forming water bloom was observed. Density of cyanobacterial blooms often exceeded 1 million cells per 1 ml of water. The increase of phytoplankton abundance during the 2000–2003 period was probably caused by diverse factors, such as a higher input of cyanobacteria from the river Stará Dyje and the Reservoir Novomlýnské, and changes in the zooplankton structure affected by changes in the fish species composition (Kopp 2006, Kopp et al. 2016). The amount of fish stock is one of the main key factors that affects the development of zooplankton and indirectly phytoplankton. However, due to the cessation of stocking and input of fish from Stara Dyje river the current state of fish population can only be estimated. Considering the fact that the draining of the pond was last carried out in 2007 and water level was lowered to about one-half of the original pond volume in 2016, the estimations are that the fish population is very dense and has a negative effect on zooplankton and phytoplankton community.

CONCLUSION

Zámecký pond is part of a National Nature Reserve, important bird area; and fishery management is highly limited by the purpose of nature conservation. Since 2004 it has been left without stocking, with the idea to improve the water quality and environment for waterfowl. However, the research of phytoplankton conducted in vegetative season 2014, 2016 and 2017 has shown that the current way of managing does not achieve positive effects. One of the suggested solutions for suppressing cyanobacterial blooms is removing the high layer of sediment, which is a source of nutrients in addition to suitable fishery management.

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