Seasonal dynamics of cyanobacterial water blooms in the Brno Reservoir

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Introduction

The Brno Reservoir was built between 1938 and 1941 on the Svratka River to prevent flooding. The reservoir is constructed as a natural lake, approximately 10 km long, at some places up to 800 m wide and contains approximately 25 million cubic meters of water.
The Brno Reservoir used to be a recreational area in the past but thanks to the massive expansion of phytoplankton, the recreational use noticeably decreased.

Anthropogenic (cultural) eutrophication of aquatic ecosystem is accompanied by cyanobacterial biomass development that represents serious environmental problems. Cyanobacteria as a photosynthesizing organisms them produce biologicaliy active compounds that may affect the growth and the development of the other water organisms and physical and chemical parameters of water (Machálek and Turánek, 1996).

The aim of this study was to monitor seasonal dynamics of phytoplankton community at the Brno Reservoir.

Materials and methods

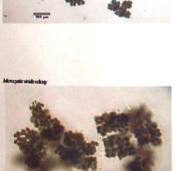
Dam water was sampled at three different localities (Hrkz, Rakovec, Sokolák) of the Brno Reservoir (to cover as wide spectrum of plant organisms as possible) in week intervals from May to October 2003.

Samples were taken from the depth of 10 cm in every single locality, collected using 1L + 100ml polyethylene bottles and transferred into laboratory of Mendel University of Agriculture and Forestry in Brno, where the additional measurements as a chlorophyll-a concentration, conductivity and the cyanobacterial cell counting were completed

Chlorophyll-a concentration according to ISO 10260 was determined using 70°C heated ethanol extraction from distintegrated cyanobacterial cells. The extract was kept for one hour in the dark at room temperature. All extracts were filtered and measured using PhotoLab Spectral spectrophotometer at excitation and emission wavelength for chlorophyll-a, which are 665 nm and 750 nm.
All samples were fixed by Lugol solution for the later estimation of phytoplankton biomass using the Bürker counting chambers.

Some basic physical and chemical characteristics such as water transparency, determined by the Secci disk, pH using pH-meter WTW pH 315i and oxygen rates using oximeter WTW OXI 315i were measured to characterize better the water conditions at every single locality. Conductivity measurements were lead by Conductivity meter Connnet 1 (emerson firm Hanna Instruments) in the laboratory.

Microcystis viridis, Microcystis ichthyoblabe, Microcystis aeruginosa



Microcystis viridis colony

Microcystis ichthyoblabe

Results

Water temperature

Optimal water temperature for the cyanobacterial water blooms is 25-35 °C (Machálek and Kerbar, 1996). These suitable conditions appeared in the Brno Reservoir in the second half of May 2003. The amount of cell growth corresponds to the temperature conditions.

18.6.2003: $59.6.10^3$ cells.ml^{-1}
25.6.2003: $762.3 . 10^3$ cells.ml^{-1}

At the time of water take-off, water temperature oscillated relatively in narrow interval, in the dependence on the air temperature and the depth of water column.

Locality no: 1. Hrkz 7,6–25 °C, summer months above 20 °C, maximum was measured 23.7.2003.
2. Sokolák 7,4–25,3 °C, maximum of water temperature was measured 14.8.2003
3. Rakovec 7,4–26 °C, maximum of water temperature was measured 23.7.2003

In comparison with the vegetative season 2004 water temperature was higher because of warmer weather conditions.

O_2 content

Values of dissolved oxygen often exceed 200% saturation in the warmest months of the season 2003. They were probably not the highest values because the measurements were lead in the morning hours

Locality no: 1. Hrkz 5,7–20,3 mg.l^{-1}
2. Sokolák 5,8–15,0 mg.l^{-1}
3. Rakovec 5,4–21,9 mg.l^{-1}

All maximal values of dissolved oxygen were measured at the same day – 23.7.2003

pH

pH values were over 10 in cyanobacterial dominance period. The correlation between pH and temperature was observed.

MARŠÁLEK et al. (2003) indicate pH values of 2003 season in 8 – 10 interval, only 5.8.2003 pH value was slightly above 10. These data are more or less equivalent to our measured data (pH >10 was measured 15.7. and stayed till 27.8., when decreased under 10 again – taken average values).

Conductivity

Conductivity values are not diverse from the other season values (298-365 µS.cm^{-1}). It is necessary to take into account the temperature correlation of the equipment it is measured with.

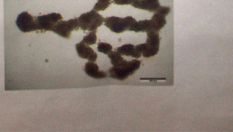
Locality no: 1. Hrkz 299-383 µS-cm^{-1}, average value - 330 µS-cm^{-1}
2. Sokolák 297 - 364 µS-cm^{-1}, average value - 323 µS-cm^{-1}
3. Rakovec 296 – 362 µS-cm^{-1}, average value - 324 µS-cm^{-1}

Phytoplankton

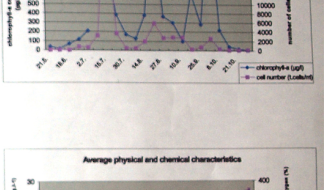
Especially the colonial cyanobacteria of *Microcystis* genus (*M. aeruginosa* and *M. ichthyoblabe*) dominated in phytoplankton of the Brno Reservoir during the vegetative period 2003.
After short spring dominance of diatoms, the cyanobacterial cells prevailed in water column during May and stayed in high number until the autumn months, when diatoms started to occur again.

The number of cyanobacterial cells of dominated *Microcystis* genus reached up to $5,58.10^7$ cells.ml^{-1} in summer months. Chlorophyll-a concentration reached the value of 4485,6 µg.l^{-1}.

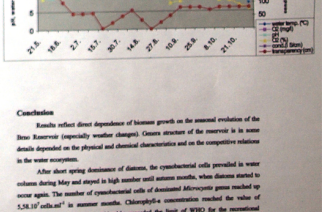
Microcystis aeruginosa colony



Average values of chorophyll-a concentration and cell number



Average physical and chemical characteristics



Conclusion

Results reflect direct dependence of biomass growth on the seasonal evolution of the Brno Reservoir (especially weather changes). Genera structure of the reservoir is in some details depended on the physical and chemical characteristics and on the competitive relations in the water ecosystem.

After short spring dominance of diatoms, the cyanobacterial cells prevailed in water column during May and stayed in high number until autumn months, when diatoms started to occur again. The number of cyanobacterial cells of dominated *Microcystis* genus reached up to $5,58.10^7$ cells.ml^{-1} in summer months. Chlorophyll-a concentration reached the value of 4485,6 µg.l^{-1}. Both values considerably exceeded the limit of WHO for the recreational waters, that is 100000 cells.ml^{-1} and 50 µg.l^{-1}.

Physicochemical parameters of every monitored locality embodied classical variations in dependence on the weather situation and the water column dimension.

Water lowering and the freeze of high amount of inocubum in winter months did not have any impact on the quantity of *Microcystis* cells. It is possible to suppose that large resources of *Microcystis* inoculum, that are able to raise the cyanobacterial water blooms in the usual size at the optimal conditions, are presented in the sediments.

The mass development of cyanobacterial water blooms is an outcome of many factors actuation (biotic and abiotic factors) that results from the above-mentioned data.

Water ecosystem of the Brno Reservoir is appeared as a very injured and there is narrow possibility of natural retrace into original condition without a human intervention. It is necessary to point that the sanitational steps for cyanobacterial elimination have to be chosen in dat way to be effective and longlasting. Algicide application is not advisable, better solution might be in mining of sediments that contain *Microcystis* inoculum. It is necessary to eliminate nutrition inlet of phosphorus and nitrogen into reservoir as well.