Monitoring of hydrochemical parameters, algae and cyanobacteria in newly built ponds near Hovorany village

ONDREJ KLIMA, RADOVAN KOPP
Department of Zoology, Fisheries, Hydrobiology and Apiculture
Mendel University in Brno
Zemědělská 1, 613 00 Brno
CZECH REPUBLIC

xklima7@node.mendelu.cz

Abstract: Observation of five ponds took place in the year 2014 in the cadastral area of village Hovorany. The aim was to monitor the development of these ponds in terms of hydrochemical parameters and the occurrence of algae and cyanobacteria. From each pond a sample of water was taken to analyze and measure the amounts of ammoniacal, nitrite and nitrate nitrogen, chlorides, orthophosphate, alkalinity, calcium, chlorophyll a, COD_{Cr}, total nitrogen and phosphorus. Dissolved oxygen, pH, the temperature of water, conductivity and transparency were measured *in situ*. Algae and cyanobacteria were taken using the plankton net and the identified species were divided into four groups (cyanobacteria, green algea, diatoms and others algea). According to the analyzed chemical parameters, following the method of Government Order No. 61/2003, the water was classified as "cyprinid water". In all the ponds there is a significant fluctuation in pH. The biggest pond, Sluňák, is the most stable. Cyanobacteria and algae gradually colonized all the ponds. In total, 61 species occurred (cyanobacteria 8 species and 53 species algae). The most numerous taxa were green algae (Chlorophyta), which dominated in the ponds Sluňák, Vrbatec, Mokřák and Jasaňák. The exception was the pond Olšovník, where the other algae prevail (Euglenophyta and Cryptophyta). On the basis of identified taxa algae and cyanobacteria, the ponds are eutrophic.

Key-Words: chlorophyta, pools, new habitat, chemical indicators, diatoms, season, colonization

Introduction

Cyanobacteria and algea are widespread all over the world. They occurr in the soil and water [5, 11]. They colonize extreme habitats, for example thermal springs, salt marshes, acidic water [5, 11, 14] and residual waters from uranium mining [6]. They get to new habitats by water during flooding or air as spores or cells in anabiosis [5, 12]. Chlorophyta are the ones who spread via the wind, followed by diatoms and cyanobacteria [4, 7].

In the newly built ponds the first occupants are bacteria, algae and cyanobacteria. The first manifestation of colonization is the production of biomass from anorganic matter and this way they allow the arrival of another organisms [5, 12]. Chlorophyta produce the biggest biomass [12]. They gradually create communities of plankton, benthos and neuston [5, 3, 1]. Abundance of green algae increases with the temperature of water [16]. For further development of population they create reserves of spores and resting cells in sediments. The impulse for developing spores and resting cells is light and sediment mixing [15]. Cyanobacteria and algae are indicators of water quality. The species composition of phytoplankton supplements chemical analyse of water and it gives us an image of the conditions in the ponds [5]. Low values of nitrogen and phosphorus limit the growth of biomass algae [16]. According to species of algae and cyanobacteria present, we can devide ponds into oligotrophy, mesotrophy and eutrophy [5, 8].

The aim of this study is to monitor the development of the newly built ponds near the village Hovorany in terms of hydrochemical parameters and algae and cyanobacteria occurrence.

Material and Methods

System of five ponds (figure 1) was built near the village of Hovorany on arable soil. Ponds do not have a tributary, but they are supplied by groundwater. The water depth and water surface are given in the table 1. All ponds are without fish. Macrofyta occure rarely.

In the year 2014, the ponds are being monthly observed. The results published in this article are from March to August. From each pond the sample of water, cyanobacteria and algae were taken, and hydrochemical parameters were measured.

Fig. 1 Satellite map of the ponds

Dissolved oxygen, pH and the temperature of water were measured *in situ* using a portable Hach HQ40d machine, and the conductivity of water was measured by the portable Hanna Combo HI 98129 machine. Transparency was measured *in situ* with a Secchi disk. The samples of water are taken in PE bottles with the volume of 0.5 l.

Table 1 Characteristic each ponds

Pond	Max. depth (m)	water surface (m^2)
1 Sluňák	2	4 796
2 Mokřák	2	480
3 Vrbatec	1.5	375
4 Olšovník	1	421
5 Jasaňák	0.5	355

The values of ammoniacal, nitrite and nitrate nitrogen, chlorides, orthophosphate, alkalinity (ANC) and calcium were determined using a standard method for analyzing the surface of water [9]. Chlorophyll "a" was determined according ISO 10260 [10]. For analysing COD_{Cr}, total nitrogen (Nt) and phosphorus (Pt), commercial supply sets from company WTW were used. All spectrophotometricaly analysis were carried out by a spectrofotometr PhotoLab 6600 UV-VIS.

Samples for microscopic determination of main groups of phytoplankton were taken using plankton net (average diameter of net eyes being 20 µm) into 50 ml plastic sample containers. The determination of phytoplankton was carried out in the native state using an optical microscope Olympus BX51. For the assessment of abundance of each group the seven-stage estimate scale was used [8].

The identified species were divided into four groups: cyanobacteria (Cyanobacteria), green algea (Chlorophyta), diatoms (Bacillariophyceae) and others algea (Dinophyta, Cryptophyta, Chrysophyceae, Xantophyceae, Euglenophyta). The results were processed in Microsoft Office Excel 2003.

Results and Discussion

The hydrochemical parameters of ponds are shown in the table 2. The greatest fluctuation of values was observed at pH, which moved from 8.25 to 10.00 (table 2). The alkalinity moved from 0.5 to 3.9, confirming the fluctuation of pH. High values were found organic matters, where the measured

COD_{Cr} in spring period extended to 137 mg.l^{-1}. By the newly built ponds there is yet no mineralized sediment, therefore a lot of organic matter occurs in the beginning. The biggest pond Sluňák was the most stable one. According to Government Order No. 61/2003, the ponds are carp water, where limits of physical and chemical parameters are determined. Value of pH should be to 9.00, all ponds exceeded this value in June and July. This occured because of the development of cyanobacteria and algea, which increase pH during photosynthesis [5, 17]. Total amount of organic matter should be to 26 mg.l^{-1}. All ponds except Sluňák exceeded this value many times in spring period. The low value of total nitrogen and phosphorus (table 2) show the presence of plants, which improve quality of water [18].

Table 2 Hydrochemical parameters are measured in the ponds

1 Sluňák		Average	Max	Min
Temperature of water	°C	17.27	26.00	8.30
Dissolved oxygen	%	95.38	106.80	85.70
pH		8.77	9.18	8.35
Conductivity	mS.m^{-1}	55.65	65.30	44.80
Nt	mg.l^{-1}	1.13	3.30	0.40
Pt	mg.l^{-1}	0.04	0.04	0.03
Chlorophyll a	µg.l^{-1}	3.70	7.40	1.48
COD_{Cr}	mg.l^{-1}	17.58	23.00	15.10
ANC	mmol.l^{-1}	2.53	3.70	1.15
2 Mokřák		**Average**	**Max**	**Min**
Temperature of water	°C	17.13	26.10	8.20
Dissolved oxygen	%	94.62	107.30	87.10
pH		8.99	9.72	8.36
Conductivity	mS.m^{-1}	58.87	70.20	51.40
Nt	mg.l^{-1}	1.02	2.70	0.40
Pt	mg.l^{-1}	0.04	0.04	0.03
Chlorophyll a	µg.l^{-1}	2.96	4.44	1.48
COD_{Cr}	mg.l^{-1}	37.73	127.00	15.50
ANC	mmol.l^{-1}	2.03	3.50	1.05
3 Vrbatec		**Average**	**Max**	**Min**
Temperature of water	°C	16.72	25.40	8.20
Dissolved oxygen	%	87.92	101.50	66.90
pH		8.66	9.23	8.25
Conductivity	mS.m^{-1}	60.83	70.50	55.10
Nt	mg.l^{-1}	1.28	3.60	0.30
Pt	mg.l^{-1}	0.05	0.06	0.04
Chlorophyll a	µg.l^{-1}	7.89	11.84	4.44
COD_{Cr}	mg.l^{-1}	44.45	131.00	19.80
ANC	mmol.l^{-1}	2.43	3.90	1.70
4 Olšovník		**Average**	**Max**	**Min**
Temperature of water	°C	16.57	25.20	8.20
Dissolved oxygen	%	85.18	100.00	57.30
pH		8.65	9.28	8.28
Conductivity	mS.m^{-1}	61.13	75.30	53.00
Nt	mg.l^{-1}	1.53	4.80	0.60
Pt	mg.l^{-1}	0.05	0.06	0.05
Chlorophyll a	µg.l^{-1}	4.44	7.40	1.48
COD_{Cr}	mg.l^{-1}	46.63	137.00	20.80
ANC	mmol.l^{-1}	2.15	3.90	1.35
5 Jasaňák		**Average**	**Max**	**Min**
Temperature of water	°C	16.52	24.60	8.50
Dissolved oxygen	%	93.80	141.80	67.50
pH		9.05	10.00	8.26
Conductivity	mS.m^{-1}	57.15	67.50	49.20
Nt	mg.l^{-1}	1.62	4.50	0.70
Pt	mg.l^{-1}	0.17	0.27	0.09
Chlorophyll a	µg.l^{-1}	14.26	51.80	1.48
COD_{Cr}	mg.l^{-1}	48.10	130.00	21.10
ANC	mmol.l^{-1}	2.32	3.45	1.20

In the ponds a total of species was found (cyanobacteria 8 species and 53 species algae). In pond Sluňák prevail golden algae (Chrysophyceae) in March, the most often occurring species being *Dinobryon divergens*. Since April most numerous were the green algae (*Zygnema sp.*, *Botryococcus braunii*, *Planktosphaeria gelatinosa*). In July, diatoms were represented the most (*Synedra acus*, *Nitzschia sigmoidea*, *Navicula sp.*). Cyanobacteria are found in large numbers only in June represented by the only species *Snowella sp.* (figure 3).

In the pond Mokřák, cyanobacteria and algae occured in March. Diatoms (*Dinobryon divergens, Malomonas sp.*) were most dominant in this month. In other samples the green algae was the most numerous (*Zygnema sp., Pandorina morum,* *Elakatothrix genevensis, Phacotus lenticularis, Spirogyra sp.).* Cyanobacteria occurred more in June, namely the species *Snowella sp.* (figure 3).

In the pond Vrbatec green algae occured the most (*Staurastrum manfeldtii*, *Ankyra ancora*, *Crucigeniella apiculata*). Golden algae (*Mallomonas akrokomos*) and euglena (*Phacus longicauda*) were most numerous during March, July and August. Diatoms and cyanobacteria were rarely present (figure 3).

In the pond Olšovník euglena *(Colacium sp., Lepocinclis texta, Euglena sp.)* and Cryptophyta (*Cryptomonas sp.*) dominated the most. Green algae (*Planktosphaeria gelatinosa*, *Ankyra ancora*, *Pandorina morum*) dominated in May, July and August (figure 3).

In the pond Jasaňák, euglena (*Colacium sp.*, *Lepocinclis texta*) were dominant in spring period. Green algae (*Scenedesmus linearis*, *Oocystis lacustris*, *Botryococcus braunii*) prevailed since May. From diatoms, *Navicula sp.*, *Nitzschia sp.*, *Stephanodiscus sp.* occured. The species *Cylindrospermum mucosum* were most numerous from cyanobacteria (figure 3).

The most numerous taxa were green algae (Chlorophyta) in the ponds. The exception was the pond Olšovník, where the other algae were prevailing (Euglenophyta and Cryptophyta).

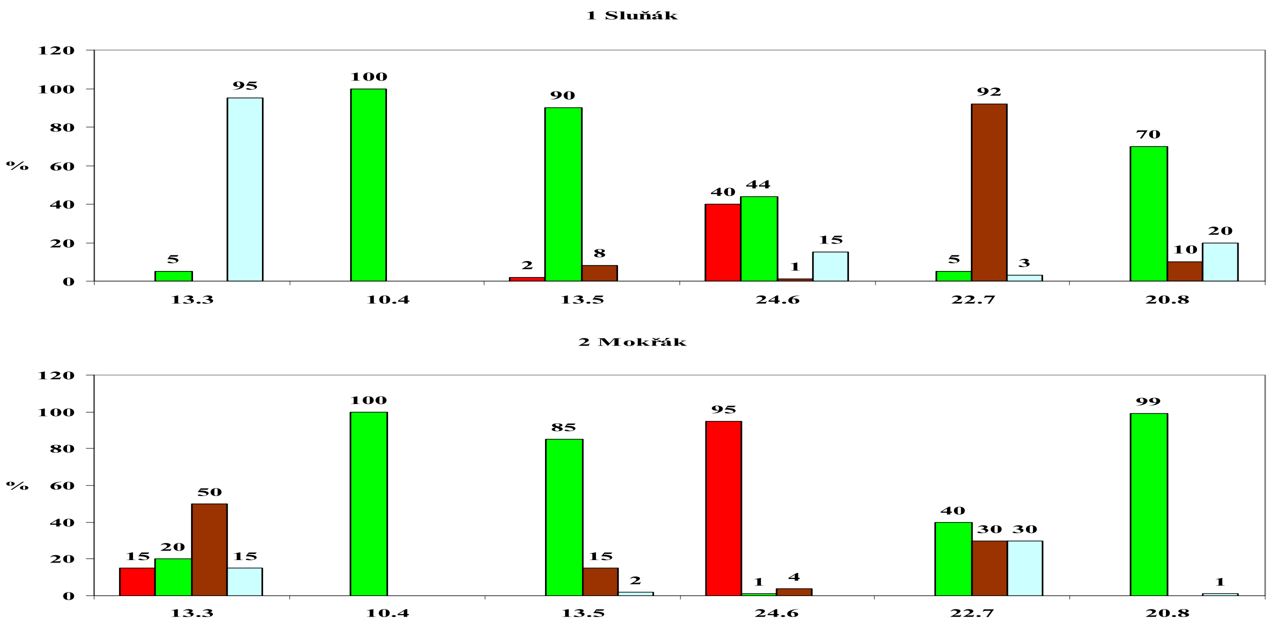
In the newly built ponds or pools the most numerous species are from the groups of Euglenophyta and Chlorophyta [3, 14]. The ability of Chlorophyta to spread by wind was confirmed [7]. Therefore they can be the first organisms in the new habitats [4, 12]. Diatoms were found both in the water column and the periphyton in accordance with Borduqui et al. [2] and Asencio [1]. The dominant occurrence of Chlorophyta indicate eutrophy in the ponds, as studies by Oikonomou et al. [13] and Asencio [1] show. Our results show that the most numerous cyanobacteria occur in the warmest period of the year. This is confirmed by Unrein et al. [17], who observed the same occurrence in nature reservoir of Laguna Grande in the South America.

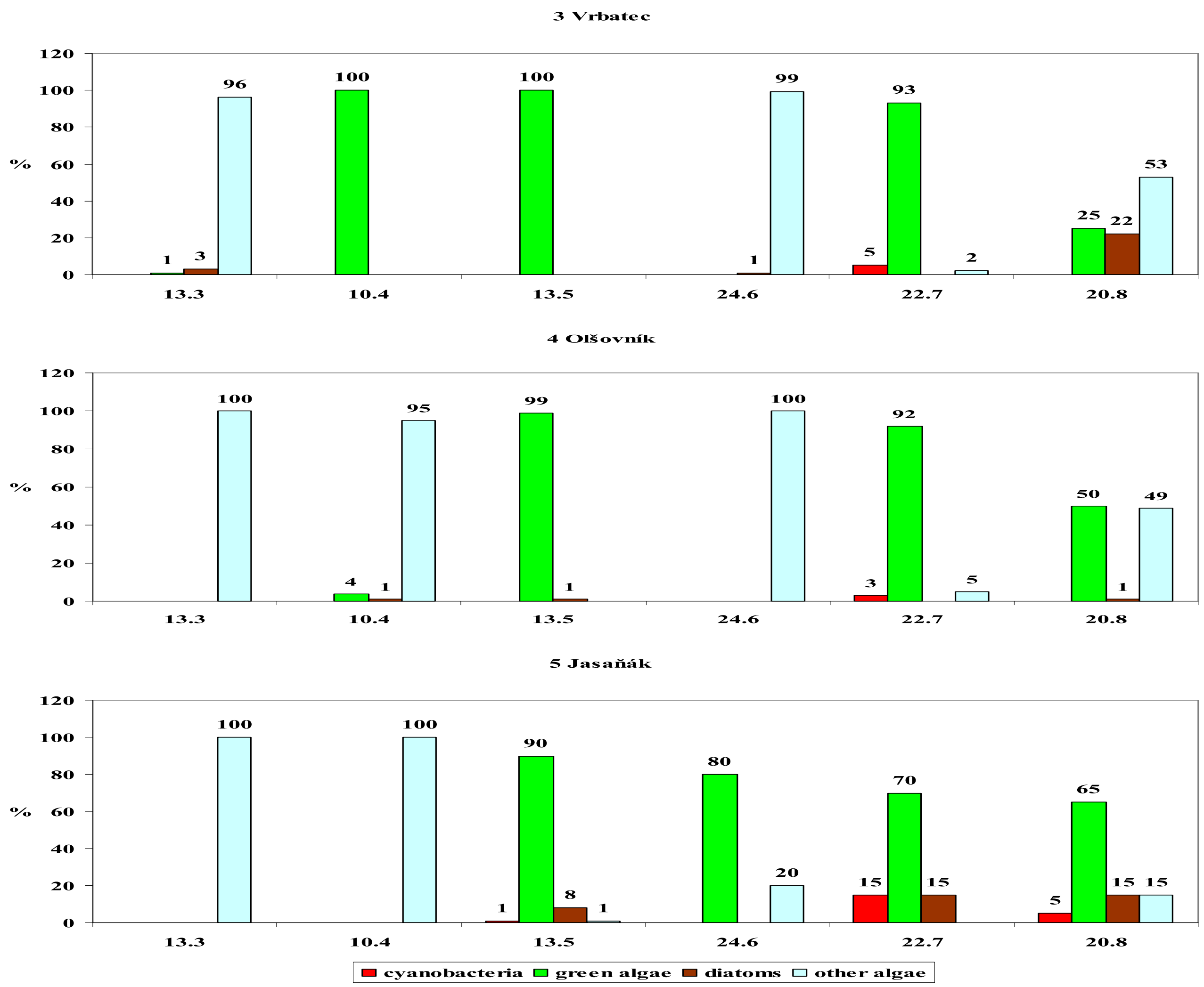
Monitoring of new habitats may help to understand the relationship between the environment and the colonizing species.

Conclusion

The ponds are being observed in the year 2014. From measured chemical parameters follows that according to Government Order No. 61/2003, the ponds are carp water. In all the ponds there is a significant fluctuation in pH. The biggest pond ‚Sluňák, is the most stable, and can be suitable for the settlement of fish community. Cyanobacteria and algae gradually colonized all ponds. In total, 61 species occurred (cyanobacteria 8 species and 53 species algae). The most numerous taxa were green algae (Chlorophyta), who quickly colonized the new habitats. The exception was the pond Olšovník, where the others algae (Euglenophyta and Cryptophyta) prevail. Based on the identified taxa algae and cyanobacteria, the ponds are eutrophic.

Fig. 3 The percentage of cyanobacteria and algae in each pond





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