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ALGAE IN MANURE AND WASTEWATER FROM THE CONSTRUCTED BARJE AND DRAGONJA WETLANDS

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ABSTRACT

In 2000 and 2001, samples were taken seasonally in three wastewater types: manure wastewater, wastewater from the constructed Barje wetland, and wastewater from the constructed Dragonja wetland. The purpose of our investigation was to determine species structure and abundance of algae. Altogether, 27 algal species were determined. Most of them belonged to Cyanophyceae. Microcystis hansgirgiana *was recorded for the first time in Slovenia.*

Key words: algae, manure, wastewaters

ALGHE PRESENTI NEL TERRICCIO DI LETAME E NELLE ACQUE DI SCOLO PROVENIENTI DAI DEPURATORI VEGETALI DI BARJE E DRAGOGNA

SINTESI

Abbiamo effettuato una ricerca sulle alghe presenti in tre habitat ipetrofici: terriccio di letame, acqua di scolo del depuratore vegetale (DV) Barje e quella del DV Dragogna. Scopo della ricerca era di identificare la composizione specifica e l'abbondanza relativa delle comunità algali negli anni 2000 e 2001. Nel terriccio di letame e nelle acque di scolo di entrambi i depuratori abbiamo individuato 27 specie algali con una prevalenza di cianobatteri. La specie Microcystis hansgirgiana è *stata individuata in Slovenia per la prima volta.*

Parole chiave: alghe, terriccio di letame, acque di scolo

INTRODUCTION

Manure wastewater is a mixture of animal excretions – excrements and urine (Leskošek, 1993). Undiluted manure contains 90% of water and 10% of dry substance. In manure, some additional water from cleaning the stables can be usually found as well. Constructed wetlands are wastewater treatment systems, where similar processes known from natural wetlands are present (Vrhovšek, 1998). In wastewaters temperature increases, especially in summer, and coupled with available nutrients creates ideal conditions for algae growth. This leads to the phenomenon known as algae bloom (Hancock & Buddhavarapu, 1993). In certain instances, algae blooms die due to environmental conditions such as low temperatures, toxicity problems created by the population, increases in pH, release of toxic metabolites, etc. Dead algae sink to the bottom where their chemical constituents are transformed, solubilized and recycled into the water. This contributes to decreases in oxygen and increases in nutrients such as phosphorus and nitrogen. The fluctuation in the algal growth cycle affects the consistency of the effluent quality of wastewater (Hancock & Buddhavarapu, 1993).

The aim of the current investigation was to find out the species structure and abundance of algae in manure wastewater, wastewater from the constructed Barje wetland and wastewater from the constructed Dragonja wetland in the years 2000 and 2001.

MATERIAL AND METHODS

Samples of algae were taken seasonally in the years 2000 and 2001. Four samples were taken from manure (May 2000, August 2000, November 2000, January 2001), another four wastewater samples from the constructed Barje wetland (April 2000, August 2000, November 2000, January 2001), and three samples from the constructed Dragonja wetland (July 2000, November 2000, January 2001). Samples of manure were taken in the grassland above the manure basin of one of the farms. Samples of wastewater from the constructed Barje wetland were taken from the wastewater accumulation basin, while wastewater samples from the constructed wetland Dragonja were taken in the bed amongst *Phragmites communis* Trin. The samples were scooped into a small vessel. The sampling sites are presented in figure 1. For precise description of sampling sites, see Krivograd Klemenčič (2001).

Algal species were identified by determination keys of Lazar (1960), Starmach (1966, 1972, 1983), Kramer & Lange-Bertalot (1986, 1988), Hindak *et al.* (1978), Cvijan & Blaženčić (1996) and Hindak (1996). The samples were first examined and then preserved in a 4 % formaldehyde solution. All samples were also treated by concentrated HNO_3 to determine the species from class Bacillariophyceae. Relative abundance was estimated with numbers 1, 3 and 5 (1 – single, 3 – customary, 5 – dominant) (Pantle & Buck, 1955).

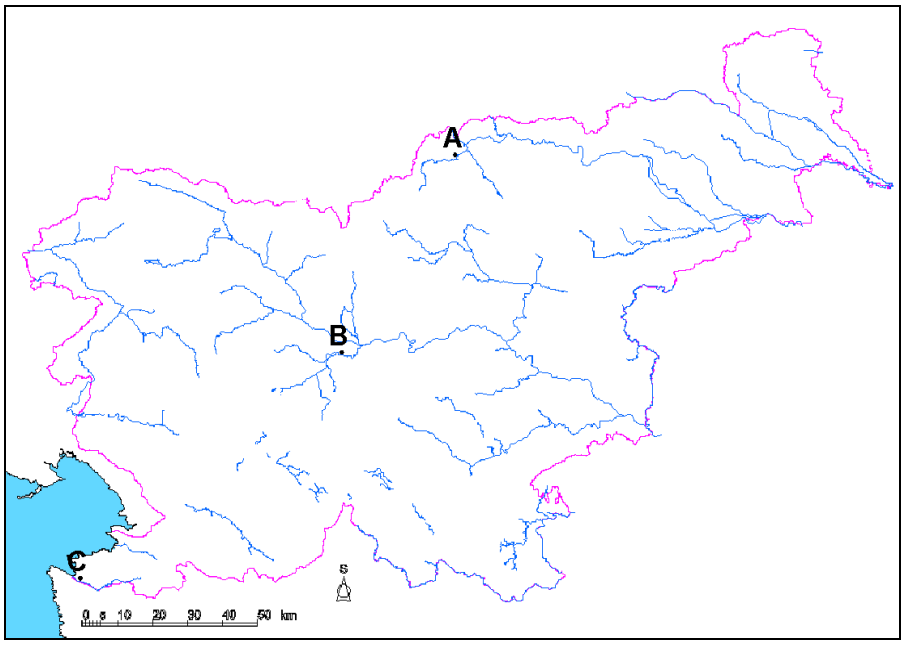

Fig. 1: Map of Slovenia with marked sampling sites. Legend: A – manure, B – constructed Barje wetland, C – constructed Dragonja wetland.
Sl. 1: Zemljevid Slovenije z označenimi vzorčnimi mesti. Legenda: A – gnojevka, B – rastlinska čistilna naprava Barje, C – rastlinska čistilna naprava Dragonja.

RESULTS AND DISCUSSION

Altogether, 27 species of algae were determined (Tab. 1). Most of them (13) belonged to Cyanophyceae, 6 to Bacillariophyceae, 6 to Chlorophyceae and 2 to Euglenophyceae.

12 species of algae were determined in manure, 7 in wastewater from the accumulation basin in the constructed Barje wetland, and 14 in wastewater from the bed amongst *P. communis* in the constructed Dragonja wetland. The algal structure by classes at all three sampling sites is shown in figure 2. The most frequent class of algae in manure and wastewater from the constructed Dragonja wetland was the class of Cyanophyceae. Cyanophyceae were most frequently found in our samples, as revealed by our research into hypertrophic waters (Whitton, 1975; Sedmak & Kosi, 1997). In wastewater from accumulation basin in the constructed Barje wetland, Cyanophyceae were absent, while Bacillariophyceae and Chlorophyceae were prevalent. The main reason for the differences between wastewater samples from both constructed wetlands was probable the sampling site. In the constructed Dragonja wetland, we took samples of algae in wastewater from the bed amongst *P. communis*, while in the constructed Barje wetland we took them from the wastewater accumulation basin. Whitton (1975) established that in phytoplankton of ventilating basins of the wastewater treatment systems Chlorophyceae prevailed, with Cyanophyceae occurring only exceptionally. In manure water, algae from class Euglenophyceae were absent.

In all four manure samples, *Microcystis hansgirgiana* and *Chlorella* sp. were present. *M. hansgirgiana*, *Chlorella* sp. and *Oscillatoria* sp. were the most common species (relative abundance = 3). *M. hansgirgiana* was recorded in Slovenia for the very first time. The most common species among diatoms was *Nitzschia umbonata*, a typical species of eutrophic waters with high values of electrolytes. *N. umbonata* is often found in the outflows of treatment systems (Kramer & Lange-Bertalot, 1988). The number of determined species in manure water between samples did not differ a great deal. The lowest number of species (4) was determined in May 2000.

In all four samples from the constructed Barje wetland, *N. umbonata* and *Chlorella vulgaris* were recorded. *C. vulgaris* was the predominant species (relative abundance = 5).

In all three samples taken in the constructed Dragonja wetland, the following species were determined: *Phormidium* sp., *Euglena* sp., *Navicula veneta* and *N. umbonata*. *N. veneta*, *N. umbonata* and *Oscillatoria tenuis* were the most common species (relativne abundance = 3). In the constructed Dragonja wetland, the number of determined species did not differ much between the seasons, while in the constructed Barje wetland the species diversity was higher in the winter than in the summer samples. Quality of outflow waters during the year is not constant. Outflow waters are most toxic in the summer (dry season) (Bulc, 1998). Changes in the quality of outflow waters have a great impact on the quantitative and qualitative structure of algal association (Bulc, 1998).

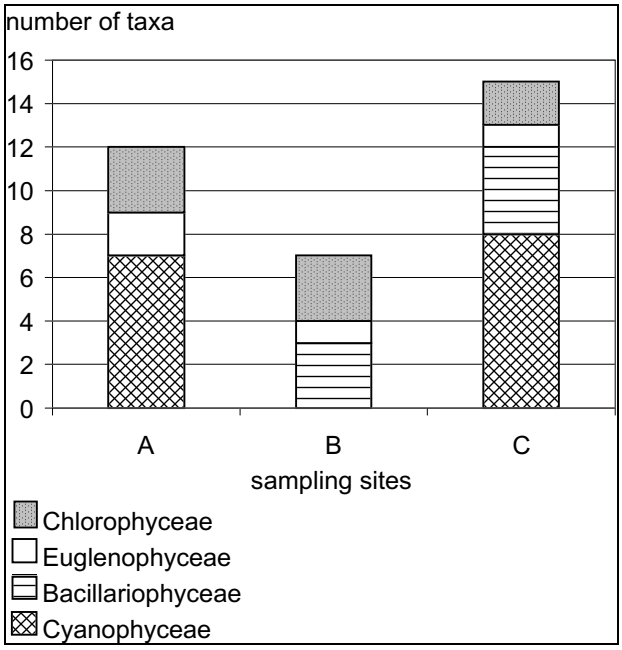

Fig. 2: Algal structure by classes in manure and wastewater from the constructed Barje and Dragonja wetlands in the years 2000 and 2001. Legend: A – manure, B – wastewater from the constructed Barje wetland, C – wastewater from the constructed Dragonja wetland.
Sl. 2: Sestava alg po razredih v gnojevki in odpadni vodi iz rastlinskih čistilnih naprav Barje in Dragonja v letih 2000 in 2001. Legenda: A – gnojevka, B – odpadna voda iz rastlinske čistilne naprave Barje, C – odpadna voda iz rastlinske čistilne naprave Dragonja.

CONCLUSIONS

Altogether, 27 species of algae were determined. Most of them (13) belonged to Cyanophyceae, 6 to Bacillariophyceae, 6 to Chlorophyceae, and 2 to Euglenophyceae. 12 species were determined in manure, 7 in wastewater from the constructed Barje wetland, and 14 in wastewater from the constructed Dragonja wetland. The most frequent classes of algae were Cyanophyceae in manure and wastewater from the constructed Dragonja wetland, and Bacillariophyceae and Chlorophyceae in wastewater from the constructed Barje wetland. In manure, the species *M. hansgirgiana* was determined, which was the first record for Slovenia.

Tab. 1: Algal species list with estimation of abundance (1 – single, 3 – customary, 5 – dominant) in manure and wastewater from the constructed Barje and Dragonja wetlands in the years 2000 and 2001. Legend: A – manure, B – wastewater from the constructed Barje wetland, C – wastewater from the constructed Dragonja wetland.
Tab. 1: Vrstna sestava alg z oceno abundance (1 – posamična, 3 – običajna in 5 – prevladujoča) v gnojevki in odpadni vodi iz rastlinskih čistilnih naprav Barje in Dragonja v letih 2000 in 2001. Legenda: A – gnojevka, B – odpadna voda iz rastlinske čistilne naprave Barje, C – odpadna voda iz rastlinske čistilne naprave Dragonja.

taxon	Sampling site		
	A	B	C
PROKARYOTA			
CYANOPHYTA			
CYANOPHYCEAE			
Gloeocapsa sp.			1
**Microcystis hansgirgiana* (Hansgirg) Elenkin	3		
Oscillatoria agardhii Gomont	1		
Oscillatoria beggiatoiformis (Grün.) Gom.			1
Oscillatoria sp.	3		
Oscillatoria subbrevis Schmidle			1
Oscillatoria tenuis Agardh	1		3
Phormidium sp.	1		1
Pseudanabaena constricta (Szafer) Lauter.			1
Rhabdoderma lineare Schm. In Lauter.	1		
Synechococcus cedrorum Sauvageau	1		
Synechococcus elongatus Naegeli			1
Synechocystis aquatilis Sauvag.			1
EUKARYOTA			
HETEROKONTOPHYTA			
BACILLARIOPHYCEAE			
Amphora coffeaeformis (Agardh) Kütz.			1
Cymbella silesiaca Bleisch		1	
Navicula sp.	1	3	
Navicula veneta Kütz.			3
Nitzschia sp.			1
Nitzschia umbonata (Ehren.) Lan.-Bert.	1	1	3
EUGLENOPHYTA			
EUGLENOPHYCEAE			
Euglena sp.			1
Euglena viridis Ehren.		1	
CHLOROPHYTA			
CHLOROPHYCEAE			
Chlamydomonas ehrenbergii Gorosch.		3	
Chlamydomonas sp.	1		1
Chlorella sp.	3		
Chlorella vulgaris Beyer.		5	
Klebsormidium flaccidum (Kütz) Silva, Mattox & Black.		1	
Trentepohlia aurea (L.) Martius	1		1

* species recorded in Slovenia for the first time

ALGE V GNOJEVKI IN ODPADNI VODI IZ RASTLINSKIH ČISTILNIH NAPRAV BARJE IN DRAGONJA

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POVZETEK

V nalogi smo raziskovali alge v treh hipertrofnih habitatih: gnojevki, odpadni vodi v rastlinski čistilni napravi (RČN) Barje in odpadni vodi v RČN Dragonja. Namen raziskave je bil ugotoviti kvalitativno vrstno sestavo in relativno abundanco algnih združb v letih 2000 in 2001. V gnojevki in v odpadni vodi v RČN Barje smo opravili po štiri vzorčenja, v odpadni vodi v RČN Dragonja pa tri. V laboratoriju smo vzorce alg pregledali pod svetlobnim mikroskopom. Pogostost posameznih vrst alg smo ocenili s števili 1, 3 in 5 (1 – posamična, 3 – običajna in 5 – prevladujoča).

Skupaj smo v gnojevki in v odpadnih vodah iz obeh RČN določili 27 različnih vrst iz štirih razredov alg. V gnojevki smo določili 12, v RČN Barje 7 in v RČN Dragonja 14 različnih vrst alg. Po številu vrst so v gnojevki in v RČN Dragonja prevladovale cianobakterije. V RČN Barje se cianobakterije niso pojavljale, prevladovale so kremenaste in zelene alge. Glavni razlog za razlike med vzorci iz obeh RČN je bilo verjetno različno mesto vzorčenja. V RČN Dragonja smo vzorčili alge v odpadni vodi v gredi med trstičjem, v RČN Barje pa v odpadni vodi v akumulacijskem bazenu.

V gnojevki smo v vseh štirih vzorcih zabeležili vrsti Microcystis hansgirgiana *in* Chlorella *sp., ki sta bili tudi med najbolj pogostimi vrstami. V RČN Barje sta se v vseh štirih vzorcih pojavljali vrsti* Nitzschia umbonata *in* Chlorella vulgaris. C. vulgaris *je bila prevladujoča vrsta. V RČN Dragonja so bile v vseh treh vzorcih ugotovljene vrste* Phormidium *sp.,* Euglena *sp.,* Navicula veneta *in* N. umbonata. N. veneta, N. umbonata *in* Oscillatoria tenuis *so bile najbolj pogoste vrste.* M. hansgirgiana *je v Sloveniji prvič zabeležena vrsta.*

Ključne besede: alge, gnojevka, odpadne vode

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