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Roman BABKO[1], Tatiana KUZMINA[2], Grzegorz ŁAGÓD[3]
and Katarzyna M. JAROMIN-GLEŃ[4]

# THE PERIPHYTON COMMUNITIES OF A MUNICIPAL WASTEWATER TREATMENT PLANT

## ZBIOROWISKA PERYFITONU MIEJSKIEJ OCZYSZCZALNI ŚCIEKÓW

**Abstract:** The study was undertaken to determine the composition of periphyton and its quantitative development during consecutive stages of wastewater treatment in a flow-type purification plant with the biological part serving as a modified Bardenpho system (Hajdow, Lublin, south-eastern Poland).The periphyton was sampled from the wastewater plant walls at all main stages of water purification. The following groups of organisms: algae, fungi, flagellates, testate amoeba, ciliates, rotifers, and nematodes were identified in the composition of periphyton. At the end of the purification process, the proportion of metazoa and protozoa in the periphyton of the successive chambers increased, while the abundance of flagellates declined. In all the sampling points studied, protozoa and metazoa formed the basis of the periphyton community and their proportion ranged from 75 to 95%.

**Keywords:** periphyton, communities, municipal wastewater treatment plant (WWTP), protozoa, metazoa

## Introduction

The periphyton is observed on all surfaces submerged in water. The biofilm was studied mostly in purification systems, where it was the main instrument and process factor of sewage treatment. Many publications are devoted to studies of physical characteristics and physiological activity of biofilms and their bacterial component [1-4]. At the same time, a relatively small number of studies provide information concerning other organisms that together with bacteria are regular components of biofilm and have a certain influence on bacterial life activity and on the purification process performed by the biofilm community. For example, the paper by Madoni [5] contains data about biofilm protozoa from rotating biological contactors (RBC) and percolating filters. Results of studies of protozoa in percolating filters have been presented by some authors [6, 7]. Results of research of ciliate populations and their distribution in RBC systems can be found in papers [8-12]. There is also evidence that, besides bacteria, ciliates are the most numerous and important organisms in the biofilm of RBC [10, 11]. Metazoa are also an important part of biofilm community, since they often reach big quantities and are influential links of trophic chains [13, 14].

Today, there is not enough information to specify the role that periphyton plays in such treatment facilities as bioreactors with activated sludge working in the flow-mode or in SBRs. Much less is known about periphyton, *ie* a biofilm growing on the walls of

[1] I.I. Schmalhausen Institute of Zoology of National Academy of Sciences of Ukraine, B. Khmelnitsky 15, 01601 Kiev, Ukraine, email: rbabko@ukr.net
[2] Sumy State University, Rymskogo-Korsakowa 2, 40007 Sumy, Ukraine, email: kuzmina_tm@ukr.net
[3] Faculty of Environmental Engineering, Lublin University of Technology, ul. Nadbystrzycka 40B, 20-618 Lublin, Poland, email: g.lagod@wis.pol.lublin.pl
[4] Institute of Agrophysics, Polish Academy of Sciences, ul. Doświadczalna 4, 20-290 Lublin, Poland, email: k.jaromin-glen@ipan.lublin.pl
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purification facilities submerged in wastewater, than about activated sludge that is functioning in bioreactors. This paper presents the study of the structure of the main periphyton groups and their quantitative development at different stages of wastewater purification. The analysis of the structure dynamics and diversity of the main periphyton groups in each purification stage can provide additional information concerning stability of the aforementioned processes and probable destabilization of the activated sludge structure and properties.

## Materials and methods

The research material comprised periphyton sampled from the main line of the technological system of the "Hajdow" mechanical-biological wastewater treatment plant in Lublin (south-eastern Poland). The analyses of the periphyton during the main stages of sewage purification were carried out in spring when activated sludge was not in optimal conditions. In the aeration chamber, the initial stages of activated sludge bulking and foaming were observed. The samples of the periphyton from the walls of the main chambers were analyzed to calculate the quantities of the major hydrobiont groups, such as flagellates, testate amoebae, rotifers, nematodes, ciliates, algae, and fungi. Ciliates were analyzed according to their ecological groups - attached ciliates, crawling ciliates, and swimming ciliates.

The samples were taken with a scraper ca. 15 cm below the sewage surface in each device. The periphyton was sampled from an area of approximately 100 $cm^2$. The sampling points included: 1 - screen chamber, 2 - grit chamber, 3 - primary clarifier, 4 - anaerobic chamber, 5 - anoxic chamber, 6 - aeration chamber, 7 - secondary clarifier, and 8 - recirculation channel. The data presented in the article are averaged from two months of the experiment with a one-week sampling period.

## Results and discussion

During the study period, there was a tendency that the proportion of metazoa and protozoa in the periphyton of the successive chambers was increasing towards the end of the purification process (Fig. 1). Their percentage at the various purification stages ranged from 75 to 95%. Together with fungi, the proportion of heterotrophic organisms in the periphyton can reach 99%. The proportion of fungi in the various stages of purification was not higher than 8%, while autotrophic organisms formed from 1 to 25% of all organism abundance. Similar results were obtained in an RBC-type water treatment plant [11]. In such periphyton (RBC), ciliates constituted the most numerous group of organisms (55-95% of the total quantity). In the periphyton conditions of the Hajdow flow-type purification plant, ciliated protozoa make up from 14 to 69%.

In treatment facilities such as aeration chambers, activated sludge usually operates on the basis of heterotrophic communities, and their autotrophic component is minimized. Therefore, the question of determination of the potential involvement of autotrophs in the periphyton of treatment plants is of great interest. The role of heterotrophic and autotrophic organisms in the periphyton structure in the conditions of the treatment plant is shown in Figure 2. There is a direct relation between the dynamics of algae, fluctuations in illumination intensity, and efficiency of the water clarification process. The quantitative representation of algae and fungi recorded at various points during this study is presented in Figure 3.

Quite an independent tendency was shown by testate amoebae and flagellates. The average values of testate amoebae abundance were decreasing insignificantly from the beginning until the end of the purification process. Simultaneously, this tendency in flagellates was quite explicit (Fig. 4). Since the beginning of the process, their abundance decreased by 30 times. It is obvious that small flagellates propagate fast in the water rich in organic matter and with minimum oxygen saturation. Thus, the flagellate dynamics will be rather determined by disturbances in the purification process or excessive inflow of wastewater. According to Curds [15], flagellates predominate in the system in the early stages because of their lower energy requirements. Heterotrophic flagellates are therefore recognized as indicators of malfunction of treatment facilities or their overload [5].

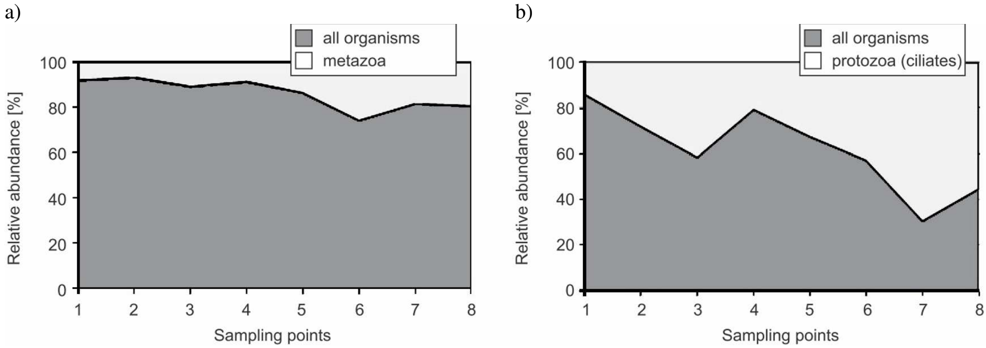


Fig. 1. Proportion of metazoa (a) and ciliates (b) in the total abundance of organisms in the periphyton along the treatment plant. Sampling points: 1 - screen chamber, 2 - grit chamber, 3 - primary clarifier, 4 - anaerobic chamber, 5 - anoxic chamber, 6 - aeration chamber, 7 - secondary clarifier, 8 - recirculation channel

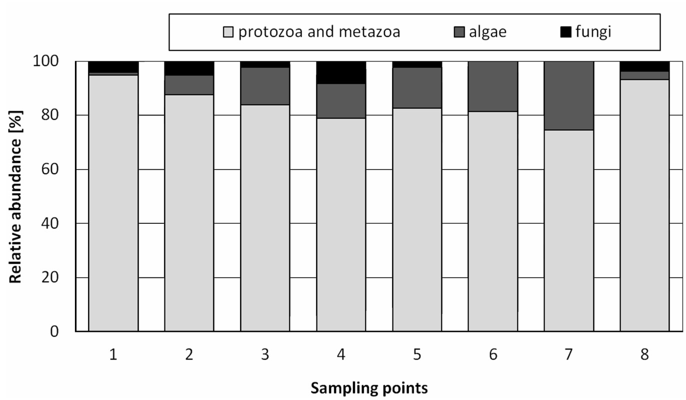


Fig. 2. The ratio of the quantitative representation of different groups of organisms in the structure of the periphyton community along the treatment plant. Sampling points: 1 - screen chamber, 2 - grit chamber, 3 - primary clarifier, 4 - anaerobic chamber, 5 - anoxic chamber, 6 - aeration chamber, 7 - secondary clarifier, 8 - recirculation channel

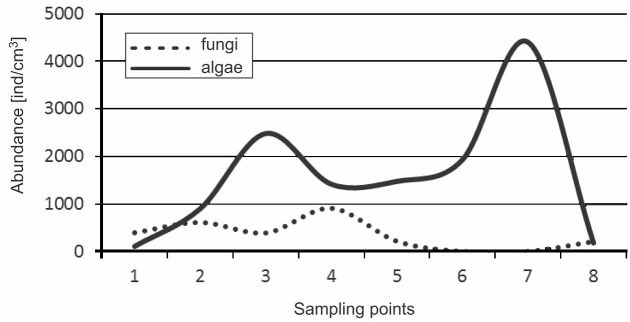


Fig. 3. Abundance of algae and fungi in the periphyton along the treatment plant. Sampling points: 1 - screen chamber, 2 - grit chamber, 3 - primary clarifier, 4 - anaerobic chamber, 5 - anoxic chamber, 6 - aeration chamber, 7 - secondary clarifier, 8 - recirculation channel

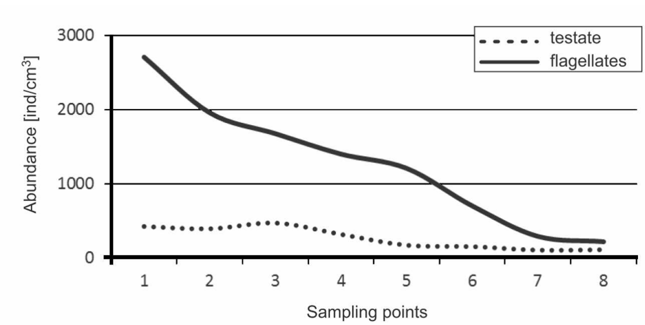


Fig. 4. Abundance of testate amoeba and flagellates in the periphyton along the treatment plant. Sampling points: 1 - screen chamber, 2 - grit chamber, 3 - primary clarifier, 4 - anaerobic chamber, 5 - anoxic chamber, 6 - aeration chamber, 7 - secondary clarifier, 8 - recirculation channel

## Summary and conclusions

The periphyton community in the successive chambers of the flow-type treatment plant with the biological part functioning in the modified system Bardenpho reached maximum abundance in the primary and secondary clarifiers. Towards the end of the purification process of the periphyton in the successive chambers, the amount of protozoa and metazoa increased. In all the sampling points studied, the basis of the periphyton community was formed by protozoa and metazoa, which accounted for 75-95%. The proportion of heterotrophs reached 99% and that of autotrophs varied from 1 to 25%.

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[1] Instytut Zoologii im. I.I. Schmalhausena Narodowej Akademii Nauk Ukrainy, Kijów, Ukraina
[2] Państwowy Uniwersytet Sumski, Sumy, Ukraina
[3] Wydział Inżynierii Środowiska, Politechnika Lubelska, Lublin, Polska
[4] Instytut Agrofizyki im. Bohdana Dobrzańskiego, Polska Akademia Nauk, Lublin, Polska

**Abstrakt:** W pracy zaprezentowano badania składu peryfitonu i jego rozwój ilościowy podczas kolejnych etapów oczyszczania ścieków w miejskiej oczyszczalni ścieków Hajdów w Lublinie, której część biologiczna pracuje w technologii zmodyfikowanego systemu Bardenpho. Próbki peryfitonu pobierano z powierzchni ścian obiektów na wszystkich głównych etapach oczyszczania ścieków. W składzie peryfitonu zostały zidentyfikowane następujące grupy organizmów: glony, grzyby, wiciowce, ameby skorupkowe, orzęski, wrotki i nicienie. W kolejnych analizowanych urządzeniach zlokalizowanych w ciągu technologicznym oczyszczalni peryfiton wykazywał wzrost ilości organizmów w obrębie grup metazoa i pierwotniaków, podczas gdy liczebność wiciowców uległa zmniejszeniu. We wszystkich badanych punktach pomiarowych podstawa zbiorowisk peryfitonu utworzona była przez pierwotniaki i metazoa, ich udział wahał się od 75 do 95%.

**Słowa kluczowe:** peryfiton, zbiorowiska, komunalna oczyszczalnia ścieków, pierwotniaki, metazoa