PHYTOPLANKTON COMMUNITY GROWTH INTERCONNECTIVITY WITH SOME ABIOTIC ENVIRONMENTAL FACTORS IN PAMBAK AND TANDZUT RIVERS

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ABSTRACT

Phytoplankton growth in the catchment basin of Debed river in Pambak and Tandzut rivers was studied. It was revealed the relationship between phytoplankton growth and some abiotic factors. According to the data analysis diatoms are quantitatively dominant group in phytoplankton community. Their quantitative growth showed strong relationship with water temperature ($T^\circ$), the quantities of water dissolved total mineral nitrogen ($N_{\text{tot}}$) and total mineral phosphorus ($P_{\text{tot}}$), NO$_2^-$, NO$_3^-$, NH$_4^+$, PO, BOD$_5$. Quantitative growth of blue-green algae showed dependency in water temperature, NO$_3^-$, PO quantity, and acido-alkaline reaction of the environment, while green algae were depend on water temperature, total $P_{\text{tot}}$, total $N_{\text{tot}}$, NO$_3^-$, PO and BOD$_5$ seasonal values. Total phytoplankton growth in Tandzut and Pambak rivers according to correlation coefficient revealed that the nitrogen compounds had greater importance for their growth.

Key words: phytoplankton community, biomass, biogenic elements

INTRODUCTION

Debed river catchment basin is located at technogenic impact zone, from where organic and inorganic materials of different origin, including pesticides and heavy metals are filled into these rivers. Moreover, the garbage, household and industrial wastewater are filled into these rivers as well, adversely affecting to the water quality.

The algoflora of Pambak, the largest affluent of Debed river, and its rivulet Tandzut were studied. Studies of phytoplankton community were carried out in 2009. Phytoplanktonic algal species composition, quantitative parameters and seasonal succession were investigated [12]. It is known that abiotic factors (river flow rate, temperature, dissolved oxygen, and especially biogenic elements) are important for phytoplankton growth. Biogenic elements, particularly nitrogen and phosphorus compounds, might be considered as planktonic algae growth limiting factor.

The aim of the current work was to find out from which abiotic factor is largely dependent Debed river affluent phytoplankton community growth as well as quantitative development of various groups of algae.

The following parameters were subjected to regression analysis: total mineral nitrogen ($N_{\text{tot}}$), total mineral phosphorus ($P_{\text{tot}}$), amonic form of nitrogen (NH$_4^+$), nitrite (NO$_2^-$) and nitrate (NO$_3^-$) forms of nitrogen, acido-alkaline reaction (pH), water temperature ($T^\circ$), permanganatic oxidation (PO), water dissolved oxygen (O$_2$), and biochemical oxygen demand (BOD$_5$).

Samples for monitoring of phytoplankton community were taken from the following stations: 1) Pambak river, till Vanadzor (area near to the asphalt producing factory), 2) Pambak river, the first bridge of Vanadzor, 3) river Pambak, till interfusing with Tandzut river, 4) river Tandzut, till interferring with Pambak river, 5) After intermixturing of Pambak and Tandzut rivers, down Vanadzor. The experimental works were carried out in the Institute of Hydroecology of the Scientific Center of Zoology and Hydroecology of NAS RA.

MATERIALS AND METHODS

Accepted hydroecological methods were used for preliminary and further laboratory treatments [1, 4]. Phytoplankton community quantitative and qualitative parameters was observed. Algae species identification was carried out according to general detectors and guidelines [9, 10, 15, 20]. Chemical analysis data were provided by the Environmental Impact Monitoring Center.

Quantitative correlation analysis was carried out between phytoplankton community biomass and chemical parameters as well as the average seasonal values.

Data analysis was done by EXCEL software package (P>0.95), correlation analysis was performed by STATISTICA8 software.
RESULTS AND DISCUSSION

Biogenic elements are chemicals, which are comprised in the composition of organisms and are necessary for their vital activity. Biogenic elements, especially nitrogen and phosphorus, play an important role in the development of phytoplankton algae such as nitric and phosphoric fertilizers for agricultural crops [18]. The impact of biogenic elements on plankton algae development were well highlighted in the literature by many authors [2, 5, 8, 11, 21, 23]. However, according to Saut, phytoplankton requirement of chemical elements is not fully explored [17]. Moreover, the comments by various authors about the same element significance often does not comply. For example, according to Pirsel, intensive growth rate of planktonic diatoms was observed in summer and winter with abundance of the nitrates, phosphates, and silicium.

The qualitative and quantitative parameters of green algae showed increase in summer, when nitrates and phosphates are reduced.

Blue-green algae might have intensive growth in the presence of minimum quantities of nitrates and phosphates, when the concentration of organic materials are high. In contrast, Reynolds reported that the blue-green algae have high demand in phosphorus and extremely increase it during eutrophication [14]. Other authors observed that blue-green algae quantity does not depend on quantity of phosphates [8]. In addition, according to Guseva there is no certain dependence between blue-green algae and phosphorus quantities [6]. Foge in blue-green algae this fact explained by the presence of gas in the vacuoles that regulate swimming movements of algae, by going down to the floor reservoir to the phosphorus-rich layers and fill phosphorus supply. Therefore, no direct connection between the amount of blue-green algae and phosphorus was reported [8]. Besides phosphorus and nitrogen compounds, water temperature, pH, PO, BOD, and other factors play an important role in phytoplankton development.

Diatoms, green, blue-green and yellow-green algae were found in algocenosis in Tandzut and Pambak rivers. Quantitatively and qualitatively dominant group of algae were diatoms, while subdominant algal groups were blue-green algae. An exception was monitored only in August, when Oscillatoria limnetica, Oscillatoria limosa species were dominated in fitocenosis due to their intensive growth. Considering phytoplankton dominant groups, their seasonal dynamics and species composition between Tandzut and Pambak rivers significant difference was not observed [12]. According to the chemical parameters seasonal average values were following:

The maximum values of mineral nitrogen were registered in winter (Pambak 5.94 mg/l; Tandzut 3.44 mg/l). Requirement of biogenic elements by aquatic vegetation was reduced in winter at the end of vegetative period. On the other hand, increase in total mineral nitrogen occurred due to decomposition of organic matter [13]. The minimum values of mineral nitrogen were observed in Pambak and Tandzut rivers (3 mg/l; 1.94 mg/l, respectively) in spring during vegetative period, along with phytoplankton quantitative development, when the absorption rate of nitrogen by plants increased.

The maximum values of mineral phosphorus were recorded in winter. Higher amount of mineral phosphorus was observed in Tandzut (0.23 mg/l) than in Pambak (0.12 mg/l). The minimum values of mineral phosphorus were registered in spring (Pambak 0.07 mg/l and Tandzut 0.04 mg/l, respectively).

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PO content in the water was high in Tandzut river (5.56 mg/l), which was observed in winter, while the minimum value was recorded in spring (2.65 mg/l). In Pambak river the maximum value of PO was recorded in summer (3.67 mg/l), and the minimum value was registered in spring (2.65 mg/l).

BOD had the highest indexes in winter (Tandzut - 4.90 mg/l), while in spring it was 2.04 mg/l. In Pambak BOD values were varied from 1.89 to 2.84 mg/l.

The maximum values of NH4+ in Pambak and Tandzut rivers were recorded in autumn (1.30 and 1.32 mg/l, respectively).

The maximum quantities of NO2 were 0.05 mg/l in Pambak in summer, and Tandzut in winter. High values of NO3 were recorded in the winter, in Pambak, 4.93 mg/l and in Tandzut 2.36 mg/l, respectively.

NH4+ (Pambak - 0.54 mg/l, Tandzut - 0.49 mg/l) and NO2 (Pambak - 0.034 mg/l, Tandzut - 0.02 mg/l) and NO3 (Pambak - 2.43 mg/l, Tandzut - 1.22 mg/l) the minimum values were registered in the spring during vegetative period, when they are intensively used by the algae (Fig. 1).

The maximum values of O2 were recorded in spring (9.16 mg/l Pambak, and 9.23 mg/l in Tandzut), while the minimum values were registered in autumn Pambak (6.53 mg/l) and in Tandzut (6.21 mg/l).

Our observations showed that between various groups of algae and mentioned chemical parameters based on the regression analysis following significant relationship (r ≥ 0.5) were recorded. Positive significant relationships were found in the following parameters:

- green algae and total P (r = 0.72, r² = 0.52) (Fig. 3); total N (r = 0.86, r² = 0.74);
- pH (r = 0.90, r²=0.80); BOD (r = 0.82, r² = 0.67) (Fig. 4);
- blue-green algae and NO2 (r = 0.97, r² = 0.95); PO (r = 0.80, r² = 0.65); pH (r=0.77, r² = 0.59); T0 (r = 0.88, r² = 0.78);
- yellow-green algae and NH4+ (r = 0.86, r² =0.74); pH (r = 0.95, r² = 0.91); PO (r = 0.60, r² = 0.36); T0 (r = 0.96; r² = 0.92);
- total phytoplankton and T0 (r = 0.96, r² = 0.92); pH (r = 0.61, r² = 0.37).
Negative significant relationship was observed in the following parameters:

- diatoms and total P\textsubscript{min} (r = -0.98, r\textsuperscript{2} = 0.97) (Fig. 9); BOD\textsubscript{5} (r = -0.94, r\textsuperscript{2} = 0.89); NO\textsubscript{2} (r = -0.97; r\textsuperscript{2} = 0.95);
- NO\textsubscript{3} (r = -0.9, r\textsuperscript{2} = 0.8); NH\textsubscript{4} (r = -0.71, r\textsuperscript{2} = 0.50) (Fig. 8);
- total phytoplankton and NO\textsubscript{3} (r = -0.83, r\textsuperscript{2} = 0.69), BOD (r = 0.71; r\textsuperscript{2} = 50).

Considering the fact of phytoplankton composition dependency in relation to quantitative parameters, drastic differences between Tandzut and Pambak rivers were not observed. On the other hand, differences were recorded according to their demand to biogenic elements and other chemical parameters. Between the diatoms, green algae and NO\textsubscript{2}, NH\textsubscript{4}, BOD\textsubscript{5} in Pambak river the relationship was not observed (Diatoms and NO\textsubscript{2} (r = -0.23, r\textsuperscript{2} = 0.05; NH\textsubscript{4} (r = -0.13, r\textsuperscript{2} = 0.01; BOD\textsubscript{5}(r=-0.2, r\textsuperscript{2} = 0.07); green algae and NO\textsubscript{2}; r = 0.25, r\textsuperscript{2} = 0.06; NH\textsubscript{4} (r = -0.2, r\textsuperscript{2} = 0.01)). In the case of Tandzut river between mentioned parameters significant relationship was observed; (Diatoms and NO\textsubscript{2} (r = -0.97, r\textsuperscript{2} = 0.95; NH\textsubscript{4} (r = -0.71, r\textsuperscript{2} = 0.50); BOD\textsubscript{5} (r = -0.94; r\textsuperscript{2} = 0.89); green algae and NO\textsubscript{2} (r = 0.75, r\textsuperscript{2} = 0.56; NH\textsubscript{4} (r = 0.98, r\textsuperscript{2} = 97)).

Between blue-green algae and PO seasonal size variation in Pambak river strong positive relationship was observed, while in Tandzut river relationship was not monitored (r = 0.8 (Pambak), r = 0.02 (Tandzut)). Between seasonal pH value and green algae in Tandzut river strong positive dependency was recorded, while in Pambak relationship was not observed (r = 0.89 (Tandzut), r = -0.2 (Pambak)).

Between seasonal variations of BOD\textsubscript{5} values and total phytoplankton in Tandzut (r=-0.7) strong negative relationship was observed, while in Pambak (r = -0.01) was not recorded. The differences between the two rivers is difficult to identify, which might be due to their ecological parameters (water temperature, flow velocity, anthropogenic factors, etc.). Negative relationship was also observed between diatoms and total mineral nitrogen and total phosphorus in lake Sevan. This is consistent with our results (Fig. 7). In accordance with our results (Fig. 2), positive relationship between green algae and total mineral nitrogen and total phosphorus was also recorded in lake Sevan. In the lake blue-green algae showed direct dependency on the mineral phosphorus content [9]. In contrast that, our observations did not show any relationship between the blue-green algae and total nitrogen content.

**CONCLUSION**

Thus, as highlighted in literature planktonic algal growth depends on water temperature, quantity of biogenic elements and organic materials, which is consistent with our results [2, 5, 8, 11, 21, 23].

The data analysis showed that in Tandzut and Pambak rivers diatoms were dominant group in phytoplankton. It was shown that the growth of diatoms depends on the water temperature, total P\textsubscript{min}, total N\textsubscript{min} content, as well as NO\textsubscript{2}, NO\textsubscript{3}, NH\textsubscript{4}, PO, BOD\textsubscript{5} content.

The relationship was established between the growth of blue-green algae and T\textsubscript{o}, NO\textsubscript{2}, PO content, and acido-alkaline reaction of the environment.
Our observations showed that the growth of green algae is related to the seasonal values of water temperature, total $P_{\text{min}}$, total $N_{\text{min}}$, NO$_3^-$, PO and BOD$_5$.

Total phytoplankton growth depends on water temperature, total $N_{\text{min}}$, and NO$_3^-$ content. As highlighted in literature, NO$_3^-$ ion is known as for the most available form of nitrogen consumed by algae [17].

Total phytoplankton growth according to correlation coefficient showed that the nitrogen compounds had greater importance for algal growth in Pambak and Tandzut rivers.

**Fig. 2.** Diatoms number (10$^3$) dependency on $P_{\text{min}}$

**Fig. 3.** Green algae number (10$^3$) dependency on $P_{\text{min}}$

**Fig. 4.** Green algal biomass ($\text{g/m}^3$) dependency on BOD$_5$.

**Fig. 5.** Total phytoplankton (10$^3$) dependency on $P_{\text{min}}$.

**Fig. 6.** Green algal number (10$^3$) dependency on $P_{\text{min}}$.

**Fig. 7.** Diatoms number (10$^3$) dependency on $N_{\text{min}}$. 
REFERENCES


Reviewer: Dr. Sci. in biology B. K. Gabrielyan