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THE EVALUATION OF THE WATER QUALITY OF TABACARIE'S LAKE

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Abstract : In the present paper, we will tackle the water quality problem in the lentic environment of one of the most well-known lakes in Constanta, Tăbăcărie. The pollution degree will be evaluated to identify the qualitative composition of the microbiota from the analysis sites, respectively, the chlorophyll indicator and the physical-chemical parameters (ammonium and phosphate ions, dissolved oxygen (DO), biochemical oxygen demand (BOD) and pH).

Key words : The lake, the lentic environment, microbiota, physical-chemical parameter.

1. INTRODUCTION

Urbanisation, overpopulation and pollution are problematic factors in the contamination of water, such as lakes in urban areas. Natural water becomes contaminated from pollutants that are brought by wind, rain, and human activities. A wide range of problems that cause lakes to become rich in nutrients have been reviewed, and both natural and anthropogenic factors cause this enrichment with nutrients. Many parameters, such as temperature, nitrogen content, DO, BOD, pH, conductivity, hardness, heavy metals and chlorine levels, can determine water quality. We consider the physico-chemical and biological aspects of aquatic ecosystems.

At the beginning of the project, we established the sampling areas of Tăbăcărie Lake:

a) First sampling point (SP1): near the bridge at the B'Arca restaurant, opposite the Ramada hotel;
b) Second sampling point (SP2): at the outflow into the Black Sea, near the Mamaia Exhibition Pavilion and the Constanta SUD Wastewater Treatment Plant;
c) Third sampling point (SP3): behind the stud farm within the Constanta Micro-Reserve, the Natural Sciences Museum Complex;
d) Fourth sampling point (SP4): in the reed bed area located between City Park Mall and the diving centre.

2. PHYSICAL-CHEMICAL METHODOLOGY AND DISCUSSIONS

We measured the following physical and chemical parameters: pH, temperature, ammonium ions $(NH_4)^+$, phosphate ions $(PO_4)^{-3}$, dissolved oxygen (DO) and biochemical oxygen demand (BOD).

pH (potential of hydrogen) helps us to identify the acidity or alkalinity of solutions on a scale from 1 to 14, where seven is neutral. In lentic sites, the pH value must be between 6.5 and 8.5. The samples were analysed with the pH-meter. Because the temperature can influence the pH levels and the oxygen concentration, we also measure this parameter. The measurements were made in situ with the help of a thermometer in °C.

The ammonium and phosphate ions were measured with the spectrophotometer Pharo 300. To determine the $(NH_4)^+$, the team added 5 mL of sample to a reaction cell containing hypochlorite ions to form monochloramine with the ammonium present. One dose of a substituted phenol was then added to produce a blue indophenol derivative. Due to the yellow colouration of the reagent blank, the final solution appeared yellow-green to green. For $(PO_4)^{-3}$ determination, orthophosphate ions in the sample reacted with molybdate ions in a sulfuric acid solution to form molybdophosphoric acid. This was subsequently reduced with ascorbic acid to generate phosphomolybdenum blue.

Figure 1 The Pharo 300 spectrophotometer

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In the case of dissolved oxygen (DO), in the field, 2 mL of 40% manganese (II) sulphate and alkaline potassium iodide were added to fix the oxygen in each sample. In the lab, 10 mL of supernatant was treated with 5 mL sulfuric acid (1:3), which was then titrated with 0.1 N thiosulfate. DO was expressed in mg O_2/L. The BOD is the amount of oxygen consumed by microorganisms in the water over 5 days. It is determined by the difference between the amount of DO found in the water sample immediately after collection and after 5 days of incubation at 20°C. Both determinations of oxygen quantity were done by the Winckler method.

Figure 2 Dissolved oxygen determination

The results for the analysed physico-chemical parameters are presented in Tables 1-6.

Table 1. pH levels

pH	November	March	April
SP 1	8.41	8.36	8.48
SP 2	8.42	8.35	8.41
SP 3	7.24	8.36	8.44
SP 4	8.14	8.31	8.3

The pH values are within legal limits. However, the data shows that the water from Tabacarie lake is weakly alkaline, a typical trait of the Dobrujan waters.

Table 2. Temperature values

Temperature	November	March	April
SP 1	8	12	17
SP 2	8	13	18
SP 3	8	13	30
SP 4	8	12	30

Recorded temperatures matched seasonal trends, except at SP 3 and 4 in April, where unusually high values suggest a possible warm water discharge from the microreservation, though further analysis is needed.

Table 3. Ammonium ion concentrations

$(NH_4)^+$	November	March	April
SP 1	1.12	2.26	1.92
SP 2	8	2.04	1.08
SP 3	6.12	2.06	2.68
SP 4	1.38	2.46	0.37

Table 4. Phosphate ion concentrations

$(PO_4)^{-3}$	November	March	April
SP 1	0.05	0.05	2.17
SP 2	0.05	0.03	3.98
SP 3	0.38	0.04	3.62
SP 4	0.05	0.05	1.16

Eutrophication indicators varied significantly between SP and across different months. Ammonium concentrations were generally consistent with water quality classes III and IV, with an average of about 1.8 mg N-NH_4^+/L, except at SP 2 and 3 in November, where higher values of 8 and 6 mg/L were recorded. Phosphate supports plant growth but can cause eutrophication above 0.3 mg/L. In November and March, levels were low (avg. 0.045 mg P/L, class I), but rose sharply in April, over 0.9 mg P/L and nearly 4 mg/L at peak, classifying the lake as hypertrophic.

Table 5. DO content

DO	November	March	April
SP 1	4.58	12.93	12.58
SP 2	5.11	13.50	11.94
SP 3	5.11	12.37	12.86
SP 4	5.90	12.47	13.08

Table 6. BOD values

BOD	November	March	April
SP 1	2.85	6.19	9.49
SP 2	0.27	8.41	10.24
SP 3	5.11	11.52	12.86
SP 4	5.34	10.18	12.80

Dissolved oxygen in the lake was low in November (5.175 mg O_2/L, class III), but doubled by March–April, improving to class I. BOD was low in November (3.4 mg O_2/L, class I) and rose sharply in April (11.34 mg O_2/L, class IV), indicating increased organic load and reduced water quality. From the DO and BOD values, we can say that the lake is in a low eutrophic

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state, as the DO concentration is greater than 9, and the high values of BOD in the spring months tell us about the presence of microorganisms that consume the said oxygen.

These criteria are in close connection with the biological aspect of the paper.

3. BIOLOGICAL METHODOLOGY AND DISCUSSIONS

The biological analysis aimed at determining chlorophyll as an indicator of algal biomass, using fluorescence methods applied to microalgae, including cyanobacteria. Monitoring biological (algal) parameters in different seasons is necessary to cover the widest possible range of algal species, depending on their optimal development.

LUGOL solution (1:1) was used for sample pigmentation; 4 mL of the water sample and 1 mL of LUGOL solution were added, followed by vortexing the mixture. The sample was left to react for 10 minutes, then analysed through optical microscopy.

Acridine orange dye was used for epifluorescent microscopic analysis. The sample was prepared by adding 100 µL of dye per mL of suspension. The mixture was homogenised and then filtered through a 0.22 µm Millipore filter using a holder device. Staining was performed for a minimum of 10 minutes, after which the sample was evaluated under a microscope with epifluorescent illumination, using a blue filter.

Chlorophyll contents were quantified with the help of the FluoroProbe III device (produced by BBE-Moldaenke, Germany). The chlorophyll contents are expected from a variety of microalgae, including cyanobacteria (1). In Figure 3, the chlorophyll to depth ratio is represented.

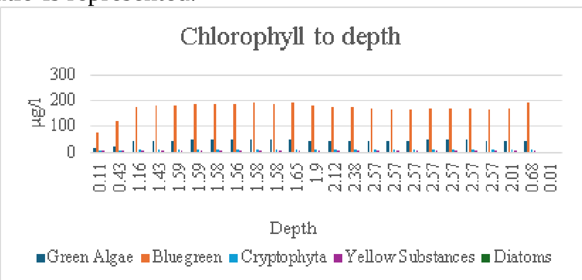

Figure 1 Chlorophyll to depth ratio

One of the most predominant cyanobacteria found by us in Tăbăcărie's Lake is *Microcystis* sp. (Figure 5). This bacterium feeds on high concentrations of nitrogen, phosphorus, and carbon. Therefore, it can be used as a bio-indicator for the eutrophication level of bodies of water. As it is represented in Figure 3 and 5, we can see a high density of these bacteria in the water. These cyanobacteria were found in all three months, along with *Oscillatoria* sp., *Chroococcus* sp. and *Scenedesmus* sp., other nitrogen and carbon-rich water-loving bacteria and algae. Both Figure 6 and 7 are from November, and the chlorophyll graph was made in March; the continuity of cyanobacteria was noticed until April.

Figure 4 Microcystis sp .

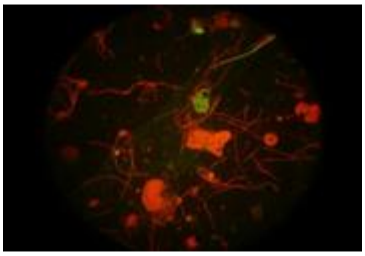

Figure 5 Epifluorescent microscopic analysis

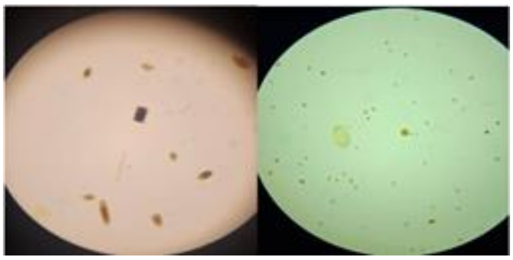

Figure 6 Two samples from SP3 (March)

In Figure 6, the presence of *Scenedesmus* sp., *Pediastrum* sp., *Rhizosolenia* sp., *Melosira* sp. and *Asterioneala* sp. can be noticed. The former two are algae which thrive in nitrogen-filled waters (2), and the latter three are diatoms which are stenobionts; they are very sensitive to changes, which makes them good bio-indicators in aquatic ecosystems.

It has been observed that in March, *Paramecium* sp. and other microorganisms such as diatoms have started to appear (Figure 6 and Figure 7). *Paramecium* is a ciliate that feeds on algae, yeast, and other bacteria. Their presence suggests a high amount of algae to feed on (Figure 8), including cyanobacteria, which is a known lover of enriched waters. In the same picture, we can also remark the presence of *Microcystis* sp.. As soon as April, we noticed the lack of diatoms in the samples, and we correlated this with the increase in $(PO_4)^{-3}$ and the decrease in $(NH_4)^{+}$.

Figure 7 Sample dominated by *Paramecium* sp.

4. CONCLUSIONS

From the point of view of the analysed physical-chemical parameters, it can be said that, for the time considered, all the analysed parameters were within normal limits, except for the phosphate ion concentrations in April, which suggests the hypertrophicity of the lake.

From all the data we have collected so far, we can deduce that Tăbăcărie's Lake has a Quality Class IV (5), after analysing the ion concentration. The presence of cyanobacteria is in direct correspondence with ion concentration. Especially SP2 and SP3, which are the more polluted zones of the lake. In SP2, water is directly spilt in the lake from the Wastewater Treatment Plant, and in SP3, water is discharged from the horse stud and other enclosures from the micro reservation. This enrichment can be directly seen from the chemical and biological research, and from the green colouration of the lake, mainly in SP3. However, more analysing needs to be done, which involves collecting and analysing data to maintain a proper monitoring process in this area.

5. ACKNOWLEDGMENTS

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