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DETERMINATION OF TOTAL ORGANIC CARBON, TOTAL NITROGEN, AND TOTAL PHOSPHORUS FROM SOIL SEDIMENTS AND MACROPHYTES FROM HORIA LAKE, TULCEA

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Abstract

Nutrients play a significant role for the environmental state of lakes, mainly because the primary production of lakes is strongly influenced by nutrient availability. From all these nutrients special attention is accorded to the total organic carbon (TOC), total nitrogen (TN) and the total phosphorus (TP). In this context, the aim of this paper was to determine the TOC, TN,and TP from the sediment and macrophytes samples from Horia Lake, Tulcea County, Romania. The lake is located in the area of Horia, being limited to the north, west, and south by the agricultural field. The slope of the ground allows the accumulation of the waters from the versants adjacent to the lake, with suspension contributions, fertilizers,and herbicides used for the adjacent corn crop. All the samples were collected in the autumn season (November 2016), from six stations of the lake. The results revealed significant differences ($p<0.05$) in the concentration of the TOC, TN, and the TP. Comparing the means values of these nutrients from macrophytes and sediments, it can be concluded that the higher values from macrophytes are the result of the assimilation capacity of these nutrients.

Key words*: Horia Lake, macrophytes, sediments, TN, TOC, TP.*

INTRODUCTION

Determination of total organic carbon (TOC) total nitrogen (TN), and total phosphorus content (TP), from sediments, have big importance for the environmental status and estimation of terrestrial and aquatic ecosystems. Mainly these nutrients derived by decomposition of the plants and animals, plankton or anthropogenic sources such as chemical contaminants, fertilizers or organic-rich waste (Pavlos et al., 2015).

Aquatic macrophytes are important component ecological systemsin lakes and can be involved in biogeochemical cycling of nutrients, such as carbon (C), nitrogen (N) and phosphorus (P) (Sasha et al., 2016).

They can offer housing for zooplankton and young fish, reduce nutrient levels by assimilation and re-synthesis of N, P, serve as a habitat for macro-invertebrates (Jeppesen, 1998; Scheffer, 1998).

There are various environmental variables which influence the growth, distribution, and abundance of aquatic macrophytes, such as water transparency, nutrient concentrations (Akasaka, 2010; Alahuhta, 2012), physical and chemical characteristics of sediments, sediment organic matter, particle size (Lougheed et al., 2001), and sediment texture (Mikulyuk et al., 2011).

The aim of this study was to investigate nutrients (TOC, TN, and TP) and macrophyte interactions for Horia Lake, from Tulcea County, Romania.

MATERIALS AND METHODS

Horia Lake is located at 2 km northwest of Horia village, a 150-meter-long dike stops the waters of Taița River in a reservoir lake (Horia Lake).

The lake is limited to north-west and south by agricultural field, and the eastern limit is represented by the inter county road 222 A. The lake has a surface around 230 ha.

Station location. For this study, the sediments and macrophytes samples were collected from six stations (established in the symmetry axle of the lake) using Marinescu grab (Figure 1).

Figure 1. Study area location and sampling station distribution

Methodology. From each station were collected three sediments samples. A total number of 18 sediments samples were analyzed for their TOC, TN and TP content and all the analysis were performed in duplicate.

Sediments samples were pre-treated according to the ISO 11464 and 11465. Its principle is drying soil samples to constant mass at 105°C and using the difference in mass of an amount of soil before and after the drying procedure to calculate the dry matter and water contents on a mass basis. After that, a representative sub-sample has to be milled until it passes a 250 µm aperture sieve.

From these stations, also were collected macrophytes samples. In order to establish the qualitative and quantitative structure of the macrophytes, the whole plant is harvested by pulling out and then insert into a plastic bag filled with water to be transferred to the laboratory. The plants were washed with water in the laboratory to remove adhered periphyton and organic and inorganic particulate matter. After that, each plants species was systematically ranked by gender and family respecting the current phylogenetic classification of plants and then dried at 105°C till constant weight.

Then, the plants were ground and sieved through a 0.5 mm mesh net and stored in plastic flasks in order to determine the TN, TP and TOC content.

All the samples were collected in the autumn season (November, 2016).

Determination of the TN, TOC, and TP was made in the Nutrition Laboratory of Romanian Centre for Modelling Recirculating Aquaculture Systems (MoRAS), University Dunărea de Jos, Galați, Romania.

The principle for the TOC method. The total nitrogen determination was made using PrimacsSLCAnalyzer from Skalar Company. First, it was determinate the Total Carbon (TC) by combustion at 105°C. In the presence of the catalyst cobalt oxide, all organically and inorganically bound carbon is oxidized or decomposed in the flow of pure oxygen into the gaseous carbon dioxide.

The flow of oxygen transports the carbon dioxide to the IR detector and the carbon dioxide is measured at 4.2 µm by IR detector and recalculated to the total carbon content according to the calibration by the standards. Then it was determinate the Inorganic Carbon (IC) at 150°C. The sample is added in a test tube in which oxygen will be purged before analysis begins, in order to remove CO_2. Then orthophosphoric acid is added to the sample in order to decompose the inorganically bound carbon to the gaseous carbon dioxide. The flow of oxygen purges the carbon dioxide from the liquid into the IR detector to be measured again. The concentration of TOC is determined: TOC=TC-IC.

The principle for the TN: The total nitrogen determination was made using Primacs SNC Analyzer from Skalar Company. The equipment uses the Dumas principle, which is dependent on the quantitative conversion of the sample into distinct gaseous species at 1100 °C in the presence of Oxygen.
In the combustion phase, the total quantity of nitrogen from the sample is converted to nitrogen oxides, which are subsequently condensed to nitrogen gas and measured by a Thermal Conductivity Detection (TCD) and to remove interferences a background correction is performed by measuring the He gas.
Total phosphorus. For phosphorus determination, it was use the spectrophotometric molybdenum blue method which is a well-established method (Murphy and Riley, 1962). Shortly, this method involves the formation of molybdophosphoric acid from orthophosphate and an excess of molybdate in acidic solution followed by reduction to give molybdenum blue. The absorbance of thus produced molybdenum blue was measured spectrophotometrically at a 660 nm wavelength at SPECORD 210 from Analytikjena.
Data analysis. Data were analyzed using ANOVA test and if significant differences were found, a post hoc Duncan test was applied. The differencewas found significant at $p<0.05$. All the statistical analysis was performed using SPSS 21 for Windows.

RESULTS AND DISCUSSIONS

In the study period, (November, 2016), the presence of macrophytes was reduced. Five plant species were identified in the shore area of Horia Lake. The present species in the studied stations are presented in Table 1.
All identified species by macrophytes belong to the same classes - Liliopsida, but different families: Poaceae, Typhaceae, Butomaceae, Polygonaceae, and Potamogetonaceae and different genres: Phragmites, Sparganium, Butomus, Polygonum, and Potamogeton (Gurău, 2007; Antonescu, 1951). Macrophytes are poorly represented in all analyzed stations, with few exceptions.
In station S1, S2, the density of the species *Phragmites communis* is high (Figure 2), compared with the S3 station was the density of the species was lower. In the case of other species, the density of square meter is one-two species.

Figure 2. *Phragmites communis* from Horia Lake

In Table 2 are presented the results of TN, TOC, and TP from macrophytes samples, and in Figures 3, 4 and 5 are presented the minimum, average and maximum values obtained for all the macrophytes found in the lake.

Tabelul 1. The presence of macrophyte species on the studied stations

Stations / Taxons	*Phragmites communis*	*Sparganium sp.*	*Butomus umbrellatus*	*Polygonum amphibium*	*Potamogeton pectinatus*
S1	+++	-	-	-	++
S2	+++	-	+	-	-
S3	++	-	-	-	-
S4	-	+	-	-	-
S5	+	-	-	+	-
S6	-	-	-	+	-

+++ = frequent form; + + = sporadic form; + rare form; absence form

Table 2. TOC, TN, and TP from macrophytes samples from all the six stations

Para-meter	*Phragmitescommunis (Mean values of S1,S2and S5)*			*Butomus umbrellatus*			*Polygonum amphibium*		*Potamogeton pectinatus*	*Sparganium sp.*
	Leaves	Stem	Root	Leaves	Stem	Root	Leaves	Stem	Leaves+stem	Leaves
TP (%)	71.62±0.10	45.58±0.05	5.11±0.05	34.67±0.04	6.67±0.03	1.10±0.04	2±0.03	35.48±0.05	11.63±0.08	12.63±0.05
TOC %)	16.20±0.06	11.09±0.04	8.59±0.10	9.07±0.05	7.34±0.04	8.37±0.03	7.48±0.04	8.20±0.04	2.06±0.04	6.20±0.04
TN (%)	1.53±0.04	0.31±0.03	0.28±0.04	2.28±0.03	1.13±0.12	1.97±0.04	3.65±0.22	0.94±0.04	1.82±0.05	0.87±0.04

*The values are expressed as mean and standard deviation for the three samples/station (each sample was made in duplicate)

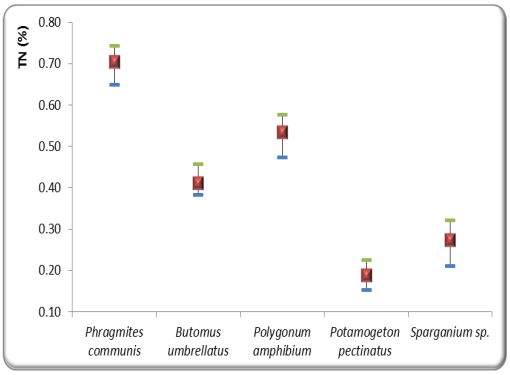

Figure 3. The minimum, average and maximum values of TN for macrophytes found in the Horia Lake

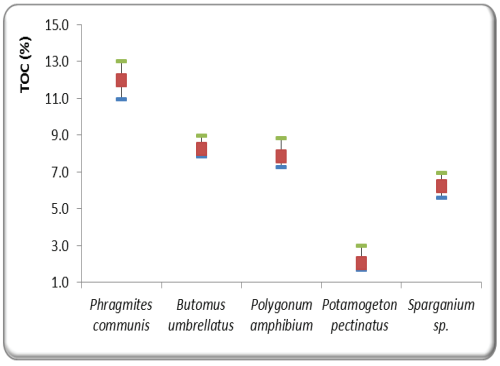

Figure 4. The minimum, average and maximum values of TOC for macrophytes found in the Horia Lake

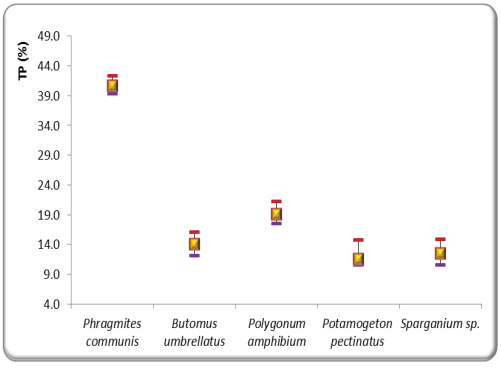

Figure 5. The minimum, average and maximum values of TP for macrophytes found in the Horia Lake

From Table 2, it can be observed that in the case of *Phragmites communis* and *Butomus umbrellatus* the highest nutrients retention was found in leaves, followed by stem and roots.

In the case of *Polygonum amphibium* the highest nutrients retention was found in the stem, an exception was in the case of TN were the highest retention was registered in leaves.

Potamogeton pectinatus is a long plant (over 1 m) and branched with narrow leaves (2-3 mm), (Sârbu et al., 2005) and for this reason,it was only possible to harvest the leaves and steam. Comparing the nutrients assimilation in *Potamogeton pectinatus* and *Sparganium sp.* with the aquatic plants from the lake, it was observed the lowest retention.

Comparing the minimum, means and maximum values of TN, TOC and TP contents in macrophytes found in Horia Lake, the values were higher in *Phragmites communis,* followed by *Polygonum amphibium*, *Butomus umbrellatus,* and *Sparganium sp.* The lowest contents of TN, TOC, and TP was found in *Potamogeton pectinatus*, which is an emersedaquatic plant (Figures 3, 4 and 5).

In Table 3 are presented the results of TP, TOC and TN, sediments samples. TP values showed significant differences (ANOVA, $p<0.05$) between the six stations. The TP values from S1 were significantly ($p>0.05$) higher than those from S6, followed by S5 and S2, while the lowest values were registered in S3 and S4.

Regarding the TOC values, the post hoc analysis Duncan divided the obtained values into three sets of data: the lowest values were registered in the S1 and S2, followed by the S4, while the highest values were recorded in the stations 3, 5 and 6.

Also, the TN content registered significant differences (ANOVA, $p<0.05$). The highest TN value was recorded, in S3, followed by the S4 and S1. No significant differences were found between the S2 and S5 stations. The lowest TN content was recorded in S6 station.

Table 3. The TP, TOC and TN content in sediments from the six stations of Horia Lake, Tulcea County

Parameter	S1	S2	S3	S4	S5	S6
TP (%)	1.58 ± 0.03^{a}	0.93 ± 0.05^{b}	0.53 ± 0.03^{c}	0.51 ± 0.03^{c}	0.96 ± 0.05^{b}	1.24 ± 0.04^{d}
TOC (%)	1.91 ± 0.03^{a}	1.82 ± 0.04^{a}	2.51 ± 0.18^{b}	2.06 ± 0.02^{c}	2.36 ± 0.09^{b}	2.41 ± 0.05^{b}
TN(%)	0.44 ± 0.04^{a}	0.36 ± 0.01^{b}	0.67 ± 0.02^{c}	0.51 ± 0.02^{a}	0.30 ± 0.04^{b}	0.28 ± 0.06^{d}

*The values are expressed as mean and standard deviation for the three samples/station (each sample was made in duplicate)

CONCLUSIONS

The results of study demonstrated the higher retention capacity of nutrients from sediment by aquatic plants. The capacity of macrophytes for reducing N, TOC, and P has a big importance in reducing phytoplankton blooms potential. Regarding the highest values of TOC and TN values from sediments samples from the S3a possible explanation would be corn culture from the adjacent lake area.
Further, a longer-term study is needed (minimum one year) to assess long-term nutrient dynamics.

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