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Distribution of Chlorophyll a in Lagoon of Butrint waters comparing with environment factors (Albania)

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Abstract

Chlorophyll a concentrations are routinely measured to estimate the standing stock and productivity of phytoplankton in freshwater and marine ecosystems. The aim of this study is to assess distribution of Chlorophyll a in Lagoon of Butrint. The Lagoon of Butrint is located in the southern part of Albania. This is the only lagoon that is connected with Jon Sea. The presence of Chlorophyll a in lagoon waters were discussed in the terms of the variable environmental factors included: depth, temperature, salinity, pH, dissolved oxygen, nitrites (NO_2^-), phosphates (PO_4^{3-}). The geographical coordinates measured in the study station is: latitude 20º 12' and longitude 39º 47'. The period of sample-taking was October, January, April, June 2010-2011. The Chlorophyll a was studied also to access the level of trophy in Butrint Lagoon. Determination of chlorophyll a is made with fluorometry method. The blooms of phytoplankton are noticed in spring and autumn. The trophic level of lake is oligotrophic. Temperature, pH and nitrite have a significant correlation with Chlorophyll a. Analyzing some hydrochemical indicators of Butrint Lake in 2004 and 2011, especially in the peak months as April, there are noticed some phenomenon that express the tendency to distortion of some environment factors. Bistrica River deviation is not functioning properly and therefore there have been increased temperatures in 2011 compared to 2004. By comparison of the data, we notice a significant increase in chlorophyll a from 2004 to 2011, resulting in the tendency crossing these waters in mesotrophic level.

Key words: Butrint Lagoon, Chlorophyll a, phytoplankton, environment factors.

1. Introduction

Lagoons are ecologically and economically important aquatic ecosystems. They provide natural food resources rich in protein which includes an array of fish and fisheries [9, 12] . One of the most important living organisms in the aquatic ecosystem is phytoplankton. Phytoplankton, the primary producer, plays an important role in the material circulation and energy flow in the aquatic ecosystem. Its presence often controls the growth, reproduction capacity and population characteristics of other aquatic organisms. Thus, investigations of phytoplankton are essential for the evaluation of the water environment. Beyond primary producers, phytoplankton helps to purify dirty water or to improve the water quality by transforming inorganic matter into organic substances [4]

However, the determination of phytoplankton biomass can be investigated in many ways; one is to measure chlorophyll a that is the fastest chemical measuring method [13] and chlorophyll a is a well accepted index for phytoplankton abundance and population of primary producers in an aquatic environment [3]

Chlorophyll a is found in all green plants including algae. For this reason it can be used to estimate the quantity of algae present in a water body. Chlorophyll a constitutes approximately 1 to 2% of the dry weight of planktonic algae. Level of chlorophyll a indicates the quality of a water body with respect to its fertilization [8] . Since the first report describing the use of in vivo chl a fluorescence to estimate chl a concentrations in ocean samples [10] , the use of profiling in situ fluorometers to record chl a concentrations in the upper water column [14] or to detect small-scale patchiness [2] has been incorporated as standard methodology in many ecological studies.

The principal aims of this research were: to determin e phytoplankton biomass as chlorophyll a, to describe

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seasonal and spatial distribution of surface chlorophyll *a*, to study the relationships between chlorophyll a and environment factors on data collected in 2010 - 2011 in waters of Butrint Lagoon, Albania.

2. Materials and Methods

2.1 Site Description

The lagoon of Butrint is located in the sud of Albania with longitude 39º 47'and latitude 20º 12'. Lagoon of Butrint is one of the most characteristic lagoon's of Albania, and in Mediterranean region is one of the most interesting aquatic ecosystem from the depth and operation. The surface of Butrint's lagoon is 16.3 km2, with a water volume 211millon m3, with the biggest length of 7.1 km and width of 3.2 km. This lagoon has tectonic origin, and from hydrographic regimen is typical coastal. From subsurface relief the northern and southerner parts are in depth 0 – 7 m, while the center part is deeper than northern and southerner parts from to 11-21.7 m. The length of Butrint canal is 3.6 km, the maximum depth is 7 m and width 70 – 100 m. The Butrint Lagoon collects waters of a reservoir with a surface 128 km^2.

Hydrologic regimes: The annual average evaporation level of lagoon is 1280 mm, whereas the difference between water levels is 12-13 cm and the water average level is 9 cm super sea level. The waves are 0.8m and are present in depth 8m affecting in water mixture.

Biological Statement: Butrint Lagoon from depth and from intensive comunication with sea, has a larger biodiversity of fishes then other lagoons. The studies has determined 64 species of fishes.

Mullet are represented with 70%, eels with 10%, sparides with 10 % and 10% other species that have no industrial importance. The activity of produce of mussels in this lagoon has begin from 1968 [7] , [4]

2.2 Sampling

The water samples were collected every 3 months during October- June 2010-2011 in the center of Butrint Lake (Fig. 1, 2). Water samples were collected at 1m (water surface), 3m and 5m water depth using a Rattner water sampler of 1 liter and then filled into polyethylene bottles. The samples were taken in the morning. The temperature, pH, salinity dissolved oxygen and Chlorophyll a were measured in situ. For the analysis of nutrients water samples were collected in clean polythene bottles and kept in a cold container and transported immediately to the laboratory.

2.3 Devices and Data analysis

The samples in different depths were taken a Rattner water sampler (HYDRO-BIOS, Apparatebau GMbH, D-2300 KIEL-Germany). The samples taking was thrown in water connect with plastic rope noted according to meters to measure the depth. The depths of water column were 1, 3 and 5 meters. Seawater temperatures were measured by using a protected thermometer with scale ranging from -5 to 31°C, attached to Rattner water sampler bottle, (HYDRO-BIOS, Apparatebau GMbH, D-2300 KIEL-Germany). pH measurements were done using a portable pH-meter (HANNA-instrument).The dissolved oxygen (DO) and salinity measurements were done using a device (WTW Multiline P4, UniversalMeter). Determinations of nutrient salts like nitrite and phosphate were carried out spectrophotometrically (Spectroquant NOVA 60 MERCK).

Fluorometry. This method relies upon the fact that chlorophyll a fluoresces at a wavelength of 663 nm when excited by radiation at a wavelength of 430 nm. Determination of chlorophyll in this way is therefore carried out in a fluorometer which has been previously calibrated with various known chlorophyll a solutions. It is also possible, with a suitable meter, to carry out this determination in the field. Chlorophyll a is measured with a device (IDROMAR-IDROLOG).

Correlation analysis in Excel Windows 2007 was used to determine the correlation between phytoplankton biomass as chlorophyll a and physico-chemical parameters, [1, 5, 6]

Results and Discussions

3.1 Environment Factors:

The water samples are taken during October, January, April and June 2010-2011. The water samples to assess the psychico-chemical parameters are taken in: Center of Butrint Lake. Means, minimums, maximums, standard deviations and variation coefficients of the obtained data are given in Table 1.

The physico-chemical parameters in the center of Butrint Lagoon are presented in Figures 1-6. Water temperature were mostly high, reaching a maximum of 26°C in June, and the minimum of 10.1°C in January (Fig. 1). The water temperatures in depth 1m changed more than in depth 3 or 5 m during the months. This happens because temperatures of surface are in influence of air temperatures. Then in depth 3 and 5 m the temperatures had a stability during the months, expect June. If we see temperatures in different depths for the same month, the temperatures are similar in months October, April and June, expect January, where the surface of water temperature was affected directly by air temperature. Referring, the temperature values April 2004 that are (17.3 for 1m, 16.1 for 3m and 15,3 for 5m) we can see the differences during 2004 -2011. Bistrica River deviation is not functioning properly and therefore there have been increased temperatures in 2011 compared to 2004. There is growing gradually temperature at the station and this leads to catastrophic temperature in July as happened in 2011. As seen in the Fig. 1. we have the same situation in different depths that should not happen, because the differences of temperatures should be significant when there is water circulation.

Table 1. Mean, Maximum, Minimum, Standard Deviations and Variation Coefficients of Chlorophyll-a and Some Physico-chemical parameters of Butrint Lagoon:

	Chl-a (µg/L)	*T (°C)*	*Salinity (‰)*	*pH*	*O_2 %*	*O_2 (mg/L)*	*NO_2^- (mg/L)*	*PO_4^{3-}(mg/L)*
Average	0.58	19.56	25.22	7.79	83.03	6.88	0.026	0.0705
Min	0.00	10.10	15.80	7.40	23.40	2.30	0.005	0.027
Max	1.89	26.00	32.80	8.37	112.20	9.98	0.070	0.16
Standard Deviation	0.77	4.30	4.84	0.31	23.90	2.18	0.030	0.062
Variation Coefficient	1.33	0.22	0.19	0.04	0.29	0.32	1.147	0.881

Table 2. Chlorophyll-a and Some Physico-chemical parameters of Butrint Lagoon in April 2004 and April 2011.

Months	*Depth (m)*	*Chl-a (ppb)*	*T (°C)*	*Salinity (‰)*	*pH*	*O2 %*	*O2 mg/l*	*NO_2^-*	*PO_4^{3-}*
April 2004	1	0,31	17,3	21,7	8,25	94,2	8,98	0,015	0,022
	3	0	16.1	24,9	8,0	81,7	7,12		
	5	0	15,3	27,3	7,8	73,97	6,95		
April2011	1	1.85	20.4	21.7	7.79	111.9	9.05	0.018	0.065
	3	0	19.9	23.7	7.7	91.1	8.15		
	5	0	18.3	26.7	7.4	85.5	7.42		

The maximum value of salinity(32.8‰) was observed in June at 5m. The minimum value of salinity (15.8‰) was observed in January at 1m (Fig. 2). If we see salinity in different depths, it increased proportionally with the depth, expect January where the salinity in 3m is higher then 5m. If we see salinity during months in 1m, the highest value was in June. This tell us that increase of temperature brings the increase of salinity. The same is for the depth 5m, except depth 3m where the highest value of salinity is in January. May be the infiltration of sea currents in this depth during January. The average value (25.22‰). Communication Channel sea-lake with its estuary is not maintained good which results as in 2004 and consequently salinitety in depth 3-5m has little difference versus superficial layer.

The maximum value of pH (8,37) was observed in October in 1m depth (Fig. 3). The minimum value of pH (7.4) was observed in January and April at 5m. According pH in different depths, it decreased with the increased of the depth. During months the highest values were in October for depths 1m, 3m and 5m. The lowest values of pH were in January. According to WAC 173-201A these pH values are within pH standard “range”.

The maximum value of Oxygen Dissolved (9.98 mg/L) was observed in January in 1m depth (Fig. 4). The minimum value of Oxygen Dissolved (2.3 mg/L) was observed in January in 5m. Oxygen Dissolved in different depths decreased with the increased of the depth. If we see Oxygen Dissolved values during months the highest values were in January for depths 1m, and April for depth 3m and 5m. The lowest values of Oxygen Dissolved are in June for 1m and 3m, and January for 5m. According to WAC 173-201A the average of Oxygen Dissolve value in surface water is lower than standard "range". Oxygen Dissolve values in 2011 have been increased compared to 2004. This increase is directly related to the values of Chlorophyll a, that are greater in 2011 compared to 2004 and that releases large quantities of oxygen.

The nitrite concentrations ranged from 0.005 mg/L in January, with highest value in June 0.07 mg/L (Fig. 5). Expect October, the concentration of nitrite is increased during January, April and June.

The phosphate concentrations reached the maximum (0.16 mg/L) in October. The minimum value (0.027 mg/L) is in June. The are two picks of phosphate concentrations in October 2010 and April 2011 (Fig.6).

Nutrients have increased significantly in 2011 compared to 2004. Respectively 20% nitrites and 2.95 times phosphates. These indicators lead to increased Chlorophyll a. Some areas near Ksamil as a result of uncontrolled urbanization leading to atrophied area.

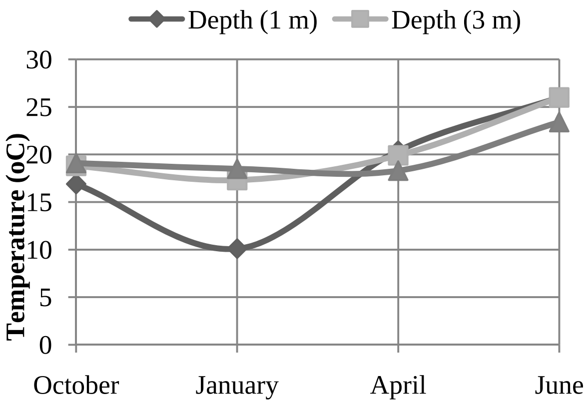

Figure 1. Temperature values during October, January, April and June according depths 1, 3 and 5m.

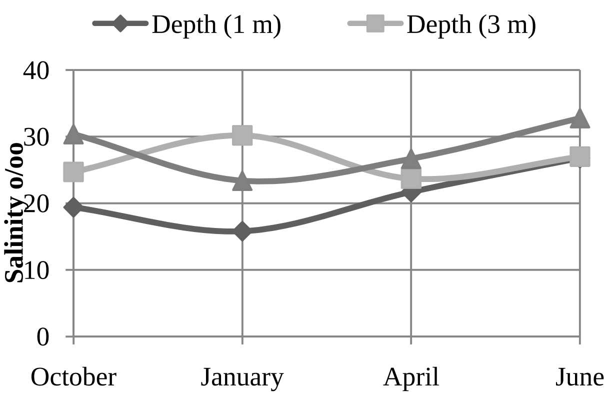

Figure 2. Salinity values during October, January, April and June according depths 1, 3 and 5m.

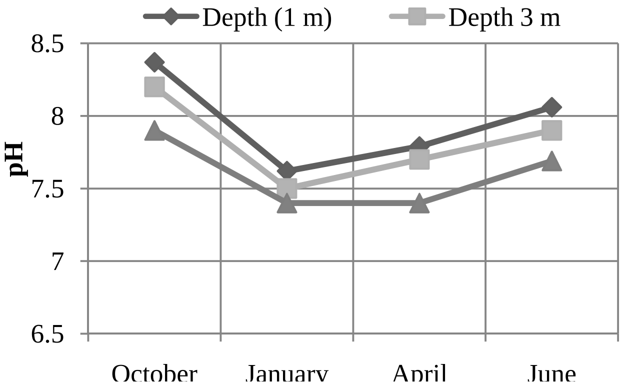

Figure 3. pH values during October, January, April and June according depths 1, 3 and 5m.

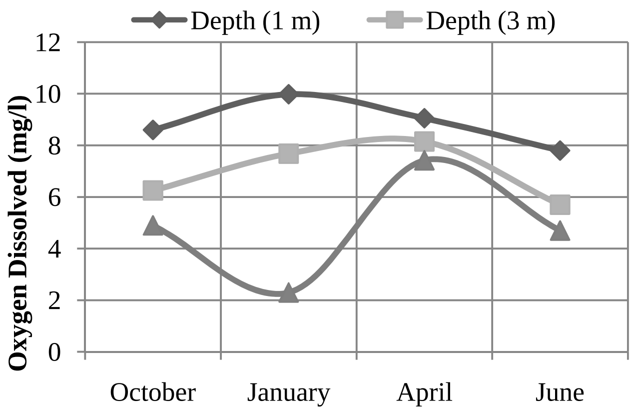

Figure 4. Oxygen Dissolved values during October, January, April and June according depths 1, 3 and 5m.

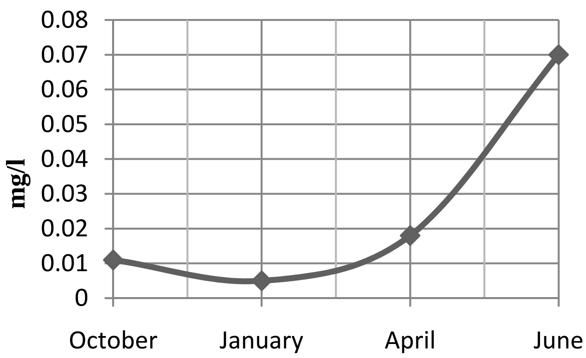

Figure 5. Nitrite values during October, January, April and June according depths 1, 3 and 5m.

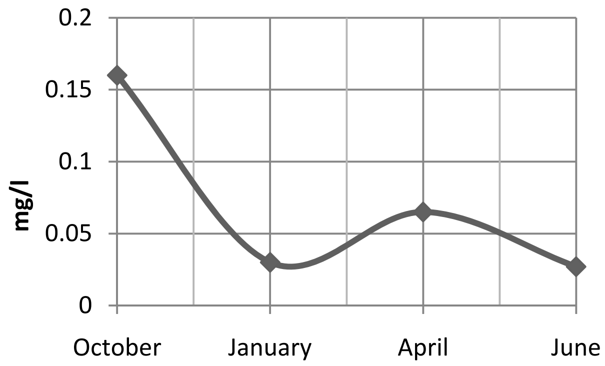

Figure 6. Phosphate values during October, January, April and June according depths 1, 3 and 5m.

3.2 Chlorophyll a Concentration

Phytoplankton biomass as chlorophyll a in Lagoon of Butrint ranged from 0 to 1.89 µg/L (Fig. 7). The maximum concentration occurred in October at 1m depth. The minimum concentration is found in depth 3m in January and April. There is no found chlorophyll a in depth 5m for all the months. Also the Oxygen Dissolved values were decreased with increase of the depth. The concentrations of Chl a according to [11] , classifies Lagoon of Butrint in level of trophy: oligotrophic with typical characteristics as low nutrients, clear water, few plant.

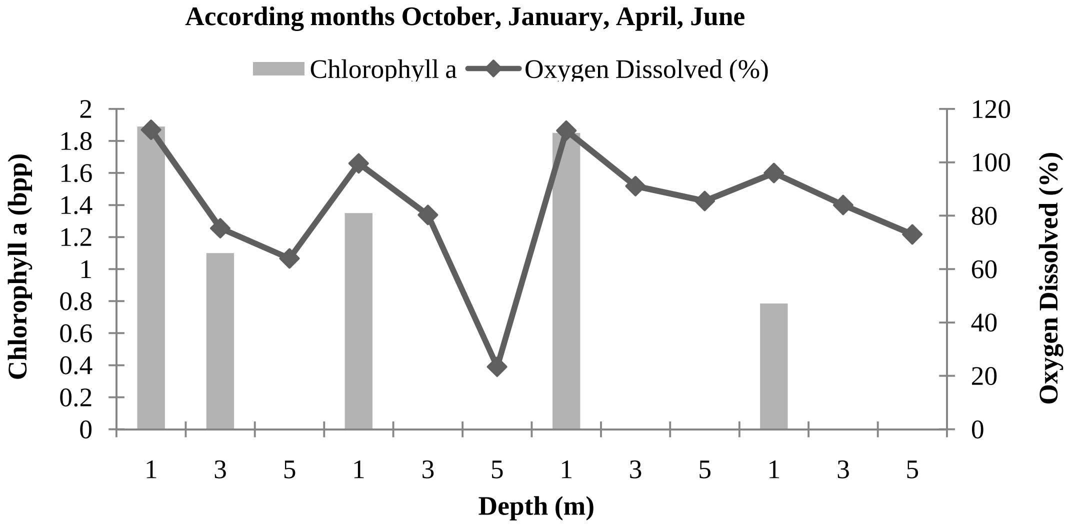

Figure7. Chlorophyll a concentration and Oxygen Dissolved valuesduring October, January, April and June according depths 1, 3 and 5m.

Table 2. Correlation coefficients between chlorophyll a and selected environmental factor.

Depth	*T (°C)*	*Salinity (‰)*	*pH*	*O_2 %*	*O_2 mg/l*	*NO_2^-(mg/l)*	*PO_4^{3-}(mg/l)*
1	0.313941	0.431732	0.580096*	-0.96357	-0.54209	0.732406*	-0.91418
3	0.956692**	0.008882	0.866025**	-0.17883	-0.98353		

* P< 0.05 , ** P< 0.01. T (°C) = Temperature, Sa (%) = Salinity; pH = Phehash; O2 % = Dissolved Oxygen, O2 mg/l = Dissolved Oxygen, NO2 = Nitrite; PO43 = Phosphate; Depth.

Analyzing some hydrochemical indicators of Butrint Lake in 2004 and 2011, especially in the peak months as April, there are noticed some phenomenon that express the tendency to distortion of some indicators. In April as it seems there is the first flourishing intensive of phytoplankton and from this flourishing we can determine the trophy level of an ecosystem.

Chlorophyll a primary being the first product, its level is closely linked with:

a. The amount of nutrients in water

b. Concentrations of suspended material, as turbitity and transparency of water

c. Anthropogenic impact in waters.

By comparison of the data, we notice a significant increase in chlorophyll a from 0.310 µg/L in 2004 to 0.795 µg/L in 2011, or 2.53 times, resulting in the tendency crossing these waters in mesotrophic level.

3.3 Relationship between chlorophyll a and physico-chemical parameters

Correlation coefficient analysis between chlorophyll a and physico-chemical parameters at two different depths are presented in Table 2. As we see at the table, in general there are no significant correlations between chlorophyll a concentration and physico-chemical parameters. Only temperature value shows a significant correlation with chlorophyll a at 3m. Also chlorophyll a concentrations were found to have a relation with pH at 1 and 3m. There is a good relation between chlorophyll a concentrations and nitrite value.

4. Conclusions

The situation of vital stratum in lagoon of Burins is till 5 m. The blooms of phytoplankton are noticed in spring and autumn. The trophic level of lake is oligotrophic. Temperature, pH and nitrite have a significant correlation with Chlorophyll a. Analyzing some hydrochemical indicators of Butrint Lake in 2004 and 2011, especially in the peak months as April, there are noticed some phenomenon that express the tendency to distortion of some environment factors. Bistrica River deviation is not functioning properly and therefore there have been increased temperatures in 2011 compared to 2004. Communication Channel sea-lake with its estuary is not maintained good which results as in 2004 and consequently salinitety in depth 3-5m has little difference versus superficial layer. Oxygen Dissolve values in 2011 have been increased compared to 2004. This increase is directly related to the values of Chlorophyll a, that are greater in 2011 compared to 2004 and that releases large quantities of oxygen. Nutrients have increased significantly in 2011 compared to 2004. By comparison of the data, we notice a significant increase in chlorophyll a from 2004 to 2011, resulting in the tendency crossing these waters in mesotrophic level.

Deteriorating trends seen in 2011, particularly in mortality catastrophe of mussels in 2012, increases the need to monitoring this lake continuously, to see

the performance in relation to:

Movement of vital layer;

Hydrochemical indicators especially Dissolved Oxygen in different stratum, temperature, H_2S and nutrients;

State of the mussel etc.

In this way we must analyze situation and taking tougher measures to reduce many crises in this lake.

5. Acknowledgments

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