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Trophic state of Albanian water ecosystems based on phytoplankton photosynthetic pigments

Fatbardha Babani
Efigjeni Kongjika
Alfred Mullaj
Ariana Ylli (Kraja)

Biological Research Institute, Tirana, Albania

Abstract

Data on the trophic state of some Albanian water bodies (the Adriatic lagoons of Vilun, Kune-Vain, Patog, Karavasta and Narta, and the ecosystem of Ohrid-Prespa) are presented. Evaluation of trophic state is based on chlorophyll *a* content in water and distribution of photosynthetic pigments, monitored from March to October. The lagoons of the Adriatic coast have different trophic states. The lagoons of Vilun, Kune-Vain and Patok are oligotrophic, but the Karavasta and Narta lagoons are characterized by a higher trophic state, estimated as mesotrophic. Lake Ohrid is oligotrophic, whereas Lake Prespa is mesotrophic. Vertical profiles of Chl *a* content demonstrated different distribution in the Ohrid and Prespa lakes.

Key-words: chlorophyll, lake, lagoon, phytoplankton, trophic state.

Introduction

The trophic state of water bodies can be divided into three categories: oligotrophic, mesotrophic and eutrophic. These categories reflect the nutrient and clarity levels, or the level of nutrients and algae in the water. Counting individual algae cells in water bodies is difficult; these categories are most easily determined by measuring the chlorophyll content of the water. Chlorophyll, a plant pigment found in algae, indicates the quantity of algae present in the water, providing an indication of the amount of nutrients present. Therefore, chlorophyll makes it possible to classify water bodies according to their trophic status as oligotrophic, mesotrophic, eutrophic and hypereutrophic (Tab. 1). A primary nutrient responsible for algae growth is phosphorus, and a direct relationship between phosphorus concentrations, chlorophyll *a* (algal biomass), and clarity has been established: phosphorus drives algal growth which then affects water clarity (Jarry *et al.,* 1991; Sanders *et al.,* 2001; Vidal *et al.,* 1999).

Trophic State	Chlorophyll (mg/m^3)	Total phosphorus (mg/m^3).
Ultraoligotrophic	← 1	
Oligotrophic	← 2.5	←10
Mesotrophic	2.5 - 8	10-30
Eutrophic	8 - 25	30-100
Hypereutrophic	→ 25	→100

Table 1 - Characterization of trophic state via Chlorophyll content.

Chlorophyll a is the green pigment in plants that is used for photosynthesis. Chlorophyll *a* is a good indicator of the total quantity of algae in a lake. Large amounts of algae in a lake can decrease the clarity of the water, alter the colour of the water (making it greener), form surface scum, reduce dissolved oxygen, alter the pH of the water, and produce unpleasant tastes and smells.

The aim of this study was to monitor and to evaluate the trophic state of the water bodies of the Ohrid-Prespa lakes and some Adriatic lagoons.

Material and methods

Chlorophyll "*a*", "*b*", and "*c*" content was determined by acetone trichromatic methods using the equations based on the absorption maxima for each component respectively (with coefficients of Jeffrey and Humphrey). All absorbance values are corrected by taking into consideration the turbidity of acetone extracts (Jarry and Legendre 1991, Jeffrey and Humphrey 1975, Lorenzen 1967, Ston and Kosakowska 2000).

Results

Adriatic coastal lagoons - Chlorophyll content

The chlorophyll content of Karavasta, Vilun, and Narta lagoons demonstrated the highest values on March. After that, the Chl content decreased until August and then increased in September-October (Fig. 1). The dynamics of Chl content in the Kune lagoon is diffe-

rent, demonstrating higher values during the summer May-July (Fig. 1).

The selected monitoring stations in each lagoon are characterized by different water connections to the sea. The dynamics of Chl content in the selected sta-

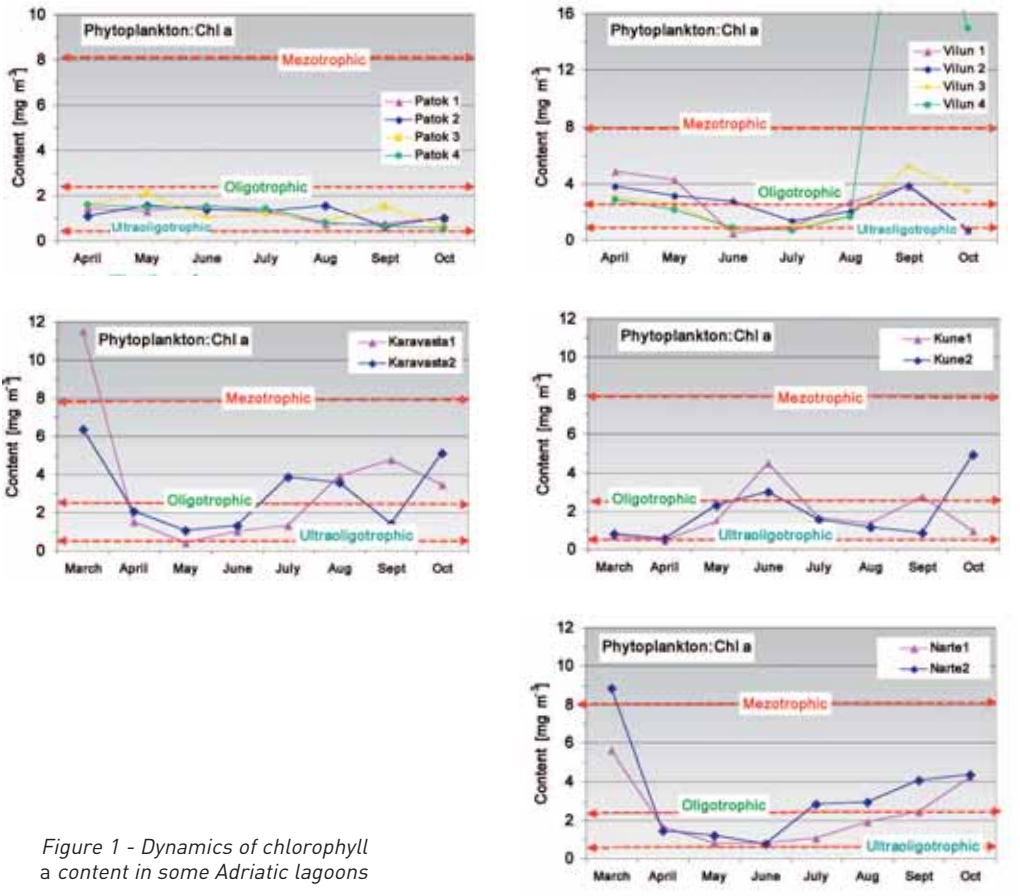

Figure 1 - Dynamics of chlorophyll a content in some Adriatic lagoons

tions demonstrated almost the same variation from March to October, especially in the Narta, Kune and Patok lagoons. A very high Chl content was observed in one of the stations in the Vilun lagoon (Fig. 1, Vilun 4), which can be explained by a poor connection of this station to the sea in this period as well as by higher pollution, especially during the summer. This station was near the beach.

Trophic state of Adriatic lagoons

Based on the trophic state characterization (Table 1), the trophic state of the Patok lagoon can be characterized as oligotrophic, and that of the Vilun lagoon as mesotrophic (Tab. 2). The trophic state at all selected stations (every year) in the Patok lagoon was similar. The trophic state of three of the selected stations in the Vilun lagoon was the same, whereas a very high trophic state was observed in one station (Tab. 2, Vilun 4). There was an improvement in the trophic state in 2005 in comparison to 2004 in both lagoons, excluding station 4 in Vilun, (Tab. 2). This improvement can be explained by the different climate conditions in these years and the better communication of both lagoons with the sea in 2005.

Table 2 - Characterization of trophic state by Chlorophyll content of Patok and Vilun lagoons.

Lagoon	Chl a	2004	Mean	2005	Mean
	Patok 1	1.921		1.141	
	Patok 2	1.798	1.859	1.214	1.187
	Patok 3	-		1.254	
	Patok 4	-		1.139	
	Vilun 1	3.563		2.526	
	Vilun 2	4.013	3.788	2.515	3.803
	Vilun 3	-		2.503	
	Vilun 4	-		7.670	

The trophic state of the Patok, Kune and Karavasta lagoons can be evaluated as oligotrophic, and the trophic state of the Vilun and Narta lagoons as mesotrophic,

Table 3 - Characterization of trophic state by Chlorophyll content of Adriatic lagoons

Lagoon	Chl a	2002	2003	Mean
	Karavasta	1.98	2.59	2.28
	Kune	1.51	1.95	1.73
	Narta	8.89	2.87	5.88
	Chl a	**2004**	**2005**	**Mean**
	Patok	1.86	1.19	1.52
	Vilun	3.79	3.81	3.80

taking into consideration the mean Chl content of all selected stations over a period of two years (Tab. 3).

Ohrid-Prespa ecosystem - Chlorophyll content

The chlorophyll *a* content in two lakes, Ohrid and Prespa, shows how much photosynthesising plant material is present in the lake water, as it is considered an expression of phytoplankton biomass (Fig. 2). The lakes have the following geographical coordinates: Ohrid - N-40º 55' 28.5"; E-020º 41' 20.2"; Prespa - N-40º 52' 27.0"; E-020º 58' 0.87".

Chlorophyll content demonstrated the highest values in March for lake Ohrid. After that, Chl content decreased until June, increased slightly in July and then decreased again (Fig. 2). The Chl content of lake Prespa is much higher than that of lake Ohrid. Chl content in lake Prespa decreased from March to June, and the Chl values in July and October are higher than those of March.

Vertical profile of Chl content

The vertical distribution of chlorophyll in the Ohrid and

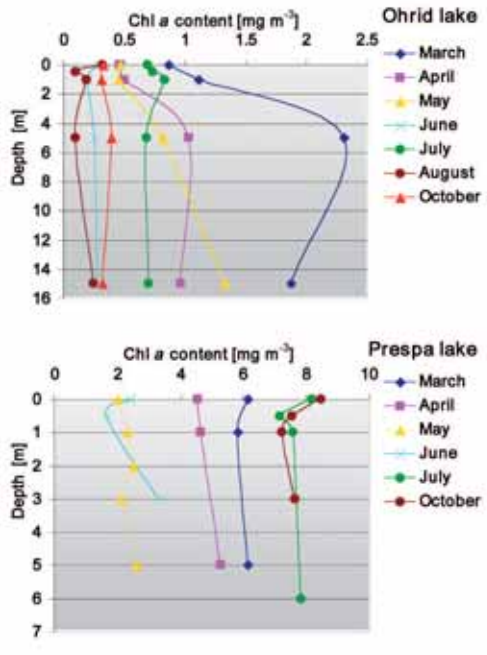

Figure 2 - Chlorophyll a content in Ohrid and Prespa lakes, March-October 2004.

Prespa lakes was different (Fig. 2). The Chl content of lake Ohrid increased from the surface to a depth of 5 m and then decreased. In contrast, in lake Prespa the Chl content is almost the same from 0 to 5 m depth.

Trophic state of the Ohri-Prespa lakes

Based on the trophic state characterization (Tab. 4), lake Ohrid can be characterized as oligotrophic, and lake Prespa as mesotrophic.

Table 4 - Characterization of trophic state by Chlorophyll content in Ohrid and Prespa lakes.

Chl a	lake Ohrid		lake Prespa	
	Lake	**Mean**	**Lake**	**Mean**
May	0.89	1.03	3.23	2.81
July	1.25		1.33	
October	0.94		3.86	
	Shore	**Mean**	**Shore**	**Mean**
May	3.80	5.7	3.85	5.71
July	11.82		5.97	
October	1.50		7.32	

The trophic state of the selected station on the shore near urban areas indicates a higher level, characterized as mesotrophic. It can be observed that the trophic state of lake Ohrid stations is higher in July and after that it decreases to an oligoptrophic level. In contrast, the trophic state of the selected station near the shore of lake Prespa increased from May to October, remaining mesotrophic. The high trophic state at the selected station near the shore can be related to higher pollution from urban areas especially during summer.

Photosynthetic pigments of phytoplankton.

The distribution of chlorophyll a and accessory pigments, Chl b and Chl c, as well as the ratios of Chl "*a*" to Chl "*b*" and Chl "*c*" was different in the two lakes (Fig. 3). The content of Chl *a* relative to Chl *b* and Chl *c* was higher in lake Prespa than in lake Ohrid.

The distribution of pigments in the algae groups is quite

unique. The kinds of chlorophylls are characteristic for each phytoplankton family and they can be used as potential taxonomic biomarkers of phytoplankton organisms. It is known that chlorophyll *b* is peculiar to green algae and chlorophyll *c* characterises Diatoms and Dinoflagellates. In contrast, in Cyanophyceae only chlorophyll *a* is present. The relative chlorophyll content shows the higher quantity of Cyanophyceae in the waters of lake Prespa than lake Ohrid, indicating higher eutrophication of lake Prespa (Schlüter *et al.* 2000).

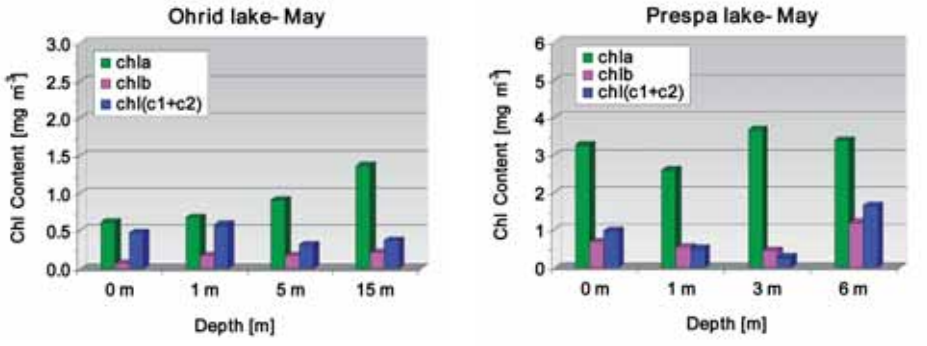

Figure 3 - Variation of content of chlorophyll a, b *and* c *in different depths in Ohrid and Prespa lakes, May 2005 (similar in other months).*

The relative distribution of chlorophylls in the station near the shore of lake Ohrid is different from that of the station in the middle of the lake, showing higher Chl a content, and thus a greater presence of Cyanophyceae in the water and a higher trophic level (Fig. 4). The differen-

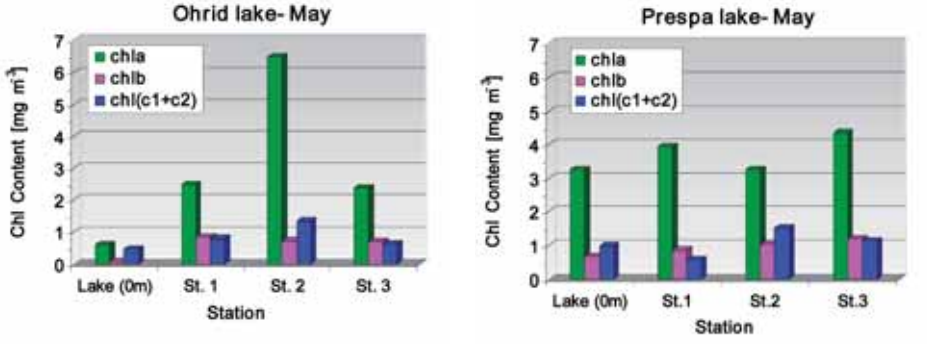

Figure 4 - Variation of content of chlorophyll a, b *and* c *in shore stations of Ohrid and Prespa lakes, May 2005.*

ces between the lake and shore stations in lake Prespa are less marked, showing approximately the same relative content of the three kinds of algae (Fig. 4).

Conclusions

1. The trophic state of the Patok, Kune and Karavasta lagoons is characterized by a low level, evaluated as oligotrophic.
2. The trophic state of the Vilun and Narta lagoons is characterized by a higher level, evaluated as mesotrophic.
3. Based on Chl content, lake Ohrid is characterized by a low trophic state, evaluated as oligotrophic.
4. Based on Chl content, lake Prespa is characterized by a high trophic state, evaluated as mesotrophic.
5. Chl content was highest in March in both lakes, which corresponds to the beginning of the phytoplankton vegetation stage.
6. Vertical profile of Chl content demonstrated different distribution in Ohrid and Prespa lakes.

References

Gotsis S. O. and Friligos N., 1990. Contribution to eutrophication and phytoplankton ecology in the Thermaikos Gulf. Thalassographica., 13, 1-12.

Jarry V., Frisoni G. F. and Legendre P., 1991. Spatial organization of a lagoon phytoplankton population under marine and continental influences. Oceanol. Acta, vol 14, No. 5, 473-488.

Jeffrey S. W., Humphrey G. F., 1975. New spectrophotometric equation for determining chlorophyll a, b, c1 and c2. Biochem. Physiol. Pflanz., 167, 194-204.

Lorenzen C. J., 1967. Determination of chlorophyll and phaeopigments: spectrophotometric equations, Limnol. Oceanogr., 12.

Sanders, R., Jickells, T. and Mills, D., 2001. Nutrients and chlorophyll at two sites in the Thames plume and southern North Sea. Journal of Sea Research, 46, 13-28.

Schlüter, L., Mohlenberg, F., Havskum, H. and Larsen, S., 2000. The use of phytoplankton pigments for identifying and quantifying phytoplankton groups in coastal areas: testing the influence of light and nutrients on pigment/chlorophyll-a ratios. Marine Ecology Progress Series [Mar Ecol Prog Ser], 192, 49-63.

Ston, J. and Kosakowska, A., 2000. Qualitative and quantitative analysis of Baltic phytoplankton pigments. Oceanologia, 42, 449-471.

Vidal, M., Duarte, C.M. and Sanchez, M.C., 1999: Coastal Eutrophication Research in Europe: Progress and Imbalances. Marine Pollution Bulletin, 38, 851-854.