A Point of View about Ecological Status of Maritime Lakes

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Abstract: *The lake Techirghiol comprises three distinct areas from a topographical, physical-chemical and biological point of view (hypersaline area of spa interest, majority as surface, intermediate area –buffer-, freshwater area) separated between them through protective dikes. Research: the period of observation was chosen May–June at the limit of the two seasons, spring and summer. Physical-chemical and electrochemical analyses were performed on water and sediment samples. Results: during the period of observations the three areas manifested differently. In the first two, the values of salinity were not altered, and in the hypersaline area they decreased by 20–25%. The hydro chemical analyses included the evaluation of dissolved O_2 content and biogenic substances. The dynamics of these parameters evolved differently. Balanced distribution was the result of normal biological activities; excessive accumulations were due to internal ecological de-adjustments or some external contributions to the system.*

Keywords: *Marine lake, status, biodiversity, salinity analysis, evaluation, dynamics, spa area, season.*

1. Introduction

A classification of the existing lakes in Romania can be detailed thus [1]:
1. mountain lakes (in volcanic craters, in glacial circuses, in karstic depressions, natural dam, artificial dam);
2. meadow lakes;
3. relic lakes;
4. heliothermal lakes;
5. havens (river limans, marine limans);
6. lakes in the Danube Delta.
In the present paper we will analyze the ecological status of the maritime lakes, namely the status of Techirghiol Lake (Figure 1) [2].

Fig. 1. Techirghiol Lake-satellite view [2]

1.1 The characteristics of Techirghiol Lake

The Techirghiol Liman and Lake Techirghiol (or Tekirghiol, Turkish Tekirgöl, meaning "Lake Tekir") is located on the edge of the spa town Eforie Nord on the Black Sea shore, 12 km away from the port of Constanţa, Romania. It is a river-marine liman [1] with an area of 10.68 km², separated from the sea through a lido, and it has a maximum depth of 9.75 m. By the small intake of freshwater, the water of the Liman increased its concentration of salts, at about 95 g/L. This phenomenon allowed the formation of a layer of sludge with therapeutic qualities [2]. The limans are specific to the Black Sea. In the communist Romania the term of *liman* for this ensemble was considered

obsolete by some commentators who did not knew the geographic terminology well, so that instead of the term *liman* the word *lake* is improperly used [3], [4]. A river-maritime liman had phases connecting the basin with the sea... when it was a marine bay. The waters of the lake, once disconnected from the sea by forming a cordon of coastal sands (about 200 m wide), became naturally hypersaline, as a result of strong evaporation in the sub-arid climate, which led to the decrease of the lacustrine water level and increase of the salt concentration at a higher level than in marine waters. There is no way to exclude marine water penetration through the deep sand. The level of the lake fluctuates both annually and on a multiannual basis; at measurements of 1909, the water level of the lake was at-1.5 m from the sea level; it decreased to-1.64 in 1953, and currently it has increased near the sea level, perhaps as a result of a less arid-semiarid climate or periods when agricultural irrigation increased the quantities of water introduced into the lake capture basin [5]. Salinity measured in 1893 showed 71.392 g/l, in 1924 it was of 106.896 g/l and in 1969 it was of 81.485 g/l, while in the 1990sit reached a level below 60 g/L, which shows synergistic effects of natural fluctuations and human interference. Currently, the waters of Lake Techirghiol are divided into 3 separate entities by the dikes built in 1983 and 1989, so there is a large area with saline water (52-55 grams of salt per litre) situated near the sea to the east, an intermediate brackish water area (6-8 g/l), and a sweetened water area (1-2.3 g/l), located at the "tail of the Lake"; the western area has swamps and palustral vegetation characteristic of sweet waters. The sweetening of the waters leads to the change of the fauna structure, especially the reduction of ratio of the species of invertebrates adapted to hypersaline waters [5].
Lake Techirghiol [6] has a maximum depth of 9.75 m, average depth of 3.6 m and the volume of water is 41.8 million m^3; the maximum length of the lake is 7.75 km, the maximum width is 4.4 km, and the area of the river basin from which its waters are collected is 185.5 km.
The biodiversity of the lake is very interesting. In samples collected between 2004-2009 from the lake waters 109 phytoplankton taxa were identified, much of these algae belonging to diatoms, but also *Clorophyte*, *Dinophyte, Euglenae* and *Crisophyte, Xantophyte*... were identified and 14 species of *Cyanobacteria planktonic*. *Macrophytes algae* are mainly represented by the species *Cladophora vagabunda*, but *Cladophora crystalline* and *Cladophora fracta* are also present. There are known from here 14 species of *Protozoa*, 93 species of *Rotiphera*, 1 species of *Copepod* and 4 species of *Diphtere*. *Artemia salina* is a brachiopod crustacean of 5-10 mm, adapted to life in hypersaline waters. *Rivulogammarus pulex* is an amphipod relict crustacean, and the gasteropode *Pseudamnicola Codreanu* is also a regional endemic relict, characteristic of Dobrogea coastal areas. The vegetation near the shores resembles that of marine salt soils, halophile species being present here, such as: *Salicornia europaea, Artemisia santonica, Suedamaritima, Sueda salsa, Atriplextatarica, Atriplex oblongifolia, Bassia sedoides, Bassia hirsuta, Acorellus pannonicus, Aster tripolium pannonicus, Hordeum geniculatum, Juncus gerardi, Spergularia media,* etc. [7].



Fig. 2.*Coracias garrulus*; Gulls-*Larus melanocephalus*; *Ajuga chamaepitys*

Legal protection is provided by Government Decision no 1266/2000. Lake Techirghiol was declared a Ramsar Site on October 20, 2011, with the number 1,610. Techirghiol Lake is also a Natura 2000 Site, based on the European Union Bird Directive, with the ROSPA0061 code. 150 species of birds are known here, of which various species are present at different times of the year (Figure 2). The area of the site is 3,035.3 hectares, between altitudes of 0 and 80 m, the area concerned being part of both the Pontic biogeographic region and the steppe region. According to

the standard form document of the site, Lake Techirghiol is important for the overwintering of 7,000 red-breasted geese (*Branta ruficollis*), 40 specimens of whooper swan (*Cygnus cygnus*), 34 great egrets (*Ardea alba*), 1 specimen of merlin (*Falco columbarius*), 1 specimen of peregrine falcon (*Falco peregrinus*), 3 specimens of arctic loon (*Gavia arctica*), 1,800 smews (*Mergus albellus*), 800 white-headed ducks (*Oxyura leucocephala*), 800 pygmy cormorants (*Phalacrocorax pygmeus*), etc. Of the species that nest here, it is worth mentioning the 30 pairs of black-winged stilt (*Himantopus himantopus*), 10-12 pairs of little bittern (*Ixobrychus minutus*), etc. During the bird visitation period, the site is used, among others, by 20 specimens of Kentish plover (*Charadrius alexandrinus*), 1,300 white storks (*Ciconia ciconia*), 600 black-headed gulls (*Larus melanocephalus*), 5,200 little gulls (*Larus minutus*), 100-120 great white pelicans (*Pelecanus onocrotalus*), 100 ruffs (*Philomachus pugnax*), 20 specimens of little tern (*Sterna albifrons*) [7], [8].

2. Material and methods

The period of observation was chosen to be May –June at the limit of the two seasons, spring and summer. Physical-chemical and electrochemical analyses were performed on water and sediment samples.

2.1. Data of water samples analyses and graphical interpretations

The hydro chemical characterization of the water samples from Lake Techirghiol, May–June, (mean values) is presented as follows (Figure 3, Figure 4, Figure 5, Figure 6, Figure 7) [1]:

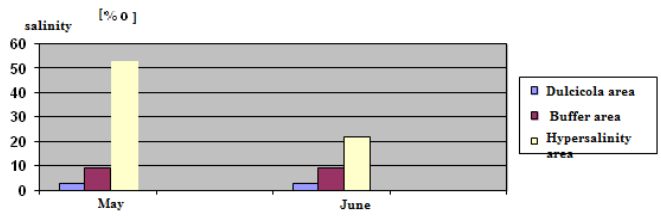

Fig. 3. Salinity variation

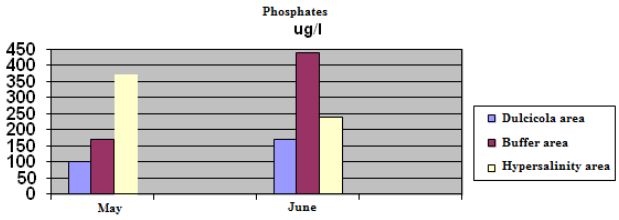

Fig. 4. Phosphates variation

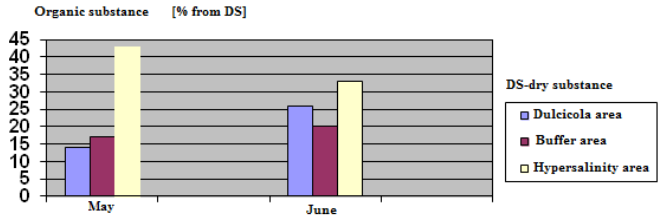

Fig. 5. Organic substances variation

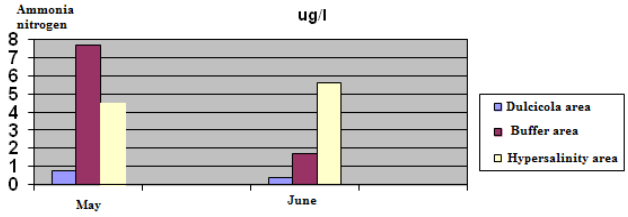

Fig. 6. Ammonia nitrogen variation

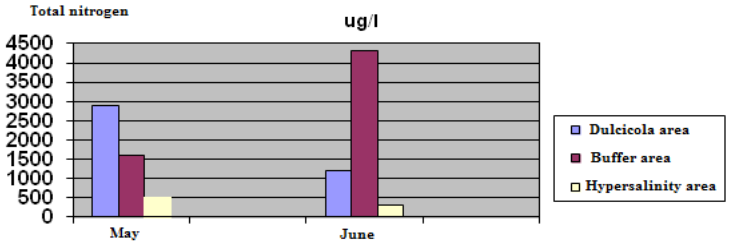

Fig. 7. Total nitrogen variation

Finally, the values of salinity were not altered and in the hypersaline area they decreased by 20–25%; the total content of salts (in the current situation expressed in NaCl ‰) was continuously decreasing; thus, in the same period of the year salinity was between 59.0 –64.0 ‰.

Hydrochemical analyses included the evaluation of dissolved O_2 content and biogenic substances (Figure 8, Figure 9, Figure 10).

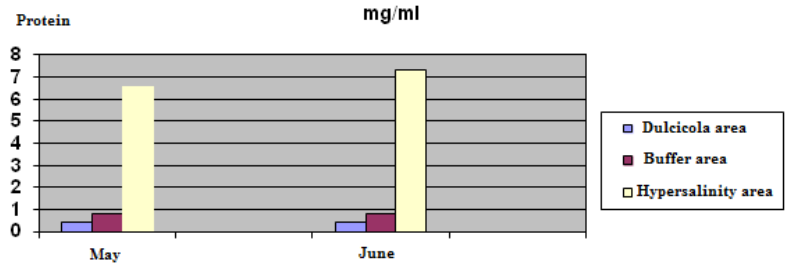

Fig. 8. Proteins variation

The dissolved O_2 content, a defining parameter in assessing the status of aquatic ecosystems, showed in the particular situation of Lake Techirghiol a state of hemostasis. The dependence on the different biological and hydro chemical support of the three zones was highlighted in the detergent values in the samples and the limits of their variation 10.7 –13.1 mg/m^3 for the Dulcicola area; 8.8 –11.3 mg/m^3 for Buffer zone and 6.4 –7.5 mg/m^3 for hypersaline area. The increase of the oxygen concentration for the May-June observation interval was common to the three zones, and the value exceeded the annual averages from previous observations. The concentration of phosphorus, whose origin was predominantly exogenous of the system (Figure 8), was much higher in the hypersaline area during the period of May, with a tendency to decrease in June. At the same time, in the other areas the tendency was increased to much higher values, although the constant values were lower in May; the observation represents an argument of the different behaviors and influences manifested in the divisions of the Techirghiol Lake ecosystem.

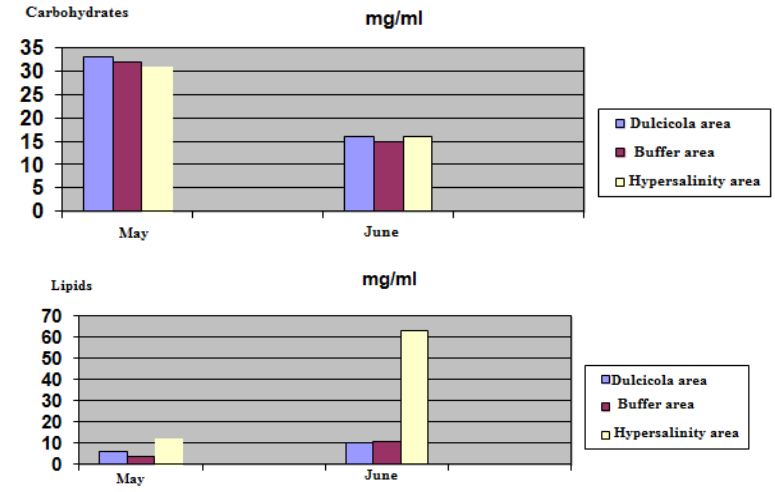

Fig. 9. Carbohydrates and Lipids variations

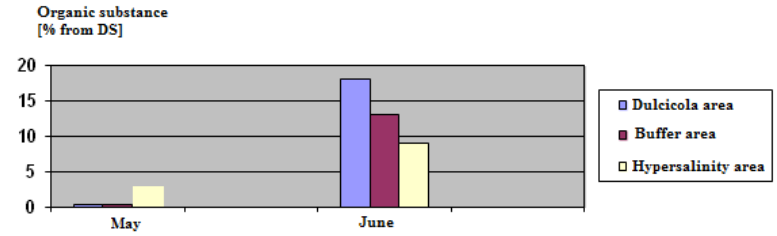

Fig. 10. Organic substances variations

The association of organic substance growth has led to the hypothesis of an additional contribution of biological origin located within the system range (Figure 10).

2.2. Data for sediments samples analyses and graphical interpretations

Sediments were generally deposits of substances from the water mass but also generated by the mineral and organic loads through the water-sediment interface. The dry substance and mineral residue (on zones 81.6, 88.3, 91.2, respectively) evolved upward from the sweet water zone to the hypersaline one, but the mineral components presented zonal particularities (Figure 11, a; b; c) [9].

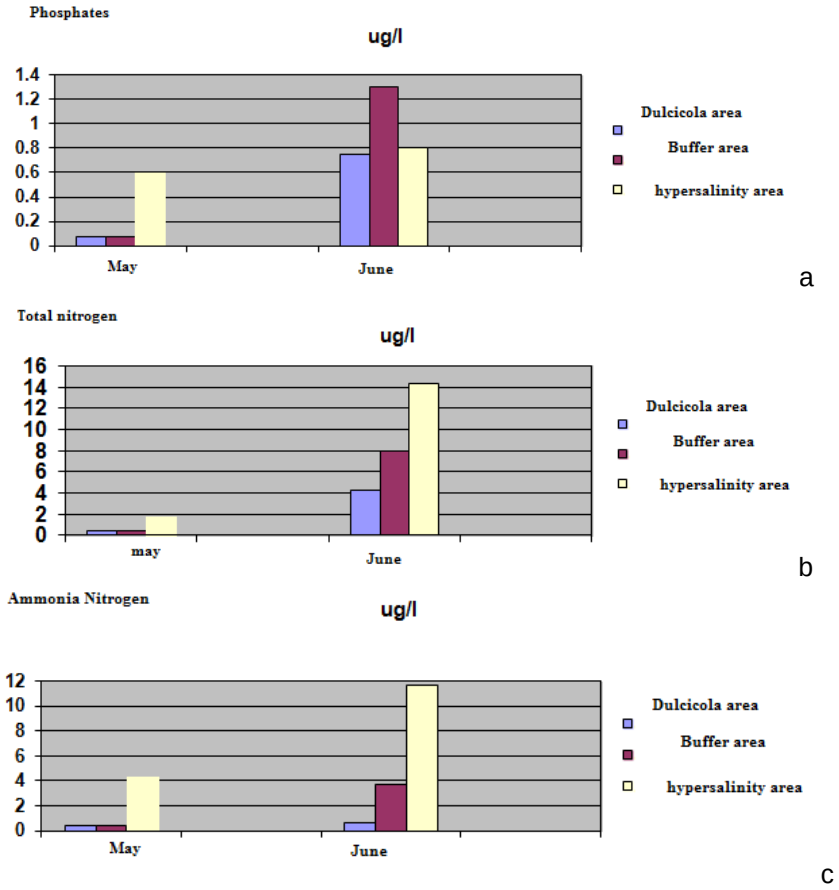

Fig. 11. Chemical characterization of sediments during May-June period

The final analysis requires the establishment of a regime protected by law or reserve, which can lead to the relocation of the Techirghiol Lake area [1].

3. Conclusions

The presence of various forms of nitrogen compounds linked to salts and the dynamics of concentrations related to origin – the mineralization of organic substance – provided complementary information on the system. In the hypersaline area the nitrogen compounds were balanced but decreased between the two observation intervals May-June; all this on a source drop-down fund – the content of organic substance, which suggests the transformation of the organic substance dissolved in other components – primarily biochemical. In the other two areas, the buffer one and the sweetened water one, the diminishing of the specified values was different, both presenting a trend of decreasing. Compared to the buffer zone the transformation processes in $N\text{-}NH_4^+$ were less intense in the sweetened water area for the same period of observation due to the specific conditions of each area.
The association to increase the content of organic substance has led to the assumption of an additional contribution of biological origin situated within the system range. Reporting to previous data showed a sense of growth which, in fact, was in continuation of the previously manifested tendency. The space-temporal distribution of the dissolved organic substance and its components was correlated with the state of the ecosystem due to their important role in the energy transfer

and resulted in the following conclusion: the balanced distribution was the result of normal biological activities; excessive accumulations were due to internal ecological disturbances or external contributions produced to the system.
Sediments were generally deposits of substances from the water mass but also generated by mineral and organic loads through the water-sediment interface.
The dry substance and mineral residue (on zones 81.6, 88.3 and respectively 91.2%d.s.) evolved upwards from the sweet water area to hypersaline area, but the mineral components presented regional peculiarities. All these situations emphasized the existence of biological processes and, consequently, biochemicals that were dynamically developed and varied within the system of the Techirghiol Lake.
The general interpretation and analysis of the data suggest the installation of a state of hemostasis resulting from the system not adjusting to the new conditions. This requires the establishment of a regime protected by law or reserve, which can lead to the relocation of the Techirghiol Lake area.

References

[1] Panaitescu, Mariana, Fanel-Viorel Panaitescu, Simona Ghita and Iulia-Alina Anton. "Evaluation of hydrochemical and biological status in Lake Techirghiol". Paper published in Book of Abstract at the 6th International Conference Modtech 2018, Constanta, Romania, June 13-16, 2018.
[2] NASA World Wind Landsat. August 17, 2009. Accessed May 2018, https://ro.wikipedia.org/wiki/Lacul_Techirghiol#/media/File:Lacul_Techirghiol.png.
[3] ***The Encyclopedia Dictionary /Dicționarul Enciclopedic*, vol. IV. Bucharest, Romanian Academy of Socialist Republic of Romania, 1966.
[4] Gâștescu, Petre, and Vasile Sencu. *The Kingdom of Limans/Împărăția limanelor*. Bucharest, Meridiane Publishing House, 1968.
[5] Lengyel, Peter. "Lacul Techirghiol", November 3, 2011. Accessed May 28, 2018. https://peterlengyel.wordpress.com/2011/11/03/lacul-techirghiol/.
[6] Gâștescu, Petre. *The lakes in Romania – regional limnology*. Bucharest, Publishing House of Academy, 1971.
[7] Gheorghievici, Liana Manuela. "The Contribution of the Micro- and Macrophytes to the Genesis of the Therapeutic Mud from Lake Techirghiol, Romania." Paper presented at the BALWOIS 2010, Ohrid, Republic of Macedonia, May 25-29, 2010.
[8] Tuculescu, Ion. *Biodynamics of Techirghiol Lake. Biocenoses and the genesis of sludge /Biodinamica lacului Techirghiol. Biocenozele si geneza nămolului.* Bucharest, Academy Publishing House, 1965.
[9] Panaitescu, Mariana, Olga Surdu, and Ioana Oncioiu. "Experimental study and statistical calculus of efficiency of Techirghiol Lake mud." Paper published at the 3rd International Conference on Environmental and Geological Science and Engineering, Constanta, Romania, September 3-5, 2010.