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Structure, diversity and seasonal dynamics of algal communities, with special attention to diatoms, from "Lacul Dulce" (Lake no.3) – Turda (Cluj county, Romania)

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Abstract. Structure, diversity and seasonal dynamics of algal communities, with special attention to diatoms, from "Lacul Dulce" (Lake No. 3) –Turda (Cluj County, Romania). The subject of the present paper is the investigation of the algal communities inhabiting of Lake No. 3 (known as "Lacul Dulce") from Turda, Cluj County. The algal flora of this lake has not yet been investigated. There have been identified 80 algal taxa, belonging to 5 phyla: Cyanoprokaryota (12 taxa), Dinophyta (5 taxa), Bacillariophyta (48 taxa), Euglenophyta (9 taxa) and Chlorophyta (6 taxa). A special attention was paid to the investigation of diatom communities, the group of algae that is the subject of the first author's PhD thesis. The 48 identified diatoms belong to the following 7 families: Thalassiosiraceae, Chaetoceraceae, Fragilariaceae, Achnanthaceae, Naviculaceae, Bacillariaceae and Epithemiaceae. Some aspects regarding community structure, seasonal dynamics, ecological preferences (salinity concentration) were also studied and are discussed in the paper

Keywords: *algae, community structure, salinity, dynamics, diversity, floristic similarity*

Introduction

The algal flora of the continental saline aquatic ecosystems is relatively poorly documented not only in Romania, but all over the world, in spite of the fact that algae are a very important link in the life cycle of any aquatic ecosystem. This is also the case of the saline lakes from the surroundings of Turda, Cluj County. There are no published records dealing with the algal flora of most of these lakes, including "Lacul Dulce", Therefore, the aim of the investigation carried out in 2005 was to reveal its algal flora and community structure, their diversity, dynamics, as well as the effects of salinity on the composition of communities based on the seasonal changes of some physical and chemical parameters.

"Lacul Dulce" is located in the „Sărată" Valley, North-West from Turda (Cluj County) (Fig. 1). The present basin was created by the collapse of an ancient salt mine, and it was initially a fresh water lake (Maxim 1937). In 1926, when the collapse took place, the water body contacted the salt layers of the ancient mine and its salinity has been increasing since then due to the dissolution process.

Materials and Methods

The sampling and processing methods are classical and internationally accepted. The samples, both planktonic and periphytic were collected seasonally during 2005. Parallel with the sampling, there were measured some of the physical and chemical parameters of the lake [such as: salinity (mg. l^{-1}), TDS (mg. l^{-1}), conductivity (μS. cm^{-1}), pH, dissolved oxygen (%, mg. l^{-1}), air and water temperature (℃)]. The samples were conserved *in situ* with 4 % formaldehyde solution, and the investigations were carried out using common laboratory techniques employing Nfpk Zeiss Jena and Nikon Eclipse E 400 microscopes and some of the common taxonomical key books (e.g. Krammer & Lange-Bertalot 1986, 1988, 1991 a, 1991 b; Ettl 1983; Ettl & Gärtner 1988; Komárek & Anagnostidis 1999; Nagy-Tóth & Barna 1999).

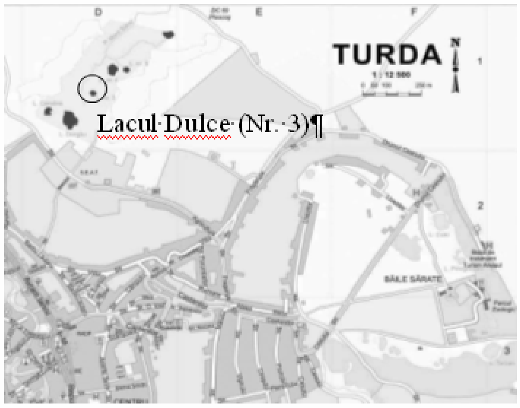

Fig. 1. Geographical location of „Lacul Dulce"

Results

There have been identified 80 taxa (Tab. 1), belonging to: Cyanoprokaryota (12 taxa), Dinophyta (5 taxa), Bacillariophyta (48 taxa), Euglenophyta (9 taxa) and Chlorophyta (6 taxa).

The 48 identified diatom species belong to 7 families: Thalassiosiraceae (1 species), Chaetoceraceae (1 species), Fragilariaceae (3 species), Achnanthaceae (3 species), Naviculaceae (23 species), Bacillariaceae (14 species) and Epithemiaceae (3 species).

Discussions

The physical and chemical parameters of the water were measured just below the surface, where the algal community of this lake is best represented. The salinity increased throughout the year 2005, from 1200 to 3000 mg.l^{-1}(Fig. 2), probably due to the dissolution process of salt layers, as well as caused by evaporation. Because the measurements were carried out only during one year, there are not enough data to make further comments ob this issue. The TDS and conductivity values exhibit the same increasing tendency from January to October (1340 to 3020 mg. l^{-1} and 2440 to 6060 μS. cm^{-1}). The variation of pH was insignificant (7.75 to 8.25), showing slightly alkaline waters through the whole year. The quantity of dissolved oxygen varied between 5.14 and 10.4 mg l^{-1}, while the water's saturation with oxygen between 57.9 and 110 %. Higher values of dissolved oxygen were found in spring, possibly due to the more intense photosynthetic activity of algae. The air and water temperature varied parallel through the w2hole sampling period.

Tabel 1. Qualitative structure of periphytic and planktonic algal communities in Lacul Dulce (Lake No. 3**)**.

TAXA	**January**		**April**		**July**		**October**	
	PF	PL	PF	PL	PF	PL	PF	PL
CYANOPROKARYOTA								
Anabaena variabilis Kützing	+	+	-	-	-	-	-	-
Geminella monospora (J.W.G. Lund) Hindák	+	+	-	-	-	-	+	-
Geminella interrupta (Turpin) Lagerheim	+	+	-	-	-	-	+	-
Lyngbya lutea (Agardh) Gomont	-	-	-	-	-	-	+	+
Oscillatoria amphibia Agardh	+	+	-	-	-	+	-	-
Oscillatoria chlorina (Kützing) Gomont	-	-	-	-	-	+	-	-
Oscillatoria guttulata van Goor	+	+	-	-	-	-	-	-
Oscillatoria pseudogeminata G. Schmid	-	-	-	-	+	+	-	-
Oscillatoria putrida Schmidle	+	-	-	-	-	-	+	-
Phormidium toficola (Näg.) Gomont	-	-	-	-	+	+	-	-
Pseudanabaena bipes Böcher	+	+	+	-	-	-	+	+
Rhabdoderma lineare Schmidle & Lauterborn	+	-	-	-	-	-	-	-
DINOPHYTA								
Gymnodinium paradoxum Schilling	-	-	-	-	+	-	-	-
Gymnodinium wawrikae Schiller	-	-	+	+	+	+	-	+
Peridinium lomnickii Woloszynska	-	-	-	-	-	+	-	-
Woloszynskia pascheri (Suchlandt) Stosch	+	-	-	-	-	-	-	-
Woloszynskia pseudopalustris (Woloszynska) Kiselev	+	-	-	-	-	+	-	-
BACILLARIOPHYTA								
Achnanthes brevipes Agardh var. *intermedia* (Kützing) Cleve	+	-	+	-	+	-	+	-
Achnanthes lanceolata (Brébisson) Grunow	-	-	-	-	+	-	+	-
Achnanthes minutissima Kützing	-	-	-	-	+	-	-	-
Amphipleura rutilans (Trentepohl) Cleve	+	-	-	-	+	-	+	-
Amphora coffeaeformis (Agardh) Kützing	+	-	+	-	-	+	-	-
Amphora commutata Grunow	+	-	+	-	-	-	-	-
Asterionella formosa Hassall	-	-	-	+	-	-	-	-
Bacillaria paradoxa Gmelin	+	+	-	-	+	+	+	-
Caloneis amphisbaena f. *subsalina* (Donkin) Van der Werff & Huls	-	-	+	-	-	-	-	-
Chaetoceros muelleri Lemmermann	-	-	-	-	+	-	-	+
Cyclotella meneghiniana Kützing	+	-	-	-	+	-	+	-
Diploneis smithii (Brébisson) Cleve	-	-	-	-	-	-	+	-
Entomoneis alata (Ehrenberg) Ehrenberg	+	+	+	-	-	-	-	+
Entomoneis paludosa (W. Smith) Reimer	+	+	-	-	-	-	-	-
Fragilaria fasciculata (Agardh) Lange Bertalot	+	+	+	+	+	+	+	+
Fragilaria pulchella (Ralfs ex Kützing) Lange Bertalot	+	+	+	-	+	-	+	-
Gyrosigma balticum (Ehrenberg) Rabenhorst	-	-	+	-	-	-	-	-
Gyrosigma nodiferum (Grunow) Reimer	-	-	+	-	-	-	-	-
Gyrosigma spencerii (Quekett) Griffith & Henfrey	+	-	+	-	-	-	-	-
Hantzschia amphioxys (Ehrenberg) Grunow	-	-	-	+	-	-	-	-
Mastogloia elliptica (Agardh) Cleve	+	+	+	-	+	+	+	-

Mastogloia smithii Thwaites	+	+	+	-	+	+	+	-
Navicula cincta (Ehrenberg) Ralfs	+	+	+	-	-	-	+	-
Navicula cuspidata (Kützing) Kützing	+	-	+	-	-	-	-	-
Navicula goeppertiana (Bleisch) H. L. Smith	+	-	+	-	-	-	+	-
Navicula gregaria Donkin	+	-	+	-	-	-	+	-
Navicula halophila (Grunow) Cleve	-	-	+	-	-	-	+	-
Navicula menisculus Schumann	-	-	+	-	-	-	-	-
Navicula peregrina (Ehrenberg) Kützing	+	-	+	-	-	-	-	-
Navicula pygmaea Kützing	+	-	+	-	-	-	-	-
Navicula salinarum Grunow	+	-	+	-	-	-	-	-
Navicula spicula (Hickie) Cleve	+	-	+	-	-	+	-	-
Nitzschia austriaca Hustedt	+	-	+	-	+	-	+	-
Nitzschia calida Grunow	+	-	-	-	-	-	-	-
Nitzschia constricta (Kützing) Ralfs	+	-	+	-	+	-	+	-
Nitzschia fasciculata (Grunow) Grunow	+	-	-	-	-	-	-	-
Nitzschia filiformis (W. Smith) Van Heurck	+	-	-	-	-	-	-	-
Nitzschia frustulum (Kützing) Grunow var. *frustulum*	+	-	+	-	+	-	+	-
Nitzschia hungarica Grunow	+	+	-	-	-	-	-	-
Nitzschia levidensis var. salinarum Grunow	+	-	+	-	-	-	-	-
Nitzschia linearis (Agardh) W. Smith	-	-	+	-	-	-	-	-
Nitzschia palea (Kützing) W. Smith	-	+	-	-	-	-	-	-
Nitzschia sigma (Kützing) W. Smith	+	+	+	-	+	-	+	-
Nitzschia tryblionella Hantzsch	+	-	-	-	-	-	-	-
Pleurosigma salinarum Grunow	-	-	+	-	-	-	-	-
Rhopalodia constricta (W. Smith) Krammer	-	-	-	-	+	-	+	-
Rhopalodia gibberula (Ehrenberg) O. Müller	-	-	-	-	+	-	+	-
Rhopalodia musculus (Kützing) O. Müller	-	-	+	-	+	-	+	-
EUGLENOPHYTA								
Euglena ehrenbergii Klebs	-	-	+	-	-	-	-	-
Euglena oblonga Schmitz	+	+	+	+	+	+	+	+
Euglena pisciformis Klebs	-	-	+	-	+	+	-	-
Euglena tripteris (Dujardin) Klebs	-	-	+	-	-	+	-	-
Euglena viridis Ehrenberg	-	-	+	-	-	+	-	-
Phacus mirabilis Pochmann	-	-	-	-	+	-	-	-
Phacus orbicularis Hübner	-	-	+	-	+	+	-	-
Trachelomonas hispida (Perty) Stein	-	-	+	+	+	+	+	+
Trachelomonas verrucosa Stokes	-	-	-	-	-	-	+	-
CHLOROPHYTA								
Carteria ellipsoidales Bold	-	-	-	-	-	+	-	+
Dunaliella carpatica Masjuk	+	-	-	-	-	-	-	-
Monoraphidium komarkovae Nygaard	-	-	-	-	+	+	+	+
Sphaerocystis schroeteri Chodat	-	-	+	+	-	-	-	-
Siyrogyra sp.	+	-	-	-	-	-	+	-
Tetraselmis cordiformis (Carter) Stein	-	-	-	-	+	+	-	-

PF – periphyton;
PL – plankton;

The algal communities consist mostly of diatoms (80 taxa) in "Lacul Dulce", representing 60 % of the algal flora (Fig. 3). The rest of 40% is represented by Cyanoprokaryota – 15 %, Euglenophyta – 11 %, Chlorophyta – 8 % and Dinophyta – 6 %. This proportion seems to be usual, especially in saline waters, where the diatoms are the dominant group. Among diatoms the best represented families are Naviculaceae and Bacillariaceae (23 and 14 taxa).

The analyses of periphytic and planktonic communities showed that most algae have a better development on hard substrata. 41 species were identified exclusively in the periphyton, 33 in both periphyton and plankton, while only 6 species were found exclusively in the plankton. Thus, it seems that most of the species prefer the first type of biotope, forming periphytic communities. The same conclusion is valid if only the group of diatoms is considered: over 90 % of species are to be found on hard substrata.

There is a seasonal dynamics regarding the species composition, number of species and diversity. Considering the periphytic algae, there is a decline in the summer period (Fig. 4), mainly due to the diatom community. This is a usual pattern for these organisms in lentil aquatic ecosystems. On the other hand, the Shannon-Wiener index was higher in spring and summer and lower in winter and autumn. The equitability reaches its peak in summer (Fig. 5). The explanation for the differences between the number of species and the diversity indices (for example, in summer there are less species, but the diversity is higher), might be explained by the abundance of certain species. In a given season, there may occur many species, and in spite of the diversity is lower, because some of the species are far more abundant than the others.

The planktonic forms have the higher number of species in summer, especially due to the Cyanopprokaryota and Euglenophyta, groups which develop better in the warm season (Fig. 4).

The higher salinity levels influence the composition of the algal community, thus more than half of the species are halophylous forms and halophytes. Considering separately the group of diatoms, the percentage of halophytes is even greater: 75 % of the species belong to this category. In other words, the salinity of water is very important limitative factor that determines the species composition of the algal community (Blinn 1995; Blinn & Herbst 1998; Wilson et al. 1996).

The similarity index of Jaccard demonstrated the highest similarity between the periphytic communities from July and October, respectively January and April (over 0.4).

A significant number of species suggest an excessive content of organic matter, 7 species indicating polysaprobic level. There are also some species that suggest high trophicity level. This might be connected with human impact (grazing cattle in the area, trying to introduce fish breeding, using the lake for recreational and balneary purposes), as well as with the luxuriant vegetation in the catchment area.

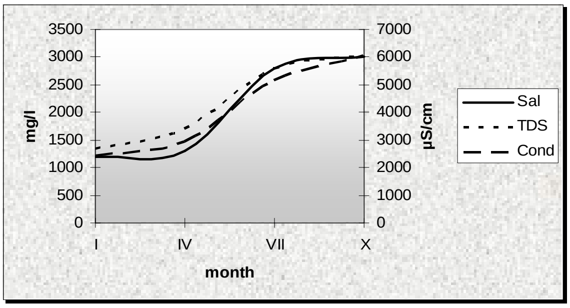

Fig. 2. Salinity, TDS and conductivity values in 2005

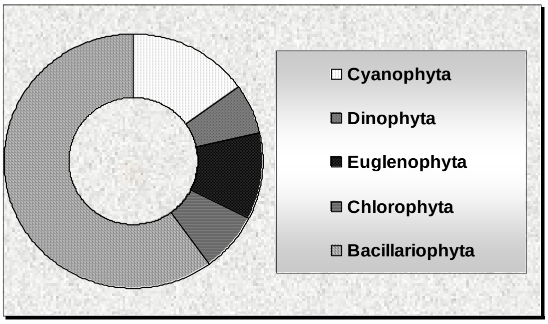

Fig. 3. Percentage distribution of taxa

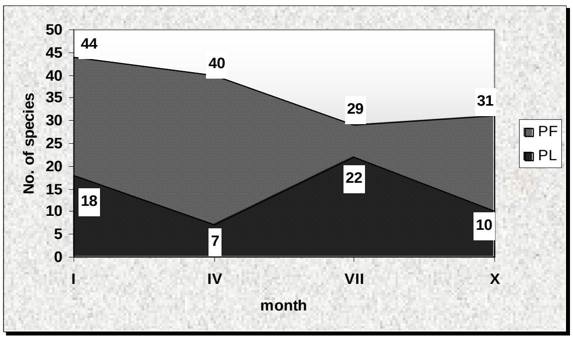

Fig. 4. Variation in the number of species during the investigated period

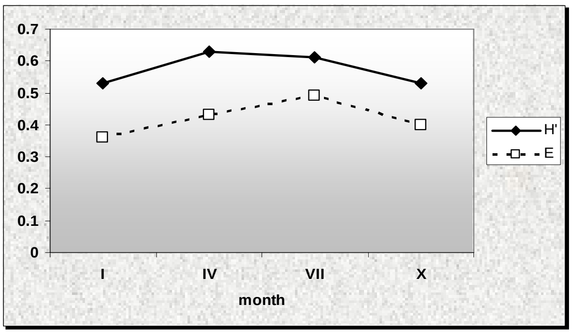

Fig. 5. Seasonal variations of Shannon – Wiener index (H') and equitability (E)

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