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THE PHYTOPLANKTON COMPOSITION FEATURES OF FIVE ROMANIAN PELOGENOUS ECOSYSTEMS

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Abstract

Planktonic algal samples were collected from lakes with different salinity (Salt Lake Brăila, Amara Lake, Fundata Lake, Techirghiol Lake and Black Lake-Sovata), in which mud used in balneary therapy is formed. A total of 189 species were recorded: 35 Cyanobacteria, 10 Euglenophyceae, 96 Bacillariophyceae, 33 Chlorophyceae, 3 Chrysophyceae, 2 Cryptophyceae, 1 Xantophyceae and 9 Dinophyceae. The highest number of phytoplankton species was recorded in Techirghiol lake (127 species) and the lowest number in Black Lake-Sovata and Salt Lake Brăila (23 species). The species diversity of microalgae was compared in different pelogenous lakes. In the case of Cyanobacteria and Bacillariophyceae, the calculated values for the Sorensen similarity coefficient reflect a weak association of species in the pelogenous lakes, while in the case of Euglenophyceae, Chrysophyceae, Crysophyceae, Dinophyceae, Xanthophyceae classes, the comparison of the species diversity was impossible because they were not found in all the studied biotopes. The composition of the Chlorophyceae class was similar in the plankton of two clusters: cluster 1- Techirghiol lake and Black lake-Sovata; cluster 2- Salt lake- Brăila, Fundata lake. The hypersaline lake Techirghiol was the most algologically productive habitat, here forming the mud with the highest content of organic substance. Salt Lake Brăila and Black Lake-Sovata were the least algologically productive ecosystems; in both lakes mud with mineral developed fraction and organic component in small percentage are formed, although they are biotopes with different salinity, one being hypersaline, the other brackish.

Key words: ecosystem, mud, pelogenous, phytoplankton, similarity, therapeutic

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1. Introduction

With regard to the mineralized lakes of Romania, the highest therapeutic importance goes, irrefutably, to the salted water lakes which are found in an appreciable number. Their salt concentration presents large variations; in some lakes, the salt quantity is limited to only a few grams per liter, whereas in others, it reaches the saturation (Morariu et al., 1968) (Table 1).

Each salt lake is a therapeutic and spa individuality, their physicochemical properties, their geo-hydrological characteristics and the areas of vegetation in which they are fitted, give each lake its own features (Morariu et al., 1968).

Phytoplankton composition varies according to the basin specificity. In eutrophic waters the main components are Cyanobacteria, Eughenophyta and Chlorophyta, the oligotrophic waters are dominated by diatoms and Crysophyceae while in dystrophy waters microalgae of the Desmidiales Order (Chlorophyceae) are especially met (Ionescu and Péterfi, 1976). The salt lakes (with a salt concentration > 30g ‰) are simple ecosystems, with a simple food chain, because they have fewer species but a larger number of individuals compared to freshwater lakes (Antonescu, 1967).

In the salted lakes, significant deposits of therapeutic mud are formed (Morariu et al., 1968).

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Table 1. Salinity variation for Romanian pelogenous lakes

Lakes	*Salinity ($g \cdot dm^{-3}$)*	*References*
Amara Lake	9.43	N.I.R.P.M.B. (1999)
Balta Albă Lake	16.24	N.I.R.P.M.B. (1997)
Cojocna Lake	101.01	N.I.R.P.M.B. (2001)
Fundata Lake	12.64	N.I.R.P.M.B. (2006)
Salt Lake Brăila	111.05	N.I.R.P.M.B. (2004)
Techirghiol Lake	78.55	N.I.R.P.M.B. (2007)

The composition of peloïds (therapeutic muds) is different and it depends on the natural conditions of their formation; they are the sediments which form as a result of the decomposition of flora and fauna under the influence of microbiological activity (Nikipelova, 2011).

The pelogenous lakes show that the dependence of mineralization degree of the mud solution and of the quality of organic matter embedded in the mud account for the specific composition of the biocenosis. The intensity of mineralization process is conditioned by the high amount of nitrogen in organic residues expressed by the C/N ratio, which differs from one pelogenous lake to another (Samson et al., 1984).

In the lakes with a concentration of salts below 100 $g \cdot dm^{-3}$, where an extremely rich biological life is developed during the warm season (Techirghiol, Amara), large reserves of organogenic **mud with sapropel character** are found (Morariu et al., 1968).

In the lakes with a high content of salts (over 100g/l), in which the biological life is reduced and the amount of organic substance is smaller, compared to the anorganic elements that are stored, **mud with mineral character** is formed (Morariu et al., 1968).

The chemical substances of the peloïd acts pharmacodynamically, through ion exchange with the skin that comes in contact. The ionic exchange capacity is determined by the clay component (mineral) and the humic substances (organic) from the peloïd (Teleki and al., 1984).

The pelogenous lakes require the maintenance of some biological, chemical standards, which may be different from the general recommedations for freshwater and saline lakes, but non-therapeutical (Bulgăreanu, 1996), because it has been observed a differentiation between the plankton, microbenthos, macrophytes and cormophytes species present in the pelogenous lacustrine ecosystems (usuallly therapeutic), and the non- pelogenous ones (Ionescu et al., 1998).

We proposed a comparative study of this particular type of ecosystem (pelogenous lakes), through the identification of the effects exercised by their physical and chemical properties over the diversity of the phytoplankton, and implicitly over the chemical composition of the mud that is formed in these lakes.

2. Material and methods

Salt Lake Brăila, Amara Lake and Fundata Lake, natural lakes from fluvial-estuary type, are located in the steppe region in the Romania Plain; Techirghiol is a river-marine type lake, located on Romanian coast of the Black Sea while Black Lake Sovata is a saline lake of anthropological origin that came into being on a massive salt mountain range in Transylvania (in northern Romania).

The study was conducted during the years 2004-2005. The samples from the five pelogenous lakes where taken in May, August and September 2004 and June, August and October 2005. The number of points from which these samples were taken, have been settled according to the area of each lake, and their position concurred with the most productive areas for peloidogenesis. From Salt Lake Brăila four points have been investigated (Pontoon, Center, Tourist Inn, Highway), from Lake Amara four points (Golf, Center, East Lake, West Lake), from Lake Fundata two points (Center, Littoral), from Lake Techirghiol three points (Sanatoriun, Boathhouse, Tower TV) and from Black Lake-Sovata two points (Center, Littoral). From each point, five parallel samples have been analyzed.

For each phytoplankton sample, 100 liters of lake water have been filtered through the plankton net, 25 μ mesh, from the epilimnion (30-50 cm depth). The concentrated samples were introduced in glass recipients, preserved immediately with Lugol solution (a proportion of 3 ml of fixing solution for 1000 ml of sample), and then labeled. The phytoplankton samples were analyzed in a Fuchs-Rosenthal chamber; for accuracy, three duplicate counting were made in chamber (both the upper and the lower chamber) for each sample of phytoplankton. Algal species were identified according to Anagonstidis and Komárek (1985, 1988), Krammer and Lang-Bertalot (1988), Sládeček (1989), Godeanu (2002), Pârvu (2003), Sigee (2005), Anastasiu (2008), Hamed (2008), Zgrundo et al. (2009). Samples for the hydrochemical analysis have been taken at the same time and from the same locations as the phytoplankton samples; the pH has been determined electrometrically, with pH primary standard solutions, the dissolved oxygen has been determined through the Winkler method, and the NO_3^- ion by spectrophotometric method at 324 nm. Water transparency was measured with Secchi disc.

The chemical analysis of the mud samples was realized according to the working methods used for the analysis of the soil (Mănescu et al., 1994). For the appreciation of the similarity degree of the phytocenosis from the five lakes, generators of therapeutic mud, Salt Lake Brăila, Amara Lake, Fundata Lake, Techirghiol Lake, Black Lake-Sovata the Sorensen index (coefficient) has been calculated, according to Eq. (1), where *a* – number of species from the first sample; *b*- number of species from the second sample; *c*- number of species common to the two samples.

$$S = 2c / a + b \quad (1)$$

Cluster analysis was applied to generate dendrograms (single linkage method (Stuetzle, 2007)), based on the Sorensen coefficient distance among samples.

3. Results and discussion

According to the compositional analysis of the phytoplankton for the five lakes, generators of therapeutic mud, the highest number of phytoplankton species was recorded in Techirghiol Lake (127 species·dm^{-3}) being followed in decreasing order of the phytoplankton diversity by Fundata Lake (64 species·dm^{-3}), Amara Lake (33 species·dm^{-3}), Salt Lake-Brăila (23 species·dm^{-3}) and Black Lake - Sovata (23 species·dm^{-3}) (Table 2).

The dominating taxonomic group from the studied lakes, regardless to the salinity variations, was represented by Bacillariophyceae (Pennales Order) and the least present was the Xantophyceae class, identified with only a single species in the phytoplankton in Techirghiol Lake (Table 3).

The Sorensen similarity coefficient has values between 0 (disimilarity) and 1 (total similarity, identity).

Table 2. List of algal species identified in five romanian pelogenous lakes

Taxa	*Salt Lake-Brăila*	*Amara Lake*	*Fundata Lake*	*Techirghiol Lake*	*Black Lake-Sovata*
Bacterioplankton					
Cyanobacteria					
Anabaena affinis Lemm.	-	-	+	-	-
Anabaena flos-aquae Breb.ex.Bornet et Flahaut	-	-	-	+	+
Anabaenopsis elenkinii Milller	-	-	-	+	-
Aphanizomenon flos-aquae (L.)Ralf	+	-	-	+	+
Aphanothece sp.(culture)	-	+	-	-	-
Beggiatoa alba (Vaucher Trevison)	-	-	-	+	-
Chroococcus turgidus Kützing Näegeli	-	-	+	+	-
Dactylococcopsis rhaphidioides (Hansgirg)	-	+	-	+	-
Gloecapsa turgida (Kütz.)Hollerbach	-	+	+	-	-
Merismopedia punctata (Meyen)	-	-	+	-	-
M.tenuissima (Lemmermann)	-	-	+	+	-
Microcoleus chtonoplastes (Fl.Dan)Thuret	+	-	-	-	-
M. vaginatus (Vauch)Gomont	+	-	-	-	-
Microcystis aeruginosa Kützing	-	-	-	-	+
Nostoc commune (Vaucher)	+	-	-	-	-
Oscillatoria animalis C.Agardh	-	-	-	+	-
O. brevis (Kütz.)Gomont	-	-	+	+	-
O. chalybea (Mert.)Gomont	-	+	+	-	-
O. formosa (Bory)	+	-	-	-	-
O. limosa (Agardh)	-	-	-	+	-
O. minima (Gicklhorn)	+	-	-	-	-
O. planctonica (Woloszynska*)*	+	-	-	-	+
O. putrida (Schmidle)	-	+	-	+	+
O. sancta (Kütz.)Gomont	-	-	-	+	-
O. splendida (Grev.ex.Gomont)	-	-	-	+	-
O. subtilissima Kützing	-	-	-	+	-
O. tenuis Agardh ex. Gomont	+	+	-	+	-
O. tenuis (Agardh) *var. natans* (Kütz.)Gomont	+	-	-	-	-
O. terebriformis (Agardh*)*	+	+	+	+	-
Phormidium fragile(Menegh.)Gomont	-	-	+	-	+
P. tenue var.chlorina (Meneghini)Gomont	-	-	-	+	-
Spirulina jenneri (Hass.)Kützing	-	+	+	+	-
S. major (Kützing)	-	-	-	+	-
S. teniussima (Kützing)	-	-	-	+	-
Synechococcus curtus (Setchell)	-	+	-	+	-

Phytoplankton					
Euglenophyceae					
Euglena pisciformis Klebs	+	-	+	+	-
E. oxyuris Schmarda	-	-	+	-	-
E. viridis Ehrenberg	-	-	+	-	-
Eutreptia viridis Perty	-	-	-	+	-
Phacus longicauda (Ehr.)Dujardin	-	-	+	-	-
P.pleuronectes (O.F.M.)Dujardin	-	-	+	-	-
Trachelomonas euristoma Stein	-	-	-	+	-
T. hispida (Perty) F. Stein	-	-	-	+	-
T. incerta Lemmermann	-	-	+	+	-
T. regularis Skvortov	-	-	-	+	-
Bacillariophyceae					
Achnanthes brevipes (Agardh)	-	-	-	+	-
A. lanceolata var.elliptica Cleve	-	-	-	+	-
A. longipes (Agardh)	-	-	-	+	-
Amphiprora paludosa W.Smith	-	-	+	+	-
Amphora coffeaformis (Agardh)	-	-	-	+	+
A. coffeaformis var. acutiuscula (Kütz.)Hustedt	-	-	-	+++	-
A. commutata Grünow	-	-	-	+	-
A. lineolata (Ehrenberg*)* *robusta* (Gregory*)*	+	-	-	-	-
A. ovalis (Kützing)	-	-	+	-	-
Aulacoseira granulata (Ehr.)Simonsen	-	-	+	-	-
Caloneis amphisbaena (Bory)Cleve	-	-	-	+	-
Cocconeis disculus (Schumann)Cleve	-	-	+	-	-
C. pediculus (Ehrenberg)	-	-	-	+	+
C. placentula (Ehrenberg)	-	-	-	+	-
C. scutellum (Ehrenberg)	-	-	-	+	-
Campylodiscus bicostatus (W.Smith)	-	+	+	-	-
Cyclotella meneghiniana Kützing	-	+	-	+	-
Cymbella gracilis (Rabenh)Cleve	-	-	-	+	-
C. ventricosa (Kützing)	-	+	-	+	-
Diatoma vulgare Bory	-	-	+	-	-
Diploneis interrupta (Kütz.)Cleve	-	-	-	+	-
Epythemia turgida (Ehr.)Kütz.	-	-	+	-	-
Fragilaria acus (Kütz)Lange-Berthalot	-	+	-	-	-
F. brevistriata Grunow	-	-	+	-	-
F. construens (Ehr.)Grunow	-	-	+	-	-
F. fasciculata (Agardh)Lange-Berthalot	-	-	+	+	-
F. ulna (Nitzsch)Lange-Berthalot	-	+	+	+++	-
Gomphonema angustatum (Kütz.)Rabenhorst	-	-	-	+	-
G. olivaceum (Lyngb)Kützing	-	+	+	-	-
Gyrosigma acuminatum (Kütz)Rabenhorst	-	-	+	-	-
G. spenceri W.Smith (Griffith&Henfrey)	-	-	-	+	-
G. strigile (W.Smith)Cleve	-	-	-	+	-
Mastogloia lanceolata Thwaites ex W.Smith	-	-	-	-	+
Melosira moniliformis (O.Müller)Agardh	-	-	+	+	-
M. moniliformis var. subglosa Grunow	-	-	-	+	-
Navicula cincta (Her.) Kützing	-	-	-	+	+
Navicula cryptocephala Kützing	+	-	++	+	-
N. cryptocephala Kützing *var.intermedia* Grunow	-	+	-	-	-
N. cryptocephala Kützing *var. veneta* (Kütz)Grunow	-	+	-	-	-
N.cuspidata Kützing	-	-	+	-	+
N. exigua (Greg.)O.Müller	-	-	-	+	-
N. halophila (Grunow)Cleve	+	-	-	-	+
N. hennedyi W.Smith	-	-	-	+	-
N. hungarica Grunow	+	-	-	-	-
N. menisculus Schumann	-	-	-	+	-
N. pigmaea Kützing	-	-	+	-	-
N. peregrina (Ehr.) Kützing	-	+	-	-	-
N. placentula (Ehr.) Grunow	-	-	-	+	-

N. placentula (Ehr.) Grunow *var.rostrata* A.Mayer	-	-	-	++	-
N. platystoma Ehrenberg	-	+	+	-	-
N. pupula Kützing	-	-	-	+	-
N. rhyncocephala Kützing	-	-	-	+	-
N. salinarum Grunow	-	-	-	+	-
Neidium affine (Ehr.)Cleve	-	-	+	-	-
Nitzschia acicularis W.Smith	-	+	+	+	-
N. apiculata Kützing Smith	-	-	-	+	-
N. closterium (Ehr.)W.Smith	-	+	-	+	+
N.commutata Grunow	-	-	-	-	+
N. distans Gregory	-	-	-	+	-
N. hungarica Grunow	+	-	-	+	-
N. lanceolata W.Smith	-	-	-	+	-
N. linearis W.Smith	-	-	+	-	-
N. longissima f.parva Grunow	-	-	-	+	-
N. longissima var. reversa Grunow	-	-	-	+	-
N.lorenziana Grunow	-	-	+	+	-
N. obtusa W.Smith	+	-	-	-	+
N. recta Hantzsch	-	-	-	+	-
N. subtilis (Kütz.)Grunow	-	-	-	+	-
N. tryblionella Hantzsch	-	-	-	+	-
N. tryblionella var. victoriae Grunow	-	-	-	+	-
Pinnularia interrupta W.Smith	-	+	-	-	
P. major Kützing Rabenhorst	-	-	+	-	-
P. microstauron (Ehr.)Cleve	-	-	-	+	-
P. microstauron var.ambigua Meister	-	-	-	+	-
P.viridis (Nitzsch)Ehrengerg	-	-	+	+	-
Pleurosigma angulatum (Queck)W.Smith	-	+	-	+	-
P. angulatum var. strigosum (W.Sm.)Cleve	-	-	-	+	-
P. delicatulum W.Smith	-	-	-	+	-
P. elongatum W.Smith	-	-	-	+	-
P. salinarum Grunow	-	+	-	-	+
Rhoicosphaenia curvata(Kütz.) Grunow	-	+	+	+	-
Rhopalodia gibba (Ehr.)O.Müller	-	-	+	+	-
R.gibba var.ventricosa (Ehr.)Grunow	-	-	-	+	-
Stauroneis anceps (Ehr.)	-	-	-	+	-
S. salina W.Smith	-	-	-	+	-
Stephanodiscus astrea (Ehr.)Grunow	-	-	-		-
Surirella ovalis Brebisson	+	+	+	+	+
S. robusta Ehrenberg	-	-	+	-	-
S. robusta Ehrenberg *var.splendida* (Ehr.)VanHeurck	-	-	+	-	-
S. spiralis Kützing	-	-	-	+	-
S. striatula Turp.	-	-	+	+	+
Synedra rumpens Kütz.	-	-	+	-	-
S. tabulata Kütz.	-	-	+	+	-
S. ulna Kütz.	-	-	+	-	-
Thalassiosira excentrica (Grun.)Jorg	-	-	-	+	-
T. parva Proshkine-Lavrenko	-	-	-	+	-
Chlorophyceae					
Ankistrodesmus falcatus (Corda)Ralfs	-	-	+	-	-
Apiocystis brauniana Nageli	-	-	-	-	+
Asterococcus superbus (Cienk.)Scherrfel	-	-	+	+	
Carteria obtusa Dill	-	-	-	+	-
Chlamydomonas simplex Pascher	-	+	+	+	+
Chlorella ellipsoidea Gerneck	-	-	-	+	-
C. vulgaris Beijrinck	-	+	-	+	-
Cladophora crystallina (Roth)Kütz.	-	+	-	+	-
C. vagabunda (L.)Hoek	-	+	-	+	-
Cosmarium punctatum Brebisson	-	-	+	-	-
C. reniforme (Ralfs)Archer	-	-	+	-	-
Crucigenia quadrata Morren	-	-	+	-	-
Dictyosphaerium ehrenbergianum Nagela	-	-	-	+	-
Dunaliella salina Teodoresco	+	-	-	+	-
Enteromorpha intestinalis (L.)Link	+	+	-	+	-

E. linza (L.)J.Agardh	-	-	-	+	-
E. maeotica Proshkina-Lavrenko	-	-	-	+	-
Gonium pectorale O.F.Müller	-	+	-	+	-
Oocystis elliptica W.West	-	-	-	+	-
Pediastrum buryanum (Turp.)Meneghini	-	-	+	-	-
P. chlatratum Lemm.	-	-	+	-	-
P. tetras (Ehrenberg)Ralfs	-	-	+	+	-
Rhizoclonium hieroglyphicum (Ag.)Kützing	-	-	+	+	-
R. hieroglyphicum (Ag.)Kutzing *var. dimorphum* (Wittr.)Stockmayer	+	-	-	-	-
R. riparium (Roth)Kütz.ex.Harv.	-	-	-	+	-
Scenedesmus acutus Meyen	-	-	+	-	-
S. crassus Chodat	-	-	+	-	-
S. quadricauda (Turp.)Brebisson in Brébisson & Godey	+	+	+	+	+
Schroederia setigera (Schrőd.)Lemmermann	-	-	-	+	-
Selenochloris bicaudata Pascher	-	-	-	+	-
Spirogyra tenuissima (Hass.)Kützing	+	-	-	-	-
Ulothrix zonata Kützing	-	-	+	+	-
Urospora penicilliformis (Roth)Areschoug	-	-	-	+	-
Chrysophyceae					
Chrysamoeba scherffelli (Pascher)Matvienko	-	-	+	+	-
Dendromonas cryptostylis Skuja	-	-	-	+	-
Desmarella moniliformis Kent	-	-	-	+	-
Cryptophyceae					
Chroomonas caudata L.Geitler	-	-	-	+	-
Chryptomonas ovata Ehrenberg	-	-	-	+	+
Xantophyceae					
Gloeobotrys chlorinus A.Pascher	-	-	-	+	-
Dinophyceae					
Amphidinium klebsii Kofoid et Swezy	-	-	-	+	-
Glenodiniopsis steinii Woloszynska	-	-	-	+	-
G. uliginosa (Schilling)Woloszynska	-	-	-	+	-
Gymnodinium eurytopum Skuja	-	-	-	+	-
G. fuscum (Ehr.)Stein	-	-	-	+	-
Oxyrrhis marina Dujardin	-	-	-	+	+
Peridinium cinctum (O.F.Mull.)Ehr.	-	-	-	+	-
Woloszynskia leopoliensis Thompson	-	-	-	+	-
W. negleta (Schilling)Thompson	-	-	-	+	-

- absent taxon ; + = present taxon; ++ = abundant taxon (26-50%) ; +++= common taxon (51-75%)

Table 3. Phytoplankton composition in five Romanian pelogenous lakes (averages±SD)

Taxonomic group	*Salt Lake Brăila (A)*	*Amara Lake (B)*	*Fundata Lake (C)*	*Techirghiol Lake (D)*	*Black Lake- Sovata (E)*
Cyanobacteria	10 (±4.95)	9 (±0.58)	10 (±1.73)	21 (±5.12)	6 (±1.14)
Euglenophyceae	1 (±0.00)	0	6 (±0.58)	6 (±2.22)	0
Bacillariophyceae	7 (±0.71)	17 (±0.58)	33 (±2.00)	63 (±11.53)	12 (±2.45)
Chlorophyceae	5 (±0.00)	7 (±0.00)	14 (±1.15)	22 (±0.82)	3 (±0.55)
Chrysophyceae	0	0	1 (±0.58)	3 (±1.00)	0
Cryptophyceae	0	0	0	2 (±0.50)	1 (±0.55)
Xantophyceae	0	0	0	1 (±0.58)	0
Dinophyceae	0	0	0	9 (±1.50)	1 (±0.45)
Total number species $\cdot dm^{-3}$	**23** (±3.78)	**33** (±6.36)	**64** (±11.41)	**127** (±20.73)	**23** (±4.39)

According to the presence/absence of the species, this indicator shows the degree of similitude between the studied samples/ communities/ecosystems. For Cyanobacteria, the calculated values (Table 4) for the Sorensen similarity coefficient (0.10-0.40) reflect a weak association of the species from this group in the studied pelogenous lakes (Fig. 1).

The water transparency, the dissolved oxygen concentration and the nitrogen concentration, important elements in the ecology of Cyanobacteria (Scagel et al., 1984), which significantly differ in the studied lakes (Table 5), have determined the variability of the composition of this group from this type of ecosystems. The most abundant species in the all five pelogenous lakes was *Oscillatoria terebriformis* Agardh; the lowest similarity coefficient 0.10 (Table 4) was registered for the lacustrine ecosystems Salt Lake Brăila and Fundata that have very different salinity (Table 5).

Most common species of Cyanobacteria were recorded in Amara Lake and Fundata Lake, lakes with a similar physical and chemical composition.

For the Bacillariophyceae class, the microalgae most representative as a number of species per cubic decimeter (126), in the plankton of the five pelogenous lakes, the level of similarity has varied between 0.08 and 0.32 (Table 6), (Fig. 2).

The minimum similarity level between Salt Lake- Brăila and Amara Lake is mainly determined by the different salinities (Table 5); salinity is one of the most important ecological factors that condition the spread of diatoms, various species of diatoms recording varying degrees of resistance to salinity and its oscillations (Ionescu and Péterfi, 1981).

The Salt Lake-Brăila and Black Lake-Sovata association as biotopes with a high level of similarity for the species of diatoms identified in the phytoplankton cat not be explained, because their physicochemical characteristics (salinity, pH, dissolved oxygen concentration, transparency, NO_3^-), having considerable variations (Table 5). The common species of diatoms that we have identified most frequently are species with a large tolerability towards the environment conditions such as:

- *Surirella ovata* Kützing, freshwater species that can tolerate slight fluctuations in osmotic pressure rather well and may, therefore, also be common in certain brackish waters, its optimum pH lies between 7.5 and 8;
- *Navicula cryptocephala* Kützing, freshwater-brackish water species (oligohalobe indifference), very widespread, almost ubiquitous (Godeanu, 2002);
- *Nitzschia hungarica* Grünow, species with a pH 8.5 optimum development; it can tolerate oxygen deficiencies; halophilous, ß- mezohalobous;
- *Cyclotella meneghiniana* Kützing, planctonic species on littoral zone, alkalibiont, eurihalobous, N-heterotrophic facultative.

The dendrogram realized based on the values of Sorensen coefficient (Table 7), reflects the formation of two clusters of lakes which have a similar composition of the phytoplankton regarding the species of the Chlorophyceae: cluster 1-Techirghiol Lake and Black Lake-Sovata; cluster 2-Salt Lake- Brăila, Fundata Lake (Fig. 3).

Clusters that are formed are surprising, because they include lakes with different mineralization, even opposite ones (Table 5); an explanation of the formation of cluster 1 could be the transparency of the water which has similar values in both lakes (1.70-1.75), thus being permitted the development of similar species of Chlorophyceae.

Table 4. Sorensen coefficient values for Cyanobacteria

S value in samples	A	B	C	D	E
A	-	0.21	0.10	0.19	0.25
B	0.21	-	0.42	0.40	0.13
C	0.10	0.42	-	0.32	0.12
D	0.19	0.40	0.32	-	0.22
E	0.25	0.13	0.12	0.22	-

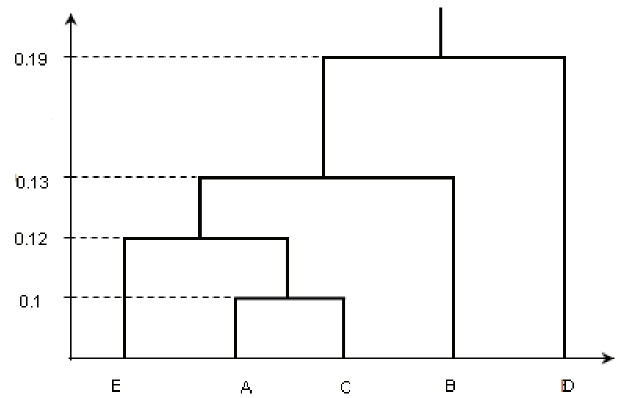

Fig. 1. Dendrogram performed single linkage method for Cyanobacteria phylum composition; axis y – Sorensen similarity coefficient values, axis x – biotopes: A- Salt Lake- Brăila; B-Amara lake; C- Fundata lake; D- Techirghiol lake; E- Black lake-Sovata

Table 5. Variation in phytoplankton diversity and chemical composition of mud depending on physicochemical features of pelogenous lakes

Lake	*Mud*	*Water*						*Phytoplankton composition*
	Global Composition (g % for native mud)	*pH*	*Salinity ($g \cdot dm^{-3}$)*	*Dissolved oxygen ($mg \cdot dm^{-3}$)*	*Transparency (m)*	*NO_3- ($mg \cdot dm^{-3}$)*	*PO_4- ($mg \cdot dm^{-3}$)*	
Amara	u= 51.624 v.s.= 4.665 m.s.= 43.711	9.0	10.57	4.92	2.25	12.4	2.5	Cyanobacteria 27.27% Bacillariophyceae 51.51% Chlorophyceae 21.22%
Black Lake-Sovata	u= 61.000 v.s.= 6.856 m.s.= 32.144	7.5	17.76	3.96	1.70	4.5	9	Cyanobacteria 27.27% Bacillariophyceae 54.54% Chlorophyceae 9.09% Cryptophyceae 4.54% Dinophyceae 4.56%
Fundata	u= 58.427 v.s.= 6.858 m.s.= 34.715	8.8	10.32	3.33	2.10	1.7	4.7	Cyanobacteria 15.62% Euglenophyceae 9.37% Bacillariophyceae 51.56% Chlorophyceae 21.87% Chrysophyceae 1.58%
Salt Lake Brăila	u= 54.498 v.s.= 6.038 m.s.= 39.464	8.5	118.52	0.86	0.25	7.4	1.6	Cyanobacteria 43.48% Euglenophyceae 4.35% Bacillariophyceae 30.43% Chlorophyceae 21.74%
Techirghiol	u= 61.569 v.s.= 8.085 s.m.= 30.355	8.3	61.49	4.29	1.75	9.5	6.3	Cyanobacteria 16.53% Euglenophyceae 4.72% Bacillariophyceae 49.61% Chlorophyceae 17.32% Chrysophyceae 2.36% Crysophyceae 1.57% Xantophyceae 0.79% Dinophyceae 7.1%

u= umidity; v.s.= volatile substances; m.s.= mineral substances

Table 6. Sorensen coefficient values for Bacillariophyceae Class

S value in samples	*A*	*B*	*C*	*D*	*E*
A	-	0.08	0.10	0.09	0.32
B	0.08	-	0.28	0.20	0.21
C	0.10	0.28	-	0.28	0.13
D	0.09	0.20	0.28	-	0.16
E	0.32	0.21	0.13	0.16	-

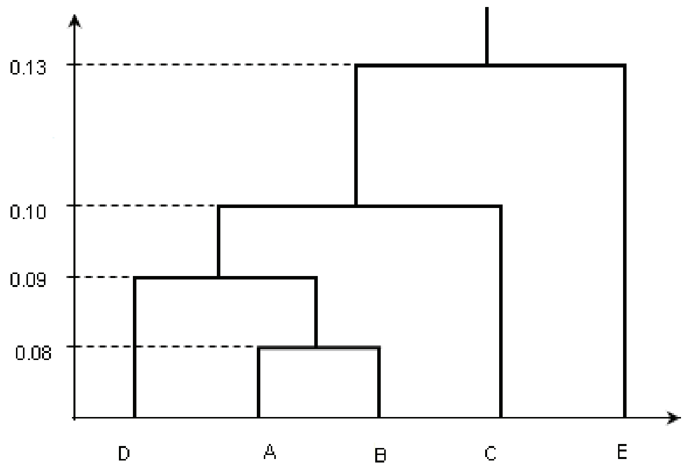

Fig. 2. Dendrogram performed single linkage method for Bacillariophyceae class composition; axis y – Sorensen similarity coefficient values, axis x – biotopes: A- Salt Lake- Brăila; B-Amara lake; C- Fundata lake; D- Techirghiol lake; E- Black lake-Sovata

Table 7. Sorensen coefficient values for Chlorophyceae Class

S value in samples	*A*	*B*	*C*	*D*	*E*
A	-	0.33	0.10	0.22	0
B	0.33	-	0.19	0.48	0.22
C	0.10	0.19	-	0.28	0.12
D	0.22	0.48	0.28	-	0.08
E	0.25	0.22	0.12	0.08	-

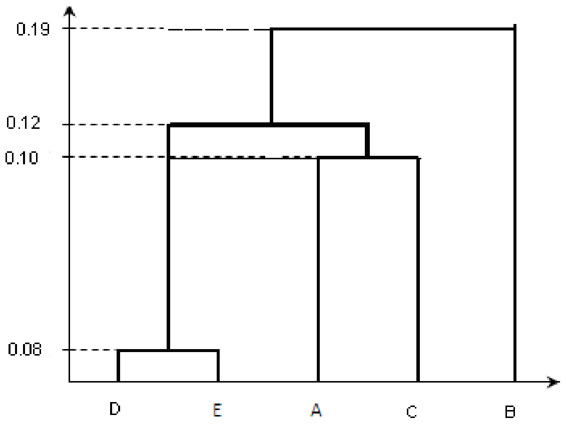

Fig. 3. Dendrogram performed single linkage method for Chlorophyceae class composition; axis y – Sorensen similarity coefficient values, axis x — biotopes: A- Salt Lake- Brăila; B-Amara lake; C- Fundata lake; D-Techirghiol lake; E- Black lake-Sovata

In case of cluster 2, a common characteristic of pelogenous biotopes is the almost identical value of pH (8.5-8.8). Also it can be observed the lack of common species of Chlorophyceae in Salt Lake-Braila and Black Lake-Sovata but also the presence of *Scenedesmus quadricauda* (cosmopolitan, widespread, ß-mezosaprobe) (Godeanu, 2002)) in four of the five analyzed biotopes, and also the species of genera *Enteromorpha* in three pelogenous lakes (Salt Lake Brăila, Amara Lake, Techirghiol Lake). For the Euglenophyceae class the comparison of the species diversity is impossible because this class was founded only in three biotopes from five studied (Table 2).

The absence of the microalgae from the Chrysophyceae, Cryptophyceae, Xantophyceae, Dinophyceae classes in the phytoplankton from Amara Lake and Salt Lake Brăila a, makes impossible a comparison of the diversity of the species from these classes in all of the five studied lakes which form peloïd.

The hypersaline lake Techirghiol, where mud with the highest content of organic substances is formed (Table 5), was the most algologically productive habitat; followed by Fundata and Amara, brackish lakes, biotopes that form sulfurous mineral mud, with medium organic fraction.

Salt Lake Brăila and Black Lake-Sovata were the least algologically productive ecosystems; in both lakes mud with mineral developed fraction and organic component in small percentage are formed, although they are biotopes with different salinity, one being hypersaline, the other brackish.

The reduced contribution of the microalgae in the economy of the peloidogenesis process is compensated in Black Lake-Sovata by the considerable contribution of organic material generated by the rich circum-lacustrine vegetation, and in Salt Lake Brăila by the abundant zooplankton, dominated by *Artemia salina* L., crustacean, an important provider of organic matter.

4. Conclusions

1. The highest number of phytoplankton species was recorded in Techirghiol Lake (127 species) and the lowest number in Black Lake-Sovata and Salt Lake Brăila (23 species).

2. For Cyanobacteria and Bacillariophyceae, the calculated values for the Sorensen similarity coefficient reflect a weak association of the species in the pelogenous lakes; for the Euglenophyceae, Chrysophyceae, Crysophyceae, Dinophyceae, Xanthophyceae classes the comparison of the species diversity was impossible because they were not found in all studied biotopes.

3. The composition of the Chlorophyceae class was similar in the plankton of two clusters: cluster 1- Techirghiol Lake and Black Lake-Sovata; cluster 2- Salt Lake- Brăila, Fundata Lake.

4. The hypersaline lake Techirghiol was the most algologically productive habitat, here forming the mud with the highest content of organic substance. Salt Lake Brăila and Black Lake-Sovata were the least algologically productive ecosystems; in both lakes mud with mineral developed fraction and organic component in small percentage are formed, although they are biotopes with different salinity, one being hypersaline, the other brackish.

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