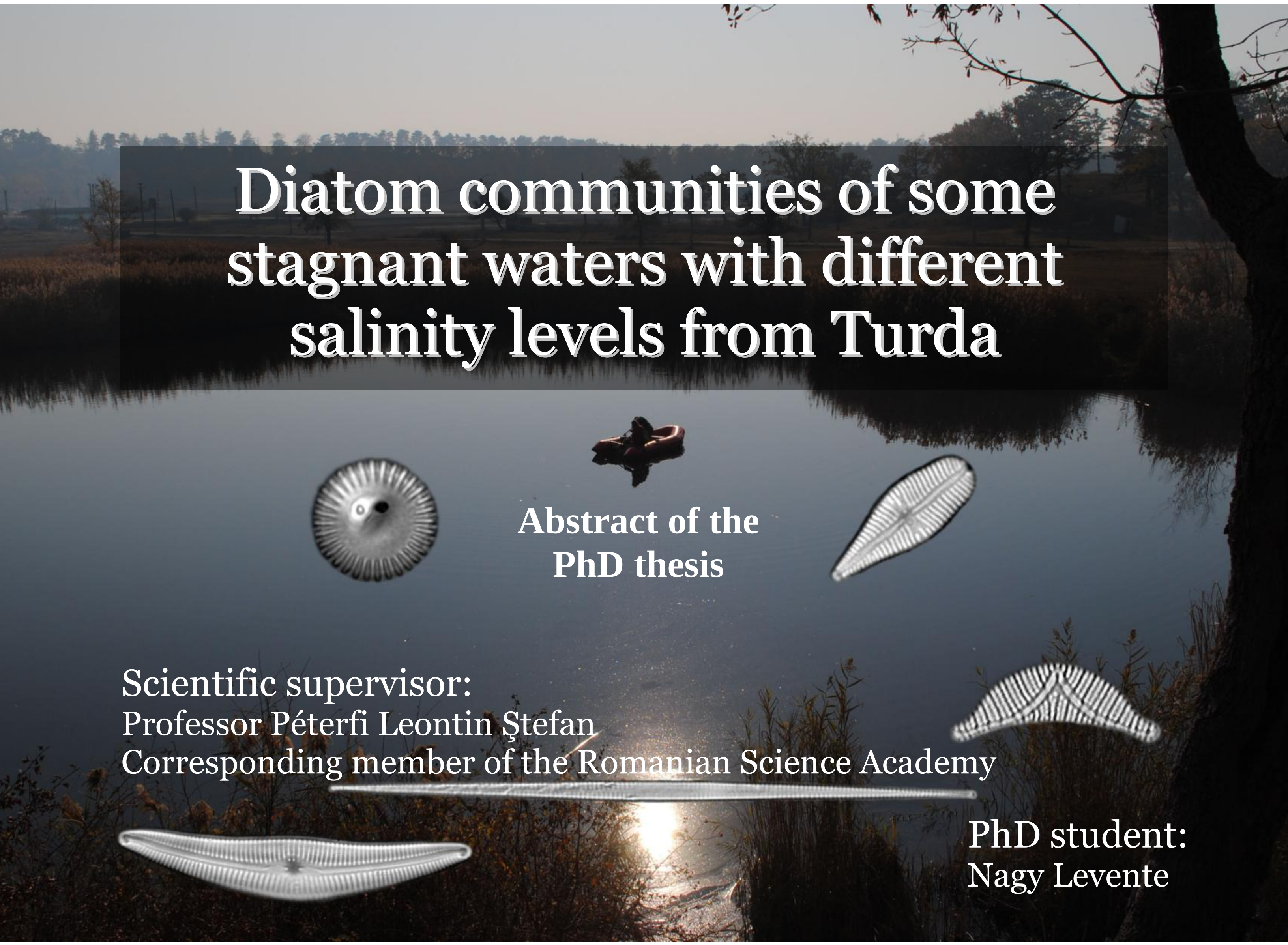
”Babeş-Bolyai” University
Faculty of Biology and Geology
Departament of Taxonomy and Ecology



Diatom communities of some stagnant waters with different salinity levels from Turda

Abstract of the PhD thesis

Scientific supervisor:
Professor Péterfi Leontin Ştefan
Corresponding member of the Romanian Science Academy

PhD student:
Nagy Levente

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➢ **Key words**: *diatoms, saline lakes, phytoplankton, periphyton, qualitative structure, density, community dynamics, vertical distribution, water quality*

Introduction

The saline lakes from Turda and their surroundings are presently part of the protected area "Sărăturile Ocna Veche" (code ROSCI0223). They represent an interesting, attractive and precious subject for different kinds of studies. Through time, aspects related to geology, biology, limnology, hydrology, archeology have been investigated. Studies regarding the salt massifs, specific landslide phenomena, lake formation or fossil organisms have been carried out. The flora characteristic to this area was also described. In addition is worth mentioning the salt exploitation activities – probably since the Roman occupation – and the use of these saline lakes for recreational and therapeutic purposes.

Studies regarding diatom communities of these aquatic ecosystems are scarce or inexistent. While some data can be found in Tömösváry's work (1880), an article signed by Pákh (1936) referring to euglenoids mentions the abundance in diatoms in some saline pools but without naming any species whatsoever. Professor L. Şt. Péterfi in his relevant article from 1965 includes a description of the submicroscopic structure of *Amphiprora paludosa* var. *subsalina* (syn. *Entomoneis paludosa* var. *subsalina*) originating from one of these pools. A publication of Róbert (1970) deals with the diatoms identified from three lakes and pools (Csiki, Privighetoarea and nameless one). Finally, in this thesis an up to date contribution to the knowledge of these communities is made, which was included also in a series of publications (Nagy & Péterfi, 2008; Nagy *et al*., 2006 a,b; 2007). The most recent information is presented in this thesis, highlighting the discovery of new species for Romania.

The author would like to stress that considering the high number and great diversity of aquatic habitats in this area, the existing diatom studies are very few. In 2010 the area – including the studied aquatic habitats – was declared protected area of national interest, reflecting the scientific value of these ecosystems. Thus, this creates an increased importance of the work included in this thesis, especially when we consider the biodiversity existing in such protected areas. Furthermore, the herein presented data offers the possibility to perform, comparative studies of past and present algal diversity shadding light on possible future composition, as well as comparisons with similar ecosystems located elsewhere.

Considering the above indicated perspectives but not only, the author considers this thesis to be an up to date complex study of diatom communities of lakes with different salinity levels from Turda area. In conducting this study it was of utmost importance to consider all the characteristic aquatic elements that influence and interrelate directly or indirectly with the investigated group.

The objectives underlying this thesis are:

- to include several aquatic ecosystems from Turda area characterized by different salinity levels that were poorly or not at all investigated for their diatom communities;
- to make an inventory and to bring new data regarding the diatom communities of these lakes;
- to observe the environmental factors and their influence on the studied biotic component;
- to observe different aspects regarding the dynamics and vertical stratification of diatom communities;
- to make comparisons between the diatom communities of the investigated lakes, with emphasis on salinity levels and its influence on the target group;
- to classify the lakes based on several biotic indexes;
- to highlight the human impact influencing directly and/or indirectly the planktonic and periphytic diatoms.

Before closing this short introduction I wish to express my appreciation and gratitude to those who contributed in a way or another to the realization of this thesis. I mention Professor Dr. Leontin Ştefan Péterfi, the scientific supervisor of the thesis; Lecturer Dr. Laura Momeu who offered me precious guidance and advice; Professor Dr. Nicolae Dragoş and the colleagues from the Biological Research Institute - Cluj, for offering logistic support during field trips. Lecturer Dr. Irina Goia and Lecturer Dr. Marcel Pârvu as part of the advissory committee are thanked for taking time to examin the thesis. My gratitude extends to my collegues and friends assistant professor Dr. Karina Battes and Dr. Daniel Țura for their precious help during field trips; my chief, Ing. Alexandru Fekete, at LRCA Romanian Water Authority – Cluj, who showed understanding and proved to be open minded to my efforts in completing this PhD; my collegues, Drs. Anna Szabó and Dr. Ioan Cărăuş; my collegues from different hungarian research institutes: Dr. Gábor Borics, Dr. Éva Ács and Dr. Gábor Várbíró; my parents József and Rózsa.

Last but not least, I want to thank my wife, Dr Claudia Nagy, for being by my side no matter the difficulties and for offering her unconditioned support and pacience.

I dedicate this work to my one year old daughter, Ayanna Künde. Unfortunately, I missed out on her presence while having to choose for the laptop's keybord in my efforts to advance with my Ph.D. thesis.

Probably the best way to end my introduction is to cite a thought from a memorable work of presumably the most famous naturalist in history:

“Few objects are more beautiful than the minute siliceous cases of the diatomaceae: were these created that they might be examined and admired under the higher powers of the microscope?”

Charles Darwin (1872)

I. Description of study area

The investigated lakes are situated on the edge of the Transylvanian basin. At Turda the diapir massif curves the floor of Arieş bench. This, combined with the old abandoned salt mines dating back to the Roman period and with the phenomenon of salt dissolution favoured the apparition of a microbasin containing the saline lakes from Turda resort area and those from “Sărată” Valley (Fig. 1. 1.).

The most representative geological elements of the area are the salt massifs, as part of a series of massifs from the Transylvanian basin. These formations can be observed on all sides of the basin and in many cases the salt rises to the surface: to the west: Ocna Sibiu, Blaj, Ocna Mureş, Turda, Cojocna or to the east: Odorhei, Benţid, Praid, Gurghiu, Sărăţel.

Formation of saline lakes from old salt mines

Most of the investigated lakes are formed by the collapse of old, bell shaped salt mines (Fig. 1. 2.). The *first phase* in the process is mine excavation, the *second phase* is mine abandonment, the *third* is mine flooding, the *fourth* is mine collapse and finally, the *fifth phase* is the further shaping and

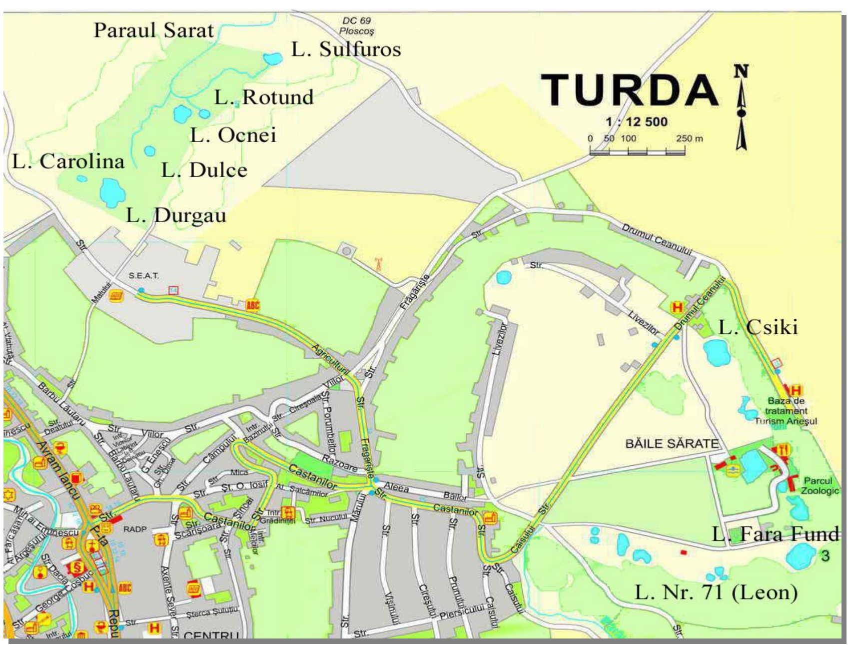

Fig. 1. 1. Geographical location of investigated lakes from Sărată Valley and Băile Romane (source: http://www.spas.ro/turda.htm, 2005)

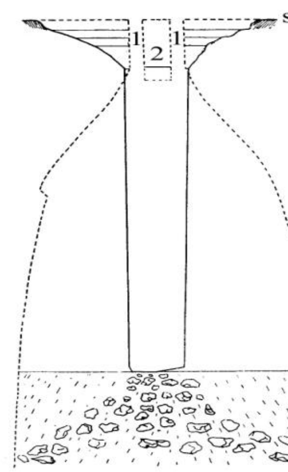

Fig. 1. 2. Profile of a bell shaped salt mine (S - surface; 1 – mine shaft; 2 – dividing wall; discontinuous line – old mine; continuous line – present basin) (after Maxim, 1942)

filling up with water leading to a lake with an enlarged surface. The freshwater input is even more intense (precipitation, trickle, even springs). Freshwater from the surface layer continues to attack and dissolve the litoral zone influencing the final shape of the lake.

II. Materials and methods

II. 1. Description of sampling sites

In order to efficiently describe the diversity of diatom communities from the investigated area, lakes with different properties (geomorphology, physical and chemical parameters, human impact intensity) have been included in this study, namely Lake Durgău (or Dörgő-tó; Maxim, 1937), Lake Csiki, Lake Leon (No. 71), Lake Dulce (No. 3 or Édes tó; Maxim, 1937), Lake Ocnei (No. 4 or Akna-tó) and Lake Sulfuros (No. 6 or Kénköves-tó; Maxim, 1937).

Lake Durgău. This lake (Fig. 2. 1.) is situated in "Sărată" Valley, above the "Ocnei" salt massif which undoubtedly influences the water's physical and chemical properties.

Fig. 2. 1. Lake Durgău (Dörgő-tó)

At the origin of this lake are one or two old salt mines (Maxim, 1937) with a wide bottom which explains its relatively great surface.

The lake has a surface of 4000 m^2, a water volume of 4186 m^3 and a maximum depth of 5.25 m (Maxim, 1937; Gâştescu, 1971). The latest measurements and calculations carried out in this study show a similar maximal depth (aprox. 5 m) but a higher surface of aprox. 6000 m^2. The lake is situated at 372 m altitude and the coordinates for phytoplankton sampling site are: N 46º35'01.8" and E 23º47'08.7". The periphyton was sampled at several stations in order to obtain compound samples.

Fig. 2. 2. Lake Dulce (Nr. 3, Édes-tó)

Lake Dulce. This is the second lake

(Fig. 2. 2.) in “Sărată” Valley, between Lake Durgău and Lake Ocnei. Originally it was more or less a freshwater lake. In 1926 the collapse of a neighbuoring mine formed a new basin. The water gradually infiltrated into the new basin and started to dissolve the salt massif. Thus, salinity levels began to increase.

The surface indicated by Maxim (1937) is 2750 m^2, but recent calculations showed a much smaller value (around 500 m^2 in 2011).

The maximum depth was 6 m. The lake’s altitude is at 363 m and the coordinates of phytoplankton sampling site are N 46º35’05.86”, E 23º47’12.67”. For periphytic diatoms compound samples were taken.

Fig. 2. 3. Lake Ocnei, Nr. 4 or Akna-tó, in 2005 (left) and 2011 (right)

Lake Ocnei. The third lake in “Sărată” Valley is Lake Ocnei (Nr. 4 or Akna-tó, Fig. 2. 3.).

This circular lake with steep banks was formed by the collapse of an old, bell shaped salt mine. The exact “age” of this lake is unknown, but it surely is older than the Middle Ages. Currently the lake is used as an official recreation area curiously named “Durgău” (Fig. 2. 3.).

The calculated lake surface is 1690 m^2 (1650 m^2 according to Maxim, 1937). Data found in literature show a maximum depth of 33.75 m and a water volume of 13340 m^3. The basin has an inverted cone shape.

The coordinates of phytoplankton sampling site are N

Fig. 2. 4. Lake Sulfuros (Nr. 6, Kénköves-tó)

46º35’09.95”, E 23º47’17.17”. Peryphitic samples, as in other cases, were taken in several stations.

Lake Sulfuros. The last lake in “Sărată” Valley” is at the lowest altitude (353 m) and it was also formed by the collapse of a salt mine (Fig. 2. 4.). It is considered to be the oldest lake from this area, dating back to the Roman or even Preroman period. Its basin has an interesting profile: in the center there is a 46 m deep “tube”. The surface given in Maxim’s work is 1000 m^2 but recent calculation indicate a higher value: 1260 m^2. The water volume was around 3385 m^3.

Planktonic diatoms were sampled from a station with the following coordinates: N 46º35’14.12”, E 23º47’28.36”

Fig. 2. 5. Lake Csiki (in summer and winter, just before “ice hole sampling”)

Lake Csiki. From all investigated lakes Csiki (Fig. 2. 5.) has the lowest values of salinity with small fluctuation both over the water column and time. Seventy years ago it was considered the lake with the largest surface in the area: 6000 m^2. Currently the surface is much smaller, around 3500 m^2.

The basin’s shape resembles that of a sinkhole, with a wide bottom and not too steep banks. This is not surprising considering the origin of this lake: an old surface salt exploitation. The maximum depth is around 5 m, while the cited literature mentions a water volume of 7207 m^3. The lake is situated at 365 m altitude and the phytoplankton sampling station is situated at the coordinates N 46º34’46.66” and E 23º48’23.38”

Fig. 2. 6. Lake Leon

Lake Leon. According to an old publication, this pond is named Lake 71. Actually in Todor's work (1948) it appears as Lake 71 with three deeper parts and each receiving another number. The author of this thesis took the liberty of renaming the pond as "Lake Leon". This, also to recognize the contribution of the scientific supervisor of this thesis, Professor Péterfi who also undertook preliminary reseach for this pond in the sixties.

It is a saline lake situated at 360 m altitude, with a small surface less than 300 m^2 (Fig. 2. 6.) and a basin profile resembling that of Lake Sulfuros. More precisely, it is a 4.5 m deep pond that has in the center a 15.88 m deep "tube", an impressive depth for a pond with such a small surface. The coordinates of the phytoplankton sampling site are N 46º34'26.21" and E 23º48'23.42".

II. 2. Sampling methods

Phytoplankton samples

The sampling period for this study was between January and December 2005.

Phytoplankton samples from Lake Durgău and Lake Csiki were taken monthly, from the whole water column (meter by meter). In other cases the sampling process took place seasonally in order to observe aspects regarding species composition, seasonal dynamics and in order to compare the six investigated lakes.

Fig. 2. 7. "Ice hole sampling"

The sampling activity was carried out even during winter when the lake surface was completely frozen (Fig. 2. 7.).

Two types of phytoplankton samples were collected: qualitative and quantitative. The qualitative samples were obtained by filtering 20 l of water recovered from each depth from the center of the lake by using a Schindler-Patalas (10 l) device (Fig. 2. 8.). Quantitative, unfiltered samples were also taken (200-250 ml).

Fig. 2. 8. The Schindler-Patalas device

The FluoroProbe Version 2.2 E1, 09/08

In order to complete the data regarding the vertical distribution of phytoplankton, in 2011 a new instrument has been used, the FluoroProbe Version 2.2 E1, 09/08 (Fig. 2. 9.), provided by the Romanian Water Authority, Someş-Tisa Branch.

This device is functioning based on the fluorescence of planktonic algae, or the spontaneous light emission of algae caused by ultraviolet light irradiance. It determines the principal algal groups in the water column based on the responses to the fluorescent excitation. The graphical representations offer suggestive pictures regarding the composition and vertical distribution of phytoplankton, parallel with the thermal stratification of the lake.

Fig. 2. 9. The FluoroProbe Version 2.2 E1, 09/08

Periphytic diatom samples

For the analysis of periphytic diatom communities, compound samples were taken. With a seasonal frequency, material was recovered from several sampling sites. This material was subsequently mixed in a compound sample representative for each season. The sampling process was carried out by scrapping the surface of submerged objects with a knife or by brushing it with a clean toothbrush. The samples were conserved *in situ* with formaldehyde (4%).

Measurement of physical and chemical parameters

In order to observe the interelationships between diatom communities and abiotic factors, *in situ* measurements of physical and chemical parameters (parallel with diatom sampling) were carried out (Fig. 2. 10.).

Measured parameters were: transparency, temperature, oxygen, pH, salinity, TDS, conductivity. In some cases further analysis were carried out in the laboratory: NH_4^+, NO_2^-, NO_3^-, N_{tot}, SO_4^{2-}, Cl^-, PO_4^{3-}, P_{tot}, Ca^{2+}, Mg^{2+} amount, water hardness and alkalinity.

Fig. 2. 10. Instruments for measuring physical and chemical parameters

Indexes used for characterizing diatom communities and investigated aquatic ecosystems

Shannon-Wiener diversity index (H'): is an index based on information theory and equitability. It is also the most frequently used index for quantifying biocoenosis diversity (Padisák, 2004). ***Equitability***: it shows how close the species' representation model in a biocoenosis is to the possibly highest diversity for the same number of species and individuals. ***Jaccard similarity index*** (I): was used to assess the association degree of different diatom communities. It is one of the simplest but at the same time eloquent similarity indexes. ***Zelinka and Marvan saprobity index*** (SI): the first methods based on biocoenosis composition used for aquatic environment quality assessment were those proposed by Kolkwitz and Marsson (1902) ("Saprobic System" or "Saprobic Method"). The methodology permits an estimation of general organic pollution level of a waterbody, based on species and their abundance occurring in the study area. ***Trophic Diatom Index*** (TDI): is based on benthic diatoms for indicating the trophic status of waterbodies (Kelly *et al*., 2001). Essentially, the method relies on the direct response of benthic diatom communities (as bioindicators) to the amount of nutrients in the water (Belton *et al*., 2005). ***Biological Diatom Index*** (IBD): it is another modern index (Prygiel & Coste, 2000). It is complex, efficient and widely used for monitoring water quality.

III. Results and discussions

III. 1. Lake Durgău

III. 1. 1. Physical and chemical parameters

Secchi transparency and photic zone. Probably the most important abiotic factor influencing the distribution of planktonic algae is light. The dynamics and distribution of these algae is related to the depth of the photic (or euphotic) zone. Variation of this parameter in 2005 was not unusual: lower values were recorded in summer (minimum value in June) as a consequence of phytoplankton biomass increase and of elevated values for particles in suspensions in the water column. It is important to underline the existence of human impact on transparency: in the warm period, when bathing was frequent, a significant resuspension of sediments occurs.

Temperature. Water temperature for the surface layers followed the variation pattern observed for air temperature. For the deep layers (especially 3-4 m) where salinity levels are higher, the temperature values remained relatively constant. The ability of saline waters to preserve thermal energy has great importance in this phenomenon (Maxim, 1937).

Oxygen. Is very important for both heterotrophic and autotrophic organisms inhabiting aquatic ecosystems. The results showed that the surface, 1 and 2 m layers are well oxygenated with annual averages of 11.02 $mg \cdot l^{-1}$, 12.44 $mg \cdot l^{-1}$ and 13.17 $mg \cdot l^{-1}$ of dissolved oxygen. Oxygen values were very low at 3 and 4 m with averages below 1 $mg \cdot l^{-1}$ (0.77 $mg \cdot l^{-1}$ and 0.84 $mg \cdot l^{-1}$, respectively) indicating hypoxic or even anoxic conditions.

pH. During 2005 pH values were higher and showed no significant variations over time at surface, 1 m and 2 m layers. The annual average values for these were: 8.33 (S) and 8.26 (at 1 m and 2 m, respectively). Deeper layers were characterized by lower values (annual average of 7.21 and 6.84 at 3 m and 4 m).

Salinity. Measurements were carried out for the whole water column. There is a pronounced stratification: surface and 1 m layers are less saline (the annual average was 1500 $mg \cdot l^{-1}$) but there is a slight increase at 2 m (3600 $mg \cdot l^{-1}$) and a sharp increase at 3 m (39000 $mg \cdot l^{-1}$) and 4 m (with annual average value close to 100000 $mg \cdot l^{-1}$).

III. 1. 2. Composition, structure and dynamics of diatom communities from Lake Durgău

One hundread and sixteen taxa have been identified from phytoplanktonic and periphytic samples (Tab. 3. 1.). These belong to 7 families: Thalassiosiraceae, Fragilariaceae, Achnanthaceae, Naviculaceae, Bacillariaceae, Epithemiaceae and Surirellaceae. Best represented families are: Naviculaceae (66 taxa) and Bacillariaceae (25 taxa).

Tab. 3. 1. List of taxa identified from Lake Durgău

ORDER CENTRALES
Suborder Coscinodiscineae
Family Thalassiosiraceae

Cyclostephanos dubius (Fricke) Round
Cyclotella comta (Ehrenberg) Kützing
Cyclotella meneghiniana Kützing
Cyclotella ocellata Pantocsek

ORDER PENNALES
Suborder Araphidineae
Family Fragilariaceae

Asterionella formosa Hassall
Diatoma vulgaris Bory
Fragilaria arcus (Ehrenberg) Cleve *var. arcus*
Fragilaria crotonensis Kitton
Fragilaria fasciculata (C.Agardh) Lange-Bertalot
Fragilaria pulchella (Ralfs ex Kützing) Lange-Bertalot
Tabellaria flocculosa (Roth) Kützing

Suborder Raphidineae

Family Achnanthaceae

Achnanthes brevipes Agardh var. *intermedia* (Kützing) Cleve
Achnanthes coarctata (Brébisson) Grunow
Achnanthes holsatica Hustedt
Achnanthes lanceolata (Brébisson) Grunow ssp. *frequentissima* Lange-Bertalot
Achnanthes minutissima Kützing
Cocconeis placentula Ehrenberg var. *lineata* (Ehrenberg) Van Heurk
Cocconeis placentula Ehrenberg var. *euglypta* (Ehrenberg) Grunow

Family Naviculaceae

Amphora coffeaeformis (Agardh) Kützing
Amphora commutata Grunow
Amphora ovalis (Kützing) Kützing
Amphora pediculus (Kützing) Grunow
Amphora veneta Kützing
Anomoeoneis sphaerophora (Ehrenberg) Pfitzer
Anomoeoneis sphaerophora (Ehrenberg) Pfitzer f. *sculpta* (Ehrenberg) Krammer
Caloneis amphisbaena (Bory) Cleve
Caloneis silicula (Ehrenberg) Cleve
Craticula riparia (Hustedt) Lange-Bertalot var. *riparia*
Cymbella cymbiformis Agardh
Cymbella microcephala Grunow
Cymbella minuta Hilse ex Rabenhorst
Cymbella pusilla Grunow
Cymbella silesiaca Bleisch
Cymbella tumidula Grunow
Didymosphaenia geminata (Lyngbye) M. Schmidt
Diploneis ovalis (Hilse) Cleve
Entomoneis alata (Ehrenberg) Ehrenberg
Entomoneis paludosa (W. Smith) Reimer var. *subsalina*

(Cleve) Krammer
Gomphonema clavatum Ehrenberg
Gomphonema minutum (C. Agardh) C. Agardh
Gomphonema olivaceum (Hornemann) Brébisson var. *olivaceum*
Gomphonema parvulum (Kützing) Kützing
Gomphonema truncatum Ehrenberg
Gyrosigma acuminatum (Kützing) Rabenhorst
Gyrosigma peisonis (Grunow) Hustedt
Gyrosigma spencerii (Quekett) Griffith şi Henfrey
Mastogloia smithii Thwaites
Navicula cincta (Ehrenberg) Ralfs
Navicula cryptocephala Kützing
Navicula cryptotenella Lange-Bertalot
Navicula digitoradiata (Gregory) Ralfs
Navicula eidrigiana Carter
Navicula gregaria Donkin
Navicula halophila (Grunow) Cleve
Navicula heimansii Van Dam şi Kooyman
Navicula lanceolata (C. Agardh) Ehrenberg
Navicula laterostrata Hustedt
Navicula margalithii Lange-Bertalot
Navicula mutica Kützing var. mutica
Navicula nivalis Ehrenberg
Navicula normaloides Cholnoky
Navicula protracta (Grunow) Cleve
Navicula pseudoscutiformis Hustedt
Navicula pupula Kützing var. *pupula*
Navicula pygmaea Kützing
Navicula radiosa Kützing
Navicula salinarum Grunow var. *salinarum*
Navicula spicula (Hickie) Cleve
Navicula stankovicii Hustedt
Navicula subrhynchocephala Hustedt
Navicula suecorum Carlson var. *dismutica* (Hustedt) Lange-Bertalot
Navicula tripunctata (O. F. Müller) Bory
Navicula trivialis Lange-Bertalot
Navicula veneta Kützing
Navicula viridula (Kützing) Ehrenberg var. *viridula*
Pinnularia appendiculata (Agardh) Cleve
Pinnularia bertrandii Kammer var. *angustifasciata* Krammer
Pinnularia divergentissima (Grunow) Cleve
Pinnularia microstauron (Ehrenberg) Cleve
Pinnularia microstauron (Ehrenberg) Cleve var. *brebissoni* (Kützing) Mayer
Pinnularia perspicua Krammer
Pleurosigma angulatum (Queckett) W. Smith
Pleurosigma elongatum W. Smith
Rhoicosphenia abbreviata (Agardh) Lange-Bertalot

Family Bacillariaceae

Bacillaria paradoxa Gmelin
Hantzschia amphioxys (Ehrenberg) Grunow
Nitzschia aurariae Cholnoky
Nitzschia clausii Hantzsch
Nitzschia communis Rabenhorst
Nitzschia constricta (Kützing) Ralfs
Nitzschia elegantula Grunow
Nitzschia fonticola Grunow
Nitzschia frustulum (Kützing) Grunow var. *frustulum*
Nitzschia hungarica Grunow
Nitzschia inconspicua Grunow
Nitzschia levidensis (W. Smith) Grunow *var. salinarum* Grunow
Nitzschia littoralis Grunow
Nitzschia lorenziana Grunow
Nitzschia nana Grunow
Nitzschia palea (Kützing) W. Smith
Nitzschia pellucida Grunow
Nitzschia pusilla Grunow
Nitzschia scalpelliformis Grunow
Nitzschia sigma (Kützing) W. Smith
Nitzschia solita Hustedt
Nitzschia subcohaerens (Grunow) Van Heurck *var. scotica* (Grunow) Van Heurck
Nitzschia tryblionella Hantzsch
Nitzschia tubicola Grunow
Nitzschia vitrea Norman *var. vitrea*

Family Epithemiaceae

Epithemia turgida (Ehrenberg) Kützing *var. granulata* (Ehrenberg) Brun

Family Surirellaceae

Campylodiscus bicostatus W. Smith
Cymatopleura solea (Brébisson) W. Smith
Surirella angusta Kützing
Surirella brebissonii Krammer şi Lange-Bertalot var. *brebissonii*
Surirella Krammer şi Lange-Bertalot var. *kuetzingii* Krammer şi Lange-Bertalot
Surirella ovalis Brébisson

The total number of periphytic algal species was 78, most being identified in January (51). In summer there was a slight decrease in species number (38 in July). The number of taxa was similar in spring and autumn (42 and 44 species, respectively).

Quantitative phytoplanktonic analysis indicated two quantitative peaks of diatom communities (Fig. 3. 1. a.): in spring (April) and in autumn (September-October). Care should be taken in interpreting the November-December peaks (Fig. 3. 1. a.). In these months the lake was frozen and so the access to the center of the lake with the pneumatic boat was impaired. Therefore, sampling was carried out close to shore where the phytoplankton is strongly influenced by the periphytic communities.

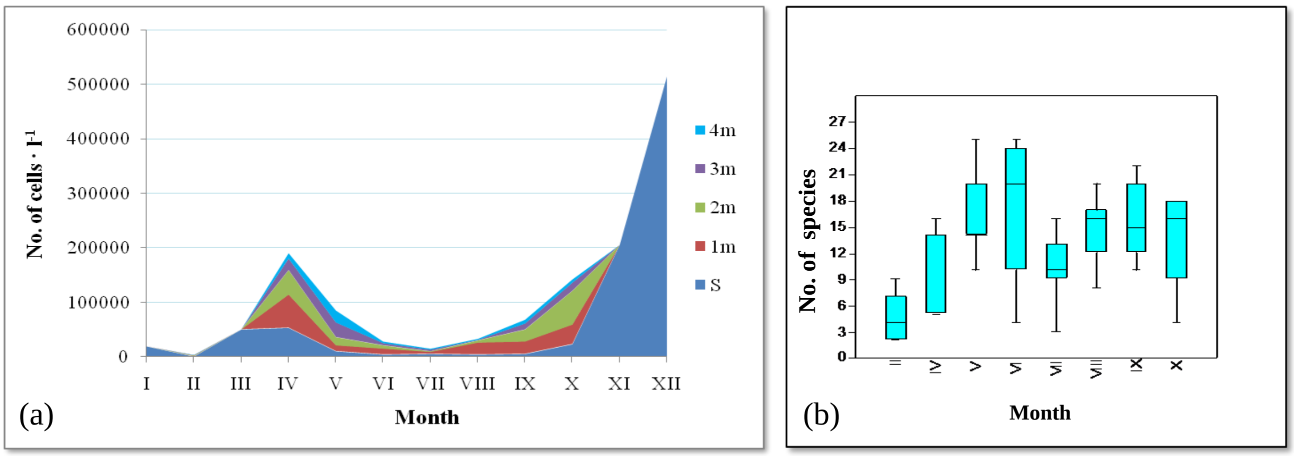

Fig. 3. 1. Monthly quantitative (a) and species number dynamics (b) of planktonic diatom communities from Lake Durgău, 2005

Regarding the vertical distribution of diatoms, a higher number of cells were observed at 1 and 2 m. Density decreases significantly at 3 and 4 m (Fig. 3. 2.).

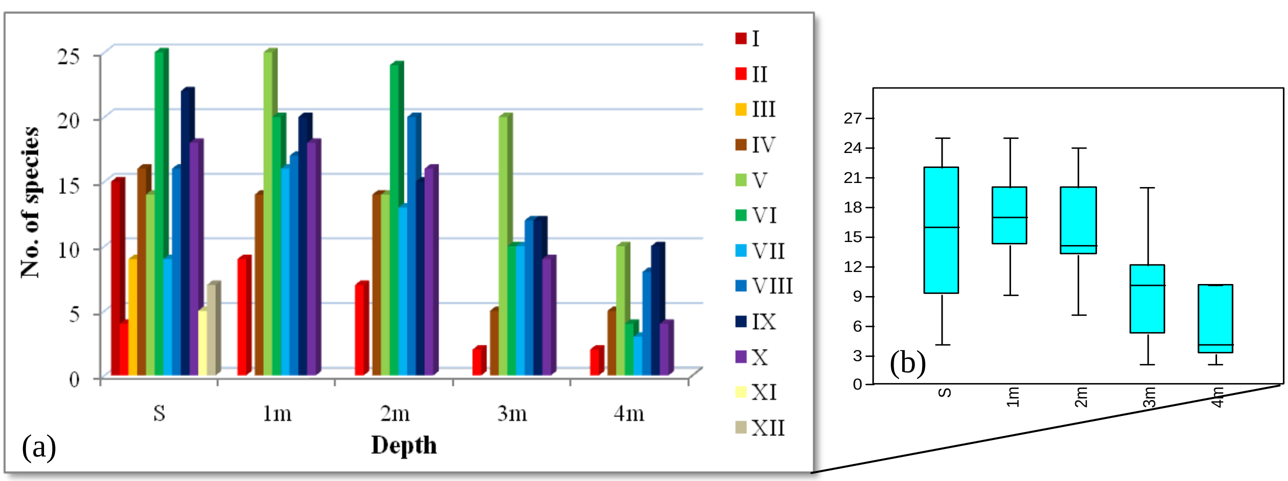

Fig. 3. 2. Monthly variation in vertical distribution of species number (a), with a representation of minimum and maximum values, of standard deviation and of median values (b) from planktonic diatom communities from Lake Durgău, 2005

In October 2011, 124 measurements were carried out with a special instrument, the FluoroProbe. The results are presented using the software of the instrument (Fig. 3. 3.). Temperature values proved once more that this lake has the capacity to store and preserve thermal energy. Values start at 3ºC at the surface, there is a gradual decrease to 2.1ºC (1.3 m deep, where the thermocline is located) and then there is an increase to 18ºC (3 m and 4m).

Chlorophyll concentration analysis suggests a stratification of diatoms. The chlorophyll concentration of diatoms is relatively constant between the surface and 1.3 m depth (fluctuating

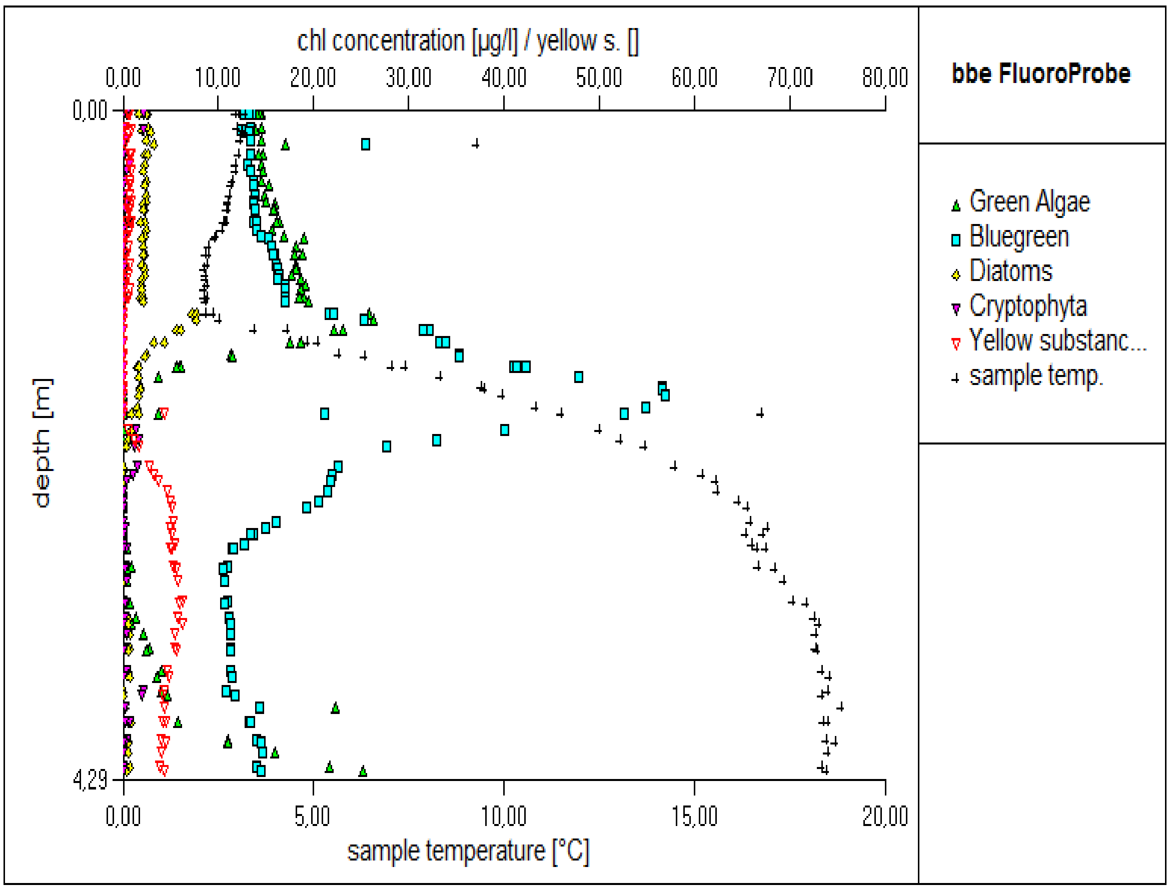

Fig. 3. 3. Graphical representation of the results obtained with the FluoroProbe Version 2.2 E1, 09/08 using the instrument's software

between 2 and 3 $\mu g \cdot l^{-1}$) and then it increases suddenly to 7.7 $\mu g \cdot l^{-1}$. There is a gradual decrease after this peak down to the depth of 2.15 m; in deeper layers values are very small, under 1 $\mu g \cdot l^{-1}$.

III. 1. 3. Water quality assessment in Lake Durgău

Calculated indexes (SI – Zelinka and Marvan saprobity index, TDI – Trophic Diatom Index and IBD – Biological Diatom Index) suggested that the water of Lake Durgău contains relatively high amounts of decomposing organic substances. It is situated at the limit between mesotrophic and eutrophic lakes and has acceptable to moderate water quality.

III. 2. Lake Csiki

III. 2. 1. Physical and chemical parameters

Secchi transparency and photic zone. Transparency measurements showed very low values in some cases. In the thermal inversion and water mixing period transparency was only 0.29 m. Maximum transparency was in April, when the occurrence of the so-called “clear-water phase” phenomenon is suggested (Lampert, 1978).

Temperature. Considering this paramether the lake followed the pattern of dimictical lakes, with two periods of water circulation: in spring and autumn.

Oxygen. The best oxygenated layers were S and 1 m. Dissolved oxygen decreases in deeper layers, reaching values under 1 mg·l^{-1} (hypoxia and anoxia).

pH. A decrease in pH in the summer period (especially in June and July) and from surface to the bottom, respectively, is observed.

Salinity. According to *in situ* measurements and Hammer’s (1986) saline lake classification, Lake Csiki is at the limit between freshwater and subsaline lakes. No significant vertical fluctuation of this parameter was observed through 2005.

III. 2. 2. Composition, structure and dynamics of diatom communities from Lake Csiki

Phytoplanktonic and periphytic samples have been analysed with 85 taxa being identified (Tab. 3. 2.). These belong to 7 families: Thalassiosiraceae, Fragilariaceae, Achnanthaceae, Naviculaceae, Bacillariaceae, Epithemiaceae and Surirellaceae.

Half of the taxa belonged to Naviculaceae (50%). The second family with the most species was Bacillariaceae with 25.88 percent.

Tab. 3. 2. List of taxa identified from Lake Csiki

ORDER CENTRALES
Suborder Coscinodiscineae
Family Thalassiosiraceae
Aulacoseira muzzanensis (Meister) Krammer
Cyclotella meneghiniana Kützing
ORDER PENNALES
Suborder Araphidineae
Family Fragilariaceae
Asterionella formosa Hassall
Diatoma ehrenbergii Kützing
Diatoma vulgaris Bory
Fragilaria arcus (Ehrenberg) Cleve *var. arcus*
Fragilaria capucina Desmazières *var. vaucheriae* (Kütz.) Lange-Bertalot
Fragilaria crotonensis Kitton
Fragilaria fasciculata (C. Agardh) Lange-Bertalot
Fragilaria pulchella (Ralfs ex Kützing) Lange-Bertalot
Fragilaria ulna (Nitzsch) Lange-Bertalot
Fragilaria ulna (Nitzsch) Lange-Bertalot var. *acus* (Kützing) Lange-Bertalot
Fragilaria ulna (Nitzsch) Lange-Bertalot *var. ulna*
Suborder Raphidineae
Family Achnanthaceae
Achnanthes brevipes Agardh var. *intermedia* (Kützing) Cleve
Achnanthes hungarica (Grunow) Grunow
Achnanthes lanceolata (Brébisson) Grunow *ssp. frequentissi-ma* Lange-Bertalot
Achnanthes minutissima Kützing
Cocconeis placentula var. *euglypta* (Ehrenberg) Grunow
Family Naviculaceae
Amphora libyca Ehrenberg

Amphora ovalis (Kützing) Kützing
Amphora pediculus (Kützing) Grunow
Amphora veneta Kützing
Anomoeoneis sphaerophora (Ehrenberg) Pfitzer
Caloneis amphisbaena (Bory) Cleve
Caloneis silicula (Ehrenberg) Cleve
Cymbella caespitosa (Kützing) Brun
Cymbella minuta Hilse ex Rabenhorst
Cymbella silesiaca Bleisch
Entomoneis paludosa (W.Smith) Reimer var. *subsalina* Cleve Krammer
Gomphonema gracile Ehrenberg
Gomphonema minutum (C. Agardh) C. Agardh
Gomphonema parvulum (Kützing) Kützing
Gomphonema truncatum Ehrenberg
Gyrosigma acuminatum (Kützing) Rabenhorst
Gyrosigma nodiferum (Grunow) Reimer
Gyrosigma spencerii (Quekett) Griffith şi Henfrey
Navicula capitata Ehrenberg var. *hungarica* (Grunow) Ross
Navicula cari Ehrenberg
Navicula cincta (Ehrenberg) Ralfs
Navicula cryptocephala Kützing
Navicula cryptotenella Lange-Bertalot
Navicula goeppertiana (Bleisch) H.L. Smith *var. goeppertiana*
Navicula gregaria Donkin
Navicula halophila (Grunow) Cleve
Navicula lanceolata (C. Agardh) Ehrenberg
Navicula menisculus Schumann var. *upsaliensis* Grunow
Navicula mutica Kützing var. *mutica*
Navicula nivalis Ehrenberg
Navicula phyllepta Kützing
Navicula pygmaea Kützing
Navicula recens (Lange-Bertalot) Lange-Bertalot
Navicula salinarum Grunow var. *salinarum*
Navicula schroeteri Meister
Navicula spicula (Hickie) Cleve
Navicula tripunctata (O. F. Müller) Bory
Navicula trivialis Lange-Bertalot
Navicula veneta Kützing
Pinnularia microstauron (Ehrenberg) Cleve var. *brebissoni* (Kützing) Mayer
Rhoicosphenia abbreviata (Agardh) Lange-Bertalot
Stauroneis phoenicente-ron (Nitzsch) Ehrenberg

Family Bacillariaceae

Hantzschia amphioxys (Ehrenberg) Grunow
Nitzschia acicularis (Kützing) W. Smith
Nitzschia calida Grunow
Nitzschia capitellata Hustedt
Nitzschia constricta (Kützing) Ralfs
Nitzschia filiformis (W. Smith) Van Heurck
Nitzschia filiformis (W. Smith) Van Heurck var. *conferta* (Richter) Lange - Bertalot
Nitzschia fonticola Grunow
Nitzschia frustulum (Kützing) Grunow var. *frustulum*
Nitzschia fruticosa Hustedt
Nitzschia gracilis Hantzsch
Nitzschia hungarica Grunow
Nitzschia inconspicua Grunow
Nitzschia intermedia Hantzsch
Nitzschia nana Grunow
Nitzschia palea (Kützing) W. Smith
Nitzschia sigma (Kützing) W. Smith
Nitzschia subcohaerens (Grunow) Van Heurck *var. scotica* (Grunow) Van Heurck
Nitzschia tryblionella Hantzsch
Nitzschia tubicola Grunow
Nitzschia vermicularis (Kützing) Hantzsch
Nitzschia vitrea Norman *var. salinarum* Grunow

Family Epithemiaceae

Epithemia sorex Kützing

Family Surirellaceae

Cymatopleura solea (Brébisson) W. Smith
Surirella angusta Kützing

Seasonal changes in species number were observed in the periphytical diatom communities of Lake Csiki. The dynamics was similar to that of Lake Durgău: there was a decreasing tendency in the first part of the year followed by an increase in autumn.

The analysis of quantitative samples outlined a few peaks in the cell number per liter. The samples collected near the shore (when a thin layer of ice made it impossible to use the pneumatic boat) were strongly influenced from a quantitative point of view by dislocated periphytical diatom cells (Fig. 3. 4. a.). Another aspect is related to the existence of two quantitative peaks: one in spring (April) and one in autumn (October).

There was a quantitative and qualitative vertical variation of diatom communities. As shown in Fig 3. 4. a., the layers where the number of diatom cells best develop during the two peaks are surface (in spring) and 1 m (in autumn).

Regarding the variation of species number, the most species were identified in samples collected from 1 m and 2 m (Fig. 3. 5. a). More than that, in some cases the species number is not very low at 4 m deep (Fig. 3. 5. b), near the bottom of the lake. Higher number of species at this depth characterize the autumn water mixing period. This phenomenon could explain these results.

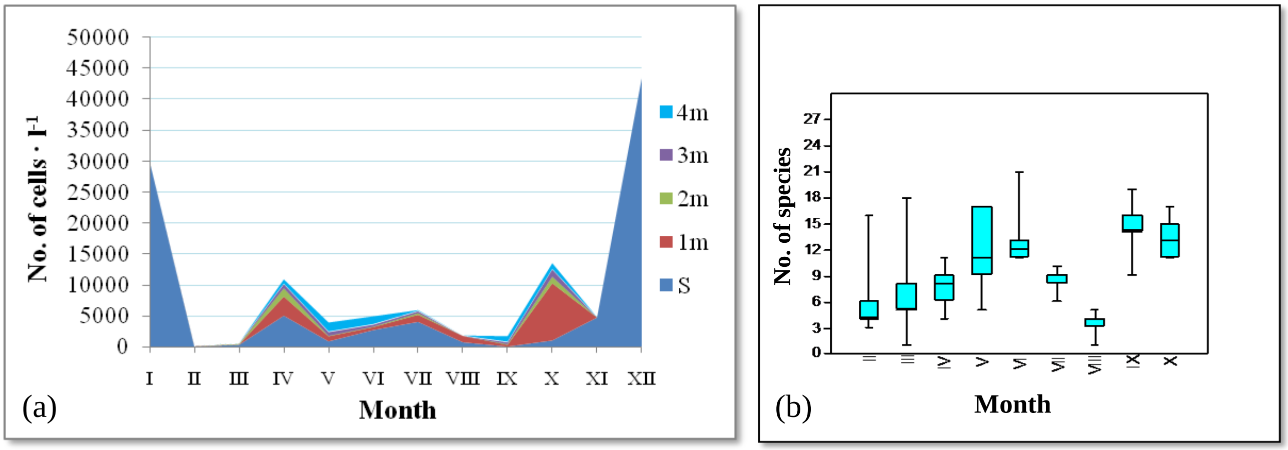

Fig. 3. 4. Monthly quantitative (a) and species number dynamics (b) of planktonic diatom communities from Lake Csiki, 2005

In the context of vertical stratification of planktonic diatoms, a series of 103 measurements were carried out in October, 2011, with the instrument called Fluoroprobe. A vertical stratification of phytoplankton has been observed. Chlorophyll concentrations were low at the surface of the lake. Maximum values were observed at 1.36 m for green algae (47.9 $\mu g \cdot l^{-1}$) and 0.65 m for Cryptophyceae (28.73 $\mu g \cdot l^{-1}$). These results suggest that green algae best develop at a lower depth than the Cryptophyceae. Diatoms, being dependent on water currents for positioning in the water column, are relatively homogeneously distributed through the water column (Fig. 3. 6.) and are poorly represented (average chlorophyll concentration: 0.42 $\mu g \cdot l^{-1}$).

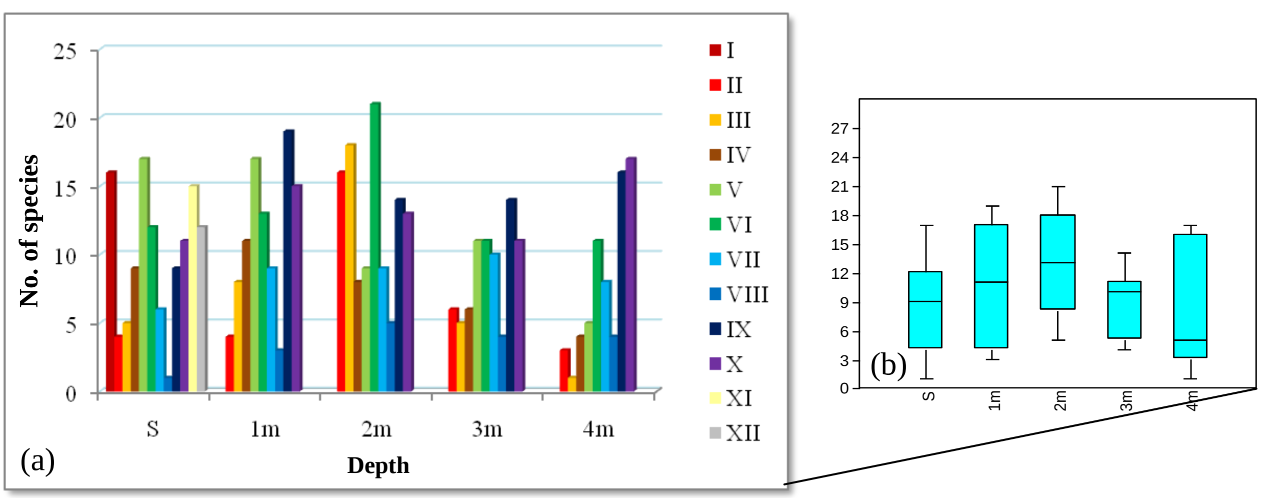

Fig. 3. 5. Monthly variation in vertical distribution of species number (a), with a representation of minimum and maximum values, of standard deviation and of median values (b) from planktonic diatom communities from Lake Csiki, 2005

III. 2. 3. Water quality assessment in Lake Csiki

The Saprobic Index (SI) values were calculated for all seasons and suggested a moderated to strong organic pollution. The TDI included the lake in the hypertrophic category for the first part of the year. However, a decrease of troficity level in autumn can be observed: in October the index value shows values characteristic to a mesotrophic lake. The third calculated index, IBD, classifies the lake in the third quality class (acceptable), excepting the spring period when values suggested the fourth quality class (poor).

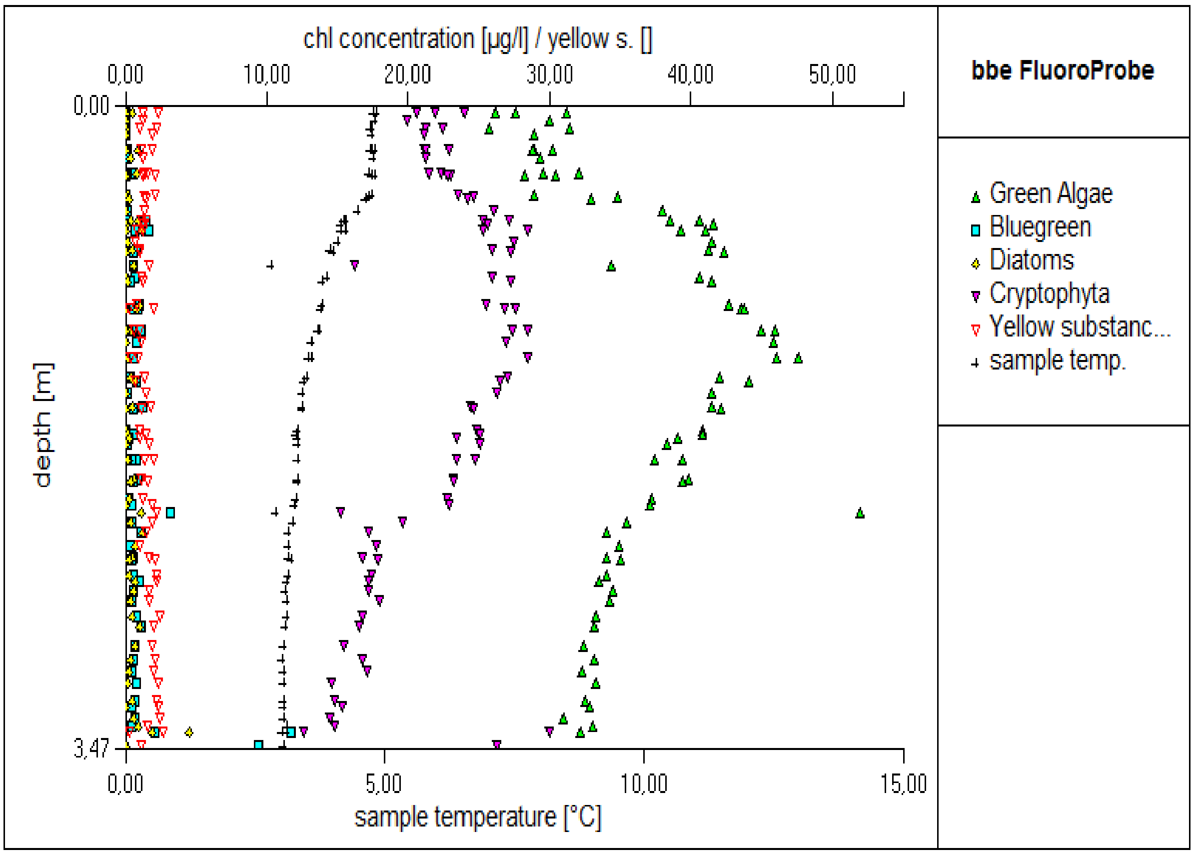

Fig. 3. 6. Graphical representation of the results obtained with the FluoroProbe Version 2.2 E1, 09/08 using the instrument's software

III. 3. Lake Leon

III. 3. 1. Physical and chemical parameters

Transparency. High transparency values were observed in the cold periods of the year. Values were low in the warm period, when temperatures were propitious for bathing.

Temperature. Deep layers (4 m) show high temperatures (13 – 17ºC) even in cold periods (October, November) when temperatures from S, 1 m, 2 m and 3 m drop significantly (e.g. 2.3 ºC at 1 m in November). This lake brings new evidence to the capability of saline lakes to retain thermal energy.

Oxygen. There was a general tendency regarding the quantity of dissolved oxygen: highest values were recorded at the surface. Values were lower in deeper layers.

pH. There was a slight increase in pH values in September. Throughout the water column only a slight decrease was observed in deep layers (especially at 4 m).

Salinity. Lake Leon is an athalassohaline lake. Salinity levels vary much depending on depth: values specific to hyposaline lakes at the surface (3-20‰), to mesohaline lakes (20-50‰) and to hypersaline lakes (>50‰ S) in deeper layers. It is undoubtedly an important environmental factor exerting a significant pressure to algal communities, especially at high concentrations.

III. 3. 2. Composition, structure and dynamics of diatom communities from Lake Leon

Microscopical analysis exhibited poor diatom communities in this lake. Not only number of species, but their relative abundance was low. Twentyfive taxa (Tab. 7. 5.) belonging to five families have been identified: (Fragilariaceae, Achnanthaceae, Naviculaceae, Bacillariaceae and Surirellaceae). More than half of these taxa (56%) belong to the Naviculaceae.

Tab. 3. 3. List of taxa identified from Lake Leon

ORDER PENNALES
Suborder Araphidineae
Family Fragilariaceae
Fragilaria fasciculata (C. Agardh) Lange-Bertalot
Suborder Raphidineae
Family Achnanthaceae
Achnanthes brevipes Agardh var. *intermedia* (Kützing) Cleve
Cocconeis placentula Ehrenberg var. *euglypta* (Ehrenberg) Grunow
Family Naviculaceae
Amphora coffeaeformis (Agardh) Kützing
Anomoeoneis sphaerophora (Ehrenberg) Pfitzer f. *sculpta* (Ehrenberg) Krammer
Caloneis bacillum (Grunow) Cleve
Gomphonema olivaceum (Hornemann) Brébisson var. *olivaceum*
Gyrosigma peisonis (Grunow) Hustedt
Navicula cincta (Ehrenberg) Ralfs
Navicula crucicula (W.Smith) Donkin
Navicula lanceolata (C. Agardh) Ehrenberg
Navicula mutica Kützing var. *mutica*
Navicula nivalis Ehrenberg
Navicula pygmaea Kützing
Navicula radiosa Kützing
Navicula recens (Lange-Bertalot) Lange-Bertalot
Navicula salinarum Grunow var. *salinarum*
Family Bacillariaceae
Hantzschia amphioxys (Ehrenberg) Grunow
Nitzschia constricta (Kützing) Ralfs
Nitzschia filiformis (W. Smith) Van Heurck var. *conferta* (Richter) Lange - Bertalot
Nitzschia hungarica Grunow
Nitzschia palea (Kützing) W. Smith
Nitzschia vitrea Norman *var. salinarum* Grunow
Family Surirellaceae
Surirella brebissonii Krammer & Lange-Bertalot var. *kuetzingii* Krammer & Lange-Bertalot
Surirella subsalsa W. Smith

The number of species in periphytic samples showed seasonal variation: it was lower in samples collected in the warm period (only 3 taxa in April and 7 in July) and higher in samples collected in the cold period (12 taxa in January and 17 in October).

The seasonal dynamics of planktonic diatoms differ from those of the lakes already described. In January, since the use of pneumatic boat was impossible due to a thin layer of ice, only surface samples were collected. 4 species have been identified from this period.

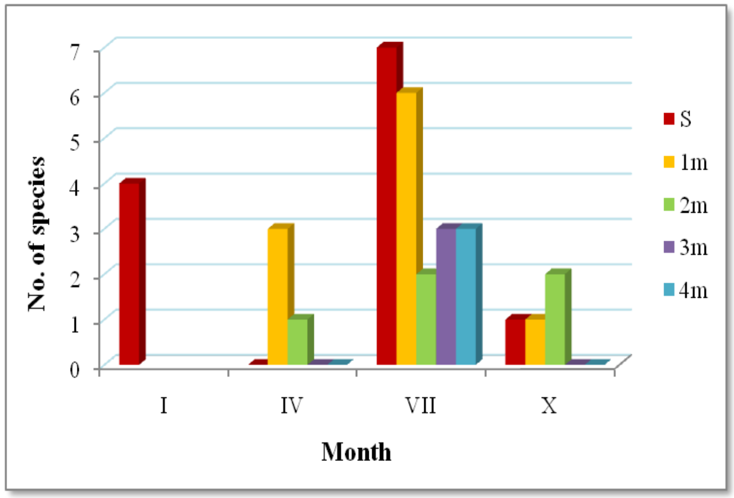

Fig. 3. 7. Number of diatom species in planktonic communities in different seasons and depths from Lake Leon, 2005

In April diatom frustules were present only in 1 m and 2 m deep layers. The species number was low in this case: 3 species at 1 m and one species at 2 m, respectively (Fig. 3. 7.). The period with the highest number of taxa was July, when the best represented layers were S and 1 m (7 and 6 taxa, respectively). The species number was lower at 2, 3 and 4 m (with 2, 3 and 3 species, respectively). In autumn there were less species and there were no diatom frustules in the samples from 3 and 4 m. In the rest of the sampled layers (S, 1 m, 2 m) species number and relative abundance were low: the identified taxa were *Cocconeis placentula* var. *euglypta* and *Fragilaria fasciculata*, two species that dominated diatom communities of this lake through the study period.

Like Lake Durgău and Csiki, Lake Leon was included in the Fluoroprobe measurement campaign. Two hundread and seventy-nine measurements have been carried out (Fig. 3. 8.). Chlorophyll concentration of diatoms was close to zero. These results support the observations from 2005, when low relative frustule abundance characterized the collected samples.

III. 3. 3. Water quality assessment in Lake Leon

Results calculated from samples collected in January and October showed moderate to heavy organic pollution. Values of TDI suggested an eutrophic lake. IBD results indicated that water quality is acceptable (third class).

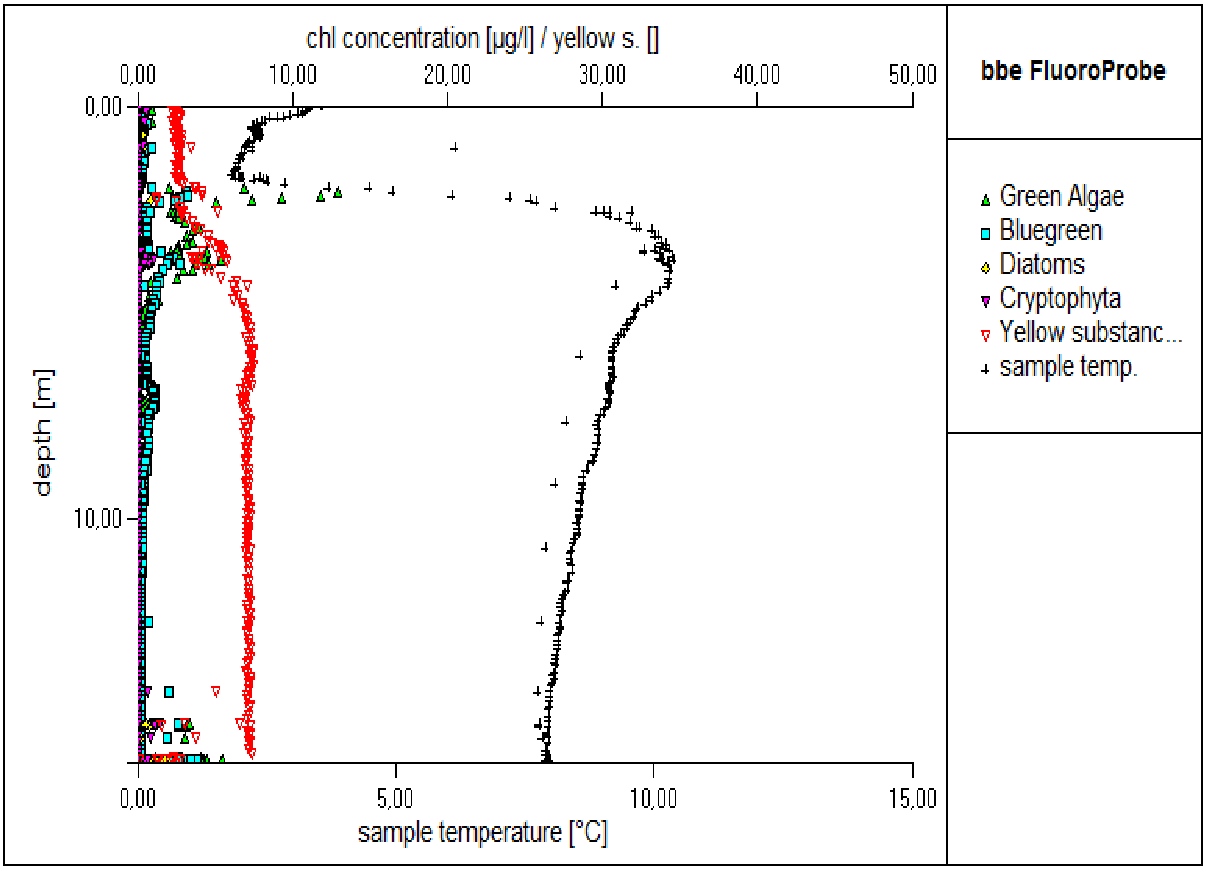

Fig. 3. 8. Graphical representation of the results obtained with the FluoroProbe Version 2.2 E1, 09/08 using the instrument's software

III. 4. Lake Dulce

III. 4 .1. Physical and chemical parameters

Some of the abiotic factors influencing the composition and structure of diatom communities were measured *in situ*. These data can be observed in Tab. 3. 4.

Tab. 3. 4. Physical and chemical parameters in Lake Dulce

Parameters and units of measurement	Month			
	I	IV	VII	X
Air temperature (ºC)	0	19	24	9
Water temperature (ºC)	1	14.6	21.8	12.9
Oxygen ($mg \cdot l^{-1}$)	8.07	10.4	5.14	6.77
Oxygen (%)	57.9	110	67.8	61
pH	7.98	8.2	7.75	8.25
Salinity ($mg \cdot l^{-1}$)	1200	1300	2800	3000
Conductivity ($\mu S \cdot cm^{-1}$)	2440	2940	5160	6060

III. 4. 2. Composition, structure and dynamics of diatom communities from Lake Dulce

There have been 48 taxa identified, belonging to 7 families: Thalassiosiraceae (one species), Chaetoceraceae (one species), Fragilariaceae (3 species), Achnanthaceae (3 species), Naviculaceae (23 species), Bacillariaceae (14 species) and Epithemiaceae (3 species). Thus, the best represented families are Naviculaceae and Bacillariaceae (Tab. 3. 5.).

Tab. 3. 5. List of taxa identified from Lake Dulce

ORDER CENTRALES
Suborder Coscinodiscineae
Family Thalassiosiraceae
Cyclotella meneghiniana Kützing
Suborder Rhizosoleniineae
Family Chaetoceraceae
Chaetoceros muelleri Lemmermann
ORDER PENNALES
Suborder Araphidineae
Family Fragilariaceae
Asterionella formosa Hassall
Fragilaria fasciculata (C. Agardh) Lange -Bertalot
Fragilaria pulchella (Ralfs ex Kützing) Lange-Bertalot
Suborder Raphidineae
Family Achnanthaceae
Achnanthes brevipes Agardh var. *intermedia* (Kützing) Cleve
Achnanthes lanceolata (Brébisson) Grunow
Achnanthes minutissima Kützing
Family Naviculaceae
Amphipleura rutilans (Trentepohl) Cleve
Amphora coffeaeformis (Agardh) Kützing
Amphora commutata Grunow
Caloneis amphisbaena (Bory) Cleve f. *subsalina* (Donkin) Van der Werff & Huls
Diploneis smithii (Brébisson) Cleve
Entomoneis alata (Ehrenberg) Ehrenberg
Entomoneis paludosa (W. Smith) Reimer
Gyrosigma balticum (Ehrenberg) Rabenhorst
Gyrosigma nodiferum (Grunow) Reimer
Gyrosigma spencerii (Quekett) Griffith & Henfrey
Mastogloia elliptica (Agardh) Cleve
Mastogloia smithii Thwaites
Navicula cincta (Ehrenberg) Ralfs
Navicula cuspidata (Kützing) Kützing
Navicula goeppertiana (Bleisch) H. L. Smith var. *goeppertiana*
Navicula gregaria Donkin
Navicula halophila (Grunow) Cleve
Navicula menisculus Schumann var. *menisculus*
Navicula peregrina (Ehrenberg) Kützing
Navicula pygmaea Kützing
Navicula salinarum Grunow var. *salinarum*
Navicula spicula (Hickie) Cleve
Pleurosigma salinarum Grunow
Family Bacillariaceae
Bacillaria paradoxa Gmelin
Hantzschia amphioxys (Ehrenberg) Grunow
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 (W. Smith) Grunow *var. salinarum* Grunow
Nitzschia linearis (Agardh) W. Smith
Nitzschia palea (Kützing) W. Smith
Nitzschia sigma (Kützing) W. Smith
Nitzschia tryblionella Hantzsch
Family Epithemiaceae
Rhopalodia constricta (W. Smith) Krammer
Rhopalodia gibberula (Ehrenberg) O. Müller
Rhopalodia musculus (Kützing) O. Müller

Most of the species have been identified from periphytic communities (32). 13 species were present in both planktonic and periphytic communities. Only 3 species were present exclusively in phytoplankton (Fig. 3. 9.). Thus, the number of periphytic species (31 and 30 in January and April, respectively) was higher than the planktonic ones. Their number was lower in October and reached its minimum in summer (July), when human impact was most intense.

The variation of Shannon-Wiener index and equitability differed from that of species number variation. H' was higher in April and July and lower in January and October (Fig. 3. 10. a.). The differences between the dynamics of diversity index and species number can be explained by the relative abundance of dominant and codominant taxa. The highest equitability was observed in July, the lowest in January.

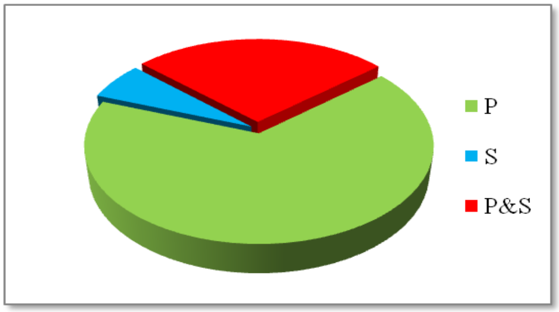

Fig. 3. 9. Percentage of diatom species from periphyton (P) and plankton (S) from Lake Dulce, 2005

Variation of taxa number was dissimilar in planktonic and periphytic diatom communities (Fig. 3. 10. b.). The highest number of diatom species in phytoplankton was in January (11). There have been identified 6 species in July and 3 in April and October. Not only the number of taxa was generally low, but also the frustule number. Planktonic diatom communities of this lake are poorly represented and are under the influence of periphytic communities. The high diversity in July is mainly due to low relative abundance of dominant species in this period. Equitability exhibited a higher value in autumn, when very few frustules have been identified in the samples.

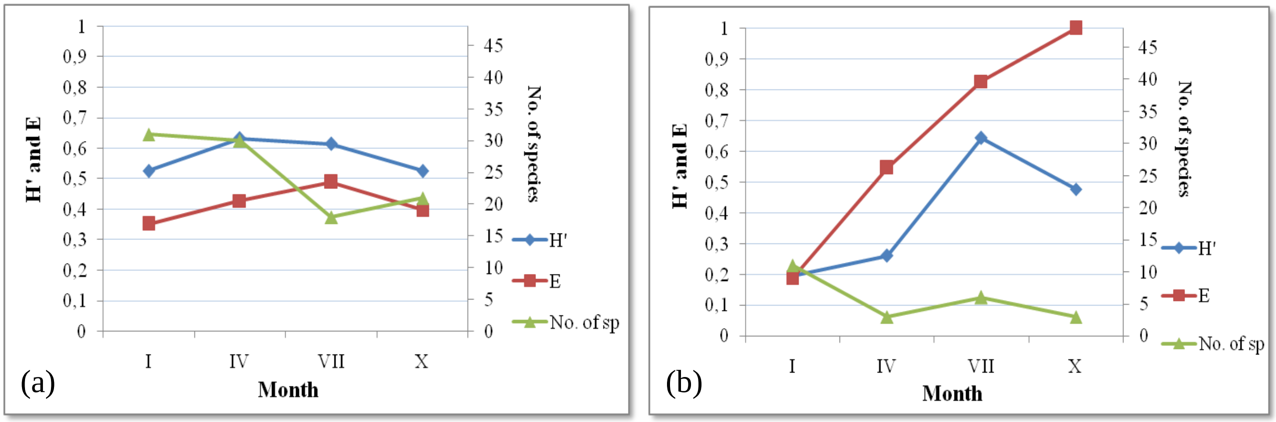

Fig. 3. 10. Variation of species number, diversity index (H') and equtability (E) in periphytic (a) and planktonic (b) diatom communities from Lake Dulce, 2005

III. 4. 3. Water quality assessment in Lake Dulce

SI values suggested strong organic pollution. TDI indicated hypertrophic conditions in the first part of the year and mesoptrophic conditions in October. IBD values showed poor water quality in the first three seasons.

III. 5. Lake Ocnei

III. 5. 1. Physical and chemical parameters

One of the most important characteristics of this lake is the high salinity level. It is a saline lake formed by the collapse of an old salt mine. It has been intensively used for balneary purposes. For these reasons this lake can be considered an interesting one. As in other cases, the discussion of the results starts with the physical and chemical parameters detailed in Tab. 3. 6.

Tab. 3. 6. Physical and chemical parameters in Lake Ocnei

Parameters and units of measurement	Month			
	I	IV	VII	X
Air temperature (ºC)	0	16,5	25	9
Water temperature (ºC)	0.9	18.5	27.1	12.9
Oxygen ($mg \cdot l^{-1}$)	8.91	12.84	6.85	6.89
Oxygen (%)	65	135.3	112.8	72.7
pH	8.34	8.6	8.21	8.25
Salinity ($mg \cdot l^{-1}$)	23200	17500	60000	45000
Conductivity ($\mu S \cdot cm^{-1}$)	38900	24700	112500	87450

III. 5. 2. Composition, structure and dynamics of diatom communities from Lake Ocnei

In this saline lake there have been 43 species identified (Tab. 3. 7.) belonging to 7 families: (Thalassiosiraceae – 11.63 %, Fragilariaceae 6.98 %, Achnanthaceae 6.98 %, Naviculaceae 34.88 %, Bacillariaceae 32.56 %, Epithemiaceae 2.32 %, and Surirellaceae 4.65 %).

Tab. 3. 7. List of taxa identified from Lake Ocnei

ORDER CENTRALES
Suborder Coscinodiscineae
Family Thalassiosiraceae
Aulacoseira granulata (Ehrenberg) Simonsen
Cyclotella comta (Ehrenberg) Kützing
Cyclotella distinguenda Hustedt *var. distinguenda*
Cyclotella meneghiniana Kützing
Stephanodiscus medius Håkansson
ORDER PENNALES
Suborder Araphidineae
Family Fragilariaceae
Fragilaria arcus (Ehrenberg) Cleve *var. arcus*
Fragilaria fasciculata (C. Agardh) Lange - Bertalot
Fragilaria pulchella (Ralfs ex Kützing) Lange Bertalot
Suborder Raphidineae
Family Achnanthaceae
Achnanthes lanceolata (Brébisson) Grunow ssp. *lanceolata* var. *lanceolata*
Achnanthes minutissima Kützing
Cocconeis placentula Ehrenberg var. *euglypta* (Ehrenberg) Grunow
Family Naviculaceae
Amphora coffeaeformis (Agardh) Kützing
Amphora veneta Kützing
Cymbella affinis Kützing
Gomphonema gracile Ehrenberg
Gomphonema olivaceum (Hornemann) Brébisson var. *olivaceum*
Gomphonema parvulum (Kützing) Kützing
Navicula cincta (Ehrenberg) Ralfs
Navicula cryptocephala Kützing
Navicula cryptotenella Lange-Bertalot
Navicula eidrigiana Carter
Navicula mutica Kützing var. *mutica*
Navicula phyllepta Kützing
Navicula pupula Kützing var. *pupula*
Navicula veneta Kützing
Pinnularia microstauron (Ehrenberg) Cleve var. *brebissoni* (Kützing) Mayer
Family Bacillariaceae

Hantzschia amphioxys (Ehrenberg) Grunow
Nitzschia compressa (Bailey) Boyer var. *compressa*
Nitzschia compressa (Bailey) Boyer var. *balatonis* (Grunow) Lange - Bertalot
Nitzschia constricta (Kützing) Ralfs
Nitzschia filiformis (W. Smith) Van Heurck var. *conferta* (Richter) Lange - Bertalot
Nitzschia fonticola Grunow
Nitzschia frustulum (Kützing) Grunow var. *bulnheimiana* (Rabenhorst) Grunow
Nitzschia frustulum (Kützing) Grunow var. *frustulum*
Nitzschia hungarica Grunow
Nitzschia inconspicua Grunow
Nitzschia nana Grunow
Nitzschia palea (Kützing) W. Smith
Nitzschia paleacea Grunow
Nitzschia pellucida Grunow

Family Epithemiaceae

Rhopalodia gibberula (Ehrenberg) O. Müller

Family Surirellaceae

Surirella brebissonii var. *kuetzingii* Krammer & Lange-Bertalot
Surirella minuta Brébisson

The species number of periphytic communities was higher than the number of planktonic species (Fig. 3. 11.). 69.77% of all taxa have been identified from peryphiton, 9.3% from plankton and 20.93% from both types of communities.

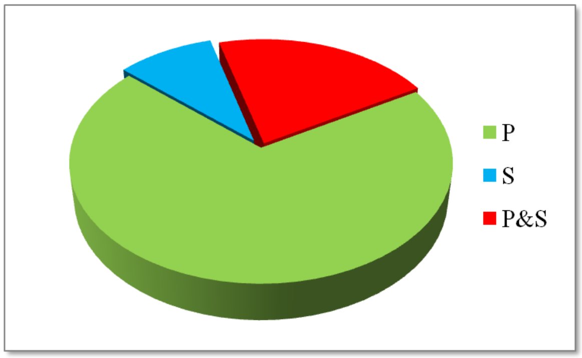

Fig. 3. 11. Percentage of diatom species from periphyton (P) and plankton (S) from Lake Ocnei, 2005

The highest number of taxa in periphyton was observed in spring, the lowest in summer. In autumn the number of species was increasing.

As showed in Fig. 3. 12. a., there are two peaks in species number: in spring and in autumn. The fact that only 8 species were present in samples collected in July can be correlated (beside other factors) with the intense human impact on diatoms developing on substrata. These diatoms can be physically dislocated by the generated waves or by touching the substrata. Another significant influence is the increase of salinity in layers near the surface as a result of bathing.

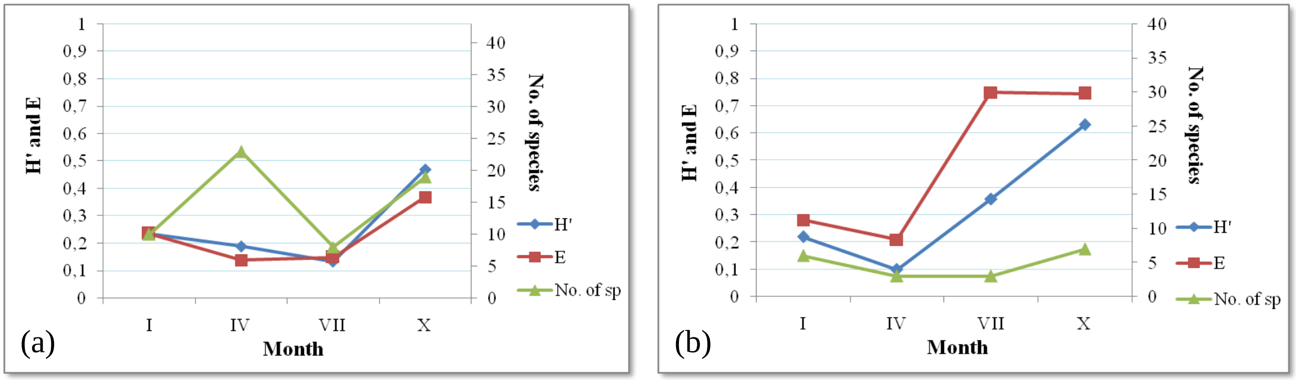

Fig. 3. 12. Variation of species number, diversity index (H') and equtability (E) in periphytic (a) and planktonic (b) diatom communities from Lake Ocnei, 2005

For the planktonic diatom communities (Fig. 3. 12. b.) species number was generally low. Most of these species (almost 70%) were present in periphyton also. There is an obvious influence of benthic diatom communities on phytoplankton: significant amounts of periphytic diatoms are dislocated from substrata and are mixed with the planktonic community. This phenomenon is more pronounced near the lake shore. The number of identified species was low through the whole sampling year. The least taxa were observed in the warm period: only 3 species in April and July.nFactors probably contributing to this are: increased salinity, low water transparency and reduced photic zone.

III. 5. 3. Water quality assessment in Lake Ocnei

The saprobic index (SI) suggested moderate to strong organic pollution in this lake. Regarding lake trophicity, TDI indicated hypertrophic conditions. According to IBD water quality is acceptable (third class).

III. 6. Lake Sulfuros

III. 6. 1. Physical and chemical parameters

Last of the investigated lakes has a reduced surface and it is situated at the lowest altitude in Sărată Valley. Like the other lakes, Lake Sulfuros originated from a collapsed salt mine. *In situ* measurements indicated that this is an athalassohaline lake (more precisely hyposaline category; Hammer, 1986). Macrophytes are abundant at the shore.

Results of physical and chemical parameters' measurements can be observed in Tab. 3. 8.

Tab. 3. 8. Physical and chemical parameters in Lake Sulfuros

Parameters and units of measurement	Month			
	I	IV	VII	X
Air temperature (ºC)	0	19	25,5	9
Water temperature (ºC)	2.5	18.6	22.4	8.8
Oxygen ($mg \cdot l^{-1}$)	18.5	15.61	10.65	8.3
Oxygen (%)	139.7	170.6	140.3	73
pH	8.18	9.18	8.64	8.43
Salinity ($mg \cdot l^{-1}$)	1200	4500	4000	4400
Conductivity ($\mu S \cdot cm^{-1}$)	2260	7990	7160	8800

III. 6. 2. Composition, structure and dynamics of diatom communities from Lake Sulfuros

Ninety-four taxa have been identified in Lake Sulfuros (Tab. 3. 9.). This is a high number of species compared to the other investigated lakes. The taxa belong to 7 families: (Thalassiosiraceae, Fragilariaceae, Achnanthaceae, Naviculaceae, Bacillariaceae, Surirellaceae, and Epithemiaceae).

Tab. 3. 9. List of taxa identified from Lake Sulfuros

ORDER CENTRALES
Suborder Coscinodiscineae
Family Thalassiosiraceae

Cyclotella distinguenda Hustedt var. *distinguenda*

ORDER PENNALES
Suborder Araphidineae
Family Fragilariaceae

Aterionella formosa Hassall
Fragilaria capucina Desmazières *var. rumpens* (Kützing) Lange-Bertalot
Fragilaria fasciculata (C. Agardh) Lange-Bertalot
Fragilaria pulchella (Ralfs ex Kützing) Lange-Bertalot

Suborder Raphidineae
Family Achnanthaceae

Achnanthes brevipes Agardh var. *intermedia* (Kützing) Cleve
Achnanthes lanceolata (Brébisson) Grunow
Achnanthes lanceolata (Brébisson) Grunow ssp. *frequentissima* Lange-Bertalot
Achnanthes minutissima Kützing
Cocconeis placentula Ehrenberg var. *euglypta* (Ehrenberg) Grunow

Family Naviculaceae

Amphora coffeaeformis (Agardh) Kützing
Amphora commutata Grunow
Amphora holsatica Hustedt
Amphora veneta Kützing
Anomoeoneis sphaerophora (Ehrenberg) Pfitzer f. *sculpta* (Ehrenberg) Krammer
Caloneis bacillum (Grunow) Cleve
Cymbella pusilla Grunow
Diploneis ovalis (Hilse) *Cleve*
Frustulia vulgaris (Thwaites) De Toni
Gomphonema affine Kützing
Gomphonema angustatum (Kützing) Rabenhorst
Gomphonema clavatum Ehrenberg
Gomphonema gracile Ehrenberg
Gomphonema minutum (C. Agardh) C. Agardh
Gomphonema parvulum (Kützing) Kützing
Gomphonema pseudoaugur Lange-Bertalot
Gyrosigma acuminatum (Kützing) Rabenhorst
Gyrosigma peisonis (Grunow) Hustedt
Gyrosigma spencerii (Quekett) Griffith & Henfrey
Mastogloia elliptica (Agardh) Cleve
Mastogloia smithii Thwaites
Navicula absoluta Hustedt
Navicula cari Ehrenberg
Navicula cincta (Ehrenberg) Ralfs
Navicula cryptocephala Kützing
Navicula cryptotenella Lange-Bertalot
Navicula cuspidata (Kützing) Kützing
Navicula digitoradiata (Gregory) Ralfs
Navicula eidrigiana Carter
Navicula elginensis (Gregory) Ralfs
Navicula erifuga Lange-Bertalot
Navicula gregaria Donkin
Navicula halophila (Grunow) Cleve
Navicula lanceolata (C. Agardh) Ehrenberg
Navicula laterostrata Hustedt
Navicula margalithii Lange-Bertalot
Navicula menisculus Schumann var. *upsaliensis* Grunow
Navicula oppugnata Hustedt
Navicula phyllepta Kützing
Navicula protracta (Grunow) Cleve
Navicula pygmaea Kützing
Navicula recens (Lange-Bertalot) Lange-Bertalot
Navicula salinarum Grunow var. *salinarum*
Navicula slesvicensis Grunow
Navicula spicula (Hickie) Cleve
Navicula subrhynchocephala Hustedt
Navicula tripunctata (O.F. Müller) Bory
Navicula trivialis Lange-Bertalot
Navicula veneta Kützing
Navicula viridula (Kützing) Ehrenberg var. *linearis* Hustedt
Pinnularia divergentissima (Grunow) Cleve
Pinnularia interrupta W. Smith
Pinnularia microstauron (Ehrenberg) Cleve var. *brebissoni* (Kützing) Mayer
Pinnularia viridis (Nitzsch) Ehrenberg
Pleurosigma salinarum Grunow
Stauroneis anceps Ehrenberg

Family Bacillariaceae

Denticula subtilis Grunow
Hantzschia amphioxys (Ehrenberg) Grunow
Nitzschia agnita Hustedt
Nitzschia angustiforaminata Lange-Bertalot
Nitzschia clausii Hantzsch
Nitzschia commutatoides Lange-Bertalot
Nitzschia constricta (Kützing) Ralfs
Nitzschia elegantula Grunow
Nitzschia flexa Schumann
Nitzschia fonticola Grunow
Nitzschia fossilis Grunow
Nitzschia frustulum (Kützing) Grunow var. *bulnheimiana* (Rabenhorst) Grunow
Nitzschia frustulum (Kützing) Grunow var. *frustulum*
Nitzschia hungarica Grunow
Nitzschia inconspicua Grunow
Nitzschia lanceola Grunow
Nitzschia linearis (Agardh) W. Smith var. *subtilis* (Grunow) Hustedt
Nitzschia palea (Kützing) W. Smith
Nitzschia pellucida Grunow
Nitzschia perspicua Cholnoky
Nitzschia sigma (Kützing) W. Smith
Nitzschia subcohaerens (Grunow) Van Heurck var. *scotica* (Grunow) Van Heurck
Nitzschia tryblionella Hantzsch

Family Epithemiaceae

Epithemia adnata (Kützing)

Brébisson
Rhopalodia gibberula (Ehrenberg) O. Müller
Family Surirellaceae
Surirella brebissonii Krammer & Lange-Bertalot var. *kuetzingii* Krammer & Lange-Bertalot
Surirella ovalis Brébisson
Surirella striatula Turpin

The number of taxa present only in periphytic communities was 38 and those in plankton 13. Most of the species (43) were present in both types of communities (Fig. 3. 13.).

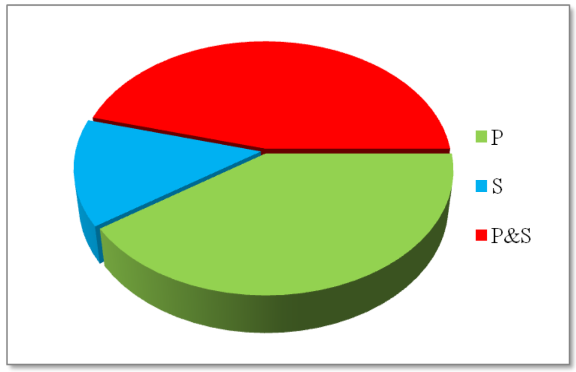

Fig. 3. 13. Percentage of diatom species from periphyton (P) and plankton (S) from Lake Sulfuros, 2005

Variation of species number was more pronounced in periphytic communities than in planktonic ones (Fig. 3. 14. a.). The highest species number was observed in January; it was decreasing in April and slowly increasing in July and October. Similar tendencies were observed for planktonic diatoms (Fig. 3. 14. b.), but the variation amplitude was more reduced.

Shannon-Wiener diversity index and equitability pointed out other aspects. In the case of periphyton the lowest values were observed in April and July, when *Cocconeis placentula* strongly dominated the communities and other species were less abundant. The highest values were registered in autumn, when the number of *Cocconeis placentula* frustules was lower and other species like *Achnanthes minutissima, Fragilaria pulchella* or *Mastogloia elliptica* exhibited higher relative abundance.

In the case of planktonic diatom communities two peaks were observed: one in spring and one in autumn. The increase of relative abundance in the mentioned periods of *Cocconeis placentula* var. *euglypta* contributed to these peaks.

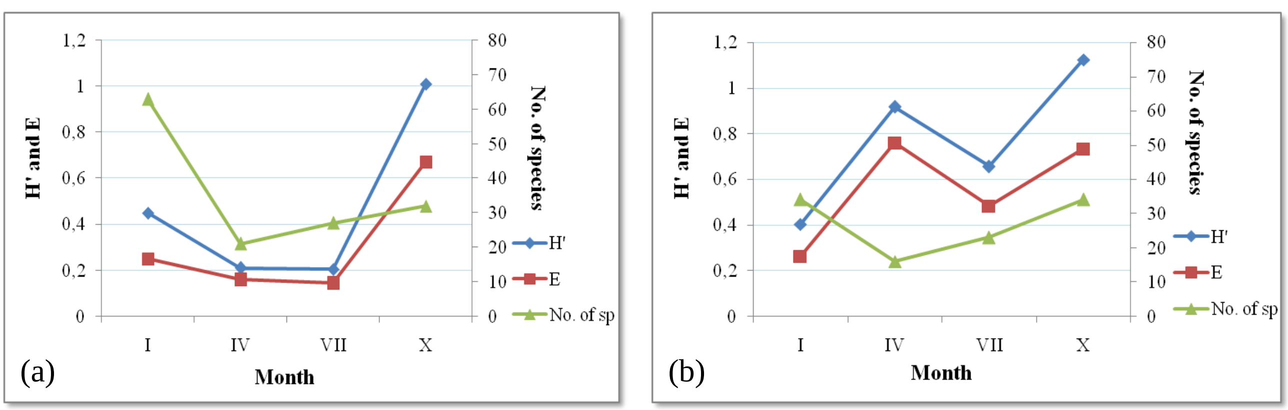

Fig. 3. 14. Variation of species number, diversity index (H') and equtability (E) in periphytic (a) and planktonic (b) diatom communities from Lake Sulfuros, 2005

III. 6. 3. Water quality assessment in Lake Sulfuros

Based on SI values it seems that Lake Sulfuros is moderately to highly polluted with organic matter. It has to be mentioned that results were better in January (second category or moderated organic pollution). Trophic Diatom Index indicated mesotrophic conditions. Biological Diatom Index generally indicated good water quality (second quality class) in the first three seasons. In autumn water quality was acceptable (third class).

III. 7. Comparisons between the results of the six investigated lakes

Physical and chemical parameters

Although a general discussion of diatom communities from the six investigated lakes is the main purpose of this part, a short reference to physical and chemical parameters is required.

The most significant difference between the parameters of the studied lakes is an abiotic factor connected to geological substrata and the formation of these lakes: salinity. Principal component analysis of investigated parameters showed that salinity, conductivity and the variation

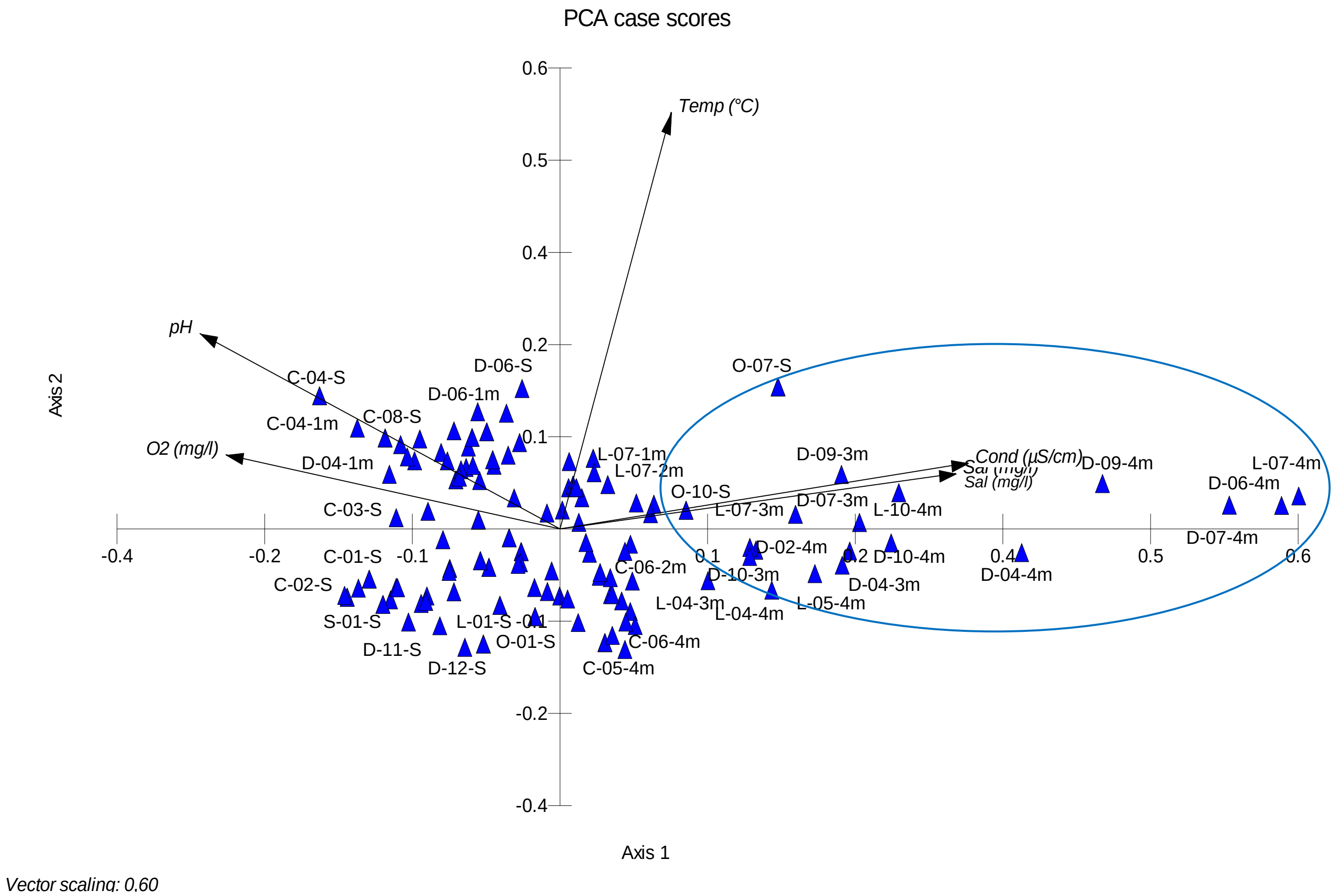

Fig. 3. 15. Principal component analisys of physical and chemical parameters from all samples
(abbreviations contain the first letter of the lake's name, month and sample type; C = Lake Csiki; D = Lake Durgău; Dl = Lake Dulce; L = Lake Leon; O = Lake Ocnei, S = Lake Sulfuros)

of these factors has a significant influence on the collected samples (Fig. 3. 15.). The samples under the strongest influence of these factors are grouped in the area marked out by the blue ellipse. Such samples originate from lakes Durgău and Leon from 3 and 4 m depths and the samples from Lake Ocnei. These are indeed the samples with highest salinity values with some impressive maxima: 236000 $mg \cdot l^{-1}$ in Lake Durgău (D-06-4m), 260000 $mg \cdot l^{-1}$ in Lake Leon (L-06-4m) or 60000 $mg \cdot l^{-1}$ in Lake Ocnei (O-07-S).

Comparisons between diatom communities of investigated lakes and the influence of salinity on these communities

An important aspect worth verifying is the relationship between average salinity levels in different lakes and taxonomical diversity of diatom communities. Apparently, salinity exerts a weak influence on these communities if values are not too high. This observation corresponds to the *intermediate salinity hypothesis*. For example, salinity levels in Lake Sulfuros were higher than in Lake Dulce or Csiki, but the number of identified taxa was higher.

On the other hand, if salinity concentration is high, its influence on diatoms is more pronounced. The fewest species were recorded in Lake Ocnei and Lake Leon, the two most saline lakes (Fig. 3. 16.).

It seems that diatom communities of different lakes are distinct but there are also similarities. The existence of many species that are common to two or more lakes is probably due to the adaptative and competitive qualities of these taxa. Another important aspect is that studied lakes are situated in close proximity. Of course, human impact also plays a role in the dispersion of these taxa.

For a better understanding of this complex matter multivariate statistical methods (Detrended correspondence analysis) were applied. In Fig. 3. 17. more than one significant aspects related to the structure of diatom communities can be observed. The first obvious aspect is that the samples from the six investigated lakes constitute different

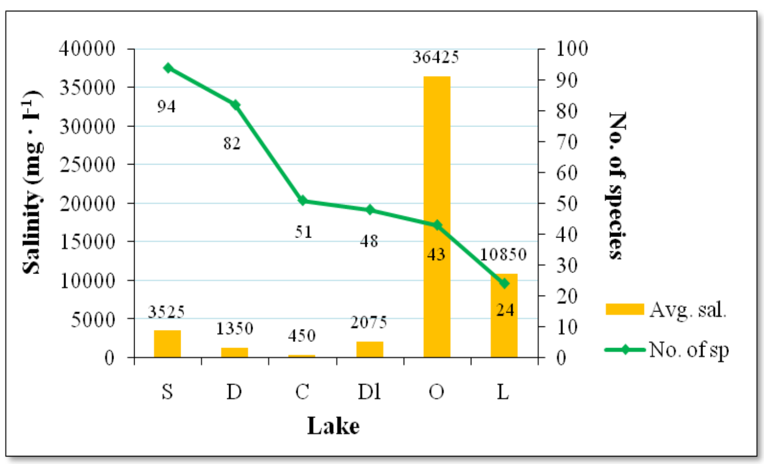

Fig. 3. 16. Variation of average salinity values and taxa numbers in studied lakes
(C = Lake Csiki; D = Lake Durgău; Dl = Lake Dulce; L = Lake Leon; O = Lake Ocnei, S = Lake Sulfuros)

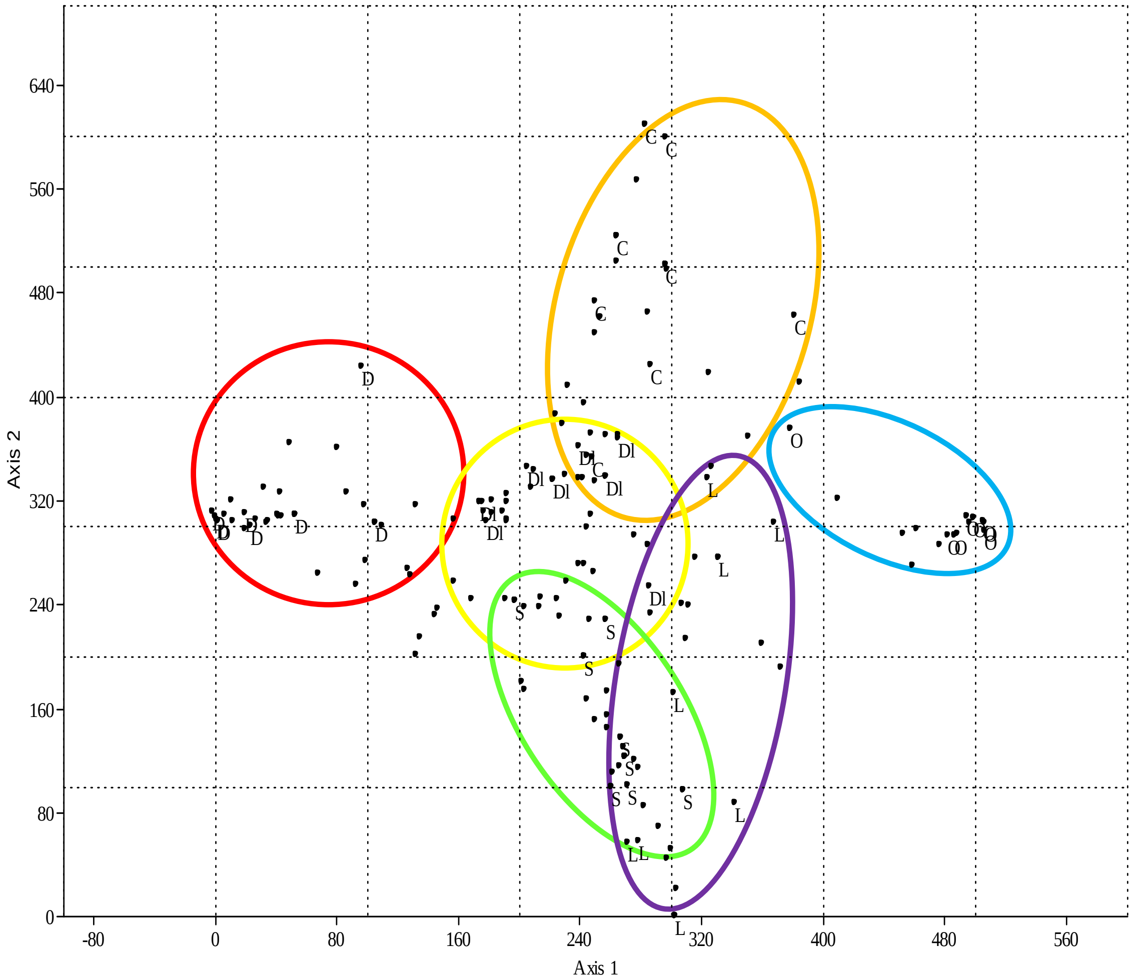

Fig. 3. 17. Detrended correspondence analisys of diatom community composition and structure from 6 investigated lakes

(C = Lake Csiki; D = Lake Durgău; Dl = Lake Dulce; L = Lake Leon; O = Lake Ocnei, S = Lake Sulfuros; unlabelled points represent taxa; labels were excluded in order to avoid graphic clutter)

groups depending on the lake of origin. Thus, diatom communities of different lakes are well separated. At the same time, there is a general grouping of the lakes with certain overlap which suggests a degree of similarity among them. An important role in this is played by the species present in more than one of the studied lakes.

Lake Leon and Lake Sulfuros obviously overlap, partly because they share the same dominating taxa: *Cocconeis placentula* var. *euglypta*.

Furthermore in the comparative analysis between the studied lakes, the Jaccard similarity index (I) and the graphical representation of clusters (dendrogram) proved to be another very helpful tool. This analysis grouped the samples depending on the source lake (Fig. 3. 18.). In other words, each lake has specific diatom communities with a particular structure.

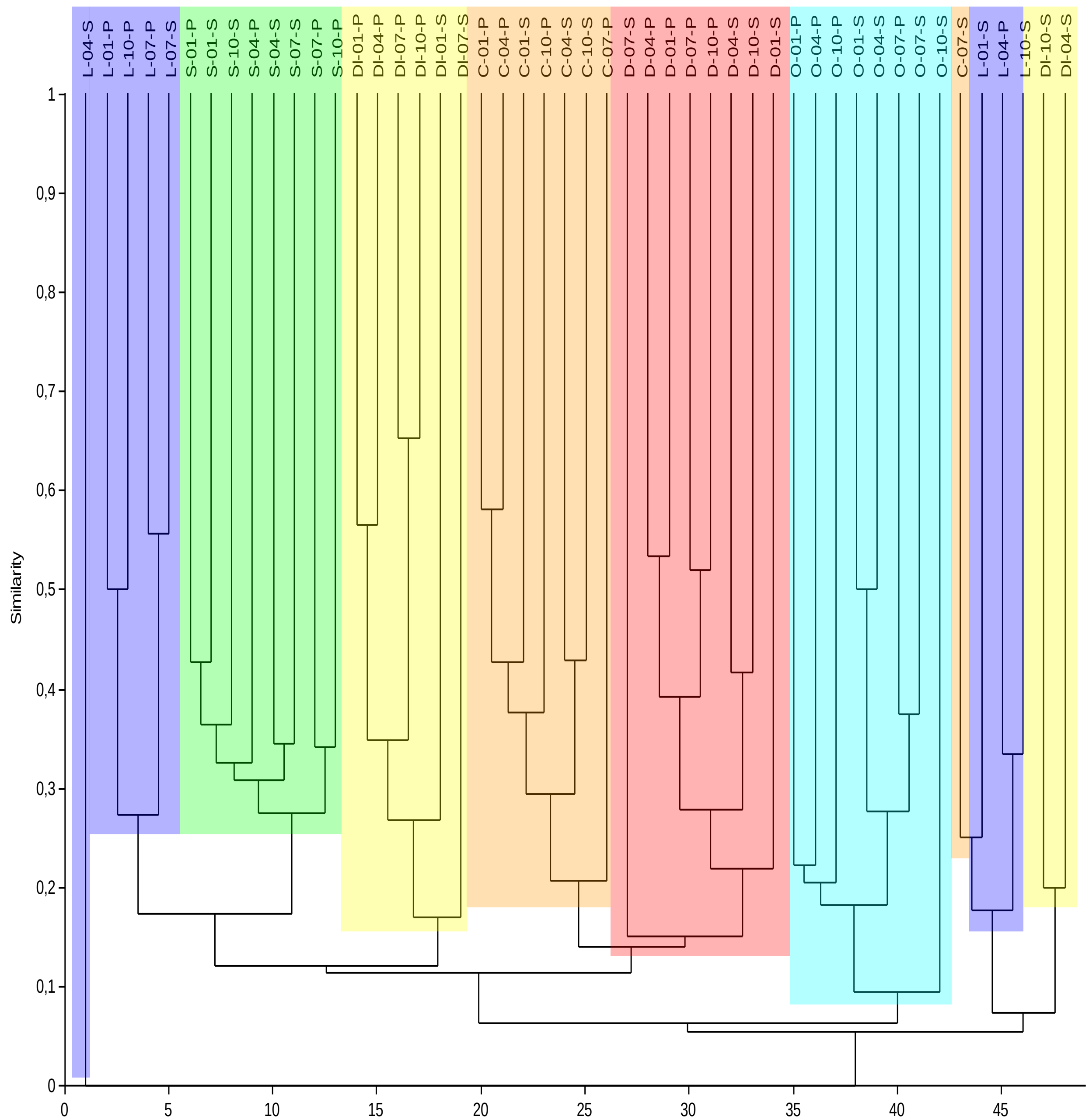

Fig. 3. 18. Similarity analisys between diatom communities from investigated lakes based on Jaccard similarity index

(C = Lake Csiki; D = Lake Durgău; Dl = Lake Dulce; L = Lake Leon; O = Lake Ocnei, S = Lake Sulfuros)

Another aspect is related to the similarity degree between lakes: Jaccard index showed that the highest similarity, based on samples used for comparisons, are Lake Leon and Lake Sulfuros. The main reason for this is the fact that 68% of all taxa from Lake Leon are also present in Lake Sulfuros. According to the dendrogram Lake Dulce also belongs to this group (but with lower similarity).

Lake Csiki and Durgău constitute a separate cluster. Even if the number of common species is high (30 taxa were present in both lakes), similarity is not so high like in the case of Lake Leon and Sulfuros because the taxa present in only one of the two lakes is also high.

Samples originating from Lake Ocnei form a separate cluster. Similarity with other investigated lakes is very low in this case.

III. 8. New taxa for Romania

An important aspect for this study is the identification of new taxa for Romania.

Before a short presentation of these species is made it is needed to mention that it is important that these taxa are verified and confirmed by at least one prestigious and experienced specialist. In this respect, the professional relationships with Professor L. Ş. Péterfi, Lecturer L. Momeu and Dr. I. Cărăuş were excellent. The author also consulted specialists from Hungary: Dr. Éva Ács from the Danube Research Institute and Dr. Gábor Borics from the Balaton Limnological Research Institute.

In total 236 samples from 6 lakes have been analysed and 203 taxa have been identified. Seventeen of these taxa were not indicated from Romania in previous scientific papers.

1. *Amphora holsatica* Hustedt – the first (and only) time signaled for Romania by Nagy & Péterfi (2008) from Lake Sulfuros, from a periphytic sample collected in October (S-10-P; Fig. 3. 19.).

2. *Caloneis amphisbaena* (Bory) Cleve f. *subsalina* (Donkin) Van der Werff & Huls – the taxon was first mentioned for Romania by Nagy *et al*. (2006 b) from Lake Dulce. It was present in the sample Dl-04-P.

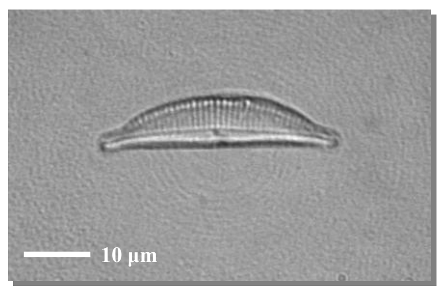

Fig. 3. 19. *Amphora holsatica* Hustedt

3. *Craticula riparia* (Hustedt) Lange-Bertalot – (Fig. 3. 20.). It was present in several planktonic and periphytic samples from Lake Durgău (April, May, June, July, August, September and October).

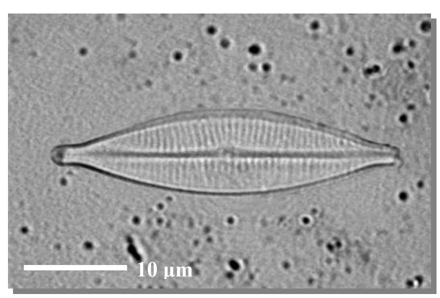

Fig. 3. 20. *Craticula riparia* (Hustedt) Lange-Bertalot

4. *Gyrosigma balticum* (Ehrenberg) Rabenhorst – this species has been identified in the sample Dl-04-P from Lake Dulce. It was first published from Romania by Nagy *et al*. (2006 b). It is a cosmopolitan species present in coastal regions and in continental saline waters. Its ecological preferences corresponds to the physical and chemical parameters measurements.

5. ***Navicula eidrigiana*** **Carter –** this taxon (Fig. 3. 21.) was first mentioned for our country in two publications in parallel: Nagy *et al*. (2006 a) and Marosi *et al*. (2006). The first article presents preliminary results from Lake Durgău near Turda while the second is a study of three ponds from the „Fânațele Clujului” Nature Reserve. Many species from these later ponds were halophiles.

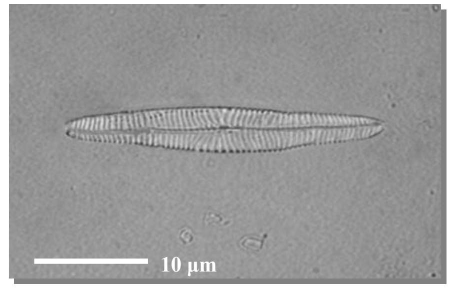

Fig. 3. 21. ***Navicula eidrigiana*** **Carter**

The taxon was afterwards also signaled in other works (Nagy *et al*., 2007, 2008). It was present in three lakes inlcuded in this study: Durgău, Sulfuros and Ocnei, all situated in the Sărată Valley. Sample codes are: D-04-P, S-01-P, S-01-S, S-04-P, S-07-S, O-04-P.

6. ***Navicula normaloides*** **Cholnoky –** the frustules of this taxon were present in Lake Durgău, sample D-01-P. The article reffering to this species is Nagy *et al*., (2006 a). The ecology of this taxon is not well known, but it can be found both in seas and continental waters.

7. ***Navicula absoluta*** **Hustedt [syn.** ***Naviculadicta absoluta*** **(Hustedt) Lange-Bertalot] –** it has been identified in sample S-01-P from Lake Sulfuros and published in Nagy *et* al. (2008).

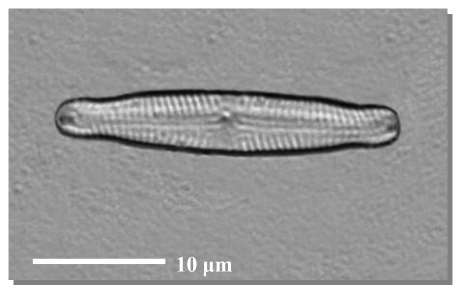

Fig. 3. 22. ***Pinnularia bertrandii*** **Krammer var.** ***angustifasciata*** **Krammer**

8. ***Navicula stankovicii*** **Hustedt** – the only publication signaling this species for Romania is Nagy *et al*. (2006 a). It was present in the periphytic community from Lake Durgău (D-01-P). Ecological aspects of this taxon are not well known.

9. ***Pinnularia bertrandii*** **Krammer var.** ***angustifasciata*** **Krammer –** another taxon never mentioned for Romania (Fig. 3. 22.). It was present in Lake Durgău in May, June, August and September.

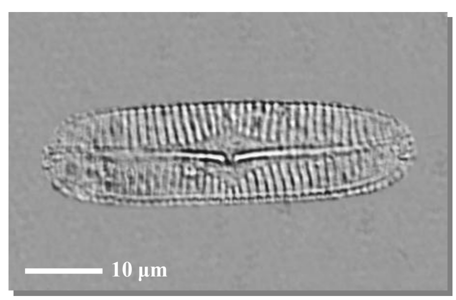

Fig. 3. 23. ***Pinnularia perspicua*** **Krammer**

10. ***Pinnularia perspicua*** **Krammer –** it is a species with relatively large frustules (Fig. 3. 23.) and it has never been signaled before for Romania. It has been identified from Lake Durgău (D-05-4m).

11. *Nitzschia aurariae* Cholnoky – like in the case of *Navicula eidrigiana*, this species (Fig. 3. 24.) was first mentioned in parallel in two articles: Nagy *et al*., 2006 a; Marosi *et al*., 2006. It has also been mentioned later on from the Danube Delta Biosphere Reserve (Török, 2009).

It was present in periphytic communities from Lake Durgău (samples D-01-P and D-07-P).

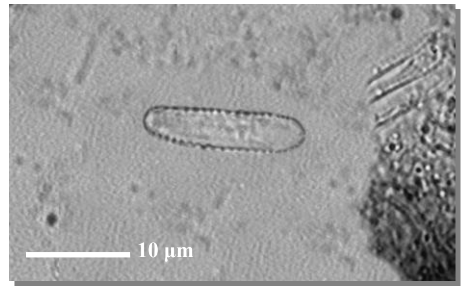

Fig. 3. 24. *Nitzschia aurariae* Cholnoky

12. *Nitzschia elegantula* Grunow – the species (Fig. 3. 25.) was first mentioned for Romania by Nagy *et al*. (2006 a). Later on, other publications reffer to this taxon: Kiss & Péterfi (2007), Nagy & Péterfi (2008).

It is an abundant species in samples collected from Lake Durgău (January, April, May, June, July, August, September and October) and it was also present in one sample originating from Lake Sulfuros (S-10-S).

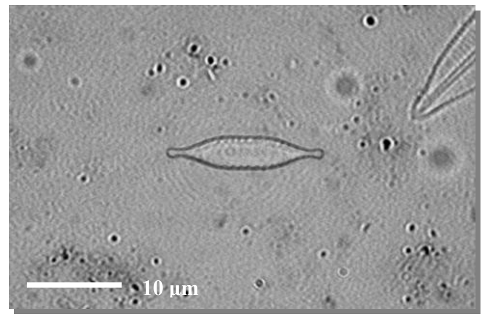

Fig. 3. 25. *Nitzschia elegantula* Grunow

13. *Nitzschia filiformis* (W. Smith) Van Heurck var. *conferta* (Richter) Lange-Bertalot – the only scientific article mentioning this taxon from Romania so far is Nagy *et al*. (2007). This publication deals with the planktonic and periphytic diatom communities from Lake Ocnei. The taxon (Fig. 3. 26.) was present in sample O-01-P.

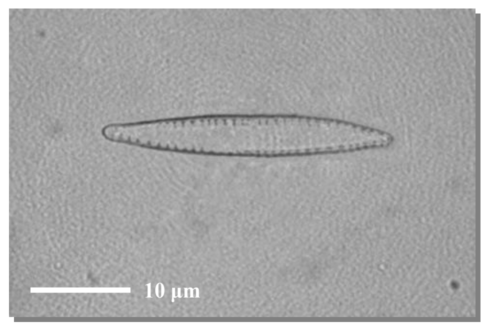

Fig. 3. 26. *Nitzschia filiformis* (W.Smith) Van Heurck var. *conferta* (Richter) Lange-Bertalot

Later on, it also has been identified in the phytoplankton of Lake Csiki (C-09-4m). It is generally considered a cosmopolitan taxon, very frequent; it often blooms in saline waters. It can also grow in sewage waters with high nutrient concentrations or in waste waters.

14. *Nitzschia fossilis* Grunow – it has been identified from Lake Sulfuros situated in Sărată Valley (sample S-07-S) and it was published by Nagy & Péterfi (2008).

15. *Nitzschia lanceola* Grunow – this species was present in a planktonic sample from Lake Sulfuros collected in January (sample S-01-S). It was published by Nagy & Péterfi (2008). The description of this species in identification books do not offer details, future studies are required.

16. *Nitzschia solita* Hustedt – two articles mention in parallel this species for the first time for Romania: Nagy *et al*. (2006 a) and Marosi *et al*. (2006). It was present in the periphytic community from Lake Durgău (D-04-P). It is a cosmopolitan species present on all continents. It can be rare or frequent, especially in waters with elevated electrolite levels. It is often present in the benthic communities of eutrophic ponds.

17. *Nitzschia subcohaerens* (Grunow) Van Heurck var. *scotica* (Grunow) Van Heurck – this taxon (Fig. 3. 27.) is first mentioned for Romania by Nagy & Péterfi (2008). This article deals with diatom communities of Lake Sulfuros from Sărată Valley. The frustules of this taxa were present in the periphyton of Lake Sulfuros (sample S-10-P) and in the plankton of Lake Durgău (D-09-3m).

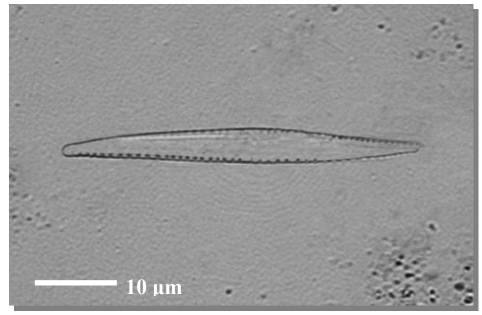

Fig. 3. 27. *Nitzschia subcohaerens* (Grunow) Van Heurck var. *scotica* (Grunow) Van Heurck

IV. Conclusions

The most relevant conclusions deriving from *in situ* observations and measurements, from qualitative and qantitative microscopical analysis and from data processing are the following:

- The investigated lakes have similar origins and were generated by the collapse of old salt mines or by filling up of surface salt exploitations. Abiotic characteristics of different lakes vary; one important factor with a large variability is salinity.
- The number of identified taxa in different lakes varied significantly. In total 203 taxa have been identified. 116 taxa were present in Durgău, 94 in Lake Sulfuros, 85 in Lake Csiki, 48 in Lake Dulce, 43 in Lake Ocnei and 25 in Lake Leon. Of all taxa 101 were present exclusively in one lake, as follows: 34 taxa in Lake Durgău, 26 in Lake Sulfuros, 19 in Lake Csiki, 13 in Lake Dulce, 7 in Lake Ocnei and 2 species in Lake Leon.
- Studies dealing with diatom communities from the investigated lakes are very few. Thus, these results bring new data for these aquatic ecosystems. The number of taxa mentioned for the first time from these aquatic habitats is 173.
- After reviewing the exiting literature on the topic another resulting conclusion was that 17 of the 203 taxa are mentioned for the first time for Romania. The species have been verified and confirmed by acknowledged phycologists.

- Among the taxa present in the investigated aquatic ecosystems there were alochthonous elements, species that usually do not develop in these types of environments.
- This study brings evidence that high salinity affects the taxonomical diversity of diatom communities. In lakes with highest salinity the number of taxa was lowest (Lake Ocnei and Lake Leon). These results confirm preexiting studies.
- Microscopical analysis indicated that high levels of salinity affect the silicification degree of diatom frustules. There is an inverted ratio between the two. In many cases deformed, abnormal, teratological frustules have been observed at high salinity levels. These observations are supported by conclusions of scientific works from international literature.
- Beside salinity other abiotic factors can play a significant role in the structure of the diatom community. Apparently, the type of substrata and the lack of macrophytes (or other suitable substrata) in Lake Ocnei strongly influence diatom communities.
- The number of species in periphytic communities exhibited seasonal variation, but no common pattern for all lakes was observed. Apparently in some cases the cold period can positively influence the development of periphytic diatom communities.
- There are variations in the horizontal distribution of planktonic diatom communities. The number of taxa and of diatom frustules seems to be higher near the shores than in the middle of the lakes.
- There is a quantitative and a qualitative dynamic of planktonic diatom communities over time. There have been two quantitative peaks in diatom frustules development: one in spring and one in autumn. The qualitative dynamic was similar. The presence of these two peaks is in concordance with the *Si depletion hypothesis* of Schelske & Stoermer (1971, 1972). This hypothesis claims that in spring an explosion of diatom populations occurs especially due to high Si and P concentrations accumulated through the winter period.
- Due to a minor shift no perfect overlap was observed between the quantitative and qualitative (variations in species number) peaks. Competition and different nutrient absorption levels can be associated with this phenomenon.
- Results are fit with the *intermediate salinity hypothesis*. This suggests that at low salinity levels the abundance of halophile species is controlled especially by biotic factors (herbivores, competition), but at high salinity levels the tolerance to this factor becomes more important.

- Another theory that seems to be confirmed by the presented results is the one refering to the shift in the limits of salinity tolerance characteristic to some species when nutrients are abundant. Thus, species that usually do not occur at high levels of salinity were present or even abundant in some saline lakes with high trophicity.
- A relation between nutrient quantities and dynamics (data obtained by chemical analysis) and the evolution of diatom communities has been observed.
- During winter ”ice hole sampling” was carried out. The analysis of these samples showed that under the thick layer of ice, even if in small quantities, diatoms were present in planktonic communities.
- There was a vertical quantitative and qualitative stratification of planktonic diatom communities. The best represented layers were between the surface and 2 m depth.
- A series of measurements have been carried out in October 2011 with the FluoroProbe. Lakes Durgău, Csiki and Leon have been chosen for these measurements, with results pointing out two main aspects: a) there was a vertical stratification of phytoplankton and b) there is also a thermal stratification (in lakes Durgău and Leon). In Lake Csiki the autumn water mixing period has been registered.
- Multivariate (DCA) and similarity (Jaccard) analysis highlighted two important and complementary aspects: on one hand diatom communities of different lakes have a site characteristic and different structure, but on the other hand due to the presence of common taxa or to the dominance of the same taxa in more than one lake there is a degree of similarity between them. Thus, the most similar lakes from this point of view are Lake Sulfuros and Lake Leon; the lowest similarity with other lakes was observed for Lake Ocnei.
- Based on both modern and traditional indexes a classification of investigated lakes has been realized. Saprobic Index, Trophic Diatom Index and Biological Diatom Index suggested that Lake Dulce has the worst water quality: IBD class was V (bad quality), trophical status was also V (hypertrophic) and SI class was III (strong organic pollution). Lake Sulfuros, where the human impact was lowest, seemed to have the best water quality among the investigated aquatic ecosystems.

In many cases there is a human impact on studied communities, manifested both directly and indirectly. This type of influence acts in multiple ways, e.g.: decreased transparency during summer, increased salinity through water mixing, direct disturbance (dislocation by touching substrata – metal poles, pieces of driftwood – or by generating waves), influence on the lakes trophic state.

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