„BABEŞ-BOLYAI” UNIVERSITY, CLUJ-NAPOCA
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COMPARATIVE STUDIES OF THE DIATOM COMMUNITIES INHABITING THE SOMEȘUL MIC RIVER AND ITS TRIBUTARIES BETWEEN FLOREȘTI AND APAHIDA (CLUJ COUNTY)

Ph.D. Thesis

(Abstract)

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Key words: diatoms, benthic communities, Someșul Mic, tributaries, floristic similarity, species richness, species diversity, water quality, diatom indices, canonical correspondence analysis (CCA)

Introduction

The present study wishes to contribute to the better knowledge of the benthic diatom communities inhabiting the Someșul Mic river and its major tributaries between Florești and Apahida (Cluj County, Romania). The diatom communities and the water quality of the whole course of the Someșul Mic river have been investigated before by Rasiga A., Momeu L. and Péterfi L.Șt. in the 1992-2001 period, but most of the tributaries haven't been studied yet from this point of view. Therefore, the present study constitutes a more elaborate investigation as well as an update of our knowledge referring to the diatom communities and the water quality of the more confined segment of the Someșul Mic river between Florești and Apahida and its major left-bank and right-bank tributaries in this area.

The investigated area is varied, including interesting territories from geological point of view (for example, gypsum containing formations in the spring zone of the Nadăș rivulet, salt diapirs in the area of the Zăpodie and Maraloiu streams, exerting effect also on the chemical properties of the Someșul Mic river from downstream Cluj-Napoca), some nature reserves in the context of the Natura 2000 programme of the European Union (such as the Făgetul Clujului-Valea Morii nature reserve with the Pleșca and Gârbău streams flowing nearby, the Fânațele Clujului reserve with the Valea Caldă stream flowing in the neighbourhood of the reserve), and also territories with high risk of pollution and disturbances (for example, the presence of Cluj-Napoca and other settlemets as sources of domestic and possibly industrial wastewaters, agricultural lands, and especially the wastes deposit site at Pata Rât a few meters close to the Zăpodie stream). The aim was to reveal significant effects of all these ”special” sites on the composition and structure of diatom communities, based on the assumption that abiotic factors of natural or anthropic origin have a strong influence upon the aquatic organisms and produce alterations that manifest at the level of species composition, structure and functions of communities. As a result, each surface water can be considered a complex system of abiotic and biotic components, which together give an (almost) unique character to the water concerned.

In order to emphasize the adaptational aspects of diatom communities to abiotic factors in the investigated area the following objectives were established:

- ✓ Identification of diatom taxa from the studied waters as a contribution to existing data regarding the distribution of diatoms in Romanian waters;
- ✓ Discovery and characterisation of species and varietes that have never been mentioned before as living in Romanian waters, and in the Someșul Mic catchment area respectively;
- ✓ Measurements of the major physico-chemical parameters of the water and the marking out of those with significant influence upon the structure of diatom communities;

- ✓ Overall and comparative characterisation of the structure of diatom communities by means of simple indices of diagnosis of biotic integrity, such as species richness and species diversity, the character and abundance of indicator species and the degree of floristic similarity;
- ✓ To answer the expectations of the European Union phrased in the Water Framework Directive by assessing and monitoring the water quality in the chosen sampling sites based on different diatom indices.

1. Short account of algological studies related to the Someșul Mic river catchment area and the sorroundings of Cluj-Napoca city

Among the most important, relatively recent studies related to the Someșul Mic river one could find those performed by Rasiga A., Momeu L. and Péterfi L.Șt. (Momeu *et al*., 1996; Rasiga *et al*., 1995-1996a, 1995-1996b, 1997, 1999; Rasiga, 2001). There have also been carried out some researches related to the algal communities of lakes and ponds located along the Fizeș Valley, one of the major tributaries of the Someșul Mic river (Momeu *et al*., 1979, 1980, 2004, 2006; Momeu, 2006; Pralea, 1988, 2000; Gudasz *et al*., 2000; Nagy *et* Momeu, 2004; Nagy *et al*., 2005), as well as some investigations referring to different aquatic habitats of the ”Alexandru Borza” Botanical Garden of Cluj-Napoca (Róbert, 1957; Neag *et al*., 2005) and of the Valea Morii nature reserve (Pop *et al*., 1962; Momeu *et al*., 2005).

2. General description of diatoms and their significance in aquatic ecosystems

Diatoms (*Bacillariophyceae*) form a group of unicellular algae, living solitarily or in colonies. The diatom cell is sorrounded by a silicon frustule with specific morphological and structural features that constitute the bases of traditional diatom identification and systematics (Raven *et al*., 2003). Diatoms inhabit almost all types of surface waters, beeing present even under extreme environmental conditions. Diatoms usually form the major qualitative and quantitative proportion (up to 80-90% of the total amount) of the phytoplankton and microphytobenthos of both oceans and continental standing and flowing waters. The distribution of diatom taxa, as well as the structure and the dynamics of the communities are beeing directly and indirectly influenced by certain physical, chemical and biological factors, such as the intensity of the light, water temperature, pH, hardness and movements of the water, the properties of the substrate, type and absolute and relative quantity of organic and inorganic substances – especially those of the silicon in the water (Wetzel, 2001) – , degree of parasitism and consumption by other aquatic organisms etc. Human activities (for examle, resulting in pollution through point-type or diffuse sources, disturbances of the substrate, inorganic nutrients in excess, algicide substances etc.) also affect the abiotic factors mentioned above, producing their own alterations in the structure and dynamics of the algal communities (Lewis *et* Wang, 1997; Leira *et* Sabater, 2005). In terms of life ”style” diatoms are divided (although not strictly) into planktonic and benthic species. Furthermore, depending on the properties of the substrate, benthic diatoms are separated into epilithic, epiphytic, epipsammic, epipelic and epizoic species (Round, 1966, 1984; Round *et al*., 2007).

Diatoms have major and many-sided significance in aquatic ecosystems as primary producers in trophic networks, as producers of the dissolved and athmospheric O_2, as active contributors to the cycle of certain chemical elements in nature (Werner, 1977b), or as major participants in the self purification processes of natural waters. Diatoms are also among the most intensely studied aquatic plant-type organisms, beeing included in paleolimnological and paleoclimatological researches, different studies regarding the ultrastructure and permeability of the silicon cell wall, as well as on the practical side of water quality assessment and monitoring, due to their good properties as biological indicators (Podani, 1992a, 1992b; Lowe *et* Pan, 1996; Prygiel *et al*., 1999; Stoermer *et* Smol, 1999).

3. Basic concepts related to water quality and the use of diatoms in its evaluation

The major concepts related to water quality are halobity, trophicity, saprobity and toxicity (Kiss, 1998), and their degree can be estimated both by chemical-biochemical methods and the analysis of the composition and structure of diatom communities. The latter is based on systems of indicator diatoms and results in different indices (such as the Halobity Index, the Saprobity Index and the Biological Diatom Index) (van Dam *et al*., 1994; Coste *et al*., 2009; Ziemann, 2010) that indicate the water quality in a more general way than momentary chemical measurements.

4. Characterisation of the Someșul Mic catchment area and the major tributaries of the river between Florești and Apahida (Cluj County)

Downstream the confluence point of the Someşul Cald (S^2=526 km^2, L=66,5 km) and Someşul Rece (S^2=331 km^2, L=45,6 km) rivers, both flowing through mountainous areas, the Someşul Mic river thus formed flowes through lower relief units in a corridor-like area between the Someşan Plateau located north and the Someşan Plain (sub-unit of the Transylvanian Plain) located south. The surface of the catchment area of the Someșul Mic river is 3 804 km^2 , while the lenght of the river course beginning from the origin of the Someșul Cald is 166,6 km (Újvári, 1972; Buta, 1967). The major investigated left-bank tributaries of the Someşul Mic river are the Nadăş rivulet (S^2=331 km^2, L=33,6 km), the Valea Chintenilor (S^2=45 km^2, L=12 km) and Valea Caldă (S^2=33 km^2, L=12 km) streams, while the right-bank tributaries included in the present research are the Gârbău stream(S^2=28 km^2, L=8 km) with its own tributary the Pleşca stream, followed by the Becaş (S^2=44 km^2, L=8 km), Zăpodie (S^2=43 km^2, L=10 km) and Maraloiu streams (Újvári, 1972).

The investigated area is very diverse from geological point of view too (Baciu *et* Filipescu, 2002).

5. Materials and methods

Benthic samples were collected from 16 sampling sites located along the Someşul Mic river and some of its tributaries between Florești and Apahida (Cluj County) (*Fig. 1*).

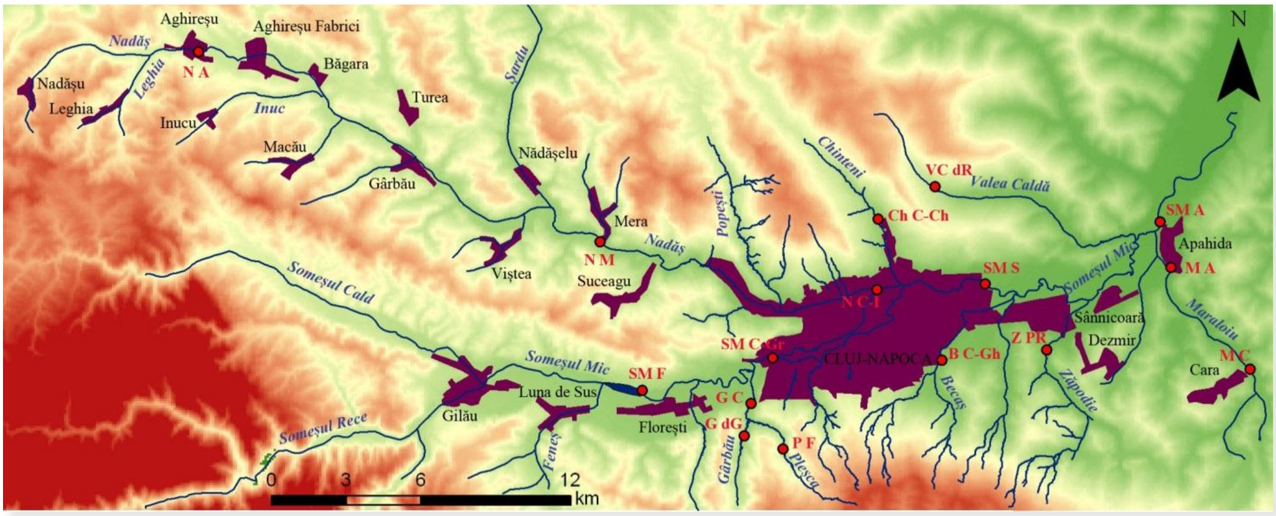


***Fig. 1.* Sampling sites on the Someşul Mic river and its major tributaries between Floreşti and Apahida**

*(**SM F**: Someşul Mic – Floreşti, **SM C-Gr**: Someşul Mic – Cluj-Napoca (Grigorescu quarter), **SM S**: Someşul Mic – Someşeni, **SM A**: Someşul Mic – Apahida, **N A**: Nadăş – Aghireşu, **N M**: Nadăş – Mera, **N C-I**: Nadăş – Cluj-Napoca (Iris quarter), **Ch C-Ch**: Chinteni – Cluj-Napoca/Chinteni zone, **VC dR**: Valea Caldă – Râpos Hill area, **P F**: Pleşca – Făget area, **G dG**: Gârbău – Gârbăului Hill area, **G C**: Gârbău – Cluj-Napoca zone, **B C-Gh**: Becaş – Cluj-Napoca (Gheorgheni quarter), **Z PR**: Zăpodie – Pata Rât, **M C**: Maraloiu – Cara, **M A**: Maraloiu – Apahida)*

The sampling procedures were carried out during 6 seasons: the autumn of 2005 (only on some sampling sites), summer and autumn of 2006, spring and summer of 2007 and spring of 2009. On every occassion 3-5 sub-samples were collected repeatedly from every available type of substrate and later mixed in order to obtain the main sample. The sampling technique differes depending on the nature of the substrate, but in most cases consists of the removal of the diatom containing layer from a more or less hard substrate with a fine brush or a Pasteur pipette into a sampling bottle (Stevenson *et* Bahls, 1999; Biggs *et* Kilroy, 2000; Ács *et* Kiss, 2004). After *in situ* fixation with 96% ethanol, the samples were processed in laboratory observing the following steps: the removal of inorganic subtrate particles form the samples through repeated washing, sedimentation and decantation; the elimination of organic matter by means of oxidative decomposition using 30% H_2O_2 and 1N HCl solutions and heating the mixture to 80−90 °C, followed by a cleaning procedure with distilled water (Ács *et* Kiss, 2004); and the preparation of mounted slides containing the cleaned frustules of diatoms for microscopical examination.

Simultaneously, the major physico-chemical properties of the water were measured in field, such as the water temperature, pH, specific conductivity, salinity and the quantity of the dissolved oxigen, and water samples were collected in order to determine in laboratory the quantities of Cl^-, NO_3^-, Na^+, K^+, SO_4^{2-}, PO_4^{3-}, NO_2^- and NH_4^+ by means of electrochemical and spectroscopic methods (Croitoru *et* Constantinescu, 1979).

The different diatom taxa were identified based on the available literature (Patrick *et* Reimer, 1966; Krammer *et* Lange-Bertalot, 1986, 1988, 1991a, 1991b; Krammer, 2000, 2002, 2003; Lange-Bertalot, 2001; ***CEMAGREF, 2000) and several data bases, taking into consideration both the morphology of the frustules and the ecological preferences of the taxa. The comparative study of the diatom communities was fulfilled through different aspects: the floristic composition of the communities, species richness (the number of the diatom taxa and genera), the character and relative abundance of diatoms with indicator properties (Sladeček, 1973; van Dam *et al.*, 1994; Krammer *et* Lange-Bertalot, 2000; Ziemann, 2010), the species diversity based on the Shannon diversity Index, and the cluster analysis of the floristic similarity of the studied communities based on the Jaccard Similarity Index. The samples were also grouped based on the physico-chemical properties of the water applying the Principal Component Analysis (PCA), whereas the correlation between the physico-chemical parameters of the water and the structure of the diatom communities was studied through multivariate analysis as the Canonical Correpondence Analysis (CCA). Water quality monitoring also took place during the autumn 2005 – spring 2009 period, using different diatom community based indices such as the Halobion Index (HI) (Ziemann, 2010), the diatom Saprobity Index (SI) (Sladeček, 1973) and the Biological Diatom Index (BDI) (Coste *et al*., 2009).

6. Results and discussions

6.1. Physico-chemical properties of water in the chosen sampling sites

The data regarding the **water temperature** measurements during the autumn 2005 – spring 2009 period show normal differences between seasons, meaning lower water temperature values in relatively cold seasons (the autumn of 2005 and 2006, and the spring of 2007 respectively) and higher values in warmer seasons (summer of 2006 and 2007 as well as the spring of 2009) (*Fig. 2*).

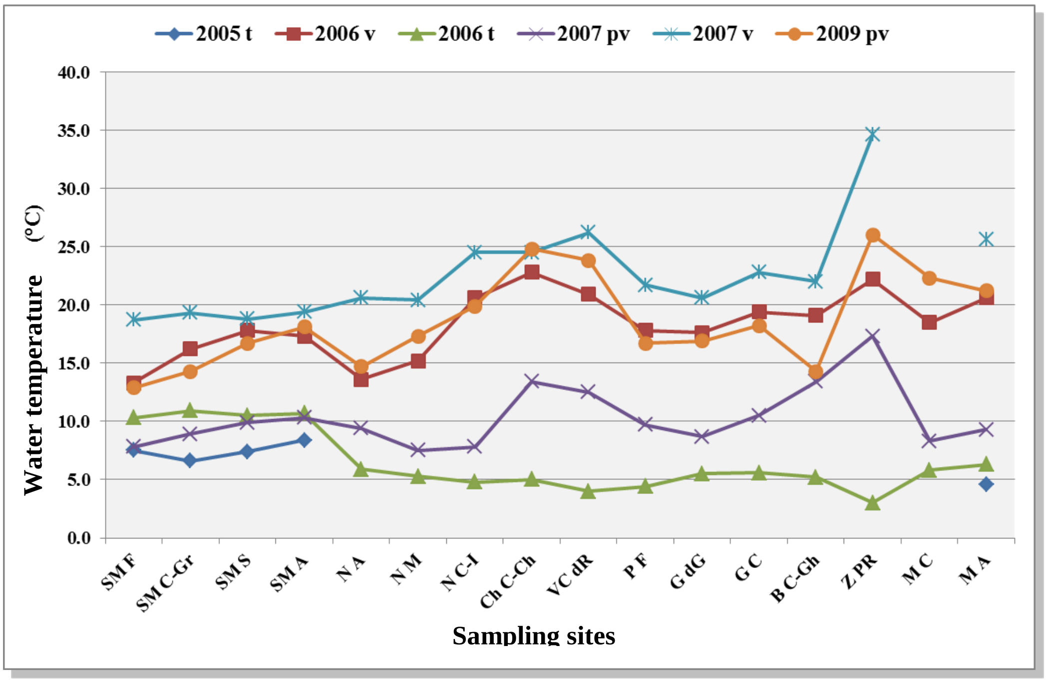


Fig. 2. **Seasonal variaton of water temperature values in the sampling sites** (*pv-spring, v-summer, t-autumn)*

As for the seasonal variation of water **pH** values there has been observed a significant increase of the values in general from the summer of 2006 to the autumn of the same year, followed by a significant decrease until the spring of 2007, but with higher pH values compared to the summer of the previous year. Toward the summer of 2007 pH values continued to decrease in a significant way compared to the spring of 2007. In the spring of 2009 pH values incresed again in general, significantly compared to the values recorded in summer 2007. However, the differences between pH values recorded in the same type of season (the two summers and two springs) proved to be insignificant. Altogether these results show some kind of seasonal pattern in the variatons of the pH of water in the case of the investigated tributaries of the Someşul Mic river (*Fig. 3*).

The degree of mineralization in the case of the river and its tributaries can be estimated based on the average specific conductance calculated for 5-6 seasons (*Fig. 4*). Thus, in the case of the Someşul Mic river there has been established a gradual increase of the mineralization from reduced to medium from upstream Cluj-Napova to downstream Apahida. The Nadăş rivulet is characterized by increased mineralization, especially in its spring area, prezenting in the same time a mild reduction of the mineralization toward the lower course. The Gârbău stream and its tributary, the Pleşca, present a medium degree of mineralization, the Chinteni and Valea Caldă streams are characterized by an increased mineralization, whereas the Zăpodie and Maraloiu streams by the highest degree of mineralization in the investigated area (*Fig. 4*).

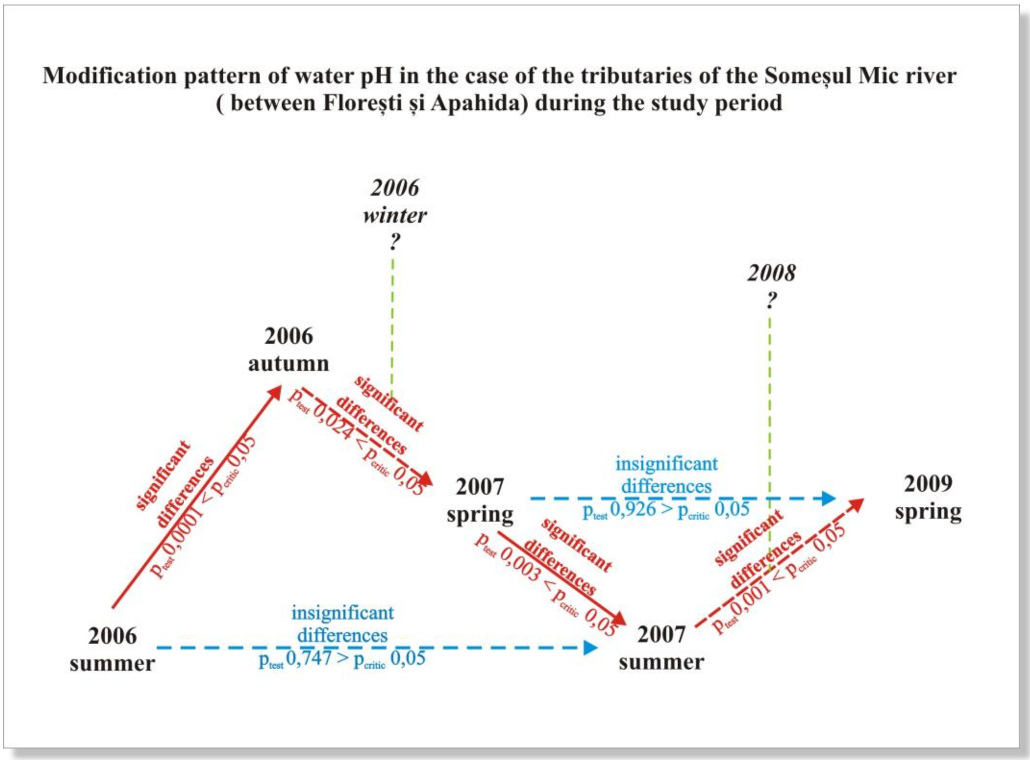


Fig. 3. **Statistically significant and insignificant differences in the seasonal variations of water pH values in the case of the tributaries of the Someșul Mic river during the study period**

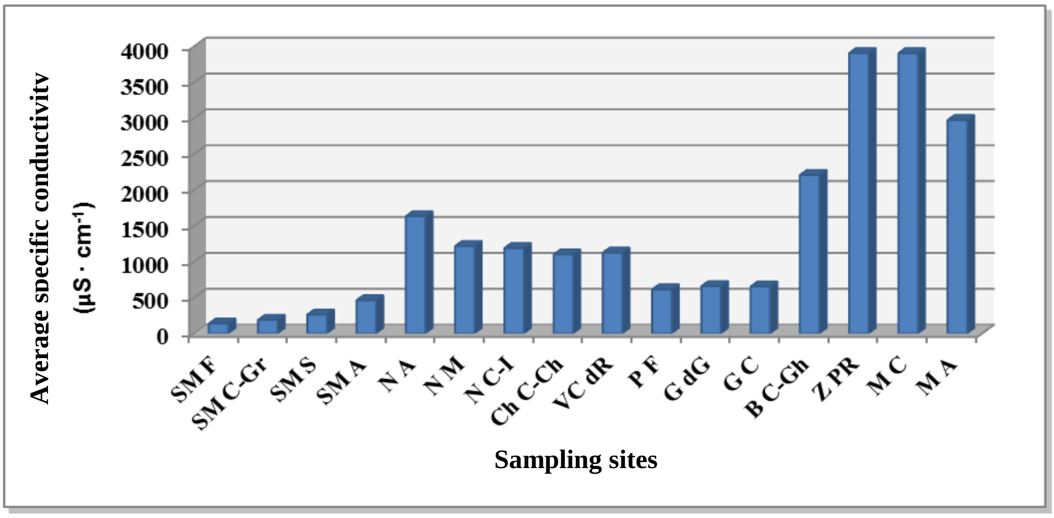


Fig. 4. **Average specific conductance of the water of the Someșul Mic river and tributaries during the study period**

Based on the concentrations of Na^+, Cl^-, SO_4^{2-}, PO_4^{3-} and NO_3^- the water of the Someșul Mic river at Florești and upstream Cluj-Napoca (Grigorescu quarter) is of good quality, belonging to the I-II quality class of natural surface waters according to Romanian legislation. a apelor de suprafață. However, NO_2^- and NH_4^+ concentrations are higher (III-IV quality class). The quantities of the different ions in the water of the Someșul Mic river at Someșeni vary considerably during the study period, between values characteristic to quality classes I and V. Average values indicate quality class II, except for the average quantities of NH_4^+, NO_2^- and PO_4^{3-} (quality class IV). The latter is probably an effect of the presence of domestic waste waters coming from point sources in the area of Cluj-Napoca city. The water of the Someșul Mic river downsream Apahida is characterized by lower dissolved O_2 concentrations, significantly higher quantities of Na^+ and Cl^- (quality classes III-V, depending on the season and the water flow), as well as relatively high NO_3^-, NO_2^- and NH_4^+ concentrations (quality classes III-IV). All these could be the signs of pollution due to use of chemical fertilizers in the area, but also those of pronounced organic pollution. In the water of the Someșul Mic river, downstream Apahida, there have been found the highest concentrations of PO_4^{3-} during the study period, more than twice as high as the inferior limit value for water quality class V. The presence of the waste water treatment facility between Someșeni and Apahida is most probably the cause of this phenomena, because the facility presents a lower efficiency in PO_4^{3-} removal form the treated water, allowing discharges of water with elevated PO_4^{3-} content into the Someșul Mic river.

The high degree of mineralization in the case of the Nadăș is due primarily to the considerable SO_4^{2-} concentrations (quality class V), in association with Ca^{2+} and partially with Na^+ ions (sodium was present in all three sampling sites in significant quantities, placing the water of the Nadăș into the 3rd quality class). The main sources of sulfate in this case are the gipsum containing geological deposits located mostly in the spring area of the rivulet and along its smaller tributaries. Cl^- concentrations were low, but PO_4^{3-},NO_3^-, NO_2^- and NH_4^+ were present in considerable quantities in all three sampling sites (PO_4^{3-}: quality classes I – II – III, NO_3–: quality classes II – III – IV, NO_2^-: quality class IV, and NH_4^+: quality classes IV – V – IV).

In the water of the Chinteni stream all determined ions were present in considerable quantities, except for the Cl^- and PO_4^{3-} which were present in much lower concentrations. Based on the average concentrations of NO_3^- and NO_2^-, the water of the Chinteni stream is of quality class III, but based on the concentrations of SO_4^{2-}, Na^+ and NH_4^+ the water belongs to quality class IV.

As for the quantities of the major ions, the Valea Caldă stream is similar to the Chinteni stream: Cl^- and PO_4^{3-} were present in low quantities (quality class I), while NO_3^- and NO_2^- average concentrations were higher (quality class III), as well as the average concentrations of Na^+ and NH_4^+ (quality class IV) and SO_4^{2-} (quality class V). Based on the concentrations of PO_4^{3-} and Cl^- in the water, the Gârbău and Pleșca streams seem to belong to quality class I, while average concentrations of Na^+ and SO_4^{2-} indicate quality classes II-III, the NO_3^- content of the water was acceptable, and the average concentrations of NO_2^- and NH_4^+ show quality classes III, and III – IV respectively. The water of the Becaș stream contained significant quantities of Na^+, aproximately 2,75 times more than the inferior limit value of the quality class V. In the same stream the Cl^- and SO_4^{2-} concentrations were medium (quality class III), the PO_4^{3-} was present is small amounts (quality class I), while the NO_3^-, NO_2^- and NH_4^+ were determined in higher concentrations (quality classes III and IV). In the case of the Zăpodie and Maraloiu streams the Na^+ concentrations proved to be aproximately 7-8 times higher than the inferior limit value for the quality class V, and the average Cl^- and SO_4^{2-} concentrations also indicate quality class V. The PO_4^{3-} ions were present in the Maraloiu in lower concentrations (quality class I), but in higher concentrations (quality class II-III) in the Zăpodie at Pata Rât. However, the nitrogen forms were present in significant quantities (quality classes III-IV-V), especially in the Zăpodie, in which case the NO_2^- and NH_4^+ concentrations significantly exceeded the inferior limit value of the quality class V.

Based on the results of the Principal Component Analysis (PCA), the investigated waters form groups depending on their physico-chemical properties, and the major defining abiotic factors of the river and its tributaries can also be emphasized. As shown in the PCA diagram for the summer of 2006 (similar in general to the other diagrams for other seasons) the sampling sites can be separated into the following groups (based on their characteristic physico-chemical parameters): the Someșul Mic river, the Pleșca and Gârbău streams, the relatively mixed group of the Nadăș, Chinteni and Valea Caldă streams, the Becaș, and the Zăpodie-Maraloiu streams (*Fig. 5*).

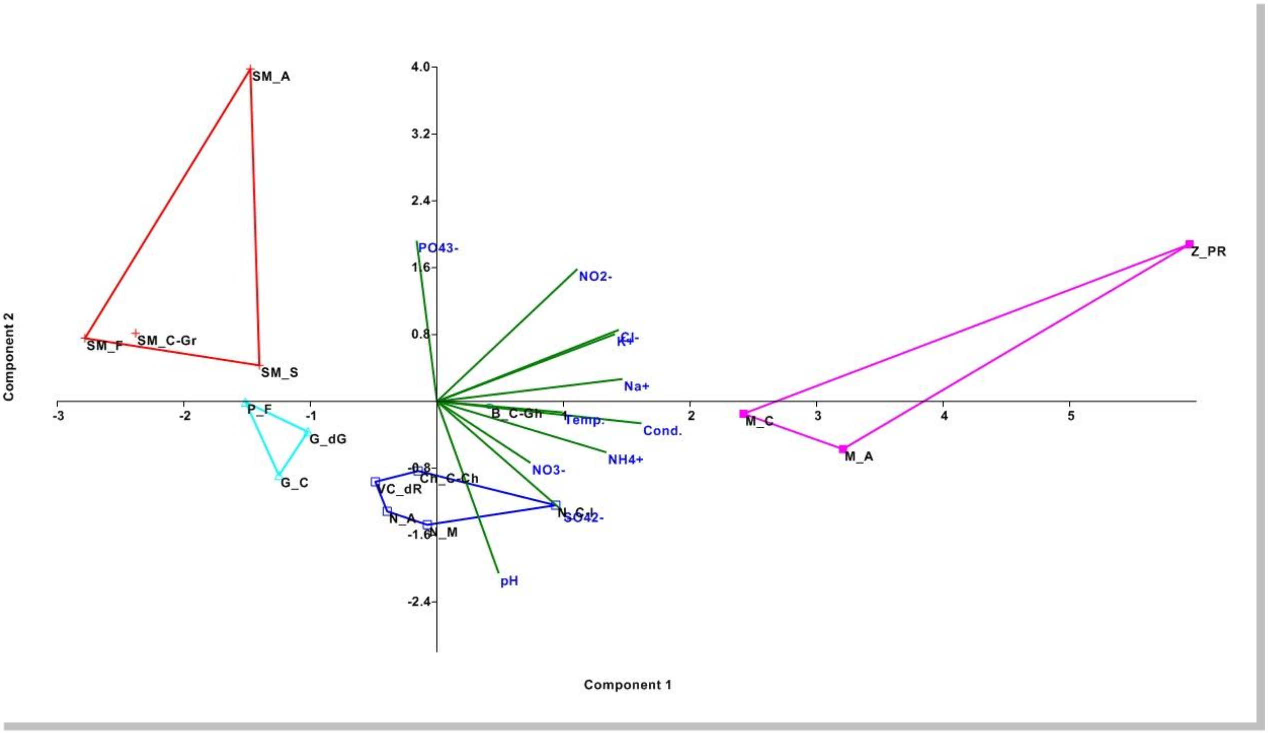


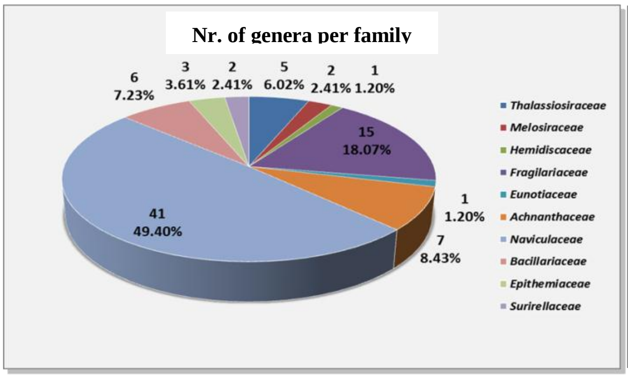
Fig. 5. **Grouping of water samples collected in the summer of 2006 by means of Principal Component Analysis (PCA)**

The characteristic physico-chemical properties in the case of the sampling sites on the Someșul Mic river upstream Cluj-Napoca consist primarily of lower values of the specific conductivity. At Someșeni the increase of the water pH was observed, while downstream Apahida pH decreased again, but significant concentrations of phosphate were recorded. The grouup of the Pleșca-Gârbău streams has its maximal simirality with the sampling sites Someșul Mic-Florești and

Someşul Mic-Cluj (Grigorescu quarter), but with values of the abiotic parameters closer to the average. The streams Nadăş, Chinteni and Valea Caldă form a mixed group, without any major outstanding abiotic parameter that would characterize them, and with values close to the average. However, the sampling sites located along the Nadăş rivulet seemed to be somewhat separated, due to the sulfatate type water. The Becaş stream is similar to a certain degree both to the Nadăş-Chinteni-Valea Caldă group and the Zăpodie-Maraloiu group, to which represents a transition to higher degrees of salinity. The Zăpodie and Maraloiu streams are strongly defined by the highest values of specific conductivity in the investigated area, due to the increased concentrations of Na^+ and Cl^-, but also K^+, SO_4^{2-} , NH_4^+ and NO_2^-.

6.2. General description of the investigated diatom communitie

From the diatom samples collected from 16 sampling sites in 4-6 seasons there have been identified 387 taxa: 341 species, 45 varietes and 1 form, which belong to 83 genera and 10 families (*Fig. 8*). The *Naviculaceae* family is represented by the most genera (41 genera, 49,40% of the total number of identified genera), but the families *Fragilariaceae* (15 genera, 18,07%), *Achnanthaceae (*7 genera, 8,43%) and *Bacillariaceae* (6 genera, 7,23%) are also relatively well represented (*Fig. 6*). As for the ”distribution” of diatom taxa per families, a little over the half of the identified taxa (203 taxa, 52,45%) belong to the *Naviculaceae* family, followed by the *Bacillariacea* (62 taxa, 16,02%), *Fragilariaceae* (46 taxa, 11,89%) and *Surirellaceae* (23 taxa, 5,94%) families (*Fig. 7*). 9 genera from 83 were represented by at least 10 taxa (meaning species, varietes and form). Thus, the genera represented by the most taxa in the samples are: *Nitzschia* (46 taxa, 11,88% of the total number of 387 identified taxa), *Navicula* ”sensu stricto” (44 taxa, 11,37%), *Pinnularia* (21 taxa, 5,42%), *Surirella* (19 taxa, 4,91%), *Gomphonema* (17 taxa, 4,40%), as well as *Fragilaria, Diatoma, Cymbella* and *Tryblionella* with 10 taxa (2,58%) each.



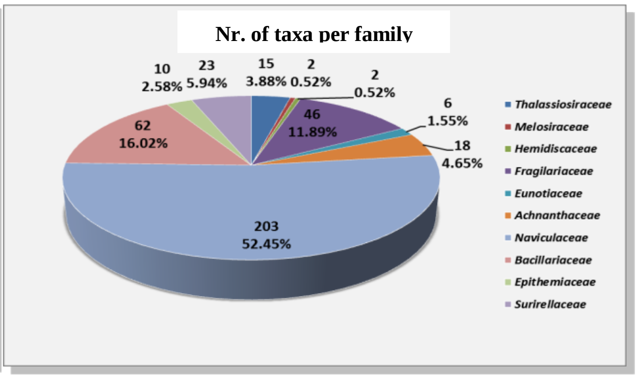


***Fig. 6.* Diatom families with number of the representing genera / *Fig. 7.* The number and percentage of taxa per family**

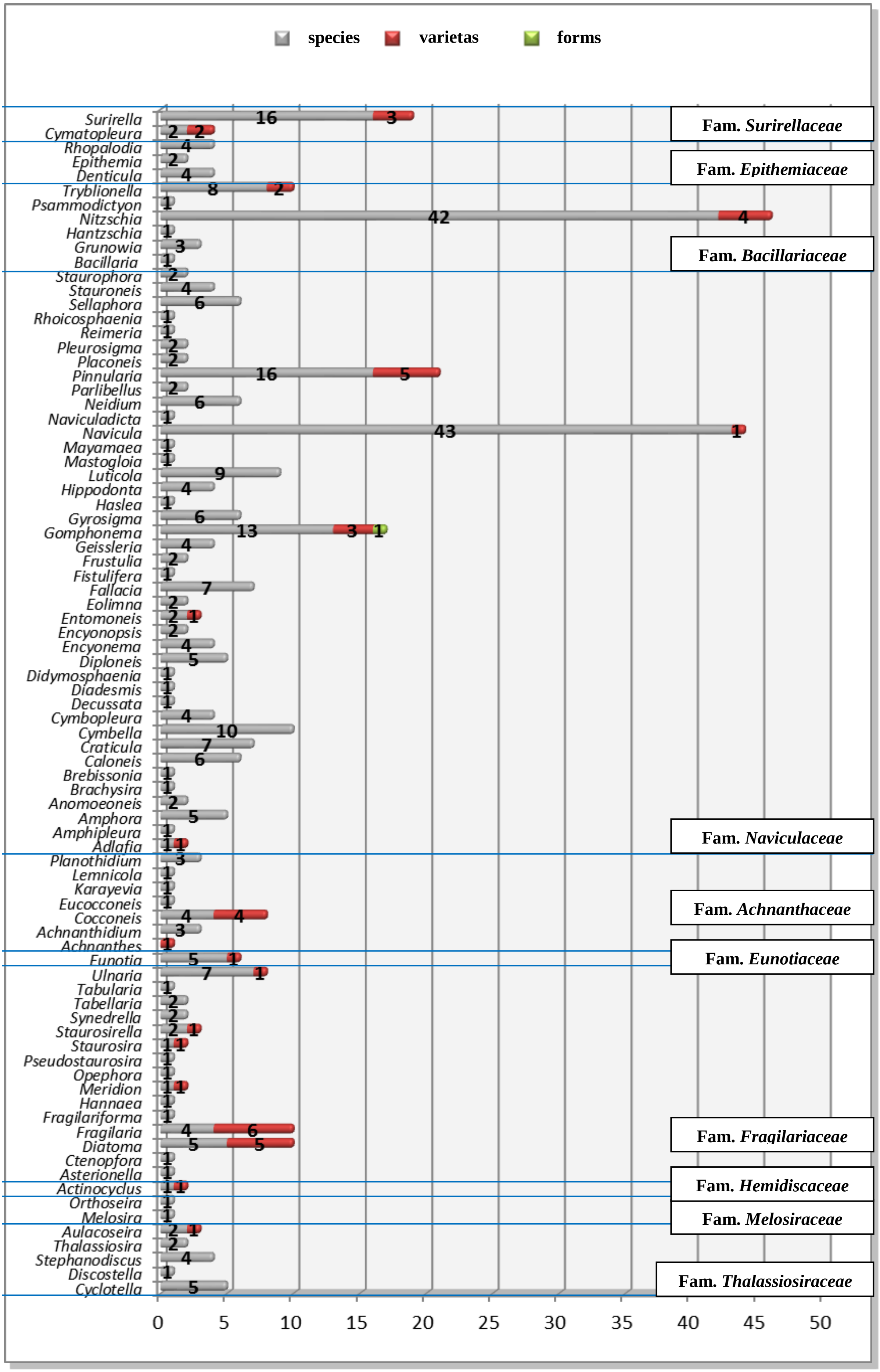


Fig. 8. **The number of diatom species, varietes and forms within the identified genera in the benthic samples**

6.3. Grouping of diatom communities based on the floristic similarity

The diagramme based on the Jaccard similarities between the investigated diatom communities (84 samples collected from 16 sites) (*Fig. 9*) indicates the formation of the same groups or aggregates of communities as shown in the diagrammes resulted from the comparison of the sampling sites/waters depending on their physico-chemical properties: the sampling sites along the Someșul Mic river, the Pleșca-Gârbău group, the Zăpodie-Maraloiu group and the relatively mixed Nadăș-Chinteni-Valea Caldă-Becaș group. Within the latter, the communities from the Nadăș and Valea Caldă streams seem to be more distinct than others. These groups correspond to the geographical localizarion of the investigated water courses from which the benthic samples were collected (*Fig. 10*). This correspondence emphasizes again, within the present study, the good indicator properties of diatoms at community level, and shows that communities adapt to physico-chemical properties of the water, and ”adjust” the taxonomic composition, species richness and diversity as well as other qualitative and quantitative parameters of the community structure to the unique ”set” of physico-chemical parameters of their aquatic habitat.

6.4. Composition, structura, species diversity and dynamics of diatom communities in the investigated area

The average number of taxa in samples collected form the Someșul Mic river varied between 110,1 and 126,6, while the maximum average diversity was recorded at Someșeni, due to the highest echitability of communities in this site (*Fig. 11*, *12* and *13*). Upstream Someșeni the diatom communities inhabiting the Someșul Mic river were generally dominated by *Achnanthidium biasolettianum, Achnanthidium minutissimum, Encyonema minutum* and *Navicula lanceolata,* species characteristic to continental waters with low to medium content of electrolites and oligo-/β-mezosaprobic. Downstream Apahida, dominant species *Fistulifera saprophila* and *Navicula gregaria,* together with subdominant species *Mayamaea atomus, Nitzschia capitellata, Navicula veneta* și *Gomphonema parvulum* var. *parvulum* f. *saprophilum,* indicate increasing salinity and saprobity of the water. The average number of taxa in the Nadăș rivulet varied between 84,8 and 94, with the highest average diversity at Aghireșu, near the spring zone of the rivulet, due to the higher echitability of communities in this zone (*Fig. 11, 12* and *13*). Dominant diatoms in the Nadăș also varied depending on the sampling site and season: *Mayamaea atomus, Gomphonema olivaceum, Achnanthidium minutissimum, Navicula capitatoradiata, Amphora pediculus, Navicula rostellata, Navicula cryptotenella* și *Navicula gregaria*.

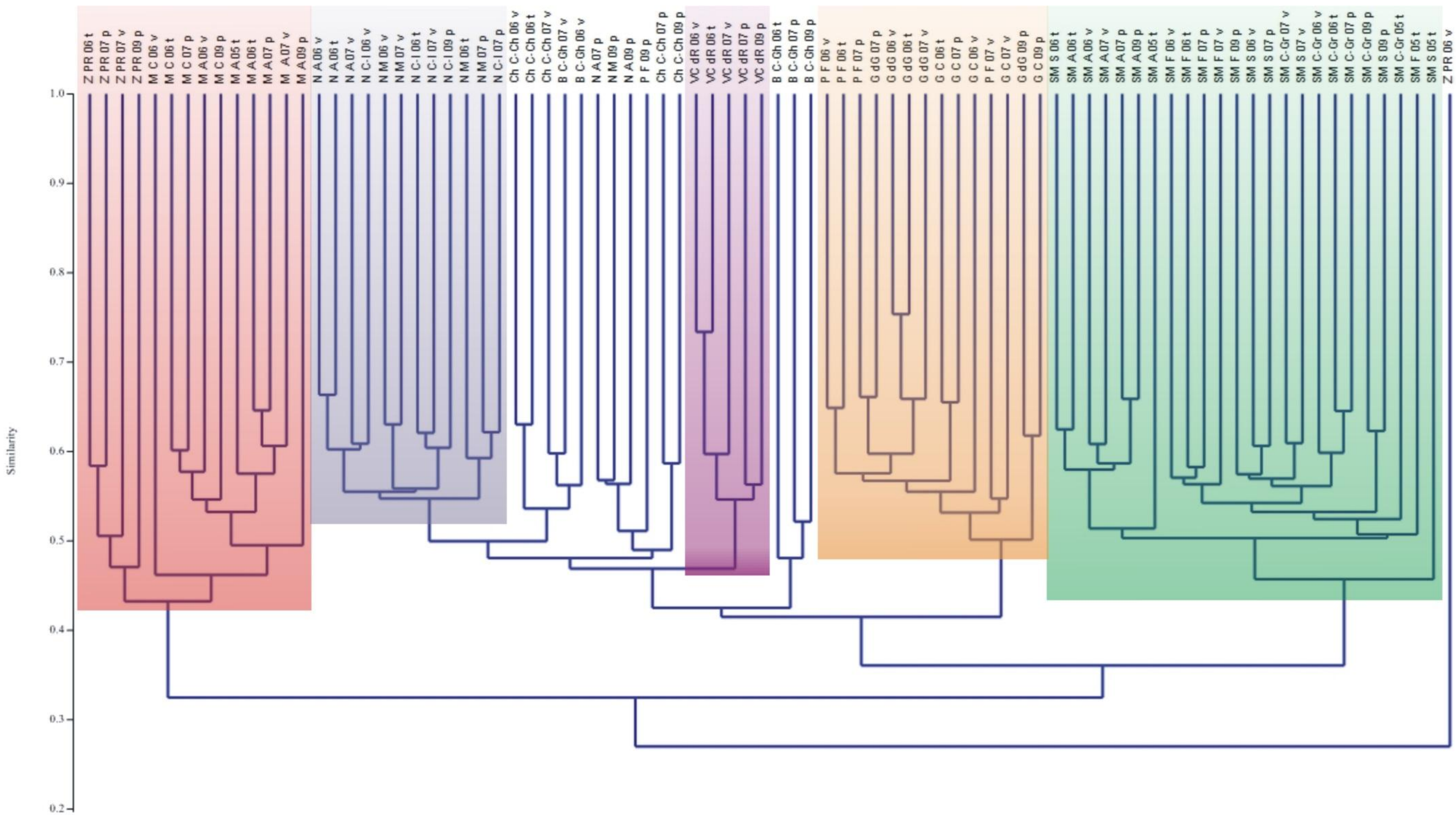


Fig. 9. **Grouping of the benthic diatom communities inhabiting the Someșul Mic river and its major tributaries between Florești and Apahida pe based on the floristic simlarity (Jaccard Similarity Index)** *(05 – 2005, 06 – 2006, 07 – 2007, 09 – 2009, pv – spring, v – summer, t – autumn)*

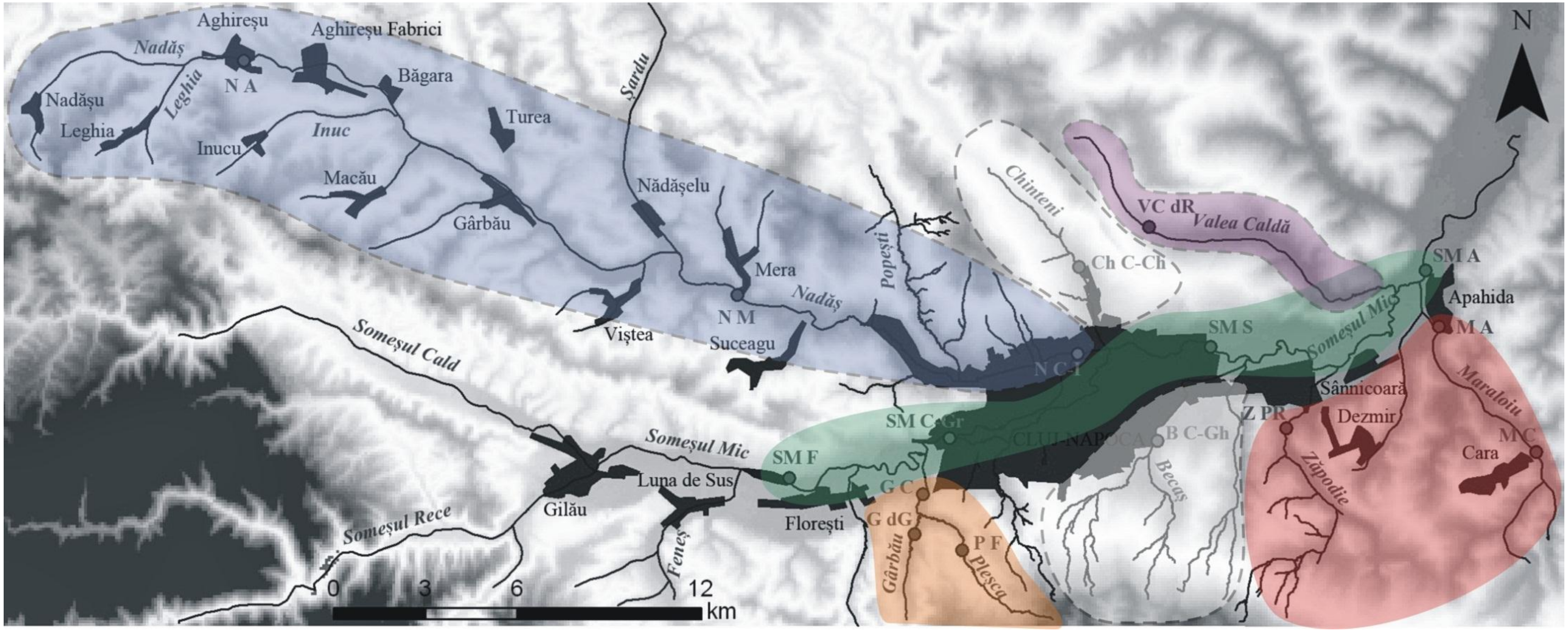


Fig. 10. **Groups or "units" of diatom communities resulted form comparison based on the floristic similarity correspond well to the geographical localization of sampling sites/water courses from which they were collected , with some interference s in the case of the Nadăș, Chinteni, Valea Caldă and Becaș streams** *(green – Someșul Mic, orange – Pleșca and Gârbău streams, red – Zăpodie and Maraloiu streams, blue – Nadăș, lila – Valea Caldă, white – Chinteni and Becaș streams)*

In the case of the communities inhabiting the Chinteni stream, an average number of 82 diatom taxa was identified, and the communities developed in the summer of 2006 proved to be the most diverse. A frecvent and relatively abundant (40 – 50% rel. abund.) species inhabiting this stream was *Amphora pediculus*, also dominant during two sampling seasons. The assamblages of dominant and subdominant diatoms of the communities inhabiting the Chinteni stream and those inhabiting the lower course of the Nadăș rivulet seem to be very much alike.

The average number of taxa in the case of the Valea Caldă stream was 77 for the study period, with maximum average species diversity recorded in the spring of 2009. *Achnanthidium minutissimum* was the dominant species during the first three sampling seasons, with aproximately 30-40% relative abundance. In the same way as in the Nadăș and Chinteni streams, the summer of 2007 proved to be somewhat special, resulting in the dominance of two diatom taxa, indicators of increasing salinity and saprobity of the water, never met before in the communities with significant abundances.

The average number of taxa of the communities inhabiting the Pleșca and Gârbău streams, varied between 93,4 and 107,4. The highest specific diversity was recorded at sampling site Gârbău-hill Gârbău (*Fig. 11, 12* și *13*). *Achnanthidium minutissimum* manifested a strong presence in these streams as well during the study period, beein the dominant species in most of the sampling seasons in all three sampling sites, with relative abundances ocasionally up to 67,11%. In this case too, the summer of 2007 was special: in every sampling site ”appeared” a ”new” dominant species (different form one site to another), which has never been recorded before as beeing present with a significant abundance in the diatom communities inhabiting the Pleșca and the Gârbău.

The average number of taxa of the communities inhabiting the Becaș stream was 80,4 for the study period, while the maximum species diversity was recorded in the summer of 2007. Both the dominant and subdominant siatom assemblages presented relatively strong seasonal variations, the dominant species beeing *Gomphonema angustum, Navicula slesvicensis, Navicula lanceolata* and *Surirella brébissonii.*

The average number of taxa (69,4 taxa) of the diatom communities inhabiting the Zăpodie downstream the waste deposit at Pata Rât, proved to be significantly lower compared to the average number of taxa of the communities inhabiting the Maraloiu stream in both sampling sites (94,6 and 98,7 taxa) (*Fig. 11, 12* și *13*). Regarding the species diversity, differences are no longer significant, due to a higher average echitability of the communities inhabiting the Zăpodie, compared to those inhabiting the Maraloiu stream. Massive development (up to 69,02% relative abundance) of *Nitzschia capitellata*, as dominant species of the communities inhabiting the Zăpodie downstream Pata Rât is a sure sign of the elevated degree of pollution and antropic impact in this area.

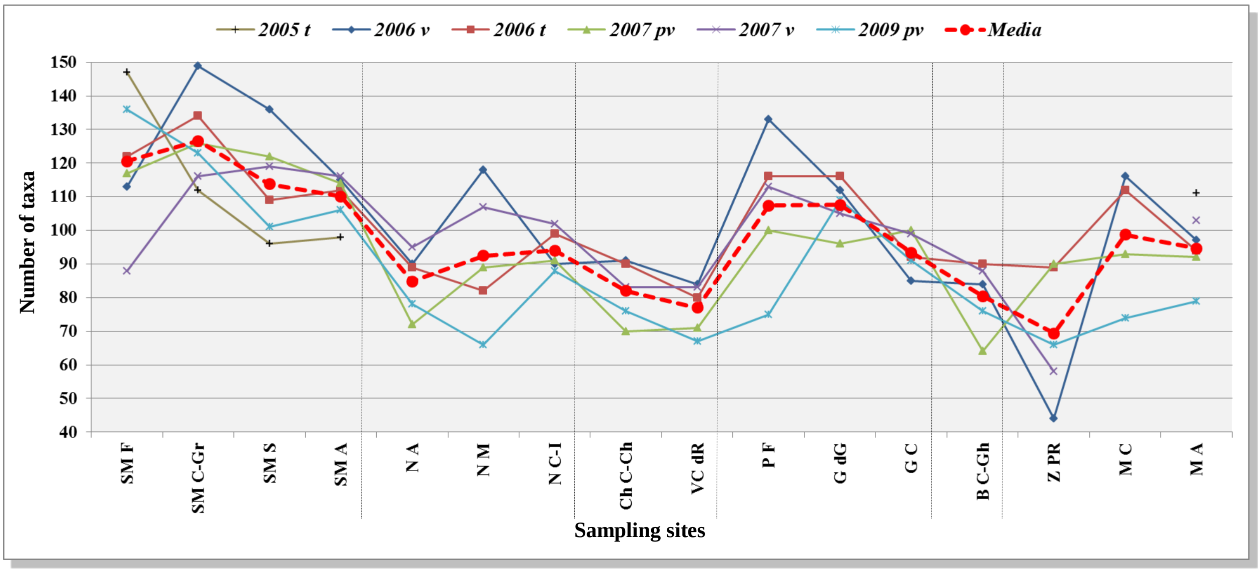


Fig. 11. **The average value and the seasonal variations of the number of taxa of the benthic diatom communities**

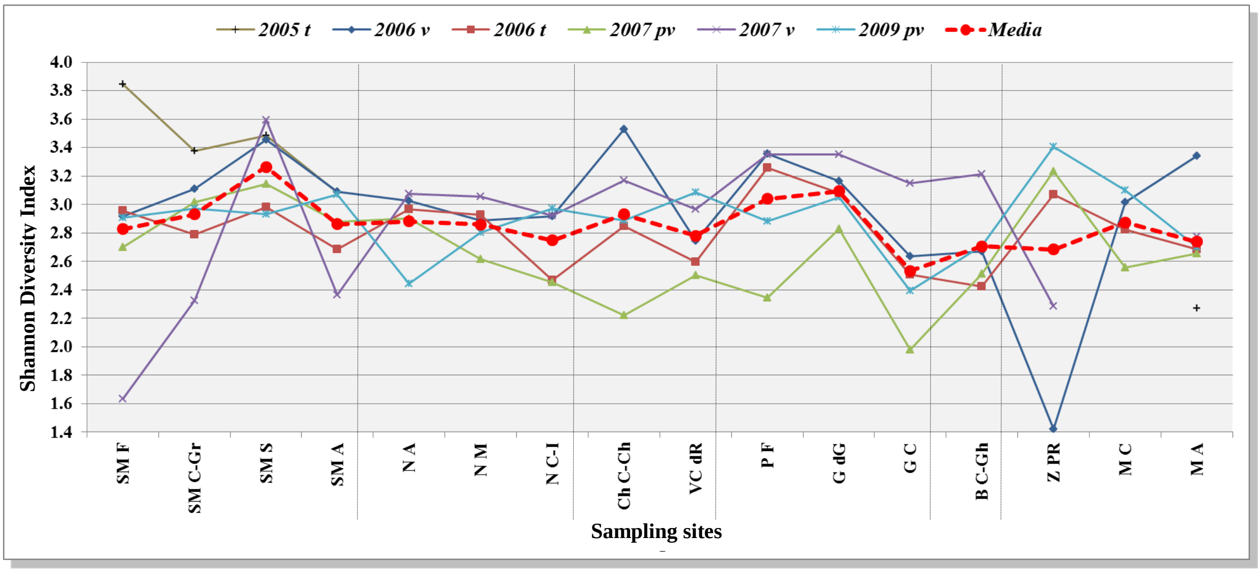


Fig. 12. **The average value and seasonal variations of the Shannon Diversity Index of the diatom communities**

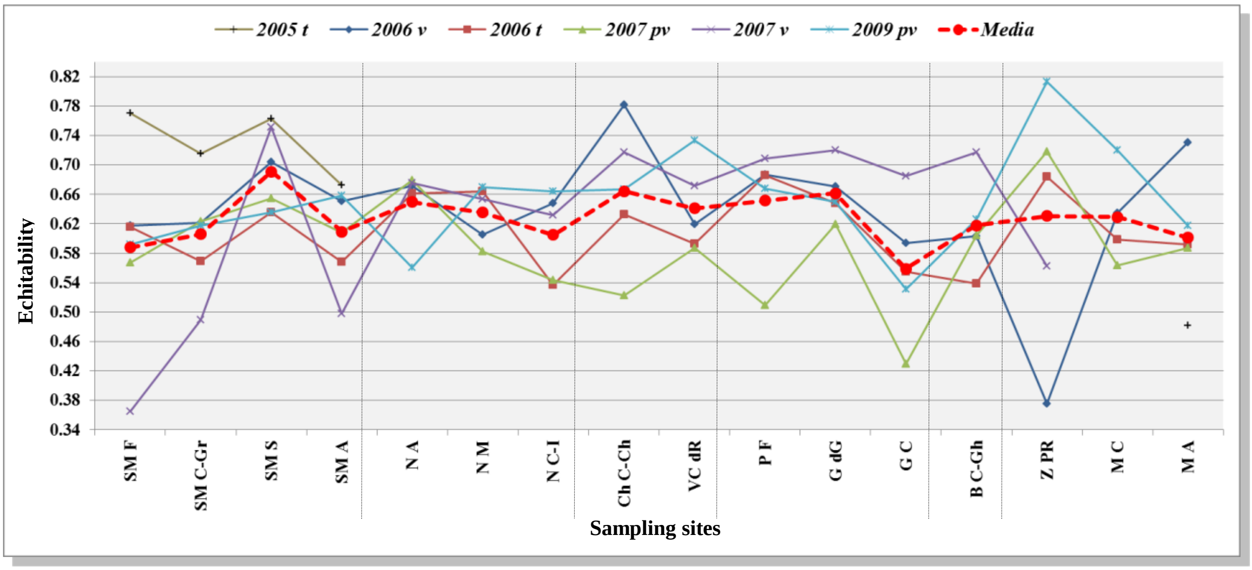


Fig. 13. **The average value and the seasonal variations of echitability of the benthic diatom communities**

Dominant diatoms of communities inhabiting the Maraloiu stream were diverse: *Navicula lanceolata*, *Navicula gregaria*, *Tryblionella hungarica*, *Cocconeis placentula*, *Surirella brébissonii*, *Amphora pediculus* and *Cyclotella meneghiniana*.

Both in the Someșul Mic river and its major tributaries there have been identified several diatoms which should be regarded as characteristic, defining taxa of each investigated water course or tributary, as they were almost constantly and abundantly present in these waters. On the other hand, there have been identified several species and variestes recorded only form one sampling site or even during one sampling season, which may not be characteristic to that specific water course at a species level, but at community level contribute to the unique ”diatom assemblage print” of the river and its tributaries.

6.5. Comparative study of the diatom communities

The major abiotic factors that influence the structure of the investigated benthic diatom communities can be marked out through Canonical Correspondence Analysis (CCA). Results of this analysis, computed for every sampling season (for exemple, the spring of 2007, *fig. 14*), correspond to those obtained by use of other statistical methods, such as the comparison and grouping of sampling sites based on the characteristic physico-chemical properties of each water course (Principal Component Analysis, PCA), and suggest a strong correlation between abiotic and biotic (distribution of diatom taxa) components of the Someșul Mic river system and its tributaries. The characteristic, almost unique structure of the diatom communities at the level of every water course (especially in the case of the Someșul Mic river, the Pleșca and Gârbău streams and the Zăpodie-Maraloiu group) is also shown in the CCA diagrams, through the separation of the sampling sites into clusters belonging to the same water course.

The results of the comparative study suggest that generally the structure of the diatom communities inhabiting the Someșul Mic river upstream Cluj-Napoca city is defined by lower specific conductivity and pH values, but usually higher dissolved O_2 saturation of the water. In contrary, the structure of the diatom communities inhabiting the river downstream Cluj-Napoca, indicates a stronger correlation with elevated specific conductivity values and higher electrolite concentrations in general, as well as the influence of the phosphate ions onto the commmunities developed downstream Apahida (probably, patrtially due to the reduced efficiency of the wastewater treatment facility at Someșeni in the removal of phosphate from the water). In CCA diagram the communities inhabiting the Pleșca and Gârbău streams are clearly separated from others, and reflect a certain affinity toward average values of the physico-chemical parameters per sampling season, but also manifest a significant resemblance to the structure of the communities inhabiting the Someșul Mic river, especially upstream Cluj-Napoca. As for the diatom communities inhabiting the Nadăș, Chinteni, Valea Caldă and Becaș streams, their structure is very much alike, with several common species and varietes, beeing defined mostly by the average values of the physico-chemical parameters, without any specific parameter having its distinct influence on the structure of these communities. On the other hand, the structure of the communities inhabiting the Zăpodie and Maraloiu streams is strongly affected by the highest specific conductivity values recorded during the study period (especially the concentrations of Na^+, Cl^-, K^+, SO_4^{2-} ions, as well as those of NH_4^+ și NO_2^- in the case of Zăpodie), indicating the influence of the salt diapirs present in this area, as well as the devastating effect of the waste material deposit at Pata Rât in the case of the Zăpodie stream.

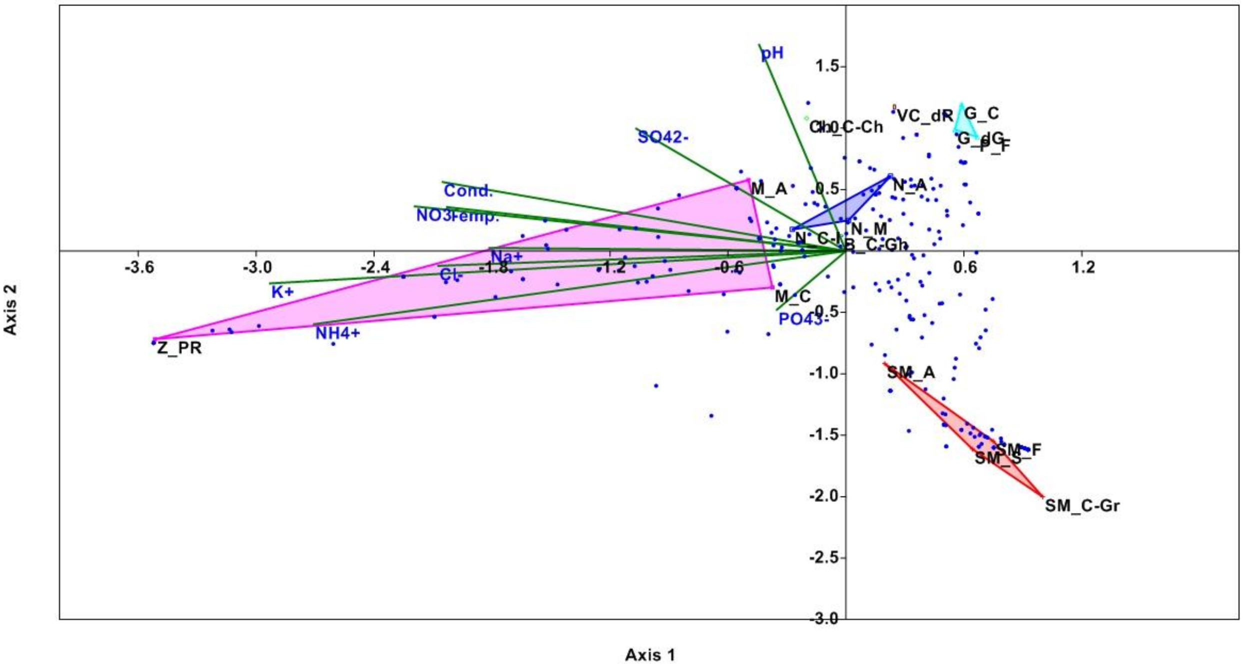


Fig. 14. **Groups of diatom communities developed in the spring of 2007, on the basis of the correlation between identified taxa and the pysico-chemical properties of the water (Canonical Correspondence Analysis, CCA)**

6.6. Diatom taxa recorded for the first time from Romanian waters

As a result of comparison between the diatom taxa list obtained during the present study and ditributional list of algae of Romania (Cărăuș, 2010) (a summary of algological data published till 2010) and two other works in diatomological research domain presented in the 2010-2012 period (Sinitean, 2011; Nagy, 2012), there have been identified 44 taxa never mentioned before in the algological literature dealing with Romanian waters. Among these diatom taxa, 32 are considered species, 9 varietes, 1 form and 2 taxa holding uncertaintes about their exact position in the sistematics of diatoms. The diatoms taxa mentioned for the first time from Romanian surface waters are:

CLASS BACILLARIOPHYCEAE

ORDER CENTRALES

Suborder Coscinodiscineae

Family *Thalassiosiraceae*; Genera / Species:

1. *Stephanodiscus oregonicus* (Ehrenberg) Håkansson
2. *Thalassiosira proschkinae* Makarova

Family *Hemidiscaceae*; Genera / Species:

3. *Actinocyclus normanii* var. *subsalsus* (Juhlin-Dannfelt) Hustedt

ORDER PENNALES

Suborder Araphidineae

Family *Fragilariaceae*; Genera / Species:

4. *Diatoma vulgaris* var. *distorta* Grunow

Suborder Raphidineae

Family *Naviculaceae*; Genera / Species:

5. *Craticula dissociata* (Reichardt) Reichardt
6. *Cymbella strontiana* Krammer
7. *Fallacia lenzii* Hustedt
8. *Fallacia monoculata* (Hustedt) Mann
9. *Fallacia omissa* (Hustedt) Mann
10. *Fallacia tenera* (Hustedt) Mann
11. *Frustulia creuzburgensis* (Krasske) Hustedt
12. *Geissleria acceptata* (Hustedt) Lange-Bertalot & Metzeltin
13. *Geissleria paludosa* (Hustedt) Lange-Bertalot & Metzeltin
14. *Gomphonema parvulum* var. *parvulum* f. *saprophilum* Lange-Bertalot & Reichardt
15. *Luticola pseudokotschyi* Lange-Bertalot
16. *Navicula* "species 4"
17. *Navicula amphiceropsis* Lange-Bertalot & Rumrich
18. *Navicula cryptotenelloides* Lange-Bertalot
19. *Navicula densilineolata* (Lange-Bertalot) Lange-Bertalot
20. *Navicula germainii* Wallace
21. *Navicula heismansioides* Lange-Bertalot
22. *Navicula joubaudii* Germain
23. *Navicula novaesiberica* Lange-Bertalot
24. *Navicula phylleptosoma* Lange-Bertalot
25. *Navicula rhynchotella* Lange-Bertalot
26. *Navicula schroeteri* var. *symmetrica* (Patrick) Lange-Bertalot
27. *Navicula tridentula* Krasske
28. *Navicula vandamii var. vandamii* Schoeman & Archibald
29. *Naviculadicta schmassmannii* (Hustedt) Werum & Lange-Bertalot
30. *Pinnularia borealis* Ehrenberg var. *sublinearis* Krammer
31. *Pinnularia brébissonii* var. *bicuneata* Grunow
32. *Pinnularia divergens* var. *sublinearis* Cleve

33. *Pinnularia frequentis* Krammer
34. *Pinnularia marchica* Schönfelder
35. *Pinnularia stomatophora* (Grunow) Cleve var. *salina* Krammer
36. *Pinnularia subcommutata* Krammer var. *nonfasciata* Krammer
37. *Pinnularia subcommutata* Krammer var. *subcommutata*
38. *Sellaphora disjuncta* (Hustedt) Mann

Family *Bacillariaceae*; Genera / Species:

39. *Grunowia solgensis* (Cleve-Euler) M. Aboal
40. *Nitzschia valdecostata* Lange-Bertalot
41. *Tryblionella compressa* var. *vexans* (Grunow) Lange-Bertalot

Family *Surirellaceae*; Genera / Species:

42. *Surirella* cf. *venusta* Østrup
43. *Surirella lapponica* Cleve
44. *Surirella suecica* Grunow

6.7. Diatom taxa recorded for the first time from the Someș river catchment area

Among the diatom taxa identified during the study period there have been also recorded 42 species and varietes never mentioned before in the algological literature regarding the catchment area of the entireSomeș river. The list of the 42 taxa contains 38 species and 4 varietes, belonging to 31 genera, *Gomphonema* and *Navicula* beeing the most represented ones.

The diatom taxa mentioned for the first time from the cachment area of the Someș river are:

CLASS BACILLARIOPHYCEAE

ORDER CENTRALES

Suborder Coscinodiscineae

Family *Thalassiosiraceae*; Genera / Species:

1. *Cyclotella bodanica* Grunow
2. *Stephanodiscus medius* Håkansson
3. *Stephanodiscus niagarae* Ehrenberg

Family *Melosiraceae*; Genera / Species:

4. *Orthoseira roseana* (Rabenhorst) O'Meara

ORDER PENNALES

Suborder Araphidineae

Family *Fragilariaceae*; Genera / Species:

5. *Opephora olsenii* Møller
6. *Pseudostaurosira brevistriata* (Grunow) Williams & Round
7. *Staurosirella leptostauron* var. *dubia* (Grunow) Bukhtiyarova
8. *Synedrella parasitica* var. *parasitica* (W.Smith) Round & Maidana
9. *Ulnaria lanceolata* (Kützing) Reichardt

Suborder Raphidineae

Family *Eunotiaceae*; Genera / Species:

10. *Eunotia intermedia* (Krasske) Nörpel & Lange-Bertalot

Family *Achnanthaceae*; Genera / Species:

11. *Eucocconeis laevis* Østrup

Family *Naviculaceae*; Genera / Species:

12. *Anomoeoneis costata* (Kützing) Hustedt
13. *Caloneis alpestris* (Grunow) Cleve
14. *Caloneis schroederii* Hustedt
15. *Craticula buderi* (Hustedt) Lange-Bertalot
16. *Cymbella compacta* Østrup
17. *Cymbella lange-bertalotii* Krammer
18. *Cymbopleura anglica* Lagerstedt
19. *Entomoneis costata* (Hustedt) Reimer
20. *Fallacia forcipata* (Greville) A.J.Stickle & D.G.Mann
21. *Gomphonema insigne* Gregory
22. *Gomphonema olivaceum* var. *salinum* Grunow
23. *Gomphonema parvulum* var. *exilissimum* Grunow
24. *Gomphonema parvulum* var. *parvulius* Lange-Bertalot & Reichardt
25. *Gyrosigma balticum* (Ehrenberg) Rabenhorst
26. *Hippodonta costulata* (Grunow) Lange-Bertalot, Metzeltin & Witkowski
27. *Luticola paramutica* (Bock) D.G.Mann
28. *Luticola pseudonivalis* (Bock) Lange-Bertalot
29. *Mastogloia lacustris* (Grunow) Grunow
30. *Navicula moskalii* Metzeltin, Witkowski & Lange-Bertalot
31. *Navicula reichardtiana* Lange-Bertalot
32. *Navicula upsaliensis* Grunow
33. *Navicula wiesneri* Lange-Bertalot
34. *Pinnularia globiceps* Gregory
35. *Sellaphora bacilloides* (Hustedt) Levkov, Krstic & Nakov
36. *Sellaphora stroemii* (Hustedt) H. Kobayasi
37. *Stauroneis borrichii* (Petersen) Lund
38. *Staurophora wislouchii* (Poretzky & Anisimova) D.G. Mann

Family *Bacillariaceae*; Genera / Species:

39. *Nitzschia angustatula* Lange-Bertalot
40. *Tryblionella balatonis* (Grunow) D.G.Mann

Family *Epithemiacea*; Genera / Species:

41. *Denticula thermalis* Kützing

Family *Surirellaceae*; Genera / Species:

42. *Surirella peisonis* Pantocsek

6.8. Fossil species in the benthic samples collected from the Pleșca and Gârbău streams and the Someșul Mic river

In the samples collected from the Pleșca and Gârbău streams and from the Someșul Mic river (during two seasons) there were identified the fossilized frustules of several marine diatom species and varietes, which either can be found in the pankton or coastal benthic communities of seas and oceans in present days (such as *Asteromphalus parvulus*, *Actinoptychus senarius*, *Rhopalodia acuminata*), or are considered extinct (for example, *Fragilaria zeilleri* var. *elliptica*). Most probably, these deteriorated frustules come from the Dej Formation (Badenian era) or the Feleac Formation (inferior Sarmatian era), geological formations present in the vallyes of the streams in discussion.

6.9. Water quality of the Someșul Mic river and its tributaries in the 2005-2009 period

Based on the values of the Halobion Index (HI) (Ziemann, 2010) most of the studied waters proved to be **oligohalobic** (within this the Someșul Mic-Florești, Someșul Mic-Cluj (Grigorescu quarter), Someșul Mic-Someșeni and partially the samples from the Pleșca and Gârbău streams belong to the ***β-oligohalobic*** waters, while the Someșul Mic-Apahida, Nadăș, Chinteni, Valea Caldă and partially the Pleșca, Gârbău and Becaș samples belong to the ***α-oligohalobic*** waters). A smaller part of the investigated water courses (partially the Becaș, as well as the Zăpodie and Maraloiu streams) are **mezohalobic,** ***β-mezohalobic*** or moderately saline waters, to be exact (*Fig. 15*).

As for the values of the Saprobity Index (SI) (Sladeček, 1973), there has been recorded generally good water quality (about oligosaprobic degree) from the point of view of organic pollution in the case of sampling sites Someșul Mic-Florești, Someșul Mic-Cluj (Grigorescu quarter), Someșul Mic-Someșeni and the Pleșca and Gârbău streams, in which cases the saprobity level remained under the critical βα-mezosaprobic level during the study period. Downstream Apahida, signs of organic pollution and quality degradation can already be observed in the case of the Someșul Mic river, especially in the summer of 2006 and 2007(*Fig. 16*). The other tributaries of the Someșul Mic suffered, at least in one sampling season during the autumn 2005-spring 2006 period, an increase of the saprobity of the water from moderate to strong, up to the critical βα-mezosaprobic level. The most poluted waters with organic materials are the Maraloiu and especially the Zăpodie, in which case the saprobity level often exceeds the critical one, up to the α-mezosaprobic level, as sure sign of the polluting effect of the waste deposit at Pata Rât (*Fig. 16*).

Based on the Biological Diatom Index (BDI) (Coste *et al*., 2009) (*Fig. 17*) the water quality of the Someșul Mic river upstream Cluj city, as well as those of Pleșca and Gârbău streams were estimated to be good to excellent during the study period; generally good and ocasionally acceptable in the case of the Someșul Mic-Someșeni, upper and middle course of the Nadăș and the Chinteni and Valea Caldă streams; variable, frecvently acceptable or mediocre in the case of the Someșul Mic-Apahida, lower course of the Nadăș, and the Becaș and Maraloiu streams, or even generally mediocre and ocasionally poor in the case of the Zăpodie, downstream Pata Rât.

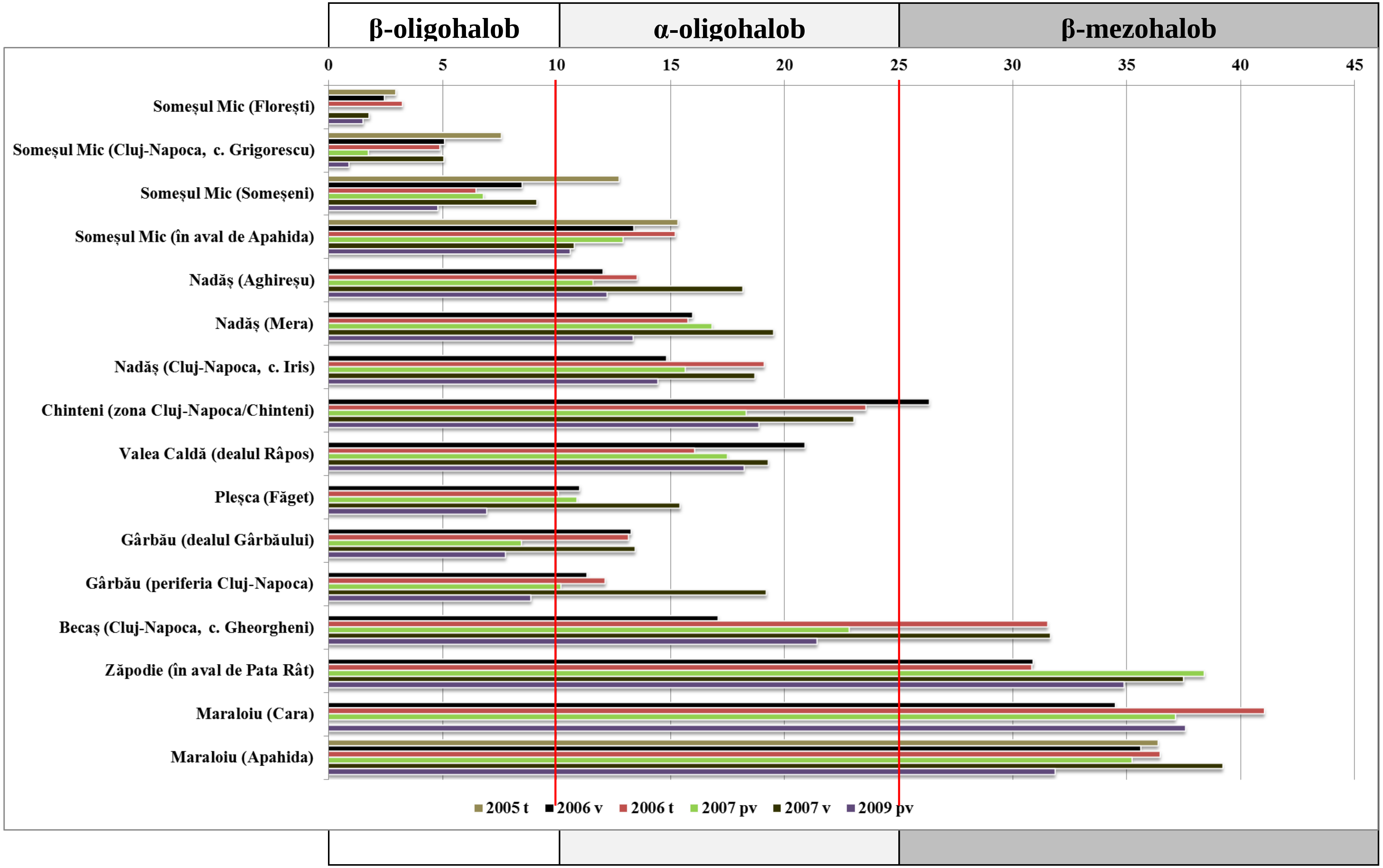


Fig. 15. **The degree of halobity of the investigated waters during the 2005-2009 period based on the Halobic Index (HI)** *(pv – spring, v – summer, t – autumn)*

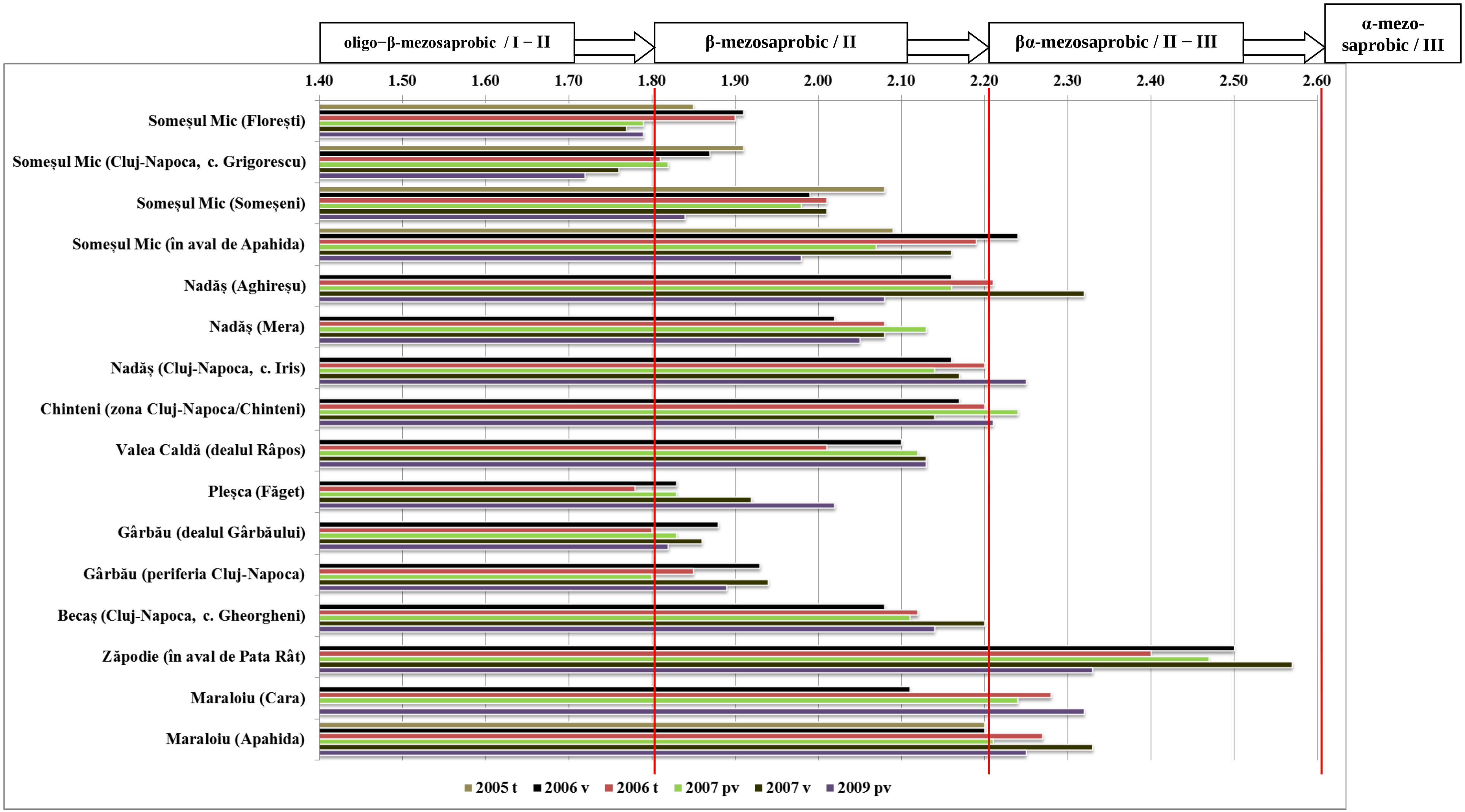


Fig. 16. **The degree of saprobity of the investigated waters during the 2005-2009 period based on the values of the Saprobity Index (SI)** ***(pv – spring, v – summer, t – autumn)***

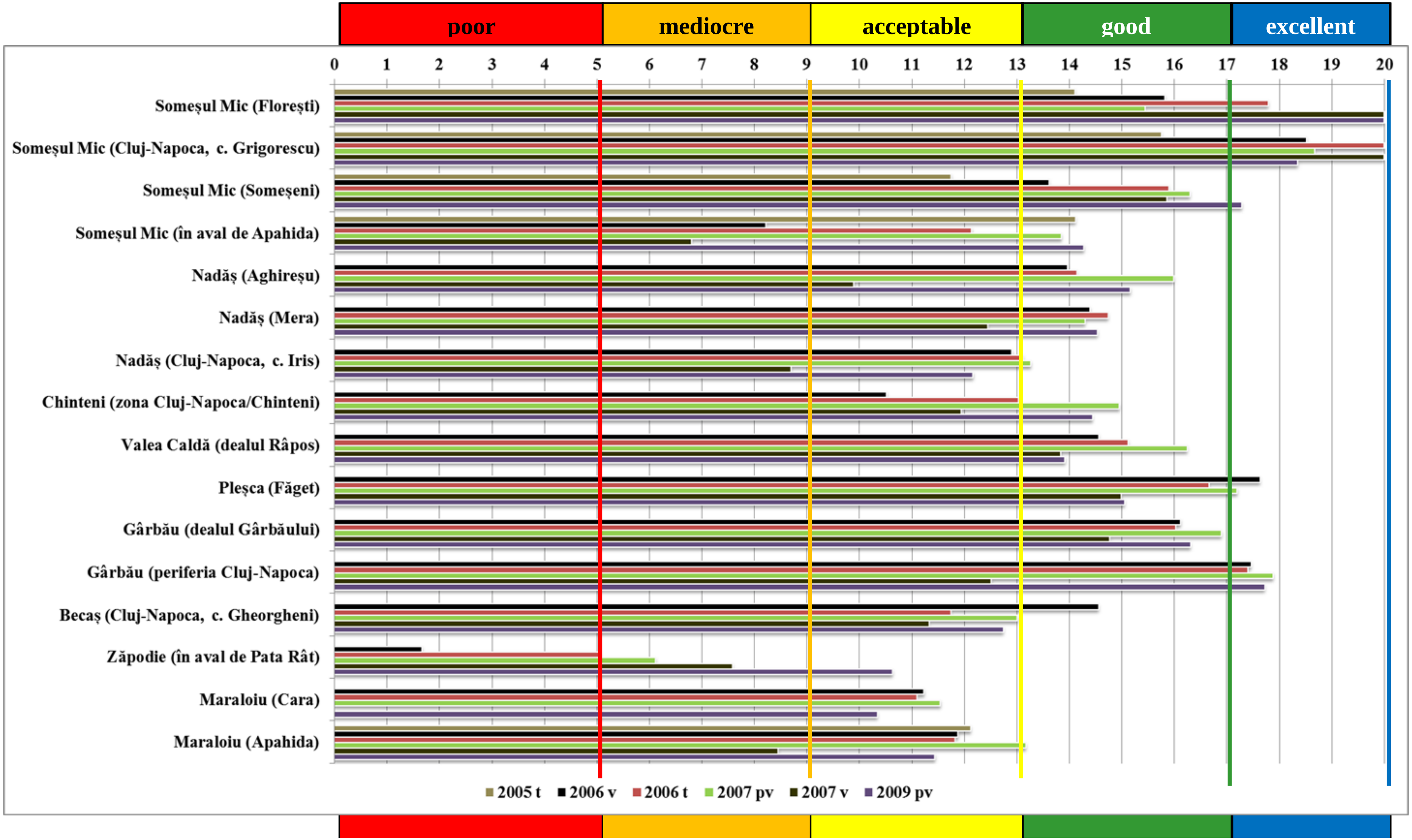


Fig. 17. **Vaiations of the water quality of the Someşului Mic şriver and its major tributaries between Florești and Apahida during the autumn 2005 – spring 2009 period based on the values of the Biological Diatom Indix (BDI)** *(pv – spring, v- summer, t – autumn)*

Conclusions

The results of the present study emphasize the following general conclusions regarding the diatom communities and the water quality of the Someșul Mic river and its major tributaries between Florești and Apahida (jud. Cluj):

1. The results regarding the specific conductivity of the waters and the electrolite concentrations in general conform data from literature, meaning that the investigated water courses belong to different types and degrees of mineralization: the Someșul Mic river shows an increasing mineralization from low (at Florești) to medium (downstream Apahida), simultanously with the transition from carbonate-type (upstream Cluj-Napoca) to saline-type (downstream Cluj-Napoca); the water of the Pleșca and Gârbău streams is carbonate-mixed type with medium mineralization; the Nadăș rivulet, defined primarily by sulphate and calcium, as well as the Chinteni and Valea Caldă streams belong to the mixed-type waters with elevated degree of mineralization; under the influence of salt diapirs, the Becaș, Zăpodie and Maraloiu streams belong to the highly mineralized waters, defined especially by large quantities of Na^+ and Cl^-.

2. On the basis of similarities between the physico-chemical parameters of the investigated water courses, several ”groups” of waters/sampling sites/tributaries have been identified, with maximum similarity between the ”members” of the same group: the Someșul Mic river (4 sampling sites), the Pleșca-Gârbău group (3 sites), the relatively mixed Nadăș-Chinteni-Valea Caldă group (5 sites), the Becaș stream (1 sampling site), and the Zăpodie-Maraloiu group (3 sampling sites). Both the comparison of data based on the floristic simiralities between diatom communities and the analysis of the correlations (CCA) between structure of communities and physico-chemical properties of the water lead, practicly, to the same conclusion and the same groups. Among them, the Someșul Mic river, the Pleșca-Gârbău and Zăpodie-Maraloiu streams seem to have the most distinct abiotic properties and diatom communities, while in the case of the Nadăș, Chinteni, Valea Caldă and Becaș tributaries some ”interferences” were identified, which somewhat lessen the unique character of this streams and the diatom communities that inhabit them.

3. In benthic samples collected from 16 sites during 4−6 sampling seasons, a total number of 387 diatom taxa was identified, belonging to 83 genera, 10 families, based on the classification system developed by Simonsen (1979) (cited by Tuba *et al.*, 2007).

4. The highest number of diatom taxa was recorded in the case of the Someșul Mic river and the Pleșca and Gârbău streams, followed by the Nadăș and Maraloiu streams, than by the Chinteni, Valea Caldă, Becaș and Zăpodie streams, with significant differences between these ”categories”. Significant seasonal differences were observed in the case of communities inhabiting the Nadăș rivulet, the Pleșca and Gârbău streams, as well as the Zăpodie and Maraloiu streams, in the form of significant increase of taxa number and species diversity (but water quality degradation in the same time!) between spring and summer of 2007, and the reverse phenomena between summer of 2007 and the spring of 2009.

5. Results also suggest that it is insufficient to estimate water quality and ecosystem integrity based only on the number of the taxa of a community, because this number can increase in correlation with water quality degradation (meaning the increase of the salinity and saprobity of the water), due to the better development of halophilic and mesohalobic, or saprophilic and saprotolerant species in the community. Over a certain, critical level, the number of taxa will, most probably, diminish signficantly if not dramatically, as can be observed in the case of the diatom communities inhabiting the Zăpodie, downstream the waste material deposit at Pata Rât.

6. Although there have been identified many common species, the diatom communities proved to be mostly characteristic, almost unique to each investigated water course, showing more or less significant differences compared to each other. Furthermore, the investigated diatom communities appeared to be well adaptad to the major, defining physico-chemical parameter of the water. Diatoms occurring frecvently and abundantly only or mostly in a certain river or stream are the most characteristic species and varietes for that particular water. As a difference, the species and/or varietes rarely observed in a community may be there accidentally, but most times they prove to be the ”new” taxa for the investigated area or a larger one.

7. ”Disturbances” such as the presence of the reservoir lake with planktonic species on the Someșul Mic river at Florești, the waste material deposit on the banks of the Zăpodie stream at Pata Rât, people that spend time near the Pleșca stream in the Făget forest in summertime, polluting the water, or the wastewater treatment facility between Someșeni and Apahida with lower efficiency in phosphate removal, and possibly others too, manifest visibly and/or significantly in the composition and structure of the diatom communities inhabiting the waters in their neighbourhood.

8. As for the water quality of the river and its major tributaries during the study period, the results have led to the following conclusions: **a.** based on the Halobion Index the Someșul Mic river between Florești and Someșeni, as well as partially the Pleșca and Gârbău streams proved to be β-oligohalobic waters; the Someșul Mic-downstream Apahida, the Nadăș rivulet, the Chinteni, Valea Caldă and partially the Pleșca, Gârbău and Becaș streams α-oligohalobic waters; the Zăpodie and

Maraloiu streams and partially the Becaş can be considered β-mezohalobic (moderately saline) waters; **b.** as concerning the organic pollution the less affected (oligosaprobic to β-mezosaprobic) were the Someșul Mic river upstream Cluj-Napoca city, as well as tributaries Pleșca and Gârbău; the Someșul Mic downstream Apahida, the Nadăş, Chinteni, Valea Caldă and Becaş streams seemed to be more affected by the presence of orgnic substances, reaching the critical βα-mezosaprobic level at least in one sampling season; in the case of the Maraloiu and especially the Zăpodie stream sign of heavy organic pollution were recorded with saprobity often exceeding the critical level; **c.** on the basis of the Biological Diatom Index the general water quality of the Someșul Mic river upstream Cluj-Napoca, and those of the Pleșca and Gârbău streams were estimated to be good to excellent; the water quality of the Someșul Mic at Someșeni, of the upper and middle course of the Nadăş, and of the Chinteni and Valea Caldă proved to be generally good, but ocasionally only acceptable; the water quality of the Someșul Mic downstream Apahida, of the lower course of the Nadăş, the Becaş and Maraloiu streams was estimated to be variable, frecvently acceptable, sometimes only mediocre; in the case of the Zăpodie downstream Pata Rât the water quality was generally mediocre to poor during the autumn 2005-spring 2009 period.

9. Among the 387 identified diatom taxa, 44 taxa (32 species, 9 varietes, 1 form and 2 unclarified taxa) are mentioned here for the fist time as ”new” at Romanian level, aong with other 42 taxa (38 species and 4 varietes) that are mentioned in premiere at the level of the cachment area of the entire Someş river. Many of these diatoms never recorded before live in special conditions (for exemple, strictly oligosaprobic waters, relatively high concentrations of sulphate, increased salinity etc.), and thus it is not accidental that the Someșul Mic river upstream Cluj-Napoca, and the Pleșca, Gârbău, Nadăş and Maraloiu streams proved to possess a higher potential to accomodate such rare diatoms in the investigated area.

Selected references

1. Ács É., Kiss K.T., 2004, *Algológiai praktikum*, ELTE Eötvös Kiadó, Budapest.
2. Baciu, C., Filipescu, S., 2002, Structura geologică, In Cristea, V., Baciu, C., Gafta, D. (eds.), *Municipiul Cluj-Napoca și zona periurbană, Studii ambientale*, Ed. Accent, Cluj-Napoca, 25-36.
3. Biggs, B.J.F., Kilroy, C., 2000, *Stream Periphyton Monitoring Manual*, NIWA, Christchurch.
4. Buta, I., 1967, *Bazinul Someşului. Studiu hidrologic,* teză de doctorat, Univ. „Babeş-Bolyai”, Cluj-Napoca.
5. Cărăuş, I., 2010, Algae of Romania. A distributional checklist of actual algae, *Studii și Cercetări, Biologie, Univ. Bacău*, 7: 1-788.
6. Coste, M., Boutry, S., Tison-Rosebery, J., Delmas, F., 2009, Improvements of the Biological Diatom Index (BDI): Description and efficiency of the new version (BDI-2006), *Ecological Indicators*, 9: 621-650.

7. Croitoru, V., Constantinescu, D.A., 1979, *Aplicații și probleme de chimie analitică*, Editura Tehnică, București.
8. Gudasz, C., Momeu, L., Tudorancea, C., 2000, Lacul Ştiucii: A limnological study, *Stud.Cercet., Biol.*, Univ. Bacău, 5: 169-182.
9. Kiss K.T., 1998, *Bevezetés az algológiába, Elméleti és gyakorlati ismeretek*, ELTE Eötvös Kiadó, Budapest.
10. Krammer, K., 2000, The genus Pinnularia, In Lange-Bertalot, H. (ed.), *Diatoms of Europe. Diatoms of the European Inland Waters and Comparable Habitats*, Volume 1, A.R.G. Gantner Verlag Kommanditgesellschaft, Ruggell.
11. Krammer, K., 2002, Cymbella, In Lange-Bertalot, H. (ed.), *Diatoms of Europe. Diatoms of the European Inland Waters and Comparable Habitats*, Volume 3, A.R.G. Gantner Verlag Kommanditgesellschaft, Ruggell.
12. Krammer, K., 2003, Cymbopleura, Delicata, Navicymbula, Gomphocymbellopsis, Afrocymbella, In Lange-Bertalot, H. (ed.), *Diatoms of Europe. Diatoms of the European Inland Waters and Comparable Habitats*, Volume 4, A.R.G. Gantner Verlag Kommanditgesellschaft, Ruggell.
13. Krammer, K., Lange-Bertalot, H., 1986, Bacillariophyceae: Naviculaceae, In Ettl, H., Gerloff, J., Heyning, H., Mollenhauer, D. (eds.), *Süsswasserflora von Mitteleuropa*, vol. 2/1, G. Fischer, Stuttgart.
14. Krammer, K., Lange-Bertalot, H., 1988, Bacillariophyceae: Bacillariaceae, Epithemiaceae, Surirellaceae, In Ettl, H., Gerloff, J., Heyning, H., Mollenhauer, D. (eds.), *Süsswasserflora von Mitteleuropa*, vol. 2/2, G. Fischer, Stuttgart.
15. Krammer, K., Lange-Bertalot, H., 1991a, Bacillariophyceae: Centrales, Fragilariaceae, Eunotiaceae, In Ettl, H., Gerloff, J., Heyning, H., Mollenhauer, D. (eds.), *Süsswasserflora von Mitteleuropa*, vol. 2/3, G. Fischer, Stuttgart.
16. Krammer, K., Lange-Bertalot, H., 1991b, Bacillariophyceae: Achnanthaceae. Kritische Ergänzungen zu Navicula (Lineolatae) und Gomphonema, In Ettl, H., Gerloff, J., Heyning, H., Mollenhauer, D. (eds.), *Süsswasserflora von Mitteleuropa*, vol. 2/4, G. Fischer, Stuttgart.
17. Krammer, K., Lange-Bertalot, H., 2000, Bacillariophyceae: English and French translation of the keys, In Büdel, B., Gärtner, G., Krienitz, L., Lokhorst, G.M. (eds.), *Süsswasserflora von Mitteleuropa*, vol. 2/5, Spektrum Akademischer Verlag, Heidelberg, Berlin.
18. Lange-Bertalot, H., 2001, Navicula sensu stricto. 10 Genera Separated from Navicula sensu lato. Frustulia, In Lange-Bertalot, H. (ed.), *Diatoms of Europe. Diatoms of the European Inland Waters and Comparable Habitats*, Volume 2, A.R.G. Gantner Verlag Kommanditgesellschaft, Ruggell.
19. Leira, M., Sabater, S., 2005, Diatom assemblages distribution in catalan rivers, NE Spain, in relation to chemical and physiographical factors, *Water Research*, 39: 73-82.
20. Lewis, M.A., Wang, W., 1997, Water quality and aquatic plants, In Wang, W., Gorsuch, J. (eds.), *Plants for environmental studies*, Lewis Publishers, Boca Raton.
21. Lowe, R.L., Pan, Y., 1996, Benthic algal communities as biological monitors, In Stevenson, R.J., Bothwell, M.L., Lowe, R.L. (eds.), *Algal Ecology, Freshwater Benthic Ecosystems*, Academic Press, San Diego, 705-739.
22. Momeu, L., 2006, Comunităţile algale din Lacul Ştiucii, In Battes, K. (ed.), *Lacul Ştiucii. Studiu monografic*, Casa Cărţii de Ştiinţă, Cluj-Napoca, 32-41.
23. Momeu, L., Budurlean, M., Cristea, V., 2005, Algal flora of the "Valea Morii" nature reserve and surrounding area, *Contribuții Botanice,* Cluj-Napoca, XL: 145-152.

24. Momeu, L., Chişe, C., Péterfi L.Şt., 2006, Planktonic algal communities of the "Ţaga Mare" fishpond (Cluj County, Romania), *Contribuții Botanice,* Cluj-Napoca, XLI, 2: 83-92.
25. Momeu, L., Dragoş, N., Péterfi L.Şt., 1979, Structura şi dinamica populaţiilor fitoplanctonice din câteva iazuri din Câmpia Transilvaniei, C*ontribuții Botanice,* Cluj-Napoca, 5-11.
26. Momeu, L., Dragoş, N., Péterfi L.Şt., 1980, Fitoplanctonul iazurilor Cătina şi Geaca I, *Contribuții Botanice,* Cluj-Napoca, 9-17.
27. Momeu, L., Péterfi L.Şt., Tudorancea, C., 2004, Periphytic algal communities of the Ştiucii Lake nature reserve (Cluj County, Transylvania, Romania), *Contribuții Botanice*, Cluj-Napoca, XXXIX: 115-125.
28. Momeu, L., Rasiga, A., Péterfi L.Şt., 1996, Aprecierea saprobității apelor în Someșul Cald și Someșul Mic, folosind diatomeele ca indicatori biologici, *An.Univ.Oradea, Biol.*, 3: 128-139.
29. Nagy L., Momeu, L., 2004, Algal communities from the wetlands of Legii and Sântejude, located in the Fizeş Brook catchment area (Cluj County), *Stud.Cercet.Biologie, Univ.Bacău,* 9: 3-6.
30. Nagy L., Momeu, L., Péterfi L.Şt., 2005, Structure and dynamics of algal communities from the Sântejude wetland (Cluj County, Romania), *Contribuții Botanice,* Cluj-Napoca, XL: 173-178.
31. Nagy, L., 2012, *Comunități de diatomee din unele ape stătătoare cu grade diferite de salinitate de la Turda*, teză de doctorat, Univ. Babeș-Bolyai, Cluj-Napoca.
32. Neag, I., Momeu, L., Péterfi L.Şt., 2005, Algal communities from some aquatic habitats of the "Alexandru Borza" Botanical Garden, Cluj-Napoca, Romania, *Contribuții Botanice,* Cluj-Napoca, XL: 153-162.
33. Patrick, R., Reimer, C.W., 1966, *The diatoms of the United States. Exclusive of Alaska and Hawaii*, vol.1, Monogr. Acad. Nat. Sci., Philadelphia.
34. Podani, J., 1992a, Monitoring system, In Kovács M. (ed.), *Biological indicators in environmental protection*, Akadémiai Kiadó, Budapest.
35. Podani, J., 1992b, Biological indication at the comunity and ecosystem levels, In Kovács M. (ed.), *Biological indicators in environmental protection*, Akadémiai Kiadó, Budapest.
36. Pop, I., Káptalan M., Rațiu, O., Hodișan, I., 1962, Vegetaţia din Valea Morii - Cluj, conservatoare de relicte glaciare, *Contribuții Botanice,* Cluj-Napoca, 183-204.
37. Pralea, F., 1988, Dinamica fitoplanctonului unor iazuri din cadrul fermei piscicole Geaca (jud. Cluj), *Ziridava*, Arad, XVII: 311-312.
38. Pralea, F., 2000, Comparative appreciations on the phytoplankton trophicity of fishponds from Cluj District, *Stud.Cerc.Muz.St.Natur. Piatra Neamt*, IX: 47-51.
39. Prygiel, J., Coste, M., Bukowska, J., 1999, Review of the major diatom based techniques for the quality assessment of rivers – state of the art in Europe, In Prygel, J., Whitton, B.A., Bukowska, J. (eds.), *Use of Algae for Monitoring Rivers III*, Agence de l'Eau Artois-Picardie, Douai, 224-238.
40. Rasiga, A., 2001, *Compoziţia şi structura comunităţilor de diatomee din Someşul Mic*, teză de doctorat, Cluj-Napoca, 4-183.
41. Rasiga, A., Momeu, L., Péterfi L.Şt., 1995-1996a, Compoziţia şi structura comunităţilor algale din Someşul Mic, Transilvania, România, *Contribuții Botanice,* Cluj-Napoca, 37-45.
42. Rasiga, A., Momeu, L., Péterfi L.Şt., 1995-1996b, Consideraţii privind evaluarea saprobităţii apelor în râurile Someşul Cald şi Someşul Mic (Transilvania) pe baza compoziţiei comunităţilor de diatomee, *Contribuții Botanice*, Cluj-Napoca, 55-60.
43. Rasiga, A., Momeu, L., Péterfi L.Şt., 1997, Diatomeele ca indicatori ai nivelelor de saprobitate în apele curgătoare, *Stud.Cercet. (Şt.Naturii),* Bistriţa, 3: 261-272.

44. Rasiga, A., Momeu, L., Péterfi L.Şt., 1999, Composition and structure of algal communities of the River Someş Basin, In: Sárkány-Kiss A., Hamar J. (eds.), *The Someş/Szamos River Valley. A study of the geography, hydrobiology and ecology of the river system and its environment*, TISCIA Monograph Series, Szolnok-Szeged-Târgu Mureş, 143-177.
45. Raven, P.H., Evert, R.F., Eichhorn, S.E., 2003, *Biology of Plants*, Sixth Edition, W.H. Freeman and Co., Worth Publishers, New York.
46. Róbert A., 1957, Note asupra neustonului observat în Grădina Botanică din Cluj, *Stud.Cerc.Biol.*, Cluj-Napoca, VIII, 3-4: 419-423.
47. Round, F.E., 1966, *The Biology of Algae*, Edward Arnold (Publishers) Ltd., London.
48. Round, F.E., 1984, *The Ecology of Algae*, Cambridge University Press, Cambridge.
49. Round, F.E., Crawford, R.M., Mann, D.G., 2007, *The Diatoms, Biology & Morphology of the Genera*, Cambridge University Press, Cambridge.
50. Sinitean, A., 2011, *Studiul comunităților de diatomee epilitice din râul Cerna*, teză de doctorat, Univ. Babeș-Bolyai, Cluj-Napoca.
51. Sladeček, V., 1973, System of water quality from the biological point of view, In Elster, H.J., Ohle, W. (eds.), *Ergebnisse der Limnologie*, Schweitzerh. Verl., Stuttgart, 1-121.
52. Stevenson, J.R., Bahls, L.L., 1999, Periphyton protocols, In Barbour, M.T., Gerritsen, J., Snyder, B.D., Stribling, J.B. (eds.), *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrate and Fish*, Second Edition, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.
53. Stoermer, E.F., Smol, J., 1999, *The Diatoms. Applications for the Environmental and Earth Sciences*, Cambridge University Press, Cambridge.
54. Tuba, Z., Szerdahelyi, T., Engloner, A., Nagy, J. (eds.), 2007, *Botanika II – Rendszertan*, Nemzeti Tankönyvkiadó, Budapest.
55. Újvári, I., 1972, *Geografia apelor României*, Ed. Ştiinţifică, Bucureşti.
56. van Dam, H., Mertens, A., Sinkeldam, J., 1994, A coded checklist and ecological indicator values of freshwater diatoms from the Netherlands, *Netherlands Journal of Aquatic Ecology*, 28, 1: 117-133.
57. Werner, D., 1977b, Silicate metabolism, In Werner, D. (ed.), *The Biology of Diatoms – Botanical Monographs*, vol. 13., Blackwell Scientific Publications, Oxford.
58. Wetzel, R.G., 2001, *Limnology, Lake and River Ecosystems*, Third Edition, Academic Press, San Diego.
59. Ziemann, H., 2010, The halobion index and its further development, *Lauterbornia*, 70: 111-131.
60. ***2000, *Guide Méthodologique pour la mise en oeuvre de l'Indice Biologique Diatomées*, Ed. CEMAGREF, Bordeaux.

Scientific papers published in the domain of the Ph.D. Thesis:

1. Szigyártó L., Péterfi L. Şt., 2011, *New data concerning diatom communities and water quality of the Someșul Mic River between Florești and Apahida (Cluj County, Romania),* Contribuții Botanice, Cluj-Napoca, XLVI, 83-92.

2. Szigyártó L., Péterfi L. Şt., 2011, *Effects of Salt Diapirs on the Structure of Diatom Communities Inhabiting the Apahida Section of the Someşul Mic River (Cluj County, Romania),* A VII-a Conferinţă de Ştiinţa Mediului în Bazinul Carpatic, Editura Ábel, Cluj-Napoca, 274-278.

3. Szigyártó L., Péterfi L. Şt., 2009, *The diatom communities and the water quality of the Nadăş and Chinteni rivulets, tributaries of the Someşul Mic river,* A V-a Conferinţă de Ştiinţa Mediului din Bazinul Carpatic, Editura Ábel, Cluj-Napoca, 227-232.

4. Szigyártó L., Péterfi L. Șt., 2008, *Studies of the diatom communities inhabiting the Someşul Mic river and its tributaries between Floreşti and Apahida (Cluj County): Data regarding the diatom communities in the Pleşca and Gârbău streams,* Acta Scientiarum Transylvanica, Biologia, Asociaţia Muzeului Ardelean, Cluj-Napoca, 16, 3: 53-65.

5. Szigyártó L., Péterfi L. Șt., 2008, *Evaluation of water quality based on diatom communities inhabiting the Someşul Mic river between Floreşti and Apahida (Cluj County, Romania),* A IV-a Conferinţă de Ştiinţa Mediului din Bazinul Carpatic, Debrecen, vol. II., 147-153.

6. Szigyártó L., Péterfi L. Șt., 2007, *Studies of the diatom communities inhabiting the Someşul Mic river and its tributaries between Floreşti and Apahida (Cluj County): Preliminary studies on the water quality of the Zăpodie and Maraloiu streams*, Contribuţii Botanice, Cluj-Napoca, XLII, 67-72.