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BENTHIC DIATOM COMMUNITIES OF THE "SOMEŞUL RECE" RIVER (TRANSYLVANIA, ROMANIA)

***Manuela FLOREAN*[1]*, Leontin Ştefan PÉTERFI*[2]*, Laura MOMEU*[1]**
[1] Universitatea „Babeş-Bolyai", Facultatea de Biologie şi Geologie, Catedra de Taxonomie şi Ecologie, Colectivul de Ecologie, str. Clinicilor, nr. 5-7, **RO-400006 Cluj-Napoca**
[2] Universitatea „Babeş-Bolyai", Facultatea de Biologie şi Geologie, Catedra de Taxonomie şi Ecologie, Colectivul de botanica, str. Republicii, nr. 42, **RO-400015 Cluj-Napoca**
e-mail: lmomeu@yahoo.com

Abstract: Benthic diatom communities of the "Someşul Rece" river (Transylvania, Romania). The paper deals with the structure and seasonal changes of the benthic diatoms inhabiting the "Someşul Rece" river. There have been identified 79 taxa sampled in April, June and October 2004. Many of them are cosmopolitan, but the acidophilous, oligotrophic, oligosaprobic elements inhabiting cold mountain rivers are also well represented. Some of the diatoms have been washed into the river from the peat bogs adjacent to its uppermost part (springs). To estimate the structure of communities the authors calculated some biological indices (species diversity, equitability, index of saprobity, biological diatom index), which allowed to establish the water quality. The floristic similarities among communities were estimated by Jaccard's index. Human impact due to hydrotechnical activities, grazing and forest clearing in the Someşul river catchment affects and alter in some respect the structure of diatom communities.

Key words: benthic diatoms, montane river, seasonal changes, Romania.

Introduction

The "Someşu Rece" basin, part of the "Someşul Mic" river drainage area, is situated in – Munţii Gilăului – Muntele Mare mountains. The Someşul Rece stream springs from the bottom of the Runcului peak (1609 m), draining the water courses of the Balomireasa Mountain [2]. The spring area shelters several raised peat bogs, called 'molhaşuri" that affects the physico-chemical properties of the river and its algal flora. Munţii Gilăului – Muntele Mare are crystalline with granitic intrusions [10]. The original natural forest dominated by fir, spruce fir, beech and at lower altitudes by other leafy tree species have been cleared, especially in Munţii Gilăului and now large areas are covered by secondary grasslands [6]. The raised peat bogs of the springs area have deep, oligo-dystrophic peat deposits, mainly of *Sphagnum, Polytrichum* and other oligotrophic plants, slightly decomposed in humic substances (humified), covering acidic, nutrient poor soils [3].

The water of the Someşu Rece river is supplied by 31% underground and 69% surface waters (30% snow, 39% rain) [4]. In the Someşul Rece basin there are several hydro-energetic arrangements; dam reservoirs located uphill Răcătău, supplied also by underground feed pipe from the Arieş river valley. Afterwards the water is sended in a similar manner into the dam reservoirs of the Someşul Cald basin. These hydroelectric works drastically disturb the naturalness of the river, namely downstream the dam reservoir the river lack most of its water and towards the confluence with the Someşu Cald its watercourse is supplied only by the effluents downhill the dam [9].

The aim of the investigations was to reveal the diatom flora and the structure of the benthic diatom communities of the river and to estimate its water quality based on biotic indices. In this way these findings are harmonized with the "Water Directives" concerning the use of water organisms in establishing the quality of water in aquatic basins and making evident the impact caused by human activity or by natural environmental changes.

Material and Methods

The benthic diatom samples were collected in April, June and October 2004, in five stands situated on the Someşu Rece river: stand I, located downstream Mărgău – Răcătău (altitude 600 m a.s.l.), stand II, situated at the inflow of the water feed pipe from the Arieş river basin upstream dam (altitude 1003 m a.s.l.), stand III, located downstream Blăjoaia (altitude 1245 m a.s.l.), stand IV, located upstream Blăjoaia at altitude of 1300 m a.s.l., and stand V, near the springs of the Someşul Rece river at 1485 m a.s.l. (Fig. 1).

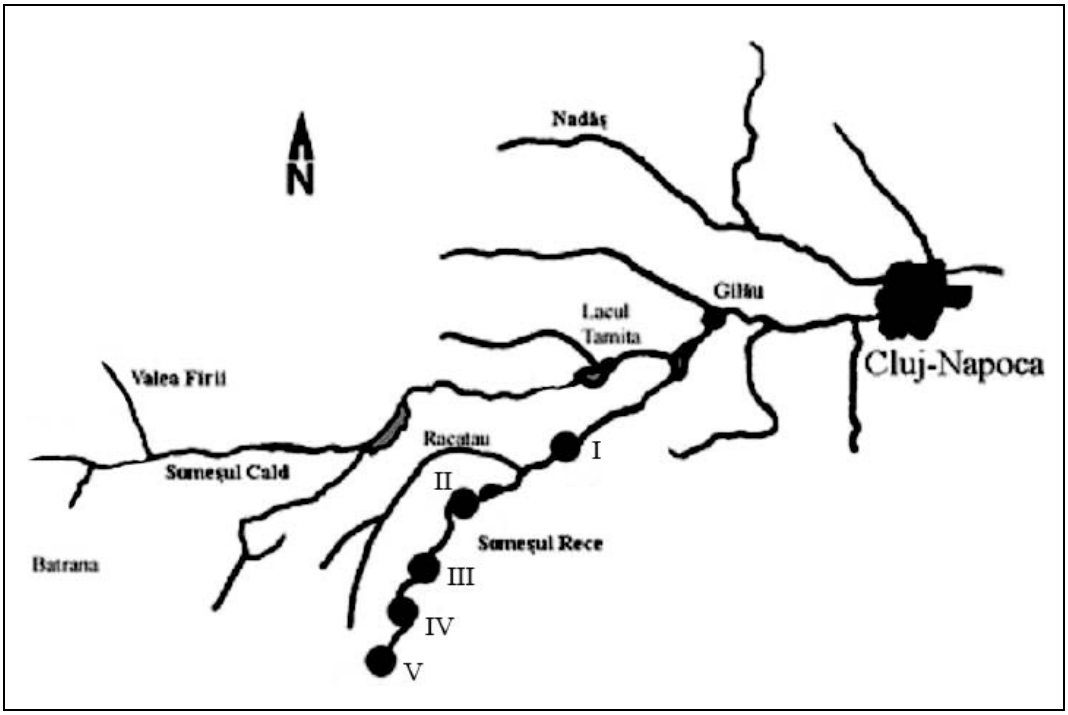

Fig. 1: The upper basin of the Someşul Mic River; stands: V- the springs; IV- uphill Blăjoaia; III – downhill Blăjoaia; II – uphill dam, at feeding pipe; I – downhill Măguri Răcătău.

The diatoms were sampled by scraping or/and by washing the surface of stones or gravel and subsequently preserved in 4% formalin. The study of the samples was performed by standard methods, the frustules were observed and examined by light microscopy and identified at species level (or rarely below). Based on community composition the following indices have been computed: species diversity (Shanon-Wiener), equitability, saprobity index [8, 11, 12, 13, 14], biotic diatom index [5], as well as the floristic similarity index of Jaccard. There were also measured some of the physico-chemical parameters of the water (table 1): temperature, pH, conductivity, salinity, dissolved oxygen ($mg.l^{-1}$ and %).

Results and Discussion

The physico-chemical parameters measured on the spot are given in table 1.

It is evident that the pH exhibits relatively low values ranging around a mean of 6.25, the acidic-slightly acidic character being exceeded only in stands located downstream (stands I and II) where the pH may be circumneutral or slightly alkaline (stand I, in October). The pH values are in accordance with the nature of substratum [10] and with the presence of adjacent raised peat bogs near the springs.

Table 1: Physico-chemical parameters of the Someşul Rece River.

Date of sampling	Stands	Parameters					
		Temperature ^{0}C	pH	Oxygen		Conductivity µS.cm^{-1}	Salinity mg.l^{-1}
				%	mg.l^{-1}		
22.04.2004	I	10.2	7.02	63.5	7.13	33	17.5
	II	-	-	-	-	-	-
	III	7.9	6.13	51	6.05	11.71	6.38
	IV	6.2	6.42	60	7.3	9.53	5.06
	V	-	-	-	-	-	-
25.06.2004	I	16.6	6.9	70.4	6.87	77.8	41.3
	II	13.3	7.09	74.4	7.74	17.38	9.28
	III	13.6	6.24	64.5	6.88	13.34	7.09
	IV	10.9	5.91	63	6.97	10.74	5.79
	V	10.8	5.05	69.9	7.77	8.63	4.58
30.10.2004	I	7	7.9	72.3	8.73	69.86	31.4
	II	5.5	6.01	64.4	8.08	24.15	18.3
	III	6.8	6.12	64.7	7.88	19.23	9.93
	IV	6.6	5.16	84.5	10.33	11.71	6.37
	V	7.9	4.93	66.6	7.96	8.56	4.31

The temperature exhibits the typical seasonal changes for temperate zone and in accordance with altitude, increasing from upstream towards downstream (Table 1). The amount of dissolved oxygen decreases from upstream towards downstream, but its percentage in the water body depends also on other conditions too, like substratum and the intensity of photosynthesis. The conductivity and salinity show markedly increasing tendency from upstream towards downstream depending on the kind of substratum and the existence of human activity (grazing, dam reservoirs, water feed pipe, forest clearings).

As concerning the diatom communities investigated, there have been identified 79 taxa, belonging to 24 genera (Table 2). Most species belong to *Eunotia* (13), *Navicula* (10), ten genera being represented by a single taxon each (Table 2). The highest species richness was recorded downstream in stands I and II.

Many diatoms are cosmopolitan like *Achnanthes minutissima, Fragilaria capucina* var. *vaucheriae, Cocconeis placentula, Gomphonema parvulum, Melosira granulata, Nitzschia linearis* etc. The microthermal elements, characteristic for cold mountain streams are well represented (ex. *Fragilaria arcus, Meridion circulare, Diatoma hiemale, D. mesodon* etc.). As concerning their preferences towards pH, one can observe that in upstream stands the acidophil species are more frequent, most of them being possibly washed into the river from the adjacent raised peat bogs (ex. *Frustulia saxonica, Cymbella perpusilla, Eunotia bilunaris, and E. exigua*). Some of such species inhabit dystrophic waters with very low conductivity and salinity (ex. *Anomoeoneis brachysira, Achnanthes helvetica*). In the downstream stands (I and II), due to changes of the physico-chemical parameters, appear basiphilous species, some of them mesotrophic (*Navicula lanceolata, Gomphonema pumilum*), others indifferent. In these downstream stands (including stand III) low density populations of the invasive *Didimosphenia geminata* are recorded for the first time in the Someşu Rece River.

Seasonal dynamics of the communities separately in each of the stands would be difficult to be analyzed due to the lack of the spring samples in stands II and V. However, a global analysis based on all identified species might be possible but difficult because the natural conditions (especially temperature) of stands vary much with altitude. In spite of that some of the findings suggests the existence of seasonal changes in community structure. The total number of recorded diatoms in April was 53, in June 51 and in October 67, showing as usual in such

temperate rivers two maxima, one in spring, another in fall. The same tendency is shown in the dendrogram (Fig. 2), the floristic lists were grouped according to the seasons.

Table 2: The qualitative structure of diatom communities from the Someşul Rece river

TAXA	April the 22nd 2004					June the 25th 2004					October the 30th 2004				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
Achnanthes helvetica	+		-	-		-	-	-	+	+	-	+	+	+	-
Achnanthes kryophilla	-		+	+		+	+	-	-	-	-	-	-	-	-
Achnanthes lanceolata	+		+	+		-	+	+	+	+	+	+	+	+	-
Achnanthes minutissima	+		+	+		+	+	+	+	+	+	+	+	+	-
Amphora libyca	+		-	+		-	-	-	-	-	+	+	-	-	-
Anomoeonis brachysira	+		+	+		-	-	-	-	+	-	-	-	-	+
Caloneis silicula	-		-	-		-	+	-	-	-	-	-	-	-	-
Cocconeis disculus	-		-	-		-	-	+	+	-	+	+	-	+	-
Cocconeis placentula	+		+	-		+	+	+	-	-	+	+	+	-	-
Cymbella amphicephala	+		-	-		-	-	-	-	-	-	-	-	-	-
Cymbella minuta	+		+	+		+	+	+	+	+	+	+	+	+	-
Cymbella naviculiformis	-		-	+		-	-	-	+	-	-	-	-	-	-
Cymbella perpusilla	-		-	+		-	+	-	-	-	-	+	+	-	+
Cymbella silesiaca	+		+	+		+	+	+	+	-	+	+	+	+	+
Cymbella sinuata	+		+	-		+	+	+	-	-	+	+	-	-	-
Diatoma hiemale	+		+	+		-	+	+	+	-	+	+	+	+	-
Diatoma mesodon	+		+	+		-	+	+	+	-	+	+	+	+	-
Diatoma vulgaris	+		-	-		+	-	-	-	-	+	+	-	-	-
Didimosphenia geminata	+		-	-		+	+	+	-	-	+	-	+	-	-
Diploneis ovalis	+		-	-		-	+	-	-	-	-	+	-	-	-
Eunotia bigibba	-		-	-		-	-	-	-	+	-	-	-	-	-
Eunotia bilunaris	+		+	+		-	-	-	+	+	-	+	-	+	+
Eunotia crista galli	-		-	-		-	-	-	-	-	-	-	-	-	+
Eunotia exigua var. exigua	-		+	+		-	+	+	+	+	-	+	-	+	+
Eunotia exigua var. tridentula	-		+	+		-	-	-	+	-	-	-	+	-	-
Eunotia fallax	-		-	-		-	-	-	-	-	-	-	-	-	+
Eunotia flexuosa	-		-	-		-	+	-	-	-	-	-	-	-	+
Eunotia microcephala	-		-	-		-	-	-	-	-	-	-	-	-	+
Eunotia minor	+		+	-		-	-	-	-	-	-	-	-	-	+
Eunotia praerupta	-		-	-		-	-	-	+	-	-	-	-	-	-
Eunotia sudetica	-		-	+		-	-	-	-	-	-	-	+	+	-
Eunotia tenella	+		+	-		-	+	-	+	+	-	+	+	-	-
Eunotia trinacria	-		-	-		-	-	-	-	-	-	-	-	-	+
Fragilaria arcus	+		+	+		+	+	+	+	+	+	+	+	-	+
Fragilaria capucina var. capucina	-		+	+		+	+	+	+	+	+	+	+	+	+
Fragilaria capucina var. vaucheriae	+		+	+		-	+	+	+	+	+	+	+	-	-
Fragilaria consturens	+		+	-		-	-	-	-	-	-	-	-	-	-
Fragilaria intermedia	-		-	-		-	-	-	-	-	-	-	-	-	+
Fragilaria pinnata	-		+	+		-	+	+	-	-	-	+	+	+	-
Fragilaria ulna	+		-	-		-	+	-	-	-	+	+	+	-	-
Fragilaria virescens	+		-	+		-	+	-	+	+	-	-	-	-	-
Frustulia saxonica	-		+	+		-	+	-	-	+	-	+	+	+	+
Frustulia vulgaris	+		+	-		-	+	-	+	+	-	-	+	+	-
Gomphonema gracile	-		+	+		+	-	-	-	-	-	+	+	-	-
Gomphonema olivaceum	-		-	-		+	-	+	+	+	+	+	-	-	-
Gomphonema parvulum	+		+	+		+	+	+	+	+	+	+	+	+	-
Gomphonema pumilum	-		-	-		+	-	-	-	-	-	-	-	-	-
Melosira granulata	+		+	+		-	+	-	+	+	-	+	+	+	+
Melosira varians	+		-	-		-	-	-	-	-	+	+	+	-	-
Meridion circulare	+		+	+		-	+	-	+	+	-	+	+	+	-
Navicula accomoda	-		-	-		-	-	-	-	-	-	-	-	-	+
Navicula capitatoradiata	-		-	-		-	-	-	-	-	-	-	-	-	+
Navicula cincta	-		-	-		-	-	-	-	-	+	+	-	-	-
Navicula cryptocephala	-		-	-		-	-	-	-	-	-	-	-	-	+
Navicula lanceolata	+		+	-		-	+	-	-	-	-	+	+	-	-
Navicula pupula	-		-	-		-	+	-	-	-	-	+	-	+	-
Navicula radiosa	+		-	-		-	-	-	-	-	-	-	-	-	-
Navicula rhynchocephala	+		+	+		-	+	-	-	-	+	+	+	+	-
Navicula tripunctata	-		-	-		-	-	-	-	-	-	-	-	-	+
Navicula veneta	-		-	-		-	+	-	-	-	-	-	-	-	-
Neidium bisulcatum	+		-	-		-	-	-	-	-	+	-	-	-	-
Nitzschia acicularis	-		-	-		-	-	-	-	-	+	-	-	-	-
Nitzschia capitellata	-		-	-		-	+	-	-	-	-	-	-	-	-
Nitzschia dissipata	+		+	-		-	-	+	-	-	+	+	-	-	-

Nitzschia frustulum	+		-	-		+	-	-	-	-	-	-	-	-	-
Nitzschia linearis	+		+	-		-	+	-	-	-	+	+	-	-	-
Nitzschia palea	-		-	-		-	+	-	-	-	-	+	-	+	-
Pinnularia borealis	-		-	+		-	+	-	-	-	+	+	-	-	-
Pinnularia brebissonii	-		-	-		-	-	-	-	-	-	-	-	-	+
Pinnularia gibba	-		-	-		-	-	-	-	+	-	-	+	-	+
Pinnularia microstauron	-		+	+		-	+	-	-	-	-	-	+	+	+
Pinnularia subcapitata	+		+	+		-	+	+	+	+	-	-	+	+	-
Pinnularia viridis	-		-	-		-	-	-	-	-	-	-	-	-	+
Rhoicosphaenia abbreviata	+		-	-		-	-	-	-	-	+	+	-	+	-
Stauroneis anceps	-		+	-		-	-	-	-	+	-	-	-	-	+
Stauroneis phoenicenteron	+		-	-		-	-	-	-	-	-	+	-	-	+
Stephanodiscus hantzschi	-		-	+		-	-	-	-	-	-	-	-	-	-
Surirella angusta	-		-	-		-	+	-	-	-	+	-	-	+	-
Tabellaria flocculosa	-		+	+		-	+	+	+	+	-	+	+	+	+

Legend: (I – V: sampling sites, see in text).

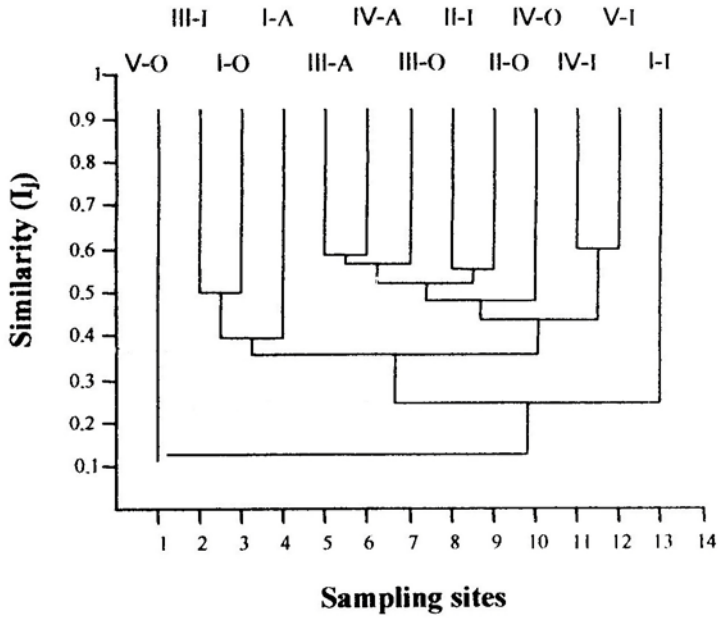

Fig. 2: Floristic similarity of stands I-V of Someşul Rece river (A – April; I – June; O - October), according to the Jaccard Index of similarity**.**

The quantitative analysis of community structure in some cases proves the same findings, the dominant taxon or its weight changes according to the seasons. In stand I the dominant taxon in spring is *Fragilaria arcus* (26.5%), *Achnanthes minutissima* in the warm season (89.7%) and in autumn (70.3%). The dominant taxa in stand III are *Achnanthes minutissima* in spring (70.1%) and in summer (20.1%) and *Fragilaria ulna* in fall (30.9%). In other stands the dominant taxon is the same in all seasons, but there are slight differences in its weight. In stand IV *Diatoma hiemale* in spring forms 70.8% of the community, in summer 64.1% and 77.2% in fall. The dominant taxa may be indicators of environmental conditions, like *Fragilaria arcus* and *Diatoma hiemale* – microthermal elements, characteristic for montane rivers, or cosmopolitan ones like *Achnanthes minutissima* and *Fragilaria ulna*, or rarely alien forms, such as *Tabellaria flocculosa*, washed into the river from the peat bogs.

The diversity (H') and equitability (E) values are given in table 3.

There is no well defined evolutionary tendency as concerning these parameters; the marked differences in diversity and equitability values might be explained by the great variety of natural and human influenced environmental conditions acting in this area. The highest value calculated for April in stand I is connected with the spring maximum of diatoms, but it is

possibly connected with the maturation process of the river from upstream towards downstream, according to the river continuum, drift and high floods.

Table 3: Species diversity and equitability in the Someşu Rece River.

	Date of sampling												
	22.04.2004			25.06.2004					30.10.2004				
Stands	I	III	IV	I	II	III	IV	V	I	II	III	IV	V
Diversity (H')	1.0	0.44	0.49	0.19	0.5	0.64	0.47	0.3	0.53	0.68	0.9	0.46	0.2
Equitability (E)	0.72	0.36	0.4	0.24	0.46	0.59	0.49	0.28	0.46	0.57	0.78	0.38	0.2

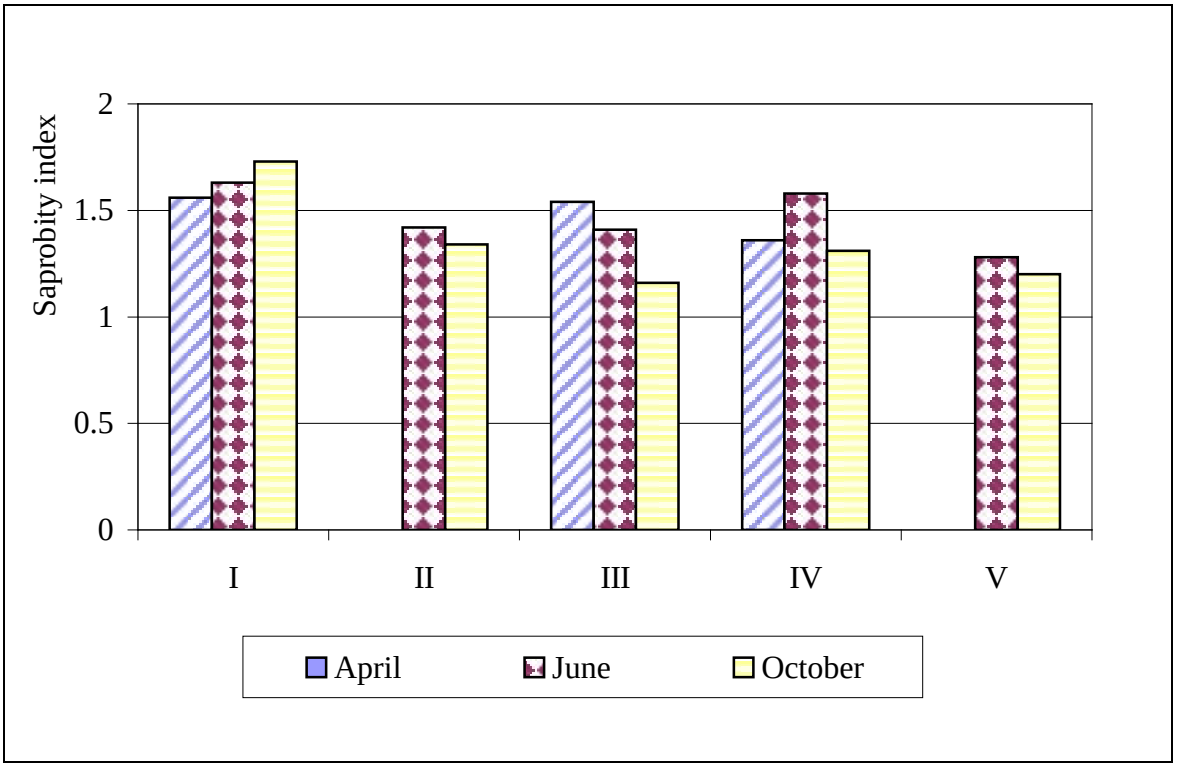

Fig. 3: Saprobity index values calculated for the Someşul Rece river

The values calculated for the saprobity index (Si) and those of the biological diatom index (BDI) are given in figures 3 and 4. According to the saprobity indices, ranging between 1.16 in stand III and 1.79 in stand I, both calculated in October, the water of the Someşu Rece River belongs to waters of oligosaprobic (≤ 1.5Si/ and β - and β-α-mesosaprobic (1.5<Si/≤2.5) character.

As concerning water quality classes, according to the saprobity index values, they are: class I – clear or slightly polluted waters (Si < 1.3), class I-II – waters with reduced pollution (1.4<Si≤1.7) and class II – waters with moderate pollution (1.8<Si<2.1). Therefore, the water of the Someşu Rece River does not exhibit special question concerning its organic loading. Although the Si index value of 1.79 is almost on the lower threshold of class II, moderately to strongly polluted waters, that means special attention should be paid by the river water quality monitoring institutes. In the same time one can observe inspecting fig. 3, the grouping tendency of the saprobity index values from upstream (stand V) towards downstream (stand I) with corresponding changes in water quality.

The biological diatom index values strengthen the good quality of the water in the Someşu Rece River (Fig. 4), showing the highest values (>17) in upstream stands (V, IV and III) – meaning outstanding; the other values (17>BDI≥13) indicate good quality water.

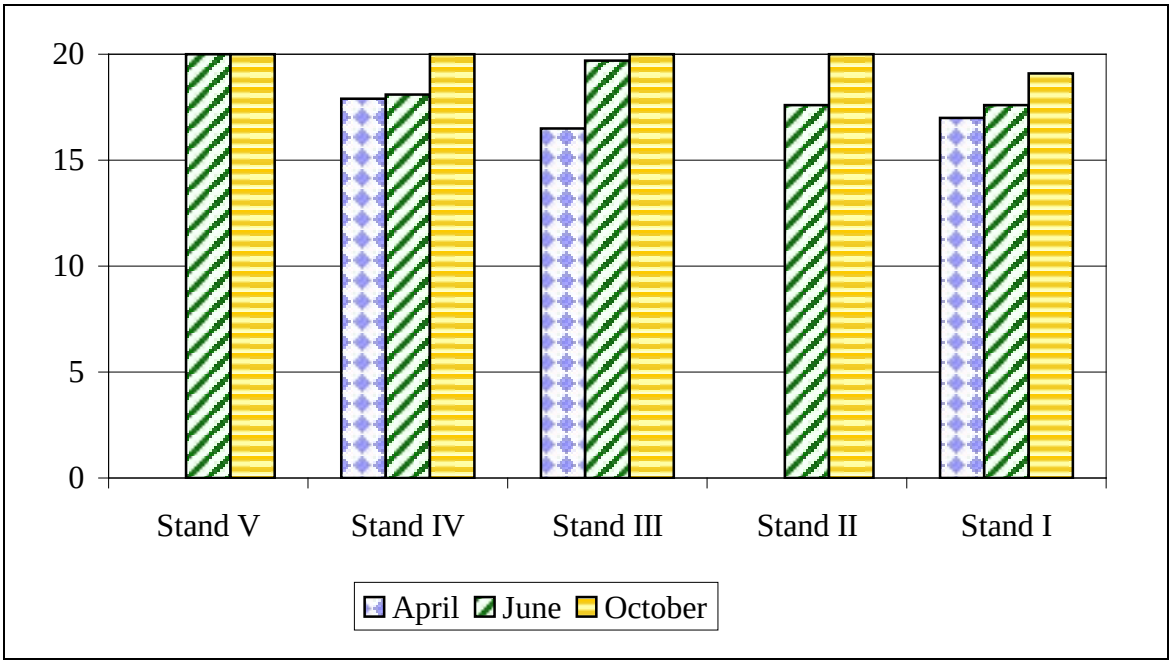

Fig. 4: Biological diatom index values calculated for the Someşul Rece river

Our results are similar to those previously published from the same river [7] or from the Someşul Cald River, especially on its upper course [1].

Conclusions

In the investigated stands of the Someşu Rece River there were recorded 79 diatom taxa in 2004, mostly cosmopolitan, eurytopic or ubiquitous forms, but several are stenotopic, showing special preferences towards, nutrients, pH and temperature.

Many of the diatoms are acidophilic or even dystrophic, washed into the river from the neighboring raised peat bogs.

Due to the varying environmental conditions the floristic similarity values are rather low, suggesting however the grouping of communities according to season and location of stands. The same is valid concerning diversity and equitability, showing the highest values in the downstream stands.

Human impact, namely the dam reservoir, the water feed pipe from the Arieş valley, forest clearing, grazing etc. alter the physico-chemical parameters of the river, and implicitly the structure of algal communities.

The level of saprobity estimated by the saprobity index indicates good quality waters (group I-II) of oligo- β-mesosaprobic and β-α-mesosaprobic characters. The BDI values suggest outstanding and good quality waters in the river. The water quality decreases from upstream towards downstream.

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COMUNITĂŢI DE DIATOMEE BENTONICE DIN RÂUL SOMEŞUL RECE (TRANSILVANIA, ROMÂNIA)

(Rezumat)

S-a determinat un număr de 79 taxoni în cele trei sezoane din anul 2004. Între speciile de alge identificate apare un număr mare de elemente cu răspândire cosmopolită. Bine reprezentate sunt şi speciile caracteistice apelor reci de munte, cele cu preferinţe acidofile, oligotrofe şi oligosaprobe. Pe lângă speciile autohtone s-a remarcat un număr de elemente cenoxene provenite din turbăriile adiacente râului în zona de izvoare. Estimările cantitative au permis calcularea unor indici biotici: diversitate specifică, echitabilitate, indice de saptorbitate, indice biologic de diatomee, pe baza cărora s-au evaluat strucutra comunităţilor de diatomee bentonice şi calitatea apei din râu: pe baza datelor calitative s-a calculat şi indicele de similaritate floristică Jaccard. Impactul antropic datorat lucrărilor hidrotehnice, defrişărilor, păşunatului din bazinul de drenaj, afectează într-o oarecare măsură structura comunităţilor de diatomee bentonice.