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The Ecological Study of mayfly communities (Insecta: Ephemeroptera) in several ecosystems from the Someş Mic river upper catchment area

-Summary of the thesis -

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Contents of the Thesis

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Introduction

The mayflies are a relatively small order of insects, of which so far have been described worldwide over 3000 species, classified in 42 families and over 400 genera (Barber-James et al., 2008). Linneus, in 1758 distinguished 11 species of mayflies and placed them in one genus, *Ephemera*, in the Neuroptera order (in Sartori, 2001). In the 19th century, Pictet (1843) and Eaton (1883-1888) continued the research on these organism, and in the first part of the 20th century new species are described by Bengtsson, Esben-Petersen, Klapalek, Mikulski, Schoenemund and Ulmer (in Sartori, 2001). After World War II, the number of fauna studies shows a significant increase due to the activity of Grandi, Jacob, Kimmins, Landa, Macan, Müller-Liebenau, Puthz, Sowa, Thomas, Edmunds, Soldán, Bauernfeind, Godunko and Klonowska-Olejnik (in Sartori, 2001).

Thesis objectives

- Assessment of the diversity of mayflies communities in Someş Mic upper river catchment
- Ecological study of the mayflies communities in the studied area related with the measured environmental parameters
- Study on the phenomenon of drift in the mayflies communities

Original contributions of the study

Report of two new mayfly species for the Romanian fauna

The analysis of the phenomenon of drift in the mayfly communities is addressed for the first time in Romania

The environmental issues addressed, the study on the mayflies communities and their relationship with the environmental parameters, are conducted for the first time in the upper catchment of the Someş Mic river.

I would like to mention here that part of this study was financed by CNCSIS project, type A, code 199/2003 (project director prof. Claudiu Tudorancea) and by CNCSIS project type Td, code 243/2007 (project director, Anca Avram).

1. Brief history of international and national research on mayflies

This chapter includes a brief bibliographic summary of some international and national published works on taxonomic and ecological studies of the order Ephemeroptera.

2. The mayflies (Insecta: Ephemeroptera), general characterization

This chapter presents summarized data from literature regarding the origin, evolution, classification, phylogeny, biology, ecology, distribution, abundance and importance of the Ephemeroptera order, and the human impact on these insects.

Ephemeroptera is an ancestral order of insects, dating from the late Carboniferous – early Permian, about 290 million years ago (Brittain and Sartori, 2003; Barber-James et al. 2008). They are considered to have reached maximum diversity in the Mesozoic (Brittain and Sartori, 2003). They are considered the oldest and most primitive groups of insects in existence today (Edmunds and McCafferty, 1988).

The systematic classification of the order Ephemeroptera is as follows (Thomas and Belfiore, 2011):

Kingdom Animalia

Subkingdom Eumetazoa

Phylum Hexapoda

Subphylum Hexapoda

Class Insecta

Order Ephemeroptera

The mayflies are hemimetabolic insects, which means that the larvae morphology (nymphs) is gradually approaching the stage of imago (adult), and the transition to the imago stage is made without complete metamorphosis (Brittain, 1982). The mayflies' lifecycle includes the following stages: larval growth period, including the emergence and the flight period of the winged insects (both subimago and imago). The eggs and larval stages are aquatic and the subimago and imago are terrestrial.

It is considered that due to the fragility of the adults and their short lifespan, mayflies have a rather limited capacity of dispersion. They are found in almost all freshwater in the world, except Antarctica and some oceanic islands (Barber - James et al., 2008), but have a much higher diversity in rivers, compared with stagnant waters (Bogoescu, 1957; Brittain and

Sartori, 2003; Barber – James et al., 2008) and some species can live in brackish water ecosystems (Barber – James et al., 2008).

The major importance of these insects lies in the fact that these are key species, their presence is considered an indicator of the degree of trophicity in aquatic ecosystems (Barbour et al., 1999; Bauernfeind and Moog, 2000), they have a central role in the saprobes' system (Sowa, 1980). The mayflies have also a very important role in the aquatic system, which derives from the diversity of the functional groups (Morse et al., 1997; Barber - James et al., 2008). Also, during their development cycle, they represent the food source of many groups of organisms (Hynes, 1970; Brittain, 1982; Brittain and Sartori, 2003).

3. The physical-geographical characterization of Someş Mic upper river catchment

Someş Mic River is located in the northwestern part of the Transylvanian Basin and is a part of the river Someş (Ujvari, 1972). The catchment area of Someş Mic River has an area of 3773 km2; the river has a length of 178 km and a multiannual average flow of 14.5 m^3/s in Cluj-Napoca (Sofronie, 2000). Someş Mic River is formed of two mountain rivers: Someş Cald and Someş Rece, which are joined at the eastern foot of the Gilău Mountains in Someş Rece locality. Someş Cald River is considered the source of Someş Mic River.

Someş Cald River has a length of 64 km and a catchment area of 534 sqkm and, stems from the Piatra Arsa Peak (1550 m asl), from the central massif of Bihor - Vlădeasa, a limestone region (Triassic - Jurassic) with karsts phenomena.

Someş Rece River has a length of 45 km, a catchment area of 335 sqkm. Its springs are in Muntele Mare Mountains; under the Runcului Peak (1609 m ASL). Someş Rece drains, through its tributaries, the central part of the Gilău Mountains (Gîstescu, 1990).

4. Location and characterization of sampling sites

The collecting program included 10 sampling sites, four of them located in the Someş Cald basin (three on the main course and one of the Batrana tributary), five on the course of Someş Rece river and one on Someş Mic river, upstream Cluj - Napoca town (Fig. 1). The station names, the code used for each sampling site, the elevation, GPS coordinates, maximum depth and width of the riverbed are shown Table 1.

Table1 Data on location, maximum depth and width of the riverbed of the sampling sites studied

Code and name of the sampling site		Elevation (m asl)	GPS coordinates	Maximum depth (m)	Riverbed width (m)
SC 1	Someşul Cald -downstream of the river's gorge	1177	N 46^{0}38’38,7’’ E 22^{0}43’38,3’’	0,30	5
SC 2	tributary Bătrâna	1198	N 46^{0}35’38,1’’ E 22^{0}45’48’’	0,40	4
SC 3	Someşul Cald - upstream of Doda Pilii	1025	N 46^{0}38’25,2’’ E 22^{0}49’38,1’’	0,60	25
SC 4	Someşul Cald - upstream of Tarnita Lake	561	N 46^{0}42’10,8” E 23^{0}12’15,1”	0,50	8
SR 1	Someşul Rece - springs	1512	N 46^{0}28’19,9’’ E 23^{0}05’5,4’’	0,40	0.5
SR2	Someşul Rece - upstream Blăjoaia	1350	N 46^{0}28’44’’ E 23^{0}04’55,4’’	0,50	4
SR 3	Someşul Rece - downstream Blăjoaia	1271	N 46^{0}30’46,1’’ E 23^{0}04’0,7’’	0,40	12
SR 4	Someşul Rece – downstream water intake from Aries catchment area	1035	N 46^{0}36’53,7’’ E 23^{0}07’25,8’’	0,70	20
SR 5	Someşul Rece - downstream Măguri - Răcătău	662	N 46^{0}39’56,6’’ E 23^{0}13’34’’	0,40	8
SM	Someşul Mic - upstream Cluj - Napoca	354	N 46^{0}45’51,3” E 23^{0}32’ 28,8”	0,60	35

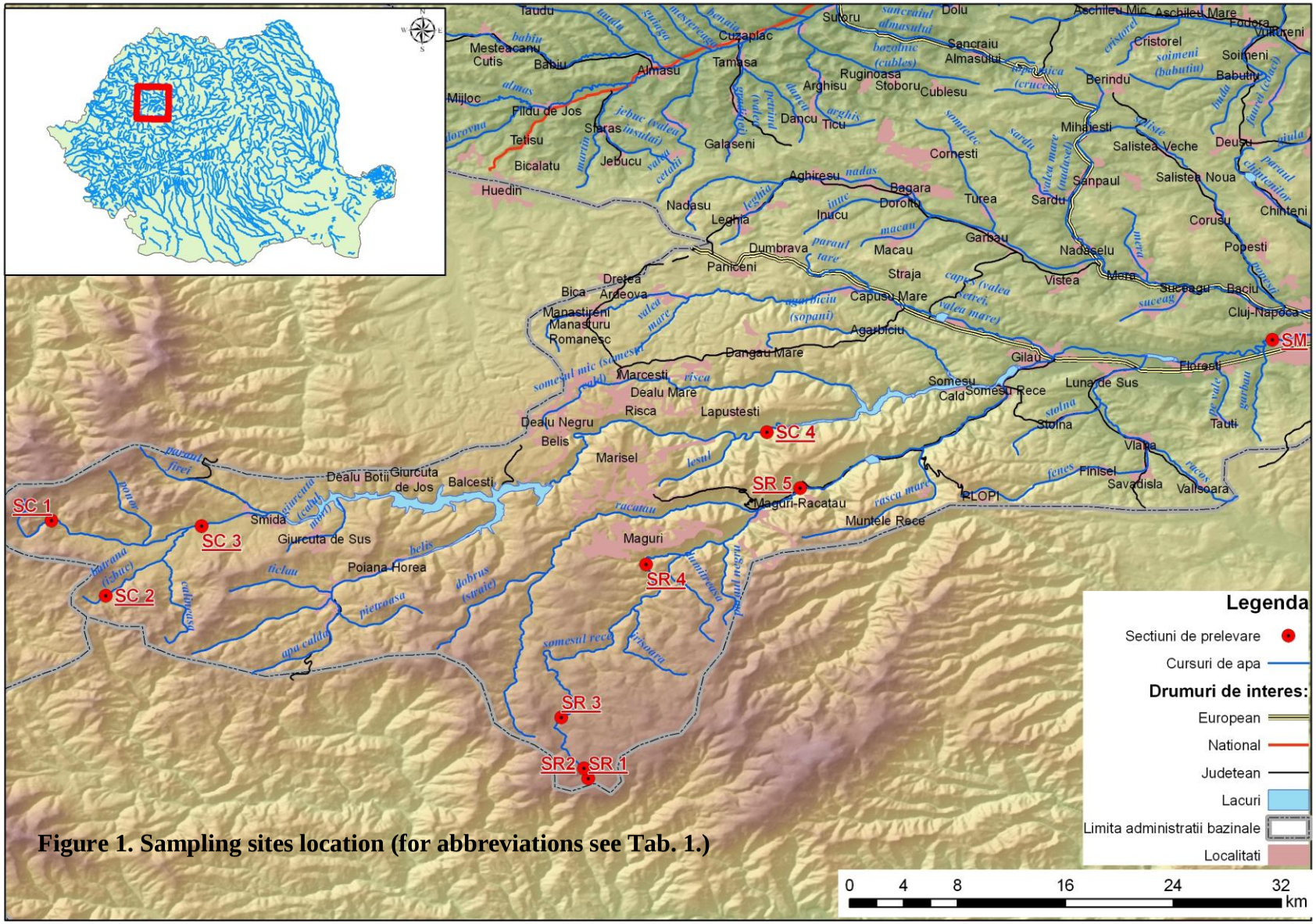

Figure 1. Sampling sites location (for abbreviations see Tab. 1.)

5. Material and methods

Benthic invertebrates quantitative samples were collected monthly during March-November in the years 2003-2004 on Someş Cald river and during March - November in 2003 at sampling sites on the Someş Rece and Someş Mic rivers. In most cases for each site 3 samples were collected, a total of 264 quantitative samples being analyzed.

Quantitative macroinvertebrate samples have been collected using a Surber benthic sampler with an area of 1060 sqcm (in 2003), and in 2004 one with an area of 900 sqcm and a 250 μm mesh net. The samples were preserved with formaldehyde 38% in the field and deposited in plastic recipients.

Drift samples were collected every 3 hours during 24 hours, on the 10th and 11th of August 2005, using a 250 μm mesh net with a metallic frame (1m long and 1m high). Two such nets were used, one located at 1,5 m from the left bank, the other at 1 m from the right bank and the distance between nets was 2m. The samples were collected at 6:00, 9:00, 12:00, 15:00, 18:00, 21:00, 24:00 and 3:00 o'clock. Each sampling lasted for 30 minutes

Along with collecting biological samples a set of physical-chemical parameters of water were measured with the following portable devices: water temperature (T) (^{0}C) and dissolved oxygen (O_2) (mg/L) were measured with an YSI Model 52 type oxygenmeter, water conductivity (EC) (μS/cm) and salinity (mg/L) were measured with a device CONSORT Model K 911, and the pH was measured with portable pH -meter CONSORT model P 902.

The biological material was sorted in the lab under a SMZ645 Nikon stereo microscope, after the samples were cleaned to remove the formaldehyde. Organisms belonging to different taxonomic groups were transferred in separate recipient with 70% alcohol. Ephemeroptera taxa were identified to the lowest level possible using the following keys: Müller-Liebenau, 1969; Malzacher (1986); Studemann *et al.*, 1992; Soldan and Landa, 1999.

Mayfly species from drift samples were measured and individuals were divided into several size classes, ranging from 0.5 to 12 mm (Tab. 6). Their length was considered from the labrum to the basis of the cerci.

For the analysis of mayflies communities various statistics indexes were calculated, using the PAST statistical program (PAlaeontological Statistics, ver. 0.93 (Hammer et al., 2002)) and the XLSTAT statistical software (trial version, www.xlstat.com).

Tables 2, 3, 4, 5 and 6 summarize the abbreviations used for mayfly species, sampling station included in the collection program, data of the sampling, drift samples and size classes for mayflies present in drift samples.

Table 2. Abbreviations used for mayflies taxa

code	genus	taxa	code	genus	taxa
Bal	*Baetis*	*alpinus*	**Sig**	*Serratella*	*ignita*
Bdi	*Baetis*	*digitatus*	**Tm**	*Torleya*	*major*
Bfu	*Baetis*	*fuscatus*	**Eda**	*Ephemera*	*danica*
Blu	*Baetis*	*lutheri*	**Plu**	*Potamanthus*	*luteus*
Bme	*Baetis*	*melanonyx*	**Ecsp**	*Ecdyonurus*	sp.
Bmu	*Baetis*	*muticus*	**Eas**	*Epeorus*	*assimilis*
Brh	*Baetis*	*rhodani*	**Rbe**	*Rhithrogena*	*beskidensis*
Bsc	*Baetis*	*scambus*	**Rcfca**	*Rhithrogena*	cf *carpatoalpina*
Bve	*Baetis*	*vernus*	**Rcfir**	*Rhithrogena*	cf *iridina*
Bsp	*Baetis*	sp.	**Rcfsa**	*Rhithrogena*	cf *savoiensis*
Cl	*Centroptilum*	*luteolum*	**Rse**	*Rhithrogena*	*semicolorata*
Ain	*Ameletus*	*inopinatus*	**Rsp1**	*Rhithrogena*	sp1
Cbe	*Caenis*	*beskidensis*	**Rsp2**	*Rhithrogena*	sp2
Cma	*Caenis*	*macrura*	**Rci**	*Rhithrogena*	*circumtatrica*
Csp	*Caenis*	sp.	**Rsp**	*Rhithrogena*	sp.
Emu	*Ephemerella*	*mucronata*	**Hc**	*Habroleptoides*	*confusa*
Epsp	*Ephemerella*	sp.	**Hl**	*Habrophlebia*	*lauta*

Table 3. Abbreviations used for sampling sites included in collection program

Catchment area	Sampling station	Code
Someşul Cald	Someş Cald - downstream of the river's gorge	**SC 1**
	tributary Bătrâna	**SC 2**
	Someş Cald - upstream of Doda Pilii	**SC 3**
	Someş Cald - upstream of Tarnita Lake	**SC 4**
Someşul Rece	Someş Rece - springs	**SR 1**
	Someş Rece - upstream Blăjoaia	**SR 2**
	Someş Rece - downstream Blăjoaia	**SR 3**
	Someş Rece - downstream water intake from Aries catchment area	**SR 4**
	Someş Rece - downstream Măguri - Răcătău	**SR 5**
Someşul Mic	Someş Mic - upstream Cluj - Napoca	**SM**

Table 4. Abbreviations used for data of the sampling

Abbreviation	Data of the sampling	Abbreviation	Data of the sampling
IV03	April 2003	**IV04**	April 2004
V03	May 2003	**V04**	May 2004
VI03	June 2003	**VI04**	June 2004
VII03	July 2003	**VII04**	July 2004
VIII03	August 2003	**VIII04**	August 2004
IX03	September 2003	**IX04**	September 2004
X03	October 2003	**X04**	October 2004
XI03	November 2003	**XI04**	November 2004

Table 5. Abbreviations used for the drift sample

Code	Sample	Code	Sample
D9	Drift sample collected from 9:00 to 9:30	**D24**	Drift sample collected from 24:00 to 24:30
D12	Drift sample collected from 12:00 to12:30	**D3**	Drift sample collected from 3:00 to 3:30
D15	Drift sample collected from 15:00 to 15:30	**D6**	Drift sample collected from 6:00 to 6:30
D18	Drift sample collected from 18:00 to 18:30	**B**	Benthos samples
D21	Drift sample collected from 21:00 to 21:30		

Table 6. Abbreviations used for size classes of mayflies taxa

Size class	Body length, cerci and antenna excluded (L)	**Size class**	Body length, cerci and antenna excluded (L)
cls.I	L=(0,5 – 1 mm)	**cls.VII**	L=(6,1 – 7 mm)
clsII	L=(1,1 – 2 mm)	**cls.VIII**	L=(7,1 – 8 mm)
cls.III	L=(2,1 – 3 mm)	**cls.IX**	L=(8,1 – 9 mm)
cls.IV	L=(3,1 – 4 mm)	**cls.X**	L=(9,1 – 10 mm)
cls.V	L=(4,1 – 5 mm)	**cls.XI**	L=(10,1 – 11 mm)
cls.VI	L=(5,1 – 6 mm)	**cls.XII**	L=(11,1 -12 mm)

6. Physical–chemical parameters of water

The following physical-chemical parameters of water were analyzed: temperature (ºC), pH, dissolved oxygen (mg/l) and conductivity (µS/cm), to highlight their influence on the mayflies communities.

pH values of the water at stations located in the drainage area of Someşul Cald river were located around 8.5, with a minimum of 7.3 and a maximum of 9.6, values that reflect the alkaline character of the water due to the calcareous substrate (Fig. 2).

The situation on Someş Rece river is different (Fig. 2), in the spring area the pH of the water recorded minimum values of 5.2 and an average of 6.28. The acid character is due to the swamp with *Sphagnum* sp. located in the proximity of the springs. At the next station pH values are slightly higher, but the average recorded value is still below 7. At the station located downstream Maguri-Racatau (SR5), the pH values recorded were the highest on Someş Rece river. At the sampling station located on Someş Mic river, upstream Cluj-Napoca, the pH values registered were between 7.34 and 8.9, with an average value of 7.97.

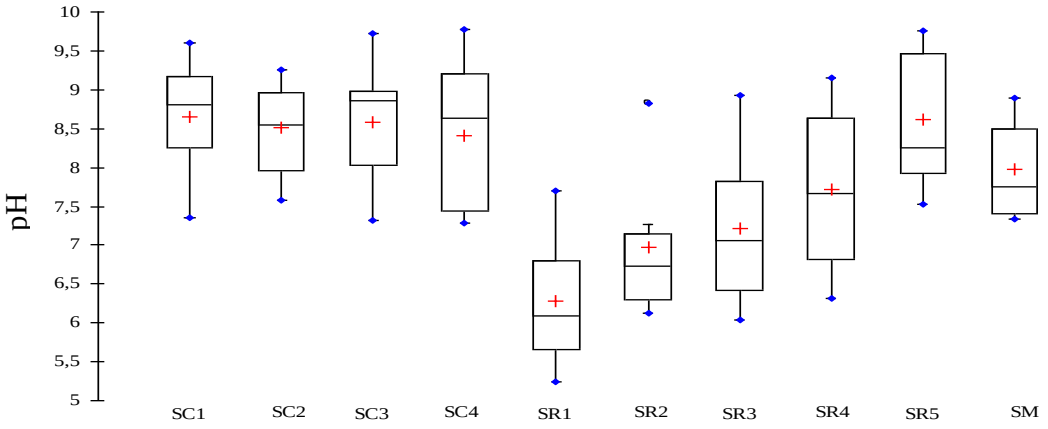

Figure 2. pH values of the water at sampling station located in the drainage basin of Someş Mic river (☐ 25%-75%; + average; — median; I - Q1–1.5 (Q3–Q1) – the lower limit, Q3+1.5 (Q3–Q1) – the upper limit (Q1 - 25% percentile, Q3 - 75% percentile);° peripheral values; x extreme values)

The big difference between the values of electrical conductivity is given by the geological substrate of the two rivers. Thus, there were high values registered at stations from Someş Cald riverbasin (Fig. 3), where the geological substrate consists of limestone rocks (Gîştescu, 1990), and low values registered at stations on Someş Rece river, where the geological substrate is composed of granitic rocks (Gîştescu, 1990).

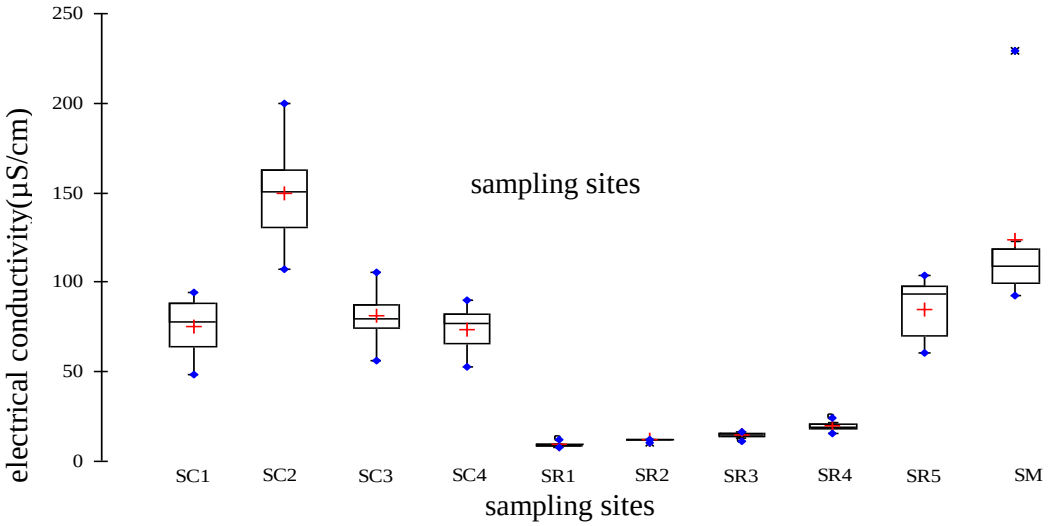

Figure 3. Values of the electrical conductivity of the water (µS/cm) at sampling station located in the drainage basin of Someş Mic river (☐ 25%-75%; + average; — median; I - Q1–1.5 (Q3–Q1) – the lower limit, Q3+1.5 (Q3–Q1) – the upper limit (Q1 - 25% percentile, Q3 - 75% percentile);° peripheral values; x extreme values)

7. Benthic invertebrate communities in the studied area

Aspects like frequency, percentage abundance and density of the groups of mayflies identified in the studied area were analyzed here.

Tables 7 and 8 present data on annual average densities of the identified groups, at the analyzed stations, from 2003 to 2004 for the stations in Someş Cald riverbasin, and in 2003 for the stations on Someş Rece and Someş Mic rivers. At all stations within Someş Cald basin, in 2003 the sum of the annual densities is higher than in 2004, and at station SC4 they are three times higher in 2003 compared with 2004. The highest densities are found at SC2 station (Bătrâna tributary) in 2003, when the total average density (all organisms) exceeds 20000 ind/sqm. The lowest density of benthic organisms (6785 ind/sqm in 2004) was recorded at the station located upstream Tarnița lake. (Tab. 7.).

Table 7. Annual average density (ind/sqm) of benthic invertebrates taxonomic groups in Someş Cald riverbasin

Sampling site	SC1		SC2		SC3		SC4	
Taxa/year	2003	2004	2003	2004	2003	2004	2003	2004
Turbellaria	1,80	1,85	77,24	41,27	3,14	0,53	22,80	49,21
Nematoda	6,29	2,47	59,36	89,15	29,48	12,70	68,20	8,99
Molusca	3,59	0,62	31,25	63,49	2,36	0,00	54,64	42,59
Oligochaeta	34,14	14,20	238,60	266,93	1389,15	884,66	3154,68	485,45
Hydrachnidia	315,14	143,21	380,90	160,58	352,20	212,70	662,54	619,84
Amphipoda	4,49	3,09	20,64	5,56	0,00	1,06	3,54	1,06
Copepoda	3,14	0,00	11,01	0,00	99,45	0,00	0,98	0,53
Ostracoda	66,04	55,56	201,65	45,77	13,76	0,53	180,03	1,59
Coleoptera	24,93	24,07	733,29	308,99	452,04	149,74	452,24	421,16
Chironomidae	5082,43	6559,88	5079,60	4235,71	8474,84	8852,38	8056,41	2358,2
Other dipterans	268,87	108,64	432,98	176,19	456,37	295,77	322,52	190,21
Ephemeroptera	2755,62	1998,46	7696,53	3033,07	2377,75	961,11	2423,94	1474,07
Plecoptera	2129,16	696,30	3971,31	2722,22	1371,46	757,67	2081,76	1055,82
Trichoptera	2925,65	3266,67	1380,11	455,56	631,68	436,51	320,36	76,72
TOTAL	13621,29	12875,0	20314,5	11604,5	15653,7	12565,3	17804,6	6785,4

At the stations on Someş Rece and Someş Mic rivers samples were taken in the year 2003. The highest total density was recorded at the station SM (33613,8 ind/sqm), value not seen at any other station, including those in Someş Cald. At SR station the total density of the benthic organisms (6139 ind/sqm) is comparable to that of station SR2 (7342 ind/sqm) and that recorded in 2004 at SC4 station (Tab. 8.).

Table 8. Annual average density (ind/sqm) of benthic invertebrates taxonomic groups at station on Someşul Rece and Someşul Mic rivers

Sampling site	SR1	SR2	SR3	SR4	SR5	SM
Taxa/year	2003	2003	2003	2003	2003	2003
Turbellaria	7,2	4,7	200,1	33,0	43,6	0,4
Nematoda	234,1	18,1	85,7	32,8	116,8	214,2
Molusca	2,2	0,0	41,3	5,8	160,4	1722,7
Oligochaeta	1073,0	1096,7	1330,6	284,4	3157,2	10989,8
Hydrachnidia	194,7	27,5	244,5	54,8	599,3	131,1
Amphipoda	24,9	12,6	0,4	0,9	9,4	1766,3
Copepoda	1446,5	11,0	143,1	38,4	32,3	16,1
Ostracoda	643,1	246,9	324,7	34,1	25,2	5,5
Coleoptera	8,3	777,5	1706,4	254,3	606,9	90,0
Chironomidae	2450,8	1275,9	4227,6	1021,1	6602,0	11089,0
Other Diptera	281,4	412,2	524,0	156,3	432,2	831,0
Ephemeroptera	0,0	1416,7	2579,0	2167,8	5641,5	2898,6
Plecoptera	4280,5	1581,0	968,6	954,2	182,8	0,0
Trichoptera	216,8	461,5	3609,7	1155,2	1500,0	3857,5
TOTAL	10863,7	7342,2	15985,5	6193,6	19109,6	33613,8

At the analyzed stations, the mayflies registered a frequency of 100%, except for Someş Rece – springs station, where they were not found at all, which is understandable due to their high sensibility to acidity (Guerold et al., 1991, 1993; McClurg et al., 2007).

The percentage abundance of this group within the aquatic communities at the sampling sites on Someş Cald river ranged from 2% (SC1, November 2004) and 64% (SC1, June 2004). During 2003-2004, at most sampling sites, the mayflies presented lower abundance in early spring, high in the months of spring-summer (May, June, July, August) slightly decreasing towards autumn (Fig. 4).

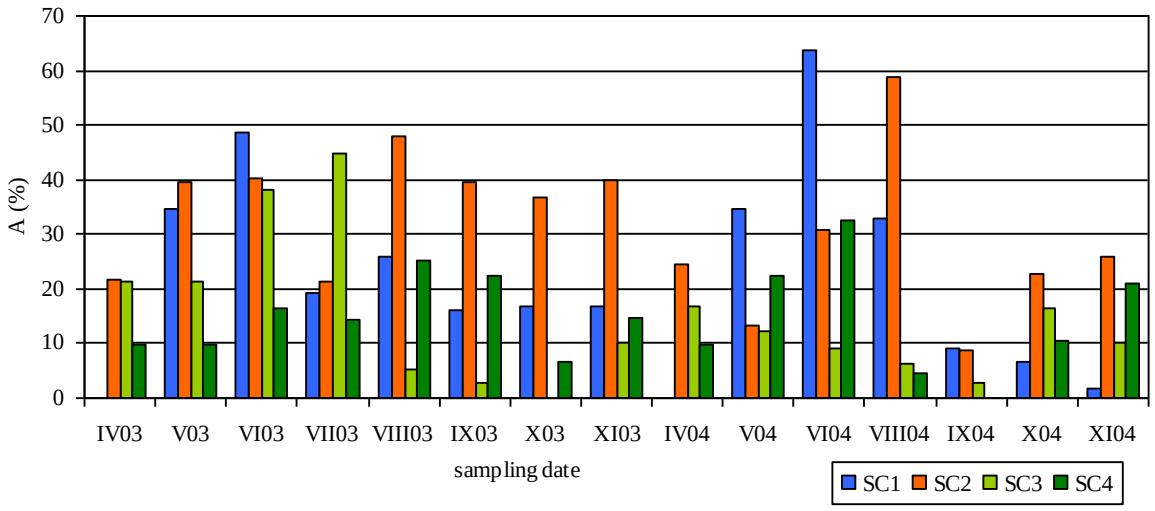

Figure 4. The percentage abundance (%) of the mayflies in the benthic invertebrates communities in Someş Cald basin, on the sampling dates, during 2003-2004

On Someş Rece and Someş Mic rivers, in 2003, generally, the same pattern is followed, except SR3, where the abundance of mayflies is higher in April and lower in May (Fig. 5). At SM sampling site, although mayflies are present in all samples, their abundance in the benthic communities is low, not exceeding 20%.

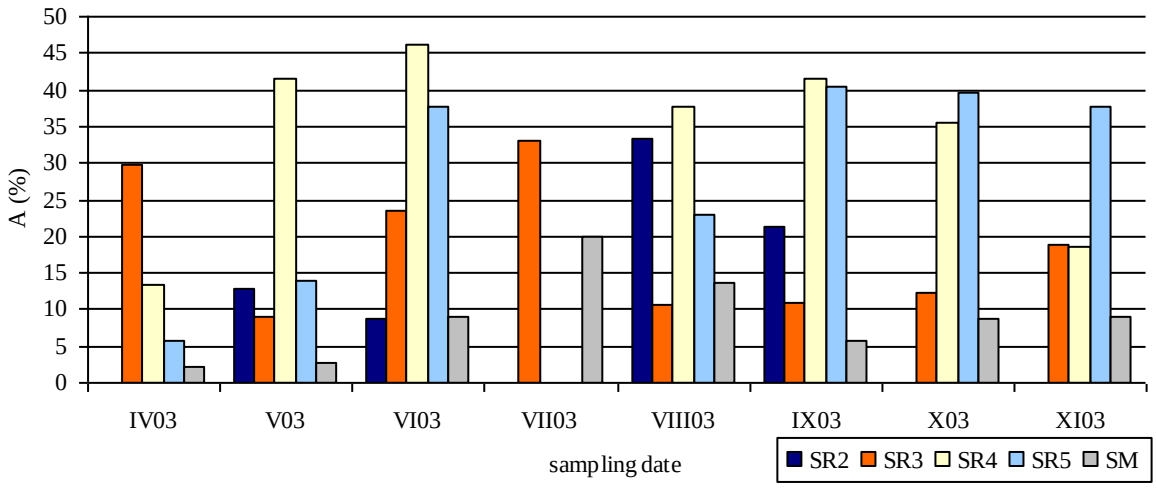

Figure 5. The percentage abundance (%) of the mayflies in the benthic invertebrates communities on Someş Rece and Someş Mic rivers, on the sampling dates, in 2003

In total a number of 76784 individuals were analyzed belonging to the order Ephemeroptera, present in 244 samples. Of them, on Someş Cald river there were 44500 individuals (33405 in 2003, and 11095 in 2004). On Someş Rece and Someş Mic, 32287 individuals were analyzed, collected in 2003.

The analysis of the average annual densities (Fig. 6) shows that on Someş Cald river they are higher in all sampling sites, and for SC2 and SC3 stations are more than double in 2003 compared with 2004. The maximum density was recorded in both years at SC2 station (Batrana tributary). On Someş Rece river, from the analysis of samples collected in 2003, it is noted that the highest densities are recorded at SR5 station, with an annual average of more than 5500 ind/sqm. At stations SR3, SR4 and SM the mayflies present densities of close values, ranged between 2100 and 2900 ind/sqm, while at SR2 station the average annual density does not exceed 1500 ind/sqm (Fig. 6).

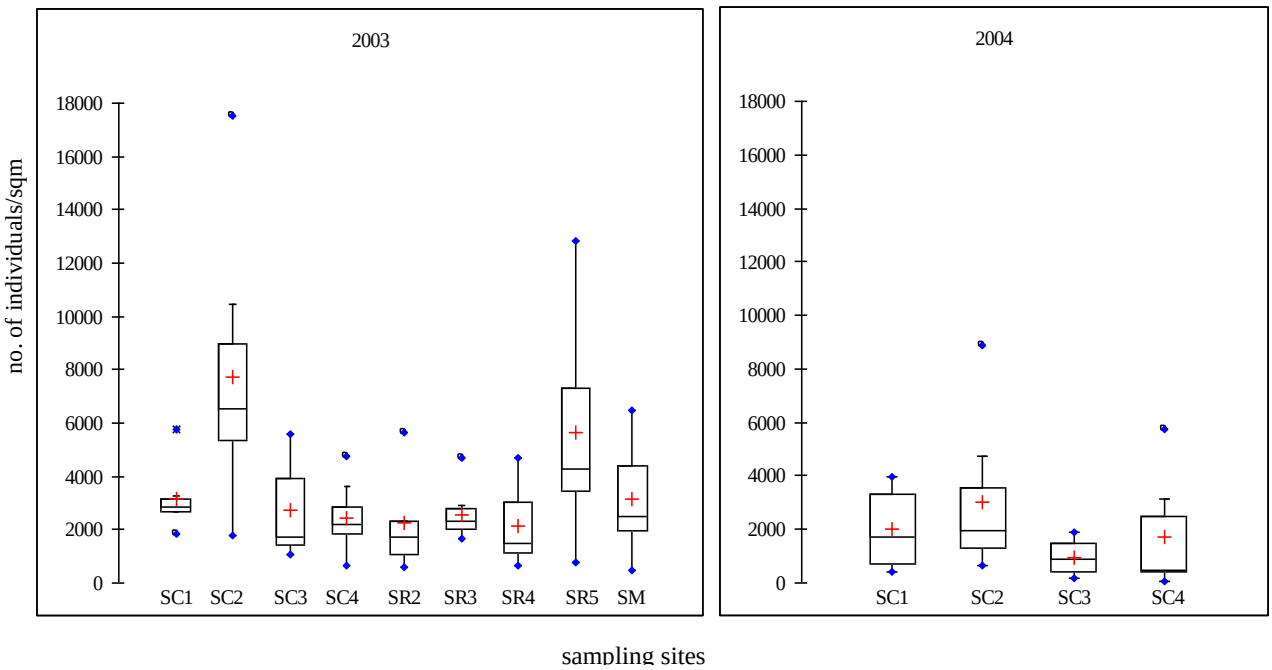

Figure 6. The average annual densities of mayflies at the studied sampling sites, in 2003 (left) and 2004 (right) (25% - 75%; + average; — median; I - Q1 - 1.5 (Q3 - Q1) - lower limit, Q3 + 1.5 (Q3 - Q1) – upper limit (Q1 - percentile 25%, Q3 - percentile 75%); ° peripheral values; x extreme values)

8. Structure and diversity of mayflies communities in the studied area

There were presented aspects regarding frequency, percentage abundance, density, monthly dynamics and spatial distribution of mayflies larvae at each analyzed station.

In the upper basin of the Someş Mic river, at the sampling sites included in this study, a number of 30 taxa were identified, systematically classified in 8 families and 14 genera. There were not identifications made for species of the *Ecdyonurus* genus and two species of the *Rhithrogena* genus could not be determined.

Two species were reported for the first time in Romania: *Baetis digitatus and Rhithrogena circumtatrica* (Avram and Cîmpean, 2011).

The species *Baetis digitatus* Bengtsson, 1912, is a rheophilic species found in rivers of different categories, with a strong or moderate water current, in protected places, with aquatic vegetation, sedges and moss (Müller - Liebenau, 1969; Sowa, 1975; Savolainen and Saaristo, 1980). To date this species has been reported in: Lithuania, Poland, the Czech Republic, Austria, Germany, France, Italy, Spain, UK, the Netherlands, Denmark, Sweden, Norway, Finland, Russia, the Dodecanese archipelago and some islands in the north of the Aegean Sea (Thomas and Belfiore, 2011). The location where this species was identified is situated at

1271m altitude, the substrate consists of boulders, gravel and coarse sand, covered in a degree of 15% by aquatic vegetation, consisting of Bioderma and moss.

Rhithrogena circumtatrica Sowa and Soldan, 1986 is a rheobiont species, found in mountain streams at medium and high altitudes (Sowa and Soldán, 1986; Zahrádková et al., 2009). To date this species has been reported in: Austria, Germany, Poland and Slovenia (Thomas and Belfiore, 2011). The station were this species was identified is located on Someş Cald river, at 1177m altitude, the substrate consisting mainly of boulders and gravel.

At the stations on Someş Cald river, where sample were collected in both years, the number of taxa identified in 2003 is higher at all stations compared with 2004 (juveniles were not considered) (Fig. 7). SC4 station shows the biggest difference between the number of taxa identified in the two years of sampling, of the 18 taxa identified in 2003, only 13 were found in 2004. Comparing Someş Rece – Someş Cald in 2003, when samples were collected from both rivers, is noticed that at the stations on Someş Rece river the number of taxa identified was lower (Fig. 7). On both rivers the number of taxa is lower at the first station. This can be explained due to high altitude at these stations (Fig. 7), the reason being that at high altitudes the period when rivers are unfrozen is shorter, the food resources are scarce, and the physical-geographic conditions are extreme (Landolt and Sartori, 2001).

At the station on Someş Mic river the number of taxa was the lowest (9 taxa) compared with all the stations investigated (Fig. 7), which is most likely due to hydromorphological changes and the presence of upstream localities.

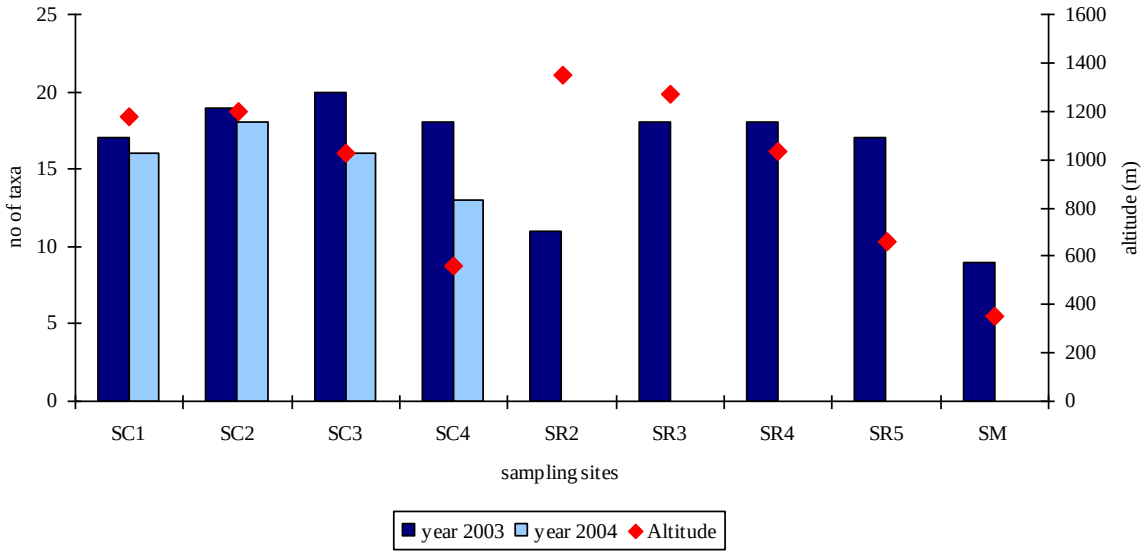

Figure 7. Altitude and number of mayflies taxa in the quantitative samples, comparison years 2003-2004 for the sampling sites in Someş Cald basin an year 2003 for the sampling sites on Someş Rece river and on Someş Mic – upstream Cluj-Napoca

At the stations on Someş Rece 24 taxa were identified, of which 23 were also present at the station in Someş Cald basin. Upstream Cluj-Napoca 9 taxa were found, of which 2 were only found at this location (Tab. 9).

Table 9. Distribution of taxa belonging to Ephemeroptera order, identified in the upper basin of Someş Mic river

Station / Taxa	SC1	SC2	SC3	SC4	SR2	SR3	SR4	SR5	SM
Baetis alpinus	■	■	■	■	■	■	■		
Baetis digitatus						■			
Baetis fuscatus									■
Baetis lutheri				■		■		■	■
Baetis melanonyx	■	■	■		■	■	■		
Baetis muticus	■	■	■	■		■	■	■	
Baetis rhodani	■	■	■	■	■	■	■	■	■
Baetis scambus			■	■		■	■	■	
Baetis vernus	■	■	■		■	■	■	■	
Centroptilum luteolum		■							
Ameletus inopinatus	■				■	■			
Caenis beskidensis		■	■	■			■	■	
Caenis macrura				■				■	■
Ephemerella mucronata	■	■	■		■	■	■	■	
Serratella ignita	■	■	■	■		■	■	■	■
Torleya major	■	■	■	■			■	■	
Ephemera danica				■				■	■
Potamanthus luteus									■
Ecdyonurus sp.	■	■	■	■	■	■	■	■	■
Epeorus assimilis	■	■	■	■		■	■	■	
Rhithrogena beskidensis		■	■	■				■	
Rhithrogena cf.*carpatoalpina*	■	■	■	■	■		■		
Rhithrogena cf. *iridina*	■	■	■	■	■	■	■	■	
Rhithrogena cf. *savoiensis*			■						
Rhithrogena semicolorata		■	■	■		■	■	■	
Rhithrogena sp1	■	■	■			■	■		
Rhithrogena sp2	■					■	■		
Rhithrogena circumtatrica	■								
Habroleptoides confusa	■	■	■	■	■	■	■	■	■
Habrophlebia lauta		■	■	■					

Diversity, equitability and similarity of the mayflies communities in the studied area

The comparative analysis of the diversity of the mayflies communities at station on Someş Cald river during 2003-2004 shows that the first two stations it is higher in the second year of sampling, although both density and number of taxa were lower in 2004, but while densities were reduced by half, the number of taxa in 2004 was less with 1 compared with 2003, so that

the equitability was higher (Fig. 8). At SC3 and SC4 stations, in 2004 both equitability and diversity are lower (Fig. 8). The lowest diversity at station on Someş Cald river, compared to those on Someş Rece, is found at the station upstream Blăjoaia, due to the mayflies' sensibility to pH values and to the high altitude of this station. The station on Someş Mic river has the lowest diversity, which once more underlines the mayflies' sensibility to the quality of the environmental parameters. In the study by Avram et al. (2009) the water quality in rivers Someş Cald, Someş Rece and Someş Mic was assessed, applying a series of biotic indices. According to this study, the water quality classes were lower at location were mayflies diversity was also lower. Thus, in the Someş Rece spring area the water quality was assessed as being of class 2-3, at the station on Someş Cald- downstream the gorges was assessed as class 1-2, and at the SM station (Someş Mic – upstream Cluj – Napoca) the water was assessed of being of class 3-4 quality.

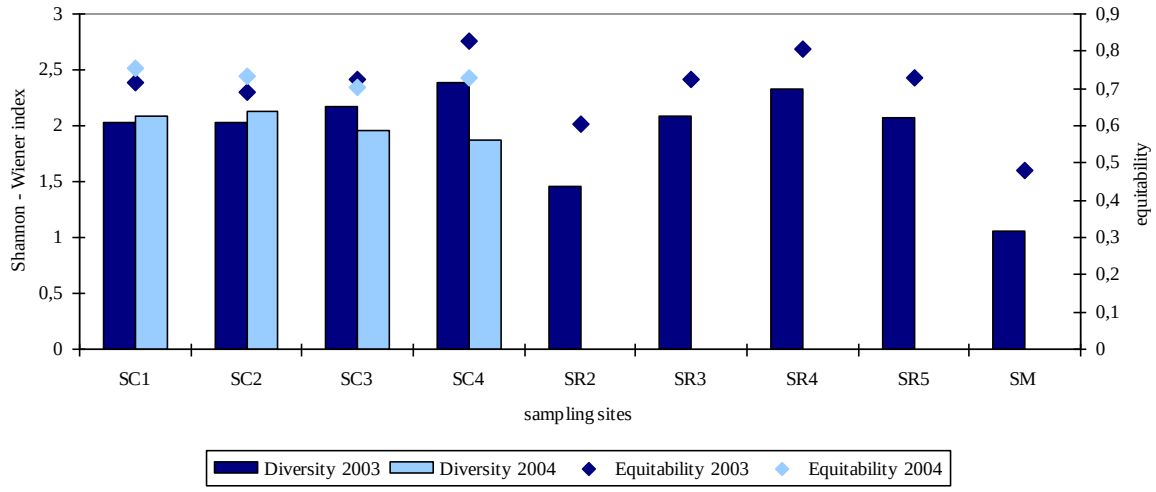

Figure 8. Values of Shannon – Wiener diversity indices and of equitability, calculated on basis of mayflies communities, at sampling sites on Someş Cald, during 2003-2004 and on Someş Rece and Someş Mic, in 2003

The B:H index expresses the ratio of the Baetidae:Heptageniidae families and allows to assess the characteristics of the watercourse (Deván and Mucina, 1986). The results of the Baetidae: Heptageniidae index (Tab. 10) are not consistent with most literature data, according to which this ratio should reduce with altitude and/or with the increase of the disturbance level (Bauernfreind and Moog, 2000), considering that the Baetidaes are indicators of strong water currents, and that the Heptagenidaes prefer more secluded areas in the riverbed (Deván and Mucina, 1986). Such a situation has been also reported by other authors (Ward and Berner, 1980), and the fact that within the Haptageniidae family in this

situation dominated the rheobiont genera *Rhithrogena* and *Epeorus*, explains the result we reached.

Table 10. The ratio of densities of the Baetiae: Heptageniidae families' representatives at the sampling sites, in 2003

Sampling site	SC1	SC2	SC3	SC4	SR2	SR3	SR4	SR5	SM
Altitude	1159	1113	1029	550	1350	1271	1035	662	354
B:H	0,269	1,897	2,247	1,886	4,401	3,503	2,163	6,028	48,09

The Jaccard similarity analysis, based on the composition of the mayflies communities at the investigated stations, highlighted in particular, the differences between the mayflies communities at stations with a certain disturbance degree SM and SR2 (Fig. 9). Thus the SM station (Someş Mic – upstream Cluj-Napoca) presents a community quite different from all other stations investigated. Here, as I said, the anthropogenic influence is strong, the rheobiont species have disappeared altogether, and of those species identified at upstream stations only *Baetis rhodani* and *Habroleptoides confusa* species and *Ecyonurus* genus are also found here. The station on Someş Rece where mayflies were found (SR2), is highly influenced by the slightly acid pH, so diversity is reduced, at a level comparable to that reported at SM.

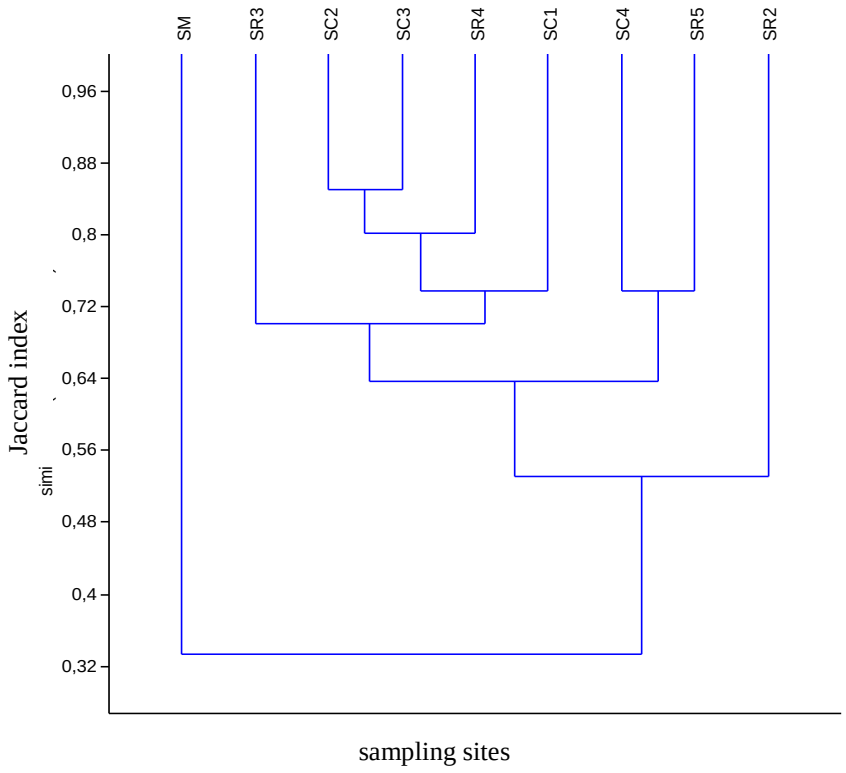

Figure 9. The similarity between sampling sites, based on the mayflies communities, calculated using the Jaccard index

The influence of abiotic factors on the mayflies communities

To view the trend of distribution of the stations based on environmental parameters the PCA (principal components analysis) was used. For this analyses, data was introduced on the location of the sampling sites, their characteristics (altitude, slope of the river (‰), land use upstream of sampling sites) and the annual average values of physical-chemical parameters determined at the sampling sites in 2003 (electric conductivity, temperature, pH, O_2). The first two axes explain 78,05% of the variance. The parameters that influence the most the ordering of the stations are land use categories, altitude, river slope, temperature, conductivity and pH. The amount of dissolved oxygen influences the grouping of the stations at a low level of statistical significance (Fig. 10). The first axis F1 (43,07%) is positively correlated with altitude, water temperature and the categories of urban and agricultural land use. The F2 axis (34,98%) is positively correlated with slope, pH, electric conductivity, dissolved oxygen and the land use categories: natural grasslands and forests. Three groups of sampling sites are noticed (Fig. 10): the first consists of SR2, SR3 and SR4, characterized by low values of pH and conductivity, located at high altitudes (above 1000 m). As land use categories, only natural grasslands and forests are found. The second group includes sampling sites SC4, SR5 and SM characterized by low altitudes (below 650 m) and high water temperatures (the annual average is above 10 ^{0}C). These are also influenced by the categories of urban and agricultural land use. The third group, of sampling sites SC1, SC2 and SC3 is influenced by high levels of conductivity and pH, but also by altitude, river slope and land use, which is covered by forest in over 90%.

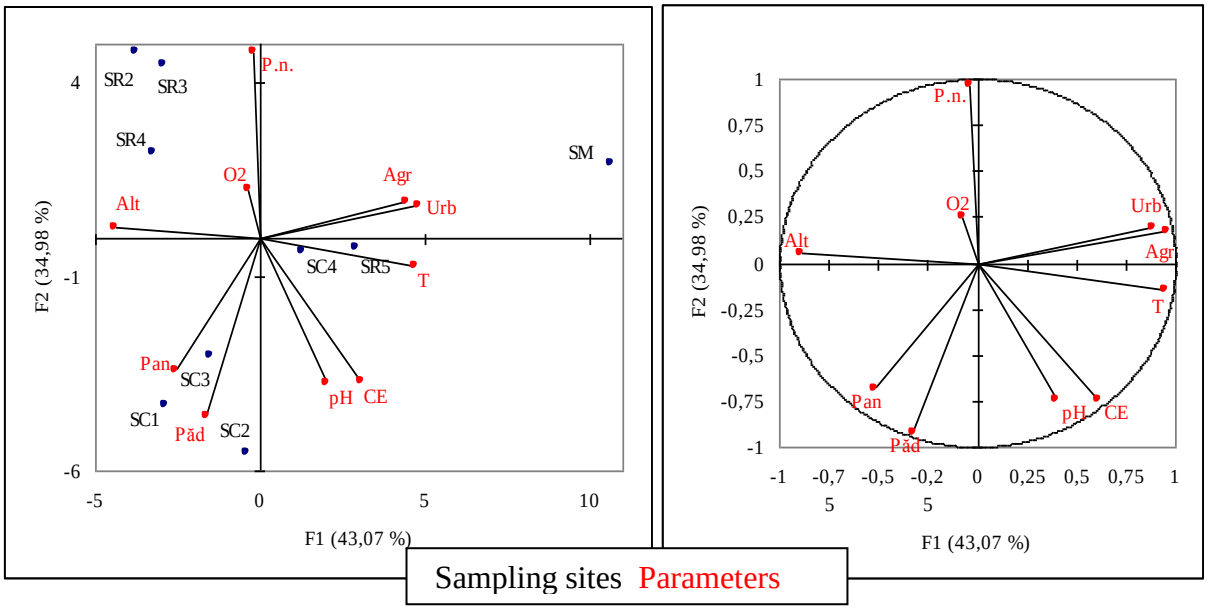

Figure 10. PCA ordination diagram .(Principal Components Analysis) with physical-chemical parameters of water at sampling sites in Someş Mic river basin (O2- dissolved oxygen (mg/L), CE – electrical conductivity (µS/cm), T – water temperature (°C), pH – water pH values) and their characteristics (P.n –natural grasslands, Păd - forests; Urb - urban; Agr - agricultural; Alt - altitude, Pan – river slope) (see section 5.4. for the remaining abbreviations)

The relationship between the mayflies communities and the environmental parameters was described by CCA (canonical correspondence analysis) (Fig. 11). Juveniles of *Baetis*, *Caenis*, *Ephemerella* and *Rhithrogena* genera were excluded from the analysis, and of the Heptageniidaes, *Ecdyonurus* was determined only at genus level. The parameters considered were altitude, amount of dissolved oxygen (mg/L), water conductivity (µS/cm), water temperature (°C) and pH values. The first two axes, F1 and F2, explain 71,23% of the variance. The first axes F1 (44,69%) is negatively correlated with electric conductivity. F2 axis (26,54%) is positively correlated with altitude, temperature and amount of dissolved oxygen and negatively with water pH. Three groups of species are noted: the first one consisting of the rheophilic species *Serratella ignita, Potamanthus luteus, Caenis macrura* and *Baetis fuscatus*, found at the station on Someş Mic river (upstream Cluj-Napoca), station characterized by elevated temperature and conductivity values and low altitudes. The second group consists of the rheobiont species *Rhithrogena beskidensis*, and rheophilic species *Torleya major, Caenis beskidensis, Baetis lutheri, Baetis scambus* and *Ephemera danica*, determined especially in sampling sites SC4 and SR5. At these stations, we can say that the transition is made from the rheobiont species dominant at upstream stations to the rheophilic species encountered at the downstream station. The third group includes all the sampling sites characterized by altitudes above 1000 m and lower water temperatures. In this group

generally find montane and submontane species, mostly rheobiont, that prefer lower water temperatures and strong currents (most species of Heptageniidae and some Baetidae), but also species without strict environmental facets such as for example *Baetis rhodani*, *Baetis vernus* (Găldean, 1992 a). This group also includes the species *Ameletus inopinatus*, *Habrolptoides confusa*, *Habrophlebia luata*, *Centroptilum luteolum* that prefer areas with a weaker current in the riverbanks, but yet with an alpine character (Deván and Mucina, 1986; Zahrádková et al., 2009).

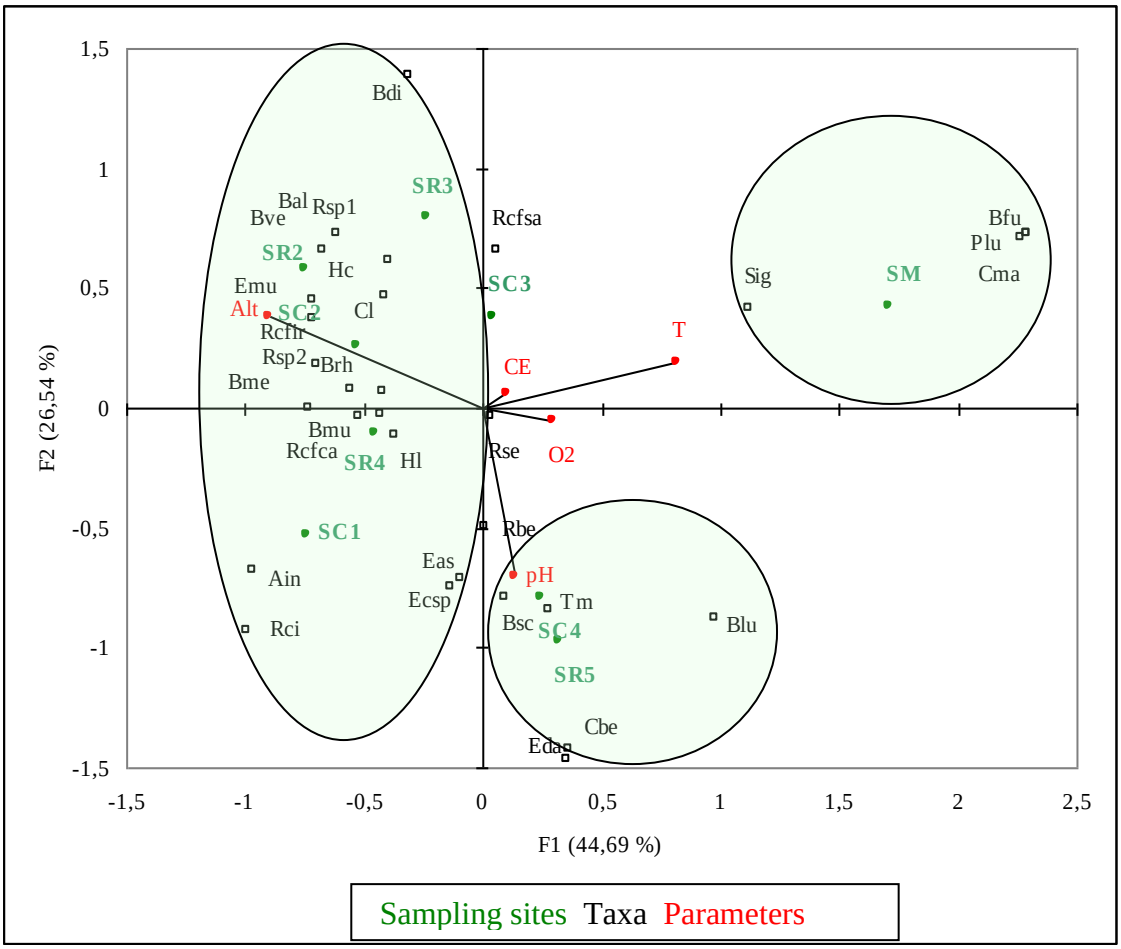

Figure 11. Canonical correspondence analysis (CCA) between Ephemeroptera taxa and the quantitative parameters of water at sampling sites in Someș Mic upper river basin (O2- dissolved oxygen (mg/L), CE – electrical conductivity (µS/cm), T – water temperature (°C), pH – water pH, Alt - altitude (see section 5.4. for the remaining abbreviations)

9. The drift of the mayflies communities

The simplest definition of the drift was given by Waters (1972): "downstream transport of aquatic organisms, due to water current". Most studies on drift focused on aquatic macroinvertebrates, but drift is important for other aquatic organisms in the meiofauna for some algae, fish larvae (fries), and frog tadpoles (Hieber et al., 2003). The literature presents three main types of drift: constant, catastrophic and behavioral (Waters, 1972).

Benthic invertebrate drift has a key role in the spatial distribution of benthic organisms (Allan, 1995) and is considered one of the most important dispersal mechanisms for them (Mackay, 1992, Allan, 1995).

Analyzing the total number of organisms found in the drift samples (Fig. 12), it is noted that the highest number was in the 21:00 sample, taken after sunset, which occurred at 20 and 48 minutes. The fact that the maximum number of organisms found in the drift is recorded after sunset has been described in many papers (Elliott, 1967, Allan, 1995). The lowest number of organisms was recorded at 9 am (below 1000 ind / sample).

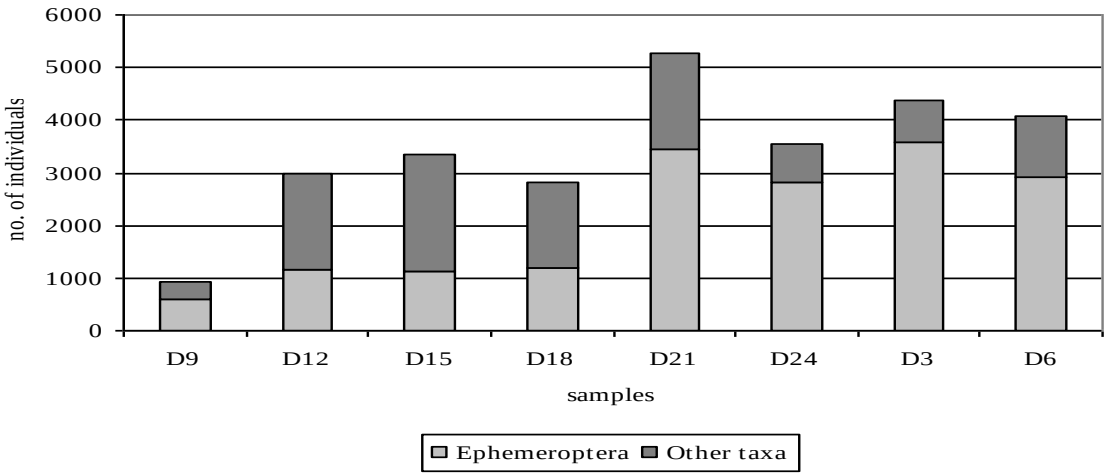

Figure 12. The number of individuals in the drift samples

Mayflies, together with chironomids represented the dominant groups as percentage abundance (Fig. 13), not only in the drift samples, but also in the benthos ones. Mayflies dominated in all samples, except those collected at noon and at 3 p.m., when chironomids exceeded their number, reaching a maximum of 48% at 15:00. Chironomids were well represented during the night as well, but their abundances did not exceed 19%. In the night samples, the mayflies recorded abundances above 70%, with a maximum of 83% at 3 a.m. The abundances of stoneflies (Plecoptera) in the drift samples, recorded a maximum percentage of 15.5% at 6 p.m., while in the benthos samples they recorded 18%. The category

"other groups" included the following: Oligochaeta, Turbellaria, Nematoda, Hydrachnidia, Amphipoda, Copepoda, Ostracoda, Coleoptera, other dipterans and Trichoptera. Their percentage abundance (as a whole) ranged between 11% at 9 a.m. and 4% at 3 a.m. In the benthos samples, the category "other taxa" included only Oligochaeta, Hydrachnidia, other dipterans and Trichoptera, and their percentage abundance did not exceed 8%.

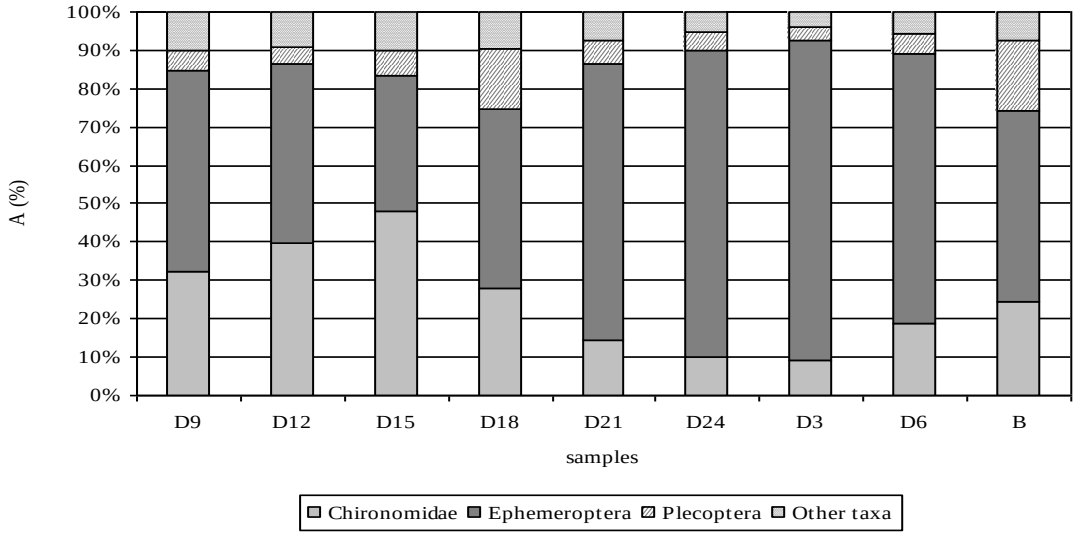

Figure 13. The percentage abundance (A (%)) of a main invertebrate groups in the drift (D9-D6) and benthos (B) samples

In the benthos samples (Fig. 14), mayflies have the highest density of 1363 ind/sqm, followed by chironomide (667 ind/sqm). Oligochaeta have the lowest density, 4 ind/sqm. Groups: Turbellarita, Nematoda, Amphipoda, Copepoda, Ostracoda and Coleoptera were not present in the benthos samples, although in the drift they were encountered, but with very low effective.

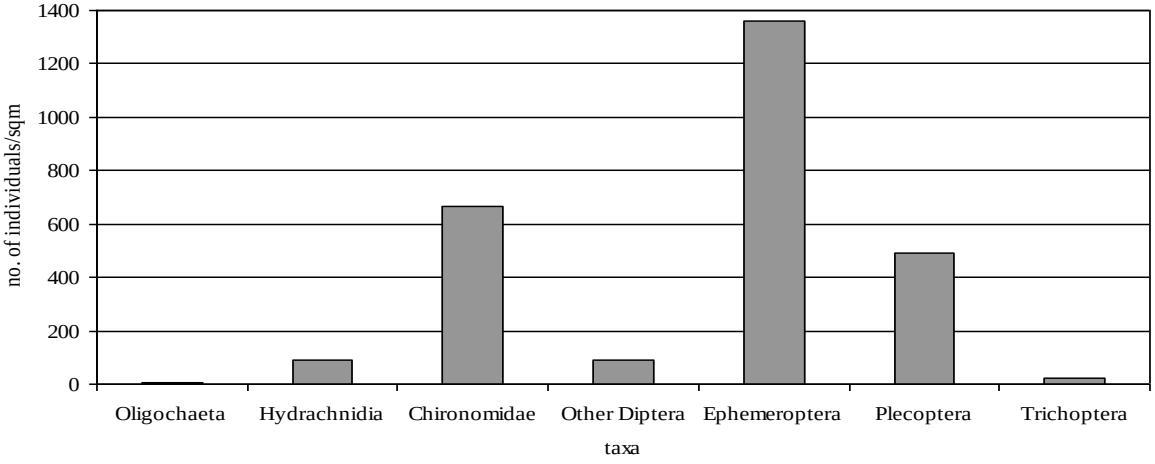

Figure 14. The density of invertebrates groups in the benthos samples (no. of individuals/sqm)

Dinamics, frecquency, percentage abundance and specific composition of mayfly communities on the drift samples

13 Ephemeroptera taxa were identified in the drift samples (Fig. 15), with the following frequencies: *Baetis melanonyx*, *Baetis* sp. and *Rhithrogena* sp. young instars reached a frequency of 100%; *Baetis rhodani, B. vernus, Serratella ignita, Ecdyonurus* sp., *Rhithrogena circumtatrica, R.* cf. *iridina, Habroleptoides confusa* and subimagoes exceeded 60%; *Baetis muticus, Epeorus assimilis* and *Rhithrogena cf carpatoalpina* recorded frequency values that did not exceed 40%.

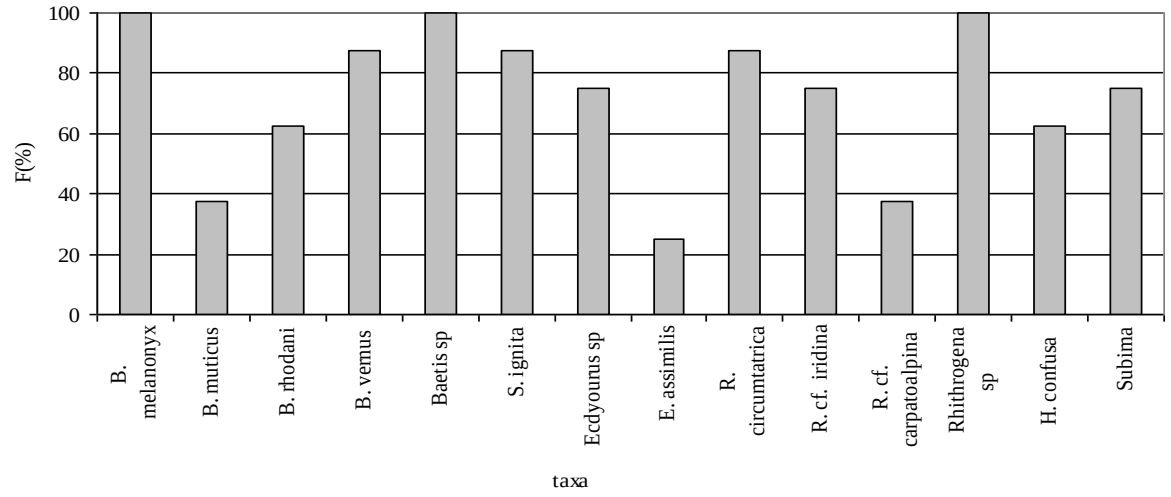

Figure 15. The frequency (F(%)) of mayflies taxa in the drift samples

Baetis muticus, *Baetis rhodani*, *Epeorus assimilis*, *Rhithrogena* cf. *carpatoalpina* and *Habroleptoides confusa* were present only in the drift samples, with no representatives in the benthos samples (Tab. 11.). They recorded very low percentage abundances compared to other mayfly species, not exceeding 0.3%. Subimagoes were also present only in the drift samples (with percentages not exceeding 0.4%) as transformation from larvae to subimago takes place on the water surface (Studemann et al., 1992). On the other hand, *Baetis melanonyx* exceeded 20%, not only in the benthos samples but also in the drift ones.

Table 11. The percentage abundance (%) of mayfly taxa in the drift and benthos samples (D - drift samples; B - benthos samples)

Taxa	*B. melanonyx*	*B. muticus*	*B. rhodani*	*B. vernus*	*Baetis* sp.	*S. ignita*	*Ecdyonurus*. sp.	*E. assimilis*	*R. circumtatrica*	*R.* cf. *iridina*	*R.* cf. *carpatoalpina*	*Rhithrogena* sp	*H. confusa*	Subimago
D	24,46	0,02	0,31	0,33	71,46	0,46	0,17	0,02	0,30	1,08	0,02	0,96	0,04	0,37
B	20,62	0,00	0,00	0,29	63,39	1,61	0,81	0,00	4,62	1,91	0,00	6,75	0,00	0,00

The mayfly species were measured and distributed in size classes, ranged between 0,5 and 12 mm (Tab. 12). The maximum length was recorded by a subimago. *Baetis* individuals smaller than 2 mm recorded the highest numbers not only in the drift samples, but also in the benthos ones. The high number of young individuals no larger than 2 mm entering the drift (12114 out of a total of 16842 individuals) agrees with the hypothesis that the vast majority of drift organisms are in their first stages of development (Waters, 1972).

Table 12. Mayfly taxa and their number of individuals in drift samples, together with the densities from the benthos samples, considering the twelve size classes

Taxa	Drift	Size classes												
	Benthos	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Baetis melanonyx	no. ind.	0	0	1301	367	833	1053	461	101	3	0	0	0	4119
	ind./sqm	0	0	115	19	41	41	44	22	0	0	0	0	281
Baetis muticus	no. ind.	0	0	0	0	3	0	0	0	0	0	0	0	3
	ind./sqm	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis rhodani	no. ind.	0	0	17	1	4	7	6	13	5	0	0	0	53
	ind./sqm	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis. vernus	no. ind.	0	0	1	6	22	17	9	0	0	0	0	0	55
	ind./sqm	0	0	0	0	0	0	4	0	0	0	0	0	4
Baetis sp.	no. ind.	4858	7115	63	0	0	0	0	0	0	0	0	0	12036
	ind./sqm	481	378	0	0	0	0	0	0	0	0	0	0	864
Serratella ignita	no. ind.	22	47	7	1	0	0	0	0	0	0	0	0	77
	ind./sqm	4	11	7	0	0	0	0	0	0	0	0	0	22
Ecdyonurus sp.	no. ind.	3	9	2	1	3	3	3	1	3	0	0	0	28
	ind./sqm	0	0	7	0	0	4	0	0	0	0	0	0	11
Epeorus assimilis	no. ind.	0	0	2	0	0	1	0	0	1	0	0	0	4
	ind./sqm	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhithrogena circumtatrica	no. ind.	0	0	40	10	0	0	1	0	0	0	0	0	51
	ind./sqm	0	0	33	26	4	0	0	0	0	0	0	0	63
Rhithrogena cf. *iridina*	no. ind.	0	0	1	2	3	24	73	56	19	4	0	0	182
	ind./sqm	0	0	0	0	0	4	11	11	0	0	0	0	26
Rhithrogena cf. *carpatoalpina*	no. ind.	0	0	0	0	0	0	0	1	3	0	0	0	4
	ind./sqm	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhithrogena sp.	no. ind.	17	43	98	2	0	0	0	0	0	0	1	0	161
	ind./sqm	33	11	48	0	0	0	0	0	0	0	0	0	92
Habroleptoides confusa	no. ind.	0	0	0	4	2	1	0	0	0	0	0	0	7
	ind./sqm	0	0	0	0	0	0	0	0	0	0	0	0	0
Subimago	no. ind.	0	0	0	0	0	6	34	13	4	4	0	1	62
	ind./mp	0	0	0	0	0	0	0	0	0	0	0	0	0

In the samples collected during the day, between 9 a.m. and 6 p.m., the number of mayfly individuals smaller than 2 mm exceeded 80%. Individuals ranging from 2 to 5 mm recorded 11-14%, while individuals larger than 5 mm recorded less than 6%. During the night, a completely different situation was recorded: the percentage of small individuals (under 2 mm) ranged between 78% at 9 p.m. and 50% at midnight. The percentage abundance

of individuals ranging from 2 to 5 mm varied between 18% at 9 p.m. and 22% at midnight, while larger individuals (>5 mm) recorded 4% at 9 p.m., 27% at midnight and 20% at 3 a.m. Thus, large individuals recorded percentages 3 times greater in some samples collected during the night compared with those taken during daytime (Fig. 16). In the benthos samples 67.5% of mayflies are smaller than 2 mm, 22% of them have body length ranging from 2 to 5 mm and 10 % are larger than 5 mm. (Fig. 16).

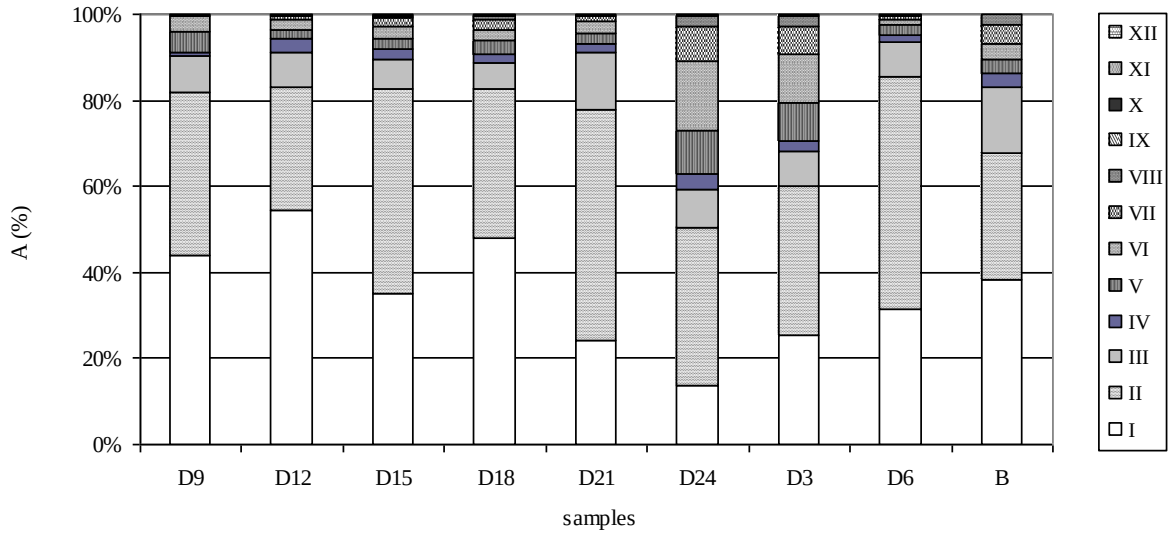

Figure 16. The percentage abundance (A%) of mayfly individuals of different sizes in drift and benthos samples

The relationship between mayfly species present in the drift samples and environmental factors - multifactorial approach

The Principal Component Analysis (PCA) was used to see if the frequency of appearance of mayflies was influenced or not by the time of the sampling. All identified taxa were considered for this analysis, together with their number and the hour of sampling.

The first two axes, F1 and F2, explained 70.89% of the total variance. All samples correlated with the first axis F1, except for the sample collected at 9 p.m. (D21). All taxa were distributed on F1 (54.31%), except for *Serattella ignita* and *Rhithrogena cf carpatoalpina, which are* distributed on F2 (16.58%). Only 4 individuals belonging to *Rhithrogena cf carpatoalpina* were identified in the drift samples, 2 sampled during the day and 2 at night, *Serratella ignita* recorded 77 individuals, 53 captured at night and only 24 during the day. This species' distribution was not well explained by the PCA ordination, probably because only juveniles were found, not exceeding 4 mm. Taxa appearing in the night samples were aggregated in the right side of the graph. Subimagoes, in the left side, are known to enter the

drift during the day (Brittain, 1980). The PCA ordination proved that light represented a very important factor influencing the mayfly drift, all taxa recording a strong tendency towards the night drift behavior, except for the subimagoes, that preferred to enter the drift during the day (Fig. 17).

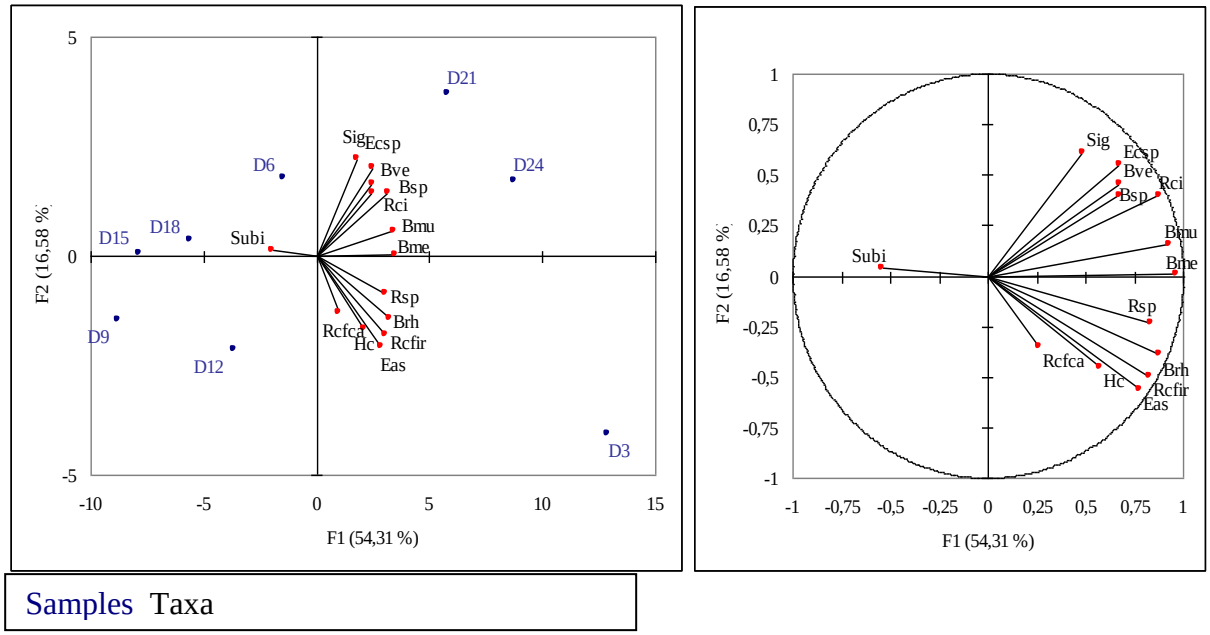

Figure 17. PCA ordination diagram (Principal Component Analysis) with the mayfly taxa and the capture times in the drift samples (D9 - D6)

The relationship between the physical and chemical parameters, the sampling periods and the size of the mayfly species entering the drift was described by the Canonical Correspondence Analysis (CCA). Size classes for species represented by less than 10 individuals were not considered. The physical and chemical parameters included in CCA were water temperature and the quantity of dissolved oxygen. The first two axis of canonical correlation, F1 and F2, explained 100% the relationship between the species sizes and the environmental factors. The first axis (F1- 93,5%) is gradient of increasing temperature, and the second axis (F2-6,5%) is gradient of decreasing oxygen (Fig. 18).

Two clusters could be distinguished, above and below F1: the first one included the samples collected at night (D21, D24, D3, D6), and the second one the ones taken during the day (D9, D12, D15, D18). Only medium-sized individuals belonging to *Rhithrogena cicumtatrica* were distributed on F2, because they were more abundant in the samples characterized by lower quantities of dissolved oxygen. All other species were distributed on F1. In the first cluster (the samples collected at night), medium-size and large-size individuals were present, except for small mayflies belonging to *Rhithrogena circumtatrica* and *Baetis*

melanonyx. The last species had representatives in all samples, but it recorded high numbers at 9 p.m. *Rhithrogena circumtatrica* recorded an atypical drift behavior, probably due to their young stage of development (78% from the larvae did not exceed 3 mm). In the second cluster (the samples collected during daytime), only small individual belonging to *Serratella ignita* and *Ecdyonurus* sp. were present, together with medium-size representatives of *Rhithrogena circumtatrica*.

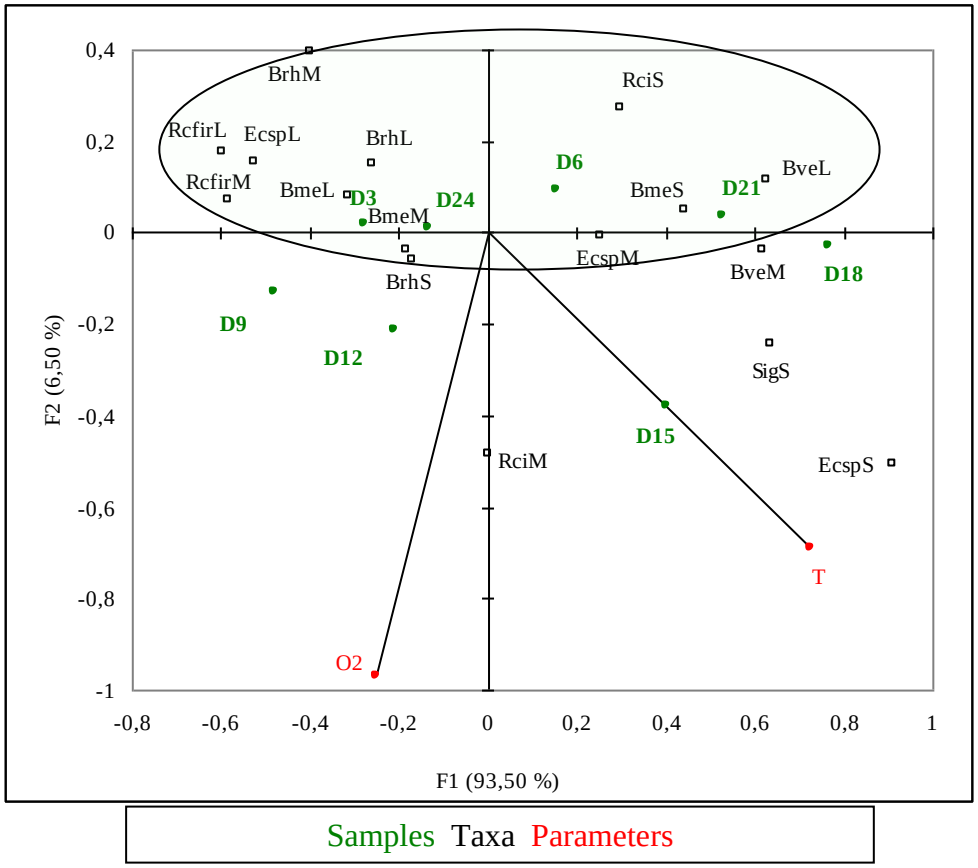

Figure 18. CCA ordination diagram (Canonical Correspondence Analysis) for the mayfly individuals of different sizes and the environmental factors at the sampling sites (T-water temperature; O_2-dissolved oxygen) S – small, with a length (L<3 mm); M – medium (L= 3-6 mm); L – large (L>6 mm))

Conclusions of the Thesis

In order to realize the ecological study of the mayflies communities 10 sampling sites were established for the sampling of the benthic macroinvertebrates, but mayfly's larvae were found only at 9 stations. A number of 76784 individuals from the Ephemeroptera order were analyzed, present in 244 samples. Of these on Someş Cald there were 44500 individuals (33405 in 2003, and 11095 in 2004), and on Someş Rece and Someş Mic 32287 individuals were analyzed, collected in 2003.

The mayflies achieved a frequency of 100% at all sampling points, except SR1 station (Someş Rece – springs) where there were not encountered at all, because of the acid pH of the water.

The abundance of this group in the aquatic communities at the sampling sites ranged from 2% to 64%.

From the comparative analysis of densities calculated for 2003 (when samples were taken from both rivers) the highest density of the mayflies was recorded at SC2 station (Someş Cald – Bătrâna tributary), followed by station SR5 (Someş Rece, downstream Măguri Răcătău settlement).

The analysis of the annual average densities achieved in the two years of sampling on Someş Cald river showed that they were higher at all sampling sites in 2003 compared with 2004.

In Someş Mic upper river basin, at the sampling sites included in this study, a number of 30 taxa were identified, systematically classified in 8 families and 14 genera. There were not identifications made for species of the *Ecdyonurus* genus and two species of the *Rhithrogena* genus could not be determined.

Of the 27 species identified, 7 are newly reported in the area, and of these *Baetis digitatus* and *Rhithrogena circumtatrica* species were reported for the first time in Romania.

At the station on Someş Mic river, upstream Cluj-Napoca town, the number of taxa was lower compared to all investigated stations, which is most likely due to the morphological changes and the settlements located upstream.

Baetis rhodani, *Habroleptoides confusa* species and representatives of *Ecdyonurus* genus have the widest distribution, being encountered at all sampling sites. The species *Baetis digitatus, Baetis fuscatus*, *Centroptilum luteolum*, *Potamanthus luteus*, *Rhithrogena* cf. *savoiensis* and *Rhithrogena circumtatrica* were only found at one station, of the 9 included in the sampling program.

The highest total frequency was recorded for the juveniles of the Baetis genus, flowed by those of *Rhithrogena* genus. Of the taxa determined at species level, *Baetis rhodani* and *Habroleptoides confusa* have frequencies higher than 70%. High frequencies have the *Baetis alpinus, Baetis muticus*, *Serratella ignita* and *Rhithrogena* cf. *iridina* species, too. *Baetis digitatus*, *Centroptilum luteolum*, *Potamanthus luteus* and *Rhithrogena* cf. *savoiensis* species had the lowest frequencies.

Regarding the dynamic of the monthly densities at all stations on Someş Cald and at SR3, SR4 and SM, their variation is similar, with high values during summer and early fall

and minimums in April-May and the end of autumn (October-November). The low densities of these months coincide with the periods of emergence, in spring and autumn most of the larvae turn into adults.

At SR2 and SR5 stations, the mayflies have low density during spring and summer, and in November they reach maximum density (over 5000 ind/mp). The accentuated increase of density in the autumn months can be explained the increase of population with the larvae hatched from eggs laid in summer.

Most of the mayflies species had a grouped distribution, but with a low degree of clustering.

The station of Someş Mic river had the lowest diversity, according to the Shannon - Wiener index, which underlines once more the mayflies' sensibility to the quality of the environmental parameters.

According to the Shannon – Wiener index, the lowest diversity, for the Someş Cald sampling sites, compared to those on Someş Rece, is present at the sampling station located upstream Blajoaia, due to the mayflies' sensibility to pH values and to the elevated altitude of this station.

The results of the Baetidae : Heptageniidae index are not consistent with most literature data, but the conclusions reached are explained by the fact that at the stations where samples were taken, *Rhithrogena* and *Epeorus* genera were dominant.

The Jaccard similarity analysis, based on the mayflies communities at the investigated stations highlighted, in particular, the differences between the mayflies communities at stations with a certain degree of disturbance SM and SR 2, but also emphasized the similarities based on the specific composition at different sampling sites.

The analysis of the distribution of mayfly species based on environmental parameters, performed using the canonical correspondence, at the 9 stations where they were found, revealed that the most important parameters that determine the distribution of species are: pH, water temperature and altitude.

After analyzing the drift phenomenon in the mayflies communities on Someş Cald river, downstream the gorges, we can state that the mayflies drift, in general, is more intense during the night compared to day.

Regarding the dynamics of the number of mayflies captured in the drift samples, their number gradually increases starting with 9:00 a.m. and registers two maximums, a main one, observed in the second part of the night, and a secondary one, which takes place after sunset.

The *Baetis melanonyx, Baetis vernus, Baetis rhodani, Rhithrogena* cf. *iridina* and *Ecdyonurus* sp. taxa exhibit a behavioral drift, both the number and the size of the individuals captured during the night are higher compared to the samples collected during the day.

The young larvae of *Baetis* and *Rhithrogena* genera are present in all drift samples, but their number is much higher during the night compared to day.

In the case of *Serratella ignita* and *Rhithrogena circumtatrica* species, despite the tendency to increase their number during the night, there was no tendency to increase the size of individuals present, however the size of the individuals collected in the benthic samples are also reduced, so we can state that individuals in the drift correspond to those in the benthos in terms of stage of development.

Based on PCA results, we can conclude that light is a very important parameter that can influence the drift behavior of the mayflies, all present taxa having a very strong tendency toward nocturnal drift behavior, except those in subimago stage, which exhibit a diurnal drift.

The CCA showed that during the night , mainly medium-sized and large individuals are present, with two exceptions: *Rhithrogena circumtatrica* and *Baetis melanonyx*, of small size. Although the latter are present in all samples collected, they are more abundant in the sample collected at 9:00 p.m. during the day small individuals are found, belonging to *Serratella ignita* and *Ecdyonurus* sp. taxa and medium-sized individuals of the *Rhithrogena circumtatrica* species.

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