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ECOLOGICAL STUDY ON AQUATIC MACROINVERTEBRATE COMMUNITIES FROM THE SOMEŞUL RECE RIVER

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***Key words**: water mites, oligochaetes, mayflies, stoneflies, the Someşul Rece River, density, diversity*

INTRODUCTION

The present paper represents a study concerning the ecology of macroinvertebrate communities from the Someşul Rece river course, with special emphasis on the following groups: oligochaetes, mayflies, stoneflies and water mites.

Previous studies concerning the Someşul Rece flora and fauna at two sampling sites located downstream and upstream of Blăjoaia were carried out by a team coordinated by Sarkany-Kiss & Hamar (1999). This study included all the major groups analyzed in the present paper, except for water mites.

So far, general studies concerning the groundwater environment in the Someşul Rece catchment area were made by Cîmpean *et al*., 2003.The list of water mite species from the groundwater habitats was published by Konnarth-Ionescu, 1979, including data from Motaş and Szalay. Mayflies communities from Apuseni Mountains were studied by Găldean, 1994.

MATERIAL AND METHOD

The Someşul Rece River, measuring 45 km in length, springs from the Muntele Mare Mountains, near the Runcului peak (1609 m) (Gâştescu, 1990). Its catchment area, having a surface of 335 km^2, is located in the South-Western part of the Someş River catchment area. The Someşul Rece River drains, by means of its tributaries, the central area of the Gilău Mountains.

The sampling sites were chosen accordingly to the geographic, geologic and hydrologic characteristics of the river catchment area (fig. 1).

The first sampling site, downstream Măguri Răcătău was located at 600 m altitude. The riverbed was about 6 m wide and the maximum water depth was 0.4 m. The vegetation from the right river bank consisted of deciduous forests and herbs, while on the left river bank only herbs were present. The access road was also located on the left river bank.

At the second site, upstream of Măguri Răcătău (1003 m altitude) the riverbed was about 15m wide, and the maximum water depth did not exceed 0.7 m. Coniferous and deciduous forests represented the vegetation from the right river bank, while herbs were found on the left river bank. The access road was located nearby, about 20 m away from the left side of the river.

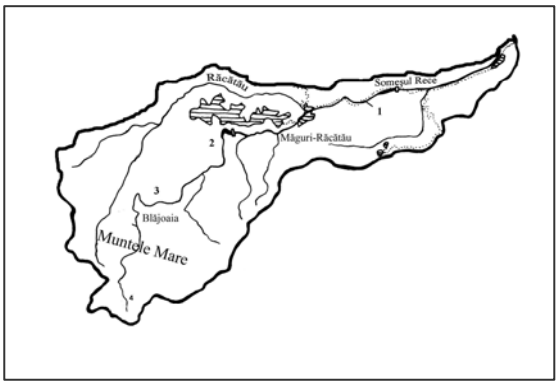

Fig. 1 The Someşul Rece catchment area
(1: downstream Măguri Răcătău, 2: upstream Măguri Răcătău, 3: downstream Blăjoaia, 4: the river source)

The sampling site called upstream Blăjoaia was located at 1245 m altitude. The riverbed width was about 10 – 12 m and the maximum water depth was around 0.60 m. The vegetation on both river banks consisted of meadows with coniferous trees. Aquatic vegetation, mostly periphyton, covered up to 15% from the riverbed.

The last sampling site was located at 1550 m altitude, on the river source, where its waters come to the surface, forming a water course surrounded by a small wetland. The average water depth was 0.45 m. The riverbed was about 0.5 m wide and had a gravel and sand substratum, partly covered by aquatic vegetation.

The last three sampling sites (the river source, downstream Blăjoaia and upstream Măguri Răcătau) were situated on the actual river course, while the other one (downstream Măguri Răcătau) was located after the dam reservoir supplied with water from the Arieş catchment area.

Quantitative samples were collected from all sampling sites described above on May the 29th, August 31st, and October 27th 2003. Three benthic samples were taken across the river bed at each site during each sampling period using a Surber type sampler (with a surface area of 1060 cm^2). Samples were washed through a fine mesh net (250µ). The samples were preserved in the field in 4% formaldehyde. Several physical and chemical parameters were measured at each site during the

collection of biological samples. The oxygen and temperature were measured with a portable YSI Model 52 oxygen meter - one that allows adjustment of oxygen saturation to altitude. The hydrogen ion concentration (as pH) was measured with a CONSORT Model P 902 pH meter; conductivity and salinity was measured with a CONSORT Model K 119 conductivity meter. The medium depth and the river bed width were also measured.

In the laboratory all organisms were sorted and identified mostly to the order level. Oligochaeta determinations were made to the species level. We are aware of some recent molecular and morphological studies conducted on family Naididae which place this group as a subfamily (Naidinae) within the larger family Tubificidae (Erséus *et al*., 2002, Erséus & Gustavsson, 2002). However, our identification were done by using Sperberg (1950), Brinkhurst (1986) and Timm (1999). Mayflies and stoneflies were identified to the genus level, according to the following key books: Studemann *et al*., 1986 for mayflies and Zwick, 2004 for stoneflies. Water mites were identified to the species level, using methods described by Di Sabatino *et al*., 2000.

RESULTS AND DISCUSSIONS

The following water physical and chemical parameters were recorded in the field: temperature, conductivity, salinity, dissolved oxygen, pH, together with the riverbed width, the sampling depth and the altitude of the sampling sites. Table 1 depicts the average values of the parameters mentioned above.

Temperature recorded normal values for a mountainous river course. Large conductivity and salinity variations were recorded at the first two sampling sites (upstream Măguri Răcătau and downstream Măguri Răcătau), located after the river course received water from the Aries catchment area. The dissolved oxygen ranged between 66.5% and 93.1% on the average, showing a well oxygenated water course. The pH values changed on going downstream, from a slightly acid value at the river source to a slightly alkaline one downstream Măguri Răcătau.

Thirteen major taxa were identified in the benthic samples. The relative percentage abundance of these groups is depicted in figures 2, 3 and 4. Other organisms were found beside the target groups, including the following: Coleoptera, Cladocera, Copepoda, Ostracoda, Amphipoda, Collembola and Diptera (Chironomidae, Blepharoceridae, Ceratopogonidae, Simuliidae and Limoniidae).

At the river source (site 4) the stoneflies recorded the highest abundance values in August and October. In May, beetles became most abundant, stoneflies recording high abundance values too. The groups with the lowest abundances in all three seasons were the mayflies, the cladocerans, the copepods and the amphipods.

Downstream Blăjoaia, the highest abundance values were reached by midges, caddis flies and oligochaetes. Upstream Măguri Răcătau, the mayflies recorded the highest abundances in all three seasons. Downstream Măguri Răcătau, oligochaetes had high abundances in May, while midges, caddis flies and mayflies in August and October. The lowest abundance values were recorded at that sampling site by nematodes, amphipods, cladocerans, copepods and ostracods.

Table 1. Average values of physical and chemical parameters measured on the Someşul Rece River in the year 2003

Parameters \ Sampling sites		The river source	Downstream Blăjoaia	Upstream Măguri Răcătau	Downstream Măguri Răcătau
Altitude (m)		1550	1245	1003	600
Riverbed width (m)		0.5-1	10-12	15	6
The average water depth (m)		0.40	0.25	0.30	0.20
Water temperature (°C)		10.7	12.8	12.0	11.30
Conductivity (µS/cm)		8.6	14.8	21.7	85.0
Salinity (mg/l)		4.6	7.9	11.5	45.1
Dissolved oxygen	(mg/l)	8.4	7.0	10.0	8.2
	(%)	76.1	66.5	93.1	73.3
pH		6.9	7.2	7.67	9.00

A total of 21 oligochaeta species were identified at the four stations during the sampling period. These species belonged to 16 genera and 6 families (Table 2). The Naididae (considered by Erséus & Gustavsson 2002, and Erséus et al. 2002 to be subfamily Naidinae) represented by 3 genera and 8 species, appeared to be the most diverse. Family Enchytraeidae, as well as family Tubificidae, were represented by four species. Other families such as Lumbricidae and Haplotaxidae were represented by fewer species. Most of the oligochaeta species occurred at each sampling site (see table 2). In general, the number of families, species richness and numerical abundance decreased along a longitudinal gradient from headwaters towards middle and lower reaches of the river.

Oligochaeta density values were similar at the sampling sites 1, 3 and 4. Moreover, a decrease in density values was observed from spring to autumn. At site 2 (upstream Măguri Răcătau) oligochaeta community recorded lower density values (only half of those recorded at all other sampling sites), due to the increased water flow and to a permanently washed riverbed.

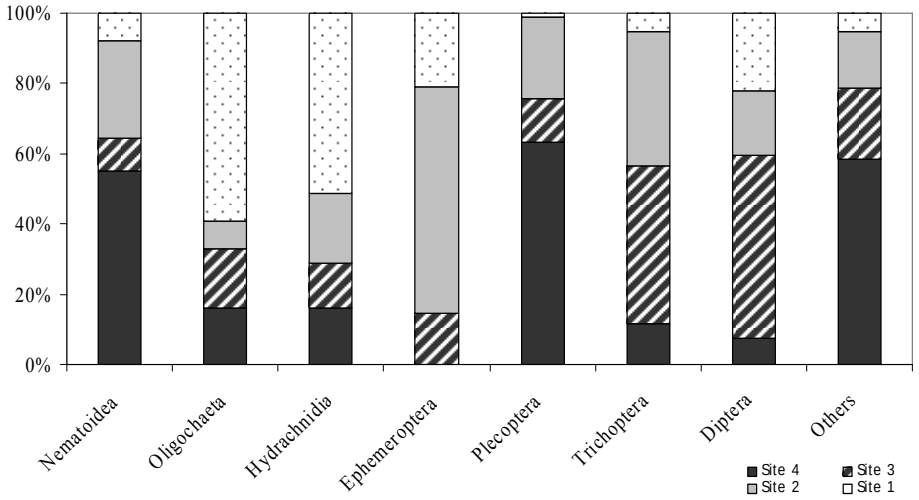

Fig. 2. Invertebrate community percentage abundance at the four sampling sites from the Someşul Rece River in May 2003

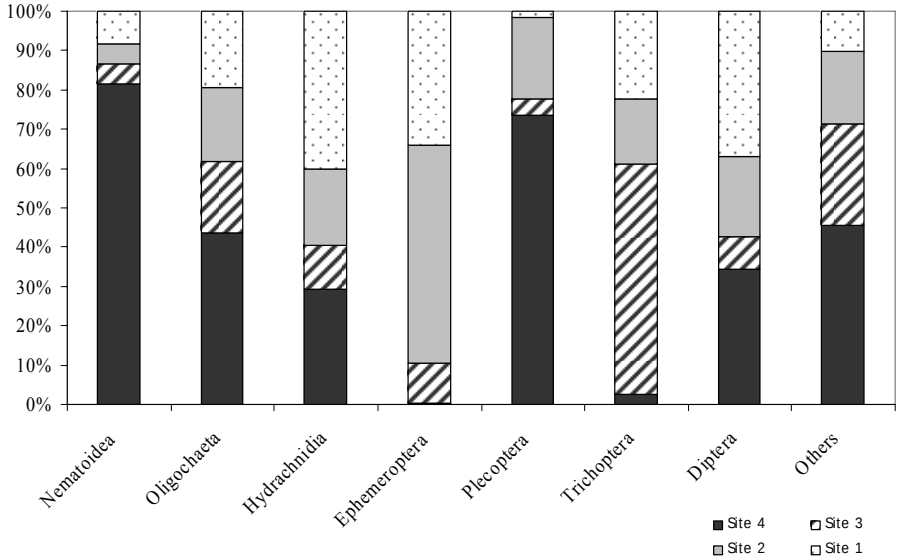

Fig. 3. Percentage abundance of invertebrate community at the sampling sites in August 2003

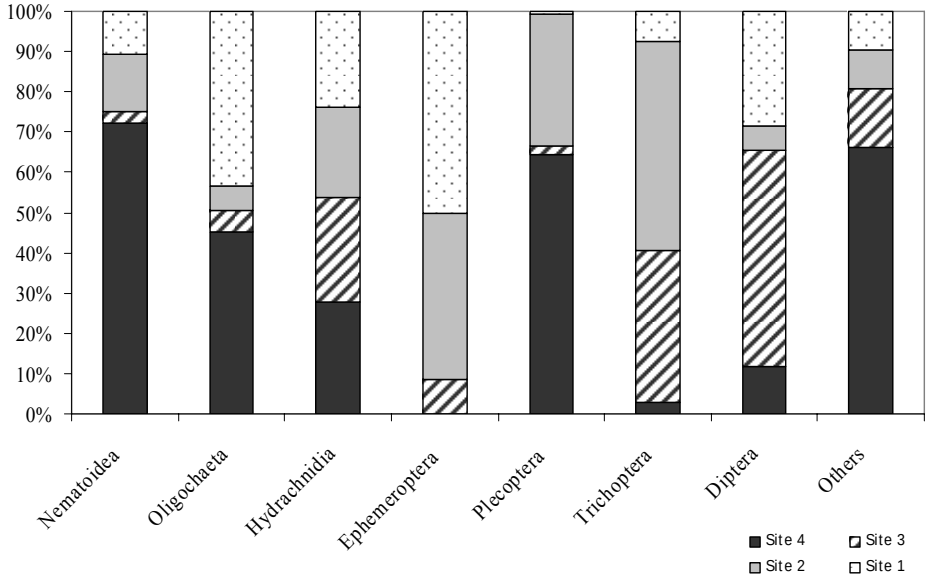

Fig. 4 Invertebrate community percentage abundance at the four sampling sites located on the Someşul Rece River in October 2003

As concerns the seasonal dynamics of oligochaeta species, at the first sampling site family Naididae was dominant. *Nais alpina, Nais bretscheri* and *Nais pardalis* recorded the highest densities. Species belonging to families Lumbriculidae and Enchytraeidae followed, but their density was much lower. At the second sampling site, the species belonging to family Lumbriculidae dominated in all seasons.

Table 2. Taxa list and their densities at the four sampling sites in the year 2003

	Taxa (ind./sqm.)	Site 4			Site 3			Site 2			Site 1		
		May	Aug.	Oct.	May	Aug.	Oct.	May	Aug.	Oct.	May	Aug.	Oct.
OLIGOCHAETA	*Nais alpina*	-	-	-	198	250	28	9	104	14	85	142	-
	Nais barbata	-	-	-	-	-	-	-	-	-	-	47	-
	Nais bretscheri	-	19	-	19	9	-	-	9	9	368	57	47
	Nais communis	19	-	85	9	19	-	-	-	-	9	19	9
	Nais elinguis	-	113	-	-	-	9	-	-	-	-	-	104
	Nais pardalis	-	-	-	38	19	47	-	19	-	33	137	9
	Pristina foreli	-	-	-	-	-	-	-	-	-	47	9	-
	Pristinella jenkinae	-	-	-	179	85	19	9	9	-	28	9	-
	Limnodrilus hoffmeisteri	-	189	-	-	-	-	-	-	-	-	-	-
	Rhyacodrilus coccineus	85	-	19	-	-	-	9	-	-	-	-	-
	Tubifex tubifex	-	132	-	-	-	47	-	-	-	-	-	-
	Spirosperma ferox	-	-	28	19	-	9	-	-	-	-	-	-
	Haplotaxis gordioides	-	9	-	57	-	-	-	-	-	-	-	-
	Lumbriculus variegatus	9	-	-	9	-	-	9	-	-	-	-	-
	Stylodrilus heringianus	245	-	217	38	19	19	108	104	9	-	-	19
	Trichodrilus sp.	-	-	-	-	-	-	47	-	-	-	-	-
	Eiseniella tetraedra	9	28	-	-	-	-	-	-	-	-	-	-
	Cernosvitoviella sp.	-	-	-	-	28	-	47	57	9	19	28	-
	Cognettia glandulosa	85	-	-	9	-	-	-	9	-	9	38	28
	Fridericia sp.	-	19	-	-	-	-	9	-	-	-	-	-
	Mesenchytraeus armatus	-	-	-	-	-	-	9	-	-	-	-	-
	Other enchytraeids	94	9	19	-	-	-	-	-	-	-	-	-
EPHEMEROPTERA	*Baetis* sp.	-	-	-	1472	481	1519	689	377	434	519	2500	3217
	Epeorus sp.	-	-	-	-	-	9	9	104	47	-	358	28
	Ecdyonurus sp.	-	-	-	47	113	9	38	-	-	47	179	189
	Rhithrogena sp.	-	9	-	264	57	1057	877	57	792	-	151	151
	Torleya sp.	-	-	-	-	-	-	-	9	-	75	94	377
	Ephemerella sp.	-	-	-	387	47	-	132	28	-	717	28	9
	Caenis sp.	-	-	-	-	-	-	-	19	-	-	9	9
	Hbrophlebia sp.	-	-	-	-	-	-	-	-	-	-	-	28
	Habroleptoides sp.	-	-	-	151	736	208	-	66	19	-	9	-
	Ephemera sp.	-	-	-	-	-	-	-	-	-	38	9	-
PLECOPTERA	*Brachyptera* sp.	-	-	-	-	170	19	-	-	-	-	-	-
	Protonemura sp.	57	-	-	-	132	-	113	-	-	-	-	-
	Amphinemura sp.	-	-	-	-	-	-	38	-	19	-	-	-
	Nemoura sp.	226	-	321	-	113	19	-	-	-	-	-	-
	Leuctra sp.	3745	2094	3575	-	443	57	142	38	104	57	-	-
	Dinocras sp.	-	-	-	-	47	-	-	-	-	-	-	-
	Perla sp.	-	-	-	-	-	-	9	94	-	104	75	75
	Isoperla sp.	-	-	-	-	-	-	-	9	38	-	-	-
	Perlodes sp.	-	-	-	-	-	-	-	-	-	9	-	-
	Arcynopteryx sp.	19	453	57	9	-	9	-	-	9	-	-	-
	Chloroperla sp.	-	-	-	-	-	-	28	-	255	66	-	104
HYDRACHNIDIA	*Panisus michaeli*	-	5	-	-	-	-	-	-	-	-	-	-
	Protzia invalvaris	-	-	-	6	-	-	-	3	-	19	9	13
	Sperchonopsis verrucosa	-	5	-	-	-	-	-	-	-	-	-	-
	Sperchon brevirostris	-	-	-	3	19	6	-	-	3	-	3	-
	Sperchon clupeifer	-	-	-	31	13	-	19	-	-	9	16	16
	Sperchon glandulosus	-	-	-	66	35	9	5	3	-	6	3	-
	Sperchon hispidus	-	-	-	-	3	3	-	-	-	-	-	-
	Sperchon mutilus	61	9	38	-	-	-	-	-	-	-	-	-
	Sperchon squamosus	9	5	-	-	-	-	-	-	-	-	-	-
	Lebertia sp.	71	14	9	50	16	25	9	-	-	41	6	16
	Monatractides madritensis	-	-	-	-	-	-	-	-	-	50	-	-
	Torrenticola thori	-	-	-	-	-	-	-	-	-	-	-	9
	Torrenticola amplexa	-	-	-	-	-	-	5	3	-	264	135	13
	Torrenticola barsica	-	-	-	-	-	-	14	3	-	110	79	3
	Torrenticola elliptica	-	-	-	6	6	-	-	-	-	-	-	-
	Hygrobates calliger	-	-	-	97	41	9	-	-	-	-	-	-
	Hygrobates foreli	-	-	-	6	13	19	-	3	-	-	-	3
	Atractides sp.	47	52	-	35	9	6	5	9	6	44	22	25
	Feltria minuta	-	-	-	-	-	-	-	3	-	3	-	-
	Feltria sp.	9	5	-	-	-	-	-	-	-	-	-	-

	Frontipodopsis ticulatifrons	-	-	-	-	-	-	19	-	-	19	-	-
	Woolastookia rotundifrons	-	-	-	-	-	-	-	-	-	6	-	-
	Aturus crinitus	-	-	-	-	-	-	-	-	3	35	47	25
	Aturus scaber	-	-	-	6	16	3	-	-	3	0	44	38
	Aturus sp.	5	-	-	-	-	-	-	-	-	-	-	-
	Kongsbergia sp.	-	-	-	-	-	-	5	3	-	3	-	-
	Stygomononia latipes	-	-	-	-	-	-	-	-	-	-	-	3

Table 3. The average Shannon-Wiener (H') values calculated for every major group at the four sampling sites on the Someşul Rece River

Taxa	Parameter	Site 1	Site 2	Site 3	Site 4
Oligochaeta	Number of species	11	12	13	14
	H'	1.952	1.831	1.833	2.156
Hydrachnidia	Number of species	18	14	11	8
	H'	2,072	2,388	2,037	1,554
Ephemeroptera	Number of genera	10	8	6	1
	H'	1.09	1.17	1.24	-
Plecoptera	Number of genera	4	7	6	4
	H'	1.03	1.61	1.08	0.43

The enchytreids density increased and the only tubificid species, *Rhyacodrilus coccineus*, was identified. At the third sampling site, five oligochaeta families were identified. Family Naididae represented the dominant one, including the following species: *Nais alpina*, *Nais pardalis* and *Pristina foreli.* Tubificid species *Tubifex tubifex* and *Spirosperma ferox,* together with the haplotaxid *Haplotaxis gordioides* recorded lower densities, not exceeding 50 ind/m^2. The maximum oligochaeta family number was found at the fourth sampling site. Family Tubificidae included four species, all recording significant densities compared to the other species present. Thus, family Tubificidae reached the highest density, followed by families Lumbriculidae and Enchytraeidae. The presence of *Tubifex tubifex* and *Limnodrilus hoffmeisteri* (both tubificid species), considered to be indicators for waters enriched with organic matter could be due to a substratum made of fine and coarse sand and mud in the river banks. Moreover, the decreased slope and water velocity could influence oligochaeta density values at that sampling site.

As concerns mayfly community, only one genus was present at the fourth sampling site: *Rhithrogena* sp. (table 2). *Baetis* sp. was identified at all sites, recording in all seasons increased density values. *Epeorus, Torleya* and *Caenis* genera were identified only at sampling sites 1 and 2, those located after the river received waters from the neighboring catchment area. *Habrophlebia* sp. and *Ephemera* sp. were identified only downstream Măguri Răcătau, due to the differences in physical and chemical parameters (see table 1).

Stonefly genus *Leuctra* was present at all sampling sites, recording the highest densities. These values decreased on going downstream. *Brachyptera* sp. and *Dinocras* sp. were identified only at the third site (downstream Blăjoaia). *Izoperla* sp. was found only at sampling site 2; *Perlodes* sp. at site 1, *Perla* sp. and *Chloroperla* sp. only at the first two sites, *Nemoura* and *Arcynopteryx* genera only at the last two sampling sites (table 2).

Twenty seven water mite species belonging to 15 genera were identified at the four sampling sites (see table 2). Eight species were identified at the fourth sampling site. Six species were identified only at that site due to its particular characteristics. *Panisus michaeli* Koenike, 1912, represented a typical species for that kind of habitat. Eleven species were identified downstream Blăjoaia. *Hygrobates calliger* and *Sperchon glandulosus* recorded the highest densities during spring 2003 (97 and 66 ind./sqm., respectively), but these values strongly decreased in summer and autumn. Fourteen water mite species were found upstream Măguri Răcătau. All these species recorded low densities in all three seasons, probably due to random flow variations caused by the water supply from the Aries catchment area. The highest number of species (18) was found downstream Măguri Răcătau. *Torrenticola* species dominated, because they preferred the sandy bottom (Di Sabatino *et al*., 2000).

As regards the oligochaeta species diversity, the highest value of Shannon-Wiener index was calculated for the third sampling site (see table 3). Even if the lowest number of species was found at site 1, due to their high equitability, the diversity index did not record the minimum value.

The mayfly community diversity at site 4 was impossible to calculate because only one individual belonging to genus *Rhithrogena* was identified (table 3). This could be caused by the pH values that did not exceed 7, most authors considering mayflies to be very sensitive to acidity.

The highest stonefly community diversity was recorded at the second site, where dissolved oxygen recorded maximum values (see table 1) and the pH recorded values no more than 8. At the river source, however, due to unfavorable ecological factors (low dissolved oxygen and low pH), their diversity recorded minimum values even if stoneflies reached the highest values of density compared to other macroinvertebrate groups.

The Shannon-Wiener index values for water mite species exceeded 2 at all sampling sites (table 3) except for site 4. Even if the species number was not maximum, the highest index value was recorded upstream Măguri Răcătau, due to the fact that

individuals were evenly distributed among species. Downstream Măguri Răcătau the water mite species number, together with the total number of sampled individuals, were maximum, but the Shannon-Wiener index did not record the highest value, probably due to lower equitability. Thus, *Torrenticola amplexa* reached very large densities compared to other species (table 2).

CONCLUSIONS

1. Thirteen benthic macronevertebrate groups were identified in the four sampling sites in 2003. Fourteen oligochaeta species, twenty seven water mite species, ten mayfly genera and seven stonefly genera were identified;
2. Oligochaeta species diversity and the family number decreased on going downstream. There are no significant differences concerning oligochaeta density at the four sampling sites, except for station 2.
3. Mayfly diversity recorded the highest values at the third site, downstream Blãjoaia, while at the river source the diversity was impossible to calculate, due to the presence of only one taxon.
4. The stonefly *Leuctra* sp. was found at all sampling sites in high densities. Maximum stonefly diversity was recorded at the second sampling site, upstream Măguri Răcătau
5. A number of 27 water mite species was identified in the four sampling sites. The highest species number was recorded at the second station (downstream Măguri Răcătau). Thus, species diversity increased from headwaters to mouth.

REZUMAT

Această lucrare îşi propune o analiză cantitativă privind diferite aspecte ecologice (desitatea, abundenţa, diversitatea specifică, dinamica sezonieră) ale comunităţilor de nevertebrate acvatice din râul Someşul Rece. În anul 2003 s-au efectuat o serie de ieşiri în teren la cele 4 staţii de prelevare a probelor şi s-au colectat sezonier câte 3 probe cantitative de zoobentos la fiecare staţie, concomitent cu măsurarea perametrilor fizico-chimici ai apei. Date cu privire la comunităţile de nevertebrate bentonice au fost prelucrate statistic, iar oligochetele, acarienii acvatici, efemeropterele si plecopterele au fost identificate pana la nivel de specie sau gen. La nivelul acestor grupuri au fost aplicaţi o serie de indici ecologici şi s-a încercat relaţionarea acestora cu parametrii fizico-chimici înregistraţi.

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