

## STRUCTURE AND DISTRIBUTION OF THE MACROINVERTEBRATES COMMUNITIES IN THE SUCEAVA RIVER (NORTHEASTERN ROMANIA)

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**Abstract.** This paper presents results from a study on the structure and dynamics of the benthic macroinvertebrates community comparative with an assessment of water quality, based on physico-chemical and biological quality elements in Suceava River. Suceava River, a third-order river, is located in Northeastern Romania, springs from a mountain area (elevation 1,000 m), has a length of 170 km and is a tributary of the Siret River. Seasonal and longitudinal changes in the benthic community of Suceava River have been studied seasonally in 3 stations Brodina, Mihoveni and Tisauti in the period 2009-2010. Samples were taken monthly for the physico-chemical quality elements, three times a year for the biological quality elements. A total of 43 taxa of macroinvertebrates were identified during two seasons. The highest diversity was recorded by Diptera (10 taxa), followed by Ephemeroptera (9 taxa), Oligochaeta (8 taxa) and Trichoptera (5 taxa). The observed changes in functional feeding groups composition of macroinvertebrates community were similar in some respects to those proposed in the river continuum concept (Vannote *et al.*, 1980). In the upper parts of the Suceava River dominated collectors/scrapers, while in the middle parts dominated collectors, filter feeders and predators. In downstream parts dominated collectors and filter feeders. Through the correlation of the data obtained from the physico-chemical and biological analysis, the water quality was established according to the Romanian standards for each section: Brodina and Mihoveni sections was I-II water category of quality, and the Tisauti section was II-III water category of quality for this period.

**Keywords:** longitudinal changes, macroinvertebrates, community, Suceava River, water quality.

**Rezumat. Structura și distribuția comunităților de macronevertebrate în râul Suceava (nord-estul României).** Aceasta lucrare prezintă rezultatele unui studiu asupra dinamicii macronevertebratelor din râul Suceava în paralel cu o evaluarea a calității apei acestuia pe baza elementelor de calitate fizico-chimice și biologice. Râul Suceava, râu de ordinal III, este localizat în NE României, izvorăște dintr-o zonă montană (1.000 m), are o lungime de 170 km și este afluent al râului Siret. Schimbările longitudinale și sezoniere ale comunității de macronevertebrate din râul Suceava au fost studiate în 3 secțiuni Brodina, Mihoveni și Tișăuți în perioada 2009-2010. Probele au fost prelevate lunar pentru elementele fizico-chimice și de trei ori pe an pentru elementele biologice de calitate. Au fost identificați 43 taxoni. Grupurile taxonomice cele mai diverse au fost Diptera (14 taxoni), Ephemeroptera (12 taxoni), Plecoptera (7 taxoni) și Trichoptera (6 taxoni). Schimbările observate în compoziția grupurilor funcționale a comunității de macronevertebrate sunt similare cu cel propuse în teoria continuum-ului râului (Vannote *et al.*, 1980). În amonte domina colectoriile/ răzuitorii și mărunțitorii, în partea de mijloc a râului domina colectoriile, filtratorii și prădătorii iar în aval domina colectoriile, filtratorii. Corelând datele obținute din analiza elementelor de calitate fizico-chimice și biologice, calitatea apei râului Suceava conform standardului românesc a fost pentru fiecare secțiune: Brodina și Mihoveni s-au încadrat în clasa I-II de calitate și Tișăuți în clasa II-III de calitate în această perioadă.

**Cuvinte cheie:** schimbări longitudinale, macronevertebrate, comunitate, râul Suceava, calitatea apei.

### Introduction

The Water Framework Directive (2000/60EC) is a European Union Directive which commits European Union member states to achieve good qualitative and quantitative status of all water bodies by 2015. The “good ecological status”, meaning that besides the

assessment of water chemical quality and biological communities, the hydromorphological integrity of the aquatic habitat is taken into consideration. Good ecological status is defined in Annex V of the Water Framework Proposal, in terms of the quality of the biological community, the hydrological characteristics and the chemical characteristics.

“Romanian Waters” National Administration is the responsible authority for water quality management by its 11 Regional Water Branches ([www.rowater.ro](http://www.rowater.ro)). Siret Water Branch (SWB) comprises four divisions: Suceava, Neamţ, Bacau, Vrancea.

The Suceava River is a major right tributary of the Siret River and the river basin covers an area of 2298 km<sup>2</sup>. It covers very different landscapes, including Eastern Carpathians, the subcarpathic hilly region, and the Suceava meadow. The major tributaries are: Putna, Pozen, Suceviţa, Şomuz, Solca, Horaiţ, Soloneţ, Hăţnuţa, Dragomirna Rivers.

This paper presents results from a study on the dynamics of the benthic macroinvertebrates community comparative with an assessment of water quality, based on physico-chemical and biological quality elements in Suceava River. The assessment of water quality based on physico-chemical and biological quality elements over the period 2009-2010, in three sections starting from the upper course of the river Suceava (Brodina). The next section is Mihoveni, it is before the river enters in Suceava city, and Tişăuţi is the section downstream the urban wastewater treatment plant.

Longitudinal and seasonal shifts in benthic community structure, either in species composition or functional feeding group composition, due to changes in physical, chemical and geomorphological characteristics, have been documented by many authors (Allan, 1975; Vannote *et al.*, 1980; Minshall *et al.*, 1985).

### **Material and Methods**

With a length of 173 km (90% belonging to Romania and 10% to Ukraine), Suceava River is a left tributary of the Siret River and its basin has a catchment in the country of 2298 km<sup>2</sup> in Romania. For the ecological assessment, three sections of Suceava River were investigated: Brodina – altitude 990 m, Mihoveni – 520 m and Tişăuţi – at 398 m, located after the municipal wastewater treatment plant (Fig. 1).

Macroinvertebrates quantitative samples were taken by standard Surber net (mouth opening 25x25 cm, mesh size 250 µm) using transect sampling methodology, three month per year in three sampling sites, in interval from April 2009-October 2010. Samples were preserved in 4% formaldehyde and organisms were sorted and identified to species level where possible.

The monitoring included physico-chemical parameters (temperature, pH, suspended solids, major anions and cations, oxygen balance, nutrients), inorganic and organic pollutants (heavy metals, phenols, detergents) and macroinvertebrates (abundance, saprobic index, functional feeding groups). The chemical analyses were carried out monthly, the biological investigations seasonally (three times/year for macroinvertebrates) (SWBR, 2009).

The following physico-chemical parameters were considered for this study: pH, total solids (TS), dissolved oxygen (DO), chemical oxygen demand (COD-Cr), biochemical oxygen demand (BOD<sub>5</sub>), conductivity. For nutrients, phosphates, ammonium, nitrite, nitrate and total nitrogen were determined, while for inorganic pollutants, the content of iron, manganese, copper and zinc was assessed.

The water quality is classified in 5 classes, according to EU- WFD and Romanian

standards (class I- high, II- good, III- moderate, IV- poor, V- bad). The sensitivity of the aquatic communities to environmental stress was assessed by the saprobic index SI (Pantle & Buck, 1955; Sladeczek, 1973): according to the benthic species, water is classified in five classes: class I- oligosaprobic, class II- beta-mesosaprobic, class III- beta-alpha-mesosaprobic, class IV- alpha-mesosaprobic and class V- polysaprobic.

For the quantitative structure description of macroinvertebrates communities we have used the relative abundance (%) and the functional feeding groups.

Functional feeding groups were determined after Moog (1995) and expressed as a percentage of density.

The map (Fig. 1) shows the location of sampling sites along the Suceava River.

### Results and Discussion

The values of physical and chemical variables measured in the study area during the study period are shown in Tables 1 and 2. According to most of the physical and chemical parameters, the water quality of the investigated stretch between 2009 and 2010 could be generally classified in class II (Tables 1, 2). According to the chemical oxygen demand (COD-Cr) and nutrient content, in Tișăuți section which is downstream the waste water treatment plant of Suceava city, the water of Suceava River is in class II (due to the values of COD above 10 mg O<sub>2</sub>/L).

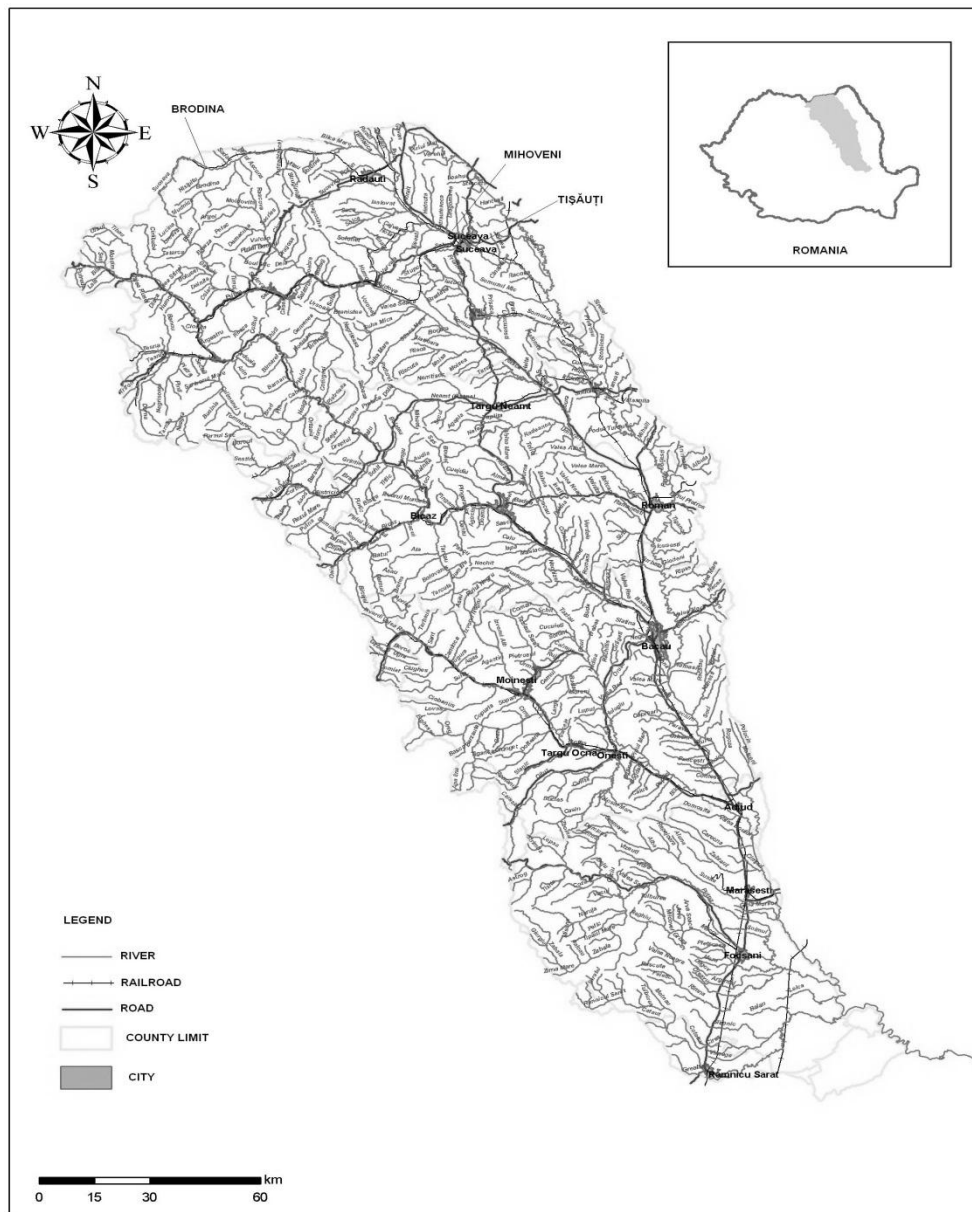
The nutrients content is generally low in the upper sections (class I), but in downstream section the high amount of ammonia and nitrites could decrease the water quality to class III (Tables 1). The high content of organic matters and nutrients in Tișăuți section may be due to the water discharge from the sewage water treatment plant of the Suceava city. The average flow in this section is 6.5 m<sup>3</sup>/s, and the average flow from the wastewater treatment plant is 1.75 m<sup>3</sup>/s.

The heavy metals content is low, but in 2010 the concentration of manganese is exceeding the standard limits for class I (Tables 2a, b). Heavy metals as Ni, As, Cd, Cr and Pb were analyzed only in Mihoveni section, because the water from this section is use in 10% of city water supply (Table 2b) and the rest it is taken from the underground water.

On the other hand, the Suceava River receives tributaries that decrease the quality of water. Pozen River is the most polluted tributary of Suceava River, but the tributary flow is small 0.24 m<sup>3</sup>/s (the Pozen River – class IV, affected by organic pollution from wastewater discharges – data from the SWBR reports 2009-2010).

**Table 1.** Average values (± S.D., n= 12) for selected chemical quality elements for the Suceava River in 2009-2010; in grey – values exceeding the standard limits for class I, according to the Romanian Order 161/2006 (Ministerul Mediului și Gospodăririi Apelor, 2006).

Suceava River	Year	COD-Cr (mg O <sub>2</sub> /L)	BOD <sub>5</sub> (mgO <sub>2</sub> /L)	N-NH <sub>4</sub> (mg/L)	N-NO <sub>2</sub> (mg/L)	N-NO <sub>3</sub> (mg/L)	Total P (mg/L)
Brodina	2009	6.034±1.517	1.511±0.335	0.037±0.043	0.007±0.006	0.648±0.373	0.024±0.016
	2010	9.191±4.743	2.179±1.237	0.032±0.050	0.007±0.007	0.626±0.521	0.018±0.007
Mihoveni	2009	8.344±3.385	2.608±1.735	0.078±0.058	0.021±0.011	1.066±0.443	0.031±0.019
	2010	9.433±5.918	2.300±0.465	0.089±0.054	0.017±0.007	1.609±0.529	0.053±0.056
Tișăuți	2009	10.135±4.090	4.140±3.004	0.829±0.489	0.065±0.093	1.137±0.516	0.145±0.076
	2010	13.491±5.161	4.421±1.673	0.678±0.457	0.026±0.010	1.670±0.482	0.135±0.068



**Figure 1.** Location of sampling sites along the Suceava River: Brodina, Mihoveni and Tişăuți.

**Table 2a.** Average values ( $\pm$  S.D., n= 4) for selected chemical quality elements for the Suceava River in 2009-2010; in grey – values exceeding the standard limits for class I, according to the Romanian Order 161/2006 (Ministerul Mediului și Gospodăririi Apelor, 2006)

Suceava river	Year	Mn (mg/L)	Cu ( $\mu$ g/L)	Zn ( $\mu$ g/L)
Brodina	2009	0.012	-	-
	2010	-	4.39 $\pm$ 1.379	8.21 $\pm$ 1.605
Mihoveni	2009	0.025 $\pm$ 0.0283	-	-
	2010	0.101 $\pm$ 0.1163	4.79 $\pm$ 2.876	9.24 $\pm$ 5.086
Tișăuți	2009	0.036 $\pm$ 0.0127	-	-
	2010	-	2.18 $\pm$ 0.396	13.04 $\pm$ 1.853

**Table 2b.** Average values ( $\pm$  S.D., n= 2) for selected chemical quality elements for the Suceava River in 2009-2010.

Suceava river	Year	Ni ( $\mu$ g/l)	As ( $\mu$ g/l)	Cd ( $\mu$ g/l)	Cr ( $\mu$ g/l)	Pb ( $\mu$ g/l)
Brodina	2009	-	-	-	-	-
	2010	-	-	-	-	-
Mihoveni	2009	-	-	-	-	-
	2010	1.84 $\pm$ 1.103	0.57 $\pm$ 0.379	0.19 $\pm$ 0.127	0.12 $\pm$ 0.014	1.52 $\pm$ 1.294
Tișăuți	2009	-	-	-	-	-
	2010	-	-	-	-	-

Benthic macroinvertebrates are commonly used for the quality assessment of rivers (Birk & Hering, 2002). Along the investigated stretch, the highest diversity was recorded by Diptera (10 taxa), followed by Ephemeroptera (9 taxa), Oligochaeta (8 taxa) Plecoptera (7 taxa), Trichoptera (5 taxa), and with 1 taxa Heteroptera, Coleoptera. EPT-taxa (Ephemeroptera, Plecoptera and Trichoptera) dominated in the Brodina site, where they represented up to 46% in abundance, while Diptera recorded 42 %. Downstream, the EPT-taxa decreased in abundance to 13%. The abundance of Oligochaeta increased in Tișăuți section (51 %), as a consequence of the increased organic pollution (NH<sub>4</sub>-N, NO<sub>2</sub>-N content above the limits for class II). In the Suceava River, a general decrease of EPT-taxa and an increase of Diptera abundance were noticed over the years (Table 3).

Oxyphilic and rheophilic species are present in the upper parts: *Perla marginata* (Panzer, 1799), *Perlodes microcephala* (Pictet, 1833), *Leuctra hippopus* (Kempny, 1899), *Habroleptoides confusa* (Sartori & Jacob, 1986), *Rhyacophila dorsalis* (Curtis, 1834). Among the ephemeropterans, stable population of *Ecdyonurus torrentis* (Kimmins, 1942), *Baetis vernus* (Curtis, 1834), *Rhitrogena semicolorata* (Curtis, 1834) are present and in the middle parts appear population of *Caenis luctuosa* (Burmeister, 1839), *Baetis vernus* with *Hydropsyche pellucidula* (Curtis, 1834).

Also are present species characterized for the “stressed” river section like *Seratella ignita* (Poda, 1761) and eurivalent species *Hydropsyche pellucidula* because of the recent floods occurs in this zone.

In the section Tisauti, near the Suceava city, the macroinvertebrates communities structure is characteristic for the river sector polluted with the domestic wastewater. With a high number of individuals and a few species appear the oligochets of Tubificidae and Naididae family, the chironomids belonging to the *Chironomus* genus.

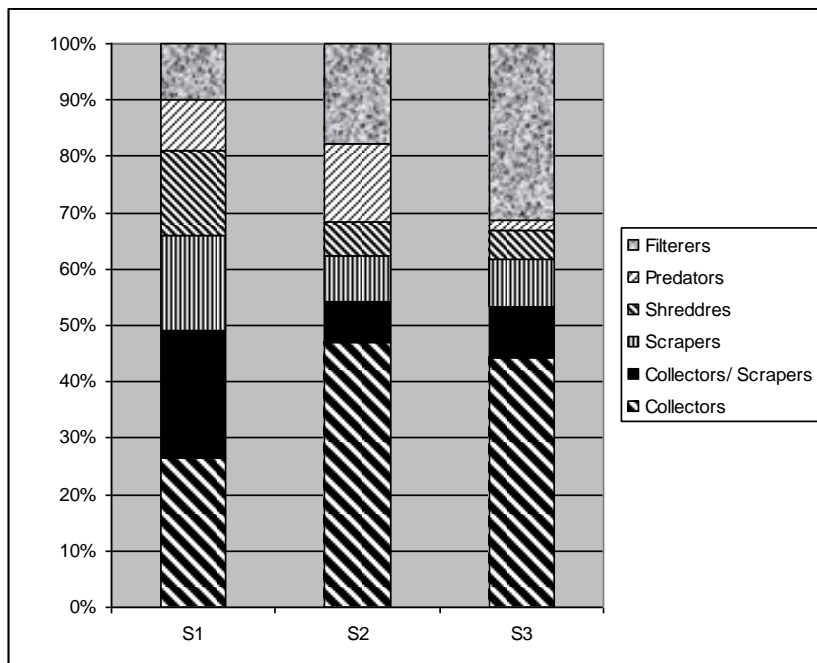
**Table 3.** Macroinvertebrates abundance (%) and saprobic index in the investigated stretch in 2009-2010; in grey – class II and class III, according to the Romanian Order 161/2006 (Ministerul Mediului și Gospodăririi Apelor, 2006).

Suceava River	Year	EPT taxa	Diptera	Oligochaeta	Crustacea	Heteroptera	Coleoptera	Hirudinea	Saprobic index
Brodina	2009	47.6	36.94	-	-	1.7	1.7	-	1.78
	2010	47.59	48.31	-	-	-	0.11	-	1.67
Mihoveni	2009	38.3	44.16	13.68	2.00	-	-	-	1.99
	2010	10.55	63.26	12.8	0.90	2.60	-	-	2.12
Tisauti	2009	20.65	51.49	23.12	-	0.20	-	3.04	2.32
	2010	7.77	41.22	50.99	-	-	-	0.62	2.41

Regarding saprobic index classes (SI), the stretches from upper part of Suceava River can be considered as oligosaprobic, the middle part Mihoveni section can be considered as beta-mesosaprobic and the 3<sup>rd</sup> section Tisauti, near of Suceava city, was beta-alpha-mesosaprobic category in the studied period.

The observed changes in functional feeding groups composition of macroinvertebrates community were similar in some respects to those proposed in the river continuum concept (Vannote *et al.*, 1980). In the upper parts of the Suceava River dominated collectors/scrapers (22.6%) and shredders (15%), while in the middle parts dominated collectors (46.9%), filter feeders (17.7%) and predators (14%). In downstream parts of the river dominated collectors (44.2%) and filter feeders (31.2%) (Fig. 2).

Through the correlation of the data obtained from the physico-chemical and biological analysis, the water quality was established according to the Romanian standards for each section: Brodina section was I category of water quality according to most of the physical-chemical parameters and biological water quality elements. Mihoveni section was I category of water quality according to the chemical quality elements, but the content of manganese exceeded the limit for class I (0.101±0.1163 mg/l) and the biological quality elements classify the site as class II. The Tişăuți section was II-III category of water quality for the studied period. Low levels of heavy metals are suggesting low metal contamination of the river, but the high content of organic matters and nutrients in Tişăuți section may be due to the water discharge from the sewage water treatment plant of the Suceava city (Tables 1 and 2).



**Figure 2.** Composition of functional feeding groups of macroinvertebrates in the Suceava River; data are shown as percentage of density (%).

### Conclusions

Our study shows that the structure and distribution of macroinvertebrates communities reveal the human impact and tend to deteriorate downstream as the river pass through the urban area due to discharge of treated and untreated domestic and industrial effluent of the city.

To reduce input from point sources of organic pollution further management measures are needed, such as a permanent monitoring of wastewater discharged into rivers and financing investments to modernize wastewater treatments plants in the Suceava River.

### Acknowledgements

Special thanks are addressed to the Water Quality Laboratory – Suceava Water Management System.

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