

The influence of the anthropic activities on the benthonic macroinvertebrates communities existing in the Jiu and Jiul de Vest rivers, south-west of Romania

Mălina Dumbravă-Dodoacă, and Milca Petrovici

West University of Timișoara, Faculty of Chemistry Biology and Geography, Department of Biology, Timișoara, Romania. Corresponding author: M. Dumbravă-Dodoacă, malinadumbrava@yahoo.com

Abstract. The different sensibility of the benthonic macro-invertebrates has been used in determining the manner in which these communities are being influenced by the alteration of the water quality. The present study aims at following this precise aspect. The benthos samples have been collected from two rivers in the south-west of Romania: Jiu (3 stations) and Jiul de Vest (2 stations). There have been studied 10 groups of benthonic invertebrates. The benthonic communities' density, abundance and frequency values have varied according to the physic-chemical conditions of the collecting station.

Key Words: benthonic macroinvertebrates, water quality, Jiu, Jiul de Vest, south-west of Romania.

Sažetak: Različita senzibilnost bentonskih makro beskralježnjaka korištena je radi određenja načina na koji kakvoća vode utječe na ove zajednice. Namjera je ovog rada praćenje navedenog aspekta. Uzorci bentosa prikupljeni su iz dviju rijeka s jugozapada Rumunjske: iz rijeke *Jiu* (čit. Žiu), (3 stanice) i *zapadni Jiu* (2 stanice). Praćeno je 10 grupa bentonskih beskralježnjaka. Vrijednosti gustoće, obilje i čestoća (frekvencija) bentonskih zajednica varirale su sukladno fizičko-kemijskim uvjetima stanice za prikupljanje.

Ključne riječi: bentonski makro beskralježnjaci, kakvoća vode, Jiu, zapadni Jiu, jugozapad Rumunjske.

Rezumat. Sensibilitatea diferită a macronevertebratelor bentonice a fost utilizată în determinarea modului în care aceste comunități sunt influențate de modificarea calității apei. Această lucrare își propune să urmărească tocmai acest aspect. Probele de bentos au fost colectate din două râuri din sud-vestul României: Jiu (3 stații) și Jiul de Vest (2 stații). Au fost urmărite 10 grupe de nevertebrate bentonice. Valorile densității, abundenței și frecvenței comunităților bentonice au variat în funcție de condițiile fizico-chimice ale stației de colectare.

Cuvinte cheie: macronevertebrate bentonice, calitatea apei, Jiu, Jiul de Vest, sud-vestul României.

Introduction. Maintaining the quality of water without affecting the aquatic communities, under the condition of a more and more obvious development of the urban and industrial centers, caused many problems throughout the time, all the way till the present moment (Acreman & Ferguson 2010; Arthington et al 2010; Yoshimura 2008).

The distribution of the different benthonic macro-invertebrates communities is considered to be one of the important indicators of the surface waters' quality (Ogbeibu & Oribhabor 2002; Badea et al 2010; Kubosova et al 2010). Notwithstanding, there is very little information on the tolerance of each organisms group related to the modification of the physic-chemical water parameters and the possibility of framing it to a certain quality class (Sloof 1983).

The Jiu and Jiul de Vest rivers cover two districts (Hunedoara and Gorj), in the south-western part of Romania. There are a series of studies related to this subject that were made in the area, but the data are far from being complete (Traistă et al 2005; Cîrțînă & Popa 2004; Cîrțînă 2007; Dumitru et al 2003).

The purpose of the here standing study is to offer a series of information related to the way in which certain categories of benthonic macro-invertebrates react to the modifications of some of the physical-chemical water parameters.

Material and Method. The samples have been collected within the period May 2009 – February 2010, according to the season, from two rivers: Jiu (3 stations) and its affluent, Jiul de Vest (2 stations), see Figure 1. There have been collected quantitative samples by using the Surber sampler (surface of 1072 cm², dimension of the meshes in the net of 250 µm). In order to determine certain parameters for the oxygen concentration, the value of the pH and the conductivity, there has been used the 350i SET type multimeter; the other physical-chemical water parameters have been purchased through collaborating with the Romanian Waters National Administration (RWNA). For the maintenance of the samples there have been used formalin (8%) and ethylic alcohol (70%). In the laboratory the identification has been made all the way up to the family level (Gheţeu 2008; Waringer & Graf 1997; Wallace et al 2003; Studemann et al 1986; Tachet et al 1994). A number of 70.166 organisms have been worked through.

There have been calculated the density ($D_i = n_i / S_p$), the abundance ($A = (n_i / N) * 100$) and the frequency ($F = N_i * 100 / N_p$), where n_i represents the total number of individuals for the i series, S_p the total researched area, N the total number of individuals belonging to all species (from the sample or the studied samples), N_i the number of stations within which been identified the subjected species, N_p the total number of stations (Stan 1995; Sîrbu & Benedek 2004).

The location of the collecting stations, according to the code number goes as it follows:

Jiu: Moi station (1): 44°53'41.6542"N-23°12'24.7330"E, altitude (alt.) 170 m; Vart station (2): 44°57'1.6998"N-23°08'2.0296"E, alt. 180 m; Defileul Jiului station (3): 45°16'51.0644"N- 23°23'34.8419"E, alt. 588 m.

Jiul de Vest: Petroşani station (4): 45°22'6.2047"N-23°22'7.4284"E, alt. 628 m; Campu lui Neag station (5): 45°18'12.3923"N, 23° 03'9.8449"E, 980 m.

The characteristic habitat of each station varied as it follows: conifers forest (5), mixed forest (3, 4), shrubs and land (1, 2).

The vegetation coverage degree showed different values: 20-25% (1), 30-40% (4), 50-60% (3, 5) and 85-90% (1).

The mean values of the width and depth of the two rivers on which the stations were set up have been of 18.3 ± 5.31 m, respectively 0.28 ± 0.08 m.

The type of substratum varied from boulders, blocks and rocks (5, 3), rocks and gravel (4, 1) to gravel, sand and ooze (2).

Results and Discussion. There have been determined the mean values of the main physical-chemical parameters for every sample collecting point, according to Table 1.

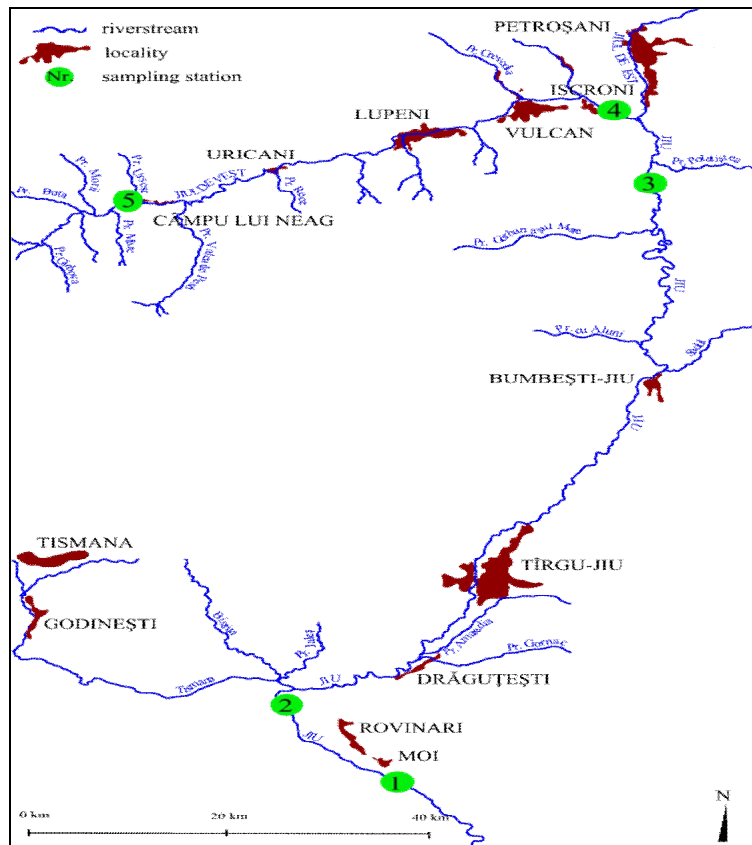


Figure 1. The location of the sample collecting stations on the rivers Jiu and Jiul de Vest.

Table 1

The mean values of the physical-chemical parameters calculated within the 5 stations (S), in the period May 2009 – February 2010

<i>Physical and chemical parameter values</i>	<i>S5</i>	<i>S4</i>	<i>S3</i>	<i>S2</i>	<i>S1</i>
Water temperature (°C)	8.88±6.23	10.13±6.65	9.08±5.63	10.75±6.70	10.25±6.57
Water velocity (m s ⁻¹)	1.34±0.06	0.98±0.11	1.02±0.16	0.61±0.10	0.85±0.08
pH	7.21±0.17	8.38±0.25	8.20±0.28	7.59±0.23	8.33±0.46
Water oxygen concentration (mg l ⁻¹)	10.66±0.65	8.18±1.53	9.87±1.24	7.05±1.24	7.42±1.37
Suspension (mg l ⁻¹)	20.5±1.27	54.5±3.44	44.25±3.24	33.75±2.17	53.25±2.93
CBO5 (mg l ⁻¹)	2.6±0.22	3.10±0.26	4.01±1.68	3.34±2.08	4.45±1.19
Conductivity (μS cm ⁻¹)	87.4±5.55	99.2±13.94	166.95±32.94	185.83±37.46	207.70±28.12
Determined residue (mg l ⁻¹)	102.65±1.22	135.67±4.16	112.40±10.76	111.13±5.24	159.45±3.28
Alkalinity (mmol l ⁻¹)	0.82±0.26	1.39±0.02	1.27±0.21	0.89±0.18	1.37±0.06
N-NH4 (mg l ⁻¹)	0.06±0.05	0.14±0.07	0.13±0.04	0.10±0.01	0.14±0.02
NO2 (mg l ⁻¹)	0.010±0.03	0.16±0.003	0.14±0.05	0.09±0.16	0.16±0.04
NO3 (mg l ⁻¹)	1.05±0.42	3.99±0.08	3.89±0.94	3.46±1.40	3.98±1.39
P-PO4 (mg l ⁻¹)	0.01±0.01	0.32±0.001	0.28±0.11	0.17±0.05	0.31±0.05
Sulfates(mg l ⁻¹)	25.88±2.47	50.35±2.76	35.43±8.77	31.28±8.25	49.18±10.39

As a result of the working through of the benthos samples there have been identified 10 benthonic macroinvertebrates. The main groups, together with the mean density, abundance and frequency values that they presented, are to be found in Table 2.

Table 2

Medium density (LC = confidence limits at $p = 0.05$),
percentaged numeric abundance and the frequency of the groups within the benthos in
the rivers Jiu and Jiul de Vest, 2009 – 2010.

Group	Density (nr. ind. m ²)		Abundance (%)		Frequency (%)	
	Jiu	Jiul de Vest	Jiu	Jiul de Vest	Jiu	Jiul de Vest
Chironomidae	5170.76±47.99	2720.77±101.84	44.59	27.49	100.00	100.00
Ceratopogonidae	685.63±18.41	71.13±5.51	5.91	0.72	100.00	50.00
Other Dipterans	45.61±1.21	183.07±104.95	0.39	1.85	97.22	100.00
Oligochaeta	4637.49±44.36	2787.62±107.05	40.00	28.17	100.00	95.83
Nematoda	2.85±0.23	0	0.02	0	19.44	0
Acaria	15.29±1.43	33.04±47.45	0.13	0.33	22.22	58.33
Ephemeroptera	88.10±2.66	1131.45±69.70	0.76	11.43	100.00	50.00
Plecoptera	0	1688.43±56.98	0	17.06	0	50.00
Trichoptera	936.98±11.03	1237.56±28.16	8.22	12.50	100.00	100.00
Coleoptera	0	45.09±2.55	0	0.46	0	50.00

The Câmpu lui Neag station (5) has been set the furthest upstream Jiul de Vest, without being affected by the presence of urban and industrial centers or other anthropic activities (see Figure 1). It also carried the role of witness for the present study.

The anthropic impact of different shapes can have a direct influence on the benthonic macro-invertebrates, from the view point of both diversity and density or abundance (Azrina et al 2006; Korte et al 2010). This situation has been underlined also in the present study.

Within the benthos of the stations set on the Jiu river, but also on Jiul de Vest (4) have been detected high mean density (ind. m²) and abundance (%) values for certain groups which stood for polluted water bio-indicators, see Figure 2 (chironomids - Chironomidae, biting midges - Ceratopogonidae, Oligochets - Oligochaeta, nematodes - Nematoda); the maximum density was established for chironomids (5170.76 ind. m²-Jiu) and oligochets (4637.49 ind. m²-Jiu). The maximums established for abundance were: 44.59% (chironomids – Jiu), respectively 40% (oligochets – Jiu).

The high values presented on the Jiul de Vest river for chironomids, oligochets and biting midges are due to station 4, with a water quality inferior to the one of station 5 (see Table 2). For station 5 these values dropped down significantly, being compensated by the presence of a group highly sensitive to the modifications of the physic-chemical water parameters (stoneflies - Plecoptera), but also by the presence of a considerably larger number of those groups indicating clean water, according to Tabel 2 and Figure 2 (mayflies - Ephemeroptera, some caddishflies species - Trichoptera, other categories of dipterans, etc).

Stoneflies (frequency – 50%) have only been identified within station 5, together with aquatic beetles (Coleoptera) (50%) and other dipterans categories (100%). Mayflies showed a frequency of 100% (Jiu) and 50% (Jiul de Vest), but the density and abundance values (Jiu) were a lot more inferior to those identified within station 5. For trichopteras the frequency was of 100%; starting with station 4 downstream the density and abundance values of this group dropped (see Figure 2). Nematodes (19.44%) were only present in the benthos of Jiu river (according to Table 2). Hydracarians (Acaria) were present with a frequency of 22.22% (Jiu), respectively 58.33% (Jiul de Vest).

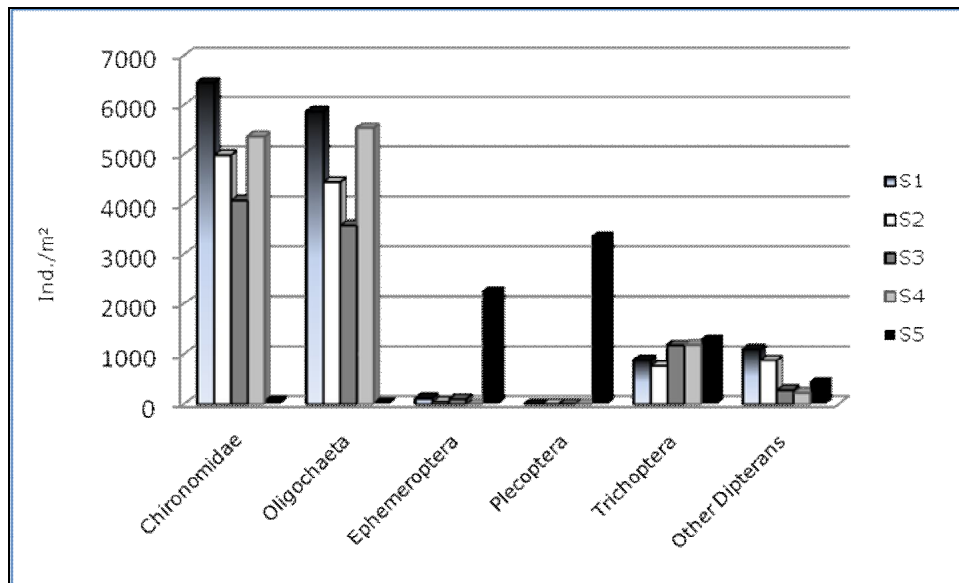


Figure 2. The mean density's dynamics of the main benthonic macro-invertebrates groups identified within the 5 stations (S), 2009-2010.

The density and the abundance of the main benthonic groups can also be tracked in relation to the mean values of the physical-chemical parameters determined for each of the 5 collecting points, according to Tabel 1.

The water temperature ($^{\circ}\text{C}$) keeps the lowest values within station 5. The more the anthropic intervention is made (downstream) and the altitude lowers, the temperature goes up, actively modifying the benthonic communities' structure. The situation has also been described in literature, the temperature playing a fundamental role in the allocation of the benthonic macro-invertebrates (Nilgün & Dügel 2008). This fact is extremely important taken into account that groups such as oligochets, chironomids, biting midges and nematods manifest significantly larger tolerance limits, adapting to various environmental conditions (Lucan-Bouché et al 1999; Hamilton et al 2008).

Also, the water speed (m s^{-1}) plays an important role in the distribution of benthonic macro-invertebrates: a low speed determines a low oxygen concentration and, therefore, the development of those organisms capable of surviving new conditions (Wotton & Hirabayashi 1999). In this study also the flow speed and the high oxygen concentration in the water at station 5 have influenced positively the development of healthy benthonic communities.

In literature it has been demonstrated the influence of the substratum on the presence of benthonic macro-invertebrates (Verdonschet 1999; Abdallah & Barton 2003). For the studied area the type of the substratum plays a fundamental role through that which ensures the conditions necessary to the development of certain communities; oligochets, chironomids, ceratopogonids and nematods prefer the substratum composed mainly by rocks and gravel to which is added the sand and the ooze, to which is added a rich organic load; stoneflies, mayflies, aquatic beetles, other dipterans (Ord. Diptera) (Fam. Rhagionidae, Fam. Limoniidae, Fam. Blepharoceridae, some of the caddisflies (Fam. Rhyacophiloidea, Fam. Brachycentridae) are adaptable to a substratum composed by boulders, blocks and rocks.

Beside all these factors there are also other parameters (the p.H., the suspensions, the CBO_5 , conductivity, determined residue, alkalinity, N-NH_4 , NO_2 , NO_3 , P-PO_4 and the sulfates) that manifest their direct influence on the subjected populations. For all these parameters there have been identified very high values in the case of stations carrying anthropic effects; one exception was station 5, according to Table 1. There are authors highlighting the influence of certain chemical factors (ph, CBO_5 , sulfates) on the distribution of benthonic communities in relation to the sensitivity that

they manifest (Wesolek et al 2010; Fleituch 2003). Some studies state that the representatives of certain groups (mayflies, caddisflies and stoneflies) are sensitive to the growth of conductivity or modification of the chemical parameters in relation to the regular limits (Wallace & Eggert 2009).

Chainho et al (2007) monitored the response of benthonic populations to the modification of the values of certain chemical water parameters (CBO_5 , NH_4 , NO_3). They noticed that these influences are more prominent during summer time. Despite that, there are few studies that could offer complete data on the influence of the chemical factors on the benthonic organisms.

Therefore, the modification of the regular values of the water parameters lead to the replacement of certain groups (mayflies, caddisflies, stoneflies) with much more tolerant (Lorenz 2003) other ones (chironomids, oligochets, etc.). The high tolerance of oligochets and chironomids has been demonstrated in numerous studies (Marchese et al 2008; Courtney & Merritt 2009; Benbow 2009; Collier et al 2010).

Moreover, the inferior quality of the water can favor the development of certain resistant groups and disfavor the distribution of other ones, even if some of the physical parameters (temperature, speed, substratum type) keep the quality in certain areas (Petrovici 2009). This is the case of the station on Jiu Valley (3), with a high speed of water flow, low temperatures, substratum formed out of boulders, rocks and gravel, but inferior to station 5 as far as the water quality is concerned.

Conclusions

There have been studied 10 groups of benthonic macro-invertebrates: chironomids, biting midges, other dipterans (except for those previously mentioned), oligochets, nematodes, hydracarians, aquatic beetles, mayflies, stoneflies and caddisflies.

The highest density and abundance values were calculated for chironomids, oligochets and biting midges; these values have corresponded to the stations located on Jiu river, but also to the Petrosani station (Jiul de Vest). The lowest values were characteristic to the Câmpu lui Neag station.

For mayflies, stoneflies, caddisflies, hydracarians and aquatic beetles the highest density and abundance values have been established for the Câmpu lui Neag station.

The density and abundance of benthonic groups has been influenced by the modification of the physical-chemical water parameters. The values of those parameters went up together with the anthropic intervention, the lowest ones being maintained within Câmpu lui Neag station.

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Authors:

Mălina Dumbravă-Dodoacă, West University of Timișoara, Faculty of Chemistry, Biology, Geography, Department of Biology, Pestalozzi Street No. 16A, 300115, Timișoara, Romania, e-mail: malinadumbrava@yahoo.com

Milca Petrovici, West University of Timișoara, Faculty of Chemistry, Biology, Geography, Department of Biology, Pestalozzi Street No. 16A, 300115, Timișoara, Romania, e-mail: milcapetrovici@yahoo.com

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