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TIMIŞ RIVER (BANAT, ROMANIA) BENTHIC MACROINVERTEBRATE COMMUNITIES STRUCTURE SPATIAL DINAMIC

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DOI: 10.2478/trser-2013-0038

KEYWORDS: benthic macroinvertebrate communities, Timiș River.

ABSTRACT

This study presents the description of the structure of benthic macroinvertebrate communities of the Timiş River (Danube Watershed) in correlation with environmental parameters. The results are based on quantitative benthic macroinvertebrates (105 samples) taken in 2011 (June-September) from 21 stations of the the Timiş River, situate between its sources and the Romanian-Serbian border (241 km). The assessed biotope variables were: altitude, slope, riverbed width, depth, substratum types, channel modification and water physico-chemical caracteristics. The results of the study reveal that the spatial structure of benthic macroinvertebrates is induced by the substrate type, by the minor riverbed modifications in comparison with the natural conditions and the quantities of oxidable matters in the water.

RÉSUMÉ: La dynamique spatiale de la structure des communautés de macroinvertébrés de la rivière Timiş (Banat, Roumanie).

Cette étude présente la description de la structure de la communauté des macroinvertébrés benthiques de la rivière Timiş (Danube, ligne de partage des eaux) en corrélation avec les paramètres environnementaux Les résultats sont basés sur la quantité de macroinvertébrés benthiques (105 échantillons) relevée en 2011 (Juin-Septembre) sur 21 stations de la rivière Timiş, situées entre sa source et la frontière serbo-roumaine (241 km). Les variables évaluées pour les biotopes sont: l'altitude, la pente, la largeur du lit, la profondeur, les types de substrat, les modifications du chenal et les caractéristiques physico-chimiques. Les résultats de l'étude révèlent que la structure spatiale des macroinvertébrés benthiques est induite par le type de substrat, par la modification du lit mineur de la rivière en comparaison avec les conditions naturelles et la quantité de matière oxydable dans l'eau Dans le cas de la rivière Timiş.

REZUMAT: Dinamica spațială a structurii comunităților de macronevertebrate bentonice din râul Timiș (Banat, România).

Lucrarea prezintă descrierea structurii comunităţilor de macronevertebrate bentonice din râul Timiș (bazinul hidrografic Dunăre) în corelație cu caracteristicile de biotop. Rezultatele se bazează pe probe cantitative de bentos (105 probe), colectate în 2011 (perioada iunie-septembrie) din 21 stații de colectare situate de-a lungul râului, de la izvoare până la granița României cu Serbia (241 km). Variabilele de biotop considerate au fost: altitudinea, panta, lățimea și adâncimea albiei minore, tipul de substrat, gradul de modificare al al albiei minore față de condițiile naturale, parametri fizico-chimici ai apei. Rezultatele studiului arată că variabilitatea structurală spațială a comunităților de macronevertebrate bentonice este condiționată de tipul de substrat, gradul de modificare a structurii albiei minore față de condițiile naturale și de cantitatea de materii oxidabile din apă.

INTRODUCTION

The benthic macroinvertebrates communities has an important role in rivers' ecological processes (Allan, 1995; Rawer-Jost et al., 2000; Leunda et al., 2009; Dudgeon, 2010), these are adequately structured for an efficient use of the available environment resources (Kreatzweiser et al., 2005; Curtean-Bănăduc, 2008; Infante et al., 2009; Diggins and Newman, 2009; Abdul-Aziz et al., 2010; Theiling, Nestler, 2010; Jiang et al., 2011; Aura et al., 2011).

The aim of the present study were to analyse the structure of the benthic macroinvertebrate communities in correlation with environmental parameters and to indentify the main biotope factors for the macroinvertebrate communities structure in Timiş River case.

The Timiş Basin is situated in South-West Romania (Fig. 1), it drains a total surface of 7,319 km^2 (5,795 km^2 in Romania and 1,524 km^2 in Serbia) (Badea, 1983). The Timiş River springs area is localized on the eastern part of the Semenic Mountains (1,135 m altitude). With a total length of 359 km (241 km in Romania) it passing mountainous (average slope of 20 m/km), hilly (1.6 m/km) and lowland (1-0.15 m/km) areas (Posea, 1982; Roşu A., 1980).

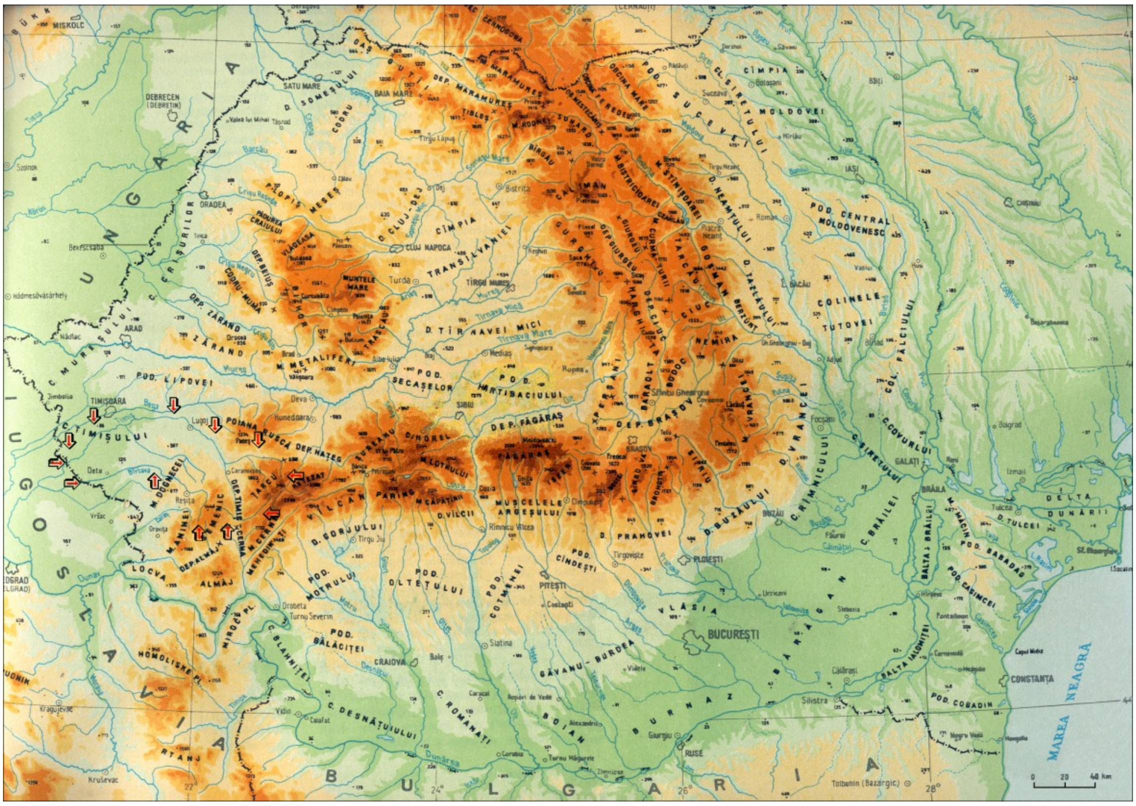

Figure 1: Timiş River basin position.

MATERIAL AND METHODS

The results are based on quantitative benthic macroinvertebrates (105 samples) taken in 2011 (June - September) from 21 stations of the the Timiş River, situate between its sources and the Romanian - Serbian border (241 km) (Fig. 2). The sampling stations were chosen according to the valley morphology, the confluence with the main tributaries and the human impact types and degrees on the river sectors (hydro-technical works, pollution sources, exploitation of the river bed and riverine land use).

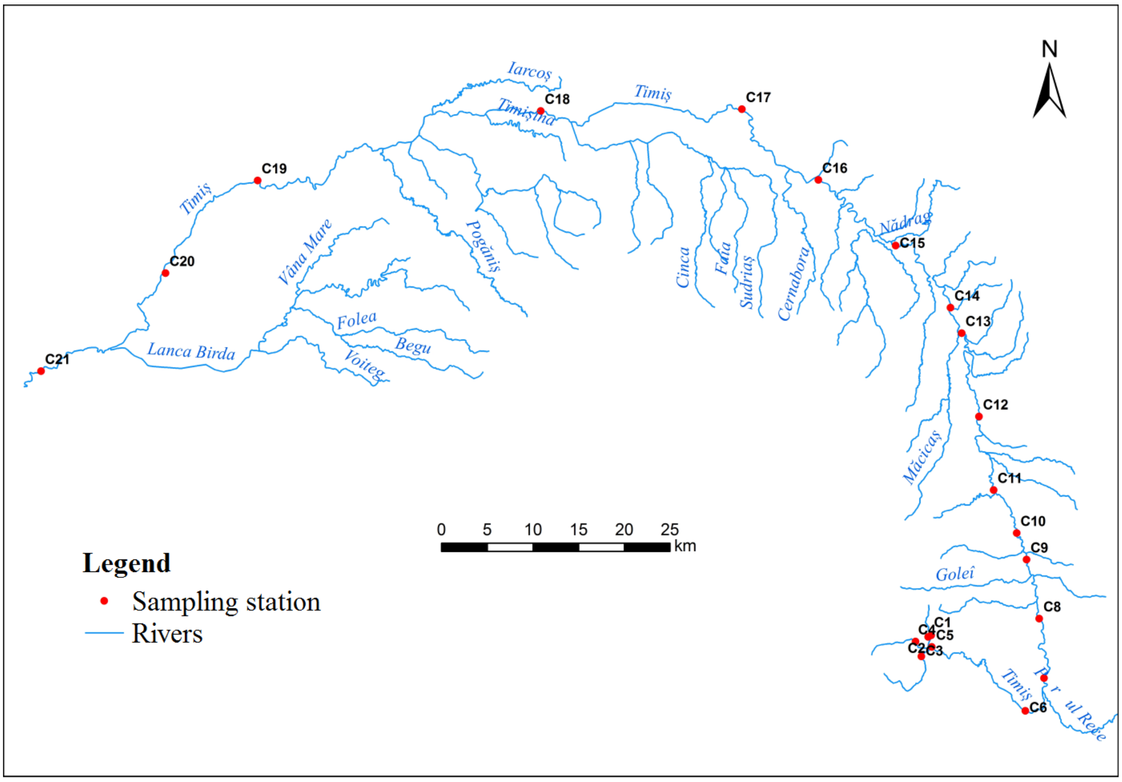

Figure 2: Benthic macroinvertebrate sampling stations location (C1-21) on Timiş River.

In each station, quantitative samples were taken from five separate points, in order to highlight the specific diversity of local micro-habitats. The sampling was carried out with an 887 cm^2 surface Surber Sampler, with a 250 µm mesh net. The sampled biological material was fixed in 4% formaldehyde solution and was analyzed in the laboratory with an Olympus (150X) stereomicroscope. The invertebrate groups were identified to order except subclasses Oligochaeta, Hirudinea and family Chironomidae and the counts were converted to number of individuals per square meter (ind./m^2).

The assessed biotope variables were: altitude, slope, riverbed width, depth, substratum types, channel modification (% in comparison with the natural state) and water physico-chemical caracteristics (pH, fixed residue, dissolved oxygen, biochemical oxygen demand - BOD_5, chemical oxygen demand - COD-Cr, NO_3^-). The substratum types were expressed as percentages of the transversal section surface (20 m length), and transformed into the following categories: sand, gravel, pebbles, cobbles, and boulders.

The conditionalities between habitat factors and the macroinvertebrate communities structure were analyzed using Canonical Correspondence Analysis - CCA (ter Braak, 1986).

RESULTS AND DISCUSSION

The benthic macroinvertebrates groups with the largest distribution along the Timiş River are Oligochaeta, Ephemeroptera, Trichoptera and Chironomidae, present in all the studied river sectors, and with a not so large distribution appear Hirudinea, Tricladida, Gastropoda (*Ancylus fluviatilis*), Bivalvia (*Corbicula fluminea*), Hydracarina, Amphipoda, Odonata, Plecoptera, Heteroptera, Coleoptera, other Diptera than Chironomidae Family (Tab. 1).

Analysis of benthic macroinvertebrates communities similarity of the 21 sectors of river, on the base of relative abundaces values oftaxonomic groups present, shows thar they can be grouped in six classes (Fig. 3): I communities with the highest relative abundace of 17%, there are amphipods, mayfly, chironomids and stoneflies, present in C2 river sector; II comunities where caddisflies and chironomids apear with relative abundances more that 20%, present in C7, C8, C9, C11, C14, C15 and C20 river sectors; III communities where numerically codominant are mayflies, caddisflies and chironomids, present in C12 and C13 river sectors; IV communities where numerically codominant are chironomids, caddisflies, present in C1, C3, C4, C5 and C6 river sectors; V communities where numerically dominant are chironomids, present in C10, C18, C19 and C21 river sectors; VI communities where numerically dominant are Oligochaeta, present in C17 river sector.

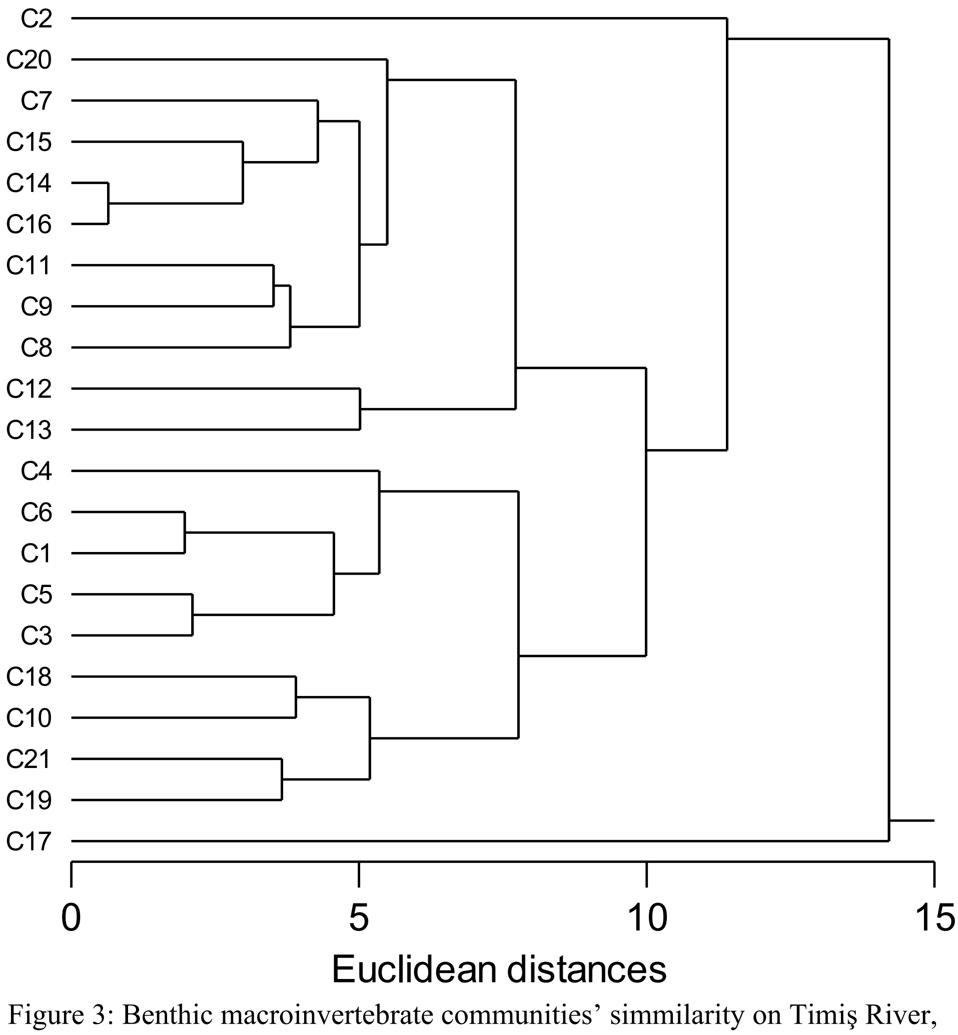

Figure 3: Benthic macroinvertebrate communities' simmilarity on Timiş River, based on taxonomic groups' relative abundance (Euclidean distance grouping for C1-C21 sampling river stations).

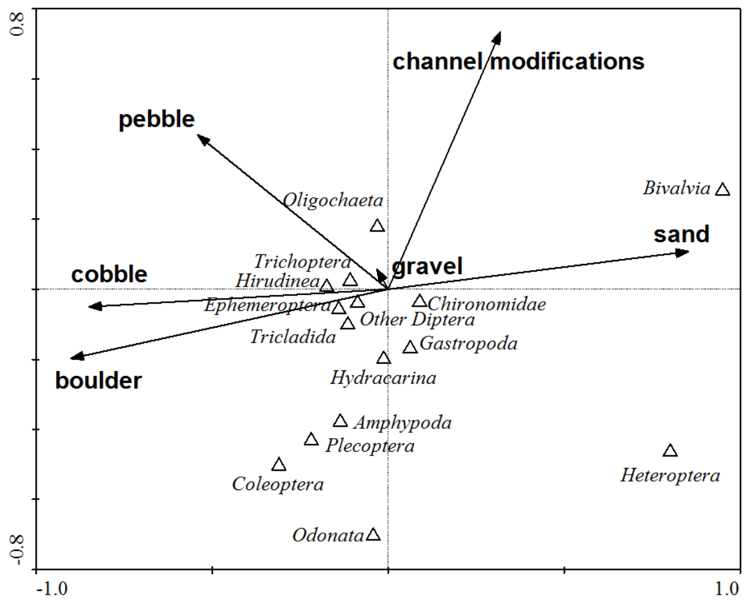

Figure 4: CCA relating macroinvertebrate groups density to substrate channel modification, in the case of the Timiş River (eigenvalues: λ1 - 0.141, λ2 - 0.085; variance explained - 64.7%)

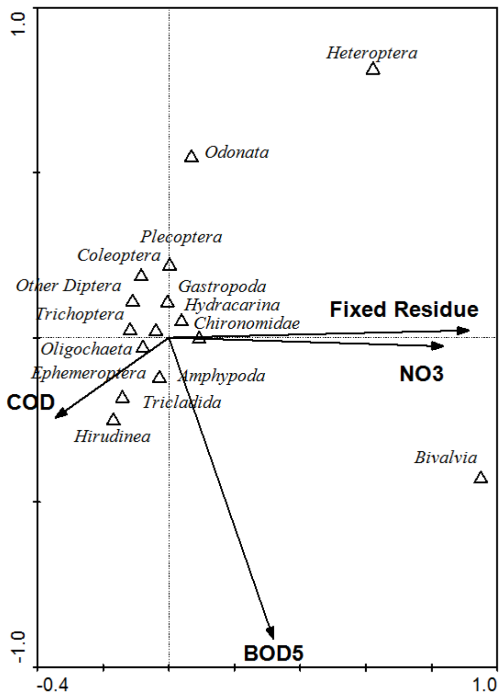

Figure 5. CCA relating macroinvertebrate groups density to fixed residue, NO_3^-, COD-Cr and BOD_5, in Timiş River (eigenvalues: λ1 - 0.151, λ2 - 0.067; variance explained - 71.9%).

The CCA relating macroinvertebrate groups density to substrate and to the channel modification (Fig. 4) indicating that: a high density of plecopters, choleopters, odonats, and amphipods is associated with lithological substrates, a high density of bivalves is associated with sandy substrates, and a large majority of macroinvertebrate groups' density residing in the Timiş River is negatively correlated with channel modifications.

The CCA relating macroinvertebrate groups density to fixed residue, NO_3, COD-Cr and BOD_5 (Fig. 5) showed that: the majority of macroinvertebrate groups' density is negatively correlated with the high values of the COD-Cr and BOD_5, except the Chironomidae, Amphypoda, Tricladida and Hirudinea; benthic macroinevertebrates density is not correlated with water salinity (fixed residue and NO_3^-).

Table 1: Benthic macroinvertebrates communities' structure in Timiş River (Ds - mean density, A% - relative abundance).

Sampling station/ position, altitude	Benthic macroinvertebrate community structure		
	Taxonomic group	Ds (ind./m^2)	A%
C1	Oligochaeta	7.44	0.50
	Hirudinea	3.72	0.25
	Amphypoda	29.99	2.01
	Ephemeroptera	424.58	28.39
	Plecoptera	112.74	7.54
	Trichoptera	101.47	6.79
	Coleoptera	131.45	8.79
	Chironomidae	672.6	44.98
	other Diptera	11.27	0.75
C2	Tricladida	7.44	0.51
	Oligochaeta	7.44	0.51
	Hydracarina	3.72	0.26
	Amphypoda	402.03	27.73
	Ephemeroptera	304.40	20.99
	Odonata	3.72	0.26
	Plecoptera	248.03	17.10
	Trichoptera	37.54	2.59
	Heteroptera	3.72	0.26
	Coleoptera	82.64	5.70
	Chironomidae	289.29	19.95
	other Diptera	60.09	4.14
C3 N 45°12'290" E 22°08'007" 870 m	Oligochaeta	56.37	6.15
	Hydracarina	7.44	0.81
	Amphypoda	3.72	0.41
	Ephemeroptera	157.84	17.22
	Plecoptera	142.73	15.57
	Trichoptera	22.55	2.46
	Coleoptera	14.99	1.64
	Chironomidae	503.49	54.93
	other Diptera	7.44	0.81
C4 N 45°13'163" E 22°07'426" 846 m	Oligochaeta	214.21	8.12
	Hydracarina	3,72	0.14
	Amphypoda	29,99	1.28
	Ephemeroptera	608,79	23.08

	Plecoptera	552,42	20.94
	Trichoptera	154.00	5.84
	Heteroptera	3.72	0.14
	Coleoptera	14,99	0.57
	Chironomidae	890.64	33.76
	other Diptera	161.56	6.12
C5 N 45°12’875” E 22°08’847” 802 m	Oligochaeta	29.99	3.33
	Hirudinea	33.82	3.75
	Ephemeroptera	210.37	23.33
	Plecoptera	105.19	11.67
	Trichoptera	14.99	1.66
	Chironomidae	503.49	55.85
	other Diptera	3.72	0.41
C6 N 45°09’299” E 22°16’838” 420 m	Tricladida	15.78	0.51
	Gastropoda	4.51	0.15
	Oligochaeta	184.89	6.01
	Hydracarina	69.9	2.27
	Amphypoda	6.76	0.22
	Ephemeroptera	863.59	28.06
	Plecoptera	175.87	5.71
	Trichoptera	259.3	8.42
	Coleoptera	171.36	5.57
	Chironomidae	1271.7	41.32
	other Diptera	54.11	1.76
C7 N 45°11’264” E 22°18’308” 354 m	Tricladida	18.04	0.99
	Gastropoda	9.02	0.49
	Oligochaeta	376.55	20.64
	Hydracarina	2.25	0.12
	Ephemeroptera	329.2	18.05
	Plecoptera	22.55	1.24
	Trichoptera	590.76	32.39
	Coleoptera	2.25	0.12
	Chironomidae	439.68	24.10
	other Diptera	33.82	1.85
C8 N 45°14’768” E 22°17’745” 296 m	Tricladida	4.51	0.20
	Gastropoda	4.51	0.20
	Oligochaeta	63.13	2.75
	Hydracarina	2.25	0.10
	Amphypoda	4.51	0.20
	Ephemeroptera	581.74	25.29
	Plecoptera	243.52	10.59
	Trichoptera	608.79	26.47
	Coleoptera	27.06	1.18
	Chironomidae	694.48	30.20
	other Diptera	65.39	2.84
C9 N 45°18’220” E 22°16’516” 265 m	Gastropoda	105.98	6.14
	Oligochaeta	112.74	6.53
	Hydracarina	99.21	5.74
	Amphypoda	2.25	0.13

	Ephemeroptera	288.61	16.71
	Odonata	2.25	0.13
	Plecoptera	45.1	2.61
	Trichoptera	514.09	29.77
	Coleoptera	4.51	0.26
	Chironomidae	469	27.15
	other Diptera	83.43	4.83
C10 N 45°19’770” E 22°15’610” 250 m	Tricladida	41.26	1.70
	Oligochaeta	45.10	1.86
	Hirudinea	11.27	0.47
	Hydracarina	18.71	0.77
	Amphypoda	7.44	0.31
	Ephemeroptera	236.75	9.77
	Plecoptera	11.27	0.47
	Trichoptera	266.74	11.01
	Coleoptera	3.72	0.15
	Chironomidae	1766.18	72.88
	other Diptera	14.99	0.62
C11 N 45°22’255” E 22°13’553” 219 m	Tricladida	4.51	0.11
	Oligochaeta	33.89	0.84
	Hydracarina	187.15	4.65
	Amphypoda	11.27	0.28
	Ephemeroptera	795.94	19.79
	Plecoptera	20.29	0.50
	Trichoptera	1400.23	34.81
	Coleoptera	6.76	0.17
	Chironomidae	1497.18	37.22
	other Diptera	65.39	1.63
C12 N 45°26’569” E 22°12’111” 175 m	Tricladida	37.54	0.72
	Gastropoda	131.45	2.52
	Oligochaeta	604.96	11.61
	Hirudinea	71.36	1.37
	Hydracarina	7.44	0.14
	Amphypoda	3.72	0.07
	Ephemeroptera	1770.01	33.96
	Plecoptera	3.72	0.07
	Trichoptera	1416.69	27.18
	Chironomidae	1086.0	20.84
	other Diptera	78.92	1.52
C13 N 45°31’456” E 22°10’413” 174 m	Oligochaeta	435.85	15.44
	Hydracarina	45.1	1.60
	Ephemeroptera	1217.59	45.68
	Plecoptera	7.44	0.26
	Trichoptera	398.31	14.11
	Coleoptera	3.72	0.13
	Chironomidae	620.07	21.97
	other Diptera	22.55	0.80
C14 N 45°32’939” E 22°09’401”	Tricladida	2.25	0.02
	Gastropoda	18.04	0.17
	Oligochaeta	1573.84	14.45

158 m	Hirudinea	9.02	0.08
	Hydracarina	9.02	0.08
	Ephemeroptera	1456.6	13.39
	Plecoptera	42.84	0.39
	Trichoptera	2901.92	26.65
	Heteroptera	2.25	0.02
	Coleoptera	6.76	0.06
	Chironomidae	4581.74	42.07
	other Diptera	284.1	2.61
C15 N 45°36’476” E 22°04’608” 142 m	Tricladida	20.29	0.18
	Gastropoda	22.55	0.20
	Oligochaeta	2550.17	22.62
	Hydracarina	38.33	0.34
	Amphypoda	2.25	0.02
	Ephemeroptera	1855.69	16.46
	Trichoptera	2786.92	24.72
	Heteroptera	2.25	0.02
	Coleoptera	27.06	0.24
	Chironomidae	3848.93	34.15
	other Diptera	117.25	1.04
C16 N 45°40’182” E 21°57’885” 117 m	Tricladida	13.53	0.29
	Oligochaeta	629.09	13.36
	Hydracarina	49.61	1.05
	Ephemeroptera	649.38	13.79
	Plecoptera	2.25	0.05
	Trichoptera	1303.27	27.67
	Coleoptera	15.78	0.34
	Chironomidae	2011.27	42.70
	other Diptera	36.08	0.77
C17 N 45°44’181” E 21°51’222” 116 m	Tricladida	15.78	1.06
	Oligochaeta	913.19	61.36
	Hydracarina	20.29	1.36
	Ephemeroptera	20.29	1.36
	Trichoptera	58.62	3.94
	Chironomidae	457.72	30.76
	other Diptera	2.25	0.16
C18 N 45°43’590” E 21°34’262” 83 m	Oligochaeta	49.61	4.33
	Ephemeroptera	261.56	22.83
	Plecoptera	15.78	1.38
	Trichoptera	67.64	5.91
	Heteroptera	9.02	0.79
	Chironomidae	741.83	64.76
C19 N 45°38’734” E 21°10’696” 83 m	Gastropoda	31.57	1.56
	Oligochaeta	311.16	15.40
	Hydracarina	20.29	1.01
	Ephemeroptera	15.78	0.78
	Trichoptera	2.25	0.12
	Heteroptera	103.72	5.13
	Chironomidae	1535.51	76.00

C20 N 45°33'000" E 21°03'033" 75 m	Tricladida	11.27	0.50
	Oligochaeta	266.74	11.77
	Hydracarina	112.74	4.98
	Ephemeroptera	63.81	2.82
	Plecoptera	14.99	0.66
	Trichoptera	939.46	41.46
	Heteroptera	14.99	0.66
	Coleoptera	14.99	0.66
	Chironomidae	823.0	36.32
	other Diptera	3.72	0.16
C21 N 45°26'859" E 20°53'309" 74 m	Gastropoda	11.27	0.21
	Bivalvia	529.08	10.01
	Oligochaeta	657.61	12.43
	Hydracarina	37.54	0.71
	Ephemeroptera	409.58	7.74
	Trichoptera	3.72	0.07
	Chironomidae	3641.49	68.82

CONCLUSIONS

The results show that structural spatial variability of benthic macroinvertebrate communities' is conditioned by the substrate type, by the degree of minor riverbed's structural change from the natural conditions, and by the oxydable matter quantity diluted in water.

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