BENTHIC MACROINVERTEBRATE COMMUNITIES IN THE NORTHERN TRIBUTARIES OF THE “IRON GATES” GORGE (DANUBE RIVER)

Angela CURTEAN-BĂNĂDUC *

* “Lucian Blaga” University of Sibiu, Faculty of Sciences, Applied Ecology Research Center, Dr. Ioan Rațiu Street 5-7, Sibiu, Sibiu County, Romania, RO-550012, angela.banaduc@ulbsibiu.ro

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ABSTRACT

The paper presents the structure of the benthonic macro-invertebrates communities in the Berzasca, Sirinia, Liubcova, and Mraconia rivers. The results are based on quantitative benthos samples (95 samples), collected in July 2014 from 19 sampling stations within the study area. In longitudinal profile, the benthonic macro-invertebrate communities of the Sirinia, Liubcova and Berzasca rivers displays relatively large structural variability, while the communities of the Mraconia River displays smaller structural variability. The structure of the benthonic macro-invertebrate communities correlated with the biotope characteristics indicates the good ecological status of the analysed rivers, with the exception of the Berzasca River sector downstream of the town of Berzasca and immediately upstream of the Danube junction, a sector with moderate ecological status due to negative effects from man-made modifications in the lotic biotope of the sector.

RÉSUMÉ: Les communautés de macroinvertébrés benthiques des affluents nord du Danube, dans la région des Portes de Fer.

L'article décrit la structure des communautés de macroinvertébrés benthiques des rivières de Berzasca, Sirinia, Liubcova et Mraconia. Les résultats obtenus sont basés sur des échantillons quantitatifs de benthos (95 échantillons) collectés en juillet 2014 sur 19 stations d'échantillonnage situées dans la zone de référence. En profil longitudinal, les communautés de macroinvertébrés benthiques des rivières de Sirinia, Liubcova et Berzasca présentent une variabilité structurelle assez importante, alors que les communautés de la rivière de Mraconia présentent une moindre variabilité structurelle. La structure des communautés de macroinvertébrés benthiques corrélée aux caractéristiques du biotope relèvent du bon état écologique des rivières analysées, à l'exception de la rivière de Berzasca en aval de la ville de Berzasca, juste avant la confluence avec le Danube, secteur présentant un état écologique modéré, dû à la modification anthropique du biotope lotique dans ce secteur.

REZUMAT: Comunitățile de macronevertebrate bentonice din afluenții nordici ai Dunării, în zona Porțile de Fier.

Lucrarea prezintă descrierea structurii comunităților de macronevertebrate bentonice din râurile Berzasca, Sirinia, Liubcova și Mraconia. Rezultatele se bazează pe probe cantitative de bentos (95 probe), colectate în iulie 2014 din 19 stații de colectare situate în zona de referință. În profil longitudinal, comunitățile de macronevertebrate bentonice din râurile Sirinia, Liubcova și Berzasca prezintă variabilitate structurală relativ mare, iar cele din râul Mraconia prezintă variabilitate structurală mai mică. Structura comunităților de macronevertebrate bentonice în corelație cu caracteristicile biotopului relevă faptul că râurile analizate prezintă o stare ecologică bună, cu excepția sectorului râului Berzasca situat aval de localitatea Berzasca, imediat amonte de confluența cu Dunărea, care prezintă stare ecologică moderată, în acest sector biotopul lotic este modificat antropic.

INTRODUCTION

Construction of the “Iron Gates” I (1972) for hidroenergy and navigation complex modified the hydrological regime of the Danube and its tributaries at the confluence with the newly-created reservoir lake (Ujvari, 1959). After the dam was constructed across the Gura Valley, and the reservoir lake was formed, the river mouths of all Danube tributaries became flooded and turned into bays.

Considering these aspects, this study aims to analyze the longitudinal dynamics of the benthic macroinvertebrate communities of the Danube tributaries flowing from the left side, from the “Iron Gates” area (Fig. 1): Berzasca River, with a catchment area of 229 km²; Sirinia, with a catchment area of 74.2 km², and Mraconia, with a catchment area of 113 km² (Tetelea, 2014).

These rivers have their sources in the Almăj Mountains and cross some sparse settlements at the confluence with the Danube. The study area is part of the “Iron Gates” Natural Park.

These analyzed rivers are classified as western Carpathian type, characterised by flood waters during spring and winter, while winter leakage is more important, due to Mediterranean climate influences which induces the early melting of snow. Rivers are short with large slopes and relatively high flow rates, resulting in a large volume of alluvial material dislocated from the riverbed (Ujvari, 1959).

Studies of the invertebrate communities in northern Danube tributaries of the “Iron Gates” were conducted during 1959 to 1970, before the dam construction and reservoir filling: Botoșanenu (1959) studied fauna of caddisflies, Prunescu-Arion (1968) recorded data on benthic fauna, Antonescu et al. (1969) carried out hydrobiological research on rivers Berzasca and Sirinia, Brezeanu, Prunescu-Arion, and Popescu Marinescu (in Bușniță et al., 1970) studied the taxonomic structure of macroinvertebrate communities in the rivers: Bozneățca, Varada, Sicolovăț, Alibeg, Liuborajdea, Crușovăț, Camenița, Oravița, Berzasca, Sirinia, Elișeva, Povalina, Tisova, Plavișevița, Mraconia, Eșelnița, Cerna, Vodița, Bahna, and Dubova. (Badea et al. 1983; Posea, 1982; Roșu, 1980).

MATERIAL AND METHODS

The results are based on quantitative benthic macroinvertebrate samples (95 samples) taken in July 2014 from 19 stations of the reference areas, located at approximately five km intervals along the four studied Danube tributaries (Fig. 2).

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 cm² 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 invertebrates were identified to order except Oligochaeta, Hirudinea and Chironomidae and the counts were converted to number of individuals per square meter (ind./m²). For the quantitative structure description of the macroinvertebrate communities we used relative abundance (A%) and mean density (Ds) measures.

The assessed biotope variables were: altitude, slope, riverbed width, depth, substratum types, channel modification (expressed as a percentage in comparison to the natural state), riverine vegetation and water physico-chemical characteristics (pH, total dissolved solids – TDS, dissolved oxygen – DO). The substratum types (mud, sand, gravel, pebbles, cobbles, and boulders) were expressed as percentages of the transversal section surface (20 m length).

Figure 1: The sampling stations location on the studied rivers: Berzasca (B1 – B6), Sirinia (S1 – S4), Liubcova (L1 – L5), Mraconia (M1 – M4).

RESULTS AND DISCUSSION

The benthic macroinvertebrate groups with the largest distribution in the reference area are Ephemeroptera, Plecoptera, Trichoptera, and Chironomida, present in all the analysed river sectors. Groups with a more restricted distribution included the Tricladida, Gastropoda, Oligochaeta, Hydracarina, Amphipoda, Odonata, Heteroptera, Coleoptera, and Dipterans other than Chironomidae Family (Tab. 1).

The similarity analysis of the benthic macroinvertebrate communities in the six lotic sectors studied on the Berzasca River, based on the relative abundance values of the present taxa, reveals the fact that they can be classified into five groups (Fig. 3; Tab. 1): I. communities dominated numerically by Ephemeropterans, accompanied by the Planaria, the Trichopterans and the Chironomids, with relative abundances between 10% and 13%, present in B1; II. communities dominated numerically by Ephemeropterans and Trichopterans, accompanied by the Oligochetes and the Plecopterans with relative abundances between 15% and 20%, present in B3; III. communities dominated numerically by Ephemeropterans and Plecopterans, in which Oligochetae present relative abundances comprised between 15% and 20%, present in B2 and B4; IV. communities dominated numerically by Ephemeropterans and Plecopterans, accompanied by Trichopterans and Chironomids with relative abundances between 13% and 19%, present in B5; V. communities dominated numerically by Chironomids, present in B6. A relatively large structural difference was found between communities from the sectors B1 – B5 and that of sector B6 – upstream of the Danube confluence, an area where the lotic habitat is modified by humans and impacted by pollution from waste water and domestic waste generated by the village of Berzasca.

Figure 2: Cluster analysis based on the benthic macroinvertebrate systematic groups relative abundance (A%), of the four analysed lotic sectors of the Sirinia River (euclidian distances, S1 – S4 sampling stations).

The benthic macroinvertebrate communities of **Sirinia River** present a relatively high structural variability along the river (Fig. 2, Tab. 1).

In the upper river sector – sector S1 – the numerically dominant taxa are the Ephemeroptera and the Trichoptera, followed by Chironomida. In this sector, Plectroperans have a relative abundance smaller than 10%, Amphipods and Dipterans have relative abundances between 12% and 20%; sector S2 is numerically dominated by Ephemeropterans, Oligochetae and Dipterans, and, with relative abundances less than 10%, Plecopterans, Trichopterans, Turbellariatae and Coleopterans; downstream, sector S3 is numerically dominated by Ephemeropterans and Dipterans, with lower abundances of Trichopterans (18.64%) and Plecopterans (13.28%), and, with relative abundances under 7%, by Oligochetae, Coleopterans, Amphipods, Turbellariates and Hydracarians; in the lower sector – sector S4 – the Chironomids dominate in numbers, followed by Oligochaeta with relative abundances of 17.23%, with Ephemeropterans, Plecopterans, Trichopterans, Turbellariates, Amphipodes and Hydracarians also being present.

Figure 3: Cluster analysis based on the benthic macroinvertebrate systematic groups relative abundance (A%), of the five analysed lotic sectors of the Liubcova River (euclidian distances, L1 – L5 sampling stations).

Based on the values of relative abundances of the present taxa, the benthic macroinvertebrate communities of the five river sectors analysed along the **Liubcova River** can be classified in three groups (Fig. 3, Tab. 1): I. Communities dominated numerically by Amphipodes, with Plecopterans and Ephemeropterans present at abundances between 7% and 15%, and Trichopterans, Oligochetae and the Dipterans present in relative abundances under 5%, all present in L2 and L4; II. Communities dominated numerically by Ephemeropterans, with Amphipodes and Plecopterans at lower abundances, and Dipterans, Trichopterans and Oligochetae in relative abundances under 4%, present in L1; III. Communities dominated by Ephemeropterans and Oligochetae, accompanied in variable proportions by Dipterans, Plecopterans, Coleopterans and Amphipodes, present in L3 and L5.

Figure 4: Cluster analysis based on the benthic macroinvertebrate systematic groups relative abundance (A%), of the four analysed lotic sectors of the Mraconia River (euclidian distances, M1 – M4 sampling stations).

Benthic macroinvertebrate communities of all four studied sectors along **Mraconia River** have a relatively small structural variability (Fig. 4, Tab. 1), and they can be grouped in two classes: I. Communities in which Ephemeropterans and Plecopterans are numerically co-dominant, with Oligochaetes and Dipterans present in relative abundances ranged between 10% and 19%, and Trichopterans, Coleopterans and Amphipods present in abundances smaller than 10%, present in M1, M2 and M4; II. Communities in which Dipterans and Ephemeropterans are numerically co-dominant, with Oligochaetes and Plecopterans present in small abundances (10.59% and 8.84% respectively), and Trichopterans, Amphipods, Coleopterans and water mites present with relative abundances smaller than 5%, present in M3.

Figure 5: Cluster analysis based on the benthic macroinvertebrate systematic groups relative abundance (A%), of the six analysed lotic sectors from the Berzasca River (euclidian distances, B1 – B6 sampling stations).

In the reference area, the highest density of benthic macroinvertebrates was recorded in **Berzasca River** (Fig. 5, Tab. 1), within the sector placed at 5.5 km upstream of the confluence with the Danube (B5).

High density of Plecopterans is associated with river sectors with a fast flow and a substratum predominantly formed of cobbles and boulders; Ephemeropterans develop populations with a large number of individuals in most of the river sectors, except the sectors in which sedimentary substratum is prevalent – sand and mud. In the case of the other benthic sectors, a dependence pattern of the density on the prevalent substratum type cannot be described in a certain sector.

In terms of biotope conditions, although they occur at relatively low altitudes (under 375 m), the studied rivers have a mountain character up to about 5-6 km upstream the confluence with the Danube, with well oxygenated waters, slightly basic pH and a content of total dissolved solids ranging between 207 mg/l (in M1) and 364 mg/l (in L4 and L5) (Tab. 1).

Table 1: Benthic macroinvertebrate community structure in Berzasca River (B1 – B6), Sirinia River (S1 – S4), Liubcova River (L1 – L5) and Mraconia River (M1 – M4), (Ds – mean density, A% – relative abundance) and riverbed characteristics (Wm – minimum width, WA – average width, WM – maximum width, Dm – minimum depth, DA – average depth, DM – maximum depth, m – mud, s – sand, g – gravel, p – pebbles, c – cobbles, b – boulders, g + m – gravel covered with thin layer of mud).

Sampling station/position, altitude, biotope characteristics	Benthic macroinvertebrate community structure		
	Taxonomic groups	Ds (ind./m ²)	A (%)
B1 N 44°40'616'', E 22°04'904'', 304 m DO = 104.2%, pH = 8.26, TDS = 286 mg/l Wm = 1.5 m, WA = 2.5 m, WM = 3.5 m Dm = 0.05 m, DA = 0.3 m, DM = 0.4 m p – 10%, c – 10%, b – 80%	Tricladida	126.27	10.04
	Gastropoda (<i>A. fluviatilis</i>)	13.53	1.08
	Oligochaeta	13.53	1.08
	Amphypoda	6.76	0.54
	Ephemeroptera	651.63	51.79
	Plecoptera	63.13	5.02
	Trichoptera	153.33	12.19
	Coleoptera	11.27	0.90
	Chironomidae	162.34	12.90
	other Diptera	56.37	4.48
B2 N 44°41'302'', E 22°03'205'', 228 m DO = 104.1%, pH = 8.15, TDS = 240 mg/l Wm = 5 m, WA = 7 m, WM = 9 m Dm = 0.1 m, DA = 0.3 m, DM = 1.2 m s – 3%, p – 7%, c – 40%, b – 50%	Tricladida	22.55	1.83
	Oligochaeta	200.68	16.30
	Hydracarina	11.27	0.92
	Amphypoda	29.31	2.38
	Ephemeroptera	405.86	32.97
	Plecoptera	266.07	21.61
	Trichoptera	105.98	8.61
	Coleoptera	54.11	4.40
	Chironomidae	101.47	8.24
	other Diptera	33.82	2.75
B3 N 44°40'287'', E 22°01'021'', 156 m DO = 106.1%, pH = 8.34, TDS = 248 mg/l Wm = 6 m, WA = 10 m, WM = 15 m Dm = 0.2 m, DA = 0.4 m, DM = 1.4 m p – 20%, c – 60%, b – 20%	Oligochaeta	205.19	18.24
	Hydracarina	2.25	0.20
	Amphypoda	6.76	0.60
	Ephemeroptera	311.16	27.66
	Plecoptera	209.7	18.64
	Trichoptera	304.4	27.05
	Coleoptera	2.25	0.20
	Chironomidae	60.88	5.41
	other Diptera	22.55	2.00

Table 1 (continued): Benthic macroinvertebrate community structure in Berzasca River (B1 – B6), Sirinia River (S1 – S4), Liubcova River (L1 – L5) and Mraconia River (M1 – M4), (Ds – mean density, A% – relative abundance) and riverbed characteristics (Wm – minimum width, WA – average width, WM – maximum width, Dm – minimum depth, DA – average depth, DM – maximum depth, m – mud, s – sand, g – gravel, p – pebbles, c – cobbles, b – boulders, g + m – gravel covered with thin layer of mud).

Sampling station/position, altitude, biotope characteristics	Benthic macroinvertebrate community structure		
	Taxonomic groups	Ds (ind./m ²)	A (%)
B4 N 44°40'40'', E 21°59'108'', 119 m DO = 104.6%, pH = 8.39, TDS = 259 mg/l Wm = 7 m, WA = 12 m, WM = 15 m Dm = 0.2 m, DA = 0.4 m, DM = 1.2 m g – 5%, p – 20%, c – 60%, b – 15%	Tricladida	2.25	0.17
	Gastropoda (<i>A. fluviatilis</i>)	94.7	7.08
	Oligochaeta	263.81	19.73
	Hydracarina	18.04	1.35
	Amphypoda	18.04	1.35
	Ephemeroptera	372.04	27.82
	Odonata	4.51	0.34
	Plecoptera	302.14	22.60
	Trichoptera	119.5	8.94
	Coleoptera	18.04	1.35
	Chironomidae	101.47	7.59
	other Diptera	22.55	1.69
B5 N 44°39'182'', E 21°57'701'', 93 m DO = 107.1%, pH = 8.55, TDS = 258 mg/l Wm = 9 m, WA = 15 m, WM = 17 m Dm = 0.15 m, DA = 0.35 m, DM = 1.3 m s – 3%, p – 35%, c – 45%, b – 17%	Gastropoda (<i>A. fluviatilis</i>)	27.06	1.02
	Oligochaeta	105.98	4.01
	Hydracarina	36.08	1.37
	Amphypoda	4.51	0.17
	Ephemeroptera	671.93	25.43
	Plecoptera	868.09	32.85
	Heteroptera	6.77	0.26
	Trichoptera	358.51	13.57
	Coleoptera	36.08	1.37
	Chironomidae	496.05	18.77
	other Diptera	38.33	1.45
B6 N 44°38'882'', E 21°57'098'', 78 m DO = 100.4%, pH = 8.42, TDS = 260 mg/l Wm = 21 m, WA = 21 m, WM = 22 m Dm = 0.25 m, DA = 0.4 m, DM = 1.8 m s – 7%, g + m – 90%, b – 3%	Gastropoda (<i>A. fluviatilis</i>)	11.27	1.37
	Oligochaeta	74.41	9.04
	Hydracarina	18.04	2.19
	Ephemeroptera	196.17	23.84
	Odonata	2.25	0.27
	Plecoptera	42.84	5.21
	Trichoptera	15.78	1.92
	Coleoptera	6.76	0.82
	Chironomidae	450.96	54.80
	other Diptera	4.51	0.55

Table 1 (continued): Benthic macroinvertebrate community structure in Berzasca River (B1 – B6), Sirinia River (S1 – S4), Liubcova River (L1 – L5) and Mraconia River (M1 – M4), (Ds – mean density, A% – relative abundance) and riverbed characteristics (Wm – minimum width, WA – average width, WM – maximum width, Dm – minimum depth, DA – average depth, DM – maximum depth, m – mud, s – sand, g – gravel, p – pebbles, c – cobbles, b – boulders, g + m – gravel covered with thin layer of mud).

S1 N 44°38'335'', E 22°05'184'', 312 m DO = 104.3%, pH = 8.18, TDS = 214 mg/l Wm = 3 m, WA = 4 m, WM = 5 m Dm = 0.05 m, DA = 0.4 m, DM = 0.8 m s – 3%, c – 30%, b – 67%	Amphypoda	36.08	4.09
	Ephemeroptera	266.07	30.18
	Plecoptera	78.92	8.95
	Trichoptera	286.36	32.48
	Chironomidae	198.42	22.51
	other Diptera	15.78	1.79
S2 N 44°38'594'', E 22°03'534'', 227 m DO = 104.2%, pH = 8.45, TDS = 296 mg/l Wm = 4 m, WA = 6 m, WM = 7 m Dm = 0.3 m, DA = 0.5 m, DM = 1.5 m g – 3%, p – 2%, c – 15%, b – 80%	Tricladida	13.53	3.41
	Oligochaeta	49.61	12.50
	Hydracarina	2.25	0.57
	Ephemeroptera	180.38	45.45
	Plecoptera	31.57	7.96
	Trichoptera	31.57	7.96
	Coleoptera	9.02	2.27
	Chironomidae	33.82	8.52
S3 N 44°37'672'', E 22°01'779'', 110 m DO = 99.1%, pH = 8.35, TDS = 316 mg/l Wm = 3 m, WA = 5 m, WM = 6 m Dm = 0.01 m, DA = 0.25 m, DM = 1.5 m c – 30%, b – 70%	other Diptera	45.1	11.36
	Tricladida	4.51	0.57
	Oligochaeta	51.86	6.50
	Hydracarina	2.25	0.28
	Amphypoda	4.51	0.57
	Ephemeroptera	239.01	29.94
	Plecoptera	105.98	13.28
	Trichoptera	148.82	18.64
	Coleoptera	22.55	2.83
	Chironomidae	45.1	5.65
S4 N 44°37'158'', E 22°00'811'', 81 m DO = 98.8%, pH = 8.21, TDS = 330 mg/l Wm = 10 m, WA = 12 m, WM = 14 m Dm = 0.02 m, DA = 0.3 m, DM = 1.5 m s – 5%, g – 32%, p – 60%, c – 3%	other Diptera	173.62	21.75
	Oligochaeta	173.62	17.23
	Amphypoda	13.53	1.34
	Ephemeroptera	99.21	9.84
	Plecoptera	74.41	7.38
	Trichoptera	22.55	2.24
	Coleoptera	9.02	0.89
	Chironomidae	613.3	60.85
	other Diptera	2.25	0.22

Table 1 (continued): Benthic macroinvertebrate community structure in Berzasca River (B1 – B6), Sirinia River (S1 – S4), Liubcova River (L1 – L5) and Mraconia River (M1 – M4), (Ds – mean density, A% – relative abundance) and riverbed characteristics (Wm – minimum width, WA – average width, WM – maximum width, Dm – minimum depth, DA – average depth, DM – maximum depth, m – mud, s – sand, g – gravel, p – pebbles, c – cobbles, b – boulders, g + m – gravel covered with thin layer of mud).

L1 N 44°45'532'', E 21°59'953'', 375 m DO = 101.6%, pH = 7.97, TDS = 291 mg/l Wm = 2 m, WA = 3 m, WM = 3.5 m Dm = 0.01 m, DA = 0.15 m, DM = 0.6 m s – 15%, g – 50%, p – 35%	Tricladida	2.25	0.30
	Oligochaeta	9.02	1.20
	Amphypoda	162.34	21.62
	Ephemeroptera	401.35	53.45
	Plecoptera	135.29	18.02
	Trichoptera	9.02	1.20
	Chironomidae	29.31	3.90
	other Diptera	2.25	0.30
L2 N 44°44'268'', E 21°58'410'', 270 m DO = 102.9%, pH = 8.19, TDS = 333 mg/l Wm = 6 m, WA = 6 m, WM = 7.5 m Dm = 0.01 m, DA = 0.15 m, DM = 0.5 m s – 10%, g – 30%, p – 45%, c – 10%, b – 5%	Oligochaeta	13.53	1.54
	Amphypoda	622.32	70.95
	Ephemeroptera	124.01	14.14
	Plecoptera	103.72	11.83
	Trichoptera	11.27	1.28
	Chironomidae	2.25	0.26
L3 N 44°43'686'', E 21°55'738'', 264 m DO = 106.1%, pH = 8.43, TDS = 358 mg/l Wm = 3 m, WA = 5 m, WM = 6 m Dm = 0.15 m, DA = 0.2 m, DM = 0.5 m s – 1%, c – 50%, b – 49%	Oligochaeta	133.04	18.55
	Amphypoda	40.59	5.66
	Ephemeroptera	299.89	41.81
	Plecoptera	65.38	9.12
	Trichoptera	115	16.03
	Coleoptera	15.79	2.20
	Chironomidae	18.18	2.53
L4 N 44°40'999'', E 21°54'919'', 124 m DO = 102.5%, pH = 8.31, TDS = 364 mg/l Wm = 4.5 m, WA = 6 m, WM = 7 m Dm = 0.1 m, DA = 0.15 m, DM = 1 m s – 5%, g – 85%, p – 10%	other Diptera	29.32	4.09
	Oligochaeta	29.31	1.50
	Amphypoda	1379.93	70.51
	Ephemeroptera	153.33	7.83
	Plecoptera	257.05	13.13
	Trichoptera	87.94	4.49
	Chironomidae	36.08	1.84
L5 N 44°39'218'', E 21°53'258'', 75 m DO = 98.5%, pH = 8.41, TDS = 364 mg/l Wm = 6 m, WA = 8 m, WM = 9 m Dm = 0.15 m, DA = 0.35 m, DM = 0.8 m m – 5%, s – 35%, g – 60%	other Diptera	13.53	0.69
	Oligochaeta	347.24	18.58
	Amphypoda	2.25	0.12
	Ephemeroptera	899.66	48.13
	Plecoptera	112.74	6.03
	Trichoptera	139.8	7.48
	Chironomidae	363.02	19.42
	other Diptera	4.51	0.24

Table 1 (continued): Benthic macroinvertebrate community structure in Berzasca River (B1 – B6), Sirinia River (S1 – S4), Liubcova River (L1 – L5) and Mraconia River (M1 – M4), (Ds – mean density, A% – relative abundance) and riverbed characteristics (Wm – minimum width, WA – average width, WM – maximum width, Dm – minimum depth, DA – average depth, DM – maximum depth, m – mud, s – sand, g – gravel, p – pebbles, c – cobbles, b – boulders, g + m – gravel covered with thin layer of mud).

M1 N 44°40'892'', E 22°12'614'', 298 m DO = 106.2%, pH = 8.28, TDS = 207 mg/l Wm = 2.5 m, WA = 3.5 m, WM = 6 m Dm = 0.1 m, DA = 0.2 m, DM = 1 m p – 9%, c – 30%, b – 61%	Oligochaeta	250.28	12.82
	Amphypoda	38.33	1.96
	Ephemeroptera	744.08	38.11
	Plecoptera	387.82	19.86
	Trichoptera	126.27	6.47
	Coleoptera	31.57	1.62
	Chironomidae	320.18	16.40
	other Diptera	54.11	2.77
M2 N 44°40'983'', E 22°14'638'', 208 m DO = 106.1%, pH = 8.42 TDS = 253 mg/l Wm = 5 m, WA = 5 m, WM = 6 m Dm = 0.1 m, DA = 0.3 m, DM = 0.4 m p – 20%, c – 50%, b – 30%	Oligochaeta	121.76	16.88
	Amphypoda	2.25	0.31
	Ephemeroptera	306.65	42.50
	Plecoptera	117.25	16.25
	Trichoptera	63.13	8.75
	Coleoptera	36.08	5.00
	Chironomidae	51.86	7.19
	other Diptera	22.55	3.13
M3 N 44°39'884'', E 22°15'638'', 136 m DO = 104.9%, pH = 8.46, TDS = 246 mg/l Wm = 2.5 m, WA = 6 m, WM = 10 m Dm = 0.1 m, DA = 0.25 m, DM = 2.5 m g – 10%, p – 20%, c – 50%, b – 20%	Oligochaeta	218.71	10.59
	Hydracarina	2.25	0.11
	Amphypoda	27.06	1.31
	Ephemeroptera	534.39	25.87
	Plecoptera	182.64	8.84
	Trichoptera	90.19	4.37
	Coleoptera	15.78	0.76
	Chironomidae	717.02	34.72
	other Diptera	277.34	13.43
M4 N 44°39'037'', E 22°16'526'', 52 m DO = 106%, pH = 8.52, TDS = 249 mg/l Wm = 9 m, WA = 9 m, WM = 10 m Dm = 0.05 m, DA = 0.15 m, DM = 1 m g – 5%, p – 20%, c – 30%, b – 45	Oligochaeta	124.01	10.93
	Amphypoda	6.76	0.60
	Ephemeroptera	426.16	37.57
	Plecoptera	311.16	27.44
	Trichoptera	103.72	9.15
	Coleoptera	9.02	0.80
	Chironomidae	112.74	9.94
	other Diptera	40.59	3.58

CONCLUSIONS

Longitudinally, benthic macroinvertebrate communities of the rivers Sirinia, Liubcova and Berzasca have a relatively high structural variability, and those of the Mraconia River have a lower structural variability.

In the case of the rivers Berzasca and Sirinia, a significant difference is clear between the structure of the communities of the river sector from 50 m upstream of the confluence with the Danube and the upstream communities. This difference is most likely due to the transition from the mountain lentic habitats upstream, and the habitats downstream, closer to the Danube confluence.

The structure of the benthic macroinvertebrate communities, in correlation with the biotope features, reveals that the studied rivers have a good ecological state, with the exception of the sector of the Berzasca River situated directly downstream from Berzasca Village and immediately upstream from the confluence with the Danube, which has a moderate condition, as a result of anthropic modification of the lotic biotope.

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