

RESEARCH ON THE ENVIRONMENTAL QUALITY IN DOAMNEI RIVER

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Abstract

The main purpose of this study is to determine the ecological quality of Doamnei River. The present paper was developed on the basis of bibliography in connection with this subject and personal field research conducted during 2016 and 2017. The research objectives aimed at: identifying the structure of the benthic biocenoses in the monitoring points; establishing saprobity index for each species identified and including the monitoring sections into the appropriate saprobity class; determining the ecological quality of Doamnei River in the monitoring points according to the methodology established by the Framework Directive 2000/60 / EC. Following the zoobenthic fauna analysis and the samples taken from the three stations along Doamnei River we have identified 48 species from 7 genera belonging to 16 families from 6 orders. Bahna Rusului station has a high quality ecological condition and Valea Rea and Ciumești have a good quality ecological condition.

Keywords: Doamnei River, environmental quality, macrozoobentos.

1. INTRODUCTION

Doamnei River is the main tributary of Argeș river upper basin, joining it near Pitești town (fig. 1). Its basin is 45°36'33" (north of Glășescu Mare peak) and 44°51'30" (to the south, right at the confluence of Doamnei River with Argeș) - north latitude and 24 ° 44'11" (Moldoveanu peak in the west) and 25°10'12 " (to the east, Malu cu Flori, Dâmbovița) - eastern longitude. It is situated in the south of Făgăraș and Iezer Păpușa mountains, between Argeș and Dâmbovița Rivers, on the territory of Argeș County (99%) and Dâmbovița (1%) (PMBH Argeș-Vedea, 2012).

Doamnei River basin has an area of 1822 square kilometres. The River itself has a length of 109.1 km, and an area of 735 square kilometres. It rises up to the ridge area of Făgăraș Mountains and forms by the confluence of two alpine streams: Valea Rea (95 square kilometres surface and 20 km long, considered as a spring) and Zârna (79 square kilometres surface and 17 km long) (PMBH Argeș-Vedea, 2012). The river flows from Lake Zârna (4840 square metres area and 0.25 m deep) and downriver it meets its right stream and Lake Jghebuoasa (12,000 square metres area and 0,8 m deep) (PMBH Argeș-Vedea, 2012).

Upstream of Bahna Rusului, Doamnei River has an average slope of 40 m/km. It enters the subcarpathian area around Slatina-Nucșoara, where its slopes retreat in Brădet-Câmpulung depression to 4-8 m / km. It has a narrow gorge-like valley. It then crosses the longitudinal depression Șapte Muscele and enters the piedmont area of Argeș Gruiuri, downstream of Domnești. The feature of this sector is the high mobility of the river bed with a strong linear erosion. The local

accumulations of alluvial sediments lead to the formation of islands and the dismantling of courses, especially downstream of the confluence with Târgului River.

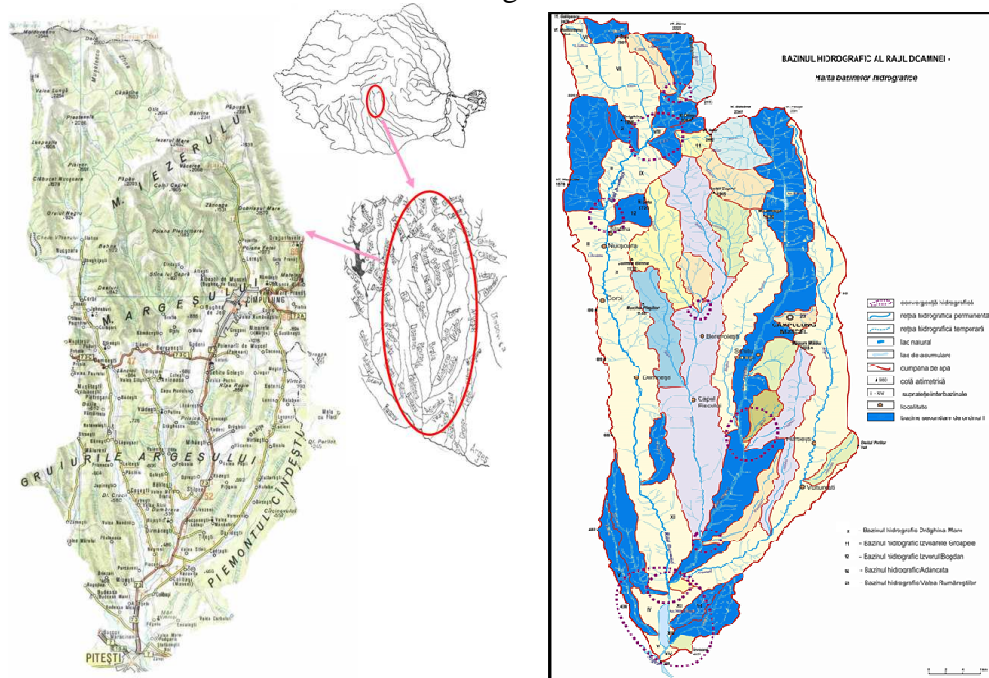


Figure 1. The river basin of Doamnei River - map of river basins (adaptation after Vișan, 2010)

A total average flow of $7.13 \text{ m}^3/\text{s}$ was taken from Doamnei River basin to Vidraru Lake on Argeș, which affected a basin area of 266 square kilometres. The main catchment is Baciului, which includes Doamnei River, downstream of Zărnei confluence with Valea Rea.

The dam has a curved shape, is 34 m high and 105 m long. The accumulation was built only for hydropower purposes, with a collection basin of 204 square kilometres, a discharge rate of $470 \text{ m}^3/\text{s}$ and a free spillway. It has 0.7 million m^3 , an area of 6 ha and is 0.2 km long. Draghina and Bradului on Cernat are lower catchments (PMBH Argeș-Vedea, 2012).

The hydrological balance gradually changes with altitude in the transient physico-geographic conditions from silvo-steppe in the southern basin, the forest area to the lower alpine area, typical of the Carpathian regions (PMBH Argeș-Vedea, 2012).

Doamnei River is snow-fed and moderate underground in the alpine area, snow-rain fed and moderate underground in the mountainous area, rain-snow fed and moderate underground in the sub-mountainous area and mainly rain-fed and moderate underground in the hilly area (PMBH Argeș-Vedea, 2012).

Knowledge of flowing water quality is a specific activity carried out systematically and periodically in order to obtain the fundamental elements for assessing the evolution of water quality and making decisions in the field of water quality management. The information generated by the monitoring program should reflect how the quality and quantity of water meet the requirements of the users or established standards, the extent to which water quality is influenced by natural processes and how water has the capacity to assimilate a large amount of waste, without reaching an unacceptable level of pollution. The monitoring program reflects the compatibility and effectiveness of control strategies and management actions in pollution control, shows the trend of changing water quality according to the change in anthropogenic activities in the area, and the effects of water quality on plants and animals. It also indicates the control measures to be taken to improve or prevent water

quality degradation. Based on these considerations, the main purpose of this study was to determine the ecological quality of Doamnei River.

The present paper was developed on the basis of bibliography in connection with this subject and personal field research conducted between 2016 and 2017. The research objectives were the following: identifying the structure of the benthic biocenoses in the monitoring points; establishing saprobity index for each species identified and including the monitoring sections into the appropriate saprobity class; determining the ecological quality of Doamnei River in the monitoring points according to the methodology established by the Framework Directive 2000/60 / EC.

2. MATERIALS AND METHODS

During August 2016 and April 2017, we had three field work trips in August, October 2016 and April 2017. Following the analysis of the geographical, hydromorphological and anthropogenic characteristics, we set up three sampling stations for qualitative and quantitative samples: Bahna Rusului, Valea Rea and Ciumești. For the quantitative analysis we took three samplings per station, with a Sorber-Sampler benthic mesh having a sampling surface of 0.16 square metres and mesh size 200 μm . We sorted and processed the samples in the Hydrobiology Laboratory of the University of Pitesti. We calculated a number of ecological indices for Ephemeroptera Order, representative of the structure of Doamnei River: ecological spectrum, frequency, species constancy, relative abundance, index of ecological significance (W). We determined the ecological status in accordance with the methodology required by the Water Framework Directive 60/2000 /EC by calculating the multimetric index in each of the sampling stations, taking into account the following indices: Saprob Index (SI), EPT_I Index (individuals) (IEPT_I), Shannon-Wiener Index (SWI), Number of Families (FAM), OCH Index (Oligochaeta-Chironomidae) Index (IOCH/IO), Function Group Index (IGF), Preferred Water Flow Index (reophil /limnophil) (REO/LIM) by the formula: $IM = 0.3*IS+0.1*IEPT_I+0.2*ISH+0.1*FAM+0.1*IOCH+0.1*IGF+0.1*REO/LIM$

3. RESULTS AND DISCUSSIONS

The maximum density of the ephemeroptera was recorded in August 2016 - Bahna Rusului Station - 731 ind./m², whereas Ciumești station recorded a low abundance (fig. 2). The high value recorded in Valea Rea, 598 ind./m² (the maximum for the Plecoptera) was surprising. This was probably due to the considerable decrease of the waste water discharged. The density decreased progressively in downstream stations; except for the situation described above, the other stations recorded low values in plecoptera. Gammaridae prevailed in Valea Rea station; these are clean water indicators; the explanation for their large number in this station has been given before. The trichoptera had the maximum values in Valea Rea station and low values in Bahna Rusului and Ciumești stations.

In October 2016 (fig. 3), the ephemeroptera reached the maximum density in Valea Rea (1050 ind./m²) with a low numerical density in Ciumești (155 ind./m²). The situation was similar for the plecoptera; the number of individuals/m² decreased progressively downstream of the other stations. The trichoptera were kept at low levels in all stations; chironomidae had a very high density in Ciumești.

In April 2017 (fig. 4), the ephemeroptera reached the maximum density in Bahna Rusului (765 ind / m²). The number of ephemeroptera / m² in the other stations decreased progressively upstream, as the flow rate decreased, and the anthropic influence was increasingly high. Plecoptera density decreased progressively from upstream downstream, reaching the maximum value in Bahna Rusului station and the minimum in Ciumești.

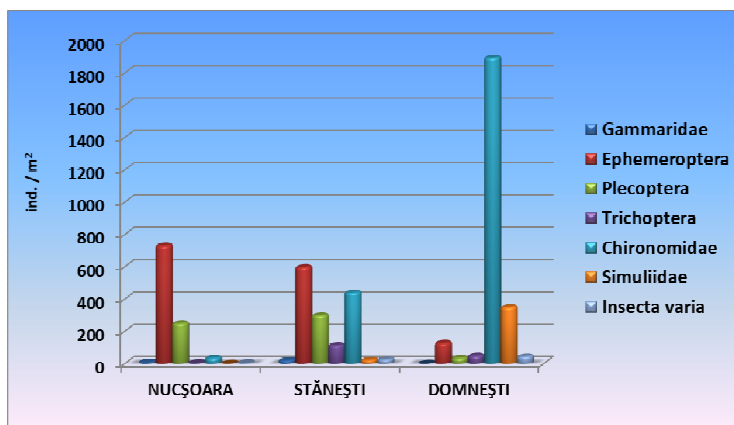


Figure 2. Structure of benthic zoocenosis in Doamnei River - August 2016

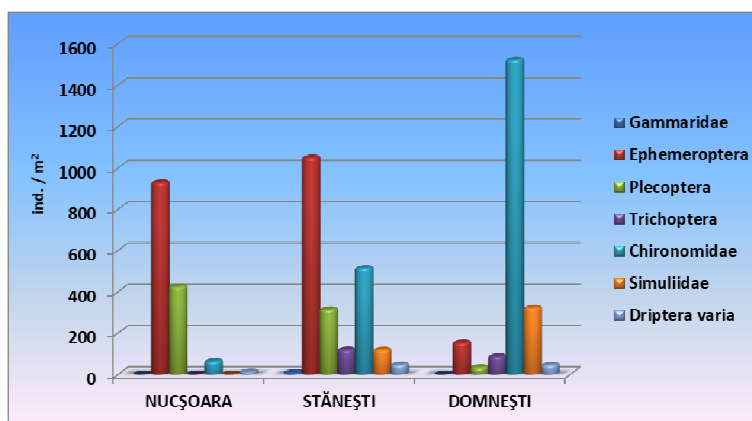


Figure 3. Structure of benthic zoocenosis in Doamnei River - October 2016

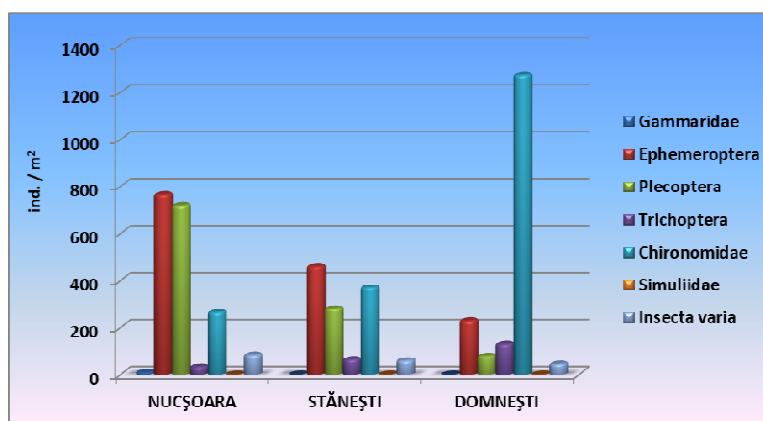


Figure 4. Structure of benthic zoocenosis in Doamnei River - April 2017

Chiromidae recorded an explosive growth in Ciumești station (1273 ind/m²). This was probably due to the abundant torrential rainfall before the sampling period, which led to the overflowing of the river, thus bringing a high organic load from the minor bed, leading to the increase of the quality class. The dominant groups were the ephemeroptera and the plecoptera with a similar downstream upstream distribution, both of which having the highest abundance values in Bahna Rusului (765 and 720 ind/m²) and the lowest in Ciumești station (80-229 ind/m²). Following the zoobenthonic

fauna analysis in the samples taken from the three stations we have identified 48 species from 7 genera belonging to 16 families from all 6 orders. They are shown in Table 1.

Table 1. Species identified in Doamnei River

SPECIES	BAHNA RUSULUI	VALEA REA	CIUMEȘTI	Saprobic value
GAMMARIDAE				
<i>Gammarus fossarum</i> , Koch 1835	9	12	-	1,7
<i>Gammarus roeselli</i> , Gervais 1835	5	15	-	2,2
<i>Gammarus balcanicus</i> , Schaferna 1922	5	6	-	1,2
TOTAL	19	33	-	
EPEHEMEROPTERA				
<i>Baëtis alpinus</i> , Pictet 1843	1087	1027	117	1,0
<i>Baëtis lutheri</i> , Muller 1967	0	0	7	1,6
<i>Baëtis muticus</i> , Linnaeus 1758	0	0	0	1,3
<i>Baëtis rhodani</i> , Pictet 1843	211	190	62	2,1
<i>Baëtis vernus</i> , Curtis 1834	53	53	38	2,3
<i>Rhithrogena semicolorata</i> , Curtis 1834	633	513	91	1,8
<i>Ecdyonurus dispar</i> , Curtis 1834	96	100	0	2,1
<i>Ecdyonurus torrentis</i> , Kimmins 1942	67	67	8	1,2
<i>Ecdyonurus venosus</i> , Fabricius 1775	75	75	74	1,4
<i>Epeorus</i> sp.	23	23	55	1,4
<i>Paraleptophlebia submarginata</i> , Stephens 1835	0	0	54	1,6
<i>Ephemera danica</i> , Muller 1764	35	35	0	1,7
<i>Ephemerella ignita</i> , Eaton 1887	19	19	6	1,5
<i>Caenis macrura</i> , Stephens 1835	5	5	0	1,8
TOTAL	2426	2107	512	
TRICHOPTERA				
<i>Glossosoma conformis</i> , Neboiss 1963	3	45	37	1,0
<i>Agapetus laniger</i> , Pictet 1834	1	21	28	1,5
<i>Oligotricha striata</i> , Linnaeus 1758	6	18	21	1,1
<i>Anabolia nervosa</i> , Curtis 1834	5	60	57	2,1
<i>Ernodes articularis</i> , Pictet 1834	7	48	39	0,5
<i>Silo pallipes</i> , Fabricius 1781	8	55	43	1,2
<i>Allogamus uncatus</i> , Brauer 1857	8	48	35	0,6
TOTAL	38	295	260	
PLECOPTERA				
<i>Capnia nigra</i> , Pictet 1833	250	81	30	1,4
<i>Leuctra fusca</i> , Linnaeus 1758	173	75	21	1,9
<i>Nemoura cinerea</i> , Reitzus 1783	75	70	25	2,1
<i>Nemoura marginata</i> , Pictet 1836	110	83	15	1,5
<i>Perla marginata</i> , Panzer 1799	92	67	21	1,0
<i>Protonemura intricata</i> , Ris 1902	155	70	11	1,2
<i>Protonemura lateralis</i> , Pictet 1836	220	190	15	0,5
<i>Protonemura meyeri</i> , Pictet 1841	180	120	10	0,3
<i>Taeniopteryx hubaulti</i> , Aubert 1946	115	135	7	1,3
TOTAL	1370	891	155	
CHIRONOMIDAE				
<i>Microspectra fusca</i> , MG. 1804	90	-	-	0,8
<i>Stempellenella brevis</i> , EDWARDS 1929	61	190	1500	1,0
<i>Chironomus bernensis</i> , KLOTZ. 1973	58	130	1400	2,9
<i>Clapodelma viridula</i> , LINN. 1767	102	125	1000	2,2

<i>Dicrotendipes notatus</i> , MG. 1818	-	70	690	2,4
<i>Polypedilum laetum</i> , mg. 1818	21	250	-	2,1
<i>Saetheria reissi</i> , JACK. 1977	10	290	-	2,2
<i>Harnischia fuscimana</i> , KIEFF. 1921	26	175	108	2,1
TOTAL	368	1330	4698	
SIMULIIDAE				
<i>Simulium balcanicum</i> , Enderlein 1924	-	80	193	2,2
<i>Simulium angustipes</i> , Edwards 1915	-	-	221	2,0
<i>Simulium carpathicum</i> , Knoz 1961	-	30	175	1,0
<i>Simulium costatum</i> , Friederichs 1920	-	28	81	1,0
TOTAL	-	138	670	
DIPTERA VARIA				
<i>Liponeura spp.</i> , Loew 1844	30	40	55	1,0
<i>Atherix marginata</i> , Meigen 1803	70	55	43	1,2
<i>Limnophila spp.</i> , Macquart 1834	5	43	40	2,0
TOTAL	105	138	138	

The data processed for ephemeroptera are listed in Tables 2 which show the frequency of species in each sampling station, the density, the constancy and the category to which each species belongs. *Baëtis alpinus* species was found in the upstream stations as a first quality indicator. *Baëtis rhodani* was found downstream as a 2nd – 3rd quality indicator. *Rhitrogena semicolorata* was characteristic for all stations, which shows that the sublayer is stony and cloddish with a high flow speed.

In terms of the ecological spectrum (Figures 5) Ecdyonuriidae were best represented in the upstream stations of Bahna Rusului (87%) and Valea Rea. This species was also well represented in Ciumesti station (44%), decreasing progressively to 30% in Valea Rea.

Baetides were best represented in Valea Rea and Ciumesti stations (50-60%), but the percentage decreased to 3% in Bahna Rusului. Ephemeridae, Leptophlebiidae, Ephemerelliidae and Caenidae had a share of less than 10% in all stations.

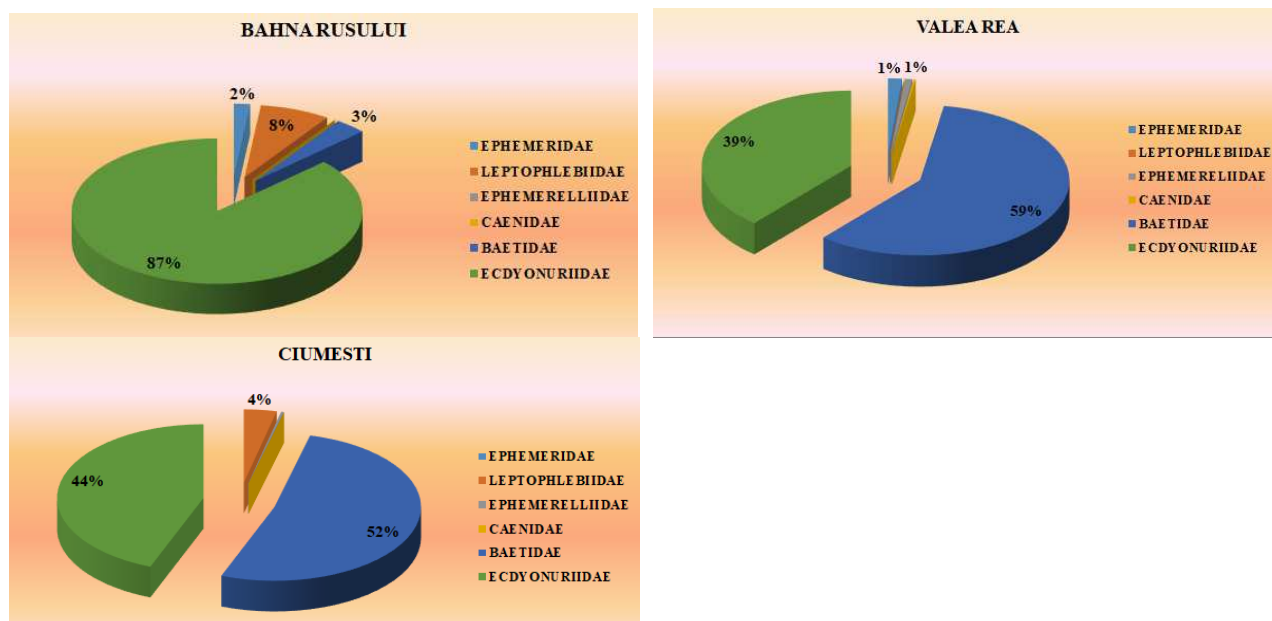


Figure 5. The ecological spectrum of families of the Ephemeroptera fauna in the River Doamnei

Table 2. Ecological characterization of the biocenosis in Doamnei River in terms of Ephemeroptera Fauna

SPECIES	AUGUST	OCTOBER	APRIL	F%	Constancy of the species	n	A	W	W _x	Category of species
BAHNA RUSULUI										
<i>Baëtis alpinus</i>	221	524	342	100	EUCONSTANT	1087	48,44	48,44	W5	CHARACTERISTIC
<i>Baëtis lutheri</i>	-	-	-	0		0	0,00	0,00	W1	ACCIDENTAL
<i>Baëtis muticus</i>	-	-	-	0		0	0,00	0,00	W1	ACCIDENTAL
<i>Baëtis rhodani</i>	110	66	35	100	EUCONSTANT	211	9,40	9,40	W4	CHARACTERISTIC
<i>Baëtis vernus</i>	10	43	-	66	CONSTANT	53	2,36	1,55	W3	ACCESSORY
<i>Rhithrogena semicolorata</i>	234	232	167	100	EUCONSTANT	633	28,20	28,20	W5	CHARACTERISTIC
<i>Ecdyonurus dispar</i>	12	84	-	66	CONSTANT	96	4,27	2,81	W3	ACCESSORY
<i>Ecdyonurus torrentis</i>	29	32	6	100	CONSTANT	67	2,98	2,98	W3	ACCESSORY
<i>Ecdyonurus venosus</i>	20	42	13	100	EUCONSTANT	75	3,34	3,34	W3	ACCESSORY
<i>Epeorus sp.</i>	-	-	23	33		23	1,02	0,33	W2	ACCESSORY
<i>Paraleptophlebia submarginata</i>	-	-	-	0	EUCONSTANT	0	0,00	0,00	W1	ACCIDENTAL
<i>Ephemera danica</i>	-	25	10	66	ACCESSORY	35	1,55	1,02	W3	ACCESSORY
<i>Ephemerella ignita</i>	-	19	-	33	ACCESSORY	19	0,84	0,55	W2	ACCESSORY
<i>Caenis macrura</i>	-	5	-	33	ACCESSORY	5	0,22	0,07	W1	ACCIDENTAL
TOTAL	731	930	765			2426				
VALEA REA										
<i>Baëtis alpinus</i>	211	504	312	100	EUCONSTANT	1027	48,44	48,44	W5	CHARACTERISTIC
<i>Baëtis lutheri</i>	-	-	-	0		0	0,00	0,00	W1	ACCIDENTAL
<i>Baëtis muticus</i>	-	-	-	0		0	0,00	0,00	W1	ACCIDENTAL
<i>Baëtis rhodani</i>	98	62	30	100	EUCONSTANT	190	9,40	9,40	W4	CHARACTERISTIC
<i>Baëtis vernus</i>	10	43	-	66	CONSTANTĂ	53	2,36	1,55	W3	ACCESSORY
<i>Rhithrogena semicolorata</i>	214	132	167	100	EUCONSTANT	513	28,20	28,20	W5	CHARACTERISTIC
<i>Ecdyonurus dispar</i>	12	88	-	66	CONSTANT	100	4,27	2,81	W3	ACCESSORY
<i>Ecdyonurus torrentis</i>	29	32	6	100	CONSTANT	67	2,98	2,98	W3	ACCESSORY
<i>Ecdyonurus venosus</i>	20	42	13	100	EUCONSTANT	75	3,34	3,34	W3	ACCESSORY
<i>Epeorus sp.</i>	-	-	23	33		23	1,02	0,33	W2	ACCESSORY
<i>Paraleptophlebia submarginata</i>	-	-	-	0	EUCONSTANT	0	0,00	0,00	W1	ACCIDENTAL
<i>Ephemera danica</i>	-	25	10	66	ACCESSORY	35	1,55	1,02	W3	ACCESSORY
<i>Ephemerella</i>	-	19	-	33	ACCESSORY	19	0,84	0,55	W2	ACCESSORY

<i>ignita</i>										
<i>Caenis macrura</i>	-	5	-	33	ACCESSORY	5	0,22	0,07	W1	ACCIDENTAL
TOTAL	598	1050	459			2107				
CIUMESTI										
<i>Baëtis alpinus</i>	40	22	55	100	EUCONSTANT	117	23,03	23,03	W5	CHARACTERISTIC
<i>Baëtis lutheri</i>	7	-	-	33	ACCESSORY	7	0,34	1,12	W3	ACCESSORY
<i>Baëtis muticus</i>	-	-	-	0		0	0,00	0,00	W1	ACCIDENTAL
<i>Baëtis rhodani</i>	10	-	52	66	CONSTANT	62	23,13	15,26	W5	CHARACTERISTIC
<i>Baëtis vernus</i>	15	3	20	100	EUCONSTANT	38	5,78	5,78	W4	CHARACTERISTIC
<i>Rhithrogena semicolorata</i>	15	26	50	100	EUCONSTANT	91	33,72	33,72	W5	CHARACTERISTIC
<i>Ecdyonurus dispar</i>	-	-	-	0		0	0,00	0,00	W1	ACCIDENTAL
<i>Ecdyonurus torrentis</i>	-	8	-	33	CONSTANT	8	0,39	0,12	W2	ACCESSORY
<i>Ecdyonurus venosus</i>	21	23	30	100	EUCONSTANT	74	5,58	5,58	W3	ACCESSORY
<i>Epeorus sp.</i>	5	43	7	100		55	4,41	4,41	W3	ACCESSORY
<i>Paraleptophlebia submarginata</i>	12	30	12	100	EUCONSTANT	54	3,62	3,62	W3	ACCESSORY
<i>Ephemera danica</i>	-	-	-	0		0	0,00	0,00	W1	ACCIDENTAL
<i>Ephemerella ignita</i>	3	-	3	66	CONSTANT	6	0,29	0,19	W2	ACCESSORY
<i>Caenis macrura</i>	-	-	-	0	ACCESSORY	0	0,00	0,00	W1	ACCIDENTAL
TOTAL	128	155	229			512				

Table 3. Index values for sampling stations

INDEX	BAHNA RUSULUI	VALEA REA	CIUMEȘTI
Saprob Index (30%)	1,08	0,90	0,72
EPT_I Index (10%)	0,67	0,88	1,46
Shannon-Wiener Index (20%)	0,01	0,01	0,01
Number of Families (10%)	0,84	0,07	0,08
Function Group Index (10%)	1,06	0,92	0,59
Preferred Water Flow Index (reophil /limnophil) (10%)	0,72	0,74	0,58
MULTIMETER INDEX	0,63	0,51	0,47
ECOLOGICAL STATUS	<i>very good ecological status</i>	<i>good ecological status</i>	<i>good ecological status</i>

4. CONCLUSIONS

After studying the field data, we have drawn the following conclusions:

- The main benthic invertebrate groups in Doamnei River are: Ephemeroptera, Plecoptera, Chironomidae, Trichoptera, and Gammaridae.

- Ephemeroptera and plecoptera are oxyphile and rheophile groups well represented in Bahna Rusului station (where the anthropic impact is low, the waters are clean, unpolluted, with high flow rate and low flow).
- The values decrease progressively in the other stations from upstream downstream. The main sources of pollution here are: accidental leakage of waste from factories in the area, natural organic matter from the animals in people's households, salt sprinkled on roads in winter, which is carried through the ground by rainwater and melted snow.
- The number of gammaridae and trichoptera is approximately constant along the river, maintaining low values.
- Depending on the season, the values are comparable in different months, without high variations.
- Bahna Rusului station is characterized by a very good ecological status - the values of the biological, hydromorphological and physico-chemical elements are characterized by values associated with those of the unaltered (reference) or minor anthropic areas.
- Valea Rea and Ciumești Stations are characterized by a good ecological status - the values of the biological, hydromorphological and physico-chemical elements are characterized by slight deviations from the values characteristic of the unaltered areas (reference) or with minor anthropic alterations.
- Ephemeroptera species as well as their ecological distribution shows that these are characteristic of the rhithron area to which the studied water course belongs.
- In the future, it is advisable to supervise Doamnei River to prevent potential sources of anthropogenic negative impact and to monitor it with an annual frequency to ensure that the quality of ecological status is maintained at least at the current level.

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