

Measurement of biological parameters in Lower Danube area

Biological water analysis is an indirect method that determines the degree of contamination of the water and is carried on indicator organisms that inhabit it. Bacteriological and chemical analyzes restore water quality momentary instead bioassay is valid retrospective and perspective, facilitating knowledge level of ecosystem degradation even after the pollution wave faded. Biological assessment methods for water quality in Europe involve analysis of benthic macroinvertebrates communities' response to pollution. These methods are generally based on three types of approaches: biotic approach, saprobe and diversity approach. The main and the most common biological indicator used to evaluate the water quality of a water body is macroinvertebrates. A first approach works at the community level and must analyze how species are related to environment variables, which are stressors that produce the most important long-term changes in the diversity, abundance and their frequency, and their response time medium and long term. Therefore a main step in a biological monitoring process is to determine the principal groups of macroinvertebrates and the main biological indicators that reflect the level of water saprobity.

Materials and methods used to determine benthic invertebrates

Streams with flowing water can generally be divided into several habitat types: pools, runs, glides, riffles, bends, undercuts, etc. Within the major habitat types other habitat categories can be created. Examples would be inorganic substrate like rocks and gravel, or organic substrate like submerged logs and leaf packs. Since each habitat type can have a different macroinvertebrate assemblage, deciding what habitat(s) to sample is necessary. The main objective is to collect a representative variety of species from the selected area.

Materials needed:

- Jars with glass stopper
- Tweezers
- Trays
- Sieves
- Binocular magnifier
- Key for determining

Choice of sampling sites of macroinvertebrates was done depending on the anthropogenic factors from stations located on the Danube (Fig. 1), on the stations located on tributaries Siret and Prut and from the reference sites (Fig. 2). For each section monitored GPS coordinates were noted (Table 2) exactly from where samples were taken and the type of substrate characteristics met (Table 1). Sampling of macroinvertebrates was done according to Romanian standards in force (SR EN 27828:2000, 28265:2001, ISO 5667-3:2007, ISO 8689-1:2003, ISO 8689-2:2003, ISO 9391:2000) by different methods and techniques depending on the nature and substrate depth.

Macroinvertebrates were collected with a rectangular benthic grab, with a opening mouth of 25 x 40 cm and 500 microns mesh size. In the laboratory, samples were washed through sieves with mesh diameter of 250 μ , 500 μ and 1000 μ and preserved in 4% formalin solution. All invertebrates were identified to the lowest possible level and using stereomicroscope Leica S6 D with magnification 40x-6.3x and the microscope Olympus CX 31.

Samples preservation

The collected material (macroinvertebrates) with the sediment where there were found are washed in-situ, removing also the coarse material (stone, wood, glass, etc..) After are extracted the organisms attached to them. The sample was deposited in plastic jars and fixed in 4% formaldehyde concentration. Formalin dissolves limestone formations and penetrates hard into chitin; therefore, molluscs and arthropods may also be conserved in 70% alcohol. The jars were labeled with the date and name of the station from which the sample was collected, after which they were transported to the laboratory for further processing. After washing, each fraction of each sample was analyzed separately, organisms being manually separated in to main groups in bottles.

Sorting

Sorting of the samples was done on benthic sieves with mesh size 250 μ , 500 μ , 1000 μ . After removal of organic matter, the material was examined under the stereomicroscope in a Petri dish and began sorting the groups of organisms. Sorted organisms are deposited in 5-10 ml plastic containers (eg ependorf) and preserved in 70% alcohol.

Samples quantifying

After sorting was passed to taxonomic identification based on phylum, class, order, family, genus, endeavoring determination to species level. The analyses were done with key determination, were made pictures and in some cases there have been prepared by dissection.

Statistical methods:

Also, for data interpretation must be used univariate (diversity analysis) and multivariate methods. For statistical analysis of experimental taxonomic and physico-chemical were used following analysis type:

- NMS ordination (non-metric multidimensional scaling) based on taxonomic data using two types of distance measure: Sorensen and Jacquard;
- Wilcoxon-test for unpaired data sets comparison;
- Principal components analysis (PCA)
- Simple linear regression

NMS ordination (non-metric multidimensional scaling)

NMS analysis is based on the distance measure Sorensen (Bray-Curtis abundance) and compares the similarity of two or more samples, making the sum of absolute differences in total abundance and is applied for qualitative variables.

Formula $QS = 2C / (A + B)$

- Where A and B are the number of species in sample A,
- And B; C = number of species common to both samples.

Compared to Euclidean distance, Sørensen distance retains sensitivity in heterogeneous data sets and gives more weight outliers.

NMS analysis based on distance measure Jacquard (presence/absence). Jaccard distance measure dissimilarity (differences) between the sets of samples (A and B) and is complementary to the Jaccard coefficient. It is obtained by subtracting the Jaccard coefficient of 1.

$$\text{Formula } J\delta(A,B)=1 - J(A, B) = 1 - \frac{|A \cup B| - |A \cap B|}{|A \cup B|}$$

Principal components analysis (PCA)

Introduced by Pearson (1901) and developed independently by Hotelling (1933), principal component analysis is probably the most well known method of multivariate analysis. It is used primarily as a tool for exploratory data analysis and to perform predictive models. The most interesting and strong covariance among variables occurs in the first axes (components), hence the name "main components" (McCune, 2002). The basic idea of PCA is to reduce the size of data sets containing a large number of interrelated variables, while retaining as much of the variation in the data. The reduction is achieved by transforming to a new set variable (composite), uncorrelated and ordered so that the first (major components) contain most of the variation present in the original data set. Thus, a data set containing a total of n objects in p -dimensional space will be reduced to n objects in k -dimensional space with k much smaller than p . Regarding mathematical, calculation of principal components returns to the determination vectors and eigenvalues for a symmetric matrix, semipositiv-defined (Jolliff, 2002).

Simple linear regression

One of the most frequent used techniques in statistics is linear regression where we investigate the potential relationship between a variable of interest (often called the response variable) and a set of one or more variables (known as the independent variables). There are flexible facilities in **R** for fitting a range of linear models from the simple case of a single variable to more complex relationships. In other words, simple linear regression fits a straight line through the set of n points in such a way that makes the sum of squared *residuals* of the model (that is, vertical distances between the points of the data set and the fitted line) as small as possible. This technique is considered appropriate to determine the correlation between biological and chemical parameters.

The data obtained were processed by different statistical methods to check whether different spatial and temporal variations of rows of data accumulated during the investigation area are therefore statistically significant. For data processing were used species and taxa densities in each state.

Statistical programs:

Also for processing and data analysis are used the following programs: Asterisk 3.3.1, STAT-GRAPHICS, Tin-R, PC-ORD

Table 1. Main characteristic type of substrate found for each sampling station

Nr.	Station	Type of substrate	Depth
S1	Amonte Galati	sand, mollusc shells	3 m
S2	Siret	loamy sand sediment	1.5 m
S3	Confluenta Siret-Dunare	sandy- clayey sediment	4 m
S4	Deversor Bac	gravel, fine mud	5 m
S5	Libertatea	organic mud	7 m
S6	Scurta	sand	8 m
S7	Prut	submerged vegetation and clay	2m
S6	Reni	clayey sediment	5 m

Table 2. The geographical coordinates of the sampling sites selected on the Lower Danube area

S1- Ostrovul Chiciului	45 ° 20 '93	28 ° 00' 88
S 2- Şendreni Siret	43 ° 23 '41	27 ° 59' 04
S3- Confluenţă Siret-Dunăre	45 ° 24 '39	28 ° 01' 53
S4- Deversor Bac	45 ° 24 '96	0,28 01' 97
S5 - Libertatea	45 ° 25 '72	28 ° 03' 33

S5- Scurta	45 ° 25 '01	28 ° 11 '16
S 7-Prut Giurgiulești Pod	45 ° 28 '30	0,28° 11' 74
S8 - Reni	45 ° 27' 66	28 ° 14 '0,39
S 9 Reni-Insula	45° 24' 57,79	28° 16' 55,65
S 10 Epava -L	45° 22' 23.74	28° 18' 22,49
S 11 Ciulinet	45° 18' 13,03	28° 23' 29,80
S 12 Isaccea	45° 16' 57,76	28° 27' 38,19
S 13 Isaccea-Tl	45° 14' 14,94	28° 38' 52,07
S 14 Insula	45° 13' 20,54	28° 12' 16,98
S 15 Ceatal Chilia	45° 13' 35,27	28° 44' 04,32

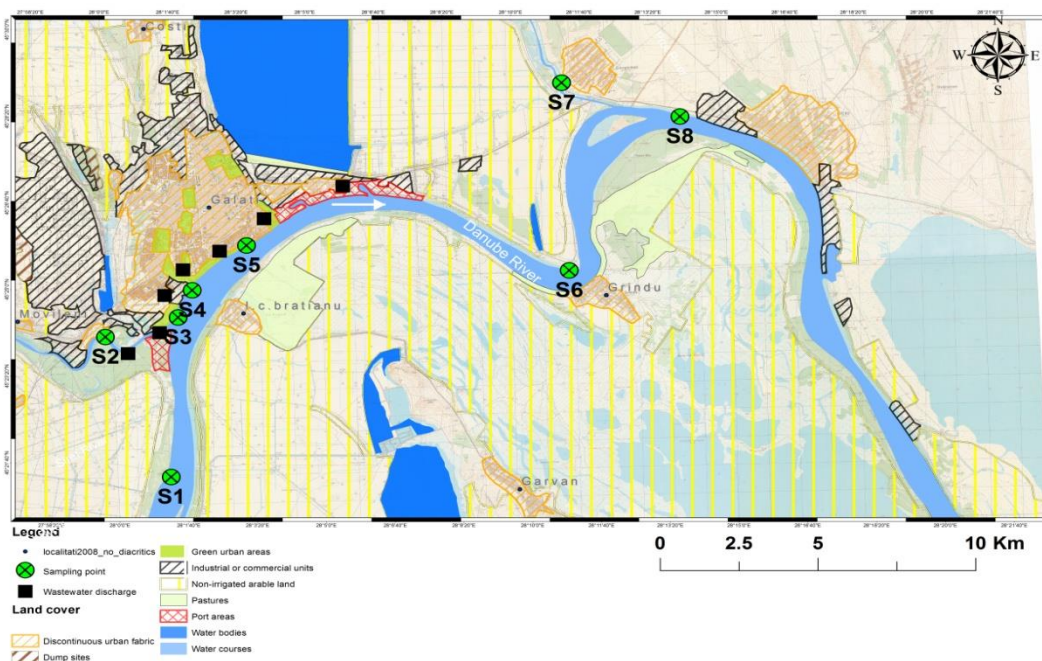


Fig. 1 Map of the sampling are situated on the Danube and its tributaries Siret and Prut

A more accurate monitoring and assessment of the quality of a water body requires to establish reference sites where the existence of anthropogenic action to be reduced, thus

macroinvertebrates communities less stressed by mechanical factors (eg substrate dredging and relocation of bodies sessile) and chemical.

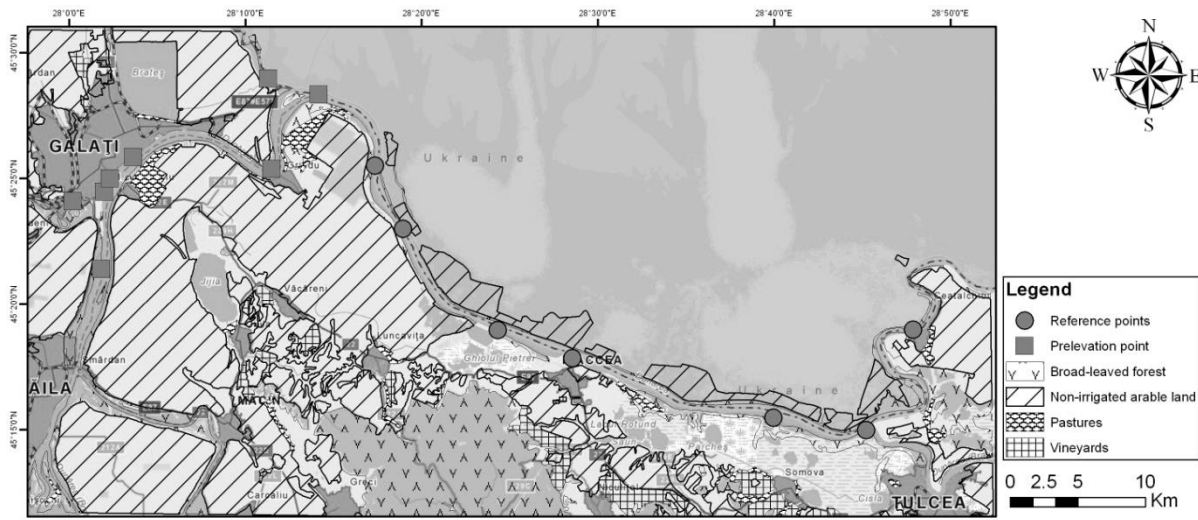


Figure 2. Map of the reference sites location and the land use surroundings

Results from determining of aquatic fauna of the Lower Danube

The most significant results are shown below

Sampling campaign I- September 2013

Analysis of aquatic fauna species, respectively species level determination of aquatic macroinvertebrates

There were determined the saprobic groups

There were determined the frequency and abundance of individuals

There was determined Saprobic Pantle-Buck Index

There was determined Simpson Diversity Index

Framing the water in quality classes in accordance with macroinvertebrates indicator

Reference document: Marcoci, S. (1984) Methodological guidelines for tracking water quality evolution through biological analyzes

Station 1- Upstream Galați (Danube)

Nr. crt.	Taxa identified		Saprobic group	Frequency	
	Group	Species		Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Dikerogammarus haemobaphes	b	7	1
2	Amphipoda	Dikerogammarus villosus	b	3	1
3	Amphipoda	Uroniphargoides spinicaudatus		7	
4	Bivalvia	Corbicula fluminea	b	38	4
5	Bivalvia	Dreissena bugensis		14	
6	Bivalvia	Dreissena polymorpha	b	20	3
7	Gastropoda	Lithoglyphus naticoides	b	32	4
8	Gastropoda	Valvata (Valvata) cristata	b	18	3
9	Gastropoda	Viviparus acerosus	b	135	6
10	Gastropoda	Viviparus viviparus	b	18	3
11	Oligochaeta	Aulodrilus sp.		3	
12	Oligochaeta	Lumbriculidae Gen sp.		3	
13	Oligochaeta	Piguetiella blanci		3	
14	Polychaeta	Hypania invalida	ba	8	1

Results		
Densitate (ex./mp):		305
Bioindicatori oligosaprobi:		0
Bioindicatori beta mezosaprobi:		272
Bioindicatori alfa mezosaprobi:		4

Bioindicatori polisaprobi:		0
EPTT(nr.)		0
EPTT(%)		0.00
EPTI(nr.)		0
EPTI(%)		0.00
Grad de curățenie C% (Knöpp):		98.08
Zona saprobă (Szabó):		oligo-beta
Pantle-Buck	Index saprob:	2.01
	Zona saprobă:	beta
Simpson	Indice Simpson (D):	0.234
	Indice de diversitate (1-D):	0.766
	Indice reciproc (1/D):	4.269
Quality class:		II.

Station 2 – Siret – Sendreni

Nr. crt.	Taxa identified		Saprobic group	Frequency	
	Group	Species		Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Corophium curvispinum Sars 1895	b	8	1
2	Amphipoda	Dikerogammarus haemobaphes (Eichwald 1841)	b	32	4
3	Amphipoda	Dikerogammarus villosus (Sowinsky 1894)	b	27	3
4	Bivalvia	Dreissena polymorpha (Pallas 1771)	b	48	4
5	Bivalvia	Dreissena bugensis Andrusov, 1897		7	
6	Diptera	Beckidia zabolotzkyi (Goetghebuer 1938)		5	
7	Diptera	Paratendipes intermedius Chernovskij,	ba	4	1

		1949			
8	Oligochaeta	Piguetiella blanci (Piguet 1906)		3	

Results		
Densitate (ex./mp):		133
Bioindicatori oligosaprobi:		0
Bioindicatori beta mezosaprobi:		116
Bioindicatori alfa mezosaprobi:		2
Bioindicatori polisaprobi:		0
EPTT(nr.)		0
EPTT(%)		0.00
EPTI(nr.)		0
EPTI(%)		0.00
Grad de curățenie C% (Knöpp):		96.15
Zona saprobă (Szabó):		oligo-beta
Pantle-Buck	Index saprob:	2.02
	Zona saprobă:	beta
Simpson	Indice Simpson (D):	0.230
	Indice de diversitate (1-D):	0.770
	Indice reciproc (1/D):	4.356
Quality class:		II.

Station 3 – Confluenta Siret- Dunare

	Taxa identified			Frequency	
Nr. crt.	Group	Species	Saprobic group	Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Corophium curvispinum Sars 1895	b	9	1
2	Amphipoda	Corophium sp. Latreille 1806		3	
3	Amphipoda	Dikerogammarus haemobaphes (Eichwald 1841)	b	8	1
4	Amphipoda	Dikerogammarus villosus (Sowinsky 1894)	b	4	1
5	Amphipoda	Gammarus pulex pulex (Linnaeus 1758)		5	
6	Amphipoda	Obesogammarus obesus (Sars 1894)		7	
7	Bivalvia	Dreissena polymorpha (Pallas 1771)	b	14	2
8	Bivalvia	Pseudanodonta complanata (Rossmassler 1835)	b	4	1
9	Diptera	Beckidia zabolotzkyi (Goetghebuer 1938)		3	
10	Diptera	Paratendipes intermedius Chernovskij, 1949	ba	10	1
11	Diptera	Polypedilum (Polypedilum) nubeculosum (Meigen 1804)	ba	5	1
12	Diptera	Polypedilum (Uresipedilum) convictum (Walker 1856)	b	3	1
13	Diptera	Rheopelopia sp. Fittkau 1962		3	
14	Ephemeroptera	Palingenia longicauda (Olivier 1791)	b	1	1
15	Gastropoda	Lithoglyphus naticoides (C. Pfeiffer 1828)	b	12	2
16	Gastropoda	Planorbis (Planorbis) carinatus O.F. Muller 1774	b	4	1
17	Mysida	Paramysis lacustris tanaitica (Martynov, 1924)	b	4	1
18	Odonata	Gomphus vulgatissimus (Linnaeus 1758)	b	5	1
19	Oligochaeta	Limnodrilus sp. Claparede 1862		3	
20	Oligochaeta	Limnodrilus udekemianus Claparede 1862	ap	6	1
21	Oligochaeta	Lumbriculidae Gen sp.		8	
22	Oligochaeta	Potamothrix sp. Vejdovsky & Mrazek 1903		4	

23	Oligochaeta	Potamothrix vej dovskyi (Hrabe 1941)	ba	4	1
24	Polychaeta	Hypania invalida (Grube, 1860)	ba	7	1
25	Trichoptera	Hydropsyche contubernalis McLachlan 1865	ba	8	1
26	Trichoptera	Hydropsyche sp. Pictet 1834		3	

Results		
Densitate (ex./mp):		146
Bioindicatori oligosaprobi:		0
Bioindicatori beta mezosaprobi:		84
Bioindicatori alfa mezosaprobi:		20
Bioindicatori polisaprobi:		3
EPTT(nr.)		3
EPTT(%)		27.27
EPTI(nr.)		12
EPTI(%)		8.14
Grad de curățenie C% (Knöpp):		81.58
Zona saprobă (Szabó):		beta
Pantle-Buck	Index saprob:	2.24
	Zona saprobă:	beta
Simpson	Indice Simpson (D):	0.043
	Indice de diversitate (1-D):	0.957
	Indice reciproc (1/D):	23.308
Quality class:		II.

Station 4- Deversor Bac (Dunăre)

	Taxa identified			Frequency	
Nr. crt.	Group	Species	Saprobic group	Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Corophium curvispinum Sars 1895	b	98	5
2	Amphipoda	Dikerogammarus haemobaphes (Eichwald 1841)	b	48	4
3	Amphipoda	Dikerogammarus villosus (Sowinsky 1894)	b	18	3
4	Amphipoda	Obesogammarus obesus (Sars 1894)		20	
5	Bivalvia	Corbicula fluminalis (O. F. Muller 1774)	b	9	1
6	Bivalvia	Corbicula fluminea (O. F. Muller 1774)	b	3	1
7	Bivalvia	Dreissena polymorpha (Pallas 1771)	b	49	4
8	Bivalvia	Sphaerium rivicola (Lamarck 1818)	ba	3	1
9	Bivalvia	Unio pictorum (Linnaeus 1758)	b	3	1
10	Diptera	Ablabesmyia (Ablabesmyia) longistyla Fittkau 1962	b	4	1
11	Gastropoda	Lithoglyphus naticoides (C. Pfeiffer 1828)	b	15	2
12	Gastropoda	Theodoxus danubialis (C. Pfeiffer 1828)	ob	3	1
13	Gastropoda	Theodoxus fluviatilis (Linnaeus 1758)	b	4	1
14	Gastropoda	Viviparus acerosus (Bourguignat 1862)	b	3	1
15	Gastropoda	Viviparus viviparus (Linnaeus 1758)	b	4	1
16	Oligochaeta	Limnodrilus udekemianus Claparede 1862	ap	6	1
17	Polychaeta	Hypania invalida (Grube, 1860)	ba	10	1
18	Trichoptera	Hydropsyche contubernalis McLachlan 1865	ba	19	3

Results		
Densitate (ex./mp):		314
Bioindicatori oligosaprobi:		1

Bioindicatori beta mezosaprobi:		271
Bioindicatori alfa mezosaprobi:		19
Bioindicatori polisaprobi:		3
EPTT(nr.)		1
EPTT(%)		14.29
EPTI(nr.)		19
EPTI(%)		5.98
Grad de curățenie C% (Knöpp):		89.06
Zona saprobă (Szabó):		beta
Pantle-Buck	Index saprob:	2.08
	Zona saprobă:	beta
Simpson	Indice Simpson (D):	0.157
	Indice de diversitate (1-D):	0.843
	Indice reciproc (1/D):	6.373
Quality class:		II.

Station 5 – Libertatea (Dunăre)

	Taxa identified			Frequency	
Nr. crt.	Group	Species	Saprobic group	Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Dikerogammarus villosus (Sowinsky 1894)	b	18	3
2	Bivalvia	Dreissena polymorpha (Pallas 1771)	b	20	3
3	Diptera	Chironomus (Chironomus) riparius Meigen 1804	ap	60	5
4	Diptera	Chrysops sp. Meigen 1803		5	
5	Diptera	Stratiomyidae Gen sp.		3	

6	Gastropoda	Lithoglyphus naticoides (C. Pfeiffer 1828)	b	70	5
7	Gastropoda	Theodoxus (Theodoxus) danubialis (C. Pfeiffer 1828)	ob	3	1
8	Odonata	Gomphus vulgatissimus (Linnaeus 1758)	b	5	1
9	Oligochaeta	Aulodrilus sp. Bretscher 1899		5	
10	Oligochaeta	Tubifex ignotus (Stolc 1886)		35	
11	Oligochaeta	Tubifex tubifex (Muller 1774)	ap	8	1
12	Oligochaeta	Tubificidae Gen sp.		70	

Results			
Densitate (ex./mp):			300
Bioindicatori oligosaprobi:			1
Bioindicatori beta mezosaprobi:			114
Bioindicatori alfa mezosaprobi:			34
Bioindicatori polisaprobi:			34
EPTT(nr.)			0
EPTT(%)			0.00
EPTI(nr.)			0
EPTI(%)			0.00
Grad de curățenie C% (Knöpp):			68.42
Zona saprobă (Szabó):			beta
Pantle-Buck	Index saprob:		2.55
	Zona saprobă:		beta-alfa
Simpson	Indice Simpson (D):		0.169
	Indice de diversitate (1-D):		0.831

	Indice reciproc (1/D):		5.911
Quality class:			III.

Station 6 – Scurta (Aval Galați- Dunăre)

Nr. crt.	Taxonii identificați		Saprobic group	Frequency	
	Group	Species		Abs. ind./m ²	Rel. (Knöpp)
MACROZOOBENTOS					
1	Amphipoda	Corophium curvispinum Sars 1895	b	38	4
2	Amphipoda	Corophium robustum Sars 1895		16	
3	Amphipoda	Dikerogammarus haemobaphes (Eichwald 1841)	b	68	5
4	Amphipoda	Echinogammarus placidus (Sars 1896)	b	3	1
5	Amphipoda	Isochaetides michaelsoni (Lastockin 1936)		3	
6	Amphipoda	Obesogammarus obesus (Sars 1894)		2	
7	Bivalvia	Dreissena polymorpha (Pallas 1771)	b	2	1
8	Bivalvia	Sphaerium rivicola (Lamarck 1818)	b	3	1
9	Diptera	Ablabesmyia (Ablabesmyia) longistyla Fittkau 1962	b	3	1
10	Diptera	Cryptochironomus obreptans (Walker 1856)	ba	3	1
11	Diptera	Polypedilum (Polypedilum) nubeculosum (Meigen 1804)	ba	1	1
12	Gastropoda	Theodoxus (Theodoxus) transversalis (C. Pfeiffer 1828)		1	
13	Isopoda	Jaera istri Veuille 1979	b	2	1
14	Mysida	Limnomysis benedeni Czerniavsky 1882	b	4	1
15	Mysida	Paramysis lacustris tanaitica (Martynov, 1924)	b	1	1
16	Odonata	Gomphus vulgatissimus (Linnaeus 1758)	b	2	1
17	Oligochaeta	Tubificidae Gen sp.		3	

18	Polychaeta	Hypania invalida (Grube, 1860)	ba	12	2
19	Trichoptera	Hydropsyche contubernalis McLachlan 1865	ba	10	1
20	Trichoptera	Hydropsyche sp. Pictet 1834		1	

Results			
Densitate (ex./mp):			176
Bioindicatori oligosaprobi:			0
Bioindicatori beta mezosaprobi:			137
Bioindicatori alfa mezosaprobi:			13
Bioindicatori polisaprobi:			0
EPTT(nr.)			2
EPTT(%)			28.57
EPTI(nr.)			11
EPTI(%)			6.16
Grad de curățenie C% (Knöpp):			88.64
Zona saprobă (Szabó):			beta
Pantle-Buck	Index saprob:		2.09
	Zona saprobă:		beta
Simpson	Indice Simpson (D):		0.208
	Indice de diversitate (1-D):		0.792
	Indice reciproc (1/D):		4.803
Quality class:			II.

Station 7 – Prut – Giurgiuleşti

Nr. crt.	Taxa identified		Saprobic group	Frequency	
	Group	Species		Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Corophium curvispinum Sars 1895	b	185	6
2	Amphipoda	Corophium robustum Sars 1895		25	
3	Amphipoda	Dikerogammarus haemobaphes (Eichwald 1841)	b	35	4
4	Amphipoda	Gammarus fossarum Koch, in Panzer 1835	b	65	5
5	Bivalvia	Dreissena polymorpha (Pallas 1771)	b	45	4
6	Coleoptera	Potamophilus acuminatus (Fabricius 1792)	ob	5	1
7	Diptera	Ablabesmyia (Ablabesmyia) longistyla Fittkau 1962	b	5	1
8	Diptera	Dicrotendipes nervosus (Staeger 1839)	a	35	4
9	Diptera	Endochironomus sp. Kieffer 1918		10	
10	Diptera	Simulium sp. Latreille 1802		55	
11	Ephemeroptera	Heptagenia sulphurea (Muller 1776)	b	55	5
12	Gastropoda	Theodoxus (Theodoxus) danubialis (C. Pfeiffer 1828)	ob	5	1
13	Isopoda	Jaera istri Veuille 1979	b	10	1
14	Trichoptera	Hydropsyche contubernalis McLachlan 1865	ba	225	6
15	Trichoptera	Rhyacophila dorsalis (Curtis 1834)	b	85	5
16	Trichoptera	Rhyacophila sp. Pictet 1834		10	

Results		
Densitate (ex./mp):		855

Bioindicatori oligosaprobi:		5
Bioindicatori beta mezosaprobi:		603
Bioindicatori alfa mezosaprobi:		148
Bioindicatori polisaprobi:		0
EPTT(nr.)		4
EPTT(%)		40.00
EPTI(nr.)		375
EPTI(%)		43.86
Grad de curățenie C% (Knöpp):		83.72
Zona saprobă (Szabó):		beta
Pantle-Buck	Index saprob:	2.19
	Zona saprobă:	beta
Simpson	Indice Simpson (D):	0.147
	Indice de diversitate (1-D):	0.853
	Indice reciproc (1/D):	6.826
Quality class:		II.

Station 8 – Reni (Dunăre)

Nr. crt.	Taxa identified		Saprobic group	Frequency	
	Group	Species		Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Gammarus fossarum Koch, in Panzer 1835	b	198	6
2	Amphipoda	Uroniphargoides spinicaudatus (Carausu 1943)		8	

3	Diptera	Beckidia zabolotzkyi (Goetghebuer 1938)		128	
4	Diptera	Chernovskiiia orbicus (Townes 1945)		8	
5	Gastropoda	Lithoglyphus naticoides (C. Pfeiffer 1828)	b	20	3
6	Oligochaeta	Eiseniella tetraedra (Savigny 1826)	b	10	1
7	Oligochaeta	Enchytraeus albidus Henle 1837	a	8	1

Results		
Densitate (ex./mp):		378
Bioindicatori oligosaprobi:		0
Bioindicatori beta mezosaprobi:		228
Bioindicatori alfa mezosaprobi:		8
Bioindicatori polisaprobi:		0
EPTT(nr.)		0
EPTT(%)		0.00
EPTI(nr.)		0
EPTI(%)		0.00
Grad de curățenie C% (Knöpp):		90.91
Zona saprobă (Szabó):		beta
Pantle-Buck	Index saprob:	2.03
	Zona saprobă:	beta
Simpson	Indice Simpson (D):	0.391
	Indice de diversitate (1-D):	0.609
	Indice reciproc (1/D):	2.558
Quality class:		II.

Sampling campaign II – November 2013

Analysis of aquatic fauna species, respectively species level determination of aquatic macroinvertebrates

There were determined the saprobic groups

There were determined the frequency and abundance of individuals

There was determined Saprobic Pantle-Buck Index

There was determined Simpson Diversity Index

Framing the water in quality classes in accordance with macroinvertebrates indicator

Reference document: Marcoci, S. (1984) Methodological guidelines for tracking water quality evolution through biological analyzes

Station 1 – Upstream Galați (Danube)

Nr. crt.	Taxa identified		Saprobic group	Frequency	
	Group	Species		Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Dikerogammarushaemobaphes	b	3	1
2	Amphipoda	Obesogammarusobessus		13	
3	Bivalvia	Pisidiumcasertanum	b	3	1
4	Bivalvia	Corbiculafluminea	b	38	4
5	Diptera	Lipiniellamoderata		1	
6	Bivalvia	Dreissenapolymorpha	b	73	5
7	Gastropoda	Lithoglyphusnaticoides	b	95	5
8	Amphipoda	Gammarusfossarum	b	150	6
9	Gastropoda	Viviparusacerosus	b	18	3
10	Gastropoda	Viviparusviviparus	b	3	1
11	Oligochaeta	Aulodrilus sp.		8	

12	Oligochaeta	Lumbriculidae Gen sp.		1	
13	Oligochaeta	Piguetiellabanci		3	

Results			
Densitate (ex./mp):			407
Bioindicatorioligosaprobi:			0
Bioindicatori beta mezosaprobi:			381
Bioindicatorialfamezosaprobi:			0
Bioindicatoripolisaprobi:			0
EPTT(nr.)			0
EPTT(%)			0.00
EPTI(nr.)			0
EPTI(%)			0.00
Grad de curățenie C% (Knöpp):			100.00
Zonasaprobă (Szabó):			oligo
Pantle-Buck	Index saprob:		2.00
	Zonasaprobă:		beta
Simpson	Indice Simpson (D):		0.232
	Indice de diversitate (1-D):		0.768
	Indicereciproci (1/D):		4.302
Quality class:			II.

Station 2 – Siret –Sendreni

Nr. crt.	Taxa identified		Saprobic group	Frequency	
	Group	Species		Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	

1	Oligochaeta	Encytraeus albidus	ba	18	3
2	Oligochaeta	Pristina longiseta	ba	2	1
3	Oligochaeta	Nais simplex	ba	7	1
4	Oligochaeta	Limnodrilus profundicola	a	12	2
5	Oligochaeta	Potamothenix vejovskyi	ba	45	4
6	Oligochaeta	Tubificidae juv.		10	
7	Diptera	Cricotopus vierrensis	b	2	1
8	Diptera	Rheocricotopus fuscipes	b	2	1

Results			
Densitate (ex./mp):			96
Bioindicatori oligosaprobi:			0
Bioindicatori beta mezosaprobi:			39
Bioindicatori alfa mezosaprobi:			47
Bioindicatori polisaprobi:			0
EPTT(nr.)			0
EPTT(%)			0.00
EPTI(nr.)			0
EPTI(%)			0.00
Grad de curățenie C% (Knöpp):			50.00
Zonasaprobă (Szabó):			beta-alfa
Pantle-Buck	Index saprob:		2.55
	Zonasaprobă:		beta-alfa
Simpson	Indice Simpson (D):		0.278
	Indice de diversitate (1-D):		0.722
	Indice reciproc (1/D):		3.600
Quality class:			III.

Station 3- Confluența Siret – Dunăre

Nr. crt.	Taxa identified	Species	Saprobic group	Frequency	
	Group			Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Dikerogammarus villosus	b	23	3
2	Amphipoda	Gammarus pulex pulex	b	48	4
3	Amphipoda	Obesogammarus obesus	b	22	3
4	Bivalvia	Dreissena polymorpha	b	34	4
5	Gastropoda	Lithoglyphus naticoides	b	238	6
6	Gastropoda	Planorbis (Planorbis) carinatus	b	2	1
7	Odonata	Gomphus vulgatissimus	b	2	1
8	Oligochaeta	Potamothenix vejdovskyi	ba	10	1
9	Gastropoda	Viviparus viviparus	b	2	1
10	Bivalvia	Corbicula fluminea	b	15	2
11	Gastropoda	Gyraulus riparius		2	
12	Oligochaeta	Aulodrilus limnobius		4	
13	Oligochaeta	Limnodrilus dehemianus	ap	6	1

Results			
Densitate (ex./mp):			407
Bioindicatori oligosaprobi:			0
Bioindicatori beta mezosaprobi:			390
Bioindicatori alfa mezosaprobi:			8
Bioindicatori polisaprobi:			3
EPTT(nr.)			0
EPTT(%)			0.00
EPTI(nr.)			0
EPTI(%)			0.00

Grad de curățenie C% (Knöpp):			94.44
Zonasaprobă (Szabó):			beta
Pantle-Buck	Index saprob:		2.03
	Zonasaprobă:		beta
Simpson	Indice Simpson (D):		0.369
	Indice de diversitate (1-D):		0.631
	Indicereciprocal (1/D):		2.709

Station 4 – DeversorBac (Dunăre)

	Taxa identified			Frequency	
Nr. crt.	Group	Species	Saprobic group	Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	CorophiumcurvispinumSars 1895	b	78	5
2	Amphipoda	Gammarusfossarum	b	18	3
3	Amphipoda	Dikerogammarusvillosus (Sowinsky 1894)	b	151	6
4	Amphipoda	Obesogammarusobesus (Sars 1894)	b	28	3
5	Bivalvia	Corbiculafluminalis (O. F. Muller 1774)	b	14	2
6	Bivalvia	Corbiculafluminea (O. F. Muller 1774)	b	50	4
7	Bivalvia	Dreissenapolymorpha (Pallas 1771)	b	20	3
8	Gastropoda	Gyraulus sp.		5	
9	Diptera	Ablabesmyia (Ablabesmyia) longistylaFittkau 1962	b	3	1
10	Gastropoda	Lithoglyphusnaticoides (C. Pfeiffer 1828)	b	26	3
11	Gastropoda	Theodoxus (Theodoxus) danubialis (C. Pfeiffer 1828)	ob	6	1
12	Gastropoda	Viviparusacerosus (Bourguignat 1862)	b	5	1
13	Gastropoda	Viviparusviviparus (Linnaeus 1758)	b	4	1
14	Oligochaeta	LimnodrilusudekemianusClaparede 1862	ap	51	5

15	Trichoptera	Hydropsychecontubernalis McLachlan 1865	ba	4	1
16	Diptera	Psychodaalternata	ap	3	1
17	Diptera	Polypedilumnubeculosum	ba	4	1
18	Diptera	Rheopelopia sp.		3	
19	Oligochaeta	Potamothenixvejdovskyi	ba	11	2

Results			
Densitate (ex./mp):			481
Bioindicatorioligosaprobi:			3
Bioindicatori beta mezosaprobi:			408
Bioindicatorialfamezosaprobi:			36
Bioindicatoripolisaprobi:			27
EPTT(nr.)			1
EPTT(%)			10.00
EPTI(nr.)			4
EPTI(%)			0.78
Grad de curățenie C% (Knöpp):			81.40
Zonasaprobă (Szabó):			beta
Pantle-Buck	Index saprob:		2.18
	Zonasaprobă:		beta
Simpson	Indice Simpson (D):		0.156
	Indice de diversitate (1-D):		0.844
	Indicereciproca (1/D):		6.394
Quality class:			II.

Station 5 – Libertatea (Dunăre)

	Taxa identified			Frequency
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Nr. crt.	Group	Species	Saprobic group	Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Amphipoda	Dikerogammarus villosus	b	2	1
2	Bivalvia	Dreissenapolyomorpha	b	28	3
3	Diptera	Chironomus (Chironomus) riparius	ap	24	3
4	Diptera	Chrysops sp.		3	
5	Diptera	Psychoda alternata	ap	3	1
6	Gastropoda	Lithoglyphus naticoides	b	84	5
7	Gastropoda	Theodoxus (Theodoxus) danubialis	ob	2	1
8	Amphipoda	Corophium curvispinum	b	3	1
9	Oligochaeta	Aulodrilus sp.		2	
10	Oligochaeta	Tubifex ignotus	ap	5	1
11	Oligochaeta	Tubifex tubifex	ap	24	3
12	Oligochaeta	Tubificidae Gen sp.		5	
13	Gastropoda	Physa acuta	ba	4	1

Results			
Densitate (ex./mp):			189
Bioindicatori oligosaprobi:			1
Bioindicatori beta mezosaprobi:			120
Bioindicatori alpha mezosaprobi:			30
Bioindicatori polisaprobi:			28
EPTT(nr.)			0
EPTT(%)			0.00
EPTI(nr.)			0
EPTI(%)			0.00
Grad de curățenie C% (Knöpp):			57.50

Zonasaprobă (Szabó):			beta-alfa
Pantle-Buck	Index saprob:		2.47
	Zonasaprobă:		beta-alfa
Simpson	Indice Simpson (D):		0.251
	Indice de diversitate (1-D):		0.749
	Indicereciproci (1/D):		3.989
Quality class:			III.

Station 6- Scurta (Dunăre)

Nr. crt.	Taxa identified		Saprobic group	Frequency	
	Group	Species		Abs.	Rel. (Knöpp)
MACROINVERTEBRATES				ind./m ²	
1	Odonata	Gomphusvulgatissimus	b	2	1
2	Amphipoda	Dikerogammarusvillosus	b	56	5
3	Amphipoda	Corophiumcurvispinum	b	25	3
4	Bivalvia	Corbiculafluminea	b	69	5
5	Gastropoda	Lithoglyphusnaticoides (C. Pfeiffer 1828)	b	31	4
6	Gastropoda	Valvatapiscinalis	b	38	4
7	Gastropoda	Theodoxusfluviatilis	b	5	1
8	Bivalvia	Dreissenapolymorpha	b	44	4
9	Amphipoda	Obesogammarusobessus	b	34	4
10	Trichoptera	Hydropsychecontubernalis McLachlan 1865	ba	4	1

Results			
Densitate (ex./mp):			308

Bioindicatorioligosaprobi:			0
Bioindicatori beta mezosaprobi:			306
Bioindicatorialfamezosaprobi:			2
Bioindicatoripolisaprobi:			0
EPTT(nr.)			1
EPTT(%)			20.00
EPTI(nr.)			4
EPTI(%)			1.30
Grad de curățenie C% (Knöpp):			98.44
Zonasaprobă (Szabó):			oligo-beta
Pantle-Buck	Index saprob:		2.01
	Zonasaprobă:		beta
Simpson	Indice Simpson (D):		0.145
	Indice de diversitate (1-D):		0.855
	Indicereciprocal (1/D):		6.874
Quality class:			II.

Station 7 – Prut Giurgiulești

Nr. crt.	Group	Species	Saprobic group	Nr. ind./sample	Density
					ind./m2
1	Odonata	Gomphusvulgatissimus	b	5	8
2	Gastropoda	Theodoxusprevostianus		1	2
3	Gastropoda	Theodoxusdanubialis	ob	3	5
4	Gastropoda	Theodoxusfluviatillis	b	5	8
5	Bivalvia	Corbiculafluminea	b	77	128
6	Bivalvia	Dreissenapolymorpha	b	357	595
7	Mysida	Paramysislacustristanaitica		6	10

8	Mysida	Limnomysisbenedeni	b	1	2
9	Ephemeroptera	Palingenialongicauda	b	1	2
10	Trichoptera	Rhyacophyladorsalis	b	3	5
11	Trichoptera	Hydropsychecontubernalis	ba	3	5
12	Bivalvia	Sphaeriumrivicola	b	2	3
13	Gastropoda	Viviparusacerosus	b	31	52
14	Gastropoda	Viviparuscontectus	b	49	82
15	Gastropoda	Potamopyrgusantipodarum		11	18
16	Gastropoda	Bithynia tentaculata	b	10	17
17	Gastropoda	Lithoglyphusnaticoides	b	82	137
18	Gastropoda	Planorbisplanorbis	ba	3	5
19	Bivalvia	Unio crassus	b	2	3
20	Gastropoda	Theodoxus subterrelictus		1	2
21	Bivalvia	Pisidium casertanum	b	5	8
22	Oligochaeta	Tubificidae genus spp		4	7

Results		
Densitate (ex./mp):		1103
Bioindicatori oligosaprobi:		3
Bioindicatori beta mezosaprobi:		1058
Bioindicatori alfamezosaprobi:		5
Bioindicatori polisaprobi:		0
EPTT(nr.)		3
EPTT(%)		21.43
EPTI(nr.)		12
EPTI(%)		1.06
Grad de curățenie C% (Knöpp):		97.67

Zonasaprobă (Szabó):		oligo-beta
Pantle-Buck	Index saprob:	2.00
	Zonasaprobă:	beta
Simpson	Indice Simpson (D):	0.328
	Indice de diversitate (1-D):	0.672
	Indicereciproci (1/D):	3.052
Quality class:		II.

Station 8- Reni (Danube)

Nr. crt.	Group	Species	Saprobic group	Nr. ind./ sample	Density
					ind./m2
1	Bivalvia	Dreissenapolymorpha	b	24	40
2	Bivalvia	Corbiculafluminea	b	49	82
3	Gastropoda	Lithoglyphusnaticoides	b	76	127
4	Mysida	Limnomysisbenedeni	b	1	2
5	Mysida	Paramysisbaeribispinosus		1	2
6	Amphipoda	Uroniphargoidesspinicaudatus		2	3
7	Amphipoda	Pontogammarusrobustoides		41	68
8	Oligochaeta	Isochaetidesmichaelsoni		4	7
9	Oligochaeta	Eiseniellatetraedra	b	9	15
10	Oligochaeta	Enchytraeusalbidus	a	14	23

Results

Densitate (ex./mp):		369
Bioindicatorioligosaprobi:		0
Bioindicatori beta mezosaprobi:		265
Bioindicatorialfamezosaprobi:		23
Bioindicatoripolisaprobi:		0
EPTT(nr.)		0
EPTT(%)		0
EPTI(nr.)		0
EPTI(%)		0
Grad de curățenie C% (Knöpp):		85.71
Zonasaprobă (Szabó):		beta
Pantle-Buck	Index saprob:	2.08
	Zona saprobă:	beta
Simpson	Indice Simpson (D):	0.218
	Indice de diversitate (1-D):	0.782
	Indice reciproc (1/D):	4.595
Quality class:		II.

Research conducted on benthic macroinvertebrates based on analyses of samples collected in study area, shows that in terms of quality they belong to the following taxa: Gastropoda, Bivalvia, Polychaeta, Oligochaeta, Crustacea, Diptera, Ephemeroptera, Odonata and Trichoptera. We find that the benthic fauna consists mainly of worms (Oligochaeta 29%), molluscs (Gastropoda 23%, bivalves 17%) crustaceans (Crustacea 16%) and insects (Diptera 11%). Insects from the orders Ephemeroptera 1% and Trichoptera 3% showed a very low frequency, these

organisms are indicators of clean water constitutes EPT index, considered a measure for assessing the degree of tolerance of organisms to pollution.

Quantitative research results are showed below:

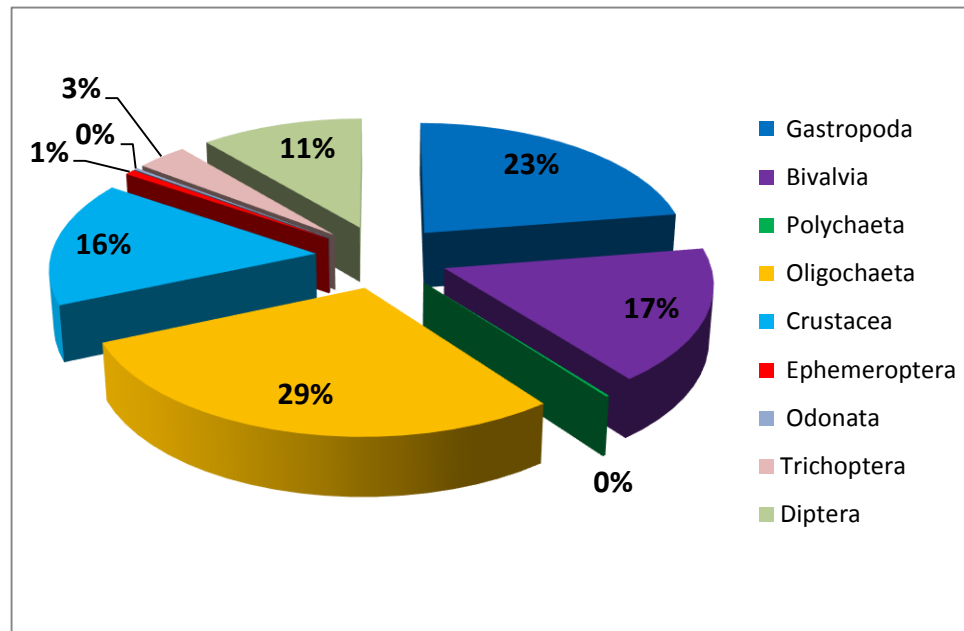


Fig. 3. Percentage abundance of dominant species determined

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