THE IMPACT OF ANTHROPOGENIC FACTORS ON THE BIOCENOTIC RECONSTRUCTION OF INDUSTRIAL ECOSYSTEMS FROM OLTENIA PLAIN

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Abstract. The researches performed within an ample national program for the recognition of the representative ecosystems in Romania, make a significant contribution to defining the place and role of a lowland watershed system – the Preajba Valley basin of Oltenia Plain. Indigenous microorganisms are present in anthropogenic environments as mixed populations and interact with each other both positively and negatively. Their presence is evidenced by the products of metabolism and not by the accumulation of biomass. The accumulation of products with inhibitory activity and the antagonistic phenomena contribute in conjunction with quantitative changes of nutrients to the emergence of new microorganisms that form succession populations in an ecosystem. In this ensemble ecosystem, gastropod populations have an important role among consumers, representing a factor of accumulation as well as transfer of mass and energy by consumers of higher order such as fish. Also, the populations of *Viviparus acerosus* and *Radix balthica* are one of the reference factors regarding the heavy metals accumulation of the Cu^{2+} and Cd^{2+} type. The clogging of lakes lead to the appearance of these marshlands covered with paludous vegetation, reduction of the depth and surface of lakes, algal blooms that harm human health and fish welfare.

Keywords: microorganisms, gastropods, Preajba Valley hydrographical basin, Oltenia Plain.

Rezumat. Impactul factorilor antropici asupra reconstrucției biocenotice a ecosistemelor industriale din Câmpia Olteniei. Cercetările efectuate în cadrul unui amplu program național de cunoaştere a unor ecosisteme reprezentative pentru teritoriul României aduc o contribuție importantă la definirea locului şi rolului unui sistem bazinal de câmpie – bazinul hidrografic Valea Preajba din Câmpia Olteniei. În mediile antropice, microorganismele autohtone există sub formă de populații mixte, interacționând unele cu celelalte atât pozitiv, cât şi negativ. Prezența lor este evidențiată prin produșii de metabolism şi nu prin acumularea de biomasă. Acumularea produșilor cu activitate inhibitoare şi fenomenele de antagonism contribuie împreună cu modificările cantitative ale nutrienților la apariția noilor comunitățíi de microorganisme care stau la baza succesiunii populațiilor într-un ecosistem. În acest ansamblu ecosistemic populațiile de gastropode ocupă un rol important între consumatori, ele reprezentând un factor de acumulare, precum şi transfer de masă şi energie către consumatorii de ordin superior – peştii. De asemenea, populațiile de *Viviparus acerosus* și *Radix balthica* reprezintă unul din factorii de referință în ceea ce priveşte acumularea de metale grele de tip Cu^{2+} și Cd^{2+}. Colmatarea lacurilor duce la apariția terenurilor mlăştinoase acoperite de vegetație palustră, reducerea adâncimii și suprafeței lacurilor, dezvoltarea algelor care dăunează vieții peştilor şi sănătății oamenilor.

Cuvinte cheie: microorganisme, gastropode, sistem bazinal Valea Preajba, Câmpia Olteniei.

INTRODUCTION

The research conducted within a broad national program for the recognition of the representative ecosystems to the Land Shaft Romania, makes an important contribution to defining the place and role of a lowland basin system – Preajba Valley basin from Oltenia Plain. The system, placed in the hydrographical basin of the Jiu, includes a network of terrestrial and aquatic ecosystems covering an area of 30 km^2. This space groups a great diversity of ecosystems, low hills covered by pastures and meadows, farmland and a complex river system – springs, streams, rivers, marshes, small reservoirs.

The two human activities that seem fundamental for the biological evolution of continental aquatic ecosystems, but also for the evolution of human society, are pollution (physical, chemical, biological) and hydro-technical facilities of water courses. In such a case, there were determined changes in the structure and functioning of natural ecosystems (BREZEANU et al., 1968; BREZEANU & GRUIȚĂ, 2002; CISMAȘIU, 2015; PĂCEȘILĂ, 2015).

The construction of dams and reservoirs can have a double impact on the river – positive, by amplifying the diversity of ecosystem types, biodiversity and negative, by imbalances of the biocoenotic structure and disruption of the physiology and behaviour of populations, especially fish (blocking migrations, reproduction or feeding of fish).

The same situation occurs in case of the Preajba Valley River, on the one hand, it is the enrichment of the natural environment with new elements of landscape and appearance of the lacustrine ecosystem with structures of specific population, and on the other, the degradation of the reophilous ecosystem downstream the dam, due to the reduced water flow, below the minimum required for keeping and functioning of reophilous biocoenotic structures (BREZEANU et al., 2011; CIOBOIU, 2011).

The primary factors of pollution consist of discharges of the untreated wastewater and poorly organized infrastructure. The activities practiced in the area are sports fishing, grazing, water for domestic use, irrigation. In addition to industrial pollution, the lacustrine ecosystems on the Preajba River shall be subject to the anthropogenic process of eutrophication. In this context, by intensifying the eutrophication process, the reservoirs are in an advanced process of biological clogging. The clogging of these reservoirs lead to the appearance of marshlands covered with paludous vegetation, reduction of their depth and surface algal blooms that harm on fish welfare and human health (CIOBOIU & BREZEANU, 2002; CISMAȘIU et al., 2015b).

In this context a domain much discussed internationally, with immediate practical applications, is the use of acidophilic microorganisms in the recovery of metals by means of microbiological processes. This method can be applied to ores and poor concentrates and mining waste that accumulate over time and cannot be processed by conventional hydrometallurgical methods (CHEN & LIN, 2000; DEAK et al., 2005; CISMAȘIU, 2011).

The bacteria in the sulfur cycle can be used to remove heavy metals. The sulphates produced by the reduction of the sulphides using the sulfate-reducing bacteria can be a way of bonding metal ions. The formation of iron sulphide is a biogeochemical important reaction because, at low temperatures, it leads to the formation of the pyrite. In addition, the presence of iron sulfide and pyrite may alter the solubility of other dissolved metals (Cu^{2+}, Zn^{2+}, Pb^{2+} and Cd^{2+}) by reactions of absorption and co-precipitation. H_2S produced by the sulphate-reducing bacteria reacts to the free or absorbed metallic ions, which it precipitates as insoluble metal sulphides.

The process can be used for the concentration of heavy metals, followed by their secondary recovering, as well as to treat industrial effluents for the purpose of bioremediation (DOPSON et al., 2003; FAUR & GEORGESCU, 2009; FURTUNA et al., 2009; CISMAȘIU et al., 2015a).

MATERIALS AND METHODS

1. Surface water, substrate chemistry and biomass measurements

Located 6 Km south of Craiova municipality, the hydrographical network composed of springs, streams, the main course of the Preajba River and small reservoirs, is under the pressure of local anthropogenic factors (Fig. 1).

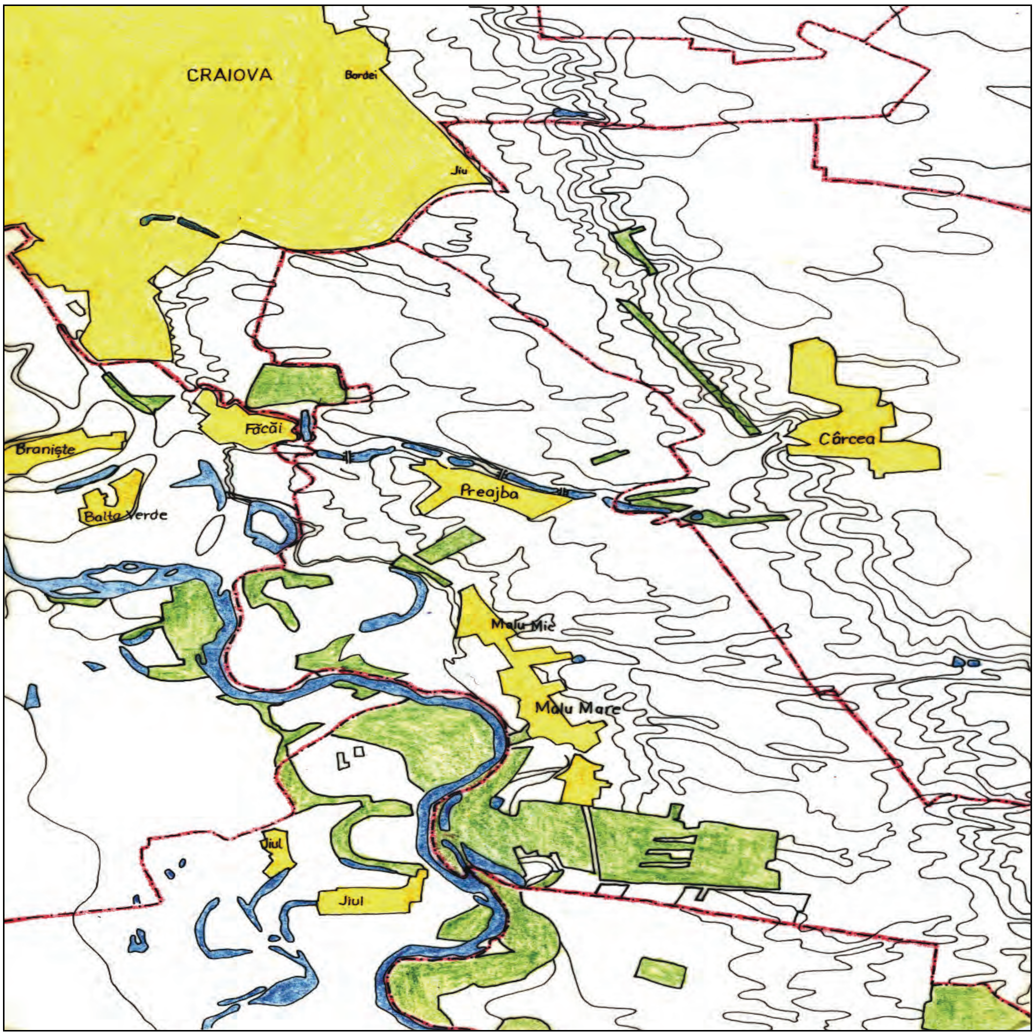

Figure 1. The location of the hydrographical basin in the lower area of the Jiu River (after CIOBOIU, 2011).

There were taken water samples (250ml) collected in clean sterile bottles for determining the chemistry with the spectrophotometer DR 2000 and sediment samples from the habitat of the reservoirs located on the Preajba Valley, based on sediment samples, the levels of chromium, nickel, zinc, lead, cadmium, copper, manganese and iron were analysed using Avanta atomic absorption spectrophotometer, SN 5378. By the same method, it was also determined the concentrations of heavy metals in the shells of *Radix balthica*, the dominant species in the reservoirs. Samples are taken in clean containers made of inert material (glass, plastic, paper); after sampling, the organic material crushed in the mortar, is dried at about 70^0C.

Mineralization made in order to shift the metals in solution is achieved in a microwave mineralizer, Ethos type D, power 1000W, equipped with Teflon tubes, programmable and it occurs as follows:

- weigh approximately 0.5g-1g dry crushed organic material and placed it in Teflon tube;
- add 3 ml of nitric acid 65%, 2 ml of HCl 37% and 1ml of hydrogen peroxide into the tube and then leave it for a few minutes;
- mineralized samples are filtered through quantitative filter paper; each pure acid extract is collected in a 25 ml flask; there are added 5 ml of standard etalon of 5 ppm and then distilled water up to the mark;
- aspirate the standard solution in the ascending order of concentration and the witness sample (zero) to construct the calibration curve, for the following wavelengths of Avante (GBB) atomic absorption spectrometer equipped with a burner for flame air / acetylene and hollow cathode lamps corresponding to the determined metals (Table 1).

Table 1. Synoptic data of wavelengths for some heavy metals determined.

Determined metal	Wavelength (nm)
Pb	217
Cd	228.8
Cu	324.7
Ni	232

2. Environmental control and survival growth

Among the microorganisms capable of removing metal ions we mention the heterotrophic bacteria from the *Acidiphilium* genus, anaerobic bacteria, which have the ability to form a gelatin polysaccharide capsule at the cell surface. The mechanism for attracting the metal ions by these bacteria is biosorption, as they retain relatively large amounts of dissolved metals through attraction facilitated by an electrical charge (GEORGESCU, 2005; CISMAȘIU et al., 2010).

The use of the heterotrophic bacteria isolated from industrial sites contaminated with metal ions to reduce heavy metal content is substantiated by numerous publications; consequently, the development of a profitable biotechnology with this group of microorganisms is very important (KISHIMOTO et al., 1993; JOHNSON et al., 1994; JOHNSON, 2001).

RESULTS AND DISCUSSION

1. Biotechnology and metals extraction

Biotechnology as a science for the concentration of metals is based on studies of biology, chemistry and physical studies of the microorganisms involved in natural processes taking place in mines and it is aimed at developing a technology applicable to ores, concentrates, especially those poorer, in order to obtain useful metals on an industrial scale. These processes refer, on the one hand, to the direct effect of the bacteria on the minerals (oxidation or reduction processes) and, on the other hand, to the action of their metabolites (KARAVAIKO et al., 1994; 1997; PETRIȘOR, 2010).

In this regard it is important to know the three recovery processes of metals from ores and mining effluents: (1) the oxidation of mineral sulphides, elementary sulfur, ferrous iron and other metals by chemoautotrophic microorganisms; (2) the formation by heterotrophic microorganisms of certain organic compounds capable to disintegrate minerals from rocks and dissolve them forming organometallic complexes; (3) the accumulation or precipitation of metals in the solution with biomass or organic compounds produced by microorganisms (BROWN & LESTER, 1982; KOMNITSAS et al., 1998; GEORGESCU et al., 1999).

The main bacteria involved in leaching ores are *Thiobacillus ferrooxidans, T. thiooxidans, T. thioparus* present in acid mine waters. These bacteria are present where metal sulphides and oxygen occur under acidic conditions. From the physiological point of view, thiobacilli are the chemoautotrophic bacteria that have the ability to oxidize inorganic iron or sulphur and its compounds to obtain the necessary energy for growth; they use atmospheric CO_2 and inorganic nitrogen as a source of carbon and nitrogen. These bacteria are aerobic, mesophilic, able to develop in strongly acidic environments and in the presence of high metal concentrations, which are usually very toxic to other life forms: 10,000 – 15,000 ppm copper; 40,000 ppm zinc, 40,000 ppm iron (ZLIGNIEW, 1988; BRIDGE & JOHNSON, 1998; JOZSA et al., 1999).

Water chemistry is characterized by a high concentration of nitrogen and phosphorous compounds (CIOBOIU & CHICIUDEAN, 2003). The amount of nitrates varies between 0.288 and 18.56 mg/l, phosphates between 3.504 and 7.964 mg/l and nitrate between 0.025 and 0.244 mg/l (Table 2).

Table 2. Concentration of nitrogen and phosphorous compounds from the reservoir water (V – XII).

	V	VI	VII	VIII	IX	XI	XII
NO3	0.288	0.288	0.96	4.278	18.56	0.288	1.848
NO2	SLD	0.025	0.053	0.155	0.244	0.045	0.091
PO4	3.504	7.946	4.684	SLD	SLD	3.539	4.892

Overall, water chemistry varies in relation with both natural factors, such as springs and streams, and anthropogenic factors mainly represented by nutrient loads carried by stormwater that washes the neighbouring agricultural areas (CIOBOIU & PLENICEANU, 2005). In terms of the quality requirements for surface water, the small reservoirs located on the Preajba River fall into the category II (bicarbonato – sulfate – calcium – magnesium) and they can be used for fish farming (except for salmoniculture), as well as for tourism and leisure activities (CIOBOIU & BREZEANU, 2009) (Table 3).

Table 3. Physico-chemical composition of water in the downstream reservoirs (average values).

Nr. crt.	Indicators	Measured values		Permissible values	Method of analysis	The used equipment
		The VII lake	The IX lake	Order no. 161/2006- The Cl. II quality		
1	Hydrogen ions conc. (pH), unit. pH	8.29	7.94	6.5 – 8.5	STAS 6325-75	pH-meter WTW 330, series 08090178
2	Electrical conductivity µS/cm, max.	664	695	-	STAS 7722-84	Cond WTW 340, series 08082507
3	Total hardness, German degrees, max.	16.28	18,04	-	STAS 3026-76	-
4	Fixed residue, mg/dm^3, min./max.	332	348	750	STAS 3638-76	Analytical balance KERN 770 series 17308244
5	Ammonia (NH_4), mg/dm^3, max.	0.25	0,69	1.0	STAS 6328-85	Spectrophotometer DR 2000, no. series 930700025411
6	Calcium (Ca^{2+}), mg/dm^3, max.	73	78	100	STAS 3662-62	-
7	Magnesium (Mg), mg/dm^3, max.	27	31	50	STAS 6674-77	-
8	Nitrite (NO_2), mg/dm^3, max.	<0.01	<0.01	0.1	Method 571	Spectrophotometer Lovibond PC spectro series 100510
9	Nitrate (NO_3), mg/dm^3, max.	13.2	9.7	13	Method 355	Spectrophotometer DR 2000, no. series 930700025411
10	Chloride (Cl), mg/dm^3, max.	49	44	50	STAS 3049-86	-
11	Oxidizable organic substances CCOCr (O_2) mgO_2/dm^3, max.	5.8	4.2	25	STAS 3002-85	-
12	Pb^{2+} (mg/dm^3, max.)	< 0.1	< 0.1	0.01	Method of operating in flame using atomic absorption spectrometer	Spectrophotometer GBC AVANTA PM, s. n. A5378
13	Zn^{2+} (mg/dm^3, max.)	0.0052	0.0056	0.2		
14	Ni^{2+} (mg/dm^3, max.)	< 0.09	< 0.09	0.025		
15	Cu^{2+} (mg/dm^3, max.)	< 0.1	< 0.1	0.03		
16	Cr^{2+} (mg/dm^3, max.)	< 0.03	< 0.03	0.05		
17	Fe^{2+} (mg/dm^3, max.)	< 0.05	< 0.05	0.5		

An important component of these industrial ecosystems is represented by microorganisms. The microbiological analysis of the affected ecosystems was focused on establishing the presence of the main physiological groups of chemoautotrophic and heterotrophic microorganisms (ESCOBAR & GODOY, 1999).

Chemoautotrophic microorganisms are primary producers, able to use chemical energy to produce complex organic substances from inorganic substances (nitrification bacteria, colourless sulfur bacteria) (GOMEZ et al., 1999). Heterotrophic microorganisms are involved in the detritic chain by the decomposition of organic waste of primary producers (Table 4).

Table 4. The physico-chemical composition of the sediment from the reservoirs (average values).

No.	Indicators	Measured values	Method of analysis	Used equipment
	Aqueous leachate analysis 1/10 (solid/lichid)			
1.	Hydrogen ions conc. (pH), unit. pH	7.8	STAS 6325-75	pH-meter WTW 330, series 08090178
2.	Electrical conductivity µS/cm	122	STAS 7722-84	Cond WTW 340, series 08082507
3.	Ammonia (NH_4), mg/dm^3	1.136	STAS 6328-85	Spectrophotometer DR 2000, series 930700025411
4.	Calcium (Ca^{2+}), mg/dm^3	19.2	STAS 3662-62	-
5.	Magnesium (Mg), mg/dm^3	3.8	STAS 6674-77	-
6.	Nitrite (NO_2), mg/dm^3	<0.01	Method 571	Spectrophotometer Lovibond PC spectro series 100510
7.	Nitrate (NO_3), mg/dm^3	1.3	Method 355	Spectrophotometer DR 2000, series 930700025411
8.	Chloride (Cl), mg/dm^3	7.1	STAS 3049-86	-
9.	DOC (mg/dm$^{3)}$)	4.3	STAS 3002-85	-

All these transformations confirm the crucial role of microbiological communities in the food web as primary producers, consumers as well as primary and secondary decomposers. The energy released by nitrification bacteria from oxidation reactions of NH_3 to nitrite and nitrite to nitrate is used in reducing CO_2. There was made a preliminary study regarding the presence of heavy metals in water, sediment and freshwater snails, which can accumulate higher levels of Cu^{2+} and Cd^{2+} than the average environmental concentration (Tables 5, 6).

Table 5. Concentrations of heavy metals in the water of studied reservoirs compared with the maximum permissible levels stipulated in Order no. 161 / 2006.

	Preajba Valley	**MPL ac. Ord. 161/2006**
Cr	<0.003	0.1
Ni	0.016	0.1
Zn	<0.005	0.05
Pb	<0.01	0.01
Cd	0.001	0.005
Cu	<0.01	0.01
Mn	<0.001	0.01
Fe	<0.005	0.1

Parameter	**The unit of measure**	**Measured values**		**Used equipment**
		Preajba Valley	**Method of analysis**	
Chromium	mg/ l	< 0.003	Working method specified in the user manual atomic absorption spectrometer GBS-Avanta	Avanta GBC atomic absorption spectrometer SN A 5378
Nickel	mg/ l	0.016		
Zinc	mg/ l	< 0.005		
Lead	mg/ l	< 0.01		
Cadmium	mg/ l	<0.001		
Copper	mg/ l	< 0.01		
Manganese	mg/ l	<0.001		
Iron	mg/ l	<0.005		

Table 6. Concentrations of metals from the soil and shells of the pulmonate snail *Radix balthica*.

No.	**METALS**	**PREAJBA Valley (sol)**	**SNAIL SHELLS**
1	Fe	0.148	0.124
2	Mn	0.0075	0.014
3	Ni	0.0045	< SLD
4	Cr	< SLD	< SLD
5	Cu	< SLD	< SLD
6	Zn	0.0005	0.006
7	Cd	0.0015	< SLD

Note: SLD – below detection limit

The performed analyses illustrate the ability of pulmonate snails species such as *Radix balthica* to accumulate metal ions of the type Fe^{2+}, Mn^{2+} and Zn^{2+} in direct correlation with the concentration of the respective ions from the soil. Also, studies have shown increased tolerance of these snail species (e.g. species of branchial snails *Viviparus acerosus)* to the presence of metal ions derived from industrial activities of solid tailings processing (CIOBOIU, 2002; CISMAȘIU et al., 2015b). These snail species are bio-indicators of contaminated industrial environments from Oltenia Plain because they indicate the emergence of negative changes in lake ecosystems earlier.

2. Biotechnology and environmental control

The effect of eutrophication process is manifested by excessive growth of phytoplankton (78 species) and paludous / aquatic macrophytes (34 species) (Figs. 2; 3). Bacillariophyceae and Chlorophyceae are the dominant groups of the phytoplankton and, during the summer, the cyanobacteria also have an intense development (Table 7).

In this context, considering the values of density and biomass and comparing, from this point of view, the studied reservoirs with other lacustrine ecosystems (BREZEANU & GÂŞTESCU, 1996), it results that they are within the category of the eutrophic ecosystems, taking into account that the reservoirs are mostly invaded by paludous and aquatic macrophytes, with specific character of highly eutrophic ecosystems.

Periphyton has a special place in the structure of the ecological communities in its composition there were identified 72 taxa. In this case, the highest number of species belongs to Bacillariophyceae and Chlorophyceae (CIOBOIU & NICOLESCU, 1999).

Abundant, especially in shore areas covered with concrete slabs and the stems of the paludous macrophytes, periphyton, where besides algae there also live bacterial populations and numerous micro-invertebrates (particularly protozoa), represents the favourite food of gastropods.

Along with periphytic and phytoplankton primary producers, macrophytes represent an important part of the organic production of the studied ecosystems.

Table 7. Numerical (specimen/l) and biomass (mg /L) density on taxonomic groups of the phytoplankton (average values).

TAXONOMIC GROUPS	NUMERICAL DENSITY THOUSAND SPECIMENS/L	WET BIOMASS MG/L
Cyanobacteria	76	0.335
Euglenophyceae	51	0.144
Pyrrophyceae	1	0.003
Heterokontae	7	0.045
Bacillaryophyceae	543.5	1.142
Chlorophyceae	394.5	0.841
TOTAL	1,073	2.510

Figure 2. Reservoir VII - Strong cyanobacterial blooms (original).

Figure 3. Large surfaces of the reservoirs covered with macrophytes (original).

In the surrounding springs, basins and small streams, there were identified the following macrophytes: *Mentha aquatica, Heleocharex palustris, Polygonium amphibium, Carex riparia*. On the surface of stems and plant leaves and on the substrate around them, it was noticed the almost exclusive presence of the diatoms loving lower temperatures, clean water, rich in silicates.

20-30% of the surface of the reservoirs is covered by paludous macrophytes, developing especially in shallow areas (5-20 cm) located at their *tail*. It also has to be added that, in the water and on the bottom, set in the substrate, aquatic plants form large populations. There were identified 34 species, including: *Phragmites communis, Typha angustifolia, Scirpus lacustris, Mentha aquatica, Carex riparia, Lemna minor, Nuphar luteum, Potamogeton crispus, P. natans, Myriophyllum spicatum* (DIHORU & ARDELEAN, 2009).

An overall assessment of macrophyte biomass production demonstrated that it can be obtained an amount of 85,200 kg/ha/year of wet biomass. This is a proof about the trophic capacity of the ecosystems.

It is known that by damming rivers and streams and formation of reservoirs there take place profound hydrological, geomorphological, hydrochemical modifications of the reophilous ecosystem and, in accordance with these, modifications of the structures and functions of animal and plant populations (BREZEANU & GÂȘTESCU, 1996).

Such modifications are also evident in the case of the Preajba Valley hydrographic basin, especially within its limits, along the unharnessed segment of the river (the upper sector) that can be considered a witness segment. Due to the diversity of the benthic biota and the structure of the zoobenthos, it acquires an outstanding diversity demonstrated by the presence of the main groups of invertebrates: ostracods, Gammarida, gastropods, bivalves, Chironomidae, Ephemeroptera, Heteroptera (Table 8).

On the muddy typical facies as well as on the sandy soil, diversity of the groups is the lower. The largest diversity was found in shore areas with paludous macrophytes, all the 13 groups being present here, some with a large number of individuals (4,600 Chironomida ind./m^2, 1,750 ostracods ind./m^2, 213 Ephemeroptera ind./m^2, 226 Plecoptera ind./m^2) (CIOBOIU, 2014).

The invertebrates in the areas with macrophytes make up populations with great numerical density and biomass. Phytophilous fauna is dominated by larvae of Chironomidae, Coleoptera, Ephemeroptera, Heteroptera, Gastropoda. In the areas from the vicinity of the shores, where the facies is made up of vegetable detritus and silt, it is present a large number of Chironomida, Ephemeroptera, Plecoptera, Oligochaeta. These areas are also populated with the highest number of gastropod individuals/m^2.

A smaller diversity of benthic invertebrates was observed in the deep areas where the facies is sandy-oozy. In the areas with macrophytes and vegetable detritus, there was identified a large number of protozoa, gastropods, larvae of Tendipedidae, Trichoptera, Odonata, Chironomida and Gammarida.

Table 8. The structure of zoobenthos (average values).

Taxonomic group	**Lake VI**			**Lake XII**		
	Nr. ex. / m^2	**Ab. %**	**F %**	**Nr. ex. / m^2**	**Ab. %**	**F %**
Chironomidae	4,693	50.3	100	800	26.4	100
Gammarida	3,506	37.6	33	-	-	-
Ostracoda	267	2.8	66	440	14.5	66
Heteroptera	213	2.2	100	160	5.2	100
Gastropoda	386	4.1	66	200	6.6	66
Bivalvia	53	0.5	33	-	-	-
Cladocera	-	-	-	227	7.4	33
Copepoda	-	-	-	320	10.5	33
Ephemeroptera	160	1.7	66	267	8.8	66
Plecoptera	-	-	-	453	14.9	33
Isopoda	26	0.3	33	80	2.6	66
Oligochaeta	-	-	-	53	1.7	33
Hirudinea	13	0.1	33	27	0.9	33
TOTAL	9,317	100.00		3,027	100.00	

3. Metal removal by active sulfate oxidation

In this context, microbial degradation is defined as a biological catalyst reduction in the chemical complexity of the sectional elements. The final product of this reaction depends on the biological transformation faced by the compound - mineralization, bioaccumulation, polymerization or co-metabolism.

The solubilisation of metals from ores or bacterial leaching is achieved by dissolving minerals or impurities using acidophilic bacteria of the *Acidithiobacillus* genus and their metabolic products. According to the available data from the scientific literature, it can be noticed that chemical and bacterial solubilisation of minerals does not correspond to a single mechanism, but to different mechanisms depending on the nature of the metal, the nature of microorganisms and physico-chemical conditions in which the bacterial culture acts (MALLK et al., 2002; ZHANG et al., 2009; HEDRICH et al., 2011).

From the point of view of the speed of the chemical and bacterial solubilisation process of useful minerals, it has been found out that, in the presence of the bacteria of the type *Acidithiobacillus ferrooxidans* and *A. thiooxidans*, the oxidation reaction of elementary sulphur under the action of oxygen and the oxidation action of the ferrous sulphate under the action of sulphuric acid and oxygen is developed faster as compared to other chemical reactions.

On the hand, the iron-oxidizing chemolithotrophic bacteria are intended to catalyse the oxidation reactions of the sulphides in the presence of oxygen, carbon dioxide and water and on the other hand, they are involved indirectly in the solubilisation process of the sulphides by the regeneration of the ferric sulphate, which is a leaching agent with increased capacity of oxidation.

The activity as primary producers of the mentioned chemosynthetic bacteria has a limited significance, because most are present in specific environmental conditions and their contribution to the synthesis of organic matter is insignificant compared to photosynthesizing organisms. These have a special importance in sulphur and nitrogen cycles (BRIDGE & JOHNSON, 1998; BACELAR-NICOLAU & JOHNSON, 1999; PASPALIARIS et al., 1999; VOICU et al., 1999; LAZĂR et al., 2004).

CONCLUSIONS

The microbiota of the rivers is so much different, mainly due to local conditions, so that there cannot be synthesized in a list of the main species present constantly. The situation is complicated by the large number and diversity of allochthonous microorganisms from soil, rainfall and tributary streams, in the case of clean rivers, and from different contamination sources in case of polluted rivers.

In anthropogenic environments, indigenous microorganisms develop as mixed populations, interacting with each other both positively and negatively. Their presence is evidenced by the products of metabolism and not by the accumulation of biomass.

The microbiota research on the aquatic biodiversity represents a complex study, which includes knowledge of the structure and life of microbial communities and the interaction between the component microorganisms with other organisms such as invertebrates and plants.

The knowledge of the existing microorganisms in the industrial areas contaminated with metallic ions and the interaction between them leads to the establishment of the role that they can play in the matter and energy flow of those ecosystems. The accumulation of the products with inhibitory activity and antagonistic phenomena contributes, together with the quantitative changes of the nutrients, to the appearance of new microorganism communities underlying the succession of populations into an ecosystems.

In this ecosystem, gastropod population have an important role among consumers, representing a factor of accumulation, as well as of mass and energy transfer to the consumers of higher order – fish. The populations of *Viviparus acerosus* and *Radix balthica* represent one reference factor with regard to the accumulation of heavy metals of the type Cu^{2+} and Cd^{2+}.

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