November, 16-17
Baia Mare
ROMANIA

ENSFI 2007

Conference proceedings

International Conference
Environment
Natural Sciences
Food Industry

1 St Edition
Baia Mare
Romania

AQUATIC ECOSYSTEMS FORMED BETWEEN STERILE DUMPS

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Abstract

We have inventoried three categories of lakes within the Jiu Valley basin: some developed in the former surface coal mines, and others resulted from rivulet damming with sterile, and aquatic ecosystems emerging from springs covered with sterile. The main geological, physical, chemical and biological characteristics of these aquatic ecosystems are presented.

Keywords: *dump heaps, aquatic ecosystems, zooplankton, nekton, benthos*

INTRODUCTION

As a result of excavation works and technological processes from extractive industry, great quantities of solid dump known as sterile result and is stored in dump heaps. Dump heaps of sterile are a typical example of human impact on deposited regions; their presence change landscape, decrease species richness and simplify the ecosystem structure. Species that are characteristic for polluted zones dominate in plant communities, and many animal populations are driven to extinction. Ore traces from sterile have aggravating character (8, 19).

Aquatic ecosystems formed on the surface of dump heaps originate from atmospheric water accumulation (directly or as water flows on dump slopes), or result from springs covered with sterile. Since most of these lakes are temporary, have low species diversity and are of recent origin, they have been less studied than others (10). More studies were focused on slope water flows impact on the proximity aquatic ecosystems (11, 17, 14). The coal mining activities in the Petroşani Depression date back to more than a century ago, thus resulting in a severe environmental contamination. The inventory and study of the specific diversity in the lentic ecosystems formed among the dump heaps, their dynamics over time and the link of these surface waters with ground-water layers were studied for the first time in Romania. Previous studies in the area were focused on the stability of sterile heaps only (9, 15, 19).

MATERIALS AND METHODS

The Upper Jiu Valley has an alpine microclimate, predominantly wet and cold, with important quantities of rain and snow falls, their quantities varying during the year (a mean of 800-1200 mm in a year). The values of multi-annual atmospheric temperatures range between 14.5°C in July and – 5.2°C in February. A characteristic of the Jiu Valley is the low intensity of evaporation due to a quite long period of clouded and foggy weather (200 days per year).The area investigated is part of the beech forest zone (habitat R4110 – South-Eastern Carpathian forests with beech, *Fagus sylvatica*, and with *Festuca drymeia*), largely spread in the mountain region and high hills, the lakes bounded area belongs to the habitat R2210 (Amphibious Danubian communities with *Bolboschoenus maritimus* and *Schoenoplectus tabernaemontani*) characteristic for water meadows and inside lakes, the habitat takes part of R2206 (Danubian pondweed beds with *Potamogeton perfoliatus, P. gramineus, P. lucens, Elodea canadensis* and *Najas marina*), suitable for lakes, ponds and channels with low water velocity, with high content of biogenous salts (7).

The physical parameters of the water (pH and conductivity) were recorded in the field and the chemical analyses of the lake water (CBO_5, CCO-Cr, Anionic detergents, sulphates, cyanide, phenols, phosphorus, magnesium, calcium, heavy metals) were performed using classical methods (18) in the chemistry laboratory of the Faculty of Mining, University of Petroşani.
Due to the lake basin configuration, with narrow and steep lake sides, limited by mace reed (*Typha* sp.) belt, with some common reed (*Phragmites* sp.), sedge (*Carex* sp.), only qualitative biological samples were collected, using a zooplankton net with horizontal trawling (mesh size of 90µm), limnological corer (mesh size of 1 mm) and fish net (mesh size of 5 mm). The benthos samples were immediately washed through a granulometric screen (mesh size of 1 mm). The organisms were preserved directly on the field with 40% formaldehyde solution to reach a 4% final concentration. The aquatic macrophytes were stored in PVC bags, at low temperature, for later identification in the laboratory.

The samples were examined in the laboratories of the Faculty of Natural Sciences, Ovidius University of Constanţa, using a Nikon SMZ-2T stereomicroscope. For a precise determination, the dissection of zooplanktonic organisms was performed in lacto phenol and the preparations were observed using a Nikon E200 microscope. Usually guides (1, 2, 3, 4, 5, 12, 13, 16) were used for species identification.

RESULTS AND DISCUSSIONS

The field trips were performed in July and September 2007 in the mining area of Jiu Valley where 12 lakes were identified (**fig. 1**). The geographical coordinates of the sampling stations were determined using a handheld Garmin GPS.

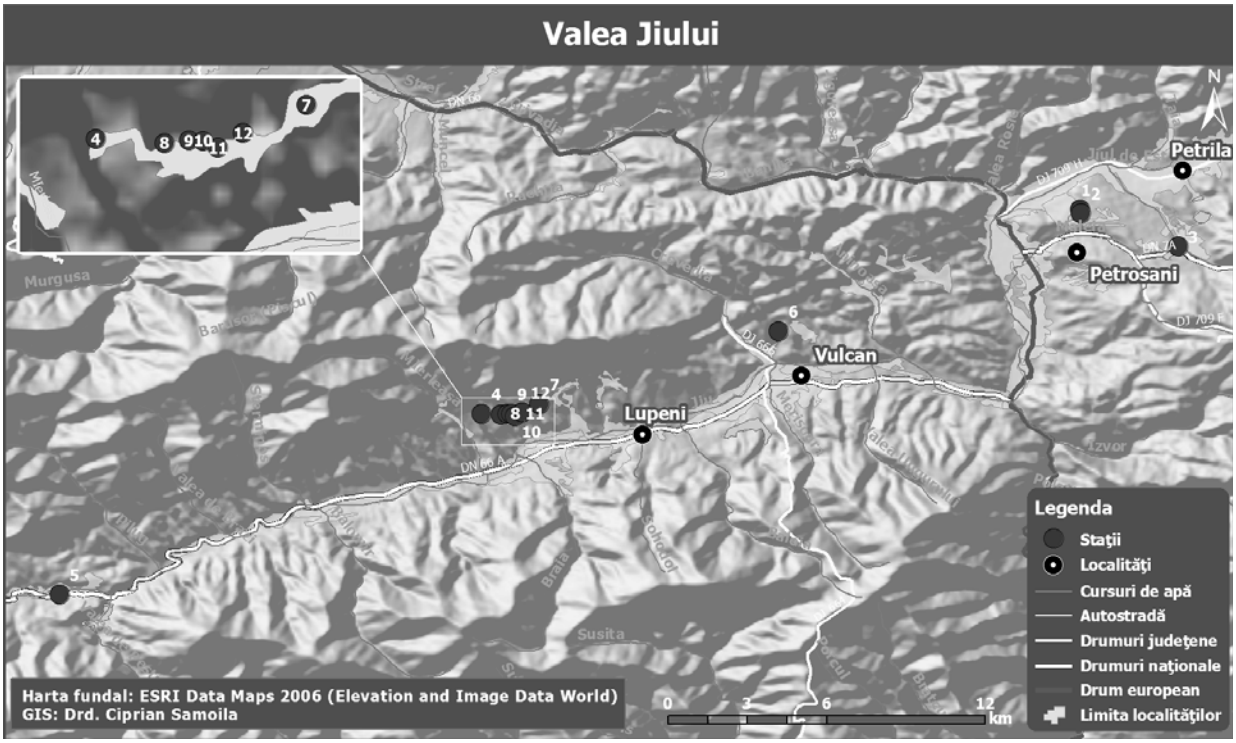

Fig. 1. Aquatic ecosystems identified in the coal mining area of Jiu Valley.

As a result of the mining activity in Jiu Valley, we identified **three categories of lakes** formed during the last decades: lakes developed in former surface coal mines, lakes resulted by rivulet damming with sterile, and aquatic ecosystems originated from springs covered with sterile.

Lakes developed in former surface coal mines

Two lakes belong to this first category: the lake from Jieţ and the other from Câmpu lui Neag, developed in former surface coal mine, the huge excavations, deeper than 20 m, filled with water originating in rheocrene springs from the area. The Jieţ Lake (station 3) (**fig. 1**) is a young ecosystem (nine years old), used for fish farming (trout, crucian carp, and perch). The owner has recently introduced even the grass carp (C*tenopharingodon idella* Valenciennes) which feeds on young shoots of mace reed. A narrow and incomplete ring of mace read with some common reed (*Phragmites* sp.) is present along the littoral zone. On the lake side there are willow trees (*Salix* sp.), birch trees (*Betula verrucosa* Ehrh.) and sea buckthorns (*Hippophaë rhamnoides* L.), and on the western side a large area is covered with horse tail (*Equisetum telmateia* Ehrh.).

The lake's water has a neutral (pH= 7.63), and strong oliogotrophic character (0.08 mg/l ammoniacal nitrogen and 0.012 mg/l phosphorus), well oxygenated (CBO_5 = 4.8 mg/l). The qualitative structure of the zooplankton is dominated by filter-feeding organisms, nine species of Rotatoria (*Keratella quadrata, Brachionus diversicornis, B. diversicornis var. homoceros, B. angularis, Euchlanis parva, Lecane luna, L. Lunaris, Polyarthra vulgaris, Rotaria* sp.), a cladoceran (*Pleuroxus aduncus*) and a copepod (*Tropocyclops prasinus*). Probably *Dreissena polymorpha* Pallas larvae were also identified in the zooplankton samples (**table 1**).

Table 1. Zooplanktonic species diversity in lakes formed between sterile dumps

SPECIES	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11	Station 12
ROTATORIA												
Asplanchna herricki Guerne		*										
Brachionus angularis Gosse		*	*									
Brachionus diversicornis Daday	*	*	*	*								
Brachionus diversicornis* var. *homoceros Wierzejski		*	*									
Brachionus forficula Wierzejski		*										
Dissotrocha aculeata Ehrenberg								*				
Euchlanis parva Rousselet			*									
Hexarthra fennicaLevander		*										
Keratella cochlearis Gosse	*	*		*	*							
Keratella quadrata Müller	*	*	*	*								
Keratella valga* f. *heterospina Klausener		*										
Lecane luna Müller			*									
Lecane lunaris Ehrenberg			*									
Polyarthra vulgaris Carlin		*	*		*							
***Rotaria* sp.**		*	*	*								
Synchaeta pectinata Ehrenberg	*	*										
BIVALVIA larvae		*	*									
CLADOCERA												
Alona quadrangularis Müller						*	*	*				
Bosmina longirostris Müller	*				*							
Chydorus sphaericus Müller							*	*				
Oxyurella tenuicaudis Sars		*										
Pleuroxus aduncus Jurine			*									
Simocephalus expinosus Koch							*					*
Cyclopoida - nauplia	*	*	*		*				*		*	
Cyclops vicinus Uljanin								*	*	*		
Macrocyclops albidus Jurine									*	*		*
Tropocyclops prasinus Jurine	*		*			*		*	*		*	

The macro-benthos is dominated by oligochaeta worms, chironomids and Plecoptera larvae, amphipods – *Rivulogammarus* sp. Some well developed individuals (8-12 cm) of the lake shell (*Anodonta cygnaea* L) were found on the lake side, and near the unloading dock built by the farmer, some individuals of *Rana esculenta* L. were observed.

The lake from Câmpu lui Neag (station 5) (**fig. 1**) is round shaped, with parts of the lakeside covered with stone plates and used as a recreational area.

The lake water has an alkaline character (pH = 8.3), with less biogenous salts as Jieţ Lake, and a reduced oxygen content (CBO_5 = 2.6 mg/l). At the sampling moment (25.07.2007), a *Ceratium hirundinella* blooming was observed in the water. The zooplanktonic diversity was reduced: only two species of Rotatorias (*Keratella cochlearis* and *Polyarthra vulgaris*) and one of cladocera (*Bosmina longirostris*) (**table 1**).

Lakes resulted by rivulet damming with sterile

Two lakes of this type were identified on Mierlaşu Valley, where sterile from Bărbăteni coal exploitation was stored, and on Valea Arsului, dammed with sterile from Vulcan mine.

The sterile dump from Bărbăteni is located two kilometres north-wide from Lupeni, on the left river of Mierlaşu Valley, the highest sterile quantity being dumped here after the 1980s. The sterile dump is formed by clay stone, marl, grit stone, argillaceous schist, and pieces of coal. The area is surrounded by hills, covered with rich vegetation, especially birch trees, with mountain orchid (*Gymnadenia conopea* (L)R.Br) and bellflower (*Campanulla glomerata* L.).

Sterile sliding resulted in the damming of Mierlaşu Valley. The lake (station 4) (**fig. 1**), situated at an altitude of 867 m, has an oval form, the lake's water has a pH = 7.65, low calcium (24.6 mg/l) and magnesium (4.4 mg/l) concentration and it is well oxygenated. The zooplankton is represented by only two Rotatoria species (*Rotaria* sp. and *Brachionus forficula*) (**table 1**). The fish fauna is represented by a great number of trout (length class of 10-15 cm), chub and bleak. Some adults and tadpoles of *Bombina variegata* L., *Bufo bufo* L. and *Rana esculenta* L.complex were observed.

In order to emphasize if waters from the lake have some influence on the phreatic ones, water samples were performed from a reocren spring, source of a brook – tributary of Mierlaşu Valley. The physical and chemical parameters point out a drinking water, consequently water flows on dumps slopes, or the lake's water from Mierlaşu area doesn't affect phreatic waters.

The Arsului Valley lake (station 6) (**fig. 1.**) is situated at an altitude of 655 m. The water infiltrations in the sterile dump generated a crumbling of the dump heat and the present sterile is used to cover the lake. In the small remaining pool, the water contains small quantities of H_2S (0.015 mg/l), and the conductivity is quite high (573 μS). A blooming of *Ceratium hirundinella* was observed. The zooplankton is diverse including four species of Rotatoria (*Brachionus diversicornis, Keratella cochlearis, K. quadrata*), a cladoceran (*Bosmina longirostris*) and copepoda nauplia (**table 1**).

An interesting lake complex is located in the waste deposit area of Lupeni coal mine, where three dump heaps are placed in between hills (Dealul Renghii), along the Boncii rivulet's valley. The hill sides are covered with beech trees (*Fagus sylvatica* L.), hedgethorns (*Crataegus monogyna* Jacq.) and also ferns (*Pteridium aquilinum* (L.)Khun) in some places. Old dumps are consolidated especially by birch trees (*Betula verrucosa*) and even sea buckthorns (*Hippophaë rhamnoides*). These species may be considered as "pioneer species" in stabilizing the sterile.

Two categories of aquatic ecosystems were formed in the area: on the one hand is the Green Lake (station 7) formed in a depression in the lower part of R3 waste dump area through atmospheric water accumulations (either directly or as water flows on the dump slopes), while on the other hand there are five lakes formed due to the Boncii rivulet's damming (station 8, located westward, and station 12, positioned easternmost of the valley). Measurements indicated that these lakes' waters have a high conductivity (1000-1100 μS), and a basic character (pH = 7.63 - 8.05. In all these lakes, the zooplankton is mainly represented by micro crustaceans such as cladocera and copepoda. The highest diversity was recorded in the lake no. 8 (**table 1**). The Green Lake holds the highest diversity in benthonic organisms: Odonata, Plecoptera and Chironomida larvae, oligochet worms, and amphipods.

In the lake no. 8, the deepest (8.5m) of all five, our observations revealed the presence of trout (length class of 1-5 cm, and 5-10 cm), bleak and rudd, and also lots of *Rana ridibunda* tadpoles.

Aquatic ecosystems originated from springs covered with sterile

R-II and R-III sterile heaps (station 1) as well as R-III and R-IV dumps (station 2), which are formed among the dumps that receive solid waste from Petrila coal mine, are the most representative for these types of ecosystems. Their basin has a narrow littoral zone, with *Potamogeton natans* L. and *Potamogeton gramineus* L. covering the lakes' surfaces.

In the lake no. 1, the zooplankton is rich in Rotatoria species and a quite rare Cyclopid copepod – *Tropocyclops prassinus* (**table 1**), offering a complete food for trout fingerlings, chub (*Leusiscus* sp.), and bleak (*Alburnus* sp.). Oligochaeta worms and insects larvae were observed in the benthos.
The locals use the northern rim of the lake for waste depositing.

The lake no. 2 is characterized by the presence of a wide mace reed belt and rich floating vegetation. It was identified the greatest number of zooplanctonic species (**table 1**) in this lake, with a conspicuous presence of 10 species of Rotatoria, and a large number of *Hexarthra fennica* individuals.

CONCLUSION

The lakes formed as result of the mining activity in the Jiu Valley are young ecosystems, with interesting fauna and flora, holding an important value in the ecological reconstruction of the area which has been altered by human impact. A thoroughly conducted study of these aquatic ecosystems, formed in sterile dumps, would prove useful towards introducing them as a particular type of **wetlands**.

REFERENCES

1. Bănărescu, P., 1964. Pisces-Osteichthyes. *Fauna R.P.R.*Editura Academiei RPR, Bucureşti: **13,** 998 pp.
2. Chiriac, Elene, Udrescu, Maria, 1965. *Ghidul naturalistului în lumea apelor dulci*. Editura ştiinţifică, Bucureşti: 335 p.
3. Ciocârlan, V., 2000, *Flora ilustrată a României. Pteritophyta et Spermatophyta*, Editura Ceres, Bucureşti: 1139 pp.
4. Cogălniceanu, D., Aioanei, F., Bogdan, M., 2000, *Amfibienii din România. Determinator*, Editura Ars Docendi, Bucureşti:100 pp.
5. Damian-Georgescu, Andriana, 1963, Copepoda Fam Cyclopidae (forme de apă dulce) *fauna RPR*, Editura Academiei RPR, Bucureşti: **4**, *6*, 204 pp.
6. Damian-Georgescu, Andriana, 1966, Crustacea Copepoda Calanoida (forme de apă dulce) *fauna RPR*, Editura Academiei RPR, Bucureşti: **4**, *11*: 130 pp.
7. Doniţă, N., Popescu, A., Paucă-Comănescu, Mihaela, Mihăilescu, Simona, Biriş I.-A., 2005. *Habitatele din România*. Editura Tehnică Silvică, Bucureşi: 496 pp.
8. Durkin, T.V., Herrmann, J.G., 1996. Introduction: focusing on the problem of mining wastes. In: US EPA (ed) *Managing environmental problem sat inactive and abandoned metals mine sites*, Seminar publication EPA/625/R-95/007, US Environmental Protection Agency, Cincinnati.
9. Fodor, D., Baican, G., 2001. *Impactul industriei miniere asupra mediului*. Ed. INFOMIN, Deva: 1-127.
10. Forray, F.L., 2002. *Geochemistry of the environment in the areas of mining works from Aries Valley (Apuseni Mountains, Romania)*, PhD thesis, http://bioge.ubbcluj.ro/~forray/PhD.
11. Forray, F.L., Hallbauer, D.K., 2000. A study of the pollution of the Aries River (Romania) using capillary electrophoresis as analytical technique: *Environmental Geology*, 39 (*12*), 1372-1384.
12. Godeanu, S.-P., 2002 – *Diversitatea lumii vii – determinatorul ilustrat al florei şi faunei României*. Ed. Bucura Mond, Bucureşti**, 1** şi **2.**
13. Negrea, St., 1983 – Cladocera, *Fauna R.S.R.*, Ed. Academiei RSR, Bucureşti, **4**, *12*: 400 p.
14. Raforth, R.L., Johnson, A., Norman, D.K., 2000. Screening level investigation of water and sediment quality of creeks in ten eastern Washington mining districts, with emphasis on metals: *Washington Department of Ecology Publication 00-3-004*, 1.
15. Rotunjanu, I., 1996. *Studiu de stabilitate pentru halda Preparatiei Petrila*. Contract nr. 16/1996 al Universitatii din Petrosani cu E.P. Petrosani.
16. Rudescu, L., 1960 – Trochelminthes. Rotatoria, *Fauna R.P.R.* Editura Academiei RPR, Bucureşti, **2**, *2*: 1192 p.
17. Stanton, M.R., 2000. The role of weathering in trace metal distribution in surface samples from the Mayday mine dump near Silverton, Colorado: *Proceedings of International Conference on Acid Rock Drainage (ICARD2000), May 21-24, Denver, Colorado*, 2, 1501-1509.

18. Wetzel, R.G., Likens, G.E., 1991. *Limnological Analyses*. 2nd Edition. Springer Verlag.
19. Wolff, F.E., McKay, D.T.(Jr.), Norman, D.K., 2004. Inactive and abandoned mine lands-Adler Mine, Twisp Mining District, Okanogan County, Washington: *Washington Division of geology and Earth resources Open File report* 2004: 1-16.
20. * * * *1984,1985, 2000, 2005, 2006. Proiect de haldare pentru halde de steril din Valea Jiului. Studii anuale de cercetare ale Facultăţii de Mine, Universitatea din Petroşani*