THE STUDY REGARDING FLORISTIC COMPOSITION OF TAILINGS DUMPS FROM MOLDOVA NOUA, IN ORDER THE RECONSTRUCTION ECOLOGICAL

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Abstract

In Moldova Nouă, the main pollutant is the ex-decantation lake in Tăuşani, belonging to the S.C. Moldamin S.A. During the period 1988-1990, the Caraş-Severin County Enterprise for the Maintenance and Exploitation of the Grasslands executed land modelling works on the slopes by planting perennial grasses in mixture. Since the completion of the modelling and planting of the slopes of the decantation lakes failed, there have been tailings dust pollution carried away by the very strong air currents. In this paper, we present a study of the floral composition of the tailings dumps in Moldova Nouă and a situation of the plant species resisting in this area. The inventorying of the plant species growing on the managed dumps has been done with the Braun-Blanquet method (1964), a method cited by Arsene (2003). We identified the measure in which the floristic composition has changed, the new species produced through self-seeding and we identified the dominant species. Results concern the structure of the plant cover already existing on the tailings dumps in Moldova Nouă from the point of view of the main technological groups of plants and of the biodiversity. In order to include the dumps in the Moldova Nouă area into the economic cycle, we need to re-cultivate it. Re-vegetation should be done with perennial plants and weeds specific to the area (*Trifolium pratense*, *Trifolium repens*, *Festuca rubra*, *Dactylis glomerata*, *Achillea millefolium*, *Lotus corniculatus*, etc.), that are not soil demanding, that are disease-resistant and that produce large amounts of vegetal material both underground and on the ground. The highest percentage of seedling was in the acacia, Russian silverberry, bird cherry, lilac, and sea-buckthorns.

Key words: tailings dumps, vegetation, biodiversity, ecological reconstruction

In Moldova Nouă (Caraş-Severin County), the processing of underground and ground ore resulted in a total amount of over 5.4 t of tailings per year. The over 30 years of mining activities in Moldova Nouă resulted in three large flotation tailings deposits on the banks of the Danube, near the localities Moldova Veche, Coronini and Veliko-Gradişte in Serbia. These tailings lakes, considered the largest ones, cover an area of 306 ha and represent sources of environmental pollution.The material stored in these lakes has varied physical, chemical and mineralogical properties, depending on the initial characteristics of the processed ores and on the ore processing technology [4, 6]. The soil in the areas neighbouring the decantation lakes have a low fertility because mainly of the tailings deposits and of the contamination of the ground horizons [2]. As a result of the analyses of the tailings in the Tăuşani Lake, the conclusion was that, as far as the heavy metal content is concerned, these samples had high concentrations of zinc and nickel. Consequently, this excess zinc in the tailings resulted in changes of the physical and physico-chemical properties of the tailings, including a lowering of the biological activity [5]. The negative effects of the sterile on the crops and on the natural grasslands, and particularly of the fine particles that are carried away by the air currents, damage the derma and, implicitly, reduce the area of chlorophyll assimilation and decrease vegetation vitality. In order to re-enter tailings dumps in the Moldova Nouă area in the economic cycle, we need to re-cultivate it.

MATERIAL AND METHOD

Observations were carried out on the area of Moldova Nouă (Caraş-Severin County) located in the southern part of the Locvei Mountains, in the Baronului Valley and in the Mare Valley, 4 km from the Danube, and the material we studied is represented by the Boşneag lakes group (1 and 2) and by the Tăuşani Lake.

The Boşneag lakes group was seeded during the period 1988-1990 with perennial plants (a mixture of perennial gramineae and legumes) aiming at stopping deflation in Moldova Nouă (Romania) Golubaţ (Serbia). To manually seed these lakes, we used species of couch grass, smooth meadow grass, cock's foot, alfalfa, and white clover.

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The Tăuşani Lake is about 3.5 km far from Coronini (Caraş-Severin County).

Observations were made during the period 2010-2011, in the Boşneag Lake 1 (west from the Danube and north from the national route DN 57 to Moldova Veche); the Boşneag Lake 2 (east from the national route DN 57 to Moldova Nouă and north from the same national route DN 57 to Moldova Veche); the Tăuşani Lake (south from the national route DN 57 to Coronini and Moldova Nouă and west from the Dunăre). The tailings lakes under study are plain lakes with all borders exposed to climate agents.

The soils in the areas neighbouring the decantation lakes have a low fertility because, mainly, of the tailings deposits and of the contamination of the ground horizons. Wind speed in the area reaches 120 km/h. deflation ix at its peak during droughty periods.

Vegetation data were collected after the Braun-Blanquet method (1964) cited by Arsene (2003). Thus, we sampled geobotanically and we obtained useful data in the pointing out of the existence of a plant cover on these flotation lakes, i.e.: parameters of the floristic composition (abundance of the gramineae, of the legumes, and of species of other plant families; the number of gramineae, of legumes, and of other plant species).

RESULTS AND DISCUSSIONS

In the 3 decantation lakes on which we carried out our observations we identified 41 plant species, belonging to 16 botanical families (tab. 1).

Observations made on the Boşneag lakes group and on the Tăuşani Lake show that the lowest plant coverage (about 10%) was in the Tăuşani Lake (154 ha), where we identified only 4 plant species: *Chondrilla juncea* (rush skeletonweed), *Salsola kali* (Russian thistle), *Robinia pseudoacacia* L. (black locust), *Onopordum acanthium* (cotton thistle).

Analysing the plant species identified in these tailings lakes, we can see that Poaceae ranks first (29.26%) followed by Asteraceae (19.51%) from the point of view of the species belonging to the same botanical family compared to the total number of species in the area (fig. 1).

In the Boşneag Lake 1, gramineae ranked first (38.4% of the total plant species identified), the largest share belonging to the species *Phragmites australis* (31% of the total number of gramineae); besides this species, there are also such species as: *Agropyron repens* (19%), *Calamagrostis epigeios* (19%), *Festuca valesiaca* (19%), *Apera spica-venti* (12.5%). Among the species developed in these tailings lakes (Boşneag Lake 1), *Asteraceae* come second in a rather large share (23%) (*Erigeron annuus*, *Taraxacum officinale*, *Picris hieracioides*) as well as other botanical families sharing 7.7% each: *Fabaceae* (*Robinia pseudoacacia*), *Salicaceae* (*Populus tremula*), *Rosaceae* (*Rubus caesius*), *Convolvulaceae* (*Convolvulus arvensis*), *Euphorbiaceae* (*Euphorbia cyparissias*). There were no legumes whatsoever (fig. 1).

In the decantation lake Boşneag 2, we identified 35 plant species, among which: 8 species of the Family *Poaceae;* 3 species of the Family *Brassicaceae*; 6 species of the Family *Asteraceae*; 5 species of the Family *Fabaceae*; and 1 species of each of the families *Salicaceae, Rosaceae, Convolvulaceae, Onagraceae, Euphorbiaceae, Ranunculaceae, Lamiaceae, Boraginaceae, Rubiaceae, Amaranthaceae, Hypericaceae, Verbenaceae, and Elaeagnaceae* (fig. 1).

In the Tăuşani Lake, only 4 plant species managed to develop, i.e.: 2 species of the Family *Asteraceae* (*Chondrilla juncea* and *Onopordum acanthium)*, 1 species of the Family *Fabaceae* (*Robinia pseudoacacia*) and 1 species of the Family *Amaranthaceae* (*Salsola kali*) (*fig. 1*).

Analysing the bioform spectrum for the plant species identified in the area of the three decantation lakes (*fig.2*), we can say that haemicryptophyta are the most numerous (H: 42%), followed by therophyta (Th: 11%) and by hemicryptophyta-geophyta (H -G: 11%).

Analysing the inventoried plant species in the tailings lakes depending on the moisture factor we could see that, of the total number of species developed on these tailings (41 species), most were plant species with a great ecological variability (euriphyta: Ux = 24.39%), followed by dry soil plant species (mezoxerophyta: U3 = U4 = 19.51%) (fig. 3).

Analysing the plant species developed on the borders of the tailings lakes, we established, depending on the factor light, that the most species of the total number of species (41 species) were light plant species that do not bear shadowing (L7 = 43.9%), followed by full light plant species (*fig. 4*). As for the factor N-mineral soil quantity, Figure 5 shows that of the total number of plant species identified on the tailings in Moldova Nouă, the species resisting and developing on nitrogen poor soils predominate (N3 = N4 = 12.19%). Among these species are the following: *Poa compressa*, *Coronilla varia*, *Oenothera biennis*, *Euphorbia cyparissias*, *Picris hieracioides*, *Crepis setosa*, *Echium vulgare*, *Lotus corniculatus*, *Medicago falcata*, and *Festuca arundinaceea.*

Table 1

Plant species growing on the tailings dumps in Moldova Nouă

Nr. crt.	Plante inventariate	Familii botanice	Însuşiri Economice
1.	*Poa compressa* (firuţa)	*Poaceae*	F_3
2.	*Aegilops cylindrica*	*Poaceae*	F_2, M
3.	*Cardaria draba* (urda vacii)	*Brassicaceae*	x
4.	*Achillea pannonica* (coada şoricelului)	*Asteraceae*	x
5.	*Chondrilla juncea* (răsfug)	*Asteraceae*	x, T
6.	*Hordeum murinum* (orz sălbatic)	*Poaceae*	F_1
7.	*Erysimum diffusum* (micsandre sălbatice)	*Brassicaceae*	x
8.	*Bromus sterilis* (obsiga aristată)	*Poaceae*	x, D
9.	*Robinia pseudoacacia* L. (salcâm alb)	*Fabaceae*	
10.	*Coronilla varia* (coroniste)	*Fabaceae*	x, T
11.	*Populus tremula L.* (plop tremurător)	*Salicaceae*	x, D
12.	*Rubus caesius L.* (mur)	*Rosaceae*	x, MF
13.	*Conyza canadensis* (bătrâniş)	*Asteraceae*	x
14.	*Convolvulus arvensis L.*(volbura)	*Convolvulaceae*	F_3, M
15.	*Oenothera biennis* (lumânărica)	*Onagraceae*	x, MF
16.	*Euphorbia cyparissias* (laptele cucului)	*Euphorbiaceae*	x, T, D
17.	*Clematis vitalba* (curpen)	*Ranunculaceae*	x
18.	*Taraxacum officinale* (păpădia)	*Asteraceae*	F_2, MF
19.	*Apera spica-venti* (iarba vântului)	*Poaceae*	F_1
20.	*Picris hieracioides* (iarba găii)	*Asteraceae*	x
21.	*Crepis setosa* (gălbenuşi)	*Asteraceae*	x
22.	*Alyssum alyssoides*	*Brassicaceae*	x
23.	*Salvia nemorosa*	*Lamiaceae*	x, MF
24.	*Sorghum halepense* (costrei)	*Poaceae*	x
25.	*Echium vulgare* (iarba şarpelui)	*Boraginaceae*	x, M, MF
26.	*Lotus corniculatus* (ghizdei)	*Fabaceae*	F_4
27.	*Galium mollugo* (drăgaica)	*Rubiaceae*	x
28.	*Salsola kali* (ciulin rusesc)	*Amaranthaceae*	x
29.	*Hypericum perforatum* (pojarniţa)	*Hypericaceae*	x, M,D
30.	*Medicago falcata* (lucerna galbenă)	*Fabaceae*	F_4, MF
31.	*Melilotus officinalis* (sulfina galbenă)	*Fabaceae*	F_2, M, MF
32.	*Verbena officinalis* (urzicuţă)	*Verbenaceae*	x, M
33.	*Hippophae rhamnoides* (cătina albă)	*Elaeagnaceae*	x, M
34.	*Lolium perenne* (raigras)	*Poaceae*	F_5
35.	*Festuca arundinaceea* (păiuş)	*Poaceae*	F_4
36.	*Onopordum acanthium* (scai măgăresc)	*Asteraceae*	x, D
37.	*Agropyron repens* (pir târâtor)	*Poaceae*	F_2, M
38.	*Calamagrostis epigeios* (trestie de câmpuri)	*Poaceae*	x
39.	*Festuca valesiaca* (păiuş)	*Poaceae*	F_1
40.	*Phragmites australis* (trestie)	*Poaceae*	x, D
41.	*Erigeron annuus*	*Asteraceae*	x

Notă: x – plante fără valoare furajeră; F1 – plante cu valoare furajeră mediocră; F2 – plante cu valoare furajeră mijlocie;
F3 – plante cu valoare furajeră bună;
F4 – plante cu valoare furajeră foarte bună; F5 – plante cu valoare furajeră excelentă; M – plante medicinale şi aromatice; MF – plante melifere;
T – plante toxice; D – plante dăunătoare pajiştilor [9].

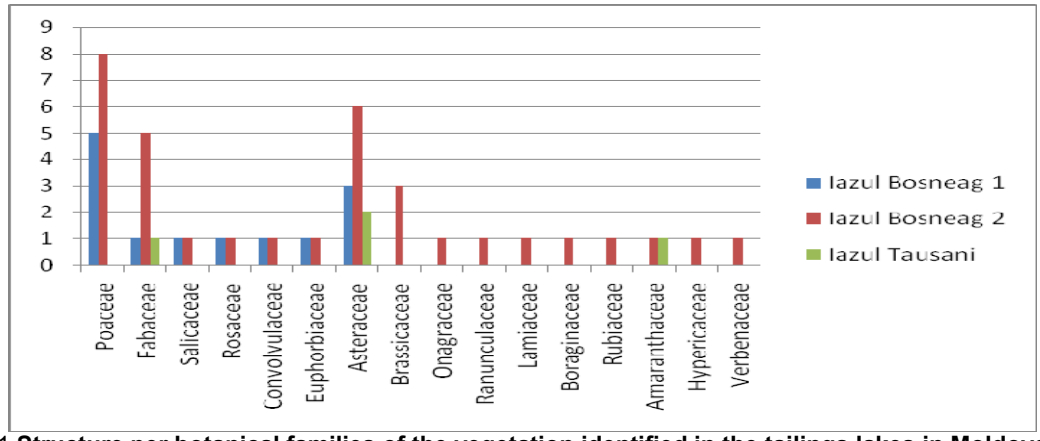

Figure1 **Structure per botanical families of the vegetation identified in the tailings lakes in Moldova Nouă**

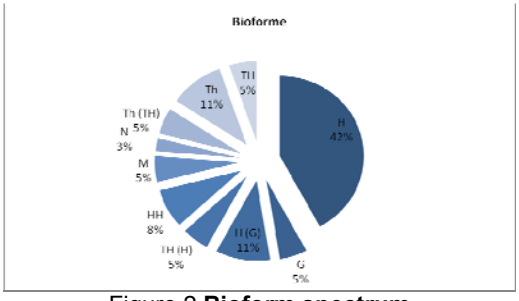

Figure 2 **Bioform spectrum**

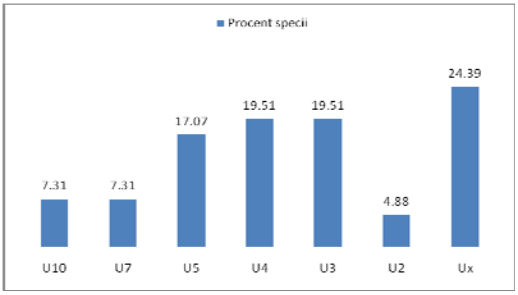

Figure 3**Species share of the total number of species depending on the moisture factor**

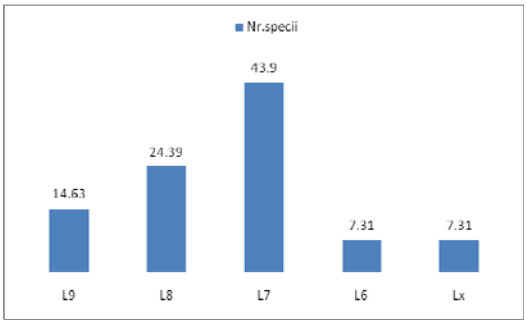

Figure 4 **Species share of the total number of species depending on the light factor**

According to the data presented in Table 1 and represented graphically in Figure 6, we can say that on the tailings dumps in Moldova Nouă predominate species with no fodder value whatsoever (about 34.15% of the total number of plant species), followed by medicinal and aromatic that have no fodder value either (x, M = 9.8%, such as *Hippophae rhamnoides*, *Verbena officinalis*, *Melilotus officinalis*, *Echium vulgare*) and by pest plants species, with no fodder value (x, D = 9.8%, among which *Bromus sterilis*, *Populus tremula*, *Onopordum acanthium*, *Phragmites australis*).

In a very small percentage (i.e. 2.4%), we found plant species with a good fodder value (e.g., *Poa compressa*), medicinal and meliferous plants with medium fodder value (e.g., *Agropyron repens*, *Taraxacum officinale*, *Cardaria draba*) and even with excellent fodder value (e.g., *Lolium perenne*).

Plant species with a very good fodder value such as *Festuca arundinaceea* and *Lotus corniculatus* represent about 4.9% in the studied area.

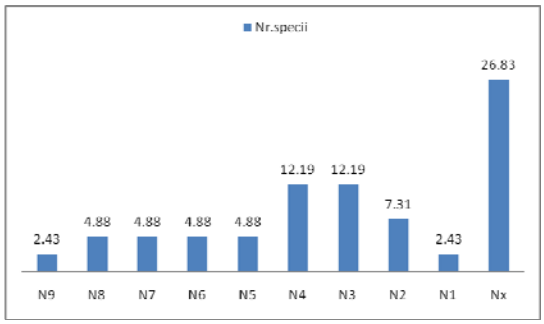

Figure 5 **Species share of the total number of species depending factor N-mineral soil quantity**

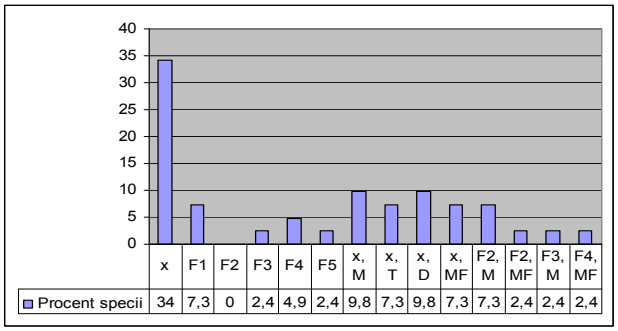

Figure 6 **Species share of the total number of species depending on their economic features**

CONCLUSIONS

As a result of our studies concerning the presence of vegetation on the tailings in Moldova Nouă, we could draw the following conclusions.

In the Boşneag Lake 1, 80% of the plant species are represented by *Phragmites australis* covering almost the entire tailings area in the lake. This species has no fodder value and it is a pest for valuable vegetation that could have developed. Despite all this, the species *Phragmites australis* managed to establish the tailings in this lake due to its roots, thus preventing flotation. Among the species seeded manually during the period 1988-1990, only the species *Agropyron repens* (couch grass) resisted in time, thus contributing to the establishment of the tailings in the lake (its abundance is about 30%); the slopes of the lake were planted with such plant species as *Robinia pseudoacacia* and *Populus tremula*, that also resisted and developed in time. For the rest, the other plant species we identified in the Boşneag Lake 1 appeared spontaneously during the 20 years. These are mainly species with no fodder value.

In the Boşneag Lake 2, the highest abundance is that of the species *Poa compresa*, covering about 50% of the lake surface< it is identified mainly by the lake borders, since it is a moderately moist soil plant. This smooth meadow grass species was seeded manually in this lake also, some 20 years ago, together with the species

Medicago falcata, and the studies we carried out show that these species adapted to the physico-chemical conditions of the tailings in the Boşneag Lake 2, being still there nowadays. Among the plants with a very good and excellent fodder value found in this lake are *Lolium perenne*, *Medicago falcata*, *Lotus corniculatus* and *Festuca arundinaceea*. The woody species planted during this period are *Hippophae rhamnoides*, *Populus tremula* and *Robinia pseudoacacia*, aiming at establishing the tailings and at making up a curtain around the lake to prevent deflation; at present, these species protect the lake from the wind. In time, other new plant species appeared in this lake too; of the 35 plant species we identified, 27 are spontaneous. Most plant species have no fodder value and they belong to the botanical families *Asteraceae*, *Fabaceae* and *Brassicaceae*.

In the Tăuşani Lake, the largest in size and the newest one, appeared after 1990, we identified only 4 spontaneous plant species: *Chondrilla juncea* (rush skeletonweed), *Salsola kali* (Russian thistle), *Robinia pseudoacacia* L. (black locust), *Onopordum acanthium* (cotton thistle). Among them, the highest abundance is that of the species *Salsola kali,* covering almost 60% of the lake surface, a species with no fodder value and light loving.

We also noticed in these lakes the existence of clover and cock's foot species that produce large amounts of vegetal material both underground and on the ground. Taking into account the ecological reconstruction of these lakes, we need to mention that re-vegetation should be done with perennial plants and weeds specific to the area that are not too demanding from the soil and particularly also mix time-resisting species developed on the tailings in Moldova Nouă (e.g., *Poa compresa*, *Medicago falcata*, *Agropyron repens*) to establish the tailings and to prevent deflation. To increase the economic value of the area, we should introduce, in the plant species mix, good fodder value too (e.g., *Convolvulus arvensis*), very good fodder value (e.g., *Festuca arundinaceea*, *Lotus corniculatus*) and even very excellent fodder value (e.g., *Lolium perenne*) species that have been also found in the lake area but in smaller shares, turning the area into a temporary grassland for small animals.

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