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THE ANALYSIS OF ECOLOGICAL BEHAVIOUR OF THE MACROLICHENS FROM ROSIA MONTANA (ROMANIA)

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ABSTRACT. The 41 foliose and fruticulose lichen species identified from Rosia Montana area were characterised using the ecological indexes for chemical reaction of the substrate, according to Ellenberg et al. (1992) and Wirth (1995). Among the 41 species identified in the studied area, 2 species are included in Habitats Directive (*Cladonia arbuscula*, *C. ciliata*) and 9 are rare species (*Cetraria islandica*, *C. sepincola*, *Cladonia bellidiflora*, *C. cervicornis*, *C. crispata*, *Pychnothelia papillaria*, *Usnea florida*, *U. subfloridana*).

Keywords: lichens, foliose, fruticulose, ecology, Romania

INTRODUCTION

Rosia Montana is situated in Romanian Western Carpathians in the north-east of Metaliferi Mountains.. The relief is developed on alpine ophiolitic formations and on Cretaceous flysch (Grigor, 2005). The hydrography is represented by the Roşia river witch is part of Mureş river basin, and by some anthropic lakes used in past for mineral processing. The climate is typical for medium and low mountains area.

The vegetation has good conditions for development of beech, which passes the top of hillocks in mixed forests consisting of beech and spruce, and spruce and fir. In valleys are present the alder habitats. A lot of forests are replaced by mesophilic secondary grasslands.

MATERIAL AND METHODS

The analysis of flora was carried out on the basis of foliose and fruticulose lichen specimens collected and determined during the summer and autumn of 2007 (Ciurchea, 2004, Purvis et al 1994; Moberg, Holmasen, 1992). The botanic nomenclature used is according to Santesson (1993). The lichen flora was analysed in relation with the ecological preferences of the species toward substrate (fig.1) and chemical reaction of the substrate (fig.4). Indicator values for the lichen species that we have used are according to Ellenberg et al. (1992) and Wirth, (1995).

Similar to other studies done in areas with pronounced anthropic influence (Crisan, 2002), we wanted to determine the degree of development of the macrolichen flora in the area and the influence of local conditions. We have established 11 representative stationeries differentiated by the antropic influence, and by ecological conditions (located on shore of Valea Rosiei, in forest formations or on dumps of surface mining.

Location of stationeries:

1. In the village, near the river: Lat. 46º 18' 17.19''N Long. 23º 7' 35. 994'' E Alt. 849.8 m
2. At east from the dump of surface mining, on northern exposition: Lat. 46º 18' 12.474''N Long. 23º 7' 45. 702'' E Alt. 864.7 m
3. At east from the dump of surface mining, on northern exposition: Lat. 46º 18' 10.902''N Long. 23º 7' 48. 042'' E Alt. 925.4 m
4. Exposition V-NV: Lat. 46º 18'9.762''N Long. 23º 7'48.402'' E Alt. 935.2 m
5. Exposition N: Lat. 46º 18'5.562''N Long. 23º 7'46.194'' E Alt. 952.4 m
6. Above the dump of surface mining: Lat. 46º 17'58.032''N Long. 23º 7' 45. 774'' E Alt. 1056.6 m
7. Beech forest, shrubs: Lat. 46º 18'9.846''N Long. 23º 6' 42.126'' E Alt. 778.4m
8. Beech forest, below the dump of surface mining: Lat. 46º 18' 0.39''N Long. 23º6' 50.574'' E Alt. 817.4 m
9. West from the dump of surface mining, on western exposition : Lat. 46º 17' 49.092''N Long. 23º6' 50. 208'' E Alt. 824.8 m
10. West from the dump of surface mining, on western exposition: Lat. 46º 17'40.29''N Long. 23º 6' 51.396'' E Alt. 875 m
11. In the dump of surface mining, western exposition: Lat. 46º 17'41.328''N Long. 23º 7' 31. 866'' E Alt. 951 m

RESULTS AND DISCUSSIONS

The 41 foliose and fruticulose species identified in the area belong to 2 orders, 6 families and 14 genera, all from Ascomycotina class (Table 1). The order Lecanorales is the widest represented with 36 species belonging to 5 families.

According to the distribution of lichen species in Central Europe, among the 41 species identified in the studied area 2 species are included in Habitats Directive (*Cladonia arbuscula*, *C. ciliata*) and 9 rare species (*Cetraria islandica*, *C. sepincola*, *Cladonia bellidiflora*, *C. cervicornis*, *C. crispata*, *Pychnothelia papillaria*, *Usnea florida*, *U. subfloridana*).

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The preferences toward the substrate indicate the predominance of the tericolous (39, 02%), followed by the epifloidic (24, 39%), ligni-epifloidic (14, 63%), epilitic (12, 19%). Smaller percentage has the teri-lignicolous (4, 87%), lignicolous (2, 43%) and teri-muscicolous (2, 43%) species.

Table 1

Repartition of the species in genera, families and orders

Order	Family	Number of genera	Number of species
Lecanorales	*Candelariaceae*	1	1
	Cladoniaceae	2	18
	Parmeliaceae	8	14
	Physciaceae	1	3
	Umbilicariaceae	1	4
Teleoschistales	*Teleoschistaceae*	1	1

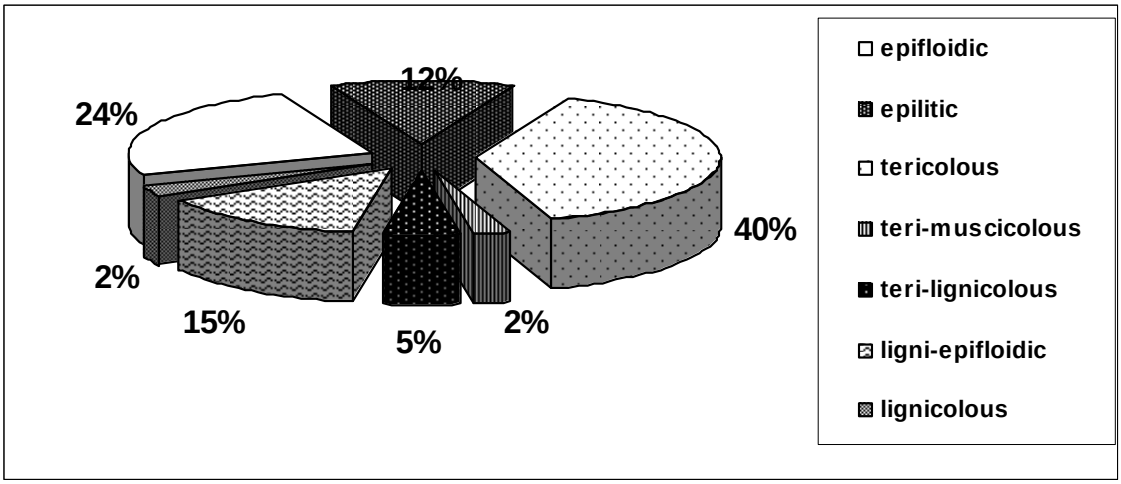

Fig. 1 Percentage repartition of the lichen species toward the substrate

Systematic arrangement

Eumycota
Ascomycotina
Discomycetes
Lecanorales

Fam. Candelariaceae
1. *Candelariela vitellina* (Hoffm.) Müll Arg.

Fam. Cladoniaceae
1. *Cladonia arbuscula* (Wallr.) Flot
2. *Cladonia bellidiflora* (Ach.) Schaer
3. *Cladonia cenotea* (Ach.) Schaer
4 .*Cladonia cervicornis* (Ach.) Flot.
5. *Cladonia ciliata* (Stirt.) Trass
6. Cladonia chlorophaea (Flörke ex Sommerf) Spreng
7. *Cladonia coccifera* (L.) Willd
8. Cladonia coniocraea (Flörke) Spreng
9. *Cladonia cornuta* (L.) Hoffm
10. Cladonia crispata (Ach.) Flot.
11. *Cladonia deformis* (L.) Hoffm
12. *Cladonia fimbriata* (L.) Fr.
13. *Cladonia macilenta* Hoffm
14. *Cladonia polydactyla* (Flörke) Spreng
15. *Cladonia pyxidata* (L.) Hoffm
16. *Cladonia squamosa* Hoffm
17. *Cladonia sulfurina* (Michx) Fr.
18. *Pycnothelia papillaria*

Fam. Parmeliaceae
1. *Evernia prunastri* (L.) Ach.
2. *Hypogimnya physodes* (L.) Nyl.
3. *Hypogimnya tubulosa* (Schaer) Hav.
4. *Pseudevernia furfuracea* (L.) Zopf.
5. *Parmelia sulcata* Taylor
6. *Parmelia conspersa* (Ach.) Hale
7. *Melanelia glabratula* (Fr. Ex Duby.) Essl in Egan
8. *Cetraria islandica* (L.) Ach.
9. *Cetraria sepincola* (Ehrh.) Ach
10. *Usnea hirta* (L.) Weber ex F. H. Wigg
11. *Usnea florida* (L.) Weber ex F. H. Wigg-
12. *Usnea subfloridana* Stirt.
13. *Vulpicida pinastri* (Scop.) J-E. Mattsson and M. J. Lai
14. *Pleurosticta acetabulatum* (Neck) Elix and Lumbsch Kothe & Elix

Fam. Physciaceae
1. *Physcia stellaris* (L.) Nyl.
2. *Physcia tenella* (Scop) DC in Lam & DC
3. *Physcia adscendens* (Fr.) H. Olivier

Fam. Umbilicariaceae
1. *Umbilicaria cylindrica* (L.) Delise ex Duby
2. *Umbilicaria polyphylla* (L.) Baumg

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3. *Umbilicaria polyrhiza* (L.) Fr.
4. *Umbilicaria hirsuta* (Sw. ex Westr) Hoffm
Ordinul Teleoschistales
Fam. Teleoschistaceae
1. Xantoria parietina (L.) Th. Fr.

Chemical composition of the substrate largely favors moderate acidophilous (29.26%) and acidophilous (21.95%) species, followed by strong acidophilous (17.07%) species. With smaller percentages are represented the euryionic (9.75%), acidophilous-moderate acidophilous (7.31%) and subneutrophilous (7.31%) species. Less represented are the moderate acidofile-subneutrophilous (4.87%) and extremely acidophilous (2.43%) species.

We have identified 16 corticolous (epifloidic) lichen species on 9 host tree species (Table 2). The larger number of lichen species was found on *Prunus domestica* (10 species) and *Populus tremula* (7 species).

In order to appreciate if the area is acidified as a result of the pollution produced from mining activities, he have compared the pH of the bark of three tree species: Populus tremula, Pinus silvestris, Picea abies (Barkman, 1958) and the values of pH indicate by 7 species of corticolous lichens developed on that trees, according to Ellenberg et al (1992) (Table 3).

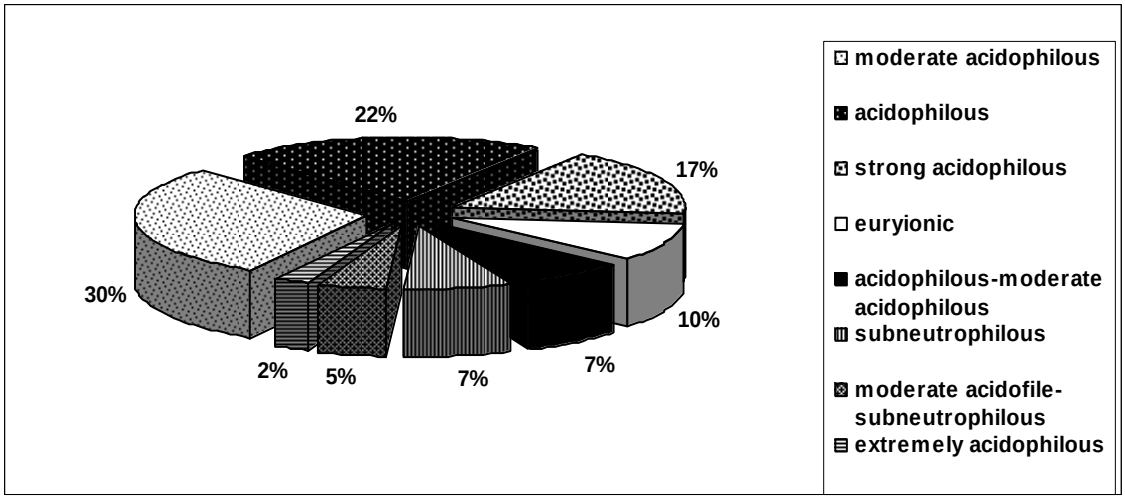

Fig. 3 Percentual repartition of the lichen species in relation with their preferences toward the chemical composition of the substrate

Table 2

Lichen species identified on trees bark

No.	Corticolous lichen species	Host tree species
1	*Candelariela vitellina*	*Prunus domestica*
2	*Cetraria sepincola*	*Betula sp.*
3	*Evernia prunastri*	*Prunus domestica*, *Populus tremula*, *Betula sp.*, *Malus sp.*
4	*Hypogimnia physodes*	*Picea abies*, *Pinus silvestris*, *Prunus domestica*, *Abies alba*, *Populus tremula*, *Betula sp.*, *Prunus domestica*
5	*Hypogimnia tubulosa*	*Picea abies*, *Pinus silvestris, Populus tremula*, *Abies alba*
6	*Melanelia glabratula*	*Prunus spinosa*
7	*Parmelia sulcata*	*Prunus domestica*
8	*Physcia adscendens*	*Populus tremula*, *Salix alba*, *Prunus domestica*
9	*Physcia stellaris*	*Salix alba*, *Prunus domestica*
10	*Physcia tenella*	*Populus tremula*, *Salix alba*, *Prunus domestica*
11	*Pseudevernia furfuracea*	*Picea abies*, *Populus tremula*, *Pinus silvestris*, *Prunus domestica*, *Abies alba*, *Betula sp.*
12	*Usnea florida*	*Malus sp.*
13	*Usnea hirta*	*Prunus domestica*, *Malus sp.*
14	*Usnea subfloridana*	*Malus sp.*
15	*Vulpicida pinastri*	*Betula sp*
16	*Xanthoria parietina*	*Populus tremula*, *Salix alba* *Prunus domestica*

Table 3

pH of tree bark species compared with the ecological preferences of corticolous lichen species according Ellenberg et al (1992)

No.	Corticolous lichen species	*Picea abies* bark pH 3.8-4.5	*Pinus silvestris* bark pH 3.4-3.8	*Populus tremula* bark pH 3.9-7.9
1	*Evernia prunastri*	-	-	*4.1-4.4*
2	*Hypogimnia physodes*	*4.1-4.4*	*4.1-4.4*	*4.1-4.4*
3	*Hypogimnia tubulosa*	*4.1-4.4*	*4.1-4.4*	*4.1-4.4*
4	*Physcia adscendens*	-	-	*5.3-6.1*
5	*Physcia tenella*	-	-	*5.7-6.5*
6	*Pseudevernia furfuracea*	*3.4-4*	*3.4-4*	*3.4-4*
7	*Xanthoria parietina*	-	-	*5.7-6.5*

CONCLUSIONS

In conclusion, the first inventory of the lichenflora on the waste dump of Roşia Montană shows a relatively high lichen species richness for a polluted area. The study had revealed a number of 41 foliose and fruticulose lichen species, 2 species are included in Habitats Directive and 9 rare species according the chorology of lichens in Central Europe.

The analysis of the lichen preferences toward the chemistry of the substrate we noticed the presence of a core of species (48.76%) composed of acidophilous (21.95%), strong acidophilous (17.07%) and extreme acidophilous (2.43%). In this first group of species are included the high majority of tericolous species. If we add the acidophilous - moderate acidophilous (7.31%) and the moderate acidophilous (29.26%), we can conclude that more than 85% of the species identified in the stationeries at Roşia Montană indicate a substrate with different degrees of acidity. This second group comprise 12 of the corticolous species (Table 3).

Nowadays, the waste dump seems to be at the beginning of a process of colonization with vegetation, the large number of Cladonias identified suggesting an earlier phase of succession.

Also, we appreciate that the dump area is affected by hydrogen cyanide, but the influence of this acid and his subsequent combinations is very complex.

The information regarding the pH of the waste dump, highlighted by the chemical preferences of the terricolous lichens toward the substrate, could be useful on a future ecological restoration project of the area.

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