PRELIMINARY DATA ON EDAPHIC ALGAE IN THE CITY OF PITEŞTI (ROMANIA)

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Abstract. In order to initiate the inventory of the edaphic algae in the city of Piteşti, soil samples were taken from Expo Park Lumina Park, the Ştrand Park, the bank of the river Argeş, Trivale forest, Trivale Park, the BCR Park, Bascov Park, Park in Prundu, Bucharest-Piteşti highway. A total of 27 genus/species were identified, out of which 22% belonging to phylum *Cyanobacteria*, 67% to phylum *Ochrophyta*, and 11% to phylum *Chlorophyta*. The prevalence of the ecobiomorph B was found, in proportion of 68%, which was followed by ecobiomorphs Cf, Ch, N and P, each represented by 7%, and C, represented by 4%. In all samples analyzed the presence was identified of the species *Hantzschia amphioxys*, alongside *Diatoma vulgare*, in polluted soils. The presence was also noted of species *Cylindrospermum* sp., *Nostoc* sp., *Nostoc commune*, and nitrogen capturing *Nostoc punctiforme*. The rate of aridity, that is the ratio of the number of *Cyanobacteria* and *Chlorophyta* species, calculated for each sample, had high values of between 1 and 4, which confirms that urban soils are characterized by arid conditions.

Keywords: cyanobacteria, edaphic algae, *Cyanobacteria*, *Ochrophyta*, *Chlorophyta*, *Hantzschia amphioxys*, *Diatoma vulgare*, nitrogen capturing species, Piteşti (Romania)

INTRODUCTION

Soil habitats are the most important non-aqueous ecosystems for algae [20]. Edaphic algae are an important autotrophic component of the biota in all terrestrial habitats. They play a significant role in soil genesis, stabilization of substrata and the formation of organic matter in natural and technogenic soils [8, 11, 12, 15]. Algae contribute to the nitrogen content of the soil through the process of biological nitrogen fixation [5], thus having an important role in soil fertility [18]. At present, numerous researches are directed towards studying the edaphic algae in various anthropized ecosystems [3]. The research conducted on the edaphic algae in soils of urban and rural areas indicate that in those areas, algal communities are degraded, as their specific diversity decreases and the taxonomic structure is simplified. The substitution occurs of characteristic species with tolerant species [2]. The city of Piteşti is part of the category of Romania's urban communities having a developed economy, based on the petrochemical industry, the wood processing industry, the car industry, the textile and leather products industry, etc. Industrial pollution is supplemented by road traffic pollution [13]. The algae are considered the most sensitive component of the soil biota in point of pollution [2]. The role of the edaphic algae was demonstrated as being that of bio-indicators of the condition of the soils, especially as far as the technogenic soils are concerned [16, 17]. Thus, taking into account the fact that the algae can be used in ecological monitoring, the purpose of the present study was to initiate necessary research to a full inventory of the edaphic algae in Piteşti.

MATERIALS AND METHODS

The city of Piteşti in the county of Argeş, attested by documents as early as 1388, is located in the central Eastern area of Southern Romania, at the intersection of the 44°51'30" parallel of North latitude with the 24°52' meridian of East longitude. The territory of Piteşti belongs to the Getic Piedmont and the Romanian Plain (the Plain of Piteşti). It lies on the line of contact between the following sub-units: the Cotmeana Piedmont (N and NW), the Argeş Hills (NNE), the Cândeşti Piedmont (ESE) and also in the transition between Getic Piedmont (N) and the Romanian Plain (S). In the area of Piteşti, the soils are part of the submontainous-silvic category, as the Danubian-Getic province lies in a transition zone, passing from the soils of the hilly level, with the brown forest soils, typical and podzolic, to the soils of the lower hills and high fields, with pseudogleic soils. Around Piteşti the podzolic soil type predominates, which is generally deep and relatively fertile.

The soil sampling was done in: Expo Park, the Trivale Park, the Ştrand Park, the Prundu Park, the Trivale forest Park, the BCR Park, the Argeş river, the Lumina Park, the Parks in Bascov, the Bucharest-Piteţti motorway embankment. The sampling was conducted in compliance with all rules of conserving sterility. The samples were collected and kept until the research in labelled sterile packs made of hard paper [2].

To identify algae the indirect method was used, by spontaneous culture [6] and the following determiners: Hindák et al. (1975) [7], Ionescu & Peterfi 1979, 1981 [9, 10], Nogy-Toth & Barna, 1998 [14]. Arranging the algae in systematic classification units was done according to Cavalier-Smith [1]. The ecobiomorph was indicated for the species identified, and for each sample the coefficient of aridity was calculated [2].

RESULTS

Following the analysis of the soil sample taken from the Expo Park 12 genus/species were determined (Table 1). 50% of the taxa belong to the phylum of *Ochrophyta*, 25% to *Cyanobacteria*, and 25% to the phylum *Chlorophyta* (Fig. 1). As regards the share of the ecobiomorphs in the soil sample analyzed, the prevalence is noted of the ecobiomorph B (Bacillariophyta type), with a percentage of 51%, followed by Ch (Ch-Chlorella type), with 17%, C (Cylindrospermum type), Cf (Cylindrospermum type, nitrogen fixing subtype), N (Nostoc type with macroscopically visible colonies) and P (Phormidium type) with 8% each (Fig. 2).

The microscopic analysis of the soil sample taken from the Trivale Park led to the identification of as many as 12 genus/species (Table 1). Diatoms predominate in the sample, with a total of 7 species, which constitutes 59% of all species determined, followed by cyanobacteria with a share of 33%, and in the last place were the green algae, with 8% (Fig. 1). As far as the distribution of ecobiomorphs is concerned, the predominance is found of ecobiomorph B: 59%, followed by P: 17% and Cf, Ch, N, with 8% each (Fig. 2).

For the Ştrand Park, the soil sample analyzed contains a total of 10 genus/species of phyla *Cyanobacteria*, *Ochrophyta* and *Chlorophyta* (Table 1). In the category of the taxa identified, the predominance is noted of diatoms, as well as with the previous samples, with 60%, followed by cyanobacteria with 30%, and the green algae with 10% (Fig. 1). As far as the ecobiomorphs are concerned, the special weight can be noted of ecobiomorph B with 60%, followed by ecobiomorphs Cf, Ch, N, P, with 10% each (Fig. 2).

Table 1. Taxa identified in soil samples taken in the area of the city of Piteşti.

Nr. crt	Genus/Species	E	1	2	3	4	5	6	7	8	9	10
	Cyanobacteria											
1	*Cylindrospermum* Kützing	Cf	+		+		+	+	+	+	+	
2	*Nostoc* Vaucher	N			+	+	+	+	+		+	
3	*Nostoc commune* Vaucher	N	+	+						+		
4	*Nostoc punctiforme* (Kützing) Elenk.	Cf								+		
5	*Oscillatoria* Vaucher ex Gomont	P	+		+	+	+	+			+	
6	*Phormidium* Kützing ex Gomont	P		+			+	+		+	+	
	Ochrophyta											
7	*Asterionella formosa* Hassall	B						+				
8	*Cocconeis* Ehrenberg	B		+								+
9	*Cymbella cistula* (Hemprich et Ehrenberg) Kirchner	B				+						
10	*Diatoma vulgaris* Bory	B	+	+	+	+	+	+	+		+	
11	*Fragilaria* Lyngbye	B		+	+			+			+	
12	*Fragilaria minuscula* Grunow	B				+			+			
13	*Gomphonema subclavatum* (Grunow) Grunow	B	+									
14	*Hantzschia amphioxys* (Ehrenberg) Grunow	B	+	+	+	+	+	+	+	+	+	+
15	*Navicula* Bory emend.Cleve	B			+	+	+			+	+	
16	*Navicula dicefala* (Ehrenberg) W. Smith	B	+									
17	*Navicula lanceolata* (C. Agardh) Kützing	B		+								
18	*Navicula nivalis* Ehrenberg	B	+									
19	*Neidium* (Ehrenberg) Pfitzer	B						+				
20	*Nitzschia* Hassall	B		+				+				
21	*Nitzschia amphibia* Grunow	B			+							
22	*Pinnularia* Ehrenberg	B			+			+				
23	*Pinnularia gibba* Ehrenberg	B							+			
24	*Pinnularia mesolepta* (Ehrenberg) W.Smith	B	+			+	+					
	Chlorophyta											
25	*Chlorella* Beijerinck	Ch	+		+				+	+		+
26	*Chlamydomonas* Pascher	C	+	+					+			
27	*Tetracystis* R. M. Brown et Bold	Ch	+									

Note: 1. Expo Park, 2. Lumina Park, 3. Ştrand Park, 4. The bank of the river Argeş, 5. Trivale forest, 6. Trivale Park, 7. BCR Park, 8. Bascov Park, 9. Prundu Park, 10. Bucharest-Piteşti highway, E-ecobiomorph, B-Bacillariophyta type, C-Cylindrospermum type, Cf-Cylindrospermum type, nitrogen fixing subtype, Ch-Chlorella type, N-Nostoc type with macroscopically visible colonies, P-Phormidium type.

In the soil sample taken from the Prundu Park 8 genus/species were identified (Table 1). Unlike previous samples, it is noted that half of the taxa belong to cyanobacteria, and the rest of 50% to the diatoms (Fig. 1). As far as the ecobiomorphas are concerned, the prevalence is noted of ecobiomorph B shows predominance (50%), followed by P with 25%, and Cf (Cylindrospermum type, nitrogen fixing subtype) and N (Nostoc type with macroscopically visible colonies) with 12.5% each (Fig. 2).

In the soil sample from the Trivale forest 8 genus/species were found (Table 1), belonging to the phyla *Cyanobacteria* and *Ochrophyta*. In terms of distribution of the taxa identified it could be noted that each phylum has an equal number of representatives (Fig. 1), very much as in the samples taken from the Prundu Park. As far as the ecobiomorphs are concerned, the special weight is observed of ecobiomorph B, with 50%, followed by ecobiomorph P, with 25%, Cf and N, with 12.5% each (Fig. 2), very much as in the soil samples taken from the Prundu Park.

The soil sample taken from the BCR Park has a lower number of taxa identified; there are 7 genus/species (Table 1) belonging to the phyla *Cyanobacteria*, *Ochrophyta*, and *Chlorophyta*. The share of those phyla in the soil sample analyzed is as follows: 57% *Ochrophyta,* 29% *Cyanobacteria* and 14% *Chlorophyta* (Fig. 1). As far as the ecobiomorphs are concerned, the predominance is noted of ecobiomorph B 58%, while ecobiomorphs Cf, Ch and N are in proportion of 14% each (Fig. 2).

The microscopic analysis of the soil sample taken from the bank of the Argeş river led to the identification of 8 taxa of the phyla *Cyanobacteria* and *Ochrophyta* (Table 1). The highest percentage of taxa belongs to the *Ochrophyta* (75%), the remaining 25% belonging to the *Cyanobacteria* (Fig. 1). The prevalence was found of the ecobiomorph B with 75%,

as the other two ecobiomorphs, N and P, can be found as 12.5% each (Fig. 2).

In the soil sample taken from the Lumina Park 9 genus/species were identified (Table 1) of the phyla *Cyanobacteria*, *Ochrophyta* and *Chlorophyta*. Most taxa (species/genera) belong to the phylum of *Ochrophyta* (67%), the next place is held by those in the phylum *Cyanobacteria* (22%), and the fewer representatives belong to the phylum *Chlorophyta* (11%) (Fig. 1). Within the ecobiomorphs identified, the predominance was found of category B (67%), followed by C, N and P, with 11% each (Fig. 2).

In the soil sample taken from Bascov, 7 taxa were identified in the phyla *Cyanobacteria*, *Chlorophyta* and *Ochrophyta* (Table 1). *Cyanobacteria* dominance was found (57%), unlike previously analyzed samples, in which diatoms prevailed (Fig. 1), the remaining species are diatoms (29%), and the lowest percentage belongs to the chlorophytes (14%). Within the ecobiomorphs, form B and Cf predominates (29%), and the other ecobiomorphs: Ch, N and P have 14% each (Fig. 2).

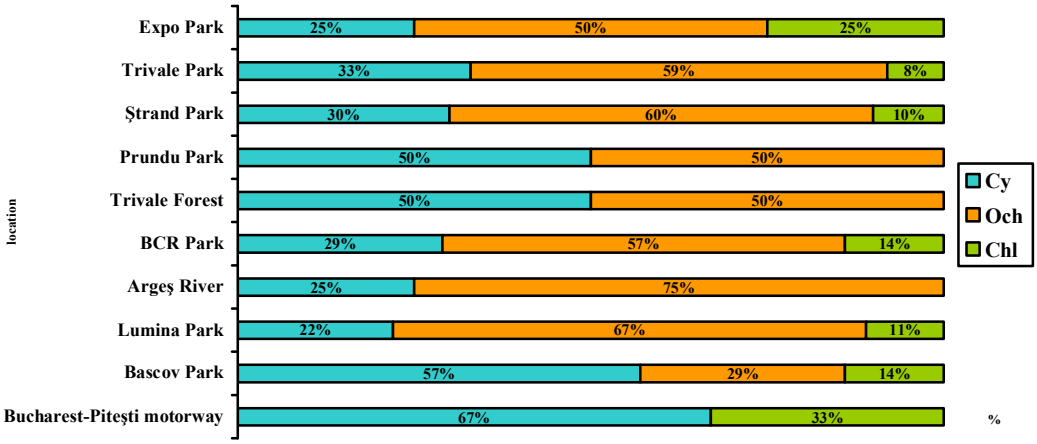

Figure 1. The share of the alga groups identified in soil sample taken Piteşti (Cy-*Cyanobacteria*, Och-*Ochrophyta*, Chl-*Chlorophyta*).

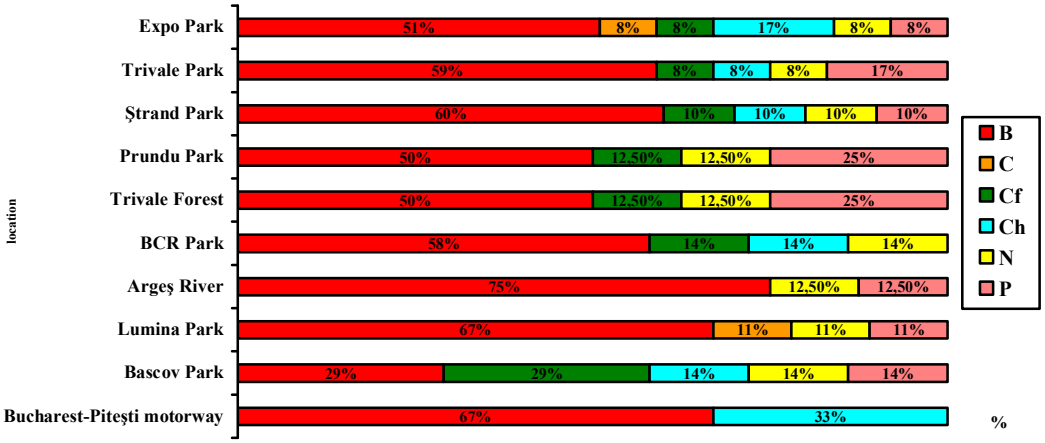

Figure 2. The share of ecobiomorph identified in soil sample taken from Piteşti: B-Bacillariophyta type, C-Cylindrospermum type, Cf-Cylindrospermum type, nitrogen fixing subtype, Ch-Chlorella type, N-Nostoc type with macroscopically visible colonies, P-Phormidium type.

In the soil sample taken from the Bucharest-Piteşti motorway embankment the lowest number of taxa was found, as against all the other samples analyzed (Table 1). The three genera identified belong to the *Ochrophyta* (67%) and *Chlorophyta* (33%) (Fig. 1). As far as the shares of the ecobiomorphs are concerned, form B shows predominance (67%), as Ch is present in a proportion of 33% (Fig. 2).

DISCUSSIONS

The preliminary research undertaken for making up the inventory of the edaphic algae in the city of Piteşti have led to the identification, so far, of as many as 27 genus/species belonging to the phyla *Cyanobacteria*, *Ochrophyta* and *Chlorophyta* [1]. The presence and predomination of diatoms was found in all the samples analyzed, in a percentage of 67%. The exception was the sample taken in the Bascov Park, where the cyanobacteria predominate. The cyanobacteria were met in 9 out of the 10 test samples, representing 22% out of the total number of the species. These are considered to be the most resistant to soil pollution [2]. 11% out of all the species identified are green algae; they were present in 6 out of the 10 test samples. The low number of taxa identified in the soil sample taken from the Bucharest-Piteşti embankment can be correlated with pollution due both to car heavy traffic in the area, and the industrial platform there [13]. Thus, in this area permanent emissions of pollutants are recorded and, in some places, cases where the maximal concentration admitted was exceeded for such pollutants as SO_2, NO_2, HCl, CO, etc. The nature of algal flora in different localities is the result of a

complex influence of the local type of vegetation, soil properties and climatic conditions, but it also depends on the input of airborne algal diasporas [19]. Thus, in the soils of the city of Chişinău the *Cyanobacteria* predominate, followed by the *Chlorophyta*, *Xantophyta*, *Bacillariophyta* and the *Euglenophyta* [2], while in the agrophytocenoses in Northern Moldavia the *Cyanobacteria* predominate, followed by *Bacillariophyta*, the *Xantophyta* and the *Chlorophyta* [18]. Ecobiomorph B, which includes 68% of the identified species, is composed of mobile algae, found in superficial layers of the moist soil, or in the mucus or other algae. The Ch ecobiomorph, which represents 7% out of the total number of the species identified, includes species that are resistant to various extreme factors; this ecobiomorph can be met with in a percentage of 8% in the soils of the city of Chişinău [2]. 7% of the species determined belong to ecobiomorph Cf, a percentage close to the one determined for the soils of the city of Chişinău (6.7%). The Cf subgroup representatives (*Cylindrospermum sp.*, *Nostoc punctiforme*) have the ability to capture atmospheric nitrogen. Ecobiomorph C is present in a percentage of 4%. The N ecobiomorph includes the *Nostoc* species forming macroscopic colonies resistant to intense light and prolonged dehydration, occurring as 7%. The P ecobiomorph contains philamentous *Cyanobacteria* that can form thin films at the surface of the soil, most of which are typical xerophytous species prevailing in arid soils. Represents 7% out of the ecobiomorphs identified, a smaller percentage by comparison with the percentage determined for the soils of the city of Chişinău (23.5%) [2].

The aridity coefficient calculated for each sample was high, ranging from 1 (Expo Park) to 4 (the Trivale Park, Bascov), which confirms that urban soils are characterized by arid conditions [2]. For the soils of the city of Chişinău, this coefficient varies between 1.40 and 3.54 [2]. For spontaneous algoflora, this coefficient varies between 0.5 and 0.9, and higher values are characteristic of meadow algocoenosas (1.8).

In all the samples analyzed the species *Hantzschia amphioxys* was identified, and in 8 out of the 10 samples there occurred *Diatoma vulgare*. Both species are found in algal associations in heavily polluted soils [2]. Also, the species *Hantzschia amphioxys* can be considered cosmopolitan, being found in different soil types [3, 4, 19].

The study conducted on the edaphic algae in the city of Piteşti was the first of this kind; in order to complete the list of species, researches are necessary that should include sample-taking from other areas of the city.

REFERENCES

[1] Cavalier-Smith, T., (2004): Only six kinkdoms of life. Proceedings of the Royal Society, Biological Sciences, 271: 1251-1262.

[2] Ciubuc, N., (2005): Algele edafice din solurile municipiului Chişinău. Moldova State University [in Romanian], Chişinău, 147 p.

[3] Dorokhova, M.F., (2007): Diatoms as indicators of soil conditions in oil production regions. International Journal of Oceanography and Hydrobiology, 36(1): 129-135.

[4] Ettl, H., Gartner, G., (1995): Syllabus der Boden-, Luft- und Flechtenalgen. Gustav Fischer Verlag, Stuttgart, 721 p.

[5] Goyal, S.K., (1997): Algae and the soil environment. Phykos, 36: 1-13.

[6] Gruia, L., (1965): Methods for the study of the soil algae. In Symposium Methods soil, Bucharest, pp. 105-114.

[7] Hindák,F., Komárek, J., Marvan, P., Růžička, J., (1975): Kľúč na určovanie výtrusných rastlín I.,II diel, riasy. SPN, Bratislava, 396 p.

[8] Hoffman, L., Ector, L., Kostikov, I., (2007): Algal flora from limed and unlimed forest soils in the Ardenne (Belgium). Systematics and Geography of Plants, 77 (1): 15-90.

[9] Ionescu, A., Peterfi, Ş., (1979): Tratat de algologie, vol. III. Academiei Române Publishing House, Bucharest, 374 p.

[10] Ionescu, A., Peterfi, Ş., (1981): Tratat de algologie, vol. IV. Academiei Române Publishing House, Bucharest, 477 p.

[11] Johansen, J., Shubert, L.E., (2001): Soil algae. pp. 297-306. In: Elster, J., Seckbach, J., Vincent, W.F., Lhotský, O. (eds.): Algae and Extreme Environments. Nova Hedwigia Beih.

[12] Maxwell, C.D., (1991): Floristic changes in soil algae and cyanobacteria in reclaimed metal-contaminated land at Sudbury, Canada. Water, Air, Soil Pollution, 60: 381-393.

[13] Miu, F., (2006): Clima şi poluarea aerului în municipiul Piteşti. University of Piteşti Press, Piteşti, 331 p.

[14] Nogy-Toth, F., Barna, A., (1998): Alge verzi unicelulare (*Chlorococcales*) – Determinator, Presa Universitară Clujeană Publisher, Cluj-Napoca, 200 p.

[15] Patova., E.N., Dorokhova, M.F., (2008): Green algae in tundra soils affected by cola mine pollutions. Biologia, 63(6): 831-835.

[16] Shtina, E., (1990): Soil algae as biological indicators. Botanical Journal, [in Russian], 75(1): 441-453.

[17] Şalaru, V., Ciubuc, N., Dudnicenco, T., (2004): Estimarea stării ecologice ale teritoriilor urbane cu ajutorul algelor edafice în calitate de bioindicatori. Analele ştiinţifice ale Universităţii de Stat din Moldova, seria Ştiinţe fizico-chimice, Chişinău, 2004: 261-262.

[18] Şalaru, V., Trofim A., Melniciuc, C., Donţu, N., (2008). Taxonomic and ecologic structure of communities of edaphic algae from the agrophytocenoses of the northern districts of Moldova. Journal of Plant Development, 15: 3-6.

[19] Zancan, S., Trevisan, R., Paoletti, M.G., (2006): Soil algae composition under different agro-ecosystems in North-Eastern Italy. Agriculture, Ecossystems and Environments, 112: 1-12.

[20] Zenova, G.M., Shtina, E.A., Dedysh, S.N., Glagoleva, O.B., Likhacheva, A.A., Gracheva, T.A., (1995): Ecological relations of algae in biocenoses. Mikrobiologiya, 64: 121-133.

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