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ANALYSIS OF THE VASCULAR FLORA FROM A SOIL AFFECTED BY ANTHROPOGENIC SOURCES

BY

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Abstract. The area of study (a length of 385 m and a width of 202 m), located at approximately 10 km outside Iaşi district (47°09'02.6"N-27°42'51.5"E), is affected by some anthropic activities such as the proximity of transport infrastructure, accidentally waste disposal and more important by industrial activities. This paper examines the floristic elements from taxonomic, environmental preferences as well as from the phyto-economic potential point of view. This analysis is necessary in order to determine the dominant species, some of which may be considered candidates for a phytoremediation process. Moreover, these data represent inputs for a diagnostic analysis of the polluted area in order to design an ecological restoration plan.

Keywords: ecological indexes; environmental preferences; floral elements; phyto-economic potential; spontaneous flora.

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1. Introduction

Over the time, industrial areas have undergone major changes, in particular, technological evolution and changing market requirements. Unfortunately, the linear economy has led to pollution of soils nearby the industrial plants and some time to lose of local identity of the area. As such, the industrial development process has as a point of reference the ecological reconstruction of the proximate polluted areas (Boroș *et al*., 2015).

In recent years, bioremediation has become one of the most popular technology used for contaminated soils. The use of microorganisms and/or plants is a promising option for remediation since it is effective and economic in removing some of the soil contaminants with less environmental damage (Chen *et al*., 2019). Phytoremediation is a particular technique that uses plants to reduce, eliminate, degrade or immobilize pollutants from the environment (Poonam *et al*., 2014). This environmentally green and cost-effective technology is now focusing on higher plants, with large biomass, that have a high tolerance to pollutants.

This study focuses on an area located at approximately 10 km outside Iasi district (47°09'02.6"N-27°42'51.5"E), in the proximity of a thermal power plant operating since 1986 and covering 1.387.574 square meters of land. The power plant converts the chemical energy of solid fuels into thermal and electrical energy by exploiting two 420 t/h steam boilers. In addition, the proximity of transport infrastructure, accidentally waste disposal and intensive but unauthorized grazing was reported in the area (Zotica *et al*., 2020).

During almost two years (2018, 2019), following the field investigations, the vascular flora of the study area was outline. This approach allowed a detailed knowledge regarding the taxonomic, ecological, chorological and economic potential of the vascular flora in the area.

This analysis is necessary in order to determine the dominant species, some of which may be consider candidates for a phytoremediation process. Moreover, these data represent inputs for a diagnostic analysis of the polluted area in order to design an ecological restoration plan.

2. Materials and Methods

The vascular flora of the area was studied during the optimal vegetation period from March 2018 to November 2019, using the line transect method (Buckland *et al*., 2007). The vouchers collected served as a study material and were subsequently determined under laboratory conditions. In order to organise the information and to establish the floral bio-form elements, comparative morphological methods were used (Sanda *et al*., 1983; Ciocârlan, 2000; Sârbu *et al*., 2001). Regarding the systematic classification of taxa, the phylogenetic system implemented by Pop and collaborators (1983) was adopted.

Indicator values of vascular plants (Ellenberg, 1974) was a useful reference mark in establishing the ecological preferences of the species. In this respect, the system developed by Ellenberg, based on five ecological indices (L, T, K, R, N), with a scale of values from 1 to 9, and one ecological indices (F) – with a scale of values from 1 to 12, illustrating with a greater subtility the different preferences of the species.

3. Results and Discussion

The scientific survey, completed with the inventory and analysis of the vascular flora, reveals a number of 123 taxa, who belong to 78 genres and 28 botanical families. The largest share belongs to the families: Compositae (18 species), Poaceae (14 species), Fabaceae (9 species), Lamiaceae (6 species), Rosaceae (5 species), Brassicaceae (4 species), Cyperaceae (4 species). These 7 families comprise 60 species, totalizing 65.21% of all reported species (Zotica *et al*., 2020).

The analysis of the floristic elements

The studied area belongs to the Euro-Asiatic domain (Euras.), which has the highest dominance (46.15%), generally characterizes the herbaceous flora of the hills and foothill regions (Table 1).

Table 1

Statistical Analysis of the Floristic Elements

The floristic element		No. of species	% per categories	% from total
Circ.	Circumpolar	12	100	13.18
Euras.	Euro-Asiatic	38	90.47	41.75
	Euro-Asiatic - continental	2	4.76	2.19
	Euras.- medit. incl. submedit.	2	4.76	2.19
	Total Euras.	42	99.99	46.15
Eur.	European	4	44.44	4.39
	European – central	3	33.33	3.29
	Eur. centr.- submedit.	2	22.22	2.19
	Total Eur.	9	99.99	9.89
Pan.	Panonic	1	100	1.09
	Pont. Medit. centr. Eur.	1	33.33	1.09
	Pont.- medit.	2	66.66	2.19
	Total Pont.	3	99.99	3.29
Submedit.	Submediterranean	2	100	2.19
Medit.	Mediterranean	3	100	3.29
Adv.	Adventive	2	100	2.19
Cosm.	Cosmopolitan	18	100	19.78

The European character of the flora is given primarily by the European elements (Eur.), represented by 4 species (4.39%), but also by the central European elements (Eur. – centr.) represented by 3 species (3.29%).

The circumpolar elements (Circ.), with 12 species (13.18%), also have a significant share. The presence of these elements is closely correlate with the latitude of the studied area, who has strongly northern origins. All of these elements (Euro-Asian, European and circumpolar) reveal the temperate climate of the area.

In addition, Polycore elements have a relatively modest representation, with a 19.78% of cosmopolitan (Cosm.) elements and 2.19% are adventive (Adv.), a fact that is due to the anthropic influences who confirm the old enlightenment of the vegetation in the area. Southern and thermophilic elements are poorly represented, with a total of 3.29% of Pontic elements (Pont.) and 3.29% Mediterranean elements (Medit.).

In other words, European and Euro-Asian elements cover up together more than half (56.04%) of the total number of species and subspecies, which is a further confirmation of the appurtenance at the Euro-Asiatic domain.

The Analysis of the Ecological Index

In order to obtain a complete and complex image of the area, ecological characteristics of the species were also analysed (Table 2).

Table 2

The Statistical Analysis of the Ecological Indexes

Value of the index	L	L%	T	T%	K	K%	F	F%	R	R%	N	N%
0	4	4.39	37	40.65	25	27.47	16	17.58	44	48.35	24	26.37
1	–	–	–	–	–	–	–	–	–	–	2	2.19
2	–	–	–	–	3	3.29	1	1.09	1	1.09	2	2.19
3	1	1.09	–	–	32	35.16	11	12.08	2	2.19	8	8.79
4	–	–	1	1.09	6	6.59	22	24.17	2	2.19	7	7.69
5	2	2.19	23	25.27	17	18.68	15	16.48	2	2.19	12	13.18
6	15	16.48	15	16.48	5	5.49	12	13.18	4	4.39	9	9.89
7	28	30.76	14	15.38	3	3.29	6	6.59	17	18.68	11	12.08
8	30	32.96	1	1.09	–	–	2	2.19	17	18.68	14	15.38
9	11	12.08	–	–	–	–	3	3.29	2	2.19	2	2.19
10	–	–	–	–	–	–	4	4.39	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–

The light index (L), preferences of the species to temperature (T), continentally index (K), soil humidity index (F), soil reaction index (R) and content of nitrogen in the soil (N) were the ecological indexes considered in the study.

The preferences of species to **light index (L**) illustrates the predominance of the light species, only exceptionally, for a short time, they can tolerate the shade (L8 - 32.96%), followed by the half-light plants (L7 - 30.76%) (include species that were found along the roads and in the meadows areas). 12.08% (L9) are full-light plants while the smallest percentage was held by the species that prefer the shade (L3 - 1.09%).

Concerning to the **preferences of the species to temperature (T),** very well represented are the eurytherms (T0 - 40.65%), followed by the mesothermophile species (T5 - 25.27%).

The **continentality index (K**) is characterized by the sub oceanic species (K3-35.16%), followed by indifferent (K0-27.47%), intermediate and subcontinental species (K5 and K4). The continentality index confirms the European character of the flora in the studied area.

Soil humidity index (F) show a large diversity within this area. With a significant share are the dry soil plant species (F4 - 24.17%), followed by the species adapted to large oscillations of the humidity regime (F0 - 17.58%) and the species adjust to moderately wet soils (F5 - 16.48%). An important presence is the intermediate plant species, from moderately wet soils to wet - damp soils (F6 - 13.18%) followed by dry soils plants (F3 - 12.08%).

Considering the **soil reaction index (R),** the majority of the species can hold large variations of pH (R0 - 48.35%), followed by species that prefer neutral soils and species in the category who marks the transition to basic soils (R7, R8 - 18.68%). There are also 2 acidophile species (R2, R3 - 2.19%) and 4 moderately acidophile species (R4 - 4.39%).

In the case of preference of the plants for the **content of nitrogen in the soil (N)**, it can be noticed a relative dominance of the species that can hold large variations of nitrogen in soil (eurynitrophile species) (N0 - 26.37%). However, if all the percentages corresponding to the categories N5 to N9 are added together, it is find that half (52.72%) of the inventoried plant species of the area prefer soils having moderate to high nitrogen contents. This situation could be explained by the increasing of anthropic impact.

The Analysis of the Phyto-Economic potential of spontaneous plants

The phyto-economic potential of the spontaneous flora in the study area offers significant possibilities of exploiting the vegetation. The rational use of spontaneous plants with an economic value is of great importance, as it could contribute to the enrichment in new sources of raw materials for industry.

Economic analysis of plants highlights the presence of melliferous species (40), followed by toxic (32), fodder (27), medicinal (24), industrial (13), feeding (11) and decorative (1) plants (Table 3).

Table 3
Economical Categories of Vegetal Species Identified in Study Area

No	Economical categories		No. of species	% from total
1	Alimentary (Al.)	culinary (Al. cu.)	9	6.08
		aromatic and spicy (Al. ar.)	2	1.35
2	Decorative (De.)		1	0.67
3	Fodder (Fr.)	poor nutritional value (Fr. 1)	10	6.75
		mediocre nutritional value (Fr. 2)	6	4.05
		good nutritional value (Fr. 3)	6	4.05
		very good nutrinional value (Fr. 4)	5	3.37
4	Industrial (In.)	woody industry (In. lm.)	1	0.67
		tinctorial and tanning substances (In. tc.)	10	6.75
		householding (In. ca.)	2	1.35
5	Medicinal (Md.)		24	16.21
6	Melliferous (Me.)	small beekeeping (Me. 1)	9	6.08
		mediocre beekeeping (Me. 2)	28	18.91
		arge beekeeping (Me. 3)	3	2.02
7	Toxic (Tx.)		32	21.62

The phyto-economic potential of spontaneous flora in area of study offers significant opportunities for capitalizing the natural vegetal ground cover.

4. Conclusions

Regarding the floristic elements, the area of study belongs to the Euro-Asiatic domain, which has the highest dominance, generally characterizing the herbaceous flora of the hills and foothill regions.

The analysis of ecological indexes reveals that most of the plants are light species, eurytherms, with a wide spread throughout Central Europe.

In terms of humidity, most of the plants show a large diversity within this area.

In addition, a relative dominance of theeurynitrophile, species that prefer soils with moderate to high nitrogen contents and species that can hold large variations of pH has been highlighted.

The economic analysis of plants reveals the presence of melliferous species, followed by toxic, fodder, and medicinal plants. The phyto-economic potential of the spontaneous flora in the study area offers significant opportunities for revaluation of the ground cover.

Three species well presented in the area *Brassica napus* (L.), *Potentilla erecta* (L.) and *Trifolium repens* (L.) could be considered for a phytoremediation process in the area.

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ANALIZA FLOREI VASCULARE CE APARȚINE UNUI SOL AFECTAT DE SURSE ANTROPOGENE

(Rezumat)

Zona de studiu este localizată în apropiere de CET Holboca, o zonă industrială situată în partea de est a municipiului Iași, cu o suprafață de 6 ha. Studiul efectuat în perioada martie 2018 - noiembrie 2019 a avut ca scop analiza compoziției floristice, din punct de vedere taxonomic, ecologic, geografic și economic. Au fost determinate 91 de specii de plante vasculare. Acest conspect ne-a permis o cunoaștere detaliată sub aspect taxonomic, ecologic, corologic și al potențialului economic al florei vasculare din această zonă, pe fondul unor cunoștințe temeinice privind particularitățile florei vasculare din acest spațiu geografic.