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ASPECTS OF SYNANTHROPIC FLORA FROM CENTRAL PARKS OF BUCHAREST

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Abstract. Situated in the Romanian Plain, Bucharest city covers 238 km^2 and comprises green spaces with different ages and degree of structural diversity (vegetation cover and internal architecture). The three parks (Cişmigiu, Izvor and Unirii) from central Bucharest have been studied as pilot area. The central parks have been chosen in accord with their different structural diversity. In this paper, we focus on synanthropic plant species having as topics: the most frequent herbaceous species from all three parks and their functional traits; the PCA multivariate statistical analysis of the plant species from parks, entire city and the surrounding forests; the heavy metal content in some plant species tissues and the dust from the leaves.

Keywords: synanthropic flora, Bucharest, central parks.

Rezumat. Aspecte ale florei sinantrope din parcurile centrale din Bucureşti. Situat în Câmpia Română, oraşul Bucureşti acoperă 238 km^2 şi conţine spaţii verzi cu vârste diferite şi variate grade ale diversităţii structurale (acoperirii cu vegetaţie şi arhitecturii interne). Cele trei parcuri (Cişmigiu, Izvor şi Unirii) situate în zona centrală a Bucureştiului au fost studiate ca zonă pilot pentru cercetări viitoare. Parcurile centrale au fost alese în raport de diversitatea lor structurală. În articolul de faţă prezentăm flora sinantropă având ca topică: cele mai frecvente specii ierboase din cele trei parcuri şi trăsăturile lor funcţionale, analiza statistică multivariată PCA a speciilor de plante din parcuri, din întregul oraş şi din pădurile din jurul oraşului; pentru unele specii evidenţiem conţinutul de metale grele din ţesuturi.

Cuvinte cheie: flora sinantropă, Bucureşti, parcuri centrale.

INTRODUCTION

The urbanization processes are intensified in time by the development of the human society. The cities' development due to the economic evolvement and to the increasing numbers of the human population determinates the migration of the human population from rural to urban areas, causing a dramatic increase of the process of environmental anthropization (SÂRBU, 1999). The city area and its components are highly heterogeneous spatially, technologically and informational, and also in terms of human population. The result of human activities is materialized in daily inputs of raw materials, fossil fuels, water, and food and by a daily output of finished industrial products, pollution, wastes, materials, which the natural environment cannot assimilate. The urban systems, the industrial complexes, are parasitic systems in terms of energy, depending strictly on the energy and raw materials from the natural systems, which supply matter and energy (VĂDINEANU, 1998). The input of matter and energy to maintain the towns functional is very large. The solid, liquid and gaseous emissions are the largest output of the towns, which are inputs for the neighbouring areas and for the town itself (positive feedback) (SUKOPP et al., 1995).

A city, as a whole, comprise "young" habitats for the species of plants and animals. The urban biodiversity is a crucial component of the urban ecosystem and has an important *ecological and cultural integrity*. The native (indigenous) components of the biodiversity are an important tool for the *ecological and cultural identity*. The different historical origin and development of the cities determines different approaches in the attempt to understand the urban biodiversity (IGNATIEVA, 2008).

In the last 5000 years, the most significant influence on flora and vegetation~~'s~~ composition was made by human impacts. The large cities and their surroundings are the best places for analysing the human impact that does not produce only changes in the composition of the urban flora but also disrupt species abundance pattern (KOWARIK, 1990).

MUCINA (1990) investigating the urban vegetation research in Europe highlighted that the studies performed in Romania over time (since 1927) were focused on syntaxonomy of ruderal vegetation from some cities and their surroundings. In the recent years, contributions to the knowledge of synanthropic flora have been made by ANDREI & ROŞESCU (2009) from Piteşti area and vegetation by RĂDUŢOIU et al. (2010) from Rovinari-Turceni area.

Around the world, there have been carried out studies on synanthropic flora of the cities (MOORE et al., 2002; MOSYAKIN & YAVORSKA, 2002; LISEK, 2012; MA & LIU, 2003; BIANCO et al., 2003; GALERA & SUDNIK-WÓJCIKOWSKA, 2004; IGNATIEVA & KONECHNAYA, 2004; BOMANOWSKA & WITOSŁAWSKI, 2008; MARTINEZ CARRETERO, 2010; OPÁLKOVÁ & CIMALOVÁ, 2011; RADANOVA & YAKIMOVA, 2012) and of some natural/semi natural areas (PAIS & JONES, 1996; SUDNIK-WÓJCIKOWSKA & MOYSIYENKO, 2008; KALRA , 1998; KIRPLUK & BOMANOWSKA, 2008).

ONETE & PAUCĂ-COMĂNESCU (2011) sketched the flora and habitats from Bucharest (present knowledge), together with information about natural environment (location, geology and topography, drainage, climate, air and water quality) and historical development of the city. Focus on central parks, the heavy metal content from soil and plants (ONETE et al., 2009; ONETE, 2010) and the bio-indicators of air pollution have been studied (ONETE et al., 2010b). A comprehensive list of plant species inventoried in the central parks was published by ONETE et al. (2010a).

MATERIALS AND METHODS

The plant species diversity has been recorded in areas shaped by man-made paths (asphalt alleys, walk paths) (Fig. 1). For the taxonomic status of plant species identified in the central parks we used CIOCÂRLAN (2009), also used for floristic status of the species. Even if BIOFLOR data base is designed for German flora, we used it for the most common species from central parks and established: type of reproduction, mode of introduction, evolutionary origin, life form, life spam, ecological strategy type and urbanity.

For multivariate statistical analysis PCA (Principal Component Analysis) we used CANOCO software and the data introduced in analysis were obtained from our studies following an urban-rural gradient (central parks and Băneasa and Baloteşti forests) and literature survey.

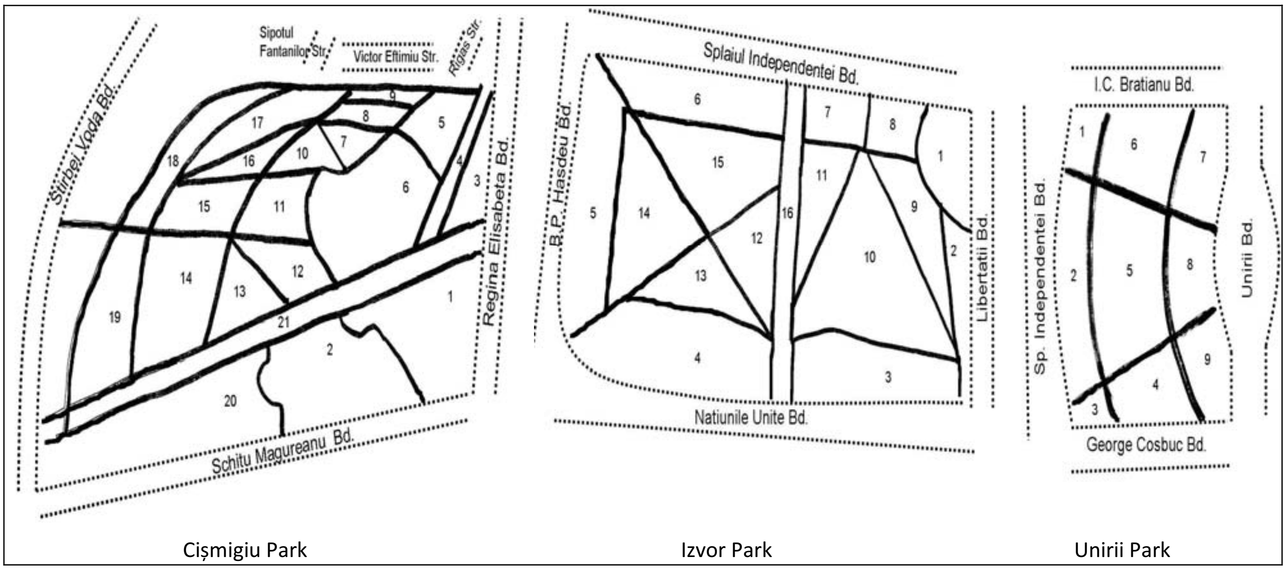

Figure 1. Diagrammatic division of the central parks from Bucharest city and the proximity of the main traffic roads.

Soil and plants samples analysed for heavy metal assessment, have been collected on transects near by the major roads and throughout the middle of the park. We followed the hypotheses that the air pollution should be diminished through the middle of the park and synanthropic vegetation has the highest degree of resistance to the heavy metal concentration in their tissues, also being the most resistant at the impact of environmental factors occurring naturally in the city.

The samples were dried, grinded with Planetary Ball Mill PM 100 and sieved. The biochemical method consisted in digestion of the samples with HNO_3 and hydrogen-peroxide 30%. Heavy metals (Pb, Cd, Cu, Zn) from soil and plant samples have been analysed with Perkin Elmer AAnalyst 800 Atomic Absorption Spectrophotometer incorporating all spectrometer and atomizer components using graphite furnace or flame techniques.

RESULTS AND DISCUSSIONS

The large tolerance of the species for large scale of the environmental factors is due to the fact that all naturally occurring species are originated and frequent from the forest-steppe zone to the boreal zone, adapted very well in the forest-steppe zone in which Bucharest is developed (ONETE et al., 2010a). In Cişmigiu Park, more non-typical species for the zone grow around the lake finding the natural conditions for their life cycle. In Izvor, in a depression formed by the western fen, the development of *Typha angustifolia* and *Phragmites australis* is non-typical for the park and shows the resistance of wild plants in the urban conditions. One year later, the depression was drained by the park manager and the species cleared out and replaced with other sown species.

A comprehensive list of the plant species from central parks have been published in ONETE et al. (2010b). Based on this list, it was possible to achieve the multivariate statistical analysis (Fig. 2) that shows the herbaceous and trees and shrubs species growing mainly in the city centre and being also characteristic in the entire city. In figure 2, forests near city (FNearCit) comprise species characteristic to the forests from forest-steppe region, as well as the wetlands in the city vicinity (WNearCit) and wetlands farther from the city (WOutCit). Brownfields are inhabited mainly with vegetation growing in non-managed areas inside and outside the city. The species diversity from the parks, primarily trees and shrubs and secondary the herbaceous species, is determined by park managers.

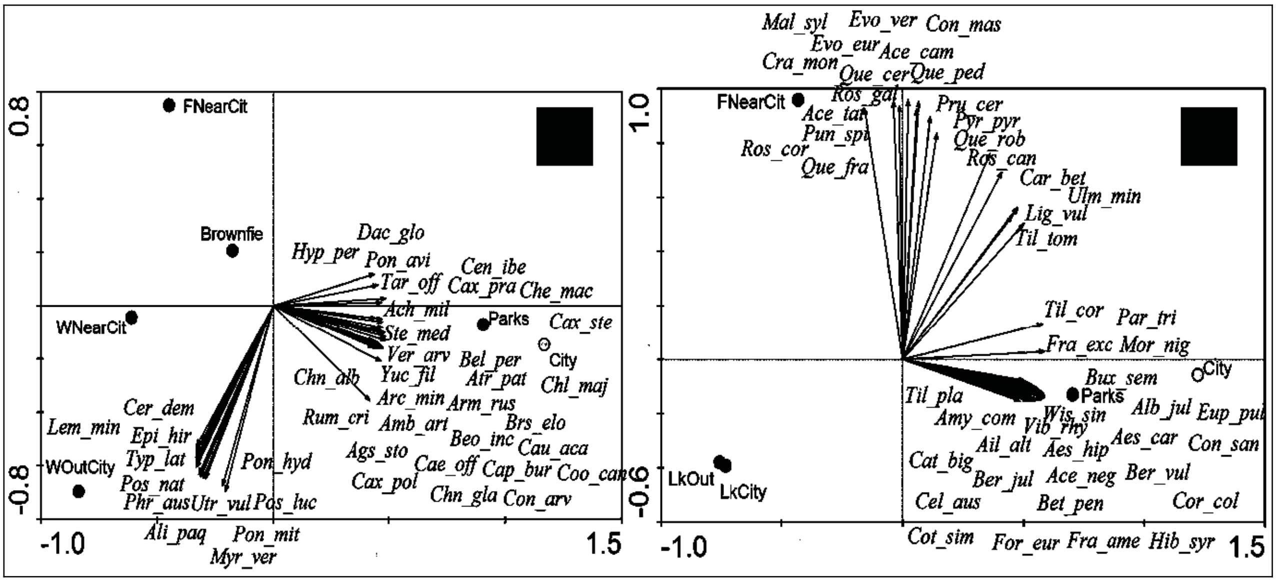

Figure 2. Principal Component Analysis of herbaceous (a) and trees and shrub (b) layers from the central parks and the surrounding areas (city and neighbouring forests and lakes).

During summer, when the air and soil temperature is excessively high for plants, the soil is cracked and nude or covered with scarce vegetation; till late in September or even October, the vegetation is dry where it exists, but in spring and autumn, the perennial species become green, with populations having better development in November. These observations allow us to point that the plants changed their phenology in the city. During the autumn, when the environmental conditions are milder and more suitable for plant life, late flowering and individuals with vegetative spread (clonal plants) were observed occupying the space where during summer it was bare soil: *Achillea millefolium*, *Agrostis stolonifera*, *Cynodon dactylon*, *Dactylis glomerata*, *Polygonum aviculare*, *Trifolium pratense*, *Trifolium repens*, *Potentilla reptans*, etc. (ONETE, 2010).

People influence their life environment by introducing and eliminating species. The percentage of foreign species increases with the decrease of the native species. The species of exotic plants (brought purposely into the town due to aesthetic reasons, or brought accidentally) mainly, via various routes, exit the town and invade the neighbouring areas, the semi-natural and natural ecosystems, causing the biodiversity of these ecosystems to decrease. Most plant species observed downtown are exotic (foreign), most times with southern or Asiatic origin, and they live there supported directly or indirectly by man (SUKOPP & WURZEL, 2003). Many species of animals and fungi also prefer the urban environment. Many plant species (trees particularly) are common to the large European cities despite the climactic and biogeographical differences (KUNICK, 1981). The urban biodiversity becomes thus levelled worldwide (IGNATIEVA, 2008). In Bucharest, because there is a desire for European integration under various aspects, a large number of Spanish Plane Trees (*Platanus hispanica*) have been planted in 2008, this tree being present in most European capitals.

The trees registered in all three parks are more frequent in Cişmigiu Park, this park being the most complex comparing with other two parks. Most abundant are the native trees, making this park more ecologically stable than the others. The shrubs are mainly cultivated, being easier for park managers to handle them than the trees. The ecological requirements of trees and shrubs are varied, most of the species being mesophyte (species adapted to neither a particularly dry nor particularly wet environment), mesothermic (species accommodated at 15°C mean annual temperature) and acido-neutrophil to poorly acido-neutrophil (species preferring pH = 6-7). The herbaceous species are large broad tolerant and mesophyte, mesothermic and acido-neutrophil to poorly acido-neutrophil, the nutrient availability of the soil being low. The works of parks maintenance remove the natural organic matter (*i.e.* litter in autumn), being necessary inorganic supplements.

In table 2, the functional traits of some species present in Cişmigiu (C), Izvor (I) and Unirii (U) from central Bucharest where established according with BIOFLOR:

1. the floristic status (FS) shows if a plant is native/indigenous or alien. Alien plant species can be archaeophytes (immigrants before the discovery of the Americas) and neophytes (immigrants after the discovery of the Americas). A-archaeophytes, N-neophytes, i-indigenous;

2. type of reproduction (TR): by seed/by spore (s), mostly by seed, rarely vegetatively (ssv), by seed and vegetatively (sv), mostly vegetatively, rarely by seed (vvs), vegetatively (v);

3. regarding the mode of introduction (MI), the plant species were introduced via several modes and/or several times. B-contaminant (unintentionally introduced species), BS-seed contaminant (unintentionally introduced as contaminants with commercial seeds), SA-agricultural weed (immigrated as a response to agriculture), VN-escaped crop and timber plant (introduced by humans for cultivation as crop or timber plant, usually unintentionally outside

cultivation), VZ-escaped ornamental (Introduced by humans for cultivation as ornamental plant, usually unintentionally outside cultivation);

4. the evolutionary origin (EO) describes whether a taxon might have evolved naturally (n) or due to human influence (a-anecophytes). For most plant species, the evolutionary origin is still unknown (u);

5. the life form (LF) refers to the vertical position of vegetative buds (as an adaptation to uncomfortable seasons) (following Raunkiaer system): Chamaephyte (C), Geophyte (G), Hemicryptophyte (H), Nanophanerophyte (N), Macrophanerophyte (M), Pseudophanerophyte (P), Therophyte (T);

6. the life span (LS) refers not only to the classes of actual life span (an-annuals, bie-biennials, per-perennials), but also to the number of generative reproductions. Here we distinguish if a species flowers and fruits only once and then dies or if it may repeatedly flower and fruit;

7. ecological strategy type (EST) following the Grime's system: competitors (c) - Trees, shrubs and forbs with high competitive power due to their morphological and/or physiological characters and life history traits; competitors/ruderals (cr) - Intermediate type between competitors and ruderals; competitors/stress-tolerators (cs) - Intermediate type between competitors and stress-tolerators; competitors/stress-tolerators/ruderals (csr) - Intermediate type, usually rosette plants or small, perennial species which can utilize spatial-temporal niches very well and have an intermediate life span; ruderals (r) - Usually annual, weedy plant species which produce many seeds and can easily colonize pioneer habitats; stress-tolerators/ruderals (sr) - Intermediate type between stress-tolerators and ruderals;

8. urbanity reflects the affinity of plant species towards urban areas: moderately urbanophobic (2) - species occurs predominantly in non-urban areas; urbanoneutral (3) - no preference of urban or non-urban areas; moderately urbanophilic (4) - species occurs predominantly in urban settlements; urbanophilic (5) - species is restricted to urban settlements.

Table 1. Functional traits of some plant species present in central parks.

Families	Species	**C**	**I**	**U**	1	2	3	4	5	6	7	8
					FS	TR	MI	EO	LF	LS	EST	U
Herbaceous												
Malvaceae	*Abutilon theophrasti* MEDIK	x	x		A	s	BS	a	T	an	cr	5
Asteraceae	*Achillea millefolium* L.	x	x	x	i	sv		n	H	per	c	3
Poaceae	*Agrostis stolonifera* L.	x		x	i	sv		n	H	per	csr	3
Brassicaceae	*Alliaria petiolata* (BIEB.) CAVARA et GRANDE	x			i	s		n	C-H	an-per	cr	2
Amaranthaceae	*Amaranthus retroflexus* L.		x		N	s		u	T	an	cr	3
Chenopodiaceae	*Atriplex patula* L.	x	x		A	s	SA	u	T	an	cr	3
Labiatae	*Ballota nigra* L.	x	x		A	s	B	u	C-H	per	c	4
Brassicaceae	*Berteroa incana* (L.) DC	x	x		N	s	B	u	H-T	an-bie	csr	3
Brassicaceae	*Capsella bursa-pastoris* (L.) MEDIK	x	x	x	i	s	-	a	H-T	an-bie	r	3
Chenopodiaceae	*Chenopodium album* L.	x	x		A	s		a	T	an	cr	3
Chenopodiaceae	*C. opulifolium* KOCH.et ZIZ.	x	x		A	s		u	T	an	cr	3
Asteraceae	*Chondrilla juncea* L.		x		i	ssv		n	H	bie-per	cs	2
Asteraceae	*Cichorium intybus* L.		x	x	A	s	VN	u	H	per	c	3
Asteraceae	*Cirsium arvense* (L.) SCOP.		x		i	sv		n	G	per	c	3
Convolvulaceae	*Convolvulus arvensis* L.		x	x	i	vvs		a	G	an	cr	4
Asteraceae	*Conyza canadensis* (L.) CRONQ.		x		N	s	B	u	H-T	an	cr	3
Poaceae	*Cynodon dactylon* (L.) PERS.	x	x	x	N	vvs	B	a	G-H	per	cs	4
Poaceae	*Dactylis glomerata* L.	x	x	x	i	ssv		n	H	per	c	2
Apiaceae	*Daucus carota* L.	x	x		i	s		n	H	bie-per	cr	3
Asteraceae	*Erigeron annuus* (L.) PERS.		x	x	N	s	B	u	H	bie-per	cr	3
Poaceae	*Festuca rubra* L.	x	x		i	sv		n	H	per	c	3
Rosaceae	*Geum urbanum* L.				i	ssv		n	H	per	csr	3
Labiatae	*Lamium amplexicaule* L.	x		x	A	s	SA	u	H-T	an	r	3
Asteraceae	*Leucanthemum vulgare* LAM.	x	x		i	sv		n	H	per	c	2
Poaceae	*Lolium perenne* L.	x	x	x	i	s		n	H	per	c	3
Fabaceae	*Lotus corniculatus* L.	x	x	x	i	ssv		n	H	per	csr	3
Malvaceae	*Malva sylvestris* L.		x	x	A	s	VN	u	H	per	c	4
Fabaceae	*Medicago lupulina* L.	x	x		i	sv		n	H-T	an-bie-per	csr	3
Plantaginaceae	*Plantago lanceolata* L.	x	x	x	A	ssv	B	u	H	per	csr	3
Plantaginaceae	*P. major* L.	x	x		i	ssv		a	H	per	csr	3
Poaceae	*Poa angustifolia* L.	x	x		i	sv		n	H	per	cs	3
Poaceae	*P. annua* L.	x	x		i	sv		a	H-T	an-per	r	3
Poaceae	*P. pratensis* L.	x	x	x	i	sv		n	H	per	c	3
Polygonaceae	*Polygonum aviculare* L.	x	x	x	i	s		n	T	an	r	3

Portulacaceae	*Portulaca oleracea* L.		x	x	A	s	VN	a	T	an	r	5
Rosaceae	*Potentilla intermedia* L.		x		N	s	B	u	H	bie-per	csr	5
Polygonaceae	*Rumex obtusifolius* L.	x	x		i	ssv		n	H	per	c	3
Poaceae	*Setaria pumila* (POIRET) SCHULTES	x	x		A	ssv	SA	u	T	an	r	3
Asteraceae	*Taraxacum officinale* WEBER ex. WIGGERS	x	x	x	i	s		n	H	per	csr	3
Fabaceae	*Trifolium hybridum* L.	x	x		i	s		n	H	per	c	2
Fabaceae	*T. pratense* L.	x	x		i	s		n	H	per	c	2
Fabaceae	*T. repens* L.	x	x	x	i	sv		n	H	per	csr	3
Trees												
Salicaceae	*Populus nigra* L. cv. *italica* MOENCH.	x	x		N	ssv		u	M	per	c	2
	Quercus robur L.		x		i	s		n	M	per	c	2
	Q. rubra L.		x	x	N	s	VN	u	M	per	c	2
Cupressaceae	*Thuja orientalis* L.	x		x	N	s	VZ	u	M-N	per	c	5
Tiliaceae	*Tilia cordata* MILLER	x	x	x	i	ssv		n	M	per	c	2
Ulmaceae	*Ulmus minor* MILLER	x		x	i	ssv		n	M-N	per	c	2
Tree - Shrubs												
Buxaceae	*Buxus sempervirens* L.	x		x	N	s		u	N	per	cs	2
Rosaceae	*Crataegus monogyna* JACQ.	x	x	x	i	s		n	M-N	per	c	2
Shrubs												
Cornaceae	*Cornus sanguinea* L.	x			i	sv		n	N	per	c	2
Corylaceae	*Corylus avellana* L.	x		x	i	ssv		n	N	per	c	2
Rosaceae	*Rubus caesius* L.	x	x	x	i	sv		n	P	per	c	3
Lians												
Araliaceae	*Hedera helix* L.	x		x	i	sv		n	N	per	cs	3

The species from table 1 were chosen according with their occurrence in the three parks and also according to the opportunity of chemical analysis performed.

The species listed above have varied degree of urbanity, but 57.89 % from plant species are native to the region/country. In the forest-steppe zone where Bucureşti is situated, the native/indigene flora is adapted to the temperate environmental conditions. In the "heat-island" of the city, the exotic/alien species brought from countries situated nearby the Equator, are already adapted at the urban conditions and may replace the native species, changing plants and animal communities due to increased death rate. Urban flora and associated fauna, across Europe and entire world, present a homogenization. Exotic species are planted in the cities from aesthetic reasons. Many native/indigenous plant species "creep" into the city. Whether they survive from the former forests that once covered the same place instead of concrete buildings and streets, or they spread into an environment created by human beings for themselves. In the parks from Bucharest, the natural vegetation had mainly disappeared, being replaced by planted species (especially trees brought from China, Japan, America, etc.). Remains of the natural vegetation adapted to the modified conditions of the city (either fertilisation or lack of the nutrients, changes in soil pH, increased temperature, etc.) because of the pollution (ONETE, 2010).

The chemical analysis of the soil revealed that the content in heavy metal is very different in different sites from all three parks. Cd has very low values in all three parks but Pb, Cu, and Zn have the highest values close to the main traffic roads. The range values show differences between max and min values from different sites, their diversity on heavy metal contain. Zn has higher values in Cişmigiu comparing with Izvor and Unirii and also comparing with the values of content in different types of soils. Cu and Pb have also higher values in Cişmigiu comparing with Unirii and Izvor and also with the values of content in different types of soils (Table 2). Based on plant tissue content of heavy metals (Table 2) we can argue that the metal uptake from soil is different with different plants species.

Table 2. Maximum value content (mg/kg d.w.) of heavy metals in soil and plant-tissues.

Name		Pb	Cd	Cu	Zn
Soil	Cişmigiu	199.8	1.21	168.5	330.3
	Unirii	104.6	0.8	105	214.5
	Izvor	92.87	0.78	89.74	194
Plant tissues	normal range of metals *	0.1 - 10	0.2 - 0.8	2 - 5	10 - 20
Trees					
Populus nigra L. cv. *italica* MOENCH.		4.96	0.47	3.67	44.43
Quercus robur L.		3.59	0.83	6.89	16.99
Q. rubra L.		3.34	0.53	9.97	21.05
Thuja orientalis L.		8.74	0.56	6.69	17.34
Tilia cordata MILLER		8.93	0.68	10.51	20.43

Ulmus minor MILLER	5.33	0.47	6.44	15.36
Tree - Shrubs				
Buxus sempervirens L.	7.68	0.37	33.30	15.61
Crataegus monogyna JACQ.	4.51	0.92	3.28	13.28
Shrubs				
Cornus sanguinea L.	3.81	0.55	13.90	13.84
Corylus avellana L.	5.93	0.38	13.64	28.52
Rubus caesius L.	2.27	0.33	15.2	7.4
Liana				
Hedera helix L.	3.32	0.58	12.9	22.11
Herbaceous				
Geum urbanum L.	8.32	0.93	23.5	66.94
Portulaca oleracea L.	0.87	1.02	1.75	13.35
Setaria viridis (L.) BEAUV.	2.05	1.02	2.73	32.70
Taraxacum officinale WEBER ex. WIGGERS	3.26	0.22	6.82	13.6

* according to PAIS & JONES JR. (1996) for Pb and Cd, and KALRA (1998) for Cu and Zn.

In the same park, the uptake of the metals is different both with different sites and distance to the main traffic road. For instance, *Buxus sempervirens* individual analysed from Cişmigiu Park, accumulates more Pb and Zn from the site nearby traffic road than the individuals from inside parks. The metal concentration in plants is affected by prevailing weather conditions, the nature of the plant surface, plants root uptake of the metals, etc. The synanthropic species are more resistant to all these conditions and also the metal uptake might have higher concentration in these species.

Plants influence and are influenced by their environment. The chemical composition of plants reflects, in general, the element composition of the growth media. In the central parks from Bucharest (Cişmigiu, Izvor and Unirii), the heavy metal concentration in the soil is highly heterogeneous being different at the entire park level, micro-site level and even at the point-like level. The proximity of intense traffic roads as major and intensive source of air pollution, leads to depositions on the soil and vegetation, influencing the heavy metal concentration in the soil. Trees in Bucureşti parks are mainly cultivated and some are native but usually cultivated in parks, margins of the roads, green fens, etc.

The heavy metal accumulation depends on their distance from the source of pollution (main boulevards) and their availability for metal uptake. The field observations revealed that the dryness percent of tree leaves is higher in young trees at the edge of major communication routes, with intense car traffic. The best bio-accumulators are the native trees and ruderal herbaceous.

CONCLUSIONS

More alien species are introduced year after year by city and park managers using more aesthetic but foreign species for the city/parks beautification. The “new arrivals” will survive better in the changing environmental conditions of the city (especially increasing temperature due to the city infrastructure and climate change) all of them having origins from hotter areas of the world. The synanthropic herbaceous flora of the central parks of Bucharest is formed mainly by indigenous/native plant species, with different degree of preferences for city habitats (urbanophilic) being introduced unintentionally via contaminants with commercial seeds, immigrated as a response to agriculture and/or crop or timber, etc. The type of reproduction is mostly by seeds but also vegetatively (or combinations of these types). Most of the presented species have naturally evolutionary origin, some are present in the city due human influence (anecophytes), but there still are needed investigations on some species unknown evolutionary origins. Due to the harsh environment of the city, the species shift their life-spam according with suitable environmental conditions for flowering and fruiting, most of them developing a vegetative reproduction combined with reproduction by seeds/spores. The species with different life form developed different ecological strategies types through their morphological and/or physiological characters and life history traits and utilize spatial-temporal niches very well for surviving into the city.

Most of the plant species act as important bio-accumulators of pollutants, but we want to stress that most medicinal plants, apart from the pharmacological effect, might become toxic because they might grow on polluted areas and accumulate pollutants in their tissues.

The combination of natural stress factors over-intensified in the city (higher temperature because of heat-reflecting asphalt and concrete, less precipitation, etc.) and intensification of pollution causes the decrease of plant resistance to the stress factors and their eventual death. The specific richness clearly decreases and plant populations further reduce their distribution areas already affected by fragmentation (due to trampled trails made by humans as short-cuts to the engineered asphalt paths). The large tolerance of the species for large scale environmental factors is due to the fact that all species are frequent in Romania from the steppe zone to the boreal zone, and adapt very well in the forest-steppe zone in which Bucureşti city is situated.

Everywhere on the globe, conditions for plants (and animals) have always changed and will always change! In the trophic network of an ecosystem, any small change acts like a "snow ball" which, without any doubt, affects us, human beings, much more.

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