FLORISTIC COMPOSITION AND DIVERSITY INDICES OF WOODY SPECIES IN FAGET FOREST, CLUJ-NAPOCA, NORTH WESTERN OF ROMANIA

COMPOZIȚIA FLORISTICĂ ŞI INDICII DE DIVERSITATE A SPECIILOR LEMNOASE DIN PĂDUREA FĂGET, CLUJ-NAPOCA, NORD VESTUL ROMÂNIEI

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Abstract*. Periurban forests and urban green spaces provide an extremely useful ecological infrastructure for modern cities. The study of woody species diversity in Făget Forest, located near Cluj-Napoca city, in N-W of Romania, highlighted the consolidated diversity of trees species, but also floristic communities resulted as from the natural evolution and interactions with environmental and anthropic factors. Although the diversity of woody species in Făget Forest calculated by diversity indices appear limited or low (Shannon-Wiener < 1), the communities have been strengthened over time, consequently the conservation status of the habitat type in terms of structure and specific functions appear as stable. The preservation of Făget Forest diversity, as well as its economic, ecological, cultural, landscape, recreational and other forest functions can assure important benefits to the city and its inhabitants.*

Keywords: floristic communities, forest, periurban spaces, diversity indices

Rezumat. *Pădurile periurbane şi spaţiile verzi din mediul urban oferă o infrastructură ecologică extrem de utilă pentru oraşele moderne. Cercetarea diversităţii speciilor lemnoase forestiere din pădurea Făget, în partea de nord-vest a României, în imediata apropiere a oraşului Cluj-Napoca, a permis evidenţierea diversităţii speciilor de arbori, dar şi comunităţile de arbori rezultate în urma procesului evolutiv şi a interacţiunilor speciilor cu factorii de mediu şi antropici. Deşi diversitatea speciilor lemnoase din Pădurea Făget,calculată pe baza indicilor de diversitate este limitată sau redusă (Shannon-Wiener <1), comunităţile formate au fost consolidate de-a lungul timpului, prin urmare statutul de conservare a tipului de habitat în ceea ce priveşte structura şi funcţiile specifice ecosistemelor forestiere este stabil. Conservarea diversităţii pădurii Făget, precum şi menţinerea funcţiilor economice, ecologice, culturale, peisagistice, recreative ale pădurii pot asigura beneficii importante oraşului şi locuitorilor săi.*

Cuvintecheie: asociaţii vegetale, indici de diversitate, păduri, zone periurbane

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INTRODUCTION

'Urban Green Infrastructure' is becoming an increasingly desirable goal in delivering essential ecosystem services in cities. Securing ecosystem services by green spaces and trees becomes a necessity with the rise of the world's population and the formation of large urban agglomerations, industrialization, global climate change or global warming and greenhouse effect (Davies and Lafortezza, 2017; Pearlmutter *et al*., 2017; DeClerck *et al*., 2010).

Periurban forests and urban green spaces provide an extremely useful ecological infrastructure for modern cities, that help control storm water runoff, pollutant filtration, temperature balancing, etc. In addition toecological benefits, they assure important landscape, educative and cultural tools, but also outdoor recreation facilities (Blood *et al*., 2016; Tu *et al*., 2016; Sestraş *et al*., 2018).

Făget Forest, belonging to Făget-Chinteni Forest District (U.P. II) is located inthevicinity of Cluj-Napoca city, in the North Western part of Romania. With a general move towards urbanization, Cluj-Napoca faces unprecedented expansion of the city limits and population, thus land is becoming an increasingly difficult resource to manage and preserve, and the local forests are no exception to the constant anthropic interferences of damaging the ecosystem and the stability of the soil. Cluj-Napoca, with a population of over 450,000 inhabitants, has a great morphological and landscape diversity. Făget Forest, one of the most important green areas near the city, can play the role of a peri-urban forest with multiple benefits for the ecosystem in the area (Sestraş *et al*., 2018).

In order to ensure the desired roles and ecosystem services of the forest, it is necessary to know the physical attributes of the forest and the trees, the functional diversity of plant communities, and to study the possibility to maintain or improve the floristic composition of the forest. These factors are indispensable for coping with the complex social, economic and cultural dynamics of the cities in the future.

MATERIAL AND METHOD

The research area was located in the Făget-Chinteni Forest District (U.P. II Făget-Chinteni), in the forest belongs to the Făget Cluj – Valea Morii site, a part of the Continental Biogeographic Region, which occupies much of Romania's territory, as well as much of Central and Western Europe (Natura 2000 - Proiect POS M: SMIS-CSNR 43241, 2015).

Topographic measurements were conducted by determining coordinates using the GNSS RTK technology (Global Navigation Satellite System - Real-time Kinematic) and a StonexS8 instrument. The coordinates were expressed in the Romanian National Projection System, respectively the Stereographic Projection 1970 and the elevations were reported to the Black Sea level. The accuracy of coordinates determined by RTK method of the Stonex GPS was 20 mm in a horizontal direction

and 30 mm in vertical direction. The real-time kinematic based global positioning system enabled by satellite navigation offers a modern alternative technology to the previous topographic instruments. The topographic measurements were performed in March, when the snow has melted and the trees had no leaves yet, thus a good connection to the satellites was possible and accurate data obtained (fixed position). At each of the 14 sample plots chosen along the forest transect (fig. 1), forest inventory was performed.

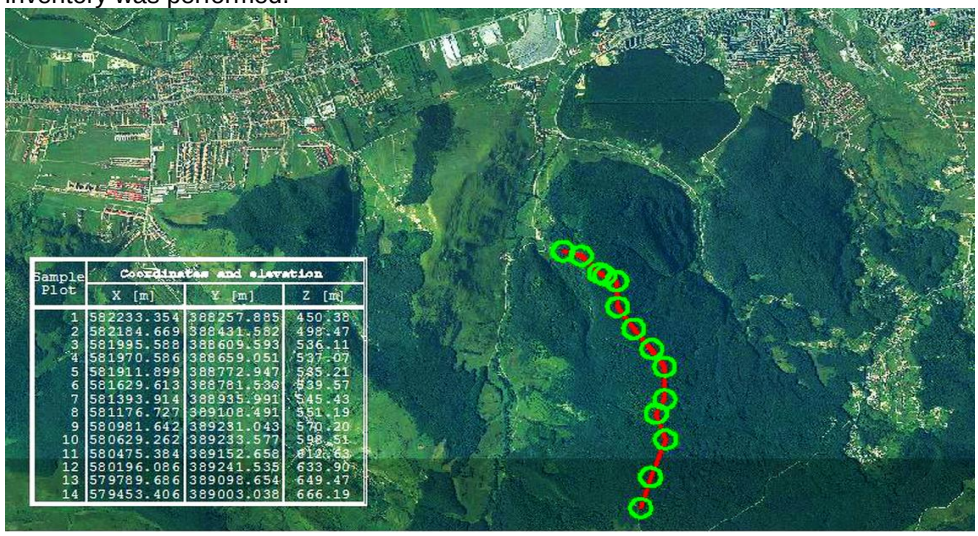

Fig. 1 Transect containing 14 plots along the Făget Forest, in close proximity to Cluj-Napoca

Each of the sample plots (of circular shape, with a radius of 12.62 m, 500 square meters) had a central tree, where the coordinates were measured. In order to carry out the study, quantitative and qualitative characteristics were taken into account, with measurements and observations being made on 413 specimens of trees. The total length of the path thought the forest was 3295.33 m and the elevation of the first sample plot and the last was 450.38 m and 666.19 m, thus an elevation difference of 251.81 m. There were considered only natural forest sites, with regular growth of the trees, with no plantation intervention as non-native trees and/or invasive non-native species.

In the current work, according to the proposed objectives, ecologic indices - Constancy (C), Dominance (D) and Index of Ecological Significance (IES, or W) - were computed and interpreted following Cenusa *et al*. (2004), and biodiversity indices have been calculated following the models presented by Kent (2011) and Magurran (2013)

RESULTS AND DISCUSSIONS

In the 14 plots analyzed there were registered 413 trees, belonging to eight species (fig. 2, tab. 1). Of all thetrees present in the researched area, the largest percentage has been identified for the species *Carpinus betulus* (42.9%), followed by *Fagus sylvatica* (24.9%), and *Quercus petraea* (23.2%). The species *Carpinus betulus* and *Quercus petraea* were identified

in 12 (C=85.7%) respectively 11 plots (C=78.6%), appearing as euconstant species (with a percent of constancy comprised between 75.1-100%).

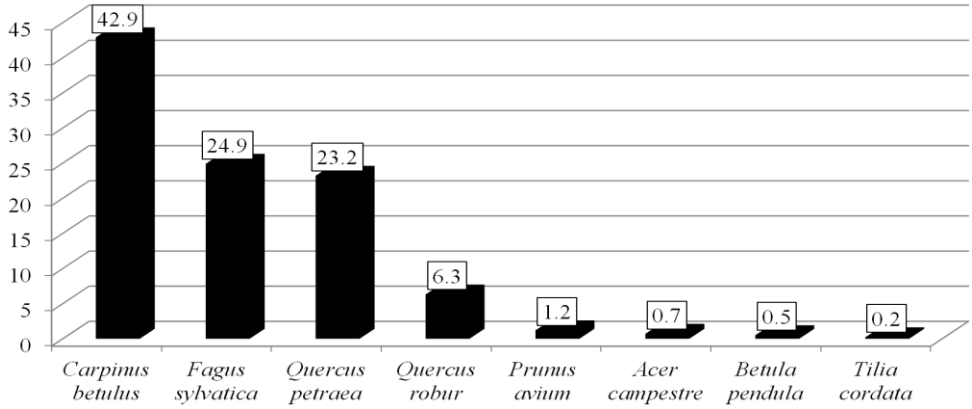

Fig. 2 Percentage of the trees per species, in the 14 plots of Făget Forest

Based on constancy value (C), which reflect the species continuity in the biotope, *Fagus sylvatica* (C=71.4%) and *Quercus robur* (C=57.1%) were assigned to constant species. The rarest presence were registered for the species: *Acer campestre* and *Betula pendula* (2 plots) and *Tilia cordata* (just in one plot from 14), all of them being considered accidentalspecies(C=1-25%).

Table 1

Constancy (C), Dominance (D) and Index of Ecological Significance (IES, or W) registered for the trees species in 14 plots*

Species	No of trees	No of plots/ sp.	Constancy (C)		Dominance (D)		IES (W)	
			%	Class	%	Class	%	Class
Carpinus betulus	177	12	85.7	C4	42.9	D5	36.7	W5
Fagus sylvatica	103	10	71.4	C3	24.9	D5	17.8	W5
Quercus petraea	96	11	78.6	C4	23.2	D5	18.3	W5
Quercus robur	26	8	57.1	C4	6.3	D2	3.6	W3
Prunus avium	5	4	28.6	C2	1.2	D4	0.3	W2
Acer campestre	3	2	14.3	C1	0.7	D1	0.1	W2
Betula pendula	2	2	14.3	C1	0.5	D1	0.1	W2
Tilia cordata	1	1	7.1	C1	0.2	D1	0.02	W1
Total	413							

***Note:** C1-accidental species (1-25%); C2-accessory species (25.1-50%); C3-constant species (50.1-75%); C4-euconstant species (75.1-100%); D1-subrecedent species (<1.1%); D2-recedent species (1.2-2%); D3-subdominant species (2.1-5%); D4-dominant species (5.1-10%); D5-eudominant species (>10%); W1-subrecedent species (accidental) (<0.1%); W2-recedent species (0.1-1%); W3-subdominant species (accessory) (1.1-5%); W4-dominant species (5.1-10%); W5-eudominant species (characteristic) (>10%).

Concerning the dominance (D), the species *Carpinus betulus*, *Fagus sylvatica*, *Quercus petraea* were grouped as eudominant species (over 10% from the biomass production), which influence decisively the Făget Forest

productivity. *Quercus robur* appeared as dominant (D=5.1-10%), whereas *Acer campestre*, *Betula pendula* and *Tilia cordata* as subrecedent species (D<1.1%).

Based on Index of Ecological Significance (IES, or W), from among the 8 species of trees, the best adapted to the environmental conditions of the area are *Carpinus betulus*, *Fagus sylvatica*, and *Quercus petraea*, all of them being framed in W5-eudominant species (characteristic) (>10%).

The diversity indices presented in table 2 highlighted species richness starting by dividing the species count by the natural log of the number of sampled trees (i.e. Margalef). Even if the number of species was relatively low, variation of the diversity coefficients in the 14 plots was high or very high (CV% between 18.6% for 'Species evenness' and 42.1% for 'Margalef's index' and 'Glisson Coefficient').

Table 2

Diversity indices as minimum - maximum values, and the average of the 14 plots, andcoefficient of variation (CV%) of each index based on its values from 14 plots

Diversity indices	Min.	Max.	Mean	CV%
Margalef's index (DMg)	0.0	1.2	0.8	42.1
Menhinick's index (DMn)	0.2	1.0	0.7	32.2
Simpson dominance index (D)	0.3	1.0	0.5	32.5
Simpson diversity index (1-D)	0.0	0.7	0.5	37.0
Simpson reciprocal index (1/D)	1.0	3.2	2.0	27.7
Shannon-Wiener diversity index (H')	0.0	1.2	0.8	37.6
Species evenness	0.5	0.9	0.7	18.6
McIntosh index	0.0	0.5	0.3	39.8
Glisson Coefficient	0.0	1.2	0.8	42.1

If these indices simply scaled the number of species to calculate diversity, the Jaccard coefficient (tab. 3) take into account how closely related or similar the species from Făget are.

Table 3

Similarity in species composition based on the Jaccard coefficient of affinity (%)

Jaccard's index		Species No.						
		2	3	4	5	6	7	8
1	*Carpinusbetulus*	20.0	8.3	11.1	20.0	33.3	0.0	0.0
2	*Fagus sylvatica*		50.0	50.0	16.7	9.1	0.0	10.0
3	*Quercus petraea*			72.7	25.0	8.3	18.2	9.1
4	*Quercus robur*				33.3	0.0	11.1	0.0
5	*Prunus avium*					20.0	20.0	0.0
6	*Acer campestre*						0.0	0.0
7	*Betulapendula*							0.0
8	*Tilia cordata*							

Jaccard similarity coefficient measureda high similarity between *Quercus petraea* and *Q.robur* species (72.7%) and illustrated50% similarity between *Fagus sylvatica* and the two *Quercus* species.The risk to diversity of this forest is

increasing especially due to the reduction of the habitat surface as a result of the excessive urbanization process of recent years (Natura 2000 - Proiect POS M: SMIS-CSNR 43241, 2015; Sestraş *et al*., 2018).

CONCLUSIONS

Although the diversity of wood species in Făget Forest revealed by diversity indices appear limited or low (Shannon-Wiener<1), the communities has been strengthened over time, consequently the conservation status of the habitat type in terms of structure and specific functions appear as stable.

Local authorities must ensure effective measures in order to preserve biodiversity of Făget, but also economic, ecologic, cultural, landscape, recreation facilities and all other functions of the forest.

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