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PHYTODIVERSITY HOTSPOTS FOR THE CITY OF CLUJ-NAPOCA

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Abstract: Our paper synthesizes the work of our teams between 1998-2000, 2003-2006 and 2009-2010 in the urban and peri-urban area of Cluj-Napoca. The main objectives were: *i*) setting up a database with the current cormophyte flora of the city; *ii*) highlighting the changes that have occurred in the last 70 years; *iii*) establishing the areas with a high level of conservation, all of them being subordinated to the preliminary study for the setting of the new General Urban Plan.

Cluj-Napoca ranks among EU cities with a medium to high phytodiversity by its 1058 plant species, 52 plant associations and 16 types of habitats. Ten areas were considered as hotspots for the phytodiversity of the city by correlating the specific richness of different plant communities to the habitat types and the presence of sozologically important species; these areas were proposed to undergo special protection for scientific and social purposes.

The scientific and conservative importance of these areas is increased by the presence of 20 endemic (End), vulnerable (VU), rare (R) or endangered (EN) taxa, as well as by the 7 types of habitats with priority status in the EU conservation strategy. The practical value of our studies consists of the contribution to the substantiation of a more environmentally friendly urban plan, which should be more useful for the community of this city with an acknowledged intellectual spirit.

Keywords: phytodiversity, hotspots, habitats, sozological categories, Cluj-Napoca

Introduction

Our paper synthesizes the results of the research performed in the periods: 1998-2000 (as part of the CNCSIS 179-BM grant, with the collaboration of 8 specialists from Belgium, Italy and Germany, in addition to the 39 Romanian specialists) [5], 2009-2010 (as part of the study "Updating of the General Urban Plan of the Cluj-Napoca City") [6], and the studies carried out by Mr. L. Filipaş as part of his PhD thesis [10] in the period 2003-2006.

It is well known that biodiversity as a whole plays an important role in the normal functioning of what is increasingly more often defined as the "*urbs ecosystem*", whose features were highlighted by us over a decade ago [3, 4]. This is a particular type of ecosystem, which must provide its inhabitants not only with conditions for living, working, circulating and entertaining, but also with conditions for breathing, resting, enjoying safety and peace, for coping with increasingly diverse types of stress [9].

The acceleration of the urbanization process is a visible fact worldwide, and in Romania, the adopted solutions take less into account the quality of the environment, although it has been demonstrated that a quality environment reduces the costs of functioning of the urban system and can even become a factor of production [20]. We can really speak of an *acute hunger for building*

areas (Fig. 1), which devours without discernment the best agricultural lands and the few green spaces existing in our cities.



a.



b.

Fig. 1: Hunger for building areas in the city of Cluj-Napoca: a. the Someş flood plain at Someşeni (in the foreground, a fragment of the Sf. Gheorghe hill), **b.** panoramic view (photo: C.V.).

The effects on the biodiversity of the urbs ecosystem are amplified, as Giordano *et al.* [14] emphasized, by the following:

- the majority of the Earth's population live in cities and metropoles, far from the natural environment, and without knowing and understanding it, decide the fate of biodiversity as a whole,

- semi-natural habitats are either incorporated by the expanding cities or turned into artificial ecosystems,

- anthropic influence is strong, diverse and changing in a very short time period.

The main **objectives** of our studies were: *1*) setting up a data base regarding the current phytodiversity of the city and evidencing the changes that have occurred over 7 decades (having Nyárády's work as a reference [15]); *2*) identifying the types of habitats existing in the space proposed by the project of the new General Urban Plan; *3*) establishing the areas that require special protection for scientific or socio-cultural purposes.

Finally, we wish to dedicate this paper to the memory of our colleagues who passed into eternity during the course of the last year: Prof. Doina IVAN, Prof. Vasile CIOCÂRLAN, Prof. Viorel SORAN, and Dr. Nicolae ROMAN.

Results and Discussion

Of all 2.403 sp. identified in the urban area of our city (which places it among European cities with a medium to high specific richness), cormophytes were the most studied and compared, followed by lepidopterans (about 900 sp.).

There are 1.353 sp. of ***cormophytes*** reported by the literature, and the presence of **1.058 sp.** of these is certain, which means that 231 sp. have disappeared over the past 70 years and the number of newly settled species (or species previously unidentified by different authors) is only 60 sp. Using Nyárády's work [15] as a reference, the current cormophyte flora of the city has a similarity index of only 86%, which reflects the deep changes in the structure of the habitats and microhabitats of the investigated area during the course of more than 7 decades.

The conservative value of the city is increased by the fact that this is the "locus classicus" for 118 taxa (among which the endemic species *Viola jooi*), by the high level of intraspecific phytodiversity: 36 ssp., 504 var. 783 f. and 132 hybrid sp. [10], as well as by the presence of taxa with a special sozological value.

Compared to previously published data [10, 11], due to their rareness and strong impact on the habitats of some taxa, we propose that particular attention be paid to the populations of the following sozologically important taxa, found in the urban area of the city:

1. *Adonis vernalis* L., a species included in the CITES Convention, frequently vegetates on the sunny slopes of the studied area;

2. *Aloperucurus myosuroides* Hudson; R [see 10, 11];

3. *Amygdalus nana L.* (syn. *Prunus tenella* Batsch, *P. nana* (L.) Stokes), VU [see 5, 10, 11];

4. *Astragalus vesicarius* L., a species with sporadic distribution in Romania; in Cluj-Napoca it is only found on the Sf. Gheorghe Hill;

5. *Carex secalina* Willd. ex Wahlenb**.** (syn. *C. lerchenfeldian*a Schur), included in the Bern Convention; at national level, it is considered VU, R, EN [see 10, 11];

6. *Centaurea atropurpurea* Waldst. et Kit., R [see 10, 11];

7. *Cephalaria radiata* Griseb. et Schenk., considered as End and VU; in Cluj-Napoca, its populations are located on the Hoia and Galcer Hills, being threatened particularly by intensive grazing;

8. *Cladium mariscus* (L.) Pohl., VU, is represented only by an extremely reduced population, located in Someşeni (near the former baths) [9], but is better developed in the Valea Morii-Valea Căpriorii reserve [2];

9. *Daphne cneorum* L., VU [see 5, 10, 11];

10. *Dictamnus albus* L., VU [see 10, 11];

11. *Echium maculatum* L. (syn. *E. rubrum* Jacq., *E russicum* J. F. Gmelin) appears in the annexes of the Habitats Directive; at national level, it is considered as VU [see 10, 11];

12. *Glaux maritima* L., VU [see 10, 11];

13. *Onosma pseudoarenaria* Schur (syn. *O. arenaria* Waldst. et Kit. ssp. *pseudoarenaria* (Schur) Jav.), a species included in the UICN-*Red List*, considered in our country as R or EN. In Cluj-Napoca, it was identified in a small population on the Hoia Hill;

14. *Orchis laxiflora* Lam. ssp**.** *elegans* (Heuffel) Soó, R [see 10, 11];

15. *Orchis purpurea L.*, R, identified in Cluj-Napoca on the south slope of the Hoia Hill (in the Bongar Valley); its population is endangered by intensive grazing;

16. *Salvia nutans* L., represented in Cluj-Napoca by a scarce population, on the south slope of the Sf. Gheorghe Hill, above the Muncii Blvd.;

17. *Serratula lycopifolia* (Vill.) A. Kerner (syn. *S. nitida* (W. et K.) Bess. non Fisch, *S. heterophylla* Desf.) appears in the annexes of the Habitats Directive, and at national level it is considered as VU [see 10, 11];

18. *Sesleria heuflerana* Schur, End for the Carpathians, is present in the Bongar Valley, on the south slope of the Hoia Hill;

19. *Thymus comosus* Heuffel ex Griseb. is End and VU [see 10, 11];

20. *Viola joói* Janka., End and R, was described as a new species for science by Janka (in 1857), in the former "Mănăştur quarry", and is on the list of endangered European species (World Conservation Monitoring Centre). The species populations are located on the south-west slope of the Galcer Hill, on the south slope of the Hoia Hill (in the Bongar Valley), and in the Baciului Gorge.

A particular note to intraspecific diversity is given by the secular trees existing within the city perimeter, the team coordinated by Pătruţ [16] proposing 16 trees to be declared natural monuments (including those sheltered by the Botanical Garden: a *Populus alba* tree aged 130-140 years, and a *Fraxinus excelsior* tree aged 190-210 years, which was knocked down by a storm in June 2014; Fig. 2).

Phytosociological diversity is marked by the presence of ***52 plant associations***, of which forests are represented by 4 types, shrubs by 3 types, grasslands by 24 types (including 5 halophilic and semi-halophilic types), hygro- and hydrophilic plants are represented only by 3 associations, weeds are well represented by 18 associations, and on the walls, one association was identified [10, 17]. In addition to these, there are fragments that might be assigned to other associations, but due to their small surface area, they were not taken into consideration.

Based on these associations, according to the system presented by Doniţă *et al*. [8], we may consider the following **16** types as the **main types of habitats** in our city (with the mention of their correspondence in the *Natura 2000 network*), evidencing the **7** EU priority types (in bold with an asterisk), for which specific richness was also estimated based on the phytosociological survey performed:

- R 1518 (1310 - Natura 2000) – *Salicornia* and other annuals colonizing mud and sand,

- ***R 1521*** (***1530****** - Natura 2000*)* **–** Pannonic salt steppes and salt marshes, with *Puccinellia limosa*; at Someşeni, 29 sp. in 550 m^2,



Fig. 2: The oldest tree in the "Al. Borza" Botanical Garden: *Fraxinus excelsior* - 190-210 years old (photo: A. Pătruţ), knocked down by a storm in June 2014 (photo: C.V.).

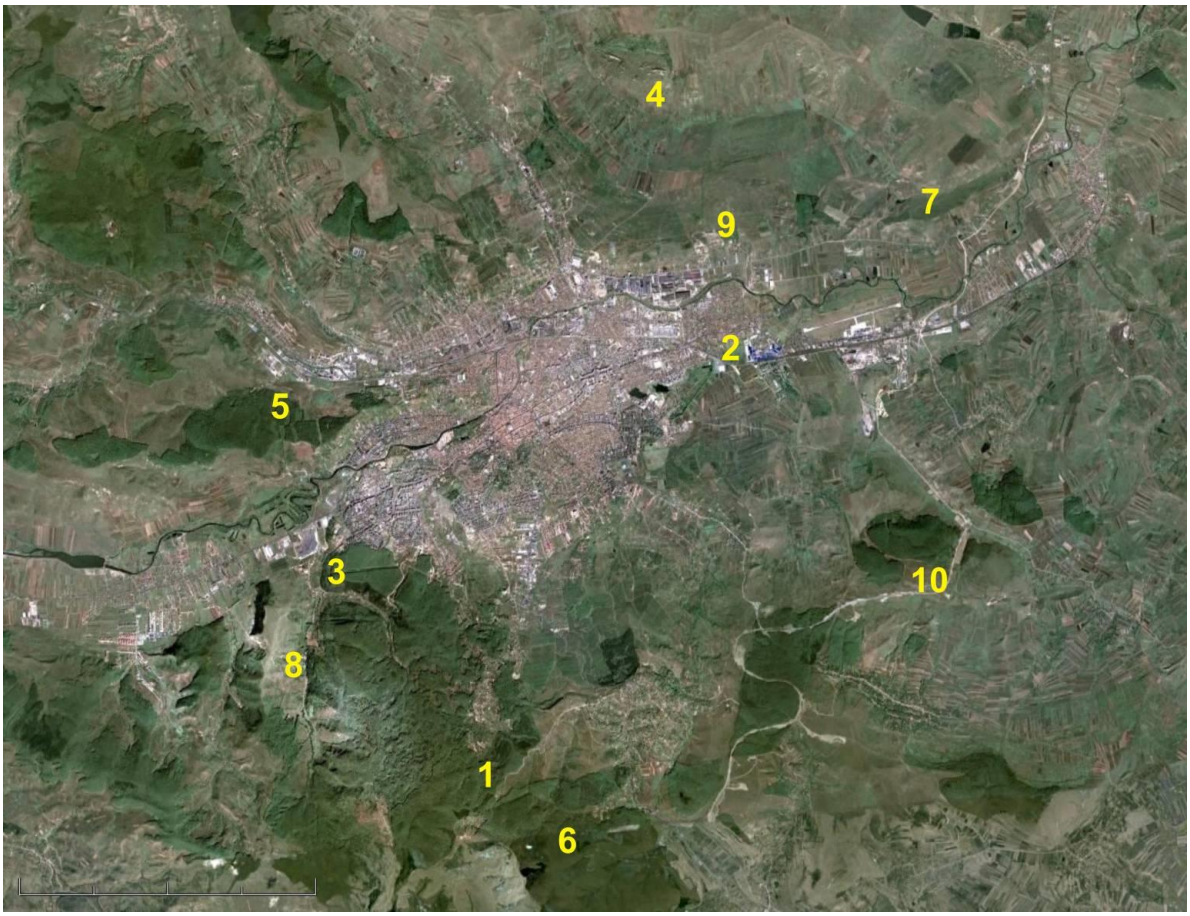


Fig. 3: Location of areas of protective-conservative interest: 1. Făget Forest, **2.** Someşeni Baths, **3**. Galcer Hill, **4**. Fânaţele Clujului, **5**. Hoia Forest-Baciului Gorge, **6.** Morii Valley-Căpriorii Valley, **7.** Sub Coastă, **8**. Hayfield in the Gârboului Valley, **9**. Sf. Gheorghe Hill, **10**. Tufele roşii Complex.

- ***R 3122*** (***40A0****** - Natura 2000) – Ponto-Pannonic scrubs with *Prunus spinosa* and *Crataegus monogyna*; sporadically, 115 sp. in 600 m^2,

- ***R 1526*** (***1530****** - Natura 2000) – Ponto-Sarmatic salt meadows, with *Triglochin maritima* and *Aster tripolium*; at Someşeni, 21 sp. in 200 m^2,

- ***R 3131*** (***40A0****** - Natura 2000) - Subcontinental peri-Pannonic scrubs with *Prunus tenella*; on Sf. Gheorghe and Cetăţuia Hills, 83 sp. in 250 m^2,

- ***R 3404*** (***6250****** - Natura 2000) – Ponto-Pannonic steppes with *Festuca rupicola* and *Koeleria macrantha*; on Hoia, Galcer and Sf. Gheorghe Hills, 78 sp. in 150 m^2,

- ***R 3406*** (***6290****** - Natura 2000) – Daco-Sarmatic steppes with *Carex humilis, Stipa joannis* and *Brachypodium pinnatum*; on Hoia and Galcer Hills, 123 sp. in 350 m^2,

- ***R 3409*** (***6290****** - Natura 2000) – Ponto-Sarmatic steppes with *Stipa lessingiana*; on Sf. Gheorghe Hill, 45 sp. in 120 m^2,

- R 3711 (6410 in Natura 2000) – Dacian meadows with *Nardus stricta* and *Molinia caerulea*,

- R 3715 (-) – Danubio-Pontic meadows with *Agrostis stolonifera*,

- R 3802 (6510 - Natura 2000) – Daco-Getic meadows with *Arrhenatherum elatius*,

- R 4118 (9130 - Natura 2000) – Dacian beech and hornbeam forests with *Dentaria bulbifera*,

- R 4124 (91Y0 - Natura 2000) – Dacian oak, beech and hornbeam forests with *Lathyrus hallersteinii*,

- R 5305 (-) – Danubian communities with *Typha angustifolia* and *T. latifolia*,

- R 5309 (-) – Danubian communities with *Phragmites australis* and *Schoenoplectus lacustris*,

- R 8703 (-) – Ruderal communities with *Agropyron repens*, *Arctium lappa*, *Artemisia annua* and *Ballota nigra*.

The 52 associations identified and the 16 main types of habitats (of which 7 priority types) allow to characterize the ecosystemic biodiversity of the city as being rich.

Under these conditions, considering the plan of extending the urban area of the city, the following ***phytodiversity hotspots*** were proposed for protection (Fig. 3):

1. The Făget Forest, despite its landscape reserve status, does not yet have clear limits. It is the most representative sample of the R 4118 type of habitat (9130 in Natura 2000) in the area, and the *Bryum rubens* bryophyte has its locus classicus here;

2. Someşeni Baths. The beautiful *Glaux maritima* population, the presence of the lapwing colony (*Vanellus vanellus*), as well as the particularity of continental salt marsh habitats (of which 1530* - Natura 2000 is a priority habitat), lead us to propose the extension of the protected area beyond the perimeter of the baths, in order to ensure a better protection of the *Glaux maritima*, *Orchis laxiflora* ssp. *elegans* populations, as well as of the few individuals of the *Cladium mariscus* glacial relict;

3. The Galcer (Galişer, Gălişor) Hill does not have a protected status, which would ensure the conservation and increase of the *Adonis vernalis*, *Centaurea atropurpurea*, *Thymus comosus*, *Daphne cneorum*, *Cephalaria radiata* populations. In addition, the locus classicus for *Viola jooi* would be preserved;

4. Fânaţele Clujului is a well studied area, which has recently been included in the Natura 2000 network, and the management of this reserve has been given to the custody of the "Green Transylvania" NGO. The two parts of the reserve – Copârşaiele and Valea lui Craiu – shelter priority habitats: R 3404 (6250* in Natura 2000), R 3406 (6290* in Natura 2000) and R 3409 (6290* in Natura 2000). Here vegetate cormophyte species such as: *Crambe tataria, Cephalaria uralensis, Serratula radiata, S. wolffi, Centaurea trinervia, Adonis volgensis* (the only locality inside the Carpathian arch), *Bulbocodium versicolor,* etc.;

5. Hoia Forest – Baciului Gorge, along with the "Romulus Vuia" Ethnographic Museum, can play a particular socio-cultural role and should be maintained for the public; an ecological route, with the necessary explanations, could also be set up.

The forest is an important recreational site and in addition, it preserves a rich nemoral herbaceous flora, while the sunny slopes of the Hoia hill shelter the following species: *Onosma pseudarenaria, Echium maculatum, Thymus comosus, Cephalaria radiata, Daphne cneorum*.

The gorge, already constituted into a paleontological reserve, preserves, in addition to its fossiliferous value, *Thymus comosus* and *Viola jooi* populations, while the cormophytes *Centaurea atropurpurea, Daphne cneorum, Orchis purpurea, Viola jooi, Sesleria heuffleriana* have been identified in the Bongar Valley. At the west extremity of the Hoia forest, there is a downy oak (*Quercus pubescens*) fragment, whose border preserves many of the previously mentioned species;

6. Morii Valley and Căpriorii Valley. Although they are not an integral part of the city perimeter, future development might affect this area that is extremely interesting, particularly through its relict habitat.

The Morii Valley reserve in particular is known to naturalists as a marsh that preserves glacial relicts, situated at a low altitude (650 m.a.s.l.): *Ligularia sibirica* – EN, *Tofieldia calyculata* – EN, *Swertia perennis* – R, *Cladium mariscus, Liparis loeselii* – EN, *Schoenus nigricans,* etc., as well as some rare species (*Ophioglossum vulgatum* – R , *Trollius europaeus* –R).

Also, in the first half of the last century, here there was a population of *Achillea impatiens* (EN), a glacial relict that is still found in only one locality in Romania. A research project (coordinated by the Botanical Conservatory in Brest, France) will be focused on the study of the possibility of regeneration of some individuals of this species starting from the fruit preserved in the soil of this reserve.

7. Sub Coastă is the most recently constituted reserve in this area that is aimed at protecting the lesser mole rat (*Spalax leucodon*) population. The traditional use of meso- and xero-mesophilic grasslands in this area is sufficient for the conservation of the lesser mole rat, as well as of some species typical for the R 3404 (6250*) and R 3406 (6290*) habitats;

8. Hayfield in the Gârbăului Valley. We propose (taking into consideration the future expansion of the urban space along this valley) the conservation by traditional use of about 3 ha of these beautiful Transylvanian xero-mesophilic grasslands (*Agrostio-Festucetum rupicolae* Csűrös-Káptalan 1971), characterized by a great floristic richness (we identified 80 sp. on a surface area of 50 m^2, among which we mention *Daphne cneorum, Adonis vernalis, Pulsatila montana, Polygala major, Anthericum ramosum,* etc.);

9. The Sf. Gheorghe Hill, on its south slope, beyond the urban facilities in the Tineretului area, comprises an open xero-mesophilic habitat belonging to the category of priority types, with frequent shrub islets and slope sources, which confer a mosaic appearance. In the proximity, there

are two black pine plantations and an apple orchard. Concerning the floristic aspect, the dwarf almond tree (*Prunus tenella*) and the herbaceous species: *Adonis vernalis, Carex secalina, Echium maculatum, Stipa lessingiana, Dictamnus albus, Cephalaria uralensis, Salvia nutans, Astragalus vesicarius,* etc. enhance the protective value of the two hectares proposed for protection;

10. The "Tufele roşii" forest – wet area complex. The expansion of the urban area towards the localities Pata and Gheorgheni may strongly affect the forest that local people call "Tufele roşii" (situated left of the Vâlcele-Dezmir bypass road) and an extensive compact wet area (situated in the superior basin of the streams coming from Gheorgheni and Pata). Both surface areas require a protection status either as areas of landscape interest or as areas of ecological (particular avifaunal) interest.

In terms of structure, the "Tufele roşii" forest is dominated by the phytocoenoses of the association *Quercetum robori-petraeae* Borza (1928) 1959, with many very young portions (in the process of regenerating) and a clear shrub layer, which favors the populations of many passeriformes (particularly Sylvidae and Turdidae). In shaded places, fragments of *Carpino-Quercetum petraeae* Borza 1941 develop, and the border and slopes shelter communities edified by hawthorn and blackthorn. The wet area is dominated by common reed (*Phragmitetum australis*).

Conclusions

Through the complex studies carried out, the Cluj-Napoca city was the first Romanian city investigated from an environmental point of view, serving as a model for similar research in other cities such as Sibiu [1].

General diversity, i.e. cormophyte diversity, places our city in the category of cities with a medium to high phytodiversity in the context of European cities.

In establishing the phytodiversity hotspots, besides specific richness, we consider the inclusion of phytosociological and ecological diversity as a necessary element that guarantees the perennity of sozologically important taxa.

The considerations presented by us complete the purely geographical analysis performed by the team coordinated by V. Surd [19].

Beyond these aspects, we ***propose***:

a. the setting up of semi-natural areas with a socio-protective role, such as Mănăştur, Lomb, Hoia forests and partly Făget forest, according to the model of Western European cities,

b. the inclusion in the plans for the management of the existing or proposed protected areas of actions aimed at contributing to the ecological training and education (in nature, through nature and for nature) of the population,

c. the maintenance and restoration of green spaces both for their sanogenic role and their ecological value,

d. a strict control of the illegal collection and marketing of spontaneous species within the city area.

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PUNCTE FIERBINŢI PENTRU FITODIVERSITATEA MUNICIPIULUI CLUJ-NAPOCA

(**Rezumat**)

Lucrarea noastră sintetizează studiile efectuate de echipele coordonate de noi în anii 1998-2000, 2003-2006 şi 2009-2010 în zona urbană şi periurbană a municipiului Cluj-Napoca.

Obiectivele principale urmărite au fost: i) constituirea unei baze de date privitoare la cormoflora actuală a oraşului; ii) evidenţierea schimbărilor survenite în ultimii 70 de ani; iii) stabilirea ariilor cu importanţă conservativă ridicată, toate subordonate studiului preliminar pentru stabilirea noului Plan Urbanistic General.

Prin cele 1.058 specii de cormofite confirmate ca existente (din cele 1.353 citate), 52 de asociaţii vegetale identificate şi 16 tipuri de habitate, Cluj-Napoca se situează între oraşele cu o fitodiversitate medie spre ridicată din cadrul U.E.

Corelând bogăţia specifică a diverselor comunităţi vegetale, cu tipurile de habitate şi cu prezenţa speciilor cu importanţă sozologică, s-au stabilit 10 arii considerate a fi «Hotspots» pentru fitodiversitatea oraşului (fig. 3). Se propune extinderea unora dintre cele ce deţin un statut protectiv, respectiv instituirea unui regim de protecţie în scop ştiinţific şi social pentru 4 arii (Dl. Galcer, Dl. Sf. Gheorghe, fânaţ pe V. Gârboului şi complexul pădure-zonă umedă de la "Tufele roşii").

Importanţa ştiinţifică şi conservativă a acestor arii este accentuată de prezenţa a 20 taxoni endemici (End), vulnerabili (VU) sau ameninţaţi (EN), precum şi de cele 7 tipuri de habitate prioritare în strategia conservativă a U.E.

O notă particulară imprimă fitodiversităţii municipiului şi arborii seculari, dintre care Pătruţ *et al*. (2009) propun 16 exemplare spre a fi declarate ca monumente ale naturii (dintre care un exemplar de frasin din Grădina Botanică a fost doborât de o furtună în iunie 2014; fig. 2).

Valoarea practică a studiilor noastre constă în aportul adus la fundamentarea unui plan urbanistic mai respectuos faţă de mediu (mai ales acum când se constată o adevărată "foame" pentru spaţii construibile – fig. 1) şi mai util (prin propunerile făcute) comunităţii acestui oraş marcat de un spirit intelectual recunoscut.

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