

FLORA OF THE CITY OF PODGORICA, MONTENEGRO (TAXONOMIC ANALYSIS)

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Abstract — In this paper we present the taxonomic segment of a floristic study undertaken in the city of Podgorica in the period of 2002-2007. The check-list of spontaneously growing vascular plants includes 1227 species and subspecies belonging to 545 genera and 118 families. The dominant families are Poaceae (11.7%), Asteraceae (11.2%) and Fabaceae (9.2%). The most abundant genera are *Trifolium* (2.1%), *Euphorbia* (1.5%), *Carex* (1.5%), *Bromus* (1.3%) and *Vicia* (1.2%). Analysis of the flora of Podgorica in comparison with some other European cities showed that the flora of Podgorica is most similar to that of Rome (Q/S= 0,7).

Key words: Urban flora, diversity, taxonomic spectrum, Podgorica, Montenegro

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INTRODUCTION

As a constant companion of human settlements and other anthropogenic landscapes, representatives of the ruderal or synanthropic flora and vegetation constitute an inseparable part of the human environment. That position creates a need for complex research that will throw light on the role of ruderal plants in the ecosystem of urban and industrial settlements and their importance in and impact on human lives.

The first investigations in the field of urban ecology in Europe focused on single habitat types (old settlements, ruins, gardens, and parks), while comprehensive studies of urban ecosystems were started in the 1970's (Sukopp, 2002).

On the territory of former Yugoslavia, special interest in the ruderal flora and vegetation appeared in the last two decades (Jovanović, 1993), while in Montenegro it started with this study. However, it should not be concluded that the area of Podgorica represents „virgin“ territory. On the contrary, the first floristic data were recorded by foreign botanists (Baldacci, Horak, Rohlena, Szyszyłowicz, and Janchen) who visited Montenegro more than

a century ago. On their way to the northern part of the country, they passed through localities that nowadays belong to the city of Podgorica (Donji Kokoti, Malo Brdo, Doljani, Duklja, etc.) and noted the presence of some taxa of vascular plants (Rohlena, 1942). However, a systematic study of the flora of Podgorica was not their objective.

Fragmentary data on the flora of Podgorica are also available in: Černjavski (1949), Slavnić and Ložušić (1965), Pulević [1966, 1971(72), 1974a, 1974b, 1977, 1979, 1982, 1983a, and 1983b], Šmarda (1968), Speta (1976 and 1980), Blečić and Pulević (1979), Šilić (1979), Pulević and Lakušić (1983), Gölz and Reinhard (1986), Bulić (1989 and 1994), Pulević and Bulić (1990), Parolly (1992 and 1995), Vasić (1995-98), Hadžiablahović (2002, 2003, 2004a, and 2006), Hadžiablahović and Bulić (2004b), Lakušić et al. (2004), Stešević (2003 and 2006a), Stešević and Jovanović (2006b), Stešević and Jogan (2007) [for more details about references published before 2004, see Pulević (1980, 1987) and Pulević and Bulić (2004)].

Podgorica is the industrial center of Montenegro and according to the census of 2003, it has 136,473

inhabitants (Šehić and Šehić, 2005). It is located in the southeastern part of the country (in the Zeta valley) and is bounded by the Kučke and Piperske mountains and Lješka hills. Its geological substrate consists of quaternary deposits (lowland) and rocks of Mesozoic age (hills) (geological map Titograd 1: 100,000). The pedological substrate consists of brown soils and terra rossa (pedological map Cetinje 2, 1: 50000). The climate is sub-Mediterranean, with short mild winters, usually without snow, and long hot summers. The relative amount of precipitation per year is 1625.3 mm, with the maximum (14.6%) in late autumn (November) and minimum (2.3%) during summer (July). Average temperature for the period of 1949-2002 was 15.5°C. The lowest average temperature was measured in January (5.3°C) and the highest in July (26.4°C). The most frequent and strongest winds blow from the north and north-east (data obtained from the Weather Bureau in Podgorica). The area is characterized by rich hydrology in the guise of the Morača River and its tributaries (the Zeta, Cijevna, Ribnica, Matica, and Sitnica) and the Mareza spring (Ičević, 2003). With respect to natural vegetation, Podgorica is located in a *Rusco-Carpinetum orientalis* zone (Blečić and Lakušić, 1976). Fragments of natural vegetation are still present at some microlocalities on the city's hills (Gorica, Malo Brdo, Dajbabska Gora, and Kakarička Gora).

MATERIALS AND METHODS

In this study our attention was focused on the spontaneously growing vascular flora; ornamental plants grown in city parks and private gardens were not taken into consideration.

The investigated area covers a surface of 86 km²; in addition to urban, it also includes the following suburban areas: Mareza, Tološi, part of Vranjičke Njive, the lower part of Rogami, Zlatičko Polje, Doljani, part of Kakarička Gora, part of Čemovsko Polje (from Vrela Ribnička through the orchards of "Agrokombinat 13. jul", up to Kuće Rakića and then by right bank of the Cijevna River up to its mouth in the Morača), Srpska Gora, Dajbabe, Dajbabska Gora, Kokotski Ovčar, Gorica, and Lješkopolje.

The collected material was identified using available literature sources: Tutin et al. (1964-1980, and 1993), Ohwi (1965), Pignati (1982), Lauber and Wagner (2001), Šilić (1979, 1990a and 1990b) and Martinčić et al. (1999) and is partially stored at the Faculty of Science in Podgorica and the Institute of Plant Sciences in Graz.

Nomenclature is mostly according to Tutin et al. (1964-1980 and 1993) and Greuter et al. (1984, 1986 and 1989).

The flora of Podgorica is compared with the floras of selected European cities: Rome (Celestigrapow, 1995), Salonika (Krigas and Kokkini, 2004, 2005), Patras (Chronopoulos and Christodoulakis, 1996), and Zurich (Landolt, 2001).

Similarity of floras was determined using Sorensen's quotient of similarity (Q/S):

$$Q/S = \frac{2j}{(a+b)} \times 100$$

where *a* is the total number of species in sample #1, *b* is the number of species in sample #2, and *j* is the number of species common to both samples.

DISCUSSION AND RESULTS

The flora of urban habitats has long been recognized as being rich in species, cities representing an accumulation of species diversity in intensively managed landscapes (Haeupler, 1974; Kuhn et al., 2004). According to Gilbert (1989), this is due to high heterogeneity of the urban landscape, which provides plants with habitats convenient for all kind of strategies. Thanks to high heterogeneity of the urban landscape and its pronounced ability to receive immigration of new species, the urban flora constantly becomes richer and richer (Sukopp and Werner, 1983).

The check-list of spontaneously growing vascular plants of the city of Podgorica includes 1227 species and subspecies, which represents more than a third of the flora of Montenegro (Rohlena, 1942; Pulević, 2005). Comparing the flora of Podgorica with some other European urban floras [those

of Berlin (Sukopp, 1990), Warsaw (Sudnik-Wojcikowska, 1988), Vienna (Adler and Mrkvicka, 2003), Zurich (Landolt, 2001), Rome (Celesti-Grapow, 1995), Salonika (Krigas and Kokini, 2002), Patras (Chronopoulos and Christodoulakis, 1996), and Poznan (Jackowiak, 1989)], we can conclude that it is also rich in the European context.

According to Sukopp and Werner (1983) and Pyšek (1989), the number of species in urban floras is influenced by several factors: geographic location and climatic conditions, the city's size, and possibilities of immigration.

Numerous studies report a positive correlation between species number and settlement size (Pyšek, 1989, 1993; Brandes and Zacharias, 1990; Klotz, 1988, 1989, 1990). Comparing the relation between city size and species richness for 77 Central European cities, Pyšek (1993) concludes that the number of species shows a highly significant linear increase with city size, regardless of whether this size is expressed as the number of inhabitants or the city's area. In his previous study from 1989, he reported that in the case of smaller cities with approximately up to 200 thousand inhabitants, the number of species found does not exceed 500; in cities with up to a million inhabitants, the number of species varies from 500 to 1200; and in cities with 1.5 to 2 million inhabitants, the total number comes to 1500.

Although Podgorica is characterized by a relatively small area (86 km²) and a small number of inhabitants (cca 140, 000), a high number of species is expected due to its geographic position and sub-Mediterranean climate.

Before the beginning of this study, published sources indicated the presence of 758 species and subspecies in the studied area. The checklist of spontaneously growing vascular plants is here supplemented by 469 additional taxa. The following taxa are reported as new for the flora of Montenegro: *Acacia deablata*, *Acer negundo*, *Albizzia julibrissin*, *Amaranthus chlorostachys*, *A. cruentus*, *A. powellii*, *Anthriscinum barrelieri*, *Artemisia verlotiorum*,

Asclepias syriaca, *Aster novi belgii*, *Bidens frondosa*, *Broussonetia papyrifera*, *Citrullus lanatus*, *Conyza albida*, *C. bonariensis*, *Erigeron annuus* subsp. *serpentalis*, *Euphorbia humifusa*, *E. marginata*, *E. nutans*, *Gagea amblyopetala*, *Gaillardia aristata*, *Helianthus tuberosus*, *Hibiscus syriacus*, *Ipomea purpurea*, *Iva xanthifolia*, *Koeleria paniculata*, *Linaria genistifolia* subsp. *genistifolia*, *Mentha piperita*, *Mirabilis jalapa*, *Opuntia vulgaris*, *Panicum capillare*, *Parthenociscus quinquefolia*, *Perilla frutescens*, *Petunia x hybrida*, *Pittosporum tobira*, *Reynoutria japonica*, *Rudbeckia triloba*, *Sedum sarmentosum*, *Setaria verticilliformis*, *Sporobolus vaginiiflorus*, *Tagetes patula*, *Tradescantia virginiana*, and *Zinnia elegans*.

The taxonomic spectrum of the flora of Podgorica encompasses four classes, 118 families, 545 genera, and 1227 species and subspecies (Table 1).

Table 1. Spectrum of classes in the flora of Podgorica.

Class	Families		Genera		Species	
	No	%	No	%	No	%
<i>Equisetinae</i>	1	0,8	1	0,2	3	0,2
<i>Filicinae</i>	6	5	7	1,3	10	0,8
<i>Dicotyledones</i>	94	79,6	430	78,9	950	77,4
<i>Monocotyledones</i>	17	14,4	107	19,6	264	21,5
Total	118	100	545	100	1227	100

The most frequent class is *Dicotyledones* (77.4%), with 94 families, 430 genera, and 950 species, while the least frequent is *Equisetinae* (0.2 %), with one family, one genus and three species.

The dominant families are: *Poaceae* (11.7%), *Asteraceae* (11.2%) and *Fabaceae* (9.2%) (Fig. 1). A significant feature of the spectrum is the presence of the families *Scrophulariaceae*, *Euphorbiaceae*, *Chenopodiaceae*, *Geraniaceae*, *Solanaceae*, *Malvaceae*, and *Amaranthaceae*, which are characterized by numerous synanthropic species. Also present are the families *Iridaceae*, *Liliaceae*, and *Orchidaceae*, which are negatively correlated with anthropogenic impacts. Such a taxonomical spectrum is in agreement with results obtained by Celesti-Grapow (1998) indicating that even the most urbanized Mediterranean settlements retain the character of the flora of their surroundings. As opposed

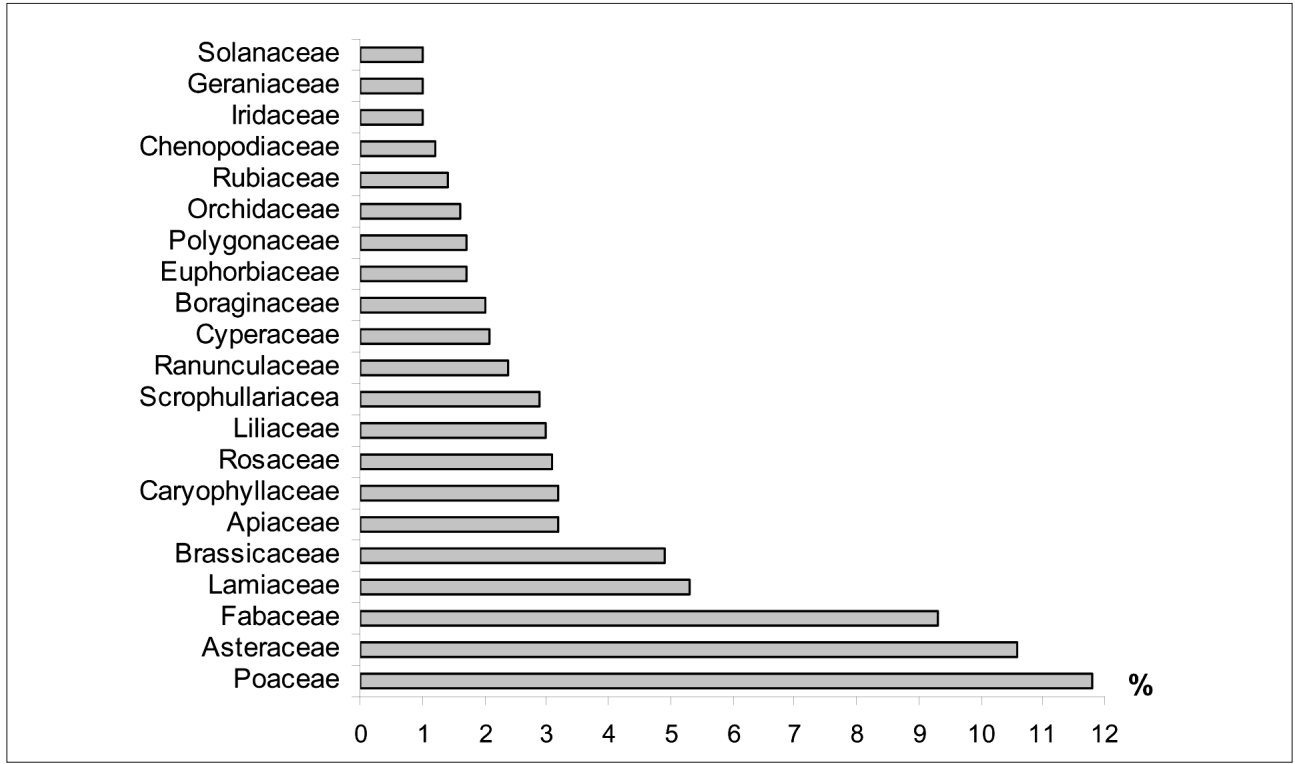


Fig. 1. Taxonomic spectrum of families present with ≥ 5 species ($\geq 0,4\%$).

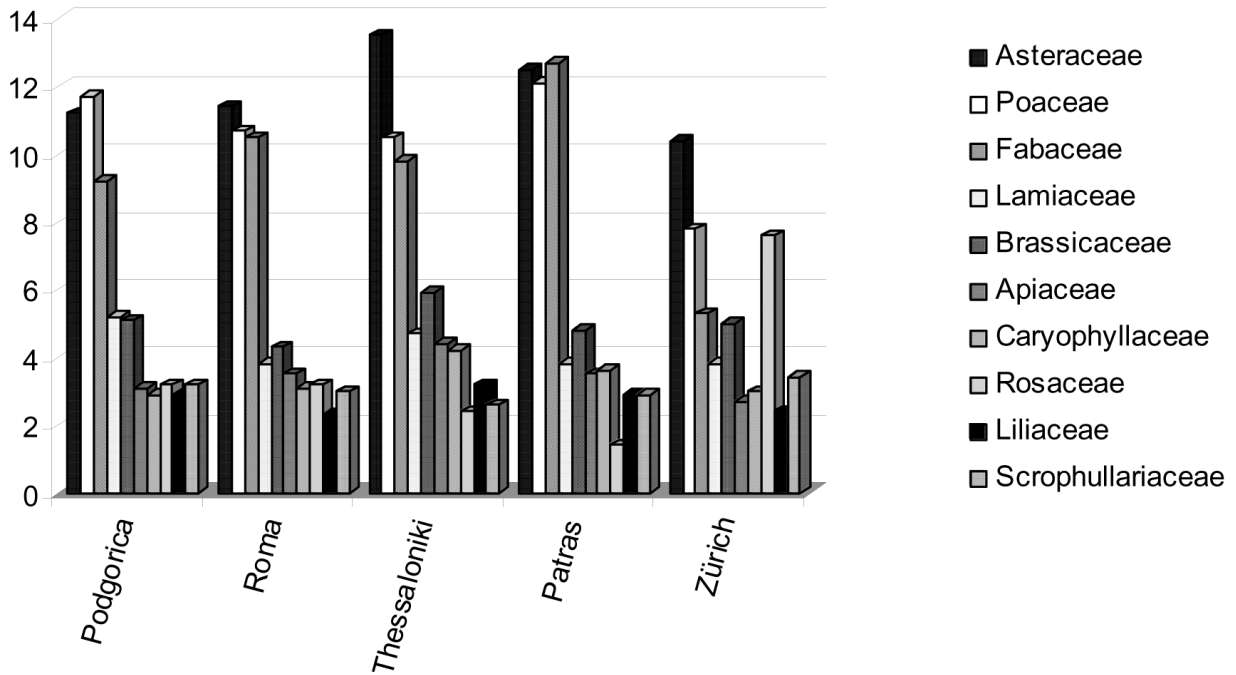


Fig. 2. Comparative taxonomic spectrum of families of Podgorica, Rome, Salonika, Patras, and Zurich.

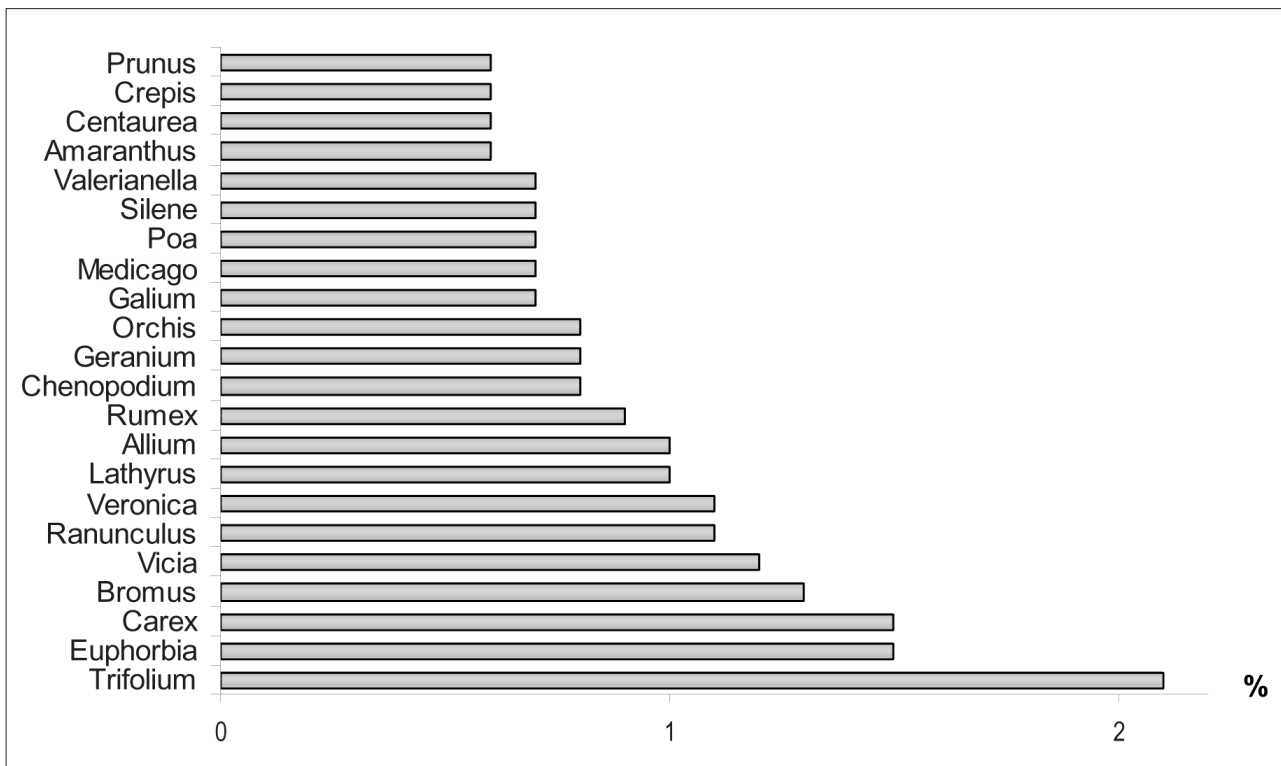


Fig. 3. Taxonomic spectrum of genera participating with > 0,5%.

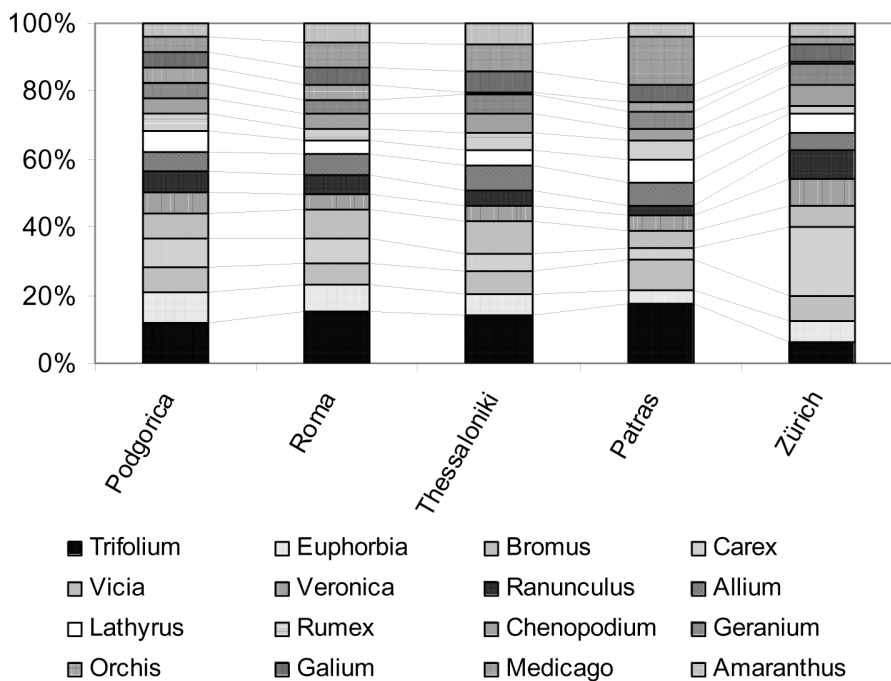


Fig. 4. Comparative taxonomic spectrum of genera of Podgorica, Rome, Salonika, Patras, and Zurich.

to Mediterranean cities, Central European cities exhibit a trend toward biotic homogenization (McKinney and Lockwood, 1999).

Comparative analysis of the urban floras of Podgorica, Rome, Salonika, Patras and Zurich showed that the flora of Podgorica is most similar to that of Rome ($Q/S=0,7$). It can be seen from Fig. 2 that the most obvious characteristic of the flora of Podgorica is "inversion" of the families *Asteraceae* and *Poaceae*. With the exception of the flora of Patras, where the most frequent family is *Fabaceae*, *Asteraceae* is the most frequent family in the floras of the other cities.

Figure 3 presents the taxonomic spectrum of genera of the flora of Podgorica.

Genera that participate in the spectrum with more than 1% are: *Trifolium* (2.1%), *Euphorbia* (1.5%), *Carex* (1.5%), *Bromus* (1.3%), *Vicia* (1.2%), *Ranunculus* (1.1%), and *Veronica* (1.1%). They are mostly represented by typical ruderal and ruderal-segetal species. Also significantly present are the synanthropic genera *Rumex* (0.9%), *Chenopodium* (0.8%), and *Amaranthus* (0.7%).

Figure 4 gives a comparison of genera in the floras of Podgorica, Rome, Salonika, Patras and Zurich.

Such high floristic richness of the Podgorica area has recently begun to be seriously disturbed by rapid urbanization. Reduction of green areas, replacement of spontaneously developing lawns with artificial grass carpets, and intentionally set fires constitute the most frequent causes of habitat loss. Special demands are imposed by the presence of 33 taxa from the national list of plants protected by law (Official Gazette of the Republic of Montenegro, 76/06). Unfortunately, one species from the list - *Sternbergia colchiciflora* - has become extinct. During landscaping of Gorica Hill, its only habitat was destroyed.

Except in the case of allergenic plants and their negative influence on human health, it can be generally stated that the flora and vegetation of man-made environments represent a significant, spontaneously

developed phytohealing factor, one which in such polluted conditions produces a whole series of positive effects (Jovanović, 1994; Vukojević et al., 2005; Tomanović et al., 2004), so they therefore deserve better treatment.

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ФЛОРА ГРАДСКОГ ПОДРУЧЈА ПОДГОРИЦЕ (ТАКСОНОМСКА АНАЛИЗА)

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У раду смо представили сегмент еколошко-фитогеографске студије урбане флоре Подгорице, спроведене у периоду 2002-2007. Постојећа чек-листа која је садржала 758 врста и подврста спонтане васкуларне флоре, допуњена је са 427 врста, од којих су као нове за Црну Гору евидентирани *Acacia deablata*, *Acer negundo*, *Albizzia julibrissin*, *Amaranthus chlorostachys*, *A. cruentus*, *A. powellii*, *Anthirrhinum barrelieri*, *Artemisia verlotiorum*, *Asclepias syriaca*, *Aster novi belgii*, *Bidens frondosa*, *Broussonetia papyrifera*, *Citrullus lanatus*, *Conyza albida*, *C. bonariensis*, *Erigeron annuus* subsp. *serpentionalis*, *Euphorbia humifusa*, *E. marginata*, *E. nutans*, *Gagea amblyopetala*, *Gaillardia aristata*, *Helianthus tuberosus*, *Hibiscus syriacus*, *Ipomea purpurea*, *Iva xanthifolia*, *Koeleria paniculata*, *Linaria genistifolia* subsp. *genistifolia*, *Mentha piperita*, *Mirabilis jalapa*, *Opuntia vulgaris*, *Panicum capillare*, *Parthenocissus quinquefolia*, *Perilla frutescens*, *Petunia x hybrida*, *Pittosporum tobira*, *Reynoutria japonica*, *Rudbeckia triloba*, *Sedum sarmentosum*, *Setaria verticilliformis*, *Sporobolus vaginiiflorus*, *Tagetes patula*, *Tradescantia virginiana* and *Zinnia elegans*.

Чек-листа спонтане васкуларне флоре града Подгорице износи 1227 врста и подврста, што представља нешто више од трећине флоре Црне Горе. Богатство и диверзитет флоре се објашња-

ва геоморфолошким и климатским карактеристикама подручја, као и диверзитетом станишта и антропогених утицаја.

У таксономском спектру биљних фамилија градског подручја Подгорице, као најзаступљеније се истичу: *Poaceae* (11,7%), *Asteraceae* (11,2%) и *Fabaceae* (9,2%). Посебан печат флори Подгорице дају породице *Scrophulariaceae*, *Euphorbiaceae*, *Chenopodiaceae*, *Geraniaceae*, *Solanaceae*, *Malvaceae*, *Amaranthaceae*, које се одликују присуством великог броја синантропних врста, али и породице *Liliaceae*, *Orchidaceae* и *Iridaceae*, чија бројност стоји у негативној корелацији са антропогеним утицајем.

У општем таксономском спектру родова са учешћем врста већим од 1%, издвајају се *Trifolium* (2,1%), *Euphorbia* (1,5%), *Carex* (1,5%), *Bromus* (1,3%), *Vicia* (1,2%), *Ranunculus* (1,1%), *Veronica* (1,1%), *Lathyrus* (1%) и *Allium* (1%), у којима преовладавају типичне рудералне или рудерално-сегеталне врсте. Поред тога, значајно су заступљени и синантропни родови *Rumex* (0,9%), *Chenopodium* (0,8%) и *Amaranthus* (0,7%).

Поређећи таксономски спектар флоре Подгорице са спектрима флоре Рима, Цириха, Солуна и Патраса утврђена је највећа сличност са флором Рима ($Q/S = 0,7$).