

Adventive Flora of the Banja Luka Region

Ljiljana Topalić-Trivunović¹, Dragana Pavlović-Muratspahić²

¹Faculty of Technology, 78000 Banjaluka, Vojvode Stepe 73, Republika Srpska, BiH

²Faculty of Science, 31000 Kragujevac, Radoja Domanovića 12, Serbia

SUMMARY

In various ruderal habitats of the Banja Luka region, 61 species of adventive plants were found, most of them originating from Northern America (23) and Asia (17). The species with the highest percentage of plant coverage and plant abundance in different ruderal communities were: *Erigeron annuus* (L.) Pers., *Ambrosia artemisiifolia* L., *Reynotria japonica* Houtt, *Conyza canadensis* (L.) Cronq and *Helianthus tuberosus* L. In this study, taxonomical, ecological, phytogeographical, and synecological analyses of the adventive flora of the Banja Luka region were performed.

Keywords: Adventive flora; Banja Luka; Ruderal community

INTRODUCTION

There have been relatively few studies dealing with research into the distribution and ecology of adventive plants in Bosnia and Herzegovina. Apart from the available data sets on the flora of Bosnia and Herzegovina (Beck, 1927; Beck and Maly, 1950; Bjelčić, 1967, 1974, 1983), there have not been many published works on adventive plants, their ecology and patterns of spread (Korica, 1952, 1957; Slavnić, 1960; Slavnić and Ložušić, 1964/65; Šilić, 1972/73; Obradović and Budak, 1982; Bjelčić and Stefanović, 1986; Abadžić, 1986/87; Trinajstić, 1990; Šarić et al., 1992; Šoljan and Muratović, 2002).

The term “adventive species” has been sporadically used in recent European flora studies. Instead, plant species introduced into certain regions as a consequence of various human activities are distinguished as either hemerchorous or anthropochorous species (Witig, 2004). This group of species is classified into two sub-groups: archeophytes that arrived before 1500, and neophytes introduced after that date (Richardson et al., 2000; Pyšek et al., 2003, 2004; Pyšek and Prach, 2003; Dehnen-Schmutz, 2004; Öpik et al., 2008).

Hence the term “adventive species”, used in specialised papers dealing with the research conducted in Bosnia and Herzegovina, as well as in this study, is interchangeable with “neophytes”, i.e. species introduced into the surveyed area after the year 1500.

The aim of this study was to establish a checklist of adventive flora for the Banja Luka region as well as to present the flora's taxonomic, ecological and phytogeographical analysis.

MATERIAL AND METHODS

Banja Luka is located on the banks of the river Vrbas in an ample, fan-shaped valley, a transition zone between the Pannonian Plain and the Dinaric Alps. The average annual amount of precipitation over the last 40 years was 1054.3 mm, with an average annual temperature of 11.1°C. The eco-climatic vegetation of Sessile Oak wood and

Hornbeam (*Quercus-Carpinetum illyricum* Ht 38) prevails in the greater part of town, while the vegetation zone of inundated woods *Quercion robori-petreae* Br.-Bl. 31 covers the low-lying part of town, and the plant species of *Salicion albae* Tx. 52 can be found in the close vicinity of the river Vrbas.

Adventive flora, as a common constituent of ruderal flora of the Banja Luka region, has been investigated in different types of ruderal habitats. Depending on the size of a particular ruderal habitat, all species which appeared on the surveyed areas of different sizes from 2 to 100 m² were recorded and phytocoenological observations were conducted according to the Braun-Blanquet cover-abundance scale (Mueller-Dombois and Ellenberg, 1974). In total, the area of 6890 m² was investigated.

Determination of plant taxa was conducted based on standard primary literature (Javorka et Csapody, 1979; Beck, 1903, 1927; Bjelčić, 1967, 1974, 1983; Josifović ed., 1970-1986; Fiori et Paoletti 1921; Pančić, 1976; Hegi, 1928-1931; Jordanov ed. 1963-1989; Klapp et Opitz, 1990; etc.), whereas Flora Europae (I-IV) was consulted as a source for adjusting the plant nomenclature.

Cover-abundance value of each species within a plant community is calculated as an average cover data in all investigated areas multiplied by 100, according to the Braun-Blanquet cover-abundance scale, and was converted into numerical scale in the following correlation: + = 0.5, 1 = 5, 2 = 17.5, 3 = 37.5, 4 = 62.5 and 5 = 87.5. The total cover value, or cover value for each species in certain orders of ruderal vegetation was determined as a single sum of all or each particular species in all plant communities. Plant life forms and natural distribution of the adventive species were determined according to Oberdorfer (2001).

Abbreviations: **Bid.** - *Bidentetalia tripartiti* Br.-Bl. et Tx 1943; **Art.** - *Artemisietalia vulgaris* Lohm. in Tx 1947; **Gl.** - *Glechometalia hederaceae* Tx. in Tx. et Brun.-H 1975; **Co.** - *Convolvuletalia sepium* Tx. 1950; **On.** - *Onopordetalia acanthii* Br.-Bl. et Tx. 1943 em. Görs 1966; **Ag.** - *Agropyretalia repentis* Oberd., Müller et Görs 1967; **Sis.** - *Sisymbrietalia* Tx 1961 em Görs 1966; **Pl.** - *Plantaginietalia majoris* Tx et Prsg. 1950; **Po.** - *Potentilletalia caulescentis* Br.-Bl. in Br.-Bl. et Jenny 1926.

RESULTS

The ruderal flora of Banja Luka has 61 species of adventive plants, the majority among them (37.70 %) native to North America (Table 1). Out of those 61 species, *Erigeron annuus* and *Ambrosia artemisiifolia* are represented with high cover values in most ruderal communities. Among 9 (14.75 %) Central American and South American species, several of them, such as *Amaranthus retroflexus*, *Galinsoga ciliat*, and *Galinsoga parviflora*, are typical for ruderal habitats, but only *Helianthus tuberosus* is represented with considerable frequency of distribution and abundance. Other most represented adventive species (in terms of percentage, 27.75 %) originate from various parts of Asia. *Reynoutria japonica*, *Medicago sativa*, *Ailanthus altissima* and *Portulaca oleracea* are found to be represented in the ruderal habitats of Banja Luka with considerable frequency of distribution and abundance in the landscape. The other species of Asian origin (*Kochia scoparia*, *Impatiens glandulifera*, *Polygonum orientale*, *Cannabis sativa*, etc.) are mainly found in different ruderal areas with insignificant coverage. Unlike the adventive species of American and Asian origin, only *Anethum graveolens* is widely represented in the ruderal plant community among the species that came from the Mediterranean area (16.39 %). Other species of Mediterranean origin, which are used either as food (*Triticum vulgare*, *Avena sativa*, *Beta vulgaris*) or spices (*Foeniculum vulgare*), or as ornamentals (*Calendula officinalis*, *Antirrhinum latifolium*, *Antirrhinum majus*, *Phalaris canariensis*) are sporadically represented in the ruderal plant communities and ruderal habitats.

Adventive plants of the ruderal flora of Banja Luka are systematized into 27 families and 55 genera, the majority of them belonging to the family of *Asteraceae* (17), then the family of *Poaceae* (5) and three other families (*Cucurbitaceae*, *Polygonaceae* and *Solanaceae*). The other families are represented with two or one species (Table 1). Out of the total number of species of *Asteraceae* family, five are represented by isolated specimens appearing on the borders of the investigated areas. *C. officinalis* and *Callistephus sinensis* were registered on a waste dump in a community of *Sisymbrietalia* order. The remaining 10 species were common in different ruderal plant communities. Four of these species (*A. artemisiifolia*, *E. annuus*, *H. tuberosus* and *Coryza canadensis*) are present in plant communities belonging to more than half of the represented orders of ruderal vegetation with high coverage.

Table 1. Survey of the adventive flora of Banja Luka region**Tabela 1.** Pregled adventivne flore u području Banje Luke

Family/Species	Life form	Floristic element	No. ord ¹ .	Cov. value ² .
ACERACEAE				
<i>Acer negundo</i> L.	P	Sj. Am.	4	10.7
<i>Acer sacharinum</i> L.	P	Sj. Am.	-	0
AMARANTHACEAE				
<i>Amaranthus hybridus</i> L.	T	Sj. Am.	1	3.3
<i>Amaranthus retroflexus</i> L.	T	Sj. Am.	5	760.7
APIACEAE				
<i>Anethum graveolens</i> L.	T	Ist.med	5	153.1
<i>Foeniculum vulgare</i> Mill	H	Zap.med	-	0
APOCYNACEAE				
<i>Vinca minor</i> L.	Ch	Smed	1	0.7
ASTERACEAE				
<i>Ambrosia artemisiifolia</i> L.	T	Sj.-Am.	8	7945.8
<i>Aster x salignus</i> Willd.	H	Sj.-Am.	-	0
<i>Aster novi-belgii</i> L.	H	Sj.-Am.	-	0
<i>Calendula officinalis</i> L.	T	Med.	1	2
<i>Callistephus chinensis</i> (L.) Nees	T	Ist. Az.	1	2
<i>Chamomilla suaveolens</i> (Purch.) Rydb.	T	Az.	2	1
<i>Conyza canadensis</i> (L.) Cronq.	T	Sj. Am.	5	189.6
<i>Cosmea bipinnatus</i> Cav.	T	Sj. Am.	-	0
<i>Erigeron annuus</i> (L.) Pers.	T /H bienn	Sj. Am.	9	2221.2
<i>Galinsoğa ciliata</i> (Rafin) S. F. Blake	T	Sr. Am.	1	2.1
<i>Galinsoğa parviflora</i> Cav.	T	J. Am.	2	9.8
<i>Helianthus tuberosus</i> L.	G	Sr. Am.	5	7352.3
<i>Rudbeckia laciniata</i> L.	G	Sj. Am.	1	3.3
<i>Solidago gigantea</i> Aiton	H	Sj. Am.	2	1.4
<i>Tagetes patulus</i> L.	T	Sr. Am.	-	0
<i>Zinnia elegans</i> Jacq	H	Sj. Am.	-	0
<i>Xanthium strumarium</i> L.				
<i>X. s. ssp. italicum</i> (Moretti) D. Love	T	Sj.Am	4	9
BALSAMINACEAE				
<i>Impatiens glandulifera</i> L.	T	Az.	3	2.6
BRASSICACEAE				
<i>Armoracia rusticana</i> P. Gaert., B. Meyer, Sch.	G	Evroaz. kont (ist.smed))	2	4.9
<i>Lepidium virginicum</i> L.	T /H bienn	(Sj. Am.) subatl	3	3.6
CANNABACEAE				
<i>Cannabis sativa</i> L.	T	Evroaz.kont	-	0
CEASALPINACEAE				
<i>Gleditsia triacanthos</i> L.	P	Sj. Am.	2	1.5
CHENOPODIACEAE				
<i>Beta vulgaris</i> L.	T/H bienn	Subatl-smed	1	1
<i>Kochia scoparia</i> (L.) Schrad.	T	C. Az.	-	0
COMMELINACEAE				
<i>Commelina virginiana</i> L.	H	Ist. Az.	1	0.4
CONVOLVULACEAE				
<i>Ipomea acuminata</i> (Vah.) Roem.	ST	J. Am.; J. Az.	1	3.3

Family/Species	Life form	Floristic element	No. ord ¹ .	Cov. value ² .
<i>Ipomea purpurea</i> Roth.	ST	J. Am. ?	1	0.4
CRASSULACEAE				
<i>Sedum spurium</i> Bieb.	Ch	C. Az.	-	0
CUCURBITACEAE				
<i>Cucurbita pepo</i> L.	ST	Sj. Am.	3	3.1
<i>Ecballium elaterium</i> (L.) Rich	G	Med	1	36.4
<i>Echinocystis lobata</i> (Michx) Torrey et A.Gray	ST	Sj. Am.	3	4.6
FABACEAE				
<i>Medicago sativa</i> L.	H	C. Az.	5	98.5
<i>Robinia pseudo acacia</i> L.	P	Sj. Am.	3	7
JUNCACEAE				
<i>Juncus tenuis</i> Willd.	H	Sj. Am.(subokean)	1	18.6
MORACEAE				
<i>Morus nigra</i> L.	P	Z. Az.	-	0
OENATHERACEAE				
<i>Oenothera biennis</i> L.	H	Ist. Az., Sj. Am.	-	0
OXALIDACEAE				
<i>Oxalis stricta</i> L.	H	Sj. Am.	4	20.1
POACEAE				
<i>Avena sativa</i> L.	T	Med-evroaz	1	0.4
<i>Panicum capillare</i> L.	T	Sj. Am.	1	1
<i>Phalaris canariensis</i> L.	G	Zap.med, atl	-	0
<i>Sorghum halepense</i> (L.) Pers.	G	Ist.med	3	134.8
<i>Triticum vulgare</i> Vill.	T	Med.	-	0
POLYGONACEAE				
<i>Fagopyrum esculentum</i> Moench	ST	C. Az.	-	0
<i>Polygonum orientale</i> L.	T	J.ist., Az	1	4.3
<i>Reynoutria japonica</i> Houtt.	G	Ist. Az.	3	8019.6
PORTULACACEAE				
<i>Portulaca oleracea</i> L.	T	(Ist.)med-smed	5	7.8
ROSACEAE				
<i>Rosa foetida</i> J. Herrmann	NP	Zap. Az.	-	0
SCROPHULARIACEAE				
<i>Antirrhinum latifolium</i> Miller	Ch	Zap.med	-	0
<i>Antirrhinum majus</i> L.	Ch	Med-smed	-	0
SIMARUBACEAE				
<i>Ailanthus altissima</i> (Mill.) Swingle	P	Ist. Az.	3	52.9
SOLANACEAE				
<i>Lycopersicon esculentum</i> Mill.	T	J. Am.	-	0
<i>Petunia x hybrida</i> Hort.	T	J. Am.	-	0
<i>Solanum tuberosum</i> L.	G	J. Am.	2	7.6
VITACEAE				
<i>Parthenocissus quinquefolia</i> (L.) Planch.	S	Sj. Am.	5	533
<i>Parthenocissus tricuspidata</i> (S.et Z.) Planch.	S	Ist. Az.	-	0

¹Number of orders in whose communities the species is recorded²Total coverage

Sorghum halepense is the most common among the family of *Poaceae* and has high cover values. The other species with high abundance are: *R. japonica* (*Polygonaceae*), *A. retroflexus* (*Amaranthaceae*) and *Parthenocissus quinquefolia* (*Vitaceae*).

The biological spectrum of adventive plants in the surveyed area comprised almost half of the annual therophytes (Table 1). Among them, two are most frequently present with high cover values: *E. annuus* and *A. artemisiifolia*. Apart from these two, *A. retroflexus*, *A. graveolens* and *C. canadensis* are also frequently found in ruderal communities. In terms of percentages, hemicriptophytes are the second most represented, but there is not a single species characterized by high abundance or frequency of occurrence in the ruderal plant communities of our research area. The situation is completely different regarding adventive geophytes, since they are represented by species of high cover values in the ruderal vegetation of our field research, such as *R. japonica*, *H. tuberosus* and *S. halepense*. Of the other represented life forms of adventive plants, two scandentophytes (lianas) are worth mentioning: woody *P. quinquefolia* and annual *Echinocystis lobata*.

DISCUSSION

The domination of adventive plants native to North America recorded in the area of Banja Luka was consistent with data gathered on the ruderal flora and vegetation in other European cities (Turk, 1990; Jovanović, 1994; Jovanović and Bartula, 1994; Jovanović and Mitrović, 1998; Milinčić, 1998; Müller and Okuda, 1998; Almeida and Freitas, 2001; Mosyakin and Yavorska, 2002; Chmura, 2004). The occurrence of these species, as well as the species of East Asian origin in ruderal habitats of European cities is attributed to macroclimatic conditions, that is a succession of certain plant stages, as well as to accidental, indeliberate introductions (Mosyakin and Yavorska, 2002; Pyšek et al., 2003; Basdorf et al., 2004; Chytry et al., 2005).

The fact that plants thus introduced are established in human-made habitats has been confirmed in numerous research papers (Bianco et al., 2003; Deutschewitz et al., 2003; Pyšek et al., 2004; Chytry et al., 2005; Richardson et al., 2007; Ziska et al., 2007). Human-made habitats, with their instability and dynamics, ensure the survival and establishment of different plant life forms and various survival strategies (Basdorf et al., 2004; Dauer et al., 2007; Ziska et al., 2007; Őpik et al., 2008). Thus, five different life forms are represented in the adventive flora of Banja Luka, but their establishment (classified using the categories of Richardson et al. 2000) in the ruderal vegetation of Banja Luka is different. Under strong anthropogenous activities that are changing the environment, ruderal plant communities, such as the therophytic community orders *Bidentetalia tripartiti* and *Sisymbrietalia*, respond favourably to the introduction of adventive species (Figure 1). However, taking into account all life forms, their establishment is more significant in hemicryptophytic and therophytic communities of the order *Artemisietalia vulgaris* (Figure 2).

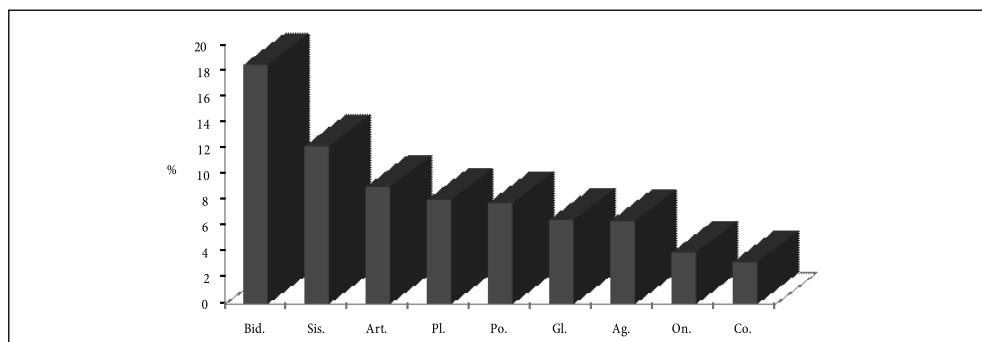


Figure 1. Percentage of adventive species out of total number of species represented in ruderal plant communities of the Banja Luka region

Slika 1. Procenat adventivnih vrsta u ukupnom broju vrsta prisutnih u ruderalnim zajednicama područja Banje Luke

Therophyte and geophyte life forms in different ruderal plant communities are established in proportion to their representation (Figure 3). Therophytes (*A. artemisiifolia*, *A. retroflexus* and *C. canadensis*) prevail in the plant communities of *Sisymbrietalia* order, whereas in the plant communities of *Artemisietalia vulgaris* order, geophytes (*R. japonica* and *H. tuberosus*) are represented with higher cover values. Taking into account the seed dispersal modes and rate of spread and invasion of new, primarily ruderal habitats (using the categories of Richardson et al., 2000) by invasive species in the surveyed area, the following species can be considered invasive: *A. artemisiifolia*, *E. annuus*, *H. tuberosus* and *R. japonica*.

Owing to instability and changing conditions in ruderal habitats, the phanerophyte life form is being either slowly established or not established at all into ruderal plant communities (Table 1). Woody plant species native to North America, such as: *Robinia pseudo-acacia*, *Acer negundo* and *Glededichia triacanthos*, as well as the East Asian species *A. altissima*, although underrepresented in ruderal plant communities, are frequently to be found in

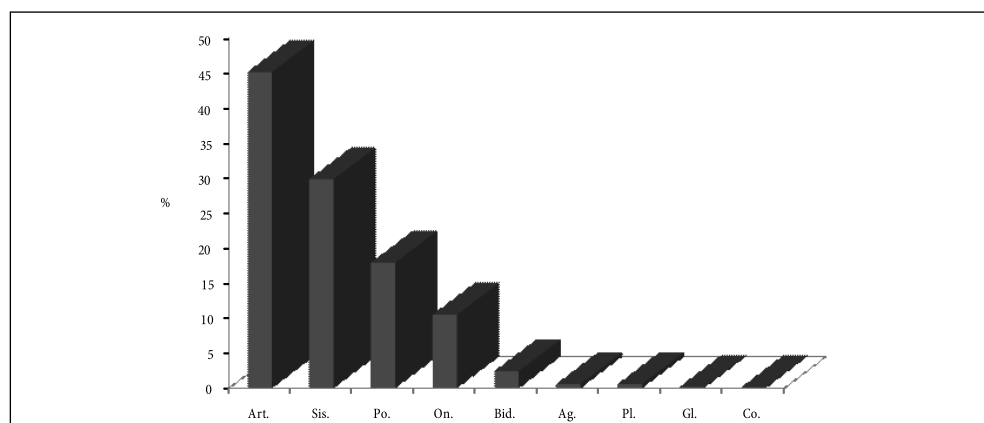


Figure 2. Percent coverage of adventive plants as compared to the overall plant coverage in ruderal plant communities of the Banja Luka region

Slika 2. Procenat adventivnih vrsta u odnosu na ukupnu pokrovnost ruderalnih biljnih zajednica u području Banje Luke

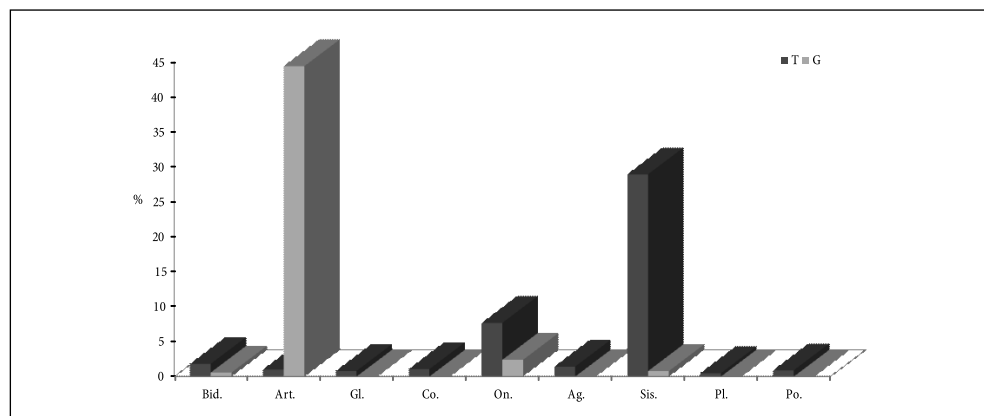


Figure 3. Percent coverage of adventive therophytes and geophytes as compared to the overall coverage in ruderal communities of the Banja Luka region

Slika 3. Procenat pokrovnosti adventivnih terofita i geofita u odnosu na ukupnu pokrovnost u ruderalnim zajednicama područja Banje Luke

the habitats of seminatural and natural plant communities of our field research. *A. altissima* and *R. pseudo-acacia* often make monodominant species composition. Since they need other supporting life forms to be able to grow, scandentophytes are also more easily and successfully established into woodland plant communities (*E. lobata*), or up on high walls (*P. quinquefolia*). In our research field, *P. quinquefolia* is more frequently to be found in different woodland plant communities, particularly along the river Vrbas.

CONCLUSION

In different ruderal habitats of the Banja Luka region, 61 adventive plant species, the majority of them native to North America (37.70 %) and Asia (27.75 %), were recorded. All life forms in the biological spectrum of adventive flora of the investigated area were represented, but the greatest number of species belonged to annual therophytes. The therophytic communities of *Bidentetalia tripartiti* and *Sisymbrietali* orders have the prevailing number of adventive species, although they are more successfully established in hemicryptophyte and therophyte communities of *Artemisetalia vulgaris* order.

REFERENCES

- Abadžić, S.:** Prilog poznavanju horologije i ekologije dviju adventivnih vrsta - *Echinocystis lobata* (Michx) Torrey et Gray i *Bidens bipinnatus* L. u flori Bosne i Hercegovine. Glasnik zemaljskog muzeja Bosne i Hercegovine u Sarajevu, 25-26, 71-77, 1986-1987.
- Almeida, I.D., Freitas, H.:** The exotic and invasive flora of Portugal. Botanical Computensis, 25, 317-327, 2001.
- Bassdorf, O., Prati, D., Auge, H., Schmid, B.:** Reduced competitive ability in an invasive plant. Ecology Letters, 7, 346-353, 2004.
- Beck, G.:** Flora Bosnae, Hercegovinae et regionis Novipazar. II. *Choripetalae*, Državna štamparija u Sarajevu, Beograd-Sarajevo, 1927.
- Beck, G., Malý, K.:** Flora Bosnae et Hercegovinae. IV *Sympetalae*. Pars 1. Svjetlost, Sarajevo, 1950.
- Bianco, M. P., Fanelli, G., Tescarollo, P., Pignatti, S.:** Ruderalization in Roman Park as a Result of Changing Management. Urban Habitats, 1, 1, 1-19, 2003.
- Bjelčić, Ž.:** Flora Bosnae et Hercegovinae. IV *Sympetalae*. Pars 2, Svjetlost, Sarajevo, 1967.
- Bjelčić, Ž.:** Flora Bosnae et Hercegovinae. IV *Sympetalae*. Pars 3, Svjetlost, Sarajevo, 1974.
- Bjelčić, Ž.:** Flora Bosnae et Hercegovinae. IV *Sympetalae*. Pars 4, Svjetlost, Sarajevo, 1983.
- Bjelčić, Ž., Stefanović, V.:** *Phytolacca americana* L. u flori i vegetaciji Bosne i Hercegovine. Godišnjak Biološkog instituta Univerziteta Sarajevo, 39, 5-11, 1986.
- Brandes, D.:** The flora of the old town centres in Europe. Urban Ecology as the Basis of Urban Planning, 49-58, 1995.
- Chmura, D.:** Penetration and naturalisation of invasive alien plant species (neophytes) in woodlands of the Silesian Upland (Southern Poland). Nature Conservation, 60, 3-11, 2004.
- Chytrý, M., Pyšek, P., Tichý, L., Knollova, I., Danihelka, J.:** Invasion by alien plants in the Czech Republic: a quantitative assessment across habitats. Preslia, 77, 339-354, 2005.
- Dauer, T.J., Mortensen, A.D., Vangessel, J.M.:** Temporal and spatial dynamics of long-distance *Conyza canadensis* seed dispersal. Journal of Applied Ecology, 44, 105-114, 2007.
- Dehnen-Schmutz, K.:** Alien species reflecting history: medieval castles in Germany. Diversity and Distributions, 10, 147-151, 2004.
- Deutschewitz, K., Lausch, A., Kühnhs, Klotz, S.:** Native and alien plant species richness in relation to spatial heterogeneity on a regional scale in Germany. Global Ecology & Biogeography, 12, 299-311, 2003.
- Fiori, A., Paoletti, G.:** Flora Italiana. Illustrata. Sancasciano val di Pesa, Stab. Tipo-Lotografico Frtelli Stianti, 1921.
- Hegi, G.:** Illustrierte Flora von Mittel-Europa. J. F. Lehmanns Verlag, München, 1923-1931.
- Javorka, S., Csapody, V.:** Iconographie der Flora des Südöstlichen Mitteleuropa. Gustav Fischer Verlag, Stuttgart, 1979.
- Йорданов, Д. (ed.):** Флора на Народна Република България. Българската - Академии на наукит, София, 1963-1989.
- Josifović, M. (ed.):** Flora SR Srbije. I-IX, SANU, Beograd, 1970-1977.
- Jovanović, S.:** Ekološka studija ruderalne flore i vegetacije Beograda. Biološki fakultet Univerziteta u Beogradu, 1994.
- Jovanović, S., Bartula, M.:** Ekološko-fitogeografske karakteristike ruderalne flore naselja Grocka kod Beograda. Glasnik Instituta za botaniku i botaničke bašte Univerziteta u Beogradu, XXX, 119-147, 1996.

- Klapp, E., Opitz von Boberfeld, W.:** Taschenbuch der Gräser. Verlag Paul Parey, Berlin und Hamburg, 1990.
- Korica, D.:** Prilog reviziji adventivne i korovske flore Bosne i Hercegovine. Godišnjak Biološkog instituta u Sarajevu, V, 1-2, 278-286, 1952.
- Korica, D.:** Florističko-ekološki prilog poznavanju livadske, ruderalne i korovske vegetacije u Sjevernoj Bosni. Acta Musei Macedonici Scientiarum Naturalium, V, 5, 73-94, 1957.
- Mack, N.R.:** Phylogenetic constraint, absent life forms, and preadapted alien plants: a prescription for biological invasions. International Journal of Plant Science, 165, 185-196, 2003.
- Marinković, D.:** Ekološko-fitogeografske karakteristike ruderalne flore Kragujevca. Magistarska teza. Univerzitet u Beogradu, Biološki fakultet, 1998.
- Mosyakin, L.S., Yavorska, G.O.:** The nonnative flora of the Kiev (Kyiv) urban area, Ukraine: a checklist and brief analysis. Urban Habitats, 1, 45-64, 2002.
- Mueller-Dombois, D., Ellenberg, H.:** Aims and methods of vegetation ecology. John Wiley & Sons, Chichester, 1974.
- Müller, N., Okuda, S.:** Invasion of alien plants in floodplains: a comparison of Europe and Japan. Plant Invasions: Ecological Mechanisms and Human Responses, 321-332, 1998.
- Oberdorfer, E.:** Pflanzensoziologische Exursionsflora für Deutschland und angrenzende Gebiete. Eugen Ulmer Verlag, Stuttgart, 2001.
- Obračević, M., Budak, V.:** *Rudbeckia hirta* L. u flori sjeveroistočne Bosne. Glasnik Zemaljskog muzeja Bosne i Hercegovine u Sarajevu, 21, 87-89, 1982.
- Õpik, M., Kukk, T., Kull, K., Kull, T.:** The importance of human mediation in species establishment: analysis of the alien flora of Estonia. Boreal Environment Research, 13, 53-67, 2008.
- Pančić, J.:** Flora Kneževine Srbije i dotatak flori Kneževine Srbije. Posebna izdanja. SANU, Odeljenje prirodno-matematičkih nauka, Beograd, 47, 1976.
- Pyšek, P., Sadlo, J., Mandak, B.:** Alien flora of the Czech Republic, its composition, structure and history. Plant Invasions: Ecological Threats and Management Solutions, 113-130, 2003.
- Pyšek, P., Prach, K.:** Research into plant invasions in a crossroads region: history and focus. Biological Invasions, 5, 337-348, 2003.
- Pyšek, P., Zdena, Ch., Antonin, P., Vojtech, J., Milan, Ch., Lubomir, T.:** Trends in species diversity and composition of urban vegetation over three decades. Journal of Vegetation Science, 15, 781-788, 2004.
- Pyšek, P., Chodholouškova, Z., Pyšek, A., Jarošík, V., Chytrý, M., Tichý, L.:** Trends in species diversity and composition of urban vegetation over three decades. Journal of Vegetation Science, 15, 781-788, 2004.
- Richardson, M.D., Pyšek, P., Rejmanek, M., Barbour, G., Panetta, D.F., West, J.C.:** Naturalization and invasion of alien plants: concepts and definitions. Diversity and Distribution, 6, 93-107, 2000.
- Richardson, M.D., Holmes, M.P., Esler, J.K., Galatowitsch, M.S., Stromberg, C.J., Kirkman, P.S., Pyšek, P., Hobbs, J.R.:** Riparian vegetation: degradation, alien plant invasions, and restoration prospect. Diversity and Distribution, 13, 126-139, 2007.
- Slavnić, Ž.:** O useljavanju, širenju i odomaćivanju nekih adventivnih biljaka u Bosni i Hercegovini. Godišnjak Biološkog instituta Univerziteta u Sarajevu, XIII, 1-2, 117-143, 1960.
- Slavnić, Ž., Ložušić, B.:** Geografsko rasprostranjenje, tipovi staništa i stepen odomaćivanja vrste *Amaranthus blitoides* S. Watson u Jugoslaviji. Glasnik Zemaljskog muzeja u Sarajevu, III/IV, 198-201, 1964-1965.
- Šarić, T., Elezović, Z., Muminović, Š.:** Ekspanzija divljeg sirka, ambrozije i smrdljive koprive u Bosni. Zbornik radova IV kongresa o korovima, Banja Koviljača, 327-337, 1992.
- Šilić, Č.:** Nova nalazišta nekih rijetkih i manje poznatih biljnih vrsta u flori Bosne i Hercegovine. Glasnik Zemaljskog muzeja Bosne i Hercegovine u Sarajevu, XI-XII, 59-79, 1972-1973.
- Šoljan, D., Muratović, E.:** Rasprostranjenje vrste *Ambrosia artemisiifolia* L. u Bosni i Hercegovini. Herbologia, 3(1), 107-111, 2002.
- Trinajstić, I.:** Prilog poznavanju rasprostranjenosti vrste *Reynoutria japonica* Houtt. (*Polygonaceae*) u Jugoslaviji. Fragmenta herbológica Iugoslavica, 19, (2), 139-143, 1990.
- Turk, B.:** Ruderalna i adventivna flora Ljubaljene. Scopolia, 23, 1-24, 1990.
- Tutin, T.G. (ed.):** Flora Europaea. 1-5, Cambridge University Press, London, 1964-1980.
- Wittig, R.:** The origin and development of the urban flora of Central Europe. Urban Ecosystems, 7, 323-339, 2004.
- Ziska, H.L., George, K., Frenz, A.D.:** Establishment and persistence of common ragweed (*Ambrosia artemisiifolia* L.) in disturbed soil as a function of an urban-rural macro-environment. Global Change Biology, 13, 266-274, 2007.

Adventivna flora područja Banje Luke

REZIME

Na različitim ruderalnim staništima područja Banje Luke konstatovana je 61 vrsta adventivnih biljaka od kojih je najveći broj porijeklom iz Sjeverne Amerike (23) i Azije (17). Najvećim pokrovnim vrijednostima i stepenom prisutnosti u različitim ruderalnim zajednicama prisutne su: *Erigeron annuus* (L.) Pers., *Ambrosia artemisiifolia* L., *Reynotria japonica* Houtt, *Conyza canadensis* (L.) Cronq i *Helianthus tuberosus* L. U radu je data taksonomska, ekološka, fitogeografska i sinekološka analiza adventivne flore područja Banje Luke.

Ključne riječi: Adventivna flora; Banja Luka; ruderalna zajednica

Received June 20, 2008

Accepted July 8, 2008