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Vascular Flora of Bardača Complex

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Abstract

This work gives overview and basic characteristics of vascular flora of Bardača complex: ecological indicator values, biological spectrum and spectrum of areal types. Total of 316 herbal species are found during floristic research conducted on the area of Bardača. Out of that number, six species are in the phylum *Pteridophyta* (two in class *Equisetatae* and four in class *Filicatae*), and 310 species belong to *Magnoliophyta* (232 in class *Magnoliate* and 78 in class *Liliate*). Based on the ecological analysis of found herbal species, researched area is mesophyll with neutral and low acidly ground, medium rich with mineral substances, with adequate light and warmth regime. Ten life forms have been found through the analysis of the biological spectrum of flora. Among them are hemicryptophyta (33,86%) and cryptophyta (geophyta 21,52% and aquatic helo-hidrophyta 7,91%). By analyzing areal types, 27 flora elements have been found, among which dominate flora elements of wide distribution (Euro-Asian, Circumpolar, Cosmopolitan and Adventive) with 204 herbal species (64,55%). Rational use of Bardača complex, according to the principles of sustainable development, implies keeping unique genetic resources because of many exponents of relic tertiary flora are present.

Key words: vascular flora, ecological index, life forms, flora elements

Introduction

The Bardača complex is typical moist habitat in the northeastern part of Lijevce Polje region in the foothill of the Motajica mountain at the confluence of the Vrbas river into the Sava river. It covers around 3.380 ha of the entire area out of which around 810 ha are water surfaces used mostly as cipridae fishponds, while the rest are meadows, moist forests and agrophytocoenoses. It is situated in the area of moderately continental climate (Milosavljević, 1980), i.e. Illyrian province. The specificity of flora is conditioned with geographic position, influence of geological base, type of soil, light and thermal conditions of habitat and especially anthropogenic influence.

Our literature does not provide enough data about floristic and phytocoenological research of the Bardača complex, which represents a huge deficiency for observing hydroecosystem as a whole. Previous research of flora and vegetation of the Bardača complex is partial and scarce: Nedović and Mejakić, 1997; Nedović et al., 2004; Šumatić et al., 2001; Kovačević, 2005, 2010; Kovačević and Kojić, 2006; Kovačević et al., 2007, 2007a; Kovačević and Šumatić, 2007; Kovačević and Stojanović, 2006, 2008, 2009.

Research of herbal world of the Bardača complex displays flora as relatively rich. Starting from the fact that every herbal species grows and successfully develops under certain circumstances of habitat and can serve as test organism, a detailed analysis of indicator values of ecological characteristics of the found species characterizes conditions and qualities of the Bardača complex habitat.

Materials and Methods

Floristic researches were conducted in the general area of Bardača. The gathered biomaterialis determined by the following publications: Flora Europea 1-5 (Tutin, T. G. Ed., 1964-1980), Flora SR Srbije I-IX (Josifović (ed.) 1970-1977), Visugyi hidrobiologia (Felfoldy, 1990), Flora Hrvatske (Domac,1994) and Ikonographie der Flora des Sudöstlichen Mitteleuropa (Javorka, 1979).

Nomenclature for defining the herbal species is adjusted according to the following publication: Flora SR Srbije I-IX (Josifović (ed.) 1970-1977). Ecological analysys was completed according to ecological indexes of the herbal species written by Kojić et al. (1997). Life forms as indicators

of climatic conditions in the habitat are described by using Raunkiaer's method (1934) which was slightly modified by Kojić et al. (1997). The elements of flora are presented according to Gajić (1980).

Results and Discussion

By analyzing the vascular flora, or taxonomic rank of ecological and phytogeographic features, we were able to take an indirect view of the conditions of the habitat which is located in the researched area, as well as the human influence on the structure and the features of the flora. Total of 316 species of the vascular flora were observed at the Bardača complex, and six of those species belong to phylum *Pteridophyta*, and the rest belong to phylum *Magnoliophyta* (Table 1).

Tab. 1. Representation of higher taxonomic categories in the flora of the Bardača complex

Pregled viših taksonomskih kategorija u flori kompleksa Bardača

Parting *Razdio*	Klass *Klasa*	Number of species *Broj vrsta*	%
Pteridophyta	*Equisetatae*	2	0,63
	Filicatae	4	1,27
Magnoliophyta	*Magnoliatae*	232	73,42
	Liliatae	78	24,68
Total/*Ukupno*		316	100,00

Flora of the Bardača complex is divided into 83 families. The families with more than 10 species are: *Asteraceae*, *Poaceae*, *Fabaceae*, *Lamiaceae*, *Ranunculaceae*, *Rosaceae* and *Cyperaceae*, with 131 of 316 found species or 41,46%. Other families have smaller number of species, so 29 families have only one species each, and 26 families have onli one species. Total of 49 genera with more than one species the biggest are *Carex*, *Polygonum* and *Potamogeton* with more than five species. Overview, ecological and phytogeographical characteristics of flora in the Bardača complex are given in the Table 2.

Tab. 2. Overview, ecologic and phytogeographical characteristics of flora in the Bardača complex

Pregled, ekološke i fitogeografske karakteristike flore kompleksa Bardača

Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Abutilon theophrasti Medik.	2	3	3	4	5	t	Adv.
Acer campestre L.	3	4	3	3	4	p	Subce.
Acer tataricum L.	2	4	1	4	5	p	Pont.-pan.
Achillea millefolium L.	2	3	3	4	3	h	Euroasian
Acorus calamus L.	5	3	3	4	3	g	Adv.
Agrimonia eupatoria L.	2	4	3	4	3	h	Euroasian
Agropyrum repens (L.) Beauv.	3	3	4	4	3	g	Euroasian
Agrostemma githago L.	3	3	3	4	3	th	Adv.
Agrostis alba L.	4	3	3	4	3	h	Subeuroasian
Ajuga reptans L.	3	3	3	3	3	h	Subce.
Alisma plantago-aquatica L.	6	3	3	4	3	g	Cosm.
Allium angulosum L.	4	4	2	4	3	g	Euroasian
Alnus glutinosa (L.) Gaertn.	5	3	3	3	3	p	Subce.
Alnus incana Moench.	4	4	3	3	3	p	Bor.-circ.
Alopecurus pratensis L.	3	3	4	3	3	h	Euroasian
Althaea officinalis L.	3	3	3	4	5	h	Subpont.-central Asian.
Amaranthus retroflexus L.	2	3	4	4	4	t	Adv.
Ambrosia artemisifolia L.	2	3	3	4	4	t	Adv.
Amorpha fruticosa L.	4	3	3	3	4	np	Adv.
Anagallis arvensis L.	3	3	3	3	3	t	Cosm.
Anchusa arvensis (L.) M.B.	2	2	3	4	4	th	Subce.
Anemone nemorosa L.	3	3	3	2	3	g	Circ.
Anemone ranunculoides L.	3	4	4	2	3	g	Subce.
Angelica sylvestris L.	4	3	3	3	3	h	Euroasian
Anthemis cotula L.	2	3	3	4	4	t	Cosm.
Anthoxanthum odoratum L.	3	2	3	4	3	h	Subeuroasian
Apera spica-venti (L.) P. B.	3	2	3	3	3	h	Euroasian
Arctium lappa L.	3	3	5	4	4	h	Euroasian
Aristolochia clematitis L.	3	4	4	3	4	g	Subm.
Arrhenatherum elatius (L.) Mert. et Koch.	3	3	4	3	3	h	Subce.

Tab. 2. Overview, ecologic and phytogeographical characteristics of flora in the Bardača complex – continued

Pregled, ekološke i fitogeografske karakteristike flore kompleksa Bardača – nastavak

Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Artemisia absianthium L.	2	3	4	5	4	hc	Subn.sib.
Artemisia vulgaris L.	3	3	4	4	3	h	Circ.
Arum maculatum L.	4	3	3	2	3	g	Central Asian
Asarum europaeum L.	3	4	3	2	4	g	Euroasian
Asclepias syriaca L.	2	4	2	3	3	g	Adv.
Atriplex patula L.	3	4	4	3	3	t	Subcirc.
Avena fatua L.	2	4	3	3	3	t	Subeuroasian
Ballota nigra L.	3	3	4	4	4	g	Subpont.
Bellis perennis L.	3	3	3	4	3	h	Subce.
Berberis vulgaris L.	2	4	2	3	3	np	Subce.
Berula erecta (Huds.) Cov.	5	3	3	4	3	g	Circ.
Bidens tripartitus L.	4	3	4	4	3	t	Subce.
Brassica napus L.	3	3	4	3	3	th	Adv.
Briza media L.	3	3	2	4	3	h	Euroasian
Butomus umbellatus L.	5	3	4	3	3	g	Euroasian
Caltha palustris L.	5	3	3	3	3	h	Circ.
Calystegia sepium (L.) R. Br.	4	4	4	3	3	g	Euroasian
Capsella bursa-pastoris (L.) Medik.	2	3	3	4	3	th	Cosm.
Cardamine pratensis L.	4	3	3	3	2	h	Circ.
Carduus acanthoides L.	2	3	4	4	4	h	Subce.
Carduus crispus L.	3	3	5	4	3	h	Euroasian
Carex acutiformis Ehrh.	5	4	3	4	4	g	Subeuroasian
Carex disticha Huds.	5	4	3	4	4	g	Ilir.-sk.-pind.
Carex hirta L.	3	3	3	3	3	g	Subeuroasian
Carex pendula Huds.	4	3	3	2	4	h	Subatl.-subm.
Carex remota L.	4	3	3	2	3	h	Subce.
Carex riparia Curt.	5	4	3	4	4	g	Subcirc.
Carex silvatica Huds.	3	3	3	1	3	h	Subcirc.
Carex vulpina L.	3	3	2	4	4	h	Subeuroasian
Carpinus betulus L.	3	3	3	2	4	p	Central European

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Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Carum carvi L.	3	3	3	4	3	th	Euroasian
Centaurea cyanus L.	2	3	3	4	4	th	Subm.
Centaurea jacea L.	3	3	3	4	3	h	Subeuroasian
Centaurea scabiosa L.	2	4	2	4	3	h	Subpont.-ca.
Ceratophyllum demersum L.	7	4	5	3	4	a	Cosm.
Chamaenerion angustifolium (L.) Scop.	3	2	4	4	3	h	Circ.
Chelidonium majus L.	3	3	4	3	3	h	Euroasian
Chenopodium album L.	2	3	4	3	3	t	Cosm.
Cichorium intybus L.	2	4	3	5	4	h	Subeuroasian
Cirsium arvense (L.) Scop.	3	3	4	4	4	g	Subeuroasian
Clematis vitalba L.	3	4	3	3	3	p	Subatl.-subm.
Colchicum autumnale L.	3	3	3	3	3	g	Central European
Conium maculatum L.	3	3	4	4	4	th	Subeuroasian
Consolida regalis S. F. Gray.	2	4	3	3	4	t	Subce.
Convallaria majalis L.	2	3	2	3	3	g	Circ.
Convolvulus arvensis L.	2	4	3	4	3	g	Cosm.
Cornus mas L.	3	4	3	3	4	np	Pont.-subm.
Cornus sanguinea L.	3	4	3	3	3	np	Subce.
Corydalis cava (L.) Koerte	3	4	4	3	3	g	Subce.
Corylus avellana L.	3	3	3	3	3	g	Subce.
Crataegus monogyna Jacq.	3	4	2	4	3	p	Subce.
Crepis biennis L.	3	3	3	3	3	h	Subce.
Cynodon dactylon (L.) Pers.	2	3	3	4	5	g	Cosm.
Cynoglossum officinale L.	2	4	4	4	3	th	Euroasian
Cynosurus cristatus L.	3	3	3	4	3	h	Subce.
Dactylis glomerata L.	3	3	4	3	3	h	Subeuroasian
Datura stramonium L.	3	3	4	4	4	t	Cosm.
Daucus carota L.	2	3	2	4	3	th	Subeuroasian
Deschampsia caespitosa (L.) P. B.	4	3	4	3	3	h	Subcirc.

Tab. 2. Overview, ecologic and phytogeographical characteristics of flora in the Bardača complex – continued

Pregled, ekološke i fitogeografske karakteristike flore kompleksa Bardača – nastavak

Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Dipsacus laciniatus L.	3	4	4	4	5	th	Pont.-ca.-subm.
Dryopteris filix-mas (L.) Schott	3	3	3	2	3	h	Cosm.
Echium vulgare L.	1	3	3	5	4	h	Subce.
Equisetum arvense L.	3	3	3	3	3	g	Circ.
Equisetum palustre L.	4	3	2	4	3	g	Circ.
Eragrostis minor Host.	1	3	2	4	5	t	Circ.
Erodium cicutarium (L.) L'Herit.	2	3	3	4	3	th	Euroasin
Eryngium campestre L.	1	4	3	4	4	h	Subpont.-subm.
Eupatorium cannabinum L.	4	4	3	3	3	h	Subce.
Euphorbia amygdaloides L.	3	4	3	2	3	hc	Subatl.-subm.
Euphorbia cyparissias L.	2	3	2	4	3	h	Euroasian
Euphorbia helioscopia L.	3	3	4	4	4	t	Subeuroasian
Evonymus europaeus L.	3	4	3	3	4	np	Subce.
Festuca ovina L.	2	2	2	4	3	h	Subeuroasian
Festuca pratensis Huds.	3	3	3	4	3	h	Euroasian
Festuca rubra L.	3	3	3	3	3	h	Circ.
Filipendula ulmaria (L.) Maxim.	4	3	3	3	3	h	Euroasian
Fragaria vesca L.	3	3	3	3	3	h	Euroasian
Frangula alnus Miller.	3	2	2	3	4	np	Subce.
Fraxinus angustifolia Vahl.	4	3	2	4	4	p	Pont.-subm.
Fumaria officinalis L.	2	3	4	3	3	t	Subeuroasian
Galanthus nivalis L.	3	3	4	3	4	g	Pont.-subm.
Galega officinalis L.	4	3	3	3	4	h	Subm.
Galeopsis speciosa Mill.	3	3	4	3	2	t	Subce.
Galinsoga parviflora Cav.	2	3	3	4	4	t	Adv.
Galium aparine L.	3	3	5	3	4	t	Euroasian
Galium mollugo L.	3	3	3	3	3	h	Subce.
Galium verum L.	2	4	2	4	3	g	Euroasian

Tab. 2. Overview, ecologic and phytogeographical characteristics of flora in the Bardača complex – continued

Pregled, ekološke i fitogeografske karakteristike flore kompleksa Bardača – nastavak

Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Genista germanica L.	2	1	2	3	3	wc	Subce.
Geranium molle L.	2	3	3	4	3	th	Subeuroasian
Geum urbanum L.	3	3	4	2	3	h	Euroasian
Glechoma hederacea L.	3	3	3	3	3	h	Euroasian
Glyceria maxima (Hartm.) Hol.	5	4	5	4	3	g	Circ.
Hedera helix L.	3	3	3	2	4	pl	Subatl.-subm.
Heleocharis palustris (L.) R. Br.	5	3	2	4	3	g	Cosm.
Helleborus odorus Walds et Kit	3	1	2	3	4	h	Midlle balk.
Hepatica nobilis Mill.	3	4	2	2	3	h	Circ.
Hesperis matronalis L.	3	3	3	3	4	th	Pont.-ca.
Holcus lanatus L.	3	3	3	4	3	h	Euroasian
Hordeum murinum L.	2	3	4	4	4	t	Subm.
Humulus lupulus L.	4	3	4	3	3	h	Subn.sib.
Hydrocharis morsus-ranae L.	6	3	3	3	4	a	Euroasian
Hypericum perforatum L.	2	3	3	3	3	h	Subeuroasian
Inula britanica L.	4	4	3	3	4	h	Subce.
Inula salicina L.	3	4	2	4	3	g	Subn.sib.
Iris pseudacorus L.	5	3	4	3	3	g	Subce.
Isatis tinctoria L.	1	4	2	4	4	th	Subpont.-subca.-subm.
Juglans regia L.	3	4	3	3	4	p	Subiran.-east.subm.
Juncus compressus Jacq.	4	3	3	4	3	g	Euroasian
Juncus conglomeratus L.	4	2	3	4	3	h	Circ.
Juncus effusus L.	4	2	3	3	3	h	Cosm.
Juncus inflexus L.	4	4	3	4	3	h	Subcirc.
Knautia arvensis (L.) Coult.	2	3	2	4	3	h	Subce.
Lactuca serriola L.	2	3	3	5	4	th	Subpont.-subca.-subm.
Lamium album L.	3	3	5	3	2	h	Euroasian

Tab. 2. Overview, ecologic and phytogeographical characteristics of flora in the Bardača complex – continued

Pregled, ekološke i fitogeografske karakteristike flore kompleksa Bardača – nastavak

Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Lamium purpureum L.	3	4	4	4	3	th	Subce.
Lathyrus tuberosus L.	2	4	2	4	4	g	Subn.sib.
Lathyrus vernus (L.) Bernh.	2	3	2	2	4	g	Subce.
Lemna gibba L.	6	4	4	4	3	a	Cosm.
Lemna minor L.	6	3	3	4	3	a	Cosm.
Lemna trisulca L.	6	3	3	4	3	a	Cosm.
Leontodon autumnalis L.	3	3	3	4	3	h	Subn.sib.
Leucanthemum vulgare Lam.	3	3	3	4	4	h	Euroasian
Leucoium vernum L.	3	3	3	3	3	g	Central European
Ligustrum vulgare L.	3	4	2	3	4	np	Subce.
Linaria vulgaris Mill.	3	3	3	4	3	h	Subce.
Lolium perenne L.	3	3	4	4	3	h	Subce.
Lotus corniculatus L.	2	4	3	4	3	h	Subeuroasian
Luzula luzuloides (Lam.) Dandy et Wil.	3	2	2	2	3	h	Central European
Lycopus europaeus L.	5	3	3	3	3	g	Subeuroasian
Lysimachia nummularia L.	4	3	3	2	3	hc	Subce.
Lysimachia vulgaris L.	4	3	3	3	3	h	Euroasian
Lythrum salicaria L.	4	3	3	3	3	h	Pont.-ca.-subm.
Malus sylvestris Mill.	3	3	3	3	3	p	Subce.
Malva silvestris L.	2	3	4	4	4	th	Euroasian
Marsilea quadrifolia L.	6	3	3	4	4	g	Circ.
Matricaria inodora L.	3	3	3	3	3	th	Euroasian
Matricaria suaveolens (Pursh) Buchenau.	3	3	4	4	3	t	Adv.
Medicago lupulina L.	2	4	3	3	4	th	Subeuroasian
Medicago sativa L.	2	4	3	4	4	h	Adv.
Melilotus albus Medic.	2	3	2	4	3	th	Subce.
Melilotus officinalis (L.) Pall.	2	4	3	4	3	th	Euroasian
Mentha aquatica L.	5	3	3	3	3	g	Euroasian
Mentha arvensis L.	4	3	3	4	4	g	Circ.

Tab. 2. Overview, ecologic and phytogeographical characteristics of flora in the Bardača complex – continued

Pregled, ekološke i fitogeografske karakteristike flore kompleksa Bardača – nastavak

Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Mentha longifolia (L.) Huds.	4	4	4	3	3	g	Subce.
Myosotis palustris (L.) Nath.	4	3	3	3	3	g	Euroasian
Myosoton aquaticum (L.) Moench.	4	3	4	3	3	h	Euroasian
Myriophyllum spicatum L.	7	4	3	3	3	a	Subcirc.
Najas marina L.	6	3	3	3	4	a	Cosm.
Nuphar lutea (L.) Sm.	6	2	2	4	3	a	Euroasian
Nymphaea alba L.	6	3	3	4	4	a	Subce.
Nymphoides peltata (Gmel.) Ktze.	5	3	4	4	5	a	Euroasian
Ononis spinosa L.	2	3	2	4	5	hc	Subce.
Oxalis acetosella L.	3	3	3	1	3	g	Circ.
Oxalis stricta L.	2	3	3	3	3	g	Adv.
Panicum crus-galli L.	3	3	4	3	4	t	Cosm.
Papaver rhoeas L.	3	4	3	3	3	th	Subeuroasian
Parietaria officinalis L.	3	4	4	3	4	h	Subm.
Paris quadrifolia L.	3	3	3	2	3	g	Subbor.-euroasian
Pastinacia sativa L.	3	4	3	4	3	th	Euroasian
Pedicularis palustris L.	5	3	2	4	3	h	Bor.euroasian
Petasites hybridus (L.) Sch.	4	3	4	3	3	g	Subce.
Phleum pratense L.	3	3	3	3	3	h	Subeuroasian
Phragmites communis Trin.	5	3	3	3	3	g	Cosm.
Pimpinella saxifraga L.	3	3	2	4	3	h	Subn.sib.
Pirus piraster Burgs.	3	4	3	3	4	p	Subce.
Plantago lanceolata L.	3	3	3	3	3	h	Euroasian
Plantago maior L.	3	3	3	4	3	h	Euroasian
Plantago media L.	2	4	2	4	3	h	Euroasian
Poa annua L.	3	3	4	4	3	th	Cosm.
Poa pratensis L.	3	3	3	3	3	h	Subcirc.
Poa trivialis L.	3	3	4	3	2	h	Subeuroasian
Polygonum amphibium L.	5	3	4	3	3	g	Subcirc.

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Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Polygonum aviculare agg. L.	3	3	4	4	3	t	Cosm.
Polygonum bistorta L.	4	3	3	3	3	h	Subbor.-euroasian
Polygonum hydropiper L.	4	2	3	3	3	th	Subcirc.
Polygonum lapathifolium L.	3	3	4	3	3	t	Subcirc.
Polygonum persicaria L.	3	3	4	3	3	t	Euroasian
Populus alba L.	3	4	3	4	5	p	Subn.sib.
Populus nigra L.	4	4	4	3	4	p	Subce.
Populus tremula L.	3	3	3	4	3	p	Subeuroasian
Potamogeton crispus L.	7	3	3	3	3	a	Cosm.
Potamogeton fluitans Roth.	7	3	3	3	3	a	Circ.
Potamogeton gramineus L.	7	4	2	4	3	a	Circ.
Potamogeton lucens L.	7	4	4	3	3	a	Circ.
Potamogeton natans L.	7	3	2	3	3	a	Cosm.
Potamogeton perfoliatus L.	7	4	2	3	3	a	Cosm.
Potentilla anserina L.	3	3	4	4	3	h	Subcirc.
Potentilla erecta (L.) Räusch.	3	3	2	3	2	h	Euroasian
Potentilla reptans L.	3	3	2	3	3	h	Euroasian
Primula acaulis (L.) Grufb.	3	3	3	3	4	h	Subatl.-subm.
Prunella vulgaris L.	3	3	3	4	3	h	Subeuroasian
Prunus avium L.	3	4	3	3	4	p	Subce.
Prunus spinosa L.	2	4	3	4	4	np	Subpont.
Pteridium aquilinum (L.) Kuhn	3	2	2	3	3	g	Cosm.
Pulmonaria officinalis L.	3	4	3	3	3	h	Subce.
Quercus robur L.	3	3	3	3	4	p	Subce.
Ranunculus acris L.	3	3	3	3	3	h	Subn.sib.
Ranunculus aquatilis L.	6	3	3	3	4	a	Cosm.
Ranunculus ficaria L.	3	3	4	3	3	g	Subce.
Ranunculus fluitans Lam.	6	3	4	3	4	a	Circ.
Ranunculus repens L.	4	3	3	3	3	h	Euroasian
Raphanus raphanistrum L.	3	2	3	4	4	t	Subce

Tab. 2. Overview, ecologic and phytogeographical characteristics of flora in the Bardača complex – continued

Pregled, ekološke i fitogeografske karakteristike flore kompleksa Bardača – nastavak

Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Rhamnus catharticus L.	3	4	2	3	3	np	Subpont.-ca.
Rhianthus minor L.	3	3	2	4	3	t	Subce.
Ribes grossularia L.	3	3	3	2	3	np	Subeuroasian
Robinia pseudo-acacia L.	2	3	4	3	4	p	Adv.
Roripa silvestris (L.) Bess.	4	4	3	4	4	h	Subeuroasian
Rosa canina L.	3	3	2	3	3	np	Subce.
Rosa gallica L.	2	3	2	3	4	np	Subpont.-ca.-subm.
Rubus caesius L.	4	3	5	3	4	np	Subn.sib.
Rubus candicans Weihe	3	3	4	3	3	np	Central European
Rumex acetosa L.	3	3	3	4	3	h	Euroasian
Rumex acetosella L.	2	1	1	5	3	h	Subcirc.
Rumex crispus L.	3	3	3	4	3	h	Euroasian
Rumex hydrolapathum Huds.	5	3	4	3	3	h	Subce
Ruscus aculeatus L.	3	3	3	2	5	np	Subatl.-subm.
Sagittaria sagittifolia L.	6	3	3	3	3	g	Euroasian
Salix alba L.	4	4	4	3	3	p	Subeuroasian
Salix caprea L.	3	3	3	3	3	p	Euroasian
Salix fragilis L.	4	3	3	3	3	p	Subce.
Salix purpurea L.	3	4	3	4	3	p	Subeurop.an
Salvinia natans (L.) Allioni	6	3	3	4	4	a	Circ,
Sambucus ebulus L.	3	4	4	4	4	g	Subpont.-subm.
Sambucus nigra L.	3	3	4	3	4	np	Subce.
Sanguisorba minor Scop.	2	4	2	4	3	h	Subeuroasian
Schoenoplectus lacuster (L.) Palla	5	3	3	4	4	g	Cosm.
Scilla bifolia L.	3	4	3	3	4	g	Subatl.-subm.
Scirpus silvaticus L.	4	3	2	3	3	g	Circ.
Senecio vulgaris L.	3	3	4	4	3	th	Euroasian
Setaria viridis (L.) P.B.	2	3	4	4	4	t	Subeuroasian

Tab. 2. Overview, ecologic and phytogeographical characteristics of flora in the Bardača complex – continued

Pregled, ekološke i fitogeografske karakteristike flore kompleksa Bardača – nastavak

Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Silene vulgaris (Mnch.) Garcke.	2	3	2	4	3	h	Subeuroasian
Sinapis arvensis L.	3	4	3	4	3	t	Subeuroasian
Sium latifolium L.	5	3	4	3	3	a	Subce.
Solanum dulcamara L.	4	3	4	3	3	wc	Subeuroasian
Solanum nigrum L.	3	3	4	4	3	t	Cosm.
Solidago serotinia Ait.	3	3	3	4	3	h	Adv.
Sonchus arvensis L.	3	3	4	3	3	h	Euroasian
Sonchus asper (L.) Hill.	3	3	4	4	3	th	Subeuroasian
Sorghum halepense (L.) Pers.	2	2	3	4	5	g	Cosm.
Sparganium simplex Huds.	5	3	4	4	4	g	Circ.
Spirodela polyrrhiza (L.) Schl.	6	3	3	4	4	a	Cosm.
Stachys officinalis (L.) Trevis	3	3	2	4	3	h	Subce.
Stachys palustris L.	4	3	3	3	3	g	Circ.
Stachys silvatica L.	4	3	4	2	3	g	Subce.
Stellaria media (L.) Mill.	3	3	4	3	3	th	Cosm.
Stenactis annua (L.) Nees	3	3	3	4	4	th	Adv.
Symphytum officinale L.	4	3	4	3	2	h	Subce.
Symphytum tuberosum L.	3	4	3	2	3	g	Pont.-subm.
Tamus communis L.	3	4	3	3	4	g	Subatl.-subm.
Tanacetum vulgare L.	3	3	3	4	3	h	Euroasian
Taraxacum officinale Web.	3	3	4	4	3	h	European
Thlaspi arvense L.	3	3	4	3	3	th	Subeuroasian
Thymus serpyllum L.	1	2	1	4	3	hc	Central European
Tilia cordata Mill.	3	3	3	2	3	p	Subce.
Tilia platyphyllos Scop	3	3	3	2	4	p	Central European
Tragopogon pratensis L.	2	3	3	4	3	h	Euroasian
Trapa natans L.	6	3	4	4	4	a	Central European
Trifolium pratense L.	3	3	3	3	3	h	Subeuroasian
Trifolium repens L.	3	3	4	4	3	h	Subeuroasian

Tab. 2. Overview, ecologic and phytogeographical characteristics of flora in the Bardača complex – continued

Pregled, ekološke i fitogeografske karakteristike flore kompleksa Bardača – nastavak

Plant species *Biljna vrsta*	Ecological indicatory values *Ekološke indikatorske vrijednosti*					Life forms *Životne forme*	Floral elements *Florni elementi*
	F	R	N	L	T		
Tussilago farfara L.	3	4	3	4	3	g	Subeuroasian
Typha angustifolia L	5	3	3	4	4	g	Circ.
Typha latifolia L.	5	3	3	4	4	g	Cosm.
Typha minima Funck.	5	4	2	4	4	g	Euroasian
Typhoides arundinacea (L.) Mnch.	4	3	3	3	4	g	Circ.
Ulmus laevis Pall.	4	4	4	2	3	p	Subce.
Ulmus minor Mill.	3	4	3	3	4	p	Subm.
Urtica dioica L.	3	3	5	3	3	h	Euroasian
Urtica urens L	3	3	5	4	3	t	Euroasian
Utricularia vulgaris L.	6	3	3	4	3	a	Circ.
Valeriana officinalis L.	4	4	3	3	3	h	Euroasian
Vallisneria spiralis L.	5	2	2	3	5	a	Adv.
Verbascum phlomoides L.	2	4	3	4	5	th	Subpont.-subm.
Verbena officinalis L.	2	3	4	4	3	th	Cosm.
Veronica anagallis-aquatica L.	5	3	3	4	3	h	Subcirc.
Veronica chamaedrys L.	3	3	3	3	3	g	Subce.
Veronica persica Poir.	3	4	4	3	3	th	Adv.
Viburnum opulus L.	3	3	3	3	4	np	Euroasian
Vicia cracca L.	3	3	3	4	3	h	Euroasian
Vicia sativa L.	3	3	3	3	3	h	Central European
Viola arvensis Murr.	3	3	3	3	3	th	Euroasian
Viola odorata L.	3	3	4	3	4	h	Subatl.-subm.
Viola silvestris Lam.	3	3	3	2	3	h	Central European
Viola tricolor L.	3	3	3	3	3	th	Euroasian
Vitis sylvestris Gmel.	3	4	3	3	5	pl	Subeuks.
Wolffia arrhiza (L.) Wimm.	6	3	3	4	4	a	Cosm.
Xanthium italicum Mor.	3	3	4	4	5	t	Adv.

By analyzing ecological characteristics of flora in the Bardača complex (Table 3), it can be ascertained that, beside taxonomic diversity, ecologic diversity is also very expressed. Thet can be seen in a large number of life forms (Table 4). Huge diversity in phlomo-geographic aspect is also expressed (Table 5).

Tab. 3. The average values of ecologic indexes of flora in the Bardača complex
Prosječne vrednosti ekoloških indeksa flore kompleksa Bardača

Indicator value *Indikatorska vrijednost*	Ecological indexes/*Ekološki indeksi*									
	F		R		N		L		T	
	№	%	№	%	№	%	№	%	№	%
1	5	1,58	3	0,95	3	0,95	2	0,63	-	0,00
2	58	18,35	16	5,06	49	15,51	24	7,59	6	1,90
3	155	49,05	216	68,35	173	54,75	144	45,57	204	64,56
4	47	14,87	81	25,63	82	25,95	141	44,62	91	28,80
5	26	8,23	-	-	9	2,85	5	1,58	15	4,75
6	17	5,38	-	-	-	-	-	-	-	-
7	8	2,53	-	-	-	-	-	-	-	-
Total/*Ukupno*	316	100,00	316	100,00	316	100,00	316	100,00	316	100,00
Average value *Srednja vrijednost*	3,36		3,19		3,14		3,39		3,36	

After we analyzed the ecological index of soil humidity, it can be said that it is dominated by submesophytes with the index of F3-43,05% (155 plant species). Subxerophytes are in the second place with the index of F2-18,35% (58 plant species) and mesophytes with the index of F4-14,87% (47 plant species). Hydrohelophytes are also very prominent on this list with the index of F5-8,23% (26 plant species), as well as floating hydrophytes with the index of F6-5,38% (17 plant species) and submersed hydrophytes with the index of F7-2,53% (8 plant species). Only five plant species (*Echium vulgare* L., *Eragtostis minor* Host., *Eryngium campestre* L., *Isatis tinctoria* L, and *Thymus serpyllum* L.) are xerophytes (F1-1,58%) which reveals that humid habitats are predominant in the Bardača complex. The average value of the ecological index for soil humidity (F-3,36) reveals that it is a mesophylic to humid habitat.

The examination of the ecological index of the soil's reaction to chemicals reveals that the plants which appear exclusively in the neutral or mildly acid ground and have the index of R3-68,35% (216 plant species) are prevalent. The large number of species is characterized by ecological index

of R4-25,63% (81 plant species) and they belong to the transitional group between neutrophytic and basophytic species while there are no plants characterized by ecological index of R5 in Bardača's flora which brings us to the conclusion that there is no alkaline soil present in this locality. Three plant species (*Genista germanica* L., *Helleborus odorus* Walds et Kit and *Rumex acetosella* L.) haveecological index of R1-0,95%, while sixteen plant species are categorized by ecological index of R2-5,06% and this data implies that the number of plant species which are commonly found in acid or in acidophytic to neutrophytic soil (6,01%) are seldom found in this region. Those findings are confirmed by the average value of ecological index for the chemical reaction of the soil R-3,19.

If we take a look at the amount of nitrogen in the soil, the stated plants in the researched area clearly show domination of mesotrophic plants with ecological index of N3-54,75% (173 plant species), which are usually found in soil that is fairly enriched with minerals, especially with nitrogen. The number of species with ecological index of N4-25,95% (173 plant species) that make up the transitional group between mesotrophic and eutrophic plants is significant, as well as the number of species with ecological index of N2-15,51% (49 plant species) that form the transitional group between oligotrophic and mesotrophic plants. Three oligotrophic (nitrophobic) species that are adapted to the soil which lacks minerals are present (0,95%), as well as nine (2,85%) eutrophic (nitrophlic) species which are clear indicators of extremely productive soil. The average value of ecological index for the amount of nitrogen in the soil (N-3,14) also points out to mesotrophic soils of the researched area.

Almost equal number of half-sciophytes with ecological index of L3-45,57% (144 plant species) and the transitional group between half-sciophytes and heliophytes with the ecological index of L4-44,62% (141 plant species), as well as the average value of ecological index for light L-3,39, show us that the light conditions of the researched area are favorable. Twenty-four plant species make up the transitional group between sciophytes and half-sciophytes with the ecological index of L2-7,59%. Plant species *Carex silvatica* Huds and *Oxalis acetosella* L. with ecological index of L1-0,63%, are sciophytic species which are adapted to the conditions of extremely low light (up to 3% of daylight). Five plant species (1,58%) belong to heliophytes (L5) and those are the plants which are adapted to the full daylight conditions.

Mesothermic (or middle-European) plant species (T3) are the most common species found in the researched area (64,56%), and along with the

transitional group between mesothermic and thermophilic plant (T1) they make up 93,36% of the plant species in the area. The average value of ecological index for the temperature T-3,36 clearly points out to mesothermic conditions of habitat of frigophylic plant species (T1).

Table 4. Spectrum of life forms in flora in the Bardača complex
Spektar životnih formi flore komplesa Bardača

Life forms *Životne forme*	№	%
Hemicryptophytes (h)	107	33,86
Geophytes (g)	68	21,52
Terofit/chamaephytic (th)	35	11,08
Terophyta	30	9,49
Aquatic helo-hydrophytes(a)	25	7,91
Phanerophytes (p)	25	7,91
Nanophanerophytes (np)	17	5,38
Herbaceous chamaephytic (hc)	5	1,58
Woody chamaephytic (wc)	2	0,63
Phanerophytic lianas (pl)	2	0,63
Total/*Ukupno*	316	100,00

Although habitat is mesophyll and moderately moist, orchestrated level of water and draughts during summer months is the reason for the wide spectrum of life forms in the Bardača complex. These forms represent the reflection of the adjustment of herbal species to the ecologic factors in the habitat. By analyzing biological spectrum of flora, ten life forms have been found. Most of them are hemi-cryptophyta (33,86%) which is in accordance with the general moderately continental climate characteristics of the researched area. Significant is the representation of cryptophyta (29,43%) made of: geophyta (21,52%) and aquatic helo-hydrophyta (7,91 %). Terophyta (9,49%) can be found in dry biotopes and they are conditioned with the presence of arable land. Terophyta, joined with hamephyta (11,08), a special form of terophyta, makes significant participation in biotopes (20,57).

Kocić and Pejinović (1982) claimed that with the decrease of certain areas the participation of terophyta is also decreased, while the participation of hemicryptophyta and hamephyta is increased. This is characteristic for the Bardača complex. Representation of phanerophyta, nanophanerophyta and phanerophytic lianas (13,92%) as remains of what used to be more

developed forest vegetation is relative and significantly degraded by anthropogenic influence. Hamephyta (woody and greenish) are slightly represented (2,21%).

Table 5. Overview of elements of flora in the Bardača complex
Pregled flornih elemenata kompleksa Bardača

Floral group *Florna grupa*	Floral elements *Florni elementi*	№	%
Euroasian (112 species ili 35,45%)	Euroasian	64	20,25
	Subeuroasian	39	12,35
	Subsouth sibir	9	2,85
Circumpolar and cosmopolitan (74 species ili 23,41%)	Circ	28	8,86
	Cosm	33	10,44
	Subcirc	13	4,11
Central European (70 species ili 22,15%)	Sub Central European	59	18,67
	Central European	11	3,48
Pontic-central Asia (19 species ili 6,02%)	Pontic-subm.	4	1,27
	Subpontic-central Asia	3	0,95
	Subpontic-subm.	3	0,95
	Pontic-cental Asia-subm.	2	0,63
	Subpontic	2	0,63
	Subpontic.-subcentral Asia-subm.	2	0,63
	Pontic.-central Asia	1	0,32
	Pontic-pan.	1	0,32
	Subpontic.-central Asia-subm.	1	0,32
Adventitiv (18 species ili 5,70%)	Adv.	18	5,70
Atlantic (9 species ili 2,85%)	Subatlantic-subm.	9	2,85
Submediterranean (7 species ili 2,22%)	Subm.	6	1,90
	Subeuks.	1	0,32
Boreal (4 species ili 1,27%)	Subboreal-European	2	0,63
	Bor.-circ	1	0,32
	Bor.-European	1	0,32
Balkan (1 species ili 0,32%)	Midlle balk.	1	0,32
Ilir (1 species ili 0,32%)	Ilir.-sk.-pind.	1	0,32
Subiran (1 species ili 0,32%)	Subiran-eastern subm.	1	0,32
Total/*Ukupno*		316	100,00

Herbo-geographic analysis of flora in the Bardača complex distinguished 27 flora elements. This analysis points out the domination of herbal species from the group of widely spread flora elements: Euro-Asian, Sub-Euro-Asian, Cosmopolitan, Circumpolar, Adventive, Sub-Circumpolar and Sub-South-Siberian. Also, significantly represented are the species belonging to the narrow spread flora elements: central European, Sub-Atlantic Sub-Mediterranean and Sub-Mediterranean.

Stojanović et al. (1994) distinguish 12 flora elements in the Vrbas-Bezdan canal. Sumatić (1997) distinguishes 15 flora elements on the area of Pannonian basin of the Republika Srpska. Kojić et al. (2000) found 25 flora elements in weed flora of meadows and pastures of Serbia. Lazić (2003) found 10 flora elements in watercourse of the Jegrička river. Nikolić (2004) found 12 flora elements in the Provala lake.

Conclusion

Bardača complex is characterized with great floristic resource consisting of 316 species of vascular flora.Taxonomic analysis of flora in the Bardača complex shows great diversity demonstrated with six herbal species from classes *Equisetatae* (2) and *Filicatae* (4), belonging to *Pteridophyta*, and 310 herbal species from classes *Magnoliatae* (232) and *Lilitae* (78), belonging to *Magnoliophyta*. The distinguished herbal species are divided into 83 families. Out of the total species number, 131 herbal species, 41,46%, belongs to families: *Asteraceae*, *Poaceae*, *Fabaceae*, *Lamiaceae*, *Ranunculaceae* and *Cyperaceae*.

The ecologic diversity of flora is reflected in the resource of ecologic groups of plants as reliable indicators of habitat in relation to different ecologic factors and biological spectrum resource (10 life forms) where the dominant are hemicryptophyta (33,86%), geophyta (21,52%), terophyta (20,57%) and aquatic helo-hydrophyta (7,91%).

Herbo-geographic diversity of flora is made of 27 areal types (flora elements) with the domination of species from the group of widely spread flora elements (Euro-Asian – 20,25%, Cosmopolitan – 10,44%, Circumpolar – 8,86% and Adventive – 5,70%).

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Vaskularna flora kompleksa Bardača

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Sažetak

U radu je dat pregled i osnovne karakteristike vaskularne flore kompleksa Bardača: ekološke indikatorske vrijednosti, biološki spektar i spektar areal tipova. Florističkim istraživanjima na području kompleksa Bardača konstatovano je 316 biljnih vrsta. Od tog broja 6 vrsta pripada razdjelu *Pteridophyta* (klasa *Equisetatae*-2 i klasa *Filicatae*-4), a 310 razdjelu *Magnoliophyta* (klasa *Magnoliate*-232 i klasa *Liliate*-78). Istraživano područje na osnovu ekološke analize konstatovanih biljnih vrsta je mezofilno sa neutralnim do slabo kiselim zemljištem, srednje bogato mineralnim materijama, te povoljanim svjetlosni i termički režimom. Analizom biološkog spektra flore konstatovano je 10 životnih formi, među kojima dominiraju hemikriptofite (33,86%) i kriptofite (geofite 21,52% i akvatične helo-hidrofite 7,91%). Analizom areal tipova konstatovano je 27 flornih elemenata među kojima dominiraju grupe flornih elementa širokog rasprostranjenja (Evroazijska, Cirkumpolarna, Kosmopolitska i Adventivna) kojim pripadaju 204 biljne vrste (64,55%). Racionalno korišćenje kompleksa Bardača po principima održivog razvoja podrazumjeva očuvanje jedinstvenih genskih resursa zbog prisustva mnogih predstavnika reliktne flore tercijara.

Ključne riječi: vaskularna flora, ekološki indeksi, životne forme, florni elementi

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