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***Danka CAKOVIĆ, Danijela STEŠEVIĆ,***
***Vuk IKOVIĆ, Mirko KNEŽEVIĆ, Nedeljko LATINOVIĆ*** [1]

# CONTRIBUTION TO THE KNOWLEDGE OF WEED FLORA IN BJELOPAVLIĆI PLAIN

## ABSTRACT

This paper presents the initial research of the weed flora of cultivated fields in Bjelopavlići plain, which is the largest strip of fertile land in Montenegro. The research was launched with the aim to examine the floristic composition, structure, seasonal dynamics and biological spectrum of weed flora, and provide data which are crucial for selecting the appropriate method and time of weed control. A review list was created through sublimation of literature, herbarium data and our own field research. This list contains 212 species and subspecies classified into 133 genera and 39 families. Legumes (*Fabaceae*), with 17.5%, compositae (*Asteraceae*) with 14.2% and grasses (*Poaceae*) with 12.3% dominate the taxonomic spectrum of the families.

Although they are represented by a small number of species, the largest share in the total biomass is occupied by families of *Amaranthaceae* (0.9%) and *Chenopodiaceae* (1.4%), which are represented exclusively by synanthropic species. Among genera, there are some with a significant number of representatives, such as *Vicia* (5.7%), *Lathyrus* and *Ranunculus* (3.8%), and *Medicago* and *Rumex* (3.3%). Genera that dominate the biomass of weeds are *Amaranthus*, *Chenopodium*, *Xanthium* and *Convolvulus*, which are at the very end of the taxonomic spectrum. Considering the geographical position of Bjelopavlići plain and the environmental conditions that are under specific Mediterranean influence, and also bearing in mind that the use of agro-technical measures works in favour of the dominance of annual life forms, the biological spectrum has a terophytic character (53.3%). Phytogeographic analysis recognised the representatives of eight areal types, as well as the elements of adventive flora. Given the wide ecological valence accompanied by the wide geographic distribution, the chorological spectrum is dominated by Eurasian species (31.1%) and cosmopolitan areal type (23.6%). Due to the sub-Mediterranean position, the share of Mediterranean floral element in a broader sense is rather significant (17%). Of the chorological spectrum, 7.5% belongs to

[1] Danka CAKOVIĆ, (corresponding author: danka.petrovic@t-com.me), Danijela STEŠEVIĆ, University of Montengro, Faculty of Science, Department of Biology, Dzorzda Washingtona bb, 81 000 Podgorica; Vuk Iković, Municipality of Danilovgrad, Trg 9. Decembra, 81410 Danilovgrad, Crna Gora (Montenegro), Mirko Knežević, Nedeljko Latinović, University of Montenegro, Biotechnical faculty, 1. Mihaila Lalića, 81000 Podgorica, Crna Gora (Montenegro)

adventive component, and is dominated by thermophilic species of North American origin. Besides the usual adventive weeds (*Amaranthus retroflexus, Galinsoga parviflora, Portulaca oleracea*), ten more species from the list of invasive plants in the flora of Montenegro were also registered: *Amarathus hybridus, Ambrosia artemisifolia, Artemisia verlotiorum, Bidens subalternans, Conyza canadensis, C. albida, Cuscuta caesattiana, Datura stramonium, Erigron annuus* and *Xanthium italicum.*

**Keywords:** Bjelopavlići plain, weed flora

## INTRODUCTION

The first analyses of weed flora in cultivated areas in Montenegro were conducted in Bjelopavlići plain. Those first analyses were carried out in 1939/1940, but the results were published much later (Pavićević 1974). Since then there have been no papers on weed flora of this area, although it is one of the most fertile areas in Montenegro, and is very important in terms of agricultural production. In the meantime, there have been significant changes in the types of crops that are typically grown in this area, as well as changes in tillage methods, fertiliser application and weed control methods. The anthropogenic influence has significantly intensified and is exerted through intensive treatment and fertilisation of soil, amelioration, increased urbanisation and industrialisation.

Bearing all of this in mind, along with the fact that floristic composition, structure, seasonal dynamics and the biological spectrum of the weed community, as well as changes that occur depending on the agro-ecological environmental factors, are of crucial importance in selecting the time and methods for weed control (Kojić and Šinžar 1968, Šinžar et al. 1992), a study of weed flora in this area was undertaken.

## MATERIALS AND METHODS

The inventory of weed flora given in this paper is based on literature and the herbarium collections of the Faculty of Natural Sciences and Mathematics in Podgorica (TGU), as well as on personal observations from field research conducted in 2012. The weed inventory includes only species that grow in arable fields. The material is determined by Domac (1973), Pignatti (1982) and Tutin et al. (1964-80, 1993), and the nomenclature is in accordance with Euro+Med (2006). Life form classification is performed according to Raunkier, elaborated and updated by Ellenberg and Mueller-Dombois (1967) and, for our circumstances, modified by Stevanović (1992). Meaning of acronyms is given in alphabetical order: a- summer, alt- high, aut- autumnal, Ch- chamaephytes, G- geophytes, H- hemicryptophytes, herb- herbaceous, n- winter, Par-parasite, T- therophytes, P- phanerophytes (P), Mi- micro-, Mes- meso, Mac- macro, N- nano, rad- root, riz -rhizome, ros- rosette, S- scadentophytes, scap- stem, semiros- semi-rosette, suffr- semi-shrubby, v- spring.

The categorisation of taxa to floral element is determined by Meusel et al. (1965, 1978, 1992) and Pignatti (1982). Meaning of acronyms used is given in alphabetical order: ADV- adventive, am- American, as- Asian-, bor- boreal, cirkumhol- circumholartic, evr- European, kosm- cosmopolitan, med- Mediterranean, merid- meridional, paleotrop- paleotropic, pon- pontic, submed- sub-Mediterranean, sr.- medium, submerid-submeridional, sj.- north, j.- south, temp- temperate.

Climate characteristics of the area are based on data obtained from a meteorological station in Danilovgrad, for the climatological series 1990–2000.

**General characteristics of the studied area**

Bjelopavlići plain is located in central Montenegro, surrounded by limestone hills and partly by flysch sediments. It covers an area of approximately 8120 ha, spreading from Glava Zete in the southeast, along the Zeta River valley, to the narrowing stripe at Velje Brdo and Donje Šume. It is about 27 km long and 8 km wide. In vertical view there are a few differences: the plain, which lies at 45–60 m above sea level; the plain border, which goes up to 300 m above sea level; and its sides, which are at 300 m above sea level (Bešić 1978).

The plain has a modified sub-Mediterranean climate. Long, dry and hot summers and mild and rainy winters are defining characteristics of this climate (Burić 2000). The average annual air temperature in Danilovgrad is 15˚C (Tab.1).

Table 1. Periodically reported data from the hydrometeorological station in Danilovgrad for the period 1990–2000.

| Average monthly air temperature ($^{o}$C) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 1990–2000 | 4.6 | 6.4 | 9.7 | 13.4 | 18.5 | 23.3 | 25.8 | 25.7 | 20.6 | 15.2 | 10.2 | 5.8 |
| Average monthly precipitation (mm) | | | | | | | | | | | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 1990–2000 | 144 | 173 | 129 | 222 | 114 | 73 | 60 | 111 | 189 | 298 | 345 | 340 |
| Absolute maximum air temperature ($^{o}$C) | | | | | | | | | | | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 1990–2000 | 21.0 | 25.2 | 28.0 | 30.0 | 32.0 | 38.8 | 41.2 | 42.0 | 37.2 | 30.0 | 26.4 | 18.4 |
| Absolute minimum air temperature ($^{o}$C) | | | | | | | | | | | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 1990–2000 | -11.2 | -11.0 | -3.6 | -1.8 | 3.0 | 6.0 | 10.0 | 9.0 | 6.2 | -1.0 | -3.4 | -8.0 |

The warmest month was July, with an average temperature of 25.8˚C, and the coldest was January, with an average temperature of 4.6˚C. This climate zone is characterised by large temperature fluctuations. The maximum temperature recorded during July and August was 42ºC, and the lowest temperature recorded in January and February was -11.2º C. For the period 1990–2000, an absolute maximum temperature of 42ºC was recorded in August. An absolute minimum

temperature of -11ºC was recorded in January. A mean daily air temperature above 0º C was recorded on more than 320 days per year, while temperatures above 15ºC occurred on 180 days. Temperatures above 25ºC occurred 130 days per year, and temperatures above 30º C occurred 50 to 70 days per year. The average annual cloudiness in Bjelopavlići was 5.2 tenths of sky coverage. On average, there were 115 cloudy days over the year, while the average number of clear days was 96.3 per year (Spatial Plan of Danilovgrad 1998). The average annual precipitation was 2000 mm and only 10% of rainfall occurred during the summer (Fig. 1). Humidity was highest in November and reached 80%. The lowest humidity was 62%, recorded in July and August. The average annual relative humidity was 71%. During June, July and August, humidity was known to be below 50%, and if we know that the humidity limit is 40%, and drought is considered to be a period of 14 days without any precipitation at high temperatures, it can be said that the area of Bjelopavlići plain is characterised by arid summers. The most frequent winds were southeastern (12 days) and northwestern winds (12 days) (Burić 2000). North and northwest winds enhance evaporation, which together with the karst landforms increases the aridity of the area.

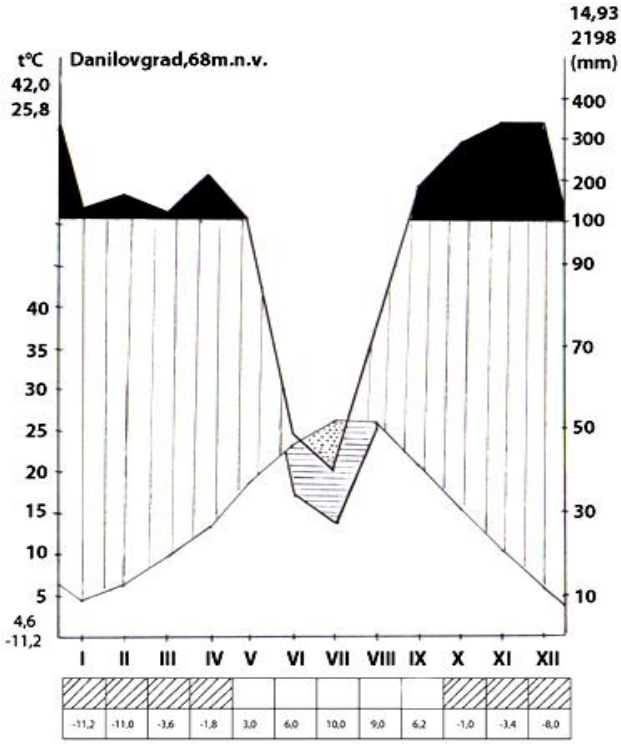


Figure 1. Climate diagram according to Walter, for the area of Danilovgrad for the climate series 1990–2000

There are several types, subtypes and varieties of soil in Bjelopavlici plain: 1. alluvium, 2. brown eutric soil on gravel and conglomerate, 3. brown eutric soil on gravel, sand and clay, 4. brown eutric vertic soil-brown soil, 5. brown eutric leached soil, 6. brown eutric pseudogley land, 7. pseudogley and 8. laterite. With regards to percentages, the brown eutric vertic soil-brown soils (37%) and the brown eutric leached soils (28%) are predominant, while other soil types and subtypes are much less common (Knežević, 2008)

## RESULTS AND DISCUSSION

According to literature sources (Pavićević 1974, Bešić 1978), herbarium data and own field observations, 212 species and subspecies within 133 genera and 39 families are registered on the arable land of Bjelopavlići plain (Tab. 2 ).

Given that the research did not encompass the entire valley, we are sure that this is not the final number of taxa.

Table 2. Checklist of weeds on Bjelopavlići plain.

| **Taxon** | **Life form** | **Floral element** |
|---|---|---|
| **EQUISETACEAE** | | |
| *Equisetum arvense* L. | Mes-Meg G rhiz | cirkumhol |
| **AMARANTHACEAE** | | |
| *Amaranthus hybridus* L. | a-aut Mes-Meg T scap | ADV (am) |
| *Amaranthus retroflexus* L. | a-aut Mes-Alt T scap | ADV (sj.am) |
| **APIACEAE** | | |
| *Bifora radians* M. Bieb. | a Mes T scap | evr-az |
| *Daucus carota* L. | a Mac-Meg H bienn semiros | kosm |
| *Tordylium maximum* L. | a Mes-Alt T scap/ H bienn | med-submed |
| *Torilis arvensis* (Huds.) Link. | v-a Mes-Meg T scap | sr.evr-med |
| *Oenanthe pimpinelloides* L. | a Mes-Meg H scap | med-submed |
| *Orlaya grandiflora* (L.) Hoffm | a Meg T scap/ H bienn | med-pont |
| *Scandix pectin-veneris* L. | v Mes-Mac T scap | sr.evr-med |
| *Smyrnium perfoliatum* L. | v-a Mac-Meg H scap | med-pont |
| **ARISTOLOCHIACEAE** | | |
| *Aristolochia clematitis* L. | v Mes-Meg G rad | med-pont |
| **ASTERACEAE** | | |
| *Achillea millefolium* L. | a Mes-Mac H semiros | evr-az (bor-submerid) |
| *Ambrosia artemisifolia* L. | a-aut Mes-Meg T scap | ADV (sj.am) |
| *Anthemis arvensis* L. | v-a Mes-Meg T scap | med-submed |
| *Artemisia vulgaris* L. | a-aut Meg-Alt H scap | cirkumhol |
| *Artemisia verlotorum* Lamotte | a-aut Mes-Mac H scap/G rad | ADV (as) |
| *Bidens tripartita* L. | a-aut Mac-Meg T scap | evr-az |
| *Bidens subalternans* D.C. | a-aut Mac-Meg T scap | ADV (j.am) |
| *Carduus crispus* L. | a Mes-Alt H bienn | evr-az |
| *Centaurea calcitrapa* L. | a Mes-Meg H scap | kosm (med) |
| *Centaurea phrygia* L. | a Mes-Meg H scap | sr.evr |
| *Centaurea solstialis* L. | a Meg T scap | med-pont |
| *Chondrilla juncea* L. | a-aut Mac-Alt H scap | med-pont |
| *Cichorium intybus* L. | a-aut Meg-Alt H scap | kosm (evr) |
| *Cirsium arvense* (L.) Scop | a-aut Mac-Alt G rad | evr-az (bor-mer) |
| *Cyanus segetum* Hill | a Mes-Mac T scap | kosm |

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|---|---|---|
| *Erigeron annuus* (L.) Pers. | a-aut Mac-Alt T scap | ADV (sj.am) |
| *Erigeron canadensis* L. | a-aut Meg-Alt T scap | ADV (sj.am) |
| *Erigeron sumatrenzis* Retz. | a-aut Meg-Alt T scap | ADV (j.am) |
| *Galinsoga parviflora* Cav. | a Mes-Mac T scap | ADV (trop.am) |
| *Gnaphalium uliginosum* L. | a Mi-Mes T scap | evr-az (bor-submer) |
| *Inula britanica* L. | a-aut Mes-Meg H scap | evr-az (temp-merid) |
| *Matricaria chamomilla* L. | v-a Mi-Mes T scap | kosm |
| *Picris hieracioides* L. | a-aut Mac-Meg H scap | evr-az |
| *Pulicaria dysenterica* Gaertn. | a-aut Mac-Meg H scap | evr-az |
| *Senecio vulgaris* L. | n-v Mes-Meg T scap | kosm |
| *Sonchus arvensis* L. | v-a Mes-Alt T scap | kosm |
| *Sonchus oleraceus* L. | v-a Mes-Meg T scap | kosm |
| *Taraxacum officinale* Weber | v-aut Mes H ros | evr-az |
| Tragopogon pratensis L. | a Meg H scap | evr-az |
| *Xanthium orientale* L. subsp. *italicum* (Moretti) Greuter | a Meg-Alt T scap | ADV (sj.am) |
| **BORAGINACEAE** | | |
| *Anchusa italica* Retz. | a Mes-Alt T semiros/ H bienn | med-submed |
| *Echium vulgare* L. | a Mes-Meg H bienn semiros | evr-az |
| *Heliotropium europeum* L. | a-aut Mes-Meg T scap | med-pont |
| *Myosotis arvensis* (L.) Hill. | v-a Mes-Mac T scap | evr-az |
| *Myosotis ramossisima* Rochel | v-a Mi-Mes T scap | evr-az |
| **BRASSICACEAE** | | |
| *Arabidopsis thaliana* (L.) Heynh. | v Mi-Mes T semiros | evr-az (bor-merid) |
| *Brassica nigra* (L.) W.D.J.Koch. | v-a Meg-Alt T semiros | Kosm |
| *Calepina irregularis* Adans. | n-v Mes-Meg T semiros | med-pont |
| *Capsella bursa-pastoris* (L.) Medicus | n-aut Mi-Meg T semiros/ H bienn | kosm (submed) |
| *Capsella rubella* Reut. | v-a Mi T semiros | med-submed |
| *Cardamine hirsuta* L. | n-v Mi-Mes T semiros | evr-az |
| *Diplotaxis tenuifolia* (L.) DC. | a-aut Mes H semiros | evr-az |
| *Rorripa sylvestris* (L.) Besser | a Mes-Mac H semiros | evr-az |
| *Sinapis arvensis* L. | v-a Mes-Meg T scap | evr-az (bor-merid) |
| *Sisymbrium officinale* (L.) Scop. | v-a Mac-Meg T semiros | evr-az (bor-merid) |
| **CARYOPHYLLACEAE** | | |
| *Agrostemma ghitago* L. | v-a Mes-Meg T scap | kosm |
| *Allysum allysoides* (L.) L. | v Mi-Mes T scap | evr-az |
| *Arenaria leptoclados* (Reichenb.) Guss | v Mi-Mes T scap | med-pont |
| *Arenaria serpyllifolia* L. | v Mi-Mes T scap | evr-az |
| *Cerastium brachypetalum* Desp. | v N-Mi T semiros | med-pont |
| *Cerastium glomeratum* Thuill | v N-Mi T semiros | kosm |
| *Dianthus armeria* L. | a-aut T scap/ H bienn | med-pont |
| *Gypsophilla paniculata* L. | a-aut Mes-Meg Ch suffr | pont |
| *Moenchia mantica* (L.) Bartl. | v Mi-Mes T scap | med-submed |
| *Petrorhagia prolifera* (L.) P.W.Ball & Heywood | v-aut Mes T scap | med-pont |
| *Silene flos-cuculi* (L.) Greuter & Burdet | v-a Mes-Meg H scap | evr-az |
| *Silene latifolia* Poiret ssp. *alba* (Miller) Greuter & Burdet | v-a Mes-Meg T scap/ H bienn | evr-az (bor-merid) |
| *Silene vulgaris* (Moench) Garcke | v-aut Mac-Meg H scap/ G rad | evr-az (bor-merid) |
| *Stellaria media* Vill. | n-aut Mi-Meg T rept | kosm |

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|---|---|---|
| *Vaccaria hispanica* (Mill.) Rauschert | v-a Mes-Mac T scap | evr-az |
| **CHENOPODIACEAE** | | |
| *Chenopodium album* L. | a-aut Meg-Alt T scap | kosm |
| *Chenopodium glaucum* L. | a-aut Mi-Mac T scap | kosm |
| *Chenopodium murale* L. | a-aut Mac-Meg T scap | kosm (med) |
| **CONVOLVULACEAE** | | |
| *Convolvulus arvensis* L. | a SG herb rhiz | kosm (med) |
| **CUSCUTACEAE** | | |
| Cuscuta cesatianaBertol. | a Par/ Scand T herb | ADV (sj.am) |
| **DIPSACACEAE** | | |
| *Knautia integrifolia* (L.) Bertol. | a Mes-Meg T scap | med-submed |
| *Scabiosa columbaria* L. | a Mes-Meg H scap | evr-az |
| **EUPHORBIACEAE** | | |
| *Euphorbia cyparissias* L. | a Mes-Mac H scap | evr-az |
| *Euphorbia falcata* L. | v-a Mi-Mes T scap | med-submed |
| *Euphorbia helioscopia* L. | v Mi-Mes T scap | evr-az (temp-merid) |
| *Mercurialis annua* L. | n-v Mes-Mac T scap | sr.evr-med |
| **FABACEAE** | | |
| *Coronilla varia* L. | a-aut Mes-Meg H scap | evr-az |
| *Hedysarum coronarium* L. | v-a Mes-Alt H scap | med-submed |
| *Lathyrus aphaca* L. | v-a Mes T scap | med-pont |
| *Lathyrus cicera* L. | v-a Mes T scap | med-submed |
| *Lathyrus hirsutus* L. | v-a Mac ST herb | med-pont |
| *Lathyrus nissolia* L. | v-a Mes-Mac T scap | med-pont |
| *Lathyrus pratensis* L. | a Mac-Meg H scap | evr-az |
| *Lathyrus sativus* L. | a Mes-Mag T scap | ADV (sj.am) |
| *Lathyrus sphaericus* Retz. | v-a Mes-Meg T scap | med-submed |
| *Lathyrus tuberosus* L. | v-a Mes-Meg G tub | sr.evr |
| *Lotus corniculatus* L. | v-aut Mes H scap | Kosm |
| *Medicago arabica* (L.) Hudson | v Mes-Mac T scap | med-submed |
| *Medicago lupulina* L. | v Mes-Mac T scap/ H scap | evr-az |
| *Medicago minima* (L.) L. | v Mi-Mes T scap | kosm |
| *Medicago orbicularis* (L.) Bartal. | v Mes-Mac T rept | med-submed |
| *Medicago polymorpha* L. | v Mes T rept | med-submed |
| *Medicago rigidula* (L.) All. | v Mes-Mac T rept | med-submed |
| *Medicago sativa* L. | a-aut Mes-Meg H scap | ADV |
| *Mellilotus officinalis* (L.) Pallas | a Mac-Alt H scap bienn | evr-az |
| *Ononis spinosa* L. | a Mi-Meg Ch suffr caesp | sr.evr-med |
| *Trifolium arvense* L. | v-a Mes-Mac T scap | evr-az |
| *Trifolium pratense* L. | v-aut Mes H scap | evr-az |
| *Trifolium repens* L. | v-aut Mi-Mes H rept | cirkumhol |
| *Trigonella monspeliaca* L. | v-a Mes-Alt T scap | med-submed |
| *Vicia cracca* L. | a Meg-Alt H scap/ ST herb | evr-az (bor-mer) |
| *Vicia grandiflora* Scop. | v-a Mes-Meg H scap/ T scap | med-pont |
| *Vicia hirsuta* (L.) Gray | v-a Mes-Meg ST herb | evr-az |
| *Vicia hybrida* L. | v-a Mes-Mac T scap | med-submed |
| *Vicia narbonensis* L. | v-a Mes-Meg T scap | pont-submed |
| *Vicia sativa* L. | v-a Mes-Meg T scap/ H bienn | evr-az |
| *Vicia sativa* L. subsp. *nigra* (L.) Ehrh. | v-a Mes-Meg ST herb | evr-az |
| *Vicia serratifolia* Jacq. | v Mes-Mac T scap | med-submed |
| *Vicia tenuifolia* Roth. | v-a Mes H scap | evr-az |

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|---|---|---|
| *Vicia tetrasperma* (L.) Schreb. | v Mes-Mac T scap | kosm |
| *Vicia villosa* subsp. *villo*sa Roth. | a Mes-Meg ST herb/ H bienn | evr-az |
| *Vicia villosa* subsp. *varia* (Host.) Corb. | v-a Mac-Alt ST herb/ H bienn | med-submed |
| **FUMARIACEAE** | | |
| *Fumaria officnalis* L. | n-v Mes-T scap | evr-az |
| **GENTIANACEAE** | | |
| *Centaurium erythraea* Rafn | a Mi-Mes H bienn semiros | evr-az |
| **GERANIACEAE** | | |
| *Erodium cicutarium* (L.) L'Hér. | n-v Mi-Mes T semiros | kosm |
| *Geranium columbinum* L. | v-a Mes T semiros | evr-az |
| *Geranium dissectum* L. | v-a Mes T semiros | evr-az |
| *Geranium purpureum* Vill. | v-a Mi-Mes T semiros | med-submed |
| *Geranium villosum* Ten. | v-a Mes-Mac T semiros | med-submed |
| **HYPERICACEAE** | | |
| *Hypericum perforatum* L. | a-aut Mes-Meg H scap | evr-az |
| **LAMIACEAE** | | |
| *Ajuga reptans* L. | a Mes H rept | sr.evr-med |
| *Calamintha nepeta* Savi. | a-aut Mes-Mac H scap | med-submed |
| *Lamium purpureum* L. | n-aut Mi-Mes T scap | evr-az |
| *Mentha longifolia* Huds. | a Mes-Meg H scap | cirkumhol |
| *Mentha pulegium* L. | a-aut Mi-Mes T scap | kosm |
| *Prunella vulgaris* L. | a Mi-Mes H scap | evr-az |
| *Salvia verticillata* L. | a-aut Mes-Mac H scap | sr.evr |
| *Scutellaria altissima* L. | a Mes-Mac H scap | med-submed |
| **LILIACEAE** | | |
| *Allium vineale* L. | a Mes-Alt G bulb | evr-az |
| **LINACEAE** | | |
| *Linum usitatissimum* L. | v-a Mes-Meg T scap | med-submed |
| **LYTHRACEAE** | | |
| *Lythrum salicaria* L. | a Mac-Alt H scap | kosm |
| **MALVACEAE** | | |
| *Malva sylvestris* L. | a-aut Mac-Meg H scap bienn | evr-az (bor-mer) |
| **OXALIDACEAE** | | |
| *Oxalis corniculata* L. | v-aut Mi-Mes H rept | kosm (submed) |
| **PAPAVERACEAE** | | |
| *Papaver rhoeas* L. | v Mes-Mac T scap | kosm |
| **PLANTAGINACEAE** | | |
| *Plantago lanceolata* L. | v-a Mi-Meg H ros | evr-az |
| *Plantago major* L. | a Mes-Mac H ros | kosm |
| **POACEAE** | | |
| *Agrostis stolonifera* L. | v-a Mes-Mac H rept | kosm (evr) |
| *Alopecurus utruculatus* (L.) Pers. | v Mes T caesp | med-submed |
| *Anthoxanthum odoratum* L. | v-a Mes-Meg H caesp | evr-az |
| *Avena barbata* Pott. ex Link | v Mes-Meg T scap | med-submed |
| *Avena fatua* Dur. | a Mes-Alt T caesp | cirkumhol |
| *Bromus arvensis* L. | a Mes-Meg T scap | evr-az |
| *Bromus erectus* Huds. | a Mac H caesp | sr.evr-med |
| *Bromus hordeaceus* L. | v-a Mes-Mac T scap | kosm |
| *Bromus secalinus* L. | v-aut Mes-Meg T caesp | cirkumhol |
| *Bromus sterilis* L. | v-a Mes-Meg T caesp | cirkumhol |

| | | |
|---|---|---|
| *Cynodon dactylon* (L.) Pers. | a-aut Mes-Mac H caesp | kosm |
| *Digitaria sanguinalis* (L.) Scop. | a-aut Mes T caesp rept | kosm |
| *Echinochloa crus-gali* (L.) Beauv. | a-aut Mac-Alt T scap | kosm |
| *Elymus repens* (L.) Gould | a Mes-Meg G rhiz | kosm (evr) |
| *Festuca rubra* L. | a Meg H caesp | cirkumhol |
| *Holcus lanatus* L. | v-a Meg H scap | sr.evr-med |
| *Hordeum murinum* L. | v-a Mi-Mes T caesp | evr-az |
| *Lolium perenne* L. | v-a Mac-Meg H caesp | sr.evr-med |
| *Lolium temulentum* L. | v-a Mes-Meg H scap | kosm |
| *Poa annua* L. | n-a Mi-Mes T caesp | kosm |
| *Poa sylvicola* Guss. | a Mes-Meg H caesp | evr-az |
| *Setaria glauca* (L.) P.B. | a-aut Mes-Mac T scap | kosm |
| *Setaria viridis* (L.) Beauv. | a-aut Mes-Mac T scap | kosm |
| *Sorghum halepense* Pars. | a-aut Mes-Meg G rhiz | ADV (paleotrop.) |
| *Vulpia ciliata* L. | v-a Mes-Meg T caesp | evr-az |
| **POLYGONACEAE** | | |
| *Bilderdyckia convolvulus* (L.) Dumort | v-a Mes-Meg ST herb | kosm (evr) |
| *Polygonum aviculare* L. | a-aut Mi-Mes T rept | kosm |
| *Polygonum persicaria* L. | a-aut Mes-Mac T scap | kosm |
| *Rumex acetosa* L. | v-a Mac-Alt H scap | cirkumhol |
| *Rumex acetosella* L. | a Mes-Mec H scap | cirkumhol |
| *Rumex conglomeratus* Murr. | a Meg H scap | evr-az |
| *Rumex crispus* L. | a Meg-Alt H scap | kosm (evr) |
| *Rumex obtusifolius* L. | a Meg-H scap | evr-az |
| *Rumex pulcher* L. | v-a Mes-Meg H scap | med-submed |
| *Rumex sanguineus* L. | v-a Mes-Meg H scap | cirkumhol |
| **PORTULACACEAE** | | |
| *Portulaca oleracea* L. | a Mes T scap | ADV (az) |
| **PRIMULACEAE** | | |
| *Anagalis arvensis* L. | v-a Mi-Mes T scap | kosm |
| *Lysimachia nummularia* L. | v-a N-Mi Ch herb rept | sr.evr |
| **RANUNCULACEAE** | | |
| *Ranunculus acris* L. | a Mac-Meg H scap | kosm |
| *Ranunculus arvensis* L. | v Mi-Mes T scap semiros | kosm |
| *Ranunculus bulbosus* L. | v-a Mes-Mac H semiros | med-submed |
| *Ranunculus ficaria* L. | n-v Mi-Mes G tub | sr.evr |
| *Ranunculus millefoliatus* Vahl. | v Mes G tub | med- submed |
| *Ranunculus muricatus* L. | v Mi-Mes T semiros | med-or-(turan)-submed |
| *Ranunculus repens* L. | a Mes-Mac H rept | kosm |
| *Ranunculus sardous* Crantz. | v-a Mes-Mac T semiros | se-med-submed |
| **ROSACEAE** | | |
| *Rubus ulmifolius* Schott. | a fo dec NP rept | atl-med-submed |
| *Sanguisorba minor* Scop. | v-a Mes-Meg H semiros | evr-az |
| **RUBIACEAE** | | |
| *Asperula arvensis* L. | v-a Mi-Mes T scap | med-submed |
| *Galim aparine* L. | v-a Mac-Alt ST herb | evr-az |
| *Galium mollugo* L. | a Meg-Alt H scap | sr.evr-med |
| *Galium verum* L. | a Mes-Meg H scap | evr-az (bor-mer) |
| *Sherardia arvensis* L. | v Mi-Mes T scap | kosm (med) |
| **SCROPHULARIACEAE** | | |
| *Linaria vulgaris* Mill. | a-aut Mes-Meg H scap | evr-az |
| *Melampyrum cristatum* L. | a Mes-Mac SemiPar/ T scap | evr-az |

| | | |
|---|---|---|
| *Parentucelia latifolia* Car. | a Mi-Mes T scap | med-submed |
| *Verbascum blattaria* L. | v Meg-Alt H bienn semiros | med-submed |
| *Verbascum phlomoides* L. | a Mes-Alt T ros/ H bienn | evr-az |
| *Verbascum lychnitis* L. | a Meg-Alt H bienn | evr-az |
| *Veronica austriaca* L. subsp. *jacquinii* (Baumg.) J. Maly | v-a Mi-Meg H scap | evr-az |
| *Veronica cymbalaria* Bodard. | v Mi-Mac T scap | med-submed |
| *Veronica persica* Poir. | n-aut Mi-Mes T scap | kosm (med-submed) |
| **SOLANACEAE** | | |
| *Datura stramonium* L. | a-aut Mes-Alt T scap | ADV (sj.am) |
| *Solanum nigrum* L. | a-aut Mes-Mac T scap | kosm |
| **VALERIANACEAE** | | |
| *Valerianella locusta* (L.) Laterrade | v Mes T semiros | kosm (med) |
| **VERBENACEAE** | | |
| *Verbena officnalis* L. | a-aut Mes-Meg H scap | kosm |
| **VIOLACEAE** | | |
| *Viola arvensis* Murr. | v-a Mi-Mac T scap (bienn) | kosm |
| *Viola kitaibeliana* Schultes | v N-Mi T semiros | atl-med-submed-pont |
| **URTICACEAE** | | |
| *Urtica dioica* L. | v-aut Mes-Alt H scap | cirkumhol |

Considering that significant contributions to research of weed flora, especially the weed flora of specific crops (corn and potato) in the central and northern regions, have been made in the last 15 years (Jovović and Stešević 2001, Jovović et al. 2001, Stešević and Jovović 2002, 2003, 2004, 2005a,b, 2011), it is not possible to make a comparison between data and highlight the overall characteristics of weed flora of Bjelopavlići plain. But if we want to express its richness through a share in the total vascular flora of Montenegro (Rohlena 1942, Pulević 2005, Stešević et al. 2008), we will get a significant percentage of 5.9%.

**Taxonomic analysis of flora**

In the taxonomic spectrum, pteridophytes (*Pteridiophyta*) are represented by a single species (*Equisetum arvense*), whereas other taxa belong to the section of angiosperms (*Angiosperms*). A class of dicots (*Magnoliopsida*) has absolute dominance within the last section. In the weed flora of Bjelopavlići plain, this class contributes 186 taxa, grouped into 36 families and 114 genera. The class of monocots (*Liliopsida*) is represented by 26 species from 18 genera and 2 families.

With regards to families, legumes (*Fabaceae*) stand out with representatives making up 17.5%. They are followed by compositae (*Asteraceae*) with 14.2% and grasses (*Poaceae*) with 12.3% (Tab. 3). These three families account for about 44% of the total flora. They are dominant in the taxonomic spectrum of vascular flora of Montenegro; however, the first ranked is the *Asteraceae* family, followed by *Fabaceae* and *Poaceae* (Stevanović et al. 1995). The dominance of legumes in the weed flora of Bjelopavlići plain could be explained by the excessive presence of these plants in lawns that were

transformed to arable land through direct cultivation, and also by the migration of plants from the surrounding meadows and grassland ecosystems. Although they only contribute a small number of species, the *Amaranthaceae* and *Chenopodiaceae* families have the highest share in the total biomass, and they are represented exclusively by synanthropic species.

Table 3. Families with the greatest number of species in the weed flora of Bjelopavlići plain.

| Family | Number of species/subspecies | % |
|---|---|---|
| *Fabaceae* | 37 | 17.5 |
| *Asteraceae* | 30 | 14.2 |
| *Poaceae* | 26 | 12.3 |
| *Caryophilaceae* | 15 | 7.1 |
| *Polygonaceae* | 10 | 4.7 |
| *Brassicaceae* | 10 | 4.7 |
| *Scrophulariaceae* | 9 | 4.2 |
| *Lamiaceae* | 8 | 3.8 |
| *Apiaceae* | 8 | 3.8 |

With regards to the number of species and subspecies, analysis of the genera taxonomic structure indicates a predominance of two genera from the *Fabaceae* family: *Vicia* (5.7%) and *Lathyrus* (3.8%) (Tab. 4). In terms of the representative numbers, second-ranked are *Lathyrus* and *Ranunculus*, while third place belongs to *Medicago* and *Rumex* (3.3%). The dominant weeds in biomass – *Amaranthus*, *Chenopodium*, *Xanthium* and *Convolvulus* – are at the very end of the taxonomic spectrum.

Table 4. Genera with the greatest number of species in the weed flora of Bjelopavlići plain.

| Genus | Number of species/subspecies | % |
|---|---|---|
| *Vicia* | 12 | 5.7 |
| *Lathyrus* | 8 | 3.8 |
| *Ranunculus* | 8 | 3.8 |
| *Medicago* | 7 | 3.3 |
| *Rumex* | 7 | 3.3 |
| *Bromus* | 5 | 2.4 |
| *Verbascum* | 4 | 1.9 |
| *Geranium* | 4 | 1.9 |

**Biological spectrum**

Considering the geographical position of Bjelopavlići plain and the environmental conditions that are under specific Mediterranean influence, and also bearing in mind that the use of agro-technical measures works in favour of

the dominance of annual life forms (Kojić and Šinžar 1985, Armesto and Vidella 1993), the predominance of therophytes in the biological spectrum is expected (Tab. 5). They contribute 53.3%. Those that bloom at the end of winter and in early spring are: *Stellaria media, Veronica persica, Senecio vulgare, Cardamine hirsuta, Mercurialis annua* and *Fumaria officnalis)*. However, most of them bloom during the spring, such as: *Myosotis arvensis, M. ramossisima, Sonchus arvensis, Capsella rubella, Euphorbia helioscopia, Medicago arabica, Geranium villosum,* and *Sherardia arvensi*. The typical ones for the late summer and autumn aspect are: *Datura stramonium, Solanum nigrum, Chenopodium album, Echinochloa crus-galli, Ambrosia artemisifolia,* etc. Thanks to their biological properties, primarily short life cycle and ability to survive in adverse conditions in the form of seeds, therophytes adapt successfully to the harsh conditions of bare habitats, and to agro-technical measures being taken for their control (Ranđelović et al. 2005).

Hemicryptophytes contribute 35.8% to the biological spectrum. With regards to phenology, most species bloom during the summer (*Euphorbia cyparissias, Carduus crispus, Medicago sativa, Prunella vulgaris,* etc.). *Taraxacum officinale, Rumex pulcher, Plantago lanceolata, Verbascum blattaria,* etc., are typical for the summer aspect, while *Artemisia vulgaris, A. verlotiorum, Calamintha nepeta,* and *Linaria vulgaris* are characteristics of the late summer and autumn aspect. Other life forms participate in the biological spectrum with less than 5%, and the most frequent weed species among them are: *Aristolochia clematitis* (spring geophytes), *Convolvulus arvensis* (summer geophytic scadentophyta), *Lathyrus tuberosus* (summer geophytes), *Sorghum halepense* (late summer and autumn geophytes), and *Ononis spinosa* (summer chamaephyta).

Table 5. Biological spectrum of weed flora of Bjelopavlići plain.

| **Biological spectrum** | **Number of species/subspecies** | % |
|---|---|---|
| Terofita (T) | 113 | 53.3 |
| Hemikriptofita (H) | 76 | 35.8 |
| Geofita (G) | 9 | 4.2 |
| Skandendofita (S) | 8 | 3.8 |
| Hamefite (Ch) | 3 | 1.4 |
| Paraziti i poluparaziti (Par, SemiPar) | 2 | 0.9 |
| Faneropite (P) | 1 | 0.5 |

**Phytogeographical analysis** Phytogeographical analysis of weed flora in Bjelopavlići plain has registered eight areal types, as well as some elements of adventive flora (Tab. 6). Given the wide ecological valence of weed species, in most cases associated with a wide geographic distribution (Kojic and Šinžar 1985), Eurasian species are predominant in the chorological spectrum, with 31.1% (*Echium vulgare, Myosotis arvense, Plantago lanceolata, Silene vulgaris, Taraxacum officnale,* etc.). They are followed by cosmopolitan species, with 23.6% (*Chenopodium album, Cichorium intybus, Convolvulus arvensis, Solanum*

*nigrum, Senecio vulgaris, Setaria viridis, Sonchus arvensis, S. oleraceus, Stellaria media,* etc.). Due to its position in the sub- Mediterranean, the share of Mediterranean floral element is significant at 17% (*Anthemis arvensis, Geranium villosum, G.purpureum, Lathyrus cicera, Medicago orbicularis, Vicia villosa* subsp. *Varia,* etc.). Fourth place in the chorological spectrum belongs to Mediterranean-Pontic and adventive species, which are present with 7%. Speaking about the former, the following species are very frequent in Bjelopavlići plain: *Aristolochia clematitis, Calepina irregularis, Chondrilla juncea, Centaurea solstitialis,* and *Heliotropium europaeum.*

Adventive flora component takes a share of 7.5% of the chorological spectrum. Thermophilic species of North American origin dominate the spectrum. In addition to the usual adventive weeds (*Amaranthus retroflexus, Galinsoga parviflora, Portulaca oleracea*), ten more species from the list of invasive plants in the flora of Montenegro have been found (Stešević and Petrović 2010): *Amarathus hybridus, Ambrosia artemisifolia, Artemisia verlotiorum, Bidens subalternans, Conyza canadensis, C. albida, Cuscuta caesattiana, Datura stramonium, Erigron annuus* and *Xanthium italicum.* Not surprisingly, most of the invasive species are from the compositae family, which is globally the largest seed plant family (Heywood 1993). It is evolutionary one of the most advanced families (Cronquist 1981), which also has some progressive features in the invasion processes, such as high rates of reproduction, specialised methods of spreading, a variety of metabolic products that ensure the protection of consumers and high levels of apomixis (Heywood 1989, Pyšek 1997). In terms of phenology, most invasive species bloom in late summer and early autumn, and besides the negative impact on crop yields, they can have harmful effects on human health. Such is the case with ragweed (*Ambrosia artemisifolia*). Until recently, in Montenegro, this species was noted only sporadically in ruderal habitats along the banks of the rivers Morača, Ribnica, Cijevna and Zeta, and in ruderal habitats along roads in Podgorica, Spuž and Danilovgrad. This year it has been noted as a weed species in row crops.

Table 6. Chorological spectrum of weed flora of Bjelopavlići plain.

| Horological type | Number of species/subspecies | % |
|---|---|---|
| Evroazijski | 66 | 31.1 |
| Kosmopolitski | 50 | 23.6 |
| Mediteransko-submediteranski s.l. | 36 | 17.0 |
| Mediteransko-pontski | 16 | 7.5 |
| Adventivna flora | 16 | 7.5 |
| Cirkumholarktički | 12 | 5.7 |
| Srednjeevropsko-mediteranski | 9 | 4.2 |
| Srednjeevropski | 5 | 2.4 |
| Pontski | 2 | 0.9 |

In future research, especially of tomato crops, special attention should be paid to *Sycios angulatus*. It was registered as a new species in the flora of Montenegro in 2005, in tomato crops in the village of Jasenova (Stešević and Jovović 2005). It is a very dangerous weed species from the pumpkin family (*Cucurbitaceae*), which is on the world list of the five most aggressive weeds and cannot be suppressed by standard safety measures. It is assumed that it was brought in with the mentioned plant seeds.

## CONCLUSIONS

The review list of weed flora in arable fields of Bjelopavlići plain contains 212 species and subspecies taxa, 133 genera and 39 families. That represents 5.9% of the total flora of Montenegro.

In the taxonomic spectrum, pteridophytes (*Pteridiophyta*) are represented by a single species (*Equisetum arvense*). Other taxa belong to the section of angiosperms (*Magnoliophyta*), and contain 180 species and subspecies, 114 genera and 36 families from the class of dicots (*Magnoliopsida*), and 26 species, 18 genera and 2 families from the class of monocots (*Liliopsida*).

Among families, the most abundant are legumes (*Fabaceae*), with 17.5%, compositae (*Asteraceae*) with 14.2% and grasses (*Poaceae*), with 12.3%. Although they are represented by a small number of species, the largest share in the total biomass is given to families of *Amaranthaceae* (0.9%) and *Chenopodiaceae* (1.4%), which are represented exclusively by synanthropic species. Among genera, there are some with a significant number of representatives such as *Vicia* (5.7%), *Lathyrus* and *Ranunculus* (3.8%), and *Medicago* and *Rumex* (3.3%). Genera that dominate the biomass of weeds are: *Amaranthus*, *Chenopodium*, *Xanthium* and *Convolvulus*, which are at the very end of the taxonomic spectrum.

Considering the geographical position of Bjelopavlići plain and the environmental conditions that are under specific Mediterranean influence, and bearing in mind that the use of agro-technical measures works in favour of the dominance of annual life forms, the biological spectrum has a terophytic character (53.3%). In the biological spectrum, hemicryptophytes are present with 35.8%, scadentophytes with 3.8%, chamaephytes with 1.4%, parasites and semi-parasites with 0.9% and phanerophytes with 0.5%.

Phytogeographical analysis of weed flora recognised eight areal types, as well as some elements of adventive flora. Given the wide ecological valence of weed species, in most cases associated with a wide geographic distribution, Eurasian species are predominant in the chorological spectrum, with 31.1%. They are followed by cosmopolitan species, with 23.6%. Due to Montenegro's position in the sub-Mediterranean, the share of Mediterranean floral element is significant at 17%. Adventive flora component takes a share of 7.5% of the chorological spectrum. Thermophilic species of North American origin dominate the spectrum. In addition to the usual adventive weeds (*Amaranthus retroflexus*, *Galinsoga parviflora*, *Portulaca oleracea*), ten more species from the list of

invasive plants in the flora of Montenegro have been found*: Amarathus hybridus, Ambrosia artemisifolia, Artemisia verlotiorum, Bidens subalternans, Conyza canadensis, C. albida, Cuscuta caesattiana, Datura stramonium, Erigron annuus* and *Xanthium italicum.*

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***Danka CAKOVIĆ, Danijela STEŠEVIĆ,***
***Vuk IKOVIĆ, Mirko KNEŽEVIĆ, Nedeljko LATINOVIĆ***

## PRILOG POZNAVANJU KOROVSKE FLORE BJELOPAVLIĆKE RAVNICE

### SAŽETAK

U radu su prikazana početna istraživanja korovske flore kultivisanih površina Bjelopovlićke ravnice, koja nesumnjivo predstavlja najveću plodnu površ u Crnoj Gori. Ista su započeta sa ciljem izučavanja florističkog sastava, građe, sezonske dinamike i biološkog spekra korovske flore, koji su presudni u izboru načina i vremena suzbijanja korova. Pregledna lista je napravljena sublimacijom literaturnih, herbarskih podataka i sopstvenih terenskih istraživanja. Sadrži 212 specijskih i subspecijskih taksona, svrstanih u 133 roda i 39 porodica. U taksonomskom spektru porodica dominiraju leptirnjače (*Fabaceae*) sa 17.5%, glavočike (*Asteraceae*) sa 14.2% i trave (*Poaceae*) sa 12.3%. Iako zastupljene malim brojem vrsta, najveći udio u ukupnoj biomasi imaju porodice *Amaranthaceae* (0.9%) i *Chenopodiaceae* (1.4%), koje su zastupljene isključivo sinantropnim vrstama. Među rodovima brojem predstavnika se ističu *Vicia* (5.7%), *Lathyrus* i *Ranunculus* (po 3.8%), *Medicago* i *Rumex* (po 3.3%). Rodovi korova koji dominiraju biomasom: *Amaranthus, Chenopodium, Xanthium* i *Convolvulus,* zauzimaju samo začelje taksonomskog spektra. Obzirom na geografsku pozicioniranost Bjelopavlićke ravnice i ekološke uslove koji nose osjetan pečat mediterana, ali i zakonitost da primjena agrotehničkim mjera favorizuje dominaciju jednogodišnje forme, biološki spektar se odlikuje terofitskim karakterom (53.3%). Fitogeografskom analizom zabilježeni su predstavnici 8 areal tipova, kao i elementi adventivne flore. Obzirom na široku ekološku valencu uglavnom udruženu sa širokim geografskim rasprostranjenjem, u horološkom spektru dominiraju vrste evroazijskog (31.1%) i kosmopolitskog areal tipa (23,6%). Radi pozicioniranosti u submediteranu, udio mediteranskog flornog elementa u širem smislu je značajan (17%). Adventivnoj komponenti pripada 7.5% horološkog spektra, a u njemu dominiraju termofilne vrste sjevernoameričkog porijekla. Osim uobičajenih adventivnih korova (*Amaranthus retroflexus, Galinsoga parviflora, Portulaca oleracea*), zabilježeno je i 10 vrsta sa liste invazivnih biljaka u flori Crne Gore: *Amarathus hybridus, Ambrosia artemisifolia, Artemisia verlotiorum, Bidens subalternans, Conyza canadensis, C. albida, Cuscuta caesattiana, Datura stramonium, Erigron annuus, Xanthium italicum.*

**Ključne riječi:** Bjelopavlićka ravnica, korovska flora.