

# Floristic characteristics of sub-Pannonian grassland in Bistrinci (East Croatia)

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## **FLORISTIC CHARACTERISTICS OF SUB-PANNONIAN GRASSLAND IN BISTRINCI (EAST CROATIA)**

### **FLORISTIČKE ZNAČAJKE SUBPANONSKOG TRAVNJAKA U BISTRINCIMA (ISTOČNA HRVATSKA)**

**Sanda Rašić, Nataša Uranjek, Sara Rašić, Edita Štefanić**

#### **ABSTARCT**

Continental dry grasslands are important habitats that are among the endangered vegetation types not only in Croatia but also in the countries of Central and Western Europe. Areas under grassland are decreasing year to year due to the decreasing traditional way of using them (mowing and grazing). Reducing the loss of grassland is a strategic goal and flora inventory is one way to protect them from extinction. Overgrown surfaces lead to a progressive succession of vegetation. The aim of this research is to determine the floristic composition of sub-Pannonian grasslands and to isolate invasive species. The research was conducted during the vegetation in 2020 and 2021, and 122 taxa from 37 families were identified.

Key words: sub-Pannonian grassland, flora, invasive species

#### **SAŽETAK**

Kontinentalni suhi travnjaci su važna staništa koja se ubrajaju u ugrožene tipove vegetacije ne samo u Hrvatskoj nego i u zemljama srednje i zapadne Europe. Površine pod travnjacima se iz godine u godinu smanjuju zbog sve manjeg tradicionalnog načina korištenja istih (košnja i ispaša). Smanjenje gubitka površina pod travnjacima strateški je cilj, a inventarizacija flore jedan je način zaštite od nestajanja. Zarastanjem površina dolazi do progresivne sukcesije vegetacije. Cilj ovog istraživanja je utvrditi floristički sastav subpanonskog travnjaka te izdvojiti invazivne vrste. Istraživanje je provedeno tijekom vegetacijske 2020. i 2021. godine pri čemu su utvrđene 122 svojte iz 37 porodica.

Ključne riječi: subpanonski travnjak, flora, invazivne vrste

## INTRODUCTION

Croatia is considered to be one of the richest countries in Europe in terms of biodiversity. The reason for it lies in the specific geographical position of Croatia at the crossroads of three biogeographical regions. Each region is characterized by special ecological, climatic and geomorphological conditions. The great diversity of habitats has also resulted in a great number of wild taxa (species and subspecies). Thanks to its geographical position, geology and climate, Croatia abounds in diverse habitat types and ecosystems. The National Habitat Classification has so far described over 900 natural and semi-natural habitat types distributed in 11 basic categories (Official Gazette 88/2014). The basic requirement for the conservation of biological diversity is the preservation of ecosystems and natural habitats in-situ and the maintenance and restoration of the population of species capable of surviving in the natural environment. One of the natural methods of dry grassland preservation is using grazing animals. According to Skender (1990), grassland is a semi-natural habitat created by human activity, which enriches biodiversity. Semi-natural dry grasslands represent dominant types in most European countries and large contribution to the biodiversity (Vrahnakis et al., 2013). Dry grasslands in Croatia belong to rare habitats (Zima et al., 2019). The grassland biotopes have relatively dry and nutrient poor soils and plants adapted to those soils and grazing animals (Dostalek and Frantik, 2008). In the area of eastern Croatia, almost all grasslands have disappeared. The reason for this lies in the fact that this is a quality soil that has been turned into arable land with intensive cultivation, abandonment of traditional agricultural production and part of it is urbanized (Krstonošić et al., 2016).

Dry grasslands form a set of plant communities built of annual and perennial herbaceous plant species (hemicryptophytes) and semi-shrubs (hametophytes). Species composition is affected by recent land use (Dubravkova et al., 2010) and have been stable for many years depending on weather fluctuations (Fischer et al., 2020). According to the available data, the vascular flora of Croatia numbers 5145 species and subspecies (Flora Croatica Database). This number is constantly growing because new plant species and subspecies are being recorded in Croatia. Among them are native species, for which Croatia is a natural area of distribution, but also foreign species brought here by human activity. The spread of introduced (non-native) species can adversely affect human health, biodiversity and cause economic damage. These species are labeled as invasive species and they are a mayor threat (Rédei et al.,

2011). According to Nikolić (2020), 77 invasive species are listed in the Croatian flora today. Invasive species are weeds, perennial plants such as *Asclepias syriaca* L., shrubs and tree species such as *Robinia pseudacacia* L. (Mataus et al., 2003, Kelemen et al., 2015).

Bistrinci is an urbanized area located on the right bank of the river Drava. The grasslands in Bistrinci are botanically important habitats with an area of 29.5 ha and are part of the National Ecological Network. The continental climate of this area is characterized by a small amount of precipitation (700-800 mm) per year. Average annual air temperature varies from 10 to 12 °C. The specific vegetation of steppe-like dry grassland, which is also covered by the Habitats Directive, has been preserved at this site. In Bistrinci exists grassland As. *Danthonio-Chrysopogonetum* Kojić, which is found in this area due to the dry continental climate as in eastern Croatia. The flora of these grasslands has not been systematically researched. In the past, these grasslands were used for grazing horses and partly for mowing. Nowadays a part of it is urbanized and the area has been declared as a construction zone. Therefore, there is a danger of the complete disappearance of these grasslands (Alegro et al., 2010). According to the National Habitat Classification of the Republic of Croatia (Official Gazette 88/2014), this habitat belongs to the sub-Pannonian grassland of the order *Festucetalia valesiancae*. The Pontic-Mediterranean species *Chrysopogon gryllus* (L.) Trin predominates in this area.

## METHODS

Floristic research was conducted in the area of Bistrinci (45° 42' N, 11° 23' E) during 2020 and 2021. The average altitude is 98 m. The investigated area included grassland of 29.5 ha.

The determination of plant taxa was performed using standard determination keys: Javorka and Csapody (1975), Domac (2002), Rogošić (2011), Franjić and Škvorc (2010, 2014). The nomenclature is harmonized according to Tutin et al. (1964-1980) and Nikolić (2020). Life form is arranged in groups according to Pignatti (1982) and Rauš and Šeljuga (1983): Ch (chamaephyte) – hamephytes are perennial plants, whose buds are 25 cm above the ground; G (geophyte) – geophytes survive in an unfavourable part of the year as tubers, bulbs and rootstocks; H (hemicryptophyte) – hemicryptophytes are perennials that have buds just above the ground; P (phanerophyte) – phanerophytes are woody species, whose buds are located

at least 25 cm above the ground and T (therophyte) – therophytes survive in an unfavourable part of the year in the form of the seeds. Plant taxa are classified into 12 groups of floral elements according to Horvatić (1963), Tutin et al. (1964-1980) and Trinajstić (1975-1986):

- Mediterranean floral element – 1
- Illyrian – Balkan floral element – 2
- Southern European floral element – 3
- Atlantic floral element – 4
- Eastern European – Pontic floral element - 5
- Southeast European floral element – 6
- Central European floral element – 7
- European floral element – 8
- Eurasian floral element – 9
- Plants of circumcholarctic distribution – 10
- Widespread plants – 11
- Cultivated and adventitious plant – 12

Invasive taxa are specifically indicated in the list (\*) and determined by Nikolić et al. (2014).

## RESULTS AND DISCUSSION

Floristic research of the grassland in Bistrinci recorded 122 wild vascular taxa that, according to the systematics, belong to 37 families (Table 1). 33 families (89,20%) belong to dicotyledons, and 4 families (10,80%) to monocotyledons.

The most numerous taxa is the Asteraceae family with 18 taxa (14,75 %), followed by Fabaceae with 15 taxa (12,29 %), Poaceae with 11 taxa (9,01 %) and Rosaceae with 10 taxa (8,19 %). 18 families are presented with only one type of taxa (Boraginaceae, Salicaceae, Chenopodiaceae, Campanulaceae, Cistaceae, Convolvulaceae, Juglandaceae, Euphorbiaceae, Clusiaceae, Malvaceae, Urticaceae, Vitaceae, Iridaceae, Resedaceae, Phytolaccaceae, Saxifragaceae, Simaroubaceae, Verbenaceae). Seven families are presented with two taxa (Caprifoliaceae, Ranunculaceae, Cyperaceae, Dipsacaceae, Liliaceae, Papaveraceae, Plantaginaceae). Figure 3. shows families with more than three taxa. Somme families have numerous taxa like in the research conducted by Mandir et al. (2018).

**Table 1 Floristic list**

**Tablica 1. Popis biljaka**

| Taxa                                       | Family          | Life form | Floral element |
|--|-----------------|-----------|----------------|
| <i>Daucus carota</i> L.                    | Apiaceae        | H         | 9              |
| <i>Eryngium campestre</i> L.               | Apiaceae        | H         | 3              |
| <i>Pastinaca sativa</i> L.                 | Apiaceae        | H         | 9              |
| <i>Peucedanum oreoselinum</i> (L.) Moench  | Apiaceae        | H         | 3              |
| <i>Achillea millefolium</i> L.             | Asteraceae      | H         | 11             |
| <i>Ambrosia artemisiifolia</i> L. *        | Asteraceae      | T         | 12             |
| <i>Anthemis austriaca</i> Jacq.            | Asteraceae      | T         | 5              |
| <i>Arctium lappa</i> L.                    | Asteraceae      | H         | 9              |
| <i>Artemisia annua</i> L. *                | Asteraceae      | H         | 11             |
| <i>Centaurea jacea</i> L.                  | Asteraceae      | H         | 9              |
| <i>Cirsium arvense</i> (L.). Scop.         | Asteraceae      | G         | 9              |
| <i>Chondrilla juncea</i> L.                | Asteraceae      | H         | 9              |
| <i>Cichorium intybus</i> L.                | Asteraceae      | H         | 11             |
| <i>Conyza canadensis</i> (L.) Cronquist*   | Asteraceae      | T         | 12             |
| <i>Erigeron annuus</i> (L.) Pers. *        | Asteraceae      | H         | 12             |
| <i>Lactuca seriola</i> L.                  | Asteraceae      | T         | 5              |
| <i>Matricaria chamomilla</i> L.            | Asteraceae      | T         | 9              |
| <i>Senecio jacobaea</i> L.                 | Asteraceae      | H         | 9              |
| <i>Solidago gigantea</i> Ait. *            | Asteraceae      | H         | 12             |
| <i>Sonchus arvensis</i> L.                 | Asteraceae      | H         | 9              |
| <i>Tanacetum vulgare</i> L.                | Asteraceae      | H         | 9              |
| <i>Tragopogon pratensis</i> L.             | Asteraceae      | H         | 9              |
| <i>Myosotis arvensis</i> (L.). Hill.       | Boraginaceae    | T         | 9              |
| <i>Alyssum alyssoides</i> (L.) Nath.       | Brassicaceae    | T         | 3              |
| <i>Capsela bursa-pastoris</i> (L.). Med.   | Brassicaceae    | T         | 11             |
| <i>Sinapis arvensis</i> L.                 | Brassicaceae    | T         | 9              |
| <i>Sisymbrium officinale</i> (L.) Scop.    | Brassicaceae    | T         | 9              |
| <i>Campanula patula</i> L.                 | Campanulaceae   | H         | 7              |
| <i>Sambucus ebulus</i> L.                  | Caprifoliaceae  | G         | 5              |
| <i>Viburnum lantana</i> L.                 | Caprifoliaceae  | P         | 6              |
| <i>Cerastium glomeratum</i> Thuill.        | Caryophyllaceae | T         | 11             |
| <i>Silene alba</i> (Mill.) E. H. L. Krause | Caryophyllaceae | T         | 9              |
| <i>Stellaria graminea</i> L.               | Caryophyllaceae | H         | 9              |
| <i>Chenopodium album</i> L.                | Chenopodiaceae  | T         | 11             |
| <i>Helianthemum canum</i> (L.) Baumg.      | Cistaceae       | Ch        | 8              |
| <i>Hypericum perforatum</i> L.             | Clusiaceae      | H         | 9              |
| <i>Convolvulus arvensis</i> L.             | Convolvulaceae  | G         | 11             |
| <i>Carex elongata</i> L.                   | Cyperaceae      | G         | 9              |

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|   |                |    |    |
|---|----------------|----|----|
| <i>Carex caryophyllea</i> Latourr.      | Cyperaceae     | G  | 9  |
| <i>Knautia arvensis</i> (L.) Coult.     | Dipsacaceae    | H  | 7  |
| <i>Scabiosa ochroleuca</i> L.           | Dipsacaceae    | H  | 8  |
| <i>Euphorbia cyparissias</i> L.         | Euphorbiaceae  | H  | 9  |
| <i>Coronilla varia</i> L.               | Fabaceae       | H  | 8  |
| <i>Lotus corniculatus</i> L.            | Fabaceae       | H  | 11 |
| <i>Medicago falcata</i> L.              | Fabaceae       | H  | 5  |
| <i>Medicago lupulina</i> L.             | Fabaceae       | T  | 9  |
| <i>Medicago minima</i> (L.) Bartol.     | Fabaceae       | T  | 11 |
| <i>Melilotus albus</i> Med.             | Fabaceae       | H  | 7  |
| <i>Melilotus officinalis</i> (L.) Pall. | Fabaceae       | T  | 9  |
| <i>Ononis spinosa</i> L.                | Fabaceae       | Ch | 7  |
| <i>Robinia pseudacacia</i> L. *         | Fabaceae       | P  | 12 |
| <i>Trifolium campestre</i> Schreb.      | Fabaceae       | H  | 7  |
| <i>Trifolium pratense</i> L.            | Fabaceae       | H  | 9  |
| <i>Trifolium montanum</i> L.            | Fabaceae       | H  | 5  |
| <i>Trifolium repens</i> L.              | Fabaceae       | H  | 9  |
| <i>Vicia grandiflora</i> Scop.          | Fabaceae       | T  | 5  |
| <i>Vicia sativa</i> L.                  | Fabaceae       | T  | 7  |
| <i>Quercus</i> sp.                      | Fagaceae       | P  | 9  |
| <i>Erodium cicutarium</i> (L.) L'Her.   | Geraniaceae    | T  | 9  |
| <i>Geranium columbinum</i> L.           | Geraniaceae    | T  | 9  |
| <i>Geranium sanguineum</i> L.           | Geraniaceae    | H  | 5  |
| <i>Iris florentina</i> L.               | Iridaceae      | G  | 9  |
| <i>Juglans regia</i> L.                 | Juglandaceae   | P  | 12 |
| <i>Ajuga reptans</i> L.                 | Lamiaceae      | H  | 7  |
| <i>Glechoma hederacea</i> L.            | Lamiaceae      | H  | 9  |
| <i>Lamium purpureum</i> L.              | Lamiaceae      | T  | 7  |
| <i>Lathyrus tuberosus</i> L.            | Lamiaceae      | G  | 10 |
| <i>Prunella vulgaris</i> L.             | Lamiaceae      | H  | 5  |
| <i>Salvia pratensis</i> L.              | Lamiaceae      | H  | 7  |
| <i>Teucrium chamaedrys</i> L.           | Lamiaceae      | Ch | 3  |
| <i>Gagea pusilla</i> (Schm.) R. S.      | Liliaceae      | G  | 9  |
| <i>Muscari comosum</i> (L.) Mill.       | Liliaceae      | G  | 3  |
| <i>Ornithogalum umbellatum</i> L.       | Liliaceae      | G  | 7  |
| <i>Malva neglecta</i> Wallr.            | Malvaceae      | T  | 11 |
| <i>Chelidonium majus</i> L.             | Papaveraceae   | H  | 9  |
| <i>Papaver rhoeas</i> L.                | Papaveraceae   | T  | 9  |
| <i>Phytolacca americana</i> L. *        | Phytolaccaceae | G  | 12 |
| <i>Plantago lanceolata</i> L.           | Plantaginaceae | H  | 9  |
| <i>Plantago major</i> L.                | Plantaginaceae | H  | 9  |
| <i>Bothriochloa ischaemum</i> (L.) Keng | Poaceae        | H  | 9  |

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|  |                  |   |    |
|--|------------------|---|----|
| <i>Bromus hederaceus</i> L.                        | Poaceae          | T | 1  |
| <i>Bromus erectus</i> Huds.                        | Poaceae          | H | 11 |
| <i>Bromus sterilis</i> L.                          | Poaceae          | T | 9  |
| <i>Chrysopogon gryllus</i> (L.) Trin.              | Poaceae          | H | 5  |
| <i>Dactylis glomerata</i> L.                       | Poaceae          | H | 9  |
| <i>Festuca valesiaca</i> Schl.                     | Poaceae          | H | 6  |
| <i>Hordeum murinum</i> L.                          | Poaceae          | T | 1  |
| <i>Lolium perene</i> L.                            | Poaceae          | H | 8  |
| <i>Setaria</i> sp.                                 | Poaceae          | T | 11 |
| <i>Sorghum halepense</i> (L.) Pers. *              | Poaceae          | G | 11 |
| <i>Polygonum aviculare</i> L.                      | Polygonaceae     | T | 11 |
| <i>Reynoutria japonica</i> Houtt. *                | Polygonaceae     | G | 12 |
| <i>Rumex acetosela</i> L.                          | Polygonaceae     | H | 10 |
| <i>Rumex crispus</i> L.                            | Polygonaceae     | H | 9  |
| <i>Rumex obtusifolius</i> L.                       | Polygonaceae     | H | 7  |
| <i>Ranunculus acris</i> L.                         | Ranunculaceae    | H | 11 |
| <i>Ranunculus repens</i> L.                        | Ranunculaceae    | H | 11 |
| <i>Reseda lutea</i> L.                             | Resedaceae       | T | 7  |
| <i>Agrimonia eupatoria</i> L.                      | Rosaceae         | H | 10 |
| <i>Cotoneaster integerrimus</i> Med.               | Rosaceae         | P | 12 |
| <i>Crataegus oxycantha</i> L.                      | Rosaceae         | P | 9  |
| <i>Filipendula vulgaris</i> Moench                 | Rosaceae         | H | 9  |
| <i>Fragaria vesca</i> L.                           | Rosaceae         | H | 9  |
| <i>Potentilla argentea</i> L.                      | Rosaceae         | H | 11 |
| <i>Potentilla recta</i> L.                         | Rosaceae         | H | 9  |
| <i>Prunus spinosa</i> L.                           | Rosaceae         | P | 9  |
| <i>Rosa canina</i> L.                              | Rosaceae         | P | 9  |
| <i>Rubus caesius</i> L.                            | Rosaceae         | P | 9  |
| <i>Cruciata laevipes</i> Opiz                      | Rubiaceae        | G | 7  |
| <i>Galium aparine</i> L.                           | Rubiaceae        | T | 9  |
| <i>Galium verum</i> L.                             | Rubiaceae        | G | 11 |
| <i>Populus alba</i> L.                             | Salicaceae       | P | 9  |
| <i>Saxifraga bulbifera</i> L.                      | Saxifragaceae    | H | 3  |
| <i>Verbascum nigrum</i> L.                         | Scrophulariaceae | H | 9  |
| <i>Verbascum phlomoides</i> L.                     | Scrophulariaceae | H | 8  |
| <i>Verbascum phoeniceum</i> L.                     | Scrophulariaceae | H | 7  |
| <i>Veronica arvensis</i> L.                        | Scrophulariaceae | T | 5  |
| <i>Veronica chamaedrys</i> L.                      | Scrophulariaceae | G | 7  |
| <i>Ailanthus altissima</i> (Mill.) Swingle*        | Simaroubaceae    | P | 12 |
| <i>Urtica dioica</i> L.                            | Urticaceae       | H | 9  |
| <i>Verbena officinalis</i> L.                      | Verbenaceae      | T | 11 |
| <i>Parthenocissus quinquefolia</i> (L.). Planch. * | Vitaceae         | P | 12 |

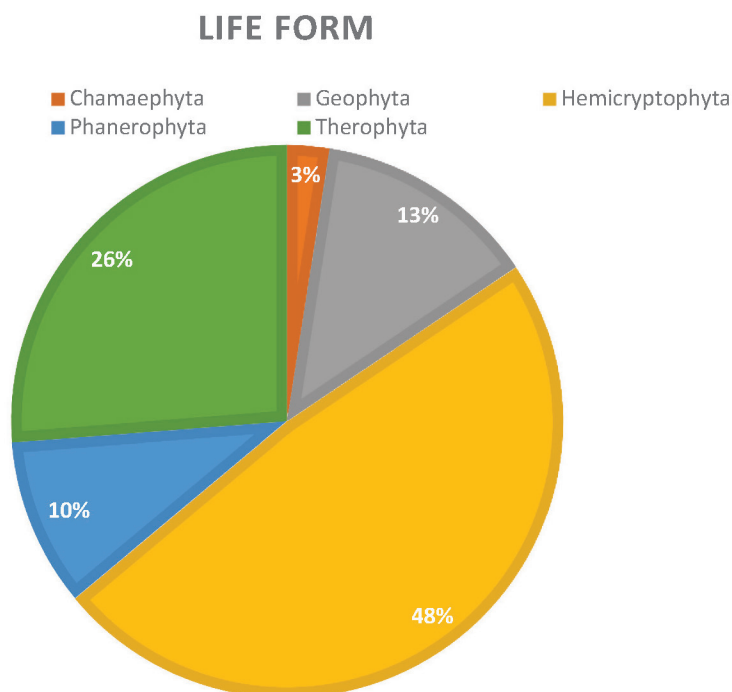


Hemicryptophytes predominate with 59 taxa (48%), followed by therophytes with 32 taxa (26%), geophyte are represented with 16 taxa (13%), phanerophyte with 12 taxa (10%), and chamaephyte with three taxa (3%) (Table 2., Figure 1.).

**Table 2 Life forms**

**Tablica 2. Životni oblici**

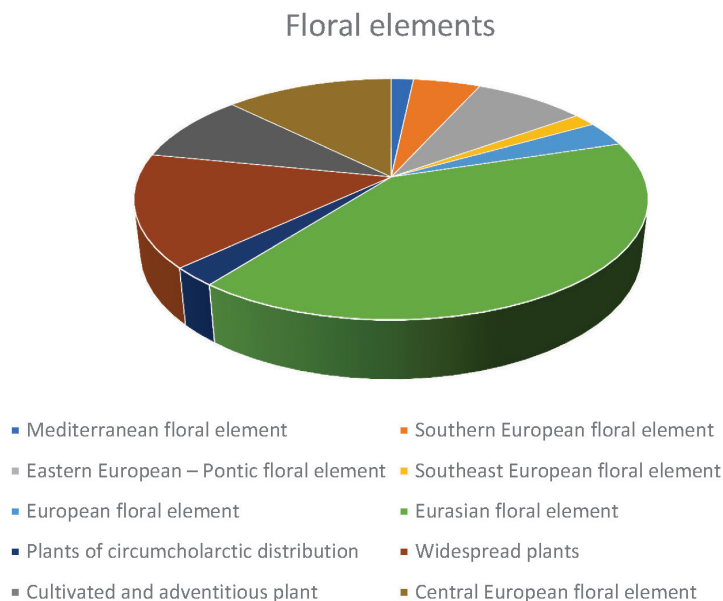
| Life forms          | Number of species | %      |
|---------------------|-------------------|--------|
| Phanerophyta (P)    | 12                | 10,00  |
| Chamaephyta (Ch)    | 3                 | 3,00   |
| Hemicryptophyta (H) | 59                | 48,00  |
| Geophyta (G)        | 16                | 13,00  |
| Therophyta (T)      | 32                | 26,00  |
| total               | 122               | 100,00 |



*Figure 1 The spectrum of the flora life forms on the grassland Bistrinci*  
*Grafikon 1. Spektar životnih oblika na travnjaku u Bistrincima*

The dominance of hemicryptophytes was also noted in studies conducted in 2017/18. (Mandir et al., 2018.). A higher presence of hemicryptophytes is characteristic of grasslands. The phanerophyte content of 10% favours the vegetation succession. The number of therophytes also increased compared to research in 2017/18 (Mandir et al., 2018.).

Phytogeographic analysis indicates the dominance of plants with Eurasian floral elements represented by 48 taxa (39%), followed by plants belonging to widespread plants with 19 taxa (15.5%), then central European floral elements with 15 taxa (12%), cultivated and adventitious plants with 11 taxa (9%), and the last come plants Eastern European – Pontic floral elements with 10 taxa (8,2%). Figure 2. shows all floral elements presented in the grassland Bistrinci.

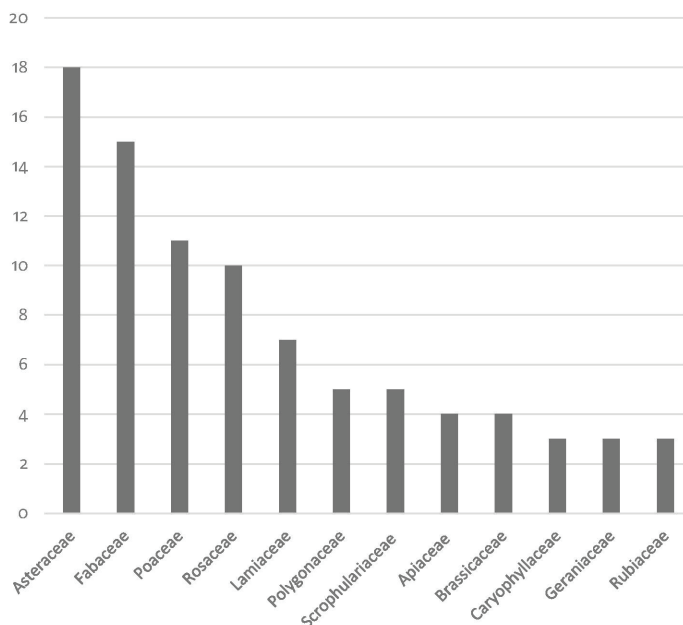


*Figure 2 The phytogeographical analysis of the flora on the grassland Bistrinci*  
*Grafikon 2. Analiza flornih elemenata travnjaka u Bistrincima*

Conducted analysis of flora shows an increase in the number of invasive taxa. Five invasive taxa, from 11 in total, belong to Asteraceae family. Invasive taxa in Croatian flora mostly come from North and South America (Nikolić et al., 2014.). Conducted research records seven such taxa. Three taxa come from Asia and only one is from Eurasia.

## CONCLUSION

Dry grasslands have almost completely disappeared in eastern Croatia. It has happened due to the urbanization, the conversion of grassland into agricultural land, the intensification of agriculture, the abandonment of villages and the changes in the traditional way of land use. These grasslands are considered to be a threatened and vulnerable habitat. The share of phanerophytes indicates that the grasslands will develop into forest. An increased number of invasive species suppresses natural vegetation. Therefore, it would be recommended to preserve such habitats by all available measures.



*Figure 3 Number of species by families*  
*Grafikon 3. Broj svojti po porodicama*

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