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## THE GRASSES (*POACEAE*) OF MEDVEDNICA NATURE PARK, CROATIA

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As a part of the study of Medvednica Nature Park flora, the distribution of the grass taxa has been studied. The floristic mapping resulted in the establishment of 100 grass taxa from 47 genera. The species *Brachypodium sylvaticum* was found to be the most widespread grass species in the Nature Park area. Twenty one species were recorded in one MTB 1/64 quadrant alone. The data on 31 taxa originate from earlier periods and their occurrence was not confirmed in the recent research. Grasses from Mount Medvednica can be assigned to 10 floral elements. Thirty five grasses which could be defined as ruderal, cultivated or weeds were found in Medvednica Nature Park. According to the Red Book of Vascular Flora of Croatia 14 species are threatened to some degree.

**Key words:** grasses, flora mapping, threat degree, distribution

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U sklopu istraživanja flore Medvednice proučavana je rasprostranjenost vrsta iz porodice trava (*Poaceae*). Analizom rezultata dosadašnjih florističkih istraživanja ustanovljeno je 100 svojiti trava iz 47 rodova. Vrsta *Brachypodium sylvaticum* je najrasprostranjenija, a 21 vrsta nađena je u samo jednom MTB 1/64 polju. Podaci o prisutnosti za 31 svojitu nisu potvrđeni našim terenskim istraživanjem. Trave Parka prirode Medvednica pripadaju u 10 florinih elemenata. Od ukupnog broja trava njih 35 se može označiti kao ruderalne, kultivirane ili korovne. Prema Crvenoj knjizi vaskularne flore Hrvatske 14 vrsta ima neki od stupnjeva ugroženosti.

**Ključne riječi:** trave, kartiranje flore, stupanj ugroženosti, rasprostranjenost

### INTRODUCTION

The grass family is one of the largest plant families worldwide. Depending on taxonomic approach it includes 600 (GOULD, 1968) to 750 genera (CONERT, 1998) and 7500 to 10000 species. Grasses inhabit a larger surface of the Earth than any other plant family. Grass species have adapted to a huge range of habitats, from tropical

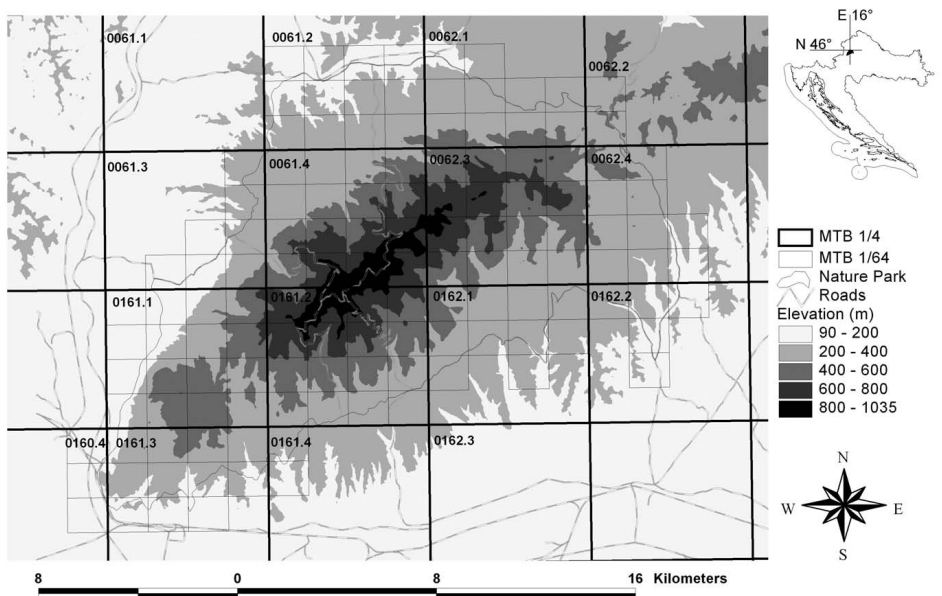
to polar climates, and they formed grassland communities after the Upper Cretaceous and especially in the Tertiary age (GOULD, 1968).

In the flora of Croatia 355 species and subspecies of about 800 (TUTIN *et al.*, 1980) taxa present in Europe were recorded (ILIJANIĆ & TOPIĆ, 2000). Among them 98 taxa are included in Croatia's Red Book of Vascular Flora (NIKOLIĆ & TOPIĆ, 2005).

Systematic floristic mapping of Croatia has not been carried out so far, not even in all protected areas such as national and nature parks. The first systematic mapping based on a grid system of flora in Croatia was carried out in Medvednica Nature Park during the years 1997 and 1998, with the principal task of testing appropriateness of MTB 1/64 grid as a basis for floristic mapping in the field. This was further tested, including chorological data about orchids from literature and herbariums as well (HRŠAK *et al.* 1999). Therefore, as a part of the study of the park's flora, the distribution of the grass taxa on Mount Medvednica has been studied, resulting in the distribution data presented in this paper.

## STUDY AREA

Mount Medvednica, approximately 40 km in length and 9 km in width, stretches from southwest to northeast between 15°49'45" – 16°07'45" east longitude and 45°49'00" – 45°59'00" north latitude (Fig. 1). It is situated north of Zagreb, the capi-



**Fig. 1.** Upper right corner – position of the studied area (Medvednica Nature Park) in Croatia. Larger image – Nature park with the MTB 1/64 mapping grid. MTB 1/4 units are labelled with the corresponding number.

tal of Croatia whose population numbers about one million inhabitants. In the center of the massif lies its highest peak Sljeme with an altitude of 1035 m.

In 1981 the western part of the Medvednica massif was declared a nature park. The total area of the Medvednica Nature Park is 228.26 km<sup>2</sup> and is mostly covered with forest (63.6 %), while grasslands, arable land, settlements and roads occupy the rest.

The climate of Mount Medvednica is moderately continental with an average temperature of 6.2°C (BÖHM *et al.*, 1979) and an average annual total precipitation of 1238 mm at the peak (HRŠAK, 1993).

## MATERIALS AND METHODS

The data on taxa distribution within the Nature Park were collected from three sources: field observation, literature and herbaria.

Field mapping was conducted between 1997 and 1998 on multiple field trips throughout the vegetation period. As a grid for stratified sampling the MTB fields of the Central European flora mapping grid were used. The basic MTB 1/64 units are approximately rectangles with average measurements of 1.5 x 1.4 km and average area of 2.1 km<sup>2</sup>; they were used according to the standard proposed for the mapping of Croatian flora for protected areas (NIKOLIĆ *et al.*, 1998). The positioning and identification of the boundaries of the mapping units in the field were determined by a GPS receiver and 1:25000 topographic maps.

The literature references used to gather data on localities were: BRKIĆ, 1972; BULIĆ, 1952; DOBROVIĆ *et al.*, 2006; EGIĆ, 1978; FORENBACHER, 1908; GLIGOREVIĆ, 1955; HULINA, 1981, 1994; JELASKA, 1999; KLINGGRÄFF, 1861; KUIŠ, 1955; MIHELJ, 1982; NEILREICH, 1868; PAVLICA, 1953; POPOVIĆ, 2002; REGER, 2002; SCHLOSSER & VUKOTINović, 1869; ŠUTIĆ-SUKIĆ, 1953; TOMIĆ, 1953 and URLIĆ-IVANOVIĆ, 1952.

The herbarium specimens that were studied belong to the herbarium of Ivo and Marija Horvat (ZAHO) and Herbarium Croaticum (ZA) in Zagreb.

The data collected from the literature and the herbaria were grouped into three age categories: data originating before 1940, data collected between 1941 and 1980 and data collected after 1981.

The nomenclature of the plant taxa was given according to Index Florae Croaticae (ILIJANIĆ & TOPIĆ, 2000).

The arrangement of the grasses into floral elements is mostly done according to ŠEGULJA (1977) and STANČIĆ (1994). For the species not mentioned there we used PIGNATTI (1982) and CONERT (1998).

Grasses present were also analyzed with respect to whether they are cultivated or occur opportunistically in habitats disturbed by human impact. We defined those grasses according to SEYBOLD *et al.* (1998), CONERT (1998) and AICHELE & SCHWEGLER (1998). These species are marked in Tab. 1 with a plus (+) sign in the related column.

The geocoding observations in the field were carried out on the spot by using a GPS receiver and 1:25000 topographic maps. The literature data were geocoded, on

the basis of locality description, while the herbarium specimens were geocoded according to the data provided on the labels. The toponyms of the finding localities which were not described precisely enough could not be geocoded, but were included in the data analysis.

All the data from the field lists, literature and herbaria were recorded in the CROFlora 2.0 database (NIKOLIĆ *et al.*, 2001).

## RESULTS

The floristic mapping in the Medvednica Nature Park resulted in 100 grass taxa from 47 genera (Tab. 1).

The species *Brachypodium sylvaticum* was recorded in 66 of the total of 135 quadrants and is the most widespread grass species in the nature park area. The second most widespread grass species was *Echinochloa crus-galli*, recorded in 50 quadrants. This species grows mostly on ruderal and weed habitats and likes a warm environment. It is not restricted by soil pH or calcium amount. On Mount Medvednica the species *Echinochloa crus-galli* is recorded in so many quadrants because of the fact that in edge and lower areas of the nature park there are many adequate habitats for its growth. In the eastern parts of the investigated area there are even some villages and agricultural land inside the nature park (Fig. 2). The rare species con-

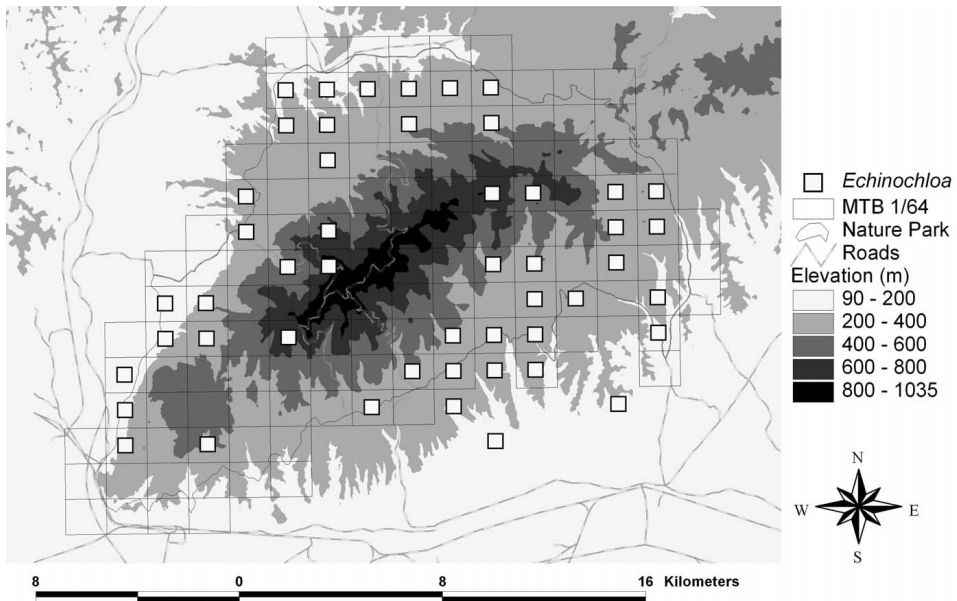


Fig. 2. Distribution of species *Echinochloa crus-galli* on MTB 1/64 grid.

**Tab. 1.** Grass species list with their status (cultivated or occurring opportunistically on habitats disturbed by man), floral elements and finding quadrants

No.	Species name	Cult./ dist.	Floral element	MTB 1/64 field
1.	<i>Agrostis canina</i> L.		Eurasian	0161/342
2.	<i>Agrostis capillaris</i> L.	+	Circum-holarctic	0162/111, 0061/441, 0161/142, 0161/241, 0161/223, 0161/221, 0061/443, 0161/122, 0161/233, 0062/131, 0061/233, 0062/324, 0162/133
3.	<i>Agrostis gigantea</i> Roth		Circum-holarctic	0161/322, 0161/223
4.	<i>Agrostis stolonifera</i> L.		Widespread	0161/342, 0061/442, 0061/324, 0062/134, 0062/144, 0062/233
5.	<i>Aira caryophyllea</i> L.		Atlantic	0161/342
6.	<i>Aira elegantissima</i> Schur		Mediterranean	0061/242, 0161/142
7.	<i>Alopecurus aequalis</i> Sobol.		Circum-holarctic	Unknown
8.	<i>Alopecurus geniculatus</i> L.		Mediterranean	Unknown
9.	<i>Alopecurus pratensis</i> L.		Eurasian	0061/443, 0161/142, 0161/342, 0161/124, 0161/311, 0161/143, 0161/314, 0161/121, 0161/123, 0062/432, 0062/434, 0162/114, 0162/121, 0162/212, 0162/214
10.	<i>Alopecurus rendlei</i> Eig.		Mediterranean	0161/142
11.	<i>Anthoxanthum odoratum</i> L.		Eurasian	0061/244, 0061/442, 0061/441, 0161/342, 0161/142, 0161/423, 0161/211, 0062/333, 0062/131, 0062/144, 0062/143, 0062/132, 0062/133, 0062/341, 0062/411, 0161/241, 0161/121
12.	<i>Apera spica-venti</i> (L.) P. Beauv.	+	Eurasian	0162/112, 0162/114, 0162/121, 0162/132, 0162/232
13.	<i>Arrhenatherum elatius</i> (L.) J. Presl & C. Presl		Eurasian	0061/442, 0161/322, 0161/421, 0161/223, 0161/224, 0161/142, 0161/321, 0161/341, 0161/311, 0161/323, 0161/331, 0161/143, 0161/314, 0161/112, 0161/114, 0160/424, 0062/131, 0062/322, 0062/134, 0062/144, 0062/132, 0062/341, 0062/431, 0062/434, 0162/114, 0162/121, 0162/212, 0162/214, 0162/232, 0162/123
14.	<i>Avena sativa</i> L.	+	Cultural and adventitious	0160/424, 0161/342, 0161/142, 0162/232, 0062/433
15.	<i>Avenula pubescens</i> (Dumort.) Dumort.		Eurasian	0061/441, 0161/314, 0162/112

16.	<i>Brachypodium pinnatum</i> (L) P. Beauv.	+	Eurasian	0061/441, 0161/342, 0161/241, 0161/313, 0161/323, 0161/331, 0161/143, 0062/134, 0062/144, 0062/233, 0062/143, 0062/132, 0062/342, 0062/343, 0062/344, 0062/411, 0062/431, 0062/432, 0062/433, 0162/112, 0162/121, 0162/122, 0162/132, 0162/131, 0162/211, 0162/212, 0162/123
17.	<i>Brachypodium sylvaticum</i> (Huds.) P. Beauv.		Eurasian	0061/344, 0061/324, 0061/431, 0061/443, 0061/441, 0061/421, 0061/241, 0061/244, 0061/242, 0161/342, 0161/142, 0161/241, 0161/223, 0161/122, 0161/233, 0161/132, 0161/133, 0161/321, 0161/341, 0161/311, 0161/141, 0161/313, 0161/331, 0161/143, 0161/314, 0161/312, 0161/134, 0161/112, 0161/114, 0161/121, 0161/123, 0062/131, 0062/321, 0062/323, 0062/134, 0062/144, 0062/233, 0062/311, 0062/143, 0062/132, 0062/133, 0062/332, 0062/333, 0062/334, 0062/341, 0062/342, 0062/343, 0062/344, 0062/411, 0062/413, 0062/414, 0062/432, 0062/433, 0062/434, 0162/111, 0162/112, 0162/113, 0162/144, 0162/121, 0162/122, 0162/132, 0162/131, 0162/141, 0162/211, 0162/214, 0162/123
18.	<i>Briza media</i> L.		Eurasian	0061/441, 0061/442, 0161/142, 0161/323, 0161/312, 0062/131, 0062/322, 0062/134, 0062/432, 0062/434, 0162/114, 0162/121, 0162/211, 0162/123, 0162/132, 0160/424
19.	<i>Bromus arvensis</i> L.	+	Eurasian	0161/342
20.	<i>Bromus benekenii</i> (Lange) Trimen		Eurasian	0061/422, 0161/234, 0062/314, 0062/324, 0062/313, 0062/312, 0062/311, 0062/332, 0062/331, 0062/333, 0062/334, 0061/343, 0062/41, 0162/111, 0162/113
21.	<i>Bromus commutatus</i> Schrad.	+	European	0161/142
22.	<i>Bromus erectus</i> Huds.		Eurasian	0061/244, 0161/342, 0161/141, 0161/313, 0161/323, 0062/134, 0062/144, 0062/341, 0062/341, 0062/342, 0062/432, 0162/112, 0162/114, 0162/121, 0162/212, 0162/123
	<i>Bromus hordeaceus</i> L.	+	Widespread	Unknown

23.	<i>Bromus hordeaceus</i> L. subsp. <i>hordeaceus</i>	+	Widespread	0061/442, 0161/223, 0161/224, 0161/142, 0161/323, 0161/312, 0161/114, 0161/123, 0162/112, 0162/114, 0161/214, 0062/132, 0062/341, 0062/343, 0062/432
24.	<i>Bromus inermis</i> Leyss.	+	Eurasian	0161/323
25.	<i>Bromus japonicus</i> Thunb.	+	Eurasian	0161/142
26.	<i>Bromus racemosus</i> L.		Widespread	0062/131, 0162/212, 0162/232
27.	<i>Bromus ramosus</i> Huds.		Eurasian	0061/423, 0161/32, 0161/223, 0161/122, 0161/241, 0161/221, 0161/212, 0062/314, 0062/313, 0062/312, 0062/311, 0062/332, 0062/331, 0062/334, 0162/111
28.	<i>Bromus secalinus</i> L.	+	Eurasian	Unknown
29.	<i>Bromus sterilis</i> L.	+	Mediterranean	0061/324, 0062/144, 0062/343, 0062/434, 0161/324, 0161/122, 0161/142, 0161/341, 0161/314, 0162/211, 0162/212, 0162/112, 0162/114, 0162/121, 0162/214, 0162/232
30.	<i>Calamagrostis arundinacea</i> (L.) Roth		Eurasian	0061/444, 0061/4, 0161/142, 0161/323, 0161/122, 0161/241, 0161/223, 0161/222, 0161/224, 0161/212, 0062/332, 0062/432, 0161/211
31.	<i>Calamagrostis epigejos</i> (L.) Roth		Eurasian	0061/442, 0061/434, 0061/234, 0061/414, 0061/432, 0161/213, 0161/342, 0161/223, 0161/233, 0161/232, 0161/132, 0161/311, 0161/313, 0161/323, 0161/331, 0161/143, 0161/314, 0161/312, 0161/123, 0062/431, 0062/314, 0062/321, 0062/322, 0062/323, 0062/313, 0062/411, 0062/413, 0062/414, 0062/432, 0062/134, 0062/144, 0062/331, 0062/333, 0062/341, 0062/342, 0062/344, 0162/111, 0162/113, 0162/122, 0162/132, 0162/131, 0162/133
32.	<i>Corynephorus canescens</i> (L.) P. Beauv.		Atlantic	Unknown
33.	<i>Cynodon dactylon</i> (L.) Pers.	+	Widespread	0061/241, 0061/231, 0061/412, 0161/142, 0161/132, 0161/341, 0161/331, 0161/314, 0062/131, 0062/343, 0162/113, 0162/121, 0162/122, 0162/132, 0162/131, 0162/141, 0162/123

34.	<i>Cynosurus cristatus</i> L.		Widespread	0061/442, 0161/242, 0161/342, 0161/141, 0161/424
	<i>Dactylis glomerata</i> L.		Central European	0161/223, 0161/423, 0161/142, 0161/124, 0161/342, 0161/213, 0161/211, 0161/242, 0161/214, 0161/234, 0161/233, 0161/212, 0161/132, 0161/133, 0161/321, 0161/323, 0161/331, 0161/314, 0161/143, 0161/112, 0161/114, 0161/123
35.	<i>Dactylis glomerata</i> (L.) subsp. <i>glomerata</i>		Central European	0161/342, 0061/243, 0061/421
36.	<i>Dactylis glomerata</i> L. subsp. <i>aschersoniana</i> (Graebn.) Thell.		Central European	0161/241, 0161/223, 0161/221, 0062/332, 0062/334
37.	<i>Danthonia decumbens</i> (L.) DC.		European	0161/342
38.	<i>Deschampsia caespitosa</i> (L.) P. Beauv.		Widespread	0061/423, 0161/322, 0161/223, 0161/323, 0062/314, 0062/342, 0062/413, 0162/211
39.	<i>Deschampsia flexuosa</i> (L.) Trin.		Widespread	0161/142, 0161/322, 0161/223, 0161/212, 0062/333
40.	<i>Dichanthium ischaemum</i> (L.) Roberty	+	Eurasian	Unknown
41.	<i>Digitaria sanguinalis</i> (L.) Scop.	+	Widespread	0061/342, 0161/142, 0062/131, 0162/122, 0162/133, 0162/211, 0162/212
42.	<i>Echinochloa crus-galli</i> (L.) P. Beauv.	+	Widespread	0061/433, 0061/434, 0061/342, 0061/324, 0061/241, 0061/244, 0061/242, 0061/232, 0061/234, 0061/231, 0061/233, 0061/412, 0061/432, 0161/213, 0161/242, 0161/243, 0161/133, 0161/321, 0161/311, 0161/112, 0161/114, 0161/121, 0161/123, 0161/131, 0062/131, 0062/314, 0062/322, 0062/323, 0062/134, 0062/132, 0062/334, 0062/343, 0062/413, 0062/414, 0062/431, 0062/432, 0062/433, 0162/122, 0162/113, 0162/114, 0162/121, 0162/132, 0162/131, 0162/133, 0162/141, 0162/212, 0162/214, 0162/233, 0162/123, 0162/312
43.	<i>Elymus repens</i> (L.) Gould	+	Circum-holarctic	0061/442, 0061/424, 0061/434, 0061/342, 0161/213, 0161/211, 0161/242, 0161/423, 0161/224, 0061/241, 0062/134, 0161/341, 0162/114, 0162/121, 0162/133, 0162/214, 0162/232, 0162/313, 0162/323, 0162/123, 0160/424, 0061/423



44.	<i>Eragrostis pilosa</i> (L.) P. Beauv.	+	Widespread	Unknown
45.	<i>Festuca alpina</i> Suter		South European	0062/324
46.	<i>Festuca altissima</i> All.		Eurasian	0061/443, 0161/214, 0161/213, 0161/222, 0161/221, 0161/122, 0161/212, 0161/321, 0161/311, 0161/143, 0062/313, 0062/332, 0062/331, 0062/333, 0062/334, 0062/341, 0062/343, 0062/413, 0062/414, 0162/132, 0162/131, 0162/133, 0162/212, 0162/232
47.	<i>Festuca arundinacea</i> Schreb.	+	Eurasian	0161/341, 0161/323, 0161/131, 0062/131, 0062/132, 0062/432, 0062/434, 162/112, 0162/113, 0162/114, 0162/121, 162/132, 0162/131, 0162/133, 0162/141, 0162/123
48.	<i>Festuca drymeja</i> Mert. & Koch		South European	0061/144, 0061/342, 0061/344, 0061/344, 0061/444, 0061/423, 0061/441, 0062/144, 0062/143, 0161/214, 0161/412, 0161/132, 0161/134
49.	<i>Festuca gigantea</i> (L.) Vill.		Eurasian	0061/342, 0061/442, 0061/433, 0061/434, 0061/443, 0061/441, 0061/241, 0061/432, 0161/324, 0161/241, 0161/213, 0161/221, 0161/214, 0161/224, 0161/132, 0161/133, 0161/321, 0161/311, 0161/141, 0161/331, 0161/143, 0161/314, 0161/312, 0161/121, 0161/123, 0062/314, 0062/321, 0062/322, 0062/323, 0062/324, 0062/313, 0062/312, 0062/341, 0062/411, 0062/413, 0062/144, 0062/143, 0062/132, 0062/133, 0062/332, 0062/331, 0062/333, 0062/334, 0162/111, 0162/112, 0162/113, 0162/211
50.	<i>Festuca heterophylla</i> Lam.		Eurasian	0161/342, 0161/322, 0161/124, 0161/223, 0161/323, 0162/122, 0161/224, 0161/421, 0161/311, 0161/121, 0062/333, 0062/314, 0062/321, 0062/322, 0062/323, 0062/324, 0062/233, 0062/143, 0062/341, 0062/343, 0062/413, 0162/114, 0162/121, 0162/133
51.	<i>Festuca ovina</i> L.		Circum-holarctic	Unknown

52.	<i>Festuca pratensis</i> Huds.		Eurasian	0061/442, 0061/441, 0161/242, 0161/142, 0161/342, 0161/124, 0161/342, 0161/323, 0161/143, 0161/314, 0161/312, 0161/114, 0062/131, 0062/134, 0062/132, 0062/343, 0062/432, 0062/433, 0062/434, 0162/114, 0162/121, 0162/1312, 0162/211, 162/212, 0162/214, 0162/232
53.	<i>Festuca pseudovina</i> Hack. ex Wiesb.		Mediterranean	0161/323
54.	<i>Festuca rubra</i> L.		Circum-holarctic	0061/442, 0061/441, 0061/131, 0162/212
55.	<i>Festuca tenuifolia</i> Sibth.		Central European	0061/441, 0161/124, 0161/142, 0062/432
56.	<i>Festuca valesiaca</i> Schleich. ex Gaudin		Southeast European	0062/431, 0062/432
57.	<i>Glyceria fluitans</i> (L.) R. Br.		Widespread	0062/312
58.	<i>Glyceria plicata</i> (Fr.) Fr.		Widespread	0061/241
59.	<i>Hierochloa australis</i> (Schrud.) Roem. et Schult.		Southeast European	0161/342, 0161/223, 0161/233, 0161/142, 0161/241, 0161/242, 0161/132, 0062/322, 0062/324, 0062/431, 0062/432, 0062/434, 0162/113, 0162/122
60.	<i>Holcus lanatus</i> L.		Eurasian	0061/244, 0061/441, 0061/442, 0061/241, 0161/223, 0161/422, 0161/142, 0161/342, 0161/314, 0161/222, 0161/122, 0161/214, 0161/341, 0161/323, 0161/143, 0161/114, 0161/121, 0062/233, 0062/131, 0062/132, 0062/341, 0062/343, 0162/114, 0162/212, 0162/232
61.	<i>Holcus mollis</i> L.		Circum-holarctic	0061/241
62.	<i>Hordeum murinum</i> L.	+	Circum-holarctic	0161/124, 0161/224, 0161/342, 0161/213, 0161/233, 0161/232, 0161/321, 0161/341, 0161/331, 0161/314, 0162/114, 0162/122, 0162/132, 0162/212, 0162/214, 0162/123
63.	<i>Koeleria pyramidata</i> (Lam.) P. Beauv.		Central European	0062/342
64.	<i>Lolium multiflorum</i> Lam.	+	Mediterranean	0161/142, 0161/322, 0161/223, 0161/112, 0062/342

65.	<i>Lolium perenne</i> L.	+	European	0061/442, 0061/342, 0061/244, 0061/242, 0061/231, 0161/242, 0161/142, 0161/233, 0161/212, 0161/331, 0161/143, 0161/314, 0161/312, 0161/112, 0161/123, 0062/131, 0062/134, 0062/132, 0061/341, 0062/343, 0062/413, 0062/431, 0062/434, 0162/113, 0162/114, 0162/122, 0162/132, 0162/131, 0162/212, 0162/214, 0160/424
66.	<i>Lolium rigidum</i> Gaudin	+	Widespread	0161/324
67.	<i>Lolium temulentum</i> L.	+	Widespread	Unknown
68.	<i>Melica ciliata</i> L.		Mediterranean	Unknown
69.	<i>Melica nutans</i> L.		Eurasian	0061/242, 0161/342, 0161/424, 0161/142, 0161/323
70.	<i>Melica uniflora</i> Retz.		European	0061/422, 0061/421, 0061/243, 0061/241, 0161/142, 0161/342, 0161/421, 0161/124, 0161/122, 0161/223, 0161/324, 0161/241, 0161/222, 0161/242, 0161/234, 0161/233, 0161/232, 0161/132, 0161/143, 0062/233, 0062/131, 0062/322, 0062/323, 062/324, 0062/312, 0062/332, 0062/333, 0062/341, 0062/343, 0062/413, 0062/434, 0162/111, 0162/113, 0162/114, 0162/132, 0162/133, 0162/212, 0162/232
71.	<i>Milium effusum</i> L.		Circum-holarctic	0061/344, 0061/443, 0061/441, 0161/223, 0161/421, 0161/214, 0161/342, 0161/122, 0161/423, 0161/323, 0161/142, 0161/241, 0161/213, 0161/221, 0062/332, 0062/331, 0062/342
72.	<i>Molinia caerulea</i> (L.) Moench subsp. <i>arundinacea</i> (Schrank) H. K. G.Paul		Eurasian	0061/443, 0061/441, 0061/423, 0061/421, 0061/243, 0061/241, 0061/412, 0061/414, 0061/432, 0161/223, 0161/221, 0161/212, 0062/312
	<i>Molinia caerulea</i> (L.) Moench		Circum-holarctic	0161/143, 0062/431, 0162/123
73.	<i>Nardus stricta</i> L.		Circum-holarctic	0061/441
74.	<i>Panicum capillare</i> L.	+	Cultural and adventitious	0061/231, 0161/322, 0161/342, 0161/132, 0161/114, 0062/132, 0062/414, 0062/433, 0162/132, 0162/131, 0162/141, 0162/212, 0162/232, 0161/123

75.	<i>Panicum miliaceum</i> L.	+	Cultural and adventitious	0061/342, 0161/331, 0160/424
76.	<i>Phalaris arundinacea</i> L.		Circum-holarctic	0161/114, 0162/123
77.	<i>Phleum alpinum</i> L.		South European	Unknown
78.	<i>Phleum phleoides</i> (L.) H. Karst.		Eurasian	Unknown
79.	<i>Phleum pratense</i> L.		Circum-holarctic	0061/442, 0061/434, 0061/412, 0161/142, 0162/311
80.	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.		Widespread	0061/244, 0062/322, 0062/413, 0062/414
81.	<i>Poa annua</i> L.	+	Widespread	0061/442, 0061/444, 0061/433, 0061/434, 0061/441, 0061/423, 0061/243, 0061/243, 0061/443, 0061/241, 0061/244, 0061/242, 0061/231, 0061/414, 0061/432, 0161/342, 0161/223, 0161/323, 0161/424, 0161/241, 0161/213, 0161/211, 0161/221, 0161/214, 0161/212, 0161/133, 0161/341, 0161/331, 0161/314, 0161/114, 0161/121, 0161/131, 0062/131, 0062/314, 0062/322, 0062/323, 0062/324, 0062/313, 0062/312, 0062/134, 0062/144, 0062/132, 0062/334, 0062/341, 0062/343, 0062/411, 0062/432, 0062/434, 0162/112, 0162/113, 0162/114, 0162/121, 0162/131, 0162/133, 0162/212, 0162/214, 0162/232, 0061/421
82.	<i>Poa bulbosa</i> L.		Eurasian	Unknown
83.	<i>Poa compressa</i> L.	+	Widespread	0061/434, 0161/342, 0161/142
84.	<i>Poa glauca</i> Vahl	+	Circum-holarctic	Unknown
85.	<i>Poa nemoralis</i> L.		Circum-holarctic	0161/342, 0161/322, 0161/223, 0161/412, 0161/324, 0161/233, 0062/321, 0062/313, 0062/332, 0062/333, 0162/111, 0162/114, 0162/122, 0162/132
86.	<i>Poa palustris</i> L.		Circum-holarctic	0162/212
87.	<i>Poa pratensis</i> L.		Circum-holarctic	0061/242, 0061/244, 0062/131, 0062/134, 0062/144, 0062/322, 0062/341, 0062/342, 0062/343, 0062/411, 0062/431, 0062/432, 0062/434, 0161/112, 0161/114, 0161/121, 0161/123, 0161/142, 0161/223, 0161/312, 0161/314, 0161/323, 0161/323, 0161/331, 0161/341, 0162/112, 0162/114, 0162/121, 0162/122, 0162/212, 0162/214, 0162/232

88.	<i>Poa trivialis</i> L.		Eurasian	0061/442, 0061/241, 0061/131, 0061/142, 0061/314, 0161/314, 0161/342, 0161/341, 0161/323, 0161/143, 0161/312, 0062/132, 0062/413, 0162/113, 0162/114, 0162/214, 0162/232
89.	<i>Secale sylvestre</i> Host.		Eurasian	0161/423
90.	<i>Sesleria autumnalis</i> (Scop.) F.W. Schultz		Southeast European	Unknown
91.	<i>Sesleria caerulea</i> (L.) Ard.		Central European	Unknown
	<i>Sesleria tenuifolia</i> Schrad.		South European	0062/233, 0062/322, 0162/132, 0062/334
92.	<i>Sesleria tenuifolia</i> Schrad. subsp <i>kalnikensis</i> (Jáv.) Deyl		South European	0159/1, 0062/3, 0062/332, 0062/432, 0062/4, 0161/132
93.	<i>Setaria italica</i> (L.) P. Beauv.		Cultural and adventitious	Unknown
94.	<i>Setaria pumilla</i> (Poir.) Schult.	+	Widespread	0161/342, 0161/211, 0161/311, 0161/313, 0161/331, 0161/314, 0161/112, 0161/114, 0161/121, 0161/131, 0062/134, 0062/144, 0062/332, 0062/334, 0062/344, 0062/411, 0062/413, 0062/414, 0062/431, 0062/432, 0062/433, 0062/434, 0160/424, 0162/112, 0162/113, 0162/114, 0162/121, 0162/122, 0162/132, 0162/131, 0162/133, 0162/141, 0162/211, 0162/214, 0162/123
95.	<i>Setaria viridis</i> (L.) P. Beauv.	+	Eurasian	0161/142, 0161/213, 0161/211, 0161/331, 0061/442, 0061/433, 0061/344, 0061/434, 0061/342, 0061/422, 0061/241, 0061/242, 0061/234, 0061/231, 0061/233, 0061/412, 0061/414, 0061/432
96.	<i>Sorghum halepense</i> (L.) Pers.	+	Circum-holarctic	0161/313, 0161/314, 0161/312, 0160/424, 0062/342, 0062/343, 0162/113, 0162/131, 0162/141
97.	<i>Trisetum flavescens</i> (L.) P. Beauv.		Circum-holarctic	0061/442, 0061/441, 0161/142, 0161/342, 0161/323, 0161/143, 0161/314, 0161/312, 0062/131, 0062/134, 0062/144, 0062/143, 0062/132, 0062/341, 0062/342, 0062/344, 0062/431, 0162/112, 0162/114, 0162/121, 0162/214, 0162/232
98.	<i>Ventenata dubia</i> (Leers) Coss.	+	Mediterranean	0161/242
99.	<i>Vulpia myuros</i> (L.) C. C. Gmel.	+	Widespread	0161/342
100.	<i>Zea mays</i> L.	+	Cultural and adventitious	0162/232

Tab. 2 Grass taxa not confirmed in the recent field research

No.	Grass taxa	Herbarium data	Literature data
1.	<i>Agrostis gigantea</i> Roth	+	+
2.	<i>Aira caryophylla</i> L.	+	+
3.	<i>Aira elegantissima</i> Schur	+	+
4.	<i>Alopecurus aequalis</i> Sobol.	–	+
5.	<i>Alopecurus geniculatus</i> L.	–	+
6.	<i>Alopecurus rendlei</i> Eig	–	+
7.	<i>Bromus arvensis</i> L.	+	+
8.	<i>Bromus commutatus</i> Schrad.	+	+
9.	<i>Bromus hordeaceus</i> L.	+	+
10.	<i>Bromus japonicus</i> Thunb.	+	–
11.	<i>Bromus secalinus</i> L.	–	+
12.	<i>Corynephorus canescens</i> (L.) P.Beauv.	–	+
13.	<i>Cynosurus echinatus</i> L.	–	+
14.	<i>Dactylis glomerata</i> L. ssp. <i>glomerata</i>	–	+
15.	<i>Danthonia decumbens</i> (L.) DC.	+	+
16.	<i>Dichanthium ischaemum</i> (L.) Roberty	–	+
17.	<i>Eragrostis pilosa</i> (L.) P.Beauv.	–	+
18.	<i>Festuca ovina</i> L.	–	+
19.	<i>Lolium rigidum</i> Gaudin	–	+
20.	<i>Lolium temulentum</i> L.	–	+
21.	<i>Melica ciliata</i> L.	–	+
22.	<i>Phleum alpinum</i> L.	–	+
23.	<i>Phleum phleoides</i> (L.) H.Karst.	–	+
24.	<i>Poa bulbosa</i> L.	+	+
25.	<i>Poa glauca</i> Vahl	–	+
26.	<i>Secale sylvestre</i> Host	–	+
27.	<i>Sesleria autumnalis</i> (Scop.) F.W.Schultz	–	+
28.	<i>Sesleria caerulea</i> (L.) Ard.	–	+
29.	<i>Setaria italica</i> (L.) P.Beauv.	–	+
30.	<i>Ventenata dubia</i> (Leers) Coss.	+	+
31.	<i>Vulpia myuros</i> (L.) C.C.Gmel.	+	–

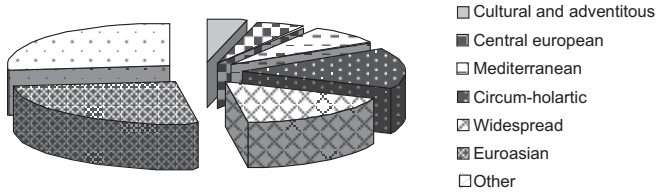


Fig. 3. Spectrum of floral elements of the grass family on Mount Medvednica.

firmed by our field research and recorded in only one quadrant, were: *Bromus inermis*, *Festuca alpina*, *Festuca pseudovina*, *Glyceria fluitans*, *Glyceria plicata*, *Holcus mollis*, *Koeleria pyramidata*, *Nardus stricta*, *Poa palustris* and *Zea mais*.

The data on 31 taxa originate from the earlier periods but their occurrence was not confirmed in the recent research (Tab. 2).

Grasses from Mount Medvednica can be assigned to 10 floral elements (Tab. 1, Fig. 3): the Atlantic floral element (2 grasses), South European floral element (5 grasses), Southeast European floral element (3 grasses), Central European floral element (6 grasses), European floral element (4 grasses), Cultural and adventitious plants (5 grasses), the Mediterranean floral element (9 grasses), Circum-holarctic plants (19 grasses), Widespread plants (20 grasses) and the Eurasian floral element (30 grasses).

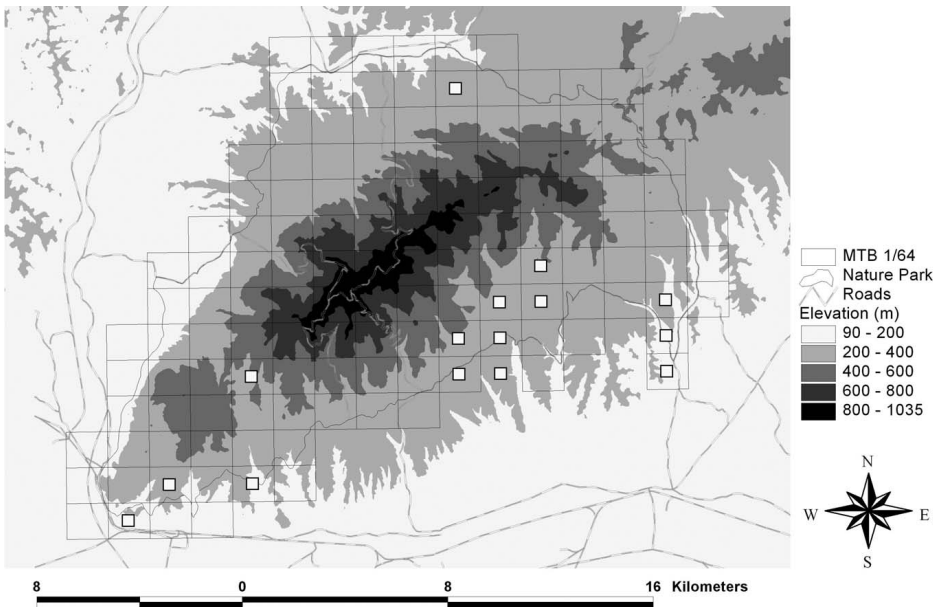


Fig. 4. MTB 1/64 quadrants with seven or more ruderal, cultivated or weed grass species.

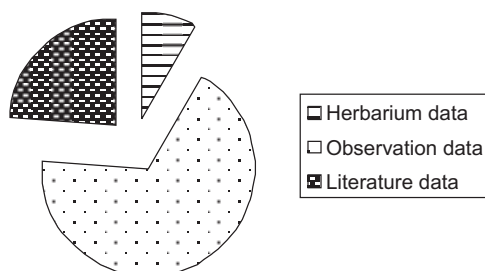


Fig. 5. The proportion of data types by their source.

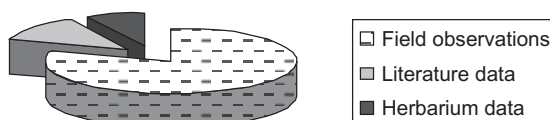


Fig. 6. Structure of geocoded data by source.

As many as 35 grasses which could be defined as ruderal, cultivated or weeds were found in Medvednica Nature Park. A map with marked quadrants where 7 or more ruderal, cultivated or weed grasses occurred was made (Fig. 4). Those quadrants are assumed to have been strongly anthropogenically affected.

The proportion of the data types by their source is shown in Fig. 5. Most of the recorded data (1487) resulted from 1007 field observations (67.7 %), while 356 records (23.9 %) and only 124 records (8.3 %) were derived from the literature and from herbaria respectively. Because of the inaccurate locality descriptions 75.8 % of herbarium data and only 43.9 % of literature data were geocoded. Among all geocoded localities, field observations account for 79.8 %, literature data items 12.7 % and herbarium-derived data items 7.4 % (Fig. 6).

Only 14 % of data have been derived from the period before the year 1940, while the majority of the data (74 %) originate from period between the years 1980 and 1998 (Fig. 7).

According to the Red Book of Vascular Flora of Croatia (NIKOLIĆ & TOPIĆ, 2005) 14 species are threatened to some degree; *Agrostis canina*, *Aira caryophyllea*, *Alo-*

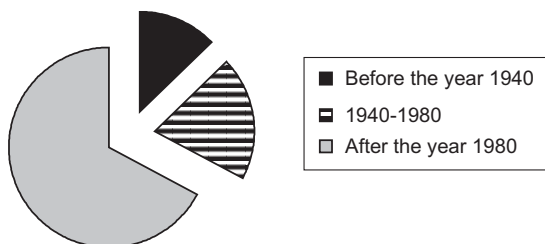


Fig. 7. Structure of data by age.



*pecurus aequalis*, *Alopecurus geniculatus*, *Alopecurus rendlei*, *Bromus commutatus*, *Corynephorus canescens*, *Festuca alpina*, *Glyceria fluitans*, *Glyceria plicata*, *Phleum alpinum*, *Poa palustris*, *Sesleria caerulea* and *Ventenata dubia*. Nine of them were not confirmed by our field research. The confirmed species that are threatened are: *Agrostis canina*, *Glyceria fluitans*, *Glyceria plicata*, *Festuca alpina* and *Poa palustris*.

DISCUSSION

The analysis of floral elements has shown the expected results. The most widespread floral element is the Eurasian floral element (30 taxa) and the Atlantic floral element is the least frequent (2 taxa). This can be explained by the geographical position of Mt Medvednica.

The analysis of a number of cultivated grasses, weeds or ruderal species shows that 35 % of all grasses from Medvednica belong to that group. The grasses that can be defined as cultivated species are *Avena sativa*, *Lolium multiflorum* and *Zea mays*. Other grasses are ruderal or/and weeds. Their distribution shows (Fig. 4) that they occur mostly in the fringe southwest and southeast parts of the Nature Park. This can be easily explained by the fact that exactly those parts of the Medvednica Nature Park border on the largest urban area in Croatia. In those fringe areas, human impact is very intensive, which is also proven by the lack of climax forest vegetation and the relatively large number of weeds, ruderal and cultivated grasses.

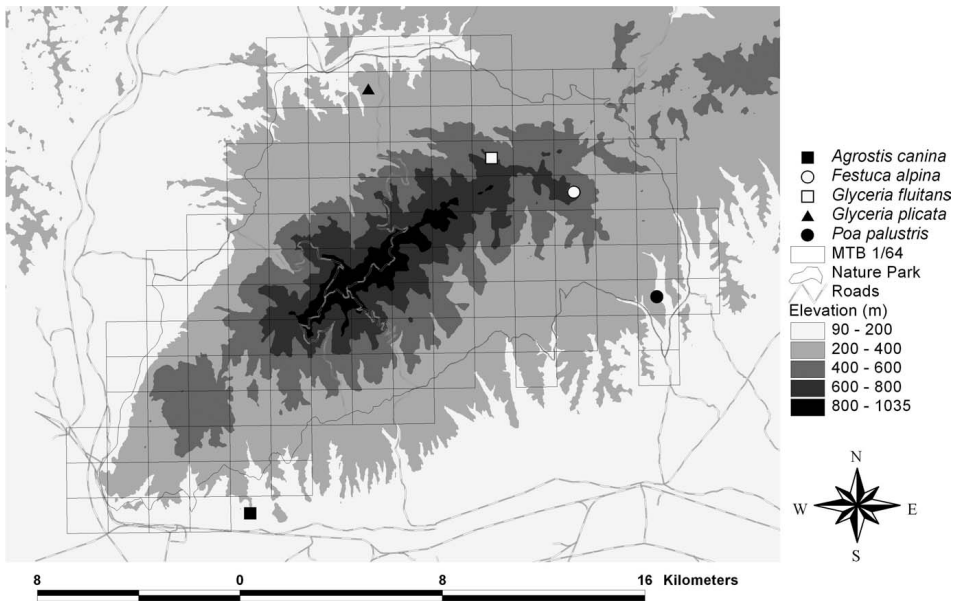


Fig. 8. Five species listed in the Red Book of Croatian flora (NIKOLIĆ & TOPIĆ, 2005) found in only one MTB 1/64 quadrant each.

There are nine species that are threatened, but our field investigations did not confirm their presence. These species are: *Aira caryophyllea*, *Alopecurus aequalis*, *A. geniculatus*, *A. rendlei*, *Bromus commutatus*, *Corynephorus canescens*, *Phleum alpinum*, *Sesleria caerulea* and *Ventenata dubia*. Records of them originate from previous investigations and it can be suggested that these species are no longer present on Medvednica. There are three possible explanations for the absence of these taxa in the recent research recording. The first is that the researchers neglected some of those taxa, although they still exist in the area of the nature park. There could be various reasons for this, but the most probable could be the rarity of the taxa. The second possibility is that some taxa have really disappeared from the flora of Medvednica. This is very possible, at least for some of species, considering the obsolescence of the data on their presence. Most of these grasses (*Aira caryophyllea*, *Corynephorus canescens* and *Ventenata dubia*) have been found mainly on dry grasslands and need open habitats. In contrast, Medvednica is mostly covered by forest, so there are maybe not enough appropriate habitats. *Alopecurus aequalis* and *A. geniculatus* are grasses that mostly grow on grassy river and brook banks, on moist to partly moist, sometimes flooded grounds. This kind of habitats is endangered everywhere, because the hydrological conditions are changed (naturally and by human impact), so it is possible that the species was found in the past but recently disappeared or became so rare that it was unrecorded in the field research. The third possible reason is that some taxa were simply misidentified or wrongly recorded. For example, for the species *Phleum alpinum* we believe that the literature record is a consequence of misidentification. It is not possible for us to check the author's determination of it, but it is not very probable that *Phleum alpinum* ever existed on Medvednica, because it usually occurs on much higher mountains.

Another five threatened species were found, but recorded in only one quadrant each. These species are: *Festuca alpina*, *Glyceria fluitans*, *Glyceria plicata*, *Poa palustris* and *Agrostis canina*. For these species it would be important to mark and conserve their habitats, so that they do not completely disappear from Medvednica Nature Park (Fig. 8).

We must express our doubt about literature records that mention the species *Poa glauca*, *Secale sylvestre* and *Festuca ovina* on Mount Medvednica. Our field research did not confirm their finding, but today we cannot prove that those findings from the past were either wrong or correct.

In our paper only the species *Brachypodium pinnatum* is mentioned, while the species *B. rupestre* has not been recorded. It is very likely that in the researched area both species exist, so we presume that some records of *B. pinnatum* apply actually to the species *B. rupestre*. This is very probable, because in some other parts of Croatia, which are by its general characteristics similar to Medvednica, both species were found (personal observations by V. HRŠAK). In floristic research in Croatia these two species were not distinguished in the past. In the future the researchers will have to pay more attention to making correct mapping of these two separate species. We decided not to distinguish *B. rupestre* from *B. pinnatum* in this research phase, because of the uncertainty in the determinations of previous records.

Although literature and observations mention the species *Sesleria tenuifolia* we believe that a determination mistake was made and that only the species *Sesleria tenuifolia* ssp. *kalnikensis* can be found on Medvednica. The distribution area for the species *Sesleria tenuifolia* ssp. *kalnikensis* is, according to STRGAR (1981), as well as south and southeast Slovenia, western Croatia as well, where Medvednica is located. The species *Sesleria tenuifolia* grows in contrast in southwest parts of Croatia. The correct name for the species *Sesleria tenuifolia* ssp. *kalnikensis* is *Sesleria juncifolia* Wulf ex Suffr subsp. *kalnikensis* (Jav.) Jogan (JOGAN, 1999).

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