

VEGETATION OF THE ŽALE CEMETERY (LJUBLJANA)

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Abstract

The paper presents results of a vegetation survey of the cemetery of Ljubljana as a specific urban habitat with a high diversity of vegetation types. Seventeen different plant communities were found, mostly weed (hoe weed and garden communities), trampled and ruderal communities. This indicates frequently disturbed habitat with different microclimatic conditions than those in the surroundings.

Key words: synanthropic vegetation, plant sociology, urban habitat, Slovenia.

Izvleček

Članek predstavlja rezultate proučevanja vegetacije ljubljanskega pokopališča, ki je poseben urbani habitat z veliko diverzitetno vegetacijskih tipov. Našli smo sedemnajst različnih rastlinskih združb, večinoma plevelnih (okopavinskih in vrtnih), pohojenih in ruderalnih sintaksonov. To nakazuje rastišče s pogostimi motnjami z drugačnimi mikroklimatskimi razmerami kot v okolici.

Ključne besede: sinantropna vegetacija, fitosociologija, urbani habitat, Slovenija.

INTRODUCTION

The cemetery is special habitat in the frame of urban environment. Therefore we could treat the cemetery as an ecosystem characterized by its history, structure and function, including both biotic and abiotic components (cf. Sukopp 2002). This reflects in many different ways: intensity and frequency of anthropogenic disturbances, heterogeneity of sites, introduction of alien species, higher temperature and lower humidity. Consequently this is visible in specific species composition of vegetation.

Systematic research of the vegetation of cemeteries is rare, usually flora were studied, while vegetation was sampled only sporadically. Generally only ornamental plants were collected, spontaneous flora has been an object of research for the last 25 years (Sukopp 2002). A survey of ecological studies of cemeteries was made by Graf (1986), a larger study after that was done also by Pyšek (1988).

Flora of the cemetery of Žale in Ljubljana was published by Babij (1998).

RESEARCH AREA

The researched area comprises the main cemetery of Ljubljana (Žale) (Figure 1), that spreads over approx. 26 ha and is surrounded by a 2-metre-high wall. The climate is mildly warm and perhumid, average temperature is 9.7 °C and precipitation 1400 mm. The microclimate is probably modified by reduced extremes (Babij 1998), although higher temperatures could be expected due to the openness of the space and to the asphalt and stone material used. A particularity of cemeteries are soils with strong human influence (according to WRB- World Reference Base for Soil Resources). The first group are Technosols whose properties and pedogenesis are dominated by their technical origin. They are sealed by technic hard rock (material created by humans,

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having properties unlike natural rock) – here we refer to pavements with their underlying unconsolidated materials. A smaller part is covered by Anthrosols, a soil type where cultivation is practised (this could be classified as Hortisols- garden soil) (WRB). A special subtype for cemeteries was introduced as necrosol (Graf 1986).

METHODS

Vegetation was sampled according to the standard Central European method (Braun-Blanquet 1964, Westhoff & van der Maarel 1973). Phytosociological nomenclature is according to Jarolímek et al. (1997), nomenclature of mosses follows

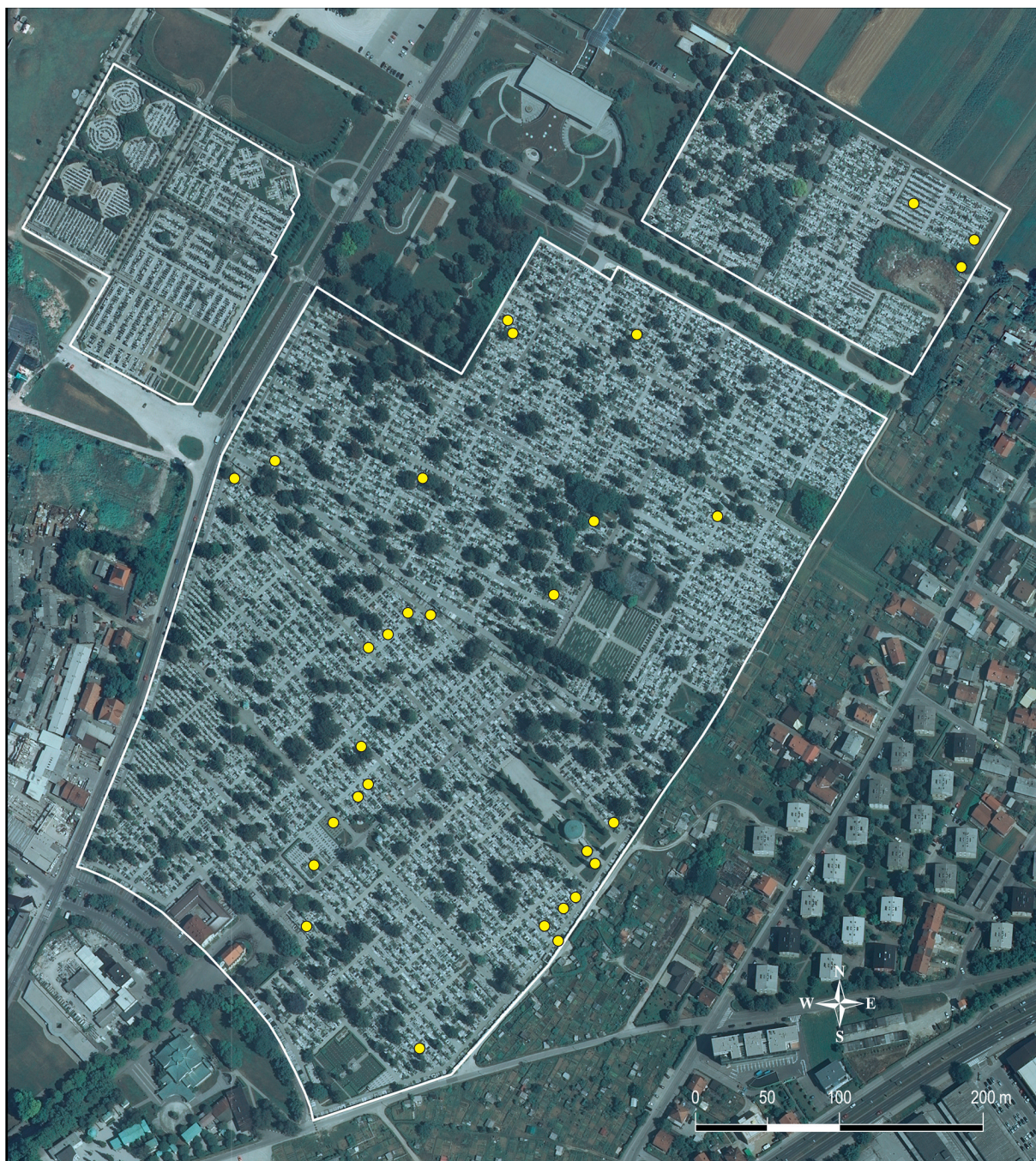


Figure 1: Researched cemetery.

Slika 1: Raziskovano pokopališče.

Martinčič (2003) and of plants Martinčič et al. (2007), except for species *Eschscholtzia californica* Cham.

RESULTS AND DISCUSSION

Syntaxonomical scheme of researched syntaxa presented in Table 1:

Asplenetea trichomanis (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977

Tortulo-Cymbalarietalia Segal 1969

Cymbalario-Asplenion Segal 1969 em. Mucina 1993

Asplenietum ruta-murariae-trichomanis Kuhn 1937 – relevé 1

Cymbalarietum muralis Görs in Oberd. 1967 – relevés 2–3

Polygono arenastrii-Poetea annuae Rivas-Martínez 1975 corr. Rivas-Martínez et al. 1991

Polygono arenastrii-Poetalia annuae R. Tx. in Géhu et al.

Saginion procumbentis R. Tx. et Ohba in Géhu et al. 1972

Sagino procumbentis-Bryetum argentei Diemont et al. 1940 – relevé 4

Hernarietum glabrae (Hohenester 1960) Jehlík et Hejný 1975 – relevé 5

Stellarietea mediae R. Tx., Lohm. et Preising in R. Tx. ex von Rochow 1951

Centaureetalia cyani R. Tx., Lohmeyer et Preising in R. Tx. ex von Rochow 1951

Veronico-Euphorbion Sissingh ex Passarge 1964

Mercurialietum annuae Kruseman et Vlieger 1939 – relevés 6–10

Sherardion arvensis Kropáč et Hejný in Kropáč 1978

Aethuso-Galeopsietum G. Müller 1964 – relevé 11

Atriplici-Chenopodietalia albi R. Tx. (1937) Nordhagen 1940

Panico-Setarion Sissingh in Westhoff et al. 1946

Echinochloo-Setarietum pumilae Felföldy 1942 corr. Mucina 1993 – relevé 12

Sisymbrietalia J. Tx. in Lohm. et al. 1962

Sisymbriion officinalis R. Tx., Lohm. et Preising in R. Tx

Erigeronto-Lactucetum serriolae Lohm. in

Oberd. 1957 em. Mucina 1978 – relevé 13
Eragrostietalia J. Tx. ex Poli 1966

Eragrostion R. Tx. ex Oberd. 1954

Portulacetum oleraceae Felföldy 1942 – relevé 14

Salsolion ruthenicae Philippi 1971

Panicetum capillaris Mititelu et Roman 1988 – relevés 15–17

Eragrostio-Polygonion arenastrii Couderc et Izco ex Carni et Mucina 1997

Eragrostio-Polygonetum arenastrii Oberd. 1954 corr. Mucina 1993 – relevé 18

Portulaco-Euphorbietum maculatae (Brandes 1993) Čarni et Mucina 1998– relevés 19–22

Chamaesyco humifusae-Oxalidetum corniculatae Forstner in Mucina 1993– relevés 23–25

Artemisietea vulgaris Lohmeyer, Preising et R. Tx. ex von Rochow 1951

Onopordetalia Br.-Bl. et R. Tx. ex Klika et Hadač 1944

Dauco-Melilotion Görs 1966

Dauco-Picridetum Görs 1966– relevé 26

Odontio-Ambrosietum artemisiifoliae Jarošímek et al. 1997– relevés 27–29

Equisetum arvense-[*Onopordetalia*] – relevé 30

Galio-Urticetea Passarge ex Kopecký 1969

Lamio albi-Chenopodietalia boni-henrici Kopecký 1969

Galio-Alliarion (Oberd. 1957) Lohmeyer et Oberd. in Oberd. et al. 1967

Impatiens parviflora-[*Galio-Alliarion*] – relevé 31

Communities of the alliance *Cymbalario-Asplenion* thrive on walls or at their foot. Stands where *Asplenium trichomanes* dominates are found on dry, sunny walls, while the association *Cymbalarietum muralis* is found on more shaded and nitrate rich sites.

Trampled habitats are frequent in the cemetery, but moist and nutrient poor communities that are classified into the alliance *Saginion procumbentis* are not so frequent as more thermophilous trampled communities. The association *Sagino-Bryetum* is characterized by moss *Bryum argenteum* and prostrate *Sagina procumbens*, that are found as a mosaic between shaded paving stones. *Hernarietum glabrae* thrives on drier and sandy ground than the previous community

and is a monodominant community of *Herniaria glabra*.

Most frequent communities found in the cemetery are mostly annual segetal and ruderal communities classified into the class *Stellarietea mediae*. This is consistent as there is strong anthropogenic pressure, considering hoeing, planting of ornamental plants and weeding (on the path also mechanically).

The association *Mercurialietum annuae* is monodominant, extremely thermophilous and is usually found on sand on graves, where there are better, nutrient rich soils. The *Aethusa-Galeopsietum* has not yet been described in Slovenia. On the cemetery it is only fragmentarily developed, characterised by diagnostic species *Aethusa cynapium*, *Medicago lupulina* and *Galeopsis tetrahit* (sensu Mucina 1993). Holzner (1973) mentions occurrence of the community on permeable, sandy, skeletal soils. The association *Echinochloo-Setarietum pumilae* is one of the most widespread associations of segetal communities, but is only fragmentarily developed on the cemetery and is dominated by C₄ grasses.

The association *Erigeronto-Lactucetum* comprises stands of biannual weeds and represents a transition between syntaxa of annual and perennial weeds. Species composition depends on the time since the last disturbance (cultivation, weeding). As disturbances are extremely frequent and intensive in the cemetery there are found numerous species of the class *Stellarietea mediae*.

The association *Portulacetum oleraceae* thrives on the cultivated part of the grave (planted by ornamental flowers), where the soil is fertile. Optimum development of the community is in the late summer.

Panicetum capillaris is a typical railroad plant community. A similar warm and dry habitat on sand is found in the cemetery. Dominant species *Panicum capillare* is regularly accompanied by *Setaria viridis*. For Slovenia the association has not been yet recorded.

Into the alliance *Eragrostio-Polygonion arenastri* we classify communities of trampled habitats, and it is characterized by C₄ species (Mucina 1993).

Eragrostio-Polygonetum is the central association of the alliance without any character species. The association *Portulaco-Euphorbietum maculatae* is characterized by the neophyte species *Euphorbia maculata* that dominates in the stands and by *Arenaria serpyllifolia* as differential

species (Brandes 1993). The association *Chamaesyco humifusae-Oxalidetum corniculatae* is recorded for the first time for Slovenia. It is indicated by dominant species *Euphorbia humifusa* and *Oxalis corniculata* and is an extremely warm community on trampled sites (sand and paved paths).

Dauco-Picridetum develops on abandoned graves, but it is rare. *Ambrosia artemisiifolia* dominated communities are on the expansion in Slovenia (it expands from ruderal to cultivated sites), but it is only fragmentarily developed in the cemetery; above all species of the class *Artemisietea* are missing. The community of species *Equisetum arvense* is frequent; similar stands are also found on the railroads. We classify it only to the level of the association according to Mucina (1993).

Communities of the class *Galio-Urticetea* are rare as the habitat is too warm and dry. *Impatiens parviflora* dominated stands thrive on shaded sites.

The vegetation of cemeteries is specific due to the uniqueness of the environment. It is extremely thermophilous, disturbances are frequent and intensive. Therefore communities of the class *Stellarietea mediae* prevail, thus hoe weed communities as thermophilous communities of trampled soil. Most communities are fragmentarily developed (less character species, above all of higher syntaxa) and are poor in species number.

Compared to the syntaxa list from Central and North European cemeteries (Graf 1986, Pyšek 1988), in our case *Galio-Urticetea* communities are lacking, indicating a more warm and dry habitat although this could be also explained by history, cemetery type and land use.

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- (Eržen Franko), on the grave, sand, of ossuary of I. WW, 102930, 464266; **9.** 5.9.2006, Ljubljana: Žale, grave of Gorup, sand, 102858, 464218; **10.** 9.8.2006, Ljubljana: Žale, grave of family Vozelj, sand, 103271, 464196; **11.** 9.8.2006, Ljubljana: Žale, grave of family Trapetovi, sand, 103170, 464133; **12.** 5.9.2006, Ljubljana: Žale, grave Klembas, sand, 102773, 464131; **13.** 5.9.2006, Ljubljana: Žale, grave Požlep, in front of ossuary of I. WW, sand, 102901, 464253; **14.** 9.8.2006, Ljubljana: Žale, grave of family Šprohar, fertile garden soil, 103280, 464192; **15.** 9.8.2006, Ljubljana: Žale, near vault Wagner, behind vault Kollman, sandy path, 102948, 464088; **16.** 5.9.2006, Ljubljana: Žale, grave Hažič Alojz, sand, path between graves, less trampled, 102901, 464253; **17.** 5.9.2006, Ljubljana: Žale, grave Purič, sandy path in front of the grave, poorly trampled, 103144, 464338; **18.** 2.9.2008, Ljubljana: Žale, paved footpath, partly shaded, 103075, 464139; **19.** 9.8.2006, Ljubljana: Žale, paved main road, 103170, 464002; **20.** 9.8.2006, Ljubljana: Žale, near grave of family Šilc, sandy path, 102858, 464052; **21.** 9.8.2006, Ljubljana: Žale, paved path, near grave Orehek, 103061, 464109; **22.** 9.8.2006, Ljubljana: Žale, near monk's grave, at vault Kollman, paved path, 102930, 464071; **23.** 5.9.2006, Ljubljana: Žale, grave Leon Šporšič, path between graves, shaded, trampled, 102878, 464239; **24.** 2.9.2008, Ljubljana: Žale, grave Koštomaj Gabrijela, footpath, paved, sunny, 103052, 464095; **25.** 2.9.2008, Ljubljana: Žale, opposite to grave Jakša Franciška, abandoned grave, better sandy soil, 103361, 464475; **26.** 9.8.2006, Ljubljana: Žale, end of cemetery of Žale, sand between graves Kačičnik and Štajdohar, 103336, 464517; **27.** 5.9.2006, Ljubljana: Žale, grave of family Logar, grave, 102870, 464231; **28.** 9.8.2006, Ljubljana: Žale, near sign 23, sandy path, 102957, 464095; **29.** 5.9.2006, Ljubljana: Žale, grave of family Adamič, sand on the grave, 103182, 464030; **30.** 2.9.2008, Ljubljana: Žale, grave Gmeiner Josipina, sandy footpath, 103270, 464282; **31.** 9.8.2006, Ljubljana: Žale, near rubbish dump on the new part of Žale, 103317, 464508.

APPENDIX (date, location, coordinates)

- 1.** 9.8.2006, Ljubljana: Žale, staircase of ossuary of I. WW, wall, 102910, 464247; **2.** 5.9.2006, Ljubljana: Žale, grave Slapšakovi, rocky tombstone, 102848, 464227; **3.** 9.8.2006, Ljubljana: Žale, wall of monument of Salesians of Don Bosco, 102900, 464057; **4.** 9.8.2006, Ljubljana: Žale, paved path between paving stones, shaded under pine and spruce in front of grave Dekvalovi, heavily trampled, 102983, 464090; **5.** 5.9.2006, Ljubljana: Žale, grave Borčič, near entrance to the cemetery of Italian soldiers, paved, trampled, 103089, 464224; **6.** 2.9.2008, Ljubljana: Žale, grave Kocmur, sandy path between graves, shaded, 103076, 464123; **7.** 2.9.2008, Ljubljana: Žale, graves Krainer Viktor, sand in front of grave, shaded, 103140, 464252; **8.** 2.9.2008, Ljubljana: Žale, Erženovi

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Table 1: Phytosociological table of vegetation of the cemetery Žale (Ljubljana).

Tabela 1: Fitocenološka tabela vegetacije pokopališča Žale (Ljubljana).

Releve number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Relevé area (m ²)	4	2	2	5	4	2	3	3	3	3	1	2	5	2	3	3	1	2	5	2	5	5	0,5	1	2	10	2	3	3	1	3
Altitude (m)	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297
Aspect (degrees)	NENW	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slope (degrees)	90	90	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cover herb layer (%)	40	20	70	20	30	40	80	70	70	50	70	40	80	70	80	80	90	30	50	50	30	80	80	30	50	100	80	90	100	80	100
Cover moss layer (%)	2	2	1	2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Number of species	4	5	4	8	9	8	7	7	7	7	11	8	10	6	8	11	14	9	10	6	8	13	9	5	7	11	7	14	10	5	6

Character and differential species of the associations

<i>Asplenium trichomanes</i>	C	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Cymbalaria muralis</i>	.	2	4	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Asplenium ruta-muraria</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Tortula muralis</i>	D	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Sagina procumbens</i>	C	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Bryum argenteum</i>	D	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Herniaria glabra</i>	C	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Mercurialis annua</i>	.	.	.	3	4	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Aethusa cynapium</i>	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Galeopsis tetrahit</i>	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Lactuca serriola</i>	.	.	.	.	+	.	.	.	.	.	3	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Portulaca oleracea</i>	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Panicum capillare</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Eragrostis minor</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	1	1	.	.	.	.	.	.	.	.	.
<i>Euphorbia maculata</i>	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	3	3	3	3	.	.	.	.	.	.	.	.
<i>Euphorbia humifusa</i>	.	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	1	.	.	.	.	.	.
<i>Oxalis corniculata</i>	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	+	2	.	.	.	.	.	.	.
<i>Daucus carota</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
<i>Picris hieracioides</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
<i>Ambrosia artemisiifolia</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	3	5	.	.	.
<i>Equisetum arvense</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.
<i>Impatiens parviflora</i>	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	4
Polygono-Poetea																																
<i>Plantago major</i>	C	.	.	+	+	.	.	.	.	.	+	.	.	.	+	+	+	.	.	+	+	.	+	+	.	.	.	.	.	.	.	.
<i>Polygonum aviculare</i> agg.	.	.	.	1	.	.	.	.	.	.	+	.	.	.	+	.	.	2	1	.	.	2	.	2	.	.	.	.	.	.	.	.
<i>Poa annua</i>	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Stellarietea mediae																																
<i>Setaria viridis</i>	C	.	.	.	.	+	+	1	1	1	2	2	+	.	1	1	1	.	+	.	+	1	.	+	+	.	1	.	2	+	.	
<i>Digitaria sanguinalis</i>	.	.	.	+	+	+	.	.	.	.	2	.	.	+	+	+	.	+	+	+	+	1	.	+	.	.	.	.	.	.	.
<i>Oxalis fontana</i>	.	.	.	.	.	.	.	+	1	.	2	+	+	.	.	.	+	.	1	+	.	.	.	.	.	.	+	1	+	.	.	
<i>Sonchus oleraceus</i>	.	.	.	.	+	1	+	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anagallis arvensis</i>	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Fallopia convolvulus</i>	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.
<i>Cerastium glomeratum</i>	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Eschscholtzia californica</i>	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Euphorbia peplus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Chenopodium album</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Diplotaxis muralis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Stellaria media</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Sonchus arvensis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Releve number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
Artemisietea																																	
<i>Silene vulgaris</i>	C	.	.	+	.	.	1	.	.	2	+	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	1	1	2	+	.	.
<i>Erigeron annuus</i>	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	2	1	+	.	+	+	.	.	.	.	.	.	1	.	.	.
<i>Convolvulus arvensis</i>	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	+	.	.	.	3	.	
<i>Conyza canadensis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	+	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.
<i>Linaria vulgaris</i>	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Elytrigia repens</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Galio-Urticetea																																	
<i>Calystegia sepium</i>	C	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Lapsana communis</i>	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
<i>Glechoma hederacea</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+
<i>Rubus caesius</i>	+
Molinio-Arrhenatheretea																																	
<i>Medicago lupulina</i>	C	.	.	+	.	.	.	.	.	.	+	.	+	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.
<i>Taraxacum officinale</i>	.	.	.	.	.	.	.	.	+	.	+	.	1	.	.	.	+	.	.	.	.	+	.	.	2	.	.	.	+	.	.	.
<i>Trifolium pratense</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.
<i>Vicia cracca</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.
<i>Pastinaca sativa</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.	.
<i>Leontodon autumnalis</i>	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
<i>Plantago lanceolata</i>	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
<i>Achillea millefolium</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.
<i>Festuca rubra</i> agg.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Poa pratensis</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Trifolium repens</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Potentilla reptans</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
<i>Dactylis glomerata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
<i>Ranunculus repens</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
<i>Rumex obtusifolius</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Other taxa																																	
<i>Microrrhinum minus</i>	C	.	.	.	.	.	.	+	+	+	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.
<i>Viola reichenbachiana</i>	.	.	.	.	.	.	.	+	.	.	.	2	.	.	.	+	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.
<i>Arenaria serpyllifolia</i>	+	.	+
<i>Sedum sexangulare</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.
<i>Bryum</i> sp.	D	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Didymodon vinealis</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Hedera helix</i>	C	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Homalothecium sericeum</i>	D	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Pimpinella saxifraga</i>	C	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Acer pseudoplatanus</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Pimpinella anisum</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Leontodon</i> sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
<i>Silene</i> sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
<i>Mahonia aquifolium</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
<i>Hypericum perforatum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
<i>Verbascum nigrum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.