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ANALYSES OF THE FLORA OF RAILWAY STATIONS IN THE MEDITERRANEAN AND SUB-MEDITERRANEAN AREAS OF CROATIA AND BOSNIA AND HERZEGOVINA

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The main aims of our study were (1) to determine the flora in railway areas with special emphasis on the presence of neophytes; (2) to describe the features of the flora through analyses of taxonomic composition, chorotypes, life forms and the phytosociological character of species found at 15 stations in the Mediterranean and sub-Mediterranean areas of Croatia and Bosnia and Herzegovina (SE Europe). According to their floristic composition, two broad groups of stations were recognized: i) stations in the most southerly area with higher annual precipitation and air temperature (cities of Ploče, Metković, Čapljina, Mostar), and ii) stations in sub-Mediterranean rural areas located exclusively at higher altitudes, including stations in three Dalmatian large cities (Zadar, Šibenik, Split). Altogether, 359 vascular plant taxa (336 species and 23 subspecies) were identified within 62 families and 230 genera. Therophytes, and Mediterraneans with a considerable proportion of Cosmopolitans were predominant. Neophytes contributed 14% of identified flora, the majority being invasive. In the phytosociological spectrum, the largest element was made up of taxa from *Stellarietea mediae* and *Festuco valesiacae-Brometea erecti* classes. Most of the railway stations studied excluding those in large cities, retain a link with the floristic composition of the plant communities of their biogeographic contexts.

Key words: man-made habitats, operating tracks, floristic survey, neophytes, nitrophilous annual vegetation, SE Europe

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Glavni ciljevi istraživanja bili su (1) utvrditi floru na željezničkim postajama s posebnim naglaskom na udio pridošlica; (2) opisati floristične značajke analizirajući taksonomski sastav, florne elemente, životne oblike i fitocenološku pripadnost biljnih svojti na 15 postaja u mediteranskom i submediteranskom području Hrvatske i Bosne i Hercegovine (Jugoistočna Europa). Analizom floističkog sastava utvrđene su dvije glavne skupine željezničkih postaja: i) postaje na krajnjem

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jugu Hrvatske i Bosne i Hercegovine s višom godišnjom količinom oborina i temperaturom zraka (Ploče, Metković, Čapljina, Mostar) te ii) postaje u ruralnim područjima na isključivo višim nadmorskim visinama, uključujući i one u tri najveća dalmatinska grada, Zadru, Šibeniku i Splitu. Ukupno je utvrđeno 359 svojti (336 vrsta i 23 podvrste) vaskularnih biljaka svrstanih u 230 rodova i 62 porodice. Prevladavali su terofiti te svojte mediteranskog flornog elementa s značajnim udjelom široko rasprostranjenih svojti. Udio neofita u ukupnoj flori bio je 14%, a većina imaju status invazivnih svojti. Fitocenološki, najveći broj svojti svojstvene su vegetacijskim razredima *Stellarietea mediae* i *Festuco valesiacae-Brometea erecti* ili njihovim nižim sintaksonima. Najveći broj istraživanih željezničkih postaja, osim onih u velikim dalmatinskim gradovima, pokazuju vezu s floističkim sastavom biljnih zajednica unutar svojeg biogeografskog položaja.

Ključne riječi: antropogena staništa, aktivni kolosjeci, flora, pridošlice, nitrofilna jednogodišnja vegetacija, JI Europa

INTRODUCTION

Man-made habitats have received increasing attention of researchers due to their growing importance for urban land management and nature conservation (Pyšek, 1995). This category comprises those habitats so completely created and maintained by human activity that they cannot be termed semi-natural, and yet nevertheless have a considerably wildlife and nature conservation interest (Ratcliffe, 1977).

Among them, railway areas in a broad sense (including tracks, platforms, stations, storehouse ramps, loading sidings, slopes of railway embankments, railway wastelands) are included into the intensively managed kind of land. In addition, the railway has greatly influenced the structure of local ecosystems, and the threats resulting from the fragmentation of natural and semi-natural biotopes (e.g., Gontier *et al*., 2006; Westermann *et al*., 2011). Railway stations, which are the major trans-shipment points for goods, are recognized as "hot spots" for expansion of synanthropic plants (Gilbert, 1989; Wiłkomirski *et al*., 2012). Plants in such extreme habitats prefer light and dry sites, and, in general, the flora is characterized by species with relatively low frequencies of occurrence (Galera *et al*., 2014).

Railways and railway verges have been the subject of botanical studies for more than 150 years (Filibeck *et al*., 2012, and references therein). In fact, there have been many different approaches to research on species occurring in railway areas. Some authors have analyzed the groups of plants that occur most frequently in railway areas (e.g., Brandes, 1983), while others have demonstrated the importance of elements of railway infrastructure for the expansion of these species (e.g., Rutkovska *et al*., 2013). In general, due to the decrease in grain and livestock rail transportation in the last few decades, railways nowadays have less rich alien flora than was observed in the first half of the 20th century (Filibeck *et al*., 2012, and references therein).

Generally, botanical studies on rail lines in central European countries are much more common than in most of Mediterranean Europe (cf., Májeková *et al*., 2014). Until now, vegetation and floristic research into railway lines and stations has been only occasionally performed in the NW Balkans, mostly in the context of the study of the urban floras (e.g., Milović & Mitić, 2012; Stešević *et al*., 2014). In inland Croatia, Marković (1977) reported plant species and associations from the slopes of railway embankments and stations. Until now, in the Mediterranean part of NW Balkans, including Croatia and Bosnia and Herzegovina, no specific or systematic research of the flora or vegetation on the railway stations has been performed.

In this study, we present the results of a complete floristic survey of the operating railway tracks of 15 railway stations of Croatia and Bosnia and Herzegovina, occurring across an intensively farmed landscape within the Mediterranean and sub-Mediterranean regions. Our main tasks were (1) to determine the flora in the railway areas with special emphasis on the presence of neophytes in this territory; (2) to describe the features of flora throughout analyses of taxonomic composition, chorotypes, life forms and the phytosociological character of species found at the stations. The paper is also a contribution to the knowledge of the railway flora of Bosnia and Herzegovina, which is still under-explored.

THE STUDY AREA

The study area of railway stations covers most of southern Croatia (the region of Dalmatia) and Bosnia and Herzegovina, extending from the eastern Adriatic coastal city of Zadar on the north-west to the town of Metković on the south-east (Fig. 1). We surveyed the flora at 13 railway stations in southern Croatia and two cities (Čapljina and Mostar) in Bosnia and Herzegovina (Tab. 1). The sampling sites were established along an altitudinal gradient from 2-300 m a.s.l. As of 2012, Croatia had a total of 2,722 kilometers of railways, including 598 railway stations and other railway facilities, and 541 and 6,063 respectively of all types of goods and passenger wagons. In Croatia, the use of 22 railway lines was abandoned in 2014. In 2013, after a 128 year long tradition, passenger traffic between Sarajevo (the capital of Bosnia and Herzegovina) and Ploče (Croatia) was halted, and now only rail freight transport is active (bulk cargo, steel products and iron and other types of goods, such as sugar, cement, petroleum, etc.).

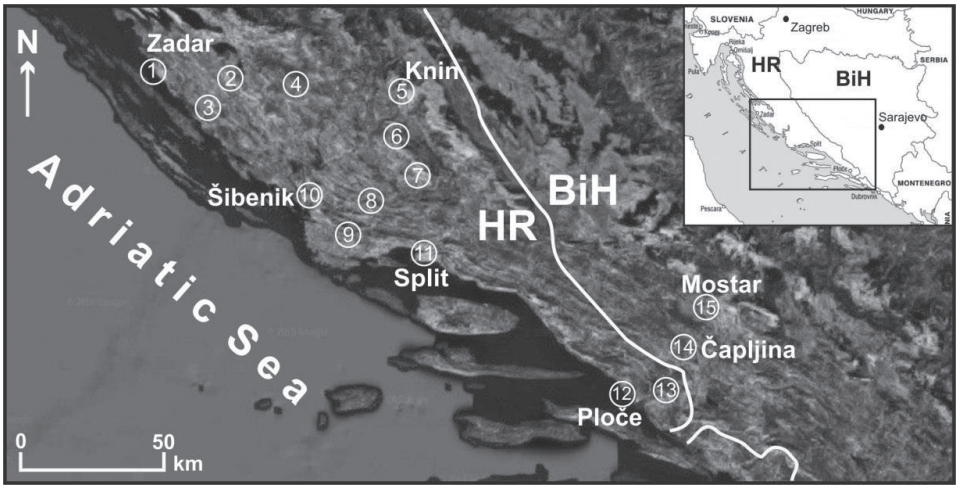

Fig. 1. Location of the railway stations investigated. The station codes are shown in Tab. 1 (HR - Croatia; BiH - Bosnia and Herzegovina).

The area is characterized by warm and dry summers, while winters are mild and rainy. The positions of the stations and a comparison of their macrobioclimates according to the Worldwide Bioclimatic Classification System (Rivas-Martínez *et al*., 2011) are given in Tab. 1.

From a biogeographic viewpoint, most of the stations are located in the Illyrian sector of the Apennino-Balkan Province, while some coastal stations in Croatia (Split, Ploče, Metković) belong to the Epiro-Dalmatian sector of the Adriatic Province (Rivas-Martínez *et al*., 2004). Phytogeographically, this area belongs to the vegetational zone of the groups of the sub-Mediterranean alliances of *Fraxino orni-Ostryion* and *Carpinion orientalis* (class *Quercetea pubescentis*), except for the stations in the Epiro-Dalmatian sector which are located within the *Fraxino orni-Quercion ilicis* alliance (class *Quercetea ilicis*). In the sub-Mediterranean region, the greater part of the surface is covered by rocky meadows of the *Scorzoneretalia villosae* order (class *Festuco valesiacae-Brometea erecti*), mostly on shallow calcareous soils.

Tab. 1. Characteristics of railway stations studied.

Code	Locality	Coordinates	Altitude (m a.s.l.)	Macrobioclimate (variant)[1]	Human population	U/R[2]	D	B	Pt	Gt loading	Gt off-loading
1	Zadar	44°06′22.1″ N; 15°14′32.7″ E	6	TSS	71,471	U	2.0	1414	3908	7,127	34,483
2	Benkovac	44°01′34.3″ N; 15°36′51.6″ E	190	TWS	2,866	U	0.2	1414	777	*ND*	*ND*
3	Đevrske	43°57′52.3″ N; 15°51′57.2″ E	229	TSS	293	R	0.01	865	NT	NT	NT
4	Kistanje	43°59′15.2″ N; 15°57′27.5″ E	239	TWS	1,909	R	0.02	865	NT	NT	NT
5	Knin	44°02′14.0″ N; 16°11′54.0″ E	238	TWS	10,633	U	0.05	865	9692	*ND*	*ND*
6	Drniš	43°51′46.7″ N; 16°10′51.0″ E	319	TWS	3,144	U	0.02	865	1522	*ND*	*ND*
7	Unešić	43°44′29.3″ N; 16°10′53.5″ E	348	TWS	320	R	0.02	865	NT	NT	NT
8	Koprno	43°42′19.6″ N; 16°10′19.6″ E	293	TWS	97	R	0.01	865	NT	NT	NT
9	Perković	43°40′33.0″ N; 16°07′03.8″ E	186	TWS	111	R	0.02	865	12840	*ND*	*ND*
10	Šibenik	43°43′48.2″ N; 15°53′52.0″ E	49	MED	34,302	U	0.4	865	29093	107,434	209,749
11	Split	43°30′17.2″ N; 16°26′34.6″ E	16	MED	167,121	U	1.5	3672	75270	159,241	234,250
12	Ploče	43°02′54.2″ N; 17°26′02.2″ E	2	TSS	6,013	U	0.2	1202	1082	1.151,747	287,615
13	Metković	43°03′23.2″ N; 17°38′47.3″ E	3	TSS	15,329	U	0.3	1202	NT	*ND*	*ND*
14	Čapljina	43°06′37.4″ N; 17°41′52.4″ E	10	TSS	7,461	U	0.01	943	NT	*ND*	*ND*
15	Mostar	43°20′58.1″ N; 17°48′49.1″ E	71	TWS	75,865	U	0.5	943	29448	420,444	*ND*

[1]TWS – Temperate (Weak submediterranean), TSS - Temperate (Strong submediterranean), MED – Mediterranean. [2]U/R – urban or rural area, D – distance from (semi-) natural vegetation (km), B – gross domestic product (mln eur), Pt – public transport of passengers (total number of passengers in 2014), Gt – transport of goods (rail freight transport in 2013, in tons), NT – embarkation and disembarkation of passengers and goods are extremely rare, ND – no data.

MATERIAL AND METHODS

Data collection

With the aim of determining the characteristics of the railway stations and cities/settlements (see Tab. 1), data on urbanism, climate conditions, human population, etc. were obtained whenever possible. In the study, urban (U) referred to all territory, population, and housing units located in places with a human population of 2,500 or more. Human population size was determined according to administrative divisions (settlements or cities) and census in 2011 and 1991 in Croatia and Bosnia, respectively (Anonymous, 1998, 2013a). Data for gross domestic product (mln eur), public transport of passengers and goods (rail freight transport in tons) in domestic and international rail traffic for each station were taken from the Statistical Reports (Anonymous, 2014ab) or have been provided by state Railway companies. Coordinates, altitudes (m a.s.l.) and distance (in km) from natural or semi-natural vegetation were determined using GPS. Macrobioclimate variants were determined according to the Worldwide Bioclimatic Classification System (Rivas-Martínez *et al*., 2011). This approach was also verified using data on precipitation, air temperature, etc. for at least a 30-year period (1982-2012) from the website https://en.climate-data.org/.

We surveyed the total flora of the operating railway tracks of the railway stations in 2013-2014. For this purpose most stations were visited in different seasons (from spring to autumn), except for those in southern Croatia (Ploče, Metković) and in Bosnia and Herzegovina (Čapljina, Mostar), which were surveyed during the summer-autumn period. However, most of the plant taxa from the anthropogenic habitats in the Mediterranean show a peak of development during late summer and early autumn. Generally, spring-flowering taxa, present only in some cases, were recognized from the dried remains of plants. In each station, the flora occurring on the operating railway tracks and platforms has been investigated. Only one plot was sampled at each station. Plot size varied, depending on the station size, from 200 to 800 m^2, with the majority (80%) of stations being 600 m^2, and the whole surface area of the stations was explored.

Taxa were determinated using the standard keys, books and guides reported in Jasprica & Milović (2016) and Milović *et al*. (2016). Biological form was verified in the field and denoted according to categories reported in Pignatti (1982), these being based on the classification of Raunkiaer (1934). Regarding chorotypes, reference was made to Horvatić (1963), Horvatić *et al*. (1967–1968), Jasprica *et al*. (2015, 2016ab), as well as to the monographs used for taxonomic nomenclature. The nomenclature of plant taxa follows the online plant database Euro+Med PlantBase (Euro+Med, 2006–2016), except for taxa marked with an asterisk (*), where Pignatti (1982) was used. In this study, archaeophytes are not discussed because they are considered as native in this database. The neophytes noted in this study were determined according to the application module 'Allochthonous plants' reported in the Flora Croatica Database (Nikolić, 2016), and the chorotype geographical labels mostly designated according to Tutin *et al.* (1968-1980, 1993), Pignatti (1982), Celesti-Grapow *et al.* (2009) and Pyšek *et al*. (2012). To indicate the degree of naturalization (the invasion status) of a taxon, we have used the terms casual, naturalized and invasive, following the definition of Richardson *et al*. (2000). The assessment of the degree of naturalization was made according to Boršić *et al*. (2008) refined by Nikolić *et al*. (2014) and Nikolić (2016). The taxa in the list are arranged alphabetically (Tab. 2). Taxa listed in the Red Book of Vascular Flora of Croatia (Nikolić & Topić, 2005; Nikolić, 2016) and the List of botanical species for the Red book of Bosnia and Herzegovina (Šilić, 1996) are marked with their corresponding IUCN status (IUCN, 2016; Anonymous, 2016ab). Taxa considered to be endemic are denoted according to Nikolić *et al.* (2015) and Nikolić (2016). In addition, strictly protected taxa (CSPT), as defined by Croatian Law are also denoted (Anonymous, 2013bc).

Finally, most taxa are associated with vegetation units (classes), in order to analyze the relationships between the floristic assemblage of the railway stations and the (semi-)natural vegetation types of the surrounding landscape. The system of characterizing species (mostly for those plants that are considered "characteristic species" of the classes) was derived from Horvat *et al.* (1974), Mucina (1997), and more recent SE Europe phytosociological literature (cf., Brullo *et al*., 2007; Šilc & Čarni, 2007; Šilc *et al*., 2008; Giupponi *et al*., 2015, etc.). The nomenclature of vegetation units mostly follows Biondi *et al*. (2014). Syntaxonomic units mentioned in the text and Tab. 2 are listed in the Appendix.

Data analysis

The classification procedure was performed in order to compare the composition of flora (based on presence-absence data) at the railway stations. A hierarchical agglomerative clustering was used based on Bray-Curtis similarity and Ward's method of group linkage as the method for grouping the formation (McCune & Mefford, 2006). The matrices consist of 259 taxa × 15 samples (railway stations). Taxa found only in one sample (station) were not included in this analysis (in total 100 taxa), because they make a low contribution to the community structure and may hinder the analysis of data (Causton, 1988). The program PC ORD ver. 5 (McCune & Mefford, 2006) was employed. Differences between groups obtained in classification were tested by analysis of similarities in the PRIMERv6 software (Clarke & Gorley, 2006).

RESULTS

Altogether 359 vascular plant taxa (336 species and 23 subspecies) were identified within 62 families and 230 genera (Tab. 2). The number of taxa at the stations varies from 47 to 152 (Fig. 2a). Seventy-two taxa were present at more than 50% of all the railway stations. Only *Chondrilla juncea* was common to all stations (Tab. 2). The most frequent taxa (present at ≥80% of all stations) were: *Convolvulus arvensis*, *Cichorium intybus*, *Daucus carota*, *Erigeron canadensis*, *Euphorbia maculata*, *E. prostrata*, *Plantago lanceolata*, *Cynodon dactylon*, *Geranium purpureum*, *Picris hieracioides*, *Portulaca oleracea*, *Setaria viridis*, *Heliotropium europaeum*, *Lactuca serriola*, *L. viminea* and *Petrorhagia saxifraga*. The number of taxa exclusively found in the large cities, rural sub-Mediterranean stations and southernmost stations was 24, 102 and 37, respectively (Tab. 2).

Fig. 2. Floristic composition of the studied railway stations (1-15). (a) total number of taxa (number of neophytes is in blue), (b) life forms and (c) chorotypes. The last column represents total number of taxa for all stations (a) or average percentage contributions for all stations (b, c). Abbreviations: life-forms: T - therophytes, H - hemicryptophytes, P - phanerophytes Ch - chamaephytes, G - geophytes; Chorotypes: MED - Mediterranean; SEU - South European; CEU - Central European; EU - European; EA - Euroasian; CH - Circum-Holarctic; WS - Cosmopolitan; CUAD - Cultivated and adventive plants. For station codes see Tab. 1.

Tab. 2. The list of the vascular plant taxa found at railway stations in Croatia and Bosnia and Herzegovina. **Names of taxa** are arranged alphabetically, followed by their occurrence at **railway stations**, **family**, **life form** (LF), **chorotype** (CT), **invasive status** (S), **origin of neophytes** (displayed on a gray background), **Croatian strictly protected taxa** (CSPT), **Croatian endemic and threatened taxa** (CE/TT), **vegetation classes**, and **their percentage contribution in total number of stations** (Frequency, %).

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/TT[6]	Vegetation classes[7]	Frequency (%)
Abutilon theophrasti Medik.	5, 6	Malvaceae	T	CUAD	inv	As				13
**Acer negundo* L.	2, 5	Aceraceae	P	CUAD	inv	Am				13
Achillea millefolium L.	1, 4, 5, 6, 7	Compositae	H	WS					M-A	33
Achillea nobilis L.	10	Compositae	H	EA					F-B	7
Aegilops neglecta Bertol.	3	Poaceae	T	MED				NT	St	7
Aegilops triuncialis L.	2, 3, 4, 6, 7, 8, 9, 15	Poaceae	T	MED					St	53
Aethionema saxatile (L.) W. T. Aiton	3	Brassicaceae	Ch	SEU					F-B	7
Agrimonia eupatoria L.	3	Rosaceae	H	CH					St	7
Ailanthus altissima (Mill.) Swingle	4, 5, 6, 10, 11, 12, 13, 14, 15	Simaroubaceae	P	CUAD	inv	As				60
Ajuga chamaepitys (L.) Schreb.	2, 6, 7, 8	Lamiaceae	T	MED					St	27
Alcea setosa (Boiss.) Alef.	15	Malvaceae	H	CUAD	nat	As				7
Alyssum alyssoides (L.) L.	2, 4, 8	Brassicaceae	T	SEU					St	20
Amaranthus albus L.	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 14	Amaranthaceae	T	CUAD	inv	Am				73
Amaranthus blitoides S. Watson	1, 6, 7, 9, 10	Amaranthaceae	T	CUAD	inv	Am				33
Amaranthus deflexus L.	5, 6, 7, 8, 9, 10, 11	Amaranthaceae	T	CUAD	inv	Am				47
Amaranthus powellii S. Watson	2, 10	Amaranthaceae	T	CUAD	cas	Am				13
Amaranthus retroflexus L.	1, 2, 5, 6, 10, 11, 13, 14	Amaranthaceae	T	WS	inv	Am				53
Ambrosia artemisiifolia L.	2, 5, 6, 9, 10, 11, 13, 14	Compositae	T	CUAD	inv	Am				53
Anagallis arvensis L.	1, 2, 4, 7, 11, 15	Primulaceae	T	WS					St	40

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Andrachne telephioides L.	7, 8, 9	Phyllanthaceae	Ch	MED					T-Br	20
Anisantha madritensis (L.) Nevski	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 13	Poaceae	T	MED					St	73
Anisantha sterilis (L.) Nevski	4, 5, 6, 7, 11	Poaceae	T	WS					St	33
Anthemis arvensis L.	4, 8, 11	Compositae	T	WS					St	20
Antirrhinum majus L.	11	Scrophulariaceae	Ch	CUAD					Pj	7
Araujia sericifera Brot.	11	Asclepiadaceae	P	CUAD	cas	Am			Qi	7
Arctium minus (Hill) Bernh.	5, 11	Compositae	H	EU					Av	13
Arenaria leptoclados (Rchb.) Guss.	1, 2, 3, 4, 5, 6, 8, 9, 10	Caryophyllaceae	T	EA					F-B	60
Artemisia absinthium L.	2, 5, 6, 7, 9	Compositae	Ch	EA					Av	33
Artemisia annua L.	6, 14, 15	Compositae	T	CUAD	inv	EA				20
Artemisia campestris L.	4, 9	Compositae	Ch	CH					F-B	13
Artemisia verlotiorum Lamotte	1, 2, 5, 6, 12, 15	Compositae	H	CUAD	inv	As				40
Arum italicum Mill.	15	Araceae	G	MED					Qi	7
Asparagus acutifolius L.	1, 2, 3, 7, 8, 9, 10	Asparagaceae	G	MED					Qi	47
Asperula aristata L. f. ssp. *scabra* (J. Presl & C. Presl) Nyman	4, 7	Rubiaceae	H	SEU					F-B	13
Asphodelus fistulosus L.	10, 12, 14, 15	Xanthorrhoeaceae	H	MED				R	T-Br	27
Asplenium ceterach L.	1, 5, 6, 8, 9	Aspleniaceae	H	SEU					At	33
Asplenium trichomanes L.	8	Aspleniaceae	H	WS					At	7
Atriplex patula L.	1, 2, 5, 6, 7, 9	Chenopodiaceae	T	WS					St	40
Aurinia sinuata (L.) Griseb.	5, 7, 8, 9, 10	Brassicaceae	Ch	MED			•	CE	At	33
Avena barbata Link	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	Poaceae	T	SEU					St	73
Avena sativa L.	2, 5, 10	Poaceae	T	CUAD						20

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Avena sterilis L.	1, 4, 5, 6, 9, 11, 12, 15	Poaceae	T	SEU					T-Br	53
Ballota nigra L. ssp. *foetida* (Vis.) Hayek	1, 5, 6, 7, 9, 10, 11, 15	Lamiaceae	H	SEU					St	53
Bellis perennis L.	15	Compositae	H	CEU					M-A	7
Berteroa mutabilis (Vent.) DC.	4, 5, 6, 14	Brassicaceae	H	MED					St	27
Bidens subalternans DC.	1, 2, 5, 9, 10, 11, 13, 14, 15	Compositae	T	CUAD	inv	Am				60
Bituminaria bituminosa (L.) C. H. Stirt.	1, 12	Fabaceae	H	MED					T-Br	13
Bothriochloa ischaemum (L.) Keng	1, 2, 3, 4, 5, 7, 10	Poaceae	H	SEU					F-B	47
Brassica napus L.	5, 6, 7, 8, 9	Brassicaceae	T	CUAD						33
Bromus hordeaceus L. ssp. *molliformis* (Billot) Maire & Weiller	1, 2	Poaceae	T	SEU					St	13
Broussonetia papyrifera (L.) Vent.	1, 5, 9	Moraceae	P	CUAD	inv	As				20
Bunias erucago L.	1, 2, 15	Brassicaceae	T	SEU					St	20
Bupleurum veronense Turra	3, 15	Apiaceae	T	MED					F-B	13
Calendula arvensis (Vaill.) L.	10	Compositae	T	SEU					St	7
Campanula erinus L.	8, 10	Campanulaceae	T	MED					At	13
Canna indica L.	12	Cannaceae	G	CUAD	cas	Am, As (Pantrop)			7	53
Capsella bursa-pastoris (L.) Medik.	15	Brassicaceae	H	WS					St	7
Capsella rubella Reut.	5, 6, 7, 9, 10, 11	Brassicaceae	T	MED					St	40
Cardamine hirsuta L.	1, 5, 6, 7, 9, 10	Brassicaceae	T	WS					St	40
Cardaria draba (L.) Desv.	5	Brassicaceae	H	WS					St	7
Carduus nutans L. ssp. *micropterus* (Borbás) Hayek	3	Compositae	H	MED			•	CE	Av	7
Carduus pycnocephalus L.	1, 2, 3, 4	Compositae	H	MED					St	27

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Carthamus lanatus L.	3, 4, 6, 7	Compositae	T	MED					Av	27
Catapodium rigidum (L.) C. E. Hubb.	1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 15	Poaceae	T	MED					F-B	73
Celtis australis L.	1, 3, 5, 9, 10, 11, 12, 13, 14, 15	Ulmaceae	P	SEU					Q-F	67
Cenchrus spicatus (L.) Cav.	5	Poaceae	T	CUAD	cas	Af			St	7
Centaurea deusta Ten.	15	Compositae	H	MED					F-B	7
Centaurea solstitialis L.	3, 4, 7, 8, 9	Compositae	H	SEU					Av	33
Centaurea spinosociliata Seenus	3, 4, 5, 8, 14	Compositae	H	MED			•	CE, NT	F-B	33
Cerastium glomeratum Thuill.	5, 10	Caryophyllaceae	T	WS					St	13
Cerastium pumilum Curtis ssp. *glutinosum* (Fr.) Jalas	3, 7, 10	Caryophyllaceae	T	WS					K-C	20
Cercis siliquastrum L.	6, 10, 14	Fabaceae	P	CUAD						20
Chenopodiastrum murale (L.) S. Fuentes & *al.*	11	Chenopodiaceae	T	WS				DD	St	7
Chenopodium album L.	5, 6, 7, 9, 10, 11, 12, 14, 15	Chenopodiaceae	T	WS					St	60
Chenopodium opulifolium W. D. J. Koch & Ziz	9	Chenopodiaceae	T	WS				DD	St	7
Chenopodium strictum Roth	1, 2, 4, 5, 6, 7, 8, 9, 10, 11	Chenopodiaceae	T	WS				DD	Av	67
Chondrilla juncea L.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	Compositae	H	EA					Av	100
Chrozophora tinctoria (L.) A. Juss.	12	Euphorbiaceae	T	MED					St	7
Cichorium intybus L.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	Compositae	H	WS					Av	93
Cirsium arvense (L.) Scop.	5, 13, 14	Compositae	G	EA					St	20
Cirsium vulgare (Savi) Ten.	1, 2, 4, 5, 9, 11	Compositae	H	EA					Av	40
**Clematis flammula* L.	1, 7, 8, 9, 13, 14	Ranunculaceae	P	MED					Qi	40

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
**Clematis vitalba* L.	1, 5, 13, 15	Ranunculaceae	P	EU					Q-F	27
Clinopodium acinos (L.) Kuntze	2, 3, 4, 5, 8, 9	Lamiaceae	T	EU					F-B	40
Clinopodium nepeta (L.) Kuntze ssp. *glandulosum* (Req.) Govaerts	15	Lamiaceae	H	SEU					T-Br	7
Clinopodium nepeta (L.) Kuntze ssp. *nepeta*	1, 5, 6, 9, 10, 11	Lamiaceae	H	SEU					T-Br	40
Clinopodium vulgare L.	6	Lamiaceae	H	WS					T-G	7
Clypeola jonthlaspi L.	9	Brassicaceae	T	MED					T-Br	7
**Consolida regalis* S. F. Gray ssp. *paniculata* (Host) Soó	5	Ranunculaceae	T	SEU						7
**Convolvulus arvensis* L.	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	Convolvulaceae	G	WS					Av	93
**Convolvulus cantabrica* L.	3, 7	Convolvulaceae	H	SEU					F-B	13
Cota segetalis (Ten.) Holub	6, 9, 10, 11	Compositae	T	MED					St	27
Crepis foetida L.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14	Compositae	T	SEU					Av	80
Crepis neglecta L.	1, 3, 6, 11	Compositae	T	MED					T-Br	27
Crepis sancta (L.) Bornm.	1, 3, 5, 6, 7, 8, 9, 10, 13	Compositae	T	MED					St	60
Crepis setosa Haller f.	6, 15	Compositae	T	SEU					St	13
Cynodon dactylon (L.) Pers.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14	Poaceae	G	WS					St	87
Cyperus rotundus L.	11	Cyperaceae	G	WS			•	EN	St	7
Dactylis glomerata L. ssp. *hispanica* (Roth) Nyman	1, 2, 3, 5, 6, 8, 10, 11, 12	Poaceae	H	MED					F-B	60
Dasypyrum villosum (L.) P. Candargy	1, 2, 3, 4, 5, 6, 8, 9, 11	Poaceae	T	MED					St	60
Daucus carota L.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15	Apiaceae	H	EA					Av	93

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
**Delphinium peregrinum* L.	4, 6, 7, 8, 9, 10	Ranunculaceae	T	SEU			•	EN	T-Br	40
Dianthus ciliatus Guss.	7	Caryophyllaceae	H	MED			•		F-B	7
Digitaria ciliaris (Retz.) Koeler	14	Poaceae	T	WS				DD	St	7
Digitaria sanguinalis (L.) Scop.	1, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14	Poaceae	T	WS					St	73
Diplotaxis erucoides (L.) DC.	2, 10	Brassicaceae	T	CUAD	inv	(W)M				13
Diplotaxis muralis (L.) DC.	6, 9, 11	Brassicaceae	T	WS					St	20
Diplotaxis tenuifolia (L.) DC.	1, 2, 5, 6, 7, 9, 10, 11, 12, 13, 14	Brassicaceae	H	WS					Av	73
Dittrichia graveolens (L.) Greuter	2, 5, 6, 10, 12	Compositae	T	SEU					M-A	33
Dittrichia viscosa (L.) Greuter	1, 2, 9, 10, 11, 12	Compositae	H	MED					Av	40
Dorycnium rectum (L.) Ser.	12	Fabaceae	H	MED			•	CR	M-A	7
Dysphania ambrosioides (L.) Mosyakin & Clemants	5, 12	Chenopodiaceae	T	CUAD	inv	Am		DD		13
**Ecballium elaterium* (L.) A. Rich.	9, 10, 11	Cucurbitaceae	G	MED				DD	St	20
Echinochloa crus-galli (L.) P. Beauv.	2, 4, 5, 13	Poaceae	T	WS					St	27
Echium italicum L.	8, 12	Boraginaceae	H	MED					Av	13
Echium plantagineum L.	1, 2, 9, 10, 14	Boraginaceae	T	MED					Av	33
Echium vulgare L.	4, 5, 7	Boraginaceae	H	EU					F-B	20
Eleusine indica (L.) Gaertn.	12, 13, 15	Poaceae	T	CUAD	inv	Af				20
Elytrigia repens (L.) Nevski	4	Poaceae	G	WS					Av	7
Ephedra foeminea Forssk.	13, 14	Ephedraceae	P	MED				NT	Qi	13
**Epilobium tetragonum* L. ssp. *tetragonum*	1	Onagraceae	H	WS					M-A	7

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Equisetum arvense L.	12	Equisetaceae	G	CH					Sp	7
Eragrostis cilianensis (All.) Janch.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Poaceae	T	WS					St	67
Eragrostis minor Host	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14	Poaceae	T	WS					St	73
Eragrostis pilosa (L.) P. Beauv.	1	Poaceae	T	WS					St	7
Erigeron annuus (L.) Desf.	1, 2, 3, 5, 6, 7, 14, 15	Compositae	T	CUAD	inv	Am				53
Erigeron bonariensis L.	1, 2, 10, 11, 14	Compositae	T	CUAD	inv	Am				33
Erigeron canadensis L.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15	Compositae	T	CUAD	inv	Am				93
Erigeron sumatrensis Retz.	1, 2, 6, 7, 9, 10, 11	Compositae	T	CUAD	inv	Am			St	47
Erodium cicutarium (L.) L'Hér.	3, 4, 5, 6, 7, 8, 9	Geraniaceae	T	WS					St	47
Erodium malacoides (L.) L'Hér.	1, 10	Geraniaceae	T	MED					St	13
Erophila verna (L.) Chevall. ssp. *praecox* (Steven) Walters	1, 5, 6, 7, 9, 10	Brassicaceae	T	WS					T-Br	40
Eryngium amethystinum L.	3, 7, 8	Apiaceae	H	MED					F-B	20
Eryngium campestre L.	5, 6	Apiaceae	H	SEU					F-B	13
Eupatorium cannabinum L.	5, 12	Compositae	H	EA					Ea	13
Euphorbia chamaesyce L.	10	Euphorbiaceae	T	SEU					St	7
Euphorbia characias L. ssp. *wulfenii* (Hoppe ex W. D. J. Koch) Radcl.-Sm.	1	Euphorbiaceae	P	MED					F-B	7
Euphorbia cyparissias L.	13	Euphorbiaceae	H	EA					F-B	7
Euphorbia falcata L.	2, 3, 4, 6, 7, 8, 9	Euphorbiaceae	T	SEU					St	47
Euphorbia helioscopia L.	1, 5, 7, 10	Euphorbiaceae	T	WS					St	27
Euphorbia maculata L.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15	Euphorbiaceae	T	CUAD	inv	Am				93

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Euphorbia nutans Lag.	14	Euphorbiaceae	T	CUAD	inv	Am				7
Euphorbia peplus L.	1, 2, 10, 11	Euphorbiaceae	T	WS					St	27
Euphorbia prostrata Aiton	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	Euphorbiaceae	T	CUAD	inv	Am		LC		93
**Fallopia convolvulus* (L.) Holub	1, 2, 5, 6, 7, 9	Polygonaceae	T	WS					St	40
Ficus carica L.	1, 2, 5, 6, 7, 9, 10, 11, 12, 13	Moraceae	P	MED					At	67
Filago germanica (L.) Huds.	4, 8	Compositae	T	WS					F-B	13
Filago pyramidata L.	2, 7	Compositae	T	MED					T-Br	13
Foeniculum vulgare Mill.	1, 2, 5, 6, 7, 10, 11, 12, 14, 15	Apiaceae	H	MED					Av	67
**Fumana procumbens* (Dunal) G. & G.	3	Cistaceae	Ch	SEU					F-B	7
Fumaria officinalis L.	5, 10	Papaveraceae	T	WS					St	13
Galinsoga quadriradiata Ruiz & Pav.	7	Compositae	T	CUAD	inv	Am				7
Galium aparine L.	5, 6, 7, 9, 10, 11	Rubiaceae	T	WS					Av	40
Galium divaricatum Lam.	2, 9	Rubiaceae	T	SEU					F-B	13
Galium murale (L.) All.	12, 13	Rubiaceae	T	MED					T-Br	13
Galium parisiense L.	13	Rubiaceae	T	SEU					St	7
Galium verum L.	5, 6	Rubiaceae	H	WS					F-B	13
Geranium molle L.	13	Geraniaceae	T	WS					St	7
Geranium purpureum Vill.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15	Geraniaceae	T	SEU					St	87
Geranium robertianum L.	13	Geraniaceae	T	WS					St	7
Geranium rotundifolium L.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	Geraniaceae	T	EA					Av	73
Glycyrrhiza glabra L.	12	Fabaceae	G	EA					Sp	7

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Hedera helix L.	1, 6, 9	Araliaceae	P	EU					Q-F	20
**Helianthemum salicifolium* (L.) Miller	3	Cistaceae	T	SEU					Hg	7
Helianthus annuus L.	5, 6, 7, 9	Compositae	T	CUAD	cas	Am				27
Helianthus tuberosus L.	1, 2, 5, 9, 11, 12	Compositae	G	CUAD	inv	Am				40
Helichrysum italicum (Roth) G. Don	2, 3, 5, 8, 9, 13	Compositae	Ch	MED					F-B	40
Heliotropium europaeum L.	1, 2, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15	Boraginaceae	T	MED					St	80
Helminthotheca echioides (L.) Holub	1, 2, 6, 11, 13	Compositae	T	MED					St	33
Herniaria glabra L.	1, 2, 3, 9, 10	Caryophyllaceae	T	EA					F-B	33
Herniaria incana Lam.	3, 4, 7, 9	Caryophyllaceae	H	SEU					F-B	27
Hippocrepis emerus (L.) Lassen ssp. *emeroides* (Boiss. & Spruner) Lassen	10	Fabaceae	P	MED					Q-F	7
Hirschfeldia incana (L.) Lagr.-Foss.	14	Brassicaceae	H	MED					Av	7
Hordeum murinum L. ssp. *leporinum* (Link) Arcang.	1, 2, 4, 5, 6, 7, 8, 9, 11	Poaceae	T	MED					St	60
Hornungia petraea (L.) Rchb.	9	Brassicaceae	T	WS					Hg	7
Hymenocarpos circinnatus (L.) Savi	11	Fabaceae	H	MED					T-Br	7
Hypericum perforatum L.	1, 2, 3, 4, 7, 8, 9, 10, 11, 12	Clusiaceae	H	SEU					T-G	67
**Ipomoea purpurea* Roth	11	Convolvulaceae	T	CUAD	cas	Am				7
Kickxia spuria (L.) Dumort.	2, 11	Scrophulariaceae	T	EA					St	13
Koeleria splendens C. Presl	3	Poaceae	H	SEU					F-B	7
Lactuca serriola L.	1, 2, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15	Compositae	H	WS					St	80
Lactuca viminea (L.) J. Presl & C. Presl	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 15	Compositae	H	SEU					F-B	80

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Lamium amplexicaule L.	6, 7, 9, 10	Lamiaceae	T	EA					St	27
**Laurus nobilis* L.	1, 9	Lauraceae	P	MED					Qi	13
Leontodon crispus Vill.	2	Compositae	H	SEU					F-B	7
Lepidium graminifolium L.	1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 14	Brassicaceae	H	SEU					St	73
Lepidium virginicum L.	1, 2, 5, 9, 14	Brassicaceae	T	CUAD	inv	Am				33
Linaria angustissima (Loisel.) Borbás	1, 2, 3, 5, 9, 11, 13	Scrophulariaceae	H	SEU					F-B	47
Linaria genistifolia (L.) Mill. ssp. *dalmatica* (L.) Maire & Petitm.	12	Scrophulariaceae	H	MED					F-B	7
Linaria simplex (Willd.) DC.	1, 4, 6, 8	Scrophulariaceae	T	MED					F-B	27
Lolium perenne L.	2, 3, 4, 5, 6, 7, 9, 11	Poaceae	H	EU					M-A	53
Lotus corniculatus L.	3, 5, 7	Fabaceae	H	WS					T-G	20
Lotus tenuis Willd.	5	Fabaceae	H	WS					M-A	7
Lycopersicon esculentum Mill.	11	Solanaceae	T	CUAD	cas	Am				7
Malva sylvestris L.	1, 2, 5, 6, 7, 8, 9, 10, 11, 12	Malvaceae	H	WS					Av	67
Marrubium incanum Desr.	3, 7	Lamiaceae	H	MED					St	13
Matricaria chamomilla L.	2, 11	Compositae	T	CUAD					St	13
Medicago littoralis Loisel.	11	Fabaceae	T	MED					T-Br	7
Medicago lupulina L.	2, 5, 6, 7, 9, 10	Fabaceae	T	WS					St	40
Medicago minima (L.) L.	3, 4, 6	Fabaceae	T	WS					T-Br	20
Medicago monspeliaca (L.) Trautv.	2, 3	Fabaceae	T	MED					F-B	13
Medicago orbicularis (L.) Bartal.	2, 6, 9, 10	Fabaceae	T	MED					T-Br	27
Medicago polymorpha L.	2	Fabaceae	T	SEU					Av	7

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Medicago prostrata Jacq.	3	Fabaceae	H	SEU					F-B	7
Medicago rigidula (L.) All.	2, 4, 7, 8, 10	Fabaceae	T	MED					F-B	33
Medicago sativa L.	2, 5, 6, 7, 8, 9, 10, 12	Fabaceae	H	WS					St	53
Melica ciliata L.	1, 3, 4, 5, 8, 9, 11, 12, 14, 15	Poaceae	H	EA					F-B	67
Melilotus albus Medik.	5	Fabaceae	T	EA					Av	7
Melilotus officinalis (L.) Lam.	5, 6, 7, 9, 14	Fabaceae	H	EA					Av	33
Mentha longifolia (L.) L.	6	Lamiaceae	H	WS					M-A	7
Mercurialis annua L.	1, 6, 11, 14	Euphorbiaceae	T	WS					St	27
Micromeria juliana (L.) Benth. ex Rchb.	8	Lamiaceae	Ch	MED					C-M	7
Microrrhinum litorale (Willd.) Speta	2, 5, 6, 7, 9, 11	Scrophulariaceae	T	MED					Tr	40
Microrrhinum minus (L.) Fourr. ssp. *minus*	2, 4, 5, 6, 7, 8, 9, 11	Scrophulariaceae	T	EU					Tr	53
Minuartia hybrida (Vill.) Schischk.	1, 3, 8, 10	Caryophyllaceae	T	EA					K-C	27
Minuartia mediterranea (Link) K. Malý	2, 3, 10, 15	Caryophyllaceae	T	MED					Hg	27
Mirabilis jalapa L.	1, 10, 11, 12	Nyctaginaceae	G	CUAD	nat	Am				27
Misopates orontium (L.) Raf.	1, 2, 5, 9, 10, 11, 12, 13	Scrophulariaceae	T	EA					At	53
Morus alba L.	5	Moraceae	P	CUAD					Q-F	7
**Nigella damascena* L.	1, 3, 6, 7, 8	Ranunculaceae	T	MED					T-Br	33
Ochlopoa annua (L.) H. Scholz	1, 5, 6, 7, 9, 10, 12, 13, 14	Poaceae	T	WS				LC	St	60
Ononis spinosa L. ssp. *antiquorum* (L.) Arcang.	3, 5	Fabaceae	Ch	MED					F-B	13
Onopordum illyricum L.	3, 7, 8, 10, 11	Compositae	H	MED					Av	33
Origanum vulgare ssp. *viridulum* (Martrin-Donos) Nyman (*Origanum heracleoticum* L.)	11	Lamiaceae	H	MED					F-B	7

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Orlaya grandiflora (L.) Hoffm.	7, 8, 10	Apiaceae	T	SEU					St	20
Oxalis articulata Savigny	1, 9	Oxalidaceae	G	CUAD	cas	Am				13
Oxalis corniculata L.	1, 4, 6, 7, 9, 10, 11, 13	Oxalidaceae	H	WS					Pj	53
Paliurus spina-christi Mill.	3, 8	Rhamnaceae	P	MED					Rh-P	13
Pallenis spinosa (L.) Cass.	10, 11	Compositae	T	MED					T-Br	13
Panicum capillare L.	5, 14	Poaceae	T	CUAD	inv	Am				13
Panicum dichotomiflorum Michx.	5	Poaceae	T	CUAD	inv	Am				7
Papaver rhoeas L.	1, 5, 6, 13	Papaveraceae	T	WS					St	27
Parietaria judaica L.	1, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15	Urticaceae	H	SEU					Pj	73
Paronychia kapela (Hacq.) A. Kern.	3	Caryophyllaceae	H	SEU					F-B	7
**Parthenocissus quinquefolia* (L.) Planchon	4, 5, 9, 10, 11, 13	Vitaceae	P	CUAD	inv	Am				40
Paspalum dilatatum Poir.	13	Poaceae	H	CUAD	inv	Am				7
Petrorhagia prolifera (L.) P. W. Ball & Heywood	1, 2, 3, 4, 6, 9, 15	Caryophyllaceae	T	EA					F-B	47
Petrorhagia saxifraga (L.) Link	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14	Caryophyllaceae	H	SEU					F-B	80
Phleum subulatum (Savi) Asch. & Graebn.	3, 4, 6, 7, 8, 9, 10	Poaceae	T	MED					Av	47
Phragmites australis (Cav.) Steud.	5, 12	Poaceae	G	WS					Ph-M	13
Phytolacca americana L.	1, 13	Phytolaccaceae	G	CUAD	inv	Am				13
Picnomon acarna (L.) Cass.	3, 7, 8, 9	Compositae	H	MED					Av	27
Picris hieracioides L.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15	Compositae	H	EA					St	87
Pilosella bauhini (Schult.) Arv.-Touv.	4	Compositae	H	EA					F-B	7

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Pilosella hoppeana (Schult.) F. W. Schultz & Sch. Bip.	13, 14	Compositae	H	SEU					F-B	13
Pilosella hoppeana (Schult.) F. W. Schultz & Sch. Bip. ssp. *testimonialis* (Peter) P. D. Sell & C. West	3	Compositae	H	SEU					F-B	7
Pilosella piloselloides (Vill.) Soják	4	Compositae	H	MED					F-B	7
Piptatherum miliaceum (L.) Coss.	9, 10, 11, 12	Poaceae	H	MED					F-B	27
Plantago altissima L.	5, 6, 11	Plantaginaceae	H	SEU					M-A	20
Plantago coronopus L.	1, 2	Plantaginaceae	T	EA					Sm	13
Plantago lanceolata L.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	Plantaginaceae	H	WS					M-A	93
Plantago major L. ssp. *intermedia* (Gilib.) Lange	5	Plantaginaceae	H	WS					P-P	7
Platanus orientalis L.	12, 13	Platanaceae	P	CUAD					Sp	13
Plumbago europaea L.	1, 6	Plumbaginaceae	Ch	MED					St	13
Polycarpon tetraphyllum (L.) L.	1, 5, 9, 10, 11	Caryophyllaceae	T	SEU					P-P	33
Polycnemum arvense L.	7	Chenopodiaceae	T	EA			•	DD	St	7
**Polygonum arenastrum* Boreau	1, 2, 5, 7, 9, 10, 11	Polygonaceae	T	WS					P-P	47
**Polygonum aviculare* L.	1, 2, 4, 5, 6, 7, 8, 9, 10, 11	Polygonaceae	T	WS					St	67
**Polygonum persicaria* L.	2, 4, 5, 9	Polygonaceae	T	WS					St	27
Populus alba L.	12	Salicaceae	P	EA					Sp	7
Populus nigra L.	6	Salicaceae	P	WS					Sp	7
Portulaca oleracea L.	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	Portulacaceae	T	WS					St	87
Potentilla argentea L.	5, 6, 9	Rosaceae	H	CH					K-C	20

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Potentilla inclinata Vill.	2	Rosaceae	H	EA					T-G	7
Potentilla reptans L.	1, 3, 5, 6, 13	Rosaceae	H	WS					M-A	33
Prunus cerasifera Ehrh.	1, 11	Rosaceae	P	CUAD						13
Prunus spinosa L.	6, 7	Rosaceae	P	EA					Rh-P	13
Psilurus incurvus (Gouan) Schinz & Thell.	2, 3	Poaceae	T	MED					T-Br	13
Pulicaria dysenterica (L.) Bernh.	12	Compositae	H	SEU					M-A	7
Reichardia picroides (L.) Roth	1, 2, 8, 9, 10, 11, 12, 14	Compositae	H	MED					T-Br	53
Reseda alba L.	1, 9, 10, 11	Resedaceae	T	MED					Av	27
Reseda lutea L.	5, 6, 9, 10	Resedaceae	H	WS					Av	27
Reseda phyteuma L.	2, 4, 6, 9	Resedaceae	T	SEU					St	27
Robinia pseudoacacia L.	1, 2, 5, 6, 11, 12, 13	Fabaceae	P	CUAD	inv	Am				47
Rostraria cristata (L.) Tzvelev	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Poaceae	T	MED					F-B	67
Rubus caesius L.	4, 5	Rosaceae	P	EA					Q-F	13
Rubus ulmifolius Schott	1, 3, 5, 6, 7, 8, 9, 10, 11, 12	Rosaceae	P	MED					N-T	67
Salsola kali L.	9	Chenopodiaceae	T	WS			•	VU	Cm	7
Salvia pratensis L.	3, 7, 11, 13	Lamiaceae	H	EU					F-B	27
Sanguisorba minor Scop.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Rosaceae	H	EA					F-B	67
Sanguisorba minor Scop. ssp. *balearica* (Nyman) Muñoz Garm. & C. Navarro	12	Rosaceae	H	SEU					F-B	7
Satureja hortensis L.	2, 5, 8, 9	Lamiaceae	T	MED					F-B	27
Satureja montana L.	7, 9	Lamiaceae	Ch	SEU					F-B	13
Saxifraga tridactylites L.	2, 3, 5, 6, 7, 8, 9, 10	Saxifragaceae	T	WS					Hg	53

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
**Scabiosa maritima* L.	1, 9, 10, 11	Dipsacaceae	H	MED					F-B	27
Scolymus hispanicus L.	1, 3, 4, 6, 7, 8, 9, 10	Compositae	H	MED					Av	53
Scrophularia canina L.	4, 6, 7, 10	Scrophulariaceae	H	SEU					Tr	27
Securigera cretica (L.) Lassen	9	Fabaceae	T	MED					St	7
Sedum album L.	6	Crassulaceae	Ch	EA					F-B	7
Sedum hispanicum L.	6	Crassulaceae	T	SEU					At	7
Sedum sexangulare L.	3	Crassulaceae	Ch	EU					F-B	7
Senecio viscosus L.	5	Compositae	T	EU					St	7
Senecio vulgaris L.	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 13	Compositae	T	WS					St	73
Seseli tortuosum L.	5, 6, 7	Apiaceae	H	SEU					F-B	20
Setaria verticillata (L.) P. Beauv.	2, 4, 10, 11	Poaceae	T	WS					St	27
Setaria viridis (L.) P. Beauv.	1, 2, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15	Poaceae	T	EA					St	87
Silene gallica L.	11	Caryophyllaceae	T	WS					T-Br	7
Silene latifolia Poir.	1, 3, 4, 5, 6, 7, 9, 10, 11, 15	Caryophyllaceae	H	EA					G-U	67
Silene otites (L.) Wibel	7, 8	Caryophyllaceae	H	SEU					F-B	13
Silene vulgaris (Moench) Garcke	1, 3, 8, 9, 12, 15	Caryophyllaceae	H	EA					St	40
Sisymbrium officinale (L.) Scop.	4, 7, 8, 9, 11, 14	Brassicaceae	T	WS					Av	40
Solanum elaeagnifolium Cav.	10	Solanaceae	H	CUAD	inv	Am				7
Solanum nigrum L.	1, 5, 9, 11, 13, 14	Solanaceae	T	WS					St	40
Solanum rostratum Dunal	8	Solanaceae	T	CUAD	nat	Am				7
Solanum villosum Mill.	10, 11	Solanaceae	T	SEU					St	13

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Sonchus arvensis L.	15	Compositae	H	WS					St	7
Sonchus asper (L.) Hill	13	Compositae	T	EA					St	7
Sonchus asper (L.) Hill ssp. *glaucescens* (Jord.) Ball	2, 5, 6, 7, 9, 10, 11, 12	Compositae	H	MED					St	53
Sonchus oleraceus L.	2, 5, 6, 10, 13, 15	Compositae	T	WS					St	40
Sonchus tenerrimus L.	1, 2, 5, 6, 9, 10, 11, 13	Compositae	T	MED					St	53
Sorghum halepense (L.) Pers.	1, 2, 5, 6, 9, 10, 12, 13, 14	Poaceae	G	WS	inv	(E)M				60
Spartium junceum L.	9, 12	Fabaceae	P	MED					Qi	13
Stachys thirkei K. Koch	3, 7, 9	Lamiaceae	H	MED					F-B	20
Stellaria media (L.) Cirillo	7, 12, 13	Caryophyllaceae	T	WS					St	20
Symphyotrichum squamatum (Spreng.) G. L. Nesom	1, 2, 11, 12, 15	Compositae	T	CUAD	inv	Am				33
Tagetes minuta L.	12	Compositae	T	CUAD	inv	Am				7
**Tamarix dalmatica* Baum	12	Tamaricaceae	P	MED					N-T	7
Tanacetum parthenium (L.) Sch. Bip.	1	Compositae	H	WS	cas	As				7
Taraxacum officinale agg. F. H. Wigg.	1, 2, 4, 5, 6, 7, 9, 11, 12, 13	Compositae	H	WS					M-A	67
Teucrium capitatum L.	14	Lamiaceae	Ch	MED					F-B	7
Tordylium maximum L.	6	Apiaceae	T	EA					Av/K-C	7
Torilis arvensis (Huds.) Link	2	Apiaceae	T	SEU					St	7
Torilis nodosa (L.) Gaertn.	1, 9	Apiaceae	T	MED					St	13
Tragopogon porrifolius L.	1, 15	Compositae	H	MED					F-B	13
Tragopogon pratensis L.	2, 4, 5, 6, 7, 8, 9	Compositae	H	EA					M-A	47

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Tragus racemosus (L.) All.	1, 2, 4, 7, 10	Poaceae	T	SEU					St	33
**Tremastelma palaestinum* (L.) Janchen	3, 4	Dipsacaceae	T	MED					Qi	13
Tribulus terrestris L.	1, 2, 5, 6, 7, 8, 9, 10, 11, 13, 14	Zygophyllaceae	T	SEU					St	73
Trifolium angustifolium L.	2, 7	Fabaceae	T	MED					T-Br	13
Trifolium campestre Schreb.	2, 3, 5, 6, 8, 9	Fabaceae	T	WS					T-Br	40
Trifolium dalmaticum Vis.	3, 4, 7, 8	Fabaceae	T	MED			•	CE	F-B	27
Trifolium pratense L.	3, 5	Fabaceae	H	EA					M-A	13
Trifolium repens L.	2, 3, 5, 11	Fabaceae	H	WS					M-A	27
Trifolium scabrum L.	3, 4	Fabaceae	T	MED					F-B	13
Trigonella esculenta Willd.	1	Fabaceae	T	MED					St	7
Triticum aestivum L.	2, 4, 5, 6, 7, 8, 9	Poaceae	T	CUAD						47
Ulmus minor Mill.	2, 5, 6, 9, 10, 11	Ulmaceae	P	WS					Q-F	40
Ulmus pumila L. (*Ulmus pinnato-ramosa* Dieck ex Koehne)	2, 9, 10, 13	Ulmaceae	P	CUAD	nat	As				27
Urospermum picroides (L.) F. W. Schmidt	1, 3, 10, 11	Compositae	T	MED					St	27
Urtica dioica L.	7	Urticaceae	H	WS					G-U	7
Verbascum blattaria L.	14	Scrophulariaceae	H	SEU					Av	7
Verbascum pulverulentum Vill.	4, 5	Scrophulariaceae	H	SEU					Av	13
Verbascum sinuatum L.	1, 5, 6, 7, 9, 10, 11, 13	Scrophulariaceae	H	MED					Av	53
Verbascum thapsus L.	2, 10, 13	Scrophulariaceae	H	EU					Av	20
Verbena officinalis L.	1, 2, 4, 5, 6, 7, 9, 10, 12	Verbenaceae	H	WS					St	60
Veronica agrestis L.	13	Scrophulariaceae	T	EA				NT	St	7

Taxon	Records from stations[1]	Family	LF[2]	CT[3]	S[4]	Origin of neoph.[5]	CSPT	CE/ TT[6]	Vegetation classes[7]	Frequency (%)
Veronica arvensis L.	2, 4, 9, 11	Scrophulariaceae	T	EA					St	27
Veronica cymbalaria Bodard	9	Scrophulariaceae	T	SEU					Pj	7
Veronica hederifolia L.	7	Scrophulariaceae	T	EA					St	7
Veronica persica Poir.	2, 4, 5, 7, 11	Scrophulariaceae	T	WS	inv	As				33
Veronica polita Fr.	7, 9, 10	Scrophulariaceae	T	EA					St	20
**Viola arvensis* Murray	2, 3, 5, 7, 9	Violaceae	T	WS					St	33
**Viola tricolor* L.	5, 6	Violaceae	T	EA					F-B	13
**Vitis vinifera* L.	12	Vitaceae	P	CUAD				LC	N-T	7
Vulpia ciliata Dumort.	1, 2, 4, 5, 7, 10	Poaceae	T	SEU					T-Br	40
Xanthium orientale L. ssp. *italicum* (Moretti) Greuter	5, 6, 9, 14	Compositae	T	WS	inv	Am				27
Xanthium spinosum L.	2	Compositae	T	WS	inv	Am				7
Xanthium strumarium L.	12	Compositae	T	WS					St	7
Zea mays L.	4, 6, 9	Poaceae	T	CUAD	cas	Am				20

[1]Station codes: **1** – Zadar, **2** – Benkovac, **3** – Đevrske, **4** – Kistanje, **5** – Knin, **6** – Drniš, **7** – Unešić, **8** – Koprno, **9** – Perković, **10** – Šibenik, **11** – Split, **12** – Ploče, **13** – Metković, **14** – Čapljina, **15** – Mostar. [2]Life forms: **Ch** – chamaephytes, **G** – geophytes, **H** – hemicryptophytes, **P** – phanerophytes, **T** – therophytes. [3]Chorotypes: **MED** – Mediterranean; **SEU** – South European; **CEU** – Central European; **EU** – European; **EA** – Euroasian; **CH** – Circum-Holarctic; **WS** – Cosmopolitan; **CUAD** – Cultivate and adventive plants. [4]Status: **cas** - casual, **nat** - naturalized, **inv** - invasive. [5]Origin of neophytes: **Am** – Americas, **As** – Asia, **M** – Mediterranean, **EA** – Eurasia, **Af** – Africa. [6]Endemic and threatened taxa: **CE** – Croatian Endemic, **CR** – Critically Endangered, **EN** – Endangered, **VU** – Vulnerable, **NT** – Near Threatened, **LC** – Least Concern, **DD** – Data Deficient, **R** - rare in Bosnia and Herzegovina. [7]The codes of classes: **At** – *Asplenietea trichomanis*, **Av** – *Artemisietea vulgaris*, **Cm** – *Cakiletea maritimae*, **C-M** – *Cisto cretici-Micromerietea julianae*, **Ea** – *Epilobietea angustifolii*, **F-B** – *Festuco valesiacae-Brometea erecti*, **G-U** – *Galio aparines-Urticetea dioiceae*, **Hg** – *Helianthemetea guttati*, **K-C** – *Koelerio glaucae-Corynephoretea canescentis*, **M-A** – *Molinio-Arrhenatheretea*, **N-T** – *Nerio oleandri-Tamaricetea africanae*, **Qi** – *Quercetea ilicis*, **Q-F** – *Querco-Fagetea sylvaticae*, **Ph-M** – *Phragmito australis-Magnocaricetea elatae*, **Pj** – *Parietarietea judaicae*, **P-P** – *Polygono arenastri-Poetea annuae*, **Rh-P** – *Rhamno catharticae-Prunetea spinosae*, **Sm** – *Saginetea maritimae*, **Sp** – *Salicetea purpureae*, **St** – *Stellarietea mediae*, **T-Br** – *Thero-Brachypodietea ramosi*, **T-G** – *Trifolio medii-Geranietea sanguinei*, **Tr** – *Thlaspietea rotundifolii*.

Hierarchical classification identified two broad groups of railway stations (northwestern – cluster A and southeastern – cluster B) of significantly different floristic assemblages (Fig. 3). In general, the number of taxa was significantly lower in the southeastern group of stations (between 47 and 71 taxa) than in the northwestern stations (88-152 taxa). In total, 31 taxa were exclusively found in the southeastern group of stations, and among them, 12 were found only in Bosnia and Herzegovina (Tab. 2): *Alcea setosa*, *Arum italicum*, *Bellis perennis*, *Capsella bursa-pastoris*, *Centaurea deusta*, *Clinopodium nepeta* ssp. *glandulosum*, *Digitaria ciliaris*, *Euphorbia nutans*, *Hirschfeldia incana*, *Sonchus arvensis*, *Teucrium capitatum* and *Verbascum blattaria.* Cluster A can be further divided into two subclusters where the stations of Đverske, Kistanje and Koprno were separated (subcluster A2). Subcluster A1.2 represents three large coastal cities: Zadar, Šibenik and Split.

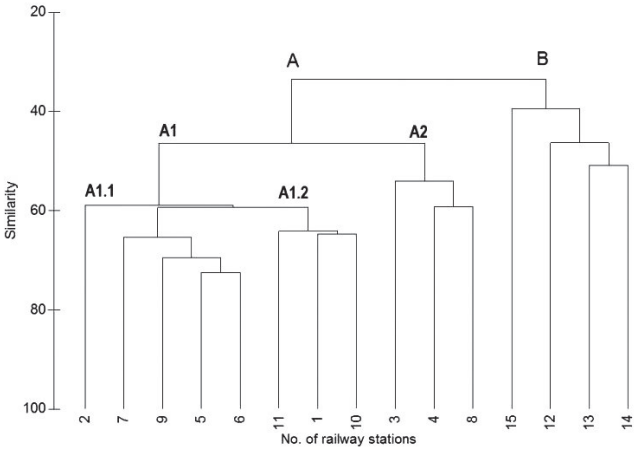

Fig. 3. Dendrogram constructed according to list of plant taxa identified at the railway stations (group link, similarity ratio, absence-presence data). The codes of stations (numbers) are given in Tab. 1.

Number of neophytes is between 3 and 26 (3 to 28% of the total number) (Fig. 2a). The highest percentage of neophytes was noted at the stations in Bosnia and Herzegovina. In total, 52 neophytes, i.e. 14% of the total number of taxa, were found at the railway stations. Among them, the most frequent (present at ≥73% of all stations) were *Erigeron canadensis*, *Euphorbia maculata*, *E. prostrata* and *Amaranthus albus*. Regarding chorotypes, most were of American origin. According to the degree of naturalization, the most prominent were invasive plants (73% of all neophytes).

Generally, no significant differences were found in life form and chorotypes among the stations (Fig. 2b, c). The analysis of plant life forms showed that the flora were dominated by therophytes (51%) and hemicryptophytes (32%), followed by phanerophytes (8%). Chamaephytes and geophytes contributed almost equally (Fig. 2b). Among neophytes, therophytes dominated (34 taxa, i.e. 65%), followed by phanerophytes (7 taxa, i.e. 14%). Dominant in the flora were Mediterranean chorotypes (26.5%), mostly circum-Mediterranean plants, followed by a considerable proportion of Cosmopolitans (24.5%) and South European plants (17.3%) (Fig. 2c).

In the phytosociological spectrum (Fig. 4), the mostly represented element (104 species, i.e. 34%) was *Stellarietea mediae*, followed by *Festuco valesiacae-Brometea erecti* (63 taxa, 21%). *Artemisietea vulgaris* is also well represented in the railway station flora (36 taxa, 12%), while the *Thero-Brachypodietea ramosi* element is more poor (24 taxa, 8%). *Molinio-Arrhenatheretea* class is represented by 16 taxa (5%), and other elements are featured ≤2.6% each.

In total, 10 plant taxa found at railway stations are strictly protected in Croatia. Four taxa are considered to be endemic, mostly belonging to the group of Illyrian-Adriatic endemics. Altogether, 18 taxa were included in the Croatian Red List. Among them, the category of Critically Endangered (CR) is assigned to only one taxon (*Dorycnium rectum*). In Bosnia and Herzegovina, *Asphodelus fistulosus* is considered to be a rare taxon.

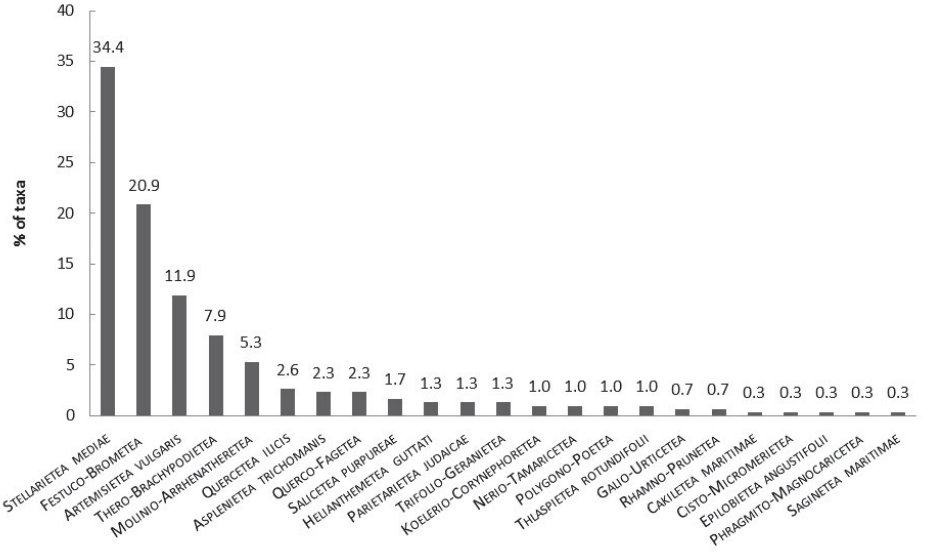

Fig. 4. The phytosociological spectrum of the species found at railway stations.

DISCUSSION

This study revealed the high richness of vascular plant taxa at railway stations in the Mediterranean and sub-Mediterranean area in southern Croatia and Bosnia and Herzegovina, and, as expected, ca 30% of these taxa occurred at low frequency (found at only one station), i.e. were considered rare (Galera *et al*., 2014). However in general, vascular plant diversity (at a scale of 110 km^2) in the Croatian Mediterranean-climate region ranks among the highest in the country, with a high overall biodiversity that is significant in a broader European context (Jelaska *et al*., 2010; Nikolić *et al*., 2015). Similarly, high vascular plant diversity was also reported for the southern part of Bosnia and Herzegovina (Redžić *et al*., 2008).

In this case, the number of taxa is high when compared to the floristic richness found on railways in the Mediterranean area of Italy (Cornelini & Petrella, 1994; Filibeck *et al*., 2012), or some north European sites (Lejmbach *et al*., 1975; Warcholińska, 2008). Other authors have given quite different results for railway areas in a broad sense and over a wide geographic area (e.g., Messenger, 1968; Altay *et al*., 2015; Májeková & Limánek, 2016; Jehlík *et al*., 2017). The disparity was probably caused by differences in the size of the studied areas, the great variability of microhabitats in the areas investigated and environmental management plans at the stations.

In the present study, there were two broad groups of stations that differed from geographic, floristic and ecological (topography, climatic conditions) points of view (clusters A and B, Fig. 3). The first group of stations (cluster B) occurs in the southernmost part of the investigated area with higher annual air temperature (15.1-16.0°C) and precipitation (>1,000 mm y^{-1}). This group covers the area from the Adriatic coast to the inland temperate (Weak sub-Mediterranean) part of Bosnia and Herzegovina (city of Mostar). In addition, as an integral part of the extensive transit system between Croatia and Bosnia, it is characterized by warm and wet conditions along the Neretva river valley, which is the main habitat for many riparian woody (e.g. *Tamarix dalmatica*, *Platanus orientalis*, etc.), and other hygrophilous or mesophilous taxa (*Pulicaria dysenterica*, *Dorycnium rectum*, etc.) (Lovrić *et al*., 1989; Jasprica, 2007). Although rivers play a significant role as corridors for the spreading of both native and non-native species, this very important topic deserves closer analysis than can be offered here (Rutkovska *et al*., 2011). Jasprica *et al.* (2010) have also highlighted the historical differences in the type and intensity of human impact that each part of NW Balkans (Mediterranean and sub-Mediterranean) has experienced.

The second group of stations (subclusters A1 and A2, Fig. 3) represents the rural stations located in the hilly hinterland (186-348 m a.s.l.) in the inland temperate (Weak sub-Mediterranean) variant of macrobioclimate, and those in large coastal Dalmatian cities (subcluster A1.2). The latter showed very similar, predominantly urban flora due to high anthropogenic pressure and distance from the (semi-)natural vegetation (Milović, 2002; Jasprica *et al*., 2010; Milović & Mitić, 2012, and references therein). By contrast, the flora of rural stations was mostly defined by intensively managed landscapes, the high contribution of annual segetal weeds (e.g. *Euphorbia falcata*, *Erodium cicutarium*, *Viola arvensis*), dry grassland and meadow (*Clinopodium acinos*, *Trifolium campestre*, *Tragopogon pratensis*, etc.) or crop taxa (*Triticum aestivum*, *Brassica napus*).

The lists of species noted along railway tracks and stations in different regions of Europe cannot be compared directly, as the differences in species composition may be due to location-related differences and variation of habitat diversity across the region. In addition, some taxa (e.g., *Geranium purpureum*, *Lepidium virginicum*, *Saxifraga tridactylites*, etc.) have different current statuses including the history of their migration in different parts of Europe (Van der Ham, 1981; Reisch, 2007; Eliáš, 2011). However, the most frequent taxa in our study have also been found in railway stations in the continental region of Croatia (Marković, 1977) and in neighbouring Hungary (Pál & Csiky, 2002). A comparison with railway flora studies in different European countries showed that *Convolvulus arvensis* was a common taxon (Altay *et al*., 2015; Sargent, 1984; Brandes, 1984). However, Croatian inland railway stations nevertheless exhibit interesting differences in their flora in comparison with those in the Mediterranean part of the country: i) they have a lower richness, while a third of them occur in both biogeographic regions, ii) hemicryptophytes and Cosmopolitans prevailed. Some taxa of a strictly Mediterranean range (e.g., *Scolymus hispanicus*, *Dasypyrum villosum*) have also been noted at stations in the inland region but show no tendency to spread.

In our study, therophytes were dominant in the life form spectrum, as has been previously reported for the flora of railway areas and other anthropogenic habitats subject to strong human pressure (see e.g., Kowarik & Tietz, 1986; Partsch & Karstner, 1995; Schinninger *et al*., 2002; Brandes, 2004; Galera *et al*., 2012). Plant characteristics such as a short life cycle and the ability to persist under dry conditions and high insolation enable these plants to grow and thrive along operating rail tracks. Despite the artificial origins of the study sites, the life form distribution retains a strong similarity with the spectrum of the regional pool (e.g., Milović, 2002, etc.). On the other hand, the relatively high proportion of phanerophytes (e.g., *Celtis australis*, *Ficus carica*, etc.) highlights the role played by the railway verges as a substitute habitat for woody taxa. Anyway, it is important to take into consideration the fact that the further growth of phanerophytes on active railway tracks is very difficult or even impossible. According to our opinion, this can also be applied for rare and threatened taxa. On the contrary, Májeková *et al*. (2014) reported that despite regular elimination of vegetation in railway areas by different types of treatment, railways and their facilities represent sites of conservation for rare and threatened taxa.

As for chorotypes, the results clearly showed a predominance of taxa of the Mediterranean element with a considerable proportion of Cosmopolitans. In this case, in contrast to the findings of Filibeck *et al*. (2012) in the Mediterranean region of the Italian Peninsula, the high percentage contribution of Mediterranean taxa with co-domination of Cosmopolitans suggests that the Mediterranean climate does not act more than partly as a strong ecological filter, while the presence of cosmopolitans suggests a high degree of human impact (e.g., Dunnett & Hitchmough, 2004). Generally these taxa had a significant influence on the physiognomy of this type of man-made habitat in the area (Jasprica *et al*., 2015, and references therein).

A considerable participation of taxa from the *Stellarietea mediae* and *Festuco valesiacae-Brometea erecti* classes indicates that the flora of the studied railway stations, at least partly, retains a strong link with the floristic composition of the plant communities of its biogeographic context. Although some of the most frequent taxa (e.g. *Chondrilla juncea*, *Convolvulus arvensis*) are associated with *Artemisietea vulgaris* class, ruderal taxa were less frequently noted, as their functional traits are scarcely adapted to a Mediterranean climate. High contribution of character-species of the *Stellarietea mediae* and *Artemisietea vulgaris* has been also found in railway areas in both Mediterranean and temperate Europe (Cornelini & Petrella, 1997; Kropáč, 2006; Fornal-Pieniak & Wysocki, 2011).

In the present study, on average, neophytes contributed 14% of the identified flora. This is consistent with the findings of Filibeck *et al*. (2012) and Altay *et al*. (2015) for Mediterranean railway areas, and only partly with those in central Europe (e.g., Czarna, 2005). Additionally, our finding closely agrees with the proportion of neophytes in urban flora of the main Croatian coastal cities and the

city of Mostar in Bosnia and Herzegovina, and in railway stations of inland Croatia (Marković, 1977; Milović & Mitić, 2012; Maslo, 2014). In general, the pattern of neophytes is similar in the investigated area to the rest of Europe, and is most strongly influenced by site conditions (Šilc *et al*., 2012).

In our survey, among neophytes, therophytes dominated, most of them being invasive. Therophytes also play a significant role in the neophytic flora of railway areas in central and north Europe (Brandes, 1983; Galera *et al*., 2011). By contrast, a very low diversity of this group of taxa was found along railways in the Mediterranean part of Italy (Filibeck *et al*., 2012). However, the distribution of Raunkiaer's life forms in neophytes is only partly similar to that in the regional native flora. In this regard, phanerophytes are over-represented and occur commonly in other anthropogenic habitats (Tafra *et al*., 2013).

In our case, five of the invasive taxa were woody plants (*Ailanthus altissima*, *Robinia pseudoacacia*, *Parthenocissus quinquefolia*, *Broussonetia papyrifera* and *Acer negundo*), which showed a common distribution here as well as in the urban flora of Mediterranean and temperate macrobioclimates (e.g., Celesti-Grapow & Blasi, 2004; Arianoutsou *et al*., 2010).

In sum, the analysis of flora of operating railway tracks is a very interesting and important aspect of floristic investigations. In this study, we could not evaluate the relationship between flora richness *vs.* environmental and socio-economic variables using numerical analyses due to the lack of site-specific dataset. However, in general, our study showed that the character of the flora associated with railway areas is mostly influenced by the degree of anthropogenic pressure, the environmental conditions prevailing in such areas and probably the land use along railways. All these factors, including railway management practices, interacted and evidently impacted on the richness and composition of the flora (Wrzesień *et al*., 2016). Our analysis will contribute to the establishment of a broader understanding of the management and conservation potential of this land use type.

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AUTHOR CONTRIBUTIONS

N.J. and M.M. contributed equally to this work: planned the research and led the writing; K.D. and A.L. performed the analyses of flora. All authors conducted the field sampling and critically revised the manuscript.

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REFERENCES

Altay, V., Ozyigt, I. I., Osma, E., Bakir, Y., Demir, G., Severoglu, Z., *et al*., 2015: Environmental relationships of the vascular flora alongside the railway tracks between Haydarpaşa and Gebze (Istanbul-Kocaeli/Turkey). Journal of Environmental Biology **36** (Special issue), 153–162.

Anonymous, 1998: Federalni zavod za statistiku. Popis stanovništva, domaćinstava/kućanstava, stanova i poljoprivrednih gazdinstava 1991. Available from: http://fzs.ba/wp-content/uploads/2016/06/stanovnistvo-prema-starosti-i-spolu-po-naseljenim-mjestima-bilten-257.pdf [Last access: 2017 Jan 17].

Anonymous, 2013a: Croatian Bureau of Statistics. Census of population, households and dwellings 2011. 2013. Available from: http://www.dzs.hr/Hrv_Eng/publication/2012/SI-1468.pdf [Last access: 2017 Jan 17].

Anonymous, 2013b: Zakon o zaštiti prirode. Narodne novine 80/2013.

Anonymous, 2013c: Pravilnik o strogo zaštićenim vrstama. Narodne novine 144/2013.

Anonymous, 2014a: Federalni zavod za programiranje razvoja. Makroekonomski pokazatelji po kantonima za 2013. Available from: http://fzzpr.gov.ba/bs/pubs/3/3/publikacije [Last access: 2017 Jan 17].

Anonymous, 2014b: Croatian Bureau of Statistics [Internet]. Gross domestic product for Republic of Croatia, nuts 2 level and counties, 2011. Available from: http://www.dzs.hr/Hrv_Eng/publication/2014/12-01-02_01_2014.htm [Last access: 2017 Jan 17].

Anonymous, 2016a: The IUCN Red List of Threatened Species in Europe: Version 2015-4. IUCN Species Survival Commission. Available from: http://www.iucnredlist.org/initiatives/europe [Last access: 2016 Jan 15].

Anonymous, 2016b: The IUCN Red List of Threatened Species in the Mediterranean: Version 2015-4. IUCN Species Survival Commission. Available from: http://www.iucnredlist.org/initiatives/mediterranean [Last access: 2016 Jan 15].

Arianoutsou, M., Bazos, I., Delipetrou, P. & Kokkoris, Y., 2010: The alien flora of Greece: taxonomy, life traits and habitat preferences. Biological Invasions **12**, 3525–3549.

Biondi, E., Blasi, C., Allegrezza, M., Anzellotti, I., Azzella, M. M., Carli, E., *et al*., 2014: Plant communities of Italy: The Vegetation Prodrome. Plant Biosystems **148**, 728–814.

Boršić, I., Milović, M., Dujmović, I., Bogdanović, S., Cigić, P., Rešetnik, I., *et al*., 2008: Preliminary checklist of invasive alien plant species (IAS) in Croatia. Natura Croatica **17**, 55–71.

Brandes, D., 1983: Flora und Vegetation der Bahnhöfe Mitteleuropas. Phytocoenologia **11**, 31–115.

Brandes, D., 1984: Flora und Vegetation von Bahnhöfen im nördlichen Deutschland. Acta Botanica Slovaca, Series A, Suppl. **1**, 9–15.

Brandes, D., 2004: Exkursionsziel Eisenbahnbrache? Der unerwartete Artenreichtum von innerstädtischen Eisenbahnflächen. from: http:// www.ruderal-vegetation.de/epub/eisenbahnbrache.pdf [Last access: 2012 Sept 8].

Brullo, S., Giusso Del Galdo, G., Guarino, R. & Minissale, P., 2007: A survey of the weedy communities of Sicily. Annali di Botanica (nuova serie) **7**, 127–161.

Causton, D. R., 1988: An introduction to vegetation analysis: Principles, practice and interpretation. London: Unwin Hyman.

Celesti-Grapow, L. & Blasi, C., 2004: The role of alien and native weeds in the deterioration of archaeological remains in Italy. Weed Technology **18**, 1508–1513.

Celesti-Grapow, L., Alessandrini, A., Arrigoni, P. V., Banfi, E., Bernardo, L., Bovio, M., *et al.*, 2009: Inventory of the non-native flora of Italy. Plant Biosystems **143**, 386–430.

Clarke, K. R. & R. N. Gorley, 2006: PRIMER v6: User Manual/Tutorial. Plymouth: PRIMER-E.

Climate-data.org, 2017: Available from: https://en.climate-data.org [Last access: 2017 Jan 17].

Cornelini, P. & Petrella, P., 1994: La flora della stazione di Roma Ostiense: variazioni e confronti con il censimento di Cacciato (1952). Annali di Botanica **52**, 457–478.

Cornelini, P. & Petrella, P., 1997: Indagini floristiche negli impianti ferroviari di Roma. Ingegneria Ferroviaria **3**, 110–116.

Czarna, A., 2005: Vascular flora of the railway station in Jarocin (western Poland). Roczniki Akademii Rolniczej w Poznaniu **373**, Botanika Steciana 9, 39–46.

Dunnett, N. & Hitchmough, J. D. (eds.), 2004: The Dynamic Landscape: Design Ecology and Management of Naturalistic Urban Planting. London: Spon Press.

Eliáš jun., P., 2011: *Geranium purpureum* Vill. – new alien species to the Slovak flora. Thaiszia – Journal of Botany **21**, 21–28.

Euro+Med, 2006–2016: Euro+Med PlantBase – the information resource for Euro-Mediterranean plant diversity. Published on the Internet http://ww2.bgbm.org/EuroPlusMed/ [Last access: 2016 March 7].

Filibeck, G., Cornelini, P. & Petrella, P., 2012: Floristic analysis of a high-speed railway embankment in a Mediterranean landscape. Acta Botanica Croatica **71**, 229–248.

Fornal-Pieniak, B. & Wysocki, C., 2011: Vegetation on the railway-line embankment at Tarnów. Ekologia, Bratislava **30**, 414–421.

Galera, H., Sudnik-Wójcikowska, B., Wierzbicka, M. & Wiłkomirski, B., 2011: Encroachment of forest species into operating and abandoned railway areas in north-eastern Poland. Plant Biosystems **145**, 23–36.

Galera, H., Sudnik-Wójcikowska, B., Wierzbicka, M. & Wiłkomirski, B., 2012: Directions of changes in the flora structure in the abandoned railway areas. Ecological Questions **16**, 29–39.

Galera, H., Sudnik-Wójcikowska, B., Wierzbicka, M., Jarzyna, I. & Wiłkomirski, B., 2014: Structure of the flora of railway areas under various kinds of anthropopression. Polish Botanical Journal **59**, 121–130.

Gilbert, O. L., 1989: The ecology of urban habitats. London, New York, Tokyo, Melbourne, Madras: Chapman and Hall.

Giupponi, L., Corti, C. & Manfredi, P., 2015: The vegetation of the Borgotrebbia landfill (Piacenza. Italy): Phytosociological and ecological characteristics. Plant Biosystems **149**, 865–874.

Gontier, M., Balfors, B. & Mörtberg, U., 2006: Biodiversity in environmental assessment - current practice and tools for prediction. Environmental Impact Assessment Review **26**, 268–286.

Horvat, I., Glavač, V. & Ellenberg, H., 1974: Vegetation Südosteuropas. Stuttgart: Gustav Fischer Verlag.

Horvatić, S., 1963: Vegetacijska karta otoka Paga s općim pregledom vegetacijskih jedinica Hrvatskog primorja. Prirodoslovna istraživanja JAZU **33**, Acta Biologica 4, 1–187.

Horvatić, S., Ilijanić, Lj. & Marković-Gospodarić, Lj., 1967-1968: Biljni pokrov okolice Senja. Senjski zbornik **3**, 298–322.

IUCN, 2016: Standards and Petitions Subcommittee. Guidelines for Using the IUCN Red List Categories and Criteria. Version 12. Available from: http://www.iucnredlist.org/documents/RedListGuidelines.pdf [Last access: 2016 June 15].

Jasprica, N., 2007: Flora delte Neretve, Biljni svijet u delti Neretve. Szentendre, Hungary: Regionalni centar zaštite okoliša za Srednju i Istočnu Europu.

Jasprica, N., Ruščić, M. & Lasić, A., 2010: Comparison of urban flora in Split, Dubrovnik and Mostar. Hrvatska misao (Sarajevo) **40**, 77–104.

Jasprica, N., Milović, M. & Pandža, M., 2015: *Picrido hieracioidis-Cirsietum candelabri* Jasprica *et al*. - a ruderal association new to Croatia. Journal of Croatian Botanical Society **3**(2), 4–14.

Jasprica, N. & Milović, M., 2016: The vegetation of the islet of Badija (south Croatia), with some notes on its flora. Natura Croatica **25**, 1–24.

Jasprica, N., Bogdanović, S., Dolina, K., Ruščić, M., Pandža, M. & Kovačić, S., 2016a: Syntaxonomy of *Arundo* stands along the eastern Adriatic coast. Plant Biosystems **150**, 887–903.

Jasprica, N., Škvorc, Ž., Dolina, K., Ruščić, M., Kovačić, S. & Franjić, J., 2016b: Composition and ecology of the *Quercus coccifera* L. along the eastern Adriatic coast (NE Mediterranean). Plant Biosystems **150**, 1140–1155.

Jehlík, V., Zaliberová, M. & Májeková, J., 2017: The influence of the Eastern migration route on the Slovak flora - a comparison after 40 years. Tuexenia **37**, 313–332.

Jelaska, S. D., Nikolić, T., Jelaska, L. S., Kušan, V., Peternel, H., Gužvica, G., *et al*., 2010: Terrestrial biodiversity analyses in Dalmatia: a complementary approach using diversity and rarity. Environmental Management **45**, 616–625.

Kowarik, I. & Tietz, B., 1986: Soils on ruined railway stations - The Anhalter Gueterbahnhof. In: Alaily, F., Grenzius, R., Renger, M., Stahr, K., Tietz, B. & Wessolek, G. (eds.). Soilscapes of Berlin (West), Mitteilungen der Deutschen Bodenkundlichen Gesellschaft **50**, 128–139.

Kropáč, Z., 2006: Segetal vegetation in the Czech Republic: synthesis and syntaxonomical revision. Preslia **78**, 123–209.

Lejmbach, B., Rurka, Z., Siedlecka, B. & Sijka, J., 1975: Flora torowisk kolejowych Pobrzeża Wschodniopomorskiego. Fragmenta Floristica et Geobotanica **21**, 53–66.

Lovrić, A. Ž., Rac, M. & Bedalov, M., 1989: Mediteranska močvarna vegetacija i florističke zanimljivosti uz donju Neretvu od Čapljine do mora. Zbornik referata naučnog skupa "Minerali, stijene, izumrli i živi svijet BiH", 7.-8. 10. 1988. Sarajevo: Zemaljski muzej Bosne i Hercegovine, 333–340.

Májeková, J., Letz, D. R., Slezák, M., Zaliberová, M. & Hrivnák, R., 2014: Rare and threatened vascular plants of the railways in Slovakia. Biodiversity: Research and Conservation **35**, 75–85.

Májeková, J. & Limánek, J., 2016: Diverzita flóry železničných staníc na trati Poprad - Plaveč (východné Slovensko). Bulletin Slovenskej botanickej spoločnosti **38**, 37–45.

Marković, Lj., 1977: O biljnom pokrovu željezničkih pruga u kontinentalnim dijelovima Hrvatske. Jugoslavensko savjetovanje o primjeni herbicida na željezničkim prugama i nasipima. Zagreb: Jugoslavensko društvo za proučavanje i suzbijanaje korova; p. 76–90.

Maslo, S., 2014: The urban flora of the city of Mostar (Bosnia and Herzegovina). Natura Croatica **23**, 101–145.

McCune, B. & Mefford, M. J., 2006: PC-ORD: multivariate analysis of ecological data. Version 5.14. MjM software design. Gleneden Beach, Oregon.

Messenger, K. G., 1968: A railway flora of Rutland. Botanical Society of the British Isles, Proceedings volume **7**, 325–344.

Milović, M., 2002: The flora of Šibenik and its surroundings. Natura Croatica **11**, 171–223.

Milović, M. & Mitić, B., 2012: The urban flora of the city of Zadar (Dalmatia. Croatia). Natura Croatica **21**, 65–100.

Milović, M., Kovačić, S., Jasprica, N. & Stamenković, V., 2016: Contribution to the study of Adriatic island flora: Vascular plant species diversity in the Croatian Island of Olib. Natura Croatica **25**, 25–54.

Mucina, L., 1997: Conspectus of classes of European vegetation. Folia Geobotanica et Phytotaxonomica **32**, 117–172.

Nikolić, T. (ed.), 2016: Flora Croatica baza podataka. Available from: http://hirc.botanic.hr/fcd. Botanički zavod, Prirodoslovno-matematički fakultet, Sveučilište u Zagrebu [Last access: 2016 July 6].

Nikolić, T. & Topić, J. (eds.), 2005: Crvena knjiga vaskularne flore Hrvatske. Zagreb: Ministarstvo kulture Republike Hrvatske, Državni zavod za zaštitu prirode.

Nikolić, T., Mitić, B. & Boršić, I., 2014: Flora Hrvatske: Invazivne biljke. Zagreb: Alfa d.d.

Nikolić, T., Milović, M., Bogdanović, S. & Jasprica, N., 2015: Endemi u hrvatskoj flori. Zagreb: Alfa d.d.

Pál, R. & Csiky, J., 2002: Phytosociological study of *Tribulus terrestris* L. weed communities habiting railway areas in Hungary. Journal of Plant Diseases and Protection **18**, 159–166.

Partsch, M. & Karstner, A., 1995: Flora und Vegetetion an Strassenraendern und Bahndaemmen im Kreis Koetchen (Sachsen-Antalt). Hercynia **29**, 193–214.

Pignatti, S., 1982: Flora d'Italia. 1–3. Bologna: Edagricole.

Pyšek, P., 1995: Approaches in studying spontaneous settlement flora and vegetation in Central Europe: a review. In: Sukopp, H., Numata, M. & Huber, A. (eds.), Urban ecology as the basis for urban planning. Hague: SPB Academic Publishing, p. 23–39.

Pyšek, P., Danihelka, J., Sádlo, J., Chrtek, J. Jr, Chytrý, M., Jarošík, V., *et al*., 2012: Catalogue of alien plants of the Czech Republic. 2nd ed.: checklist update, taxonomic diversity and invasion patterns. Preslia **84**, 155–255.

Ratcliffe, D. A., 1977: A nature conservation review: the selection of biological sites of national importance to nature conservation in Britain; vol 1. Cambridge, New York: Cambridge University Press.

Raunkiaer, C., 1934: The life forms of plants and statistical plant geography. Oxford: Clarendon Press.

Redžić, S., Barudanović, S. & Radević, M., 2008: Bosnia and Herzegovina - Land of Diversity, First national Report of Bosnia and Herzegovina for the Convention on Biodiversity. Sarajevo: Federal Ministry of Environment and Tourism.

Reisch, C., 2007: Genetic structure of *Saxifraga tridactylites* (Saxifragaceae) from natural and man-made habitats. Conservation Genetics **8**, 893–902.

Richardson, D. M., Pyšek, P., Rejmánek, M., Barbour, M. G., Panetta, F. D. & West, C. J., 2000: Naturalization and invasion of alien plants: concepts and definitions. Diversity and Distributions **6**, 93–107.

Rivas-Martínez, S., Penas, A. & Díaz, T. E., 2004: Bioclimatic and Biogeographic Maps of Europe. Cartographic service, University of León, Spain. Available from: http://www.globalbioclimatics.org/form/maps.htm [Last access: 2016 Feb 15].

Rivas-Martínez, S., Sáenz, S. R. & Penas, A., 2011: Worldwide bioclimatic classification system. Global Geobotany **1**, 1–634.

Rutkovska, S., Pučka, I., Novicka, I. & Evarts-Bundersanta, P., 2011: Relationship of geographic distribution of the most characteristical invasive plant species in habitats adjacent to the river Daugava within the territory of Daugavpils city. Acta Biologica Universitatis Daugavpiliensis **11**, 163–175.

Rutkovska, S., Pučka, I., Evarts-Bundersanta, P. & Paidere, J., 2013: The role of railway lines in the distribution of alien plant species in the territory of Daugavpils City (Latvia). Estonian Journal of Ecology **62**, 212–225.

Sargent, C., 1984: Britain's railway vegetation. Cambridge: Institute of Terrestrial Ecology.

Schinninger, I., Maier, R. & Punz, W., 2002: Der stillegende Frachtbahnhof Wien-Nord. Standortbedingungen und oekologische Charakteristik der Gefaesspflanzen einer Bahnbrache. Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien **139**, 1–10.

Stešević, D., Caković, D. & Jovanović, S., 2014: The urban flora of Podgorica (Montenegro, SE Europe): annotated checklist, distribution atlas, habitats and life-forms, taxonomic, phytogeographical and ecological analysis. Ecologica Montenegrina **1**, 1–171.

Šilc, U. & Čarni, A., 2007: Formalized classification of the weed vegetation of arable land in Slovenia. Preslia **79**, 283–302.

Šilc, U., Vrbničanin, S., Božić, D., Čarni, A. & Dajić Stevanović, Z., 2008: Phytosociological alliances in the vegetation of arable fields in the northwestern Balkan Peninsula. Phytocoenologia **38**, 241–254.

Šilc, U., Vrbničanin, S., Božić, D., Čarni, A. & Dajić Stevanović, Z., 2012: Alien plant species and factors of invasiveness of anthropogenic vegetation in the Northwestern Balkans - a phytosociological approach. Central European Journal of Biology **7**, 720–730.

Šilić, Č., 1996: Spisak biljnih vrsta (*Pteridophyta* i *Spermatophyta*) za Crvenu knjigu Bosne i Hercegovine. Glasnik Zemaljskog muzeja Bosne i Hercegovine (PN) **31**, 323–367.

Tafra, D., Milović, M. & Pandža, M., 2013: Non-native flora of the town of Omiš (Dalmatia, Croatia). Natura Croatica **22**, 135–146.

Tutin, T. G., Heywood, V. H., Burges, N. A., Moore, D. M., Valentine, D. H., Walters, S. M. & Webb, D. A. (eds.), 1968–1980: Flora Europaea 2–5. Cambridge: Cambridge University Press.

Tutin, T. G., Burges, N. A., Chater, A. O., Edmondson, J. R. E., Heywood, V. H., Moore, D. M., Valentine, D. H., Walters, S. M. & Webb, D. A. (eds.), 1993: Flora Europaea 1 (2nd ed.). Cambridge: Cambridge University Press.

Van der Ham, R. W. J. M., 1981: De Virginische kruidkers, *Lepidium virginicum* L., in Limburg. Natuurhistorisch Maandblad **70,** 101–105.

Warcholińska, A. U., 2008: Vascular plants flora of the railway grounds of Zduńska Wola. Folia Biologica et Oecologica **4**, 95–110.

Westermann, J. R., Lippe von der, M. & Kowarik, I., 2011: Seed traits, landscape and environmental parameters as predictors of species occurrence in fragmented urban railway habitats. Basic and Applied Ecology **12**, 29–37.

Wiłkomirski, B., Galera, H., Sudnik-Wójcikowska, B., Staszewski, T. & Malawska, M., 2012: Railway Tracks - Habitat Conditions, Contamination, Floristic Settlement - A Review. Environment and Natural Resources Research **2**, 86–95.

Wrzesień, M., Denisow, B., Mamchur, Z., Chuba, M. & Resler, I., 2016: Composition and structure of the flora in intra-urban railway areas. Acta Agrobotanica **69**(3), 1666.

Appendix

Syntaxa quoted in the text and Tab. 2 (in alphabetical order):

Artemisietea vulgaris Lohmeyer, Preising et Tüxen ex von Rochow 1951
Asplenietea trichomanis (Braun-Blanquet in Meier et Braun-Blanquet 1934) Oberdorfer 1977
Cakiletea maritimae Tüxen et Preising ex Braun-Blanquet et Tüxen 1952
Carpinion orientalis Horvat 1958
Cisto cretici-Micromerietea julianae Oberdorfer ex Horvatić 1958
Epilobietea angustifolii Tüxen et Preising ex von Rochow 1951
Festuco valesiacae-Brometea erecti Braun-Blanquet et Tüxen ex Braun-Blanquet 1949
Fraxino orni-Ostryion Tomažič 1940
Fraxino orni-Quercion ilicis Biondi, Casavecchia et Gigante in Biondi et al. 2013
Galio aparines-Urticetea dioicae Passarge ex Kopecký 1969
Helianthemetea guttati (Braun-Blanquet in Braun-Blanquet, Roussine et Nègre 1952) Rivas Goday et Rivas-Martínez 1963
Koelerio glaucae-Corynephoretea canescentis Klika in Klika et V. Novák 1941
Molinio-Arrhenatheretea Tüxen 1937
Nerio oleandri-Tamaricetea africanae Braun-Blanquet et O. Bolòs 1958
Parietarietea judaicae Oberdorfer 1977
Phragmito australis-Magnocaricetea elatae Klika in Klika et Novák 1941
Polygono arenastri-Poetea annuae Rivas-Martínez 1975 corr. Rivas-Martínez, Báscones, T.E. Diáz, Fernández-González et Loidi 1991
Quercetea ilicis Braun-Blanquet ex A. Bolós et O. de Bolòs in A. Bolòs y Vayreda 1950
Quercetea pubescentis Doing-Kraft ex Scamoni et Passarge 1959
Querco-Fagetea sylvaticae Braun-Blanquet et Vlieger in Vlieger 1937
Rhamno catharticae-Prunetea spinosae Rivas Goday et Borja ex Tüxen 1962
Saginetea maritimae Westhoff, Leeuwen et Adriani 1962
Salicetea purpureae Moor 1958
Scorzoneretalia villosae Kovačević 1959
Stellarietea mediae Tüxen, Lohmeyer et Preising ex von Rochow 1951
Thero-Brachypodietea ramosi Braun-Blanquet 1947
Thlaspietea rotundifolii Braun-Blanquet 1948
Trifolio medii-Geranietea sanguinei Müller 1962