ANNALI DI BOTANICA
Ann. Bot. (Roma), 2020, 10: 33–54
Journal homepage: http://annalidibotanica.uniroma1.it

EFFECTS OF *ROBINIA PSEUDOACACIA* COVERAGE ON DIVERSITY AND ENVIRONMENTAL CONDITIONS OF CENTRAL-NORTHERN ITALIAN *QUERCUS PUBESCENS* SUB-MEDITERRANEAN FORESTS (HABITAT CODE 91AA*): A THRESHOLD ASSESSMENT

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(Received 24 January 2020; received in revised form 12 March 2020; accepted 20 March 2020)

Abstract - The invasive alien species *Robinia pseudoacacia* may lead to species homogenization in high invaded forest ecosystems. Its invasive behaviour is poorly known in dry forest habitats and low cover-abundance conditions. We have investigated central-northern Italian *Quercus pubescens* forest habitats (code 91AA* - EU Habitat Directive) without and with the presence of *R. pseudoacacia* and in respect of *R. pseudoacacia* dominant communities that are present in the same forest potential areas. Using levels of *R. pseudoacacia* cover-abundance values (Braun-Blanquet scale) we classified the vegetation relevés in five groups: from 0 (total absence) to 4 (dominant conditions). Through the calculation of some indices, we highlighted the relations between groups of relevés and the variation in term of ecological features. A threshold has been identified at low coverage values of *R. pseudoacacia*. We detected a significant difference in the lower invaded sites in term of presence of nitrophilous and alien species, Shannon diversity index and changes in nutrient, moisture, light and reaction Ellenberg indicator values. These results inform about the early alarm level to set in monitoring *Q. pubescens* forest habitats in sub-Mediterranean areas.

Keywords: alien species; black locust; plant invasion; EU Habitat Directive; sub-mediterranean; oak forest; Braun-Blanquet cover-abundance scale

Introduction

The global trend of naturalization of species outside their natural habitat is a phenomenon in increasing speed, it has been demonstrated that almost 4% of all currently known vascular plants species on Earth have become naturalized outside their natural range linked to some human activities (Van Kleunen et al., 2015). Moreover, the number of alien species found in all types of habitats is permanently increasing in Europe (Lambdon et al., 2008; Vilà et al., 2010; Essl et al., 2011) where the Mediterranean basin is one of the biodiversity hotspots under threat.

In Europe black locust (*Robinia pseudoacacia*) is one of the three most widely distributed invasive alien species (Lambdon et al., 2008; Pysek et al., 2009). Its physiological characteristics, e.g.: nitrogen-fixing and light-demanding species with a fast growth and high capacity of vegetative reproduction, make it an efficient pioneer tree species also in its native range (Boring & Swank, 1984). This species acts as a 'transformer' species (sensu Richardson et al., 2000), an invasive species that is able to alter the conditions of an ecosystem over a substantial area (Lazzaro et al., 2018a; Slabejová et al., 2019). *R. pseudoacacia* invasion has been proven to have an impact, in comparison with the native habitats, on plant communities (e.g.: Benesperi et al., 2012; Sitzia et al., 2012; Staska et al., 2014; Campagnaro et al., 2018a; Lazzaro et al., 2018a; Sitzia

doi: 10.13133/2239-3129/16447

et al., 2018; Slabejová et al., 2019). Furthermore, the indirect effect of *R. pseudoacacia* on species composition is strongest on poor sandy soils in which nitrogen is the primary limiting soil resource (Dzwonko & Loster, 1997). In this European context of concern, and moreover, in the Mediterranean basin, forest habitats are under threat by alien tree species (Cierjacks et al., 2013; Wagner et al., 2017; Dyderski & Jagodzin, 2018), in particular through competition in the process of natural vegetation succession (Campagnaro et al., 2018b). Currently, in central-northern Italy, the spread of *R. pseudoacacia* is enhanced by the urbanization in hilly areas and forest management. In this context it can outcompete native trees in dry and nutrient-poor sites (Mondino & Scotta, 1987) where it may alter ecosystem structure and dynamics of native oak forests (Tani et al., 2012), being able to vegetate in the potential areas of these coenoses, occupying similar functional space (Dalle Fratte et al., 2019). In particular, we focus on *Quercus pubescens* 91AA* priority habitat (Eastern white oak woods-Annex I of the Habitats Directive), one of the forest habitats types under threat of invasion by invasive alien tree species according to the Italian interpretation manual (Biondi et al., 2009). Its conservation status at the national level, assessed in the EU-28 interpretation manual, goes from unfavourable to bad (European Commission, 2013). Outside central Europe, precise information about patterns and levels of invasion in natural oak wood habitats are extremely poor (Vitkova & Kolbek, 2010). Most studies tend to compare heavily invaded sites, but it has been indicated that to assess the level of ecosystem change is necessary to consider the gradient of alien plant cover-abundance (Hulme et al., 2013; Panetta & Gooden, 2017). Moreover, the recent assessments provided at the national scale by the Italian Society of Vegetation Science (SISV) under the project "Updating of the National alien species database under the work program to support the Implementation of Regulation (EU) n. 1143/2014 on invasive alien species" (Lazzaro et al., 2018b; Bagella et al., 2019), consider only alien species with cover-abundance values above class 3 of Braun-Blanquet scale (corresponding to 25-50% of cover). The level of impact threshold through invaded ecosystems, along alien species cover-abundance gradient, in respect of temperate sub-Mediterranean oak wood habitats, is poorly known.

Therefore, shifting the focus from the species composition of a single plot or group to the ecological characteristics of the considered area, to analyze the effects of increasing cover-abundance values of *R. pseudoacacia* and detect a point of change in the ecological conditions in respect of *Q. pubescens* forests, in the present study we want to:

1. Investigate central-northern Italian *Quercus pubescens* forest habitats (habitat code 91AA* - Eastern white oak woods- Annex I of the Habitats Directive) without and with the presence of *R. pseudoacacia* and in respect of *R. pseudoacacia* dominant communities that are present in the same landscape position of the typical native forests of the hilly area (see section 'Data collection').
2. Investigate these communities along different *R. pseudoacacia* cover-abundance values (Braun-Blanquet scale) with a focus on the low cover-abundance situations inside *Q. pubescens* forests.
3. Find a relation between levels of *R. pseudoacacia* cover-abundance values and vegetation indices related to modified condition in respect to *Q. pubescens* forests.
4. Find a cover-abundance threshold value to assess the alarm level to monitor this sensitive habitat type.

Materials and Methods

Study area and sites

We investigated the *R. pseudoacacia* communities of central-northern Italy (Fig. 1) through the selection of literature vegetation cover-abundance data and unpublished data (Appendix 1). The selection of the sites follows strictly the distribution of the *Q. pubescens* 91AA* habitat in central-northern Italy, according to the third report of the habitat directive (Genovesi et al., 2014). The sites were further screened to achieve homogeneous conditions that indicate the potential areas of *Q. pubescens* forests. We only selected data on slope morphologies from hilly sites within a temperate bioclimate with sub-Mediterranean variant (according to Rivas-Martines, 2001; Pesaresi et al., 2014, and information about bioclimate at local scale from the published vegetation studies).

Data collection

The vegetation survey was conducted according to the phytosociological methods of the Zurich-Montpellier school (Braun-Blanquet, 1928), in 100 m^2 plots, for a total of 30 phytosociological relevés. To select the literature findings, we selected ecological criteria aiming the maintenance of topographic, climatic and site conditions that assure for the *Q. pubescens* natural potential vegetation. Suitable *R. pseudoacacia* data were selected from phytosociological studies that fitted in the defined study area to maintain homogeneous conditions along the dataset. Firstly, we excluded data belonging to a different environment such as data from floodplain forests, related to grassland invasion conditions or in a different landscape position

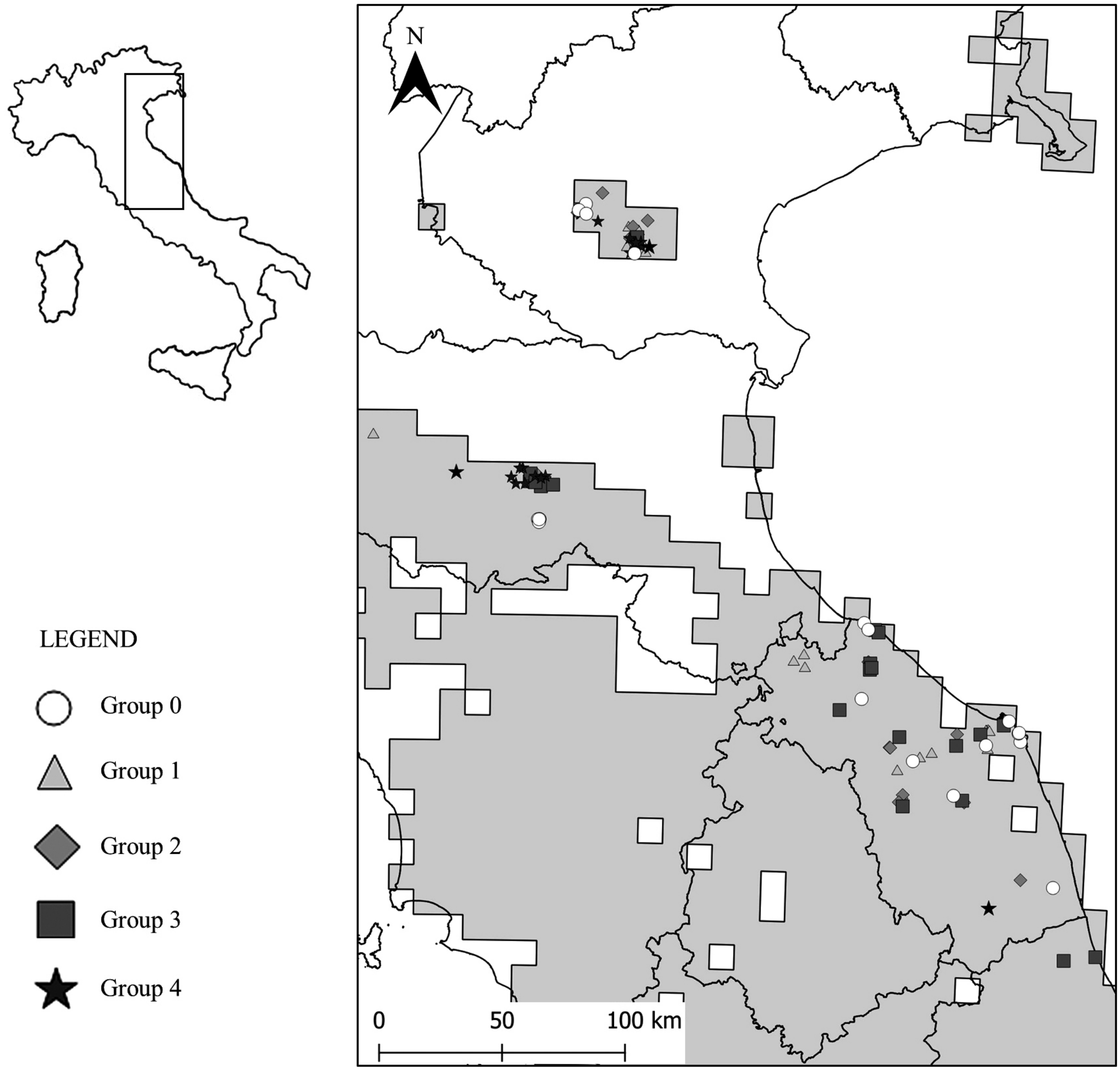


Figure 1. Map showing the study area corresponding to the *R. pseudoacacia* communities found within the distribution of central-northern Italian *Quercus pubescens* sub-Mediterranean forests (Eastern white oak woods - habitat CODE 91AA*) indicated in grey. The shapes of the sites labels indicate for the group belonging.

in respect of the typical native forests of the hilly area. In GIS environment we overlapped the remaining sites to the distribution map of the priority habitat 91AA* (Genovesi et al., 2014) to choose only the sites that fall in the squares of distribution. We selected *R. pseudoacacia* vegetation data defined at the association level or community level and *Q. pubescens* forest data with the presence of *R. pseudoacacia* with low cover-abundance values (+, 1 and 2 expressed in Braun-Blanquet scale). Moreover, we collected data of *Q. pubescens* dominating forests associations, geographically representative of each area of distribution belonging to 91AA* habitat, without the presence of *R. pseudoacacia* (Table 1). After the selection following the chosen criteria, 104 literature plots were remaining. The *R. pseudoacacia* vegetation data goes from clearly dominant *R. pseudoacacia* forests up to conditions of presence in the oak forest covering all the possible cover-abundance values according to the Braun-Blanquet scale (Braun-Blanquet, 1928). To reach a balanced number of plots it was also performed a constrained selection method on the already selected vegetation matrix (see 'Data analysis chapter'). The final dataset counts a total of 105 plots as shown in Table 2 (28 sampled plots and 77 literature plots), and 341 total species. The nomenclature of the species follows the updated checklists by Bartolucci et al. (2018) for native taxa and by Galasso et al. (2018) for alien taxa.

Table 1. The five groups with the indication of number of plots, the respective *R. pseudoacacia* percentage cover range (0% indicate for the *R. pseudoacacia* absence and the dominance of *Q. pubescens*), the *R. pseudoacacia* cover-abundance values (Braun-Blanquet, 1928), and corresponding values of van der Maaler scale (van der Maaler, 1979).

Groups	N° plots	*R. pseudoacacia* % Cover	Braun-Blanquet scale	van der Maaler scale
0	22	0%	-	-
1	21	<1%	+	2
		1-5%	1	3
		6-25%	2	5
2	22	26-50%	3	7
3	22	51-75%	4	8
4	18	76-100%	5	9

Creation of the indices matrix

To highlight peculiar ecological conditions related to a specific level of cover-abundance value of *R. pseudoacacia* we consider indicators widely used in invasion studies (Simonova & Lososova, 2008). We chose to use Ellenberg indicator values because they allow the shifting from a multi-dimensional system based on floristic matrices, to a smaller system reduced to 6 dimensions. This system is able to express and synthesize the environmental requirements of species and communities in an ecosystem (Diekmann, 2003). We used Ellenberg indicator values (EIVs) (Ellenberg, 1992), re-formulated for the Mediterranean conditions (Pignatti et al., 2005), for light (L), temperature (T), continentality (C), moisture (M), reaction (R) and nutrients (N). We also used the first update of Ellenberg's Indicator values for the Flora of Italy for *Pteridophyta, Gymnospermae* and *Monocotyledoneae* (Guarino et al., 2012). Ellenberg indicator values of alien species follow Domina et al. (2018). EIVs were mediated at plot level and downscaled from 1 to 9, to be comparable through groups. To compare the ecological indicator values of the plots, we used weighted average values because they are reliable predictors of site conditions.

Table 2. Localities and sources of the used phytosociological relevés. Number of relevés in each group.

Localities	Prov.	Authors	N° of releves					
			Gr. 0	Gr. 1	Gr. 2	Gr. 3	Gr. 4	Tot
Euganei hills	PD	Buffa & Ghirelli, 1993	0	7	3	0	6	16
Onferno Nature Reserve	RN	Zitti et al., 2005	0	3	0	0	0	3
Val Baganza	PA	Adorni, 2001	0	1	0	0	0	1
Central Apennine - Marche region	-	Allegrezza et al., 2002	6	0	0	0	0	6
Gallignano	AN	Biondi & Allegrezza, 2004	0	3	0	0	0	3
Ancona hills	AN	Biondi & Allegrezza, 1996	5	1	0	0	0	6
Vallecorsa	FR	Blasi & Di Pietro, 1998	1	1	0	0	0	2
Vicenza	VI	Campagnaro et al., 2018a	0	0	6	1	1	8
Euganei hills	PD	Lorenzoni, 1976	1	0	0	0	0	1
Berici hills	VI	Tasinazzo & Fiorentin, 2000	5	0	2	1	3	11
Mount Sole	BO	Ubaldi, 1980	4	0	0	0	0	4
Bologna hills	BO	Ubaldi, 2003	0	0	2	6	8	16
Central Italy	AN	sampled plots	0	5	9	14	0	28

All the species were assigned to different syntaxonomic groups according to Mucina et al. (2016) and Biondi et al. (2014). The status of alien species was assigned following the Italian checklist for alien species (Galasso et al., 2018). Percentage weighted presence of syntaxonomical classes for each plot was calculated. The syntaxonomical classes considered are: *Querco-Fagetea*, *Rhamno-Prunetea*, *Trifolio-Geranietea*, *Festuco-Brometea*, *Galio-Urticetea/Artemisietea/Stellarietea* (the latter considered all together as Nitrophilous communities) and others (Table 3, syntaxonomical attributes).

The *Querco-Fagetea* class includes forest species of native woods and nemoral herbaceous species. To better comprehend the response of the nemoral component to the different *R. pseudoacacia* cover-abundance values we also considered the herbaceous elements of the *Querco-Fagetea* class (Nem_herb). To analyze the changes in vegetation structure and life strategies, we considered also the Raunkiaer life-forms in the indices matrix. The following categories were distinguished, according to Pignatti (1982): chamaephytes (Ch), geophytes (G), hemicryptophytes (H), nanophanerophytes (NP), phanerophytes (P), therophytes (Thero). We used weighted average values. For each plot total number of species (Richness), Shannon diversity index (H), (Simpson index (D) and Evenness index – data not shown) were also calculated and averaged at the plot level.

Table 3. List of the species present in >20% of the plots with the indication of life form, syntaxonomical attribute, EIVs and the medium percentage cover (%) of the species for each of the five groups. Species significantly related to groups are indicated with the significance level and in a progressive grey colored scale (from dark grey corresponding to 15% of medium percentage coverage, to white that correspond to 0% of medium percentage coverage). *** p ≤ 0.001; ** p ≤ 0.01; * p ≤ 0.05; p ≤ 0.1. (Legend of syntaxonomical attributes: AL alien species; NTR Nitrophilous species of the classes *Galio-Urticetea*/*Artemisietea*/*Stellarietea*; RP *Rhamno-Prunetea*; QF *Querco-Fagetea*; Nem_herb herbaceous nemoral species of the class *Querco-Fagetea;* TG *Trifolio-Geranietea*).

	Life form	Syntaxonomical attribute	L	T	M	R	N	Gr.0	Gr.1	Gr.2	Gr.3	Gr.4	p-value
Robinia pseudacacia	P	AL	3,8	5,3	3,0	X	8,0	0,0	4,0	11,6	14,5	14,8	***
Sambucus nigra	P	NTR	5,3	3,8	3,8	X	9,0	0,0	2,0	3,5	6,8	6,7	***
Galium aparine	T	NTR	4,5	X	3,0	5,0	5,0	0,0	0,3	1,9	1,6	3,5	***
Stellaria media	T	NTR	4,5	X	3,0	7,0	8,0	0,0	0,6	1,5	0,3	4,2	*
Urtica dioica	H	NTR	X	X	4,5	X	8,0	0,0	0,0	1,1	3,1	1,2	***
Arum italicum	G	NTR	4,5	6,0	3,0	5,0	5,0	0,1	1,1	1,6	2,6	1,0	*
Clematis vitalba	P	RP	5,3	5,3	3,8	7,0	7,0	1,7	1,3	2,4	3,2	2,0	*
Rubus ulmifolius	NP	RP	3,8	6,0	3,0	5,0	8,0	1,5	2,6	2,7	5,1	3,0	p
Quercus pubescens s.l.	P	QF	5,3	6,0	2,3	7,0	4,0	9,6	9,2	1,9	1,2	0,7	***
Fraxinus ornus	P	QF	3,8	6,0	2,3	8,0	3,0	4,1	4,0	2,0	1,2	0,3	***
Rubia peregrina	P	QF	3,8	6,8	3,0	5,0	3,0	2,3	2,2	0,5	1,0	0,0	*
Cornus sanguinea	P	RP	5,3	3,8	5,3	8,0	X	3,0	2,3	1,6	1,8	0,8	**
Viola alba subsp. *dehnhardtii*	H	Nem_herb	3,8	6,0	3,8	7,0	6,0	2,2	1,0	0,2	0,4	0,4	***
Crataegus monogyna	P	RP	4,5	5,3	3,0	6,0	3,0	3,2	3,0	2,1	1,9	1,6	***
Brachypodium rupestre	H	TG	6,0	4,5	3,8	8,0	4,0	2,9	1,0	0,2	1,0	0,0	***
Laurus nobilis	P	QF	1,5	5,3	6,0	4,0	6,0	0,3	3,0	2,0	3,4	0,0	***
Euonymus europaeus	P	RP	4,5	3,8	3,8	8,0	5,0	1,0	1,0	2,0	2,8	0,7	**
Hedera helix	P	QF	3,0	3,8	3,8	X	X	3,2	7,0	7,4	7,6	5,5	p
Prunus spinosa	P	RP	5,3	3,8	X	X	X	0,7	1,7	0,7	1,5	0,4	
Ligustrum vulgare	NP	RP	5,3	4,5	X	8,0	X	1,0	2,2	1,9	0,6	1,3	p
Ruscus aculeatus	G	Nem_herb	3,0	6,0	3,0	5,0	5,0	1,9	2,7	2,2	1,4	1,2	
Asparagus acutifolius	G	Nem_herb	4,5	6,8	1,5	5,0	5,0	2,5	2,0	1,1	0,9	0,5	
Acer campestre	P	QF	3,8	5,3	3,8	7,0	6,0	1,7	1,6	2,9	1,0	1,3	
Ulmus minor	P	RP	3,8	5,3	X	8,0	X	0,5	2,2	2,4	2,1	2,3	
Dioscorea communis	G	Nem_herb	3,8	5,3	3,8	8,0	6,0	1,3	1,7	2,6	1,5	2,5	

Data analysis

Before calculations, the same species occurring in more layers were merged, taken the highest cover value. In the resulting data set, each species was present once. For the statistical analysis of the vegetation, the species cover-abundance values of the considered plots were converted to the Van der Maarel (1979) ordinal scale. To highlight the effects of the *R. pseudoacacia* presence on *Q. pubescens* forests, we created five groups of *R. pseudoacacia* plots sorted by their cover-abundance values and transformed in percentage values (Table 1). In a GIS environment, we assessed the equal distribution of each group within the study area. To reach a balanced number of plots within each group for a significative comparison we used the Heterogeneity-constrained random resampling (HCR) method to operate a selection (Lengyel et al., 2011).

Statistical analysis

The data were processed using the 'vegan' package (Oksanen et al., 2018) of the R software (R core team, 2018). The indices matrix was undergone at a normalization process using the 'decostand' function on vegan package. Before calculation, we performed an exploratory investigation. To simplify the model, a Spearman correlation analysis was performed through the indices matrix using the corrplot package (Wei & Simko, 2017) in R studio software to assess covariation or significative relations among indices. Some indices show a strong collinearity, so we chose to select them among those. We chose to use the Shannon index to highlight the vegetation composition diversity and the weighted indices to express better the ecological characteristics. We identified the relationships between *R.*

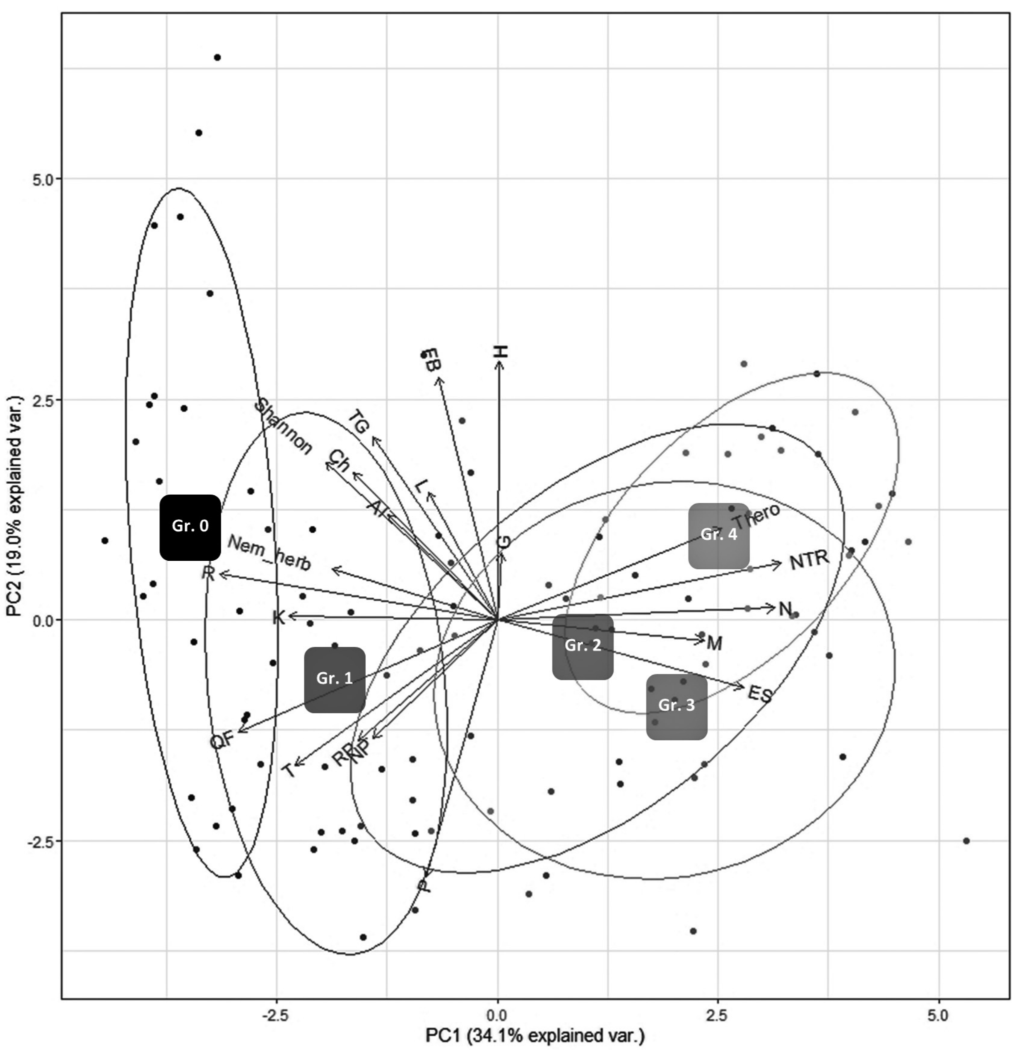
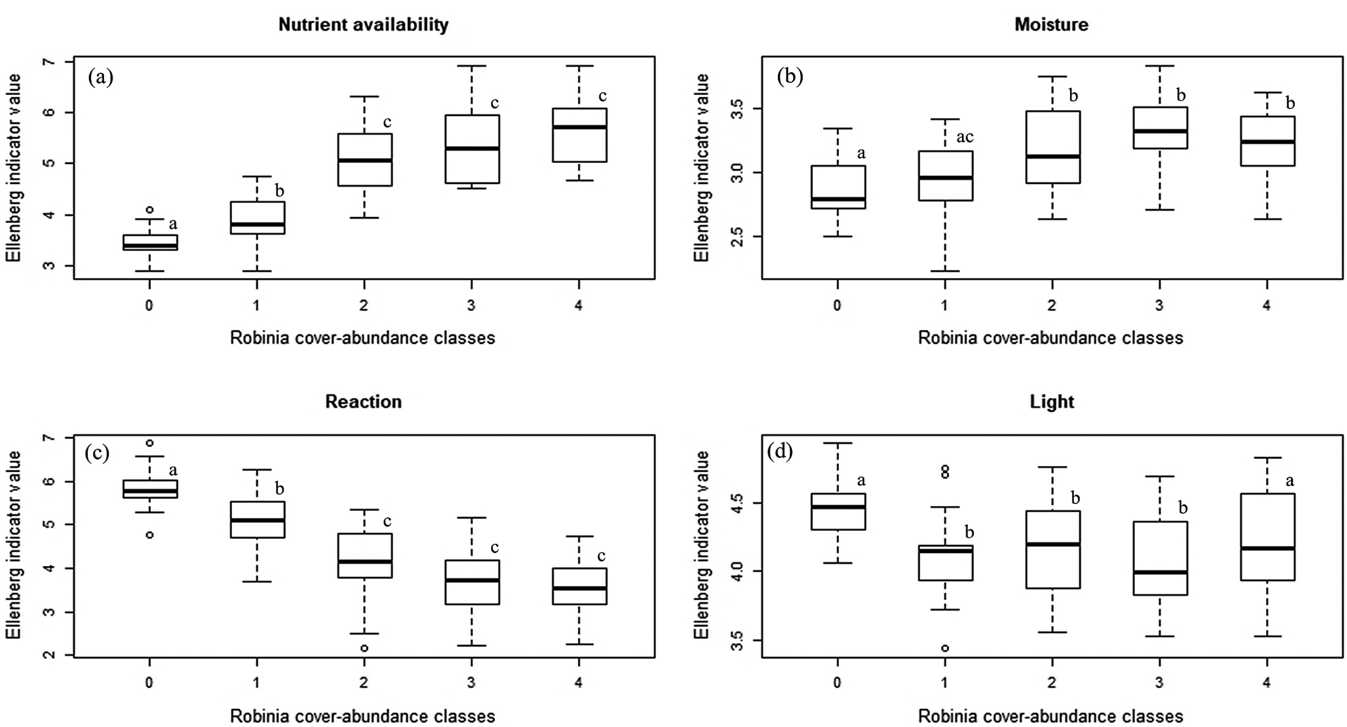


Figure 2. Principal Component Analysis (PCA) ordination diagram of the 105 plots (clusters are overimposed to PCA plot) with the overlaid of the significative ecological variables (Total variation explained 53.1%: axis PC1 34.1% and 19% axis PC2). Legend: see table 3.

pseudoacacia cover groups and the vegetation indices and tested correlation among the parameters. The Shapiro test was used to test the normality of the analyzed data and the Bartlett test for the homoscedasticity. Box plot diagrams were used to illustrate data distribution along groups. As the distribution of the data was not normal, we used the non-parametric Kruskal-Wallis rank sum test to analyze the variance of the groups. To assess the differences between the compared groups the Wilcoxon rank sum test ($p < 0.05$) was used as a post hoc analysis. To identify the principal gradients of variation of the indices through the groups a Principal Component Analysis (PCA) was performed. Finally, we tested the five cover-abundance groups against all species occurring on (Table 3). In Appendix 2 the complete list of species was reported.

Results

The results from the PCA ordination diagram (Fig. 2) show a clear separation between groups 0 and 1 and from these groups and the others. The main separation is made along the first axis (PC1 34,1%). *Q. pubescens* forest plots (Group 0) and plots with low *R. pseudoacacia* cover (Group 1) are related to the weighted presence of herbaceous nemoral species, forest species, reaction and continentality Ellenberg indicators. More invaded groups are found to be related to exotic, nitrophilous, therophytes species and Ellenberg indicators for nutrient and moisture. The second axis (PC2 19,0%) separates plot related to the weighted presence of phanerophytes and nanophanerophytes species from the ones related to the weighted presence of hemicryptophytes species.



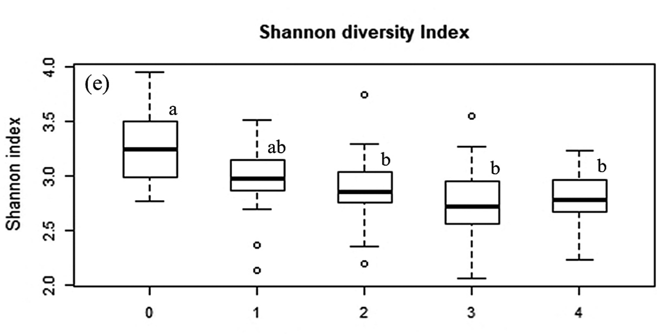


Figure 3. Box plot of the EIVs and Plant diversity index related to the five coverage groups considered: EIV for Nutrients (a), EIV for Moisture (b), EIV for Reaction (c), EIV for Light (d), Shannon index (e). Different letters indicate significant differences at $P < 0.05$ between means according to the Kruskal-Wallis rank sum test.

Effects of the increasing *R. pseudoacacia* cover-abundance values

The trends of the indices are well visualized by the box plots in Fig. 3 and 4. Along the 5 groups, Shannon diversity Index (H) shows a decreasing trend from group 0 to group 5 ($p<0.01$) with the lowest diversity values in pure *R. pseudoacacia* stands (Fig. 3 e).
Ellenberg indicators for nutrients, reaction and moisture (Fig. 3 a, c, b) are the most significative ($p<0.001$). Nutrient indicator is linked to Nitrogen availability and it shows already an increasing trend from the group 1 with a significative presence of nitrophilous species such as *Sambucus nigra* ($p<0.001$), *Galium aparine* ($p<0.001$), *Stellaria media* ($p<0.001$) and *R. pseudoacacia* ($p<0.001$) itself (Table 3 and Fig. 4 f). From the post hoc analysis, we can see a significative difference between group 1 and the others for this index. Moreover, we cannot detect a significative difference in nutrient indicator levels linked to the most invaded groups (groups 2, 3 and 4). Moisture indicator values along the cover-abundance scale flat on groups with higher coverage values and it shows a changing point from group 1. Through the pairwise post hoc comparison, moisture indicator is significatively different between *Q. pubescens* pure forests and the other groups; moreover, in plots with the presence of *R. pseudoacacia* it begins to be significative only from group 3 relatively to the group 1 conditions ($p<0.05$). Also, EIV for light shows a significant trend in the gradient (Fig. 3 d). *Q. pubescens* forest has higher EIV for light and it differs significantly from the first three groups, while not from the fourth. EIV for reaction (Fig. 3 c) shows a linkage with *R. pseudoacacia* environmental conditions. Lower values of this index are found on higher invaded groups that indicate for more species linked to low soil pH conditions (sub-acid/acid soils). Moreover, through the explorative correlation analysis, we detected a negative correlation between this indicator and the weighted presence of exotic and nitrophilous species (Spearman coefficient respective -0.75 and -0.79). Regarding the presence of exotic species (Fig. 4 g), we observed a similar trend both in the overall progression shown by the box plots and in the comparison among groups, with the absolute distance of the *Q. pubescens* forest from other conditions. Some exotic species recorded are *Ailanthus altissima, Anredera cordifolia, Erigeron canadensis, Parthenocissus quinquefolia, Phytolacca americana, Solidago canadiensis*. Group 1 is significantly different from both group 0 ($p<0.05$) and the others that are also statistically similar. Herbaceous nemoral species are not statistically different among group 1 and group 0 (Fig. 4 h). Considering nemoral species all together (herbaceous and non-herbaceous) groups 0 and 1 show significative higher values of forest species belonging to native woods (of the *Querco-Fagetea* class) such as *Fraxinus ornus*, *Cornus sanguinea*, *Crataegus monogyna*, and *Q. pubescens* itself, and more specifically of herbaceous nemoral species such as *Asparagus acutifolius*, *Viola alba* subsp. *dehnhardtii*, *Rubia peregrina* (Table 3). Herbaceous nemoral species don't statistically differ along the last three groups, where begin to lose their cover-abundance values and presence (Table 3). Regarding the life forms, therophytes annual species respond significantly along the *R. pseudoacacia* cover-abundance gradient (Fig. 4 i). This index characterizes the groups with higher coverage values of *R. pseudoacacia,* indicating disturbance conditions. More specifically we can see how group 4 is the richest in annual species and differ from the others. The effect of this index is detectable from group 2 that differs significantly from group 1.

Discussion

The *R. pseudoacacia* invasive behaviour has been studied in dry forest habitats (Italian *Q. pubescens* forest habitat code 91AA* - EU Habitat Directive) and in low cover-abundance conditions. Testing for the response of the five groups of plots with respect to the set of ecological indices we found a significative relationship between these values and increasing levels of *R. pseudoacacia* cover-abundance. Especially we highlighted the central role of the low cover-abundance group. There is a clear impact threshold at level of group 1 (<1%-25% *R. pseudoacacia* coverage), in condition of dominating *Q. pubescens* forests with the co-presence of non-dominating *R. pseudoacacia.* According to literature findings (Benesperi et al., 2012; Trentanovi et al., 2013; Slabejová et al., 2019), Shannon diversity index was significantly higher in the *Q. pubescens* reference forests. In accordance with Touza et al. (2008), we observed a decrease in species diversity and changes in community functional composition. This is caused by the shift of the species pool to more homogeneous composition. Indeed *R. pseudoacacia* forests show a specific floristic composition, characterized by nitrophilous and non-forest species (e.g.: Allegrezza et al., 2019), masking the floristic variability typical of forest coenoses in a landscape. Analyzing those communities in a gradient of cover-abundance values we found that diversity expressed by Shannon index is detectable when *R. pseudoacacia* cover-abundance values are higher than 25% of the total specific coverage of the sampling minimum area. Our main finding is that *R. pseudoacacia* with low cover-abundance values (represented by the plots in the group 1) inside *Q. pubescens* forests of the 91AA* habitat, can determine changes in ecological features expressed by the species and the indices here considered. In contrast with the findings of Staska et al. (2014), we detected that in temperate sub-Mediterranean bioclimate in hilly sites, low

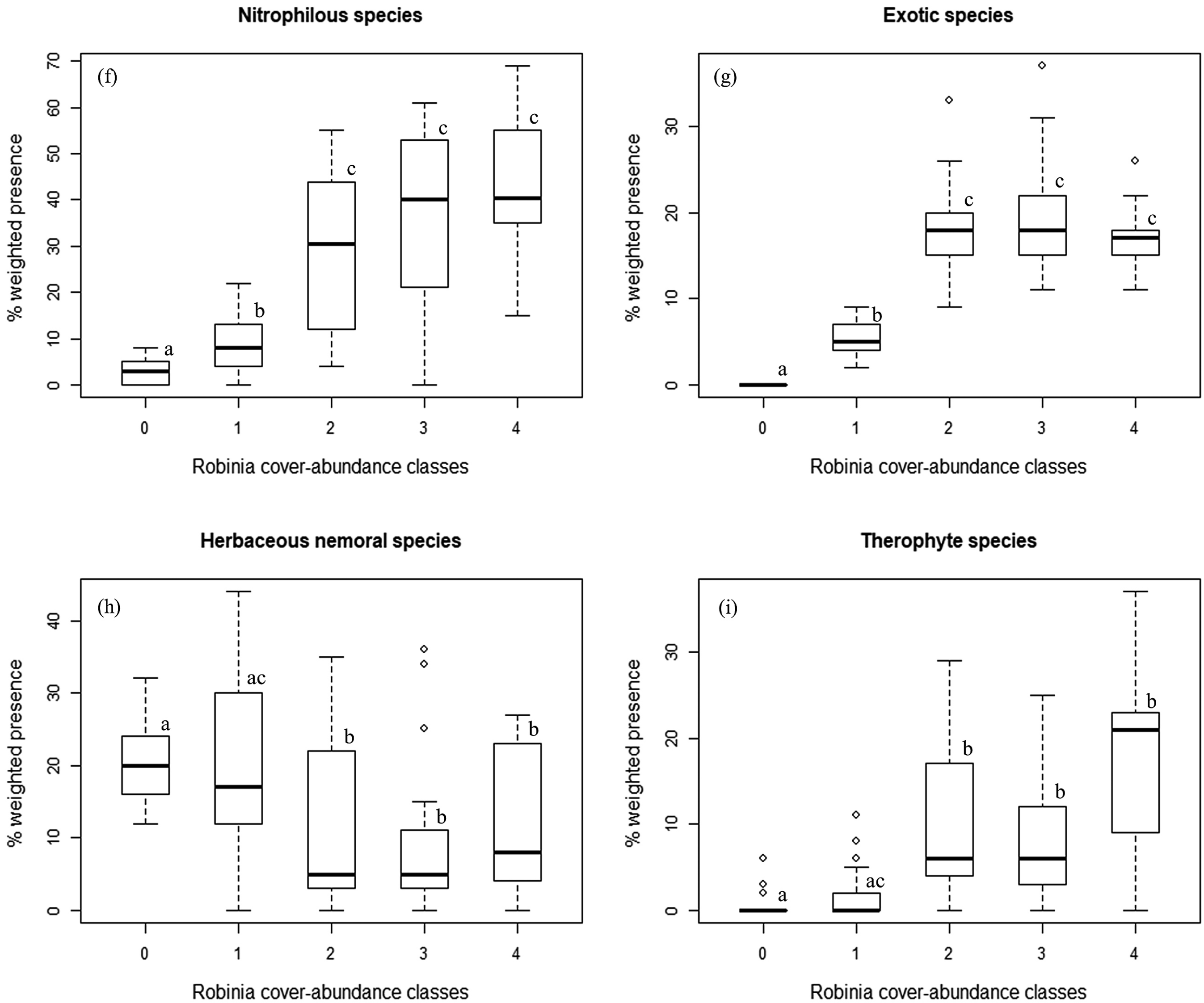


Figure 4. Box plot of the syntaxonomical classes and life forms related to the five coverage groups considered: Nitrophilous species (f); Exotic species (g); Herbaceous nemoral species (h); Annual species (therophyte) (i). Different letters indicate significant differences at $P < 0.05$ between means according to the Kruskal-Wallis rank sum test.

cover values of *R. pseudoacacia* (group 1: cover values <1-25%) determine an initial effect on the community in term of changes in ecological indices. We found that the initial enrichment in nitrophilous species starts from <1% to 25% of *R. pseudoacacia* coverage (group 1) and gain cover-abundance values starting from this condition. The trends of EIV for nutrient follows the trend of weighted percentage presence of nitrophilous species of the groups, assessed by syntaxonomical classes, such as *Sambucus nigra, Galium aparine, Stellaria media* and *R. pseudoacacia* and linked to annual life forms (Table 3). The trend of EIVs for moisture and light along the five groups confirm the low adaptive capacity to dry and arid conditions (Jin et al., 2011) and the low canopy cover of *R. pseudoacacia* coenoses (Slabejová et al., 2019). It is known that *Q. pubescens* forests are characterized by a relatively open canopy, but also *R. pseudoacacia* stands have a considerable amount of light reaching the understory layer over the whole vegetation (Krumm & Vitkova, 2016). In both cases, high light levels reaching the forest floor enable the survival of light-demanding species. As been proven by Sitzia et al. (2018) the effects of light availability in the understory layer and the detectable response in term of EIV for light, are only detectable in most invaded and uninvaded groups (Fig. 3 d). The lowest *R. pseudoacacia* coverage group also shows a significant difference in reaction EIVs in respect of the pure *Q. pubescens* forests in which they are found.

This is in accordance with several studies that described the relationships between *R. pseudoacacia* stands and changing in soil reaction conditions due to the increase in nitrogen (Montagnini et al., 1986; Vitkova et al., 2015; Lazzaro et al., 2018a). In our dataset, at the level of group 1 an enrichment in alien, ruderal, annual and non-forest species is detectable. The presence of exotic species is an indicator of disturbed environments and is enhanced by the *R. pseudoacacia* itself (Von Holle et al., 2006). These detectable changes could be a sign of initial alterations of growing conditions and relative effects on the competitive success of species. Nemoral plants species are known to vegetate in nutrient-poor soils and suffer the competition with faster-growing species in invaded conditions (Touza et al., 2008).

Considering group 1 as a key element, while on the one hand, we are witnessing the progressive enrichment of species linked to the disturbance, on the other we observe how the species linked to forest conditions progressively decrease their coverage in groups with *R. pseudoacacia* dominance (Table 3). The forest and nemoral species of the dataset, such as *Fraxinus ornus, Rubia peregrina, Cornus sanguinea, Crataegus monogyna*, *Asparagus acutifolius*, *Viola alba* subsp. *dehnhardtii* are defined as target species of the habitat 91AA* (Biondi et al., 2009; European Commission, 2013). In the group 1 are also comprised forest coenoses of the 91AA* habitat; the decrease in coverage of the target species of the habitat is not enough to determine the loss of the habitat itself but reflects the homogenization process carried out by *R. pseudoacacia* (Fig. 2).

Although these novel forests ecosystems are also characterized by the presence of forests and herbaceous nemoral species (Allegrezza et al., 2019; Vitkova et al., 2020), in comparison with the Italian oak woods of the habitat 91AA*, they lose coverage and presence of the nemoral target species (Table 3). The considered groups, even if not in direct contact with each other, express successive phases of the invasion process in the potential area of the oak forest and in conditions of direct presence into the same oak woods. These *R. pseudoacacia* coenoses are inserted in the theme outlined by the so-called 'novel ecosystems' which are defined as 'Synthetic ecosystems, include conditions and combinations of organisms never before in existence' (Odum, 1962). Novel ecosystems are mediated by anthropic intervention and bring about modifications to the resident ecosystems that are not yet completely clarified (Hobbs et al., 2006; Zavaleta et al., 2001). The successional dynamics in the case of *R. pseudoacacia* communities, in the same landscape position of the native oak forests, are still an open topic. The main results of the present paper highlight the effects of *R. pseudoacacia* coverage on the typical forests communities of the hilly landscape, that if iterated for a long period could lead to modifications of the vegetational succession as we know it.

Conclusions

This work is important in the context of the assessment of impacts by alien species on Italian forest habitats; usually, it is considered only the classic definition for dominant alien tree species: coverage higher than class 3 of Braun-Blanquet scale (25-50% of coverage) (Lazzaro et al., 2018b). We demonstrate that considering the only medium-high cover-abundance range of the invasive alien tree species could cause an underestimation of the potential impacts on protected forests coenoses. It is possible to state that by carrying out monitoring in *Q. pubescens* forests of the habitat 91AA* and detecting a presence of *R. pseudoacacia* with cover values from <1% to 25% is enough to start planning strategies to optimize efforts in maintaining the integrity of the 91AA* forest habitat. It is also essential the detection of nitrophilous, alien and annual species along with low cover-abundance values of 91AA* habitat target species. It is precisely in these *R. pseudoacacia* low coverage conditions that it is preferable to concentrate monitoring activities to avoid the loss of the habitat itself.

These results can be useful for forest managers and planners to implement an effective monitoring model and to cope with the replacement of native forest habitats with alien tree species, which has ecological and economic impacts with consequences for nature and society.

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Appendix 1

Origins, localities and coordinates (WGS89 UTM 33) of the plots

GROUP 0

Plot 89: rel. 185, tab. 3 in Allegrezza et al., 2002, (rel. 12, tab. 10 in Taffetani, 2000), from Colle Petrella-M. Ascensione (AP); **Plot 91**: rel. 30, tab. 2 in Allegrezza et al., 2002, (rel. 8, tab. 3 in Ubaldi et al., 1984), from Cappuccini di Fossombrone (PU); **Plot 94**: rel. 138, tab. 2 in Allegrezza et al., 2002, (rel. 1, tab. 13 in Ubaldi, 1988), from Fiorenzuola di Focara (PU); **Plot 95**: rel. 139, tab. 2 in Allegrezza et al., 2002, (rel. 2, tab. 13 in Ubaldi, 1988), from Fiorenzuola di Focara (PU); **Plot 97**: rel. 26, tab. 2 in Allegrezza et al., 2002, (Baldoni & Sanchioni), from Sant'Elena (AN); **Plot 99**: rel. 176, tab. 3 in Allegrezza et al., 2002, (Taffetani & Giannangeli), from San Lorenzo Treia (MC); **Plot 101**: rel. 7 in Lorenzoni, 1976 from Sassonegro-Arquà Petrarca Colli Euganei (PD); **Plot 102**: rel. 59, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 105**: rel. 62, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 107**: rel. 64, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 108**: rel. 65, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 109**: rel. 66, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 119**: rel. 3, tab. 1 in Ubaldi, 1980, from Monte Sole (BO); **Plot 120**: rel. 4, tab. 1 in Ubaldi, 1980, from Monte Sole (BO); **Plot 122**: rel. 6, tab. 1 in Ubaldi, 1980, from Monte Sole (BO); **Plot 123**: rel. 7, tab. 1 in Ubaldi, 1980, from Monte Sole (BO); **Plot 125**: rel. 6, tab. 2 in Blasi & Pietro, 1998, from Monte Rotondo, Vallecorsa (FR); **Plot 127**: rel. 6, tab. 1 in Biondi & Allegrezza, 1996, from Pietralacroce (AN); **Plot 129**: rel. 7, tab. 1 in Biondi & Allegrezza, 1996, from M. Conero (AN); **Plot 130**: rel. 2, tab. 1 in Biondi & Allegrezza, 1996, from M. Conero (AN); **Plot 131**: rel. 3, tab. 1 in Biondi & Allegrezza, 1996, from M. Conero (AN); **Plot 132**: rel. 4, tab. 1 in Biondi & Allegrezza, 1996, from M. Conero (AN).

Group 0 coordinates

Plot 89, 398407.5, 4761595.3, gr. 0; **Plot 91**, 323441.1, 4838853.4, gr.0; **Plot 94**, 325487.2, 4869650.4, gr.0; **Plot 95**, 326906.5, 4866850.4, gr.0; **Plot 97**, 343261.5, 4813510.3, gr.0; **Plot 99**, 359171.4, 4799316.4, gr.0; **Plot 127**, 381958.0, 4828891.8, gr.0; **Plot 129**, 372812.1, 4819355.3, gr.0; **Plot 130**, 386340.3, 4820367.0, gr.0; **Plot 131**, 385641.4, 4823702.7, gr.0; **Plot 132**, 385838.2, 4823951.5, gr.0; **Plot 125**, 368882.4, 4589756.9, gr.0; **Plot 101**, 240425.1, 5017202.6, gr.0; **Plot 102**, 221504.0, 5033746.3, gr.0; **Plot 105**, 220569.8, 5034447.0, gr.0; **Plot 107**, 222284.9, 5036852.5, gr.0; **Plot 108**, 219314.2, 5034684.2, gr.0; **Plot 109**, 222243.0, 5033055.1, gr.0; **Plot 119**, 198704.1, 4914703.1, gr.0; **Plot 120**, 198029.2, 4914677.5, gr.0; **Plot 122**, 198362.0, 4913546.6, gr.0; **Plot 123**, 198476.9, 4914646.1, gr.0.

GROUP 1

Plot 1: rel. 14, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 2**: rel. 15, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 3**: rel. 16, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 4**: rel. 13, tab. 2 in Blasi & Pietro, 1998, from Carpinella Colle Palombi, Vallecorsa (FR); **Plot 5**: rel. 2, tab. 1 in Biondi & Allegrezza, 2004, from Gallignano (AN); **Plot 6**: rel. 3, tab. 1 in Biondi & Allegrezza, 2004, from Gallignano (AN); **Plot 7**: rel. 1, tab. 1 in Biondi & Allegrezza, 1996, from Monte della Crescia (AN); **Plot 8**: unpublished from Gallignano (AN); **Plot 9**: unpublished from Scisciano (AN); **Plot 10**: unpublished from Albacina (AN); **Plot 11**: unpublished from Pontechiaradovo (AN); **Plot 12**: unpublished from Castelbellino (AN); **Plot 13**: rel. 4, tab. 1 in Biondi & Allegrezza, 2004, from Gallignano (AN); **Plot 14**: rel. 10, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 15**: rel. 11, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 16**: rel. 12, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 17**: rel. 13, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 140**: rel. 9, tab. 2 in Adorni, 2001, from Monticello, Felino-Val Baganza (PA); **Plot 141**: rel. 1, tab. 2 in Zitti et al., 2005, from Onferno Nature Reserve: next to Ca' Bernardo (RN); **Plot 142**: rel. 2, tab. 2 in Zitti et al., 2005, from Onferno Nature Reserve: next to Ca' Bernardo (RN); **Plot 143**: rel. 4, tab. 2 in Zitti et al., 2005, from Onferno Nature Reserve: next to Ca' Bernardo (RN).

Group 1 coordinates

Plot 14, 242243.4, 5025326.6 gr.1; **Plot 15**, 243322.9, 5019501.6, gr.1; **Plot 16**, 239964.9, 5023731.0, gr.1; **Plot 17**, 238346.4, 5026924.6, gr.1; **Plot 1**, 244503.8, 5016812.9, gr.1; **Plot 2**, 237444.0, 5019366.0, gr.1; **Plot 3**, 243456.6, 5020376.2, gr.1; **Plot 141**, 301071.9, 4856755.0, gr.1; **Plot 142**, 296923.5, 4854312.9, gr.1; **Plot 143**, 301279.6, 4851672.5, gr.1; **Plot 140**, 135375.4, 4953466.6, gr.1; **Plot 5**, 373529.6, 4824874.5, gr.1; **Plot 6**, 372851.4, 4824705.0, gr.1; **Plot 13**, 373905.4, 4824801.2, gr.1; **Plot 7**, 373373.6, 4817373.4, gr.1; **Plot 4**, 366577.7, 4590173.5, gr.1; **Plot 8**, 372660.8, 4824706.1, gr.1; **Plot 9**, 346025.1, 4814458.1, gr.1; **Plot 10**, 338783.7, 4799836.9, gr.1; **Plot 11**, 336950.6, 4809590.4, gr.1; **Plot 12**, 350832.6, 4816155.3, gr.1.

GROUP 2

Plot 18: unpublished, from San Bartolo (PU); **Plot 19**: rel. 38, tab. 1 in Allegrezza et al., 2019, from Mombaroccio (PU); **Plot 20**: rel. 44, tab. 1 in Allegrezza et al., 2019, from Arcevia (AN); **Plot 21**: rel. 43, tab. 1 in Allegrezza et al., 2019, from Arcevia (AN); **Plot 22**: rel. 17, tab. 1 in Allegrezza et al., 2019, from Treia (MC); **Plot 23**: unpublished from Oretzzano (FM); **Plot 26**: rel. 33, tab. 1 in Allegrezza et al., 2019, from Albacina (AN); **Plot 28**: rel. 20, tab. 1 in Allegrezza et al., 2019, from Monsano (AN); **Plot 29**: rel. 19, tab. 1 in Allegrezza et al., 2019, from Cerreto d'Esi (AN); **Plot 30**: rel. 22, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 31**: rel. 19, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 33**: rel. 15, tab. S2 in Campagaro et al., 2018, from Vicenza; **Plot 34**: rel. 16, tab. S2 in Campagaro et al., 2018, from Padova; **Plot 35**: rel. 9, tab. S2 in Campagaro et al., 2018, from Padova; **Plot 36**: rel. 23, tab. S2 in Campagaro et al., 2018, from Vicenza; **Plot 37**: rel. 28, tab. S2 in Campagaro et al., 2018, from Padova; **Plot 38**: rel. 27, tab. S2 in Campagaro et al., 2018, from Vicenza; **Plot 39**: rel. 74, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 40**: rel. 76, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 41**: rel. 7, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 42**: rel. 8, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 43**: rel. 9, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei.

Group 2 coordinates

Plot 41, 240927.0, 5023621.6, gr.2; **Plot 42**, 238753.3, 5022887.4, gr.2; **Plot 43**, 240347.7, 5022821.6, gr.2; **Plot 33**, 228867.7, 5040816.1, gr.2; **Plot 34**, 240073.6, 5027439.0, gr.2; **Plot 35**, 239966.9, 5019997.0, gr.2; **Plot 36**, 218861.0, 5033972.9, gr.2; **Plot 37**, 245860.4, 5029401.7, gr.2; **Plot 38**, 221498.4, 5036100.7, gr.2; **Plot 39**, 221972.0, 5036733.9, gr.2; **Plot 40**, 220731.8, 5035102.1, gr.2; **Plot 30**, 199478.7, 4936271.5, gr.2; **Plot 31**, 197800.4, 4933961.3, gr.2; **Plot 18**, 330829.1, 4864960.1, gr.2; **Plot 23**, 385372.7, 4764942.3, gr.2; **Plot 19**, 326544.8, 4853487.5, gr.2; **Plot 20**, 334058.8, 4819246.6, gr.2; **Plot 21**, 334353.8, 4819089.2, gr.2; **Plot 22**, 363377.3, 4796527.4, gr.2; **Plot 26**, 338875.4, 4800114.2, gr.2; **Plot 28**, 361215.9, 4823782.4, gr.2; **Plot 29**, 337228.0, 4797247.3, gr.2.

GROUP 3

Plot 44: rel. 41, tab. 1 in Allegrezza et al., 2019, from San Bartolo (PU); **Plot 45**: rel. 7, tab. 1 in Allegrezza et al., 2019, from San Bartolo (PU); **Plot 47**: rel. 35, tab. 1 in Allegrezza et al., 2019, from Mombaroccio (PU); **Plot 48**: rel. 37, tab. 1 in Allegrezza et al., 2019, from Mombaroccio (PU); **Plot 49**: rel. 39, tab. 1 in Allegrezza et al., 2019, from Mombaroccio (PU); **Plot 50**: unpublished from Aqualagna (PU); **Plot 51**: unpublished from Arcevia (AN), loc. Montale; **Plot 52**: rel. 45, tab. 1 in Allegrezza et al., 2019, from Treia (MC); **Plot 54**: rel. 1, tab. 1 in Allegrezza et al., 2019, from Giulianova (TE); **Plot 55**: rel. 6, tab. 1 in Allegrezza et al., 2019, from Bellante (TE); **Plot 56**: rel. 8, tab. 1 in Allegrezza et al., 2019, from Ancona; **Plot 58**: unpublished from Jesi (AN); **Plot 60**: rel. 21, tab. 1 in Allegrezza et al., 2019, from Cerreto d'Esi (AN); **Plot 61**: rel. 25, tab. 1 in Allegrezza et al., 2019, from Agugluano (AN); **Plot 62**: rel. 25, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 63**: rel. 24, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 64**: rel. 23, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 65**: rel. 17, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 66**: rel. 16, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 67**: rel. 26, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 69**: rel. 8, tab. S2 in Campagaro et al., 2018, from Padova; **Plot 70**: rel. 79, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI).

Group 3 coordinates

Plot 69, 241573.9, 5023148.1, gr.3; **Plot 70**, 220103.7, 5034976.7, gr.3; **Plot 62**, 195636.4, 4934003.5, gr.3; **Plot 63**, 200455.6, 4931662.8, gr.3; **Plot 64**, 202068.6, 4933885.5, gr.3; **Plot 65**, 196403.5, 4937131.1, gr.3; **Plot 66**, 205019.1, 4932488.9, gr.3; **Plot 67**, 197742.9, 4929299.7, gr.3; **Plot 50**, 313836.5, 4834105.9, gr.3; **Plot 51**, 338090.0, 4823267.6, gr.3; **Plot 58**, 360595.0, 4819861.4, gr.3; **Plot 44**, 329095.7, 4866168.4, gr.3; **Plot 45**, 330885.7, 4865086.5, gr.3; **Plot 47**, 327266.4, 4852881.1, gr.3; **Plot 48**, 327212.3, 4850191.2, gr.3; **Plot 49**, 327718.8, 4851120.7, gr.3; **Plot 52**, 362604.0, 4797291.2, gr.3; **Plot 54**, 415133.4, 4733446.5, gr.3; **Plot 55**, 402294.9, 4732120.0, gr.3; **Plot 56**, 379813.4, 4827006.9, gr.3; **Plot 60**, 338763.0, 4795535.0, gr.3; **Plot 61**, 370428.0, 4823568.3, gr.3.

GROUP 4

Plot 71: rel. 31, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 72**: rel. 30, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 73**: rel. 34, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 74**: rel. 33, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 75**: rel. 32, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 76**: rel. 26, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 77**: rel. 35, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 78**: rel. 18, tab. 7 in Ubaldi, 2003, from Bologna hills (BO); **Plot 79**: rel. 29, tab. S2 in Campagaro et al., 2018, from Vicenza;

Plot 80: rel. 75, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 81**: rel. 77, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 82**: rel. 78, tab. 3 in Tasinazzo & Fiorentin, 2000, from Colli Berici (VI); **Plot 83**: rel. 1, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 84**: rel. 2, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 85**: rel. 3, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 86**: rel. 4, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 87**: rel. 5, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei; **Plot 88**: rel. 6, tab. 1 in Buffa & Ghirelli, 1993, from Colli Euganei.

Group 4 coordinates

Plot 83, 238571.5, 5017139.3, gr.4; **Plot 84**, 240268.2, 5020548.4, gr.4; **Plot 85**, 242997.7, 5019431.0, gr.4; **Plot 86**, 242777.7, 5021255.8, gr.4; **Plot 87**, 238594.8, 5022782.3, gr.4; **Plot 88**, 240958.7, 5020981.0, gr.4; **Plot 79**, 226780.3, 5029986.0, gr.4; **Plot 80**, 221966.1, 5035019.5, gr.4; **Plot 81**, 220560.3, 5034391.7, gr.4; **Plot 82**, 220156.0, 5033322.0, gr.4; **Plot 71**, 192998.5, 4935116.0, gr.4; **Plot 72**, 193947.7, 4933297.7, gr.4; **Plot 73**, 197744.6, 4931626.6, gr.4; **Plot 74**, 201755.4, 4931506.2, gr.4; **Plot 75**, 200472.0, 4934688.2, gr.4; **Plot 76**, 190614.2, 4933439.3, gr.4; **Plot 77**, 191848.7, 4935129.3, gr.4; **Plot 78**, 187827.9, 4936638.5, gr.4.

Appendix 2

Complete list of species with the indication of the life form, syntaxonomical attribute, EIVs, and the medium percentage cover (%) of the species for each of the five groups. Species present one-time per-group were omitted. Species significantly related to groups are indicated with the significance level and in a progressive grey colored scale (from dark grey corresponding to 15% of medium percentage coverage, to white that corresponds to 0% of medium percentage coverage). *** p ≤ 0.001; ** p ≤ 0.01; * p ≤ 0.05; p ≤ 0.1.

	Life form	Syntaxonomical attribute	L	T	M	R	N	Gr.0	Gr.1	Gr.2	Gr.3	Gr.4	p-value
Robinia pseudacacia L.	P	AL	3,75	5,25	3	X	8	0,0	4,0	11,6	14,5	14,8	***
Sambucus nigra L.	P	NTR	5,25	3,75	4	X	9	0,0	2,0	3,5	6,8	6,7	***
Galium aparine L.	T	NTR	4,5	X	3	5	5	0,0	0,3	1,9	1,6	3,5	***
Stellaria media (L.) Vill. subsp. *media*	T	NTR	5	X	3	7	8	0,0	0,6	1,5	0,3	4,2	*
Urtica dioica L. subsp. *dioica*	H	NTR	X	X	5	X	8	0,0	0,0	1,1	3,1	1,2	***
Arum italicum Mill. subsp. *italicum*	G	NTR	4,5	6	3	5	5	0,1	1,1	1,6	2,6	1,0	*
Clematis vitalba L.	P	RP	5,25	5,25	3,75	7	7	1,7	1,3	2,4	3,2	2,0	**
Rubus ulmifolius Schott	NP	RP	3,75	6	3	5	8	1,5	2,6	2,7	5,1	3,0	p
Quercus pubescens Willd. s.l.	P	QF	5,25	6	2	7	4	9,6	9,2	1,9	1,2	0,7	***
Fraxinus ornus L. subsp. *ornus*	P	QF	4	6	2	8	3	4,1	4,0	2,0	1,2	0,3	***
Rubia peregrina L.	P	QF	4	7	3	5	3	2,3	2,2	0,5	1,0	0,0	*
Cornus sanguinea L.	P	RP	5,25	3,75	5	8	X	3,0	2,3	1,6	1,8	0,8	**
Viola alba Besser subsp. *dehnhardtii* (Ten.) W. Becker	H	Nem_herb	4	6	4	7	6	2,2	1,0	0,2	0,4	0,4	***
Crataegus monogyna Jacq.	P	RP	4,5	5,25	3	6	3	3,2	3,0	2,1	1,9	1,6	***
Brachypodium rupestre (Host) Roem. & Schult.	H	TG	6	4,5	3,75	8	4	2,9	1,0	0,2	1,0	0,0	***
Laurus nobilis L.	P	QF	1,5	5,25	6	4	6	0,3	3,0	2,0	3,4	0,0	***
Euonymus europaeus L.	P	RP	4,5	3,75	4	8	5	1,0	1,0	2,0	2,8	0,7	**
Hedera helix L. subsp. *helix*	P	QF	3	3,75	4	X	X	3,2	7,0	7,4	7,6	5,5	p
Prunus spinosa L. subsp. *spinosa*	P	RP	5,25	3,75	X	X	X	0,7	1,7	0,7	1,5	0,4	
Ligustrum vulgare L.	NP	RP	5,25	4,5	X	8	X	1,0	2,2	1,9	0,6	1,3	p
Ruscus aculeatus L.	G	Nem_herb	3	6	3	5	5	1,9	2,7	2,2	1,4	1,2	

	Life form	Syntaxonomical attribute	L	T	M	R	N	Gr.0	Gr.1	Gr.2	Gr.3	Gr.4	p-value
Asparagus acutifolius L.	G	Nem_herb	4,5	6,75	2	5	5	2,5	2,0	1,1	0,9	0,5	
Acer campestre L.	P	QF	3,75	5,25	3,75	7	6	1,7	1,6	2,9	1,0	1,3	
Ulmus minor Mill. subsp. *minor*	P	RP	3,75	5,25	X	8	X	0,5	2,2	2,4	2,1	2,3	
Dioscorea communis (L.) Caddick & Wilkin.	G	Nem_herb	3,75	5,25	4	8	6	1,3	1,7	2,6	1,5	2,5	
Presence <20%													
Castanea sativa Mill.	P	QF	3,75	6	X	4	X	0,1	4,3	0,8	0,4	0,5	
Prunus avium L. subsp. *avium*	P	QF	3	3,75	4	7	5	0,3	1,1	0,9	0,5	0,4	
Corylus avellana L.	P	QF	4,5	3,75	4	5	8	0,3	0,6	0,9	0,4	0,7	
Muscari comosum (L.) Mill.	G	NTR	5,25	6	2,25	7	0	0,1	0,1	0,7	1,2	0,7	
Viola reichenbachiana Jord. ex Boreau	H	Nem_herb	3	3,75	4	7	6	0,2	1,1	0,3	0,1	0,7	
Rosa canina L.	NP	RP	6	3,75	3	X	X	0,2	0,6	1,0	0,3	0,3	
Symphytum tuberosum L. s.l.	G	Nem_herb	3	3,75	4,5	7	5	0,1	0,4	0,8	0,1	1,0	
Mespilus germanica L.	P	QF	3,75	6	3	X	X	0,2	0,8	0,2	0,4	0,4	
Geum urbanum L.	H	NTR	3	3,75	4	6	7	0,0	0,1	0,3	0,4	0,8	
Hepatica nobilis Mill.	G	Nem_herb	3	4,5	3	7	X	0,3	0,1	0,2	0,1	0,1	
Rubus plicatus Weihe & Nees	NP	RP	5,25	4,5	3	5	7	0,0	0,8	2,1	0,5	1,3	
Veronica hederifolia L.	T	FB	4,5	4,5	4	3	7	0,0	0,3	0,4	0,2	2,1	
Lonicera caprifolium L.	P	RP	4,5	3,75	5	X	5	0,9	1,0	0,3	0,0	0,4	
Cardamine bulbifera (L.) Crantz	G	Nem_herb	2,25	3,75	4	7	6	0,0	1,0	0,1	0,1	1,4	
Bryonia cretica subsp. *dioica* (Jacq.) Tutin	G	NTR	6	5,25	4	8	6	0,0	0,3	0,5	0,4	1,2	
Lamium maculatum L.	H	NTR	5,25	5,25	3	5	4	0,0	0,4	0,2	0,2	1,3	
Ailanthus altissima (Mill.) Swingle	P	AL	4,5	5,25	4	5	5	0,0	0,3	0,8	0,8	0,2	
Brachypodium sylvaticum (Huds.) P. Beauv. subsp. *sylvaticum*	H	Nem_herb	3	3,75	4	6	6	0,5	0,8	0,2	0,5	0,0	
Alliaria petiolata (M. Bieb.) Cavara & Grande	H	NTR	3,75	4,5	3,75	7	9	0,1	0,0	0,5	0,6	0,6	
Ranunculus bulbosus L.	H	FB	6	4,5	2	7	3	0,5	0,4	0,0	0,2	0,6	
Viola odorata L.	H	FB	3,75	4,5	4	X	8	0,1	0,7	0,3	0,0	0,5	
Viburnum lantana L.	P	RP	5,25	3,75	3	8	5	1,1	0,2	0,0	0,1	0,2	
Inula conyzae (Griess.) Meikle	H	NTR	5	5	3	7	3	0,8	0,1	0,1	0,4	0,0	
Rubus hirtus Waldst. & Kit. group	NP	RP	5,25	4,5	3	5	7	0,3	0,2	0,0	0,6	0,1	
Rosa arvensis Huds.	NP	QF	3,75	3,75	3,75	7	5	0,7	0,2	0,0	0,0	0,2	
Helleborus odorus Waldst. & Kit.	G	TG	3,75	5,25	4	8	6	0,0	0,1	0,2	0,1	0,6	
Asparagus tenuifolius Lam.	G	Nem_herb	4,5	5,25	3	6	5	0,2	0,4	0,3	0,0	0,2	
Acer opalus Mill. subsp. *obtusatum* (Waldst. & Kit. ex Willd.) Gams	P	QF	3,75	3,75	5	7	7	0,2	0,3	0,3	0,2	0,0	
Campanula trachelium L. subsp. *trachelium*	H	Nem_herb	3	3,75	3,75	8	8	0,1	0,3	0,2	0,3	0,0	
Rhamnus alaternus L. subsp. *alaternus*	P	QF	3	6,75	1,5	4	4	0,2	0,2	0,3	0,1	0,0	

	Life form	Syntaxonomical attribute	L	T	M	R	N	Gr.0	Gr.1	Gr.2	Gr.3	Gr.4	p-value
Helleborus viridis L. subsp. *bocconei* (Ten.) Peruzzi	G	TG	3,75	3,75	4,5	7	6	0,1	0,2	0,0	0,2	0,1	
Clinopodium nepeta (L.) Kuntze	Ch	TG	3,75	5,25	2	9	3	0,0	0,1	0,1	0,1	0,2	
Pulmonaria officinalis L.	H	Nem_herb	4	5	4	8	6	0,0	0,1	0,2	0,1	0,1	
Poa trivialis L.	H	NTR	4,5	X	5	X	7	0,0	0,0	1,3	1,0	1,8	
Aegonychon purpurocaeruleum (L.) Holub	H	Nem_herb	3,75	5,25	3	8	4	1,8	1,1	0,0	0,1	0,0	
Lonicera etrusca Santi	P	RP	5,25	6	2	6	4	1,5	1,3	0,0	0,2	0,0	
Parietaria judaica L.	H	NTR	5,25	6	2	X	6	0,0	0,0	0,8	1,0	0,6	
Ostrya carpinifolia Scop.	P	QF	3	6	3	X	X	1,6	0,2	0,2	0,0	0,0	
Allium ursinum L.	G	Nem_herb	1,5	X	5	7	8	0,0	0,0	0,7	0,2	0,9	
Chaerophyllum temulum L.	T	NTR	4	5	3,75	X	8	0,0	0,0	0,4	1,0	0,2	
Polygonatum multiflorum (L.) All.	G	TG	1,5	3,75	3,75	7	4	0,0	0,7	0,0	0,4	0,5	
Geranium robertianum L.	T	TG	3	4,5	3	5	5	0,0	0,0	0,7	0,1	0,7	
Juglans regia L.	P	NTR	4,5	4,5	4	6	6	0,0	0,3	0,7	0,5	0,0	
Taraxacum F.H.Wigg. sect. *Taraxacum*	H	NTR	5,25	X	4	X	7	0,0	0,0	0,6	0,4	0,5	
Lamium orvala L.	H	TG	2,25	3,75	5	7	8	0,0	0,0	0,7	0,1	0,7	
Quercus ilex L. subsp. *ilex*	P	QF	1,5	6,75	2	X	X	0,9	0,1	0,4	0,0	0,0	
Ballota nigra L.	H	NTR	6	4,5	4	X	8	0,0	0,0	0,3	0,2	1,0	
Melittis melissophyllum L.	H	Nem_herb	3,75	4,5	3	7	3	0,8	0,3	0,0	0,4	0,0	
Dactylis glomerata L. subsp. *glomerata*	H	FB	5,25	4,5	3	5	6	0,4	0,3	0,0	0,6	0,0	
Sorbus torminalis (L.) Crantz	P	QF	3	4,5	3	7	4	0,8	0,0	0,0	0,3	0,2	
Celtis australis L.	P	RP	5,25	6	2	7	4	0,0	0,1	0,7	0,0	0,4	
Avena fatua L.	T	AL	4,5	X	5	7	X	0,0	0,0	0,3	0,4	0,4	
Sinapis alba L. subsp. *alba*	T	NTR	6	7,5	2,25	7	2	0,0	0,1	0,1	0,9	0,0	
Parietaria officinalis L.	H	NTR	3	6	4	7	7	0,0	0,0	0,6	0,1	0,4	
Cornus mas L.	P	RP	5	5	4	8	4	0,5	0,0	0,5	0,1	0,0	
Silene nutans L.	H	NTR	5,25	3,75	2	7	3	0,4	0,4	0,2	0,0	0,0	
Anemonoides nemorosa (L.) Holub	G	Nem_herb	X	X	X	5	X	0,0	0,4	0,0	0,1	0,6	
Stachys sylvatica L.	H	TG	3	X	5,25	7	7	0,0	0,6	0,2	0,2	0,0	
Cirsium arvense (L.) Scop.	G	NTR	6	X	3	X	7	0,0	0,0	0,1	0,2	0,6	
Arctium lappa L.	H	NTR	6,75	3,75	4	7	9	0,0	0,0	0,1	0,4	0,4	
Aegopodium podagraria L.	G	NTR	3,75	X	4,5	7	8	0,0	0,1	0,6	0,1	0,0	
Ficaria verna Huds.	G	FB	3	4	5	7	7	0,0	0,3	0,2	0,0	0,3	
Viola hirta L.	H	FB	4,5	3,75	2	8	2	0,2	0,0	0,4	0,0	0,2	
Primula vulgaris Huds.	H	FB	5	4	4	7	5	0,0	0,3	0,1	0,3	0,0	
Epimedium alpinum L.	H	Nem_herb	4,5	3,75	5	7	6	0,0	0,0	0,1	0,1	0,4	
Vitis vinifera L.	P	NTR	4,5	6	4,5	8	6	0,0	0,1	0,4	0,1	0,0	
Veronica chamaedrys L.	H	TG	4,5	X	3	X	X	0,0	0,2	0,1	0,0	0,3	
Arum maculatum L.	G	NTR	2,25	4,5	5	7	8	0,0	0,0	0,2	0,1	0,3	
Sonchus asper (L.) Hill	T	NTR	5,25	3,75	3	7	7	0,0	0,1	0,3	0,1	0,0	

	Life form	Syntaxonomical attribute	L	T	M	R	N	Gr.0	Gr.1	Gr.2	Gr.3	Gr.4	p-value
Campanula trachelium L. subsp. *trachelium*	H	Nem_herb	3	3,75	4	8	8	0,1	0,3	0,0	0,1	0,0	
Mycelis muralis (L.) Dumort. subsp. *muralis*	H	Nem_herb	3	3,75	3,75	X	6	0,0	0,1	0,1	0,1	0,0	
Asplenium scolopendrium L. subsp. *scolopendrium*	H	Al	1,5	4,5	4	8	6	0,0	0,0	0,0	0,1	0,2	
Anisantha sterilis (L.) Nevski	T	NTR	5	5	3	X	5	0,0	0,0	2,0	0,0	4,2	
Rosa sempervirens L.	NP	QF	4,5	6	2	4	6	1,8	1,3	0,0	0,0	0,0	
Smilax aspera L.	NP	QF	4,5	7,5	2	5	3	1,6	1,2	0,0	0,0	0,0	
Carex flacca Schreb. subsp. *flacca*	G	FB	5	4	5	8	X	1,7	0,8	0,0	0,0	0,0	
Quercus cerris L.	P	QF	4,5	6	3	4	4	1,8	0,5	0,0	0,0	0,0	
Emerus major Mill. subsp. *emeroides* (Boiss. & Spruner) Soldano & F.Conti	NP	RP	5,25	4,5	2	9	2	1,1	0,8	0,0	0,0	0,0	
Cytisophyllum sessilifolium (L.) O.Lang	P	RP	4,5	3,75	4,5	4	5	1,7	0,1	0,0	0,0	0,0	
Humulus lupulus L.	P	NTR	5,25	4,5	6	6	8	0,0	0,0	0,0	0,9	0,9	
Sorbus domestica L.	P	QF	3	5	2,25	8	3	1,5	0,2	0,0	0,0	0,0	
Elymus repens (L.) Gould subsp. *repens*	G	FB	5,25	X	3,75	X	8	0,0	0,0	0,9	0,0	0,7	
Teucrium chamaedrys L.	Ch	FB	5,25	4,5	2	8	1	1,3	0,2	0,0	0,0	0,0	
Osyris alba L.	NP	QF	5,25	6	2	4	2	1,1	0,3	0,0	0,0	0,0	
Geranium sanguineum L.	H	TG	4,5	5,25	2	5	4	0,7	0,0	0,4	0,0	0,0	
Lactuca sativa L. subsp. *serriola* (L.) Galasso, Banfi, Bartolucci & Ardenghi	H	NTR	6,75	5,25	3	6	4	0,0	0,0	0,2	0,0	0,8	
Artemisia vulgaris L.	H	NTR	6,75	5,25	3	X	5	0,0	0,0	0,0	0,2	0,8	
Rumex sanguineus L.	H	Nem_herb	3	3,75	6	7	7	0,0	0,4	0,0	0,0	0,6	
Geranium dissectum L.	T	NTR	5,25	6	1,5	5	2	0,0	0,0	0,0	0,1	0,8	
Silene latifolia Poir. subsp. *alba* (Mill.) Greuter & Burdet	H	NTR	4,5	6,75	2,25	4	2	0,0	0,0	0,0	0,5	0,4	
Galium mollugo L. subsp. *mollugo*	H	FB	4,5	3,75	3,75	5	4	0,0	0,0	0,1	0,0	0,7	
Epipactis helleborine (L.) Crantz	G	Nem_herb	2,25	3,75	4	7	5	0,7	0,1	0,0	0,0	0,0	
Quercus petraea (Matt.) Liebl.	P	QF	4,5	4,5	4	4	6	0,3	0,0	0,0	0,5	0,0	
Ficus carica L.	P	NTR	5,25	6	X	5	X	0,0	0,0	0,7	0,1	0,0	
Glechoma hederacea L.	H	NTR	4,5	5,25	3	5	3	0,0	0,0	0,4	0,0	0,3	
Carpinus orientalis Mill. subsp. *orientalis*	P	QF	3	5,25	2	4	5	0,6	0,1	0,0	0,0	0,0	
Cephalanthera longifolia (L.) Fritsch	G	Nem_herb	3	3,75	2,25	8	3	0,4	0,3	0,0	0,0	0,0	
Cruciata glabra (L.) C.Bauhin ex Opiz	H	TG	3,75	4,5	4	6	6	0,5	0,1	0,0	0,0	0,0	
Cirsium vulgare (Savi) Ten.	H	NTR	6	3,75	4	X	8	0,0	0,0	0,1	0,0	0,5	
Anisantha diandra (Roth) Tutin ex Tzvelev	T	NTR	6	6	2	5	4	0,0	0,0	0,3	0,3	0,0	
Asplenium adiantum-nigrum L.	H	Nem_herb	4,5	5,25	3	2	3	0,0	0,4	0,0	0,2	0,0	
Avena sterilis L.	T	AL	6	6,75	2	6	4	0,0	0,0	0,3	0,4	0,0	

	Life form	Syntaxonomical attribute	L	T	M	R	N	Gr.0	Gr.1	Gr.2	Gr.3	Gr.4	p-value
Cercis siliquastrum L.	P	QF	6	5,25	3	7	4	0,5	0,1	0,0	0,0	0,0	
Tanacetum corymbosum (L.) Sch.Bip.	H	Nem_herb	6	X	4	X	5	0,2	0,5	0,0	0,0	0,0	
Prunus mahaleb L.	P	RP	5,25	3,75	2	8	2	0,4	0,2	0,0	0,0	0,0	
Petasites fragrans (Vill.) C. Presl	G	NTR	5,25	6	5	7	6	0,0	0,0	0,1	0,5	0,0	
Clinopodium vulgare L. subsp. *vulgare*	H	NTR	5,25	3,75	3	7	3	0,3	0,0	0,0	0,2	0,0	
Vincetoxicum hirundinaria Medik.	H	TG	4,5	3,75	2	7	3	0,4	0,0	0,0	0,0	0,2	
Pistacia terebinthus L.	P	QF	6,75	6	1,5	7	2	0,5	0,1	0,0	0,0	0,0	
Melissa officinalis L. subsp. *altissima*	H	NTR	4,5	6	3	6	4	0,0	0,1	0,0	0,4	0,0	
Serratula tinctoria L.	H	FB	5,25	4,5	X	8	5	0,3	0,0	0,0	0,0	0,2	
Solidago virgaurea L.	H	Nem_herb	3,75	X	4	X	5	0,4	0,2	0,0	0,0	0,0	
Bromopsis erecta (Huds.) Fourr.	H	FB	6	3,75	2	8	3	0,4	0,1	0,0	0,0	0,0	
Viburnum tinus L. subsp. *tinus*	P	QF	4	7	3	5	3	0,0	0,0	0,3	0,2	0,0	
Scandix pecten-veneris L.	T	NTR	5,25	5,25	2,25	8	4	0,0	0,0	0,0	0,1	0,4	
Inula salicina L.	H	FB	5,25	3,75	3	9	2	0,3	0,1	0,0	0,0	0,0	
Alopecurus myosuroides Huds.	T	NTR	4,5	4,5	5	7	7	0,0	0,0	0,0	0,3	0,1	
Festuca heterophylla Lam.	H	Nem_herb	3,75	3,75	3	5	4	0,3	0,0	0,0	0,2	0,0	
Lonicera xylosteum L.	P	QF	3,75	3,75	4	7	X	0,3	0,1	0,0	0,0	0,0	
Chamaeiris foetidissima (L.) Medik.	G	Nem_herb	5,25	5,25	3	4	5	0,0	0,0	0,1	0,2	0,0	
Spartium junceum L.	P	RP	5,25	5,25	3	7	2	0,2	0,2	0,0	0,0	0,0	
Erigeron canadensis L.	T	AL	6	4,5	3,75	X	7	0,0	0,0	0,3	0,1	0,0	
Prunus cerasifera Ehrh.	P	AL	6,75	5,25	4	5	5	0,0	0,2	0,2	0,0	0,0	
Rumex crispus L.	H	NTR	5	4	5	X	5	0,0	0,0	0,0	0,1	0,2	
Acer monspessulanum L. subsp. *monspessulanum*	P	QF	4,5	6	2	8	4	0,2	0,0	0,1	0,0	0,0	
Acer pseudoplatanus L.	P	QF	3	X	5	X	7	0,0	0,0	0,2	0,0	0,1	
Rumex acetosa L.	H	NTR	6	X	X	4	5	0,0	0,0	0,1	0,2	0,0	
Polygala nicaeensis Risso *ex* W.D.J.Koch subsp. *nicaeensis*	H	FB	6	4,5	2	7	2	0,2	0,1	0,0	0,0	0,0	
Olea europaea L.	P	NTR	8,25	7,5	1	X	2	0,0	0,1	0,0	0,2	0,0	
Scilla bifoglia L.	G	Nem_herb	3,75	4,5	5	7	6	0,0	0,0	0,1	0,0	0,2	
Agrimonia eupatoria L. subsp. *eupatoria*	H	TG	5,25	4,5	3	8	4	0,1	0,2	0,0	0,0	0,0	
Galanthus nivalis L.	G	QF	3,75	5,25	X	7	7	0,1	0,0	0,0	0,2	0,0	
Ajuga reptans L.	H	FB	4,5	X	5	X	6	0,2	0,1	0,0	0,0	0,0	
Eupatorium cannabium L.	H	NTR	5,25	5,25	5	5	7	0,0	0,0	0,1	0,2	0,0	
Mercurialis perennis L.	G	Nem_herb	1,5	3,75	X	7	7	0,0	0,0	0,2	0,1	0,0	
Helleborus foetidus L. subsp. *foetidus*	Ch	TG	3,75	4,5	3	8	3	0,1	0,0	0,2	0,0	0,0	
Allium carinatum L.	G	FB	6,75	5,25	2	6	3	0,0	0,0	0,1	0,1	0,0	
Malus sylvestris (L.) Mill.	P	QF	5,25	3,75	4	7	5	0,0	0,1	0,0	0,0	0,2	
Rumex obtusifolius L.	H	NTR	5,25	3,75	2	X	9	0,0	0,0	0,2	0,0	0,1	

	Life form	Syntaxonomical attribute	L	T	M	R	N	Gr.0	Gr.1	Gr.2	Gr.3	Gr.4	p-value
Geranium rotundifolium L.	T	NTR	5,25	6	2	6	3	0,0	0,0	0,0	0,1	0,2	
Daucus carota L.	H	NTR	6	4,5	3	5	4	0,0	0,1	0,1	0,0	0,0	
Crataegus laevigata (Poir.) DC.	P	RP	4,5	4,5	3,75	5	4	0,0	0,0	0,0	0,1	0,2	
Prunus laurocerasus L.	P	AL	6,75	5,25	4	5	5	0,0	0,0	0,1	0,1	0,0	
Vinca minor L.	Ch	FB	3	4,5	4	X	6	0,0	0,1	0,0	0,1	0,0	
Arundo donax L.	G	NTR	6	6,75	4	5	6	0,0	0,0	0,1	0,1	0,0	
Convolvulus sepium L.	H	NTR	6	4,5	5	7	9	0,0	0,0	0,1	0,1	0,0	
Melica uniflora Retz.	H	Nem_herb	2,25	3,75	3,75	6	X	0,1	0,1	0,0	0,0	0,0	
Helleborus viridis L. subsp. *viridis*	G	TG	2,25	4,5	4	8	5	0,0	0,1	0,1	0,0	0,0	
Euphorbia cyparissias L.	H	FB	5,25	5,25	2,25	5	5	0,1	0,2	0,0	0,0	0,0	
Lathyrus sylvestris L. subsp. *sylvestris*	H	TG	5,25	3,75	3	4	4	0,2	0,1	0,0	0,0	0,0	
Lathyrus vernus (L.) Bernh.	G	QF	3	3	3	7	X	0,0	0,1	0,1	0,0	0,0	
Asarum europaeum L.	H	Nem_herb	2,25	3,75	5	8	6	0,0	0,0	0,1	0,1	0,0	
Erythronium dens-canis L.	G	Nem_herb	3,75	3,75	2,25	6	8	0,0	0,0	0,1	0,0	0,1	
Loncomelos brevistylus (Wolfner) Dostál	G	FB	6,75	6	1,5	6	2	0,1	0,1	0,0	0,0	0,0	
Asplenium onopteris L.	H	Nem_herb	2,25	6,75	2	5	3	0,1	0,1	0,0	0,0	0,0	
Asplenium ceterach L.	H	Al	6,75	5,25	2	7	3	0,1	0,1	0,0	0,0	0,0	