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Research Article

A Study on the Ground Layer Species Composition in Rocky, Roadside and Forest Habitats in Trabzon Province

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Abstract: In this study, the ground layer species growing in altitudinal zones from sea level to high mountains were investigated according to their distribution, floristic composition and some habitat characteristics in the province of Trabzon in the north-eastern Black Sea region. Surveyed over four growing seasons (1994-1997), 285 taxa from 44 families were recorded in the Değirmendere and Solaklı Çayı river basins in Trabzon. The floristic composition based on species occurrence and cover, together with environmental data, was assessed in rocky, roadside and forest habitats along three altitudinal zones. As a result of the floristic analysis, 213 species in rocky, 141 species in roadsides and 94 species in forest sites were recorded from a total of 205 sampling plots. While similarities related to the species cover in floristic tables of plots were demonstrated by cluster analysis, the relations between plant species composition and some habitat features were discussed according to the ordination method.

Key Words: Ground layer species, Trabzon, floristic composition, habitat

Trabzon Yöresinin Kayalık, Yol Şevi ve Orman Yetişme Ortamlarına Ait Yer Örtücü Bitki Tür Kompozisyonları Üzerine Bir Araştırma

Özet: Bu araştırmada, Doğu Karadeniz Bölgesi'nde Trabzon ve yöresinin deniz seviyesinden yüksek dağlık kesimlere kadar değişen yükselti zonlarında yetişen yer örtücü bitkilerin dağılımları, floristik kompozisyonları ile bu bitkilere ait bazı yetişme ortamı özellikleri araştırılmıştır. Bu amaçla, 1994-1997 yılları arasında yapılan dört yıllık arazi çalışmalarında Trabzon'un Değirmendere ve Solaklı Çayı'nın bulunduğu iki önemli havzada, 44 familyaya ait toplam 285 bitki taksonu yöre florası içinden belirlenmiştir. Bitkilerin tür bazında bulunma ve örtme değerlerine bağlı oluşturdukları floristik kompozisyonlar bazı yetişme ortamı özellikleri ile birlikte kayalık, yol şevleri ve ormanaltı olmak üzere 3 farklı habitattan seçilerek değerlendirilmişlerdir. Buna göre; toplam 205 örnek alanda yapılan floristik analizler sonucunda, 213 adeti kayalık ortamlarda, 141 adeti yol şevlerinde ve 94 adeti ise orman altında kaydedilmiştir. Floristik kompozisyonlarda yer alan türlerin örtüş değerlerine bağlı benzerlikler küme analizi ile, bitkilerle bazı yetişme ortamı özellikleri arasındaki ilişkiler ise ordinasyon metoduna göre irdelenmiştir.

Anahtar Sözcükler: Yer örtücü bitki, Trabzon, floristik kompozisyon, yetişme ortamı

Introduction

Floristic structure or vegetation in natural habitats, which develops differently depending on the time and ecological conditions, has received increasing attention from botanists and plant ecologists. It is well known that physiographic, edaphic, climatic and biotic factors have been regarded as the most important elements contributing to the formation of the climax structure in any environmental scale or region (Akman & Ketenoğlu, 1987; Çepel, 1992). In this structure, ground layer species play an important role with respect to the cover of the soil surface.

The north-eastern Black Sea region, one of the most important regions of Turkey as regards biogeography, has approximately 2300 taxa and an endemism rate of 23% (Anşin, 1982). The morphological features of the region and the vegetation change over short distances. In particular, the colchic phytogeographic element plays a role in the ground layer of forests. Ground layer species forming the floristic diversity of this region display a continuous patchy mosaic structure along the rock characterised by granite and basalt (Acar et al., 2001). In addition, they undertake important functions with respect to vegetation dynamics and the constant greening of soil surfaces along roads connecting different settlements (Acar & Var, 2001).

Although the flora and vegetation of the north-eastern Black Sea region have frequently been studied (Anşin, 1979; Vural, 1996; Küçük, 1998), relatively few studies regarding the ecology of natural plant communities have been reported (Anşin, 1981; Küçük & Altun, 1998). These studies generally attempt to assess forest structures, and no studies have been conducted outside forested areas. Moreover, there are no quantitative studies identifying the major environmental factors correlated with the compositional gradient of the vegetation in Trabzon and its environs.

This paper, therefore, describes the distribution and composition of the ground layer species, as well as the habitat characteristics of rocks, roadsides and forests. A knowledge of both floristic and ecological data is important because it can be used for future biological surveys of floristic diversity.

Material and Methods

Study Area: The study area consists of two main river basins (Değirmendere and Solaklı Çayı) and their surroundings in Trabzon province lat 40°33'-41°07'N and long 39°14'-39°45'E in the north-eastern Black Sea Region of Turkey (Figure 1). The Değirmendere river basin is bordered by the Black Sea to the north and by Gümüşhane province to the south, stretching from Deveboynu Tepesi towards Zigana Dağı, both of which are part of the Kalkanlı Mountains. The Solaklı Çayı basin extends from sea level to the Soğanlı and Anzer Mountains, encircled by Bayburt to the south, Erzurum to the southwest, Rize to the east, and the Black Sea to the north. The ecological characteristics of these research areas have been described in detail by Acar and Var (2000).

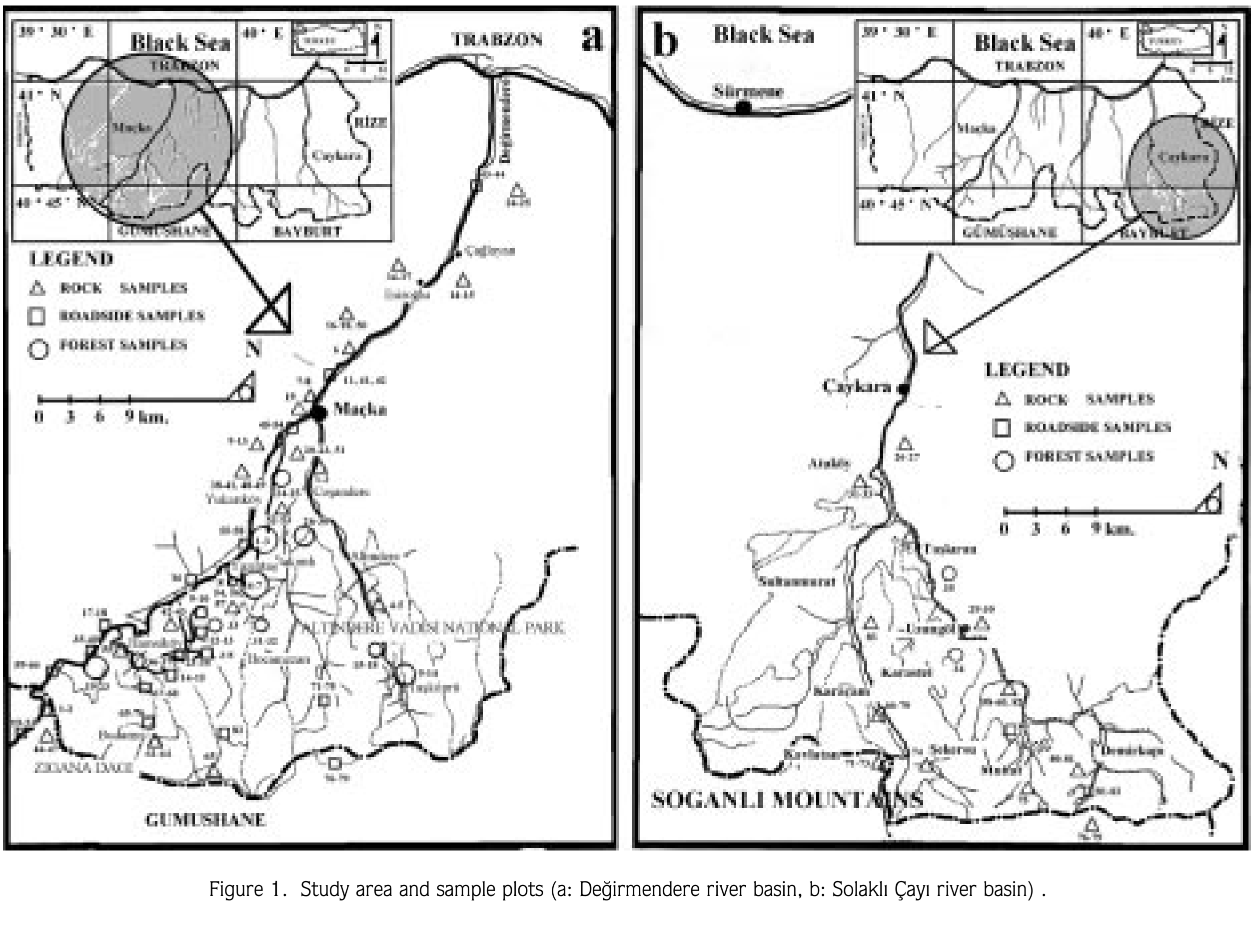

Figure 1. Study area and sample plots (a: Değirmendere river basin, b: Solaklı Çayı river basin) .

The morphology is roughly mountainous, ranging from 0 to 3500 m in height. Volcanic and plutonic rocks dominate the region's geological structures. The main soil type is podzolic, in which pH values are low due to extensive washing and extreme climatic conditions (Topraksu Kartoğrafya Md., 1981). The climate of the area is similar to the Black Sea climate type of the region (Erinç, 1969; Akkaş, 1990), the winter is mild and rainy and the summer is moderately hot. Climatic data representing the study area were provided by four meteorological stations (Trabzon, Maçka, Meryemana and Of). Data provided by the Trabzon Meteorological Station shows that the mean annual air temperature is 14.5 ºC, with January mean minima ranging from 0 to 3 ºC and August mean maxima ranging from 18 to 26 ºC. Total annual precipitation averages about 833.8 mm, occurring from October through April (DMGM, 1997). According to climate diagrams drawn based on Walter's (1970) method using meteorological data, the Değirmendere basin has a short period of water deficit in summers, although this deficit was not observed in the Solaklı basin (Figure 2). In the study area, three major vegetation types dominate: pseudomacchie, forest and alpine (Davis, 1965-1985; Anşin, 1979; Küçük, 1998).

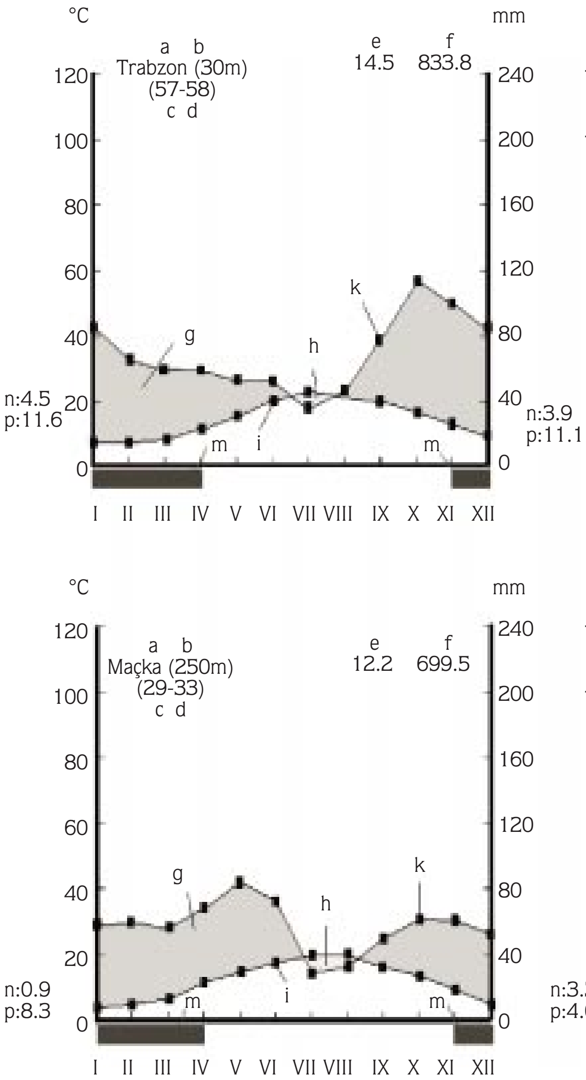

Figure 2. Climate diagrams from the meteorological stations in the study area (a. Name of meteorological station, b. Altitude of meteorological station, c. Duration of temperature measurement, d. Duration of rain measurement, e. Annual average of temperature, f. Annual rain average, g. Rainy period, h. Arid period, i. Temperature curve, k. Rain curve, l. Freezing months, m. Probable freezing months, n. The minimum average temperature of the coldest month, p. Absolute minimum temperature).

Sampling Procedure: Floristic and environmental data were collected from June to September in 1994-1997 during several visits to rocky, roadside and forest habitats of Trabzon province. These habitats were sampled at three altitudinal zones (0-400 m, 400-1800 m and over 1800 m). Each sample plot was defined by carefully selecting a representative area of a vegetation type (Akman & Ketenoğlu, 1987). Considerably degraded sections, especially along roadsides, were avoided. A total of 205 sample plots (85 plots for rocky, 83 plots for roadside and 37 plots for forest sites) were designed. Floristic data based on species occurrence (presence/absence) and percentage cover (%) were recorded in mainly small quadrates (25 m^2). The cover of each species was visually estimated. All species were identified in the laboratory, using KATO (Herbarium of the Forestry Faculty, Karadeniz Technical University) specimens and some botanical sources (i.e., Boissier, 1975). Taxa names given in this study conform to those of Davis (1965-1985).

The plant species composition includes the growth form type, the percentage frequency of occurrence (%) and the mean cover value of each species recorded in three altitudinal zones. The plant species were arranged according to the sequence given in The Flora of Turkey (Davis, 1965-1985) and their growth form type was determined according to various botanical studies (Lawrence, 1951; Davis, 1965-1985; Ramsay & Oxley, 1997; Acar & Var, 2000). The mean cover values of each species (C) appearing in each sample plot were calculated from

$$C = (\Sigma \% c / N) \times 100 \quad (1)$$

Where % c represents the mean cover percentages for each species and N the total number of sample plots for each altitudinal zone.

In addition to floristic data, topographic (altitude, exposure, slope) features were recorded and soil samples were taken from soil profiles, 0-50 cm for each sampled plot. The soil samples were packed in plastic bags and analysed to describe their physical and chemical properties in the Soil and Ecology Laboratory, Forestry Faculty, Karadeniz Technical University. The following variables were measured for the fine fraction (< 2 mm): texture (% sand, % clay and % silt) using the hydrometer method (Bouyoucos, 1951); skeleton (> 2 mm) content by sieving; organic matter suggested by Gülçür (1974) (weight loss on ignition at 500 ºC for 2 h); moisture content (after drying at 105 ºC for 48 h); pH [H_2O] (1:1 by vol. dilution with distilled water using a digital pH-meter). The interpretation of these variables was carried out according to Akalan (1988) and Çepel (1992).

Data and Statistical Analysis: In order to analyse variation in the floristic composition of the ground layer species and to obtain their environmental relations, various multivariate analysis techniques were employed. Before performing these techniques, the data matrix for each habitat regarding the floristic and environmental variables was structured. As the rows consisted of different taxa for species classification and environmental parameters for ordination analysis, the columns included the sample plots for both approaches.

As a classification technique, the unweighted pair group arithmetic averaging strategy (UPGMA) was performed on three data sets (108 species x 85 plots for rocky, 74 species x 83 plots for roadside and 65 species x 37 plots for forest habitats), considering dominant species occurring in more than 10% of individuals in the habitats in any altitudinal zone. Since UPGMA is termed hierarchical polythetic agglomerative clustering (Lunt, 1997; Neave & Norton, 1998), with a measure of the Bray-Curtis (Czekanowski) dissimilarity co-efficient (Ludwig & Reynolds, 1988), it was applied to establish species assemblage groups for each habitat in this study.

Using the DECORANA programme, detrended correspondence analysis (DCA), an ordination technique, was performed to explore the relationship between the species composition of each habitat and the environmental variables (Hill, 1979; Hill & Gauch, 1980). In this indirect gradient analysis, species cover data were ordinated on two axes, and the data set of the environmental variables (i.e., soil depth, sand, silt, clay, skeleton, pH, organic matter, moisture content, coverage, slope, exposure, altitude) was evaluated. In this process, the cover data were transformed using a five-point scale: 1 = 1-10%, 2 = 11-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-100%.

In order to determine the variation of the environmental data with respect to habitat type, a one-way analysis of variance (ANOVA) on the non-transformed data was performed. When significant variance occurred between habitat types, Duncan's multiple test was implemented to determine whether the difference between any homogeneous habitats was significant, exploring significance levels at $p < 0.001$, 0.01 and 0.05. These statistics were carried out using SPSS 7.5 for Windows.

Results

Distribution, Floristic Composition and Classification of the Species

A total of 285 plant taxa belonging to 44 families and 142 genera were identified during this study (Appendix). The best represented families were *Leguminosae* with 37 species, *Labiatae* with 24 species, *Rosaceae* with 23 species, *Compositae* with 22 species and *Cruciferae* with 17 species (Figure 3). Through the surveys based on species life span, nine woody species (3%), 254 perennial species (89%), two biennial species (1%) and 20 annual species (7%) were identified.

In general, three habitat types were identified; rocky, roadside and forest understory habitats. The species distribution of these habitats with respect to various altitudinal zones is indicated in the Appendix. This distribution of species including rare species is as follows: 213 species in rocky, 141 species in roadside and 94 species in forest habitats. Fifty-nine species at 0-400 m, 128 species at 400-1800 m and 113 species over 1800 m were recorded in a total of 85 sample plots taken from rocky habitats, while in roadside habitats with 83 sample plots, these zones had 39, 89 and 80 species, respectively. The forest habitats of the study area were sampled both with 10 plots at 400-1000 m dominated by hardwood and softwood trees where 45 species were recorded, and 27 plots at 1000-1800 m dominated by conifer trees where 85 species were recognised.

The ground layer species recorded in the study area were examined according to their growth forms, height and coverage percentages. Figure 4 demonstrates that there exists a significant variability among the distribution

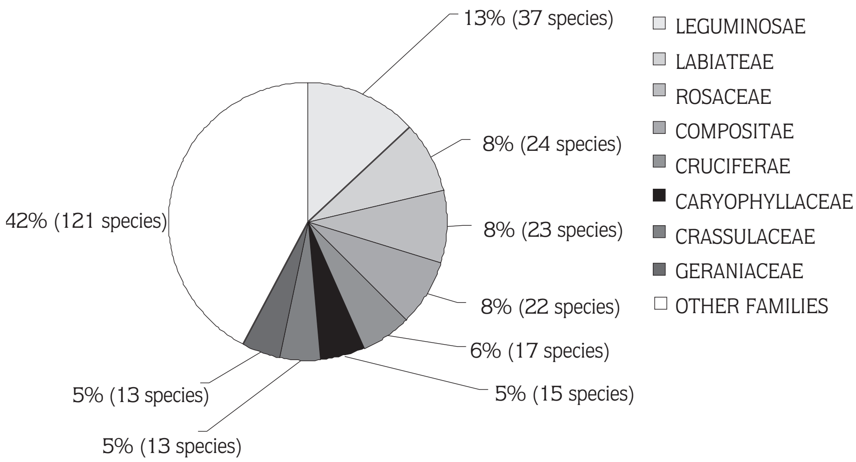

Figure 3. Distribution of the species by families.

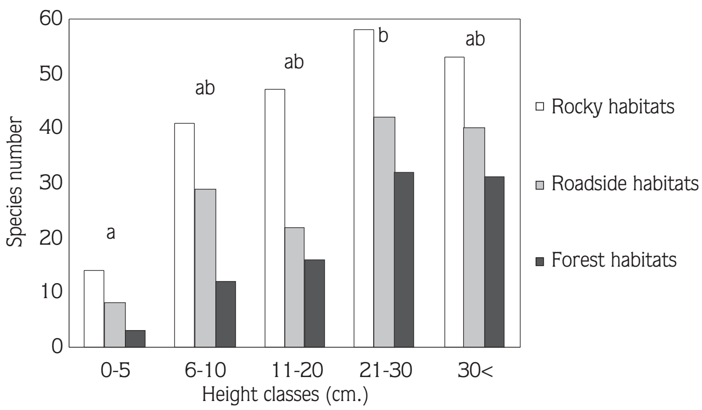

Figure 4. The distribution of ground layer species in the rocky, roadside and forest habitats by height classes. Each class was significantly different at $p < 0.001$. Data include the 285 species for 205 sample plots. Bold letters (a, ab, b) show different groups according to Duncan's multiple test.

in five height classes at $p < 0.001$. For each habitat type, the 21-30 cm height class has more species than the other classes. In addition, the sample plots in three habitats were dominated by procumbent-prostrate, spreading, creepers and clumps (Table 1). Considering all 11 growth forms, a number of species with an over - 75% covering rate were less abundant. However, those of 0-25% covering were generally recorded. Spreading species occurred in most of the samples of rocky and forest quadrates, whereas procumbent-prostrate species were mostly recorded at roadsides, but usually with low cover.

In the study, the floristic compositions were determined in a total of 205 sample plots in each altitudinal zone. As shown in the appendix, the distributions of the species varied among the zones as well as different habitats. *Sedum pallidum* M.Bieb. var. *bithynicum* (Boiss.) D.F.Chamb. (70%), *Veronica persica* Poir. (65%) and *Galium sylvaticum* L. (55%) in Zone I, *Veronica persica* (42%), *Sedum spurium* M.Bieb. (40%) and *Sedum pallidum* subsp. *bithynicum* (37%) in Zone II, and *Minuartia circassica* (Albov) Woron. (50%), *Myosotis alpestris* F.W.Schmidt (50%) and *Campanula tridentata* Schreb. (45%) were recorded along 85 rocky sample plots. According to floristic data from 83 sample plots in roadsides, the most dominant species were observed on the cutting, filling and upper slopes. These included *Galium sylvaticum* (73%), *Trifolium campestre* Schreb. (64%) and *Coronilla orientalis* Mill. var. *orientalis* (55%) in Zone I, *Trifolium pratense* L. var. *pratense* (55%), *Galium sylvaticum* (51%), *Stachys annua* (L.) L. subsp. *annua* var. *annua* (39%) in Zone II and *Thymus praecox* Opiz subsp. *caucasicus* (Ronniger) Jalas var. *grosshemii* (Ronniger) Jalas (57%), *Lotus corniculatus* L. var. *alpinus* Ser. (45%) and *Trifolium ochroleucum* Huds. (45%) in Zone III.

The study area, generally, has different forest zones dominated by hardwood trees at low altitudes, hardwood and softwood trees, and pure softwood trees at higher altitudes up to alpine zones. The Oriental spruce (*Picea orientalis* L.), widespread in the Black Sea region of Turkey, occurs mainly as groups or stands above 400 m. For this reason, the sample plots to determine the ground layer species found together with forest trees were selected in these Oriental spruce forests as well as in the mixed forest stands of *Fagus orientalis* Lipsky and *Picea orientalis*, and *Pinus sylvestris* L. in Zigana Dağı. Therefore, the determined species in the forest habitats included *Epimedium pubigerum* (DC.) Mor. & Decne. (80%), *Lathyrus vernus* (L.) Bernh. (70%) and

Table 1. The growth form distribution of species by cover percentages in three habitats. Numbers indicate the number of species (R: Rocky habitats, Ro: Roadside habitats, F: Forest habitats).

GROWTH FORM TYPES	COVER PERCENTAGE														
	0-5			5-25			26-49			50-74			75-100		
	R	Ro	F	R	Ro	F	R	Ro	F	R	Ro	F	R	Ro	F
Erect	14	9	6	1	-	-	1	-	-	-	-	-	-	-	-
Ascending-decumbent	10	10	4	2	1	1	-	-	-	-	-	-	-	-	-
Procumbent-prostrate	35	33	12	5	4	5	-	1	-	-	-	-	-	1	-
Creeper	33	20	13	1	4	1	-	-	1	1	-	-	1	-	3
Spreading	41	22	17	4	5	4	-	-	-	-	1	-	-	-	-
Dwarf-mount-compact	7	5	-	2	-	1	-	-	1	-	-	-	-	-	-
Clump	24	11	9	1	-	4	-	-	-	-	-	-	-	-	1
Cushion	1	1	-	1	-		-	-	-	-	-	-	-	-	-
Rosette	16	6	2	1	-	3	-	-	1	-	-	-	-	-	-
Mosaic-moss	6	3	1	1	-		-	-	-	-	-	-	-	-	-
Trailing	4	4	2	-	-	2	-	-	-	-	-	-	-	-	-
TOTAL	191	124	66	19	14	21	1	1	3	1	1	0	1	1	4

Helloborus orientalis Lam. (60%) in Zone I and *Oxalis acetosella* L. (81%), *Galium rotundifolium* L. (78%) and *Sedum stoloniferum* C.C.Gmel. (59%) in zone II.

The studied species exhibited occurrence differences among the sample plots. To make statistical significance possible for clustering, the species in the three habitat types were separated into different groups. Figures 5, 6 and 7 show the dendrograms from flexible UPGMA clustering analysis based on the dissimilarity levels for each habitat.

In rocky habitats, the species were divided into eight species groups (Groups 1-8) of which the most distinctive, higher level species groups were recognised at three and four group levels (cophenetic correlation = 0.76) (Figure 5). Given all 92 species in these habitats, the species occurring in Group 1 were characterised by the highest relative cover values, consisting of *Sedum spurium*, *Veronica persica, Galium sylvaticum, Sedum pallidum* subsp. *bithynicum*, *Teucrium polium* L., *Cruciata taurica* (Pallas ex Willd.) Ehrend. and *Anthemis tinctoria* L. var. *pallida* with a wide altitudinal range. Groups 2 and 3 represent species found in an area exposed to damp and shade in relation to the forest edges, and Group 4 is characterised by the species occurring in sun-exposed rock sites. In addition, the other groups contain the species which are typical of the subalpine and alpine sites encountered in the survey. These are found in soils of pH < 6 with moderately high fertility.

In the species classification for roadside habitats, six groups were defined at the 92% dissimilarity level. From species assemblages resulting from the dendrogram (Figure 6), *Trifolium pratense* subsp. *pratense* is the most dominant and highest covering taxon of the given 72 species. While Groups 1-4 were associated with the less fertile and moderately disturbed sites at the lower altitudes in the whole survey, Groups 5 and 6 reflected the ecological characteristics of the roadsides in the high mountain areas with less disturbed areas.

As for the forest habitats, the classification based on the basic floristic of selected 36 species provided five major groups at a 86% dissimilarity level (Figure 7). The dendrogram, which could be explained with two and three group levels, showed that Group 1 (including *Oxalis acetosella* and *Galium rotundifolium*) and Group 2 (*Sedum stoloniferum* and *Galium odoratum* (L.) Scop.), particulary recorded in the *Picea orientalis* forest stands, had the highest cover values in all five groups and are also consistent with high frequencies. Group 5 was composed of species from less fertile soil at the lower stands, while *Alchemilla barbatiflora* Juz. in Group 4 occurred in the different ecological sites dominated by *Picea orientalis,* and *Alchemilla sintenisii* Rothm. in Group 3 was characterised as understory taxon in the spatial structure of the *Pinus sylvestris* stands.

The Habitat Characteristics of Species Compositions and Ordination

The habitat features in rocky, roadside and forest sample plots were analysed using ANOVA and Duncan's multiple test. Table 2 indicates the results of some properties in the sample plots of three habitats. Of the 11 properties, clay (%) showed no significant differences at $p < 0.001$ and $p < 0.05$, but the others had significant differences between different habitat types. Generally, the soil texture in these habitats was essentially sandy loam. In other words, sand (%) in the soil was measured at 84.09% for rocky, 77.24% for roadside and 81.83% for forest sites, while clay (%) in soils was 2.37%, 3.28% and 2.90%, respectively. In terms of pH values, the forest habitats were lower by 5.32, but roadside habitats were higher than the others. The organic matter (%) results showed that forest habitats (7.34%) were the richest in humus. By contrast, the others had soils with moderate humus content. According to the moisture content in soils, roadsides were classified as arid, rocky areas as semi-arid and forest habitats as humid.

The DCA ordination based on 205 sample plots provided the relationships of the floristic composition in the studied habitats with the measured environmental variables. According to Figure 8, the first axis was positively associated with that exposure, sand, altitude, organic matter, soil depth and moisture content, which explained 48% of the total variation. However, the second axis explained 25% of the variation, and was correlated with silt, skeleton and pH, but was not related to coverage, slope and clay. This confirmed that the major trend in ground layer vegetation species composition generally corresponded to the soil moisture regime.

The other DCA ordination of all 205 samples from three habitats based on cover data is also shown in Figure 9. Axes I and II explain 26.5 and 16.3% of the total variance, respectively. The ordination diagram (eigenvalues: Axis 1 = 0.777; Axis 2 = 0.704; Axis 3 =

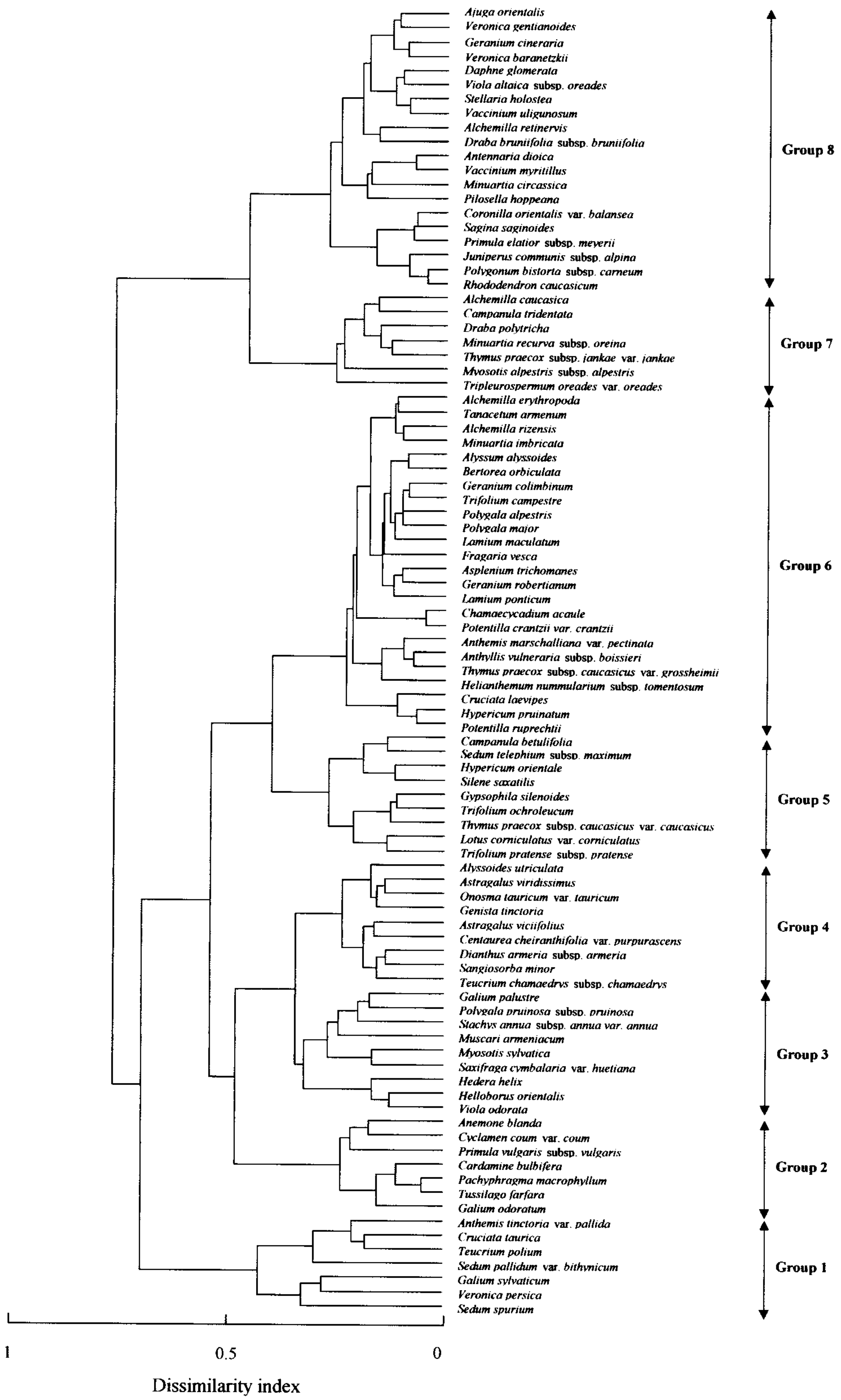

Figure 5. Dendrogram showing the UPGMA classification of ground layer species in rocky habitats.

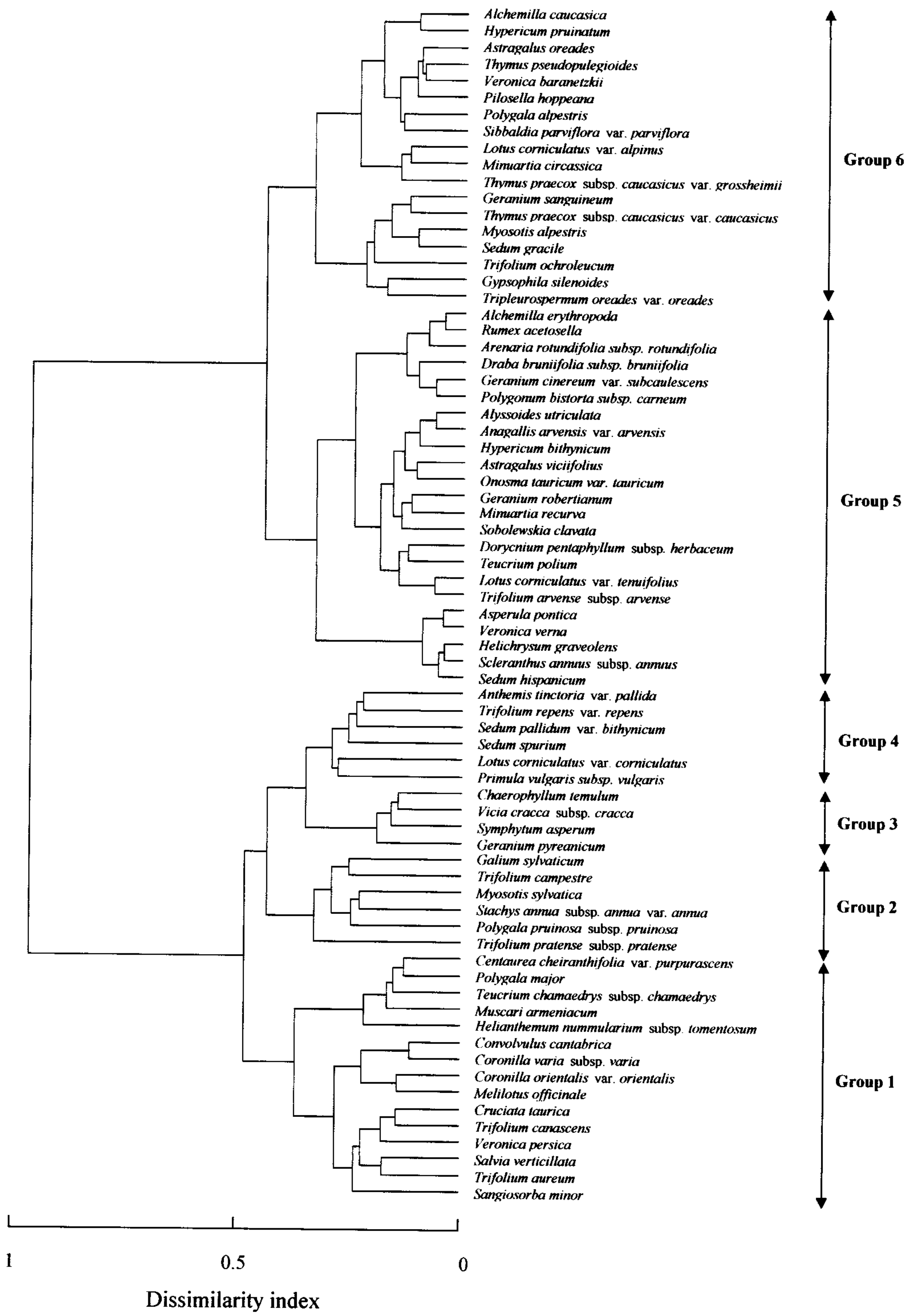

Figure 6. Dendrogram showing the UPGMA classification of ground layer species in roadside habitats.

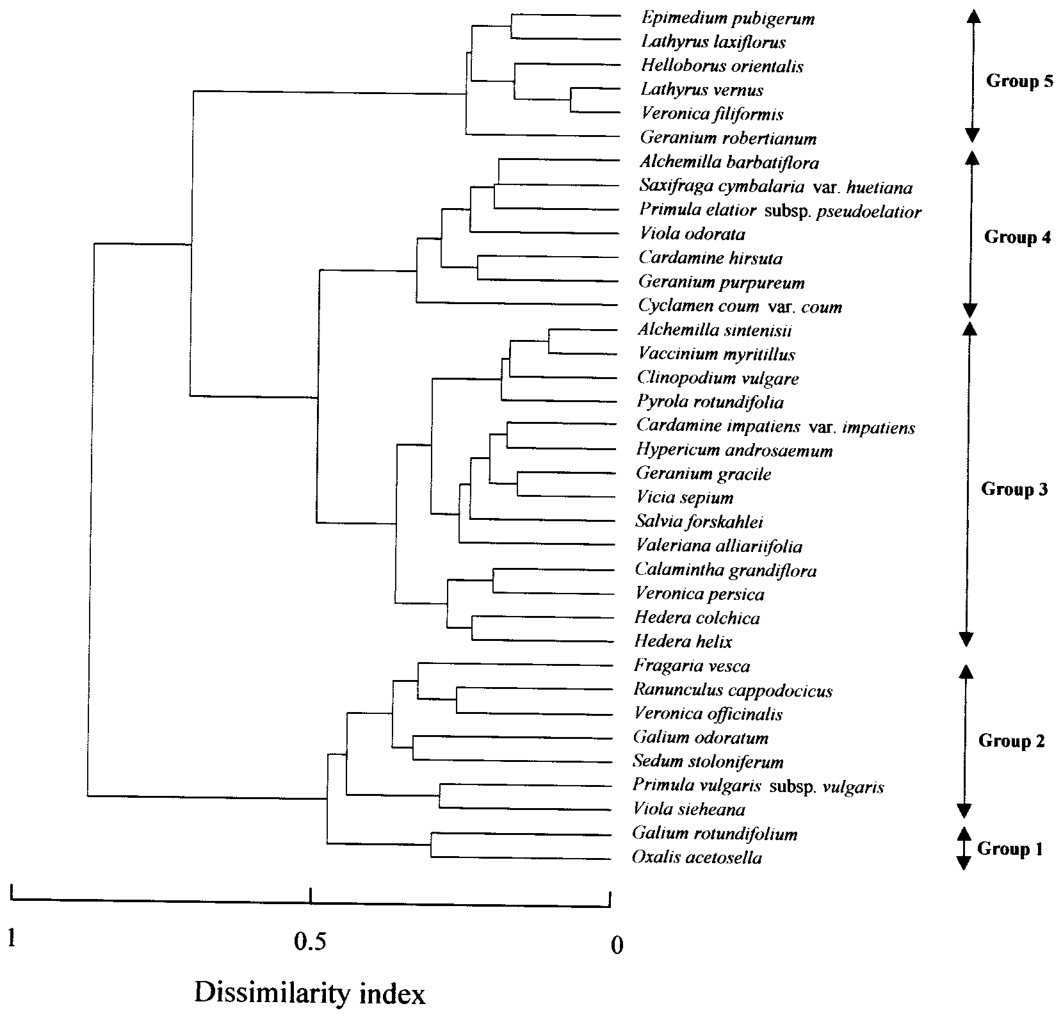

Figure 7. Dendrogram showing the UPGMA classification of ground layer species in forest habitats.

0.550; Axis 4 = 0.501) revealed that rocky sample plots had relatively high scores on Axis 1 and a greater spread on Axis 2 compared with other samples. The forest sample plots had generally lower scores on Axis 1, but there was little differentiation on Axis 2. According to Figure 9, roadside plots were positively correlated with Axis 2 as well slightly with Axis 1. Nevertheless, some plots were recorded next to the rocky plots which were dispersed in the ordination plot because of the fact that each of them contains similar species. As shown in the same figure, the ordination diagram shows a gradient along Axis 1, which could be related to soil depth, high on the left to low on the right. Similarly, the gradient on Axis 2 could be related to moisture content and organic matter, with low at the top and higher to the bottom, as with pH values, with high at the top and lower to the bottom.

Discussion and Conclusion

This study deals with determining the ground layer species in the natural flora of Trabzon province by means of conducting a general floristic survey and investigating the composition of species in selected habitats. For this purpose, a total of 205 relevés were sampled in rocky, roadside and forest sites. The number of the species recorded in three habitats was 285, and this constituted nearly 12% of the total number of species in the north-eastern Black Sea region.

Table 2. One-way analysis of variance (ANOVA) and Duncan's multiple test results of some environmental properties in three habitat types.

Properties	Habitat type	Sample numbers	Mean	Standard deviation	F rate	Significance	Duncan's test
	Rocky (1)	83	84.09	1.03	8.276	0.0002	(1-2)*(1-2)**,
Sand (%)	Roadside (2)	83	77.24	1.24			(2-3)**
	Forest (3)	37	81.83	1.98			
	Rocky (1)	83	2.37	0.33	1.598	0.2048	N.S.
Clay (%)	Roadside (2)	83	3.28	0.41			
	Forest (3)	37	2.90	0.41			
	Rocky (1)	83	13.50	0.94	7.249	0.0009	(1-2)*
Silt (%)	Roadside (2)	83	19.49	1.24			(1-2)**, (2-3)**
	Forest (3)	37	81.83	1.98			
	Rocky (1)	83	41.48	1.46	30.864	0.0000	(1-2)*, (1-3)**
Skeleton (%)	Roadside (2)	83	55.93	1.32			(1-2)**, (1-3)**
	Forest (3)	37	53.89	1.78			
	Rocky (1)	83	6.32	0.13	29.049	0.0000	(1-2)**, (1-3)**,
pH	Roadside (2)	83	6.95	0.11			(2-3)**
	Forest (3)	37	5.32	0.15			
	Rocky (1)	83	4.60	0.28	48.588	0.0000	(1-2)*, (1-3)*,
Organic matter (%)	Roadside (2)	83	3.21	0.22			(2-3)*, (1-2)**,
	Forest (3)	37	7.34	0.19			(1-3)**, (2-3)**
	Rocky (1)	83	16.92	1.22	24.839	0.0000	(1-3)*, (2-3)*,
Moisture content (%)	Roadside (2)	83	14.80	1.44			(1-3)**, (2-3)**
	Forest (3)	37	81.83	1.98			
	Rocky (1)	83	12.05	0.75	21.476	0.0000	(1-3)*, (2-3)*,
Soil depth (cm)	Roadside (2)	83	13.66	1.18			(1-3)**, (2-3)**
	Forest (3)	37	23.95	1.86			
	Rocky (1)	83	12.73	0.48	11.004	0.0000	(1-2)*, (2-3)*,
Species number	Roadside (2)	83	10.49	0.42			(1-2)**, (2-3)**
	Forest (3)	37	81.83	1.98			
	Rocky (1)	83	73.07	1.99	2.533	0.0819	(1-3)**
Coverage (%)	Roadside (2)	83	69.34	1.68			
	Forest (3)	37	64.87	4.31			
	Rocky (1)	83	4.00	0.00	186.486	0.0000	(1-2)*, (1-3)*,
Slope	Roadside (2)	83	2.52	0.08			(2-3)*, (1-2)**,
	Forest (3)	37	2.84	0.06			(1-3)**, (2-3)**

* $p < 0.01$, ** $p < 0.05$, N.S.: not significant at $p < 0.01$ and $p < 0.05$

The findings of this study demonstrated that the habitat features and floristic composition based on altitude and vegetation structure possessed variability, affecting covering and the number of species in particular. These results were consistent with the studies by Anşin (1979) and Çepel (1992), who focused on the fact that the habitat variables, altitude and precipitation played a role in the different vegetation formations.

Plant species assemblages are often characterised by their dominant or canopy species. The patterns in the distribution of these assemblages were also used to make spatial predictions of their occurrences across any region (Neave & Norton, 1998). The ordination of the species assemblages from three habitats in this survey is clearly related to a number of environmental factors (Figure 8). The distribution of the species groups obtained by cluster

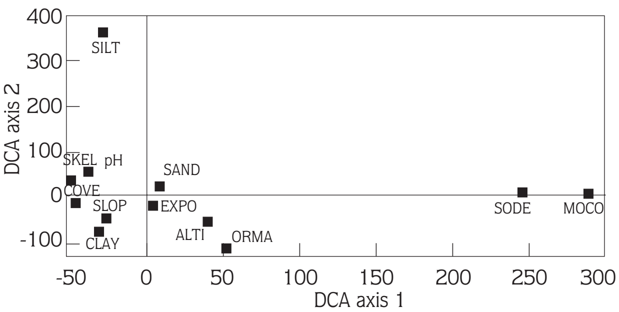

Figure 8. Ordination of correlation between axes scores and habitat variables based on 205 sample plots. (SODE: soil depth, SAND: sand, SILT: silt, CLAY: clay, SKEL: skeleton, pH: pH, ORMA: organic mater, MOCO: moisture content, COVE: coverage, SLOP: slope, EXPO: exposure and ALTI: altitude).

analysis reflects these relations. These findings correspond with the results of several authors. Ullmann et al. (1995 and 1998) suggested that the distribution of roadside species of European origin may be related to their biogeographic affinities and environmental tolerances. Although this distribution is strongly related to environment, and the adjacent land-use also has a profound effect, it was not examined as a variable in this study. However, this is confirmed by the field observations of senior authors for these research habitats. In addition, several researchers have used various environmental attributes to characterise the distribution of species, species assemblages and the habitat of species. For example, Ellenberg (1991) assigned indicator values for various environmental factors such as temperature, continentality, soil moisture, soil reaction and soil nitrogen supply to species of central European flora. Considering these factors, soil moisture (+0.44) was positively correlated ($p < 0.01$) with the positions of the species on the axes of the species ordination. In this study, soil moisture content was associated with species distribution (Figure 8).

Plant distribution is well known to be related to environmental and edaphic factors. In addition, soil characteristics such as moisture and pH have been strongly correlated with vegetation. In the current study, the distribution of plant species in the study area was varied by an altitudinal factor, and the influence of some environmental characteristics on this distribution along rocky, roadside and forest habitats became stronger, and species assemblages for each habitat were separated into groups according to dominant species composition. Thus, the rocky species were classified into eight groups, and the roadside species and forest species were divided into six and five groups, respectively. In the classification process, the UPGMA algorithm used in this study has been frequently recommended (Sokal & Sneath, 1963; Sneath & Sokal, 1973; ter Braak, 1987), and the use of this method is almost a convention in agglomerative clustering analysis (van Tongeren, 1987).

The forest species findings were compatible with earlier studies (Anşin, 1979; Küçük, 1998) in spite of the fact that the results of rocky and roadside habitats could not be discussed because of the lack of any studies relating to species distribution patterns in these habitats. In a study conducted by Anşin (1979), who investigated a part of the Değirmendere river basin (Meryemana), it was in the pure Oriental spruce stands with different growing sites that *Oxalis acetosella, Galium odoratum, G. rotundifolium, Cardamine impatiens* L., *Cyclamen coum* Mill., *Sanicula europaea* L., *Fragaria vesca* L., *Veronica officinalis* L., *Geranium robertianum* L. and *Geranium gracile* Ledep. ex Nordm. etc. had rich floristic compositions. Some species in these compositions were regarded to as allowing a decision to be made concerning their ecological characteristics. Similarly, Küçük (1998) defined *Picea orientalis* and *Pinus sylvestris-Vaccinium myritillus* associations on the backward ranges of part of the north-eastern Black Sea region, the Kürtün-Örümcek forests, and described the distinctive species of the association such as *Veronica officinalis, Oxalis acetosella* and *Cyclamen coum*. Quezél et al. (1980) and Akman (1995) also stated that some plant associations belonging to vegetation types of the region had some distinctive and similar species in the UPGMA groups in this study. They included, for instance, *Pinus sylvestris-Epimedium pinnatum* subsp. *colchicum* and *Picea orientalis-Sedum stoloniferum* in forest vegetation and *Sibbaldia parviflora-Agrostis lazica, Polygonum bistorta* subsp. *carneum-Stachys macrantha, Centaurea appendicigera-Senecio taraxifolia* and *Rhododendron caucasicum-Vaccinium myritillus* in subalpine and alpine vegetation.

Recently, the structure and compositions of local plant assemblages apart from the main vegetation types have received greater attention. One of the most remarkable reasons for this is the anthropological influence on natural flora, especially settlements or man-made inclusions, from urban to rural. In addition, proper numerical procedures for identifying the floristic composition in any ecological scale, as well as traditional methods, have been developed (Gauch, 1982; Legendre & Legendre, 1983; Düzenli, 1990; Pitkänen, 1997 and 1998; Kehl, 1998; Sweeney & Cook, 2001). The cluster analysis and ordination methods used in this study are very helpful in describing the floristic analysis statistically, as it would be assessed in various disciplines such as plant ecology, landscape ecology and forest management. Therefore, the results in this study were given based on the numerical evaluation as well as traditional ones. Several researchers considered the relationships between species distribution patterns and ecological preferences and suggested that species distributional limits in the floristic survey might strongly be expected to clarify the indicators of the biodiversity. Consequently, it may be proposed from this study that the floristic diversity of the selected habitats should be examined in the future to see at what level their environmental tolerance ranges will be.

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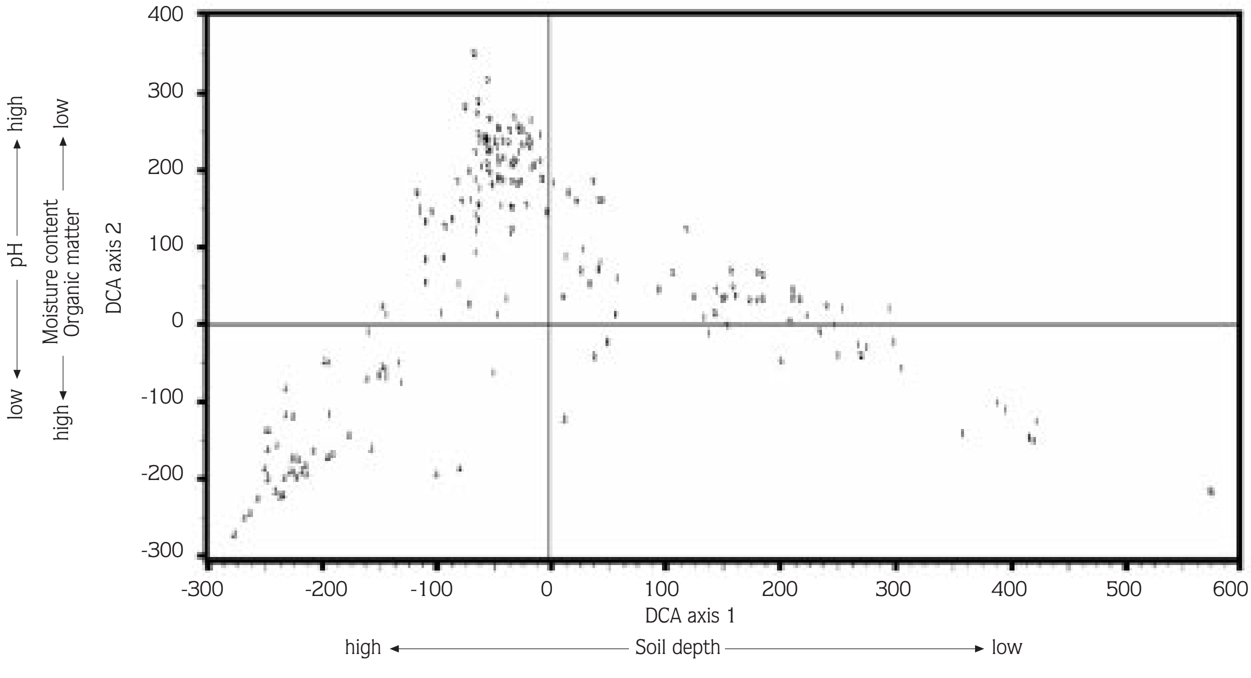

Figure 9. Ordination of 205 quadrate samples in rocky (1), roadside (2) and forest habitats (3) based on percentage cover data.

Appendix. The floristic composition of ground layer species in rocky, roadside and forest habitats.

(n= Number of sample plots, %: Percent frequency of occurrence, C: Mean coverage value)

PLANT SPECIES	ROCKY (R)*			ROADSIDE (Ro)*			FOREST (F)*	
	0-400 m (I) (n=20)	400-1800 m (II) (n=43)	1800 m < (III) (n=22)	0-400 m (I) (n=11)	400-1800 m (II) (n=49)	1800 m < (III) (n=23)	400-1000 m (I) (n=10)	1000-1800 m (II) (n=27)
	% (C)	% (C)	% (C)	% (C)	% (C)	% (C)	% (C)	% (C)
ASPLENIACEAE								
Asplenium trichomanes	15 (< 1)	-	-	-	-	-	-	-
CUPRESSACEAE								
Juniperus communis subsp. *alpina*	-	-	14 (45)	-	-	-	-	-
RANUNCULACEAE								
Anemone blanda	-	12 (105)	-	-	-	-	-	-
Helloborus orientalis	15 (188)	16 (175)	-	-	-	-	60 (603)	-
Ranunculus cappadocicus	-	-	-	-	-	-	30 (475)	33 (86)
R. caucasicus	-	-	-	-	-	-	10 (1)	-
BERBERIDACEAE								
Epimedium pubigerum	-	-	-	-	-	-	80 (4250)	7 (83)
CRUCIFERAE								
Alyssoides utriculata	20 (50)	14 (53)	-	-	2 (10)	-	-	-
Alyssum alyssoides	-	12 (41)	-	-	-	-	-	-
Berteroa orbiculata	10 (87)	-	-	-	-	-	-	-
Cardamine bulbifera	-	12 (116)	-	-	-	-	-	-
C. hirsuta	-	-	-	-	-	-	-	30 (185)
C. impatiens var. *impatiens*	-	-	-	-	-	-	10 (50)	11 (102)
Draba bruniifolia subsp. *bruniifolia*	-	-	27 (104)	-	-	13 (23)	-	-
D. polytricha	-	-	45 (106)	-	-	-	-	-
Malcolmia africana	10 (< 1)	-	-	-	-	-	-	-
Pachyphragma macrophyllum	-	16 (210)	-	-	-	-	-	-
Sobolewskia clavata	-	-	-	-	10 (296)	-	-	-
CISTACEAE								
Helianthemum nummularium subsp. *tomentosum*	-	-	14 (68)	18 (160)	20 (58)	22 (99)	-	-
VIOLACEAE								
Viola altaica subsp. *oreades*	-	-	18 (148)	-	-	-	-	-
V. odorata	25 (26)	19 (19)	-	-	-	-	40 (2)	19 (56)
V. reichenbachiana	-	-	-	-	-	-	10 (50)	48 (87)

V. sieheana	-	-	-	-	-	-	10 (50)	48 (87)
POLYGALACEAE								
Polygala alpestris	-	-	14 (1)	-	-	17 (23)	-	-
P. major	-	-	-	18 (2)	14 (21)	-	-	-
P. pruinosa subsp. *pruinosa*	35 (26)	16 (36)	-	45 (5)	39 (73)	-	20 (100)	-
P. vulgaris	15 (25)	-	-	-	-	-	20 (100)	-
CARYOPHYLLACEAE								
Arenaria rotundifolia subsp. *rotundifolia*	-	-	-	-	-	13 (1)	-	-
Dianthus armeria subsp. *armeria*	-	16 (13)	-	-	-	-	-	-
Gypsophila silenoides	-	14 (233)	-	-	-	26 (534)	-	-
Minuartia circassica	-	-	50 (252)	-	-	30 (44)	-	-
M. imbricata	-	-	18 (46)	-	-	-	-	-
M. recurva subsp. *oreina*	-	-	32 (263)	-	-	13 (240)	-	-
Pethorhagia saxifraga	-	-	-	-	-	-	-	-
Sagina saginoides	-	-	23 (126)	-	-	-	-	-
S. saxatilis	-	14 (64)	-	-	-	-	-	-
Stellaria holostea	-	-	18 (2)	-	-	-	-	-
ILLECEBRACEAE								
Scleranthus annuus subsp. *annuus*	-	-	-	-	-	22 (99)	-	-
POLYGONACEAE								
Polygonum bistorta subsp. *carneum*	-	-	14 (68)	-	-	13 (23)	-	-
Rumex acetosella	-	-	-	-	-	13 (23)	-	-
GUTTIFERAE								
Hypericum androsaemum	-	-	-	-	-	-	-	15 (66)
H. bitynicum	-	-	-	-	-	13 (1)	-	-
H. calycinum	-	-	-	-	-	-	-	-
H. orientale	-	19 (76)	-	-	-	-	-	-
H. pruinatum	-	-	14 (307)	-	-	34.78 (902)	-	-
GERANIACEAE								
Geranium cineraria	-	-	18 (69)	-	-	-	-	-
G. cinerum var. *subcaulescens*	-	-	-	-	-	13 (77)	-	-
G. columbinum	10 (88)	-	-	-	-	-	-	-
G. gracile	-	-	-	-	-	-	-	22 (296)
G. purpureum	-	-	-	-	-	-	10.00 (175)	22 (121)
G. pyrenaicum	-	-	-	-	27 (58)	-	-	-
G. robertianum	15 (< 1)	-	-	28 (3)	-	-	60.00 (229)	-
G. sanguineum	-	-	-	-	-	22 (24)	-	-
OXALIDACEAE								
Oxalis acetosella	-	-	-	-	-	-	10 (< 1)	81 (973)
O. corniculata	10 (< 1)	-	-	-	-	-	-	-
LEGUMINOSAE								
Anthyllis vulneraria subsp. *boissieri*	-	-	17 (45)	-	-	-	-	-

Astragalus oreades	-	-	23 (91)	-	-	17 (23)	-	-
A. viciifolius	-	19 (117)	-	-	12 (11)	-	-	-
A. viridissumus	-	12 (181)	-	-	-	-	-	-
Coronilla orientalis var. *balansae*	-	-	18 (68)	-	-	-	-	-
C. orientalis var. *orientalis*	-	-	-	55 (3427	27 (557)	-	-	-
C. varia subsp. *varia*	-	-	-	36 (842)	12 (159)	-	-	-
Dorycnium pentaphyllum subsp. *herbaceum*	-	-	-	27 (432)	-	-	10 (1)	-
Genista tinctoria	20 (189)	19 (378)	-	-	-	-	-	-
Lathyrus laxiflorus subsp. *laxiflorus*		-	-	-	-	-	50 (700)	-
L. vernus	-	-	-	-	-	-	70 (152)	-
Lotus corniculatus var. *alpinus*	-	-	27 (126)	-	-	43 (132)	-	-
L. corniculatus var. *corniculatus*	20 (< 1)	14 (221)	-	27 (47)	33 (< 1)	17 (99)	-	-
L. corniculatus var. *tenuifolius*	-	-	-	27 (206)	-	-	-	-
Melilotus officinalis	-	-	-	36 (773)	12 (88)	-	-	-
Onobrychis armena	-	-	14 (45)	-	-	-	-	-
Trifolium arvense subsp. *arvense*	-	-	-	18 (46)	-	-	-	-
T. aureum	-	-	-	18 (500)	12 (11)	-	-	-
T. campestre	10 (188)	-	-	64 (323)	35 (283)	-	30 (2)	-
T. canascens	-	-	-	-	12 (98)	-	-	19 (102)
T. ochroleucum	-	12 (35)	-	-	10 (240)	44 (307)	-	-
T. pratense var. *pratense*	10 (< 1)	-	-	45 (457)	55.10 (746)	35 (100)	20 (50)	15 (19)
T. repens var. *repens*	-	-	23 (24)	27 (3)	16 (67)	22 (2)	10 (< 1)	-
Vicia cracca subsp. *cracca*	-	-	-	-	24 (62)	-	-	-
V. sepium	-	-	-	-	-	-	10 (50)	-
ROSACEAE								
Alchemilla barbatiflora	-	-	-	-	-	-	-	22 (75)
A. caucasica	-	-	36 (490)	-	-	30 (447)	-	-
A. erythropoda	-	-	14 (68)	-	-	17 (2)	-	-
A. retinervis	-	-	36 (342)	-	-	-	-	-
A. rizensis	-	-	14 (1)	-	-	-	-	-
A. sintenisii	-	-	-	-	-	-	-	11 (222)
Alchemilla sp.	-	-	-	-	-	13 (315)	-	-
Aremonia agrimonoides	75 (< 1)	-	-	-	-	-	-	-
Fragaria vesca	-	12 (24)	-	-	-	-	20 (50)	56 (251)
Potentilla crantzii var. *crantzii*	-	-	14 (24)	-	-	-	-	-
P. elatior	-	-	-	-	-	-	-	19 (< 1)
P. erecta	-	-	-	-	-	-	-	11 (19)
P. ruprechtii	-	-	14 (171)	-	-	-	-	-
Sanguisorba minor	10 (< 1)	12 (1)	-	55 (208)	27 (261)	-	-	-
Sibbaldia parviflora var. *parviflora*	-	-	36 (206)	-	-	30 (230)	-	-
CRASSULACEAE								
Sedum gracile	-	-	18 (24)	-	-	22 (2)	-	-

S. hispanicum var. *hispanicum*	-	-	14 (81)	-	-	17 (77)	-	11 (19)
S. pallidum var. *bithynicum*	70 (1551)	37 (245)	-	36 (251)	18 (67)	17 (261)	-	-
S. pilosum	-	-	14 (1)	-	-	-	-	-
S. spurium	30 (202)	40 (309)	41 (251)	-	22 (211)	43 (253)	-	-
S. stoloniferum	-	19 (181)	-	-	-	-	40 (400)	59 (1011)
S. tenellum	-	-	36 (274)	-	-	-	-	-
S. telephium subsp. *maximum*	15 (275)	-	-	-	-	-	-	-
SAXIFRAGACEAE								
Saxifraga cymbalaria var. *huetiana*	10 (< 1)	21 (111)	-	-	-	-	10 (< 1)	26 (223)
S. paniculata subsp. *cartilaginea*	-	-	14 (81)	-	-	-	-	-
UMBELLIFERAE								
Chaerophyllum temulum	-	-	-	-	24 (546)	-	-	-
Chamaesciadium acaule	-	-	18 (81)	-	-	-	-	-
Sanicula europaea	-	-	-	-	-	-	20 (< 1)	22 (334)
ARALIACEAE								
Hedera colchica	-	-	-	-	-	-	60 (52)	15 (176)
H. helix	25 (100)	12 (87)	-	-	-	-	60 (425)	-
VALERIANACEAE								
Valeriana alliariifolia	-	-	-	-	-	-	40 (176)	26 (103)
COMPOSITAE								
Antennaria dioica	-	-	27 (195)	-	-	-	-	-
Anthemis marschalliana var. *pectinata*	-	-	14 (45)	-	-	-	-	-
A. tinctoria var. *pallida*	45 (439)	23 (216)	-	36 (48)	18 (37)	17 (2)	-	-
A. tinctoria var. *tinctoria*	-	-	-	-	-	-	10 (1)	-
Bellis perennis	-	-	-	-	-	-	-	11 (< 1)
Centaurea cheiranthifolia var. *purpurascens*	-	19 (65)	-	-	16	-	-	-
Helichrysum graveolens	-	-	-	-	-	17 (23)	-	-
Hieracium gentile	-	-	-	-	-	-	10 (1)	-
Pilosella hoppeana	-	-	18 (2)	-	-	22 (99)	-	-
Tanacetum armenum	-	-	14 (103)	-	-	-	-	-
Tripleurospermum oreades var. *oreades*	-	19 (251)	36 (71)	-	-	43 (372)	-	-
Tussilago farfara	-	19 (90)	-	-	-	-	-	-
CAMPANULACEAE								
Campanula alliariifolia	-	-	-	-	-	-	-	15 (1)
C. betulifolia	-	12 (76)	-	-	-	-	-	-
C. rapunculoides	-	-	-	-	-	-	-	11 (< 1)
C. tridentata	-	-	45 (230)	-	-	-	-	-
ERICACEAE								
Pyrola rotundifolia	-	-	-	-	-	-	-	15 (194)
Rhododendron caucasicum	-	-	18 (818)	-	-	-	-	-
Vaccinium myrtillus	-	-	36 (320)	-	-	-	-	11 (343)
V. uliginosum	-	-	18 (1)	-	-	-	-	-

PRIMULACEAE								
Anagallis arvensis var. *arvensis*	-	-	-	18 (2)	-	-	-	-
Cyclamen coum var. *coum*	20 (50)	26 (141)	-	-	-	-	40 (101)	30 (104)
Primula elatior subsp. *meyeri*	-	-	14 (81)	-	-	-	-	-
P. elatior subsp. *pseudoelatior*	-	-	-	-	-	-	-	30 (288)
P. vulgaris subsp. *vulgaris*	-	33 (365)	-	-	16 (138)	13 (23)	60 (526)	41 (214)
GENTIANACEAE								
Gentiana verna subsp. *pontica*	-	-	23 (25)	-	-	-	-	-
CONVOLVULACEAE								
Convolvulus cantabrica	-	-	-	45 (5)	-	-	30 (1)	-
BORAGINACEAE								
Myosotis alpestris subsp. *alpestris*	15 (275)	12 (76)	50 (94)	-	-	26 (67)	-	-
M. sylvatica	-	28 (182)	-	-	39 (171)	-	-	-
Onosma tauricum var. *tauricum*	20 (113)	12 (163)	-	18 (160)	-	-	-	-
Symphytum asperum	-	-	-	-	18 (12)	-	-	-
SCROPHULARIACEAE								
Veronica baranetzkii	-	-	14 (103)	-	-	13 (1)	-	-
V. filiformis	-	-	-	-	-	-	-	19 (1027)
V. gentianoides	-	-	36 (127)	-	-	-	-	-
V. officinalis	-	-	-	-	-	-	-	59 (94)
V. persica	65 (53)	42 (281)	-	-	18 (12)	-	40 (101)	11 (37)
V. verna	-	-	-	-	-	13 (1)	-	-
LABIATEAE								
Ajuga orientalis	-	-	36 (297)	-	-	-	-	-
A. reptans	-	-	-	-	-	-	30 (3)	-
Calamintha grandiflora	-	-	-	-	-	-	10 (50)	15 (101)
Clinopodium vulgare	-	-	-	-	-	-	20 (< 1)	22 (149)
Lamium maculatum	20 (188)	-	-	-	-	-	-	-
L. ponticum	20 (88)	-	-	-	-	-	-	-
Origanum vulgare	-	-	-	-	-	-	10 (< 1)	-
Prunella vulgaris	-	-	-	-	13 (47)	35 (100)	-	48 (93)
Salvia forskahlei	-	-	-	-	-	-	-	19 (177)
S. verticillata	-	-	-	-	18 (12)	-	-	-
Stachys annua subsp. *annua* var. *annua*	25 (425)	14 (152)	-	27 (47)	39 (217)	-	-	-
S. macrantha	-	-	14 (85)	-	-	-	-	-
Teucrium chamaedrys subsp. *chamaedrys*	20 (1)	-	-	27 (3)	20 (22)	-	-	-
T. chamaedrys subsp. *trapezunticum*	-	-	-	-	-	-	20 (< 1)	-
T. polium	40 (377)	14 (187)	-	36 (447)	-	-	-	-
Thymus praecox subsp. *caucasicus* var. *caucasicus*	-	12 (82)	23 (25)	-	-	35 (339)	-	-
T. praecox subsp. *caucasicus* var. *grossheimii*	-	-	14 (45)	-	-	57 (535)	-	-
T. praecox subsp. *jankae* var. *jankae*	-	-	23 (319)	-	-	-	-	-
T. pseudopulegioides	-	-	-	-	-	13 (23)	-	-

THYMELAECEAE								
Daphne glomerata	-	-	18 (216)	-	-	-	-	-
EUPHORBIACEAE								
Euphorbia amygdaloides	-	-	-	-	-	-	10 (50)	-
E. villosa	-	-	-	-	-	-	10 (175)	-
RUBIACEAE								
Asperula pontica	-	-	-	-	-	17 (23)	-	-
Cruciata laevipes	-	-	23 (126)	-	-	-	-	-
C. taurica	35 (552)	23 (320)	-	18 (2)	12 (128)	-	-	-
Galium odoratum	10 (188)	-	-	-	-	-	50 (250)	41 (454)
G. palustre	-	26 (111)	-	-	-	-	-	-
G. rotundifolium	-	-	-	-	-	-	50 (976)	78 (1001)
G. sylvaticum	55 (177)	23 (279)	14 (46)	73 (1024)	51 (451)	-	-	-
LILIACEAE								
Muscari armeniacum	25 (613)	26 (373)	18 (80)	-	14 (133)	-	-	-
Polygonatum multiflorum	-	-	-	-	-	-	-	11 (< 1)
Ruscus colchicus	-	-	-	-	-	-	10 (50)	-
ORCHIDACEAE								
Cephalenthera longifolia	-	-	-	-	-	-	30 (50)	19 (1)
DIOSCORACEAE								
Tamus communis	-	-	-	-	-	-	40 (2)	-

* **Rare species occurring in less than 10% for each altitudinal habitat** → CUPRESSACEAE: *J. sabina* (R.III); RANUNCULACEAE: *Actaea spicata* (Ro.II, F.I, F.II), *Ranunculus buhsei* (F.II), *R. repens* (R.II); BERBERIDACEAE: *Epimedium pinnatum* subsp. *colchicum* (R.I); PAPAVERACEAE: *Corydalis caucasica* (R.II, F.II); CRUCIFERAE: *Alyssum murale* subsp. *murale* var. *murale* (R.III), *Aubrieta olympica* (R.II), *Bornmuellera cappadocica* (R.III), *Cardamine raphanifolia* (Ro.II), *Clypeola jonthlaspi* (Ro.I, Ro.II,Ro.III), *Thlapsi arvense* (R.I, Ro.II); CISTACEAE: *Cistus creticus* (R.I), *C. salvifolius* (R.I), *Fumana procumbens* (R.I, R.II, Ro.II); CARYOPHYLLACEAE: *Cerastium banaticum* (R.III), *C. fontanum* subsp. *triviale* (R.II, F.II), *Silene odontopetale* (R.III), *S. vulgaris* var. *vulgaris* (R.II, Ro.III), *Mürbeckiella huetii* (Ro.III); POLYGONACEAE: *Oxyria digyna* (R.III); LINACEAE: *Linum bienne* (Ro.II); GERANIACEAE: *Erodium moschatum* (Ro.I), *Geranium asphodeloides* (Ro.II), *G. bohemicum* (Ro.II), *G. collinum* (F.II), *G. psilostemon* (R.II); LEGUMINOSAE: *Chamaecytisus supinus* (R.II), *Genista albida* (R.III), *Oxytropis* sp. (R.III), *Psoralea bituminosa* (Ro.I, Ro.II, Ro.III), *Vicia cracca* subsp. *tenuifolia* (R.II), *Lathyrus aphaca* var. *biflorus* (Ro.I), *L. pratensis* (Ro.II), *L. roseus* (Ro.II, F.II), *Trifolium rytidosemium* var. *rytidosemium* (R.III, Ro.III), *T. sintenisii* (R.II), *Melilotus falcata* (Ro.I), *M. papillosa* (R.III, Ro.III); ROSACEAE: *Alchemilla dura* (Ro.III), *A. oriturcica* (F.II), *A. persica* (R.II), *A. plicatissima* (Ro.III), *Alchemilla* sp. (Ro.III), *Alchemilla* sp. (Ro.III), *Alchemilla* sp. (Ro.II), *Alchemilla* sp. (Ro.II), *Cotoneaster nummularia* (R.III); CRASSULACEAE: *Sedum acre* (R.II, R.III), *S. album* (R.II, Ro.III, F.II), *S. alpestre* (R.II), *Sempervivum armenum* var. *armenum* (R.II, R.III), *S. minus* var. *minus* (R.II, R.III); SAXIFRAGACEAE: *Saxifraga moschata* (R.III), *S. rotundifolia* (R.II, R.III, Ro.III, F.II), *S. sibirica* subsp. *mollis* (R.III); UMBELLIFERAE: *Smyrnium vulgare* (R.II, F.II); DIPSACACEAE: *Scabiosa caucasica* (R.III), *S. columbaria* (R.II); COMPOSITAE: *Anthemis biebersteinii* (R.II), *A. cretica* subsp. *argaea* (R.III), *Centaurea appendicigera* (R.III), *C. nigrifimbria* (Ro.III), *C. pseudoscabiosa* (Ro.II), *Doronicum orientale* (R.II), *Petasites albus* (R.II), *Scorzonera cana* var. *cana* (R.III), *Senecio inops* (R.III), *S. vernalis* (R.III); CAMPANULACEAE: *Jasione supina* subsp. *pontica* (R.III); ERICACEAE: *Orthilia secunda* (R.II); PRIMULACEAE: *Primula auriculata* (R.III), *P. longipes* (R.III); APOCYNACEAE: *Vinca major* (Ro.II), *V. minor* (R.I); GENTIANACEAE: *Gentiana pyrenaica* (R.III); CONVOLVULACEAE: *Calystegia silvatica* (R.II, Ro.II); BORAGINACEAE: *Echium vulgare* (Ro.I), *Lithospermum purpurocaeruleum* (R.II), *Myosotis arvensis* subsp. *arvensis* (R.III), *Omphalodes cappodocica* (R.II), *Symphytum longipetiolatum* (R.I, F.II); SCROPHULARIACEAE: *Linaria genistifolia* (Ro.III), *Veronica beccabunga* (Ro.III); LABIATEAE: *Lyocopus europaeus* (R.II), *Salvia glutinosa* (F.II), *Satureja sipicigera* (R.I, R.II, Ro.II), *Scutellaria pontica* (Ro.III), *Stachys iberica* subsp. *iberica* var. *iberica* (R.II, Ro.I, Ro.II); THYMELAECEAE: *Daphne oleoides* subsp. *kurdica* (R.III); EUPHORBIACEAE: *Euphorbia chamaesyce* (R.II), *E. djimilensis* (R.III), *E. herniarifolia* var. *glaberrima* (R.III); CANNABACEAE: *Humulus lupulus* (Ro.II); EMPETRACEAE: *Empetrum nigrum* subsp. *hermaphroditum* (R.III); URTICACEAE: *Parietaria judaica* (R.II); RUBIACEAE: *Crucianella* sp. (R.III), *Galium verum* subsp. *verum* (Ro.II, Ro.III); LILIACEAE: *Colchicum speciosum* (R.II, R.III), *Muscari neglectum* (R.III), *Paris incompleta* (F.II), *Scilla bifolia* (R.II); AMARYLLIDACEAE: *Galanthus rizehensis* (R.II); ORCHIDACEAE: *Goodyera repens* (F.II)

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