

Research Article

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Classification of some plant species according to Grime's strategies in a *Quercus cerris* L. var. *cerris* woodland in Samsun, northern Turkey

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Abstract: This study was carried out on 2 permanent plots of *Quercus cerris* L. var. *cerris* woodland in the Kurupelit region of Samsun, northern Turkey. Grime's CSR strategies were determined for 85 plant species from the 2 study plots (61 and 50 species from plot 1 and plot 2, respectively) according to the method that was applied. Most of the plant species in both plots had secondary and tertiary strategies, and this suggests that plants were exposed to more than one pressure factor. In both plots, CR (competitor-ruderal) was the most common strategy.

Key words: Competition, Grime's CSR strategies, plant traits, Quercus cerris, stress, disturbance

Türkiye'nin kuzeyinde (Samsun) bir *Quercus cerris* L. var. *cerris* ormanında bulunan bazı bitkilerin Grime'in stratejilerine göre sınıflandırılması

Özet: Bu çalışma Samsun'un Kurupelit bölgesinde bulunan bir *Quercus cerris* L. var. *cerris* ormanından alınan iki devamlı örnek parselde yürütülmüştür. Örnek parsellerden toplanan bitkilerin Grime'in CSR stratejileri belirlenmiştir. Araştırma kapsamında 1. örnek parselden 61, 2. örnek parselden 50, toplamda 85 türün CSR stratejisi belirlenmiştir. Araştırma sonuçlarına göre, her iki alanda da bitkilerin büyük bir kısmı ikincil ve üçüncül strateji göstermektedir. Bu da bitkilerin birden fazla baskıya maruz kaldığını ifade etmektedir. Her iki örnek parselde de en çok bulunan bitki stratejisi CR'dir (competitor-ruderal).

Anahtar sözcükler: Bitki özellikleri, Grime'in CSR stratejileri, Quercus cerris, rekabet, stres, tahribat

Introduction

Because of habitat diversity and environmental factors in different combinations, there are various functional modifications in plants. Survival and growth potentials of plants are determined by their adaptation and competitive

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ability. "Understanding the distribution of plant species across environmental gradients requires bringing theories together regarding the construction of plants, as well as their interactions with the environment, and the assembly of communities" (Craine, 2005). Classification of some plant species according to Grime's strategies in a *Quercus cerris* L. var. *cerris* woodland in Samsun, northern Turkey

Some "eco-ethological" classifications of plants have been proposed, the greatest ones being those based on biological types, ecological groups, method of diaspore dispersal, morphological types, adaptative strategies, and demographic strategies. These classifications are sometimes labelled as plant-ecology-strategy schemes, since they have as their goal predicting patterns in species distribution rather than predicting the effects of diversity on the provision or maintenance of ecosystem function (Decocq & Hermy, 2008). A plant strategy may be defined as a grouping of similar or analogous genetic characteristics recurring widely among species or populations, which leads to similarities in ecology (Grime, 1977; Garbey et al., 2004). The use of functional traits has repeatedly been advocated to understand and predict the distribution and abundance of plant species in natural habitats (Grime et al., 1988; Keddy, 1992; Westoby, 1998; Weiher et al., 1999; Lavergne et al., 2003).

Plant characteristics, such as life form and strategy, have been used to explain succession (Bazzaz, 1987; Grime, 1987; Grubb, 1987; Tilman, 1990; Rydin & Borgegara, 1991). Grime's model (Grime, 1977, 1979, 1987; Grime et al., 1988) tries to explain the course of succession in terms of the CSR strategies (C: competitive, S: stress tolerant, R: ruderal) linked to different stages of succession (Ecke & Rydin, 2000).

The triangular model (Grime, 1974) describes the various equilibria that are possible between competition, stress, and disturbance and recognizes 4 main types of secondary strategies that appear to have evolved in relation to particular equilibria (Grime, 1977). In addition to the 3 primary and 4 secondary strategies, Grime et al. (1988) distinguished 12 additional intermediate strategies.

Grime et al. (1988) applied this system to 502 common British species. Several studies have also confirmed the central assumption and predictions of the CSR model or modified versions (Kautsky, 1988), including the decreasing stress and disturbance (Wilson & Keddy, 1986; Campbell & Grime, 1992; Turkington et al., 1993; White et al., 1997). Moreover, predicted species traits in particular habitat types have also been confirmed (Kautsky, 1988; Rørslett, 1989; Murphy et al., 1990; Campbell & Grime, 1992; White et al., 1997; Greulich & Bornette, 1999).

On the other hand, several studies, such as those by Craine (2005) and Westoby (1998), recommended

Grime's CSR system by comparing Grime's strategies with other suggested life strategies. According to Craine (2005), Grime does little to address whether his theories can accommodate plants that can tolerate the stress of shade and eventually overtake faster growing, less shade-tolerant species as better competitors for light. Craine (2005) stated that in CSR theory, disturbance is assumed not to be important in the event of a low nutrient supply, yet, at the same time, Grime asserted that disturbance is important in removing species from these same habitats (Grime, 2007). Tilman (2007) asserted that consumer-resource mechanisms are a building block for theories that incorporate other tradeoffs faced by plants, such as those between competitive ability and dispersal.

Turkey has the richest flora in the temperate zone, with approximately 10,000 vascular plants. Along with its rich flora, it also has a wide diversity of habitats (Kandemir, 2009). The aim of our study was to determine the CSR strategies of a number of plants in 2 permanent plots with distinct disturbance levels in a *Quercus cerris* L. var. *cerris* woodland in northern Turkey, to get valuable information about the plant community structure of the area.

Materials and methods

This study was carried out in a Quercus cerris L. var. cerris forest (Turkey oak) in the Kurupelit region of Samsun, northern Turkey (41°21.982'N, 36°11.152'E). In the study area, the annual mean temperature is 14.2 °C, the mean maximum temperature is 27.1 °C in August, the mean minimum temperature is 3.5 °C in February, and the total annual precipitation is 668.9 mm. The climate is Mediterranean, with a dry period of 2 months (July-August). The mean altitude of the study area from sea level is 200 m. The soil type of the study area is grey-brown and podzolic. Because of the precipitation due to rainfall, the colours of the upper horizon (A) and the deep layers of these soils are grey and brown, respectively (Özen & Kılınç, 1988). The study area is a woodland about 20 ha in size. Quercus petraea (Mattuschka) Liebl. subsp. iberica (Steven ex M.Bieb.) Krassiln., Quercus cerris L. var. cerris L., and Carpinus orientalis Mill. are the dominant species at the tree layer, and Crataegus monogyna Jacq. subsp. monogyna Jacq., Ligustrum vulgare L., Smilax exelsa L., and Clematis vitalba L. are the dominant species at the shrub layer. Additionally, there are some Mediterranean

elements, such as *Phillyrea latifolia* L., *Ruscus aculeatus* L. var. *aculeatus* L., and *Cistus creticus* L. In the herbaceous layer, *Lathyrus laxiflorus* (Desf.) Kuntze subsp. *laxiflorus* Desf., *Asperula arvensis* L., *Cyclamen coum* Mill. var. *coum* Mill., *Geranium asphodeloides* Burm. Fil. subsp. *asphodeloides* Burm. Fil., *Primula vulgaris* Huds. subsp. *sibthorpii* (Hoffmanns.) W.W.Sm. & Forrest, *Lithospermum purpurocaeruleum* L., and *Viola odorata* L. are the important species (Özen & Kılınç, 1988).

In the study area, 2 permanent plots $(60 \times 20 \text{ m})$ with different disturbance levels were selected. The first plot was highly disturbed by the lumbering of some of the trees and the harvesting of all plants at the herb and shrub layers of the woodland 2 years ago for regeneration, timber production, and management. The second was comparatively less disturbed, with only the harvesting of some of the herbs and shrubs about

5-7 years ago for regeneration. The less disturbed plot had 65% canopy cover, while the highly disturbed plot had 45% canopy cover.

Field surveys were carried out March-August 2005 in the plant growing season, since the CSR system (Grime, 1974, 1977, 1979) involves the established (or adult) phase of plant life histories (Hodgson et al., 1999). During the field studies, phenological observations were also recorded. The study area was visited weekly and certain numbers of plant individuals were taken from both plots. Taxonomic nomenclature followed that of Davis (1965-1985) and Davis et al. (1988), and Latin names were updated following Brummitt and Powell (1992). Plant specimens were deposited in the Ondokuz Mayıs University Herbarium (OMUB). Predictor variables were then established to determine the CSR strategies of each species according to Hodgson et al. (1999) (Table 1).

Variable	Definition							
Canopy height	Six-point classification	1 1-49 mm 2 50-99 mm 3 100-299 mm 4 300-599 mm 5 600-999 mm 6 >999 mm						
Dry matter content	Mean of percent dry matter content in the largest fully hydrated and fully expanded leaves (%)							
Flowering period	Normal duration of flowering period (months)							
Flowering start	Six-point classification	1First flowering in March or earlier2in April3in May4in June5in July6in August or later, before leaves in spring						
Lateral spread	Six-point classification (in graminoids) (in nongraminoids) (in graminoids) (in nongraminoids)	1Plant short-lived2Loosely tufted ramets radiating about a single axis, no thickened root-stock2Compactly tufted about a single axis, no thickened root-stock3Compactly tufted ramets appressed at base3Compactly tufted about a single axis, thickened root-stock present4Shortly creeping, <40 mm between ramets						
Leaf dry weight	Natural logarithm of mean dry weight in the largest fully hydrated and fully expanded leaves (mg), plus 3							
Specific leaf area	Mean of area/dry weight quotient in the largest fully hydrated and fully expanded leaves (mm ² /mg)							

Table 1. Definitions of predictor variables required for CSR allocation of plant species (Hodgson et al., 1999).

Classification of some plant species according to Grime's strategies in a *Quercus cerris* L. var. *cerris* woodland in Samsun, northern Turkey

Canopy heights of plants were measured and lateral spreads were determined in the field. The canopy height was measured with a meter from the ground level to the maximum point of the plant canopy for shrubs and herbs, and with a Suunto mark clinometer for trees. Lateral spreads of each plant species were determined according to the 6-point classification of Hodgson et al. (1999).

Additionally, the flowering start and flowering periods of plants were determined by weekly phenological observations in the study plots. "Flowering period" means the duration of flowering in months, and "flowering start" indicates when the first flowering bloom was observed for each plant species. The flowering period variable is only required for nongraminoids (Hodgson et al., 1999).

For calculation of specific leaf area, leaf dry matter content, and leaf dry weight, the largest and fully expanded fresh leaves of adult individuals of each plant species were collected from the plots. Multitudinous leaf samples of each plant species were taken for repetition.

The largest and fully expanded leaves of adult individuals of each plant species were digested in the laboratory. Any petioles were removed and, for compound leaves, the individual leaflets were removed to include only laminar material. For leaves with massive midrib support structure, such as those of *Petasites hybridus* L., a plot of lamina was excised from a leaf (Wilson et al., 1999). Humid weights of leaves were established by using Kern PLS 360-3 scales. Leaves were then put into a drying oven at 60 °C for about 48 h until reaching constant weight. When the weights of the leaf samples became stable, they were weighed again, and their dry weights were established. The percentage of the dry matter content of leaves was calculated by the following formula:

$$\label{eq:mean_dry_weight} \begin{array}{l} \mbox{Mean dry weight (mg)} \\ \mbox{Dry matter content (\%)} = & & \\ \mbox{Mean humid weight (mg)} \\ \end{array} \times 100 \mbox{ Eq. 1.}$$

For specific leaf area (SLA) calculations of plant species, the largest fully expanded and fully hydrated

leaves of adult individuals of each plant species were used. Leaf area measurement software produced by the University of Sheffield was used to determine mean leaf areas of plants. SLA values of each species were calculated by using the following equation, as mm²/mg:

SLA = $\frac{\text{Mean leaf area (mm²)}}{\text{Mean leaf dry weight (mg)}}$ Eq. 2.

For allocating plant species to CSR strategies, 2 customised spreadsheets (for grasses and for nongrasses), developed to perform all of the necessary calculations by Hodgson et al. (1999) (written in Microsoft Excel for WindowsTM, Version 5.0), were used. After 7 predictor variables (for graminoids, 6 predictor variables) were established for each species, these variables were put into spreadsheets, and then the CSR strategies of the plant species were determined by automatic data transformation. The CSR strategy of a species is determined in 5 steps. These steps are data assembly, regression, transformation, adjustment, and identification of CSR type. In the spreadsheets, there are special lines for transforming data. For detailed explanations (working procedure) of the spreadsheets, see Hodgson et al. (1999).

In this study, Grime's CSR strategies (1979, 2002) were determined for 61 plant species collected from a highly disturbed plot and a less disturbed plot, according to the method applied by Hodgson et al. (1999).

However, we omitted some of the plant species from both plots because of their unsuitability for CSR allocation as reported by Hodgson et al. (1999). For example, *Ruscus aculeatus* L. was excluded because of its stem metamorphosis. The stem is the major photosynthetic organ for *Ruscus aculeatus*, but predictor variables related to leaves (e.g. SLA, dry matter content, leaf dry weight) cannot be determined correctly.

Results

In the present study, 61 plant species from the highly disturbed plot (plot 1) and 50 plant species from the less disturbed plot (plot 2), a total of 85 plant species from both plots, were collected, and their CSR strategies were determined. Twenty-seven plant species were common to both plots. Most of the plant species collected from both plots were nongraminoid annual, biennial, or perennial herbs. There were also several trees, shrubs, and graminoids.

From the highly disturbed plot, the 61 plant species collected were allocated into 10 different functional types (CR, C/CR, C/SC, SC, C, R/CR, SC/CSR, S/SC, C/CSR, and S/CSR) (Table 2). The

Table 2. Plant species and their CSR allocations, collected from plot 1 and plot 2, and comparison of plants' CSR strategies to Grime's results.

Lathyrns kačijlenssCSCCSCSperial arvensisCRCRCRHelleborns orientalisCSCCSCArtoolaansa orientalisCRCRSCornium appleholdsisCRCRVartoolaansa orientalisCRCCRCRCCROrniuto appleholdsisCRCRCRVartoolaansa orientalisCRCCRCCRCRCAlgos reptansCRCRCRSRHypericam perparkaaraCRCCRCCRCCRCRanunculus constantinopoltanusCRCRCRTrifolum merseCRCRSCRRanunculus constantinopoltanusCRCRSCRTrifolum arvenseCRCRSCRRanunculus constantinopoltanusCRCRSCRHolesa handenseCRSSNobootis scientalCRCRRCHolesa handenseCRSSMosotis scientalCRRCSSavia forshahletCRSSSarophalaris scopolivar. scopoliCRTSSSSSSSarophalaris scopolivar. scopoliCRSS	Таха	Plot 1	Plot 2	Grime et al.	Taxa	Plot 1	Plot 2	Grime et al.
HeldebarsCRCSCCSCCampanda glometantaCRCRSAGrandum aghodebarCRCRCRViola donataCICRCRCRSRAjper trytmsCRCRCRVipericam perfortumCRCRCRCSRCSRAjper trytmsCRCRSRPipericam perfortumCRCRCRCRCRLithogermam purpurcacenteumCRCRPipericam perfortum merceCRCRSRSRViola sichantCRCRSICSPieritam inverseCRCRSRAgrenta orientalisCRCRViola sichant merceCRSRSRAgrenta orientalisCRCRPieritam inverseCRSRSRStachys annua subsp. annua subsp. annua subsp. annua subsp. annua subsp. annuaCRSRSRSRSRSRSRStachys annua subsp. annuaCRSRSRCRSR <td>Lathyrus laxiflorus</td> <td>C/SC</td> <td>C/SC</td> <td></td> <td>Asperula arvensis</td> <td>CR</td> <td>CR</td> <td></td>	Lathyrus laxiflorus	C/SC	C/SC		Asperula arvensis	CR	CR	
Granius appondebuladesCRC <td>Helleborus orientalis</td> <td>C/SC</td> <td>C/SC</td> <td></td> <td>Campanula glomerata</td> <td>CR</td> <td></td> <td>S</td>	Helleborus orientalis	C/SC	C/SC		Campanula glomerata	CR		S
Orninlogation signaladamCRCRCRCRCRCRCRCRSRApparametalies constantinopolitansCRCRCRCRApparametalies constantinopolitansCR	Geranium asphodeloides	CR	C/CR		Astrodaucus orientalis	C/CR		
Ajager apriansCRCRCRCRSRHypericam performanmCRCR/CSRCR/CSRCR/CSRRCR	Ornithogalum sigmoideum	CR	CR		Viola odorata	C/CR	C/CR	CSR
Ramacolata constantinopolatums CR CR Plantago Parcoclata CR	Ajuga reptans	C/CR	CR	CSR	Hypericum perforatum	CR	CR/CSR	CR/CSR
Linkoperam perpunciaeruleumCKCFigliaim pixode?CRCRSecondGeramiun sanguineumCRCRSi/CRNichenis cretica subsp.creticaCRSMoosti siculaCRCRNichenis cretica subsp.creticaC/CRSSMyosti siculaCRKCRNichenis cretica subsp.creticaC/CRSSAppendio crientafiaCRSSicondC/CRSSSStachy amma subsp. annuaR/CRSSSicondC/CRSSStepholularia scopolir at. scopolirC/CRSSSSSSSStepholularia scopolir at. scopolirC/CRSS <td>Ranunculus constantinopolitanus</td> <td>CR</td> <td>CR</td> <td></td> <td>Plantago lanceolata</td> <td>CR</td> <td></td> <td>CSR</td>	Ranunculus constantinopolitanus	CR	CR		Plantago lanceolata	CR		CSR
Geranius anguineumCRS/CRS/CRTifolium arvenseCRCRAnthenis cretica subsp.creticaCRCRS/CRS/CRWolo siduanR/CRKMathenis cretica subsp.creticaCRCRS/CRS/CRApperlat orientalisCRV9rentucelia latifolia subsp.latifoliaS/CRS/CRS/CRStachy amus subsp.amuaCRV9rentucelia latifolia subsp.latifoliaS/CRVS/CRStachy amus subsp.amuaC/CRV9rentucelia latifolia subsp.latifoliaC/CRVS/CRStachy amus subsp.amuaC/CRVSSalchia forschultC/CRVS/CRMyosotis ranosisimaR/CRVSSalca carinaC/CRC/CRVS/CRVicia lutcaC/CRC/CRS/CSS/CSSalca informany subsp. monogynaC/CRC/CRVVicia lutcaC/CRC/CRS/CSS/CSSalca informany subsp. monogynaC/CRC/CRVVicia lutcaC/CRC/CSRS/CSS/CSSalca informany subsp. monogynaC/CRC/CRVFestue heterophyllaS/CSRS/CSRS/CSSalca informany subsp. monogynaC/CRC/CRVSSilene dichotomaC/CRC/CSRS/CSSalca informany subsp. monogynaC/CRC/CSRSSSilene dichotomaC/CRC/CSRS/CSRS/CSRS/CSRS/CSRS/CSRSSSilene dichotomaC/CR<	Lithospermum purpurocaeruleum	C/SC			Trifolium physodes	CR		
Viola siehanCRCRCRCRCRCRCRCRMyosotis siculdCRCRCRCRCRCRCRSachy annu subsp. annuaCRCRParentu cellia latifolia subsp. latifoliaSRCCRCRSachy annua subsp. annuaCRSMachago svariaCRCRSRCStephadia vispolit var. scophitCRSMachago svariaCRCRSRCFilpendia vilgarisCRCRSCacarbina functional subsp. annuaCRSHymenocarpus circinnatusRCRSSRCSRCCRCRSCKigattran vilgareCCRCRSSaca caninaCRCRSCVicia lukaCCRSCRSCRSCRSCRCRCRCRStachypolina sybvitarSCRSCRSCRSCRSCRCRCRCRCRStachypolina sybvitarSCRSCRSCRSCRSCRCRCRCRCRSCStachypolina sybvitarSCRCRCRCRCRCRCRSCSCR <td>Geranium sanguineum</td> <td>CR</td> <td>CR</td> <td>S/CSR</td> <td>Trifolium arvense</td> <td>CR</td> <td></td> <td>SR</td>	Geranium sanguineum	CR	CR	S/CSR	Trifolium arvense	CR		SR
Myosofis sicula R/CR K/CR Kork CR CR CR CR Ageretia orientalis CR CR CR CR CR Stachys annus aubsp. annua R/CR CR CR CR Strachyndiaria scopoliti var. scopoliti CR CR CR CR Filipendula vulgaris C/CR CR CR CR Myosofi starnosissima R/CR SR Cricium bysantinum C/CR CR Myosofi ramosissima R/CR SR Cricium bysantinum CR CR Vicia lutaa C/CR SR Cricium speatodpersonata subsp. pseudopersonata C/CR CR Vicia lutaa C/CR SC SR Cricium speatopersonata subsp. pseudopersonata CR CR Vicia lutaa C/CR CR RC Tadopogon aureus CR CR CR Carex divulas subsp. divulsa S/CSR SC/CSR S/S Scharing duracia mongyna subsp. pseudopersonata C/SR CR CR Carex divulas subsp. divulsa S/CSR SC/CSR SC C/SR CR C Schendychotoma CR CR CR CR C SC Schendychotoma CR<	Viola siehana	CR	CR		Anthemis cretica subsp. cretica	CR		
Åperula orientalisCR✓Origanum valgareCR✓Stachys annua subsp. annuaNCRMCRMCRNCCVStachys annua subsp. annuaNCRMCRMCRNCCNCCFilipendula valgarisC/SCSSalvia forskahleiC/CRVNCMyosotis ramosisinaNCRSSC/CRNCNCNCNCMyosotis ramosisinaNCRSSSCCSC <td>Myosotis sicula</td> <td>R/CR</td> <td>R/CR</td> <td></td> <td>Holcus lanatus</td> <td>C/CR</td> <td></td> <td>CSR</td>	Myosotis sicula	R/CR	R/CR		Holcus lanatus	C/CR		CSR
Stachys annua absp. annuaRICRParentucellia laifolia subsp. laifoliaSISCUScrophularia scopolit va. scopolitCR-Medicago x variaCHighendual vulgarisCICRSSalvia forskahdniCICR-Myosotis ramoissimaRICR-SRCharophylum byzantinumCR-Myosotis ramoissimaRICR-SRCircli meseudopersonata subsp. pseudopersonataCICR-SCVicia lutaCICR-SRSoca caninaCRCSCSCVicia lutaCICRCICR-Tagopogon aureusCICRC/CRSCBrachypodium sylvaticumS/CSRS/CSRS/CSRS/CSRS/CSRC/CRC/CRSCDactylis glomerataC/CSRC/CSRC/CSRC/CSRC/CSRSCSCSCSilene dichotomaCRCRCRCRCRCRSCSCPrunella vulgarisCRCRCRCRCRCRSCSCTifolium subteraneumSC-G/CSRS/CSRMinus algubraCSCSCPrunella vulgarisCRCRCRCRCrSCSCSCVicia craccaCICRCICRSCCCRSCSCSCVicia craccaCRCRS/CSRS/CSRMinus algubraCSCSCVicia craccaCRCRS/CSRS/CSRS/CSRS/CSRS/C	Asperula orientalis	CR			Origanum vulgare	CR		
Serophularia scopolit var. scopolit Filipendud vulgarisCRMedicago x variaCFilipendud vulgarisC/SCSSalvia forskahleiC/CRFHymenocarpus circinnatusR/CRCricum pseudopersonata subsp. pseudopersonataC/CRFByosotis ramosisinaR/CRSRCircium pseudopersonata subsp. pseudopersonataC/CRSCLjeustrum vulgareC/CRSCRoa caninaCCSCVicia luteaC/CRSCRoa caninaC/CCCSCBrachypodium sylvaticumSC/SRSC/CSRS/SCSetaria glaucaC/CSRC/SCSCBrachypodium sylvaticumSC/SRS/CSRS/SCSetaria glaucaC/CSRC/SCSCBrachypodium sylvaticumSC/SRS/CSRS/SCSetaria glaucaC/CSRC/SCSCBachypodium sylvaticumSC/SRS/CSRS/SCSetaria glaucaC/SCRSCSCBachypodium sylvaticumSC/SRS/SCSCSCSCSCSCBachypodium sylvaticumC/CSRC/CSRC/CSRC/SCRSCSCBachypodium sylvaticumCRCRCRCRCRSCSCBachypodium sylvaticumCRCRCRCRCRSCSCBachypodium sylvaticumCRCRCRCRCRSCSCBachypodium sylvaticumCRCRCRCRCRSCSCFrinuela vulgarisCR <td><i>Stachys annua</i> subsp. <i>annua</i></td> <td>R/CR</td> <td></td> <td></td> <td>Parentucellia latifolia subsp. latifolia</td> <td>S/SC</td> <td></td> <td></td>	<i>Stachys annua</i> subsp. <i>annua</i>	R/CR			Parentucellia latifolia subsp. latifolia	S/SC		
Filtpendula vulgarisC/SCSSalvia forskahleiC/CRJHymenocarpus circinnatusR/CRCharcophylum byzantinumC/CRKMyosotis ramosissimaR/CRSRCircium pseudopersonata subsp. pseudopersonataC/CRKKysotis ramosissimaR/CRSCRosa caninaCCSCSCVicia luteaC/CRS/CSRS/SCSSeataria glaccaC/SCC/SCS/SCParchypodium sylvaticumS/CSRS/CSRS/SCSeataria glaccaC/CSRC/CSRCDachys glomerataC/CSRC/CSRS/SCSCSCSCSCSilene dichotomaCRCC/CSRC/SCSCSCSilene dichotomaCRCRCRC/SCSCSCEuphorbia strictaCRCRCRC/SCSCSCSilene dichotomaCRCRC/CSRC/SCSCSCEuphorbia strictaCRCRCRC/SCSCSCSilene dichotomaCRCRC/CSRC/SCSCSCSilene dichotomaCRCRC/SCC/SCSCSCSilene dichotomaCRCRC/SRFrainus oxycarpaC/SCC/SCSCSilene dichotomaCRCRC/SRGalium doratingC/SCSCSCSilene dichotomaCRCRC/SRFrainus oxycarpaC/SCSCSCSilene dichotomaCRC	Scrophularia scopolii var. scopolii	CR			Medicago x varia	С		
hymenocarpos circinnatusR/CRChaerophylum byzantinumCRMyosotis ramosissimaR/CRSRCircium pseudopersonata subsp. pseudopersonataC/CRLigustrum vulgareC/CRSRCircium pseudopersonata subsp. pseudopersonataC/CRCSCVicia luteaC/CRS/CSRSC/CSRSCRosa caninaCRCSCSCVicia luteaC/CRS/CSRSC/CSRS/SCSetario glaucaC/SCC/SCRSCSCBrachypodium sylvaticumSC/CSRS/SCSetario glaucaC/SCRC/SCRSCSCDarchyls glomentaC/CSRC/CSRS/SCSetario glaucaC/SCRC/SCRSCDarchyls glomentaC/CSRC/CSRS/SCSetario glaucaC/SCRSCSCStene chlotoomaCRCRCRCromulla variaCSCSCSEPunella vulgarisCRCRCRCRSRSCSCSCTrifolium subteraneumSCCCCSCSCSCVicia craccaC/CCRCRR/CRGranius glabraC/SCC/SCSCVicia craccaC/CRCRSCMuerus glabraC/SCSCSCScia craccaC/CRCRSCMuerus glabraC/SCSCSCVicia craccaC/CRCRSCMuerus glabraC/SCSCSCScia craccaC/CRCRSCMuerus glabra	Filipendula vulgaris	C/SC		S	Salvia forskahlei	C/CR		
Mysotix modissimaR/CRSRCircum pseudopersonata subsp. pseudopersonataC/CRVLigustrum vulgareC/CRSCRosa caninaCCSCSCVicia luteaC/CRCTragopogon aureusCRCSCSCSCBrachypodium sylvaticumSC/SRSC/CSRS/SCSetaria glaucaC/CRCSCSCDachylis glomentaS/SCSC/CSRS/SCSetaria glaucaC/CRCCSCDachylis glomentaS/SCC/CSRS/SCSetaria glaucaC/CSRC/CSRSCSCDachylis glomentaS/SCC/CSRC/CSRCoronilla variaCRCRSCSCSilene dichotomaCRCRCRCRCRSCSCSCPrunella vulgarisCRCRCRCRRacinus oxycarpaC/SCC/SCSCIrifolium subterraneumSCC/CRCoronis anguinaaCCSCSCSCVicia cracaC/RCRCRSCQuercus cerris var. cerrisC/SCC/SCSCPrimula vulgarisCRCRS/SCSuban palifaliam var. bithynicumR/CRK/CRSCPrimula vulgarisCRCRS/SCSuban palifaliam var. bithynicumR/CRSCSCIdaium aparineCRCRS/SCSuban palifaliam var. bithynicumR/CRSCSCSCIdaium adoratinCRCRS/SC <t< td=""><td><i>Hymenocarpus circinnatus</i></td><td>R/CR</td><td></td><td></td><td><i>Chaerophylum byzantinum</i></td><td>CR</td><td></td><td></td></t<>	<i>Hymenocarpus circinnatus</i>	R/CR			<i>Chaerophylum byzantinum</i>	CR		
Lightstrum vulgareC/CRSCRosa caninaCCSCSCVicia luteaC/CRTragepogon aureusCRTragepogon aureusCRTFestuca heterophyllaS/CSRS/CSRS/SCSetaria glaucaC/SCC/SCSCBrachypodium sylvaticumS/CSRS/SCSetaria glaucaC/SCC/SCCSCCarex divulsa subsp. divulsaS/SCEpilobium hirsutumCRCRCCSCDachyl glomerataC/CSRC/CSRC/CSRC/CSRS/SCEpilobium hirsutumCRC/SCSCSilene dichotomaCRCRAcer campestreC/SCSCSCSCFrunella vulgarisCRCRCRCRGRSCSCSCVicia cracaC/CRCRR/CRCruprinus orientalisSCSCSCSCVicia cracaC/CRCRR/CRCruprinus orientalisCSCSCSCVicia cracaC/CRCRSCQuercus cerris var. cerrisC/SCC/SCSCSCVicia cracaCRCRS/SCRSilae excelsaC/CRKCRSC	Myosotis ramosissima	R/CR		SR	<i>Circium pseudopersonata</i> subsp. <i>pseudopersonata</i>	C/CR		
Vicia luteaC/CRTragopogon aureusCRFestuca heterophyllaS/CSRS/C/CSRCrutaegus monogyna subsp. monogynaC/SCC/SCSCBrachypodium sylvaticumSC/CSRS/CSRS/SCSetaria glaucaC/CSRC/CSRCCarex divulsa subsp. divulsaS/SCC/CSRCormilla variaCCSCSCDactylis glomerataC/CSRC/CSRCormilla variaCSCSCSCSCSilene dichotomaCRCRCRAcer campestreC/SCSCSCFrunella vulgarisCRCRCRSCSCSCSCIrjolium subterraneumSCC/CSRC/CSRC/SCSCSCLapsana communis subsp. communisCRC/CRR/CRGrinus orientalisSCSCSCVicia cracaC/CRCRC/CSRC/SCSCSCSCSCClematis villabaCRCRC/CSRC/SCSCSCSCPrimula vulgarisCRCRS/CSRSmilax excelsaC/CRSCSCPrimula vulgarisCRCRS/CSRSedum palidum vat. bithynicumR/CRK/CRSCIdoluten umbellatumCRCRS/CSRSedum palidum vat. bithynicumSCSCSCScS/CSRSedum palidum vat. bithynicumCRC/CRSCSCSCScScSCSCSCSCSCSCSC </td <td>Ligustrum vulgare</td> <td>C/CR</td> <td></td> <td>SC</td> <td>Rosa canina</td> <td>С</td> <td>С</td> <td>SC</td>	Ligustrum vulgare	C/CR		SC	Rosa canina	С	С	SC
Festuca heterophyllaS/CSRS/CSRS/CSRC/Tatagus monogyna subsp. monogynaC/SCC/SCS/SCSBrachypodium sylvaticumSC/CSRS/SCStaria glaucaC/CSRC/CSRCSCarex divulsa subsp. divulsaS/SCEpilobium hirusutumCRCRCRCSDactylis glomerataC/SRC/CSRC/CSRC/CSRC/CSRCSSSilen dichotomaCRCRCRCRC/CSRC/CSRSSEuphorbia strictaCRCRCRAcer campestreC/SCC/SCSCPrunella vulgarisCRCRCRCRC/CSRC/SCSCSTrifolium subsp. communisCRCRR/CRCarpinus orientalisCSCSCSVicia craccaC/CRC/CRC/CSRUlnus glabraCCSCSCSGalium aparineCRCRCRS/CSRSmilax excelsaC/CRSSSHohostoarCRCRS/CSRSedum palidum var. bitynicumCCRSCSCSCHubus discolorCRCRS/CSRSedum palidum var. bitynicumR/CRSCSCSCSelubus discolorCRCRSC/CSRGeuru urbanumSCSCSCSCGalium odoratumCRCRSC/CSRGeuru urbanumSCSCSCSCGalium odoratumCRCRSC/	Vicia lutea	C/CR			Tragopogon aureus	CR		
Brachypodium sylvaticum SC/CSR SC/CSR S/SC Setaria glauca C/CSR C/CSR Carex divulsa subsp. divulsa S/SC Epilobium hirsutum CR CR C Dactylig glomerata C/CSR C/CSR C/CSR C/CSR CR C Silene dichotoma CR CR Hedera helix C/CSR C/CSR SC Euphorbia stricta CR CR Aeer campestre C/SC SC SC Prunella vulgaris CR CR CR CR CR SC SC Trifolium subterraneum SC CR R/CR Carpitus orientalis SC SC SC Idalum aparine CR CR CR C/CSR Umus glabra C SC SC Galum aparine CR CR SC Sc Sc Sc Sc Sc Sc Sc Primula vulgaris CR CR SC Quercus cerris var. cerris C/SC C/SC SC Primula vulgaris CR CR SC Sc Sc	Festuca heterophylla	S/CSR	SC/CSR		Crataegus monogyna subsp. monogyna	C/SC	C/SC	SC
Carex divulsa subsp. divulsaS/SCEpilobium hirsutumCRCRCRCDactylis glomerataC/CSRC/CSRC/CSRCoronilla variaCSSilene dichotomaCRCRCRCRCRC/CSRC/CSRSCEuphorbia strictaCRCRCRCRCRCRSCSCPrunella vulgarisCRCRCRCSRFraxinus oxycarpaC/SCC/SCSCItipfilum subterraneumSCUercus petrea subsp. ibericaC/SCC/SCC/SCSCLapsana communis subsp. communisCRCRR/CRCarpinus orientalisSCSCSCItipfilum subterraneumSCC/CRC/CRC/CRC/SCSCSCSCItipfilum subterraneumSCC/CRC/CRC/SC<	Brachypodium sylvaticum	SC/CSR	SC/CSR	S/SC	Setaria glauca	C/CSR		
Dartylis glomerataC/CSRC/CSRC/CSRC/CSRC/CSRSCSilene dichotomaCRCRHedera helixC/CSRC/CSRSCEuphorbia strictaCRCRCRAcer campestreC/SCC/SCSCPrunella vulgarisCRCRCRCRAcer campestre aubsp. ibericaC/SCC/SCSCPrunella vulgarisCRCRCRCRCRC/CSRC/SCC/SCSCLapsana communis subsp. communisCRCRR/CRCarpinus orientalisSCC/SCC/SCSCLapsana communis subsp. communisCRCRR/CRCarpinus anguineaCCSCSCGalium aparineCRCRSCQuercus cerris var. cerrisC/SCC/SCSCSCPrimula vulgarisCRCRS/CSSmilax excelsaC/CRKSCSCPrimula vulgarisCRCRS/CSSedum pallidum var. bithynicumR/CRK/CRK/CRHolosteum unbellatumCRCRSC/CSRGeum urbanumSCSCSCSellaria holosteaCRCRSC/CSRGeum urbanumSCSCSCGalium odoratumCRCRSC/CSRGarduus princerphalusSCSCSCSellaria holosteaCRCRSC/CSRFrifolium fragiferumCRC/CRSCGaliun odoratumCRCRCRVerbascum bilatariaCRCR	Carex divulsa subsp. divulsa	S/SC			Epilobium hirsutum	CR	CR	С
Sile dichotomaCRHedera helixC/CSRC/CSRSCSCEuphorbia strictaCRCRCRAcer campestreC/SCSCPrunella vulgarisCRCRCRCSRFraxinus oxycarpaC/SCC/SCSCTrifolium subterraneumSCQuercus petrea subsp. ibericaC/SCC/SCC/SCLapsana communis subsp. communisCRCRR/CRCornus sanguineaCC/SCC/SCSCCalana aparineCRCRCRCRCrurus serris var. cerrisC/SCC/SCSCSCClematis vitalbaCRCRSCSCSCSCSCSCSCPrimula vulgarisCRCRSCSuccus cerris var. cerrisC/CRC/SCSCSCPrimula vulgarisCRCRSCSuccus sparsifloraC/CRC/SCSCSCVeronica pectinata var. pectinataSCSCSUcs sparsifloraR/CRK/CRSCStellaria holosteaCRCRSC/SSRGenu urbanumSCSCSCGonundoratumCRCRSC/CSRGardius pycnocephalusSCC/CSRK/SRGanua doratusCRCRCSRTrifolium fragiferumC/CSRC/CSRK/CSRGalium odoratusCRCRSC/SSRGardius pycnocephalusCRC/CSRSCSonchus oleraceusCRCSVerbascum blattariaCRC/CSRR/CSRSo	Dactylis glomerata	C/CSR	C/CSR		Coronilla varia	С		
Euphorbia stricta CR CR Acer campestre C/SC SC Prunella vulgaris CR CR CSR Fraxinus oxycarpa C/SC C/SC Trifolium subterraneum SC SC Quercus petrea subsp. iberica C/SC C/SC C/SC Lapsana communis subsp. communis CR CR R/CR Carpinus orientalis SC SC SC Lapsana communis subsp. communis CR CR R/CR Carpinus orientalis SC SC SC Lapsana communis subsp. communis CR CR R/CR Carpinus orientalis SC SC SC Lapsana communis subsp. communis CR CR R/CR Corpus sanguinea C SC SC Claitur aparine CR CR SC SC Quercus cerris var. cerris C/SC C/SC SC Cleinati stritalba CR CR SC Sc Sc Sc Sc Sc Primula vulgaris CR CR SC Sc Sc Sc Sc Sc Primula vulgaris CR CR SC Sc Sc Sc Sc Rubus discolor CR CR Sc Sc	Silene dichotoma	CR			Hedera helix	C/CSR	C/CSR	SC
Prinuella vulgarisCRCRCRCSRFraxino axycarpaC/SCSCTrifolium subterraneumSCQuercus petrea subsp. ibericaC/SCC/SCSCLapsana communis subsp. communisCRCRR/CRCarpinus orientalisSCSCSCVicia craccaC/CRCRR/CRCornus sanguineaCCCGalium aparineCRCRSCQuercus cerris var. cerrisC/SCC/SCSCClematis vitalbaCRCRSCQuercus cerris var. cerrisC/SCC/SCSCPrimula vulgarisCRCRSCSCSCSCPrimula vulgarisCRCRS/SSRSmilax excelsaC/CRK/CRHolosteun umbellatumCRSedum pallidum var. bithynicumR/CRK/CRVeronica pectinata var. pectinataSCSC/SSRGeum urbanumSCSCGalium odoratumCRSC/CSRGeum urbanumSCSCStellaria holosteaCRCRSC/CSRGeum urbanumSCGunanthe pinpinelloidesCRC/CRVerbascum blattariaCRCRCynosurus cristatusC/CRC/CRPrilum exaratum subsp. exaratumC/CSRCRSonchus oleraceusC/SCVicia hirsutaCRR/CSRR/CSRAnagallis arvensisR/CRK/SRK/SRK/SRK/SR	Euphorbia stricta	CR	CR		Acer campestre	C/SC		SC
Trifolium suberraneumSCQuercus perea subsp. ibericaC/SCC/SCLapsana communis subsp. communisCRCRR/CRCarpinus orientalisSCSCLapsana communis subsp. communisCRC/CRC/CSRUlmus glabraCSCSCGalium aparineCRCRCRCornus sanguineaCSCC/SCSCClematis vitalbaCRCRSCQuercus cerris var. cerrisC/SCC/SCSCPrimula vulgarisCRCRS/CSRSmilax excelsaC/CRSCRubus discolorCCScSc/CRSc/CRMyosotis sparsifloraR/CRHolosteum umbellatumCRSCSCMyosotis sparsifloraR/CRSCVeronica pectinata var. pectinataSCCRSC/CSRGeum urbanumSCSCStellaria holosteaCRCRSC/CSRGeum urbanumSCCR/CSRGenanthe pimpinelloidesCRC/CSRVerbascum blattariaCRCR/CSRSonchus oleraceusC/CSRCarduus pycnocephalusCRCR/SRPinllyrea latifoliaC/CSRVicia hirsutaCRC/SSRR/CSRAnagallis arvensisK/CRK/CRK/CRK/CSRCR	Prunella vulgaris	CR	CR	CSR	Fraxinus oxycarpa	C/SC		
Lapsana communis subsp. communisCRCRR/CRCarpina orientalisSCSCSCVicia craccaC/CRC/CSRUlmus glabraCCGalium aparineCRCRCRCornus sanguineaCCCCSCSCSCSCSCSCSCSCC/SCSCC/SCSCSCC/SCSCC/SCSCC/SC </td <td>Trifolium subterraneum</td> <td>SC</td> <td></td> <td></td> <td><i>Quercus petrea</i> subsp. <i>iberica</i></td> <td>C/SC</td> <td>C/SC</td> <td></td>	Trifolium subterraneum	SC			<i>Quercus petrea</i> subsp. <i>iberica</i>	C/SC	C/SC	
Vicia cracca C/CR C/CSR Umus glabra C Galium aparine CR CR Cornus sanguinea C Clematis vitalba CR SC Quercus cerris var. cerris C/SC C/SC SC Primula vulgaris CR CR SC Quercus cerris var. cerris C/CR C/SC SC Rubus discolor CR CR S/CSR Smilax excelsa C/CR CR Holosteum unbellatum CR CR Sedum pallidum var. bithynicum R/CR R/CR Veronica pectinata var. pectinata SC R Myosotis sparsiflora R/CR R/CR Iathyrus inconspicuus CR CR SC/CSR Geum urbanum SC SC Galium odoratum CR SR SC/CSR Geum urbanum SC SC Stellaria holostea CR CR SC SC SC SC Qonanthe pimpinelloides CR CR CR CR CR CR Sonchus oleraceus C/CR C/CR Phleum exaratum subsp. exaratum C/CSR C/SC	Lapsana communis subsp. communis	CR	CR	R/CR	Carpinus orientalis	SC	SC	
Galium aparineCRCRCornus sanguineaCClematis vitalbaCRSCQuercus cerris var. cerrisC/SCC/SCSCPrimula vulgarisCRCRS/CSRSmilax excelsaC/CRC/CRRubus discolorCCCyclamen coumC/CRR/CRHolosteum umbellatumCRSCSedum pallidum var. bithynicumR/CRR/CRVeronica pectinata var. pectinataSCMyosotis sparsifloraR/CRSCLathyrus inconspicuusCRSC/CSRGeum urbanumSCSCGalium odoratumCRSC/CSRGeum urbanumSCSCStellaria holosteaCRCSRTrifolium fragiferumC/CRCROenanthe pimpinelloidesCRC/CSRCarduus pycnocephalusCRCRSonchus oleraceusC/CRC/CRPhleum exaratum subsp. exaratumC/CSRR/CSRPhillyrea latifoliaC/SCC/SCVicia hirsutaCRR/CSRAnagallis arvensisR/CRK/SRMyosotis sparsifloraR/CR	Vicia cracca	C/CR		C/CSR	Ulmus glabra	С		
Clematis vitalba CR SC Quercus cerris var. cerris C/SC C/SC SC Primula vulgaris CR CR S/CSR Smilax excelsa C/CR CR Rubus discolor C C Cyclamen coum CR CR CR Holosteum umbellatum CR SC Myosotis sparsiflora R/CR R/CR Veronica pectinata var. pectinata SC CR Ranunculus ficarii subsp. ficariiformis SC SC Galium odoratum CR SC SC SC SC SC Stellaria holostea CR CR SC SC SC SC Gonanthe pimpinelloides CR CR CSR Trifolium fragiferum C/CR CR/CR Cynosurus cristatus C/CSR Carduus pycnocephalus CR CR CR Sonchus oleraceus C/SC Vicia hirsuta C/CSR C/SSR R/CSR Phillyrea latifolia C/SC Kica hirsuta CR SR/CR SR/CR Anagallis arvensis R/CR K/CR K/SR SR/SR SR/SR <td>Galium aparine</td> <td>CR</td> <td>CR</td> <td></td> <td>Cornus sanguinea</td> <td>С</td> <td></td> <td></td>	Galium aparine	CR	CR		Cornus sanguinea	С		
Primula vulgaris CR CR S/CSR Smilax excelsa C/CR Rubus discolor C Cgclamen coum CR CR Holosteum umbellatum CR Sedum pallidum var. bithynicum R/CR Veronica pectinata var. pectinata SC Myosotis sparsiflora R/CR Lathyrus inconspicuus CR SC/CSR Ranunculus ficarii subsp. ficariiformis SC Galium odoratum CR SC/CSR Geum urbanum SC SC Stellaria holostea CR SC SC SC Oenanthe pimpinelloides CR CR Verbascum blattaria CR CR Cynosurus cristatus C/CSR Carduus pycnocephalus C/CSR C/SSR Sonchus oleraceus C/CSR Philum exaratum subsp. exaratum C/CSR K/CSR Phillyrea latifolia C/SC Vicia hirsuta CR R/CSR Ranunculus sceleratus CR K/SR Myosotis sparsiflora R/CR	Clematis vitalba	CR		SC	Quercus cerris var. cerris	C/SC	C/SC	SC
Abusa discolorCCyclamen coumCRHolosteum umbellatumCRSedum pallidum var. bithynicumR/CRVeronica pectinata var. pectinataSCMyosotis sparsifloraR/CRLathyrus inconspicuusCRRanunculus ficari subsp. ficari iformisSCGalium odoratumCRSC/CSRGeum urbanumSCStellaria holosteaCRCSRTrifolium fragiferumC/CRCR/CSROenanthe pimpinelloidesCRCSRVerbascum blattariaCRCRSonchus oleraceusC/CRC/CSRPhleum exaratum subsp. exaratumC/CSRR/CSRPhillyrea latifoliaC/SCVicia hirsutaCRK/CSRAnagallis arvensisR/CRR/SRK/SRK/SR	Primula vulgaris	CR	CR	S/CSR	Smilax excelsa	C/CR		
Holosteum umbellatumCRSedum pallidum var. bithynicumR/CRVeronica pectinata var. pectinataSCMyosotis sparsifloraR/CRLathyrus inconspicuusCRRanunculus ficari subsp. ficari iformisSCGalium odoratumCRSC/CSRGeum urbanumSCStellaria holosteaCRCSRTrifolium fragiferumC/CRCR/CSROenanthe pimpinelloidesCRCSRVerbascum blattariaCRCRCynosurus cristatusC/CSRC/CRRPhleum exaratum subsp. exaratumC/CSRR/CSRPhillyrea latifoliaC/SCVicia hirsutaCRR/CSRAnagallis arvensisR/CRR/SRKSRKSR	Rubus discolor		С		Cyclamen coum		CR	
Veronica pectinata var. pectinata SC Myosotis sparsiflora R/CR Lathyrus inconspicuus CR Ranunculus ficaria subsp. ficariiformis SC Galium odoratum CR SC/CSR Geum urbanum SC Stellaria holostea CR CSR Trifolium fragiferum C/CR CR/CSR Oenanthe pimpinelloides CR CSR Verbascum blattaria CR Cynosurus cristatus C/CSR Carduus pycnocephalus CR Sonchus oleraceus C/CR Phleum exaratum subsp. exaratum C/CSR Phillyrea latifolia C/SC Vicia hirsuta CR Ranunculus sceleratus CR Myosotis sparsiflora R/CR Anagallis arvensis R/CR R/SR K	Holosteum umbellatum		CR		Sedum pallidum var. bithynicum		R/CR	
Lathyrus inconspicuusCRRanuculus ficaria subsp. ficariiformisSCGalium odoratumCRSC/CSRGeum urbanumSCStellaria holosteaCRCSRTrifolium fragiferumC/CRCR/CSROenanthe pimpinelloidesCRVerbascum blattariaCRCRCynosurus cristatusC/CSRCarduus pycnocephalusCRC/SRSonchus oleraceusC/CRPhleum exaratum subsp. exaratumC/CSRPhillyrea latifoliaC/SCVicia hirsutaCRRanunculus sceleratusCRMyosotis sparsifloraR/CRAnagallis arvensisR/CRR/SRK	Veronica pectinata var. pectinata		SC		Myosotis sparsiflora		R/CR	
Galium odoratum CR SC/CSR Geum urbanum SC Stellaria holostea CR CSR Trifolium fragiferum C/CR CR/CSR Oenanthe pimpinelloides CR Verbascum blattaria CR CR Cynosurus cristatus C/CSR Carduus pycnocephalus CR C/SR Sonchus oleraceus C/CR Phleum exaratum subsp. exaratum C/CSR Phillyrea latifolia C/SC Vicia hirsuta CR Ranunculus sceleratus CR Myosotis sparsiflora R/CR	Lathyrus inconspicuus		CR		Ranunculus ficaria subsp. ficariiformis		SC	
Stellaria holostea CR CSR Trifolium fragiferum C/CR CR/CSR Oenanthe pimpinelloides CR Verbascum blattaria CR CR Cynosurus cristatus C/CSR Carduus pycnocephalus CR C Sonchus oleraceus C/CR Phleum exaratum subsp. exaratum C/CSR C/CSR Phillyrea latifolia C/SC Vicia hirsuta CR R/CSR Ranunculus sceleratus CR KSR Myosotis sparsiflora R/CR	Galium odoratum		CR	SC/CSR	Geum urbanum		SC	
Oenanthe pimpinelloides CR Verbascum blattaria CR Cynosurus cristatus C/CSR Carduus pycnocephalus CR Sonchus oleraceus C/CR Phleum exaratum subsp. exaratum C/CSR Phillyrea latifolia C/SC Vicia hirsuta CR R/CSR Ranunculus sceleratus CR Myosotis sparsiflora R/CR	Stellaria holostea		CR	CSR	Trifolium fragiferum		C/CR	CR/CSR
Cynosurus cristatus C/CSR Carduus pycnocephalus CR Sonchus oleraceus C/CR Phleum exaratum subsp. exaratum C/CSR Phillyrea latifolia C/SC Vicia hirsuta CR R/CSR Ranunculus sceleratus CR Myosotis sparsiflora R/CR Anagallis arvensis R/CR R/SR K	Oenanthe pimpinelloides		CR		Verbascum blattaria		CR	
Sonchus oleraceus C/CR Phleum exaratum subsp. exaratum C/CSR Phillyrea latifolia C/SC Vicia hirsuta CR R/CSR Ranunculus sceleratus CR Myosotis sparsiflora R/CR Anagallis arvensis R/CR R/SR K	Cynosurus cristatus		C/CSR		Carduus pycnocephalus		CR	
Phillyrea latifolia C/SC Vicia hirsuta CR R/CSR Ranunculus sceleratus CR Myosotis sparsiflora R/CR Anagallis arvensis R/CR R/SR K	Sonchus oleraceus		C/CR		Phleum exaratum subsp. exaratum		C/CSR	
Ranunculus sceleratusCRMyosotis sparsifloraR/CRAnagallis arvensisR/CRR/SR	Phillyrea latifolia		C/SC		Vicia hirsuta		CR	R/CSR
Anagallis arvensis R/CR R/SR	Ranunculus sceleratus		CR		Myosotis sparsiflora		R/CR	
	Anagallis arvensis		R/CR	R/SR				

most abundant functional type was CR, the competitor-ruderals (40%). SC/CSR (2%) and S/CSR (2%) were the rarest functional types (Figure 1). Among trees, only *Carpinus orientalis* was SC; the others were C/SC. *Clematis vitalba*, *Smilax excelsa*, and *Hedera helix*, as climbers, were respectively CR, C/CR, and C/CSR. Among other shrubs, *Crataegus monogyna* subsp. *monogyna* was C/SC, *Ligustrum vulgare* was C/CR, and *Cornus sanguinea*, *Ulnus glabra*, and *Rosa canina* were C. Most of the nongraminoids were generally SC/CSR, S/CSR, C/CSR, or S/SC. Competition was the major pressure factor, but disturbance and stress were also effective on the plant species in the highly disturbed plot.

From the less disturbed plot, the 50 plant species collected were allocated into 9 different functional types (Table 2). Most of the plant species collected from the less disturbed plot were allocated into the CR, competitive-ruderal, type (46%) (Table 2), and the others were allocated in turn to the C/SC, C/CR, SC, R/CR, C/CSR, C, SC/CSR, and RC/CSR types (Figure 1). CR/CSR (2%) was the rarest functional type in the less disturbed plot. Of trees, Quercus cerris var. cerris and Quercus petraea subsp. iberica were C/SC, and Carpinus orientalis was SC. Among shrubs, Crataegus monogyna subsp. monogyna and Phillyrea latifolia were C/SC, Rosa canina and Rubus discolor were C, and Hedera helix, as a climber, was C/CSR. While the CSR strategies of most graminoids in this plot were the SC/CSR or C/CSR types, those of nongraminoid herbs were the CR, SC, C/SC, or C/CR



 \blacksquare Plants in less-disturbed plot $\hfill \square$ Plants in highly-disturbed plot

Figure 1. Comparative representation of the functional types of the plant species between plot 1 and plot 2.

types. Similar to the highly disturbed plot, the major pressure factor was competition, but disturbance and stress were also effective. The CSR strategies of annual herbs were mostly CR, R/CR, or C/CR, and those of perennial herbs were SC, S/SC, CR, C/SC, or C/CR, in both plots.

Most of the plant species in the highly disturbed plot were competitors and ruderals. However, in the less disturbed plot, most of the plant species were also stress-tolerators in addition to competitors and ruderals. Although the S/SC and S/CSR functional types were widely found in the highly disturbed plot, no S/SC or S/CSR functional types were observed in the less disturbed plot. Meanwhile, the CR/CSR functional type was found in the less disturbed plot, but no species from that category were recorded in the highly disturbed plot.

Discussion

According to the results of the present study, the number of plant species in plot 1 was much greater than in plot 2. The vegetation cover of plot 1 may be sparse in comparison to plot 2 because of lumbering. For this reason, the light supply per plant species may be different between the 2 plots (lower in plot 2, higher in plot 1). Thus, the plant species in plot 1 may utilise the light and temperature more than those in plot 2. High light and temperature allows more plant species to grow, and this could be a reason for the differences between the 2 plots. Again, succession levels of the plots may be different. In early phases of succession, fast-growing ruderal species are dominant, but in progressive phases of succession, because of competition, competitors are dominant (Smith et al., 2010). Therefore, plot 1 is rich in ruderal species.

In both plots, most of the plant species were competitor-ruderals (CR), but there were more of these in plot 2 than in plot 1. This functional type occurred under 2 selective pressures, competition and disturbance. Grime (1977) explained competitive ruderals (CR) as adapted to circumstances in which there is a low impact of stress and competition is restricted to a moderate intensity by disturbance (e.g. fertile cattle pastures and meadows). Competitive species, i.e. species with dominant competitive ability (C s.l. strategy: C+CR+CS), present high vegetative development, ecological plasticity, and occasionally some allelopathic potential (Vidal et al., 2000; Çakır et al., 2010). The results of our study showed that competition and disturbance were the most effective pressure factors in the study area. Competition was defined as the "tendency of neighboring plants to utilize the same quantum of light, ion of a mineral nutrient, molecule of water, or volume of space" and disturbance as "consist[ing] of the mechanisms which limit the plant biomass by causing its destruction" by Grime (1977). Competitor species have some selective advantages, such as rapid growth, and can be dominant in the vegetation. Ruderal species are characterised by rapid growth, high seed production relative to biomass, small stature with limited lateral spread, and high frequency of flowering. CR species have a combination of competitor and ruderal plant traits.

Quercus cerris var. *cerris* was the dominant species in the study area and was allocated to the C/SC functional type in both plots. In CSR classifications, most of the trees were allocated into the SC group (Figure 2; Grime, 1977). Similarly, all trees were allocated to SC and C/SC in the present study. Grime (1977) defined SC as adapted to undisturbed conditions experiencing moderate intensities of stress (e.g. open forest or scrub on infertile soils).

Functional types of plant species showed that more than one pressure was effective in the study area. Competition and disturbance seemed to be major pressure factors, even if there were stress tolerators. We may consider that not all of the species have similar ecological requirements for growth. Consequently, an ecological factor may be limiting and stress-inducing for one species, but not for others. This may be the reason for the coexistence of different functional types in the same area.

It is thought that Grime's CSR strategy theory may be disqualified in some cases. As Hodgson et al. (1999) reported, several problems exist within 4 particular groups of species: (1) Those for which the stem is the major photosynthetic organ (e.g. *Juncus effusus*). A similar situation was found in the present study for the individuals of *Ruscus aculeatus* in both plots. Since the stem of *R. aculeatus* is the major photosynthetic organ (stem metamorphosis), the predictor variables related to leaves, such as SLA, leaf dry matter content, and leaf dry weight, could not be determined correctly. For this reason, *R. aculeatus* was excluded from analysis in this study. (2) Succulents



Figure 2. Diagram describing the range of strategies encompassed by a- annual herbs, b- biennial herbs, c- perennial herbs and ferns, d- trees and shrubs, e- lichens, f- bryophytes. From Grime (1977).

(*Sedum acre*), which, using the present predictor regressions, are classified as ruderals because of the very high water content of their thick, fleshy leaves. Similarly, in our study, *Sedum pallidum* in plot 2 was classified as R/CR. More detailed studies in the future may solve the problems of classification of succulents according to the CSR system. (3) Low-growing species of very shaded habitats with thin, watery leaves (e.g. *Oxalis acetosella*) and (4) halophytes, for which a substantial correction for ash content is needed when calculating leaf attributes.

We compared our results with internally stored tables covering approximately 1000 European species. The tool looks up the CSR identity (functional type) of each of the species presented (Hunt et al., 2004). Although some of these plants occurred in our study area, there were differences in the plant strategies between the final classifications of Grime's studies and ours (Table 2). These differences may be explained by several factors, including attributes of the study area (location, altitude, climate, nutrient supply, and soil structure), structure and composition of vegetation, and intra- and interspecific interactions of the species found in the study area. The successional stage of the

References

- Bazzaz FA (1987). Experimental studies on the evolution of niche in successional plant populations. In: Gray AJ, Crawley MJ & Edwards PJ (eds.) *Colonization, Succession and Stability*, pp. 245-272. Oxford: Blackwell Scientific Publications.
- Brummitt RK & Powell CE (1992). *Authors of Plant Names*. Kew: Royal Botanic Gardens.
- Caccianiga M, Luzzaro A, Pierce S, Ceriani RM & Cerabolini B (2006). The functional basis of a primary succession resolved by CSR classification. *Oikos* 112: 10-20.
- Campbell BD & Grime JP (1992). An experimental test of plant strategy theory. *Ecology* 73: 15-29.
- Craine JM (2005). Reconciling plant strategy theories of Grime and Tilman. *J Ecol* 93: 1041-1052.
- Craine JM (2007). Plant strategy theories: replies to Grime and Tilman. *J Ecol* 95: 235-240.
- Çakır YB, Özbucak T, Kutbay HG, Kılıç D, Bilgin A & Hüseyinova R (2010). Nitrogen and phosphorus resorption in a salt marsh in northern Turkey. *Turk J Bot* 34: 311-322.
- Davis PH (ed.) (1965-1985). Flora of Turkey and the East Aegean Islands. Vols. 1-9. Edinburgh: Edinburgh University Press.

studied plots might also have affected the final outcomes of the allocations, since CSR strategies may be diverse in different successional phases and the CSR system (Grime, 1974, 1977, 1979) involves the established (or adult) phase of plant life histories (Hodgson et al., 1999). Therefore, further studies that include the factors stated above in their experimental designs are needed to show which factors affect the allocation of plant species into different strategies.

Although the CSR classification, in its current form, is designed only to investigate herbaceous plants (but see Hodgson et al. [1999] for a discussion on possible future developments), it can also allow a functional interpretation of real vegetation in which plant communities are dominated by herbaceous species (Caccianiga et al., 2006). Moreover, the balance between competition, stress, and disturbance is a major determinant of vegetation structure and species composition at any site (McIvor & McIntyre, 1997). In this context, our classification of 85 plant species into CSR strategies (57 of them for the first time) in a woodland in northern Turkey might be useful for further studies on plant community ecology and conservation efforts.

- Davis PH, Mill R & Tan K (eds.) (1988). *Flora of Turkey and the East Aegean Islands* (Suppl. 1). Vol. 10, Edinburgh: Edinburgh Univ Press.
- Decocq G & Hermy M (2008). Are there herbaceous dryads in temperate deciduous forests? *Acta Bot Gallica* 150: 373-382.
- Ecke F & Rydin H (2000). Succession on a land uplift coast in relation to plant strategy theory. *Ann Bot Fenn* 37: 163-171.
- Garbey C, Murphy KJ, Thiebaut G & Müller S (2004). Variation in Pcontent in aquatic plant tissues offers an efficient tool for determining plant growth strategies along a resource gradient. *Freshwater Biol* 49: 1-11.
- Greulich S & Bornette G (1999). Competitive abilities and related strategies in four aquatic plant species from an intermediately disturbed habitat. *Freshwater Biol* 41: 493-506.
- Grime JP (1974). Vegetation classification by reference to strategies. *Nature* 250: 26-31.
- Grime JP (1977). Evidence for the existence of three primary strategies in plants and its relevance to ecological and evolutionary theory. *Am Nat* 111: 1169-1194.
- Grime JP (1979). *Plant strategies and vegetation process*. Chichester, New York: John Wiley.

- Grime JP (1987). Dominant and subordinate components of plant communities: implications for succession, stability and diversity.
 In: Gray AJ, Crawley MJ & Edwards PJ (eds.) Colonization, Succession and Stability, pp. 413-428. Oxford: Blackwell Scientific Publications.
- Grime JP, Hodgson JG & Hunt R (1988). Comparative Plant Ecology. A Functional Approach to Common British Species. London: Unwin Hyman.
- Grime JP (2002). *Plant Strategies, Vegetation Process, and Ecosystem Properties.* 2nd edition. Chichester, New York: John Wiley Second Edition.
- Grime JP (2007). Plant strategy theories: a comment on Craine (2005). J Ecol 95: 227-230.
- Grubb PJ (1987). Some generalizing ideas about colonization and succession in green plants and fungi. In: Gray AJ, Crawley MJ & Edwards PJ (eds.) *Colonization, Succession and Stability*, pp. 81-102. Oxford: Blackwell Scientific Publications.
- Hodgson JG, Wilson PS, Hunt R, Grime JP & Thompson R (1999). Allocating C-S-R plant functional types, a soft approach to a hard problem. *Oikos* 85: 282-294.
- Hunt R, Hodgson JG, Thompson K, Bungener P, Dunnett NP & Askew AP (2004). A new practical tool for deriving a functional signature for herbaceous vegetation. *Appl Veg Sci* 7: 163-170.
- Kandemir A (2009). The rediscovery of some taxa thought to have been extinct in Turkey. *Turk J Bot* 33: 113-122.
- Kautsky L (1988). Life strategies in aquatic soft bottom macrophytes. *Oikos* 53: 126-135.
- Keddy PA (1992). A pragmatic approach to functional ecology. *Funct Ecol* 6: 621-626.
- Lavergne S, Garnier E & Debussche M (2003). Do rock endemic and widespread plant species differ under the leaf-height-seed plant ecology strategy scheme? *Ecol Lett* 6: 398-404.
- McIvor JG & McIntyre S (1997). Responsible use of exotic tropical pasture cultivars an ecological framework. *Trop Grassl* 31: 332-336.
- Murphy KJ, Rørslett B & Springuel I (1990). Strategy analysis of submerged lake macrophyte communities: an international example. *Aquat Bot* 36: 303-302.

- Özen F & Kılınç M (1988). A phytosociological study on the vegetation of Ondokuz Mayıs University Kurupelit campus area and its surroundings. In *IX. National Biological Congress Booklet*, pp. 463-472. Sivas, Turkey.
- Rørslett B (1989). An integrated approach to hydropower impact assessment. II. Submerged macrophytes in some Norwegian hydro-electric lakes. *Hydrobiologia* 175: 65-82.
- Rydin H & Borgegard SO (1991). Plant characteristics over a century of primary succession on islands: Lake Hjalmaren. *Ecology* 72: 1089-1101.
- Smith H, Feber RE, Morecroft MD, Taylor ME & Macdonald DW (2010). Short-term successional change does not predict longterm conservation value of managed arable field margins. *Biol Cons* 143: 813-822.
- Tilman D (1990). Constraints and tradeoffs: toward a predictive theory of competition and succession. *Oikos* 58: 3-15.
- Tilman D (2007). Resource competition and plant traits: a response to Craine et al. 2005. *J Ecol* 95: 231-234.
- Turkington R, Klein E & Chanway CP (1993). Interactive effects of nutrients and disturbance, an experimental test of plant strategy theory. *Ecology* 74: 863-878.
- Vidal E, Médail F, Tatoni T & Bonnet V (2000). Seabirds drive plant species turnover on small Mediterranean islands at the expense of native taxa. *Oecologia* 122: 427-434.
- Weiher E, Vander Werf A, Thompson K, Roderick M, Garnier E & Eriksson O (1999). Challenging Theophrastus: a common core list of plant traits for functional ecology. J Veg Sci 10: 609-620.
- Westoby M (1998). A leaf-height-seed (LHS) plant ecology strategy scheme. *Plant Soil* 199: 213-227.
- White TA, Campbell BD & Kemp PD (1997). Invasion of temperate grassland by a subtropical annual grass across an experimental matrix of water, stress and disturbance. *J Veg Sci* 8: 847-854.
- Wilson PJ, Thompson K & Hodgson JG (1999). Specific leaf area and dry matter content as alternative predictors of plant strategies. *New Phytol* 143: 155-162.
- Wilson SD & Keddy PA (1986). Measuring diffuse competition along an environmental gradient, results from a shoreline plant community. Am Nat 127: 862-869.