Morphological Traits of Red Oak (*Quercus rubra* L.) and Ground Vegetation in Stands in Different Sites and Regions of Lithuania

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Abstract

Red oaks were first introduced in Lithuanian forests in about 1875. This study aimed to assess morphological traits and ground vegetation of red oak stands in different sites and regions of Lithuania. The study was conducted in 32 red oak forest stands located in the western, central and southern regions of Lithuania. Morphological traits of red oak and ground vegetation of the stands were recorded. The differences in morphological traits and ground vegetation of red oak between different sites and regions were assessed using redundancy analysis, canonical correspondence analysis (CCA) and indicator species analysis.

Morphological traits of red oak did not differ significantly between different sites, being similar in both fertile and unfertile sites. Similarly, morphological traits of red oak growing in the southern continental region and western coastal region of Lithuania did not differ significantly. Only two-stems and dense crown trees slightly increased further from the western region. Species number in red oak stands in the southern continental region of Lithuania was lower than that in the western coastal region. The vegetation structure of alien red oak stands differ in southern and western Lithuania.

Key words: red oak, CCA, climatic condition, site type, stem straightness.

Introduction

Invasion ecology has conventionally focused on exotic plant species with early successional life-history traits that are adapted to colonize areas following disturbance (Martin et al. 2009). Most theories of plant invasion have been developed for grasslands communities. Levine et al. (2004) conducted a comprehensive literature review of experimental studies on biotic resistance to exotic plant invasion. Forty-two of the 53 studies covered by the review were conducted in grasslands or grass-like communities, whereas only six were conducted in forests or shrublands. However, there is a lack of research describing shade-tolerant forest species. Shade-tolerant alien trees are highly invasive; however, their pool is relatively small because most invasive woody species were deliberately introduced and chosen specifically for their early successional life-history traits (Martin et al. 2009). Observations of forest tree invasion are complex because the environmental impacts may be seen only after some time. Forest trees mature and begin to produce seedlings much later than trees in an open landscape. In addition, formation of new plant communities following clear-cutting takes time. Plant communities in plots of planted alien species differ from those in native forest. However, such studies can be conducted only in mature stands where alien species have been planted at least 50 years previously. Fruiting red oaks in Lithuanian forest stands were analyzed in the present study of vegetation communities.

Red oak (*Quercus rubra* L.) was introduced in Europe in the 17th century. Before being planted in forests, it was first planted in botanical collections. The first use in forestry was at the end of the 19th century and beginning of the 20th century (Duceusso et al. 1997). Plantations were established all over Europe. In Russia, red oaks have grown in the park of the St. Petersburg forest technical academy since 1870. Red oak was planted in many places in Ukraine. In Belovezh forests of Poland, red oak trees producing seeds and saplings are abundant in the understory of the stands. In the Saratov region of Russia, red oak has become naturalized (Якушев and Березуцкий

2007). In Latvian Švedes forest, red oak has been growing since the end of the 19th century (Dreimanis 2006).

Red oaks were introduced in Lithuanian forests in about 1875 (Ramanauskas 1963). In 1950, they were found in 95 forest sites (Gelaževičius 1950). In 1962–1963, in Lithuania, ten fast-growing, good-quality stemmed and crowned trees were selected for study. Because of fast growth in the young stage, red oak was considered as highly productive, and broader planting was recommended (Kairiūkštis 1968).

Today, there are 73 red oak stands in Lithuanian forests; however, only a few are mature. Red oak is naturalized in Lithuania and could spread up to 1–1.5 km under poorer site conditions (Riepšas and Straigytė 2008). It is important to evaluate the economic value of red oak and potential negative influence of this species on forest ecosystems. Alien species may be recommended for forest cultivation if they are more economically attractive than native species. It is therefore necessary to evaluate morphological traits of red oak under different growth conditions for use of these traits as indicators of timber quality in forests.

This study aimed to characterize morphological traits of *Q. rubra* and vegetation communities that develop under the influence of these alien trees in Lithuanian forests in different forest sites and climatic regions. Our objectives were as follows: to determine whether red oak forests in southern part of Lithuania showed differences in tree morphological traits and ground vegetation vs. those in the western part of Lithuania; to detect differences in tree morphological traits in sites of the different fertility.

Materials and methods

The study was conducted in 32 red oak forest stands located in the western, central and southern regions of Lithuania (Figure 1). The western region is situated near the coast and has a milder oceanic climate, whereas the southern and central regions have a more continental climate. Because of similar climatic conditions and the low number of red oak stands in central Lithuania, vegetation samples in the central and southern regions were analysed simultaneously. Red oak stands were investigated from 2010 to 2011. The experimental plots were selected in 40-–80-year-old stands dominated by red oak. Genetic origin of red oak was unknown, but acorns of red oak most likely were collected in the same region (Kaliningrad region). All trees were planted using conventional technologies and we assume no difference in planting technology.

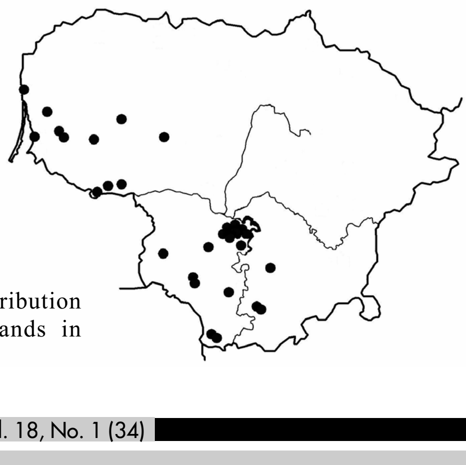

Figure 1. Distribution of red oak stands in Lithuania

In every stand, the following morphological traits of red oak were measured: tree age, height, diameter at breast height (DBH), tree position according to the Kraft classification, crown top condition, crown dieback, crown size, crown density, stem damage, stem straightness, straight stem height, stem form, angle between stem and crown and branch accretion. Tree heights were measured with a Haglof electronic clinometer. Tree ages were determined using an increment borer and counting the rings from the outside edge of the core to the pith.

Crown dieback was defined as branch mortality that begins at the terminal portion of a branch and proceeds toward the trunk. Dead branches below the upper 50% of the crown were assumed to have died from competition and shading, and were not considered part of crown dieback. Binoculars were used for data collection. Crown density was measured from 1 length tree height away from the tree. Foliage below the crown ball was not included in the crown (Tallent-Halsell 1994). In total, 271 trees were measured.

Forest sites were classified into three classes according to soil nutrient availability (Table 1): unfertile sites (authomorphic sands, low nutrient availability soils); fertile sites (authomorphic sands or sandy loam, intermediate nutrient availability soils); very fertile sites (authomorphic loamy or clay loamy, high nutrient availability soils).

All ground vegetation species in the stand were recorded. Projection cover was estimated according to the Braun-Blanquet scale (Dierschke 1994). Thirty-two geobotanical descriptions were made: 19 in southern and 13 in western Lithuania. Nomenclature was according to Rothmaler (1972, 1990).

The differences in morphological traits of red oak between site types and regions were assessed using the weighted-averaging (constrained unimodal) ordination method, partial detrended canonical correspondence analysis (DCCA) (Lepš and Šmilauer 2003) and indicator species analysis by PC-ORD (Dufrene and Legendre 1997). Covariables were used in addition to the explanatory variables in partial DCCA. In the partial analysis, the variation in morphological trait composition explained by the covariables was subtracted,

Table 1. Description of forest sites (authomorphic soils) (after Karazija (1988), Buivydaitė (2002), Vaičys et al. (2006))

Symbol	Nb	Nc	Nd
Degree of soil fertility	Unfertile	Fertile	Very fertile
Soil texture	Sand	Sandy loam, loam	Clay loam, clay
pH_{KCl}	4.3±0.1	4.5±0.1	4.8±0.1
% Base Saturation	25±3	33±3	43±3
Average amount of humus in top soil (0-50 cm) $t*ha^{-1}$	89±7	100±5	111±5
Average amount of nitrogen in top soil (0-50 cm) $t*ha^{-1}$	5.0±0.3	5.5±0.3	5.9±0.3
Average amount of K_2O in top soil (0-50 cm) $kg*ha^{-1}$	266±34	364±28	575±38
Average amount of P_2O_5 in top soil (0-50 cm) $kg*ha^{-1}$	95±23	237±22	347±334
Main soil types according FAO (2006)	*Albic ARENOSOL*	*Haplic ARENOSOL Haplic PLANASOL Haplic LUVISOL*	*Mollic PLANASOL Haplic CAMBISOL*
Main* and secondary tree species	Pine*, spruce, birch, aspen	Spruce*, pine, birch, aspen, oak	Oak*, spruce, birch, hornbeam, aspen, lime, grey alder, pine, ash

and constrained ordination on the residual variation was then performed. Such an analysis allowed separation of the effects of regions and site-type fertility on morphological traits from those of the covariables. Second-order polynomial detrending, inter-response variable distance scaling of ordination scores and biplot scaling were used for the analysis. A response variable was included in the ordination diagrams if it fitted 3 or more ordination diagrams (Lepš and Šmilauer 2003). The distance between the symbols of morphological traits in the ordination diagram approximates the distribution dissimilarity of relative abundances of those traits across the samples as measured by their chi-square distance. Morphological trait points in proximity correspond to traits often occurring together. Centroids of environment (dummy) variables are interpreted as individual groups of samples. The distance of a morphological trait point from the symbols of an individual group shows the relationship of that morphological trait with the group. The trait is predicted to occur with the highest relative frequency in groups whose symbols lie nearest to that particular group of sample points.

Indicator values in our analysis show the percentage of perfect indication of morphological traits in sites and regions. It is based on combining the values for the relative abundance of trees with a specific morphological trait in the group and the relative frequency of this trait in the group. The relative abundance and frequency of trees showing each morphological trait were calculated for red oak stands. A Monte Carlo test of significance of the observed maximum indicator value with 1000 permutations was performed.

The differences of red oak forest vegetation between different sites and regions were evaluated by detrended correspondence analysis (DCA), canonical correspondence analysis (CCA) and partial CCA (Jongman 1997) using the program CANOCO for Windows (Lepš and Šmilauer 2002). The variation in vegetation composition explained by the covariables was subtracted, and constrained ordination on the residual variation was performed in partial CCA. Such an analysis allowed separate effects of regions on vegetation from those of the covariables (site types). A Monte Carlo test of significance was then performed.

Results and discussion

Morphological traits

The average indices of morphological traits of red oak trees are shown in Table 2. The oldest red oak stands were in western Lithuania, whereas the youngest were in central Lithuania. The majority of trees with whole tops, normal-sized leaves and angular stem form belonged to the second Kraft class and displayed a crown branch angle of 50–70°. In the southern region of Lithuania, the crown density of trees was 40%–50%. The crown density was lower in the western region. Most crowns showed no dieback. Conversely, in the southern region of Lithuania, occurrence of crown dieback

Table 2. Average indices of morphological traits of red oak trees

Site by nutrient regime	Infertile	Fertile	Very fertile	Infertile	Fertile	Very fertile
Region of Lithuania	southern	southern	southern	western	western	western
n	6	115	57	20	44	29
Age	35	55	50	70	56	53
Height (m)	17	20	24	26	21	26
DBH (cm)	27	28	30	30	32	30
Crown dieback	0	<30%	<30%	0	0	0
Crown size	medium	wide	medium	medium	medium	medium
Crown density	40%–50%	40%–50%	40%–50%	40%–50%	30%–40%	30%–40%
Straight stem height (m)	4.5	9.3	8.5	8.6	5.9	5.7

was observed on numerous occasions; however, it did not exceed 30%. Straight stem height was 8–10 m in most sites and regions, except in western Lithuania where it was 2–4 m lower. Morphological traits of red oaks of different ages did not differ significantly.

In the fertile (c) site, red oak trees tended to have wider crowns, straight stems and narrow crown branch angles (Figure 2). According to partial DCCA, the covariables (regions dummy variables, tree age, stand stocking level) explained 3.95% of the total inertia, whereas site fertility, after accounting for the covariables, explained 2.31%. The Monte Carlo test with 1000 permutations under the reduced model of significance of all canonical axes gave an F-ratio of 2.166 and a p-value of 0.001. The total inertia in a unimodal method is the total variance in the dependent variables as measured by the chi-square statistic of the table of sample-dependent variables divided by the table total (ter Braak and Šmilauer 2002). Most (93.73%) of the total inertia of the variation in morphological trait was unexplained.

Significant differences were found between regions in occurrence of oak trees with 40%–49% crown

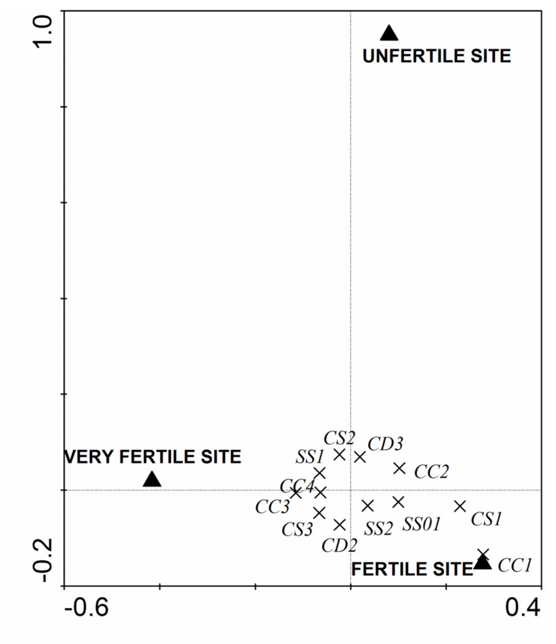

Figure 2. Partial detrended canonical correspondence analysis (DCCA) ordination diagram constrained on residual variation in morphological traits of red oak by site fertility after accounting for the effect of region, tree age and stand stocking volume. The first canonical axis is the horizontal one. SS01: straight single stem; SSI: curved single stem; SS2: two-stemmed tree; CC1: crown branch angle ≥ 90°; CC2: crown branch angle 70–90°; CC3: crown branch angle 50–70°; CC4: crown branch angle 30–50°; CD2: crown density 30%–39%; CD3: crown density 40%–49%; CS1: crown wide; CS2: crown medium-sized; CS3: crown narrow

density (Table 3). Morphological traits showed no significant differences by site; however, the following few tendencies could be distinguished: three-stemmed trees were more typical on unfertile sites , crown branch angles of 50–70° were more common on fertile sites and varied on infertile sites, whereas wide crowns were more common on fertile sites.

Table 3. Morphological traits of red oak in different sites

Phenotype difference (phenotype code in DCCA)	Maximal indicator value in the group	Very fertile sites	Fertile sites	Infertile sites	Monte Carlo test, P*
Crown size narrow	33	3	23	25	0.439
Crown size medium	45	33	20	45	0.152
Crown size wide	43	43	24	5	0.198
Crown density 20%–29%	38	14	38	0	0.222
Crown density 30%–39%	39	32	39	26	0.476
Crown density 40%–49%	50	28	16	50	0.028
Crown density 50%–59%	23	23	14	0	0.493
Stem straight	40	13	40	26	0.435
Stem crooked	38	38	24	37	0.673
Two-stemmed tree	34	31	34	13	0.704
Three-stemmed tree	36	9	9	36	0.201
Crown branch angle >70°	39	12	39	25	0.458
Crown branch angle 50–70°	45	45	13	10	0.198
Crown branch angle 30–50°	35	35	24	21	0.713
Crown branch angle < 30°	24	7	24	11	0.710

In the southern region, considered a continental one, two-stemmed trees with denser crowns are expected (Figure 3). According to partial DCCA, the region (dummy variables) factor, after accounting for covariables (site-type fertility dummy variables, tree age and stand stocking level) explained 2.01 % of the total inertia (Monte Carlo Test with 1000 permutations under reduced model of significance of all canonical axes: $F = 5.631$; $p = 0.001$). The covariables explained 4.26% of the total inertia.

All alien species in a new ecosystem have a different floristic and climatic environment. Their success is often influenced by the presence of few enemies (the enemy release hypothesis; Keane and Crawley 2002). Introduced plants face 84% fewer fungal species and 24% fewer virus species than those growing in their natural environment (Mitchell and Power 2003). Red oak grows faster in Europe and suffers less damage by enemies than in its natural environment in North America (Blossey and Nötzold 1995). Our research results agree with these propositions; red oak trees are very healthy and free of mildew and virus diseases in Lithuanian forests.

At the young stage, red oaks show better volume growth than native oaks (Daubrée and Kremer 1993). They possess good potential for natural coppicing and seed regeneration. Susceptibility to fungi and insect damage does not differ markedly from that of native tree species (Danusevičius et al. 2002). Previous studies show that in very fertile sites, the growth in height of red and common oaks is similar. In fertile sites, red

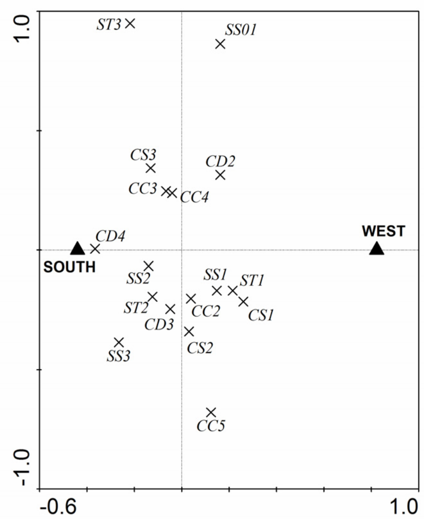

Figure 3. Partial detrended canonical correspondence analysis (DCCA) ordination diagram constrained on residual variation in morphological traits of red oak by region after accounting for the effect of site-type fertility, tree age and stand stocking volume. Only one independent constraint (horizontal axis) is formed from the environmental data. SS01: straight single stem; SSI: curved single stem; SS2: two-stemmed tree; SS3: three-stemmed tree; ST1: straight stem height up to 6 m; ST2: straight stem height 6.1-12 m; ST3: straight stem height 12.1-18 m; CC2: crown branch angle 70-90°; CC3: crown branch angle 50-70°; CC4: crown branch angle 30-50°; CC5: crown branch angle < 30°; CD2: crown density 30%-39%; CD3: crown density 40%-49%; CD4: crown density 50%-59%; CS1: crown size wide; CS2: crown size medium; CS3: crown size narrow

oak grows faster in diameter up to 80 years of age; however, at later stages, no marked difference in growth rate is observed between these species (Gradeckas 2005). The low number of enemies allows red oak to put its energy into growth rather than defence (Gradeckas and Malinauskas 1990). These observations favour increased plantation of red oak in the forest. However, because red oak plantations were established with low-quality planting material, the stands possess stems whose quality is poor and not better than that of native oak stems (Danusevičius 2002). Our results are in agreement with these results. In both regions and all sites, the stem quality is very poor, with two-stemmed trees and straight stems that are very short for the timber industry. From the point of view of the timber industry, red oak is less valuable than the native pedunculate oak under all growing conditions.

Vegetation composition

We recorded 113 species of ground vegetation in total: 99 in southern and 59 in western Lithuania. In total, 30 species were found in the ground layer: 28 in southern and 14 in western Lithuania. The most frequent species in southern Lithuania were *Sorbus aucuparia, Acer platanoides, Corylus avellana, Padus serotina, Picea abies* and *Malus toringo.* The most frequent species in western Lithuania were *Padus avium, Frangula alnus, Fraxinus excelsior* and *Acer pseudoplatanus*. In total, 78 species were recorded in the herb layer: 67 in southern and 43 in western Lithuania. The most frequent species in southern Lithuania were *Aegopodium podagraria, Veronica chamaedrys, Veronica officinalis, Hepatica nobilis* and *Luzula pilosa.* The most frequent species in western Lithuania were *Oxalis acetosella, Stellaria media, Viola riviniana, Deschampsia flexuosa* and *Melampyrum nemorosum* (Table 4).

Table 4. Distribution of ground vegetation in the southern and western regions of Lithuania

Name of species	Frequency %		
	Average	Southern	Western
1	2	3	4
Undergrowth			
Quercus rubra	81	79	85
Sorbus aucuparia	56	68	38
Padus avium	41	32	54
Acer platanoides	34	42	23
Corylus avellana	34	47	15
Frangula alnus	34	26	46
Fraxinus excelsior	25	21	31
Padus serotina	19	26	8
Picea abies	19	26	8
Malus toringo	16	26	0
Amelanchier spicata	13	16	8
Pinus sylvestris	13	21	0
Tilia cordata	13	11	15
Acer pseudoplatanus	9	0	23
Betula pendula	6	11	0
Chaenomeles	6	11	0
Euonymus europaeus	6	11	0
Physocarpus opulifolius	6	11	0
Populus tremula	6	11	0
Rhamnus cathartica	6	11	0
Salix caprea	6	11	0
Sambucus racemosa	6	11	0
Ulmus glabra	6	11	0
Carpinus betulus	6	5	8
Acer campestre	3	5	0
Acer tatarica	3	5	0
Aesculus pavia	3	5	0
Sorbaria sorbifolia	3	5	0
Viburnum opulus	3	5	0
Sambucus nigra	3	0	8
Lonicera xylosteum	3	0	8
Herbs			
Rubus idaeus	50	47	54
Oxalis acetosella	34	26	46
Maianthemum bifolium	31	32	31
Aegopodium podagraria	28	32	23

Table 4 continued

1	2	3	4
Mycelis muralis	28	26	31
Veronica chamaedrys	25	37	8
Stellaria media	25	21	31
Veronica officinalis	22	32	8
Urtica dioica	22	21	23
Viola riviniana	22	16	31
Deschampsia flexuosa	22	11	38
Equisetum pratense	19	21	15
Stellaria holostea	19	21	15
Vaccinium myrtillus	19	21	15
Anemone nemorosa	16	26	0
Hepatica nobilis	16	26	0
Luzula pilosa	16	26	0
Festuca ovina	16	21	8
Poa nemoralis	16	16	15
Fragaria vesca	16	11	23
Impatiens noli-tangere	13	21	0
Ajuga reptans	13	16	8
Deschampsia cespitosa	13	16	8
Lamiastrum galeobdolon	13	16	8
Dryopteris filix-mas	13	11	15
Melampyrum nemorosum	13	0	31
Chamerion angustifolius	9	16	0
Pteridium aquilinum	9	16	0
Solidago virgaurea	9	11	8
Calamagrostis arundinacea	9	5	15
Hypericum perforatum	9	5	15
Trientalis europaea	9	5	15
Agrostis capillaris	6	0	15
Circaea lutetiana	6	11	0
Convolvurus arvensis	6	11	0
Dryopteris carthusiana	6	11	0
Epilobium montanum	6	11	0
Galium album	6	11	0
Hieracium umbelatum	6	11	0
Taraxacum officinale	6	11	0
Brachypodium sylvaticum	6	5	8
Convallaria majalis	6	5	8
Equisetum sylvaticum	6	5	8

Table 4 continued

1	2	3	4
Hieracium murorum	6	5	8
Impatiens parviflora	6	5	8
Polygonatum multiflorum	6	5	8
Stellaria nemorum	6	5	8
Asarum europaeum	6	0	15
Athyrium filix-femina	6	0	15
Dryopteris cristata	6	0	15
Actaea spicata	3	5	0
Arabis glabra	3	5	0
Carex digitata	3	5	0
Chelidonium majus	3	5	0
Crepis paludosa	3	5	0
Dactylis glomerata	3	5	0
Fallopia convolvulus	3	5	0
Festuca giganthea	3	5	0
Hypericum maculatum	3	5	0
Lupinus luteus	3	5	0
Milium effusum	3	5	0
Nardus stricta	3	5	0
Paris quadrifolia	3	5	0
Parthenocisus quinquefolia	3	5	0
Phyteuma spicatum	3	5	0
Ptelea trifoliata	3	5	0
Ranunculus lanuginosus	3	5	0
Rumex acetosella	3	5	0
Stachys sylvatica	3	5	0
Viola mirabilis	3	5	0
Viola reichenbachiana	3	5	0
Anthriscus sylvestris	3	0	8
Astragalus glycyphyllos	3	0	8
Galeopsis tetrahit	3	0	8
Geum rivale	3	0	8
Geum urbanum	3	0	8
Mosses			
Pleurozium schreberi	25	21	31
Plagiomnium undulatum	19	32	0
Atrichum undulatum	6	11	0
Polytricum juniperinum	6	11	0
Rhizomnium punctatum	6	0	15

Detrended correspondence analysis (DCA) showed that red oak forest in the regions was differentiated in the ordination space (Figure 4). Red oak stands in the southern and western regions formed separate groups, indicating that the species composition of red oak communities differed between the southern and western regions.

Canonical correspondence analysis (CCA) of the vegetation of red oak with region and stand-structure indices (species number; tree cover; site conditions; shrub, herb and moss layers) showed (Figure 5) that in red oak stands in southern Lithuania the covers of mosses and shrubs and the stand second layer were higher than those in western Lithuania. Red oak stands in southern Lithuania grew in more nutrient-deficient sites. In stands in western Lithuania, the herb cover and basal area of the stand were greater than those in southern Lithuania.

The Monte Carlo test of CCA of red oak ground vegetation with region as an environmental variable accounting for site-type influence (as covariables) showed significant differences (F =1.431, p = 0.014). Region accounted for 4.9% of the variation in ground vegetation.

All the studied forest stands are reforested with red oak after clear-cutting. Formation of stable vegetation communities requires a long time. Vegetation communities that form in red oak stands remain un-

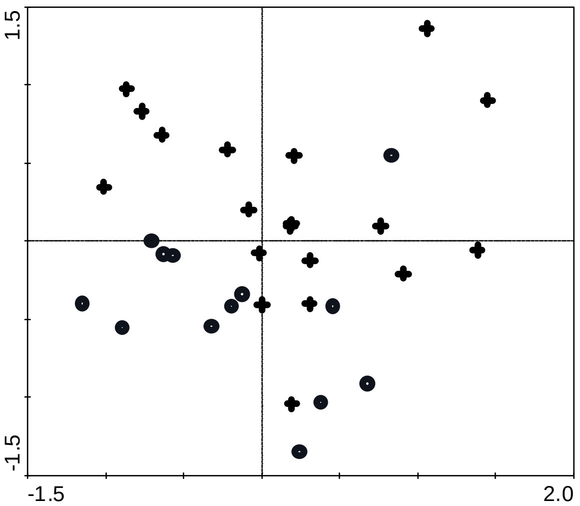

Figure 4. Detrended correspondence analysis (DCA) ordination of ground vegetation of red oak stands. O: western Lithuania; +: southern Lithuania

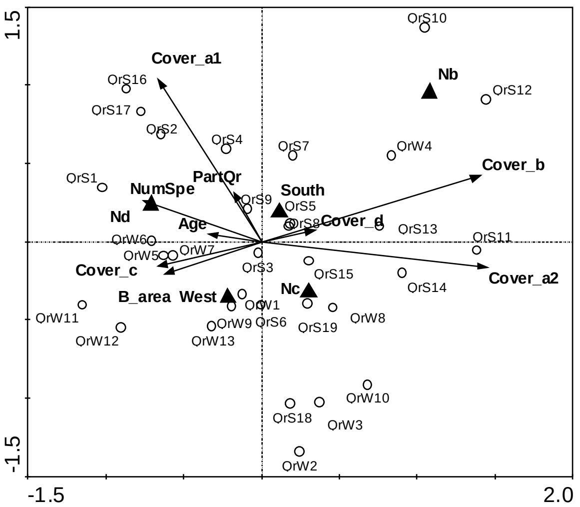

Figure 5. Canonical correspondence analysis (CCA) ordination of ground vegetation of red oak with stand-structure indices and environmental variables. Nb: unfertile sites; Nc: fertile sites; Nd: very fertile sites; B_area: basal area of the stand; NumSpe: number of species; PartQr: proportion of red oak in stand; South: southern region of Lithuania; West: western region of Lithuania; Cover_a1, Cover_a2, Cover_b, Cover_c, Cover_d: cover of first stand layer, second stand layer, undergrowth, herb layer and moss layer, respectively

known because this species is alien and has become established in Lithuanian forests only recently. Our study on vegetation structure of red oak stands is the first in Lithuania and we have no other data for comparison. These data will be valuable for future research. Invasive woody plant species that alter the vegetation structure and species composition of native communities pose conservation problems (Martin 1999). Comparative studies of alien red oak and native oak forest stands showed a negative effect of red oak on ground vegetation diversity (Marozas et al. 2009) and soil microorganism activity (Straigytė et al. 2009). Red oak stands may threaten to change the vegetation community structure in the future because of the vigour of seedling spread and their successive occupation of new forest gaps.

Conclusion

1. Morphological traits of red oak that grew in the southern continental and western coastal regions of Lithuania did not differ significantly. Only two-stems and dense crown trees slightly increased further from the western region.
2. Morphological traits of red oak did not differ significantly between unfertile and fertile sites.
3. Species number was lower in red oak stands in the southern continental region of Lithuania. The vegetation structure of alien red oak stands differ in southern and western Lithuania.

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МОРФОЛОГИЧЕСКИЕ ОСОБЕННОСТИ ДУБА КРАСНОГО (*QUERCUS RUBRA* L.) И РАСТИТЕЛЬНЫЙ ПОКРОВ В ДРЕВОСТОЯХ НА ПОЧВАХ РАЗЛИЧНОГО ПЛОДОРОДИЯ В РАЗЛИЧНЫХ РЕГИОНАХ ЛИТВЫ

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Резюме

Посадка дуба красного в Литве впервые началась примерно в 1875 году. Цель исследования — установить морфологические признаки дуба красного и растительный покров на участках различного плодородия и в различных регионах. Исследования проводились в 32 древостоях, расположенных в западной, центральной и южной частях Литвы. Оценивались морфологические признаки дуба красного и растительный покров участков. Различия морфологических признаков и растительного покрова оценивались с использованием многомерных методов (DCA, CCA, DCCA) и индикаторного видового анализа.

Установлено, что различия плодородия почвы на морфологические признаки дуба красного влияния не оказывают. Морфологические признаки исследуемых деревьев, произрастающих как на плодородной, так и на менее плодородной почве, схожие. Отмечены незначительные морфологические различия признаков дуба красного в континентальной части по сравнению с дубом красным на прибрежных участках. В континентальной части Литвы установлено чуть большее число двуствольных дубов с более густой кроной. Различается также растительный покров участков дуба красного в западных и южных регионах.

Ключевые слова: иноземные виды, CCA, регион, участок, растительность