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Comparison of the herb layer composition in stands of several tree species in the Louny region

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Influence of introduced northern red oak stands (*Quercus rubra* L.) on herb understory with comparison with herb understory of autochthonous Sessile oak (*Quercus petraea* agg. L) and Scots pine (*Pinus sylvestris* L.) was observed in Louny region area on 14 plots. The analysis of the ground vegetation was performed using classical phytosociological methods. Significant changes were not determined in the site character, when comparing particular tree species stands, the differences consisted especially in the natural regeneration of tree species. Northern red oak showed a tendency of more fast penetration in the neighboring stands.

Key words: northern red oak, *Quercus rubra*, Sessile oak, *Quercus petraea* agg., Scots pine (*Pinus sylvetsris*), herb layers, comparison

Introduction

The northern red oak (*Quercus rubra* L.) has been planted in the Europe since 1691. Tree was very attractive in parks and ornamental collonades due to its marvellous colour in the autumn. Since 70‘s and 80‘s of the 20th century it has been speculating about its plantation in Czechoslovak forests due to hard dieback of autochthonous oak species (namely Sessile oak – *Q. petraea* agg. L.) by tracheomycosis (Burkovský 1985, Čapek et al. 1985, Gubka et Špišák 2010). Despite increased interest, this introduced tree species covers only 0.14% of the whole forest cover of Czechia to the year of 2010 (Miltner 2016). To make its wider use in forestry, it requests to know more about its influence on the habitat of the natural landscape. Podrázský (1995) found that this introduced tree species could be the best for afforestation of reclamation areas due to fine litter and suitable humus form in such planted stands. Herb layer represents the clear reflection of the environmental conditions. It is often used as a bio-indication of the habitat (e.g. Kulich at al. 2002). Characteristic composition of the oak forest herb layer (including red oak stands, of course) in Eastern North America is described by McClenahen et Long (1995). Detailed description was made by Straigyté et al. (2012), including herb layer of red oak stands in Lithuania. This paper is the first step to show possible differences of herb layer in red oak stands (introduced tree species) and Sessile oak, Scots pine and European beech stands (natural tree species) in the Czech conditions.

Methods

Chosen area of Louny district is characteristic by the lack of precipitation due to massive of Krušné hory Mts. (Ore Mts.) on the west. Plots were set up close Budyně nad Ohří and Peruc (Louny region). Climatic and soil conditions are described by Miltner (2016). Phytocoenological relevés were made in close canopy stands (2nd age class and older) of red oak and adjacent stands covered by autochthonous tree species (Tab. 1 + Appendix). Zlatník's scale has been used to describe species coverage (Zlatník 1978, p. 152). Taxonomical nomenclature was used according to Kubát (2002). Relevés were described in DBreleve program (Matějka 2013). Ellenberg's eco-values (Ellenberg et al. 1992) were computed for every relevéd plot as weighted averages of species coverage and tabulated values.

Relevés were classified by Ward (1963) method in PC-ORD system. Afterwards relevés were processed by CANOCO program (ter Braak et Šmilauer 2002), in which indirect gradient analysis DCA was used. This analysis has opened variability of the herb layer composition.

Results

Tab. 1 shows results of Ellenberg's eco-values. They could be influenced by the small amount of species in E_1 layer, their low coverages and also by the lack of tabulated values of some species – either due to species indifference to corresponding factor or species is not tabulated (e.g. *Quercus rubra*). The highest dispersion shows factor of the light stand conditions (I_L <3.02; 7.98>; i.e. shadow to semi-sunny habitats). Semi-sunny habitats apparently correspond with possible light penetration from the stand border, since the stands canopy were 80% at least (Appendix). Higher values of dispersion have proved to indices of soil reaction (I_R <2.37; 5.00>; i.e. acidophilous to slightly acidophilous habitats) and soil nitrogen content (I_N <3.64; 6.00>; i.e. poor to rich nitrogen content habitats). Nitrogen content is influenced by the litter amount and its type (see dominant tree layer – Appendix) and also by an intensive agriculture activity in the close area, since this landscape has historically agricultural use (and the forests are often secondary there – Koláček 2009). According to humidity, habitats are slightly to fresh humid (I_H <4.50; 5.33>). Indices of temperature (I_T <4.99; 5.99>) and continentality (I_C <2.00; 3.94>) fit to localities – foothill zone and west of the Central Europe.

DCA ordination (Fig. 1) shows marked difference of the plot PE 4 from all others. A closer look at the input data (Appendix) indicates, that vegetation of this plot fits to a higher forest vegetation zone (FVZ) – beech. Second ordination axis divides plots according to nutrient content, from poor – plot BU 5 to nitrogen rich – plot BU 3.

Ward's dendrogram (Fig. 2) divides plots to 4 groups. Plots BU 1, BU 4, PE 1 and PE 2 belong to 1st group. *Quercus rubra* and *Rubus fruticosus* dominate on understory (E_1) of these plots. Plots BU 2, BU 7, BU 5, BU 3, BU 6 and BU 8 cover 2nd group. These plots have not conspicuous dominance of some species in understory (E_1) and beyond plot BU 7, they have more species with low coverage in understory. Third group represents only one plot PE 4. As it is documented by DCA ordination (Fig. 1), this plot is different by its dominance of *Fagus sylvatica* in understory (E_1) as the only plot. The last 4th group covers plots BU 9, BU 10 and PE 3. They are plots in whose understory (E_1) *Quercus petraea* dominates, which are plots of compared autochthonous tree species.

Discussion

Chmura (2013) and Woziwoda et al. (2014) dedicate to influence of northern red oak on herb understory in south Poland territory, mainly of industrial Silesia forests, by more wide studies. Real natural forests almost don't exist there in this plane (or slightly hilly) area. Forests with autochthonous tree species are there only and also forests with these introduced species. Marozas et al. (2008) compared understory layer of northern red and common oaks forests (*Quercus robur*), but in such not industrial area yet. They all conclude, that herb understory in northern red oak stands is species poorer in comparison to autochthonous tree species stands with common oak. Their area is climatically different of ours and soils are more humid. Therefore, common oak was dominant tree species for comparison. As it is mentioned above, our plots were in rain shadow area (therefore sessile oak and Scots pine) and mostly nutrient poor (see forest type – Tab. 1). Results of our observation are rather different for this reason. Conditions of abiotic environment are reflected on all stands with

Table 1: Basic information about study plots

Localities	Budyně nad Ohří										Peruc			
Plots	**BU 1**	**BU 2**	**BU 3**	**BU 4**	**BU 5**	**BU 6**	**BU 7**	**BU 8**	**BU 9**	**BU 10**	**PE 1**	**PE 2**	**PE 3**	**PE 4**
Dominant tree species	*Q. rubra*	*Q. rubra*	*Q. rubra*	*P. sylvestris*	*Q. rubra*	*P. sylvestris*	*Q. rubra*	*P. sylvestris*	*Q. petraea*	*Q. petraea*	*Q. rubra*	*Q. petrea + other*	*Q. petraea*	*F. sylvatica*
Exposure	S	0	0	0	0	0	0	0	0	0	0	0	0	S
Slope (°)	2	0	0	0	0	0	0	0	0	0	0	0	0	10
Stand canopy (%)	90	90	90	90	95	90	100	80	80	95	95	95	95	100
E0 (%) layer (moss)	0	5	0,5	0	0,5	0,5	0,1	0,5	0,5	0,5	0	0	0	0,1
E1 (%) layer	30	1	5	20	5	10	0,1	5	40	40	20	40	60	50
E2 (%) layer	10	0	0	10	10	30	0	30	10	0	0	5	40	0,5
E3 (%) layer	90	90	90	90	95	90	100	80	80	95	95	95	95	100
Average of stand age	41	41	41	41	49	36	34	64	73	111	103	104	150	109
Forest type (Viewegh 2000)	1K1	1K1	1K1	1K1	1S6	1S6	1K1	1K1	1S6	1S6	1S6	1S6	1C2	1S6
Elevation (m a.s.l.)	297	272	274	289	276	276	270	275	275	280	300	305	329	329
Latitude	50°21,722’	50°21,737’	50°21,774’	50°21,712’	50°21,575’	50°21,592’	50°21,683’	50°21,690’	50°21,721’	50°22,228’	50°22,172’	50°22,157’	50°21,855’	50°21,893’
Longitude	14°19,513’	14°19,398’	14°19,226’	14°19,192’	14°19,288’	14°19,905’	14°19,976’	14°19,961’	14°19,964’	14°20,978’	13°59,070’	13°59,087’	13°58,966’	13°58,933’

one exception. Both compared stands (northern red oak and adjacent sessile oak, event. Scots pine) also content northern red oak seedlings, but sessile oak seedlings are present on mother stands only and Scots pine seedlings lack (see Appendix). Absence of Scots pine seedlings could be explained by the fact, that pure stands of this tree species are not autochthonous here, which is declared by classification of forest types (Tab. 1). However, it should be emphasized, that our observation has been made in specific territory (rain shadow) and on 14 plots only. We have to extend our research to other territories, but it could be problem to find sufficient amount of plots, since the northern red oak total area is 6000 ha only in Czechia (Miltner 2016) and stands area of the third age class and older is considerably smaller (Kouba et Zahradník 2011).

Conclusion

Results of Ellenberg's eco-values (Tab. 2) have not proved differences among *Quercus rubra* and *Q. petraea* (*Pinus sylvestris* and *Fagus sylvatica* alternatively) stands in soil reaction and nitrogen content factors primarily. This shows, that the introduced *Q. rubra* does not appreciably influence soil chemistry. However, the further analyses (Ward's dendrogram and DCA ordination) show, that adult stands of the introduced tree species (*Q. rubra*) expanded more by its juvenile seedlings to adjacent compared stands of autochthonous *Q. petraea* and *P. sylvestris*. It could be symptom of its better germination and survivability in drier habitats.

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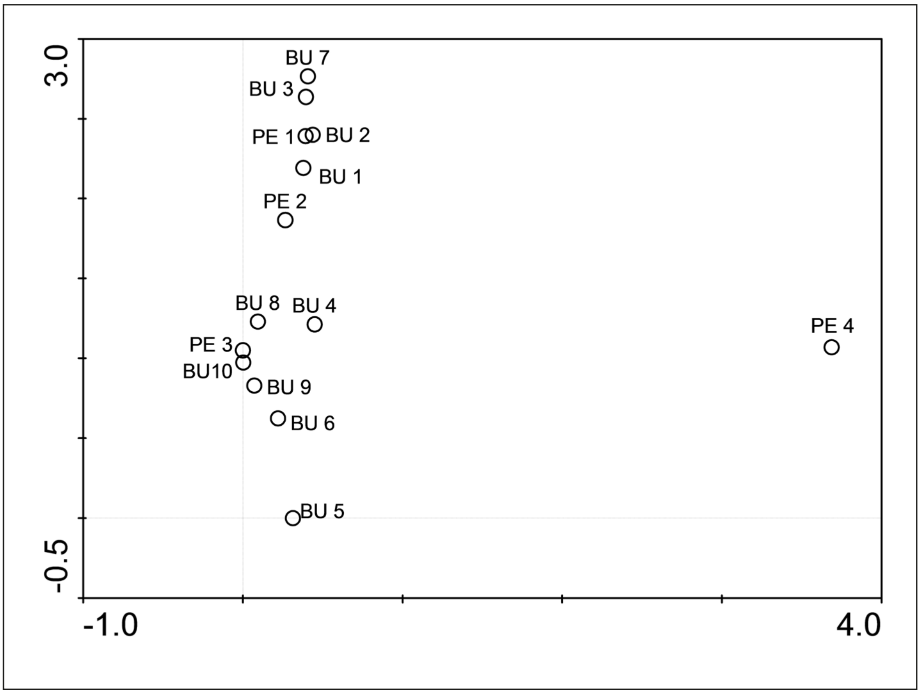

Fig. 1: DCA ordination of research plots

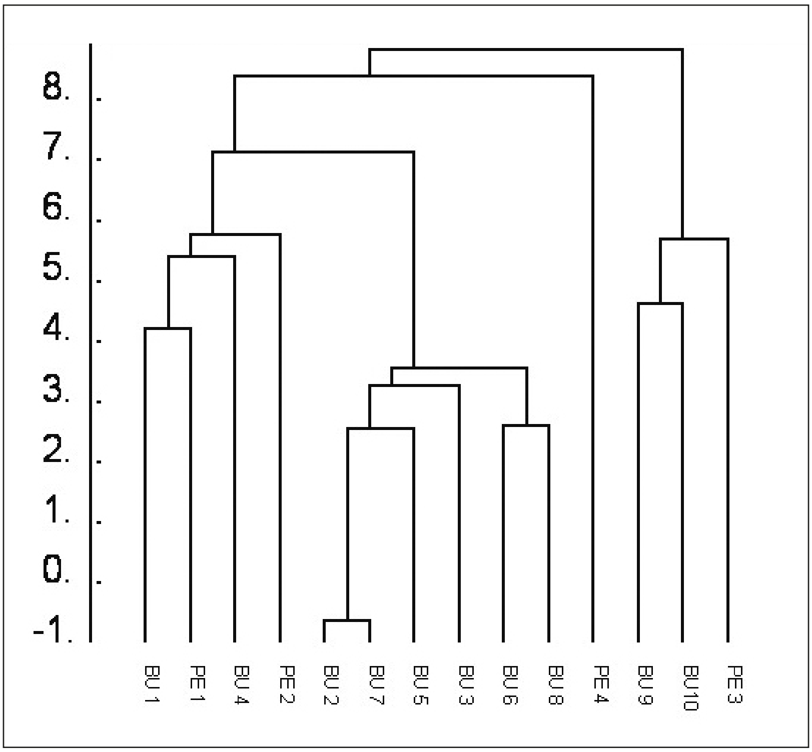

Fig. 2: Ward's dendrogram of research plots

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Table 2: Ellenberg's factors values of research plots at Budyně nad Ohří and Peruc territories

Ellenberg's factor	Plots													
	'BU 1'	**'BU 2'**	**'BU 3'**	**'BU 4'**	**'BU 5'**	**'BU 6'**	**'BU 7'**	**'BU 8'**	**'BU 9'**	**'BU10'**	**'PE 1'**	**'PE 2'**	**'PE 3'**	**'PE 4'**
Light	7,77	5,00	5,50	6,87	4,17	6,23	-	6,37	6,01	5,99	7,98	7,17	5,75	3,02
Temperature	5,02	5,00	-	5,05	5,00	5,48	-	5,75	5,99	5,99	4,99	5,38	5,95	5,01
Continentality	3,03	5,00	2,00	2,93	3,94	3,56	-	3,22	2,01	2,65	3,01	2,65	2,46	2,01
Soil moisture	4,91	4,50	5,33	4,53	5,00	5,00	-	4,97	4,79	4,99	4,99	5,01	4,93	5,00
Soil reaction	3,00	-	5,00	2,73	3,67	2,37	-	2,83	2,91	4,50	3,00	2,99	4,00	4,50
Soil nitrogen	4,03	-	6,00	3,64	4,82	3,41	-	4,82	4,80	4,00	3,99	4,05	5.54	5,67

Appendix: Phytocoenological table of relevés

Plots	BU 1	BU 2	BU 3	BU 4	BU 5	BU 6	BU 7	BU 8	BU 9	BU 10	PE 1	PE 2	PE 3	PE 4
E3 (over 3 m)														
Betula pendula								1						
Fagus sylvatica														+5
Larix decidua		1										1		
Pinus sylvestris				+4		+5		+4				1		
Quercus rubra	+5	+5	+5		+5		+5				+5			
Quercus petraea		1		-2	+				-5	+5		-5	+5	
Tilia cordata												+		
E2 (between 1 and 3 m)														
Acer pseudoplatanus													+3	
Aesculus pavia												1		
Betula pendula						+2		-3						
Fagus sylvatica	-2													+
Quercus rubra								1						
Sorbus aucuparia				1					-2				+	
Tilia cordata					-2									
E1 (up to 1 m)														
Acer pseudoplatanus												+	-2	
Avenella flexuosa						1		r	r			+		
Betula pendula								r						
Brachypodium sylvaticum														r
Calamagrostis epigeios						r		+						
Carex pairaei										r				
Carex pilulifera			r		r				+	r				
Dryopteris dilatata						r						r		r
Fagus sylvatica		r		+						r		r		+3
Fraxinus excelsior												r		
Impatiens parviflora	+												+	
Larix decidua										r	r			
Melampyrum pratense					r	r								
Picea abies											r	r		r
Poa nemoralis				r	r	r				+			1	
Quercus petraea		+		+		1		1	+3	+3		+2	-4	
Quercus rubra	-2	1	1	+	+		r	+			-2	-2		r
Rubus fruticosus agg.	-3			-2		1		+	+	r	+2	-3	1	r
Sorbus aucuparia	1	r	r	-2	1	+		r	-2					
Tilia cordata					1	+								
Urtica dioica			r											
Vaccinium myrtillus						1								
E0 (moss)														
Dicranella hetromalla		+	+		+		r			+				
Pleurozium schreberi						+		+		r				
Polytrichum formosum		1				r		r	+					r