

Role of chosen grass species in herb layer structure of all-aged timber pine woods

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Abstract. The present paper depicts the role of selected grass species in all-aged pine woods exploited as production forest. The studies were conducted on permanent plots 32 m x 64 m, placed in tree stands 30, 50, 70, 90, 130 yrs old in western part of the Olkusz Upland. Basic subplot amounted to 2 m² and within it floristic composition of vascular plant species and their vertical cover-abundance in the scale: 1, 5, 10, 20, ... 100 % were recorded. Based on obtained data it stated that *Deschampsia flexuosa* and *Festuca ovina* play the most significant role in assembly of ground flora of pine forests varying in age. Furthermore frequency of occurrence and abundance of these species changed dependently on age of forest stands. Their role is the highest in the youngest and the oldest tree stands, which owing to them have a "grassy" appearance – one of degeneration forms of forest phytocoenoses.

Key words: pine woods, forest management, disturbance of phytocoenoses, *Deschampsia flexuosa*, *Festuca ovina*.

Introduction

Forest use and complex of techniques of forest management cause many, sometimes, permanent changes in structure and floristic composition of forest communities (ŁASKA 2001). A strong development of grass cover in field layer of forest communities is defined as cespityzation (OLACZEK 1974). It is one of forms of degenerations i.e. one of criteria applied in qualitative characterization of effects of degeneration processes

Tab. 1. Characteristics of monoculture pine woods (*Pinus sylvestris*) occurring on the study plots

Age of tree stand on study plot [years]	Number of trees on study plot 2042m ²	Number of trees per ha	Medium height of tree [m] ± standard deviation	Medium breast height of tree [cm] ± standard deviation	Medium cover of canopy [m ²] ± standard deviation	Type of distribution
30	678	3310	10.5 ± 1.10	9.5 ± 2.26	6.5 ± 3.37	homogenous
50	441	2153	12.3 ± 1.84	12.9 ± 3.77	10.5 ± 4.82	homogenous
70	80	391	13.7 ± 1.44	22.1 ± 4.01	31.9 ± 9.62	homogenous
90	139	679	11.0 ± 1.59	18.3 ± 4.71	26.5 ± 19.37	homogenous
130	57	278	12.2 ± 1.35	24.0 ± 4.91	85.9 ± 16.81	random

(BALCERKIEWICZ 2002). Dependently on disturbance factors and primary plant community cespityzation can manifest by various grass species. Therefore, the aim of carried out studies was to establish which grasses and during which stage of forest cultivation play the most significant role.

The study area

The studies were conducted on the permanent plots in western part of the Olkusz Upland (KONDRACKI 1994). Woodlands of this area belong to Forest Inspectorate of Olkusz. According to administrative division the study area lies on the territory of Małopolska province, commune Olkusz.

Material and Methods

The study objects were coniferous forest communities. These communities occurred on poor, sand podzolic soils with low level of underground waters. In the study area they were represented by phytocoenoses of suboceanic pine wood *Leucobryo-Pinetum* W. MAT. (1962) 1973. Five typical patches of the association occurring in the same soil conditions exploited by forest management. The selected study plots varied only in age of monoculture of pine stand which amounted respectively to: 30, 50, 70, 90, 130 yrs. The data characterizing tree layer and shrub layer of the study plots were shown in Tables 1, 2.

The study plots 32 m x 64 m were divided into 512 squares (subplots) with a side of 2 m. Within each subplot floristic composition and cover-abundance of occurring vascular plant species (KERSHAW 1978) of the scale 1, 5, 10, 20, ... 100 %. (KIMS 1991, KIMS et al. 1992). These data were used in characterization of the study plots in relation to value of cover, and percentage of grass species in all-aged tree stands. Statistical significance of differences between the investigated of phytocoenoses area were calculated with Tukey test ($p < 0.01$). Nomenclature follow: MIREK et al. (2002) and MATUSZKIEWICZ (2001).

Results

Amongst 60 vascular plant species recoded in ground flora of the study plots 9 grass

Tab. 2. Characteristics of shrub layer occurring on the study plots

Age of tree stand of the study plot	50		70		90		130	
Species name	Frequency (for 512 subplots)	Medium cover [%]	Frequency (for 512 subplots)	Medium cover [%]	Frequency (for 512 subplots)	Medium cover [%]	Frequency (for 512 subplots)	Medium cover [%]
<i>Frangula alnus</i>	8	0.06						
<i>Sorbus aucuparia</i>	2	0.01					1	0.01
<i>Juniperus communis</i>	2	0.001	62	0.61				
<i>Pinus sylvestris</i>			198	2.43	221	10.2	142	4.48
<i>Betula pendula</i>			42	0.44	1	0.01	94	3.78
<i>Betula pubescens</i>			112	1.89			11	0.30
<i>Quercus rubra</i>			155	1.66				
<i>Pinus nigra</i>			34	0.24				
<i>Populus tremula</i>			18	0.22				
<i>Padus avium</i>			16	0.19				
<i>Salix caprea</i>			8	0.08				
<i>Picea excelsa</i>			3	0.14				
<i>Salix repens</i>			1	0.01				

species were noted (Tab. 3). Typical forest species are only *Deschampsia flexuosa* and *Festuca ovina*. They occurred on each of five the studied plots with high frequency but with diverse cover. *Deschampsia flexuosa* tends to decrease in cover on the study plots with increasing age of tree stand. (Fig. 1) respectively: from 22.5% on the plot with youngest tree stand (30-yrs); to 2.5% the oldest (130-yrs). The study plots differ from each other significantly in relation to percentage cover *Deschampsia flexuosa* (Tab. 4).

Values of percentage cover of *Festuca ovina* in tree stands: 30, 50 and 130 yrs old are different significantly (Tab. 5). However, values of *Festuca ovina* with tree stand 70 and 90 yrs old are similar. In contradistinction to *Deschampsia flexuosa*, cover of *Festuca ovina* is higher in elder tree stands with more thinned canopy tree. Instead, in the plots with younger tree stands there is smaller contribution of this species (Fig. 2).

It stated that grasses species show changeable participation in ground flora dependently on development of tree stand. Thus, mean percentage of grasses in the herb layer of the youngest tree stand amounted to more than 80%. In the patches of 50, 70, and 90 yrs old tree stands their importance decreased but cover was not less than 30 %. In 130 yrs old

Tab. 3. Percentage of grass species in herb layer of all-aged coniferous forests

Species name	Age of pinewood in the study plots									
	30		50		70		90		130	
	Frequency	Maximum of cover [%]	Frequency	Maximum of cover [%]	Frequency	Maximum of cover [%]	Frequency	Maximum of cover [%]	Frequency	Maximum of cover [%]
<i>Deschampsia flexuosa</i>	512	90	511	50	512	60	511	20	487	50
<i>Festuca ovina</i>	502	50	497	20	512	60	510	40	508	80
<i>Calamagrostis epigejos</i>					36	5			219	30
<i>Agrostis capillaris</i>	23	5	1	1	31	5	53	20	25	5
<i>Antoxantum odoratum</i>			1	1	1	1	1	1		
<i>Poa compressa</i>									4	5
<i>Poa pratensis</i>			27	5			4	5		
<i>Avenula pubescens</i>							1	1		

Tab. 4. Results of statistical test for differences between covers of *Deschampsia flexuosa* on the study plots
(Significant differences at probability $p < 0.01$ are in bold)

Study plot	30-yrs old	50-yrs old	70-yrs old	90-yrs old	Frequency	Medium cover [%]
30 –yrs old					512	22.5
50 –yrs old	0.000017				511	12.7
70 –yrs old	0.000017	0.000017			512	7.8
90 –yrs old	0.000017	0.000017	0.000036		511	5.4
130 –yrs old	0.000017	0.000017	0.000017	0.000017	487	2.5

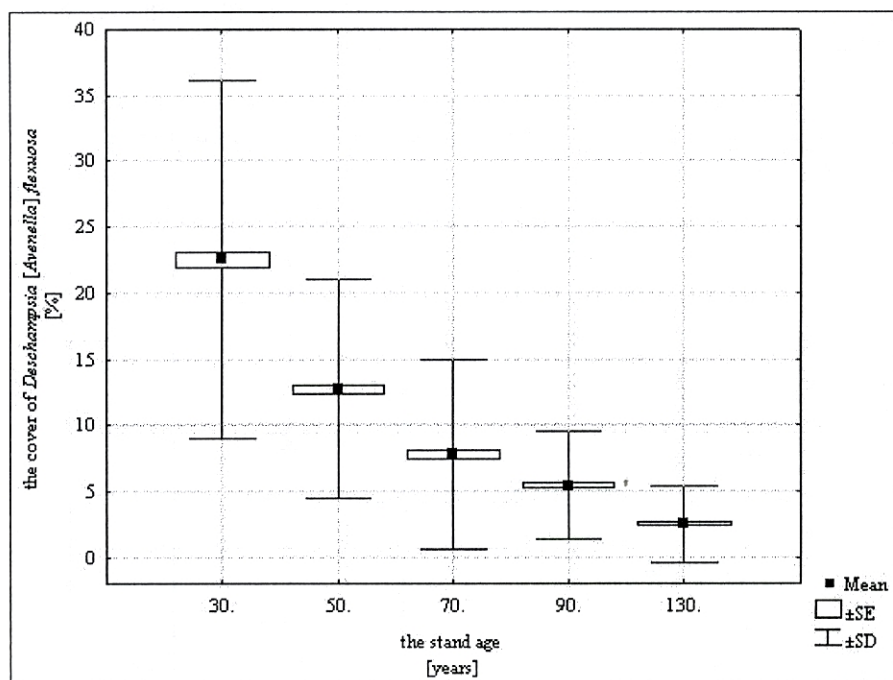
Tab. 5. Results of statistical test for differences between covers of *Festuca ovina* on the study plots
(Significant differences at probability $p < 0.01$ are in bold)

Study plot	30-yrs old	50-yrs old	70-yrs old	90-yrs old	Frequency	Medium cover [%]
30 –yrs old					502	7.0
50 –yrs old	0.000017				497	4.1
70 –yrs old	0.000017	0.000017			512	10.6
90 –yrs old	0.000017	0.000017	0.499599		510	10.0
130 –yrs old	0.000017	0.000017	0.000019	0.000017	508	12.8

Tab. 6. Results of statistical test of differences between total covers of grasses on the study plots
(Significant differences at probability $p < 0.01$ are in bold)

Study plot	30-yrs old	50-yrs old	70-yrs old	90-yrs old	Medium percentage
30-yrs old					82.0
50-yrs old	0.000017				50.1
70-yrs old	0.000017	0.000017			34.5
90-yrs old	0.000017	0.000017	0.991792		35.1
130-yrs old	0.000017	0.998395	0.000017	0.000017	50.4

Fig. 1. Value of cover of *Deschampsia flexuosa* on the study plots differed in age of pine tree stand



tree stands percentage cover of grasses increased up to 50% (Fig. 3). Taking into account differences between medium cover of grasses dependently on age of tree stands significant difference ($p < 0.01$) was revealed in all study plots except for 70, 90 yrs old and 50 and 130 yrs old (Tab. 6).

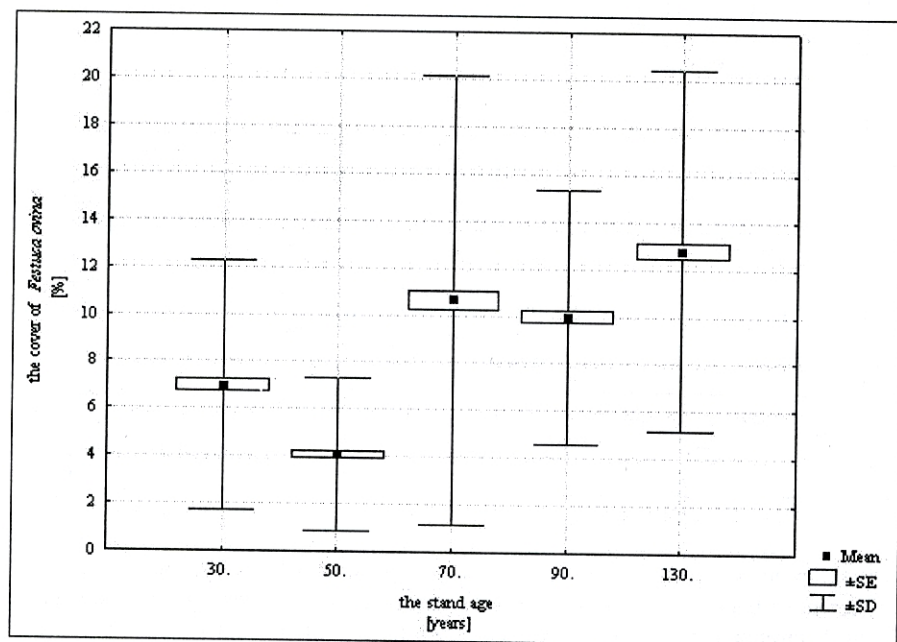
Grassy appearance of ground flora in 130 yrs old tree stands is also, apart from highest cover of *Festuca ovina* and *Deschampsia flexuosa*, the effect of frequent and abundant occurrence of *Calamagrostis epigeios*, (Tab. 3) compared to other accompanying species.

Representatives of grasses not associated with non-forest communities do not play considerable role in the structure of ground flora of coniferous forests (Tab. 3).

Discussion

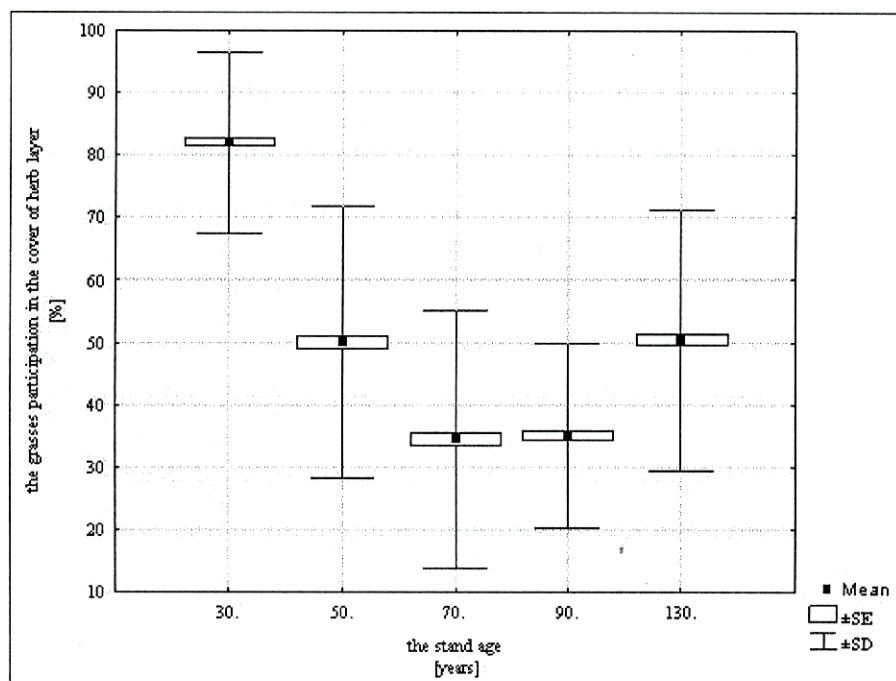
In the studied all-aged coniferous forests did not play identical role in assembly of herb layer within entire cultivation cycle. Their role distinctly decreased in 70, 90 yrs old tree stands, what probably is caused by increasing dominance of dwarf shrubs among others: *Vaccinium myrtillus*, *V. vitis-idea* (ŚLIWIŃSKA-WYRZYCHOWSKA 2000). Domination of building structured grass species in herb layer e.g. *Deschampsia flexuosa* result from vegetative reproduction and tendency to aggregative clusters formation (ANTKOWIAK et CYBULKO 1967, PYŠEK 1992, SZMEJA 1993). ØKLAND (1995) in his study concluded that dominant species in coniferous forest usually are species exhibiting clonal growth. The presented study show that it is not a rule, because *Festuca ovina* - dominant species in ground flora in all-aged coniferous forests is a plant which rate of growth amounts to 3cm per year and is "low-mobile vegetatively" (MASLOV 1989).

Fig. 2. Value of cover of *Festuca ovina* on the study plots differed in age of pine tree stand



KIMSA et al (1992) also pay special attention to importance of *Festuca ovina* in formation of herb layer in coniferous forests. WIKĄ (1983) in studies on coniferous communities (*Leucobryo-Pinetum*) of the Kraków-Częstochowa Upland noted considerable cover (more than 50%) both *Festuca ovina* and *Deschampsia flexuosa* apart from dominant *Vaccinium myrtillus*. MICHALIK (1980) in coniferous forests in central part of the Kraków Upland (at present-the Olkusz Upland) distinguished *Leucobryo-Pinetum* variant with *Deschampsia flexuosa* in which this species completely dominated in herb layer, forming dense patch with sparsely occurred accompanying species *Calluna vulgaris* and *Vaccinium vitis-idaea*. *Deschampsia flexuosa* is a species frequently occurring in ground flora within whole range of *Leucobryo-Pinetum* (MATUSZKIEWICZ et MATUSZKIEWICZ 1973).

Fig. 3. Percentage of grasses species in cover of herb layer on the study plots differed in age of pine tree stand



Dominant grass species shape characteristic grassy appearance which results from former disturbance of ecological balance as an effect of clearing or thinning within phytocoenoses (SOKOŁOWSKI 1972). The following results of the survey confirm this phenomenon, where grasses are main components of tree study plots out of five analysed ones. According to MATUSZKIEWICZ et MATUSZKIEWICZ (1973) *Deschampsia flexuosa*, *Festuca ovina* and *Calamagrostis epigejos* are not only grasses which have potential impact on formation of spatial structure of ground flora in coniferous forest.

Not abundant contribution of non-forest grass species confirmed this thesis (Tab. 3). WIK (1983) put the blame on man's activity as a cause of this state, because in the vicinity of the studied forest complexes there are meadows and arable fields. These phytocoenoses are penetrated by local people collecting mushrooms and forest fruits. Moreover, they are cut by dense network of forest roads and footpaths what encourages migration of non-woodland species. However, they do not affect structure of herb layer owing to their low frequency and not abundant occurrence.

In case of coniferous communities in marginal zone of forest complexes massive occurrence of *Festuca ovina* is noted. In thinned coniferous forests *Deschampsia flexuosa*, and on clearings *Calamagrostis epigeios* (BALCERKIEWICZ 2002) species form dense litter which hamper development of other plants (JAŃCZAK-WĘGLARSKA 1996). Strong development of plants in ground flora, among others *Deschampsia flexuosa* or *Calamagrostis epigeios* leads to harmful decrease of species diversity of these plant communities (SIERKA et CHMURA 2004, SIERKA et CHMURA 2005).

Summary

Deschampsia flexuosa and *Festuca ovina*, generally, play the most significant role in formation of structure of herb layer in all-aged coniferous forests.

The frequency and cover of *Deschampsia flexuosa* decrease with the increase of age of forest stands.

Their importance is the highest in the oldest and the youngest cultivation sites resulting in grassy appearance of these phytocoenoses which is a qualitative effect of community disturbance.

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