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Research Article

THE CHANGES IN MANAGED FIR FOREST IN BESKID MTS DUE TO FOREST MANAGEMENT AFTER 11 YEARS

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ABSTRACT

New phytosociological studies on permanent study plot (40 ´ 40 m) divided into 16 subplots in the managed forest were conducted in the upper part of basin of Bystrzanka (Beskid Niski Mts, SE Poland). The aim of the research was to determine the direction of changes in the *Rubus hirtus-Abies alba* community in the vicinity of the forest where forest management treatments are applied. It was recorded that the total number of species increased from 52 in 2000 to 80 in 2011. The DCA showed significant changes in species composition and the cover of species. Among others, the increase of forest edge species (epilobisation) and ruderal species (therophytization) and first of all the increase of meadow was observed. The structure of the community also changed; the mean cover of shrub species decreased.

Keywords: phytosociological relevés, DCA, montane forest, human impact, forest degeneration.

INTRODUCTION

Forest management through timber exploitation, cultivation, silvopastoral system and even some methods of protection leads to changes in the structure and functioning of forest ecosystems. These changes also occur in the vicinity of sites where forest treatments are performed. Some forest treatments are applied in nature reserves as well. The cessation of any forest management practices mainly results in regeneration of forest phytocoenoses, increase of species richness, changes in proportion of ecological groups of species. There is a rich literature body on temporal changes in forests under protection [6, 8, 12]. Smaller number of publications are devoted to changes in managed and disturbed forests, in phytocoenoses difficult to classify in terms of syntaxonomical affiliation. Our study concern changes in managed forest exemplified by plant community in the Beskid Niski in southern Poland.

The main goal of the study was to examine modifications in the structure, species richness and species composition of the permanent study plot after 11 years.

STUDY AREA

The permanent study plot was established in 2000 [5] in the upper section of the Bystrzanka river basin in the managed forest westwards from Bieśnik near village Bystra next to Szymbark (N 49° 39’ 24.6’’, E 21° 03’ 21.4’’) (Beskid Niski Mts.). The site is characterized by low inclination c.a. 10–20° on the eastern-northern slope. The forest occupies a habitat of beechwood *Dentario glandulosae – Fagetum*. According to Staszkiewicz [18] this phytocoenosis represents *Rubus hirtus – Abies alba* [5].

METHODS

In the study methods used in work by Dubiel et al. [5] were applied on the formerly placed the study plot which was marked in the field. The study plot was prevented from any human interference i.e. no direct forest management treatments were applied including clear-cutting, thinning, cultivation of trees etc. The plot is of quadrate size with a side of 40 m and is divided into 16 smaller subplots (10×10 m). In each subplot the phytosociological relevè was taken according to commonly applied Braun-Blanquet approach. Moreover, bryophyte species were inventoried. In order to examine the gradient of variation in species composition and the cover of plants between the 2000 and 2011 Detrended Correspondence Analysis (DCA) was done. To examine differentiation of species composition and the cover of species between the years eigenvalues (plot scores) along two first DCA axes were compared in terms of mean and range. The number of species (*S*), Shannon-Wiener index (*H'*) and evenness index (*E*) as well as structure of phtocenosis (cover of tree layer, shrub layer, herb layer and moss layer) were compared between the years by means of Wilcoxon matched pair test. The G-test was applied to compare the proportions of species between the years. The simplified synoptic table with mean ±SD cover as well as the frequency (number of subplots occupied by a species) of all recorded species in 2000 and 2011 were given. Nomenclature follows Mirek et al. [14], Matuszkiewicz [13], Klama [9] and Ochyra et.al. [15].

RESULTS

The DCA results indicated a great differentiation in the vegetation after 11 years (Fig. 1), however, the two first axes explained only 20.4% of variation in species data. All species with their mean and SD of percent cover are given in table 1. The number of representatives of the *Molinio-Arrhenatheretea* class increased significantly from 2 in 2000 to 12 species in 2011 (G = 4.72, p = 0.029), the number of the species of the remaining classes was similar between the two years. The obtained results demonstrated that since 2000 to 2011 significant increase in species richness occurred from 52 to 80 respectively, whereas 37 species are common for both years, 15 species were not confirmed in 2011 and 42 were new ones (G = 8.41, p = 0.0037). The mean number of species per a subplot (19.6 ± 5.5) in 2000 was significantly higher than in 2011 (15.1 ± 5.7)(V = 82.5, p = 0.01063). Similarly mean *H'* index in 2000 amounted to 2.6 ± 0.31 and in 2011 – 2.4 ± 0.36 (V = 110, p = 0.02). However, *E* index in 2011 – 0.79 was significantly higher in 2011 – 0.79 than in 2000 – 0.73 (V = 7, p < 0.001). The cover of shrub layer was significantly lower in 2011 and non-significantly – tree layer and moss layer, whereas percent cover of herb layer was higher in 2011 (Fig. 2).

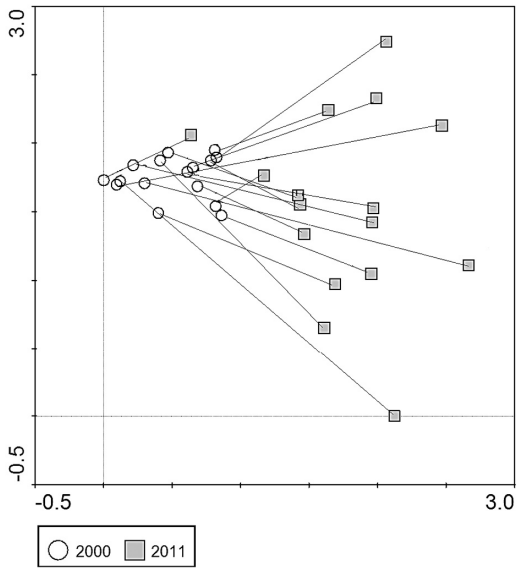

Fig. 1. The ordination of plots along the two first axes of DCA Detrended Correspondence Analysis) on the basis of percent cover of plant species in the permanent study plot (*Rubus hirtus – Abies alba* community in Beskid Mts) ($\lambda_1 = 0.4$, $\lambda_2 = 0.242$)

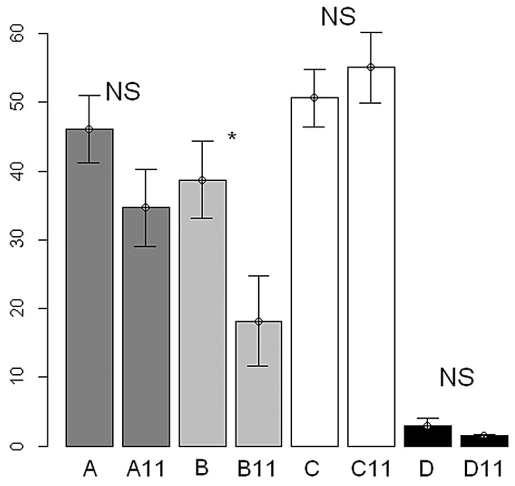

Fig. 2. Comparison in percent cover of layers (mean ±SE) in the permanent study plot (A–trees, B – shrubs, C – herbs, D – mosses and liverworts) (Wilcoxon matched pair-test) between 2000 and 2011. (* – p < 0.05, NS – non-significant)

Table 1. Synoptic table of monitored community fir forest with blackberry *Rubus hirtus – Abies alba* in water catchment area of the Bystrzanka stream (Beskid Niski Mts)

Species	16.09.2000			05. 07. 2011		
	frequency	mean	SD	frequency	mean	SD
Ch. Querco – Fagetea + Ch. Fagetalia						
Atrichum undulatum d	4	0.5	0	2	0.5	0
Carex sylvatica	8	0.5	0	11	4.5	4.84
Cerasus avium c	1	0.5	0	3	0.5	0
Corylus avellana c	–	–	–	1	5	0
Dentaria glandulosa	1	0.5	0	–	–	–
Dryopteris filix-mas	2	0.5	0	1	0.5	0
Fraxinus excelsior c	4	0.5	0	–	–	–
Galeobdolon luteum	7	0.5	0	–	–	–
Lysimachia nemorum	7	1.14	1.70	2	5	0
Fagus sylvatica a	9	62.5	21.65	1	5	0
Fagus sylvatica b	14	2.42	2.31	5	20.5	16.34
Fagus sylvatica c	16	13.12	20.21	9	9.55	7.64
Prenanthes purpuerea	7	0.5	0	5	2.3	2.46
Ch Vaccinio-Picetea						
Abies alba a	12	11.87	10.06	13	33.65	20.40
Abies alba b	16	37.5	22.64	6	32.5	23.24
Abies alba c	16	4.37	4.09	4	0.5	0
Galium rotundifolium	9	2	2.25	–	–	–
Pyrola minor	1	5	0	1	5	0
Vaccinium myrtillus	2	0.5	0	1	0.5	0
Ch Molinio-Arrenatheretea						
Achillea millefolium	–	–	–	1	0.5	0
Dactylis glomerata	–	–	–	2	0.5	0
Deschampsia caespitosa	1	0.5	–	2	0.5	0
Juncus conglomeratus	–	–	–	1	0.5	0
Juncus effusus	3	2	2.59	9	18.67	19.90
Leontodon hispidus	–	–	–	1	0.5	0
Plantago lanceolata	–	–	–	1	0.5	0
Poa pratensis	–	–	–	1	0.5	0
Poa trivialis	–	–	–	1	0.5	0
Prunella vulgaris	–	–	–	5	2.3	2.46
Ranunculus acris	–	–	–	1	0.5	0
Rumex acetosa	–	–	–	1	0.5	0
Accompanying species						
Acer pseudoplatanus c	7	0.5	–	3	0.5	0
Agrostis capillaris	2	2.75	3.18	6	16.67	11.90
Amblystegium serpens d	–	–	–	1	0.5	0
Athyrium filix-femina	15	7.87	10.43	9	5.39	4.94
Betula pendula c	–	–	–	5	2.3	2.46
Brachythecium rutabulum d	–	–	–	7	0.5	0
Calamagrostis arundinacea	3	0.5	0	3	5	0
Calamagrostis arundinacea	3	0.5	0	3	5	0
Calamagrostis epigejos	1	5	0	–	–	–
Cardamine flexuosa	1	0.5	0	–	–	–
Carex ovalis	2	0.5	0	–	–	–
Carex pallescens	2	0.5	0	6	3.5	2.32
Carex remota	3	2	2.59	2	5	0
Carex sp.	3	0.5	0	–	–	–
Chamaenerion angustifolium	–	–	–	1	0.5	0
Deschampsia flexuosa	–	–	–	1	0.5	0
Dicranella heteromalla d	10	0.5	0	6	0.5	0
Dryopteris carthusiana	8	0.5	0	–	–	–
Dryopteris dilatata	3	0.5	0	2	2.75	3.18
Eupatorium cannabinum	–	–	–	1	0.5	0
Festuca gigantea	–	–	–	2	0.5	0
Geranium robertianum	–	–	–	2	0.5	0

Table 1. cont.

Gnaphalium uliginosum	–	–	–	1	0.5	0
Gymnocarpium robertianum	–	–	–	1	0.5	0
Hedera helix	1	0.5	0	–	–	–
Hieracium murorum	2	0.5	0	1	0.5	0
Hypericum maculatum	–	–	–	1	0.5	0
Hypericum perforatum	–	–	–	4	1.625	2.25
Hypnum cupressiforme d	–	–	–	3	0.5	0
Leontodon autumnalis	–	–	–	2	0.5	0
Lophocolea heterophylla d	–	–	–	2	0.5	0
Luzula pilosa	6	1.25	1.83	2	0.5	0
Lycopus europaeus	–	–	–	3	0.5	0
Maianthemum bifolium	10	0.95	1.42	9	7.288	5.98
Mentha arvensis	–	–	–	1	0.5	0
Mnium hornum d	–	–	–	1	0.5	0
Mycelis muralis	5	0.5	0	1	0.5	0
Oxalis acetosella	14	1.466	1.92	5	3.2	2.46
Plantago major	–	–	–	2	0.5	0
Plagiothecium laetum d	6	2	2.32	–	–	–
Polytrichastrum formosum d	12	3.41	4.93	10	0.5	0
Poa annua	–	–	–	3	3.5	2.59
Pohlia nutans d	–	–	–	1	0.5	0
Polygonum hydropiper	1	0.5	0	–	–	–
Polygonum persicaria	–	–	–	1	5	0
Quercus robur c	–	–	–	3	0.5	0
Ranunculus flammula	–	–	–	1	5	0
Ranunculus repens	–	–	–	2	0.5	0
Rosa canina	1	0.5	0	2	0.5	0
Rubus hirtus	16	28.75	19.06	10	34.5	17.51
Rubus idaeus	1	0.5	0	1	5	0
Rubus sp	–	–	–	3	30.83	11.54
Rumex crispus	–	–	–	1	0.5	0
Sambucus racemosa c	1	0.5	0	–	–	–
Senecio fuchsii	14	0.82	1.20	6	0.5	0
Solidago gigantea	–	–	–	1	0.5	0
Sorbus aucuparia b	1	0.5	0	–	–	–
Sorbus aucuparia c	14	0.5	0	3	2	2.59
Stachys palustris	–	–	–	1	0.5	0
Tetraphis pellusida d	–	–	–	2	0.5	0
Trifolium repens	–	–	–	2	2.75	3.18
Veronica chamaedrys	–	–	–	1	0.5	0
Veronica officinalis	7	1.14	1.70	6	3.2	2.46
Viburnum opulus c	1	0.5	0	–	–	–

DISCUSSION

The comparison of species composition after 11 years demonstrated considerable changes. As in other floristic studies conducted mainly in forest reserves of Poland [4, 20, 7] the increase of total number of species occurred. Among others, species of forest fringe and non-woodland habitats including invasive plants as *Solidago gigantea* appeared. This species was recorded only in one subplot but its appearance indicates increasing disturbance of the forest floor. In many cases the increase in species richness is a result of the penetration of invasive alien species into plant community [8, 12, 20] which their abundance is higher, however, some studies show that the proportion of alien species amongst new species is relatively small [7].

In our study generally native species are newcomers but majority of them are non-woodland species. One possible reason could be another time of vegetation sampling. In a previous study [5] phytosociological relevés were taken in mid September and for this reason the authors stated that probably 1–2 species could be omitted. Taking into account which species were new in 2011 (study at the beginning of July) it cannot be confirmed that early spring species were

excluded from the analysis in 2000. The most striking result is the presence of meadow species (representatives of the *Molinio-Arrhenatheretea* class) e.g. *Dactylis glomerata, Deschampsia caespitosa, Juncus conglomeratus, J. effusus, Poa pratensis, P. trivialis, Plantago lanceolata, Triforium repens*. Their appearance can be connected with the decrease of cover of overstory species especially in shrub layer (Fig. 2). and higher availability of light at forest bottom. Analyzing changes in species composition some degeneration forms of forest community can be distinguished [11, 16].

The fringe species which occurred as *Chamaenerion angustifolium, Geranium robertianum* are plants known as indicators of epilobisation [3] and therophytization sensu Krotoska et al. [10] instead of therophytization as a massive occurrence of therophytes sensu Barbero et al. [1].

These species are neither frequent nor abundant, however, they are common in the vicinity of the study plot. Such high differences both in species composition, number of species and structure of phytocoenosis may be the result of forest management practices, which were conducted in the vicinity of the study plot. These were thinning of tree stand, clear-cutting and earth works. Moreover, the analysis of the map made by authors of the former work [5] and the comparison with the present state indicated that, according to hydrographic conditions, the area underwent profound changes. The changes in ephemeral water courses could result in the decline of tree stand which is mainly composed of fir *Abies alba*. At present, much lower seedlings of *Abies alba* were observed in comparison to 2000 (Tab. 1).

The increased cover of herbaceous non-woodland species could have hampered the development of young fir individuals. Bomanowska and Kiedrzyński [2] in their review work emphasize that the directions and range of dynamic changes in plant cover including forests are similar across the country and regeneration mainly occurs in protected forest areas where use is limited or has completely ceased. We believe that the cessation of all forest management treatments, not only within the study plot but in neighbourhood, might give the opportunity to study direction and rate of regeneration of forest community. In turn, this could bring profits both for nature conservation practice and knowledge about the succession of forest communities.

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