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CHANGES IN MIXED CONIFEROUS FOREST (*QUERCO ROBORIS - PINETUM*) AS A RESULT OF FOREST ECONOMY IN THE SILESIAN UPLAND

ZMIANY W BORZE MIESZANYM (*QUERCO ROBORIS - PINETUM*) JAKO EFEKT GOSPODARKI LEŚNEJ NA WYŻYNIE ŚLĄSKIEJ

Key words: mixed coniferous forest, forest economy, disturbances of woodland communities, the Silesian Upland.

Summary: In the present paper the results of the phytosociological studies on mixed coniferous community *Querco roboris - Pinetum* in the Silesian Upland were shown. Different types of plant community disturbances were observed, caused by various forms of forest economy and these are: impoverishment of floristic composition, decrease of species diversity, monotypization, pinetyzation, fruticetyzation, geranietyzation, neophytization and cespityzation.

Słowa kluczowe: bór mieszany, gospodarka leśna, degeneracja fitocenoz leśnych, Wyżyna Śląska.

Streszczenie: W prezentowanym artykule przedstawiono wyniki badań fitosocjologicznych prowadzonych w zbiorowisku boru mieszanego *Querco roboris - Pinetum* obszaru Wyżyny Śląskiej. Stwierdzono występowanie licznych form degeneracji zbiorowiska, spowodowanych różnymi typami gospodarki leśnej i są to: zubożenie składu gatunkowego, spadek różnorodności gatunkowej, monotypizacja, pinetyzacja, fruticetyzacja, geranietyzacja, neofityzacja, cespityzacja i eurytopizacja.

INTRODUCTION

Primeval areas of our country were covered by forest vegetation, which due to numerous changes in human economy, taking place in the second of 18th century, rapidly decreased its area and woodland communities underwent considerable transformations [Grabania, 1963].

The main aim of forestry management was then to transform multispecies and all-aged tree stands into single-species and even-aged monocultures with impoverished floristic composition [Dzwonko, Loster, 1992]. The coniferous woody species were

planted in habitats of mesic forests and pine phytocoenoses exploited by forest husbandry had been invaded by plants from other plant communities [Żmuda, 1973]. Selective tree clearance led to strong development of expansive grassy species in herb layer or excessive development of blackberries (*Rubus* sp.). Clear cutting resulted in die-back of plants of shadow places and encroachment of species from forest margins [Halastra, Nowak, 1983]. The Silesian Upland is the area being under strong direct and indirect human activities what is reflected, among others, by plentiful degenerations forms of forest communities [Cabała, 1990; Orczewska, Chmura, 2001; Sierka, 2003]. Ones of the first plant communities undergoing different sorts of human impact were communities of mixed coniferous forest [Hereźniak, 1993], as one of the most important forest communities in regard to human economy, providing wood of good quality [Białobok et al., 1993].

The goal of the following work is to show the effects of forest economy on floristic composition, structure and biodiversity of forest phytocoenoses: a case of mixed coniferous forest *Querco roboris-Pinetum*.

STUDY AREA

The studies were conducted in the Silesian Upland (341.1). The borders of this area were adopted after Kondracki [2001].

MATERIAL AND METHODS

The impact of forest management conducted in phytocoenoses of mixed coniferous forest was estimated based on phytosociological data collected in the years: 1998-2001 using classical method of Braun-Blanquet.

The phytosociological relevés taken in the patches of mixed coniferous forest were listed in the analytic table with the use of computer program package PROFIT for geobotanical analyses [Balcerkiewicz, Słownikowski, 1998] according to criterion of similarity of relevé to group of relevés, described by Jaccard's formula.

Nevertheless, in regard to limited space in the following work a short version of the table was introduced. Mean percentage cover-abundances for species important from the view-point of presented problem in each patch of examined plant community as well as the same value for distinguished, by classification method, groups of patches representing internal plant community were shown.

The species playing the most important role in a creation of plant community were defined based on principal components analysis (PCA) using computer program package MVSP 3.0 [Kovach, 1998]. The similarity of the studied patches was investigated by the method of cluster analysis (Ward's method). The similarity of the objects was expressed by Euclidean distance. Results of the analysis were shown on dendrograms. Also species diversity by Shannon in the patches was expressed by values of Shannon-Wiener index [Shannon, 1948].

RESULTS

In disturbed patches of community of mixed coniferous forest total 97 plant species were recorded. In relevés on the average 18 species were noted.

Taking into account syngenetic structure of the community, prevalence of species from *Querco-Fagetea* class was observed (**17,5%**), what means bigger fertility of habitats in comparison with e.g. pine woods [Kurowski, 1979]. The species of *Vaccinio-Piceetea* and *Molinio - Arrhenatheretea* classes were represented by **9,3%** respectively, however forest edges species make the smallest contribution to total number of species **5,1%.**

The effect of forest economy is abundant occurrence of species mentioned in the table 1. in studied phytocoenoses of mixed coniferous forest showing various types of disturbance.

Based on principal components analysis (PCA) groups of species playing the most considerable role in studied patches were distinguished and these are: in tree stand *Pinus sylvestris* and *Quercus robur*; however in herb layer: *Carex brizoides, Impatiens parviflora, Rubus hirtus* and *Pteridium aqulinum* (fig. 1).

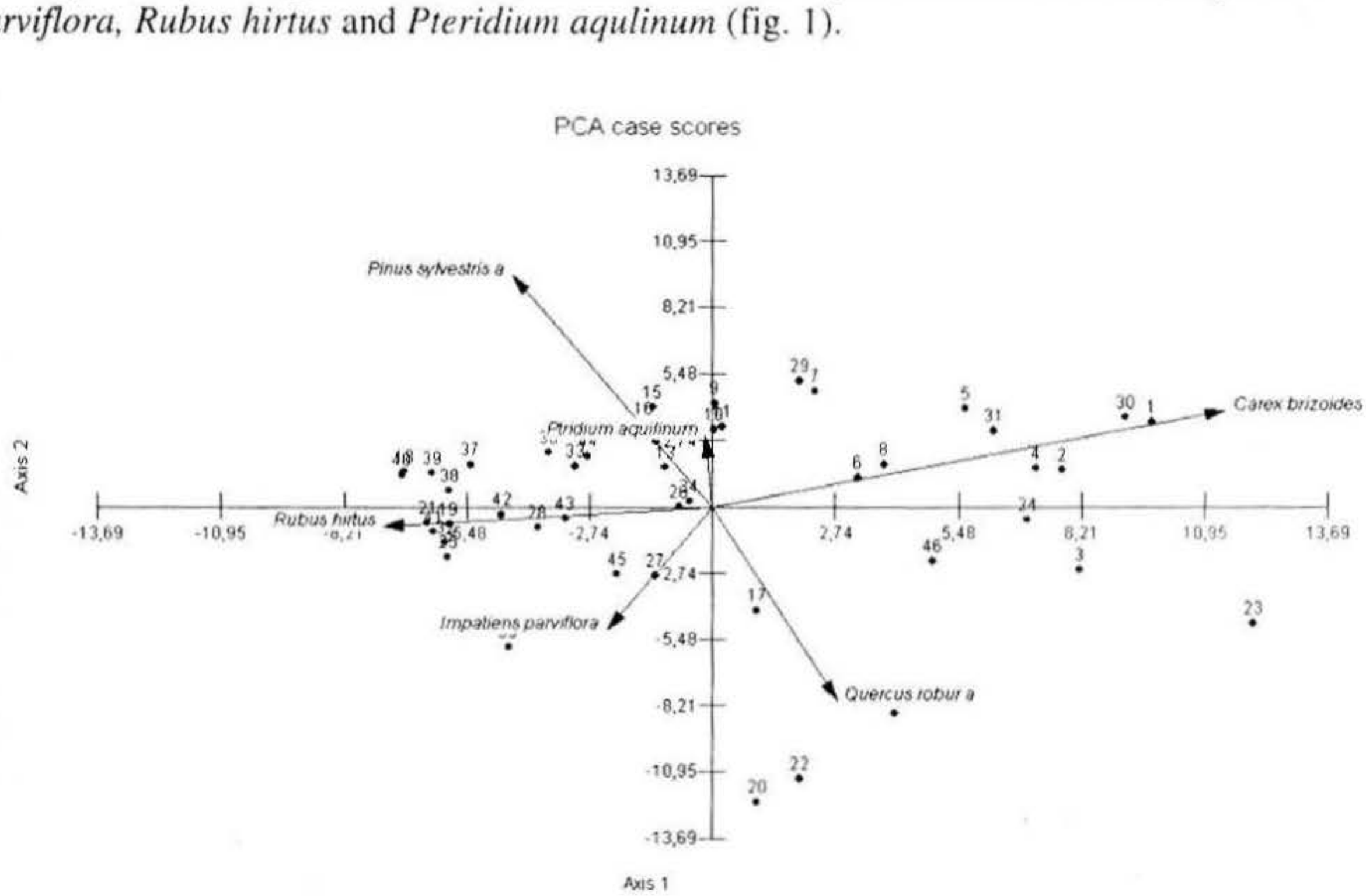

Fig. 1. The results obtained from principal components analysis (PCA) based on the frequency of species of phytocoenosis *Querco roboris - Pinetum*

The results of cluster analysis reveal internal differentiation of the patches of examined plant community into 4 groups of patches (fig. 2).

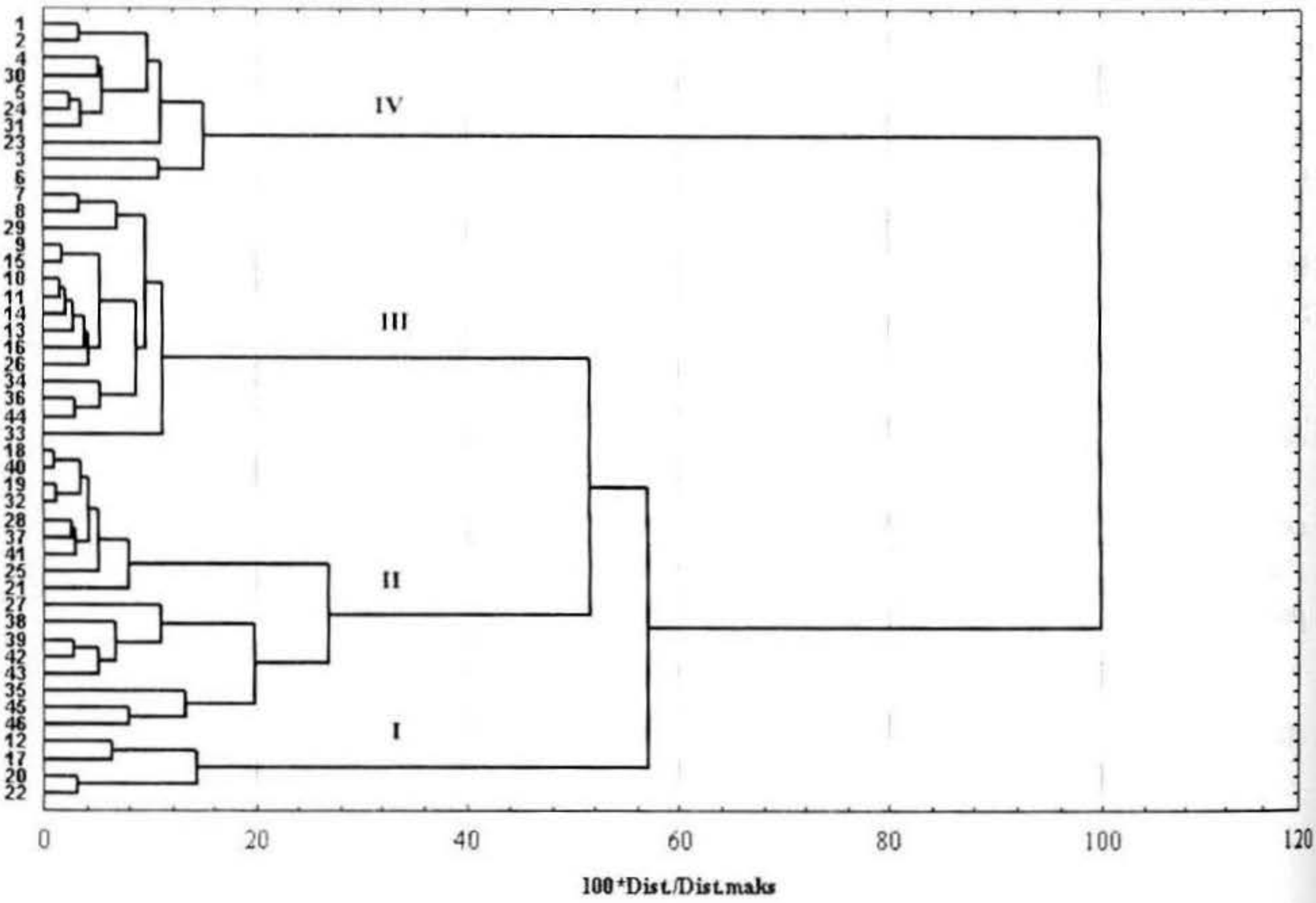

Fig. 2. The similarity of the patches of mixed coniferous community

I. group of patches, in which tree stand with medium cover 67,5 (tab. 1) is mainly composed of *Quercur robur* with tendency to regeneration. The significance of Scots pine is small. The well-developed shrub layer: *Sorbus aucuparia* and *Frangula alnus*. In the herb layer the most abundant are: *Vaccinium myrtillus* and *Rubus idaeus*.

II. groups of the patches in tree stand with cover 67,6% (tab. 1), built by *Pinus sylvestris* and *Fagus sylvatica* with an admixture of *Picea excelsa*. The numerous are species of forest edges as well as invasive alien *Impatiens parviflora* which occurs here in masses.

III. groups of the patches, in which tree stand reveals medium cover amounting to 70% (tab. 1). It is composed of regenerating Scots pine with an admixture of *Betula pendula* and *Quercus robur*. The herb layer is dominated by *Vaccinium myrtillus* and expansive species - *Carex brizoides*.

IV. groups of the patches in tree stand (mean cover 67,0%) built by *Pinus sylvestris* and not abundantly by *Picea excelsa*. In the herb layer *Pteridium aquilinum* and *Carex brizoides* prevail and not so numerously: *Deschampsia caespitosa* and *Rubus hirtus*.

Analysis of values of species diversity index shown that it ranges from 0,766 to 1,319, on the average for all analysed patches amounts to **0,911** (standard deviation - 0,132). The lowest and the highest values of species diversity index were recorded in the patches with oak tree stand and small admixture of Scots pine as well as *Vaccinium myrtillus*.

Tab. 1. The percentage of chosen species in the community mixed coniferous forest

	Data for phytocoenosis				Data for lower units			
	$\bar{x}$	Min.	Max.	s	I	II	III	IV
Tree layer cover a	68,3	30,0	90,0	116,9	67,5	67,6	70	67,0
Shrub layer cover b	21,6	0,0	60,0	196,2	30	19,7	23	15,5
Herb layer cover c	92,8	70,0	100,0	65,2	92,5	91,2	90	100,0
Moss layer cover d	13,6	0,0	40,0	109,2	15	3,3	13	3,0
Number of analysed relevés	46,0	46,0	46,0		4	17	15	10,0
Mean number of species in relevé	17,7	10,0	32,0	18,9	20,5	16,7	20	15,1
Pinus sylvestris a	41,5	0,0	62,5	447,1	5,6	43,2	57,5	29,0
Pinus sylvestris b	1,8	0,0	17,5	25,1	0,0	0,3	3,9	1,7
Pinus sylvestris c	0,1	0,0	5,0	0,5	0,0	0,0	0,0	0,5
Picea abies a	2,9	0,0	37,5	70,1	0,0	2,3	0,3	8,0
Picea abies b	2,0	0,0	17,5	25,5	0,0	2,7	1,5	2,2
Fagus sylvatica a	3,2	0,0	37,5	74,4	0,0	7,4	1,2	0,5
Fagus sylvatica b	1,5	0,0	17,5	15,1	0,0	1,2	3,0	0,5
Betula pendula a	6,3	0,0	62,5	159,6	4,4	5,4	5,5	9,7
Quercus robur a	9,0	0,0	62,5	355,6	56,2	2,0	2,2	12,2
Quercus robur b	3,8	0,0	37,5	78,3	1,2	1,3	7,0	4,2
Sorbus aucuparia b	3,1	0,0	17,5	35,0	14,3	2,6	2,6	0,1
Frangula alnus b	2,8	0,0	37,5	47,9	11,8	1,3	1,0	4,5
Padus serotina b	2,2	0,0	37,5	47,9	1,2	5,3	0,0	0,5
Vaccinium myrtillus	7,7	0,0	37,5	100,8	6,8	3,8	12,2	8,0
Vaccinuim vitis-idaea	0,7	0,0	17,5	8,0	4,4	0,0	0,7	0,5
Rubus idaeus	8,4	0,0	37,5	127,0	15,0	10,0	6,0	6,6
Rubus hirtus	16,0	0,0	62,5	579,0	0,0	40,0	1,2	3,7
Calamagrostis epigeios	1,3	0,0	17,5	14,3	0,0	0,7	0,4	1,0
Carex brizoides	20,6	0,0	87,5	840,7	4,5	2,2	12,7	70,0
Deschampsia flexuosa	3,8	0,0	17,5	43,3	6,8	3,1	6,0	0,5
Pteridium aquilinum	14,4	0,0	37,5	189,0	13,7	11,6	19,7	11,2
Impatiens parviflora	9,5	0,0	62,5	228,0	25,0	17,4	2,3	0,6
Urtica dioica	1,7	0,0	37,5	32,4	1,2	1,3	2,6	1,0
Pleurozium schreberi d	1,8	0,0	17,5	25,2	0,0	1,6	3,9	0,5

SUMMARY AND CONCLUSIONS

The phytocoenoses of mixed coniferous forest in the Silesian Upland occupy large areas like in other regions of the country; however, they are strongly disturbed. The causes of forest degeneration of this phytocoenosis are mainly various forms of forest husbandry. In the analysed patches of plant community *Querco roboris - Pinetum* the following degeneration forms *sensu* Olaczek [1972, 1974], [Łaska, 2001] were distinguished:

1. Impoverishment of floristic composition in the herb layer and decrease of biodiversity. For instance, in the community of mixed coniferous forest in Roztoczański National Park there are 120 species, medium number in the relevé – 32 [Izdebski et al,. 1992]. The species diversity depends on form of forest economy [Bernadzki, 1993]. In general, cutting negatively affects species richness [Burianek, 1999].
2. Homogenization of herb layer leading to loss of micro-mosaic differentiation by appearance of dominant species like species from genus *Rubus* sp. as a result of partial felling.
3. The unification of age and species of the tree stand-monotypization, caused by planting of single-species, in mentioned plant community - pine tree stand [Olaczek, 1972].
4. Change in structure of tree stand. The noted structure of pine-oak tree stand with regenerating beech suggests that could be one of regeneration forms of deciduous forest or as the effect of forest cultivation [Pawlaczyk, 1997].
5. Excessive development of shrubs-fruticetyzation – e.g. development of *Frangula alnus*, usually caused by clearing as a result of selective cutting or introduction of species with open-work crown like *Betula pendula* [Olaczek, 1972].
6. Frequent appearance of forest edges terophytes like *Impatiens parviflora* [Brzeg, Krotoska, 1984] – geranietyzation. Thus, it is also species of alien origin which is permanently established in natural phytocoenoses, so this process at the same time is neophytization. It is caused by cultivation of single-species tree stand and their thinning as well as the occurrence of margin effect.
7. The excessive development of expansive grassy species in herb layer like: *Carex brizoides, Deschampsia flexuosa* - cespityzation, resulting in considerable decrease of species richness. This form of degeneration is associated with thinning and ground overdrying [Sierka, 2002].
8. Penetration of species from other plant communities e.g. meadow species [Żmuda, 1973].
9. Contribution of wide-tolerant species to the plant community like *Pteridium aquilinum* - eurytopization [Żmuda, 1973]. This is the effect of disturbance of ecological balance in the phytocoenosis and decrease in competitiveness of species being characteristic elements for the plant community.

Further exploitation of mixed coniferous community may probably lead to intensification of processes of degeneration including change of phytocoenosis [Faliński, 1966].

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