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Changes of ecologicals conditions and factors in peak spruce stands of the 7 altitudinal vegetation zone

J. Nič

Doc. Ing. Juraj Nič, PhD, Katedra fytológie, Lesnícka fakulta, Technická univerzita vo Zvolene, Masarykova 24, Slovenská republika, e-mail: nic@vsld.tuzvo.sk

Abstract: Nič, J. 2008: Changes of ecologicals conditions and factors in peak spruce stands of the 7 altitudinal vegetation zone. – *Beskydy,* 1 (1): 71–76

Natural spruce stands of the Low Tatras and Poľana consist of communities of the 6th and the 7th altitudinal vegetation zone, mainly of the group of the forest type /gft/ *Sorbeto Piceetum /SP/.* In the year 2006, the repeated phytocoenological research was carried out on 48 areas under monitoring. These areas were founded in the year 1982. The goal of the research was to evaluate quantitative and qualitative changes of basic phytocoenoses, changes of abudance and dominance parameters of shelterwood synusia complex and changes of basic ecological factors as well /light, temperature, continentality, moisture, soil acidity and content of nitrogen in soil/. At the same time we have also evaluated the change of diversity of individual taxa in the examined communities. The results pointed out that the communities were heavily acidified during the period of last 24 years and this fact is manifested in the increase of dominant occurence of mesophytic acidophilic species and in the decline of mesotrophic species. The stands of the communities have been opened up considerably and this resulted in the decline of the genuine forest sciophytes. All these influnced diversity of individual taxa during the examined period of time.

Keywords: diversity of species, ecological analysis, group of the forest type *Sorbeto-Piceetum*

Introduction

Every ecosystem has its own principles of origin and development that results in its outside manifestation. The rapid development of civilization breaks ecosystem integrity, changes its dynamic structure and causes frequent ecological disorders. These result in the decline of many communities and the impoverishment of biosphere. That is the reason the impact of the changed ecological contitions to the health state of forest belongs to research priorities at the moment. Herbaceous synusia is one of the significant bioindicators for medium up to longdated changes of ecosystem. It is more dynamic in comparison with synusia of tree species. If we take into consideration its bigger dependence from factors of surroundings, changes of intensity of its influence are more immediate. Problems of herbaceous synusia were studied by e.g. Ambros (1985, 1986), Jurko (1990), Ellenberg (1992) and others. According to the results of these authors, at the present time two illusory contradictory phenomenons, acidification and eutrophication, influence the vegetation. According to Ambros, Míchal (1992) the most significant stressors, synergistically with emisions, are at the present time: atmospheric deposition of heavy metals, increased concentration of ozone, nitrogene oxides, sulphur dioxide and other pollutants and increasing variability of meteorological situations as well.

Many of these factors are present mainly in the high mountains and that is why the subject of the research were the natural spruce stands situated in the 7th altitudinal vegetation zone in the Low Tatras and orographic unit Poľana.

We have chosen communities belonging to the group of forest type (gft) *Sorbeto-Piceetum* (*SP*), that are according to Hančinský (1972) the most frequent in these mountains, to observe ecological conditions.

In 1982 the network of 68 areas has been established in this gft. Forty eight of them have been identified in 2006. The phytocoenological research has been done on the restored areas again. The goal of the research was to evaluate the present situation and the stucture of the stands,

to evaluate the changes in abudance and dominance of types of shelterwood synusia complex and changes of ecological conditions during the period of previous 24 years as well.

Methodics and material

We have followed the methodics by (Križová, Nič 2001) during terrain works, establisment and analysis of areas of phytocoenological surveys. This methodics corresponds with methodics used in the year 1982 (Nič 1982). The same team took part in terrain works.The restored areas, according to Hančinský (1972), belong to forest types (ft) as follows:

7101 *Vaccinium myrtillus, Vaccinium vitis-idaea, Calamagrostis villosa, Homogyne alpina, Sphagnum girgensohnii*

7103 *Vaccinium myrtillus, Calamagrostis villosa, Homogyne alpina*

7106 *Luzula sylvatica, Vaccinium myrtillus, Oxalis acetosella, Homogyne alpina, Cicerbita alpina*

We have compared qualitative and quantitative changes of herbaceous synusia, species composition and similarities according to index I_s by Sörensen. Evaluation of ecological spectrum was done with the help of ecological analysis method by Nič (1985), comparing 6 basic ecological factors, (light, temperature, continentality, humidity, soil reaction and content of nitrogen in soil). We have used the program PHYTEC (Černušák, Černušáková (1989) for evaluation. We have evaluated changes of stands structure and changes of tree species distribution by comparing the present situation with the situation in the year 1982 and at the same time we have compared quality and species composition in the individual tree layers-stories (Zlatník, 1976). We have used methodics by Jurko (1990) for determination of ecological diversity.

Results

We have recorded the changes of the examined areas during the period of 22 years as follows:

Picea abies /L./ Karst., together with *Sorbus aucuparia* /L./ and *Acer pseudoplatanus* /L./ on the subdominant level, are of dominant representation in the species composition. We have concluded that the health situation of stand is not good. Approximately 32% of *P. abies* are attacked by red rot and most of them are becoming thinner in assimilatory organs. *S. aucuparia,* which represents the accompanying tree species for *P. abies* in this altitude is declining. We have found out 20% of dry deposition and 30% mainly in gft SP are heavily damaged by red deer browsing. *Fagus sylvatica* /L./ and *A. pseudoplatanus* that form subdominat stands are not full-grown trees. *F. sylvatica* is often damaged by late freezing. The natural drop-out of tree species from 140 up to 180 years old occur in stands, mainly *P. abies* from over dominant and dominant level. The stands become disconnected and opened up. The species composition is very low in the woody species layers 5_{1a} / height from 25 cm up to 1.3 m / and 5_{1b} / height up to 25 cm /, at some areas almost zero, though the natural rejuvenation of *P. abies* and partially *F. sylvatica* in the layer 5_2 / seedlings / is rich.

Herbaceous layer (tab. 1) of the examined areas, as far as the species are concerned, consists of 20–28 taxa of the examined forest types, whereby the total degree of coverage is 60–80%.

Mesophyte acidophilic species as *Vaccinium myrtillus, Deschampsia flexuosa, Calamagrostis arundinacea* and subalpine acidophilic species as *Homogyne alpina, Luzula sylvatica* are dominant in herbaceous synusia. *Athyrium distentifolium* together with sub mountainous species as *Prenanthes purpurea, Oxalis acetosella,* and *Maianthemum bifolium* in the forest type 7101.

The results of the ecological analysis pointed out that shade-loving species up to semishade-loving species dominate these communites, as far as the temperature is concerned, indicators of cold up to mild warm are applicable here, but on the other hand 50% of species are indifferent in the relation to this factor.

Suboceanic species dominate these communities, they like freshly humid soil that is heavily acidic or acidic and poor in the content of mineral nitrogen in soil.

Discussion

The period of 24 years starting by the foundation of areas and ending by their reproduction, provide enough material to evaluate the changes of spruce forest at the top forest boundary. The significant changes happened in the tree species composition and in the composition of synusia undergrowth as well.

We can conclude that there is a reduction of canopy and a fall of stand density in all areas. This corresponds with data by Ambros, Míchal (1992). Stands became more opened than in 1982 because stand density of all areas with the exception of ft 7106 fell down 15% and canopy 20%. Thirty % of spruces were lost due to natural dying from the above dominant level and dominant level. During the period of 24 years there was the transfer from the subdominant level to the dominant level or above dominant level but only in minimum so the total structure of stands became more simple. The natural rejuvenation of *P. abies, Abies alba (Mill.), S. aucuparia* and *A. pseudoplatanus* on the areas of the year 1982, in the tree species layers $5_{1a,}$ $5_{1b,}$ 5_2 that should have reached the

subdominant level, is not present. We have not examined the reasons of this situation therefore we can only presume that this is due to climate, red deer outbreak and high degree of vegetation coverage, mainly of humidestructive species and fern. All these have influnced the development of natural rejuvenation unfavourably.

We have found out the changes of herbaceous synusia as follows: in the communities there is the decline of sciophyt species *Luzula luzuoides, Oxalis acetosella, Stellaria nemorum* and hemisciophyt *Prenanthes purpurea, Cicerbita alpina, Doronicum austriacum,* there is the increase of fern cover and humidestructive species. There is higher occurence of fern mainly in ft 7101 at the upper forest boundary. We have also found out the changes in the species composition of phytocoenoses. Comparing the situation to the year 1982, some species are missing on the areas. For example: 6 taxa are missing in the forest type 7106, 7 taxa are missing in the forest type 7103, and 5 taxa are missing in the forest type 7101. The values of similarity index I_s are from 64% up to 68% and are considered to be significant for all forest types (tab. 2).

Tab. 1: The synthetic plant coenological table of the group of forest types Sorbeto-Piceetum. First columns represent mean species cover in per-cer second ones are species constancies

Forest type	7101				7103				7106			
Year	1982		2006		1982		2006		1982		2006	
Calamagrostis arundinacea	20,8	V	18,7	V	14,4	V	17,2	V	3,8	III	2,6	II
Calamagrostis villosa	11,8	V	13,6	V	18,7	V	20,6	V	16,8	V	17,2	V
Avenella flexuosa	1,9	V	1,8	V	2,4	V	2,8	V	0,6	V	0,3	III
Festuca ovina	.	.	.	.	0,04	II	.	.	.	.	.	.
Luzula luzuloides	4,3	V	6,7	V	1,2	V	3,9	V	.	.	0,01	I
Luzula sylvatica	6,5	V	7,4	V	8,7	V	9,1	V	12,8	V	12,6	V
Milium effusum	.	.	.	.	0,1	II	.	.	.	.	.	.
Poa chaixii	.	.	.	.	.	.	.	.	0,01	I	.	.
Athyrium distentifolium	3,4	III	3,8	IV	.	.	.	.	0,04	II	.	.
Adenostyles alliariae	0,02	II	.	.	.	.	.	.	1,2	III	0,8	III
Campanula rotundifolia	.	.	.	.	0,01	I	.	.	.	.	.	.
Chamaerion angustifolium	.	.	.	.	0,01	I	.	.	.	.	.	.
Cicerbita alpina	0,01	I	.	.	.	.	.	.	1,4	II	1,2	II
Doronicum austriacum	.	.	.	.	.	.	.	.	2,3	II	2,2	II
Dryopteris filix-mas	6,8	V	6,4	V	1,2	II	3,7	III	2,4	II	3,1	III
Dryopteris spinulosa	3,2	III	7,6	IV	.	.	0,01	I	.	.	.	.
Fragaria vesca	.	.	.	.	0,01	I	.	.	.	.	.	.
Gentiana asclepiadea	1,2	IV	1,4	IV	1,4	V	1,5	III	1,7	III	1,3	III
Hieracium sylvaticum	.	.	.	.	0,01	I	.	.	.	.	.	.
Homogyne alpina	16,2	V	.	.	18,4	V	20,8	V	19,4	V	20,3	V
Hypericum maculatum	.	.	.	.	.	.	.	.	0,01	I	.	.
Maianthemum bifolium	0,2	V	.	.	.	.	.	.	0,1	IV	.	.
Oxalis acetosella	6,2	V	7,4	IV	8,4	V	9,2	V	9,1	V	7,3	IV
Phyteuma orbiculare	.	.	.	.	.	.	.	.	0,01	I	.	.
Polygonatum verticillatum	1,2	V	1,3	IV	1,4	V	1,2	IV	0,8	IV	1,4	III
Prenanthes purpurea	4,2	V	3,8	IV	5,8	V	4,3	V	5,2	V	4,6	V
Rubus idaeus	1,8	IV	2,7	IV	2,2	IV	3,8	IV	4,8	V	5,4	V
Senecio nemorensis	1,4	III	1,9	IV	1,9	IV	2,1	IV	2,7	IV	3,8	IV
Soldanella hungarica	0,9	IV	1,2	IV	0,8	V	0,9	V	0,7	V	0,4	III
Stellaria nemorum	.	.	.	.	.	.	.	.	0,01	IV	.	.
Vaccinium myrtillus	28,6	V	32,4	V	29,4	V	33,4	V	19,7	V	22,5	V
Vaccinium vitis-idaea	1,3	III	2,2	IV	2,3	IV	2,8	IV	0,8	III	0,2	II
Valeriana tripteris	.	.	.	.	.	.	.	.	.	.	0,01	I
Veratrum lobelianum	0,01	I	.	.	0,01	I	.	.	0,7	IV	0,02	I
Pleurozium schreberii	2,8	V	3,6	V	1,2	III	1,4	III	0,5	II	0,01	I
Rhytidiadelphus triquetrus	3,5	V	3,8	V	2,6	III	3,6	III	.	.	.	.
Sphagnum girgensohnii	14,8	V	15,8	V	0,7	II	0,8	II	.	.	.	.

Tab. 2: McNaughton´s index of dominance Cn, Hill´s index of diversity N2, Shannon-Weaver´s index of diversity H. Is is average Sörensen´s similarity index of plant communities comparing relevés from 1982 and 2006

FT	year	Cn	N2	H
	1982	27.8	1.52	1.75
7101	2006	24.4	1.14	1.68
	1982	23.8	1.72	1.96
7103	2006	22.1	1.65	1.91
	1982	30.1	2.02	2.52
7106	2006	31.5	1.42	2.61

Tab. 3: Ecological spectrum of the forest types (FTs) according to light (L), temperature (T), continentality (C), moisture (M), reaction (R), and nitrogen (N)

FT	year	L	T	C	M	R	N
7101	1982	4.34	3.85	3.96	5.84	2.43	2.34
	2006	5.62	3.88	3.98	5.87	2.15	2.23
7103	1982	4.22	3.63	4.15	5.96	2.65	2.65
	2006	5.01	3.67	4.14	5.95	2.27	2.33
7106	1982	4.39	3.76	4.01	5.74	2.79	2.86
	2006	5.56	3.78	4.08	5.77	2.24	2.65

There is the expressive increase of number and cover of mesophyte acidifiable and subalpine species. On the other hand while comparing the year 1982 there is the absence of subalpine eutrophic species ft 7106.

Index of dominance C_n (McNaughton) according to the evaluation scale is low in all ft (tab. 2). Hill`s index of diversity N_2 points out that there is the decrease of absolute values at all ft. According to Jurko (1990) these decreases are not significant because they do not represent the transition of one degree to another one. Shannon index H, that is sensitive for number and coefficient of all species and partially for dominants,has low values at analysed communities (ft 7101, 7103), low values up to medium at (ft 7106).

The results of ecological analysis have pointed out that the during the followed period of time three ecological factors have changed: light, soil reaction and content of nitrogen in soil. As far as the relation to light is concerned synusia of undergrowth indicates the increase of light uptake (decline of true forest sciophytes), the higher composition of hemiheliophytes, mainly humidestructive species (tab. 3). The main reason for that is opening up of stands by natural root kill and the loss od asimilation organs at *P. abies* as well. The differences of values of the average ecological number are from 0.79 at ft 7103 up to 1,28 at ft 7101 for this ecogical factor.

All forest types became soil acidified that fully corresponds with the results by Ambros, Míchal (1992) and Nič (1985, 1999, 2002). At the same time the decrease of the average ecological number of soil reaction was accompanied with the decrease of average ecological number of nitrogen. This entitles us to conclude that there are correlation relations between acidity and trophic level as mentioned by Jurko et al.(1981). Though we have no results of soil analysis form forested area, with regard to very similar reaction of herbaceous synusia it is possible to conclude that the examined territories are under acidification influence of air pollution.

Conclusions

It is possible to conclude after analysing natural spruce stands in the chosen mountains of Slovakia as follows:

During the period of 24 years the examined areas have changed in stand density, canopy density, tree species composition and structure of stands. The stands are more irregular, their health state has turned worse and the natural rejuvenation is minimal.

There is the cover increase of species indicating soil acidity, there is the decline of true forest sciophytes and there is the increase of cover and number of humidestructive species in stand synusia. The results of ecological anylysis have pointed out that there are the most significant changes at three eclogical factors: light, soil reaction and content of nitrogen in soil. But changes of soil reaction are especially significant thus pointing out the increase of soil acidity. All these approve us to conclude that the examined areas are under acidification influence of pollutant load.

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