Succesional development of vegetation on permanent plots in the High Tatra Mts

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Abstract

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This paper deals with development of vegetation in the High Tatra Mts, following the wind storm on November 19, 2004. The issue has been discussed with data acquired from permanent plots established for this purpose on various windfall-affected sites allowing comparing among effects of various management treatments. The research plots series consists of a control plot unaffected by the windstorm (REF), a plot which the windthrown timber has been removed from (EXT), six plots affected by fire (FIR), a plot with windthrown timber, left to self-development (NEX), and a hydrologically managed plot (WTR). On these plots, phytosociological relevés were recorded from 2005 to 2008. The data were subjected to table analysis with using the Braun-Blanquet approach, and statistically processed with the CANOCO software. The communities were compared through PCA and CCA analyses. PCA has resulted in indicating as the most similar sites REF and NEX with typical forest plant species associated with moist, shady and cool sites, and acidic, nutrient-poor soils. The sites FIR, EXT and WTR showed opposite tendencies. Conditions typical for these sites were preferred by species indicating sunny and warm sites, richer in nutrients.

Keywords

CCA, Ellenberg indicator values, High Tatras Mts, PCA, succession, windfall

Introduction

For several decades, long-term changes in vegetation have become of considerable importance in ecological research, both theoretical and applied. An ecological succession is characterised by a distinctive course of structural and functional changes, as defined by Odum (1977) and other authors. A succession comprises several stages: initial, early, medium, and climax – forming a successional series. Individual stages differ in the species composition, spatial structure and environmental conditions (Križová et al., 2001). The development of vegetation after disturbances of forest ecosystems has been studied by several authors. Fischer (2002), for example, reports results from research plots established in 1988 in the Bavarian forest affected by windstorm. Neuhäuslová and Wild (2001) describe communities with dominant *Calamagrostis villosa* that represent the most common woodland clearing vegetation. Results of the research performed on the windfall plots in the High Tatras Mts were reported also by Šoltés et al. (2008). Papers devoted to vegetation dynamics emphasize the importance of herb vegetation as the bioindicator of medium-term and long-term changes in the forest ecosystems (Križová, 1996).

Material and methods

The initial data on permanent plots (Table 1) and phytocenological relevés recorded in 2005 and 2006 were taken over the from paper Šoltés et al. (2008). In 2007 and 2008, we collected phytosociological relevés from the same permanent plots (PPs) 20 × 20 m in area. The plots have been labelled as follows: REF – plot unaffected by the windstorm; EXT – wind-affected plot, windthrown timber removed; FIR – six plots affected by the fire, and NEX – wind-affected plot, windthrown timber kept – left to self-development; WTR – hydrologically managed plot (water was accumulated by little barriers), windthrown timber removed.

Phytosociological relevés on the above mentioned plots were made annually in July. Abundance and dominance of species were evaluated with the modified Braun-Blanquet scale (Barkman et al., 1964). The nomenclature follows Marhold and Hindák (1998). Phytosociological data were processed by table analysis (Braun-Blanquet, 1964). For the synthesis, however, was selected only the FIR site, plot 4 (Table 1), because this plot was the most similar to the other study plots in site conditions. There were processed herb layer species, moss layer species and woody plants up to 1.5 m in height from the natural regeneration. In the next step were applied Principal components analysis (PCA) and Canonical correspondence analysis (CCA), the CANOCO for Windows software (Ter Braak and Šmilauer, 1998) working with the percentage of species cover. The results were interpreted through ecological factors (light, temperature, continentality, soil reaction and nutrients) calculated as Ellenberg´s indicator values (EIV) (Ellenberg et al., 1992).

Results and discussion

In comparison with the other plots, changes on the REF plot were slow and successional. The herb layer (including regenerated woody plants) consisted of species typical for the natural larch-spruce forest communities (group of forest types Lariceto-Piceetum): *Sorbus aucuparia, Picea abies, Larix decidua, Vaccinium myrtillus, Avenella flexuosa, Calamagrostis villosa, Maianthemum bifolium, Luzula sylvatica, Oxalis acetosella, Vaccinium vitis-idaea, Dryopteris dilatata, Melampyrum sylvaticum* and abundant moss layer. On the other hand, mosses, namely *Ptilium crista-castrensis, Polytrichum commune, Blepharostoma trichophyllum, Dicranum montanum*, *Hylocomnium splendens* and *Plagiomnium affine* were either missing or occurred very rarely on the other PPs (EXT, WTR, NEX, FIR). In the E_1 layer on REF plot, *Dryopteris filix-mas, Homogyne alpina, Gentiana asclepiadea, Trientalis europaea* were differential species missing on the other plots. The phytosociological Table 2 shows development of species composition and percentage on particular plots from 2005 to 2008, and the floristic differentiation of the plots. The NEX plot was the least floristically differentiated, and it was the most similar to the control REF plot. The significant increase in species diversity on the other PPs (EXT, WTR, FIR) was caused by the occurrence of clear-cut species and other heliophilous species such as *Chamerion angustifolium, Senecio viscosus, Taraxacum officinale, Senecio nemorensis* agg.*, Hieracium murorum, Rumex acetosella, Calamagrostis arundinacea, Veronica officinalis, Carex leporina,* pioneer tree species *Betula carpatica, Salix caprea*, and others. The above mentioned species were either missing or occurred very rarely on the control plot (REF). Some of them were found on the NEX site. Within the last two years, the expansion of *Calamagrostis villosa* was recorded on each plot (except of the FIR plot).

The results of PCA analysis (Fig. 1) showed the tendency of common occurrence of species and the floristic similarity of plots. The dependence of species on light, temperature and nitrogen content in soil is evident. The intensity of the above mentioned factors was influenced by management treatments. According to the second principal axis in the Figure 1, the typical forest species (herbs, mosses, and woody plants) such as *Vaccinium myrtillus, Vaccinium vitis-idaea, Maianthemum*

Table 1. Plots (20 × 20 m) established in 2005 and 2006 by the Research Station of TANAP (The High Tatras National Park)

Research site	Plot [No]	Locality	N	E	Altitude [m]	Inclination	Aspect
REF	1	Smrekovec	49º07.29'	20º06.23'	1,228	3º	S
EXT	2	Danielov dom	49º07.28'	20º09.77'	1,065	5º	S
FIR	4	Tatranské zruby	49º07.82'	20º11.80'	1,081	3°	S
	5	Tatranské zruby	49º07.95'	20º11.54'	1,071	10º	E
	6	Tatranské zruby	49º08.30'	20º10.93'	1,239	10º	E
	7	Tatranské zruby	49º08‘03'	20º12,11'	1,020	3º	S
	8	Tatranské zruby	49º08.20'	20º11.80'	1,074	10º	E
	9	Tatranské zruby	49º08.47'	20º11.55'	1,196	7º	EES
NEX	10	Jamy	49º09.57'	20º15.19'	1,196	10º	S
WTR	3	Horný Smokovec	49º08.77'	20º14.30'	1,109	10º	S

Table 2. Table of phytocenological relevés recorded in 2005–2008 on plots with different management treaments. Species covers are given in percentage.

Plots	REF				NEX				WTR				EXT				FIR			
Years	05	06	07	08	05	06	07	08	05	06	07	08	05	06	07	08	05	06	07	08
Dryopteris filix-mas	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prenanthes purpurea	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ptilium crista-castrensis	3	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polytrichum commune	3	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharostoma trichophyllum	3	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Homogyne alpina	3	4	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gentiana asclepiadea	1	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trientalis europaea	3	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum montanum	3	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiomnium affine	3	3	3	3	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.
Urtica dioica	3	3	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2	2	2
Plagiothecium laetum	3	3	3	2	3	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.
Pleurozium schreberi	68	68	68	64	1	1	1	3	.	.	.	.	38	.	.	.	2	.	.	2
Sphagnum capillifolium	3	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicranum scoparium	18	18	18	18	4	4	1	3	2	2	.	.	1	.	.	2	2	.	.	.
Taraxacum officinale	1	3	3	2	.	.	.	.	.	2	2	2	.	1	1	.	.	2	2	2
Melampyrum sylvaticum	3	4	4	4	.	.	.	.	1	2	.	2	3	1	1	2	.	.	.	.
Dryopteris dilatata	3	3	3	3	.	3	3	2	.	.	2	2	1	3	3	.	.	.	.	.
Hylocomium splendens	38	38	38	38	4	4	4	3	2	2	.	.	3	.	.	.	.	.	.	.
Vaccinium vitis-idaea	3	.	3	2	.	.	.	.	.	2	2	2	3	3	3	2	.	.	.	.
Sorbus aucuparia	3	3	3	.	.	.	3	2	2	3	3	3	3	3	3	2	.	.	.	.
*Picea abies**	4	4	8	8	1	4	1	3	3	3	3	3	3	3	3	3	.	.	.	.
Vaccinium myrtillus	68	68	68	88	68	68	68	38	18	18	18	18	18	4	8	8	2	2	2	2
Avenella flexuosa	3	8	18	38	8	18	68	38	2	18	18	18	3	18	18	18	2	3	2	2
Calamagrostis villosa	8	18	38	18	3	68	86	88	3	38	68	64	18	68	68	64	2	8	8	8
Maianthemum bifolium	3	3	3	3	1	3	3	3	4	4	4	4	3	3	3	2	.	2	2	2
Luzula luzuloides	3	3	3	2	1	1	1	3	.	2	2	2	3	3	3	2	2	2	2	2
Oxalis acetosella	8	8	8	38	1	4	3	3	.	.	.	.	1	3	.	.	.	.	.	.
Picea abies•	18	18	18	.	4	1	.	.	.	.	.	.	3	3	3	.	.	.	.	.
Chamerion angustifolium	.	.	3	2	.	3	1	3	.	3	18	38	3	4	38	38	.	8	88	88
Larix decidua	.	.	3	2	.	.	.	2	.	2	.	.	.	.	.	.	.	.	.	.
Carex species	.	.	.	2	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Solidago virgaurea	.	.	.	2	.	.	.	.	.	.	.	.	3	1	1	.	.	.	.	.
Rubus idaeus	.	.	.	2	.	.	3	2	.	2	2	3	.	3	3	2	.	3	3	3
Calluna vulgaris	.	.	.	.	3	3	3	2	.	2	.	3	.	3	3	2	.	2	2	2
Dicranella heteromalla	.	.	.	.	.	3	3	2	.	.	.	.	.	.	.	.	.	.	2	2
Veronica officinalis	.	.	.	.	.	3	.	2	.	.	.	2	.	.	.	.	.	2	2	2
Carex leporina	.	.	.	.	.	3	4	.	.	.	.	2	1	.	.	.	.	.	.	.
Betula carpatica	.	.	.	.	.	.	3	2	.	.	.	3	.	.	.	.	.	.	.	.
Salix caprea	.	.	.	.	.	.	3	2	.	.	.	3	.	.	.	.	.	.	2	2
Mycelis muralis	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2	2
Populus tremula	.	.	.	.	.	.	.	.	2	.	.	2	.	.	.	.	3	4	18	2
Calamagrostis arundinacea	.	.	.	.	.	.	.	.	.	2	2	18	3	3	38	18	2	3	3	3
Hieracium murorum	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	2
Senecio viscosus	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2
Rumex acetosella s.lat.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	.
Sambucus racemosa	.	.	.	.	.	.	.	.	.	.	3	3	.	1	1	2	.	2	4	4
Carex tomentosa	.	.	.	.	.	.	.	.	.	.	8	8	.	.	3	4	.	.	.	.
Senecio nemorensis agg.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	2	.	.	1	1
Polytrichum formosum	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2
Viola reichenbachiana	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	.	.	.	.	.
Senecio sylvaticus	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	.	.	2	2	.
Carex digitata	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Cirsium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
Cirsium eriophorum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
Epilobium montanum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	.	2	2	2
Hypericum maculatum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	.	.	.	.
Galeopsis tetrahit	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.
Trifolium repens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.

Species not included in the table: *Juncus effusus* WTR/06,08:2, *Carex sylvatica* WTR/06:3, *Luzula multiflora* WTR/06:2. *Polygonum aviculare* EXT/06, 07:1, *Salix silesiaca* EXT/08:2, *Acer pseudoplatanus* WTR/07:1, *Atrichum undulatum* NEX/07:3, *Cladonia digitata* REF/08:2.
Abbreviations: *Height up to 1.5 m. •Height above 1.5 m.

bifolium, Melampyrum sylvaticum, Oxalis acetosella, Prenanthes purpurea, Avenella flexuosa, Gentiana asclepiadea, Homogyne alpina, Trientalis europaea, Ptilium crista-castrensis, Polytrichum commune, Blepharostoma trichophyllum, Dicranum montanum, Hylocomium splendens, Plagiomnium affine, Picea abies and *Larix decidua* and others had the optimum on the REF plots (Table 2). These species are typical for relatively moist, shady and cool sites with acidic, nutrient-poor soils. The NEX plot was very similar to the REF plot, regardless of the absence of its 'own' typical species. As for the second principal axis, WTR, EXT and FIR plots showed the contrary position – with light and temperature as significant factors. The species on the FIR plot indicated sunny and warm sites with higher contents of nutrients (including nitrogen) and soil reaction. These communities included species as *Chamerion angustifolium, Veronica officinalis, Rubus idaeus, Taraxacum officinale, Urtica dioica, Senecio viscosus, Senecio nemorensis* agg.*, Senecio sylvaticus, Trifolium repens, Galeopsis tetrahit, Epilobium montanum, Cirsium eriophorum, Cirsium arvense* and pioneer woody plants (*Sambucus racemosa, Salix caprea, Populus tremula*). *Calamagrostis villosa* manifested a special status. This characteristic species of indigenous communities responded to the better light conditions by expansive spreading on all the disturbed plots except the FIR plot (Table 2).

Based on the mean EIV (Table 3), we can assess significant changes in efficiency of principal ecological factors indicated by herb species on particular sites. The change in mean EIV by 0.5 is considered as a significant alteration according to Jurko et al. (1981). Succesional changes on the REF plot were not significant. On the NEX plot, significant changes of EIV were found in relation to light (+0.63) and moisture (+0.93) – due to the increase of *Calamagrostis villosa* cover. Significant increases of light (up to +1.82 of the EIV), soil reaction (+0.93) and nutrients (+1.59) were recorded on the WTR plot. Significant increases of light (+1.09), soil reaction (+0.51) and content of soil nutrients (+0.79) were found on the EXT plot. On the FIR plot, the herb layer indicated the highest light increase and the highest increase in the mean light value (+1.84). For the soil reaction, we also found an increase (+1.57). But the highest increase was recorded for nutrients (+3.37). A decrease (–0.56) was recorded only in case of moisture indicator value. Light was the factor with the most pronounced influence. In addition to direct effect on the vegetation, light significantly affects the process of litter biodegradation. Such

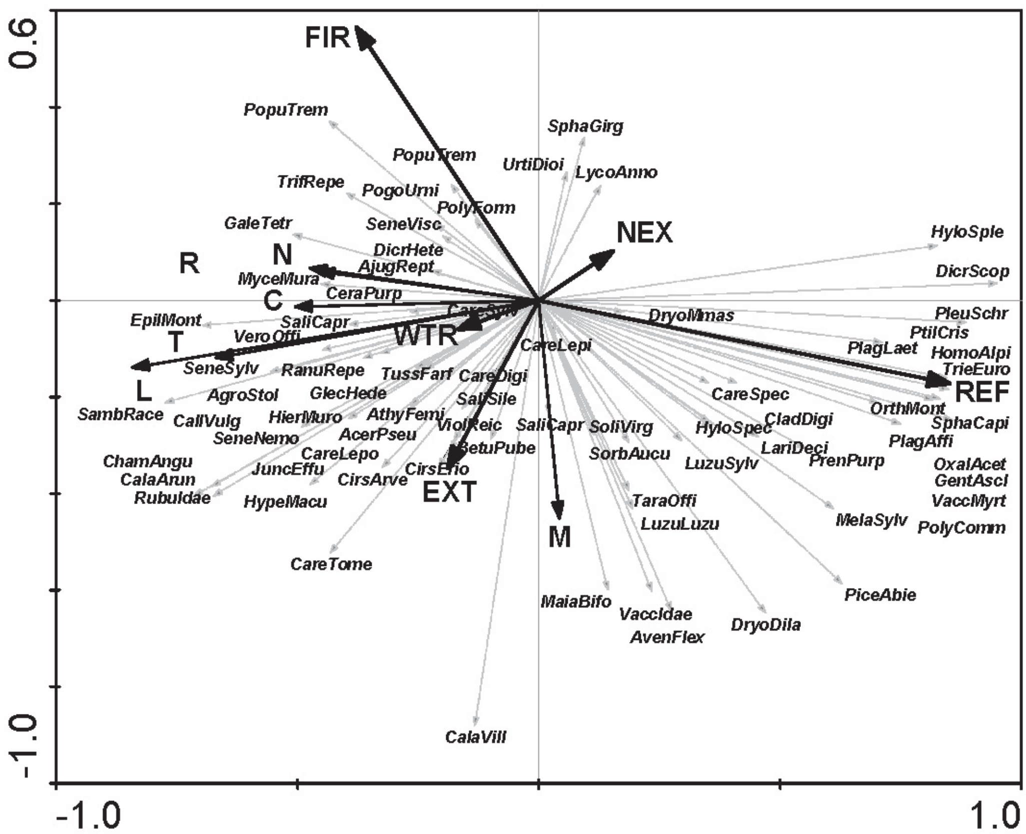

Fig. 1. PCA with supplementary variables indicating relations among plant species, environmental factors and differrent management treatments (T – temperature, R – soil reaction, C – continentality, M – moisture, N – nutrients, L – light).

factors such as the soil reaction value and the nutrients (nitrogen) content are also indirectly affected by light. The results of Ellenberg indicator value analysis confirmed the results obtained by PCA and CCA (Table 3).

Six permanet plots established on the FIR site were subjected to CCA analysis. We expected the most intensive succesional changes from the initial stage, as the vegetation cover was completely destroyed by the fire (in August 2005). The 'year' was used as the predictor, whereas mean EIV for light, temperature, continentality, moisture, soil reaction, nutrients and years (2005, 2006, 2007, 2008) were used as supplementary variables. Monte Carlo permutation test serving as tool for assessment of the predictor statistical significance showed that the variable "year" was significant. The level of significance P was 0.002, the species-data variation λ was 15%. To obtain a simpler, better readable graph, we selected a 5% threshold weight for each species (Fig. 2). Figure 3 shows only the species with the highest change rate from 2005 to 2008. This figure clearly indicates the time gradient of the species occurrence. The scores on principal axes determine the species optimum in relation to the predictor 'year' and to the supplementary variables. In 2005, several forest species with relatively higher moisture demands were the most frequent on this site, such as *Avenella flexuosa, Vaccinium myrtillus* and *Calamagrostis villosa*. In 2006, such species as *Epilobium montanum, Senecio sylvaticus, Galeopsis tetrahit, Taraxacum officinale, Urtica dioica, Tussilago farfara,* and *Cirsium arvense* appeared.

In 2007, the most significant increase in the coverage was found for *Chamerion angustifolium*. The cover of other humidestructive species as well as some forest species such as *Rubus idaeus, Veronica officinalis*, *Senecio nemorensis, Hypericum maculatum, Scrophularia nodosa, Mycelis muralis, Carex ovalis, Carex tomentosa, Calluna vulgaris*, *Maianthemum bifolium, Luzula luzuloides* and *Sambucus racemosa* increased too. When comparing year 2008 with the preceding year, no significant changes were recorded.

A detailed research on these sites was carried out also by botanists of the Research Station of TANAP (Šoltés et al., 2008). These authors found the most significant changes to the herb-layer on the FIR site – due to destructed herb layer, and patches of damaged organic litter. In the next years, the disappearance of *Chamerion angustifolium* and the appearance of nitrophilous vegetation of *Sambucus racemosa* and *Rubus idaeus* were recorded. Our findings from other sites related to the increase in species coverage are consistent with the results reported by Šoltés et al. (2008). The similar research is also performed in the Czech Republic with comparable conclusions. That research is focussing

Table 3. Mean EIV of environmental factors on permanent plots for period 2005–2008

Plot	Year	L	T	C	M	R	N
REF	2005	4.16	4.15	3.68	5.59	3.24	3.82
REF	2006	4.86	4.09	3.63	5.88	2.95	3.35
REF	2007	5.30	4.06	3.59	6.13	2.73	3.20
REF	2008	4.26	4.06	3.08	5.54	2.98	4.02
NEX	2005	5.17	4.00	3.00	5.75	2.35	2.91
NEX	2006	5.74	4.00	3.61	6.65	2.24	2.72
NEX	2007	5.90	4.09	3.21	6.61	2.21	2.68
NEX	2008	5.80	4.04	3.42	6.68	2.17	2.71
WTR	2005	4.60	4.00	4.50	5.75	2.40	2.60
WTR	2006	5.81	4.18	3.54	6.15	2.47	2.98
WTR	2007	6.18	4.24	3.92	6.34	3.02	3.39
WTR	2008	6.42	4.37	4.08	6.05	3.33	4.19
EXT	2005	5.33	4.11	3.93	5.93	2.73	3.36
EXT	2006	5.76	4.08	3.64	6.43	2.52	3.14
EXT	2007	6.33	4.40	3.98	5.91	3.34	4.29
EXT	2008	6.42	4.28	4.05	6.01	3.24	4.15
FIR	2005	5.50	4.33	3.00	5.67	3.00	3.50
FIR	2006	6.41	4.20	3.88	5.67	3.76	4.93
FIR	2007	7..36	4.39	4.65	5.19	4.63	6.94
FIR	2008	7.34	4.61	4.65	5.11	4.57	6.87

L – light, T – temperature, C – continentality, M – moisture, R – soil reaction, N – nutrients.

on communities with dominant species *Calamagrostis villosa* at clearings of mountain ranges in spruce and spruce-beech forests in the Czech Republic (Neuhäuslová and Wild, 2001). In the Junco effusi-Clamagrostietum villosae association, the authors found the herb layer divided into two sublayers. In the upper sublayer dominated *Calamagrostis villosa* with admixture of ferns (*Athyrium distentifolium, A. filix-femina* and *Dryopteris dilatata*), higher plants (*Chamerion angustifolium, Senecio hercynicus, S. ovatus*) and scrubs (*Vaccinium myrtillus, Rubus idaeus*) or *Juncus* species. In the lower sublayer, *Avenella flexuosa* dominated. On some localities, *Oxalis acetosella* and *Trientalis europaea* were dominant species. In juvenile stands (up to 5 years of age), remnants of synanthropic vegetation occurred, but they disappeared during the course of succession. According to our results, the distinct vertical stratification and high fern cover in the High Tatras Mts had not been developed until 4 years after the disturbation. Strong competition between the dominant species is in progress. *Chamerion angustifolium* is owergrowing *Calamagrostis villosa* in some places.

Conclusions

Based on the obtained results, it can be concluded that the initial successional changes on the studied sites occurred just in 2006, but the most significant changes to the vegetation were found in the third year after the windstorm disturbance (in 2007).

The site affected by the fire (FIR) was occupied predominantly by heliophilous, nitrophilous and humidestructive species such as *Chamerion angustifolium, Veronica officinalis, Rubus idaeus, Urtica dioica, Senecio viscosus, Senecio nemorensis* agg., *Senecio sylvaticus* and others species. The EXT plot from which the windthrown timber had been removed was progressively colonised by *Calamagrostis villosa* and other species such as *Calamagrostis arundinacea*, *Calluna vulgaris, Ajuga reptans, Galeopsis tetrahit, Trifolium repens Epilobium montanum, Cirsium eriophorum, C. arvense* or pioneer tree species (*Sambucus racemosa, Salix caprea, Populus tremula* and others). Changes found on the NEX plot with the lying timber, left to self-development, were less intensive. This site was floristically most similar to the control REF plot. No spreading nitrophilous species were found on the REF plot. The characteristic species for this plot are e.g. *Picea abies, Vaccinium myrtillus, Avenella flexuosa, Calamagrostis villosa, Maianthemum bifolium, Luzula luzuloides, Oxalis acetosella* and *Dryopteris dilatata*. The moss-layer is abundant.

Natural regeneration of tree species was observed on each site. After initial absence of herb competition, *Populus tremula* had been established on the nitrogen-rich site (the FIR plots). On the other hand, *Picea abies* and *Sorbus aucuparia* were missing. In the last years,

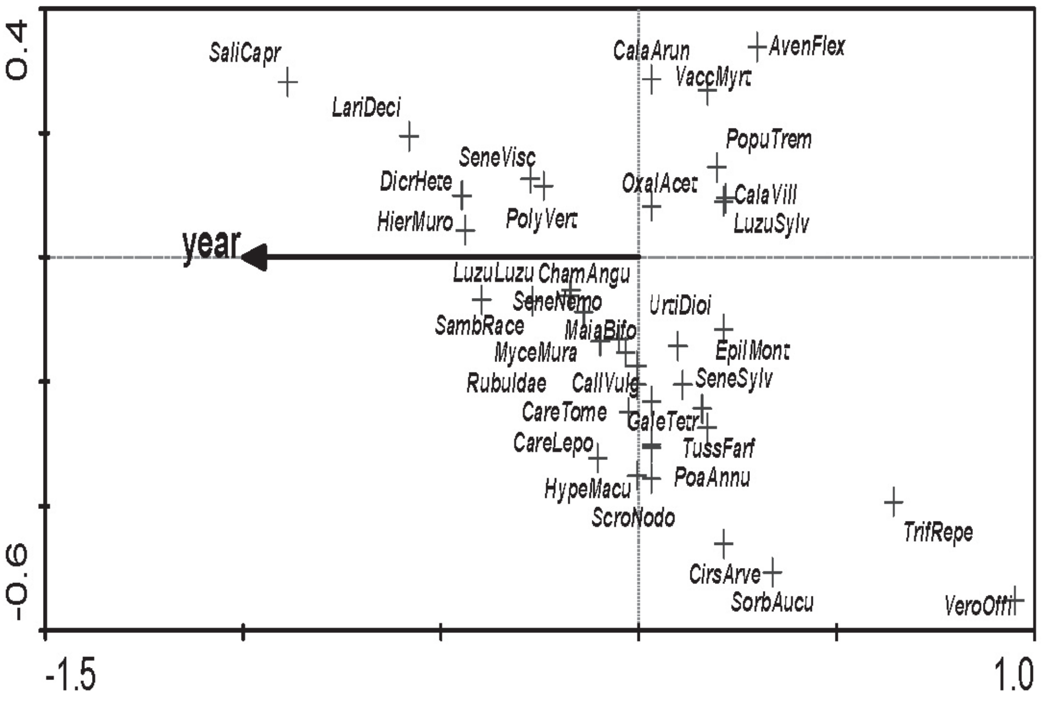

Fig. 2. Species response to temporal gradient on FIR plot. CCA, Monte Carlo test indicate relations of species to the variable 'year'. Species with weight less than 5% are not plotted.

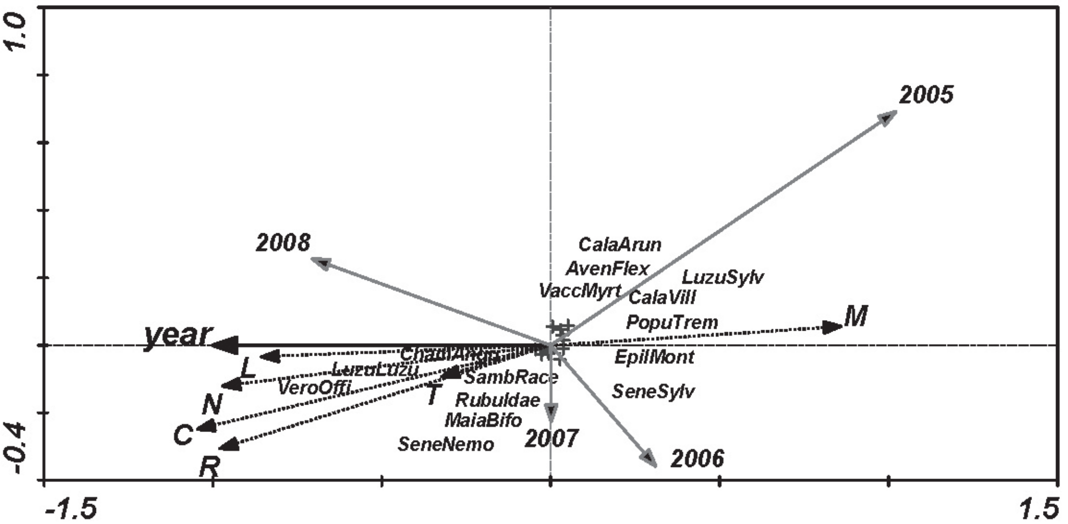

Fig. 3. Environmental changes on FIR plot according to mean Ellenberg indicator values in CCA. The predictor variable is "year" and supplementary variables are T – temperature, R – soil reaction, C – continentality, M – moisture, N – nutrients, L – light, sampling years 2005, 2006, 2007, 2008.

Sambucus racemosa has been spreading through the majority of sites. On the relatively moist sites, it has been *Betula carpatica*. An increase in moisture preferring species was observed on the hydrologically managed site (*Juncus effusus, Carex tomentosa, Luzula multiflora*).

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Sukcesný vývoj vegetácie na trvalo monitorovaných plochách vo Vysokých Tatrách

Súhrn

Práca podáva výsledky z trvalo monitorovaných plôch (TMP) na území po vetrovej kalamite z 19. novembra 2004 vo Vysokých Tatrách. Pre sledovanie dynamiky vegetácie boli založené TMP s rôznym manažmentom: referenčná plocha – REF, nepostihnutá kalamitou (Vyšné Hágy); plocha so spracovaným kalamitným drevom – EXT (Danielov dom); plocha postihnutá požiarom – FIR (Tatranské Zruby); plocha s nespracovaným kalamitným drevom, ponechaná na samovývoj – NEX (Jamy) a plocha s hydrologickým manažmentom WTR. Zo získaných výsledkov vidno, že zmeny vegetácie na sledovaných TMP sa začali prejavovať už v roku 2006, ale najvýznamnejšie zmeny vo vývoji vegetácie boli zaznamenané v roku 2007, a to najmä na plochách so spracovanou kalamitnou hmotou. Na ploche po požiari (FIR) prevládli svetlomilné, nitrofilné, humideštruktívne druhy, napr: *Chamaerion angustifolium, Veronica officinalis, Rubus idaeus, Taraxacum officinale, Urtica dioica, Senecio viscosus, Senecio nemorensis* agg., *Senecio sylvaticus* atď. Zatiaľ čo plochy s vyvezenými vývratmi expanzívne ovládol vlhkomilný a svetlomilný druh *Calamagrostis villosa* a ďalšie ako *Calamagrostis arundinacea*, *Calluna vulgaris, Ajuga reptans, Galeopsis tetrahit, Trifolium repens, Epilobium montanum, Cirsium eriophorum, Cirsium arvense)* a prípravné dreviny (*Sambucus racemosa, Salix caprea, Populus tremula)* a iné. Plocha ponechaná na samovývoj (NEX) bola čo do druhového zloženia najviac podobná porovnávacej ploche REF. V bylinnej etáži na NEX ploche prevažovali druhy pôvodného lesa, *Picea abies, Vaccinium myrtillus, Avenella flexuosa, Maianthemum bifolium, Luzula luzuloides, Oxalis acetosella, Dryopteris dilatata.* V dôsledku presvetlenia sa zvýšila pokryvnosť *Calamagrostis villosa.* Nitrofilné druhy a humideštruktívne druhy sa uplatňovali ojedinele.

Na všetkých plochách bolo zaznamenané aj prirodzené zmladenie drevín. *Populus tremula, Sambucus racemosa, Salix caprea* pri zmladzovaní na kalamitných plochách uprednostňujú presvetlené stanovištia obohatené dusíkom, zatiaľ čo napr. *Betula carpatica* preferuje vlhkejšie stanovištia. V zárastoch *Chamaerion angustifolium* vôbec nezmladzuje *Picea abies* a *Sorbus aucuparia*. Nárast vlhkomilnej vegetácie bol zaznamenaný na hydrologicky manažovanej ploche *(Juncus effusus, Carex tomentosa, Luzula multiflora*).

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